

SPECIFICATION

ANTIBACTERIAL TREATMENT DEVICE

TECHNICAL FIELD

The present invention relates to an antibacterial treatment device capable of applying antibacterial treatment to laundry using metal ions.

BACKGROUND ART

In performing washing with a washing machine, a finishing material is often added to water (particularly, rinsing water). As a finishing material, a softening agent or past agent is commonly used. In addition to this, there has been an increasing need to provide an antibacterial capability to the laundry by a finishing treatment.

It is desirable for hygienic reasons that laundry is dried in the sun. However, due to increasing women employment rate and nuclear families, there are increasing number of families where all family members are absent during the day. Such families have to dry laundry in a room. Even in families where somebody exists during the day, drying has to be performed in a room when it rains.

In the case of drying in a room, as compared with drying in the sun, laundry is prone to propagation of bacteria or mold. This tendency is pronounced when the drying of laundry requires a long time such as at high humidity or low temperature, for example, in rainy season. Laundry may generate a nasty smell depending on the propagation state. Therefore, in families where drying has to be usually performed in a room by necessity, it is strongly desired to apply an antibacterial treatment to laundry in order to suppress propagation of bacteria or mold.

Recently, there have been increasing cases where antibacterial-and-deodorization treatments or bacteria-controlling treatments are applied to fiber of clothes. However, it is difficult to select all domestic fabric articles from antibacterial-and-deodorization-treated articles. Further, the effects of antibacterial-and-deodorization treatments are degraded as washings are repeatedly performed.

Therefore, there has been suggested that laundry is antibacterial-treated each time washing is performed. For example, Japanese Patent Laid-Open Application Publication "JP-A-No. 5-74487" discloses a electric washing machine equipped with an ion generating apparatus for generating metal ions having antibacterial capability such as silver ions, or copper ions. Japanese Patent Laid-Open Application Publication "JP-A-No. 2000-93691" discloses a washing machine which disinfects washing liquid by generating an electric field. Japanese Patent Laid-Open Application Publication "JP-A-No. 2001-276484" discloses a washing machine equipped with a silver-ion-adding unit which adds silver ions to washing water.

Among methods for performing antibacterial treatments during washing processes, methods which utilize metal ions are effective and practical. Metal ions are eluted from an electrode at an anode side by applying a voltage between a pair of electrodes immersed in water. For example, in the case where the anode is formed from silver, the following reaction occurs; $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$. Thus, silver ions Ag^+ are eluted into the water. After dewatering, the metal (for example, silver) exists as ions and offers antibacterial effects until the laundry is dried. After the laundry is dried, silver exists as silver salt. However, if wetted again, the silver salt is re-ionized and restores the antibacterial capability. Namely, this means that an antibacterial coating has been applied to the surface of the laundry.

From above, it is concluded that an ion elution unit including a pair of electrodes enclosed in a case can be installed in a washing machine in order to apply an antibacterial treatment (antibacterial coating) to laundry. However, a washing machine includes various components placed inside thereof and therefore it is not easy to provide an installation space for the ion elution unit without increasing the size of the washing machine. Further, if antibacterial treatments are performed only with washing machines equipped with an ion elution unit, it can not be said that sufficient benefits are provided to consumers.

Further, the electrodes of the ion elution unit wear as they are continuously used and accordingly the amount of eluted metal ions decreases. Thus, when the ion elution unit has been used for a long time, the amount of eluted metal ions becomes unstable or a predetermined amount of eluted metal ions can not be ensured. Therefore, it is necessary to replace the entire ion elution unit which has been used for a long time or only the electrodes.

However, if the ion elution unit is incorporated into the washing machine, the replacement will require disassembling the washing machine, which would be a burdensome operation for users. In order to lessen user's efforts required for the operation, it is possible to provide an access opening for putting the ion elution unit in and out of the washing machine. However, this will increase the complexity of the construction of the washing machine, thereby increasing the manufacturing cost.

DISCLOSURE OF THE INVENTION

The present invention is made in view of the above circumstances. It is an object of the present invention to enable easily combining an ion elution unit for eluting metal ions in water for applying antibacterial treatments to laundry with a washing

machine with a conventional construction and using it. Also, it is an object of the present invention to enable easily replacing the ion elution unit.

Namely, it is an object of the present invention to realize a feed-water apparatus equivalent to a feed-water apparatus equipped with an ion elution unit, even when the feed-water apparatus (washing machine) is not originally equipped with an ion elution unit for generating metal ions.

In order to attain the aforementioned objects, the present invention suggests an antibacterial treatment device having the following constructions.

(1) The antibacterial treatment device comprises an ion elution unit which generates metal ions by applying a voltage between a pair of electrodes and a power supply unit for the ion elution unit, wherein the ion elution unit has a case including an inlet for connecting a feed-water hose thereto and an outlet which is detachably communicated with and connected to a feed-water valve of a washing machine.

According to this configuration, the ion elution unit is retrofitted to the feed-water portion of the washing machine, and a washing machine with a conventional construction may be employed. Namely, an existing washing machine can be changed to a washing machine having antibacterial treating functions. Further, the replacing operation of the ion elution unit after long-use is extremely easy.

(2) The antibacterial treatment device comprises an ion elution unit which generates metal ions by applying a voltage between a pair of electrodes and a power supply unit for the ion elution unit, wherein the ion elution unit includes a case which is at least partially immersible in water, and this case includes, at the water-immersible portion, a water-flow opening for supplying water to the electrodes.

According to this configuration, the case of the ion elution unit is immersed in water to introduce water into the case through the water-flow opening to cause the

elution of metal ions. Therefore, there is no need to provide a specific configuration for mounting or holding the ion elution unit. Further, there is no need for connecting a feed-water hose to the ion elution unit. Further, since the ion elution operation is performed in water pooled in the washing bath, uniform ion-containing water can be generated. Consequently, metal ions uniformly adhere to laundry, thereby providing uniform antibacterial effects. Further, in the event that the performance of the ion elution unit is degraded due to long-use, it is only necessary that the old unit is discarded and a new unit is used. Thus, no effort is required for replacing the unit.

Further, the ion elution unit can be immersed in water not only within the washing bath of the washing machine. Since any container which can accommodate the case of the ion elution unit may be utilized, it is possible to generate metal ion-containing water using a bucket, basin, cup, etc. Therefore, when there is a need to apply the antibacterial treatment to a single handkerchief, for example, it is possible to generate only a small amount of metal ion-containing water sufficient to immerse the single handkerchief within a small container, which prevents wasting water resource.

(3) In the aforementioned antibacterial treatment device, the power supply unit employs a battery as the power supply.

According to this configuration, the antibacterial treatment can be performed at places where commercial power supply can not be utilized or houses equipped with insufficient number of receptacles even though fed with commercial power supply.

(4) In the aforementioned antibacterial treatment device, the power supply unit includes a timer for setting the feeding time for the electrodes.

According to this configuration, by controlling the feeding time, it is possible to elute an amount of metal ions appropriate to the amount of water in which laundry is to be immersed. Thus, it is possible to ensure a required metal ion concentration,

thereby increasing the reliability of the antibacterial treatment.

(5) In the aforementioned antibacterial treatment device, at least a part of the case is formed by a sight-through portion which enables visually noticing the electrodes placed therein.

According to this configuration, the state of the electrodes placed in the ion elution unit can be directly visually noticed. Thus, a user can determine the timing of replacement of the ion elution unit from the wear state of the electrodes and can replace the unit before the occurrence of serious performance degradation. Consequently, the ion elution unit can be always used when it can offer sufficient antibacterial effects.

(6) The antibacterial treatment device according to the present invention is an antibacterial treatment device including an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects. The above ion generating portion is configured to be removably installed outside of the feed-water apparatus and on the water supply path to the feed-water apparatus (from a water supply tap).

Here, as the aforementioned ion generating portion, it is possible to employ, for example, (a) an ion elution unit which generates ions of the metal constituting the electrodes by applying a voltage to a pair of electrodes, or (b) a metal-ion eluting material (for example, silver sulfide as a silver-eluting material) loaded in a cartridge which enables elution of metal ions by flowing water through the cartridge.

According to the aforementioned configuration, the ion generating portion can be retrofitted outside of the feed-water apparatus (for example, a washing machine) and therefore even when the feed-water apparatus is an existing type of feed-water apparatus which is not originally equipped with an ion generating portion, a feed-water apparatus equivalent to the feed-water apparatus equipped with an ion generating portion may be

realized. Therefore, wasteful replacement of a feed-water apparatus is not required and an existing feed-water apparatus may be effectively utilized. Further, the ion generating portion is removable from the water supply path to the feed-water apparatus and thus the replacement of the ion generating portion can be easily achieved.

(7) In the aforementioned antibacterial treatment device, the above ion generating portion is constituted by an ion elution unit including a unit main body which encloses (at least two) electrodes and through which the aforementioned water passes.

According to this configuration, when a voltage is applied to a pair of electrodes, for example, ions of the metal constituting the electrodes (for example, silver ions) are eluted and the ions are added to water flowing through the unit main body. Therefore, this metal ion-containing water is supplied to object (for example, laundry) from the ion elution unit through the feed-water apparatus, and thus the effects of metal ions (for example, antibacterial effects) can be certainly exerted on the objects.

The number of the electrodes may be any number equal to or more than a pair (two). Even when three or four electrodes are employed, by applying a voltage to the electrodes, metal ions can be eluted to provide desired effects of metal ions.

(8) In the aforementioned antibacterial treatment device, the ion elution unit includes (a) the first connecting portion for connecting the unit main body to the water supply tap or the first hose for flowing water supplied from the tap, and (b) the second connecting portion for connecting the unit main body to the second hose for flowing water to be supplied to the feed-water apparatus or the feed-water apparatus.

According to the aforementioned configuration, with the first connecting portion, the ion elution unit can be connected to the water supply tap directly or indirectly through the first hose. Also, with the second connecting portion, the ion

elution unit can be connected to the feed-water apparatus directly or indirectly through the second hose. Therefore, with combinations of these connecting methods, there are increased variations in the connection for installing the ion elution unit on the water supply path from the water supply tap to the feed-water apparatus. Therefore, it is possible to realize installing methods of the ion elution unit according to the needs of users.

(9) In the aforementioned antibacterial treatment device, the electrodes may be formed integrally with the unit main body.

For example, when the electrodes are formed separately from the unit main body, the unit main body must be formed from at least two separated cabinets in order to enable mounting the electrodes within the unit main body. In this case, there is a possibility of water leaks through the junctures of the two separated cabinets, which may degrade the sealing capability.

However, by forming the electrodes integrally with the unit main body as the present invention, there is no portion corresponding to the above junctures, and there is no problem of water leaks. Thus, the sealing capability of the unit main body can be certainly maintained.

(10) In the aforementioned antibacterial treatment device, the unit main body may be formed to be a shape for flowing out water in a different direction from the flow-in direction of the water.

According to this configuration, even when the flow-in direction of water flowing into the unit main body is the vertical direction, the flow-out direction of the water can be changed to, for example, the horizontal direction. Therefore, even when the distance between the feed-water apparatus and the ion elution unit is too small, the second hose for connecting the ion elution unit and the feed-water apparatus can be

easily routed without forcibly bending the second hose.

(11) The aforementioned antibacterial treatment device may further include a driving unit for driving the ion elution unit, and the driving unit may include a voltage generating section for generating a voltage to be applied to the electrodes of the ion elution unit.

As the voltage generating section, for example, a battery which is embedded, a plug which is inserted to a domestic plug socket and a connection cord, and an AC adapter, etc., may be employed. By applying the voltage generated at the voltage generating section of the driving unit to the electrodes of the ion elution unit for driving the ion elution unit, it is possible to certainly obtain the function for eluting metal ions from the electrodes in the ion elution unit.

(12) In the aforementioned antibacterial treatment device, the ion elution unit may further include a detecting means for detecting at least one of the presence or absence of water flows within the unit main body and the flow rate thereof.

When the detecting means detects the presence or absence of water flows within the unit main body, the driving unit can apply a voltage to the electrodes only when there are such water flows, for example. Consequently, it is possible to elute a required amount of metal ions only when there are water flows to which metal ions are to be added, thereby enabling stably supplying water containing a desired concentration of metal ions.

On the other hand, when there is no water flow, namely when there is no water to which metal ions are to be added, if a voltage is applied to the electrodes, this results in waste electric power consumption. However, according to the above configuration, such wasteful electric power consumption at the driving unit can be avoided.

Further, when the detecting means detects the flow rate of water flows within

the unit main body, the driving unit can change the voltage applied to the electrodes or the current flowing through the electrodes depending on the flow rate, thereby changing the amount of eluted metal ions. Consequently, even when the flow rate of water supplied to the feed-water apparatus varies depending on the installation place of the feed-water apparatus or when the flow rate of water supplied to the feed-water apparatus (for example, a washing machine) is varied on purpose, the driving unit can change the amount of eluted metal ions depending on the aforementioned flow rate, and thus the metal ion concentration of the metal ion-containing water can be made constant for any flow rate. This enables properly performing a desired antibacterial treatment, without generating excess and deficiency of the amount of eluted metal ions required for the antibacterial treatment.

(13) In the aforementioned antibacterial treatment device, the detecting means may include a rotator which is rotated by water passing therethrough, a magnet enclosed within the rotator, and a magnetism detecting portion for detecting at least one of the presence or absence of water flows and the flow rate thereof based on magnetism changes of the magnet caused by rotations of the rotator.

When the rotator rotates due to water flowing through the unit main body, the magnet enclosed in the rotator also rotates and accordingly the magnetism (magnetic flux, magnetic field) generated from the magnet changes. By detecting the presence or absence of such magnetism changes with the magnetism detecting portion, it is possible to detect the presence or absence of water flows within the unit main body, namely whether or not there is water passing through the unit main body. Further, by detecting the number of periodic aforementioned magnetism changes within a unit time with the magnetism detecting portion, it is possible to detect the number of rotations of the rotator within a unit time and also the flow rate of water flowing through the unit main

body.

Thus, since the detecting means is configured to include the rotator, the magnet and the magnetism detecting portion, at least one of the presence or absence of water flows within the unit main body and the flow rate thereof can be certainly detected, based on magnetism changes of the magnet.

(14) In the aforementioned antibacterial treatment device, the driving unit may further include a control section for controlling the application of a voltage generated at the voltage generating section to the electrodes, and the control section may apply the voltage to the electrodes when the magnetism detecting portion detects the water flows.

According to the above configuration, a voltage can be applied to the electrodes to cause the elution of metal ions when water starts to flow within the unit main body (namely, when it is determined that metal ions must be added to water). This can prevent wasteful electric power consumption at the driving unit, such as a case where a voltage is applied to the electrodes when there is no water flow within the unit main body (namely, when it is not required to add metal ions to water).

(15) In the aforementioned antibacterial treatment device, the driving unit may further include a control section for controlling the application of a voltage generated at the voltage generating section to the electrodes, and the control section may change the voltage applied to the electrodes or the current flowing through the electrodes depending on detected flow rates, when the magnetism detecting portion detects the flow rates.

Depending on the installation area or the installation place of the feed-water apparatus, the flow rate of the water supplied from the water supply tap to the feed-water apparatus may vary. However, according to the above configuration, the driving unit changes the voltage applied to the electrodes or the current flowing through

the electrodes depending on the detected flow rate of water within the unit main body, thereby changing the amount of eluted metal ions depending on the flow rate. Thus, the metal ion concentration of metal-ion-containing water can be made constant regardless of the installation place or area of the feed-water apparatus. As a result, a desired antibacterial treatment can be properly performed without generating excess and deficiency of the amount of eluted metal ions required for the antibacterial treatment.

(16) In the aforementioned antibacterial treatment device, the detecting means may be provided to be separable from the unit main body.

According to the above configuration, when replacement of the unit main body is necessary due to wear of the electrodes within the unit main body, it is unnecessary to replace the detecting means. This enables effective utilization of the detecting means. On the contrary, when replacement of the detecting means is necessary due to failure, etc., it is unnecessary to replace the electrodes in the unit main body, thereby enabling effective utilization of the electrodes.

(17) In the above antibacterial treatment device, the driving unit may include a vibration sensor which is provided on the outer surface of the feed-water apparatus and detects the time when the elution of metal ions is required and a control section for controlling the application of a voltage generated at the voltage generating section to the electrodes. The control section may apply the voltage to the electrodes when the vibration sensor detects the aforementioned time.

For example, in the case where the feed-water apparatus is constituted by a washing machine, the washing machine performs laundry-washing processes, which are a washing process, a rinsing process, a dewatering process and a drying process. Since the manner of the operation is varied among the respective laundry-washing processes (for example, the rotation speed of the washing bath is varied), the behavior of

vibrations of the feed-water apparatus varies among the respective washing processes.

On the other hand, in the case of the aforementioned laundry-washing processes, the elution of metal ions is required only at least after the rinsing process. This is because even if metal ion-containing water is supplied during the washing process, metal ions flow away when water containing no metal ion is used during the following rinsing process and consequently metal ions can not adhere to laundry. Thus, metal ions which have been previously supplied are wasted, which is inefficient. Therefore, in this case, the rinsing process is the time when the elution of metal ions is required, namely when metal ions can be efficiently adhered.

Further, the vibration sensor can detect the time when the elution of metal ions is required based on vibrations of the feed-water apparatus, with the following method. For example, the vibration sensor detects a laundry-washing process that requires the elution of metal ions (for example, the rinsing process), based on differences in the vibration periodicity due to differences in the rotation speed of the washing bath, the stirring member (pulsometer), or the motor, etc., constituting the feed-water apparatus.

The control section applies a voltage to the electrodes of the ion elution unit to cause the elution of metal ions when the vibration sensor detects the time when the elution of metal ions is required (the operation time period of the rinsing process, in the aforementioned example) based on vibrations of the feed-water apparatus. Therefore, the control section can cause the elution of metal ions when the elution of metal ions is required. Namely, this case eliminates the necessity of manual input by a user for turning on or off the application of a voltage to the electrodes, and enables performing the elution of metal ions only during an effective process.

(18) In the aforementioned antibacterial treatment device, the driving unit may be removably placed outside of the feed-water apparatus.

The driving unit may be placed, for example, on the outer surface of the feed-water apparatus or a wall around the feed-water apparatus. Since the driving unit is removably placed outside of the feed-water apparatus, the driving unit can be retrofitted together with the ion elution unit. Therefore, even when the existing feed-water apparatus is not equipped with an ion elution unit, it is possible to easily realize a feed-water apparatus equivalent to a feed-water apparatus equipped with an ion elution unit and a driving unit. This eliminates the necessity of replacement of the existing feed-water apparatus, enabling effective utilization of the existing feed-water apparatus. Further, since the driving unit is placed outside of the feed-water apparatus, repair or battery replacement for the driving unit can be easily performed in the event of failure or at the end of battery life.

(19) In the aforementioned antibacterial treatment device, the feed-water apparatus is a washing machine which supplies water to laundry, which is the object which is fed with water.

In the case where the feed-water apparatus is a washing machine, the antibacterial treatment device of the present invention can be retrofitted to the washing machine and therefore the effects of the present invention described above can be obtained with the washing machine, namely, for example, it is possible to realize a washing machine equivalent to a washing machine capable of eluting metal ions with the existing washing machine.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a vertical cross sectional view illustrating a general configuration of a washing machine according to a first embodiment of the present invention.

Fig. 2 is a schematic vertical cross sectional view of the feed-water opening.

Fig. 3 is a flow chart of the entire laundry-washing process.

Fig. 4 is a flow chart of the washing process.

Fig. 5 is a flow chart of the rinsing process.

Fig. 6 is a flow chart of the dewatering process.

Fig. 7 is a vertical cross sectional view illustrating the first embodiment of the ion elution unit.

Fig. 8 is a schematic horizontal cross sectional view illustrating the first embodiment of the ion elution unit.

Fig. 9 is a circuit diagram of the ion elution unit driving circuit.

Fig. 10 is a vertical cross sectional view illustrating a second embodiment of the ion elution unit.

Fig. 11 is an explanation diagram schematically illustrating the connection of the antibacterial treatment device according to a third embodiment of the present invention in the case where this antibacterial treatment device is applied to a washing machine.

Fig. 12 is a side view illustrating a general configuration of the first hose communicating and connecting the above ion elution unit constituting the above antibacterial treatment device to a water supply tap.

Fig. 13 is an exploded perspective view illustrating a general configuration of the first connecting portion of the first hose.

Fig. 14 is a cross sectional view illustrating the configuration of the first connecting portion connected to the water supply tap.

Fig. 15A and Fig. 15B are cross sectional views illustrating a general configuration of the second connecting portion of the first hose connected to the ion elution unit.

Fig. 16 is a side view illustrating another configuration of the first connecting portion.

Fig. 17 is a perspective view illustrating the appearance of the ion elution unit connected to the first hose.

Fig. 18 is a front view of the ion elution unit when the ion elution unit is connected to the water supply tap through the first hose.

Fig. 19 is a cross sectional view of the ion elution unit, which is viewed from behind.

Fig. 20 is a cross sectional view of the ion elution unit, which is viewed laterally.

Fig. 21 is a cross sectional view illustrating in detail the internal construction of the ion elution unit, which is viewed from the front side.

Fig. 22 is a cross sectional view illustrating in detail the internal construction of the ion elution unit, which is laterally viewed.

Fig. 23 is an exploded perspective view illustrating an exemplary configuration of the first connecting portion of the ion elution unit.

Fig. 24 is a perspective view illustrating a general configuration of the detecting portion of the ion elution unit.

Fig. 25 is a cross sectional view illustrating another configuration of the unit main body of the ion elution unit.

Fig. 26 is a cross sectional view illustrating another exemplary configuration of the ion elution unit.

Fig. 27A to Fig. 27D are respectively a plan view, a front view, a side view and a rear view illustrating the outer configuration of the driving unit constituting the antibacterial treatment device.

Fig. 28 is a block diagram illustrating a general configuration of the driving unit.

Fig. 29 is a block diagram illustrating another exemplary configuration of the driving unit.

BEST MODE FOR CARRYING OUT THE INVENTION

Embodiment 1

Hereinafter, embodiments of the present invention will be described based on the drawings. First, a first embodiment will be described based on Figs 1 to 9.

Fig. 1 is a vertical cross sectional view illustrating the entire configuration of a washing machine 1. The washing machine 1 is a full-automatic type washing machine and includes an outer box 10. The outer box 10 has a rectangular parallelepiped shape and is formed from a metal or synthetic resin. The top surface and the bottom surface of the outer box 10 are opening portions. A top plate 11 formed from a synthetic resin is overlaid on the top opening of the outer box 10. The top plate 11 is secured to the outer box 10 by bolts.

In Fig. 1, the front surface of the washing machine 1 is shown in the left-hand portion and the back surface of the washing machine 1 is shown in the right-hand portion. A back panel 12 which is also formed from a synthetic resin is overlaid on the top surface of the top plate 11 near the backside. The back panel 12 is secured to the top plate 11 with bolts. A base 13 formed from a synthetic resin is overlaid on the bottom opening portion of the top plate 11. The base 13 is secured to the outer box 10 by bolts. Representations of the bolts which have been described are omitted.

At the four corners of the base 13, legs 14a, 14b for supporting the outer box 10 on the floor are provided. The legs 14b near the backside are fixed legs formed

integrally with the base 13. The legs 14a near the front surface are threaded legs having a variable height and the level of the washing machine 1 is adjusted by rotating them.

A laundry introducing opening 15 for introducing laundry into a washing bath, which will be described later, is formed through the top plate 11. A cover 16 is provided such that it covers the laundry introducing opening 15. The cover 16 is connected to the top plate 11 through a hinge portion 17 and rotates within a vertical plane.

A water bath 20 and a washing bath 30 which also serves as a dewatering bath are placed in the outer box 10. The water bath 20 and the washing bath 30 have a cylindrical cup shape having an opening at the top surface and are placed concentrically such that the water bath 20 is placed outside of the washing bath 30 with their axes placed vertically. The water bath 20 is suspended by suspension members 21. The suspension members 21 are placed at a total of four places to connect lower portions of the outer surface of the water bath 20 and corners of the inside surface of the outer box 10 to support the water bath 20 such that it can swing in a horizontal plane.

The washing bath 30 has a peripheral wall which is mildly-tapered so as to upwardly widen. This peripheral wall includes no opening for passing fluid therethrough except a plurality of dewatering holes 31 which are annularly provided at the top portion. Namely, the washing bath 30 is a so-called "no-hole" type washing bath. At the edge of the top opening of the washing bath 30, there is mounted an annular balancer 32 for suppressing vibrations when the washing bath 30 is rotated at high speeds for dewatering laundry. At the inside bottom surface of the washing bath 30, there is placed a pulsometer 33 for generating flows of washing water or rinsing water within the bath.

On the bottom surface of the water bath 20, a driving unit 40 is mounted. The driving unit 40 includes a motor 41, a clutch mechanism 42 and a brake mechanism 43 and a dewatering shaft 44 and a pulsometer shaft 45 are upwardly protruded from their center. The dewatering shaft 44 and the pulsometer shaft 45 have a double-shaft configuration in which the dewatering shaft 44 is placed outside of the pulsometer shaft 45. After entering the water bath 20, the dewatering shaft 44 is coupled to the washing bath 30 to support it. The pulsometer shaft 45 enters the washing bath 30 and is coupled to the pulsometer 33 to support it. Sealing members for preventing water leaks are placed between the dewatering shaft 44 and the water bath 20 and between the dewatering shaft 44 and the pulsometer shaft 45.

A feed-water valve 50 which electromagnetically opens and closes is placed at the space under the back panel 12. A connection pipe 51 and a feed-water pipe 52 extend from the feed-water valve 50. The connection pipe 51 extends towards the top surface of the back panel 12 and an ion elution unit 100 is detachably coupled thereto. The construction and function of the ion elution unit 100 will be described later in detail. On the other hand, the feed-water pipe 52 extends horizontally under the back panel 12 and is coupled to a container-shaped feed-water opening 53. The feed-water opening 53 exists at a position facing to the inside of the washing bath 30 and has a configuration as illustrated in Fig. 2.

Fig. 2 is a schematic vertical cross sectional view of the feed-water opening 53, which is viewed from the front surface side. The feed-water opening 53 has an opened top surface and the inside thereof is partitioned into the left side and the right side. The left partition is a detergent room 54 and serves as a preparation space for charging detergent. The right partition is a finishing-agent room 55 and serves as a preparation space for charging finishing agent. A horizontally-long water injection opening 56 for

pouring water into the washing bath 30 is provided at a bottom portion of the front surface of the detergent room 54. A siphon portion 57 is provided in the finishing-agent room 55.

The siphon portion 57 includes an inner pipe 57a which vertically raises from the bottom surface of the finishing-agent room 55 and a cap-shaped outer pipe 57b which covers the inner pipe 57a. A gap for passing water therethrough is formed between the inner pipe 57a and the outer pipe 57b. The bottom of the inner pipe 57a opens towards the inside of the washing bath 30. The lower end of the outer pipe 57b is spaced apart by a predetermined interval from the bottom surface of the finishing-agent room 55 and this interval forms a water inlet. When water is poured into the finishing-agent room 55 to a level above the upper end of the inner pipe 57a, this causes a siphon effect and water is sucked out of the washing-agent room 55 through the siphon portion 57 to drop into the washing bath 30.

The feed-water valve 50 includes a main feed-water valve 50a and a sub feed-water valve 50b. The connection pipe 51 is common to both the main feed-water valve 50a and the sub feed-water valve 50b. The feed-water pipe 52 includes a main feed-water pipe 52a connected to the main feed-water valve 50a and a sub feed-water pipe 52b connected to the sub feed-water valve 50b.

The main feed-water pipe 52a is connected to the detergent room 54 and the sub feed-water pipe 52b is connected to the finishing-agent room 55. Namely, the path from the main feed-water pipe 52a through the detergent room 54 to the washing bath 30 and the path from the sub feed-water pipe 52b through the finishing-agent room 55 to the washing bath 30 are separated systems.

Returning to Fig. 1, the explanation will be continued. At the bottom of the water bath 20, there is mounted a drain hose 60 for draining water from the water bath

20 and the washing bath 30 to the outside of the outer box 10. Into the drain hose 60, water from a drain pipe 61 and a drain pipe 62 is flowed. The drain pipe 61 is connected to the bottom surface of the water bath 20 at a position near the perimeter. The drain pipe 62 is connected to the bottom surface of the water bath 20 at a position near the center.

An annular partition wall 63 is secured to the inside bottom surface of the water bath 20 such that it internally encloses the connected portion of the drain pipe 62. An annular sealing member 64 is mounted at the upper portion of the partition wall 63. The sealing member 64 contacts the perimeter surface of a disk 65 secured to the outer surface of the bottom of the washing bath 30 to form an isolated drain space 66 between the water bath 20 and the washing bath 30. The drain space 66 communicates with the inside of the washing bath 30 through a drain opening 67 formed through the bottom of the washing bath 30.

A drain valve 68 which electromagnetically opens and closes is provided on the drain pipe 62. An air trap 69 is provided on the drain pipe 62 upstream of the drain valve 68. A connecting pipe 70 extends from the air trap 69. A water-level switch 71 is connected to the upper end of the connecting pipe 70.

A control section 80 is placed on the front surface side of the outer box 10. The control section 80 is placed under the top plate 11. The control section 80 receives control commands from a user through an operation/display portion 81 provided on the top surface of the top plate 11 and outputs operation commands to the driving unit 40, the feed-water valve 50 and the drain valve 68. Further, the control section 80 outputs display commands to the operation/display portion 81.

The operation of the washing machine 1 will be described. The cover 16 is opened and laundry is introduced into the washing bath 30 through the laundry

introducing opening 15. A detergent is introduced into the detergent room 54 of the feed-water opening 53. A finishing agent is introduced into the finishing-agent room 55 of the feed-water opening 53, if it is required. Also, the finishing agent may be introduced in the middle of the washing process.

After the preparation has been made for introduction of the detergent, the cover 16 is closed and washing states are selected by operating a plurality of operation buttons. Finally, a start button is pushed to start the washing process according to the flow charts of Figs 3 to 6.

Fig. 3 is a flow chart illustrating the entire laundry-washing process. At a step S201, it is determined whether or not a so-called reserved operation in which washing is started at a set time has been selected. If the reserved operation has been selected, the process proceeds to a step S206. If it has not been selected, the process proceeds to a step S202.

In the case where the process proceeds to the step S206, it is determined whether or not an operation starting time has come. If the operation starting time has come, the process proceeds to the step S202.

At the step S202, it is determined whether or not a washing process has been selected. If the washing process has been selected, the process proceeds to a step S300. The nature of the washing process will be separately described referring to the flow chart of Fig. 4. After the washing process has been completed, the process proceeds to a step S203. If the washing process has not been selected, the process immediately proceeds to the step S203 from the step S202.

At the step S203, it is determined whether or not a rinsing process has been selected. If the rinsing process has been selected, the process proceeds to a step S400. The nature of the rinsing process will be separately described with the flow chart of Fig.

5. After the rinsing process has been completed, the process proceeds to a step S204. If the rinsing process has not been selected, the process immediately proceeds to the step S204 from the step S203.

At the step S204, it is determined whether or not a dewatering process has been selected. The nature of the dewatering process will be separately described with the flow chart of Fig. 6. After the dewatering process has been completed, the process proceeds to a step S205. If the rinsing process has not been selected, the process immediately proceeds to the step S205 from the step S204.

At a step S205, a termination process of the control section 80 (particularly, an operation device (micro computer) included therein) automatically proceeds according to a procedure. Further, the completion of the laundry-washing process is indicated by an ending sound. After all of the aforementioned steps have been completed, the washing machine 1 waits for the next laundry-washing process in a powered-OFF state.

Next, the washing process, the rinsing process and the dewatering process will be described, respectively, based on Figs. 4 to 6.

Fig. 4 is a flow chart of the washing process. At a step S301, water level data in the washing bath 30 detected by the water-level switch 71 is acquired. At a step S302, it is determined whether or not the capacity sensing has been selected. If it has been selected, the process proceeds to a step S308. If it has not been selected, the process proceeds to a step S303 from the step S302.

At the step S308, the amount of laundry is determined by the rotation load of the pulsometer 33. After the capacity sensing, the process proceeds to the step S303.

At the step 303, the main feed-water valve 50a is opened to pour water into the washing bath 30 through the main feed-water pipe 52a and the feed-water opening 53. The detergent put in the detergent room 54 of the feed-water opening 53 is introduced to

the washing bath 30 together with the water. The drain valve 68 is maintained in the closed state. When the water-level switch 71 detects a water level being at the set value, the main feed-water valve 50a is closed. Then, the process proceeds to a step S304.

At the step S304, a mixing operation is performed. Namely, the pulsometer 33 rotates in reverse directions to shake the laundry in the water to mix the laundry with the water. This causes the laundry to sufficiently absorb water and releases air trapped at several portions of the laundry. In the event that the water level detected by the water-level switch 71 is lowered than the initial level as a result of the mixing operation, the main feed-water valve 50a is opened to resupply water for restoring the water level to the set level at a step S305.

Further, if a laundry-washing course including "a cloth-quality sensing" has been selected, the cloth-quality sensing is performed in conjunction with the mixing operation. After the mixing operation is performed, the change of the water level from the set water level is detected and if the water level is lowered by an amount equal to or greater than a predetermined value, it is determined that the laundry has a water-absorbing cloth quality.

After the set water level is stably achieved at a step S305, the process proceeds to a step S306. According to the setting by a user, the motor 41 rotates the pulsometer 33 in a predetermined pattern to generate main water flows for washing within the washing bath 30. The laundry is washed by the main water flows. The dewatering shaft 44 is braked by the brake apparatus 43 and thus the washing bath 30 will not rotate even when the washing water and the laundry move.

After the period of main water flows has elapsed, the process proceeds to a step S307. At the step S307, the pulsometer 33 is inverted little at a time to disentangle the

laundry in order to evenly distribute the laundry within the washing bath 30. This is performed for preparing for dewatering rotations of the washing bath 30.

Then, the nature of the rinsing process will be described based on the flow chart of Fig. 5. The dewatering process is first performed at a step S500, which will be described with the flow chart of Fig. 6. After the dewatering, the process proceeds to a step S401. At the step S401, the main feed-water valve 50a is opened to feed water to the set water level.

After the feeding of water, the process proceeds to a step S402. At the step S402, a mixing operation is performed. The mixing operation is the same as that performed at the step S304 in the washing process.

After the mixing operation, the process proceeds to the step S403. In the event that the water level detected by the water-level switch 71 is lowered than the initial level as a result of the mixing operation, the main feed-water valve 50a is opened to resupply water for the water level to the set water level.

After the set water level is restored at the step S403, the process proceeds to a step S404. According to the setting by the user, the motor 41 rotates the pulsometer 33 in a predetermined pattern to generate main water flows for rinsing within the washing bath 30. The laundry is rinsed by the main water flows. The dewatering shaft 44 is braked by the brake apparatus 43 and thus the washing bath 30 will not rotate even when the rinsing water and the laundry move.

After the period of main water flows has elapsed, the process proceeds to a step S405. At the step S405, the pulsometer 33 is inverted little at a time to disentangle the laundry in order to evenly distribute the laundry within the washing bath 30 for preparing for dewatering rotations of the washing bath 30.

While in the above description a "pool-rinsing" in which the rinsing is

performed using rinsing water pooled within the washing bath 30 is performed, a “shower water injection” in which water is poured from the feed-water opening 53 while the washing bath 30 is rotated in a low speed may be performed in some cases. Whether either or both of them are selected is dependent on the user’s selection.

Then, the nature of the dewatering process will be described based on the flow chart of Fig. 6. First, the drain valve 68 is opened at a step S501. The washing water within the washing bath 30 is drained through the drain space 66. The drain valve 68 is kept open during the dewatering process.

When most of the washing water is removed from the laundry, switching between the clutch device 42 and the brake device 43 is made. The timing of the switching between the clutch device 42 and the brake device 43 may be before the start of drain or concurrently with the drain. Then, the motor 41 rotates the dewatering shaft 44. Thus, the washing bath 30 performs the dewatering rotation. The pulsometer 33 rotates together with the washing bath 30.

When the washing bath 30 rotates at a high speed, the laundry is pressed against the perimeter wall of the washing bath 30 by a centrifugal force. Washing water contained in the laundry is also concentrated at the inside surface of the perimeter wall of the washing bath 30. Since the washing bath 30 is tapered to widen upwardly as previously described, the washing water subjected to the centrifugal force ascends the inside surface of the washing bath 30. The washing water is discharged from the dewatering holes 31 when it reaches the upper end of the washing bath 30. The washing water separated from the dewatering holes 31 collides against the inside surface of the water bath 20 and slips down the inside surface of the water bath 20 to flow down to the bottom of the water bath 20. Then, the above washing water is discharged to the outside of the outer box 10 through the drain pipe 61 and the

subsequent drain hose 60.

In the flow of Fig. 6, a dewatering operation is performed at a relatively low speed at the step S502 and then a dewatering operation at a high speed is performed at a step S503. After the step S503, the process proceeds to a step S504. At the step S504, the energization of the motor 41 is interrupted and a stopping process is performed.

The ion elution unit 100 is connected to the feed-water valve 50 through the connection pipe 50. Hereinafter, based on Figs 7 to 9, the configuration and function of the ion elution unit 100 and the role of the ion elution unit 100 when it is mounted to the washing machine 1 will be described.

Figs. 7 and 8 are cross sectional views of the ion elution unit 100. Fig. 7 is a vertical cross sectional view and Fig. 8 is a schematic horizontal cross sectional view. The ion elution unit 100 includes a tube-shaped case 110 formed from an insulating material such as synthetic resin, silicon or rubber. The case 110 is placed such that the axis of the tube shape is placed horizontally. A tube-shaped inlet 111 is protruded upwardly from one side and a tube-shaped outlet 112 is downwardly protruded from the other side.

The inlet 111 includes a male-threaded portion 111a on the outer surface thereof and the outlet 112 includes a female-threaded portion 112a on the inner surface thereof. By engaging the female-threaded portion 112a of the outlet 112 with the male-threaded portion formed on the outer surface of the connection pipe 51, the case 110 is connected to the connection pipe 51 to be communicated to the feed-water valve 50. An O-ring 112b is placed at the deepest portion of the female-thread portion 112a. The O-ring 112b is intimately contacted with the tip end of the connection pipe 51 to form a water tight portion.

A nut-type connection device 111b is threadably engaged with the male-threaded portion 111a of the inlet 111 (see, Fig. 1). The connection device 111b couples and secures one end of the feed-water hose 180 to the inlet 111. The other end of the feed-water hose 180 is coupled to a water supply tap (not shown).

The manner of the connection of the outlet 112 to the connection pipe 51 and the manner of the connection of the feed-water hose 180 to the inlet 111 are not limited to the aforementioned thread systems. Any water-relating connection systems which are generally used in households such as clamping rings or collet-chuck type connection devices may be employed.

Further, in the present embodiment, the outlet 112 is coupled to the connection pipe 51 protruded towards the upper surface of the back panel 12 of the washing machine 1, the component to which the outlet 112 is coupled is not limited to the connection pipe 51. The outlet 112 may be coupled to any components placed between the outlet 112 and the feed-water valve 50. The outlet 112 may be directly coupled to the feed-water valve 50 depending of the configuration of the washing machine 1. Namely, only the state that the outlet 112 is detachably communicated and connected to the feed-water valve 50 and the attachment and detachment thereof can be performed outside of the washing machine 1 must be satisfied.

The case 110 includes an opening at its end near the inlet 111 and two plate-type electrodes 113, 114 are inserted therefrom. The electrodes 113, 114 are formed from a metal which serves as a source of antibacterial metal ions, namely silver, copper, zinc, etc. The size of the electrodes 113, 114 may be, for example, 2 cm × 5 cm with a thickness of about 1 mm.

The electrodes 113, 114 have terminal portions 115, 116 at ends. By inserting the terminal portions 115, 116 through a disc-shaped cap 117 combined with the

opening of the case 110, the electrodes 113, 114 are secured to the cap such that they are spaced apart from each other. By covering the opening of the case 110 with the cap 117, the electrodes 113, 114 are secured to the inside of the case 110 such that they extend in the axial direction of the case 110.

A dome-shaped watertight cap 118 is secured to the cap 117. A feeding cable 119 extending from the power supply unit 101 (see Fig. 1) is inserted into the watertight cap 118. The feeding cable 119 includes insulating core wires 119a, 119b inside thereof. The insulating core wire 119a is connected to the terminal portion 115 and the insulating core wire 119b is connected to the terminal portion 116 within the watertight cap 118.

In order to prevent water from leaking into the watertight cap 118A, a proper watertight sealing treatment has been applied between the case 110 and the cap 117 and between the cap 117 and the electrodes 115, 116, between the cap 117 and the watertight cap 118, and between the watertight cap 118 and the feeding cable 119.

The power supply unit 101 incorporates the driving circuit for the ion elution unit 100 and this circuit will be described in detail later. In addition to the feeding cable 119, a power supply code 102 for connecting the power supply unit 101 to commercial power supply is extended from the power supply unit 101.

Within the case 110, water flows from the inlet 111 to the outlet 112 in parallel with the longitudinal direction of the electrodes 113, 114. When a predetermined voltage is applied to the electrodes 113, 114 in the presence of water within the case 110, metal ions of the metal constituting the electrodes are eluted from the anode side of the electrodes 113, 114.

Fig. 9 is a circuit block diagram of the driving circuit 120 of the ion elution unit 100. A transformer 122 is connected to the commercial power supply 121 through

a power supply switch 132 to lower a voltage of 100 V to a predetermined voltage. The actuator portion of the power supply switch 132 is exposed at the outer surface of the power supply unit 101 and can be operated from the outside. The output voltage of the transformer 122 is rectified by a full-wave rectifier circuit 123 and then changed to a constant voltage by a constant voltage circuit 124. A constant current circuit 125 is connected to the constant voltage circuit 124. The constant current circuit 125 operates to supply a constant current to an electrode driving circuit 150, which will be described later, regardless of changes of the resistance within the electrode driving circuit 150.

A rectifier diode 126 is connected to the commercial power supply 121 in parallel with the transformer 122. The output voltage of the rectifier diode 126 is smoothed by a condenser 127, then changed to a constant voltage by a constant voltage circuit 128, and then supplied to a micro computer 130. The micro computer 130 activates and controls a triac 129 connected between one end of the primary coil of the transformer 122 and the commercial power supply 121.

The electrode driving circuit 150 is constituted by NPN transistors Q1 to Q4, diodes D1 and D2, and resistances R1 to R7, which are connected as in the figure. The transistor Q1 and the diode D1 constitute a photo coupler 151 and the transistor Q2 and the diode D2 constitute a photo coupler 152. Namely, the diodes D1 and D2 are photo diodes and the transistors Q1 and Q2 are photo transistors.

When the micro computer 130 applies a high-level voltage to a line L1 and applies a low-level voltage or OFF (zero voltage) to a line L2, the diode D2 turns on and accordingly the transistor Q2 turns on. When the transistor Q2 turns on, this generates currents flowing through the resistances R3, R4 and R7 to bias the base of the transistor Q3, which turns on the transistor Q3.

On the other hand, since the diode D1 is in the OFF state, the transistor Q1 is in the OFF state and the transistor Q4 is in the OFF state. In this state, currents flow from the electrode 113 at the anode side and the electrode 114 at the cathode side. Thus, metal ions, which are positive ions, and negative ions are generated in the ion elution unit 100.

When the ion elution unit 100 is fed with a current in a single direction for a long time, the electrode 113 which is in the anode side in Fig. 9 wears and impurities in the water adhere to the electrode 114 which is in the cathode side as scale. This will degrade the performance of the ion elution unit 100 and therefore the electrode driving circuit 150 can be operated in a forced electrode cleaning mode.

In the forced electrode cleaning mode, the micro computer 130 switches the control such that the voltages on the lines L1 and L2 are reversed to generate currents flowing in the opposite direction through the electrodes 113, 114. In this case, the transistors Q1 and Q2 turn on and the transistors Q2 and Q3 are in the OFF state. The micro computer 130 has a counter function and performs the aforementioned switching each time a predetermined count value is reached.

In the event that changes of the resistance in the electrode driving circuit 150, particularly changes of the resistances of the electrodes 113, 114, causes decreases in the current flowing between the electrodes, etc., the constant current circuit 125 increases its output voltage to prevent decreases in the current. However, when the cumulative operating time becomes large, the ion elution unit 100 will reach the end of its life, and thus it becomes impossible to prevent decreases in the current even by switching to the forced electrode cleaning mode or increasing the output voltage of the constant current circuit 125.

Therefore, in this circuit, the current flowing between the electrodes 113, 114

in the ion elution unit 100 is monitored based on the voltage caused across the resistance R7 and in the event the current reaches a predetermined minimum current value, a current detection circuit 160 detects that. The information that the minimum current value has been detected is transferred to the micro computer 130 through the photo diode D3 and the photo transistor Q5 constituting a photo coupler 163. The micro computer 130 drives a warning annunciation means 131 through a line L3 to cause it to perform a predetermined warning annunciation. The warning annunciation means 131 is constituted by a proper display means such as an LED or a liquid crystal display and placed on the case outer surface of the power supply unit 101.

In order to address troubles such as short-circuits in the electrode driving circuit 150, there is provided a current detection circuit 161 for detecting a current being equal to or greater than a predetermined maximum current value. Based on the output from the current detection circuit 161, the micro computer 130 drives the warning display means 131. Also, when the output voltage of the constant current circuit 125 reduces below a predetermined minimum value, a voltage detection circuit 162 detects that and the micro computer 130 similarly drives the warning annunciation means 131.

A timer 133 is connected to the micro computer 130. The timer 133 includes an operating portion at the case outer surface of the power supply unit 101. By operating this operating portion, a proper time setting can be performed.

The antibacterial treatment device comprising the ion elution unit 100 and the power supply unit 101 is used as follows.

At first, the outlet 112 of the ion elution unit 100 is mounted to the connection pipe 51 of the washing machine 1. The feed-water hose 180 is connected to the inlet 111. The tap to which the other end of the feed-water hose 180 is connected is opened to cause water flows within the case 110 of the ion elution unit 100. Actually, water

flows generate when the feed-water valve 50 is opened. The power supply code 102 of the power supply unit 101 is connected to a receptacle of commercial power supply. The power supply unit 101 may be secured to a side surface or the top surface of the washing machine 1 through a proper mounting means.

Metal ions are introduced during the rinsing process. When the process enters the step S401 (feeding water) in the flow chart of Fig. 5, the power supply switch 132 is turned on to feed a current to the electrodes 113, 114 to elute ions of the metal constituting the electrodes into the water. In the case where the metal constituting the electrodes is silver, the following reaction occurs; $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$. Thus, silver ions Ag^+ are eluted into the water. The current flowing between the electrodes is a direct current. The water containing metal ions is introduced to the washing bath 30 from the feed-water opening 53.

The length of the feeding time is set by the timer 133. The length of time required for raising the metal ion concentration in the rinsing water to a predetermined level is dependent on the amount of the rinsing water. Therefore, the time setting of the timer 133 is performed by determining the amount of the rinsing water. Here, a conversion table of the amounts of rinsing water and corresponding required feeding times may be prepared. The conversion table may be displayed on the surface of the ion elution unit 100 by proper means such as attaching a seal, printing, imprinting, etc. The conversion table may be also provided on the power supply unit 101.

The injection of rinsing water at the step S401 is performed through the main feed-water valve 50a. The flow rate of the water injection is set such that the elution of ions has been completed before the injection of rinsing water is completed. When a predetermined amount of rinsing water containing a predetermined concentration of metal ions has been pooled, the main feed-water valve 50a is closed to end the feeding

of water. After that, the rinsing process from the step S402 is performed. Subsequently, the dewatering process is performed according to the flow chart of Fig. 6.

While rinsing water is stirred during the rinsing process, contact between the laundry and metal ions is facilitated. Metal ions gradually adhere to the fiber of the laundry, thus forming an antibacterial coating over the surface of the laundry.

In the case where a finishing agent is to be introduced, the introducing operation is performed near the end of the step S404 (main water flow). At this time, the sub feed-water valve 50b is opened to flow water through the finishing agent room 55 of the feed-water opening 53. In the case where the finishing agent has been introduced in the finishing agent room 55, the finishing agent is introduced into the washing bath 30 together with water from the siphon portion 57. Since the siphon effect occurs only when the water level within the finishing agent room 55 reaches a predetermined height, the liquid finishing agent may be stored in the finishing agent room 55 until water is supplied to the finishing agent room 55 at the time it is required.

When a predetermined amount (the amount sufficient to cause the siphon effect in the siphon portion 57 or more) of water has been supplied to the finishing agent room 55, the sub feed-water valve 50b is closed. The rinsing water containing the finishing agent introduced thereto is stirred for a predetermined time, thus facilitating contact between the laundry and the finishing agent. After the predetermined time has elapsed, the process proceeds to a step S405 (balance).

The introduction of the finishing agent is performed after a predetermined time has elapsed since the start of the rinsing with the rinsing water containing metal ions. If metal ions and the finishing agent (softening agent) are introduced to the rinsing water at the same time, the metal ions will react with constituents of the softening agent, which degrades the antibacterial effect. However, by introducing the finishing agent

as previously described, the finishing agent is introduced after metal ions have sufficiently adhered to the laundry, which prevents the reaction between metal ions and the constituents of the finishing agent, thereby enabling retaining the antibacterial effects of metal ions on the laundry.

Preferably, the metal constituting the electrodes 113, 114 is silver, copper, or an alloy of silver and copper. Silver ions eluted from a silver electrode offer excellent antibacterial effects and copper ions eluted from a copper electrode offer excellent mold resistance. Also, silver ions and copper ions can be concurrently eluted from an alloy of silver and copper. Since silver ions are positive ions and laundry is negative-charged in the water, silver ions are electrically adsorbed to the laundry. Silver ions are electrically neutralized when adsorbed to the laundry. Therefore, silver ions will be less prone to react with chloride ions (negative ions), which are constituents of the finishing agent (softening agent). Since silver ions are gradually adsorbed to the laundry over time, the introduction of the finishing agent must be performed after some time has elapsed. Therefore, 10 minutes of stirring time is secured after the introduction of silver ions. As the stirring time after the introduction of the finishing agent, about 3 minutes is sufficient.

Metal ions are introduced to the washing bath 30 through the main feed-water pipe 52a and the detergent room 54. The finishing agent is introduced to the washing bath 30 from the finishing-agent room 55. Since the path for introducing metal ions to the rinsing water and the path for introducing the finishing agent to the rinsing water are separated systems, it is possible to prevent metal ions from passing through the path for introducing the finishing agent to rinsing water and contacting with residual finishing agent in the path to form a compound, thus losing their antibacterial capability.

While in the aforementioned configuration, the power supply switch 132 is

turned on and the time setting of the timer 133 is performed after the washing machine 1 enters the rinsing process, this is inconvenient for users. In order to overcome this inconvenience, the following configuration may be employed.

Namely, a flow-rate switch is provided within the case 110. A user turns on the power supply switch 132 in the power supply unit 101 at first, then performs time setting of the timer 133 and then pushes the start key of the washing machine 1 to start the laundry-washing process. Namely, when the flow-rate switch detects that a large amount of water injection is being performed at a second time through the feed-water valve 50 (main feed-water valve 50a) (except the injection of resupplied water at the step S305), namely that the injection of rinsing water at the step S401 is being performed, the micro computer 130 starts the operation and feeds a current to the electrodes 133, 134 for the time set by the timer 133.

The electrodes 113, 114 wear as the elution of metal ions is continued and thus the amount of eluted metal ions decreases. When the ion elution unit 100 has been used for a long time, the amount of eluted metal ions becomes unstable or a predetermined amount of eluted metal ions can not be ensured. Therefore, the ion elution unit 100 must be replaced with a new unit when the electrodes 113, 114 reach their life limit.

In order to enable determining whether or not the electrodes 113, 114 have reached their life limit, the ion elution unit 100 is designed to have the following contrivances.

One end of each of the terminal portions 15, 16 of the electrodes 113, 114 will be called "a root" and the other end will be called "a tip end". The electrodes 113, 114 are juxtaposed, but are not placed in parallel. As can be seen in Fig. 8, the electrodes 113, 114 are placed in a tapered-shape such that the closer to the tip ends, the smaller

the distance therebetween. By placing them as described, metal ions are eluted from portions of the electrodes 113, 114 at which there is a narrower distance therebetween, and therefore the electrodes 113, 114 dissolve from their tip ends. Therefore, by noticing the lengths from the roots to the tip ends, it is possible to grasp how much volumes of the electrodes 113, 114 have been reduced.

In order to enable knowing the length from the roots to the tip ends of the electrodes 113, 114, the case 110 is formed as follows. Namely, a side surface (front surface) or the top surface of the case 110 is made from a transparent synthetic resin to form it as a sight-through portion. It is determined whether or not the time to replace the ion elution unit 100 comes by directly visually noticing the state of the electrodes 113, 114 through the sight-through portion.

In order to provide the sight-through portion in the case 110, the entire case 110 may be formed from a transparent synthetic resin to enable looking the entire electrodes 113, 114. Also, a slit including a transparent plate fitted therein may be provided at the front surface of the case 110 to enable looking the electrodes 113, 114 through the slit.

The material constituting the transparent portion is not required to be completely transparent and may be semi-transparent. Namely, it is necessary only that the sizes (lengths) of the electrodes 113, 114 inside thereof can be grasped.

Scale marks for determining the wear of the electrodes 113, 114 may be provided at the transparent portion. Since the lengths from the roots to the tip ends of the electrodes 113, 114 are the measure for determining the wear, scale marks aligned straightly from the tip ends of the electrodes to the roots of the electrodes may be provided. A scale mark, of the scale marks, which provides an indication of the replacement of the ion elution unit 100 may be made to be particularly larger or have a

different shape in order to enable determining at a glance the time to replace the ion elution unit 100.

Only the ion elution unit 100 requires replacement and it is unnecessary to replace the power supply unit 101. Therefore, a detachable connector may be provided at a part of the feeding cable 119 to enable replacing only the ion elution unit 100 with a new one and continuing to use the existing power supply unit 101.

The power supply unit 101 may employ batteries instead of commercial power supply as the power supply. The batteries may be housed within the case of the power supply unit 101. With this configuration, the antibacterial treatment may be performed at places where commercial power supply may not be utilized, such as camp-sites or houses equipped with insufficient number of receptacles even though fed with commercial power supply.

Embodiment 2

Then, a second embodiment of the present invention will be described based on Fig. 10. Fig. 10 is a vertical cross sectional view of the ion elution unit 100. Further, components common to or having the same functions as those in the first embodiment are designated by the same reference characters as those employed in the explanation of the first embodiment and explanation thereof will be omitted.

A lattice-shaped water flow opening 110a is formed at one end of the case 110 of the ion elution unit 100 according to the second embodiment. There is no opening having differentiated functions such as an "inlet" and an "outlet" as the first embodiment. The sizes of the individual openings of the water flow opening 110a are set such that fingers or the like can not contact the electrodes 113, 114. A hook 110b is formed integrally with the side surface of the case 110. Similarly to the ion elution

unit 100 according to the first embodiment, water leaks into the watertight cap 118 are prevented and the ion elution unit 100 can be entirely immersed in water.

The ion elution unit 100 is employed with at least half of the case 110 immersed in rinsing water within the washing bath 30. Thus, water enters into the case 110 through the water flow opening 110a. The entered water is guided to the electrodes 113, 114 and thus the electrodes 113, 114 are immersed therein. At this time, a voltage is applied to the electrodes 113, 114 to cause the elution of metal ions. The water containing metal ions flows out through the water flow opening 110a.

The ion elution unit 100 may be simply employed within water or employed with the hook 110b hung into a dewatering hole 31. Also, the ion elution unit 100 may be suspended by hitching a string or the like to the hook 110b. In the case where the hook 110b is hung on something to use the ion elution unit 100 with the case 110 placed vertically, the electrodes 113, 114 can not be immersed in water when air has not been removed from the case 110. Therefore, the case 110 may be provided with air relief holes at the end near the cap 117.

According to the ion elution unit 100 according to the second embodiment, the case 110 is immersed in water and water is introduced into the case 110 through the water flow opening 110a to immerse the electrodes 113, 114 in the water in order to perform the elution of metal ions. Therefore, there is no need to provide a specific construction for mounting or holding the ion elution unit 100 to the washing machine 1. Also, there is no need to couple the feed-water hose 180 to the ion elution unit 100.

Further, the ion elution operation is performed in water pooled within the washing bath 30 and therefore uniform ion-containing water may be generated. Therefore, metal ions uniformly adhere to laundry, which provides uniform antibacterial effects.

In the event that the performance of the ion elution unit 100 is degraded since it has been utilized for a long time, it is necessary to only discard the old unit and employ a new unit. This saves the effort of replacement of the unit.

Further, the ion elution unit 100 can be immersed in water not only within the washing bath 30 of the washing machine 1. Since any container which can accommodate the case 110 of the ion elution unit 100 may be utilized, it is possible to generate water containing metal ions using a bucket, basin, cup, etc. Therefore, when there is a need to apply the antibacterial treatment to a single handkerchief, only a small amount of metal ion-containing water sufficient to immerse the single handkerchief can be generated within a small container, which prevents wasting water resource.

When the power supply unit 101 of the ion elution unit 100 according to the second embodiment is adapted to be driven by batteries, the antibacterial treatment apparatus has complete portability. This widens the range of uses and, for example, the antibacterial treatment apparatus can be carried to places for outdoor activity for applying an antibacterial treatment to cloths etc.

Similarly to the first embodiment, a conversion table of the amounts of water and corresponding driving times of the ion elution unit 100 required for eluting proper amount of metal ions may be provided on the surface of the ion elution unit 100 or the power supply unit 101. Based on the conversion table, a user can set the timer to generate metal ion-containing water with a proper concentration.

Embodiment 3

Next, a third embodiment of the present invention will be described based on Figs 11 to 29. The same components as those of the first and second embodiments will be designated by the same reference characters and explanation thereof will be

omitted.

Fig. 11 is an explanation diagram schematically illustrating the connection of an antibacterial treatment apparatus according to the present embodiment in the case where this antibacterial treatment apparatus is applied to the washing machine 1. The antibacterial treatment apparatus 200 according to the present embodiment includes an ion elution unit 300 and a driving unit 400.

The ion elution unit 300 is an ion generating portion for generating metal ions (for example, silver ions) which are added to water, which is supplied from the washing machine 1 as a feed-water apparatus to objects (for example, laundry).

The ion elution unit 300 is connected to a water supply tap 201 through a first hose 202 and connected to the washing machine 1 through a second hose 203. Thus, water supplied from the tap 201 is supplied to the washing machine 1 through the first hose 202, the ion elution unit 300 and the second hose 203 in order.

From this placement of the ion elution unit 300, it can be said that the ion elution unit 300 is placed outside of the washing machine 1 and placed on the water-supply path from the tap 201 to the washing machine 1. The most significant characteristic of the present invention is that the ion elution unit 300 can be retrofitted to the outside of the washing machine 1, not the inside of the washing machine 1.

The driving unit 400 drives the ion elution unit 300 and is removably placed outside of the washing machine 1. For example, the driving unit 400 is placed by suspending it from a hook attached to a wall around the washing machine 1 or the outer surface of the washing machine 1 and therefore is made to be removable.

The driving unit 400 is sealed at the outer circumference with a sealing member and thus has a watertight configuration. Consequently, the driving unit 400 can be reliably operated without causing adverse effects of water or moisture on the

internal circuit of the driving unit 400 even in the case where the driving unit 400 is placed near an apparatus (washing machine 1) using water as in the present embodiment or in the case where the driving unit 400 is disposed at places where there may be water leaks, unsafe places where the driving unit 400 may be splashed with water or humid places.

Also, in the case where the driving unit 400 is placed on the outer surface of the washing machine 1, the following method may be employed instead of using a hook as previously described. That is, a magnet having a magnetic force which will not affect the internal circuit may be placed on the backside of the driving unit 400, namely the surface of the driving unit 400 which faces the washing machine 1, to removably contact and mount the driving unit 400 to the outer surface of the washing machine 1 with the magnetic force of the magnet.

Further, the driving unit 400 is electrically connected to the ion elution unit 300 through a code 500. This enables feeding a voltage for driving the ion elution unit 300 to the ion elution unit 300 from the driving unit 400 through the code 500.

Hereinafter, details of the ion elution unit 300 and the driving unit 400 will be described. First, the first hose 202 and the second hose 203 will be described.

(1. First Hose)

Fig. 12 is a side view illustrating a general configuration of the first hose 202. The first hose 202 communicates and connects the water supply tap 201 with the ion elution unit 300 and includes a flexible hose main body 210, a first connecting portion 211 and a second connecting portion 212.

(1-1. First Connecting Portion)

The first connecting portion 211 is provided at one end of the hose main body 210 and is communicated and connected to the water supply tap 201. The first

connecting portion 211 is constructed by a fastening portion 221 and a movable means 222 which are separable, as illustrated in Fig. 13.

At first, the fastening portion 221 will be described. The fastening portion 221 is comprised of hardware 231 and a screw connecting portion 232.

The hardware 231 is a substantially-cylindrical-shaped fastening member which is mounted to the tip end of the water supply tap 201. More specifically, four screws are circumferentially and evenly placed at an upper part of the outer surface of the hardware 231 and by fitting the hardware 231 to the tap 201 and fastening them with these screws, the hardware 231 is secured to the tap 201. Thus, the hardware 231 can be reliably fastened to the tap 201 by using simple tools. Thread grooves are incised on the outer surface of the hardware 231 at a position below the position of the screws. Further, a sealing elastic member (for example, rubber) is mounted inside of the hardware 231.

The screw connecting portion 232 includes a first cylindrical portion 232a having a substantially-cylindrical shape and thread grooves which are formed on the inner surface thereof and are engagable with the thread grooves at the outer surface of the hardware 231, and a second cylindrical portion 232b having a substantially cylindrical shape and formed inside of the first cylindrical portion 232a apart therefrom by a predetermined distance. The opening portions of these first cylindrical portion 232a and the second cylindrical portion 232b at the hose main body 210 side are attached onto a doughnut-shaped disc along the outer and inner perimeters of this disc. Thus, the screw connecting portion 232 is formed.

At the bottom of this screw connecting portion 232, a connecting pipe 233 which communicates with the second cylindrical portion 232b is integrally formed. When inserted into the movable means 222, the connecting pipe 233 guides water

passing through the fastening portion 221 to the movable means 222. On the outer surface of this connecting pipe 233, there is formed a groove 233a (see Fig. 14) into which steel balls 241a of the movable means 222, which will be described later, are slightly fitted. On the outer surface of the first cylindrical portion 232a of the screw connecting portion 232, there is formed a collar 234 which is engaged and locked by an engaging-and-locking portion 244 of the movable means 222, which will be described later.

On the other hand, the movable means 222 is configured to include an insertion portion 241, a movable portion 242, a connecting portion 243 and an engaging-and-locking portion 244.

The insertion portion 241 has a substantially-cylindrical shape and the aforementioned connecting pipe 233 is inserted into the inside of the insertion portion 241. The inner diameter of the insertion portion 241 is substantially equal to the outer diameter of the connecting pipe 233. In the wall of the insertion portion 241, there are steel balls 241a with a small diameter provided evenly and circumferentially at four positions. The steel balls 241a are movable in the direction perpendicular to the center axis of the insertion portion 241 (hereinafter, referred to as the radial direction). These steel balls 241a are formed to have a diameter slightly greater than the thickness of the aforementioned wall.

The movable portion 242 covers the insertion portion 241 from outside apart by a slight distance therefrom and can be moved in the direction of the flow of water flowing therethrough. The movable portion 242 has a substantially cylindrical shape. The movable portion 242 is biased toward the upstream side in the direction of water flow (toward the opposite side from the hose main body 210) by a biasing means 245 such as a spring. The movable portion 242 can be manually pushed down toward the

downstream side (toward the hose main body 210).

The connecting portion 243 is communicated and connected to the hose main body 210. The engaging-and-locking portion 244 is formed to protrude from the outer surface of the movable portion 242. When the connecting pipe 233 has been inserted into the insertion portion 241, the engaging-and-locking portion 244 engages with and locks the collar 234 of the fastening portion 221.

In the aforementioned configuration, in order to secure the first hose 202 to the tap 201, the fastening portion 221 is first secured to the water supply tap 201. Namely, the hardware 231 is secured to the tap 201 by screw fastening and the thread grooves of the hardware 231 and the thread grooves of the screw connecting portion 232 are engaged with each other to secure them.

Then, while the movable portion 242 of the movable means 222 is manually pushed down toward the downstream side in the water flow direction and retained, the insertion portion 241 is inserted to the connecting pipe 233 of the fastening portion 221. At this time, any pushing force is not applied to the steel balls 241a in the radial direction of the insertion portion 241, and therefore the connecting pipe 233 is inserted into the insertion portion 241 while the steel balls 241a are radially outwardly forced.

When the hand is released from the movable portion 242 upon completion of the insertion, the movable portion 242 is moved toward the fastening portion 221 by the biasing force of the biasing means 245. At this time, the inner surface of the movable portion 242 contacts with the steel balls 241a of the insertion portion 241 and applies a pushing force to the steel balls 241a radially inwardly from outside. Consequently, the steel balls 241a are fitted into the groove 233a of the connecting pipe 233 inserted into the insertion portion 241 and push against it, and thus the fastening portion 221 and the movable means 222 are secured to each other. Further, at the same time, the collar 234

of the fastening portion 221 is engaged and locked by the engaging-and-locking portion 244 of the movable means 222, thereby preventing the movable means 222 from being disengaged from the fastening portion 221.

On the other hand, in order to separate the fastening portion 221 from the movable means 222, the movable portion 242 is manually pushed down toward the downstream side in the water flow direction while the engaging and locking of the collar 234 by the engaging-and-locking portion 244 is manually released. Thus, the pressing against the steel balls 241a by the movable portion 242 is released, and accordingly the pressing against the connecting pipe 233 by the steel balls 241a is released. This enables disengaging the connecting pipe 233 from the insertion portion 241, thereby enabling separating the fastening portion 221 from the movable means 222.

As described above, the first connecting portion 211 includes the fastening portion 221 which is mounted to the tap 201 of the water supply and the movable means 222 which can be inserted to and disengaged from the connecting pipe 233 of the fastening portion 221. The movable means 222 includes (a) the insertion portion 241 into which the connecting pipe 233 is inserted and (b) the movable portion 242 which is connected to the hose main body 210 and is movable in the direction of insertion and disengagement of the connecting pipe 233, wherein the connecting pipe 233 is inserted into the insertion portion 241, the movable portion 242 moves to press the pressing members (the steel balls 241a) provided in the insertion portion 241 toward the connecting pipe 233.

By employing this movable means 222, the fastening portion 221 and the hose main body 210 may be communicated and connected to each other or separated from each other through one-touch operation of the movable means 222. Therefore, women

(housewives) or weak-handed persons can easily attach and detach them.

By providing, in the movable means 222, the biasing means 245 for biasing the movable means 242 toward the upstream side in the water flow direction as described above, the movable portion 242 can be easily moved by the biasing force. Therefore, the steel balls 241a can be easily pressed against the connecting pipe 233 by the movement of the movable portion 242 toward the upstream side in the water flow direction. As a result, the connecting pipe 233 and the movable means 222 can be easily secured to each other.

As the movable means 222, a configuration for moving the movable portion 242 with a screw system is possible. However, the system described in the present embodiment has excellent usability and is less prone to looseness, thereby ensuring securing.

Further, while in the above description the fastening portion 221 includes the hardware 231 and the screw connecting portion 232 which are separable from each other, it is possible to form them integrally. In this case, the fastening portion 221 can be mounted to the tap 201 by inserting the hardware 231 to the tip end of the tap 201 and fastening screws.

Also, in some cases, a member corresponding to the hardware 231 may be originally mounted to the water supply tap 201. In this case, the fastening portion 221 may be constituted from only the screw connecting portion 232 and the hardware 231 may be eliminated. In this case, the hardware 231 is not required and thus the number of components is reduced, thereby enabling saving the product cost.

From the above description, it can be said that the fastening portion 221 of the first connecting portion 211 according to the first embodiment can be constructed by (a) the hardware 231 and the screw connecting portion 232 which are separable from each

other or by (b) only the screw connecting portion 232 which is threadably engagable with the hardware mounted to the water supply tap 201.

Also, some water supply taps 201 may be originally equipped with a member corresponding to the aforementioned screw connecting portion 232. In this case, the first connecting portion 211 may be constituted by only the movable means 222 to be adaptable to such water supply taps 201. This also negates the need for the fastening portion 221, thereby saving the product cost.

(1-2. Second Connecting Portion)

The second connecting portion 212 of the first hose 202 is provided at the other end of the hose main body 210 and communicated and connected to the ion elution unit 300. In the present embodiment, the second connecting portion 212 has completely the same configuration as that of the movable means 222 of the aforementioned first connecting portion 211.

Therefore, in order to communicate and connect the first hose 202 with the ion elution unit 300, the following process may be performed. At first, as illustrated in Fig. 15A, a first connecting portion 302 of the ion elution unit 300 is inserted into the inside of the insertion portion 241 of the movable means 222 of the second connecting portion 212 of the first hose 202, while the movable portion 242 is manually moved toward the hose main body 210 (toward the upstream side in the water flow direction) and retained. Then, as illustrated in Fig. 15B, when the insertion has been completed, the hand is released from the movable portion 242 and therefore the movable portion 242 is moved toward the ion elution unit 300 by the biasing force of the biasing means 245. Consequently, the movable portion 242 presses the steel balls 241a inwardly in the radial direction of the insertion portion 241 and thus the steel balls 241a are fitted in a slot 302c (see Fig. 15A) formed on the outer surface of the connecting pipe 302a of the

first connecting portion 302 and press the first connecting pipe 302. As a result, the second connecting pipe 212 and the first connecting pipe 302 are secured to each other.

Also, in order to separate the first hose 202 from the ion elution unit 300, the movable portion 242 is manually moved toward the hose main body 210 (the upstream side in the water flow direction) to release the pressing against the first connecting portion 302 by the steel balls 241a. Consequently, the first connecting pipe 302 can be pulled from the insertion portion 241, and accordingly the first hose 202 can be separated from the ion elution unit 300.

Since the second connecting portion 212 includes the movable means 222 as described above, the first hose 202 and the ion elution unit 300 may be communicated and connected with each other or separated from each other through one-touch operation of the movable means 222. Therefore, the same effects as those obtained by the first connecting portion 211 may be obtained and for example, anyone can easily connect and disconnect them.

(2. Second Hose)

The second hose 203 illustrated in Fig. 11 communicates and connects the ion elution unit 300 with the washing machine 1 as a feed-water apparatus. The second hose 203 is constituted by a flexible hose main body and a first connecting portion and a second connecting portion provided at the opposite ends of the hose main body.

The hose main body of the second hose 203 corresponds to the hose main body 210 of the first hose 202. The first connecting portion and the second connecting portion of the second hose 203 are constituted by only the movable means 222 constituting the first connecting portion 211 or the second connecting portion 212 of the first hose 202. Therefore, the second hose 203 and the ion elution unit 300 can be easily connected or disconnected and also the second hose 203 and the washing

machine 1 can be easily connected or disconnected through the one-touch operation of the movable means 222 by the completely the same method as that for communicating and connecting the first hose 202 with the ion elution unit 300.

The first hose 202 and the second hose 203 described above may be formed from rubber or resin to provide them with flexibility. Thus, even if the portions communicated and connected to the first hose 202 and the second hose 203 are subjected to vibrations (shock waves) or external forces (high pressures), such shocks or the like may be lessened due to the flexibility of the first hose 202 and the second hose 203. Therefore, the burden on the ion elution unit 300 connected to the first hose 202 and the second hose 203 may be reduced, thus suppressing the occurrence of failures, etc. Further, there is little possibility of water leaks at the communicating and connecting portions. Thus, the reliability of the ion elution unit 300 may be increased.

While in the above description both the first hose 202 and the second hose 203 have the movable means 222 at the opposite ends, the present invention is not limited to this configuration. For example, as illustrated in Fig. 16, a cap-type connecting portion having thread grooves incised on the inner surface thereof and capable of rotating the water flow direction in the hose main body 210 may be provided at one end of the hose main body 210 (for example, the second connecting portion 212) to form the first hose 202 and the second hose 203. Further, this cap-type connecting portion may be provided at the opposite ends (the first connecting portion 211 and the second connecting portion 212) of the hose main body 210.

For example, in the case where the connecting portions of the objects (the tap 201, the ion elution unit 300, or the washing machine 1) to which the first hose 201 and the second hose 203 are to be connected are formed to be a cylindrical shape with thread grooves formed on the outer surface thereof, the first hose 201 and the second

hose 203 having the above configuration may be employed to make it easy to connect and disconnect them by rotation of the aforementioned cap-type connecting portion. Further, as compared with the configuration of Fig. 12, the number of components of the connecting portions may be reduced, thereby saving the product cost.

Also, depending on the configuration of the ion elution unit 300, the first hose 202 may be directly connected to the ion elution unit 300, or the first hose 202 may be connected to the ion elution unit 300 thorough a screw-type or lock-type fastening portion.

(3. Ion Elution Unit)

Next, detail configurations of the ion elution unit 300 will be described.

Fig. 17 is a perspective view illustrating the appearance of the ion elution unit 300 connected to the first hose 202. Figs 18 to 20 are a front view of the ion elution unit 300, a cross sectional view of the ion elution unit 300 viewed from the behind, and a cross sectional view of the ion elution unit 300 viewed laterally, wherein the ion elution unit 300 is connected to the water supply tap 201 through the first hose 202.

The ion elution unit 300 includes a case 300a including two cabinets abutable in the water flow direction of water flowing therethrough, the cabinets being attached to each other. The case 300a hides the connecting portion between the ion elution unit 300 and the first hose 200 to prevent the appearance from being spoiled.

Fig. 21 is a cross sectional view illustrating in detail the internal construction of the ion elution unit 300, which is viewed from the front side. Fig. 22 is a cross sectional view illustrating in detail the internal construction of the ion elution unit 300, which is laterally viewed.

As illustrated in these figures, the ion elution unit 300 includes a unit main body 301, a first connecting portion 302, and a second connecting portion 303.

Hereinafter, the respective configurations will be described.

(3-1. First Connecting Portion)

The first connecting portion 302 communicates and connects the aforementioned first hose 202 to the unit main body 301 and is formed integrally with the unit main body 301. The first connecting portion 302 is configured to have a connecting pipe 302a and a collar 302a.

The connecting pipe 302a is inserted into the insertion portion 241 of the second connecting portion 212 of the first hose 202. When the connecting pipe 302a has been inserted into the insertion portion 241, the collar 302b is engaged and locked by the engaging-and-locking portion 244 of the first hose 202, which prevents the first hose 202 from disengaged from the ion elution unit 300.

The first connecting portion 302 may be also configured as follows.

Fig. 23 is an exploded perspective view illustrating another exemplary configuration of the first connecting portion 302. This first connecting portion 302 is comprised of hardware 304 and a screw connecting portion 305. The hardware 304 has completely the same configuration as that of the hardware 231 of the first connecting portion 211 of the first hose 202.

The screw connecting portion 305 has the completely the same configuration as that of the screw connecting portion 232 of the aforementioned first connecting portion 211. Namely, the screw connecting portion 305 includes a first cylindrical portion 305a having a substantially-cylindrical shape and thread grooves which are formed on the inner surface thereof and are engagable with the thread grooves on the outer surface of the hardware 304, and a second cylindrical portion 305b having a substantially cylindrical shape and formed inside of the first cylindrical portion 305a apart therefrom by a predetermined distance. The opening portions of these first

cylindrical portion 305a and the second cylindrical portion 305b at the unit main body 301 side are attached onto a doughnut-shaped disc along the outer and inner perimeters of this disc. Thus, the screw connecting portion 232 is formed.

At the bottom of the screw connecting portion 305, the unit main body 301 which communicates with the second cylindrical portion 305b is integrally formed. Further, the second cylindrical portion 305b is configured to have a shape which can be inserted into the insertion portion 241 of the movable means 222 of the first hose 202.

With this configuration, the ion elution unit 300 and the first hose 202 can be connected to each other by inserting the second cylindrical portion 305b into the insertion portion 241 of the first hose 202 and securing them. Thus, the ion elution unit 300 can be communicated and connected to the water supply tap 201 through the first hose 202.

On the other hand, by securing the hardware 304 to the tap 201 using screws and engaging the thread grooves on the hardware 304 with the thread grooves on the first cylindrical portion 305a, the ion elution unit 300 may be also directly connected to the tap 201 without using the first hose 202.

Accordingly, with this configuration of the first connecting portion 302, in communicating and connecting the ion elution unit 300 to the tap 201, the first connecting portion 302 can be easily adapted to both the case of employing the first hose 202 and the case of not employing the first hose 202.

(3-2. Second Connecting Portion)

As illustrated in Figs. 21 and 22, the second connecting portion 303 communicates and connects the aforementioned second hose 203 (see Fig. 11) with the unit main body 301 and is formed integrally with the unit main body 301. The second connecting pipe 303 is configured to include a connecting pipe 303a and a collar 303b.

The connecting pipe 303a is inserted into the insertion portion of the first connecting portion of the second hose 203. When the connecting pipe 303a has been inserted into the above insertion portion, the collar 303b is engaged and locked by the engaging-and-locking portion of the second hose 203, which prevents the second hose 203 from disengaged from the ion elution unit 300.

Also, the first connecting pipe 303a is formed to be a shape fittable to the connection pipe 51 (see Fig. 1) of the washing machine 1.

With this configuration, the ion elution unit 300 and the second hose 203 are connected to each other by inserting the connecting pipe 303a into the insertion portion 241 of the second hose 203 and securing them. Therefore, the ion elution unit 300 can be communicated and connected to the washing machine 1 through the second hose 203. On the other hand, the ion elution unit 300 may be directly communicated and connected to the washing machine 1 by fitting the connecting pipe 303a to the connection pipe 51 of the washing machine 1.

Accordingly, with this configuration of the second connecting portion 303, in communicating and connecting the ion elution unit 300 with the washing machine 1, the second connecting portion 303 can be easily adapted to both the case of employing the second hose 203 and the case of not employing the second hose 203.

By providing, in the ion elution unit 300, the aforementioned first connecting portion 302 and the second connecting portion 303 as described above, the ion elution unit 300 can be communicated and connected to the first hose 202 or the water supply tap 201 and the ion elution unit 300 can be communicated and connected to the second hose 203 or the washing machine 1 with a simple configuration. This enables saving the product cost of the ion elution unit 300.

(3-3. Unit Main Body)

The unit main body 301 is formed from an insulating material (for example, resin). Water supplied from the tap 201 flows therethrough and then is supplied to the washing machine 1. The unit main body 301 encloses a pair of electrodes 311, 312 and includes terminal portions 313, 314 corresponding to the respective electrodes 311, 312 and a detecting portion 315.

(3-3-1. Electrodes)

The electrodes 311, 312 are constituted by flat-plate-shaped silver plates of 1 cm*3 cm with a thickness of about 0.5 mm. The electrodes are placed such that the distance between their opposing surfaces gradually decreases from the upstream side (the upper side in Figs. 21 and 22) to the downstream side (the lower side in Figs. 21 and 22) in the water flow direction of water flowing through the unit main body 301.

By applying a voltage between the pair of electrodes 311, 312 from the driving unit 400 which will be described later through the code 500 and the terminal portions 313, 314, metal ions are eluted from the electrodes 311, 312. Then, the above metal ions are added to water flowing through the unit main body 301 and the water is supplied to the washing machine 1 as metal ion-containing water.

Preferably, the metal constituting the electrodes 311, 312 is silver, copper, zinc or an alloy of them. Silver ions eluted from a silver electrode and zinc ions eluted from a zinc electrode offer excellent antibacterial effects and copper ions eluted from a copper electrode offer excellent mold resistance. Also, from an alloy of these metals, ions of the constituting metals of the alloy can be eluted, thereby offering excellent antibacterial effect and mold resistance. Therefore, by constituting the electrodes 311, 312 from a proper metal, effects inherent to the metal can be obtained.

Further, it is not necessary to constitute the both electrodes 311, 312 from the same metal and one of the electrodes may be constituted from an insoluble electrode

(for example, titanium) or a carbon electrode.

Here, the antibacterial mechanism in the case of using silver electrodes as the electrodes 311, 312 will be concretely described as follows.

For example, when a person sweats, his cloths smell. This is caused by propagation of fungus. Sweat is naturally odorless and contains, as a constituent, glyceride including fatty acid and glycerin. The glyceride is decomposed by fungus, thereby generating fatty acid as a result of the decomposition of the glyceride. Thus, the resultant fatty acid smells.

However, in the case of employing silver electrodes as the electrodes 311, 312, when a voltage is applied to these electrodes, the following reaction occurs at the electrode at the anode side: $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$, and thus silver ions are eluted in the water. The silver ions affect fungus which is the source of smells, thus inactivating the fungus. Therefore, the constituents (glyceride) of sweat will not be generated by decomposition, which suppresses generation of smells. Further, aforementioned inactivation means the effects of sterilizing, eliminating or destroying fungus, or decomposition, elimination, etc.

The aforementioned electrodes 311, 312 are formed integrally with the unit 301. Namely, the unit main body 301 formed integrally with the electrodes 311, 312 may be formed by a method which places the electrodes 311, 312 within a photo-curing resin and cures the resin by ultraviolet irradiation or a method which places and holds the electrodes 311, 312 in a mold, then introduces resin therein and cools and cures the resin (insert molding). Further, with this integral forming, the electrodes 311, 312 are supported within the unit main body 301 by a part of the inner wall thereof.

For example, in the case where the unit main body 301 is constituted by several cabinets attached to one another, there is a risk of water leaks from the inside through

the junctures of these cabinets. However, by integrally forming the unit main body 301 with the electrodes 311, 312 enclosed therein, there is no problem of water leaks through the junctures and thus the sealing capability of unit main body 301 may be favorably maintained.

Further, the electrodes 311, 312 gradually wear and are lessened as a result of the elution of metal ions. Accordingly, the distance between the electrodes 311, 312 will be increased and the surface areas of electrodes 311, 312 will be reduced. In this case, the voltage required to feed an equivalent current through the electrodes 311, 312 for ensuring a predetermined amount of eluted metal ions is increased. However, the voltage which can be supplied has an upper limit. When the voltage reaches the upper limit, the current flowing through the electrodes 311, 312 decreases from then on. Consequently, the amount of eluted metal ions is decreased, which prevents a predetermined concentration of metal ions from being ensured. Therefore, in order to reliably obtain the antibacterial effects of metal ions, the electrodes 311, 312 must be replaced with new ones when it has become impossible to ensure an amount of eluted metal ions.

In the present embodiment, the electrodes 311, 312 are formed integrally with the unit main body 301 as previously described, and therefore the entire unit main body 301 is replaced with a new one. Namely, the unit main body 301 of the present embodiment is a disposable-type unit. By enabling replacing it as a unit, improper assembly or deformation of the electrodes can be prevented when a user replaces the electrodes and thus a user can easily safely achieve the replacement.

While in the present embodiment there has been described a case where the unit main body 301 includes a pair (two) of electrodes 311, 312, the number of the electrodes is not limited to this. Even when the unit main body 301 includes more than

two electrodes, the effects of the present invention may be obtained by applying a voltage to these electrodes to cause the elution of metal ions.

(3-3-2. Terminal portions)

The terminal portions 313, 314 are terminals for electrically connecting the electrodes 311, 312 to the driving unit 400 and are formed through the side wall of the unit main body 301. One ends of the terminal portions 313, 314 are electrically connected to the electrodes 311, 312 through, for example, silver soldering. The other ends are electrically connected to the driving unit 400 through the code 500. The aforementioned silver soldering is a method which bonds metal to a base material by using, as a soldering material, a silver alloy of silver and copper or zinc etc., and by melting the soldering material which melts at a lower temperature than the base material, without melting the metal of the base material.

In the present embodiment, the terminal portions 313, 314 are configured to have a shape with a round cross section at least at the portion which passes through the unit main body 301. With this configuration, the internal pressure (water pressure) of the unit main body 301 is evenly circumferentially applied to the aforementioned portions of the terminal portions 313, 314 passing through the unit main body 301, which reduces the possibility of water leaks even at high water pressures. As a result, the ion elution unit 300 may be safely utilized. Further, even when such a configuration is employed, there are little variations in the production of the ion elution unit 300, and thus the production margin can be increased.

Particularly, in the present embodiment, the terminal portions 313, 314 are configured to have a cylindrical shape with a round cross section throughout the entire portion in the axial direction. The portions of the terminal portions 313, 314 which pass through the unit main body 301 are sealed with sealing members 313a, 314a such

as O-rings (see Fig. 19). Since the terminal portions 313, 314 are configured to have a cylindrical shape, the insertion of the above sealing members 313a, 314a can be easily achieved, thereby obtaining reliable sealing capability at the portion passing through the unit main body.

(3-3-3. Detecting Portion)

The detecting portion 315 is a detecting means for detecting at least one of the presence or absence of water flows within the unit main body 301 and the flow rate of the water flows. In the present embodiment, the detecting portion 315 is provided upstream of the electrodes 311, 312 in the water flow direction within the unit main body 301. This detecting portion 315 includes a rotator 316 (see Fig. 24), a magnet 317 and a magnetism detecting portion 318.

Fig. 24 is an enlarged perspective view illustrating the rotator 316. The rotator 316 is rotated by water passing through the unit main body 301 and includes a rotation shaft 321 in the water flow direction. The rotation shaft 321 is supported by a bearing which is not shown. Two vanes 322 which receive water are attached to the rotation shaft 321 at symmetrical positions. Water flows through the unit main body 301 while impinging on the vanes 322, and therefore the vanes 322 are subjected to forces in the rotational direction about the rotation shaft 321. Consequently, the entire rotator 316 rotates about the rotation shaft 321.

Further, the rotator 316 includes two cap-shaped containing portions 322. The bottoms of the containing portions at the opposite side from the openings 323a are attached to symmetrical positions of the rotation shaft 321. The aforementioned magnet 317 is enclosed in at least one of the two containing portions 323. In the case where the magnet 317 is contained within only one of the containing portions 323, a weight having a weight equivalent to that of the magnet 317 is enclosed in the other

containing portion 323 to keep the balance of the rotator 316 during rotation. The opening 323a of each containing portion 323 is closed by a cover which is not shown.

The magnetism detecting portion 318 (see Fig. 22) detects at least one of the presence or absence of water flows within the unit main body 301 and the flow rate thereof based on the change of the magnetism of the magnet 317 caused by the rotation of the rotator 316. The magnetism detecting portion 318 is provided on the unit main body 301. The magnetism detecting portion 318 is formed from a hall IC for detecting the change of the magnetism of the magnet 317 without contacting to it through the resin forming the wall of the unit main body 301.

In the aforementioned configuration, when the rotator 316 rotates due to water flowing through the unit main body 301, the magnetism (magnetic flux, magnetic field) generated from the magnet 317 also changes. By detecting the change of the magnetism with the magnetism detecting portion 318 without contacting to it, the presence or absence of water flows within the unit main body 301 can be detected.

Further, by detecting the number of periodic aforementioned magnetism changes within a unit time with the magnetism detecting portion 318, the number of rotations of the rotator 316 within a unit time can be detected and also the flow rate of water flowing through the unit main body 301 can be detected.

Namely, by configuring the detecting portion 315 as described above, at least one of the presence or absence of water flows within the unit main body 301 and the flow rate thereof can be certainly detected.

Further, since the detecting portion 315 is configured to include the rotator 316 (rotating member) which is rotated by water flowing through the unit main body 301, the presence or absence of water flows can be easily certainly detected even when the flow rate of water is low. Further, the number of rotations of the rotator 316 changes

depending on the flow rate of the flowing water and therefore the magnetism detecting portion 318 can accurately detect the flow rate of water by detecting detection signals responsive to the flow rate.

While in the present embodiment, the above detecting portion 315 is formed integrally with the unit main body 301, the detecting portion 315 may be formed to be separable from the unit main body 315. Namely, the detecting portion 315 and the unit main body 301 may be constructed as separate components and then they may be combined. In this case, when the unit main body 301 is required to be replaced due to wear of the electrodes 311, 312 within the unit main body 301, it is unnecessary to replace the detecting portion 315. As a result, the detecting portion 315 may be effectively utilized, thereby saving the cost of replacement of the unit.

The installing position of the detecting portion 315 is not limited to upstream of the electrodes 311, 312 of the unit main body 301 in the water flow direction, and it may be downstream of the electrodes 311, 312. Also, the detecting portion 315 may be provided in a flow-out-direction variable portion 306 (see Fig. 26) which will be described later. Also, the detecting portion 315 may be provided at the first connecting portion 301, the second connecting portion 303, or outside of the ion elution unit 300 (for example, the first hole 202 or the second hose 203) as long as it is on the water supply path from the water supply tap 201 to the washing machine 1.

Also, the rotation shaft 321 of the rotator 316 may be provided in the direction intersecting with the water flow direction to cause the rotator 316 to rotate like a waterwheel.

Further, while the present embodiment has been described regarding the case where the detecting portion 315 has a rotation-detecting-type configuration using the rotator 316, the detecting portion 315 may be configured as a flow-type system.

The flow-type system is a method which detects water flows by detecting the movement of a movable body using a proper sensor, wherein the movable body is supported by a spring within a water flow path, and when water flows the movable body is moved by flows of the water pushing the movable body. For example, by providing a magnet within the movable body and placing the magnetism detecting portion (hall IC) at the position where the movable body moves when water flows, the water flows can be detected by magnetism detection. By configuring the detecting portion 315 as a flow-type system, the magnetism detection may be performed by detecting the difference between the magnetism when there are water flows and the magnetism when there is no water flow, not by detecting the rotation speed of the rotator 316, and thus water flows can be certainly detected even with a detecting portion (hall IC) with a low response speed.

As described above, the detecting portion 315 may be configured to include a movable body which moves with water flows, a magnet enclosed within the movable body, and a magnetism detecting portion for detecting the presence or absence of water flows by detecting the magnetism of the above magnet at the position where the movable body moves.

(3-4. Effects)

The above antibacterial treatment device according to the present embodiment is an antibacterial treatment device 200 including an ion generating portion (for example, the ion elution unit 300) for generating metal ions (for example, silver ions) to be added to water which is supplied from a feed-water apparatus (for example, the washing machine 1) to objects (for example, laundry). The above ion generating portion is configured to be removably installed outside of the feed-water apparatus and on the water supply path from the water supply tap 201 to the feed-water apparatus.

More specifically, the above ion generating portion is constituted by the ion elution unit 300 including the unit main body 301 which encloses a pair of electrodes 311, 312 and through which the aforementioned water passes. The ion elution unit 300 includes (a) the first connecting portion 302 for connecting the unit main body 301 to the water supply tap 201 or the first hose 202 for flowing water supplied from the tap 201, and (b) the second connecting portion for connecting the unit main body 301 to the second hose for flowing water to be supplied to the feed-water apparatus or the feed-water apparatus. Thus, the ion elution unit 300 is configured to be removably installed on the aforementioned supply path.

Thus, the ion generating portion may be retrofitted to the outside of the washing machine 1 and therefore even when the washing machine 1 is an existing type of washing machine which does not originally include an ion generating portion, a washing machine equivalent to the washing machine 1 including the ion generating portion may be realized. Therefore, unnecessary replacement of the washing machine 1 such as replacing the washing machine 1 with a washing machine 1 equipped with an ion generating portion is not required and an existing washing machine 1 may be effectively utilized. Further, the ion generating portion is removable from the water supply path to the washing machine 1 and thus the replacement of the ion generating portion can be easily achieved.

Further, since the ion elution unit 300 includes the aforementioned first connecting portion 302 and second connecting portion 303, the ion elution unit 300 may be placed outside of the washing machine 1 as follows.

First, there is a method for placing the ion elution unit 300 such that the water path is constituted by the water supply tap 201, the first hose 202, the ion elution unit 300, the second hose 203 and the washing machine 1 (the connecting method of Fig.

11).

Second, there is a method for placing the ion elution unit 300 such that the water path is constituted by the water supply tap 201, the ion elution unit 300, the second hose 203 and the washing machine 1.

Third, there is a method for placing the ion elution unit 300 such that the water path is constituted by the water supply tap 201, the first hose 202, the ion elution unit 300 and the washing machine 1.

Since the ion elution unit 300 includes the first connecting portion 302 and the second connecting portion 303, there are increased variations in the connection for installing the ion elution unit 300 on the water supply path from the water supply tap 201 to the washing machine 1 as previously described. Therefore, it is possible to realize installing methods of the ion elution unit 300 according to the needs of users.

(3-5. Other Configurations of Ion Elution Unit)

(3-5-1. Shape of Unit Main Body)

While there has been previously described a case where the unit main body 300 of the ion elution unit 300 has a shape extending vertically downwardly along the flow direction of water flowing therethrough, the shape of the unit main body 1 is not limited to it. For example, as illustrated in Fig. 25, the unit main body 301 is formed to be a shape including a 90-degree-bent portion downstream of the electrodes 311, 312 in the water flow direction for changing the flow direction of water flowing therethrough. Namely, the unit main body 301 may be formed to be a shape for flowing out water in a different direction from the flow-in direction of water flowing into the unit main body 301. Further, Fig. 25 illustrates an example where the ion elution unit 300 is directly connected to the water supply tap 201.

With this configuration, the flow-out direction of water from the ion elution

unit 300 may be changed from the vertical direction to, for example, the horizontal direction and therefore the second hose 203 to be connected to the second connecting portion 303 of the ion elution unit 300 can be easily routed. Namely, even when the distance between the connection pipe 51 of the washing machine 1 and the ion elution unit 300 is too small, the ion elution unit 300 and the washing machine 1 can be connected by diverting the second hose 203 without forcibly bending the second hose 203. This reduces the physical burden on the second hose 203.

(3-5-2. Flow-out Direction Changing Portion)

Also, as illustrated in Fig. 26, a flow-out direction changing portion 306 for changing the flow-out direction of water from the unit main body 301 may be connected to the unit main body 301 instead of bending the unit main body 301.

The flow-out direction changing portion 306 is constituted by a cylindrical-shaped pipe which is bent substantially at a 90 degree angle. One end of the flow-out changing portion 306 is rotatably mounted to the second connecting portion 303 of the ion elution unit 300 and the second hose 203 (see Fig. 11) is fitted to the other end. Water supplied from the water supply tap 201 flows through the unit main body 301 vertically downwardly, then turns by substantially 90 degree and flows horizontally at the flow-out direction changing portion 306. The water is then supplied to the washing machine 1 through the second hose 203. Therefore, the second hose 203 can be unrestrainedly routed to avoid walls surrounding the washing machine 1, which makes it easy to utilize the ion elution unit 300.

Further, a state displaying section 402 (see Fig. 27) of the driving unit 400 which will be described later may be unitized to the flow-out direction changing portion 306. In this case, by rotating the flow-out direction changing portion 306, the state displaying section 402 can be placed at a position which can be easily viewed by users.

This improves the visibility of the state displaying section 402.

Further, as illustrated in Fig. 26, an engaging-and-locking portion 306a for engaging and locking the collar 303b of the second connecting portion 303 of the ion elution unit 300 may be provided on the outer surface of the flow-out direction changing portion 306 to prevent the flow-out direction changing portion 306 from being disengaged from the second connecting portion 303.

(3-5-3. Angled Placement of Unit Main Body)

While the unit main body 301 having the aforementioned configuration is placed such that water flows vertically downwardly therein, the present invention is not limited to this placement. For example, the unit main body 301 may be configured to be obliquely placed, namely the unit main body 301 may be configured to be placed such that water flows obliquely with respect to the vertical direction therein. The concept that water flows obliquely with respect to the vertical direction includes the case where water flows horizontally (laterally).

According to this configuration, the height-wise (vertical) dimension of the unit main body 301 and, therefore, the ion elution unit 300 can be reduced without changing the size of the electrodes 311, 312. Therefore, even when there is insufficient height-wise space between the water supply tap 201 and the washing machine 1, the ion elution unit 300 can be easily installed without abutting it against surrounding apparatuses or walls while the metal ion elution capability is maintained equivalent to the case where the ion elution unit 300 is placed such that the water flows vertically. As a result, the decision branch of the installation places for the ion elution unit 300 can be widened.

(3-5-4. First Filter)

As illustrated in Fig. 21 and Fig. 22, a first filter 331 for eliminating impurities

from water may be provided upstream, in the water flow direction, of the electrodes 311, 312 in the unit main body 301 of the ion elution unit 300.

With this configuration, impurities such as debris or metal scrap in water can be arrested by the first filter 331, thereby preventing such impurities from adhering to the electrodes 311, 312 or clogging between the electrodes 311, 312. This may prevent harmful effects caused by adhesion of impurities (for example, decreases in the amount of eluted metal ions).

Further, the first filter 331 is preferably configured to be placed at the water inlet of the ion elution unit 300, namely at the first connecting portion 302. In this case, there is a merit that the maintenance can be easily performed since when the ion elution unit 300 is removed from the supply path, a user can easily perform cleaning of the first filter. Further, as compared with a configuration in which the ion elution unit 300 is provided with a removing portion for removing the first filter 331, the number of components can be reduced since there is no need for providing such a removing portion. Further, there is no need for sealing which would be required at the removing portion and it is unnecessary to worry about water leaks.

Preferably, the first filter 331 is placed upstream of the detecting portion 315 in the water flow direction. In this case, impurities such as debris or metal scrap in water are prevented from adhering to or clogging in the detecting portion 315 to adversely affect the detection of the detecting portion 315 resulting in malfunction.

Also, the first filter 331 may be provided on the water supply path (for example, in the first hose 202) between the ion elution unit 300 and the tap 201 instead of within the aforementioned ion elution unit 300. In this case, the same effects as aforementioned can be obtained.

(3-5-5. Second Filter)

A second filter for eliminating impurities in water may be provided downstream, in the water flow direction, of the electrodes 311, 312 within the unit main body 301 of the ion elution unit 300. This second filter may be provided either within the ion elution unit 300 or on the water supply path (for example, in the second hose 203) between the ion elution unit 300 and the washing machine 1.

With this configuration, even if metal scraps of the electrodes 311, 312 of the ion elution unit 300 are flowed to the downstream side, they are arrested by the second filter. This prevents metal scraps from colliding on the apparatus (the washing machine 1) or articles (laundry) resulting in harmful effects.

The second filter is preferably placed at the water outlet of the ion elution unit 300, namely in the second connecting portion 303. In this case, a user can easily clean the second filter by removing the ion elution unit 300 from the supply path and therefore maintenance of the second filter can be easily performed. Further, as compared with a configuration in which the ion elution unit 300 is provided with a removing portion for removing the second filter, the number of components can be reduced since there is no need for providing such a removing portion. Further, there is no need for sealing which would be required at the removing portion and it is unnecessary to worry about water leaks.

Also, the second filter may be provided downstream in the water flow direction of the electrodes 311, 312 and upstream in the water flow direction of the detecting portion 315. Namely, the second filter may be placed between the electrodes 311, 312 and the detecting portion 315 placed downstream thereof. In this case, the second filter prevents metal scraps of the electrodes 311, 312 from flowing toward downstream side, thereby preventing the metal scraps from colliding on the detecting portion 315 resulting in malfunction of the detecting portion 315.

(3-5-6. Separation of First Connecting Portion and Second Connecting Portion from Unit Main Body)

The aforementioned first connecting portion 302 may be configured to be separable from the unit main body 301 enclosing the electrodes 311, 312. Further, the aforementioned second connecting portion 303 may be similarly configured to be separable from the unit main body 301. In this case, when the unit main body 301 is required to be replaced due to wear of the electrodes 311, 312, it is unnecessary to replace the first connecting portion 302 and the second connecting portion 303. As a result, the first connecting portion 302 and the second connecting portion 303 can be effectively utilized, thereby saving the cost of replacement of the unit.

(3-5-7. Generator)

The ion elution unit 300 according to the present embodiment may incorporate a generator which generates electric power through rotation of a rotator caused by water flows within the unit main body. The above rotator may be the rotator 316 of the detecting portion 315. With this configuration, only when water flows through the unit main body 301, a voltage is automatically applied to the electrodes 311, 312 through private power generation to automatically cause the elution of metal ions.

(3-5-8. Other Configurations of Ion Generating Portion)

While there has been described an example where the ion elution unit 300 including the electrodes 311, 312 for eluting metal ions is employed as the ion generating portion, the present invention is not limited thereto. The ion elution portion may be constituted by a metal-ion eluting material (for example, silver sulfide as a silver-eluting material) loaded in a cartridge which enables elution of metal ions by flowing water through the cartridge (without applying a voltage).

(4. Driving Unit)

Next, details of the driving unit 400 will be described.

Fig. 27A to Fig. 27D are respectively a plan view, a front view, a side view and a rear view illustrating the outer configuration of the driving unit 400. Fig. 28 is a block diagram illustrating the internal detail construction of the driving unit 400. The internal basic construction of the driving unit 400 is almost the same as that of the driving circuit 120 of the power supply unit 101 illustrated in Fig. 9 of the first embodiment.

The driving unit 400 drives the ion elution unit 300 and includes a operating section 401, a state displaying section 402, a voltage generating section 403, a transformer circuit 404, a power-supply voltage detecting section 405, a current detection circuit 406, and a control section 407. The control section 407 controls the operations of the respective portions. Further, on the backside of the driving unit 400, there is provided a hole 400a for inserting the hook attached to a wall or the washing machine 1 therethrough (see Figs. 27C and 27D). Hereinafter, details of the respective configurations will be described.

(4-1. Operating Portion)

The operating section 401 enables a user to perform the operation of switching ON/OFF of the operation of the driving unit 400 and is comprised of a knob, a lever, a button etc. By providing this operating section 401 on the driving unit 400, the user can place the driving unit 400 at a place which makes it easy to operate the driving unit 400 and can switch the operation of the driving unit 400.

Particularly, in the present embodiment, as illustrated in Fig. 27B, the operating section 401 is constituted by a rotation-type knob. Thus, the operating state of the driving unit 400 can be easily visually noticed from the physical state change, such as rotations, of the operating section 401. This eliminates the necessity of

providing a LED, etc., for displaying the ON/OFF operating state of the operation and also prevents wasteful electric power consumption for such display. Particularly, in the case of battery-drive, such electric power consumption which would be otherwise wasted may be effectively utilized for the battery-drive.

Any operating section 401 may be employed provided that it utilizes no electric power and the state thereof is changed physically to enable visually noticing the operating state of the driving unit 400. As such physical state changes, rotations of the above knob, projections and depressions of a button, tilts of a lever, changes of the collar and letters on a button, etc., are possible.

(4-2. State Displaying Section)

The state displaying section 402 displays the operating state of the driving unit 400 and is constituted by LEDs, for example. More specifically, the state displaying section 402 is comprised of a battery-life display lamp 402a and a silver-ion elution lamp 402b. The turning-on and turning-off of these lamps are controlled by the control section 407, which will be described.

The battery-life lamp 402a is a lamp which blinks when the power-supply voltage detecting section 405, which will be described later, detects the battery of the voltage generating portion 403 reaching its end of life. When there is a residual battery capacity in the operation-ON-state and the operation-OFF-state of the driving unit 400, the battery-life lamp 402a is maintained at the turned-off state in order to save the battery consumption.

The silver-ion display lamp 402b is a lamp which blinks when a voltage generated from the voltage generating section 403 which will be described later is applied to the electrodes 311, 312 and thus silver ions as metal ions are eluted. The elution of silver ions can not be viewed by human eyes. Therefore, by providing the

silver ion displaying lamp 402b to inform a user that silver ions are eluted, the user can notice that the elution of silver ions are certainly performed and the time when silver ions are eluted. Thus, the user can safely use the antibacterial treatment device 200 according to the present invention.

When the electrodes 311, 312 of the ion elution unit 300 have worn due to the elution of silver ions and thus the current flowing through the electrodes 311, 312 have decreased for the aforementioned reason, it can be determined that the electrodes 311, 312 have reached the end of their life (the time to replace them). Therefore, when the current detection circuit 406, which will be described later, detects that the current flowing through the electrodes 311, 312 decreases below a threshold value, the control section 407 determines that the electrodes 311, 312 have worn and are required to be replaced and causes the silver-ion displaying lamp 402b to rapidly blink. Consequently, it is possible to inform the user that the replacement of the ion elution unit 300 (the unit main body 301) is necessary, thereby urging the user to perform the replacing operation.

When the electrodes 311, 312 have worn, it must be prioritized over battery exhaustion to urge the user to replace the ion elution unit 300, in order to prevent the user from using them without knowing that a desired antibacterial treatment can not be performed. Therefore, the control section 407 continues to cause the silver-ion display lamp 402b to blink until the operation of the driving unit 400 is brought into the OFF-state by the operation of the operating section 401 or the battery is exhausted.

In the event that the code 500 connecting the driving unit 400 to the ion elution unit 300 is disengaged for some reasons, the electrodes 311, 312 of the ion elution unit 300 is not fed with a voltage through the code 500 and thus there is no current flowing through the electrodes 311, 312, even though the operation of the driving unit 400 is in

the ON-state. Therefore, in this case, similarly to the aforementioned case, the control section 407 causes the silver-ion display lamp 402b to rapidly blink to inform the user about the abnormal state, based on detection signals from the current detection portion 406.

As described above, in the event of abnormal states (the end of battery life, wear of the electrodes 311, 312, disengagement of the code 500, etc) which adversely affect the metal ion elution of the ion elution unit 300, the control section 407 continues to cause the battery-life display lamp 402a and the silver-ion elution lamp 402b to be displayed (blinked or rapidly blinked) until the main power supply (battery) gets exhausted. This makes it possible to certainly inform the user about the abnormal states, thereby urging the user to perform proper operations (replacement of the battery, replacement of the unit main body 301, or reconnection of the code 500).

Also, a warning means for generating warning sounds (for example, a buzzer) may be provided on the driving unit 400 and in the event of the aforementioned states which adversely affect metal ion elution, the control section 407 may cause the warning means to generate warning sounds to inform users about the abnormal states, based on abnormal detection signals (battery-life detection signals) from the power-supply voltage detecting section 405 and abnormal detection signals (signals indicative of reduction of the current of the electrodes 311, 312) from the current detection circuit 406.

Since the driving unit 400 includes the state displaying section 402 as previously described, the user can easily grasp the operating state of the ion elution unit 300 from the display of the state displaying section 402.

Also, the above state displaying section 402 may be configured as a display unit separated from the driving unit 400. In this case, only the display unit may be

placed at a position which can be easily viewed. For example, the driving unit 400 may be placed on a side surface of the washing machine 1 and the display unit may be placed on the front surface of the washing machine 1. Therefore, the user can quickly grasp the operating state of the ion elution unit 300.

Also, the aforementioned display unit may be placed on the ion elution unit 300. By providing the display unit on the ion elution unit 300, which is the object to be monitored in term of the operating state, the user can directly grasp the operating state of the ion elution unit 300.

As previously described, the state displaying section 402 includes a plurality of display lamps, which are the battery-life lamp 402a and the silver-ion elution lamp 402b, corresponding to respective operating states. However, the state displaying section 402 may employ a single display portion (display lamp) for displaying a plurality of states by changing the displaying mode according to respective operating states.

Namely, the state displaying section 402 may be configured to change the displaying mode of a single display lamp, for example, by turning on, blinking or rapidly blinking the displaying lamp according to respective operating states. For example, the silver-ion elution lamp 402b may be lighted in the power-supply-ON state, blinked when silver-ion-elution is being performed and rapidly blinked in the event of silver ion abnormal states. In this case, a plurality of operating states can be displayed with a single component, which enables reduction of the number of components, thereby saving the cost of the driving unit 400 and the electric power consumption. Further, the user is not required to notice a plurality of display portions and can easily notice the operating state. Further, a single display portion does not occupy a large display space on the driving unit 400 and therefore the driving unit 400 may be configured to be compact.

Further, in the case where a single display lamp is utilized to display an excessive number of states, the user may not easily notice the operating state. Therefore, the number of the display lamps may be determined in consideration of both the number of operating states to be displayed and the visibility for users. In this regard, the configuration of Fig. 27B employing two display lamps provides a favorable balance between the number of operating states and the visibility for users.

Also, the silver-ion elution lamp 402b of the state displaying section 402 may be turned off after a predetermined time (for example, two seconds) has elapsed since it starts lighting or blanking. In the case where the voltage generating section 403 is constituted by a dry battery (battery) 403a, waste of electric power consumption of the dry battery 403a can be reduced, thereby enabling using the dry battery 403a for a long time.

For example, in order to elute a predetermined amount of silver ions from the electrodes 311, 312, it is necessary to feed a current of about 20 mA to the electrodes 311, 312. On the other hand, in order to turn on a LED, a considerable amount of current, namely a current of about 3 mA, is required for only a single LED. Therefore, when a LED is lighted for a long time, the battery can be exhausted immediately. As a result, the dry battery 403a to be used for the silver-ion elution of the ion elution unit 300 will be also utilized for another application (for displaying the LED), and thus the dry battery 403a will be immediately exhausted, which adversely affects the silver-ion elution.

However, by turning off the silver-ion elution lamp 402b of the state displaying section 402 after a predetermined time has elapsed, limited energy such as the dry battery 403a may be effectively utilized only for the elution of metal ions, thereby saving the running cost.

Particularly, with this configuration which turns on and turns off the silver-ion elution lamp 402b just after power-on when it is determined through circuit checks that the ion elution unit is under the state where metal ion elution can be normally performed, the user can verify, at power-on, whether or not the ion elution unit can be normally utilized and wasteful electric power consumption can be saved by the subsequent turning-off.

Further, with the configuration in which the silver-ion elution lamp 402b rapidly blinks, etc., in the event that abnormality is found at this time, for informing the user about the abnormality, the user can certainly know the abnormality.

(4-3. Voltage Generating Section)

The voltage generating section 403 generates a voltage to be applied to the electrodes 311, 312 of the ion elution unit 300. More specifically, a dry battery 403a, a plug (power supply connector) which is inserted to a domestic plug socket (commercial power supply) and a connection code 403b, and a AC adapter for converting an alternating current into a direct current may be employed as the voltage generating section 403. The application of the voltage generated from the voltage generating section 403 to the electrodes 311, 312 is controlled by the control section 407.

By applying the voltage generated at the voltage generating section 403 to the electrodes 311, 312 through the transformer circuit 404 which will be described later and the code 500, metal ions are eluted from the electrodes 311, 312 in the ion elution unit 300.

Also, when the voltage generating section 403 is constituted by the battery 403a to perform battery-driving, the driving unit 400 can be installed at arbitrary places. For example, the driving unit 400 can be utilized even at a place where commercial power supply can not be utilized or places where there is insufficient number of

receptacles even though commercial power supply can be utilized. Namely, the user can use the driving unit 400 at arbitrary places to drive the ion elution unit 300, without worrying about the presence or absence of commercial power supply.

Also, the voltage generating section 403 may be configured to include all of the dry battery 403a, the aforementioned plug and the connection code 403b and the AC adapter. This enables driving the ion elution unit 300 through both the battery-drive and the drive of commercial power supply. For example, under environments where commercial power supply can not be utilized, the ion elution unit 300 can be driven by the dry battery 403a, while under environments where commercial power supply can be utilized, the commercial power supply can be utilized through the aforementioned plug and connection code 403b or the AC adapter. Thus, the user can select an optimal power supply according to the power supply environment in order to drive the ion elution unit 300.

Also, the ion elution unit 300 can be driven not only by battery-driving and also by commercial power supply, thereby saving the running cost and preventing interruption of the operation of the driving unit 400 due to battery exhaustion.

Also, the voltage generating section 403 may be constituted by a rechargeable battery and the rechargeable battery may be configured to be automatically charged through the aforementioned plug and connection code 403b and the AC adapter. This eliminates the necessity of providing a separated battery charger, thereby improving user's convenience.

Also, the aforementioned plug as the voltage generating section 403 may be either connected to the driving unit 400 through the connecting code 403b or formed integrally with the driving unit 400 itself. This eliminates the necessity of utilizing the connection code 403b, thereby enabling downsizing the entire driving unit 400. This

may reduce the installation space for the entire driving unit 400.

(4-4. Transformer Circuit)

The transformer circuit 404 is a circuit for transforming (increasing or decreasing) a voltage generated at the voltage generating section 403 and supplying the transformed voltage to the ion elution unit 300. Since the driving unit 400 includes this transformer circuit 404, a sufficient voltage (for example, about 20 V) to cause metal ion elution in the ion elution unit 300 may be obtained even in the case where the voltage generating section 403 is constituted by a common dry battery 403a which outputs a voltage of 1.5 V.

Namely, the voltage generating section 403 can be constituted by the dry batteries 403a which output a voltage of 9 V or 12 V. However, these dry batteries are expensive, require higher running cost and are difficult to continuously use, as compared with a commonly used battery having an output of 1.5 V.

However, by providing the transformer circuit 404 in the driving unit 400 as previously described, such inconvenience can be avoided and also higher voltages can be output as required.

Further, in the case where commercial power supply is utilized as the voltage generating section 403, the transformer circuit 404 decreases an AC of 100 V to about 20 V, for example, to provide a voltage suitable for causing metal ion elution in the ion elution unit 300.

Also, the transformer circuit 404 may be configured to change the applied voltage according to the load (the resistance of the electrodes 311, 312). The electrodes 311, 312 are driven by a constant current and if a high voltage is always applied to them, the remaining portion of the voltage applied to the electrodes 311, 312 other than the portion required for the metal ion elution is consumed as energy by heats

in the constant current circuit, resulting in wasteful electric power consumption. However, by changing the applied voltage depending on the load as previously described, the electric power loss is reduced, thereby effectively utilizing the battery energy.

(4-5. Power-Supply Voltage Detecting Section)

The power-supply voltage detecting section 405 detects the end of battery life or power supply abnormality by monitoring the output voltage of the voltage generating section 403. More specifically, when the output voltage of the voltage generating section 403 reduces below a predetermined voltage, the power-supply voltage detecting section 405 determines that the battery has reached the end of the life or there is power supply abnormality and outputs a signal indicative thereof to the control section 407. In this case, the control section 407 causes the battery-life lamp 402a of the state displaying section 402 to blink for informing the user about the occurrence of the abnormality.

Consequently, in the case where the voltage generating section 403 is constituted by the dry battery 403a, it is possible to inform the user that the battery has reached the end of its life and it is time to replace it. This may prevent harmful effects such as liquid leaks due to continuous use of the dry battery 403a.

When the voltage source of the voltage generating section 403 is constituted by either the dry battery 403a or commercial power supply, if the output voltage of the voltage generating section 403 reduces for some reasons, the ion elution unit 300 can not properly operate and, for example, the amount of eluted metal ions reduces. However, since the power-supply voltage detecting section 405 monitors the output voltage of the voltage generating section 403, such inconvenience can be prevented, thereby enabling properly operating the ion elution unit 300.

(4-6. Current Detection Circuit)

The current detection circuit 406 detects the current flowing through the electrodes 311, 312 of the ion elution unit 300 and if this current reduces below a threshold value, outputs a signal indicative thereof to the control section 407. When this current reduces below the threshold value, it can be determined that the electrodes 311, 312 have worn due to the elution of metal ions and the electrodes 311, 312 have reached the end of their life. Therefore, the control section 407 causes the silver-ion display lamp 402b to rapidly blink for informing the user about the end of the life of the electrodes 311, 312, thereby urging the user to replace the ion elution unit 300 (unit main body 301).

This may prevent reduction of the amount of metal ions eluted from the electrodes 311, 312 due to wear of the electrodes 311, 312, resulting in loss or reduction of desired effects (for example, antibacterial effect) of metal ions.

Also, when the current detection circuit 406 detects that the current exceeds the threshold value, it can be determined that there is an abnormal state such as short-circuiting in the circuits or the electrodes 311, 312. Therefore, in this case, the current detection circuit 406 may output a signal indicative thereof to the control section 407 and the control section 407 may perform control to inform the user about the abnormal state.

(4-7. Control Section)

(4-7-1. First Control)

The control section 407 controls the operations of respective portions of the driving unit 400 as previously described. In the present embodiment, the control section 407 controls the application of a voltage generated at the voltage generating section 403 to the electrodes 311, 312 of the ion elution unit 300 depending on the

presence or absence of water flows within the unit main body 301 detected by the magnetism detecting portion 318 of the ion elution unit 300.

More specifically, the control section 407 performs control to cause the voltage generated at the voltage generating section 403 to be applied to the electrodes 311, 312 of the ion elution unit 300 when the magnetism detecting portion 318 of the ion elution unit 300 detects water flows within the unit main body 301 and to stop the application of the voltage to the electrodes 311, 312 when the magnetism detecting portion 318 does not detect the above water flows.

When there is no water flow in the unit main body 301, the user or the apparatus do not require metal-ions-containing water and do not flow water, or there is no water in the unit main body 301. Therefore, there is no need to elute metal ions (silver ions) from the electrodes 311, 312 by applying a voltage. Therefore, if a voltage is continued to be applied to the electrodes 311, 312, there will be wasteful electric power consumption in the driving unit 400.

However, since the control section 407 performs the aforementioned control, a voltage can be applied to the electrodes 311, 312 to elute metal ions from the electrodes 311, 312 when water starts to flow within the unit main body 301, namely only when metal-ions-containing water is required and water exists and flows within the unit main body 301. Thus, since a voltage is applied to the electrodes 311, 312 to elute metal ions only when there is a need to elute metal ions, wasteful electric power consumption at the driving unit 400 can be eliminated.

Also, if a voltage is applied to the electrodes 311, 312 when there is no water flow within the unit main body 301, there will be a high concentration of eluted metal ions around the electrodes 311, 312, which may prevent subsequent elution of metal ions. Further, water containing an unnecessarily-large amount of metal ions will be

generated, which may result in wasted expensive metal of the electrodes 311, 312. Also, water containing an unnecessarily-high concentration of metal ions will be generated, which may provide adverse effects.

However, according to the aforementioned control, a voltage is not applied to the electrodes 311, 312 when there is no water flow, it is unnecessary to worry about the aforementioned problems. Further, in an apparatus which automatically feeds water such as the washing machine 1, the elution of metal ions can be automatically performed, which may eliminate user's manipulation for controlling the metal elution in synchronization with the feeding of water by the apparatus.

(4-7-2. Second Control)

The control section 407 may perform control to change the voltage applied to the electrodes 311, 312 or the current flowing through the electrodes 311, 312 depending on the detected flow rate, when the magnetism detecting portion 318 detects the flow rate of water flowing within the unit main body 301.

The flow rate of the water supplied from the water supply tap 201 varies depending on the area or the place where the washing machine 1 is installed. If a voltage is applied to the electrodes 311, 312 to elute the same amount of metal ions at areas where the above flow rate is high and areas where the above flow rate is low, the amount of water supplied within the same time interval varies and thus the metal ion concentration varies depending on the flow rate of water. Therefore, when the amount of laundry and the amount of water supplied to the laundry are constant, the amount of metal ions adhering to the same amount of laundry varies and there may be cases where sufficient effects for laundry (for example, antibacterial effect) can not be obtained due to a small amount of metal ions or cases where laundry is contaminated by metal compound adhered to the laundry due to a large amount of metal ions.

However, since the control section 407 performs the aforementioned control, it is possible to elute, from the electrodes 311, 312, an amount of metal ions corresponding to the flow rate of water flowing within the unit main body 301. Thus, the metal ion concentration of metal-ion-containing water can be made constant regardless of the installation place of the washing machine 1, thereby preventing the occurrence of excess and deficiency of the amount of eluted metal ions. This enables properly performing a desired process using metal ions according to the amount of laundry, regardless of the installation place of the washing machine 1, and prevents contamination of the laundry due to excessive elution of metal ions.

Also, by changing the amount of metal ions eluted within a unit time depending on the flow rate of water in the unit main body 301, the user can obtain metal-ion-containing water with a predetermined metal ion concentration, regardless of variations of the flow rate. As a result, in the case where the metal ions are silver ions, the user can obtain stabilized antibacterial effects.

(4-7-3. Third Control)

The control section 407 may perform control for stopping the application of a voltage to the electrodes 311, 312 after a predetermined time has elapsed since the voltage generating section 403 starts to apply the voltage to the electrodes 311, 312.

For example, when the flow rate of water flowing within the unit main body 301 is low, if the elution of metal ions from the electrodes 311, 312 is continuously performed, the metal ion concentration of the metal-ion-containing water becomes extremely high and thus the electrodes 311, 312 will early wear or the laundry will be contaminated by metal compound adhered to it.

However, according to the aforementioned control of the control section 407, even when the flow rate is low, the elution of metal ions can be interrupted at a proper

time point and therefore it is possible to prevent the occurrence of excessive concentration due to an excessive amount of eluted metal ions or significant reduction of the life of the electrodes 311, 312.

The counting of the predetermined time may be reset to zero in the event that the voltage application has been interrupted for a predetermined time or more. In this case, the time resetting is not immoderately performed even when multiple times of feed-water are performed in order to increase the amount of water within the washing bath 30 to a predetermined amount or when the user temporarily interrupts the feed-water. Therefore it is unnecessary to worry about troubles such as the case where the predetermined time is excessively elongated and as a result an unnecessarily large amount of metal ions is eluted, resulting in an excessively-high concentration.

(4-8. Other Configurations)

The antibacterial treatment device 200 according to the present invention may employ a driving unit 400' illustrated in Fig. 29 instead of the driving unit 400 illustrated in Fig. 28. In addition to the constructions of the driving unit 400, this driving unit 400' includes at least one of a concentration setting section 408, a water-feed-amount setting portion 409, an elution number counting section 410, a feed-water number counting section 411, a elution-starting feed-water number setting section 412, a storage section 413 and a vibration sensor 414.

(4-8-1. Concentration Setting Section)

The concentration setting section 408 enables a user to set the metal ion (silver ion) concentration. In this case, the control section 407 performs a control for changing the voltage generated at the voltage generating section 403 according to the concentration set at the concentration setting section 408 and applying the voltage to the electrodes 311, 312. Also, the control section 407 may change the current flowing

through the electrodes 311, 312 or the time period that the voltage generated at the voltage generating section 403 is applied to the electrodes 311, 312.

In this case, a user can set the metal ion concentration of the metal-ion-containing water by setting the concentration with the concentration setting section 408. For example, it is possible to provide a metal ion concentration appropriate to an antibacterial capability requested by a user. This may increase the usability and the range of use of the antibacterial treatment device 200 according to the present invention.

(4-8-2. Feed-Water Amount Setting Section)

The feed-water amount setting section 409 is for setting the amount of water fed to the washing machine 1 as a feed-water apparatus. In this case, the control section 407 performs a control for changing the elution time of metal ions (silver ions), namely the time period that the voltage generated at the voltage generating section 403 is applied to the electrodes 311, 312 (the time period that a current is fed to the electrodes 311, 312), depending on the amount of water set by the feed-water amount setting section 409.

The amount of eluted metal ions for obtaining a predetermined metal ion concentration required for the antibacterial treatment for laundry is determined by the amount of water fed to the washing machine 1. The amount of eluted metal ions is basically in accordance with Faraday's laws and therefore by changing the time period that a predetermined current is fed to the electrodes 311, 312 through application of a voltage, depending on the aforementioned amount of water, metal-ion-containing water with a desired concentration can be stably supplied to the washing machine 1 without using expensive means such as flow-rate detecting means (the detecting portion 315).

The metal-ion elution time can be changed by changing the total time that a

voltage is applied to the electrodes 311, 312 or changing the ratio (time) of the ON time and the OFF time in the case where the voltage application to the electrodes 311, 312 is alternately turned on and off.

(4-8-3. Elution Number Counting Section)

The elution number counting section 410 counts the number of times that the elution of metal ions (silver ions) has been performed at the ion elution unit 300. Here, the number of times that the elution of metal ions has been performed may be (a) the number of times that the application of voltage to any one of the electrodes 311, 312 has been turned on in the case where the voltage is alternately applied to the electrodes 311, 312 from the voltage generating section 403 or (b) the number of times that the metal ion elution from the electrodes 311, 312 has started and then ended.

In this case, the control section 407 causes the silver-ion display lamp 402b of the state displaying section 402 to rapidly blink when the number of times that metal ion elution has been performed exceeds a predetermined value. As the number of times that metal ion elution has been performed increases, the electrodes 311, 312 gradually wear and therefore by counting the number of times that metal-ion elution has been performed at the counter portion 408, the life of the electrodes 311, 312 can be expected to some extent.

Therefore, it is possible to inform a user about the end of the life of the electrodes 311, 312, urging him to replace the unit main body 301, through the rapid blink of the silver-ion display lamp 402b caused by the control section 407.

Such effects can be easily obtained with a simple configuration such as the elution number counting section 410.

(4-8-4. Feed-Water Number Counting Section)

The feed-water number counting section 411 counts the number of times that

water has been fed from the ion elution unit 300 to the washing machine 1 as a feed-water apparatus, based on the presence or absence of water flows detected by the detecting portion 315 of the ion elution unit 300. For example, when the detecting portion 315 detects water flows within the unit main body 301 at first, the feed-water number counting section 411 counts it as a first feed-water and when the detecting portion 315 detects that there is no water flow and then detects water flows again, the feed-water number counting section 411 counts it as a second feed-water.

In the case where the feed-water number counting section 411 is provided, the control section 407 applies the voltage generated at the voltage generating section 403 to the electrodes 311, 312 of the ion elution unit 300 to cause the elution of metal ions from the electrodes 311, 312, after the number of times that feed-water has been performed counted by the feed-water number counting section 411 reaches a number corresponding to the time requiring the metal ion elution (a number corresponding to a laundry-washing process which requires metal ion elution), for example, after a third feed-water.

In a normal operation of the laundry-washing process of the washing machine 1, the washing process is first performed and then the rinsing process is performed. As feed-water for the washing machine 1, there are a main feed-water for supplying a predetermined amount of water for the respective processes and an additional feed-water for adding makeup water in the middle of the respective processes in order to compensate for a lowered water level due to absorption of water into clothes. For example, if metal-ion-containing water is supplied to the washing machine 1 during the washing process, metal ions will flow away together with water containing a large amount of contamination of clothes and detergent constituents and thus the metal ions will not sufficiently work on the clothes, resulting in wasting the metal ions.

However, since the electrodes 311, 312 are not fed with a voltage during the washing process in which the first feed-water (main feed-water) and the second feed-water (additional feed-water) are performed and the electrodes 311, 312 is fed with a voltage to cause the elution of metal ions from the subsequent rinsing process, it is possible to avoid wasting eluted metal ions, enabling effective utilization of metal ions. Further, contaminations of the laundry have been substantially removed in the washing process, and therefore by subsequently supplying metal-ion-containing water, metal ions can easily work on the laundry.

(4-8-5. Elution-Starting Feed-Water Number Setting Section)

The elution-starting feed-water setting portion 412 is for setting the number of times that feed-water is performed before starting the metal ion elution from the electrodes 311, 312 of the ion elution unit 300. In the case where the elution-starting feed-water number setting section 412 is provided, the control section 407 applies the voltage generated at the voltage generating section 403 to the electrodes 311, 312 of the ion elution unit 300 to cause the elution of metal ions from the electrodes 311, 312 when the number of times that feed-water has been performed counted by the feed-water number counting section 411 reaches the number of feed-waters set by the elution-starting feed-water number setting section 412.

For example, in the case where the rinsing process after the washing process includes a plurality of rinsing processes (for example, three pool-rinsing processes), feed-water to the washing machine 1 is performed during the respective rinsing processes. At this time, in order to cause metal ions to adhere to clothes for applying the antibacterial effects thereto, metal-ions-containing water have to be fed to the washing machine 1 at least during the final rinsing process and therefore it is not necessary to supply metal-ions-containing water to the washing machine 1 during the

rinsing processes before the final rinsing process. This is because metal ions provided during rinsing before the final rinsing process will be flowed away by the rinsing during subsequent processes and will not be sufficiently effectively utilized, resulting in wasting metal ions.

However, according to the aforementioned control of the control section 407, metal ion-containing water is supplied when the number of times that feed-water has been performed is the number set by the elution-starting feed-water number setting section 412. Therefore, even when the rinsing process includes a plurality of rinsing processes, metal ion-containing water can be fed to the washing machine 1 only during the final rinsing process, for example, by setting the number of feed-waters corresponding to the final rinsing process. Consequently, the elution of metal ion is not performed during the other processes (the washing process and the rinsing processes other than the final rinsing process) which require no metal ion-containing water, thereby preventing wasteful metal ion elution and enabling effective utilization of metal ions.

In the case where the elution-starting feed-water number setting section 412 is provided, the control section 407 may continuously apply the voltage generated at the voltage generating section 403 to the electrodes 311, 312 of the ion elution unit 300 to cause the elution of metal ions from the electrodes 311, 312, after the number of times that feed-water has been performed counted by the feed-water number counting section 411 reaches the number set by the elution-starting feed-water number setting section 412.

As illustrated in Fig. 5, the dewatering process is performed at the beginning of the rinsing process. During this dewatering process, unbalance of the washing bath 30 can be generated. This unbalance means a phenomenon in which laundry is placed

unevenly within the washing bath 30 to disturb the balance of rotations at dewatering start-up, thereby resulting in significant vibrations of the washing bath 30 and the washing machine 1.

Therefore, in the event that a detecting means (not shown) of the washing machine 1 detects such unbalance, the control means of the washing machine 1 performs a control for causing feed-water to the washing bath 30 for unwinding the laundry in order to modify the unbalance.

Therefore, in the case where the feed-water for modifying such unbalance is performed, the feed-water number counting section 411 counts it as a feed-water and therefore there may be cases where the number set by the elution-starting feed-water number setting section 412 is not agreement with the number which corresponds to the final rinsing process. Namely, there may be cases where the actual number of times that feed-water has been performed reaches the number set by the elution-starting feed-water number setting section 412 and thus metal ion-containing water starts to be supplied before the final rinsing process.

However, according to the aforementioned control of the control section 407, metal ion-containing water is continuously supplied to the washing machine 1 after the number of times that feed water has been performed reaches the number set by the elution-starting feed-water number setting section 412, and therefore metal ion-containing water can be fed to the washing machine 1 during the final rinsing process in the event of unexpected troubles such as increases of the number of feed-waters due to the occurrence of unbalance. As a result, a desired antibacterial treatment can be performed during the final rinsing process. Namely, this prevents water containing no metal ion from being fed during the final rinsing process to decrease the amount of previously-supplied metal ions adhered to clothes resulting in

inconveniences, such as a case where the user can not obtain a desired antibacterial treatment.

Also, the unbalance can occur after the rinsing process, namely during the dewatering process after the final rinsing process, and in this case the process for modifying the unbalance is performed. In this case, similarly, according to the aforementioned control of the control section 407, metal ion-containing water is continuously supplied to the washing machine 1 after the number of times that feed-water has been performed reaches the number set by the elution-starting feed-water number setting section 412, and this may prevent inconveniences similar to the aforementioned inconveniences caused by water containing no metal ion being fed after the final rinsing process.

(4-8-6. Storage Section)

The storage section 413 is a storage means for prestoring the feed-water timing at which it is necessary to supply metal ion-containing water (silver-ion water) to the washing machine 1. While in Fig. 29 the storage means 413 is formed separately from the control section 407, the storage means 413 may be constituted by a memory in the control section 407.

The aforementioned feed-water timing may be stored in the storage means 413 by default. Also, a feed-water timing setting portion, not shown, may be provided and a feed-water timing set by this feed-water timing setting portion may be stored in the storage section 413. Also, the feed-water amount setting section 409 and the elution-starting feed-water number setting section 412 described above may be utilized as the aforementioned feed-water timing setting portion.

In the case where this storage section 413 is provided, the control section 407 may drive the voltage generating section 403 in synchronization with the feed-water

timing for metal ion-containing water which is stored in the storage section 413 to cause application of a voltage to the electrodes 311, 312 of the ion elution unit 300.

For example, when “a time period until feeding of metal ion-containing water” is stored in the storage section 413 as the aforementioned feed-water timing, the control section 407 drives the driving unit 400 to cause the application of a voltage to the electrodes 311, 312 after the above time period has elapsed since the operating section 401 turns on the driving unit 400.

Also, when “a predetermined feed-water flow rate”, for example, is stored in the storage section 413 as the above feed-water timing, the control section 407 drives the driving unit 400 to cause the application of a voltage to the electrodes 311, 312 when the flow rate detected by the detecting portion 315 reaches the aforementioned feed-water flow rate.

Also, when “a number of times that feed-water should be performed before the rinsing process”, for example, is stored in the storage section 413 as the above feed-water timing, the control section 407 drives the driving unit 400 to cause the application of a voltage to the electrodes 311, 312 when the current number of times that feed-water has been performed reaches the aforementioned number.

As described above, since the storage section 413 stores the feed-water timing for the washing machine 1 and the elution of metal ions from the electrodes 311, 312 is performed with the feed-water timing, metal ion-containing water can be supplied only when metal ion-containing water is required.

For example, the washing machine 1 performs the washing process, the rinsing process, the dewatering process and the drying process, etc., as the laundry-washing processes. Even if metal ion-containing water is supplied to the washing machine 1 during the washing process, metal ions will not adhere to laundry and will flow away

together with detergent, resulting in wasted metal ions.

However, by supplying metal ion-containing water to the washing machine 1 based on the aforementioned feed-water timing, the elution of metal ions does not start immediately when the operating section 401 turns on the driving unit 400 and the elution of metal ions starts when the rinsing process starts, for example, to supply metal ion-containing water to the washing machine 1. Therefore, even if the driving unit 400 is early turned on, namely, for example, the driving unit 400 is turned on at the start of washing, unnecessary metal ions are not eluted. This enables effective utilization of the electrodes 311, 312, thereby reducing wasteful wear of them. Further, this enables effective utilization of eluted metal ions, thus causing them to work on laundry.

According to the aforementioned configuration, since the control section 407 supplies metal ion-containing water to the washing machine 1 with predetermined feed-water timing, metal ions are automatically eluted and supplied to the washing machine 1 when it is necessary to supply metal ion-containing water to the washing machine 1. Thus, the user is not required to manually operate the operating section 401 with a timing at which metal ion-containing water is required. Thus, only by turning on the driving unit 400 at the start of washing, a user is not required to stay around the driving unit 400 and can do other works. Therefore, this improves user's convenience.

In the case where feeding of metal ion-containing water is caused by manual input to the operating section 401, there is a risk that the feed-water timing for metal ion-containing water may be missed out in the event that the user forgets to operate the operating section 401. However, according to the above configuration, metal ion-containing water is automatically supplied when it is required with a predetermined timing and therefore it is unnecessary to worry about such troubles.

Also, the storage section 413 may store a required feeding time and required amount of metal ion-containing water and the control section 407 may perform a control for automatically interrupting application of a voltage to the electrodes 311, 312 from the voltage generating section 403 after the above feeding time has elapsed since the start of feeding of metal ion-containing water or after the above amount of metal ion-containing water has been supplied. Thus, even if the user forgets to turn off the driving of the driving unit 400 at the operating section 401, wasteful electric power consumption or wasteful metal ion elution can be avoided.

(4-8-7. Vibration Sensor)

The vibration sensor 414 is a detecting means for detecting the time at which the elution of metal ions is required (for example, the rinsing process), based on vibrations of the washing machine 1 as a feed-water apparatus. The control section 407 performs a control for applying a voltage generated at the voltage generating section 403 to the electrodes 311, 312 of the ion elution unit 300, when the vibration sensor 414 detects the aforementioned time.

For example, the behavior of vibrations of the washing machine 1 varies between in the washing process and in the rinsing process due to factors such as the rotation speed of the washing bath 30, the amount of water within the washing bath 30, the rotation speed of the pulsometer 33, etc. More specifically, during the stirring process in the washing process or the rinsing process, the pulsometer 33 rotates at about 100 rpm (the motor also rotates at about 100 rpm) and during the inter-dewatering process therebetween the washing bath 30 rotates at about 900 rpm (the motor also rotates at about 900 rpm). Thus, the period of vibrations (frequency) significantly varies between during these processes. Therefore, the vibration sensor 414 can certainly detect a washing process (for example, the rinsing process) which requires the

elution of metal ions, based on differences of the period of vibrations caused by the differences in the rotation speed of the washing bath 30, the pulsometer 33, the motor, etc.

Therefore, since the control section 407 performs the aforementioned control, a voltage can be applied to the electrodes 311, 312 to cause the elution of metal ions when the washing process enters the rinsing process. Therefore, even when the driving unit 400 is early turned on, unnecessary metal ions are not eluted from the electrodes 311, 312. As a result, there are provided the same effects as those of the configuration in which the storage section 413 is provided to supply metal ion-containing water with a predetermined timing, namely, for example, the electrodes 311, 312 can be effectively utilized, thus reducing wasteful wear of them.

Also, the detection of the time at which metal-ion elution is required may be performed as follows. Namely, the range of the vibration amplitude of the washing machine 1 during washing processes (for example, the rinsing process) which require the elution of metal ions may be prestored in the storage section 413 and the control section 407 may determine whether or not the vibration amplitude of the washing machine 1 is within the aforementioned range. Also, the range of vibration amplitude during the washing process may be prestored in the storage section 413 and the control section 407 may determine whether or not the vibration amplitude of the washing machine 1 is outside the aforementioned range.

Also, the vibration sensor 414 may detect vibrations of the feed-water valve 50. Thus, the vibration sensor 414 can detect the time when the feed-water valve 50 is being driven, namely the time when feed-water is being performed. Therefore, the control section 407 can perform, based on such detection, a control for causing the elution of metal ions during feed-water to supply metal ion-containing water.

Also, the control section 407 may perform a control for automatically interrupting the voltage application to the electrodes 311, 312 from the voltage generating section 403 when the vibration sensor 414 detects vibrations of the washing machine 1 in the dewatering process. In this case, even if the user forgets to turn off the driving of the driving unit 400 through the operating section 401, wasteful electric power consumption or wasteful metal ion elution can be avoided.

(4-9. Effects)

The driving unit 400 configured as described above is removably placed outside of the washing machine 1 as a feed-water apparatus. Therefore, the driving unit 400 can be retrofitted together with the ion elution unit 300 and therefore even when the washing machine 1 is an existing type of washing machine equipped with no ion elution unit, a washing machine equivalent to the washing machine 1 equipped with an ion elution unit can be easily be realized. This eliminates the necessity of wasteful replacement of an existing washing machine 1, thereby enabling effective utilization of the existing washing machine 1. Further, since the driving unit 400 is placed outside of the washing machine 1, repair or battery replacement for the driving unit 400 can be easily performed in the case of failure or at the end of battery life.

(5. Others)

While respective embodiments of the present invention have been described, the scope of the present invention is not limited to them and various changes can be made therein without departing from the spirit of the present invention. Further, the antibacterial treatment device according to the present invention is not limited to be used in a full-automatic washing machine of the type described in the aforementioned respective embodiments. The present invention is applicable to every type of washing machine such as lateral drum types, angled drum types, dryer-cum-types or

double-bathes types.

The antibacterial treatment device according to the present invention can function on a stand-alone basis, be easily installed and requires no specific skills for the operation thereof. Therefore, by taking advantage of the characteristics, the antibacterial treatment device according to the present invention can be utilized in a wide range of applications not only for washing machines. For example, the antibacterial treatment device according to the present invention can be easily placed on a feed-water path of a household electrical appliance utilizing water (for example, a dishwashing machine or water cleaner) other than washing machines. In this case, the antibacterial treatment device according to the present invention can be applied to electrical appliance of any specifications and models.

By disinfecting water for use with the antibacterial treatment device according to the present invention and immersing objects to be washed into the water, it is possible to apply an antibacterial treatment, using the metal ion-containing water, to kitchen goods, such as dish, a cutting board, a rice paddle, a spongy for washing dish or a scrub brush, and bath/toiletry goods, as well as clothes. By immersing object to be washed into metal ion-containing water pooled within a container, not by pouring metal ion-containing water onto object to be washed, it is possible to effectively apply an antibacterial treatment to various types of object to be washed using a small amount of water.

The antibacterial treatment device according to the present invention may be also utilized for disinfecting water within a water bath or rain water pooled within a rain-water bath, for preventing infection during bath, or for disinfecting a water-bath for fish. Further, the antibacterial treatment device according to the present invention can be utilized not only at ordinary households, but also for disinfecting or

antibacterial-treating various types of articles to prevent infection of pathogenic bacteria to human bodies in medical institutions or public facilities.

The antibacterial treatment device according to the present invention can be utilized in the field and requires no specific training to use. Therefore, the antibacterial treatment device according to the present invention can be utilized at places where there is no water supply facility or places where there is unusable water supply facility (for example, camp sites, disaster sites, refugee camps, etc) to apply an antibacterial treatment to water available on the spot. It is possible to disinfect water and also apply an antibacterial treatment to various types of articles using the water. Therefore, ordinary people can utilize the antibacterial treatment device at either leisure sites or disaster sites to maintain a certain sanitary level regardless of the installation environments.

Further, even if water which has been antibacterial-treated by the antibacterial treatment device according to the present invention is released to rivers or ponds, it will not damage the ecosystem under water as compared with water disinfected by chlorine.

In the case of using the antibacterial treatment device according to the present invention in the field, it is desirable to use batteries as the power supply, as previously described. It is desirable that a secondary battery, solar battery or combinations of them can be used, not only dry batteries.

Of course, the configurations described in the first and the second embodiments are applicable to the antibacterial treatment device 200 according to the third embodiment. Thus, for example, they can be realized in the configuration in which the driving unit 400 includes a timer for setting the feeding time of the electrodes 311, 312 and the configuration in which at least a part of the unit main body 301 is comprised of a sight-through portion which enables looking the electrodes 311, 312

placed inside thereof therethrough.

INDUSTRIAL APPLICABILITY

The antibacterial treatment device according to the present invention is applicable to washing machines or household electrical appliances utilizing water (for example, a dishwashing machine or water cleaner) other than washing machine. Further, the antibacterial treatment device according to the present invention is applicable to antibacterial treatments for kitchen goods or bath and toiletry goods, and disinfection or antibacterial treatments for various types of articles in medical institutions, public facilities, or fields.

CLAIMS

1. An antibacterial treatment device comprising an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects, wherein

the ion generating portion is removably installed on the water supply path to the feed-water apparatus and outside of the feed-water apparatus,

the ion generating portion is constituted by an ion elution unit including a unit main body which encloses electrodes and through which the water passes,

the antibacterial treatment device further comprising a driving unit for driving the ion elution unit,

the driving unit includes:

a state displaying section for displaying the operating state of the driving unit,

an elution number counting section for counting the number of times that the elution of metal ions has been performed in the ion elution unit, and

a control section for performing a control for causing the state displaying section to blink when the number of times that the elution of metal ions has been performed exceeds a predetermined value.

2. An antibacterial treatment device comprising an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects, wherein

the ion generating portion is removably installed on the water supply path to the feed-water apparatus and outside of the feed-water apparatus,

the ion generating portion is constituted by an ion elution unit including a unit main body which encloses electrodes and through which the water passes,

the antibacterial treatment device further comprising a driving unit for driving the ion elution unit,

the driving unit includes:

a state displaying section for displaying the operating state of the driving unit,

a current detection circuit for detecting the current flowing through the electrodes, and

a control section for performing a control for causing the state displaying section to blink when the current decreases below a threshold value.

3. An antibacterial treatment device according to claim 2, wherein the driving unit further includes:

a voltage generating section for generating a voltage to be applied to the electrodes, and

a supply voltage detecting section for monitoring the output voltage of the voltage generating section, and

the control section causes the state displaying section to blink when the output voltage decreases below a predetermined voltage.

4. An antibacterial treatment device comprising an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects, wherein

the ion generating portion is removably installed on the water supply path to the feed-water apparatus and outside of the feed-water apparatus,

the ion generating portion is constituted by an ion elution unit including a unit main body which encloses electrodes and through which the water passes,

the antibacterial treatment device further comprising a driving unit for driving the ion elution unit,

the driving unit includes a voltage generating section for generating a voltage to be applied to the electrodes of the ion elution unit, and

the driving unit further includes:

a concentration setting section for setting the metal ion concentration, and

a control section for performing a control for changing the voltage generated at the voltage generating section according to the concentration set by the concentration setting section and for applying the changed voltage to the electrodes of the ion elution

unit.

5. An antibacterial treatment device comprising an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects, wherein

the ion generating portion is removably installed on the water supply path to the feed-water apparatus and outside of the feed-water apparatus,

the ion generating portion is constituted by an ion elution unit including a unit main body which encloses electrodes and through which the water passes,

the antibacterial treatment device further comprising a driving unit for driving the ion elution unit,

the driving unit includes a voltage generating section for generating a voltage to be applied to the electrodes of the ion elution unit, and

the driving unit further includes:

a concentration setting section for setting the metal ion concentration, and

a control section for performing a control for changing the current generated at the voltage generating section according to the concentration set by the concentration setting section and for applying the changed current to the electrodes of the ion elution unit.

6. An antibacterial treatment device comprising an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects, wherein

the ion generating portion is removably installed on the water supply path to the feed-water apparatus and outside of the feed-water apparatus,

the ion generating portion is constituted by an ion elution unit including a unit main body which encloses electrodes and through which the water passes,

the antibacterial treatment device further comprising a driving unit for driving the ion elution unit,

the driving unit includes a voltage generating section for generating a voltage to

be applied to the electrodes of the ion elution unit, and

the driving unit further includes:

a concentration setting section for setting the metal ion concentration, and

a control section for performing a control for changing the length of time that the voltage generated at the voltage generating section is applied to the electrodes of the ion elution unit according to the concentration set by the concentration setting section

7. An antibacterial treatment device comprising an ion generating portion for generating metal ions to be added to water which is supplied from a feed-water apparatus to objects, wherein

the ion generating portion is removably installed on the water supply path to the feed-water apparatus and outside of the feed-water apparatus,

the ion generating portion is constituted by an ion elution unit including a unit main body which encloses electrodes and through which the water passes,

the antibacterial treatment device further comprising a driving unit for driving the ion elution unit,

the driving unit includes a voltage generating section for generating a voltage to be applied to the electrodes of the ion elution unit, and

the driving unit further includes:

a feed-water amount setting section for setting the amount of water to be fed to the feed-water apparatus, and

a control section for performing a control for changing the length of time that the voltage generated at the voltage generating section is applied to the electrodes of the ion elution unit according to the amount of water set by the feed-water amount setting section.