

SPECIFICATION

ION ELUTION UNIT, APPLIANCE INCORPORATING AN ION ELUTION UNIT, AND WASHER INCORPORATING AN ION ELUTION UNIT

5

Technical field

The present invention relates to an ion elution unit for eluting metal ions having an antimicrobial effect into water, and also relates to an appliance, in particular a washer, that uses water mixed with metal ions generated by such ion elution unit.

10

Background art

When laundry is washed in a washer, it is common to add a treatment substance to water, in particular rinsing water. Typical examples of such treatment substances include softening and starching agents. In addition to these, in recent years, the demand has been
15 increasing for treatment whereby laundry is subjected to antimicrobial treatment.

From the hygienic point of view, it is desirable to hang laundry in the sun to dry. However, in recent years, with the increase in the number of women who go to work, and with the increase in the number of nuclear families, there have been an increasing number of households where no one is at home in the daytime. In these households, there is no choice
20 but to hang laundry indoors to dry. Even in households where someone is at home in the daytime, in rainy weather, there is no choice but to hang laundry indoors to dry.

As compared with hanging laundry in the sun to dry, hanging it indoors tends to promote growth of bacteria and mold in laundry. This tendency is marked particularly when it takes time to dry laundry, as when humidity is high, such as in a rainy season, or when

temperature is low. As the amount of bacteria and mold increases, laundry may become smelly. For this reason, in households where there is usually no choice but to hang laundry indoors to dry, there is a high demand for antimicrobial treatment of textile articles for the purpose of suppressing growth of bacteria and mold.

5 Nowadays, many clothes are available that have previously been treated with antimicrobial/deodorizing or fungistatic treatment. However, it is difficult to replace all the textile articles in a household with those previously treated with antimicrobial/deodorizing treatment. Moreover, even with such textile articles, as they are washed repeatedly, the efficacy of antimicrobial/deodorizing treatment wears off.

10 Conceived under these circumstances was the idea of treating laundry with antimicrobial treatment every time it is washed. For example, Japanese Utility Model Laid-Open No. H5-74487 discloses an electric washer furnished with an ion generator that generates metal ions, such as silver ions or copper ions, that exert a sterilizing effect. Japanese Patent Application Laid-Open No. 2000-93691 discloses a washer that generates an
15 electric field with which to sterilize cleaning fluid. Japanese Patent Application Laid-Open No. 2001-276484 discloses a washer furnished with a silver ion adding unit that adds silver ions to cleaning water.

Disclosure of the invention

20 An object of the present invention is to provide an ion elution unit for generating metal ions having an antimicrobial effect which can be used with no damage to its electrodes and which does not affect the downstream side even if its electrodes chip off. Another object of the present invention is to provide an appliance, in particular a washer, that uses water mixed with metal ions generated by such an ion elution unit to avoid adverse effects brought about by growth of bacteria, that does no damage to the ion elution unit, and that permits the ion elution unit to operate efficiently. Still another object of the present invention is to provide a washer that is provided with an ion elution unit on the upstream side

of a detergent chamber for mixing detergent with water so as to prevent passage of water containing detergent through the ion elution unit and thereby prevent deterioration of the performance of the ion elution unit resulting from detergent ingredients depositing on its electrodes in the form of scale.

To achieve the above object, according to the present invention, an ion elution unit is constructed in the following manner. In an ion elution unit that generates metal ions by applying a voltage between electrodes, a strainer is provided on the downstream side of the electrodes. With this construction, even when the electrodes wear or become brittle after long-time use and ultimately they break and let their fragments flow off, the fragments are caught by the strainer so as not to flow further downstream. This prevents fragments of the electrodes from damaging objects located downstream.

According to the present invention, an appliance incorporates the ion elution unit described above, and uses water mixed with metal ions generated by the ion elution unit. With this construction, it is possible to use water mixed with metal ions generated by the ion elution unit. For example, if the appliance is a washer, it is possible to treat laundry with antimicrobial treatment using metal ions and thereby prevent proliferation of bacteria and mold and generation of an offensive smell. If the appliance is a dish washing machine, it is possible to treat eating utensils with antimicrobial treatment using metal ions and thereby enhance hygiene. If the appliance is a humidifier, it is possible to prevent proliferation of bacteria and algae in the water stored in its water tank and thereby prevent bacteria and alga spores from being spread into the air and causing an infection or allergy in a person who inhaled them. Moreover, since a strainer is provided on the downstream side of the electrodes, even when the electrodes wear or become brittle after long-time use and ultimately they break and let their fragments flow off, the fragments are caught by the strainer so as not to flow further downstream. This prevents fragments of the electrodes from damaging objects located downstream.

According to the present invention, in the appliance constructed as described above, the appliance is a washer. With this construction, it is possible to prevent foreign matter contained in water or fragments of the electrode from sticking to and thereby soiling or damaging laundry. Moreover, it is possible to prevent a situation in which an article of laundry is squeezed and dried with foreign matter or a fragment of the electrodes left stuck to it with the result that a person who wears the article feels annoyed or gets hurt by the foreign matter or fragment of the electrodes.

According to the present invention, an appliance is constructed in the following manner. In an appliance that incorporates an ion elution unit that generates metal ions by applying a voltage between electrodes, the appliance being capable of using water mixed with metal ions generated by the ion elution unit, a water inlet of the ion elution unit is connected on the downstream side of a water feed valve provided in the appliance, and a strainer provided in a connection pipe of the water feed valve is shared as an upstream-side strainer of the ion elution unit. With this construction, the strainer that prevents entry of foreign matter into the water feed valve also prevents entry of foreign matter into the ion elution unit. This eliminates the need to separately provide a strainer on the upstream side of the ion elution unit, and thus helps simplify the construction of the appliance and reduce its cost.

According to the present invention, in the appliance constructed as described above, the appliance is a washer. With this construction, it is possible to prevent foreign matter from entering into the water feed valve and damaging the water feed valve itself or the ion elution unit provided on its downstream side. It is also possible to prevent foreign matter contained in water or fragments of the electrode from sticking to and thereby soiling or damaging laundry. Moreover, it is possible to prevent a situation in which an article of laundry is squeezed and dried with foreign matter or a fragment of the electrodes left stuck to it with the result that a person who wears the article feels annoyed or gets hurt by the foreign matter or fragment of the electrodes.

According to the present invention, an appliance is constructed in the following manner. In an appliance that incorporates an ion elution unit that generates metal ions by applying a voltage between electrodes, the ion elution unit having a strainer provided on downstream side of the electrodes, an appliance using water mixed with metal ions generated by the ion elution unit, the appliance has a main water feed passage set for a high flow rate and a sub water feed passage set for a low flow rate, and the ion elution unit is placed in the main water feed passage. With this construction, the appliance can use whichever of high-rate and low-rate water currents suits the intended purpose, and in addition the high-rate water current passes through the ion elution unit to carry metal ions away from it, preventing metal ions from flowing back to the electrodes. This makes it possible to efficiently operate the ion elution unit. Moreover, since a strainer is provided on the downstream side of the electrodes, even when the electrodes wear or become brittle after long-time use and ultimately they break and let their fragments flow off, the fragments are caught by the strainer so as not to flow further downstream. This prevents fragments of the electrodes from damaging objects located downstream.

According to the present invention, in the appliance constructed as described above, the appliance is a washer. With this construction, it is possible to use whichever of high-rate and low-rate water currents suits the intended purpose, and in addition the high-rate water current passes through the ion elution unit to carry metal ions away from it, preventing metal ions from flowing back to the electrodes. This makes it possible to efficiently generate metal ions necessary to treat laundry with antimicrobial treatment. Moreover, it is possible to prevent foreign matter contained in water or fragments of the electrode from sticking to and thereby soiling or damaging laundry. Moreover, it is possible to prevent a situation in which an article of laundry is squeezed and dried with foreign matter or a fragment of the electrodes left stuck to it with the result that a person who wears the article feels annoyed or gets hurt by the foreign matter or fragment of the electrodes.

According to the present invention, in the appliance constructed as described above, the appliance is a washer, and in addition a water feed mouth through which water is fed to the washing tub has the interior thereof divided into a detergent chamber and a treatment agent chamber, with water from the main water feed passage introduced into the detergent chamber and water from the sub water feed passage introduced into the treatment agent chamber. With this construction, the passage through which metal ions are fed into the

washing tub is separate from the passage through which the treatment agent is fed into the washing tub. This prevents metal ions from making contact with and forming a compound with the treatment agent present in a high concentration in the passage through which it is fed, and thus prevents metal ions from losing its antimicrobial effect.

According to the present invention, in the appliance constructed as described above, the ion elution unit has a water inlet and a water outlet provided at one and another ends, respectively, of a casing along the direction of longer sides thereof, and is placed with the longer sides of the casing kept substantially horizontal. With this construction, it is possible to arrange the ion elution unit and the water piping for it compactly so as not to be bulky in the height direction.

According to the present invention, an appliance is constructed in the following manner. In a washer that incorporates an ion elution unit that generates metal ions by applying a voltage between electrodes, the washer using water mixed with metal ions generated by the ion elution unit, the washer being provided with a detergent chamber and a treatment agent chamber, the ion elution unit is placed in a position upstream relative to a wafer feed mouth through which water is fed to the washing tub and in a position downstream relative to a water feed valve so that water from the water feed valve is fed through the ion elution unit to the water feed mouth, and the water feed mouth has a detergent chamber provided inside it. With this construction, the ion elution unit is located on the upstream side of the detergent chamber, where detergent is mixed with water. This prevents water containing detergent from passing through the ion elution unit or flowing backward from the detergent chamber. Thus, it is possible to prevent detergent ingredients from making contact with the electrodes and depositing on them in the form of scale. This helps prevent lowering of the performance of the ion elution unit.

Brief description of drawings

Fig. 1 is a vertical sectional view of a washer embodying the present invention.

20

Fig. 2 is a schematic vertical sectional view of a water feed mouth.

Fig. 3 is a partial top view of an interior of the washer.

Fig. 4 is a top view of an ion elution unit.

Fig. 5 is a vertical sectional view taken along line A-A shown in Fig. 4.

Fig. 6 is a vertical sectional view taken along line B-B shown in Fig. 4.

Fig. 7 is a horizontal sectional view of the ion elution unit.

Fig. 8 is a perspective view of an electrode.

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

Fig. 10 is a flow chart of an entire session of laundry washing.

5 Fig. 11 is a flow chart of a washing process.

Fig. 12 is a flow chart of a rinsing process.

Fig. 13 is a flow chart of a squeezing process.

Fig. 14 is a flow chart of a final rinsing process.

10 **Best mode for carrying out the invention**

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

Fig. 1 is a vertical sectional view showing the overall construction of a washer 1. The washer 1 is of the fully automatic type, and has a cabinet 10. The cabinet 10 is box-shaped, is formed of a metal or synthetic resin, and has openings at its top and bottom. The top opening of the cabinet 10 is covered with a top plate 11, which is formed of a synthetic resin and is fixed to the cabinet 10 with screws. In Fig. 1, the front and rear of the washer 1 point leftward and rightward, respectively. A rear portion of the top surface of the top plate 11 is covered with a back panel 12, which is formed of a synthetic resin and is fixed to the cabinet or the top plate 11 with screws. The bottom opening of the cabinet 10 is covered with a base 13, which is formed of a synthetic resin and is fixed to the cabinet 10 with screws. None of the screws mentioned thus far are shown in the figure.

In four corners of the base 13, there are provided feet 14a and 14b for supporting the cabinet 10 on a floor. The rear feet 14b are fixed feet that are integrally formed with the base 13. The front feet 14a are screw feet of which the height can be adjusted. Turning these permits the washer 1 to be leveled.

In the top plate 11, there is formed a laundry inlet opening 15 through which laundry is put in the washing tub described later. The laundry inlet opening 15 is covered with a lid 16 from above. The lid 16 is coupled to the top plate 11 with a hinge 17 so as to be pivotable in a vertical plane.

Inside the cabinet 10, there are provided a water tub 20 and a washing tub 30 that serves also as a squeezing tub. The water tub 20 and the washing tub 30 both have the shape of a cylindrical cup open at its top, and the two tubs are arranged concentrically with their axes vertical and with the washing tub 30 placed inside the water tub 20. The water tub 20 is suspended from the cabinet 10 with suspension members 21. The suspension members 21 are arranged in four places so as to connect a lower portion of the outer surface of the water

tub 20 to corner portions of the inner surface of the cabinet 10, and support the water tub 20 in such a way as to permit it to swing in a horizontal plane.

The washing tub 30 has a circumferential wall that widens upward with a gentle taper. This circumferential wall has a plurality of drain holes 31 formed in a ring-shaped arrangement around its topmost portion, and has, other than these drain holes, no opening that
5 permits passage of liquid. That is, the washing tub 30 is of the so-called "holeless" type. Around the rim of the top opening of the washing tub 30, there is fitted a ring-shaped balancer 32 for suppressing the vibration that the washing tub 30 produces when rotated at high speed for the squeezing of laundry. Inside the washing tub 30, on its bottom surface, there is
10 provided a pulsator 33 for producing a current of washing or rinsing water inside the tub 30.

The water tub 20 has a drive unit 40 fitted to its bottom surface from below. The drive unit 40 includes a motor 41, a clutch mechanism 42, and a brake mechanism 43, and has a squeezing spindle 44 and a pulsator spindle 45 protruding from its center upward. The squeezing spindle 44 and the pulsator spindle 45 form a double-spindle structure, with the
15 pulsator spindle 45 placed inside the squeezing spindle 44. The two spindles both penetrate the water tub 20. The squeezing spindle 44 is then connected to the washing tub 30 so as to support it. On the other hand, the pulsator spindle 45 further penetrates the washing tub 30, and is then connected to the pulsator 33 to support it. Between the squeezing spindle 44 and the water tub 20, and between the squeezing spindle 44 and the pulsator spindle 45, there are
20 provided sealing members for preventing leakage of water.

Inside the space below the back panel 12, there is provided a water feed valve 50 that is opened and closed electromagnetically. The water feed valve 50 has a connection pipe 51 that penetrates the back panel 12 to extend upward. To the connection pipe 51 is connected a water feed hose (not shown) through which to supply clean water such as tap water to the

washer. The water feed valve 50 feeds water to a container-shaped water feed mouth 53 provided in a position in which it points to the inside of the washing tub 30. The water feed mouth 53 has a structure as shown in Fig. 2.

Fig. 2 is a schematic vertical sectional view of the water feed mouth 53. The water feed mouth 53 has an opening formed at the front, and has a drawer 53a inserted into it through that opening. The drawer 53a has its interior divided into a plurality of sections (in this embodiment, two sections, namely a left-hand and a right-hand section). The left-hand section is a detergent chamber 54 that serves as a storage space in which to store a detergent. The right-hand section is a treatment agent chamber 55 that serves as a storage space in which to store a treatment agent for laundry washing. At the bottom of the detergent chamber 54, there is formed a water outlet 54a that is open to the inside of the water feed mouth 53. In the treatment agent chamber 55, there is provided a siphon 57. The water feed mouth 53 has a water outlet 56 formed in a portion thereof below the drawer 53a. Through the water outlet 56, water is fed into the washing tub 30.

The siphon 57 is composed of an inner pipe 57a that extends vertically upward from the bottom surface of the treatment agent chamber 55 and a cap-shaped outer pipe 57b with which the inner pipe 57a is capped. Between the inner pipe 57a and the outer pipe 57b is left a gap that permits passage of water. The inner pipe 57a, at its bottom, is open to the bottom of the water feed mouth 53. A predetermined gap is kept between the bottom end of the outer pipe 57b and the bottom surface of the treatment agent chamber 55 so as to serve as a water inlet. When water is poured into the treatment agent chamber 55 up to a level higher than the top end of the inner pipe 57a, the principle of a siphon works to cause the water to flow through the siphon 57 out of the treatment agent chamber 55 to the bottom of the water feed mouth 53 and then drop into the washing tub 30.

The water feed valve 50 is composed of a main water feed valve 50a and a sub water feed valve 50b. The main water feed valve 50a is set for a comparatively high flow rate, and the sub water feed valve 50b is set for a comparatively low flow rate. The main and sub water feed valves 50a and 50b may be set for their respective flow rates by giving them
5 different internal structures, or by giving them the same valve structure but combining them with flow rate restricting members that are stopped to different degrees. The connection pipe 51 is shared between the main and sub water feed valves 50a and 50b.

The main water feed valve 50a is connected through a main water feed passage 52a to an opening formed in the ceiling of the water feed mouth 53. This opening is open to the
10 detergent chamber 54. Accordingly, the high-rate water current that flows out of the main water feed valve 50a is poured through the main water feed passage 52a into the detergent chamber 54. The sub water feed valve 50b is connected through a sub water feed passage 52b to an opening formed in the ceiling of the water feed mouth 53. This opening is open to the treatment agent chamber 55. Accordingly, the low-rate water current that flows out of
15 the sub water feed valve 50b is poured through the sub water feed passage 52b into the treatment agent chamber 55. That is, the passage through which water is fed from the main water feed valve 50a through the detergent chamber 54 into the washing tub 50 is separate from the passage through which water is fed from the sub water feed valve 50b through the treatment agent chamber 55 into the washing tub 30.

20 Incidentally, some models of washers do not have a water feed valve that is divided into a main and a sub water feed valve, and do not have a treatment agent chamber but have only a detergent chamber. In a case where the washer is of this type, all the water from the water feed valve is poured into the detergent chamber.

Back in Fig. 1, to the bottom of the water tub 20 is fitted a drain hose 60 through

which to drain water out of the water tub 20 and the washing tub 30. Water flows into the drain hose 60 from drain pipes 61 and 62. The drain pipe 61 is connected to a rather peripheral portion of the bottom surface of the water tub 20, and the drain pipe 62 is connected to a rather central portion of the bottom surface of the water tub 20.

5 Inside the water tub 20, on its bottom surface, there is fixed a ring-shaped partition wall 63 in such a way as to enclose the portion of the water tub 20 where the drain pipe 62 is connected to it. The partition wall 63 is fitted with a ring-shaped sealing member 64 at its top. This sealing member 64 is kept in contact with the circumferential surface of a disk 65 fixed to the outer surface of the bottom of the washing tub 30 so as to form a separate drain
10 space 66 between the water tub 20 and the washing tub 30. The drain space 66 communicates with the interior of the washing tub 30 through a drain outlet 67 formed in the bottom of the washing tub 30.

The drain pipe 62 is provided with a drain valve 68 that is opened and closed electromagnetically. In a portion of the drain pipe 62 located on the upstream side of the
15 drain valve 68, there is provided an air trap 69. From the air trap 69 extends a lead pipe 70. The lead pipe 70 is, at its top end, connected to a water level switch 71.

In a front portion of the cabinet 10, there is provided a controller 80. The controller 80 is arranged beneath the top plate 11. The controller 80 receives operation requests from the user via an operation/display panel 81 provided on the top surface of the top plate 11, and
20 sends operation commands to the drive unit 40, the water feed valve 50, and the drain valve 68. The controller 80 also sends display commands to the operation/display panel 81. The controller 80 includes a drive circuit for driving the ion elution unit described later.

Now, the operation of the washer 1 will be described. The lid 16 is opened, and laundry is put in the washing tub 30 through the laundry inlet opening 15. The drawer 53a is

pulled out of the water feed mouth 53, and detergent is put in the detergent chamber 54 inside the drawer 53a. A treatment agent (softening agent) is put in the treatment agent chamber 55. The treatment agent may be put there in the middle of a session of laundry washing, or may be omitted if unnecessary. With the detergent and treatment agent (softening agent) put in
5 their respective chambers, the drawer 53a is put into the water feed mouth 53.

After the detergent and treatment agent (softening agent) are made ready for addition in this way, the lid 16 is closed, and a desired course of laundry washing is selected by operating a group of operation buttons on the operation/display panel 81. Subsequently, when a start button is pressed, a session of laundry washing is executed according to the flow
10 charts shown in Figs. 10 to 13.

Fig. 10 is a flow chart showing the entire session of laundry washing. In step S201, laundry washing is started at a previously set time. Whether or not a timer-started operation is selected or not is checked. If a timer-started operation is selected, the flow proceeds to step S206; if not, the flow proceeds to step S202.

15 In step S206, whether or not the operation start time has come is checked. If the operation start time has come, the flow proceeds to step S202.

In step S202, whether or not a washing process is selected is checked. If a washing process is selected, the flow proceeds to S300. How the washing process in step S300 proceeds will be described later with reference to Fig. 11. On completion of the washing
20 process, the flow proceeds to step S203. If no washing process is selected, the flow proceeds directly from step S202 to step S203.

In step S203, whether or not a rinsing process is selected is checked. If a rinsing process is selected, the flow proceeds to S400. How the rinsing process in step S400 proceeds will be described later with reference to Fig. 12. In Fig. 10, it is assumed that the

rinsing process is performed three times, and the rinsing processes so performed at different times are distinguished by referring to them with differently suffixed step numbers, namely "S400-1," "S400-2," and "S400-3." How many times to perform the rinsing process can be freely set by the user. In the case being described, "S400-3" is the final rinsing process.

5 On completion of the rinsing process, the flow proceeds to step S204. If no rinsing process is selected, the flow proceeds directly from step S203 to step S204.

 In step S204, whether or not a squeezing process is selected is checked. If a squeezing process is selected, the flow proceeds to S500. How the squeezing process in step S500 proceeds will be described later with reference to Fig. 13. On completion of the
10 squeezing process, the flow proceeds to step S205. If no squeezing process is selected, the flow proceeds directly from step S204 to step S205.

 In step S205, a predetermined sequence of operations for terminating the operation of the controller 80, in particular the processor (microcomputer) provided in it, is automatically executed. In addition, the end of the session of laundry washing is indicated by sounding an
15 end-of-operation beep. On completion of all the operations, the washer 1 goes back into a stand-by state in preparation for a new session of laundry washing.

 Next, with reference to Figs. 11 to 13, the individual processes of washing, rinsing, and squeezing will be described.

 Fig. 11 is a flow chart of the washing process. In step S301, the water level inside
20 the washing tub 30 as sensed by the water level switch 71 starts being monitored. In step S302, whether or not laundry amount sensing is selected is checked. If laundry amount sensing is selected, the flow proceeds to step S308; if not, the flow proceeds directly from step S302 to S303.

 In step S308, the amount of laundry is measured on the basis of the rotation load of the

pulsator 33. On completion of laundry amount sensing, the flow proceeds to step S303.

In step S303, the main water feed valve 50a is opened, and water is poured into the washing tub 30 through the water feed mouth 53. Since the main water feed valve 50a is set for a high flow rate, water quickly fills the washing tub 30. Meanwhile, the detergent put in
5 the detergent chamber 54 is washed away from it by the large amount of water, so that all the detergent is, in a form mixed with water, put in the washing tub 30. The drain valve 68 remains closed. When the water level switch 71 detects the set water level, the main water feed valve 50a is closed. The flow then proceeds to step S304.

In step S304, a preparatory operation is performed. The pulsator 33 is rotated
10 repeatedly in the forward and then reverse directions to agitate the laundry and water so that the laundry makes satisfactory contact with water. This permits the laundry to absorb an ample amount of water, and permits air trapped in many parts of the laundry to escape. If, as a result of the preparatory operation, the water level as detected by the water level switch 71 becomes lower than at the beginning, then, in step S305, the main water feed valve 50a is
15 opened to supply additional water to recover the set water level.

If a course of laundry washing including "cloth type sensing" is selected, when the preparatory operation is performed, the type of cloth is sensed. On completion of the preparatory operation, the change of the water level from the set water level is detected, and, if the drop in the water level is greater than a predetermined value, the laundry is judged to be
20 of the highly water-absorbent cloth type.

When, in step S305, the set water level is stably obtained, the flow proceeds to step S306. According to the settings made by the user, the motor 41 rotates the pulsator 33 in a predetermined pattern so as to produce, in the washing tub 30, a main current of water for washing. With this main current of water, the laundry is washed. The squeezing spindle 44

remains braked by the brake mechanism 43 so that, even when the washing water and the laundry move, the washing tub 30 does not rotate.

On completion of the period in which the laundry is washed with the main current of water, the flow proceeds to step S307. In step S307, the pulsator 33 is rotated repeatedly in the forward and then reverse directions at short time intervals. This permits the laundry to loosen, and thereby permits it to spread evenly in the washing tub 30. This is done in preparation for squeezing rotation of the washing tub 30.

Next, with reference to the flow chart shown in Fig. 12, the rinsing process will be described. First, in step S500, the squeezing process is executed, of which a description will be given later with reference to the flow chart shown in Fig. 13. On completion of squeezing, the flow proceeds to step S401. In step S401, the main water feed valve 50a is opened, and water is supplied up to the set water level.

On completion of the supply of water, the flow proceeds to step S402. In step S402, a preparatory operation is performed. The preparatory operation here is performed to peel the laundry, which has clung to the washing tub 30 in step S500 (squeezing process), off the washing tub 30, permit the laundry sufficient contact with water, and let the laundry absorb an ample amount of water.

On completion of the preparatory operation, the flow proceeds to step S403. If, as a result of the preparatory operation, the water level as detected by the water level switch 71 becomes lower than at the beginning, the main water feed valve 50a is opened to supply additional water to recover the set water level.

After recovering the set water level in step S403, the flow proceeds to step S404. According to the settings made by the user, the motor 41 rotates the pulsator 33 in a predetermined pattern so as to produce, in the washing tub 30, a main current of water for

rinsing. With this main current of water, the laundry is rinsed. The squeezing spindle 44 remains braked by the brake mechanism 43 so that, even when the rinsing water and the laundry move, the washing tub 30 does not rotate.

On completion of the period in which the laundry is rinsed with the main current of water, the flow proceeds to step S406. In step S406, the pulsator 33 is rotated repeatedly in the forward and then reverse directions at short time intervals. This permits the laundry to loosen, and thereby permits it to spread evenly in the washing tub 30. This is done in preparation for squeezing rotation.

In the above description, rinsing is assumed to be performed with rinsing water stored in the washing tub 30, i.e., as "stored-water rinsing." It is, however, also possible to perform rinsing with additional water supplied continuously, i.e., as supplied-water rinsing, or with water kept supplied from the water feed mouth 53 while the washing tub 30 is rotated at low speed, i.e., as "shower rinsing."

In the final rinsing process, a sequence of operations slightly different from that described above is executed. This sequence will be described in detail later.

Next, with reference to the flow chart shown in Fig. 13, the squeezing process will be described. First, in step S501, the drain valve 68 is opened. The washing water in the washing tub 30 is drained through the drain space 66. The drain valve 68 remains open during the squeezing process.

When most of the washing water has exited from the laundry, the clutch mechanism 42 and the brake mechanism 43 are switched. The clutch mechanism 42 and the brake mechanism 43 may be switched before or at the same time that the washing water starts being drained. Now, the motor 41 rotates the squeezing spindle 44. This causes the washing tub 30 to start squeezing rotation. The pulsator 33 rotates together with the washing tub 30.

When the washing tub 30 rotates at high speed, the laundry is pressed against the inner circumferential wall of the washing tub 30 by the centrifugal force. The washing water present in the laundry also gathers on the inner surface of the circumferential wall of the washing tub 30, and, since the washing tub 30 widens upward in a tapered shape as described earlier, the washing water driven by the centrifugal force rises along the inner surface of the washing tub 30. When the washing water reaches the top end of the washing tub 30, it is drained through the drain holes 31. The washing water that has left the drain holes 31 hits the inner surface of the water tub 20, and then flows down along the inner surface of the water tub 20 to the bottom of the water tub 20. The washing water is then drained out of the cabinet 10 through the drain pipe 61 and then through the drain hose 60.

In the flow shown in Fig. 13, after squeezing is performed at relatively low speed in step S502, squeezing is performed at high speed in step S503. On completion of step S503, the flow proceeds to step S504. In step S504, the supply of electric power to the motor 41 is stopped, and terminating operations are performed.

The washer 1 is furnished with an ion elution unit 100. The ion elution unit 100 is connected on the downstream side of the main water feed pipe 52a. Now, with reference to Figs. 3 to 9, the structure and functions of the ion elution unit 100 and the purpose for which it is incorporated in the washer 1 will be described.

Fig. 3 is a partial top view showing the arrangement of the water feed valve 50, the ion elution unit 100, and the water feed mouth 53. The ion elution unit 100 is connected directly, at one end, to the main water feed valve 50a and, at the other end, to the water feed mouth 53. That is, the ion elution unit 100 alone constitutes the entire main water feed passage 52a. The sub water feed passage 52b is formed by connecting, with a hose, a pipe protruding from the water feed mouth 53 to the sub water feed valve 50b. In the schematic representation

shown in Fig. 1, to make explanations simple, the water feed valve 50, the ion elution unit 100, and the water feed mouth 53 are shown to be arranged in the front/rear direction of the washer 1; in reality, however, these are arranged not in the front/rear direction but in the right/left direction of the washer 1.

5 In a case where the washer is of the type of which the water feed valve is not separated into a main and a sub water feed valve and of which the water feed mouth has no treatment agent chamber but only a detergent chamber, the water feed valve and the water feed mouth have simply to be connected together through the ion elution unit 100.

10 The water feed valve 50, the ion elution unit 100, and the water feed mouth 53 are arranged at gently decreasing heights so that water flows down from the water feed valve 50 on the upstream side to the ion elution unit 100 on the downstream side, then from the ion elution unit 100 on the upstream side to the detergent chamber 54 of the water feed mouth ⁵³ on the downstream side, and then from there through the water outlet 56 to the washing tub 30. This prevents water from flowing backward from the detergent chamber 54 to the ion elution
15 unit 100. In this way, it is possible to prevent detergent ingredients from making contact with the electrodes 113 and 114 and depositing on them in the form of scale. This helps prevent lowering of the performance of the ion elution unit 100.

20 Figs. 4 to 8 show the construction of the ion elution unit. Fig. 4 is a top view, Fig. 5 is a vertical sectional view taken along line A-A shown in Fig. 4, Fig. 6 is a vertical sectional view taken along line B-B shown in Fig. 4, and Fig. 7 is a horizontal sectional view. Fig. 8 is a perspective view of an electrode.

 The ion elution unit 100 has a casing 110 formed of a transparent or semitransparent synthetic resin (uncolored or colored) or an opaque synthetic resin. The casing 110 is composed of a casing body 110a that is open at the top and a lid 110b that covers the top

opening of the casing body 110a (see Fig. 5). The casing body 110a is elongate, and has a water inlet 111 at one end and a water outlet 112 at the outer end along its longer sides. The water inlet 111 and the water outlet 112 are both pipe-shaped. The cross-sectional area of the water outlet 112 is smaller than that of the water inlet 111.

5 The casing 110 is arranged with its longer sides held horizontal. When held horizontal in this way, the casing body 110a has its bottom surface inclined so as to be increasingly low toward the water outlet 112 (see Fig. 5). That is, the water outlet 112 is located at the lowest level within the space inside the casing 110.

The lid 110b is fixed to the casing body 110a with four screws 170 (see Fig. 4).

10 Between the casing body 110a and the lid 110b is sandwiched a seal ring 171 (see Fig. 5).

Inside the casing 110, two plate-shaped electrodes 113 and 114 are arranged face-to-face along the current of water flowing from the water inlet 111 to the water outlet 112. With water present inside the casing 110, when a predetermined voltage is applied between the electrodes 113 and 114, metal ions of the metal of which the electrodes 113 and 114 are
15 formed are eluted from whichever of them is at the anode side at the moment. The electrodes 113 and 114 are, for example, plates of silver each measuring 2 cm × 5 cm and about 1 mm thick, and are arranged 5 mm apart from each other.

The electrodes 113 and 114 may be formed of any other material than silver, provided that it is a metal from which metal ions having an antimicrobial effect can be generated.

20 Apart from silver, examples of such metals include copper, alloy of silver and copper, and zinc. Silver ions eluted from a silver electrode, copper ions eluted from a copper electrode, and zinc ions eluted from a zinc electrode all exert an excellent antimicrobial and fungistatic effect. From alloy of silver and copper, silver and copper ions can be eluted simultaneously.

The ion elution unit 100 permits a choice of whether to elute metal ions or not

according to whether a voltage is applied or not. The ion elution unit 100 also permits the amount of eluted metal ions to be controlled through control of the current and the time for which the voltage is applied. As compared with a method whereby metal ions are eluted from a metal-ion-carrying substance such as zeolite, the ion elution unit 100 is easier to use
5 because it permits the choice of whether to add metal ions or not and the adjustment of the concentration of metal ions to be both made electrically.

The electrodes 113 and 114 are arranged not perfectly parallel but with a taper in such a way that, as seen in a plan view, the distance between the electrodes decreases from the upstream side to the downstream side with respect to the water current flowing inside the
10 casing 110, i.e., from the water inlet 111 to the water outlet 112 (see Fig. 7).

The shape of the casing body 110a itself, as seen in a plan view, is also so formed as to be increasingly narrow from its end where the water inlet 111 is formed to its end where the water outlet 112 is formed. That is, the cross-sectional area of the space inside the casing 110 gradually decreases from the upstream side to the downstream side.

15 The electrodes 113 and 114 are rectangular as seen from in front, and are provided with terminals 115 and 116, respectively. The terminals 115 and 116 are formed so as to protrude downward from the lower edges of the electrodes 113 and 114, at positions inward of their upstream-side ends.

The electrode 113 and the terminal 115 are integrally formed of the same metal
20 material, and so are the electrode 114 and the terminal 116. The electrodes 115 and 116 are placed through through-holes formed in the bottom wall of the casing body 110a so as to appear below the bottom surface of the casing body 110a. At the places where the terminals 115 and 116 penetrate the casing body 110a, there are provided watertight seals 172 as shown in an enlarged view within Fig. 6. The watertight seals 172, together with the second sleeves

175 described later, form a double seal structure to prevent leakage of water there.

Formed integrally with the bottom surface of the casing body 110a is an insulating wall 173 for insulating the terminals 115 and 116 from each other (see Fig. 6). The terminals 115 and 116 are connected to the drive circuit included in the controller 80 by way of nonillustrated cables.

The parts of the terminals 115 and 116 located inside the casing 110 are protected by sleeves formed of insulating materials. Here, two kinds of sleeve are used. First sleeves 174 are formed of a synthetic resin, and are fitted around base portions of the terminals 115 and 116, respectively. The first sleeves 174 are so formed that parts thereof extend along one side surface of the electrodes 113 and 114, respectively, and, on the side surfaces of those parts, projections are formed, which engage with through holes formed in the electrodes 113 and 114 (see Figs. 6 and 7). This prevents the electrodes 113 and 114 from coming off the sleeves 174. Second sleeves 175 are formed of soft rubber, and serve to fill the gap between the first sleeves 174 and the bottom wall of the casing body 110a. The second sleeves 175 also serve to prevent leakage of water through the gap between themselves and the casing body 110a and through the gap between themselves and the electrodes 113 and 114.

As described above, the terminals 115 and 116 are formed on rather upstream-side parts of the electrodes 113 and 114, and the first sleeves 174, which are fitted around the terminals 115 and 116, form a support for the upstream-side parts of the electrodes 113 and 114. On the inner surface of the lid 110b, there are formed fork-shaped support portions 176 at positions corresponding to the first sleeves 174 (see Fig. 6). A firm support is achieved resulting from these support portions 176 pinching the top edges of the first sleeves 174 as well as the second sleeves 175 filling the gaps between the first sleeves 174 and the casing body 110a. The fork-shaped support portions 176 pinch the electrodes 113 and 114 between

long and short fingers, and thereby keep an appropriate interval between the electrodes 113 and 114 on the lid 110b side.

The downstream-side parts of the electrodes 113 and 114 are also supported by support portions formed on the inner surface of the casing 110. From the bottom wall of the casing body 110a, fork-shaped support portions 177 protrude upward. Likewise, from the ceiling surface of the lid 110b, fork-shaped support portions 178 protrude downward so as to face the support portions 177 (see Fig. 5 and 8). The electrodes 113 and 114 have, in their downstream-side parts, their bottom and top edges pinched by the support portions 177 and 178 so as to be unmovably held.

As shown in Fig. 7, the electrodes 113 and 114 are so arranged that spaces are left between the inner surface of the casing 110 and the surfaces of the electrodes 113 and 114 that face away from each other. Moreover, as shown in Fig. 5, the electrodes 113 and 114 are so arranged that spaces are left between the inner surface of the casing 110 and the top and bottom edges of the electrodes 113 and 114 (except at the places where they make contact with the support portions 176, 177, and 178). Furthermore, as shown in Figs. 7 and 5, spaces are left also between the inner surface of the casing 110 and the upstream-side and downstream-side edges of the electrodes 113 and 114.

In a case where the casing 110 needs to be made narrower, the electrodes 113 and 114 may be arranged so that their surfaces that face away from each other are kept in close contact with the inner surface of the casing 110.

To prevent foreign matter from making contact with the electrodes 113 and 114, a metal strainer is disposed on the upstream side of the electrodes 113 and 114. In the embodiment being described, as shown in Fig. 2, a strainer 180 is provided inside the connection pipe 51. The strainer 180 serves to prevent entry of foreign matter into the water

feed valve 50, and is shared as a strainer disposed on the upstream side of the ion elution unit 100.

Another metal strainer 181 is disposed on the downstream side of the electrodes 113 and 114. As the electrodes 113 and 114 are used for a long time, they become increasingly
5 thin and may ultimately break. In such a case, the strainer 181 prevents fragments of the electrodes 113 and 114 from flowing out. The strainer 181 is disposed, for example, in the water outlet 112.

The strainers 180 and 181 may be disposed at any other places in the water feed passage than specifically described above, provided that they are disposed "on the upstream
10 and downstream sides of the electrodes," respectively. The strainers 180 and 181 are made removable so that the foreign matter caught in them can be removed and that they can be cleaned to remove substances that cause clogging.

Fig. 9 shows the drive circuit 120 for driving the ion elution unit 100. A transformer 122 is connected to commercially distributed electric power 121 so as to step down 100 V to a
15 predetermined voltage. The output voltage of the transformer 122 is rectified by a full-wave rectifier circuit 123, and is then formed into a constant voltage by a constant voltage circuit 124. To the constant voltage circuit 124 is connected a constant current circuit 125. The constant current circuit 125 operates in such a way as to supply a constant current to the electrode drive circuit 150 described later without being influenced by variation in the
20 resistance through the electrode drive circuit 150.

To the commercially distributed electric power 121 is also connected, in parallel with the transformer 122, a rectifying diode 126. The output voltage of the rectifying diode 126 is smoothed by a capacitor 127, is then formed into a constant voltage by a constant voltage circuit 128, and is then supplied to a microcomputer 130. The microcomputer 130 controls

the starting of a triac 129 connected between one end of the primary coil of the transformer 122 and the commercially distributed electric power 121.

The electrode drive circuit 150 is composed of NPN-type transistors Q1 to Q4, diodes D1 and D2, and resistors R1 to R7. These are interconnected as shown in the figure. The transistor Q1 and the diode D1 form a photocoupler 151, and the transistor Q2 and the diode D2 form a photocoupler 152. That is, the diodes D1 and D2 are photodiodes, and the transistors Q1 and Q2 are phototransistors.

Suppose now that the microcomputer 130 feeds a high-level voltage to a line L1 and a low-level voltage (zero voltage) to a line L2. Then, the diode D2 turns on, and this causes the transistor Q2 to turn on. When the transistor Q2 turns on, a current flows through the resistors R3, R4, and R7, and this causes a bias to be applied to the base of the transistor Q3. Thus, the transistor Q3 turns on.

On the other hand, the diode D1 is off, and thus the transistors Q1 is off, and accordingly the transistor Q4 is off. In this state, a current flows from the anode-side electrode 113 to the cathode-side electrode 114. As a result, in the ion elution unit 100, there are generated metal ions as positively-charged ions together with negatively-charged ions.

When a current is passed through the ion elution unit 100 in one direction for a long time, while the electrode 113, which is at the anode side in Fig. 9, wears off, the electrode 114, which is at the cathode side, collects impurities such as calcium in water in the form of scale deposited on it. Moreover, chlorides and sulfides of the metal of which the electrodes are formed are produced on their surfaces. This degrades the performance of the ion elution unit 100. To avoid this, the electrode drive circuit 150 is so configured that it can be operated with the polarities of the electrodes reversed.

To reverse the polarities of the electrodes, the microcomputer 130 switches modes of

control so as to invert the voltage applied between the lines L1 and L2 and thereby reverse the current that flows between the electrodes 113 and 114. In this mode, the transistors Q1 and Q4 are on, and the transistors Q2 and Q3 are off. The microcomputer 130 has a counter capability, and switches modes of control as described above every time a predetermined
5 count is reached.

When the resistance through the electrode drive circuit 150, in particular the resistance of the electrodes 113 and 114, varies and as a result, for example, the current that flows between the electrodes decreases, the constant current circuit 125 raises its output voltage to compensate for the decrease. However, as the total use time increases, the ion elution unit
10 100 eventually reaches the end of its useful life. When this happens, even if the polarities of the electrodes are reversed, or even if the mode of control is switched to an electrode cleaning mode in which the electrodes are kept at particular polarities for a longer time than in normal operation so that impurities deposited on the electrodes are forcibly removed, or even if the output voltage of the constant current circuit 125 is raised, it is no longer possible to
15 compensate for the decrease in the current.

To cope with this, in the circuit under discussion, the current that flows between the electrodes 113 and 114 of the ion elution unit 100 is monitored on the basis of the voltage that it produces across the resistor R7. When the current becomes equal to a predetermined minimum current, a current detection circuit 160 detects it. The fact that the minimum
20 current has been detected is transmitted from a photodiode D3, which is a part of a photocoupler 163, through a phototransistor Q5 to the microcomputer 130. The microcomputer 130 then drives, by way of a line L3, an indicator to make it indicate a predetermined warning. A warning indicator 131 serves as the indicator. The warning indicator 131 is provided in the operation/display panel 81 or in the controller 80.

Moreover, to cope with a fault such as short-circuiting within the electrode drive circuit 150, there is provided a current detector that detects the current being larger than a predetermined maximum current. On the basis of the output of this current detector, the microcomputer 130 drives the warning indicator 131. A current detection circuit 161 serves
5 as the current detector. Furthermore, when the output voltage of the constant current circuit 125 becomes lower than a previously set minimum voltage, a voltage detection circuit 162 detects it, and the microcomputer 130 likewise drives the warning indicator 131.

The metal ions generated by the ion elution unit 100 are added into the washing tub 30 in the following manner.

10 Metal ions and a softening agent used as a treatment agent are added in the final rinsing process. Fig. 14 is a flow chart showing the sequence of operations for final rinsing. In the final rinsing process, on completion of the squeezing process in step S500, the flow proceeds to step S420. In step S420, whether or not addition of a treatment substance is selected is checked. If "addition of a treatment substance" is selected through settings on the
15 operation/display panel 81, the flow proceeds to step S421; if not, the flow proceeds to step S401 in Fig. 12 to perform the final rinsing process in the same manner as in the rinsing process already performed.

In step S421, whether or not addition of two kinds of treatment substance, namely metal ions and a softening agent, is selected is checked. If "addition of metal ions and a
20 softening agent" is selected through settings on the operation/display panel 81, the flow proceeds to step S422; if not, the flow proceeds to step S426.

In step S422, the main and sub water feed valves 50a and 50b are both opened, so that water flows through both the main and sub water feed passages 52a and 52b.

Step S422 is a metal ion elution process. A predetermined amount of water for

which the main water feed valve 50a is set, i.e., an amount of water larger than that for which the sub water feed valve 50b is set, flows through the ion elution unit 100 while filling the space inside it. Simultaneously, the drive circuit 120 applies a voltage between the electrodes 113 and 114 so that ions of the metal of which they are formed are eluted into
5 water. In a case where the electrodes are formed of silver, the reaction $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$ takes place at the positive-side electrode, causing silver ions Ag^+ to be eluted into water. The current that flows between the electrodes is a direct current. The water thus mixed with metal ions enters the detergent chamber 54, and is poured through the water outlet 54a and then the water outlet 56 into the washing tub 30.

10 An amount of water smaller than that flowing out of the main water feed valve 50a flows out of the sub water feed valve 50b, and is poured through the sub water feed passage 52b into the treatment agent chamber 55. If a treatment agent (softening agent) is put in the treatment agent chamber 55, it is added, along with water, through the siphon 57 into the washing tub 30. That is, the treatment agent (softening agent) is added at the same time that
15 the metal ions are. The principle of a siphon does not work until the water level inside the treatment agent chamber 55 reaches a predetermined level. This makes it possible to keep the liquid treatment agent (softening agent) in the treatment agent chamber 55 until water is poured into it with due timing.

When a predetermined amount of water (sufficient to cause the principle of a siphon to
20 work in the siphon 57, or more) is poured into the treatment agent chamber 55, the sub water feed valve 50b is closed. This operation of pouring water, i.e., the operation of adding a treatment agent, is automatically performed so long as "addition of a treatment agent" is selected, irrespective of whether or not a treatment agent (softening agent) is put in the treatment agent chamber 55.

When a predetermined amount of water mixed with metal ions is poured into the washing tub 30, and it is judged that, thereafter, simply water free of metal ions needs to be added up to the set water level to obtain a predetermined concentration of metal ions in rinsing water, the application of the voltage to the electrodes 113 and 114 is stopped. Even
5 after the ion elution unit 100 stops generating metal ions, the main water feed valve 50a continues to feed water until, when the water level inside the washing tub 30 reaches the set water level, it stops feeding water.

As described above, in step S422, metal ions and a treatment agent (softening agent) are added simultaneously. This, however, does not necessarily mean that the period during
10 which the ion elution unit 100 generates metal ions needs to completely overlap the period during which the principle of a siphon works to add the treatment agent (softening agent) into the washing tub 30. Either of these periods may start and end earlier than the other. The treatment agent (softening agent) may be added while, after the ion elution unit 100 stops generating metal ions, additional water free of metal ions is being poured. What is important
15 here is that addition of metal ions and addition of a treatment agent (softening agent) be performed individually within a single sequence.

As described earlier, the terminal 115 and the electrode 113 are integrally formed of the same metal material, and so are the terminal 116 and the electrode 114. This, as opposed to a case where different metal parts are jointed together, prevents a potential difference
20 between the electrode and terminal, and thus prevents corrosion. Moreover, forming them integrally helps simplify the manufacturing process.

The electrodes 113 and 114 are arranged with a taper so that the interval between them decreases from the upstream side to the downstream side. This permits the electrodes to remain parallel to the current of water, and thus makes them less likely to vibrate even when

they wear and become thin. Moreover, there is no risk of the electrodes being excessively deformed and short-circuited.

The electrodes 113 and 114 are supported with spaces left between them and the inner surface of the casing 110. This prevents short-circuiting between the electrodes 113 and 114
5 resulting from growth of a metal layer from them to the inner surface of the casing 110.

Even though the terminals 115 and 116 are formed integrally with the electrodes 113 and 114, while it is inevitable that the electrodes 113 and 114 wear with use, it is unacceptable that the terminals 115 and 116 do. In the embodiment being described, the parts of the terminals 115 and 116 located inside the casing 110 are protected by the sleeves 174 and 175
10 formed of insulating materials, and thus suffer less from wear resulting from energization. This prevents breakage of the terminals 115 and 116 in the middle of use.

It is at positions inward of the upstream-side ends of the electrodes 113 and 114 that the terminals 115 and 116 are formed. The electrodes 113 and 114 wear from those parts thereof where the interval between them is narrow. They wear quickly also at the ends.
15 The terminals 115 and 116 are formed, indeed, on rather upstream-side parts of the electrodes 113 and 114, but not at their very ends but at positions inward of their ends. This eliminates the risk of the terminals breaking at their base portions as a result of their wear, having started at their ends, reaching the terminals.

The upstream-side parts of the electrodes 113 and 114 are supported by the first
20 sleeves 174 and the support portions 176. On the other hand, the downstream-side parts of the electrodes 113 and 114 are supported by the support portions 177 and 178. The electrodes 113 and 114, supported firmly in this way at both their upstream-side and downstream-side parts, do not vibrate even in a water current. This eliminates the risk of the electrodes 113 and 114 breaking as a result of vibration.

The terminals 115 and 116 penetrate the bottom wall of the casing body 110a and protrude downward therefrom. Thus, even when condensation occurs on the outside of the casing 110 as a result of vapor making contact with the casing body 110a (when laundry washing is performed with warm water from a bath tub, vapor tends to enter the washer 1), or
5 as a result of the casing 110 being cooled by water passed therethrough, condensed water flows down along the cables connected to the terminals 115 and 116 without lingering at the boundaries between the terminals 115 and 116 and the casing 110. This eliminates the risk of the terminals 115 and 116 being short-circuited by condensed water. The casing body 110a is arranged with its longer sides kept horizontal. This makes it easy to form the
10 terminals 115 and 116, which are formed on sides of the electrodes 113 and 114, in such a way that they protrude downward from the bottom wall of the casing body 110a.

The water outlet 112 of the ion elution unit 100 has a smaller cross-sectional area and thus a higher flow resistance than the water inlet 111. Thus, the water that has entered the casing 110 through the water inlet 111 fills the interior of the casing 110 without forming a
15 pool of air, and thus completely soaks the electrodes 113 and 141. This prevents a situation in which part of the electrode 113 and 114 does not contribute to the generation of metal ions and thus remains uneluted.

Not only is the cross-sectional area of the water outlet 112 smaller than that of the water inlet 111, the cross-sectional area of the space inside the casing 110 gradually decreases
20 from the upstream side to the downstream side. This makes production of disturbed currents and bubbles inside the ion elution unit 100 less likely, and thus ensures a smooth current of water. There is no risk of bubbles causing part of the electrodes to remain uneluted. Moreover, metal ions are permitted to quickly leave the electrodes 113 and 114 and are prevented from returning to them. This helps enhance ion elution efficiency.

The ion elution unit 100 is arranged in the main water feed passage 52a, which is set for a high flow rate, and thus a large amount of water flows through the ion elution unit 100. This permits metal ions to be carried out of the casing 110 quickly and prevents them from returning to the electrodes 113 and 114. This helps enhance ion elution efficiency.

5 The water outlet 112 is located at the lowest level within the space inside the casing 110. Thus, when water stops being fed to the ion elution unit 100, all the water inside the ion elution unit 100 flows out of it through the water outlet 112. This prevents a situation where, in a cold season, the water remaining inside the casing 110 freezes with the result that the ion elution unit 100 is broken or destroyed.

10 The strainer 180 is disposed on the upstream side of the electrodes 113 and 114. Thus, even when solid foreign matter is present in the water fed to the ion elution unit 100, the foreign matter is caught by the strainer 180 so as not to reach the electrodes 113 and 114. This prevents the electrodes 113 and 114 from being damaged by foreign matter, prevents them from being short-circuited by foreign matter and causing an excessively large electric
15 current to flow or causing shortage of generated metal ions.

 The strainer 181 is disposed on the downstream side of the electrodes 113 and 114. Thus, even when the electrodes 113 and 114 wear or become brittle after long-time use and ultimately they break and let their fragments flow off, the fragments are caught by the strainer 181 so as not to flow further downstream. This prevents fragments of the electrodes 113 and
20 114 from damaging objects located downstream.

 In a case where the ion elution unit 100 is incorporated in a washer 1 as in this embodiment, without the strainers 180 and 181, foreign matter or fragments of the electrodes may stick to laundry. Foreign matter or fragments of the electrode may soil or damage laundry. Moreover, if an article of laundry is squeezed and dried with foreign matter or a

fragment of the electrodes left stuck to it, a person who wears the article may touch the foreign matter or fragment of the electrodes and feel annoyed or, in an extreme case, get hurt by it. Disposing the strainers 180 and 181 helps avoid such a situation.

It is not absolutely necessary to provide both the strainers 180 and 181. One or both
5 of the strainers 180 and 181 may be omitted, provided that their absence causes no problem.

Back in the flow chart of Fig. 14, in step S423, rinsing water mixed with the metal ions and the treatment agent (softening agent) is agitated with a powerful current of water (powerful swirl) to prompt contact between the laundry and the metal ions and sticking of the treatment agent (softening agent) to the laundry.

10 Sufficient agitation with a powerful swirl permits the metal ions and treatment agent (softening agent) to uniformly dissolve in water and reach every part of the laundry. After agitation with a powerful swirl for a predetermined period of time, the flow proceeds to step S424.

In step S424, by contrast, agitation is performed with a mild current of water (mild
15 swirl). The aim here is to make the metal ions stick to the surface of the laundry and exert their effect. Agitation is performed gently because, so long as there is a current of water, however mild it is, the user is unlikely to mistakenly believe that the operation of the washer 1 has ended. If, however, there is another means for making the user recognize that rinsing is being performed, for example, if it is possible to display an indication on the
20 operation/display panel 81 to attract the user's attention, the water may be kept still, instead of being agitated.

After agitation with a mild swirl for a period of time sufficiently long to permit the laundry to absorb metal ions, the flow proceeds to step S425. In step S425, agitation is performed with a powerful current of water (powerful swirl) again to make doubly sure.

This permits metal ions to reach and stick to even those parts of the laundry which they have thus far failed to reach.

After step S425, the flow proceeds to step S406. In step S406, the pulsator 33 is rotated repeatedly in the forward and then reverse directions at short time intervals to loosen
5 the laundry. This permits the laundry to spread evenly in the washing tub 30 in preparation for squeezing rotation.

An example of how time is distributed among the individual steps is as follows: step S423 (powerful swirl) lasts for 4 minutes; step S424 (mild swirl) lasts for 4 minutes 15 seconds; step S425 (powerful swirl) lasts for 5 seconds, and step S406 (loosening and
10 spreading) lasts for 1 minute 40 seconds. Thus, it takes 10 minutes in total to perform steps S423 to S406.

In principle, it is desirable to add metal ions and a treatment agent (softening agent) separately. This is because, when metal ions make contact with treatment agent ingredients, they form compounds, and this lessens the antimicrobial effect of metal ions. However, in
15 rinsing water, a considerable amount of metal ions remain intact throughout, and the reduced antimicrobial effect can be compensated for to a certain degree by appropriately setting the concentration of metal ions. Accordingly, in this embodiment, metal ions and a treatment agent (softening agent) are added simultaneously so that, while the obtained antimicrobial effect is somewhat reduced, the time required for rinsing is reduced as compared with in a
20 case where they are added separately in separate rinsing processes. This helps make housework efficient.

It is inevitable that the metal ions meet the treatment agent (softening agent) inside the washing tub 30, but it is desirable to prevent their contact before they are added into the washing tub 30. In this embodiment, the metal ions are added into the washing tub 30

through the main water feed passage 52a and then through the detergent chamber 54, and the treatment agent (softening agent) is added into the washing tub 30 through the treatment agent chamber 55. That is, the passage through which the metal ions are added to rinsing water is separate from the passage through which the treatment agent is added to the rinsing water.

- 5 This prevents contact between the metal ions and the treatment agent (softening agent) before they meet in the washing tub 30, and thus prevents the metal ions from making contact with the treatment agent (softening agent) in a high concentration, forming compounds, and losing their antimicrobial effect.

In the above description, the final rinsing process is described as being performed as
10 "stored-water rinsing" with rinsing water stored in the washing tub 30. It is, however, also possible to perform the final rinsing process as "supplied-water rinsing." In that case, water mixed with metal ions is kept supplied.

Also when the laundry does not spread evenly in step S406, and therefore it is necessary to perform "laundry-spreading rinsing" with water supplied once again, water
15 mixed with metal ions is used

Addition of the first treatment substance, namely metal ions, and addition of the second treatment substance, namely a treatment agent (softening agent) are both optional. That is, addition of one or both of the treatment substances can be omitted. When addition of both the treatment substances is omitted, the flow proceeds from step S420 to step S401 as
20 described earlier. Now, a description will be given of a case where only one of the two kinds of treatment substance is added.

If, in step S421, addition of two kinds of treatment substance, namely metal ions and a softening agent, is not selected, it means that addition of only one of them is selected. In this case, the flow proceeds to step S426.

In step S426, whether or not addition of metal ions as a treatment substance is selected is checked. If addition of metal ions is selected, the flow proceeds to step S427; otherwise, the flow proceeds to step S428.

5 In step S427, the main water feed valve 50a is opened, so that water flows through the main water feed passage 52a. The sub water feed valve 50b remains closed. When water flows through the ion elution unit 100, the drive circuit 120 applies a voltage between the electrodes 113 and 114 so that ions of the metal of which the electrodes are formed are eluted into water. When a predetermined amount of water mixed with metal ions is poured into the washing tub 30, and it is judged that, thereafter, simply water free of metal ions needs to be
10 added up to the set water level to obtain a predetermined concentration of metal ions in rinsing water, the application of the voltage to the electrodes 113 and 114 is stopped. Even after the ion elution unit 100 stops generating metal ions, the main water feed valve 50a continues to feed water until, when the water level inside the washing tub 30 reaches the set water level, it stops feeding water.

15 After step S427, the flow proceeds to step S423. Thereafter, the flow proceeds, as when metal ions and a treatment agent (softening agent) are added simultaneously, through steps S423 (powerful swirl), S424 (mild swirl), and S425 (powerful swirl) to step S406 (loosening and spreading).

If, in step S426, addition of metal ions as a treatment substance is not selected, it
20 means that addition of a treatment agent (softening agent) alone is selected. In this case, the flow proceeds to step S428.

In step S428, the main and sub water feed valves 50a and 50b are both opened, so that water flows through both the main and sub water feed passages 52a and 52b. However, the ion elution unit 100 is not driven, and therefore no metal ions are generated. When a

sufficient amount of water to cause the principle of a siphon to work is poured into the treatment agent chamber 55, and the treatment agent (softening agent) is added through the siphon 57 into the washing tub 30, the sub water feed valve 50b is closed.

Even after the sub water feed valve 50b is closed, the main water feed valve 50a
5 continues to feed water until, when the water level inside the washing tub 30 reaches the set water level, it stops feeding water.

After step S428, the flow proceeds to step S423. Thereafter, the flow proceeds, as when metal ions and a treatment agent (softening agent) are added simultaneously, through steps S423 (powerful swirl), S424 (mild swirl), and S425 (powerful swirl) to step S406
10 (loosening and spreading).

As described above, even in a case where only one kind of treatment substance is added, the steps with a powerful swirl, a mild swirl, and then a powerful swirl are all performed so that the treatment substance firmly sticks to the laundry. It is not necessary, however, to distribute time among the individual steps in the same manner for metal ions and
15 for a treatment agent (softening agent), and therefore time distribution is adjusted to suit each treatment substance.

A treatment agent (softening agent) does not take so long a time as metal ions do to stick to laundry. Accordingly, it is possible to perform, after step S428, only steps S423 (powerful swirl) and S406 (loosening and spreading) and finish step S423 (powerful swirl)
20 briefly, for example in two minutes.

While the ion elution unit 100 is driven, the constant current circuit 125 of the drive circuit 120 controls the voltage so that the current that flows between the electrodes 113 and 114 remains constant. This makes the amount of eluted metal ions per unit time constant. With the amount of eluted metal ions per unit time constant, by controlling the amount of

water passed through the ion elution unit 100 and the period of time for which ions are eluted, it is possible to control the concentration of metal ions inside the washing tub 30. This makes it easy to obtain a desired concentration of metal ions.

Here, the current that flows between the electrodes 113 and 114 is a direct current. If
5 this current is an alternating current, the following phenomenon occurs. Specifically, assuming that the metal ions are silver ions, when the polarities of the electrodes are reversed, a reverse reaction $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ takes place, causing eluted silver ions to return to the electrode. This does not happen with a direct current.

Scale is deposited on whichever of the electrodes 113 and 114 is used as the negative
10 electrode. As a direct current continues to be passed between the electrodes without reversing their polarities, more and more scale is deposited, making it increasingly difficult to elute metal ions at a predetermined rate. On the other hand, the electrode that is used as the positive electrode wears more quickly, resulting in "one-sided wear." To avoid these problems, the polarities of the electrodes 113 and 114 are reversed periodically.

15 As metal ions are eluted, the electrodes 113 and 114 gradually wear, decreasing the amount of eluted metal ions. After long-time use, the amount of eluted metal ions may become unstable, or it becomes impossible to elute a predetermined amount of metal ions. Therefore, the ion elution unit 100 is made replaceable so that, when the electrodes 113 and 114 reach the end of their useful life, it can be replaced with a new unit. Moreover, the user
20 is notified, through the operation/display panel 81, of the fact that the electrodes 113 and 114 have reached the limit of their life so as to be prompted to perform maintenance as by replacing the ion elution unit 100.

It is to be understood that the present invention may be carried out in any other manner than specifically described above as an embodiment, and many modifications and

variations are possible within the scope of the invention.

It is also to be understood that the present invention may be applied to any other type of appliance than washers, for example dish washers and humidifiers, and to any other type of washer than those of fully automatic type like the one taken up in the embodiment describe
5 above, that is, to all types of washer, such as those having horizontal drums (of the tumbler type), those having slanted drums, those which function also as dryers, and those with two separated tubs.

Industrial applicability

10 The present invention finds wide application in situations where exploitation of the antimicrobial effect of metal ions is attempted. An ion elution unit according to the present invention can be effectively combined not only with a washer but also with a dish washer, a humidifier, or any other type of appliance where growth of bacteria and mold needs to be suppressed.

CLAIMS

1. An ion elution unit that generates metal ions by applying a voltage between electrodes,
wherein a strainer is provided on a downstream side of the electrodes.
2. An appliance that incorporates the ion elution unit according to claim 1 and that uses water mixed with metal ions generated by the ion elution unit.
3. The appliance according to claim 2,
wherein the appliance is a washer.
4. An appliance that incorporates an ion elution unit that generates metal ions by applying a voltage between electrodes, the appliance being capable of using water mixed with metal ions generated by the ion elution unit,
wherein a water inlet of the ion elution unit is connected on a downstream side of a water feed valve provided in the appliance, and a strainer provided in a connection pipe of the water feed valve is shared as an upstream-side strainer of the ion elution unit.
5. The appliance according to claim 4,
wherein the appliance is a washer.
6. An appliance that incorporates the ion elution unit according to claim 1 and that uses water mixed with metal ions generated by the ion elution unit,
wherein the appliance has a main water feed passage set for a high flow rate and a sub water feed passage set for a low flow rate, and the ion elution unit is placed in the main water feed passage.
7. The appliance according to claim 6,

wherein the appliance is a washer.

8. The appliance according to claim 7,

wherein a water feed mouth through which water is fed to a washing tub has an interior thereof divided into a detergent chamber and a treatment agent chamber, with water from the main water feed passage introduced into the detergent chamber and water from the sub water feed passage introduced into the treatment agent chamber.

9. The appliance according to claim 2,

wherein the ion elution unit has a water inlet and a water outlet provided at one and another ends, respectively, of a casing along a direction of longer sides thereof, and is placed with the longer sides of the casing kept substantially horizontal.

10. The appliance according to claim 4,

wherein the ion elution unit has a water inlet and a water outlet provided at one and another ends, respectively, of a casing along a direction of longer sides thereof, and is placed with the longer sides of the casing kept substantially horizontal.

11. The appliance according to claim 6,

wherein the ion elution unit has a water inlet and a water outlet provided at one and another ends, respectively, of a casing along a direction of longer sides thereof, and is placed with the longer sides of the casing kept substantially horizontal.

12. A washer that incorporates an ion elution unit that generates metal ions by applying a voltage between electrodes, the washer using water mixed with metal ions generated by the ion elution unit, the washer being provided with a detergent chamber and a treatment agent chamber,

wherein the ion elution unit is placed on an upstream side of a water feed mouth through which water is fed to a washing tub and on a downstream side of a water feed valve so that water from the water feed valve is fed through the ion elution unit to the water feed mouth, and the water feed mouth has a detergent chamber provided inside it.