SPECIFICATION

TITLE

DRUM-TYPE WASHING-DRYING MACHINE

Technical Field

[0001] The present invention relates to a drum-type washing-drying machine.

Background Art

[0002] General drum-type washing-drying machines comprise a drum that is rotatably disposed in a water tank, and performs washing, rinse, and drying of laundry such as clothes and the like loaded in the drum. In recent years, drum-type washing-drying machines which are equipped with functions to deodorize clothes, kill various germs and the like have been proposed as goods that have an enhanced added value (see patent documents 1, 2).

[0003] The patent document 1 discloses a drum-type washing-drying machine that incorporates an ion generation apparatus to generate positive ions and negative ions which have a sterilization effect of killing airborne germs. This drum-type washing-drying machine is equipped with an ion generation apparatus that is disposed above a water tank and in a circulation wind path which is arranged from behind the water tank, over the tank, and to the front of the tank. One end of the circulation wind path is connected to an outlet that is opened through a rear lower portion of the tank, and the other end of the circulation wind path is connected to a cylindrical hollow circulation member that is unitarily formed with a packing which is disposed around an opening of the water tank for a tight contact with an open-close cover, thereby positive ions and negative ions generated from the ion generation apparatus are supplied into a drum via the circulation wind path.

Besides, the patent document 1 proposes a drum-type washing-drying machine in which an ion generation apparatus is disposed above a rear portion of a water tank, an ion outlet of the ion generation apparatus is directly connected to the water tank to directly supply positive and negative ions into a drum.

[0004] The patent document 2 discloses a drum-type washing-drying machine that incorporates an ozone generation apparatus to generate ozone which has effects of deodorizing clothes, killing various germs and the like. In this drum-type washing-drying machine, a supply path, which supplies ozone generated from the ozone generation apparatus disposed on a lower portion of a water tank, is connected to a halfway position of a circulation wind path (drying wind path) which is arranged from behind the water tank, over the tank, and to the front of the tank. One end of the circulation wind path is connected to an outlet (way out) that is opened through a rear lower portion of the tank, and the other end of the circulation wind path is connected to a circulation opening (inlet) formed through a front upper portion of the water tank, thereby ozone generated from the ozone generation apparatus is supplied into the circulation wind path via the supply path, and is further supplied into a drum with the aid of an air stream that is circulating through the circulation wind path.

[patent document 1] JP-A-2003-135889

[patent document 2] JP-A-2007-195896

Disclosure of the Invention

Problems to be Solved by the Invention

[0005] However, in the drum-type washing-drying machine disclosed in the patent document 1, because the way out of the circulation wind path or the ion

outlet is connected to the water tank, detergent bubbles jump out of the water tank in the washing or rinse step, invade into the circulation wind path or into the ion supply path, and sometimes adhere to the ion generation apparatus. Besides, water vapors that are flowing in the circulation wind path in the drying step sometimes adhere to the ion generation apparatus. In addition, because the ion generation apparatus is disposed above the washing tank, high-temperature air due to temperature rise inside the machine stagnates around the ion generation apparatus, and the temperature of the ion generation apparatus sometimes increases extremely. In these cases, reliability of the ion generation apparatus fall dramatically. Because the way out of the circulation wind path or the ion outlet is directly connected to the water tank, there are problems that not only vibration of the water tank can damage or crack the connection portion but also parts and working steps increase in number, consequently, the structure becomes complicated and the cost increases. Moreover, because the circulation wind path passes above the water tank, it is necessary to secure a space where the circulation wind path and the ion generation apparatus are disposed above the machine, which causes a problem that the machine becomes bulky.

[0006] In the drum-type washing-drying machine disclosed in the patent document 2, because ozone that is harmful to the human health is used, it is necessary to secure safety by forming an ozone leak prevention structure and the like. Besides, there are problems that parts exposed to ozone are easily corroded, and frequency of part exchanges increases and maintenance cost increases, and there is also a problem that the product life becomes short because of the termination of production of replacement parts. In addition, there is a problem that

ozone stinks when the open-close cover is opened and laundry in the drum is taken out after completion of a deodorization and sterilization operation that uses ozone.

[0007] The present invention has been made to cope with the conventional problems, and it is an object of the present invention to provide a drum-type washing-drying machine in which ions having a function to sterilize and deodorize clothes are generated from an ion generation apparatus, and the ions are stably supplied into a circulation wind path that circulates air in a drum irrespective of vibration or rocking of a water tank and the drum, thereby odor and various germs of clothes can be efficiently removed.

[0008] Besides, it is an object of the present invention to provide a drum-type washing-drying machine which as an additional operation separate from the operations of washing, dewatering, and drying, can safely and efficiently deodorize clothes and kill germs that grow out of clothes by stably supplying ions, which are generated from the ion generation apparatus, have a function to sterilize and deodorize clothes (sterilization and deodorization function) and are harmless to the human body, into the circulation wind path that is used to circulate the air in the drum.

Means for Solving the Problem

[0009] To achieve the above object, a drum-type washing-drying machine according to the present invention comprises:

a water tank;

a drum which is rotatably disposed in the water tank and is used to carry out washing, dewatering and drying of clothes loaded in the drum;

a circulation wind path which is used to take air out of the drum via its one

end and to return the air into the drum via the other end;

heating means which is disposed in the circulation wind path and heats the air that is flowing in the circulation wind path;

an ion generation apparatus which is disposed above the water tank and uses electric discharge to generate ions that have a function to sterilize and deodorize clothes;

ion supply wind sending means which sends ions generated from the ion generation apparatus; and

an ion supply wind path which is used to supply ions generated from the ion generation apparatus into an ion introduction hole that is formed through an upper portion of the water tank;

wherein one end of the ion supply wind path is connected to an outlet of the wind sending means, and the other end is disposed away from and directed toward the ion introduction hole.

[0010] According to this structure, the other end (outlet) of the ion supply wind path is away from the ion introduction hole that is formed through the upper portion of the water tank. Therefore, even if detergent bubbles leak from the ion introduction hole to the outside of the water tank in the washing and rinse steps, or even if water vapors appear from the clothes loaded in the drum and come out via the ion introduction hole that is formed through the upper portion of the water tank in the drying step, the detergent bubbles and water vapors are prevented from invading into the ion supply wind path.

[0011] The drum-type washing-drying machine according to the present invention is characterized in that the ion generation apparatus generates positive

and negative ions.

[0012] According to this structure, because the positive and negative ions are harmless to the human body and have no corrosive effects on the parts, safety is high compared with that of the conventional goods that use ozone, and it is possible to prevent maintenance cost from increasing.

[0013] The drum-type washing-drying machine according to the present invention is characterized in that the ion introduction hole communicates with a space between a rear inner side of the water tank and a rear outer side of the drum.

[0014] According to this structure, ions introduced via the ion introduction hole into the space between the rear inner side of the water tank and the rear outer side of the drum are send from the space into the circulation wind path, where the ions are mixed with the air that is flowing in the circulation wind path and supplied into the drum. Accordingly, it is not necessary to dispose a special additional path that introduces ions into the circulation wind path.

[0015] The drum-type washing-drying machine according to the present invention is characterized in that circulation wind sending means which forcibly circulates air present in the ciculation wind path is disposed on a rear outer side of the water tank, and the ion introduction hole is located substantially vertically over the circulation wind sending means.

[0016] According to this structure, ions are sent from the ion introduction hole toward a portion which is part f of the space between the rear inner side of the water tank and the rear outer side of the drum and has the highest negative pressure, thereby ions can be efficiently mixed with the air that is flowing in the circulation wind path.

[0017] The drum-type washing-drying machine according to the present invention is characterized in that the circulation wind path is formed in a space between a lower inner side of a circumferential surface of the water tank and a lower outer side of a circumferential surface of the drum.

[0018] According to this structure, because the circulation wind path is not arranged above the water tank, an unused space present above the water tank can be effectively used to dispose the ion generation apparatus, the wind sending means and the ion supply wind path.

[0019] The drum-type washing-drying machine according to the present invention is characterized in that the ion supply wind path is a duct formed of a hard resin.

[0020] According to this structure, because the ion supply wind path can be composed of a rigid duct, if the duct is formed into a suitable shape that can go around the existing parts disposed in the machine, the unused space in the machine can be effectively used, and parts cost can be reduced.

[0021] The drum-type washing-drying machine according to the present invention is characterized in that a check valve is disposed at an outlet of the wind sending means.

[0022] According to this structure, even if detergent bubbles leak from the hole formed through the upper portion of the water tank to the outside of the water tank in the washing or rinse step, or even if water vapors generated in the drying step come out via the ion introduction hole formed through the upper portion of the water tank and invade into the ion supply wind path, the detergent bubbles and the water vapors are blocked by the check valve that is disposed at the outlet of the

wind sending means, thereby the detergent bubbles and the water vapors are prevented from adhering to the ion generation apparatus. Accordingly, it is possible to surely generate positive and negative ions from the ion generation apparatus.

[0023] The drum-type washing-drying machine according to the present invention is characterized in that a filter is disposed at an inlet of the wind sending means.

[0024] According to this structure, even if dust is contained in the air sucked into the ion supply wind path by operation of the wind sending means, the dust is caught by the filter disposed at the inlet of the ion supply wind path, thereby the dust is prevented from adhering to the ion generation apparatus. Accordingly, it is possible to surely generate positive and negative ions from the ion generation apparatus.

[0025] The drum-type washing-drying machine according to the present invention is characterized in that around a circumferential portion of the other end of the ion supply wind path, a vapor receiving portion is disposed to let vapors, which come out via the ion introduction hole to the outside of the water tank, turn into water drops and drip on an outer surface of the water tank.

[0026] According to this structure, water vapors, which are generated in the drying step and come out via the hole of an upper portion of the water tank, collide with the vapor receiving portion disposed around the circumferential portion of the other end of the ion supply wind path and turn into water drops. The water drops move on a wall surface of the vapor receiving portion and drip on an outer surface of the water tank. Accordingly, it is possible to prevent the water vapors from invading into the ion supply wind path.

[0027] The drum-type washing-drying machine according to the present invention is characterized in that the ion introduction hole is a hole (air removal hole) which is used to remove air from the water tank.

[0028] According to this structure, because the air removal hole formed through the upper portion of the water tank can also be used as the ion introduction hole concurrently, change of a metal mold to produce the water tank is unnecessary, and production cost of the drum-type washing-drying machine can be reduced.

[0029] To achieve the above object, a drum-type washing-drying machine according to the present invention comprises:

a water tank;

a drum which is rotatably disposed in the water tank and is used to carry out washing, dewatering and drying of clothes loaded in the drum;

a circulation wind path which is used to take air out of the drum via a bottom portion of the water tank and to return the air into the drum;

circulation wind sending means which is disposed in the circulation wind path and makes the air flow in the circulation wind path from one end of the circulation wind path to the other end of the circulation wind path;

heating means which is disposed in the circulation wind path and heats the air that is flowing in the circulation wind path;

an ion generation apparatus which uses electric discharge to generate ions that have a function to sterilize and deodorize clothes;

ion supply wind sending means which supplies ions generated from the ion generation apparatus into the air that is flowing in the circulation wind path;

a command key which as an additional separate operation besides

operations of washing, dewatering and drying, gives a command to execute a sterilization and deodorization operation of loading clothes into the drum and using the function of the ions to deodorize clothes and kill various germs that grow out of the clothes; and

control means which based on a command from the command key, operates the circulation wind sending means, the ion generation apparatus, the heating means, and the ion supply wind sending means in a predetermined way.

[0030] According to this structure, air that contains ions that have the sterilization and deodorization function is given to the clothes loaded in the drum, and odor and various germs of the clothes are removed by the ions. Because the ions are harmless to the human body, safety is high compared with that of the conventional goods that use ozone, and maintenance cost can be prevented from increasing. When the dedicated command key is pushed, this sterilization and deodorization operation is executed as an additional operation separate from the operations of washing, dewatering, and drying.

[0031] Besides, the drum-type washing-drying machine according to the present invention is characterized in that it comprises a drum motor to rotate the drum, and during the time of sterilization and deodorization operation, uses the command key to allow a selective operation of rotating the drum or bringing the drum into a stop state.

[0032] According to this structure, clothes that are easily damaged and deformed by the sterilization and deodorization operation, that is, delicate clothes can be washed by air (air washing) with the drum rotation stopped. On the other hand, an efficient sterilization and deodorization operation can be performed on

clothes that have no possibility of being damaged and deformed with the drum rotated.

[0033] The drum-type washing-drying machine according to the present invention is characterized in that it comprises water supply mans for supplying water into a bottom portion of the water tank, and drainage means for draining the water from the water tank. During the sterilization and deodorization operation, the heating means and the water supply means are operated, and the drainage means is stopped during a given time duration, thereby water vapors are supplied into the drum. In this case, the step of supplying water vapors into the drum may be carried out at the start time of executing the sterilization and deodorization operation or may be carried out a plurality of times at given time intervals during the time of executing the sterilization and deodorization operation.

[0034] According to this structure, the clothes loaded in the drum are steamed by the heated water vapors and can be finished fluffily. Because it is known that the higher the humidity becomes, the higher the sterilization and deodorization effect of positive and negative ions becomes, it is possible to increase the humidity inside the drum and to boost the effect of positive and negative ions. In addition, water-soluble compounds of odor content that comes out of the clothes dissolve in water vapors which are floating in the drum, thereby the odor removal effect becomes high.

[0035] The drum-type washing-drying machine according to the present invention is characterized in that the ion generation apparatus generates positive and negative ions.

[0036] According to this structure, because the positive and negative ions are

harmless to the human body and have no corrosive effect on the parts, safety is high compared with that of the conventional goods that use ozone, and maintenance cost can be prevented from increasing.

Advantages of the Invention

[0037] According to this invention, ions having a function to sterilize and deodorize clothes are generated from an ion generation apparatus, and the ions are stably supplied into a circulation wind path that circulates air in a drum irrespective of vibration or rocking of a water tank and the drum, thereby odor and various germs of clothes can be efficiently removed.

[0038] Besides, according to this invention, as an additional operation separate from the operations of washing, dewatering, and drying, it is possible to safely and efficiently deodorize clothes and kill germs that grow out of clothes by stably supplying ions, which are generated from the ion generation apparatus, have a function to sterilize and deodorize clothes (sterilization and deodorization function) and are harmless to the human body, into the circulation wind path that is used to circulate the air in the drum.

Brief Description of the Drawings

[0039] [Fig. 1] is a schematic view showing an appearance of a drum-type washing-drying machine according to an embodiment of the present invention seen from obliquely above.

[Fig. 2] is a schematic vertical sectional view showing the above drum-type washing-drying machine which is sectioned in the vicinity of the left end in Fig. 1 and seen from the right.

[Fig. 3] is a schematic vertical sectional view showing an internal

structure of a cylindrical water tank seen form the rear side in the axial direction (parallel to C.L. in fig. 2) of the water tank.

[Fig. 4] is a schematic vertical sectional view showing the above drum-type washing-drying machine which is sectioned in the vicinity of the right end in Fig. 1 and seen from the right.

[Fig. 5] is a schematic view showing an upper portion of the above drum-type washing-drying machine with a ceiling plate removed and seen from obliquely above.

[Fig. 6] is a schematic sectional view showing an ion wind supply unit seen from one side.

[Fig. 7] is a plan view showing an example of an operation panel of a drum-type washing-drying machine.

[Fig. 8] is a block diagram of a control circuit of a drum-type washing-drying machine.

[Fig. 9] is a flow chart showing an example of a 10-minute course of sterilization and deodorization operation.

[Fig. 10] is a flow chart showing an example of on/off switch control of a heater.

[Fig. 11] is a flow chart showing an example of an example of rotation-speed switch control of a fan motor.

[Fig. 12] is a timing chart showing an example of control over a 10-minute course of sterilization and deodorization operation.

[Fig. 13] is a flow chart showing an example of a 30-minute course of sterilization and deodorization operation.

[Fig. 14] is a timing chart showing an example of control over a 30-minute course of sterilization and deodorization operation.

List of Reference Symbols

[0040]

[1] housing

[2] ceiling plate

[20] water tank

[22a] ion introduction hole (air removal hole)

[30] drainage duct (drainage means)

[32] drainage hose (drainage means)

[33] drainage valve (drainage means)

[34] drum

[36] drum motor

[38] drying water supply pump (water supply means)

[39] wind sending duct (circulation wind path)

[40] heater (heating means)

[42] wind sending machine (circulation wind sending means)

[48] drying water supply valve (water supply means)

[60] ion wind supply unit

[61] ion generation apparatus

[62] wind sending machine (ion supply wind sending means)

[63] wind sending duct (ion supply wind path)

[63a] flow-in opening (one end)

[63b] flow-out opening (other end)

[63c] vapor receiving portion

[64] fan case

[64a] inlet

[64b] outlet

[65] blade

[66] fan motor

[67] check valve

[68] filter

[78] sterilization and deodorization key (command key)

[81] control portion (control means)

Best Mode for Carrying Out the Invention

[0041] Hereinafter, a drum-type washing-drying machine according to an embodiment of the present invention is explained based on Figs. 1 - 5 . Fig. 1 is a schematic view showing an appearance of a drum-type washing-drying machine seen from obliquely above, Fig. 2 is a schematic vertical sectional view showing the above drum-type washing-drying machine which is sectioned in the vicinity of the left end in Fig. 1 and seen from the right, and Fig. 3 is a schematic vertical sectional view showing an internal structure of a cylindrical water tank seen form the rear side in the axial direction (a direction parallel to C.L. in Fig. 2) of the water tank.

Fig. 4 is a schematic vertical sectional view showing the above drum-type washing-drying machine which is sectioned in the vicinity of the right end in Fig. 1 and seen from the right, and Fig. 5 is a schematic view showing an upper portion of the above drum-type washing-drying machine with a ceiling plate removed and seen from obliquely above.

[0042] As shown in Fig. 1, a drum-type washing-drying machine according to

an embodiment of the present invention comprises a housing 1 that forms an appearance of the drum-type washing-drying machine. This housing 1 is composed of a ceiling plate 2 that forms the upper surface and a bottom base 3 that forms the lower portion, and has a body portion 4 that forms the sides of front, back, left and right. The ceiling plate 2 includes a step potion 2a that is formed on the rear side and is lowered by one step, and a tap water supply opening 9 and a bath water supply opening 10 described later are formed through the step portion 2a. As shown in Fig. 2, on a portion that is part of the back side (the inner side of the housing 1) of the ceiling plate 2 and is the central portion in the front-to-rear direction (front-rear direction) of the drum-type washing-drying machine, a suspension mount portion 17 which is formed of a metal plate and to which one end of each of suspensions 52, 54 is connected is disposed.

[0043] The bottom base 3 has a substantially rectangular shape in horizontal section, and the respective dimensions in the front-to-rear direction and in the right-to-left direction are formed in such a manner that they become short by one or two steps in the inward direction of the drum-type washing-drying machine compared with the body portion 4 that forms the upper portion of the housing 1. On the lower side of the bottom surface of the bottom base 3, feet 3a, which come into contact with at floor surface after installation to support the drum-type washing-drying machine, are mounted in the vicinity of the respective corners of the substantially rectangular bottom base 3. On the upper side of the bottom surface of the bottom base 3, damper mount portions 18, 19 to which one end of each of dampers 50, 51 is connected are disposed. Seeing the drum-type washing-drying machine from the front side, the damper mount portion 18 is disposed on

the left side, and the damper mount portion 19 is disposed on the right side, and the damper mount portions 18, 19 are located at the same positions when seeing the drum-type washing-drying machine from the side.

[0044] As shown in Fig. 2, the body portion 4 has a substantially rectangular shape in horizontal section, and its front side is formed into a substantially arc shape in such a manner that the front side is inclined toward the rear side with respect to a vertical plane as it extends upward. As shown in Fig. 1, through the front side of the body portion 4, a housing opening portion 4a which communicates the inside and the outside of the hosing 1 with each other is formed, and a detergent case 6 that holds detergent, bleach, and textile softener, and an operation panel 7 that has operation keys and a display portion are disposed on the front side of the body portion 4.

[0045] The housing opening portion 4a is opened and closed by a open-close door 5 that is mounted slidably in a vertical direction on the body portion 4. The detergent case 6 has a vessel, not sown, which is mounted on the inner side of the body portion 4, and is disposed slidably in the front-rear direction on an upper left portion above the housing opening portion 4a of the body portion 4. The operation panel 7 is disposed to the right side of the detergent case 6 and on an upper right portion above the housing opening portion 4a of the body portion 4, and various settings and operation commands can be inputted by a user's operation.

[0046] On the side behind the operation panel 7 that is described later and located inside the drum-type washing-drying machine, as shown in Fig. 2, a control circuit 8 which controls operation of the drum-type washing-drying machine is disposed. In response to a user's setting, the control circuit 8 controls operations of

the respective portions of the drum-type washing-drying machine in such a manner that operation programs for a "standard course," a "large laundry course," and a "dry course" are executed to carry out continuously washing, rinse and dewatering steps (and a drying step) or separately the respective steps. As described later, in the drum-type washing-drying machine according to the present invention, besides these washing, dewatering and dying steps, as a separate step, it is possible to load clothes into the drum and carry out the sterilization and deodorization operation to deodorize the clothes and kill various germs that grow out of the clothes by supplying air which contains positive and negative ions into a drum.

[0047] As shown in Fig. 2, through the step portion 2a which is disposed on the backward side of the ceiling plate 2 and lowered by one step, a tap water supply opening 9 which is used to supply water from a tap (not shown), which supplies town water, into the drum-type washing-drying machine, and a bath water supply opening 10 which is used to supply bath water into the drum-type washing-drying machine are formed. Town water supplied through the tap water supply opening 9 flows into a water tank 20 described later via a water supply pipe 11, the detergent case 6, a water supply vessel 12 having the detergent case 6, and a water supply duct 13 that connects the water supply vessel 12 and the water tank 20 wit each other. The water supply pipe 11 is equipped with a water supply valve 14, and the water supply valve 14 is controlled by the control circuit 8 to be opened and closed, thereby the control is carried out to supply town water into the water tank 20. The water supply duct 13 is formed of a material, for example, nylon, rubber or the like that has flexibility, and is structured in such a manner that vibration of the water tank is not easily transferred to the housing 1.

[0048] Besides, a drying water supply pipe 38 which extends downward is connected to the upstream side of the water supply valve 14 in the water-current direction of the water supply pipe 11. The drying water supply pipe 38 is equipped with a drying water supply valve 48, and the drying water supply valve 48 is controlled by the control circuit 8 to be opened and closed, thereby the control is carried out to run town water to a heat exchange pale 41 described later. The drying water supply pipe 38 and the dying water supply valve 48 comprise water supply means in the present invention.

[0049] Bath water taken in through the bath water supply opening 10 flows into a water tank 20 described later via a bath water pipe 15, the detergent case 6, the water supply vessel 12 having the detergent case 6, and the water supply duct 13 that connects the water supply vessel 12 and the water tank 20 wit each other. The bath water pipe 15 is equipped with a bath water pump 16, and the bath water pump 16 is controlled by the control circuit 8 to be operated or stopped, thereby the control is carried out to supply bath water into the water tank 20.

[0050] As shown in Fig. 2, the water tank 20 having a bottomed cylindrical shape is disposed inside of the housing 1 in such a manner that the water tank 20 is inclined downward 5° to 30° to a horizontal plane. As shown in Fig. 3, when seen from the axial direction (a direction parallel to C.L. in Fig. 2) of the cylindrical shape of the water tank 20, the water tank 20 is formed in such a manner that the upper circumferential wall has a cylindrical shape and part of the lower circumferential wall protrudes outwardly in the radial direction. A front portion 21 that forms the front side in the axial direction of the water tank 20 and a back portion 22 of that forms the rear side in the axial direction of the water tank 20 are

connected to each other by a screw 29, thereby the water tank 20 is formed. On the front portion 21, a suspension mount portion 23 to which one end of the suspension 52 is connected is disposed at the center portion of the upper circumferential surface of the front portion 21. On the rear portion 22, a suspension mount portion 25 to which one end of the suspension 54 is connected is disposed at the center portion of the backward side of the upper circumferential surface of the back portion 22. Besides, damper mount portions 26, 27 to which one end of each of the dampers 50, 51 is connected are disposed on the rear portion 22. Seeing the drum-type washing-drying machine from the front side, the damper mount portion 26 is disposed on the left side, and the damper mount portion 27 is disposed on the right side, and the damper mount portions 26, 27 are located at the same positions when seeing the drum-type washing-drying machine from the side.

[0051] As shown in Fig. 2, the front portion 21 is equipped with a water tank opening portion 21a which is opened facing the housing opening portion 4a. Around the water tank opening portion 21a, a door packing 28 is mounted between the water tank opening portion 21a and the housing opening portion 4a to connect both openings with each other in a water-tight manner. The door packing 28 is equipped with a bellows portion 2a in such a manner that vibration of the water tank 20 is not easily transferred to the housing 1. When the open-close door 5 is closed, the open-close door 5 and a seal portion 28b of the door packing 28 come into a water-tight contact with each other, thereby liquid in the water tank 20 is prevented from leaking via the housing opening portion 4a. The water supply duct 13 is connected to the center portion of the upper side of the water tank 20, and water that is supplied through the tap water supply opening 9 and the bath water

supply opening 10 flows into the water tank 20 via this water supply duct 13.

[0052] On the other hand, as shown in Fig. 2, a drainage duct 30 that is used to drain the water, washing liquid and the like in the water tank 20 to the outside of the water tank 20 is connected to a position that is present on the lower backward side of the water tank 20 and is lowest from the floor surface. This drainage duct 30 is connected to a drainage hose 32, which communicates with the outside of the water tank 20, via a filter unit 31 to remove lint contained in the water flowing from the water tank 20 and via a drainage valve 33. The drainage valve 33 is controlled by the control circuit 8 to be opened and closed so that the water drainage from the water tank 20 is controlled. The drainage duct 30, the drainage hose 32 and the drainage valve 33 comprise drainage means of the present invention.

[0053] As shown in Fig. 2, in the water tank 20, like the water tank 20, a drum 34 having a bottomed cylindrical shape is disposed in such a manner that the axis (C.L. in Fig. 2) of the cylindrical body is inclined downward 5° to 30° to a horizontal plane. As shown in Fig 3, the axis of the cylindrical body of the drum 30 is disposed substantially coaxially with the axis of the upper circumferential wall of the water tank 20. In other words, the distance between the lower circumferential wall of the drum 34 and the lower circumferential wall of the water tank 20 that protrudes outwardly in the radial direction is larger than the distance between the upper circumferential wall of the drum 34 and the upper circumferential wall of the water tank 20, and a wind sending duct 39 described later is disposed in a space between the lower circumferential wall of the drum 34 and the lower circumferential wall of the water tank 20 that protrudes outwardly in

the radial direction. The drum 34 is equipped with a drum opening portion 34a that is opened facing the housing opening portion 4a and the water tank opening portion 21a, and laundry is loaded and removed into and from the drum 34 via the housing opening portion 4a, the water tank opening portion 21a, and the drum opening portion 34a.

[0054] The drum 34 is equipped with a plurality of small holes 34b through the entire circumferential surface of the cylindrical body (in Fig. 2, only 12 small holes 34b are shown, and the other small holes 34b are not shown). The small holes 34b are formed to communicate the inside of the water tank 20 and the inside of the drum 34 with each other so that the water and the liquid in the water tank 20 and the drum 34 can flow between the water tank 20 and the drum 34. On the inner wall of the drum 34, baffle plates 34c that protrude toward the center axis of the cylindrical body of the drum 34 are disposed. The baffle plates 34a are disposed in such a manner that they present a rotation symmetry having a n-turn (n: a natural number equal to 2 or larger) rotation axis in the circumferential direction, for example, the baffle plates 34a are disposed at three points (3-turn rotation axis) at intervals of 120° . In the washing step or in the rinse step, as the drum 34 rotates, the baffle plates 34c repeatedly lift loaded laundry and let them drop into the washing water or into the rinse water so that the washing or rinse of the laundry is carried-out.

[0055] On the center portion of the rear surface of the drum 34, a drum shaft 34d whose axial direction is the same as that of the cylindrical body of the drum 34 is disposed protruding backward. The drum shaft 34d penetrates the bottom surface of the back portion 22 that forms the back side of the water tank 20, and its

tip portion goes into a drum motor 36, that is, an electric motor, which is mounted on the rear side of the back portion 22 with a screw 35. The drum motor 36 comprises a motor cover 36a to cover the outer circumference, a bearing 36b to rotatably support the drum shaft 34d, a rotor 36c to rotate the drum shaft 34d, and a stator 36d to give rotation power to the rotor 36c by magnetic force. Based on control by the control circuit 8, the drum motor 36 drives the rotor 36c via the stator 36d to rotate the drum 34.

[0056] On the portion surrounding the drum opening portion 34a, a constricted portion 34e is so formed and disposed as to become smaller in diameter toward the inside of the drum 34 in the radial direction, and a liquid balancer 37 is fixed along the circumference of the constricted portion 34e. The liquid balancer 37 is composed of an annular hollow case and a liquid such as salt water and the like filled in the case. Even if imbalance due to uneven distribution of laundry occurs during the time of a high-speed rotation of the drum 34 especially in the dewatering step, this liquid balancer 37 can cancel the imbalance by movement of the liquid therein.

[0057] As shown in Fig. 4, the wind sending duct 39 is formed in a right-side portion of the space defined between the inner lower circumferential surface of the water tank 20 and the outer lower circumferential surface of the drum 34. The wind sending duct 39 forms a wind circulation path that takes out air from the drum 34 via the back end and returns the air into the drum 34 via the front end. The back end of the wind sending duct 39 is connected to a fan case 45 described later. The front end of the wind sending duct 39 forms a wind sending opening 39a that is located between a lower edge of the water tank opening portion 21a and a

lower edge of the drum opening portion 34a. Via this wind sending opening 39a, warm air is blown toward a lower portion of the internal space of the drum 34.

[0058] As shown in Fig. 3, a heater portion 40 (heating means) is disposed in the wind sending duct 39. The heater portion 40 comprises a heater case 43 and a heater 44 disposed in the heater case 43. The heater 44 heats washing water or rinse water in the step of washing or rinse to rise washing and rinse effects, and heats the air in the water tank 20 in the drying step.

[0059] As shown in Fig. 2, the heat exchange plate 41 for dehumidification is disposed in a left-side portion of the space defined between the inner lower circumferential surface of the water tank 20 and the outer lower circumferential surface of the drum 34. The heat exchange plate 41 has an opened sectional shape, and water that is supplied via the tap water supply opening 9 and the drying water supply pipe 38 is run on the heat exchange plate 41 to cool the air in the water tank 20 in the drying step.

[0060] As shown in Fig. 3, a wind sending machine 42 (circulation wind sending means) is disposed on the left side (the right side when seen from the rear side) of a lower portion of the rear surface of the water tank 20. The wind sending machine 42 is composed of a fan case 45, a blade 46 housed in the fan case 45, and a fan motor 47 to rotate the blade 46. This fan motor 47 is directly connected to the blade 46, and rotates the blade 46 by direct driving. The wind sending machine 42 takes in air that has come via the heat exchange plate 41 and blows the taken-in air into the heater 40 disposed in the wind sending duct 39.

[0061] Specifically, in the drying step of the drum-type washing-drying machine, air heated by the heater 40 flows into the drum 34 via the wind sending

duct 39 and the wind sending opening 39a and vaporizes water content of laundry. Damp air that contains a large amount of the vaporized water content is cooled by the heat exchange heat 41 so that the water content condenses and the damp air changes into dry air. The dry air is sent by the wind sending machine 42 to the heater portion 40 disposed in the wind sending duct 39, where the dry air is reheated by the heater portion 40 and is used to remove the water content of the laundry. These operations are repeated until completion of the drying step to dry the laundry, thus the dying step proceeds. Because the heater portion 40, the heat exchange plate 41, and the wind sending machine 42 are disposed on the lower portion of the water tank 20, these members are submerged by the washing water and the rinse water in the washing and rinse steps, and lint and the like adhering to these members can be removed.

[0062] Next, an ion wind supply unit that is a distinctive structure of the drum-type washing-drying machine according to the present invention is explained wit reference to Figs. 4-6. Fig. 4 is a schematic vertical sectional view of the drum-type washing-drying machine seen from the right, Fig. 5 is a schematic view of an upper portion of the drum-type washing-drying machine with the ceiling plate removed and seen from obliquely above, and Fig. 6 is a schematic sectional view of an ion wind supply unit seen from the side.

[0063] As shown in Figs. 4 and 5, an ion wind supply unit 60 comprises an ion generation apparatus 61 that generates positive and negative ions with the aid of electric discharge (discharge), a wind sending machine (ion supply wind sending means) 62 that sends positive and negative ions which are generated from the ion generation apparatus 61, and an wind sending duct (ion supply wind path) 63 that

supplies positive and negative ions which are generated from the ion generation apparatus 61 into the wind sending duct (circulation wind path) 39 via a cylindrical ion introduction hole 22a that is formed through an upper portion of the water tank 20.

[0064] The ion generation apparatus 61 is an apparatus that generates positive and negative ions and sends them into air that has been taken in by the wind sending machine 62. Specifically, for example, when an alternating-current voltage is applied across electrodes, an ionization phenomenon due to electric discharge and the like occurs in the air, thereby positive and negative ions are generated. In this phenomenon, for example, $H^+(H_2O)n$ is chiefly generated as positive ions, and $O_2^-(H_2O)n$ is chiefly generated as negative ions.

[0065] These positive and negative ions $H^+(H_2O)n$ and $O_2^-(H_2O)m$ generate H_2O_2 or ・OH as active species through chemical reaction. It is known that because H_2O_2 or ・OH presents extremely strong activation, these compounds can be used to surround and remove floating matters such as floating particles, airborne germs and the like in the air. Here, ・OH is a kind of active species and represents radical OH. Chemical reactions in which H_2O_2 or ・OH is generated from $H^+(H_2O)n$ and $O_2^-(H_2O)m$ are represented by the following formulae:

[0066]
$$H^+(H_2O)n + O_2^-(H_2O)m \rightarrow \cdot OH + 1/2O_2 + (m + n)\, H_2O \quad (1)$$

$$H^+(H_2O)n + H^+(H_2O)n' + O_2^-(H_2O)m + O_2^-(H_2O)m' \rightarrow 2 \cdot OH + O_2 + (m + m' + n + n')\, H_2O \quad (2)$$

$H^+(H_2O)n + H^+(H_2O)n' + O_2^-(H_2O)m + O_2^-(H_2O)m'$

$$\rightarrow H_2O_2 + O_2 + (m + m' + n + n')\,H_2O \qquad (3)$$

[0067] This $\cdot OH$ acts on and decomposes C-C bonds, C = C bonds, and C = O bonds of organic compounds that become sources of odor, thereby a odor removal effect occurs. Hereinafter, decomposition actions of compounds that become typical sources of odor are represented in chemical formulae.

[0068] Reaction with acetic acid:

$$CH_3COOH + 8 \cdot OH \rightarrow 2\,CO_2 + 6\,H_2O \qquad (4)$$

Reaction with acetaldehyde:

$$CH_3CHO + 10 \cdot OH \rightarrow 2\,CO_2 + 7\,H_2O \qquad (5)$$

Reaction with benzene:

$$C_6H_6 + 30 \cdot OH \rightarrow 6\,CO_2 + 18\,H_2O \qquad (6)$$

[0069] As shown in Fig. 6, the wind sending machine 62 is composed of a fan case 64, a blade 65 housed in the fan case 64, and a ion supply fan motor 66 to rotate the blade 65. The fan case 64 is formed of a resin into a single body, and as shown in Fig. 5, a circular inlet 64a having a cross-shape frame is opened through the upper surface, and as shown in Fig. 6, a cylindrical-shape outlet 64b is formed at the rear side. As shown in Fig. 6, a check valve 67 is mounted at the outlet 64b so that air is prevented from flowing back into the fan case 64. Besides, a filter 68 is disposed at the inlet 64a covering the frame portion.

[0070] The ion supply fan motor 66 is directly connected to the blade 65, and rotates the blade 65 by direct driving. The wind sending machine 62 takes in air through an opening (not shown) and the like for heat radiation formed through the housing 1 and sends out the taken-in air to the wind sending duct 63.

[0071] The ion generation apparatus 61 is mounted on a position which is present on the upper surface of the fan case 64 and backward from the inlet 64a, and its discharge portion is located at a position in the wind sending path that extends from the inlet 64a to the outlet 64b. The fan case 64 is fixed to the suspension mount portion 17 (see Fig. 2) and to the right-side upper wall end potion of the housing 1 with a screw. Thus, an unused space right above the circumferential surface of the water tank 20 can be efficiently used to dispose the ion generation apparatus 61 and the wind sending machine 62.

[0072] As shown in Figs. 4 and 5, the cylindrical ion introduction hole 22a for air removal is formed unitarily with and through a left upper portion of the circumferential surface of the back portion 22 of the water tank 20. There is a risk that if water is supplied into the drum 34 when internal pressure of the water tank 20 is high, the water flows back, therefore, to prevent the risk, the ion introduction hole 22a is formed to leak air from the water tank 20 for a low internal pressure of the water tank 20.

[0073] The wind sending duct 63 is a part that is formed of a hard resin and has a structure divided into upper and lower portions, and is built by fitting the upper and lower portions with each other. As shown in Fig. 6, a flow-in opening 63a that faces forward is formed at one end of the wind sending duct 63. The flow-in opening 63a of the wind sending duct 63 is connected to the outlet 64b of the fan case 64. As shown in Fig. 5, the body portion of the wind sending duct 63 has a gradually bent plane shape that extends from right to left over the back potion 22 of the water tank 20. As shown in Fig. 6, a flow-out opening 63b that faces downward is formed at the other end of the wind sending duct 63. The flow-out opening 63b

of the wind sending duct 63 is disposed away from and facing the ion introduction 22a of the upper portion of the water tank 20. Here, the distance L between the flow-out opening 63b of the wind sending duct 63 and the ion introduction hole 22a of the upper portion of the water tank 20 is set to about 17 mm in a usual state, which is the shortest distance that allows positive and negative ions generated from the ion generation apparatus 61 to be efficiently supplied into the water tank 20 avoiding collision which is caused between the flow-out opening 63b and the ion introduction hole 22a when the ion introduction hole 22a is moved upward by vibration of the water tank 20. The inner diameter $\phi 1$ of the flow-out opening 63b of the wind sending duct 63 is set to about 29 mm, and the inner diameter $\phi 2$ of the ion introduction hole 22a of the upper portion of the water tank 20 is set to about 23 mm. The inner diameter $\phi 1$ of the flow-out opening 63b is larger than the inner diameter $\phi 2$ of the ion introduction hole 22a, which is a design that makes it possible to cope with a positional error of the ion introduction hole 22a that occurs at the time of disposing the water tank 20.

[0074] A vapor receiving portion 63c that lets vapors coming out of the ion introduction hole 22a turn into water drops and drip on a portion of the outer circumferential surface of the water tank 20 is formed unitarily with and around the flow-out opening 63b of the wind sending duct 63.

[0075] Fig. 7 is a plan view of an operation panel of the drum-type washing-drying machine. An operation panel 7 is equipped with a power on key 72, a power off key 73, a washing-drying switch key 74, and a start/pause key 75. The power on key 72 and the power off key 73 are keys to supply/stop electric power to the drum-type washing-drying machine. The washing-drying switch key 74 is pushed to

carry out washing and dewatering, or carry out only drying of laundry, that is, to select the washing course or the drying course. The start/pause key 75 is a key to send a command to start operation of the drum-type washing-drying machine and to stop temporarily the machine during the operation.

[0076] The operation panel 7 is equipped with a course key 76 and a drying course key 77. The course key 76 is a key that is pushed to carry out washing and dewatering without drying, that is, to select the washing course. The drying key 77 is a key that is pushed to select the drying course when the drying course is selected or to add the drying course to the washing course

[0077] For example, at every time when the course key 76 is pushed, a current kind of operation mode is switched successively to another kind of operation mode relating to washing of a plurality of kinds of operation mode that are presented over the course key 76 by a 3 × 2 array and the another kind of mode is indicated. For example, the indication is switched from top to bottom and from left to right. Specifically, if the course key 76 is pushed one time, a "standard" mode is turned on, if the course key 76 is pushed one more time, the "standard" mode is turned off and a "warm water" mode is turned on, and if the course key 76 is pushed still one more time, the "warm water" mode is turned off and instead a "large laundry" mode is turned on, thereby a kind of washing is successively selected.

[0078] Also when the drying course key 77 is pushed, kinds of operation mode relating to washing and drying and a kind of operation mode relating to drying can be successively selected.

[0079] Further, the operation panel 7 is equipped with a sterilization and deodorization key 78 (command key). The sterilization and deodorization key 78

is a key that is operated when it is not necessary to wash laundry, but it is desired to carry out deodorization of the clothes. For example, if clothes that smell of cigarette are loaded into the drum 34 and the sterilization-deodorization key 78 is pushed, content displayed on a display portion 79 is changed depending the number of pushes in the following order of: "10," "30," "__10," and "__30." Here, the underline "__" means that the drum 34 is rotated during the sterilization and deodorization operation. When the start/pause key 75 is pushed with the "10" or "30" displayed, air that contains positive and negative ions is supplied into the drum 34 for the displayed time duration without rotating the drum 34, and the sterilization and deodorization operation is carried out as an operation separate from washing and drying. When the start/pause key 75 is pushed with the "__10" or "__30" displayed, air that contains positive and negative ions is supplied into the drum 34 for the displayed time duration with the drum 34 rotated, and the sterilization and deodorization operation is carried out as an operation separate from washing and drying. In other words, the sterilization-deodorization key 78 is a key to carry out the sterilization and deodorization operation separately from washing and drying operations on laundry that have no need to be washed and dried. In this embodiment, the operation that is carried out with the "10" or "__10" displayed is referred to as a "10-minute course," and the operation that is carried out with the "30" or "__30" displayed is referred to as a "30-minute course."

[0080] Other keys and various indications that represent operation states are arranged on the operation panel 7. However, because they have no direct relationship with the present invention, their explanations are skipped.

[0081] Fig. 8 is a block diagram of a control circuit of the drum-type washing-drying machine which shows only components that relate to distinctive operations of the drum-type washing-drying machine according to the present invention. A control circuit 8 (see Fig. 2) is equipped with a control portion 81 (control means) that is composed of a CPU, a ROM, a RAM and the like. Command signals from the power on key 72, the start/pause key 75, the sterilization-deodorization key 78 and the other keys that are arranged on the above operation panel 71 are given to the control portion 81. Detection signals from a thermistor 57 and a water level sensor 58 that are disposed in the fan case 45 (see Fig. 4) are also given to the control portion 81. In response to command signals given to the control portion 81, the control portion 81 controls operations of the drum motor 36, the fan motor 47, the heater 44, the ion generation apparatus 61, the ion supply fan motor 66, the drying water supply valve 48, the drainage valve 33, and the lock mechanism 56.

[0082] 10-Minute Course: Fig. 9 is a flow chart showing an example of the 10-minute course of sterilization and deodorization operation that is performed by the control potion 81 shown in Fig. 8, Fig. 10 is a flow chart showing an example of an on/off changeover control of the heater in the step S113 shown in Fig. 9, Fig. 11 is a flow chart of an example of changeover control of rotation speed of a fan motor in the step S114 in Fig. 9. Fig. 12 is a timing chart showing operations of the drum 34, the lock mechanism 56, the ion generation apparatus 61, the ion supply fan motor 66, the fan motor 47, the heater 44, the drying water supply valve 48, the drainage valve 33, and the drum motor 36 during the time when the 10-minute course of sterilization and deodorization operation is carried out. Next, the operation is explained with reference to the timing chart in Fig. 12 and based chiefly on the

flow charts in Figs. 8 to 11.

[0083] When the 10-minute course is started, the control portion 81 operates the lock mechanism 56 (the step S100), determines whether or not the drum is rotating (the step S101), and drives the drum motor 36 to slowly rotate forward the drum 34 if the underline "__" is displayed on the display portion 79 (the step S102).

[0084] If the underline "__" is not displayed on the display portion 79, the drum motor 36 is not driven. In other words, the sterilization and deodorization operation is carried out without rotating the drum 34. Carrying out the sterilization and deodorization operation without rotating the drum 34 is effective on clothes that have a possibility of being damaged, deformed or the like, that is, delicate clothes.

[0085] Then, the fan motor 47 is turned on by the control portion 81 (the step S103), and the heater 44 also is turned on by the control portion 81 at the same time (the step S104). Thus, air in the drum 34 is circulated via the wind sending duct 39, and the air is heated by the heater 44. As described later, the rotation speed of the fan motor 47 is switched between a high speed (3500 rpm) and a low speed (1750 rpm) for low power consumption, and is set to the high speed (3500 rpm) at the time of start.

[0086] The ion generation apparatus 61 also is turned on (the step S105), and at the same time, the ion supply fan motor 66 is turned on (the step S106). Thus, positive and negative ions generated from the ion generation apparatus 61 are supplied via the wind sending duct 63 and the ion introduction hole 22a of the left upper portion of the water tank 20 into the space between the rear outer side of the drum 34 and the rear inner side of the water tank 20. This space has a negative

pressure because of the operation of the wind sending machine 42, therefore, although the flow-out opening 63b of the wind sending duct 63 and the ion introduction hole 22a of the water tank 20 are disposed facing each other as described above, suction force works between the flow-out opening 63b and the ion introduction hole 22a, and the positive and negative ions can be efficiently supplied into the space by the suction force. The ion generation apparatus 61 and the ion supply fan motor 66 are kept in the on state until completion of the sterilization and deodorization operation.

[0087] Then, the drying water supply valve 48 is turned on (the step S107). At this time, the drainage valve 33 is still in the off state. Thus, town water is held in the space between the inner side of the circumferential surface of the bottom portion of the water tank 20 and the outer side of the circumferential surface of the bottom portion of the drum 34. Air heated by the heater 44 is circulated and the town water held in the space is heated by the heated air, thereby water vapors appear on the surface of the heat exchange plate 41. Accordingly, the clothes loaded in the drum 34 are steamed by the heated water vapors and can be finished fluffily. Because it is known that the higher the humidity becomes, the higher the sterilization and deodorization effect of positive and negative ions become, humidity in the drum 34 is raised to boost the effect of positive and negative ions. Besides, water-soluble compounds of the odor content coming from the clothes dissolve in water vapors floating in the drum 34 and the odor removal effect increases.

[0088] If the inside of the wind sending duct 39 is clogged by water, it becomes impossible to send out wind. Accordingly, during the time of water

supply, the water level is monitored by the water level sensor 58 not to hold more water than needed, and if it is determined that the water level has reached a given level (the step S108), the drying water supply valve 48 is turned off (the step S109).

[0089] If it is determined that 3 minutes have passed after the start of water supply (the step S110), the drainage valve 33 is turned on (the step S111), and the drying water supply valve 48 is turned on (the step S112). Thus, the held water is drained to the outside of the machine. The drainage valve 33 is kept in the on state until completion of the sterilization and deodorization operation.

[0090] Then, on-off changeover control of the heater 44 is carried out based on a temperature detection signal from the thermistor 57 (the step S113). For example, as shown in Fig. 10, if the thermistor 57 detects a temperature of 70°C or higher (the step S201), the heater 44 is turned off (the step S202). If the thermistor 57 detects a temperature of 67°C or lower (the step S203), the heater 44 is turned on (the step S204). Thus, it is possible to achieve low power consumption and to keep the internal temperature of the drum 34 at about 60°C.

[0091] The rotation speed of the fan motor 47 is controlled to be switched from high to low, or from low to high based on the on or off state of the heater 44 and a detection result of the thermistor 57 (the step S114). For example, as shown in Fig. 11, if the heater 44 is in the off state (the step S301) and the thermistor 57 detects a temperature of 70°C or lower (the step S302), the rotation speed of the fan motor 47 is set to low (1750 rpm). If the heater 44 is in the on state (the step S301), the rotation speed of the fan motor 47 is set to high (3500 rpm) (the step 304). Thus, low power consumption and low noise can be achieved.

[0092] If the drum 34 is rotating during the time of sterilization and

deodorization operation, the clothes loaded in the drum 34 are stirred in the drum 34 and exposed equally to the positive and negative ions, thereby the sterilization and deodorization efficiency is increased.

[0093] On the other hand, if the drum 34 is in the stop state, the clothes loaded in the drum 34 are not stirred and air that contains positive and negative ions is given to the clothes, thereby the sterilization and deodorization operation is performed on the clothes. There is no possibility that the clothes are damaged and deformed in shape by the sterilization and deodorization operation.

[0094] In the step S115, if it is determined that 8 minutes have passed after the start/pause key 75 is pushed, that is, after the sterilization and deodorization operation is started, a cool down operation is started. Specifically, the heater 44 is turned off (the step S116), and the rotation speed of the fan motor 47 is set to high (the step S117). Thus, the inside of the drum 34 is rapidly cooled down. In this embodiment, the ion generation apparatus 61 and the ion supply fan motor 66 are kept in the on state even during the cool down operation. However, they may be turned off.

[0095] In this 10-minute course, the sterilization and deodorization operation is carried out for 10 minutes. When 10 minutes have passed, it is determined that the sterilization and deodorization operation has been completed in the step S118, and the drum motor 36 is turned off (the step S119), the fan motor 47 is turned off (the step S120), the ion generation apparatus 61 is turned off (the step S121), the ion supply fan motor 66 is turned off (the step S122), the drying water supply valve 48 is turned off (the step S123), the drainage valve 33 is turned off (the step S124), and the operation of the lock mechanism 56 is released (the step S125), thereby the

sterilization and deodorization operation is completed.

[0096] In the sterilization and deodorization operation, ozone is not used. Accordingly, because

ozone is not contained in the air present in the drum 34 when a user opens the open-close door 5 and takes out the clothes loaded in the drum 34, the user does not smell unpleasant ozone odor.

[0097] 30-Minute Course: Fig. 13 is a flow chart showing an example of the 30-minute course of sterilization and deodorization operation that is performed by the control potion 81 shown in Fig. 8, and Fig. 14 is a timing chart showing operations of the drum 34, the lock mechanism 56, the ion generation apparatus 61, the ion supply fan motor 66, the fan motor 47, the heater 44, the drying water supply valve 48, the drainage valve 33, and the drum motor 36 during the time when the 30-minute course of sterilization and deodorization operation is carried out. Next, the operation is explained wit reference to the timing chart in Fig. 14 and based chiefly on the flow chart in Figs. 13.

[0098] When the 30-minute course is started, the control portion 81 operates the lock mechanism 56 (the step S400), determines whether or not the drum is rotating (the step S401), and drives the drum motor 36 to slowly rotate forward the drum 34 if the underline "__" is displayed on the display portion 79 (the step S402).

[0099] If the underline "__" is not displayed on the display portion 79, the drum motor 36 is not driven. In other words, the sterilization and deodorization operation is carried out without rotating the drum 34. Carrying out the sterilization and deodorization operation without rotating the drum 34 is effective on clothes that have a possibility of being damaged, deformed or the like, that is, delicate

clothes.

[0100] Then, the fan motor 47 is turned on by the control portion 81 (the step S403), and at the same time, the heater 44 also is turned on by the control portion 81 (the step S404). Thus, air in the drum 34 is circulated via the wind sending duct 39, and the air is heated by the heater 44. As described later, the rotation speed of the fan motor 47 is switched between a high speed (3500 rpm) and a low speed (1750 rpm) for low power consumption, and is set to the high speed (3500 rpm) at the time of start.

[0101] The ion generation apparatus 61 also is turned on (the step S405), and at the same time, the ion supply fan motor 66 is turned on (the step S406). Thus, positive and negative ions generated from the ion generation apparatus 61 are supplied via the wind sending duct 63 and the ion introduction hole 22a of the left upper portion of the water tank 20 into the space between the rear outer side of the drum 34 and the rear inner side of the water tank 20. This space has a negative pressure because of the operation of the wind sending machine 42, therefore, although the flow-out opening 63b of the wind sending duct 63 and the ion introduction hole 22a of the water tank 20 are disposed away from and facing each other as described above, suction force works between the flow-out opening 63b and the ion introduction hole 22a, and the positive and negative ions can be efficiently supplied into the space by the suction force. The ion generation apparatus 61 and the ion supply fan motor 66 are kept in the on state until completion of the sterilization and deodorization operation.

[0102] Then, the drying water supply valve 48 is turned on (the step S407). At this time, the drainage valve 33 is still in the off state. Thus, town water is held in

the space between the inner side of the circumferential surface of the bottom portion of the water tank 20 and the outer side of the circumferential surface of the bottom portion of the drum 34. Air heated by the heater 44 is circulated and the town water held in the space is heated by the heated air, thereby water vapors appear on the surface of the heat exchange plate 41. Accordingly, the clothes loaded in the drum 34 are steamed by the heated water vapors and can be finished fluffily. Because it is known that the higher the humidity becomes, the higher the sterilization and deodorization effect of positive and negative ions become, humidity in the drum 34 is raised to boost the effect of positive and negative ions. Besides, water-soluble compounds of the odor content coming from the clothes dissolve in water vapors floating in the drum 34 and the odor removal effect increases.

[0103] If the inside of the wind sending duct 39 is clogged by water, it becomes impossible to send out wind. Accordingly, during the time of water supply, the water level is monitored by the water level sensor 58, and if it is determined that the water level has reached a given level (the step S408), the drying water supply valve 48 is turned off (the step S409).

[0104] If it is determined that 3 minutes have passed after the start of water supply (the step S410), the drainage valve 33 is turned on (the step S411), and the drying water supply valve 48 is turned on (the step S412). Thus, the held water is drained to the outside of the machine.

[0105] Then, on-off changeover control of the heater 44 is carried out based on a temperature detection signal from the thermistor 57 (the step S413). For example, as shown in Fig. 10, if the thermistor 57 detects a temperature of 65℃ or higher

(the step S201), the heater 44 is turned off (the step S202). If the thermistor 57 detects a temperature of 55℃ or lower (the step S203), the heater 44 is turned on (the step S204). Thus, it is possible to achieve low power consumption and to keep the internal temperature of the drum 34 at about 60℃.

[0106] The rotation speed of the fan motor 47 is controlled to be switched from high to low, or from low to high based on the on or off state of the heater 44 and a detection result of the thermistor 57 (the step S414). For example, as shown in Fig. 11, if the heater 44 is in the off state (the step S301) and the thermistor 57 detects a temperature of 70℃ or lower (the step S302), the rotation speed of the fan motor 47 is set to low (1750 rpm). If the heater 44 is in the on state (the step S301), the rotation speed of the fan motor 47 is set to high (3500 rpm). Thus, low power consumption and low noise can be achieved.

[0107] If the drum 34 is rotating during the time of sterilization and deodorization operation, the clothes loaded in the drum 34 are stirred in the drum 34 and exposed equally to the positive and negative ions, thereby the sterilization and deodorization efficiency is increased.

[0108] On the other hand, if the drum 34 is in the stop state, the clothes loaded in the drum 34 are not stirred and air that contains positive and negative ions is given to the clothes, thereby the sterilization and deodorization operation is performed on the clothes. There is no possibility that the clothes are damaged and deformed in shape by the sterilization and deodorization operation.

[0109] In the step S415, if it is determined that 10 minutes have passed after the start/pause key 75 is pushed, that is, after the sterilization and deodorization operation is started, the drainage valve 33 is turned off (the step S416), the heater

44 is turned on (the step S417), and the rotation speed of the fan motor 47 is set to high (the step S418). Thus, town water is held again in the space between the inner side of the circumferential surface of the bottom portion of the water tank 20 and the outer side of the circumferential surface of the bottom portion of the drum 34. Air heated by the heater 44 is circulated and the town water held in the space is heated by the heated air, thereby water vapors appear on the surface of the heat exchange plate 41. In other words, in the 30-minute course, the step of supplying water vapors into the drum 34 is carried out two times wit a time delay, thereby the sterilization and deodorization operation can be carried out more thoroughly than that in the 10-minute course.

[0110] If the inside of the wind sending duct 39 is clogged by water, it becomes impossible to send out wind. Accordingly, during the time of water supply, the water level is monitored by the water level sensor 58 not to hold more water than needed, and if it is determined that the water level has reached a given level (the step S419), the drying water supply valve 48 is turned off (the step S420). In the timing chart in Fig. 14, the drying water supply valve 48 is not turned off in this step. This means that although the water level sensor 58 has continued monitoring the water level, the water level has not reached a given level during the water supply.

[0111] If it is determined that 4 minutes have passed after the start of water supply (the step S421), the drainage valve 33 is turned on (the step S422), and the drying water supply valve 48 is also turned on (the step S423). Thus, the held water is drained to the outside of the machine. The drainage valve 33 is kept in the on state until completion of the sterilization and deodorization operation.

[0112] Then, like the step described above, on-off changeover control of the heater 44 is carried out based on a temperature detection signal from the thermistor 57 (the step S424). The rotation speed of the fan motor 47 also is controlled to be switched from high to low, or from low to high based on the on or off state of the heater 44 and a detection result of the thermistor 57 (the step S425).

[0113] In the step S426, if it is determined that 28 minutes have passed after the start/pause key 75 is pushed, that is, after the sterilization and deodorization operation is started, a cool down operation is started. Specifically, the heater 44 is turned off (the step S427), and the rotation speed of the fan motor 47 is set to high (the step S428). Thus, the inside of the drum 34 is rapidly cooled down. In this embodiment, the ion generation apparatus 61 and the ion supply fan motor 66 are kept in the on state even during the cool down operation. However, they may be turned off.

[0114] In this 30-minute course, the sterilization and deodorization operation is carried out for 30 minutes. When 30 minutes have passed, it is determined that the sterilization and deodorization operation has been completed in the step S429, and the drum motor 36 is turned off (the step S430), the fan motor 47 is turned off (the step S431), the ion generation apparatus 61 is turned off (the step S432), the ion supply fan motor 66 is turned off (the step S433), the drying water supply valve 48 is turned off (the step S434), the drainage valve 33 is turned off (the step S435), and the operation of the lock mechanism 56 is released (the step S436), thereby the sterilization and deodorization operation is completed.

[0115] In both the 10-minute course and the 30-minute course, if the start/pause key 75 is pushed during the sterilization and deodorization operation,

temperature in detected by the thermistor 57. If the temperature detected by the thermistor 57 is a given door-open prohibition temperature (e.g., 50℃) or lower, all the components such as the heater 44, the ion generation apparatus 61, the fan motor 47 and the others are turned off. On the other hand, If the temperature detected by the thermistor 57 exceeds the given door-open prohibition temperature, with the lock mechanism 56 kept in the on state, all the components such as the heater 44, the ion generation apparatus 61 and others are turned off except the fan motor 47, and the sterilization and deodorization operation is stopped. Then, the rotation speed of the fan motor 47 is set to high, and a large amount of wind is sent into the drum 34 to cool the inside of the drum 34. In 30 seconds, if a temperature equal to or lower than the given door-open prohibition temperature is detected by the thermistor 57, the on state of the lock mechanism 56 is released. If the temperature detected by the thermistor 57 still exceeds the door-open prohibition temperature, a large amount of wind is sent into the drum 34 to cool the inside of the drum 34 with the rotation speed of the fan motor 47 kept at high.

[0116] Test Example: The deodorization effect of the sterilization and deodorization operation of the drum-type washing-drying machine according to the embodiments of the present invention are verified by the following test.

Odor Transfer Method: Samples are hung from a 250-L acryl box, and odor of one cigarette is transferred to the samples (transfer time: 30 minutes (burned for 15 minutes, and smoked for 15 minutes)).

Treatment Method: The 10-minute course and 30-minute course of sterilization and deodorization operations are respectively applied to one group of samples and to another group of samples of the above samples using an ion

generation apparatus that generates chiefly $H^+(H_2O)n$ as the positive ion and O_2^- $(H_2O)n$ as the negative ion (called test examples 1 and 2, respectively).

Organoleptic Test: Organoleptic tests are applied to the above two groups of samples which have undergone the above treatments and to the other group of samples (reference example) which have not undergone the above treatments in order to evaluate the samples by a 6-step odor-intensity notification method.

0: no odor

1: almost undetectable odor

2: what kind of odor detectable

3: easily detectable odor

4: strong odor

5: intense odor

[0117] Because organoleptic evaluation has a large error if only one sample is used, the average value of a plurality of samples is adopted for each group. The result is presented in the table 1.

[0118]

Table 1

Samples	Average Odor Intensity
Reference Sample	4.0
Test Sample 1	3.0
Test Sample 2	1.8

[0119] As shown in table 1, the average odor intensity of the samples (test example 1) which have undergone the 10-minute course of treatment is lower by

1.0 than the reference example of groups which have not undergone any treatment. The average odor intensity of the samples (test example 2) is lower by 2.3 than the reference sample. It is confirmed that both courses have a significant odor removal effect. The result shows that if the 10-minute course is applied to clothes that do not have a strong odor, and if the 30-minute course is applied to clothes that have a strong odor, a necessary and sufficient odor removal effect can be obtained.

[0120] According to the embodiments of the present invention, air that contains ions which have the sterilization and deodorization effect is given to the clothes loaded in the drum 34 so that odor, various germs and the like of the clothes are removed by the ions. Because these ions are harmless to the human body, safety is high compared with that of the conventional machines that use ozone, and maintenance cost can be prevented from increasing. When the dedicated sterilization-deodorization key 78 is pushed, this sterilization and deodorization operation is carried out as an operation separate from the washing, dewatering and drying operations. Accordingly, the sterilization and deodorization operation only can be carried out as the main purpose separately from the washing operation and the drying operation after the washing operation.

[0121] During the sterilization and deodorization operation, part of the positive and negative ions generated from the ion generation apparatus 61 may be sent out to the outside of the hosing 1. Thus, germs and odor in the outside space of the housing 1 can also be removed, and a product that has a higher added value can be provided.

[0122] In the embodiments of the present invention, the positive and negative ions are generated from the ion generation apparatus. However, an ion generation

apparatus which generates either one of the positive and negative ions which can separately sterilize and deodorize clothes may be incorporated.

What is claimed is:

[1.] A drum-type washing-drying machine, comprising:

a water tank;

a drum which is rotatably disposed in the water tank and is used to carry out washing, dewatering and drying of clothes loaded in the drum;

a circulation wind path which is used to take air out of the drum via its one end and to return the air into the drum via the other end;

heating means which is disposed in the circulation wind path and heats the air that is flowing in the circulation wind path;

an ion generation apparatus which is disposed above the water tank and uses electric discharge to generate ions that have a function to sterilize and deodorize clothes;

ion supply wind sending means which sends ions generated from the ion generation apparatus; and

an ion supply wind path which is used to supply ions generated from the ion generation apparatus into an ion introduction hole that is formed through an upper portion of the water tank;

wherein one end of the ion supply wind path is connected to an outlet of the wind sending means, and the other end is disposed away from and directed toward the ion introduction hole.

[2.] The drum-type washing-drying machine according to claim 1, wherein the ion generation apparatus generates positive and negative ions.

[3.] The drum-type washing-drying machine according to claim 2, wherein the ion introduction hole communicates with a space between a rear inner side of

the water tank and a rear outer side of the drum.

[4.] The drum-type washing-drying machine according to claim 3, wherein circulation wind sending means which forcibly circulates air present in the circulation wind path is disposed on a rear outer side of the water tank, and the ion introduction hole is located substantially vertically over the circulation wind sending means.

[5.] The drum-type washing-drying machine according to any one of claims 1 to 4, wherein the circulation wind path is formed in a space between a lower inner side of a circumferential surface of the water tank and a lower outer side of a circumferential surface of the drum.

[6.] The drum-type washing-drying machine according to claim 5, wherein the ion supply wind path is a duct formed of a hard resin.

[7.] The drum-type washing-drying machine according to any one of claims 1 to 6, wherein a check valve is disposed at an outlet of the wind sending means.

[8.] The drum-type washing-drying machine according to any one of claims 1 to 7, wherein a filter is disposed at an inlet of the wind sending means.

[9.] The drum-type washing-drying machine according to any one of claims 1 to 8, wherein a vapor receiving portion which lets vapors that come out via the ion introduction hole to the outside of the water tank turn into water drops and drip on an outer surface of the water tank is disposed around a circumferential portion of the other end of the ion supply wind path.

[10.] The drum-type washing-drying machine according to any one of claims 1 to 9, wherein the ion introduction hole is a hole that is used to remove air from the water tank.

[11.] A drum-type washing-drying machine, comprising:

a water tank;

a drum which is rotatably disposed in the water tank and is used to carry out washing, dewatering and drying of clothes loaded in the drum;

a circulation wind path which is used to take air out of the drum via a bottom portion of the water tank and to return the air into the drum;

circulation wind sending means which is disposed in the circulation wind path and makes the air flow in the circulation wind path from one end to the other end;

heating means which is disposed in the circulation wind path and heats the air that is flowing in the circulation wind path;

an ion generation apparatus which uses electric discharge to generate ions that have a sterilization and deodorization function;

ion supply wind sending means which supplies ions generated from the ion generation apparatus into the air that is flowing in the circulation wind path;

a command key which as an additional separate operation besides operations of washing, dewatering and drying, gives a command to execute a sterilization and deodorization operation of loading clothes into the drum and using the function of the ions to deodorize clothes and kill various germs that grow out of the clothes; and

control means which based on a command from the command key, operates the circulation wind sending means, the ion generation apparatus, the heating means, and the ion supply wind sending means in a predetermined way.

[12.] The drum-type washing-drying machine according to claim 11, further

comprising a drum motor to rotate the drum, and during the time of sterilization and deodorization operation, the command key is used to allow a selective operation of rotating the drum or bringing the drum into a stop state.

[13.] The drum-type washing-drying machine according to any one of claims 11 and 12, further comprising water supply mans for supplying water into a bottom portion of the water tank, and drainage means for draining the water from the water tank, and during a sterilization and deodorization operation, the heating means and the water supply means are operated, and the drainage means is stopped during a given time duration, thereby water vapors are supplied into the drum.

[14.] The drum-type washing-drying machine according to claim 13, wherein the operation of supplying water vapors into the drum is carried out at the start time of the sterilization and deodorization operation.

[15.] The drum-type washing-drying machine according to any one of claims 13 and 14, wherein the operation of supplying water vapors into the drum is carried out a plurality of times at time intervals during the time of performing the sterilization and deodorization operation.

[16.] The drum-type washing-drying machine according to any one of claims 11 and 15, wherein the ion generation apparatus generates positive and negative ions.