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(71) Applicant: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

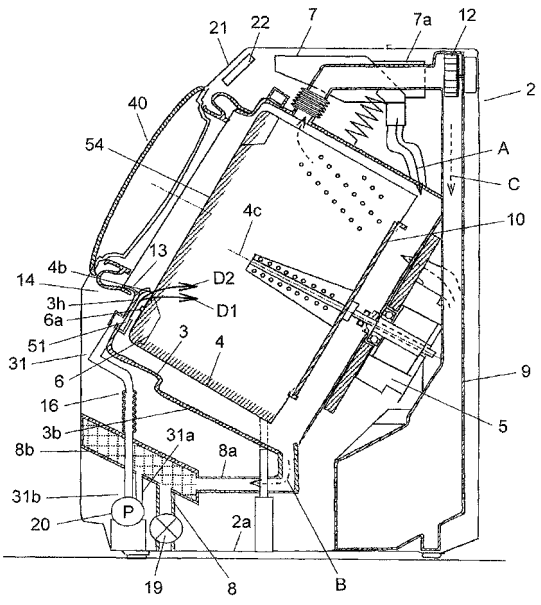
(72) Inventors:
- **Terai, Kenji**
  Osaka-shi
  Osaka 540-6207 (JP)
- **Matsuoka, Shinji**
  Osaka-shi
  Osaka 540-6207 (JP)
- **Murao, Tsuyoshi**
  Osaka-shi
  Osaka 540-6207 (JP)
- **Horibe, Yasuyuki**
  Osaka-shi
  Osaka 540-6207 (JP)

(74) Representative: **Schwabe - Sandmair - Marx**
Patentanwälte
Stuntzstraße 16
81677 München (DE)

(54) Drum type washing machine

(57) A water circulation system comprises a spray orifice (51) provided behind a front side wall (34) of a water tub (3) and a flow path (52) formed between a back surface of the front side wall (34) of the water tub (3) and a front side wall surface of a rotary drum (4), wherein the front side wall surface (4b) of the rotary drum (4) has a shape so formed that a distance of the front side wall surface (4b) from the axis of rotation varies with rotation of the rotary drum (4), and circulating water sprayed from the spray orifice (51) is discharged through the flow path (52) into the rotary drum (4). The system can spray the circulating water evenly over laundries regardless of an amount and kind of the laundries put in the water tub (3) without requiring a complicated structure.

FIG. 1



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Description

TECHNCAL FIELD

[0001] The present invention relates to a drum type washing machine having a rotary drum of a closed-bottom cylindrical shape disposed in a water tub for washing laundries placed inside the rotary drum by rotating the same.

BACKGROUND ART

[0002] Drum type washing machines hitherto known include such a kind that has a rotary drum disposed inside a water tub in an orientation that an axis of rotation is either horizontal or tilted downward off a horizontal plane from the front side having an opening toward the back side forming a bottom wall, and a circulating function having a circulation pump to circulate water in the water tub as described hereinafter.

[0003] Japanese Patent Unexamined Publication, No. 1999-276791 (Patent literature 1) discloses a technique of using a single pump, which is operated as a circulation pump in both a washing step and a rinsing step to circulate any of rinsing water and washing water and actively stir detergent and the washing water to help dissolve the detergent quickly in an early stage of the washing step, and also as a drain pump in a spin-drying step and a draining step. It also discloses a technique of using a filter case disposed in midstream of a circulation path at a suction side of the circulation pump for collecting foreign objects in the water being suctioned to prevent them from entering the circulation pump.

[0004] Japanese Patent Unexamined Publication, No. 2005-58741 (Patent literature 2) discloses a technique of avoiding a problem that detergent collects inside a heater containing space or certain other spaces by way of circulating water in a water tub with a circulation pump. It also discloses a technique of improving an efficiency of washing by promptly heating the objects to be washed prior to the start of washing.

[0005] Japanese Patent Unexamined Publication, No. 2006-223572 (Patent literature 3) discloses a technique of disposing a circulation pump unit on a base plate constituting a bottom portion of an outer cabinet of the washing machine, the circulation pump unit comprising a circulation pump and a filtering section for collecting laundry waste such as lint. The technique disclosed here is to mount the circulation pump to the base plate with an elastic cushion placed between them to prevent vibration of a pump motor from propagating to the base plate when washing water is circulated in a water tub, thereby avoiding noise caused by resonance of vibrations between the pump motor and the cabinet.

[0006] Japanese Patent Unexamined Publication, No. 2006-239142 (Patent literature 4) discloses a technique of removing lint and the like objects stuck to a heater for the drying purpose and the vicinity thereof by spraying water in a water tub to the heater and the vicinity thereof in addition to inside of a rotary drum.

[0007] However, all of the techniques related to the water circulation as disclosed in the patent literatures 1 through 4 are designed to spray the circulating water into the rotary drum from one end of a pipe. Since such techniques have the function of spraying water only partially to the laundries inside the rotary drum, they do not take full advantage of circulating the otherwise useful water. Although the techniques disclosed in the patent literatures 2 and 4 employ unique spray nozzles designed to spray water to wide areas, they both need to increase a pumping pressure, which becomes a cause of high cost. There are also limitations on an extent possible to increasing the pumping pressure. In addition, the techniques disclosed in the patent literatures 1, 3 and 4 make piping arrangements very complex because of their structures requiring a pipe in the water circulation system to penetrate through a front side wall of the water tub and have it open to the inside of the rotary drum, which causes further increase in the cost.

SUMMARY

[0008] The present invention provides a drum type washing machine designed to spray water circulated by a circulation pump to laundries evenly regardless of an amount and kind of the laundries put in a water tub without requiring a complex structure, thereby achieving improvement of washing performance effectively while also avoiding unnecessary rise in cost.

[0009] The drum type washing machine of the present invention comprises a rotary drum formed into a closed-bottom cylindrical shape, a water tub containing the rotary drum in an orientation that an axis of rotation is either horizontal or tilted downward off a horizontal plane from the front side having an opening toward the back side forming a bottom wall, a motor for driving the rotary drum into rotary motion, a control unit for executing at least one of a washing step and a rinsing step by way of controlling the motor, and a water circulation system for circulating washing water in the water tub into the rotary drum through a circulation path communicating with the water tub by means of a circulation pump provided in the circulation path. The water circulation system comprises a spray orifice provided behind a front side wall of the water tub and a flow path formed between a back surface of the front side wall of the water tub and a front side wall surface of the rotary drum, wherein the front side wall surface of the rotary drum has a shape so formed that a distance of the front side wall surface from the axis of rotation varies with rotation of the rotary drum, and circulating water sprayed from the spray orifice is discharged through the flow path into the rotary drum.

[0010] Accordingly, the water circulation system has the function of suctioning washing water inside the water tub and circulating it back into the water tub in any of the washing, rinsing and the like steps by means of the cir-

culation pump and the circulation path. In this case, connection of the circulation path to the front side wall of the water tub is all what is needed to complete flow communication with the flow path formed between the front side walls of the water tub and the rotary drum, and the circulating water can hence be discharged into the rotary drum from an annular discharge port formed between inner perimeters of the front side walls by passing through this flow path without requiring any special pipe work. Since the circulating water is discharged from the annular discharge port between the inner perimeters of these front side walls by passing through the flow path between the front side walls of the water tub and the rotary drum, discharge of the water can be made without needing any discharge port of special configuration or structure that may snag or disturb the laundries in the rotary drum.

[0011] In addition, rotation of the rotary drum can change a discharging direction of the circulating water vertically because the distance of the front side wall surface of the rotary drum from the axis of rotation varies with rotation of the rotary drum. This helps improve the washing performance effectively while avoiding unnecessary increase in the cost by way of spraying the circulating water evenly over the laundries regardless of an amount and kind of the laundries put in the water tub.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1 is a sectional view of a drum type washing machine according to one exemplary embodiment of the present invention;

Fig. 2A is a sectional view of a circulation pump of the drum type washing machine;

Fig. 2B is a side view of the circulation pump of the drum type washing machine;

Fig. 2C is a bottom view of the circulation pump of the drum type washing machine;

Fig. 3A is a front view showing a duct connecting a discharge side passage of a water circulation path to a water tub of the drum type washing machine;

Fig. 3B is a cross sectional view showing the duct connecting the discharge side passage of the water circulation path to the water tub of the drum type washing machine;

Fig. 3C is a longitudinal sectional view showing the duct connecting the discharge side passage of the water circulation path to the water tub of the drum type washing machine;

Fig. 4A is a front view showing a rotary drum of the drum type washing machine;

Fig. 4B is a longitudinal sectional view showing a relationship between the rotary drum and the water tub of the drum type washing machine;

Fig. 4C is a longitudinal sectional view showing another relationship between the rotary drum and the water tub of the drum type washing machine; and

Fig. 5 is front view showing another rotary drum of the drum type washing machine.

DETAILED DESCRIPTION OF PREFFERED EMBODIMENTS

[0013] Description is provided hereinafter of exemplary embodiments of the present invention with reference to the accompanying drawings. The exemplary embodiments described herein are illustrative and they are not intended to limit the scope of the present invention.

EMBODIMENT

[0014] A drum type washing machine of the first exemplary embodiment has water tub 3 disposed in a freely swingable manner in machine's main body 2 as shown in Fig. 1. Rotary drum 4 is placed inside water tub 3 in a rotatable manner. Rotary drum 4 is driven by motor 5 mounted from the exterior side to the back of water tub 3 and rotated about rotational axis 4c. Rotary drum 4 is provided with fluid balancer 6 around the front end to reduce vibration during a spin-drying step, and rib 6a is formed in front of fluid balancer 6 to prevent foreign objects such as credit cards from slipping inside.

[0015] In addition, the drum type washing machine of this exemplary embodiment has the function of executing at least a washing step, a rinsing step, a spin-drying step and a drying step by automatically controlling motor 5, water feeding system 7, water draining system 8 and drying system 9 shown in Fig. 1 according to a mode setting and control program. Drying system 9 may be excluded however, since the spin-drying step and the drying step can be omitted.

[0016] Water feeding system 7 supplies water at the appropriate times as shown by solid line arrow A by opening and closing a solenoid valve (not shown). The feeding water can also be used to dispense detergent in detergent compartment 7a into water tub 3 at the right time.

[0017] Water draining system 8 drains washing water from water tub 3 through drain pipe 8a connected to the underside of water tub 3, as shown by dash-dot arrow B, by opening and closing drain valve 19 at each end of the washing step and the rinsing step as needed after passing it through drain filter 8b for collecting lint and the like objects. Drain filter 8b is removable from the outside.

[0018] Drying system 9 uses blower 12 to circulate air in water tub 3 and rotary drum 4 in the direction shown by dashed line arrow C in Fig. 1. Drying system 9 comprises a filter (not shown) for collecting and removing lint and the like dust, a dehumidifier (not shown) for dehumidifying the air introduced therein after the lint and dust are filtered, and a heating unit (not shown) for producing hot air by heating the dehumidified air, among other components. Blower 12 delivers the hot air into rotary drum 4 through vent filter 10.

[0019] In addition to the functions described above, the drum type washing machine of this exemplary em-

bodiment also has a function of circulating the washing water in water tub 3 when necessary during the washing step and the rinsing step by means of water circulation system 16 to improve the washing and rinsing performance. This water circulation system 16 operates circulation pump 20 to circulate the washing water in water tub 3 through drain pipe 8a, drain filter 8b, intake side passage 31a leading to circulation pump 20 in water circulation path 31, circulation pump 20, discharge side passage 31b from circulation pump 20 in water circulation path 31, in this order, and to return it back into water tub 3.

[0020] Selection of a mode such as an operating course and various functions can be made by giving inputs to operation panel 21 provided on an upper front side of machine's main body 2. Based on the input data, control unit 22 displays the information for the user to examine on a display section in operation panel 21. When an input setting section of operation panel 21 is given at the same time a command of starting operation, control unit 22 takes in a data from a water level detector or the like device for detecting a water level in water tub 3 and starts the operation such as washing, spin-drying and drying by controlling the drain valve, the water feed valve and the like.

[0021] Rotary drum 4 has a rotary shaft connected directly to motor 5 mounted on water tub 3. Rotary drum 4 and water tub 3 are disposed with their axes of rotation tilted at angle θ of 20 ± 10 degrees to the horizontal plane as viewed from the open side (i.e., left side in Fig. 1) toward the bottom side (i.e., right side in Fig. 1). This arrangement can help the user to put laundries in and out of rotary drum 4 easily without forcing him/her to take a difficult posture like bending forward since water tub 3 and rotary drum 4 have their openings tilted upward as opposed to the case of horizontal arrangement even if rotary drum 4 is set to the same height. The experiences obtained by the inventors of the present application have taught that the tilting angle set to 20 ± 10 degrees, in particular, can provide the position most suitable for many people of different heights from small children (excluding infants) to adults or even those confined to wheelchairs to easily put laundries in and out of rotary drum 4. The above angle can also give washing water of a sufficient depth even when the water of a limited amount is supplied into rotary drum 4 since the water is kept to stay in the back side. Water tub 3 is placed over rotary drum 4 in a manner and position close to each other with the same inclination in order for the supplied water to work effectively to the laundries inside rotary drum 4. Machine's main body 2 has door 40 attached to the front side. Door 40 can be opened or closed to hermetically seal opening 13 in water tub 3 with sealing member 14 attached to a peripheral edge thereof.

[0022] In the spin-drying step, rotary drum 4 is driven continuously at a speed as high as 1,000 rpm, for instance. This tends to cause the laundries to stick to the inner surface of rotary drum 4 with the clothes left tangled, twisted and wrinkled in the course of the washing step and the rinsing step, and to make the wrinkles remain persistently. It therefore makes troublesome to take the laundries out, and gives a time-consuming task to restore them. It may also leave stubborn wrinkles in the clothes, removal of which may require a considerable time.

[0023] In order to eliminate these problems, the washing machine of the present embodiment is provided with a reciprocal arc-rotation drive mode for repeating a rapid forward are-rotation and a rapid reverse are-rotation to turn rotary drum 4 for a circular angle larger than 90 degrees but smaller than 180 degrees in the washing step or both of the washing step and the rinsing step. The washing machine is also provided with a reciprocal continuous-rotation drive mode for repeating a continuous forward rotation and a continuous reverse rotation of rotary drum 4 alternately at a rotational speed suitable to exhibit such a behavior that the laundries lifted by the rotation of rotary drum 4 falls from a given height when their own weights exceed the lifting force, in the washing step or both of the washing step and the rinsing step. In addition, the washing machine can be operated to carry out the reciprocal are-rotation drive mode and the reciprocal continuous-rotation drive mode alternately in the washing step or both of the washing step and the rinsing step. This operation can substantially improve the problem of tangling, twisting and wrinkling of the laundries, and make the clothes not easily wrinkled while also increasing the effect of mechanical force.

[0024] According to this exemplary embodiment here, the arc-rotation of rotary drum 4 at a high speed for the circular angle larger than 90 degrees but smaller than 180 degrees followed by a sudden application of braking can lift the laundries up to the maximum position exceeding 90 degrees but less than 180 degrees. The sudden braking at the final stage of lifting the laundries can make good use of the inertia and own weights of the laundries to let them come off the inner surface of rotary drum 4 and fall down by the own weights on the side horizontally opposite that where the laundries have been stuck and lifted. This operation can hence provide an especially high effect of disentangling the laundries containing water and in a condition sufficiently swelled, loosened and slick, as well as the effect of mechanical force to the laundries. Accordingly, it can improve the washing performance.

[0025] In the operation designated as the reciprocal arc-rotation drive mode, the rapid forward arc-rotation in the forward direction and the rapid reverse are-rotation in the reverse direction are repeated alternately. This alternate rapid are-rotation in the both directions can change the lifting position and the falling position of the laundries alternately to the right and the left sides at each time of the rapid arc-rotation. The operation can therefore improve the disentangling effect while also preventing the laundries from tangling, and increase a frequency of imposing the effect of mechanical force upon the laundries. The washing performance can be improved as a result. The high disentangling effect of this operation can

also restrain tangling of the laundries attributed to the progress of the washing and the rinsing steps. In addition, continuation of the reciprocal are-rotation drive mode provides an effect of beat washing which can improve the effectiveness of the washing and rinsing.

[0026] When the operation is carried out only with the reciprocal are-rotation drive mode, however, a result of the washing is likely to become irregular because the laundries are not agitated properly to change their positions vertically and those at the bottom side of rotary drum 4 remain not movable although extents of tangling, twisting and wrinkling of them can be reduced. However, good agitation for changing the vertical positions of the laundries becomes achievable when operated in combination with the reciprocal continuous-rotation drive mode. In other words, the combined operation with the reciprocal continuous-rotation drive mode can reduce unevenness of the mechanical force that can be impressed on the laundries if operated only in the reciprocal are-rotation drive mode, and lessen the tangling, twisting and wrinkling of the laundries that can occur if operated only in the reciprocal continuous-rotation drive mode. Accordingly, both of these modes can provide the laundries with two different kinds of motions during washing and rinsing. More specifically, the reciprocal arc-rotation drive mode can provide the laundries with motions of the firm effect of beat washing while also lessening the tangling, twisting and wrinkling of the laundries. In addition, the reciprocal continuous-rotation drive mode can provide the laundries with motions of washing stubborn stain effectively and uniformly while reducing irregularity of the washing by the manner of moving the laundries intensively and continuously.

[0027] The reciprocal are-rotation drive mode, when carried out in the drying step is especially suitable for smoothing down wrinkles left in the laundries after the spin-drying, and it can improve finishing quality considerably and reduce the post-finishing tasks substantially. It is desirable, however, to set the rotational angle of rotary drum 4 inside a range of 90 to 200 degrees since there are cases that the laundries become so light after the drying step as not likely to stick to the inner surface of rotary drum 4.

[0028] It is appropriate to keep the maximum rotational speed of rotary drum 4 at a normal level of 45 $\pm$ 5 rpm in the reciprocal continuous-rotation drive mode. It is desirable, on the other hand, that the maximum rotational speed of rotary drum 4 in the reciprocal are-rotation drive mode is set to 40 rpm or faster in the washing and rinsing steps, and 50 rpm or faster after the spin-drying.

[0029] Description is provided now of circulation pump 20. As shown in Fig. 1, circulation pump 20 is fixed to base plate 2a that constitutes the bottom of machine's main body 2. More precisely, circulation pump 20 has impeller 20a housed inside pump casing 20b made of a plastic resin and circulation motor 20c with metallic motor casing 20d, wherein an open side of pump casing 20b is butt-joined to bearing partition 20d1 at the front end of motor casing 20d and assembled into one unit as shown in Fig. 2A to Fig. 2C. Impeller 20a is connected directly to motor shaft 20e and fitted to mounting seat 35. Mounting seat 35 has mounting tab 35a of a shape of generally the letter C at three positions in the perimeter thereof. Circulation pump 20 is mounted to base plate 2a with bolts (not shown) fixed to bosses (not shown) on base plate 2a through these mounting tabs 35a. Circulation pump 20 suctions washing water from L-shaped intake port 20f formed unitary under pump casing 20b. Circulation pump 20 then expels the washing water through discharge port 20g formed unitary in the tangential direction of pump casing 20b, and discharges the washing water from the periphery of water tub 3 by way of discharge side passage 31b.

[0030] Description is provided next of water circulation system 16. Water circulation system 16 uses circulation pump 20 disposed in water circulation path 31 connected with water tub 3 to circulate the washing water in water tub 3 into rotary drum 4 through water circulation path 31. As shown in Fig. 1 and Fig. 3A to Fig. 3C, water tub 3 is provided with spray orifice 51 formed in the lowermost part of front side wall 3h around opening 13. Discharge side passage 31b of water circulation path 31 is connected to spray orifice 51 from the outside. As shown by solid line arrows D1 and D2 in Fig. 1, circulating water (the term "circulating water" is used to refer to the washing water in water tub 3 when being circulated through water circulation path 31) delivered from discharge side path 31b is sprayed into a space between a back surface of front side wall 3h of water tub 3 and a corresponding surface of front side wall 4b of rotary drum 4. The water is hence discharged into rotary drum 4 through flow path 52 formed between the surfaces of front side wall 3h of water tub 3 and front side wall 4b of rotary drum 4. In this case, a rotational speed of the motor in circulation pump 20 is set to 3,500 rpm, for instance. Since spray orifice 51 for the water from discharge side path 31b is located in a position not becoming in contact with laundries in rotary drum 4, it does not snag the laundries to disturb their movements necessary for washing, rinsing and drying, and not to tear or damage the laundries. The structure is also free from impairing the aesthetically fine exterior. Since flow path 52 is formed between front side wall 3h of water tub 3 and front side wall 4b of rotary drum 4, the structure becomes so simple and inexpensive that it does not require any special components but only uses sealing member 56 (refer to Fig. 3C) as will be described later, and reduces the risk of water leakage.

[0031] Spray orifice 51 is opened behind front side wall 3h of water tub 3 in a direction of the rotational center of rotary drum 4, as shown in Fig. 3C. To be more specific, spray orifice 51 is formed between front side wall 3h of water tub 3 and front side wall 4b of rotary drum 4, and the opening directed toward annular discharge port 53 in a part of flow path 52. The circulating water sprayed from spray orifice 51 is hence discharged efficiently from flow path 52 toward the rotational center of rotary drum

4, as shown by solid line arrow D. To be exact, the circulating water is discharged efficiently in the radial direction toward annular discharge port 53 and into a rotating area inside of rotary drum 4. The washing water can hence be supplied efficiently regardless of an amount of laundries. In particular, front side wall 3h of water tub 3 has sloped surface 3h1 tilted toward the back side of machine's main body 2 from a position corresponding to spray orifice 51 to the vicinity of the inner periphery, and curved surface 3h2 curved toward opening 54 of rotary drum 4 from sloped surface 3h1 to the inner periphery. This configuration can guide the circulating water sprayed into flow path 52 along sloped surface 3h1 and curved surface 3h2 as shown by solid line arrow D in Fig. 3C, and discharge it through opening 54 in rotary drum 4 toward the back side of rotary drum 4. It can hence improve an efficiency of supplying the circulating water to the laundries.

[0032] Here, water tub 3 has connecting port 51a formed in front side wall 3h for connection of discharge side passage 31b. Spray orifice 51 for spraying the circulating water from connecting port 51a to flow path 52 has an opening of a predetermined size W1 in the perimetric direction, which is opened into flow path 52 and toward the rotational center of rotary drum 4. When connecting port 51a is provided in front side wall 3h of water tub 3, spray orifice 51 formed with the opening directed toward flow path 52 can smoothly guide the circulating water from discharge side path 31b to flow path 52 without causing disorder. The structure can hence achieve stable discharge of the circulating water from a predetermined area W2 of annular discharge port 53 corresponding to the predetermined size in the perimetric direction of spray orifice 51 toward a given direction into rotary drum 4 while spreading horizontally (i.e., from right to left side in a front view of machine's main body 2). As a result, the circulating water flowing in from connecting port 51a is guided by spray orifice 51 to flow path 52 without disorder. Accordingly, the circulating water can be discharged steadily from the predetermined area in the perimetric direction corresponding to spray orifice 51 toward the given direction while spreading horizontally, and supplied to laundries inside rotary drum 4 steadily and efficiently regardless of their amount.

[0033] Spray orifice 51 guides the circulating water to the opening leading to flow path 52 between discharge side passage 31b connected to connecting port 51a and connecting end 55d. This can satisfy the optimum guiding conditions for spray orifice 51 provided in connecting port 51a connected to discharge side passage 31b to guide the circulating water toward flow path 52 by virtue of a combination of the simple configurations collaborative with connecting end 55d of connecting port 51a in communication with discharge side passage 31b. In other words, the above combination of the simple configurations for guiding the circulating water toward flow path 52 can satisfy the optimum working conditions such as the discharging flow of a large width in the perimetric direction, a sufficient depth in the front-to-back direction and a high velocity to increase a splashing distance regardless of the amount of laundries. Moreover, the structure does not specifically complicate the piping configuration, which may otherwise increase the risk of water leakage and increase in the cost.

[0034] Spray orifice 51 is opened at the bottom of front side wall 3h in generally the center position of water tub 3, as shown in Fig. 1 and Fig. 3A to Fig. 3C, and this spray orifice 51 and the front end of discharge side passage 31b are connected with duct 55 made of a plastic resin illustrated in Fig. 3A and Fig. 3B. This duct 55 is formed of front and rear members 55a and 55b that are attached together into a flat shape in the front-to-back direction. Discharge side passage 31b has a configuration horizontally lopsided on one side with respect to the opening of spray orifice 51 and extended forward into a direction generally in parallel to the axis of water tub 3 from circulation pump 20. Duct 55 has connecting pipe 55c formed integrally with one end of rear member 55b, which is connected to discharge side passage 31b as an extension path. Duct 55 has such a configuration that it extends generally horizontally from the above-said one end of rear member 55b to the proximity of the lower side of spray orifice 51, and it is curved and raised upward at the other end to the position of spray orifice 51. Duct 55 also has connecting end 55e formed integrally in an upwardly raised portion, or connecting end 55d of rear member 55b, as shown in Fig. 3C. Connecting end 55e is connected to connecting port 51a opened into front side wall 3h of water tub 3 at spray orifice 51 with sealing member 56 placed between them and they are fixed with screw 57.

[0035] As described, duct 55 is formed into the flat configuration in the front-to-back direction and connecting between connecting port 51a in front side wall 3h of water tub 3 and circulation pump 20 by extending sideway from connecting end 55e along the periphery of water tub 3. This flat configuration of duct 55 helps ease the installation into even a small space between front side wall 3h of water tub 3 and the front wall of machine's main body 2, and it rectifies the circulating water into the water flow of a width and a depth suitable for the opening size of spray orifice 51 for properly guiding the water from connecting port 51a to spray orifice 51 and spraying it into flow path 52. Accordingly, the above structure can satisfactorily supply the circulating water from annular discharge port 53 without a disorder in a flow pattern having a large width in the perimetric direction, a sufficient depth in the front-to-back direction and a high discharging velocity to increase the splashing distance, and it can thereby improve further the effectiveness of washing and rinsing.

[0036] The configuration of duct 55 is such that it extends horizontally from the periphery of water tub 3 to the proximity of the lower side of connecting port 51a of spray orifice 51 at the bottom of front side wall 3h, and is curved into upwardly raised portion, or connecting end

55d, where duct 55 is connected to connecting port 51a. By virtue of this configuration, duct 55 can guide the flatly rectified circulating water to connecting port 51a and spray orifice 51 of the same flat orientation without causing disturbances in the flow while passing through the upwardly raised portion of curved shape at connecting end 55d, and spray the water to the predetermined area in the perimetric direction inside flow path 52. It therefore makes possible to discharge the washing water more steadily from a large area of annular discharge port 53 to improve the effectiveness of the washing water on the laundries.

[0037] In particular, spray orifice 51 is formed in a manner to open toward annular discharge port 53 between the upper part of the opening edge of connecting port 51a and deflecting wall 51c formed integrally and extending from connection port 51a opened in front side wall 3h of water tub 3 to front side wall 4b of rotary drum 4 and in parallel to front side wall 3h. Connecting end 55e is provided with throttle wall 55f having a curved surface, wherein a spray passage formed between throttle wall 55f and deflecting wall 51c is squeezed smoothly from duct 55 to spray orifice 51. Throttle wall 55f accelerates the circulating water delivered from duct 55 toward spray orifice 51 to produce a high-speed flow of the water running vigorously along sloped surface 3h1 and curved surface 3h2 on the backside of front side wall 3h of water tub 3. In other words, a throttle space S is formed between sloped surface 3h1 to curved surface 3h2 and front side wall 4b of rotary drum 4. This ensures reliable discharge of the circulating water through a given passage to diagonally upward in a back area inside of rotary drum 4 in a manner to form a parabolic orbit across a long traveling distance while spreading horizontally, and sprayed over a large area on the laundries in rotary drum 4.

[0038] It is also acceptable, however, to employ a throttle path of any configuration formed between connecting end 55e facing connecting port 51a of duct 55 and spray orifice 51 to produce a high-speed flow of the water. That is, any combination of a simple configuration with connecting end 55e at connecting port 51a of discharge side passage 31b can be used for guiding the circulating water delivered from spray orifice 51 provided in connecting port 51a to flow path 52 when such combination can satisfy good working conditions such as the discharging flow of a large width in the perimetric direction, a sufficient depth in the front-to-back direction and a high velocity to increase the splashing distance regardless of a amount of the laundries. Such combination does not specifically complicate the piping structure to increase the risk of water leakage and to cause a high cost.

[0039] Here, front side wall 4b of rotary drum 4 is formed into generally an elliptical shape (including an ellipse) in the front view as shown in Fig. 4A. That is, front side wall 4b comprises diametrally-large front wall portions 4b1 and diametrally-small front wall portions 4b2. Because of this structure, front side wall 4b of rotary drum 4 at the lowermost position corresponding to the location of spray orifice 51. shifts downward when diametrally-large front wall portions 4b1 move to vertical positions during rotation of rotary drum 4 as shown in Fig. 4B, and on the other hand, front side wall 4b shifts upward when diametrally-small front wall portions 4b2 move to the vertical positions as shown in Fig. 4C. When diametrally-large front wall portions 4b1 move to the vertical positions, i.e., when front side wall 4b moves downward at the position corresponding to spray orifice 51, the position of front side wall 4b becomes lower than curved surface 3h2 of front side wall 3h of water tub 3. When the circulating water is discharged from annular discharge port 53, it is deflected by curved surface 3h2 and therefore directed toward the lower area in rotary drum 4 as shown by solid line arrow D1 When diametrally-small front wall portions 4b2 move to the vertical positions, i.e., when front side wall 4b moves upward at the position corresponding to spray orifice 51, the position of front side wall 4b becomes higher than curved surface 3h2 of front side wall 3h of water tub 3. The circulating water discharged from annular discharge port 53 is therefore deflected upward by front side wall 4b and directed toward the upper area in rotary drum 4 as shown by solid line arrow D2.

[0040] When considering a moment, as a starting point, when front side walk 4b is in the lowermost position at the lowest side corresponding to spray orifice 51, i.e., when diametrally-large front wall portions 4b1 move to the vertical positions, the circulating water is discharged first toward the lower area in rotary drum 4. As rotary drum 4 continues to rotate, front side wall 4b shifts gradually upward and the discharging direction of the circulating water also changes upward. Front side wall 4b reaches the uppermost point and the circulating water is discharged toward the upper area in rotary drum 4 when rotary drum 4 is rotated to 90° from the starting point and diametrally-small front wall portions 4b2 move to the vertical positions. When rotary drum 4 is rotated further, front side wall 4b shifts gradually downward and the discharging direction of the circulating water also changes gradually upward. Front side wall 4b reaches the lowermost point and the circulating water is discharged toward the lower area in rotary drum 4 when rotary drum 4 is rotated to 180° from the starting point. The above cycle of operation is repeated while rotary drum 4 is kept rotating, and the discharging direction of the circulating water continues to change from downward to upward and upward to downward to achieve effective distribution of the washing water over the laundries in a large area inside rotary drum 4. This can hence result in an improvement of the effect of dissolving detergent, the effect of washing and the effect of rinsing.

[0041] The above operation can avoid a situation that the circulating water is supplied only partially even in an instance of washing a large amount of clothes or large-sized clothing such as futons and blankets, thereby reducing irregularities in the performance of washing and rinsing.

[0042] In addition, the surface of front side wall 4b of rotary drum 4 may be formed into a shape generally polygonal (including any of regular polygons) in the front view of rotary drum 4 as shown in Fig. 5, which illustrates another example of front side wall 4b of rotary drum 4. In the case of this configuration, the discharging direction is pointed downward when rotary drum 4 is rotated and any of the vertices, i.e., diametrally-large front wall portions 4b3, of the polygonal front side wall approaches annular discharge port 53 of the circulating water. The discharging direction is pointed upward when rotary drum 4 is rotated and the center of any of the sides, i.e., diametrally-small front wall portions 4b4, of the polygonal front side wall approaches annular discharge port 53 of the circulating water. The circulating water can be sprayed evenly over the laundries in this manner. When rotary drum 4 makes one complete rotation, the circulating water will be discharged while changing the direction up and down for a number of times equal to that of the polygonal vertices. The discharging directions can therefore be changed more frequently with an increase in number of the polygonal vertices while the drum makes its one complete rotation.

[0043] In the above exemplary embodiment, the surface of front side wall 4b of the rotary drum was shown as either the elliptical or the polygonal shape in the front view. However, it can be of any other shape as long as it changes the distance of the side from the rotational axis at least twice with rotation of the rotary drum, instead of a shape of line symmetry like the elliptical and the polygonal shapes.

[0044] In the present embodiment, circulation pump 20 was illustrated as having a structure for mounting to base plate 2a, which serves the bottom of machine's main body 2, but this is not restrictive. Like advantages as this exemplary embodiment can be achieved even with a structure having circulation pump 20 mounted to bottom part 3b of water tub 3 (refer to Fig. 1) to circulate the washing water in water tub 3.

[0045] As discussed above, the drum type washing machine of the present invention comprises a rotary drum formed into a closed-bottom cylindrical shape, a water tub containing the rotary drum in an orientation that an axis of rotation is either horizontal or tilted downward off a horizontal plane from the front side having an opening toward the back side forming a bottom wall, a motor for driving the rotary drum into rotary motion, a control unit for executing at least one of a washing step and a rinsing step by way of controlling the motor, and a water circulation system for circulating washing water in the water tub into the rotary drum through a water circulation path in communication with the water tub by means of a circulation pump provided in the water circulation path, wherein the water circulation system comprises a spray orifice provided behind a front side wall of the water tub and a flow path formed between a back surface of the front side wall of the water tub and a front side wall surface of the rotary drum, and further wherein the front side wall surface of the rotary drum has a shape so formed that a distance of the front side wall surface from the axis of rotation varies with rotation of the rotary drum, and circulating water sprayed from the spray orifice is discharged through the flow path into the rotary drum.

[0046] According to this structure, the water circulation system has the function of suctioning washing water inside the water tub and circulating it back into the water tub in any of the washing, rinsing and the like steps by means of the circulation pump and the water circulation path. All what is needed is to connect the water circulation path to the front side wall of the water tub without requiring any special piping for making connection with the flow path formed between the front side walls of the water tub and the rotary drum. Accordingly, this structure can discharge the circulating water into the rotary drum with the simple and less expensive piping configuration having a low risk of water leakage. In addition, rotation of the rotary drum can change a discharging direction of the circulating water vertically without using any special shape and structure of the discharging port of the circulating water since a distance of the front side wall surface of the rotary drum varies in distance from the axis of rotation with the rotation. This system can spray the circulating water evenly over the laundries regardless of an amount and kind of the laundries put in the water tub without requiring a complicated structure. It can hence help improve the washing performance effectively while avoiding unnecessary increase in the cost.

[0047] The front side wall surface of the rotary drum of the present invention has an elliptical shape in the front view of the rotary drum. This configuration causes a discharging direction of the circulating water to move downward when the rotary drum rotates and the major axis of the elliptical front side wall approaches the discharging port of the circulating water. It also causes the discharging direction to move upward when the rotary drum rotates and the minor axis of the elliptical front side wall approaches the discharging port of the circulating water. It can thus spray the circulating water evenly over the laundries. Since the elliptical front side wall has two perimetric points corresponding to each of the minor axis and the major axis, the circulating water is discharged while changing its direction upward and downward two times when the drum makes one complete rotation.

[0048] In the present invention, the front side wall surface of another rotary drum has a polygonal shape in the front view of the rotary drum. According to this configuration, the discharging direction is pointed downward when the rotary drum is rotated and any of the vertices of the polygonal front side wall approaches the discharge port of the circulating water. The discharging direction is pointed upward when the rotary drum is rotated and the center of any of the sides of the polygonal front side wall approaches the discharge port of the circulating water. The circulating water can be thus sprayed evenly over the laundries in this manner. When the rotary drum makes one complete rotation, the circulating water will

be discharged while changing the direction up and down for a number of times equal to that of the polygonal vertices. The discharging directions can therefore be changed more frequently with increase in number of the polygonal vertices while the drum makes its one complete rotation.

Claims

1. A drum type washing machine comprising:

a rotary drum formed into a closed-bottom cylindrical shape;
a water tub containing the rotary drum in an orientation that an axis of rotation is set horizontal or tilted downward off a horizontal plane from a front side having an opening toward a back side forming a bottom wall;
a motor for driving the rotary drum into rotary motion;
a control unit for executing at least one of a washing step and a rinsing step by way of controlling the motor; and
a water circulation system for circulating washing water in the water tub into the rotary drum through a water circulation path in communication with the water tub by means of a circulation pump provided in the water circulation path,

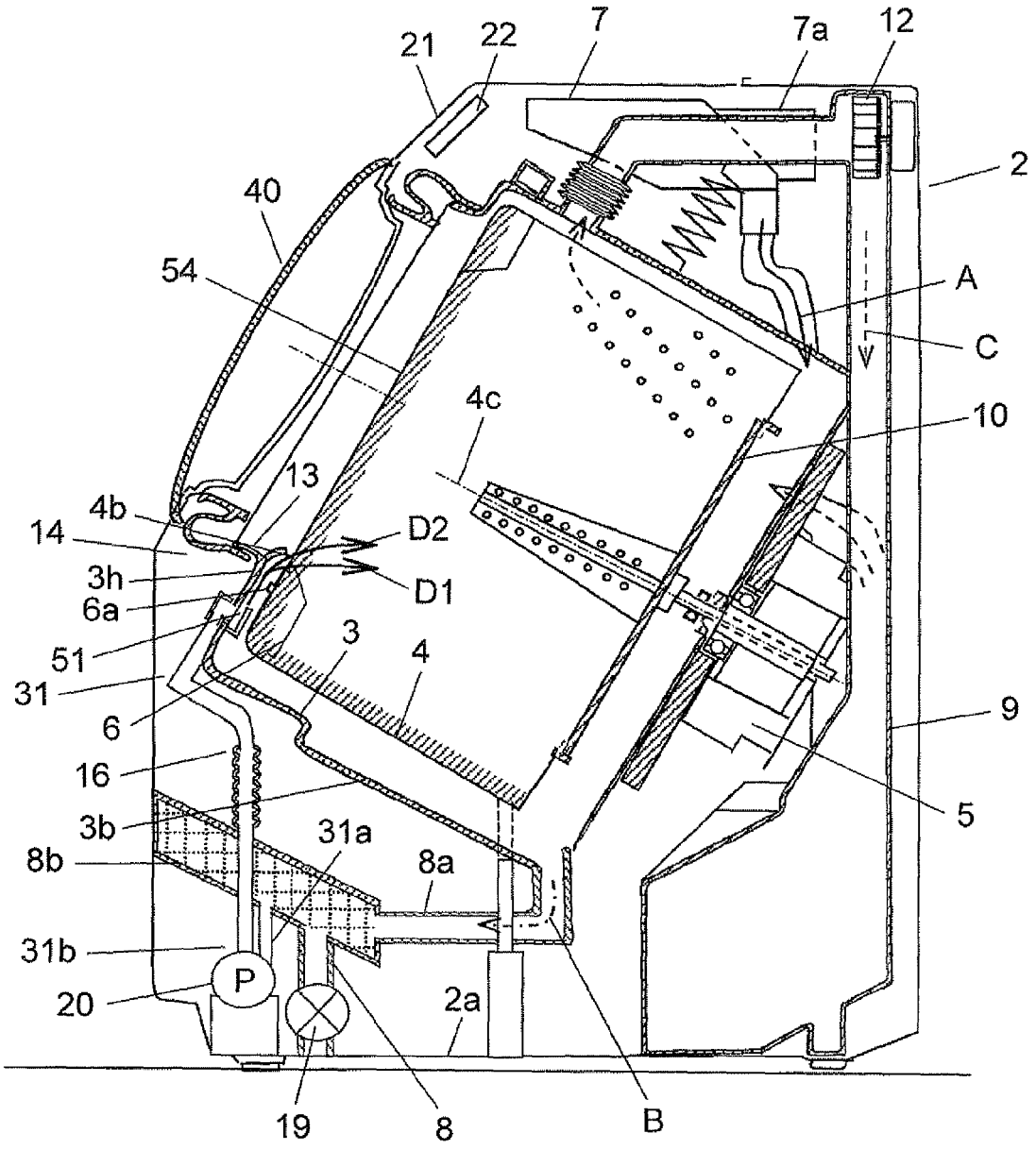
wherein the water circulation system comprises a spray orifice provided behind a front side wall of the water tub and a flow path formed between a back surface of the front side wall of the water tub and a front side wall surface of the rotary drum, and
the front side wall surface of the rotary drum has a shape so formed that a distance of the front side wall surface from the axis of rotation varies with rotation of the rotary drum, and the circulating water sprayed from the spray orifice is discharged through the flow path into the rotary drum.

2. The drum type washing machine of claim 1, wherein the front side wall surface of the rotary drum has an elliptical shape in a front view of the rotary drum.

3. The drum type washing machine of claim 1, wherein the front side wall surface of the rotary drum has a polygonal shape in the front view of the rotary drum.

4. The drum type washing machine of claim 1, wherein the front side wall surface of the rotary drum has a shape so formed that a distance of the front side wall surface from the axis of rotation varies into at least two steps consisting of a far distance and a near distance with rotation of the rotary drum.

FIG. 1


21
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7a
12
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40
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C
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10
13
4b
14
D2
3h
D1
6a
3
4
51
31
6
9
16
5
3b
31a
8b
8a
31b
P
20
2a
19
8
B

FIG. 2A

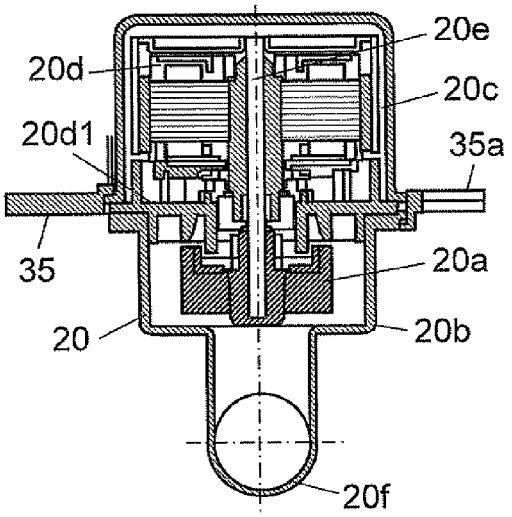


FIG. 2B

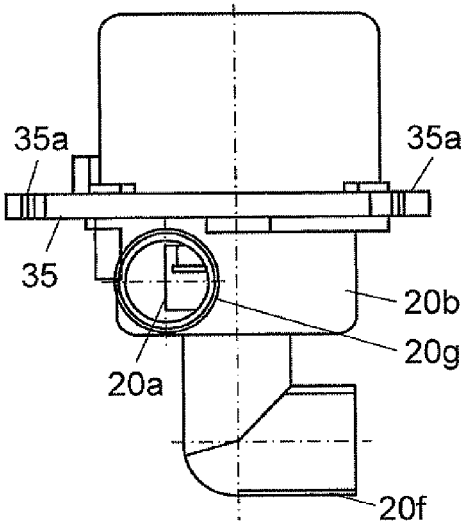


FIG. 2C

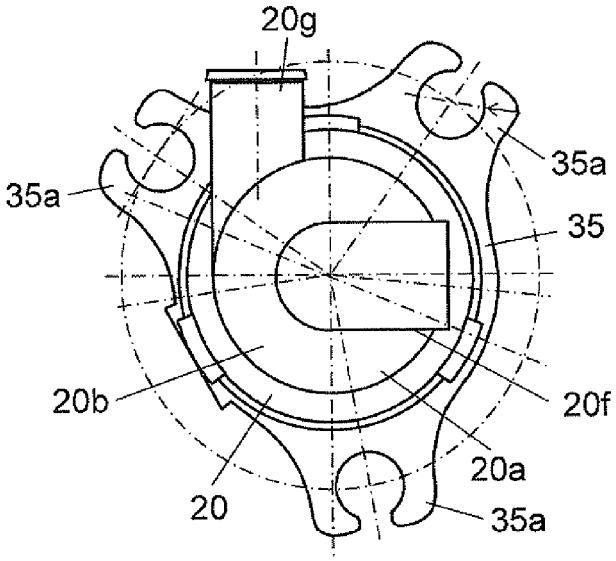


FIG. 3A

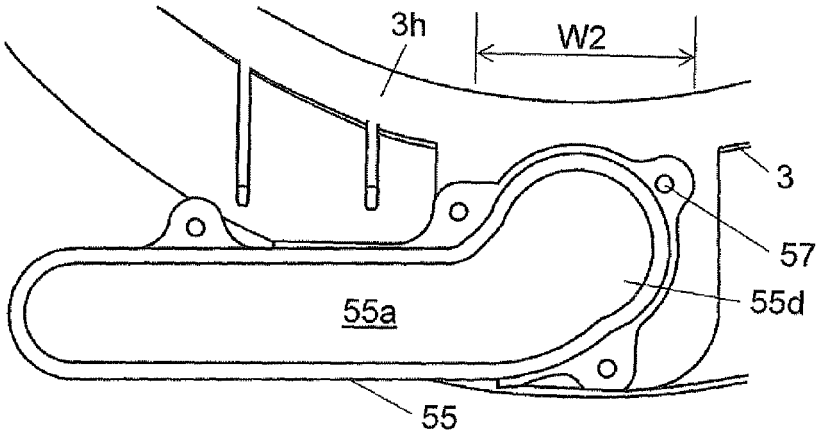


FIG. 3B

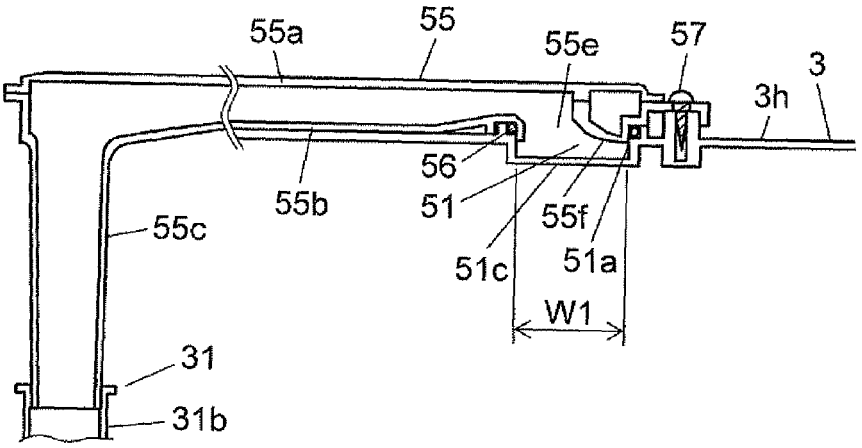


FIG. 3C

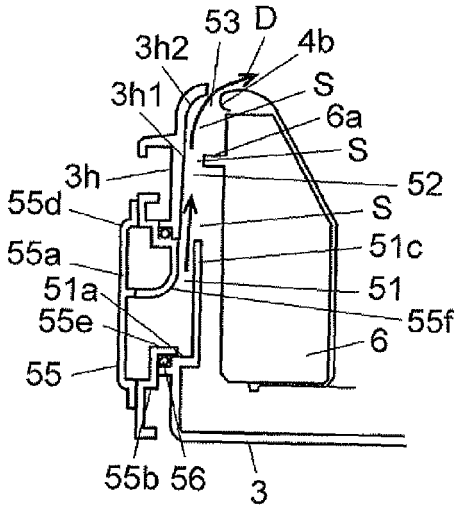


FIG. 4A

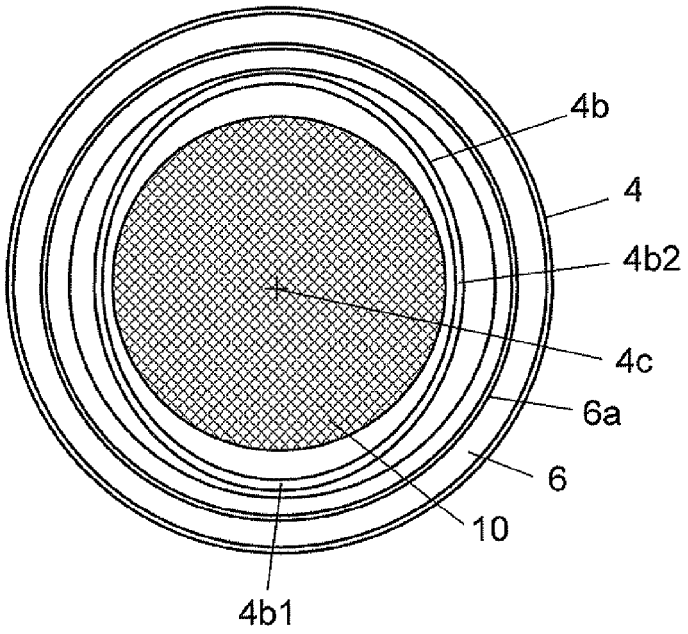


FIG. 4B

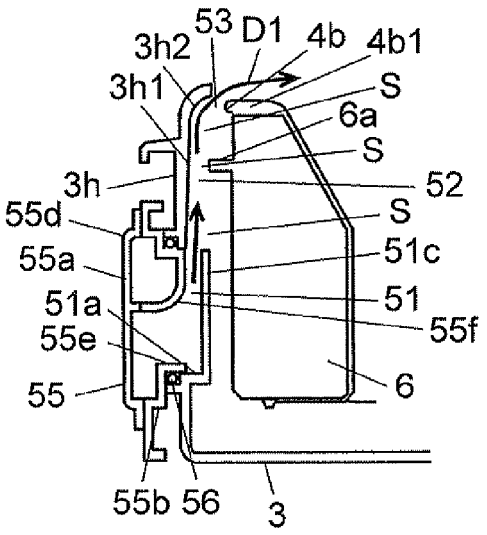


FIG. 4C

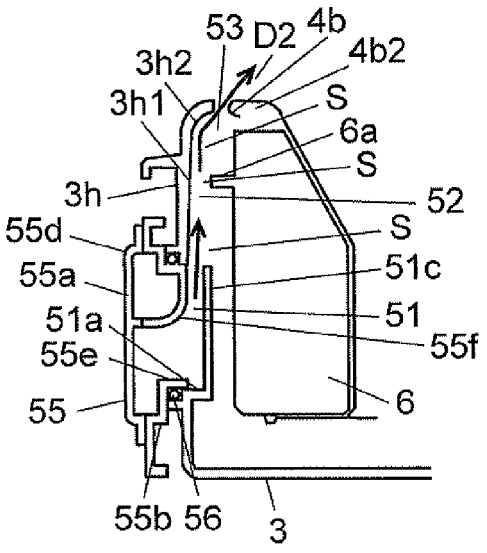
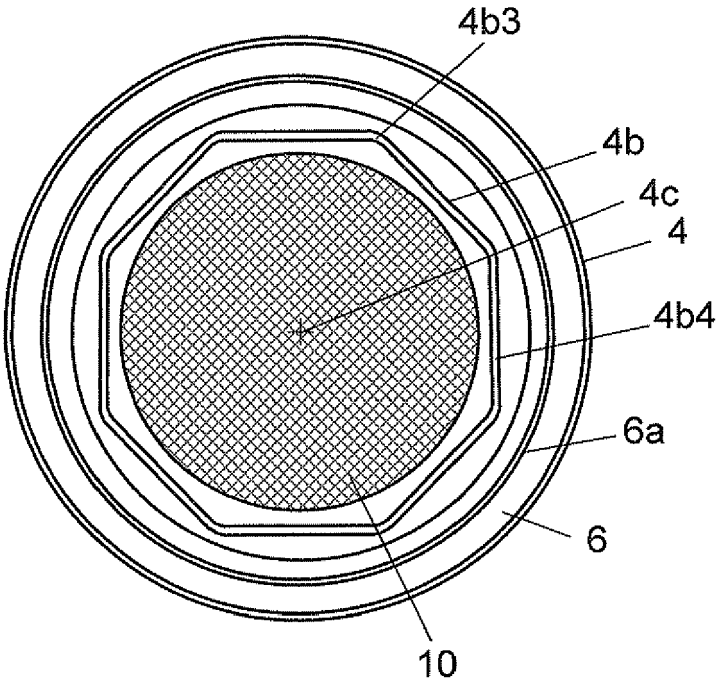


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 10 15 1609

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A	JP 2007 117135 A (MATSUSHITA ELECTRIC IND CO LTD) 17 May 2007 (2007-05-17) * abstract; figure 1 *	1	INV. D06F39/08
A	US 4 809 524 A (SICKERT RICHARD G [US] ET AL) 7 March 1989 (1989-03-07) * figure 8 *	1	
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D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 July 2010	Kising, Axel

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23-07-2010

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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