

DESCRIPTION

WASHING MACHINE

5 TECHNICAL FIELD

The present invention relates to a washing machine which has a washing tub rotatably disposed in the washing machine, and which is for washing clothes inside the washing tub.

10 BACKGROUND ART

Conventionally, there is known a washing machine which has an agitator rotatably disposed on a bottom portion of a washing tub, and which is for washing laundry by a water stream generated by the agitator (for example, see PTL 1).

15 The washing machine achieves an effect of cleaning the laundry by a combination of the following effects. Specifically, the effects are the effect of a water stream caused by a rotation movement of the agitator, and an effect achieved by directly moving the laundry by raised blades provided on the agitator. That is, an aim of the actions and the effects described above is to
20 remove dirt from the laundry by a temporal change in the shape of the laundry, friction among pieces of the laundry, and friction due to the laundry contacting a side wall of an inner tub.

However, normally, during a rotation movement of the agitator, the laundry is agitated with a radius of rotation which is smaller at a rotation
25 center and which is larger near an outer periphery of the agitator. Therefore, even in the same washing tub, the effect of cleaning is varied (unevenness in washing) depending on positions of pieces of laundry. Accordingly, with the

conventional washing machine, a base forming the agitator and the shape of raised blades provided on the base are modified so as to generate a complex water stream by the agitator. This increases the chance of exchange of positions of the pieces of laundry moving in washing water, and reduces
5 variance in the cleaning performance.

In recent years, washing capacity is more and more increased, but with growing awareness towards saving water, washing machines are being developed for which the amount of water used as washing water is set as small as possible.

10 In a washing machine as described above, the amount of washing water at the time of washing is small relative to the volume of laundry. Accordingly, buoyancy of the laundry in the washing water is small, and the laundry tends to sink. The sunken laundry changes its shape to a certain degree in accordance with protrusions/recesses of the agitator, realizing a state
15 in which the weight of the laundry is placed on an upper surface of the agitator. In this state, the effect of the laundry being moved by being in direct contact with the blades of the agitator contributes more than the effect of water stream. Accordingly, with the structure of the agitator of the conventional washing machine, especially in a case where the amount of washing water is
20 small, there is not much chance of exchange of positions between pieces of laundry. As a result, there is a problem that pieces of laundry tend to be unevenly washed.

Citation List

Patent Literature

25 PTL 1: Unexamined Japanese Patent Publication No. 2004-321629

SUMMARY

Embodiments of present invention provides a washing machine by which unevenness in washing is unlikely even in a case where the amount of washing water is small relative to the volume of laundry.

That is, in an aspect, a washing machine is provided comprising an
5 inner tub, opened upward, for accommodating laundry and washing water, and
an agitator, disposed on an inner bottom portion of the inner tub, for being
rotated by a rotation driving unit. Furthermore, the agitator includes a
center vane extending from a rotation center of the agitator toward an outer
periphery of the agitator, the center vane being raised upward from a base of
10 the agitator, and a peripheral vane extending from the outer periphery toward
the rotation center, the peripheral vane being raised upward from the base of
the agitator. Moreover, the center vane and the peripheral vane are disposed
at different positions in a circumferential direction of the agitator wherein a
washing machine comprising: an inner tub, opened at least upward, for
15 accommodating laundry and washing water; and an agitator, disposed on an inner
bottom portion of the inner tub, for being rotated by a rotation driving unit, wherein
the agitator includes: center vanes extending from a rotation center of the agitator
toward an outer periphery of the agitator, the center vanes being raised upward from
a base of the agitator, and peripheral vanes extending from the outer periphery
20 toward the rotation center, the peripheral vanes being raised upward from the base of
the agitator, and wherein the center vanes and the peripheral vanes are disposed at
different positions in a circumferential direction of the agitator, wherein each of the
center vanes includes a blade upper surface, wherein the blade upper surface of
each of the center vanes has a width in the circumferential direction reduced toward
25 the outer periphery of the agitator.

In an aspect, a washing machine is provided an inner tub, opened at least
upward, for accommodating laundry and washing water; and an agitator,

disposed on an inner bottom portion of the inner tub, for being rotated by a rotation driving unit, wherein the agitator includes: center vanes extending from a rotation center of the agitator toward an outer periphery of the agitator, the center vanes being raised upward from a base of the agitator, and
5 peripheral vanes extending from the outer periphery toward the rotation center, the peripheral vanes being raised upward from the base of the agitator, and wherein the center vanes and the peripheral vanes are disposed at different positions in a circumferential direction of the agitator, wherein each of the center vanes includes a blade upper surface and blade side surfaces
10 formed on both sides of the blade upper surface, and a width of the blade upper surface of each of the center vanes, on a side of a rotation center of the center vane, is set to 1/20 or more of a length of a rotation track of a tip end portion of the center vane.

In an aspect, a washing machine is provided an inner tub, opened at least
15 upward, for accommodating laundry and washing water; and an agitator, disposed on an inner bottom portion of the inner tub, for being rotated by a rotation driving unit, wherein the agitator includes: center vanes extending from a rotation center of the agitator toward an outer periphery of the agitator, the center vanes being raised upward from a base of the agitator, and
20 peripheral vanes extending from the outer periphery toward the rotation center, the peripheral vanes being raised upward from the base of the agitator, and wherein the center vanes and the peripheral vanes are disposed at different positions in a circumferential direction of the agitator, wherein each of the peripheral vanes includes a blade upper surface and blade side surfaces
25 formed on both sides of the blade upper surface, and a width of the blade upper surface of each of the peripheral vanes, on a side of an outer periphery of the peripheral vane, is set to 1/20 or more of a length of the outer periphery of the

agitator.

Accordingly, even in a case where the amount of washing water used is small relative to the volume of laundry, the chance of exchange of positions of pieces of laundry may be increased by a rotation movement of the agitator. As a
5 result, a washing machine by which uneven washing is unlikely may be realized.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a plan view showing a structure of an agitator of a washing
10 machine according to an exemplary embodiment of the present invention.

FIG. 2 is a cross-sectional view of the agitator in FIG. 1, along a line
2-2.

FIG. 3 is a perspective view of the agitator of the washing machine
according to the present exemplary embodiment.

FIG. 4 is a diagram for illustrating movement of laundry due to

rotation of the agitator, in a washing step of the washing machine according to the present exemplary embodiment.

FIG. 5 is a diagram for illustrating movement of laundry due to rotation of the agitator, in the washing step of the washing machine according to the present exemplary embodiment.

FIG. 6 is a diagram for illustrating movement of laundry due to rotation of the agitator, in the washing step of the washing machine according to the present exemplary embodiment.

FIG. 7 is a cross-sectional view of the washing machine according to the present exemplary embodiment.

DESCRIPTION OF EMBODIMENT

Hereinafter, an exemplary embodiment of the present invention will be described with reference to the drawings. Note that the present invention is not limited to the exemplary embodiment.

EXEMPLARY EMBODIMENT

Hereinafter, a schematic structure of a washing machine of an exemplary embodiment of the present invention will be described with reference to FIG. 7. Additionally, a structure of a fully automatic washing machine which automatically performs washing to spinning is described as an example with respect to the washing machine of the present exemplary embodiment.

FIG. 7 is a cross-sectional view of the washing machine according to the exemplary embodiment of the present invention.

As shown in FIG. 7, the washing machine of the present exemplary embodiment at least includes housing 1, outer tub 3 accommodated in housing 1, inner tub 4, motor 10, controller 11, and the like. Outer tub 3 is disposed

inside housing 1, and is elastically supported in housing 1 by a plurality of suspensions 2. Vibration of outer tub 3 occurring at the time of spinning or the like is thereby absorbed by suspensions 2, and transmission of noise and vibration to outside is reduced. Inner tub 4 is disposed inside outer tub 3, and
5 agitator 7 is disposed on an inner bottom portion of inner tub 4.

In addition, motor 10 is attached to a bottom portion of outer tub 3, and is connected to inner tub 4 and agitator 7 by clutch 23. By switching rotation of motor 10 by clutch 23, inner tub 4 and agitator 7 are individually rotated. In this case, output of motor 10 is transmitted to drive shaft 8 of inner tub 4
10 via speed reduction mechanism 9 to thereby rotate inner tub 4.

Furthermore, balancer 6 is disposed on an upper portion of inner tub 4, and balancer 6 suppresses vibration of inner tub 4 occurring at the time of rotation of inner tub 4.

The washing machine of the present exemplary embodiment is
15 configured as described above.

In the following, operation of the washing machine of the present exemplary embodiment will be described.

First, a user opens lid 16 provided at a top of housing 1, puts laundry
25 and detergent in inner tub 4, and starts operation of the washing machine.

20 When operation is started, controller 11 opens water valve 15, supplies water into inner tub 4, and rotates agitator 7 by motor 10. Agitation is thereby performed by contact of water stream caused by rotation of agitator 7 with laundry 25, and a washing step is performed.

Next, when the washing step which continues for a predetermined
25 period of time is complete, controller 11 drains dirty washing water in inner tub 4 through drainage hose 22. Then, when drainage is complete, a rinsing step is performed.

In the rinsing step, controller 11 opens water valve 15, and newly supplies water into inner tub 4. Furthermore, controller 11 agitates the supplied water and laundry 25 by agitator 7, and rinses laundry 25. Then, when the rinsing step is complete, a spinning step is performed.

5 In the spinning step, controller 11 performs switching, by clutch 23, so as to transmit rotation of motor 10 to inner tub 4, and to rotate inner tub 4. Then, the washing water absorbed by laundry 25 is removed by a centrifugal force by rotation of inner tub 4, and is discharged into outer tub 3 through small holes 5 formed in a circumferential surface of inner tub 4. A series of
10 steps from the washing step to the spinning step is thereby completed. Additionally, the series of steps is controlled by controller 11, and is performed fully automatically in the case of the fully automatic washing machine of the present exemplary embodiment.

That is, in the present exemplary embodiment, agitation of the water
15 stream and laundry 25 by agitator 7 in the washing step is the factor that affects the cleaning performance regarding unevenness in washing, for example.

Accordingly, agitator 7 of the present exemplary embodiment is structured, as described below, to increase the chance of exchange of positions
20 between laundry near the rotation center and laundry near the outer periphery in a state where the amount of washing water is small relative to the volume of the laundry. Unevenness in washing is thereby reduced. Furthermore, because washing operation may be performed with a small amount of water, an effect such as water saving may be enhanced.

25 In the following, the structure of agitator 7 of the washing machine according to the present exemplary embodiment will be described with reference to FIGS. 1 and 2.

As shown in FIGS. 1 and 2, agitator 7 of the present exemplary embodiment is configured at least base 26, center vanes 27 provided on base 26, peripheral vanes 28, and the like. Base 26 has a substantially circular shape (including a circle), and is horizontal or is formed of a sloped curved surface sloping upward toward outer periphery 7b. Furthermore, a large number of small holes 29 are formed in base 26. Washing water inside the inner tub may thereby be efficiently discharged through small holes 29. In addition, at the time of agitation by base 26, convection of washing water may be caused through small holes 29. As a result, the washing efficiency and the like may be enhanced. Center vanes 27 are provided on base 26, radially from rotation center 7a to outer periphery 7b, for example. Peripheral vanes 28 are provided on base 26, radially inward from outer periphery 7b of agitator 7 toward rotation center 7a, for example.

Additionally, in the present exemplary embodiment, a structure in which three center vanes 27 and three peripheral vanes 28 are formed at regular intervals is described as an example. Specifically, peripheral vane 28, or center vane 27, is provided at a position displaced from center vane 27, or peripheral vane 28, respectively, by 60 degrees with respect to rotation center 7a of agitator 7.

Furthermore, center vanes 27 of agitator 7 are provided, each having a blade shape that is continuous from rotation center 7a of agitator 7 toward outer periphery 7b, up to a position at about half the radius of agitator 7, and that is raised upward from base 26. On the other hand, peripheral vanes 28 are provided, each having a blade shape that is continuous from outer periphery 7b of agitator 7 toward rotation center 7a, up to a position at about half the radius of agitator 7, and that is raised upward from base 26.

Specifically, as shown in FIGS. 1 to 3, center vane 27 is formed

including screw fastening portion 26a provided at rotation center 7a of agitator 7 and extending radially in the direction of outer periphery 7b from rotation center 7a of agitator 7. In addition, center vane 27 is formed gradually sloping downward toward base 26 as it gets closer to outer periphery 7b from
5 rotation center 7a of agitator 7. Furthermore, center vane 27 is formed having a shape whose width in a rotation direction (circumferential direction) is reduced from rotation center 7a of agitator 7 toward outer periphery 7b.

Center vane 27 formed as described above includes blade side surface 27a forming one side surface, blade upper surface 27b forming an upper
10 surface, and blade side surface 27c forming another side surface.

Blade upper surface 27b of center vane 27 is the surface on which laundry is to be placed. As described above, blade upper surface 27b is formed to have a shape that gradually slopes downward and that is narrowed from rotation center 7a of agitator 7 toward outer periphery 7b. Furthermore,
15 blade upper surface 27b is formed to have a shape that is the highest at center portion 27bb in the circumferential direction of agitator 7, and that is gradually sloped from center portion 27bb toward both sides (blade side surface 27a and blade side surface 27c) in the circumferential direction.

In addition, blade side surface 27a and blade side surface 27c of center
20 vane 27 are each formed to have a shape that steeply slopes downward from an outer peripheral edge of blade upper surface 27b in the circumferential direction of agitator 7.

In this case, width W1 of blade upper surface 27b of center vane 27, at a base point portion on a side of rotation center 7a of agitator 7 and in the
25 circumferential direction, is set to about 1/20 or more of the length of a rotation track of tip end portion 27d of center vane 27. This setting is based on various considerations.

With this structure, in the case of performing the washing step with an amount of water that is small relative to the volume of laundry, an area receiving a frictional force by rotation of laundry is increased. Therefore, pieces of laundry are easily moved, and the positions of the pieces of laundry are easily exchanged. This results in reduced unevenness in the washing.

Furthermore, as shown in FIGS. 1 to 3, peripheral vane 28 of agitator 7 is formed extending from outer periphery 7b of agitator 7 toward rotation center 7a. In addition, peripheral vane 28 is formed to be the highest at a side of outer periphery 7b of agitator 7, and to gradually slope downward toward base 26 as it gets closer to rotation center 7a from outer periphery 7b of agitator 7. Moreover, peripheral vane 28 is formed having a shape whose width in the rotation direction is reduced from outer periphery 7b of agitator 7 toward rotation center 7a.

Peripheral vane 28 formed as described above includes blade side surface 28a forming one side surface, blade upper surface 28b forming an upper surface, and blade side surface 28c forming another side surface.

Blade upper surface 28b of peripheral vane 28 is the surface on which laundry is to be placed. As described above, blade upper surface 28b is formed to have a shape that gradually slopes downward and that is narrowed from outer periphery 7b of agitator 7 toward rotation center 7a. Furthermore, blade upper surface 28b is formed to have a shape that is the highest at center portion 28bb in the circumferential direction of agitator 7, and that is gradually sloped from center portion 28bb toward both sides (blade side surface 28a and blade side surface 28c) in the circumferential direction.

In addition, blade side surface 28a and blade side surface 28c of peripheral vane 28 are each formed to have a shape that steeply slopes downward from an outer peripheral edge of blade upper surface 28b in the

circumferential direction of agitator 7.

In this case, width W2 of blade upper surface 28b of peripheral vane 28, at outer periphery 7b of agitator 7 as a base point is set to about 1/20 or more of the length of the outer periphery of peripheral vane 28. This setting is
5 based on various considerations.

With the structure, in a case of performing the washing step with an amount of water that is small relative to the volume of laundry, the buoyancy of the laundry is small, and the laundry comes in direct contact with the blade upper surface. Accordingly, an area receiving a frictional force by rotation of
10 the agitator is increased. Therefore, pieces of laundry are easily moved, and the positions of the pieces of laundry are easily exchanged. This results in reduced unevenness in the washing.

Agitator 7 of the washing machine of the present exemplary embodiment is structured as described above.

15 In the following, operation and actions of agitator 7 structured in the above manner will be specifically described taking the washing step as an example.

Normally, in the case where washing is performed, in the washing step, with an amount of washing water that is small relative to the volume of
20 laundry 25, the buoyancy of laundry 25 in the washing water in inner tub 4 is small. Accordingly, laundry 25 does not float in the washing water, but tend to sink. Sunken laundry 25 changes its shape to a certain degree in accordance with protrusions/recesses of agitator 7, near agitator 7. Accordingly, laundry 25 is placed in a state where more laundry 25 is on blade
25 upper surface 27b of center vane 27 and blade upper surface 28b of peripheral vane 28 than on base 26 of agitator 7.

When agitator 7 shown in FIG. 1, for example, is rotated clockwise in

the above state, a force for moving laundry 25 is strongly exerted by center vane 27, in an order of blade side surface 27a, blade upper surface 27b, and blade side surface 27c. Accordingly, center vane 27 may easily move laundry 25 in the above order.

5 This is because the laundry near blade side surface 27a rotates in accordance with rotation of agitator 7 by coming in direct contact with blade side surface 27a. Accordingly, a force in the rotation direction of agitator 7 is easily applied to the laundry.

10 Furthermore, in the case where the amount of washing water in inner tub 4 is small, the buoyancy of the laundry near blade upper surface 27b obtained by the washing water is small, and the laundry comes in direct contact with blade upper surface 27b. Accordingly, a rotational force is applied, by rotation of agitator 7, to laundry 25 near blade upper surface 27b by a frictional force with blade upper surface 27b.

15 Additionally, blade side surface 27a directly applies a rotational force to laundry 25 near a front side of blade side surface 27a in the rotation direction, by an agitation action of blade side surface 27a by the rotation of agitator 7. Accordingly, the agitation action, on laundry 25, by blade side surface 27a is greater than that by blade upper surface 27b.

20 That is, laundry near blade side surface 27c moves merely by the action of coming into contact with laundry moved by blade upper surface 27b and blade side surface 27a. Accordingly, the agitation action on the laundry at blade side surface 27c is smaller than that at blade side surface 27a and blade upper surface 27b.

25 Furthermore, as in the case of center vane 27, when agitator 7 is rotated clockwise, a force for moving laundry 25 is strongly exerted by peripheral vane 28, in an order of blade side surface 28a, blade upper surface

28b, and blade side surface 28c, shown in FIG. 1. Accordingly, peripheral vane 28 may easily move laundry 25 in the above order.

This is because the laundry near blade side surface 28a rotates in accordance with rotation of agitator 7 by coming in direct contact with blade
5 side surface 28a. Accordingly, a force in the rotation direction of agitator 7 is easily applied to the laundry.

Furthermore, in the case where the amount of washing water at the time of washing is small relative to the volume of laundry 25, buoyancy of laundry near blade upper surface 28b obtained by the washing water is small.
10 The laundry near blade upper surface 28b therefore comes in direct contact with blade upper surface 28b. Accordingly, a rotational force is applied, by rotation of agitator 7, to laundry 25 near blade upper surface 28b by a frictional force with blade upper surface 28b.

Additionally, blade side surface 28a directly applies a rotational force
15 to laundry 25 near a front side of blade side surface 28a in the rotation direction, by an agitation action of blade side surface 28a by the rotation of agitator 7. Accordingly, the agitation action, on the laundry, by blade side surface 28a is greater than that by blade upper surface 28b.

That is, laundry near blade side surface 28c moves merely by the
20 action of coming into contact with laundry moved by blade upper surface 28b and blade side surface 28a. Accordingly, the agitation action on the laundry at blade side surface 28c is smaller than that at blade side surface 28a and blade upper surface 28b.

On the other hand, as inner tub 4 is rotated, laundry, in the washing
25 water, which is at a position higher than a position near a bottom surface (agitator 7) of inner tub 4 gets entangled with laundry near the bottom surface (agitator 7) or comes in contact with the laundry. That is, when laundry near

agitator 7 moves, laundry at a higher position moves following the movement of the laundry near the bottom surface. A similar movement as the movement of laundry described above is thereby caused. However, as the position of laundry gets nearer to the water surface (surface of washing water
5 (on the atmosphere side)), the influence of movement of the laundry near the bottom surface (agitator) reduces, and thus, the movement of laundry near the water surface is small.

As described above, agitator 7 having the structure described above agitates the laundry by the agitation action by center vane 27 and the
10 agitation action by peripheral vane 28 acting on the laundry at the same time. Laundry may thus be effectively cleaned.

In the following, exchange of positions of pieces of laundry caused by the action of agitator 7 described above will be specifically described with reference to FIGS. 4 to 6.

15 FIGS. 4 to 6 are diagrams for illustrating movement of laundry due to rotation of the agitator, in the washing step of the washing machine according to the present exemplary embodiment. FIGS. 4 to 6 show an example in which agitator 7 rotates in the clockwise direction.

Specifically, FIG. 4 shows positions of pieces of laundry before agitation
20 by agitator 7. FIG. 5 shows the positions of the pieces of laundry immediately after start of a clockwise rotation operation. FIG. 6 shows the positions of the pieces of laundry in a state where agitator 7 is further rotated clockwise from the state in FIG. 5.

First, as shown in FIG. 4, in a state before agitation by agitator 7, piece
25 25b of laundry is at a position on a front side of blade side surface 27a of center vane 27 in the rotation direction. In the same manner, pieces 25e, 25h of laundry are each at a position on a front side of blade side surface 28a of

peripheral vane 28 in the rotation direction. Accordingly, a force of agitator 7 in the rotation direction acts most on pieces 25b, 25e, 25h of laundry, resulting in a great amount of movement of pieces 25b, 25e, 25h.

Specifically, when agitator 7 rotates clockwise, pieces 25b, 25e, 25h of laundry move in directions indicated by arrows B, E, H in FIG. 5, for example, from the state shown in FIG. 4. Here, arrow B shows the amount and direction of movement of piece 25b of laundry. Arrow E shows the amount and direction of movement of piece 25e of laundry. Likewise, arrow H shows the amount and direction of movement of piece 25h of laundry.

Furthermore, piece 25c of laundry shown in FIG. 4 is at a position near blade upper surface 27b of center vane 27, and piece 25f of laundry is at a position near blade upper surface 28b of peripheral vane 28. Accordingly, pieces 25c, 25f of laundry move by frictional forces due to contact with blade upper surface 27b of center vane 27 and blade upper surface 28b of peripheral vane 28. That is, pieces 25c, 25f of laundry move, in accordance with rotation of agitator 7, in directions indicated by arrows C, F in FIG. 5, for example, from the state shown in FIG. 4. Here, arrow C shows the amount and direction of movement of piece 25c of laundry, and arrow F shows the amount and direction of movement of piece 25f of laundry.

Furthermore, pieces 25a, 25d, 25g of laundry shown in FIG. 4 are pushed by piece(s) of laundry with a great amount of movement, such as piece 25b of laundry, and move in the directions indicated by arrows A, D, G in FIG. 5, for example, from the state shown in FIG. 4. Here, arrow A shows the amount and direction of movement of piece 25a of laundry. Arrow D shows the amount and direction of movement of piece 25d of laundry. Likewise, arrow G shows the amount and direction of movement of piece 25g of laundry.

The lengths of the arrows shown in FIG. 5 represent relative amounts

of movement of the pieces of laundry. That is, the relationship among the amounts of movement of pieces of laundry is arrows B, E, H > arrows C, F > arrows A, D, G.

Next, the positions of the pieces of laundry after agitator 7 is further
5 rotated clockwise from the state in FIG. 5 will be described with reference to FIGS. 5 and 6.

First, as shown in FIG. 5, piece 25a of laundry with a small amount of movement, to which an agitation force is not applied, is present at a position, in a circumferential rotation direction, to which piece 25b of laundry, near
10 blade side surface 27a of center vane 27, with a great amount of movement is to move, for example. Accordingly, movement of piece 25b of laundry in the circumferential direction is restricted. On the other hand, on a side of outer periphery 7b of agitator 7 of piece 25b of laundry, pieces 25e, 25f of laundry with a great amount of movement move in the rotation direction, thus creating
15 a space.

Accordingly, piece 25b of laundry whose movement in the circumferential direction is restricted by piece 25a of laundry moves, as shown by arrow I in FIG. 6, in the direction of the vacant space by the agitation action of center vane 27. As a result, piece 25b of laundry moves from a
20 position near center vane 27 to a position near peripheral vane 28.

In addition, as shown in FIG. 5, piece 25g of laundry with a small amount of movement, to which an agitation force is not applied, is present at a position, in a circumferential rotation direction, to which piece 25h of laundry, near peripheral vane 28, with a great amount of movement is to move, for
25 example. Accordingly, movement of piece 25g of laundry in the circumferential direction along peripheral vane 28 is restricted. On the other hand, on a side of rotation center 7a of agitator 7 of piece 25g of laundry, pieces

25b, 25c of laundry with a great amount of movement move in the rotation direction, thus creating a space.

Accordingly, piece 25h of laundry whose movement in the circumferential direction is restricted by piece 25g of laundry moves, as shown
5 by arrow J in FIG. 6, in the direction of the vacant space by the agitation action of peripheral vane 28. As a result, piece 25h of laundry moves from a position near peripheral vane 28 to a position near center vane 27.

That is, the chance of exchange of positions between laundry on an inner peripheral side of inner tub 4 and laundry on an outer peripheral side is
10 increased by the movement of pieces of laundry shown in FIGS. 4 to 6.

On the other hand, with the structure of an agitator of a conventional washing machine, there is not much chance of exchange of positions, and thus the cleaning effect tends to be small for the laundry on the inner peripheral side of inner tub 4, compared to the laundry on the outer peripheral side.

15 However, as described above, according to the washing machine of the present exemplary embodiment, the chance of exchange of positions between the laundry near the outer periphery of agitator 7 and the laundry near the inner periphery is increased. Accordingly, unevenness in washing the laundry may be reduced. In addition, because washing can be performed with
20 a small amount of washing water, the effect of saving water may be enhanced.

In addition, according to the washing machine of the present exemplary embodiment, laundry does not easily obtain buoyancy especially in the washing step in which washing is performed with a small amount of washing water relative to the volume of laundry. In this case, when the
25 agitator is rotated, an area of contact between laundry and the center vanes and the peripheral vanes of the agitator is increased, and a great frictional force is applied to the laundry. Therefore, the laundry is more easily agitated

than by the conventional washing machine.

Moreover, according to the present exemplary embodiment, the center vanes and the peripheral vanes of the agitator are provided at different positions in the circumferential direction with respect to the rotation center.

5 Accordingly, the part (position) that acts most strongly on laundry is shifted by the difference in the angles between the disposed center vanes and peripheral vanes. Accordingly, laundry which starts moving by direct contact with the center vanes moves to a space where laundry which started moving by direct contact with the peripheral vanes was present. On the other hand, laundry
10 which starts moving by direct contact with the peripheral vanes moves to a space where laundry which started moving by direct contact with the center vanes was present. As a result, the positions of laundry near the center of the inner tub and laundry near the outer periphery may be easily exchanged. Furthermore, with the structure described above, the washing step may be
15 performed with a small amount of washing water, and an enhancement in the effect of water saving and a reduction in the unevenness in the washing may be realized at the same time.

Moreover, according to the present exemplary embodiment, the center vanes and the peripheral vanes of the agitator are alternately provided in the
20 rotation direction. Accordingly, a part that acts most strongly on the laundry that is being rotated and a part that acts most weakly are shifted from each other. This shift causes exchange of positions of pieces of laundry to be performed uniformly by the whole agitator. As a result, unevenness in the washing of laundry may be suppressed more effectively.

25 Furthermore, according to the present exemplary embodiment, the center vanes and the peripheral vanes of the agitator are provided at regular intervals in the rotation direction. Accordingly, a part that acts most strongly

on the laundry that is being rotated and a part that acts most weakly are shifted from each other. This shift causes exchange of positions of pieces of laundry to be performed more uniformly by the whole agitator. As a result, unevenness in the washing of laundry may be suppressed even more effectively.

Moreover, according to the present exemplary embodiment, lengths of the center vanes and the peripheral vanes in the radial direction are set such that a rotation track of tip end portions of the center vanes of the agitator is greater in diameter than a rotation track of tip end portions of the peripheral vanes. Accordingly, laundry which does not receive a force in the rotation direction of the agitator may be reduced as much as possible. Thus, exchange of positions of pieces of laundry may be uniformly performed by the whole agitator. As a result, unevenness in the washing of laundry may be suppressed even more effectively.

Moreover, according to the present exemplary embodiment, each center vane of the agitator includes the blade upper surface and the blade side surfaces formed on both sides of the blade upper surface, and the width of the blade upper surface, on a side of the rotation center of the center vane, is set to about 1/20 or more of the length of a rotation track of the tip end portion of the center vane. Accordingly, in the case of performing the washing step with a small amount of washing water, laundry comes in direct contact with the blade upper surface. Thus, an area which receives a frictional force by rotation of the agitator is increased, and laundry may be easily moved. As a result, the positions of pieces of laundry may be easily exchanged, and occurrence of unevenness in the washing of laundry may be further reduced.

Moreover, according to the present exemplary embodiment, each peripheral vane of the agitator includes the blade upper surface and the blade

side surfaces formed on both sides of the blade upper surface, and the width of the blade upper surface, on a side of the outer periphery of the peripheral vane, is set to about 1/20 or more of the length of the outer periphery of the agitator. Accordingly, in the case of performing the washing step with a small amount of washing water, laundry comes in direct contact with the blade upper surface. Thus, an area which receives a frictional force by rotation of the agitator is increased, and laundry may be easily moved. As a result, the positions of pieces of laundry may be easily exchanged, and occurrence of unevenness in the washing of laundry may be further reduced.

Furthermore, according to the present exemplary embodiment, the length of the center vane of the agitator in the radial direction is set to about half the radius of the agitator. Accordingly, exchange of positions of pieces of laundry may be performed uniformly near the center of the inner tub and near the outer periphery. As a result, unevenness in the washing of laundry may be further reduced.

Furthermore, according to the present exemplary embodiment, the length of the peripheral vane of the agitator in the radial direction is set to half the radius of the agitator. Accordingly, exchange of positions of pieces of laundry may be performed uniformly near the center of the inner tub and near the outer periphery. As a result, unevenness in the washing of laundry may be further reduced.

Moreover, according to the present exemplary embodiment, the blade upper surface of the center vane is provided in a manner sloping downward closer to the base of the agitator, toward the outer periphery of the agitator. Accordingly, laundry positioned on a side of the inner periphery may be moved by the center vane. As a result, the positions of pieces of laundry may be easily exchanged, and unevenness in the washing of laundry

may be reduced.

Moreover, according to the present exemplary embodiment, the blade upper surface of the center vane is provided in a manner sloping downward closer to the base of the agitator, toward the blade side surfaces provided on both sides in the circumferential direction of the agitator. Accordingly, laundry positioned on a side of the center of the agitator may be moved to the side of the blade upper surface of the center vane. As a result, the positions of pieces of laundry may be easily exchanged, and unevenness in the washing of laundry may be reduced.

Moreover, according to the present exemplary embodiment, the blade upper surface of the center vane has a width in the circumferential direction reduced toward the outer periphery of the agitator. Accordingly, laundry positioned on a side of the center of the agitator may be moved to the side of the outer periphery. As a result, the positions of pieces of laundry may be easily exchanged, and unevenness in the washing of laundry may be reduced.

Furthermore, according to the present exemplary embodiment, the blade upper surface of the peripheral vane is provided in a manner sloping downward closer to the base of the agitator, toward the rotation center of the agitator. Accordingly, laundry positioned on a side of the outer periphery may be moved by the peripheral vane. As a result, the positions of pieces of laundry may be easily exchanged, and unevenness in the washing of laundry may be reduced.

Moreover, according to the present exemplary embodiment, the blade upper surface of the peripheral vane is provided in a manner sloping downward closer to the base of the agitator, toward the blade side surfaces provided on both sides in the circumferential direction of the agitator. Accordingly, laundry positioned on a side of the outer periphery of the agitator may be moved to the side of the blade upper surface of the peripheral vane.

As a result, the positions of pieces of laundry may be easily exchanged, and unevenness in the washing of laundry may be reduced.

Moreover, according to the present exemplary embodiment, the blade upper surface of the peripheral vane has a width in the circumferential
5 direction reduced toward the rotation center of the agitator. Accordingly, laundry positioned on a side of the outer periphery of the agitator may be moved to the side of the inner periphery. As a result, the positions of pieces of laundry may be easily exchanged, and unevenness in the washing of laundry may be reduced.

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INDUSTRIAL APPLICABILITY

The present invention may be widely used in the field of cleaning appliances such as a washing machine, for which reduction in the unevenness in washing is desired even when the amount of used water is small relative to
15 the volume of laundry.

REFERENCE MARKS IN THE DRAWINGS

	1	Housing
	2	Suspension
20	3	Outer tub
	4	Inner tub
	5, 29	Small hole
	6	Balancer
	7	Agitator
25	7a	Rotation center
	7b	Outer periphery
	8	Drive shaft

	9	Speed reduction mechanism	
	10	Motor	
	11	Controller	
	15	Water valve	
5	16	Lid	
	22	Drainage hose	
	23	Clutch	
	25, 25a, 25b, 25c, 25d, 25e, 25f, 25g, 25h	Piece of laundry	
	26	Base	
10	26a	Screw fastening portion	
	27	Center vane	
	27a, 27c, 28a, 28c	Blade side surface	
	27b, 28b	Blade upper surface	
	27bb, 28bb	Center portion	
15	27d	Tip end portion	
	28	Peripheral vane	

CLAIMS

1. A washing machine comprising:

an inner tub, opened at least upward, for accommodating laundry and washing water; and

an agitator, disposed on an inner bottom portion of the inner tub, for being rotated by a rotation driving unit,

wherein the agitator includes:

center vanes extending from a rotation center of the agitator toward an outer periphery of the agitator, the center vanes being raised upward from a base of the agitator, and

peripheral vanes extending from the outer periphery toward the rotation center, the peripheral vanes being raised upward from the base of the agitator, and

wherein the center vanes and the peripheral vanes are disposed at different positions in a circumferential direction of the agitator,

wherein each of the center vanes includes a blade upper surface and blade side surfaces formed on both sides of the blade upper surface, and a width of the blade upper surface of each of the center vanes, on a side of a rotation center of the center vane, is set to 1/20 or more of a length of a rotation track of a tip end portion of the center vane.

2. A washing machine comprising:

an inner tub, opened at least upward, for accommodating laundry and washing water; and

an agitator, disposed on an inner bottom portion of the inner tub, for being rotated by a rotation driving unit,

wherein the agitator includes:

center vanes extending from a rotation center of the agitator toward an outer periphery of the agitator, the center vanes being raised upward from a base of the agitator, and

peripheral vanes extending from the outer periphery toward the rotation center, the peripheral vanes being raised upward from the base of the agitator, and

wherein the center vanes and the peripheral vanes are disposed at different positions in a circumferential direction of the agitator,

wherein each of the peripheral vanes includes a blade upper surface and blade side surfaces formed on both sides of the blade upper surface, and a width of the blade upper surface of each of the peripheral vanes, on a side of an outer periphery of the peripheral vane, is set to $1/20$ or more of a length of the outer periphery of the agitator.

3. The washing machine according to claim 1 or 2, wherein the center vanes and the peripheral vanes are alternately disposed in a rotation direction of the agitator.

4. The washing machine according to claim 1 or 2, wherein the center vanes and the peripheral vanes are disposed at regular intervals with respect to the rotation center of the agitator.

5. The washing machine according to claim 1 or 2, wherein lengths of the center vanes and the peripheral vanes in a radial direction are set such that a

rotation track of tip end portions of the center vanes, on a side of the outer periphery of the agitator, is greater in diameter than a rotation track of tip end portions of the peripheral vanes, on a side of the rotation center of the agitator.

6. The washing machine according to claim 1 or 2, wherein a length of the center vanes in a radial direction is set to half a radius of the agitator.

7. The washing machine according to claim 1, wherein a length of the peripheral vanes in a radial direction is set to half a radius of the agitator.

8. The washing machine according to claim 1, wherein the blade upper surface of each of the center vanes is provided in a manner sloping downward closer to the base of the agitator, toward the outer periphery of the agitator.

9. The washing machine according to claim 1, wherein the blade upper surface of each of the center vanes is provided in a manner sloping downward closer to the base of the agitator, toward the blade side surfaces provided on both sides in the circumferential direction of the agitator.

10. The washing machine according to claim 1, wherein the blade upper surface of each of the center vanes has a width in the circumferential direction reduced toward the outer periphery of the agitator.

11. The washing machine according to claim 2, wherein the blade upper surface of each of the peripheral vanes is provided in a manner sloping downward closer to the base of the agitator, toward the rotation center of the agitator.

12. The washing machine according to claim 2, wherein the blade upper surface of each of the peripheral vanes is provided in a manner sloping downward closer to the base of the agitator, toward the blade side surfaces provided on both sides in the circumferential direction of the agitator.

13. The washing machine according to claim 2, wherein the blade upper surface of each of the peripheral vanes has a width in the circumferential direction reduced toward the rotation center of the agitator.