(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 489 403 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
29.05.2019 Bulletin 2019/22

(21) Application number: **17830852.4**

(22) Date of filing: **06.07.2017**

(51) Int Cl.:
D06F 15/02 *(2006.01)* ***D06F 47/06*** *(2006.01)*

(86) International application number:
PCT/JP2017/024773

(87) International publication number:
WO 2018/016332 (25.01.2018 Gazette 2018/04)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **22.07.2016 JP 2016144476**
30.09.2016 JP 2016192816
15.05.2017 JP 2017096427

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

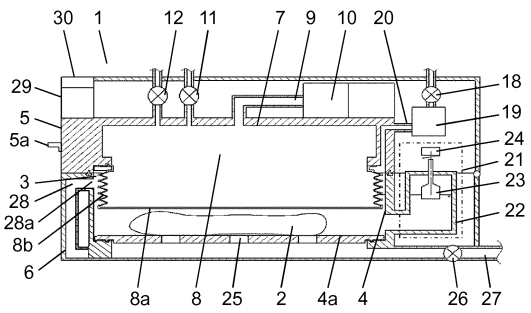
(72) Inventors:
- **HORIBATA, Hiroshi**
  Osaka-shi
  Osaka 540-6207 (JP)
- **TAHARA, Mikio**
  Osaka-shi
  Osaka 540-6207 (JP)
- **NAWAMA, Junichi**
  Osaka-shi
  Osaka 540-6207 (JP)
- **KAWAI, Masahiro**
  Osaka-shi
  Osaka 540-6207 (JP)
- **ANDO, Mariko**
  Osaka-shi
  Osaka 540-6207 (JP)

(74) Representative: **SSM Sandmair**
Patentanwälte Rechtsanwalt Partnerschaft mbB
Joseph-Wild-Straße 20
81829 München (DE)

(54) WASHING MACHINE

(57) A washing machine according to the present disclosure includes: a washing tub configured to accommodate a washing object and wash water; a pressurizing and depressurizing part having a pressing part configured to freely advance to and retreat from the washing object accommodated in the washing tub; and a controller configured to control the pressurizing and depressurizing part. The pressurizing and depressurizing part is configured to press and release pressing against the washing object by using the pressing part to cause the washing object to contract and expand, so that water currents in multiple directions are generated inside the washing object. This can suppress fabric damage and loss of shape of the washing object, and also enhance a washing effect.

FIG. 2



EP 3 489 403 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a washing machine configured to wash laundry such as clothes.

BACKGROUND ART

[0002] So-called top-loading washing machines and front-loading washing machines are known as conventional washing machines. A top-loading washing machine is configured to wash laundry such as clothes by agitation in a rotary tub. A front-loading washing machine is configured to wash laundry in a rotary tub by lifting up and dropping down the laundry in a rotation direction of the rotary tub. These washing machines are configured to rub and scrub laundry by exerting mechanical force on the laundry, which may cause wear and tear on the laundry. Accordingly, it is common to press-wash the laundry by handwashing, in particular, that can easily be damaged or that can easily lose shape when pulled by other laundry due to entanglement. In addition, there have been proposed various washing machines configured to wash laundry without heavily exerting mechanical force on the laundry.

[0003] In order to reduce fabric damage and loss of shape of laundry, top-loading washing machines are proposed to apply a centrifugal force to the laundry and to add a press-washing effect to the laundry by changing the strength of the centrifugal force applied to the laundry (see PTL 1, for example).

[0004] FIG. 22 is a longitudinal sectional view of a conventional washing machine disclosed in PTL 1. In FIG. 22, outer tank 51 contains rotatably disposed washing and spin-drying tub 52. Outer tank 51 is suspended on washing machine outer frame 54 with suspension rods 53. Motor 55 is configured to rotate washing and spin-drying tub 52 through V-belt 56 and deceleration mechanism 57. Controller 58 is configured to successively control motor 55, water-supply valve 59, drain valve 60, etc., to control a sequence of a washing step, a rinsing step, a spin-drying step, and the like. Controller 58 is configured to shift a rotational speed of washing and spin-drying tub 52 between the rotational speeds of spraying wash water and of not spraying wash water.

[0005] In order to prevent fabric damage to woolen clothes, clothes with a dry-cleaning symbol, and the like, it is proposed to provide an auxiliary tool above a rotary vane provided on a bottom of a washing tub and place clothes on the auxiliary tool so that the clothes are pressed and washed (see PTL 2, for example). Rotation of the rotary vane generates a water current in a vertical direction, and the water current causes the auxiliary tool on which the clothes are placed to sink downward. When the rotation of the rotary vane stops and the water current in the vertical direction is weakened, the auxiliary tool rises upward. These operations are repeated, and according to the repetition, the clothes are pressed and washed.

[0006] It is also proposed that a washing machine detachably incorporates a press-washing attachment inside a washing tub to press and wash the laundry (see PTL 3, for example). The press-washing attachment includes a circular push plate having an inner diameter slightly smaller than that of a washing tub, and a screw shaft screwed with the center of the push plate and vertically extending inside the washing tub. The push plate moves up and down by rotating the screw shaft. The laundry is repeatedly pressed against the bottom of the washing tub by the push plate so that the laundry is pressed and washed.

[0007] According to the conventional configuration disclosed in PTL 1, a strong water current is generated by a centrifugal force outwardly from the center of the washing tub, which causes a shear stress due to the water current to be applied to soils attached to fiber of the laundry. As a result, soils are removed from the fiber, and moved to the outside of the laundry by the water current. However, the water current generated inside the fiber flows outwardly in one direction relative to the laundry clinging to an inner periphery wall of the washing tub, and thus a shear stress is not applied on a soil at a portion that is hardly exposed to the water current, which leads to insufficient removal of the soils. In addition, the laundry clings to the washing tub, and thus cannot be washed while maintaining the shape.

[0008] According to the conventional configuration disclosed in PTL 2, the auxiliary tool that has sunk downward due to the water current rises upward with a buoyant force, and thus the water current that passes through the laundry during the upward movement is weak. A water current strong enough to remove soils is generated only in one direction during the downward movement of the auxiliary tool, and thus soils are not removed sufficiently.

[0009] According to the conventional configuration disclosed in PTL 3, the push plate moves up and down according to the rotation of the screw shaft that is vertically provided at the center of the washing tub. Thus, the push plate needs to be formed of a highly rigid material so as to compress the laundry even at a peripheral part away from the center. With this configuration, the laundry is compressed strongly at a higher part where the laundry is piled, and is not compressed at all or compressed very weakly at a lower part, since the laundry is not always accommodated in the washing tub with a uniform thickness. This causes non-uniformity of a washing effect and causes a portion where soils are not removed sufficiently. Further, the screw shaft provided at the center of the washing tub prevents the laundry to be set in the washing tub in a spread state, and the laundry is pressed against the bottom of the washing tub in a folded small shape, thus causing wrinkles in the laundry.

Citation List

Patent Literature

[0010]

PTL 1: Unexamined Japanese Patent Publication No. 2000-350883
PTL 2: Unexamined Japanese Patent Publication No. 9-38376
PTL 3: Unexamined Japanese Patent Publication No. 10-33884

SUMMARY OF THE INVENTION

[0011] The present disclosure is to solve the above problems, and an object thereof is to provide a washing machine capable of enhancing a washing effect while suppressing fabric damage and loss of shape of the laundry.

[0012] In order to solve the above conventional problems, a washing machine of the present disclosure includes: a washing tub configured to accommodate a washing object and wash water; a pressurizing and depressurizing part having a pressing part configured to freely advance to and retreat from the washing object accommodated in the washing tub; and a controller configured to control the pressurizing and depressurizing part. The pressurizing and depressurizing part is configured to press and release pressing against the washing object by using the pressing part to cause the washing object to contract and expand, so that water currents in multiple directions are generated inside the washing object.

[0013] With this configuration, water currents in multiple directions can be generated inside the washing object without agitating the washing object. This can enhance a washing effect while suppressing fabric damage and loss of shape of washing object.

[0014] The washing machine according to the present disclosure can suppress fabric damage and loss of shape of the washing object, and also enhance a washing effect.

BRIEF DESCRIPTION OF DRAWINGS

[0015]

FIG. 1 is an external perspective view of a washing machine according to a first exemplary embodiment of the present disclosure.
FIG. 2 is a sectional view of the washing machine according to the present exemplary embodiment taken along line 2-2 in FIG. 1.
FIG. 3 is a sectional view of the washing machine in a state in which a lid of the washing machine shown in FIG. 2 is open.
FIG. 4 is a sectional view of the washing machine according to the present exemplary embodiment taken along line 4-4 in FIG. 1.
FIG. 5 is a sectional view of the washing machine shown in FIG. 4 in a state in which pressure is applied inside a pressing part.
FIG. 6 is a sectional view of another example of the washing machine according to the present exemplary embodiment taken along line 6-6 in FIG. 1.
FIG. 7 is a sectional view of a washing machine according to a second exemplary embodiment of the present disclosure taken along line 7-7 in FIG. 1.
FIG. 8 is a sectional view of a washing machine according to a third exemplary embodiment of the present disclosure taken along line 8-8 in FIG. 1.
FIG. 9 is a sectional view of the washing machine in a state in which a lid of the washing machine shown in FIG. 8 is open.
FIG. 10 is a graph showing transition of an internal pressure of a pressing part of the washing machine according to the present exemplary embodiment.
FIG. 11 shows an example of a change in expansion/contraction specifications of the pressing part in a washing step with reference to a volume of a washing object of the washing machine according to the present exemplary embodiment.
FIG. 12 is a sectional view of a washing machine according to a fourth exemplary embodiment of the present disclosure taken along line 12-12 in FIG. 1.
FIG. 13 is a sectional view of a washing machine according to a fifth exemplary embodiment of the present disclosure taken along line 13-13 in FIG. 1.
FIG. 14 is a sectional view of the washing machine in a state in which a lid of the washing machine shown in FIG. 13 is open.
FIG. 15 schematically shows a movement of the washing machine according to the present exemplary embodiment.
FIG. 16 schematically shows a movement of the washing machine according to the present exemplary embodiment.
FIG. 17 schematically shows a movement of a washing machine according to a sixth exemplary embodiment of the present disclosure.
FIG. 18 schematically shows a movement of the washing machine according to the present exemplary embodiment.
FIG. 19 schematically shows a movement of a washing machine according to a seventh exemplary embodiment of the present disclosure.
FIG. 20 schematically shows a movement of the washing machine according to the present exemplary embodiment.
FIG. 21 schematically shows a movement of a washing machine according to an eighth exemplary embodiment of the present disclosure.
FIG. 22 is a longitudinal sectional view of a conventional washing machine.

DESCRIPTION OF EMBODIMENTS

[0016] A washing machine according to a first disclosure includes: a washing tub configured to accommodate a washing object and wash water; a pressurizing and depressurizing part having a pressing part configured to freely advance to and retreat from the washing object accommodated in the washing tub; and a controller configured to control the pressurizing and depressurizing part, and the pressurizing and depressurizing part is configured to press and release pressing against the washing object by using the pressing part to cause the washing object to contract and expand, so that water currents in multiple directions are generated inside the washing object. With this configuration, water currents in multiple directions can be generated inside the washing object without agitating the washing object. This can enhance a washing effect while suppressing fabric damage and loss of shape of the washing object.

[0017] A washing machine according to a second disclosure is the washing machine according to the first disclosure, in which the pressurizing and depressurizing part is configured to press the washing object by using the pressing part to cause the wash water contained in the washing object to flow out of the washing object, and the pressurizing and depressurizing part is configured to release pressing by the pressing part against the washing object to cause the wash water to flow into the washing object so that the washing object contains the wash water. With this configuration, water currents in multiple directions can be generated inside the washing object with a simple configuration. This can enhance a washing effect while suppressing fabric damage and loss of shape of the washing object.

[0018] A washing machine according to a third disclosure is the washing machine according to the first or the second disclosure, and further includes a water storage unit configured to store the wash water that has been flowed out of the washing object to an outside of the washing object when the washing object is pressed, and the water storage unit is disposed outside the washing tub and is communicated with an inside of the washing tub. With this configuration, a wide area is secured inside the washing tub to spread and wash the washing object.

[0019] A washing machine according to a fourth disclosure is the washing machine according to the first or the second disclosure, and further includes a water storage unit configured to store the wash water that has been flowed out of the washing object to an outside of the washing object when the washing object is pressed, and the water storage unit is disposed inside the washing tub. With this configuration, a space to store the wash water flowed out from the washing object can be secured inside the washing tub, which simplifies the structure.

[0020] A washing machine according to a fifth disclosure is the washing machine according to the third or the fourth disclosure, in which the water storage unit is disposed in such a manner that water level of the wash water stored in the water storage unit is higher than the washing object accommodated in the washing tub. With this configuration, the wash water in the water storage unit can be forcibly returned toward the washing object accommodated in the washing tub by utilizing a head difference between the wash water in the water storage unit and the wash water in the washing tub. This increases a flow rate of the wash water flowing into the pressed and contracted washing object, thereby enhancing a washing effect.

[0021] A washing machine according to a sixth disclosure is the washing machine according to the third or the fourth disclosure, in which the water storage unit includes a stored-water pressurizing unit, and the stored-water pressurizing unit is configured to pressurize the wash water stored in the water storage unit when pressing by the pressing part against the washing object is released. With this configuration, the wash water in the water storage unit can be forcibly returned toward the washing object accommodated in the washing tub. This increases a flow rate of the wash water flowing into the compressed and contracted washing object, thereby enhancing a washing effect.

[0022] A washing machine according to a seventh disclosure is the washing machine according to any one of the first to the sixth disclosures, in which the pressurizing and depressurizing part includes: a pressing part configured to expand and contract; a pressurizing device configured to supply fluid into the pressing part to expand the pressing part; and a discharge valve configured to discharge the fluid inside the pressing part. This configuration enables pressing of the washing object according to a shape of the washing object, so that a water current can be generated throughout the washing object, thereby enhancing a washing effect.

[0023] A washing machine according to an eighth disclosure is the washing machine according to the seventh disclosure, in which the controller is configured to close the discharge valve when the pressurizing device is driven to supply the fluid into the pressing part, and the controller is configured to open the discharge valve when the pressurizing device is stopped to discharge the fluid inside the pressing part. With this configuration, the washing object can be pressed and released appropriately.

[0024] A washing machine according to a ninth disclosure is the washing machine according to the seventh or the eighth disclosure, and further includes a lid including the pressing part and provided on an upper part of the washing tub in a freely openable and closable manner, and the controller is configured to control the pressurizing and depressurizing part to release pressure or cause negative pressure in the pressing part when a user closes the lid against the washing tub. This configuration allows a user to close the lid without the need for large force for contracting the pressing part, and thus user's convenience is maintained.

[0025] A washing machine according to a tenth disclo-

sure is the washing machine according to the ninth disclosure, in which the controller is configured to open the discharge valve to open the pressing part to an atmosphere so that pressure in the pressing part is released. This configuration allows a user to close the lid without the need for large force for contracting the pressing part, and thus user's convenience is maintained.

[0026] A washing machine according to an eleventh disclosure is the washing machine according to the ninth disclosure, in which the pressurizing device is formed of a device configured to pressurize and depressurize the pressing part, and the controller is configured to control the pressurizing device to perform a depressurizing operation to cause negative pressure in the pressing part. This configuration allows a user to close the lid without the need for large force for contracting the pressing part, and thus user's convenience is maintained.

[0027] A washing machine according to a twelfth disclosure is the washing machine according to any one of the first to the eleventh disclosures, and further includes a pressure detector configured to measure an internal pressure of the pressing part, and the controller is configured to control expansion and contraction of the pressing part in the washing step according to a value of the internal pressure of the pressing part in an expansion state or a contraction state of the pressing part detected by the pressure detector. This configuration enables the pressing part to perform an expansion and contraction movement and the like suitable for the volume of the washing object.

[0028] A washing machine according to a thirteenth disclosure is the washing machine according to the twelfth disclosure, in which the controller is configured to calculate various numerical values based on a value of the internal pressure of the pressing part detected by the pressure detector and estimate a volume of the washing object based on the various numerical values, and is configured to control the expansion and contraction of the pressing part in the washing step according to an estimation result. For example, when the volume of the washing object is estimated to be small as in the case of a few pieces of thin clothes, the speed, the displacement magnitude, or the maximum pressure of the expansion and contraction movement of the pressing part in the washing step is reduced. This suppresses deformation and movement of thin clothes in the washing tub. As a result, wrinkles of the clothes due to the pressing movement by the pressing part can be suppressed, and also collapse of the folded clothes at the time when a user takes out the clothes after washing can be suppressed.

[0029] A washing machine according to a fourteenth disclosure is the washing machine according to the twelfth or the thirteenth disclosure, in which the controller is configured to control the pressurizing and depressurizing part so as to change a speed, a displacement magnitude, or a maximum pressure of the expansion and contraction of the pressing part in the washing step according to a maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of the pressing part detected by the pressure detector. With this configuration, the volume of the washing object is estimated in comparison with the threshold value Ps of the maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of the pressing part that has been previously stored in the controller, thereby achieving appropriate washing according to the volume of the washing object. This can enhance a washing effect while suppressing fabric damage and loss of shape of the washing object.

[0030] A washing machine according to a fifteenth disclosure is the washing machine according to any one of the twelfth to the fourteenth disclosures, in which the controller is configured to control the pressurizing and depressurizing part so as to change a speed, a displacement magnitude, or a maximum pressure of the expansion and contraction of the pressing part in the washing step according to a maximum value Pmax within a predetermined time of the internal pressure of the pressing part detected by the pressure detector. With this configuration, the volume of the washing object is estimated in comparison with the threshold value Pm of the maximum value Pmax within a predetermined time of the internal pressure of the pressing part that has been previously stored in the controller, thereby achieving appropriate washing according to the volume of the washing object. This can enhance a washing effect while suppressing fabric damage and loss of shape of the washing object.

[0031] A washing machine according to a sixteenth disclosure is the washing machine according to any one of the twelfth to the fifteenth disclosures, in which the controller is configured to detect the internal pressure of the pressing part by using the pressure detector before supplying water in the washing tub. This configuration achieves an accurate estimation of the volume of the washing object without an influence of water absorption of the washing object.

[0032] A washing machine according to a seventeenth disclosure is the washing machine according to any one of the first to the sixth disclosures, in which the pressurizing and depressurizing part includes: a driver; a rotary plate rotated by the driver; and a pressing part joined to the rotary plate through a shaft. With this configuration, pressing and releasing the pressing against the washing object can be performed at high speed, and thus water currents in multiple directions can be efficiently generated inside the washing object. This can enhance a washing effect while suppressing fabric damage and loss of shape of the washing object.

[0033] A washing machine according to an eighteenth disclosure is the washing machine according to the first disclosure, in which the washing machine includes a plurality of the pressing parts. The pressurizing and depressurizing part is configured to press and release pressing against the washing object by using the pressing parts to cause the washing object to contract and expand, so

that the water currents in multiple directions are generated inside the washing object. With this configuration, a plurality of portions of the washing object are pressed alternately or sequentially at different timings inside the washing tub. Accordingly, water currents in multiple directions can be generated throughout the washing object without agitating the washing object, thereby enhancing a washing effect while suppressing fabric damage to and loss of shape of the washing object. Since the plurality of pressing parts are provided, the washing machine according to the present disclosure can easily handle the washing object, even when the washing object has portions with different thicknesses in the washing tub.

[0034] A washing machine according to a nineteenth disclosure is the washing machine according to the eighteenth disclosure, in which the washing machine includes a plurality of the pressurizing and depressurizing parts. Each of the pressurizing and depressurizing parts includes: one of the pressing parts configured to expand and contract; a pressurizing pump configured to supply the fluid into corresponding one of the pressing parts; and a discharge valve configured to discharge the fluid inside corresponding one of the pressing parts. The controller is configured to control the pressurizing and depressurizing parts so that each of the pressing parts expands and contracts at an arbitrary timing. With this configuration, a plurality of portions of the washing object are pressed at different timings.

[0035] A washing machine according to a twentieth disclosure is the washing machine according to the eighteenth disclosure, in which the pressing parts include at least a first pressing part and a second pressing part. The pressurizing and depressurizing part includes: the pressing parts; a plurality of discharge valves configured to discharge fluid inside the pressing parts, respectively; a switching part including a plurality of switching valves; and a pressurizing pump that is communicated with the pressing parts through the switching part and is configured to supply the fluid into the pressing parts. The controller is configured to control the pressurizing and depressurizing part in such a manner that the second pressing part contracts when the first pressing part expands. This configuration allows one pressurizing pump to selectively switch pressurization against the plurality of pressing parts, so that a plurality of portions of washing object are pressed in turn.

[0036] A washing machine according to a twenty-first disclosure is the washing machine according to the twentieth disclosure, in which the pressurizing and depressurizing part further includes: a suction path communicating the pressing parts with a suction side of the pressurizing pump; a suction path switching part provided on the suction path; a discharge path communicating the pressing parts with a discharge side of the pressurizing pump; and a discharge path switching part provided on the discharge path. The controller is configured to control the pressurizing and depressurizing part in such a manner that air contained in the first pressing part in a contraction state moves into the second pressing part in an expansion state through the suction path switching part and the discharge path switching part. With this configuration, the expansion of one of the pressing parts and the contraction of the other pressing parts are efficiently performed at the same time, and thus a plurality of portions of the washing object are pressed in different timings.

[0037] A washing machine according to a twenty-second disclosure is the washing machine according to the eighteenth disclosure, in which the pressurizing and depressurizing part includes: an electric motor; a rotary shaft having a plurality of cranks and rotated by the electric motor; and the pressing parts respectively joined to the cranks through shafts that are rotatably joined to the pressing parts respectively. With this configuration, a plurality of portions of the washing object are pressed at different timings at a speed according to the rotational speed of the electric motor.

[0038] Exemplary embodiments of the present disclosure are described below with reference to the drawings. Note that the present disclosure is not limited to the following exemplary embodiments.

(First exemplary embodiment)

[0039] FIG. 1 is an external perspective view of a washing machine according to a first exemplary embodiment of the present disclosure. FIG. 2 is a sectional view of the washing machine according to the present exemplary embodiment taken along line 2-2 in FIG. 1. FIG. 3 is a sectional view of the washing machine in a state in which a lid of the washing machine shown in FIG. 2 is open. FIG. 4 is a sectional view of the washing machine according to the present exemplary embodiment taken along line 4-4 in FIG. 1. FIG. 5 is a sectional view of the washing machine shown in FIG. 4 in a state in which pressure is applied inside a pressing part. Every figure used in the exemplary embodiments of the present disclosure is a schematic diagram in which arrangements, sizes, and the like of components are shown in a manner just enough for explanation.

[0040] Referring to FIGS. 1 to 3, washing machine 1 is formed of water tub 6 which is a lower member and lid 5 which is an upper member. Water tub 6 includes washing tub 4 having a square shape with a predetermined depth. Opening 3 is formed on a whole upper surface of washing tub 4. Washing object 2 which is laundry such as clothes is loaded from opening 3. Lid 5 is swingably attached to a rear edge of an upper side of water tub 6 through hinge 6a to open and close opening 3 of washing tub 4.

[0041] Washing object 2 is adjusted in shape and accommodated on bottom 4a of washing tub 4 by a user. According to the present exemplary embodiment, washing object 2 is for example woolen fabric, such as a sweater and a cardigan, a scarf of a sensitive material formed of an extra-fine fiber, or the like. In other words, washing object 2 is preferably an object that loses shape or is

damaged easily when being washed by a general washing machine that exerts mechanical force on washing object 2.

[0042] A front surface of lid 5 includes handle 5a. A user rotates lid 5 along arrow R1 shown in FIG. 3 with holding handle 5a to open and close opening 3, and lid 5 can be held in an opened state. When opening 3 is closed, lid 5 is locked by a locking device (not shown) and held in a closed state. The locking device is released by an operation of handle 5a so as to open lid 5.

[0043] Pressurizing and depressurizing part 7 is provided inside lid 5. Pressurizing and depressurizing part 7 includes flexible pleated bag-shaped pressing part 8 formed of rubber, a synthetic resin, or the like, pressurizing pump 10 that communicates with an inside of pressing part 8 through hose 9 and is configured to supply fluid such as gas or liquid to the inside of pressing part 8, and discharge valve 11 configured to discharge the fluid that has been supplied to pressing part 8 to an outside of pressing part 8.

[0044] Pressing part 8 includes pressing surface 8a to press washing object 2 and pleated extension part 8b. Pressing part 8 is attached to lid 5 on a side of washing tub 4, and is configured to expand and contract in a freely extensible manner so as to freely advance to and retreat from washing object 2 accommodated on bottom 4a of washing tub 4. Pressing part 8 expands to the extent that pressing surface 8a reaches bottom 4a of washing tub 4.

[0045] Pressurizing and depressurizing part 7 includes constant pressure release valve 12 configured to open and discharge fluid when pressure inside pressing part 8 reaches a predetermined value. Constant pressure release valve 12 prevents pressing part 8 from being pressurized with pressure exceeding a predetermined value. In the present exemplary embodiment, the fluid supplied into pressing part 8 is explained as air, for example.

[0046] Lid 5 includes freely-deformable hollow packing 16 (see FIGS. 4 and 5). When lid 5 is closed, packing 16 comes into close contact with sealing part 17 formed in a recessed shape along a periphery of opening 3 of washing tub 4. With this configuration, an inside of washing tub 4 makes a fluid-tight space when lid 5 is closed, and thus leakage of water or air from opening 3 is prevented during the steps of washing, rinsing, and drying.

[0047] Lid 5 includes water-supply path 20 configured to supply wash water to washing tub 4. Water-supply path 20 includes water-supply valve 18 and communicates with the inside of washing tub 4 through detergent case 19. Tap water (wash water) is supplied to the inside of washing tub 4 by opening water-supply valve 18, and the water supply is stopped by closing water-supply valve 18.

[0048] Water level detector 21 is provided to communicate with the inside of washing tub 4. Water level detector 21 includes water level detection tub 22 having an opening at an upper part thereof, float 23 configured to move vertically according to a change in water level inside water level detection tub 22, and water level switch 24 configured to detect a rise to a predetermined position of float 23.

[0049] Bottom 4a of washing tub 4 includes drain holes 25 configured to discharge the wash water that has been used in the washing step or the like. Drain holes 25 communicate with drain passage 27 provided with drain valve 26. The wash water is discharged from washing tub 4 by opening drain valve 26, and stopped by closing drain valve 26.

[0050] Water tub 6 includes overflow passage 28 configured to discharge the wash water in washing tub 4 to an outside of washing tub 4 when a water level inside washing tub 4 reaches a value equal to or higher than a predetermined value. Overflow passage 28 includes overflow hole 28a at an upper part of washing tub 4, and communicates with drain passage 27 downstream of drain valve 26.

[0051] Controller 29 is provided on an inner side surface of lid 5. Operation display 30 is provided on an upper surface of controller 29. Controller 29 is configured to control pressurizing pump 10, discharge valve 11, water-supply valve 18, drain valve 26, and the like to successively perform a sequence of a washing step, a rinsing step, and a drying step.

[0052] As shown in FIGS. 4 and 5, water storage units 13 are provided adjacent to washing tub 4. Each of water storage units 13 communicates with the inside of washing tub 4 at a lower part of washing tub 4. Washing tub 4 is supplied with wash water, and the wash water can move between the inside of washing tub 4 and an inside of each of water storage units 13 through communication part 14. Each of water storage units 13 is disposed such that upper surface 13a thereof is positioned higher than pressing surface 8a. It is preferable that the water level of the wash water stored in each of water storage units 13 is not less than a height of washing object 2 accommodated in washing tub 4.

[0053] Upper surface 13a of each of water storage units 13 includes vent hole 15. Vent hole 15 is a through hole configured to discharge air inside corresponding one of water storage units 13 to an outside when the wash water flows in the one of water storage units 13 from communication part 14, and to supply external air to the corresponding one of water storage units 13 when the wash water flows out of the one of water storage units 13.

[0054] The description now turns to operations and functions of the washing machine configured as described above.

[0055] Operation display 30 is provided at a front part of an upper surface of lid 5 so that a user selects an operation course, and inputs processing time of each step, and the like. Controller 29 performs the steps from washing to drying as a sequence of operations based on the setting. A user can arbitrarily select an operation, for example, such that a washing step only is performed. Such setting operation can be performed after washing object 2 is loaded (described later).

[0056] A user operates handle 5a to unlock and open

lid 5, adjusts washing object 2 in shape, and sets washing object 2 on bottom 4a in washing tub 4. Washing object 2 may be folded to be set depending on the size thereof.

[0057] After setting washing object 2, a user operates handle 5a to close lid 5 against washing tub 4. During this operation, controller 29 releases pressure inside pressing part 8 or controls pressurizing and depressurizing part 7 to suck the inside of pressing part 8 to cause negative pressure therein. Specifically, controller 29 opens discharge valve 11 to open pressing part 8 to an atmosphere, thereby releasing pressure inside pressing part 8. Alternatively, controller 29 drives pressurizing pump 10 as a vacuum pump by rotating pressurizing pump 10 in a direction opposite to a direction at the time of pressurization to cause negative pressure by sucking the inside of pressing part 8. With this configuration, a user can close lid 5 without the need for force to contract pressing part 8.

[0058] When lid 5 is closed and locked, controller 29 starts washing operation according to the operation course set on operation display 30.

[0059] First, controller 29 performs a water supply operation. Controller 29 releases water-supply valve 18 to supply tap water serving as wash water and detergent to the inside of washing tub 4 through water-supply path 20. At this time, the wash water gradually penetrates into washing object 2 and is contained between fiber of washing object 2. Controller 29 closes water-supply valve 18 when the wash water is supplied to a predetermined water level inside washing tub 4 as shown in FIG. 4 and water level switch 24 of water level detector 21 detects that the wash water reaches a predetermined water level.

[0060] After the water supply operation, controller 29 drives pressurizing pump 10 to supply air into pressing part 8 to expand pressing part 8. When extension part 8b extends and pressing part 8 extends toward washing object 2 as shown in FIG. 5, pressing surface 8a compresses washing object 2. Being pressed and compressed by pressing surface 8a, washing object 2 is made thin.

[0061] According to a change in the volume of washing object 2 caused by the compression, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current from inside to outside of washing object 2, and the water current removes soils attached to washing object 2 away from fiber of washing object 2. As shown in FIG. 5, the wash water that has been pushed out of washing object 2 moves in directions of arrows A to water storage units 13 through communication parts 14. Air inside each of water storage units 13 is discharged from vent hole 15 to an outside.

[0062] Controller 29 drives pressurizing pump 10 for a predetermined time or until pressure inside pressing part 8 reaches a predetermined value. Then, controller 29 immediately stops pressurizing pump 10 and opens discharge valve 11. By opening discharge valve 11, air inside pressing part 8 is discharged to an outside of pressing part 8, so that internal pressure of pressing part 8 is decreased. Note that various known techniques, such as detection using a pressure gauge, can be used to detect that the pressure inside pressing part 8 reaches a predetermined value, and thus, detailed description of the detection is omitted.

[0063] When water head pressure of the wash water stored in water storage units 13 becomes larger than the interior pressure of pressing part 8, the wash water inside water storage units 13 moves in directions of arrows B through communication parts 14 to the inside of washing tub 4 as shown in FIG. 4. This causes the wash water to flow into washing object 2, thereby expanding washing object 2 and further contracting pressing part 8. At this time, a water current in a direction different from that of the water current generated by pressing washing object 2 is generated inside washing object 2, so that soils are further removed.

[0064] In a washing step, contraction and expansion of washing object 2 is repeated by this pressurizing and depressurizing part 7 (for example, one second of pressurization due to expansion of pressing part 8 and one second of depressurization due to contraction of pressing part 8) for a predetermined time (for example, for 10 minutes), thereby exhibiting a press-washing effect on washing object 2. In other words, soils can be removed by generating water currents from multiple directions inside washing object 2 without exerting mechanical force such as agitation and beat-washing on washing object 2.

[0065] When a washing course in which the steps from washing to drying are sequentially performed is set, controller 29 performs a rinsing step and a drying step subsequent to a washing step.

[0066] In the rinsing step, a rinsing operation with accumulated water is performed subsequent to a drain operation and a preparatory drying operation, for example. In the drain operation, drain valve 26 is opened, the wash water inside washing tub 4 is discharged to an outside through drain passage 27. In the preparatory drying operation, pressurizing pump 10 is driven while drain valve 26 is opened, so that washing object 2 is pressed and contracted and a part of the wash water contained in washing object 2 is forcibly discharged.

[0067] In the rinsing operation with accumulated water, drain valve 26 is closed, and then water-supply valve 18 is opened to supply a predetermined amount of wash water into washing tub 4. At this time, the wash water to be supplied into washing tub 4 does not include detergent. Then, pressurizing pump 10 is driven for a predetermined time in the same manner as the washing step, and pressurization on washing object 2 by expansion of pressing part 8 and depressurization of washing object 2 by discharging air inside pressing part 8 are performed. With this configuration, washing object 2 is repeatedly contracted and expanded, so that the concentration of the detergent in the wash water inside washing object 2 is reduced. This rinsing step is repeated a plurality of times (twice, for example).

[0068] After the rinsing step, controller 29 performs the

drying step. In the drying step, drain valve 26 is opened to discharge the wash water inside washing tub 4 to an outside. Then, pressurizing pump 10 is driven while drain valve 26 remains opened, so that washing object 2 is pressed and contracted and a part of the wash water contained in washing object 2 is forcibly discharged.

[0069] According to the present exemplary embodiment, pressurizing and depressurizing part 7 includes freely extensible pressing part 8 having flexibility, pressurizing pump 10 configured to expand pressing part 8, and discharge valve 11 configured to discharge fluid inside pressing part 8. Water head pressure of the wash water stored in each of water storage units 13 is utilized to contract pressing part 8. However, this shall not be construed as a limitation, and pressing part 8 may be depressurized by a vacuum pump (not shown) instead of discharge valve 11. Pressurizing pump 10 may be reversed to be used as a vacuum pump.

[0070] In this case, a discharging amount and a discharging speed of fluid from pressing part 8 can be controlled even when washing object 2 is thin fabric with less flexibility such as a scarf, or thick fabric with elasticity such as knitwear. As a result, the washing machine can obtain stable washing performance according to a condition of washing object 2.

[0071] FIG. 6 is a sectional view of another example of the washing machine according to the present exemplary embodiment taken along line 6-6 in FIG. 1. Specifically, stored-water pressurizing unit 31 configured to pressurize the inside of each of water storage units 13 (for example, a pressurizing pump, a piston, etc.) and exhaust valve 32 configured to discharge air and stop discharging air inside each of water storage units 13 are provided on an upper part of each of water storage units 13 instead of vent hole 15 of each of water storage units 13 shown in FIG. 4.

[0072] Referring to FIG. 6, exhaust valve 32 of each of water storage units 13 is opened when pressing part 8 is expanded. In the washing machine according to the present exemplary embodiment, at the time of contraction of pressing part 8, exhaust valve 32 is closed in accordance with opening of discharge valve 11, and stored-water pressurizing unit 31 is driven to pressurize the inside of each of water storage units 13, so that the wash water is pressurized to move into washing tub 4. This configuration increases a flow rate of the wash water flowing into contracted washing object 2, thereby reducing a washing time as well as enhancing a washing effect.

[0073] Pressing surface 8a has moderate flexibility while having rigidity enough to contract washing object 2. This configuration may be achieved by forming pressing surface 8a with a material such as rubber or resin. Pressing surface 8a may be formed by mounting a foamed rubber sheet having a predetermined thickness without water absorbency for example, on a flat plate formed of a material with a high rigidity. These materials and mounting techniques of pressing surface 8a are not limited. Even when compressed and deformed washing object 2 accommodated on bottom 4a does not have a uniform height, this configuration allows pressing surface 8a to deform in accordance with the height of washing object, thereby enabling pressing surface 8a to press entire washing object 2. As a result, the washing machine can obtain stable washing performance.

[0074] Such flexible configuration is not limited to pressing surface 8a, but bottom 4a of washing tub 4 that is placed opposite to pressing surface 8a so as to sandwich washing object 2 may have moderate flexibility. When at least one of the two surfaces has flexibility, a pressing effect against washing object 2 can be exhibited.

[0075] Pressing surface 8a may have rigidity so as not to be deformed by compression of fabric or wool. Such configuration allows pressing surface 8a to be tilted in accordance with the height of compressed and deformed washing object 2 due to flexibility and variations in extension of extension part 8b when pressing part 8 expands, thereby enabling pressing surface 8a to press entire washing object 2. As a result, the washing machine can obtain stable washing performance.

[0076] Further, pressing surface 8a may be uneven. The uneven shape is not limited, and may have any shape regardless of the length, such as a circle, a projection of a polygon, a groove, and the like. If anything is to be considered, it is desirable to form the uneven shape without enclosing a flow of the wash water discharged from washing object 2 at the time of pressing washing object 2.

[0077] As described above, the washing machine according to the present exemplary embodiment includes: washing tub 4 configured to accommodate washing object 2 and wash water; pressurizing and depressurizing part 7 having pressing part 8 configured to freely advance to and retreat from washing object 2 accommodated in washing tub 4; and controller 29 configured to control pressurizing and depressurizing part 7 to successively perform the steps of washing, rinsing, and a drying, and pressurizing and depressurizing part 7 is configured to press and release pressing against washing object 2 by using pressing part 8 to cause washing object 2 to contract and expand, so that water currents in multiple directions are generated inside washing object 2. With this configuration, water currents in multiple directions can be generated inside washing object 2 without agitating washing object 2. This can suppress fabric damage and loss of shape of washing object 2, and also enhance a washing effect.

[0078] Pressurizing and depressurizing part 7 is configured to press washing object 2 by using pressing part 8 to cause the wash water contained in washing object 2 to flow out of washing object 2, and pressurizing and depressurizing part 7 is configured to release pressing by pressing part 8 against washing object 2 to cause the wash water flowed out of washing object 2 to flow into washing object 2. With this configuration, water currents in multiple directions can be generated inside washing

object 2 with a simple configuration. This can enhance a washing effect while suppressing fabric damage and loss of shape of washing object 2.

[0079] The washing machine further includes water storage units 13 configured to store the wash water that has been flowed out of washing object 2 to an outside of washing object 2 when washing object 2 is pressed, and water storage units 13 are disposed outside washing tub 4 and are communicated with an inside of washing tub 4. With this configuration, a wide area is secured inside washing tub 4 to spread and wash washing object 2.

[0080] Water storage units 13 are disposed in such a manner that water level of the wash water stored in water storage units 13 is higher than washing object 2 accommodated in washing tub 4. With this configuration, the wash water in water storage units 13 can be forcibly returned toward washing object 2 accommodated in washing tub 4 by utilizing a head difference between each of the wash water in water storage units 13 and the wash water in washing tub 4. This increases a flow rate of wash water flowing into compressed and contracted washing object 2, thereby enhancing a washing effect.

[0081] Each of water storage units 13 includes stored-water pressurizing unit 31, and stored-water pressurizing unit 31 is configured to pressurize the wash water stored in corresponding one of water storage units 13 when pressing by pressing part 8 against washing object 2 is released. With this configuration, the wash water in water storage units 13 can be forcibly returned toward washing object 2 accommodated in washing tub 4. This increases a flow rate of the wash water flowing into compressed and contracted washing object 2, thereby reducing a washing time as well as enhancing a washing effect.

[0082] Pressurizing and depressurizing part 7 includes: pressing part 8 configured to expand and contract; pressurizing pump 10 configured to supply fluid such as air into pressing part 8 to expand pressing part 8; and discharge valve 11 configured to discharge the fluid inside pressing part 8. This configuration enables pressing of washing object 2 according to a shape thereof, so that a strong water current can be generated throughout washing object 2, thereby enhancing a washing effect.

[0083] Controller 29 is configured to close discharge valve 11 when pressurizing pump 10 is driven to supply air into pressing part 8, and controller 29 is configured to open discharge valve 11 when pressurizing pump 10 is stopped to discharge air inside pressing part 8.
With this configuration, washing object 2 can be pressed and released appropriately.

[0084] Controller 29 is configured to control pressurizing and depressurizing part 7 to release pressure or cause negative pressure in pressing part 8 when a user closes lid 5 against washing tub 4. This configuration allows a user to close lid 5 without applying force for contracting pressing part 8.

[0085] Controller 29 is configured to open discharge valve 11 to open pressing part 8 to an atmosphere so that pressure in pressing part 8 is released. This configuration allows a user to close lid 5 without applying force for contracting pressing part 8.

[0086] Alternatively, controller 29 may be configured to drive pressurizing pump 10 as a vacuum pump by rotating pressurizing pump 10 in a direction opposite to a direction at the time of pressurization and perform a depressurizing operation to cause negative pressure in pressing part 8. This configuration allows a user to close lid 5 without applying force for contracting pressing part 8.

[0087] Although one pressing part 8 is provided according to the present exemplary embodiment, pressing part 8 is not limited to one. A plurality of pressing parts 8 may be provided inside washing tub 4. In such a case, independent pressing surfaces 8a may be provided on lower surfaces of pressing parts 8, respectively. One pressing plate (not shown) may be provided to connect the lower surfaces of pressing parts 8 so as to serve as pressing surface 8a against washing object 2.

(Second exemplary embodiment)

[0088] FIG. 7 is a sectional view of a washing machine according to a second exemplary embodiment of the present disclosure taken along line 7-7 in FIG. 1. In the washing machine according to the present exemplary embodiment, water storage units 13 are provided inside washing tub 4. Since other configurations are the same as those of the first exemplary embodiment, the same components are denoted by the same numerals and the detailed descriptions of the first exemplary embodiment are applied to those of the present exemplary embodiment.

[0089] As shown in FIG. 7, washing tub 4 incorporates water storage units 13 configured to store the wash water flowed out from the inside of washing object 2 at the time of pressing washing object 2. Each of water storage units 13 is a space formed between one of side walls 4b of washing tub 4 and extension part 8b that is one of side walls of freely expandable pressing part 8. The wash water flowed out of washing object 2 that has been pressed by expansion of pressing part 8 moves to and is stored in water storage units 13.

[0090] The volume of the spaces serving as water storage units 13 is an interior volume of washing tub 4 excluding pressing part 8 configured to expand vertically. Since pressing part 8 occupies a large area of washing tub 4, the volume and a horizontal cross section of water storage units 13 are less than those of washing tub 4. This configuration raises the water level of the wash water stored in water storage units 13 and increases the water head pressure. As a result, the wash water forcefully flows into washing object 2 according to contraction of pressing part 8 to expand washing object 2 and further contract pressing part 8. At this time, a water current in a direction different from that of the water current generated by pressing washing object 2 is generated inside washing object 2, so that soils are further removed.

[0091] As described above, in the washing machine according to the present exemplary embodiment, washing tub 4 further incorporates water storage units 13 configured to store the wash water flowed out of the inside of washing object 2 at the time of pressing washing object 2. With this configuration, a space to store the wash water flowed out of washing object 2 can be secured inside washing tub 4, so that the structure can be simplified. Since the volume and the horizontal cross section of water storage units 13 are made small, the water head pressure is increased, so that a flow rate of the wash water is increased. This enhances a washing effect.

(Third exemplary embodiment)

[0092] FIG. 8 is a sectional view of a washing machine according to a third exemplary embodiment of the present disclosure taken along line 8-8 in FIG. 1. FIG. 9 is a sectional view of the washing machine in a state in which a lid of the washing machine shown in FIG. 8 is open. FIG. 10 is a graph showing transition of an internal pressure of a pressing part of the washing machine according to the present exemplary embodiment. FIG. 11 shows an example of a change in expansion/contraction specifications of the pressing part in a washing step with reference to a volume of a washing object of the washing machine according to the present exemplary embodiment.

[0093] The washing machine according to the present exemplary embodiment further includes pressure detector 33 configured to measure an internal pressure of pressing part 8, in addition to the configuration of the first exemplary embodiment or the second exemplary embodiment. Since other configurations are the same as those of the first exemplary embodiment or the second exemplary embodiment, the same components are denoted by the same numerals and the detailed descriptions of the first exemplary embodiment are applied to those of the present exemplary embodiment.

[0094] As shown in FIGS. 8 and 9, pressure detector 33 is provided on a discharge path equipped with discharge valve 11 configured to discharge fluid in pressing part 8 to an outside of pressing part 8. Pressure detector 33 is configured to measure an internal pressure of pressing part 8. Pressure detector 33 is a general pressure gauge such as a liquid-column gauge, a Bourdon gauge, and a diaphragm gauge.

[0095] Being provided near discharge valve 11, pressure detector 33 can measure a decompression state particularly at the time of discharging fluid with high sensitivity. The discharge path is provided detachably from pressurizing and depressurizing part 7 including pressing part 8, thereby facilitating inspection and replacement of pressure detector 33.

[0096] Controller 29 includes a storage unit (not shown) formed of a nonvolatile memory or the like. The storage unit stores in advance reference data to be compared with the internal pressure of pressing part 8, such as a threshold value Ps of a maximum value $(\Delta P/\Delta T)$max of an increasing rate of pressure within a predetermined time, a threshold value Pm of a maximum value of pressure Pmax within a predetermined time, and drive specification data of pressurizing pump 10 associated with the threshold values (a speed, a displacement magnitude, a maximum pressure of expansion and contraction, etc.).

[0097] The description now turns to operations and functions of the washing machine configured as described above.

[0098] When a user sets washing object 2 and closes and locks lid 5, controller 29 starts washing operation according to the operation course that has been set on operation display 30.

[0099] Prior to the water supply operation to washing tub 4, controller 29 drives pressurizing pump 10 of pressurizing and depressurizing part 7 to supply air into pressing part 8 to expand pressing part 8. At this time, controller 29 detect a state of an internal pressure rise of pressing part 8 in time sequence by using pressure detector 33. A transition of the internal pressure rise of pressing part 8 varies depending on a volume of washing object 2 set in washing tub 4. The volume of washing object 2 can be referred to as a term, "bath ratio" used by persons skilled in art.

[0100] FIG. 10 shows one example of transition of an internal pressure rise of pressing part 8 at this time. FIG. 10 is a graph of detection data comparing one piece of thick clothes as a typical example of large volume (small bath ratio) and one piece of thin clothes as a typical example of small volume (large bath ratio). As shown in FIG. 10, in the case where the volume is large, the maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of pressing part 8 is larger than the threshold value Ps, and the maximum value Pmax within a predetermined time of the internal pressure of pressing part 8 is also larger than the threshold value Pm. On the other hand, in the case where the volume is small, the maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of pressing part 8 is smaller than the threshold value Ps, and the maximum value Pmax within a predetermined time of the internal pressure of pressing part 8 is also smaller than the threshold value Pm.

[0101] The volume of washing object 2 is estimated by controller 29 as described below. Controller 29 calculates in real time, various numerical values such as an increased value $\Delta P/\Delta T$ per unit time of the internal pressure of pressing part 8 based on a value of the internal pressure of pressing part 8 detected by pressure detector 33. On the basis of the calculated values, controller 29 then calculates various numerical values, such as the maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of pressing part 8 and the maximum value Pmax within a predetermined time of the internal pressure of pressing

part 8.

[0102] Controller 29 estimates the volume of washing object 2 by comparing the maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increasing rate detected by pressure detector 33 to the threshold value Ps previously stored in the storage unit, or by comparing the maximum value Pmax within a predetermined time of the internal pressure of pressing part 8 to the threshold value Pm previously stored in the storage unit.

[0103] After supplying water in washing tub 4, controller 29 controls pressurizing pump 10 of pressurizing and depressurizing part 7 according to an estimated result and changes expansion and contraction of pressing part 8 to perform a washing step. Referring to FIG. 11, in the case where the volume of accommodated washing object 2 is large, controller 29 increases the speed of expansion and contraction of pressing part 8, increases a magnitude of vertical displacement of pressing surface 8a, or increases the maximum pressure inside pressing part 8, for example. On the other hand, in the case where the volume of accommodated washing object 2 is small, controller 29 decreases the speed of expansion and contraction of pressing part 8, decreases a magnitude of vertical displacement of pressing surface 8a, or decreases the maximum pressure inside pressing part 8, for example.

[0104] The basic movement of the washing step and the subsequent rinsing step and drying step are performed in the same manner as in the first exemplary embodiment.

[0105] A plurality of threshold values Ps and a plurality of threshold values Pm may be provided to classify the volume of washing object 2 into a plurality of levels, and washing object 2 may be handled according to the levels.

[0106] The determination of the volume of washing object 2 by detecting the internal pressure of pressing part 8 may be performed after supplying water into washing tub 4, but is preferably performed prior to supplying water into washing tub 4 as in the present exemplary embodiment in order to avoid an influence on a detection result due to water absorption of washing object 2.

[0107] As described above, the washing machine according to the present exemplary embodiment further includes pressure detector 33 configured to measure an internal pressure of pressing part 8 in addition to the configuration of the first or the second exemplary embodiment, and controller 29 is configured to control expansion and contraction of pressing part 8 in a washing step according to a value of the internal pressure of the pressing part 8 in an expansion state or a contraction state of pressing part 8 detected by pressure detector 33. This configuration enables pressing part 8 to perform an expansion and contraction movement and the like suitable for the volume of washing object 2.

[0108] Controller 29 is configured to calculate various numerical values based on a value of the internal pressure of pressing part 8 detected by pressure detector 33 and estimate a volume of washing object 2 based on the various numerical values, and is configured to control the expansion and contraction of pressing part 8 in the washing step according to an estimation result. For example, when the volume of washing object 2 is determined to be small as in the case of a few pieces of thin clothes, the speed, the displacement magnitude, or the maximum pressure of the expansion and contraction movement of pressing part 8 in the washing step is decreased.

This suppresses deformation and movement of thin clothes in washing tub 4. As a result, wrinkles of the clothes due to the pressing movement by pressing part 8 and collapse of the folded clothes at the time when a user takes out the clothes which is washing object 2 after washing can be prevented.

[0109] Controller 29 is configured to control pressurizing and depressurizing part 7 so as to change a speed, a displacement magnitude, or a maximum pressure of the expansion and contraction of pressing part 8 in the washing step according to a maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of pressing part 8 detected by pressure detector 33. With this configuration, the volume of washing object 2 is estimated in comparison with the threshold value Ps of the maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of pressing part 8 that has been previously stored in the storage unit, thereby achieving appropriate washing according to the volume of washing object 2. This can enhance a washing effect while suppressing fabric damage and loss of shape of washing object 2.

[0110] Controller 29 is configured to control pressurizing and depressurizing part 7 so as to change a speed, a displacement magnitude, or a maximum pressure of the expansion and contraction of pressing part 8 in the washing step according to a maximum value Pmax within a predetermined time of the internal pressure of pressing part 8 detected by pressure detector 33. With this configuration, the volume of washing object 2 is estimated in comparison with the threshold value Pm of the maximum value Pmax within a predetermined time of the internal pressure of pressing part 8 that has been previously stored in the storage unit, thereby achieving appropriate washing according to the volume of washing object 2. This can enhance a washing effect while suppressing fabric damage and loss of shape of washing object 2.

[0111] Controller 29 is configured to detect the internal pressure of pressing part 8 by using pressure detector 33 before supplying water in washing tub 4. This configuration achieves an accurate estimation of the volume of washing object 2 without an influence of water absorption of washing object 2.

(Fourth exemplary embodiment)

[0112] FIG. 12 is a sectional view of a washing machine according to a fourth exemplary embodiment of the present disclosure taken along line 12-12 in FIG. 1. In

the washing machine according to the present exemplary embodiment, pressurizing and depressurizing part 41 is formed of a link mechanism including electric motor 42 serving as a driver, rotary plate 43 rotated by electric motor 42, and shaft 44, and pressing part 45 joined to the link mechanism.Since other configurations are the same as those of the first exemplary embodiment, the same components are denoted by the same numerals and the detailed descriptions of the first exemplary embodiment are applied to those of the present exemplary embodiment.

[0113] As shown in FIG. 12, one end of shaft 44 is joined to a periphery of rotary plate 43 configured to rotate by driving of electric motor 42, and the other end of shaft 44 is joined to pressing part 45. Pressing part 45 can move vertically by a configuration in which, for example, a periphery of pressing part 45 is guided by side walls of washing tub 4. When rotary plate 43 rotates in a direction of arrow R2 by driving of electric motor 42, pressing part 45 moves vertically inside washing tub 4. When pressing part 45 moves down inside washing tub 4, washing object 2 is pressed and compressed so that wash water inside washing object 2 is pushed out and moves to water storage units 13.

[0114] Pressing part 45 moves up inside washing tub 4 to move away from washing object 2, thereby releasing compression of washing object 2, thus washing object 2 expands and the wash water stored in water storage units 13 moves into washing tub 4. Pressing part 45 advances to and retreats from washing object 2 in a vertical direction, so that the wash water moves in a direction of arrow C between washing tub 4 and each of water storage units 13.

[0115] Vertical strokes of pressing part 45 between an upward position and a downward position can be set according to a distance from a rotational center of rotary plate 43 to a joint position between rotary plate 43 and shaft 44. Water storage units 13 may be provided either inside or outside of washing tub 4.

[0116] As described above, in the washing machine according to the present exemplary embodiment, pressurizing and depressurizing part 41 includes: electric motor 42 which is a driver; a link mechanism formed of rotary plate 43 and shaft 44; and pressing part 45. With this configuration, outflow of wash water from interior of washing object 2 and inflow of wash water into washing object 2 are repeated, thereby removing soils of washing object 2 by the water current in multiple directions generated inside washing object 2. This enhances a washing effect.

(Fifth exemplary embodiment)

[0117] A washing machine according to a fifth exemplary embodiment differs from the washing machine according to the first exemplary embodiment in a point described below, and has a configuration substantially the same as the washing machine according to the first exemplary embodiment in the other points. In the description of the washing machine according to the fifth exemplary embodiment, the components the same as those of the washing machine according to the first exemplary embodiment are denoted as the same reference numerals, and a part of or an entire description of the component is omitted.

[0118] FIG. 13 is a sectional view of washing machine 101 according to the present exemplary embodiment of the present disclosure taken along line 13-13 in FIG. 1. FIG. 14 is a sectional view of washing machine 101 in a state in which a lid of washing machine 101 shown in FIG. 13 is open. FIGS. 15 and 16 each schematically show a movement of washing machine 101 according to the present exemplary embodiment.

[0119] Pressurizing and depressurizing part 107 according to the present exemplary embodiment includes first pressurizing and depressurizing part 107a and a second pressurizing and depressurizing part 107b. Specifically, first pressurizing and depressurizing part 107a includes pressing part 108a, pressurizing pump 110a, and discharge valve 111a. Second pressurizing and depressurizing part 107b includes pressing part 108b, pressurizing pump 110b, and discharge valve 111b.

[0120] More specifically, pressurizing and depressurizing parts 107 (107a, 107b) respectively include flexible pleated bag-shaped pressing parts 108 (108a,108b) formed of rubber, a synthetic resin, or the like, pressurizing pumps 110 (110a, 110b) that respectively communicate with pressing parts 108 (108a, 108b) through hoses 109 (109a, 109b) and supply fluid such as gas or liquid into pressing parts 108 (108a, 108b) respectively, and discharge valves 111 (111a, 111b) configured to discharge the fluid supplied to pressing parts 108 (108a, 108b) (hereinafter, reference signs "a", "b" indicative of plurality may be omitted unless necessary for distinction).

[0121] Two pressurizing and depressurizing parts 107a, 107b are aligned inside lid 5. Each of pressing parts 108a, 108b is attached to lid 5 on a side of washing tub 4, and is configured to expand and contract in a freely extensible manner so as to freely advance to and retreat from washing object 2 accommodated on bottom 4a of washing tub 4. Each of pressing parts 108a, 108b includes pressing surface 108c to press washing object 2 and pleated extension part 108d. Each of pressing parts 108a, 108b extends to the extent that pressing surface 108c reaches bottom 4a of washing tub 4.

[0122] Pressurizing and depressurizing parts 107 (107a, 107b) respectively include constant pressure release valves 112 (112a, 112b) configured to release fluid when pressure inside corresponding one of pressing parts 108 (108a, 108b) reaches a predetermined value. Constant pressure release valves 112 respectively prevent pressing parts 108 from being pressed with pressure exceeding a predetermined value. In the present exemplary embodiment, the fluid supplied to the inside of pressing parts 108 is explained as air, for example.

[0123] The description now turns to operations and

functions of washing machine 101 configured as described above. The following description omits a part of or all of description of the operations and the functions common to those of washing machine 1 according to the first exemplary embodiment.

[0124] When water supply is finished in an initial washing step, controller 29 closes discharge valve 111a of first pressurizing and depressurizing part 107a and drives pressurizing pump 110a for a predetermined time or until pressure of pressing part 108a reaches a predetermined value. Then, air is supplied into pressing part 108a to expand pressing part 108a. When extension part 108d extends and pressing part 108a extends toward washing object 2 as shown in FIG. 15, washing object 2 disposed below pressing part 108a is partly compressed and made thin at a position pressed by pressing surface 108c. At this time, controller 29 opens discharge valve 111b of second pressurizing and depressurizing part 107b so that pressing part 108b becomes a contractible state.

[0125] Expansion of pressing part 108a causes compression and volume change of washing object 2, and according to the volume change of washing object 2, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current inside washing object 2, and the water current removes soils attached to washing object 2 from fiber of washing object 2.

[0126] The wash water contained in washing object 2 moves inside washing object 2 in a direction shown by arrow A from under pressing part 108a to under pressing part 108b. The wash water that moves in this manner pushes pressing surface 108c of pressing part 108b upward while expanding a part of washing object 2 under pressing part 108b, so that air is discharged from opened discharge valve 111b to contract pressing part 108b.

[0127] Then, controller 29 closes discharge valve 111b of second pressurizing and depressurizing part 107b and drives pressurizing pump 110b for a predetermined time or until pressure of pressing part 108b reaches a predetermined value, so that air is supplied into pressing part 108b to expand pressing part 108b. When extension part 108d extends and pressing part 108b extends toward washing object 2 as shown in FIG. 16, pressing surface 108c presses a part of washing object 2 under pressing part 108b. At this time, controller 29 opens discharge valve 111a of first pressurizing and depressurizing part 107a so that pressing part 108a becomes a contractible state.

[0128] Expansion of pressing part 108b causes compression and volume change of washing object 2, and according to the volume change of washing object 2, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current inside washing object 2, and the water current removes soils attached to washing object 2 from fiber of washing object 2.

[0129] The wash water contained in washing object 2 moves inside washing object 2 in a direction shown by arrow B from under pressing part 108b to under pressing part 108a. The wash water that moves in this manner pushes pressing surface 108c of pressing part 108a upward while expanding a part of washing object 2 under pressing part 108a, so that air is discharged from opened discharge valve 111a to contract pressing part 108a.

[0130] In the washing step, each of pressing parts 108a, 108b alternately performs contraction and expansion repeatedly at different timings (for example, one second of pressurization by expansion of pressing part 108a and one second of depressurization by contraction of pressing part 108b) for a predetermined time (for example, for 10 minutes). This configuration enables exhibiting a press-washing effect on washing object 2. In other words, soils can be removed by generating water currents in multiple directions inside washing object 2 without exerting mechanical force such as agitation and beat-washing on washing object 2.

[0131] When a washing course in which the steps from washing to drying are sequentially performed is set, controller 29 performs a rinsing step and a drying step subsequent to a washing step.

[0132] In the rinsing step, a rinsing operation with accumulated water is performed subsequent to a drain operation and a preparatory drying operation, for example. In the drain operation, drain valve 26 is opened, the wash water inside washing tub 4 is discharged to an outside through drain passage 27. In the preparatory drying operation, discharge valves 111 a, 111b are closed and pressurizing pumps 110a, 110b are driven while drain valve 26 remains opened, so that washing object 2 is pressed and contracted and a part of the wash water contained in washing object 2 is forcibly discharged.

[0133] In the rinsing operation with accumulated water, water-supply valve 18 is opened to supply a predetermined amount of wash water inside washing tub 4. Then, pressurizing pumps 110a, 110b are driven in the same manner as the washing step, so that each of pressing parts 108a, 108b alternately performs contraction and expansion repeatedly at different timings, thereby reducing the concentration of detergent in the wash water inside washing object 2. This rinsing step is repeated a plurality of times (twice, for example).

[0134] After the rinsing step, controller 29 performs the drying step.

[0135] In the drying step, drain valve 26 is opened to discharge the wash water inside washing tub 4 to an outside. Then, discharge valves 111 a, 111b are closed and pressurizing pumps 110a, 110b are driven while drain valve 26 remains opened, so that washing object 2 is pressed and contracted due to expansion of pressing parts 108a, 108b. As a result, a part of the wash water contained in washing object 2 is forcibly discharged.

[0136] According to the present exemplary embodiment, pressurizing and depressurizing part 107 includes flexible pressing part 108, pressurizing pump 110 configured to supply fluid into pressing part 108 to expand pressing part 108, and discharge valve 111 configured

to discharge the fluid inside pressing part 108 to contract pressing part 108. However, this shall not be construed as a limitation, and pressing part 108 may be depressurized by a vacuum pump (not shown) instead of discharge valve 111. Pressurizing pump 110 may be reversed to be used as a vacuum pump.

[0137] According to the present exemplary embodiment, two pressurizing and depressurizing parts 107 (107a, 107b) are provided and alternately performs expansion and contraction. However, this shall not be construed as a limitation, and three or more pressurizing and depressurizing parts 107 may be provided and operated at different timings so as to expand and contract pressing parts 108 in sequence. In such a case, when at least one of pressing parts 108 expands, the other pressing parts 108 are configured to contract, and expansion and contraction of pressing parts 108 may be performed regularly or on a random basis.

[0138] As described above, the washing machine according to the present exemplary embodiment includes a plurality of pressing parts 108. Pressurizing and depressurizing part 107 is configured to press and release pressing against washing object 2 by using pressing parts 108 to cause washing object 2 to contract and expand, so that the water currents in multiple directions are generated inside washing object 2. With this configuration, a plurality of portions of washing object 2 are pressed alternately or sequentially at different timings inside washing tub 4. Accordingly, water currents in multiple directions can be generated throughout washing object 2 without agitating washing object 2, thereby enhancing a washing effect while suppressing fabric damage to and loss of shape of washing object 2. Including the plurality of pressing parts 108, washing machine 101 can easily handle washing object 2 inside washing tub 4, even when washing object 2 has portions with different thicknesses.

[0139] The washing machine includes a plurality of pressurizing and depressurizing parts 107. Each of pressurizing and depressurizing parts 107 includes: one of pressing parts 108 configured to expand and contract; pressurizing pump 110 configured to supply the fluid into corresponding one of pressing parts 108; and discharge valve 111 configured to discharge the fluid inside corresponding one of pressing parts 108. Controller 29 is configured to control pressurizing and depressurizing parts 107 so that each of pressing parts 108 expands and contracts at an arbitrary timing. With this configuration, a plurality of portions of washing object 2 are pressed at different timings. Accordingly, water currents in multiple directions can be generated throughout washing object 2 without agitating washing object 2, thereby enhancing a washing effect while suppressing fabric damage to and loss of shape of washing object 2.

(Sixth exemplary embodiment)

[0140] FIGS. 17 and 18 each schematically show a movement of a washing machine according to a sixth exemplary embodiment of the present disclosure. According to the present exemplary embodiment, pressurizing and depressurizing part 107 includes discharge valves 111 (111a, 111b), pressing parts 108 (108a, 108b), and pressurizing pump 110c communicating with pressing parts 108 (108a, 108b) through switching part 131. Controller 29 controls pressurizing and depressurizing part 107 by switching switching part 131 such that one of pressing parts 108b contracts when the other one of pressing parts 108a expands. Since other configurations are the same as those of the fifth exemplary embodiment, the same components are denoted by the same numerals and the detailed descriptions of the fifth exemplary embodiment are applied to those of the present exemplary embodiment.

[0141] In FIGS. 17 and 18, a plurality of (for example, two) freely extensible pressing parts 108 (108a, 108b) having flexibility provided on lid 5 on a side of washing tub 4 are configured to freely advance to and retreat from washing object 2 accommodated on bottom 4a of washing tub 4. Pressurizing and depressurizing part 107 includes discharge valve 111a configured to discharge air inside one of pressing parts 108a to an outside, and discharge valve 111b configured to discharge air inside the other one of pressing parts 108b to an outside.

[0142] Pressurizing pump 110c is communicated with pressing part 108a and pressing part 108b through switching part 131. Switching part 131 includes switching valve 131a configured to open and close a communication passage to pressing parts 108a, and switching valve 131b configured to open and close a communication passage to pressing part 108b.

[0143] The description now turns to operations and functions of the washing machine configured as described above. Note that operation-course settings by a user, loading of washing object 2, and a sequence of operations of the operation courses are the same as those of the fifth exemplary embodiment. Hereinafter, controlling of pressurizing and depressurizing part 107 by controller 29 is described by taking a washing step as an example.

[0144] In the washing step, after a predetermined amount of water is supplied to washing tub 4, controller 29 closes discharge valve 111a, opens switching valve 131a, closes switching valve 131b, and drives pressurizing pump 110c. Then, air is supplied into pressing part 108a to expand pressing part 108a. As shown in FIG. 17, extension part 108d extends and pressing surface 108c presses washing object 2 in pressing part 108a. At this time, controller 29 opens discharge valve 111b so that pressing part 108b becomes a contractible state.

[0145] As shown in FIG. 17, expansion of pressing part 108a causes compression and volume change of washing object 2, and according to the volume change of washing object 2, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current inside washing object 2, and the water current removes soils attached to washing object 2 from

fiber of washing object 2.

[0146] The wash water contained in washing object 2 moves inside washing object 2 in a direction shown by arrow A from under pressing part 108a to under pressing part 108b. The wash water that moves in this manner pushes pressing surface 108c of pressing part 108b upward while expanding a part of washing object 2 under pressing part 108b, so that air is discharged from opened discharge valve 111b to contract pressing part 108b.

[0147] Then, controller 29 closes discharge valve 111b, opens switching valve 131b, closes switching valve 131a, and drives pressurizing pump 110c, so that air is supplied into pressing part 108b to expand pressing part 108b. As shown in FIG. 18, extension part 108d extends and pressing surface 108c presses washing object 2 in pressing part 108b. At this time, controller 29 opens discharge valve 111a so that pressing part 108a becomes a contractible state.

[0148] Expansion of pressing part 108b causes compression and volume change of washing object 2, and according to the volume change of washing object 2, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current inside washing object 2, and the water current removes soils attached to washing object 2 from fiber of washing object 2.

[0149] The wash water contained in washing object 2 moves inside washing object 2 in a direction shown by arrow B from under pressing part 108b to under pressing part 108a. The wash water that moves in this manner pushes pressing surface 108c of pressing part 108a upward while expanding a part of washing object 2 under pressing part 108a, so that air is discharged from opened discharge valve 111a to contract pressing part 108a.

[0150] In this manner, opening and closing of switching valves 131a, 131b of switching part 131, and opening and closing of discharge valves 111 (111a, 111b) are switched. As a result, one pressurizing pump 110c can expand and contract pressing parts 108 (108a, 108b) alternately, so that water currents in multiple directions can be generated inside washing object 2.

[0151] According to the present exemplary embodiment, two pressing parts 108 are provided and are expanded and contracted one after the other. However, this shall not be construed as a limitation, and three or more pressing parts 108 may be provided and operated at different timings so as to expand and contract pressing parts 108 in sequence. In such a case, when at least one of pressing parts 108 expands, the other pressing parts 108 are configured to contract, and expansion and contraction of pressing parts 108 may be performed regularly or on a random basis.

[0152] As described above, in the washing machine according to the present exemplary embodiment, pressing parts 108 include at least first pressing part 108a and second pressing part 108b. Pressurizing and depressurizing part 107 includes: pressing parts 108; a plurality of discharge valves 111 configured to discharge fluid inside pressing parts 108, respectively; switching part 131 including a plurality of switching valves 131a, 131b; and pressurizing pump 110c that is communicated with pressing parts 108 through switching part 131 and is configured to supply the fluid into pressing parts 108. Controller 29 is configured to control pressurizing and depressurizing part 107 in such a manner that second pressing part 108b contracts when first pressing part 108a expands. This configuration allows one pressurizing pump 110c to selectively switch pressurization against the plurality of pressing parts 108, so that a plurality of portions of washing object are pressed in turn.

(Seventh exemplary embodiment)

[0153] FIGS. 19 and 20 each schematically show a movement of a washing machine according to a seventh exemplary embodiment of the present disclosure. According to the present exemplary embodiment, pressurizing and depressurizing part 107 includes a plurality of pressing parts 108 (108a, 108b). Suction path 132 communicating with pressing parts 108 (108a, 108b) is provided on a suction side of pressurizing pump 110c. Two switching valves 133a, 133b are provided as suction path switching part 133. Discharge path 134 communicating with pressing parts 108 (108a, 108b) is provided on a discharge side of pressurizing pump 110c. Two switching valves 135a, 135b are provided as discharge path switching part 135. With this configuration, air in one of pressing parts 108 in a contraction state can move into the other one of pressing parts 108 in an expansion state. Since other configurations are the same as those of the fifth and sixth exemplary embodiments, the same components are denoted by the same numerals and the detailed descriptions of the fifth and sixth exemplary embodiments are applied to those of the present exemplary embodiment.

[0154] In FIGS. 19 and 20, freely extensible pressing parts 108 (108a, 108b) having flexibility (for example, two pressing parts) provided on lid 5 on a side of washing tub 4 are configured to freely advance to and retreat from washing object 2 accommodated on bottom 4a of washing tub 4, and two communication paths, i.e., suction path 132 and discharge path 134, each of which communicates with two pressing parts 108 are provided.

[0155] A suction side of pressurizing pump 110c is connected to suction path 132 communicating with pressing parts 108a, 108b. Suction path 132 is equipped with suction path switching part 133. According to the present exemplary embodiment, switching valve 133a is provided on suction path 132 between pressing part 108a and pressurizing pump 110c. Switching valve 133b is provided on suction path 132 between pressing part 108b and pressurizing pump 110c.

[0156] A discharge side of pressurizing pump 110c is connected to discharge path 134 communicating with pressing parts 108a, 108b. Discharge path 134 is equipped with discharge path switching part 135. Accord-

ing to the present exemplary embodiment, switching valve 135a is provided on discharge path 134 between pressing part 108a and pressurizing pump 110c. Switching valve 135b is provided on discharge path 134 between pressing part 108b and pressurizing pump 110c.

[0157] The description now turns to operations and functions of the washing machine configured as described above. Note that operation-course settings by a user, loading of washing object 2, and a sequence of operations of the operation courses are the same as those of the fifth exemplary embodiment. Hereinafter, controlling of pressurizing and depressurizing part 107 by controller 29 is described by taking a washing step as an example.

[0158] In the washing step, when a predetermined amount of water is supplied to washing tub 4, controller 29 closes switching valve 133a provided on suction path 132, and opens switching valve 133b. At the same time, controller 29 closes switching valve 135b provided on discharge path 134, opens switching valve 135a, and drives pressurizing pump 110c. With this configuration, as shown in FIG. 19, air in pressing part 108b moves into pressing part 108a through opened switching valve 133b and opened switching valve 135a. Accordingly, contraction of pressing part 108b and expansion of pressing part 108a are performed simultaneously. In pressing part 108a, extension part 108d extends and pressing surface 108c presses washing object 2.

[0159] Expansion of pressing part 108a causes compression and volume change of washing object 2, and according to the volume change of washing object 2, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current inside washing object 2, and the water current removes soils attached to washing object 2 from fiber of washing object 2. The wash water contained in washing object 2 moves inside washing object 2 in a direction shown by arrow A from under pressing part 108a to under pressing part 108b.

[0160] Then, controller 29 opens switching valve 133a provided on suction path 132, and closes switching valve 133b. At the same time, controller 29 closes switching valve 135a provided on discharge path 134, opens switching valve 135b, and drives pressurizing pump 110c. With this configuration, as shown in FIG. 20, air in pressing part 108a moves into pressing part 108b through opened switching valve 133a and opened switching valve 135b. Accordingly, contraction of pressing part 108a and expansion of pressing part 108b are performed simultaneously. In pressing part 108b, extension part 108d extends and pressing surface 108c presses washing object 2.

[0161] Expansion of pressing part 108b causes compression and volume change of washing object 2, and according to the volume change of washing object 2, the wash water contained in washing object 2 is pushed out of washing object 2. This generates a water current inside washing object 2, and the water current removes soils attached to washing object 2 from fiber of washing object 2. The wash water contained in washing object 2 moves inside washing object 2 in a direction shown by arrow B from under pressing part 108b to under pressing part 108a. The washing step is performed by repeating these operations alternately in this manner.

[0162] Accordingly, one pressurizing pump 110c can simultaneously perform opposite operations, i.e., expansion of pressing part 108a and contraction of pressing part 108b, and vice versa. In addition, different portions of washing object 2 are pressed by the plurality pressing parts 108a, 108b alternately, so that water currents in multiple directions can be efficiently generated inside washing object 2, thereby enhancing a washing effect.

[0163] As described above, the washing machine according to the present exemplary embodiment is the washing machine according to the sixth exemplary embodiment, in which pressurizing and depressurizing part 107 further includes: suction path 132 communicating pressing parts 108 with a suction side of pressurizing pump 110; suction path switching part 133 provided on suction path 132; discharge path 134 communicating pressing parts 108 with a discharge side of pressurizing pump 110; and discharge path switching part 135 provided on discharge path 134. Controller 29 is configured to control pressurizing and depressurizing part 107 in such a manner that air contained in first pressing part 108a in a contraction state moves into second pressing part 108b in an expansion state through suction path switching part 133 and discharge path switching part 135. With this configuration, a plurality of portions of washing object 2 are pressed in different timings, while efficiently performing expansion and contraction of the plurality of pressing parts 108 (108a, 108b) simultaneously.

(Eighth exemplary embodiment)

[0164] FIG. 21 schematically shows a movement of a washing machine according to an eighth exemplary embodiment of the present disclosure. According to the present exemplary embodiment, pressurizing and depressurizing part 141 includes electric motor 142, rotary shaft 143 including a plurality of cranks 144 and rotated by electric motor 142, and a plurality of pressing parts 146 (146a, 146b) respectively joined to shafts 145 (145a, 145b) that are rotatably joined to cranks 144 (144a, 144b). Since other configurations are the same as those of the fifth exemplary embodiment, the same components are denoted by the same numerals and the detailed descriptions of the fifth exemplary embodiment are applied to those of the present exemplary embodiment.

[0165] In FIG. 21, rotary shaft 143 configured to be rotated by driving of electric motor 142 is supported by a plurality of bearings 147 on lid 5 in a rotatable manner. Rotary shaft 143 includes a plurality of cranks 144a, 144b disposed at a constant distance. Cranks 144a, 144b are provided such that rotation of rotary shaft 143 causes a predetermined height difference between cranks 144a

and 144b in a vertical direction.

[0166] Cranks 144a, 144b are respectively connected to shafts 145a, 145b at one end of shafts 145a, 145b in a rotatable manner. The other ends of shafts 145a, 145b are respectively connected to pressing parts 146a, 146b in a rotatable manner. Due to rotation of rotary shaft 143, pressing parts 146a, 146b that are respectively joined to cranks 144a, 144b through shafts 145a, 145b move vertically inside washing tub 4 at positions adjacent to each other, and move between an upward position and a downward position one after the other.

[0167] Different portions of washing object 2 are pressed alternately with the vertical movement of pressing parts 146a, 146b. Vertical strokes of pressing parts 146a, 146b between the upward position and the downward position can be set according to shapes of cranks 144a, 144b.

[0168] According to the washing machine configured as described above, operation-course settings by a user, loading of washing object 2, and a sequence of operations of the operation courses are the same as those of the fifth exemplary embodiment. Controller 29 controls pressurizing and depressurizing part 141 in the washing step for example, and moves pressing parts 146a, 146b vertically to wash washing object 2.

[0169] Since different portions of washing object 2 are alternately pressed by pressing parts 146a, 146b due to the rotation of rotary shaft 143, so that water currents in multiple directions can be efficiently generated inside washing object 2, thereby enhancing a washing effect.

[0170] As described above, according to the present exemplary embodiment, pressurizing and depressurizing part 141 includes: electric motor 142; rotary shaft 143 having the plurality of cranks 144 and rotated by electric motor 142; and pressing parts 146 respectively joined to cranks 144 through shafts 145 that are rotatably joined to pressing parts 146 respectively. With this configuration, a plurality of portions of washing object 2 are pressed at different timings at a speed according to a rotational speed of the electric motor, and water currents in multiple directions are effectively generated inside washing object 2, thereby enhancing a washing effect while suppressing fabric damage to and loss of shape of washing object 2.

[0171] Note that each of the above exemplary embodiments can be implemented in combination of the other exemplary embodiment.

INDUSTRIAL APPLICABILITY

[0172] The washing machine according to the present disclosure can enhance a washing effect while suppressing fabric damage to and loss of shape of washing object, and thus useful as a washing machine or the like for a washing object, particularly delicate clothes that loses shape or is damaged easily, or the like.

REFERENCE MARKS IN THE DRAWINGS

[0173]

1, 101: washing machine
2: washing object
4: washing tub
7, 41, 107, 107a, 107b, 141: pressurizing and depressurizing part
8, 45, 108, 108a, 108b, 146, 146a, 146b: pressing part
10, 110, 110a, 110b, 110c: pressurizing pump (pressurizing device)
11, 111, 111a, 111b: discharge valve
13: water storage unit
29: controller
31: stored-water pressurizing unit
33: pressure detector
42, 142: electric motor (driver)
43: rotary plate (link mechanism)
44, 145, 145a, 145b: shaft (link mechanism)
131: switching part
131a, 131b, 133a, 133b, 135a, 135b: switching valve
132: suction path
133: suction path switching part
134: discharge path
135: discharge path switching part
143: rotary shaft
144 (144a, 144b): crank

Claims

1. A washing machine comprising:

a washing tub configured to accommodate a washing object and wash water;
a pressurizing and depressurizing part having a pressing part configured to freely advance to and retreat from the washing object accommodated in the washing tub; and
a controller configured to control the pressurizing and depressurizing part,
wherein the pressurizing and depressurizing part is configured to press and release pressing against the washing object by using the pressing part to cause the washing object to contract and expand, so that water currents in multiple directions are generated inside the washing object.

2. The washing machine according to claim 1, wherein the pressurizing and depressurizing part is configured to press the washing object by using the pressing part to cause the wash water contained in the washing object to flow out of the washing object, and the pressurizing and depressurizing part is configured to release pressing by the pressing part against the washing object to cause the wash water to flow

into the washing object so that the washing object contains the wash water.

3. The washing machine according to claim 1 or 2, further comprising a water storage unit configured to store the wash water that has been flowed out of the washing object to an outside of the washing object when the washing object is pressed,
wherein the water storage unit is disposed outside the washing tub and is communicated with an inside of the washing tub.

4. The washing machine according to claim 1 or 2, further comprising a water storage unit configured to store the wash water that has been flowed out of the washing object to an outside of the washing object when the washing object is pressed,
wherein the water storage unit is disposed inside the washing tub.

5. The washing machine according to claim 3 or 4, wherein the water storage unit is disposed in such a manner that water level of the wash water stored in the water storage unit is higher than the washing object accommodated in the washing tub.

6. The washing machine according to claim 3 or 4, wherein
the water storage unit includes a stored-water pressurizing unit, and
the stored-water pressurizing unit is configured to pressurize the wash water stored in the water storage unit when pressing by the pressing part against the washing object is released.

7. The washing machine according to any one of claims 1 to 6, wherein the pressurizing and depressurizing part includes:

a pressing part configured to expand and contract;
a pressurizing device configured to supply fluid into the pressing part to expand the pressing part; and
a discharge valve configured to discharge the fluid inside the pressing part.

8. The washing machine according to claim 7, wherein the controller is configured to close the discharge valve when the pressurizing device is driven to supply the fluid into the pressing part, and
the controller is configured to open the discharge valve when the pressurizing device is stopped to discharge the fluid inside the pressing part.

9. The washing machine according to claim 7 or 8, further comprising a lid including the pressing part and provided on an upper part of the washing tub in a freely openable and closable manner, wherein
the controller is configured to control the pressurizing and depressurizing part to release pressure or cause negative pressure in the pressing part when a user closes the lid against the washing tub.

10. The washing machine according to claim 9, wherein the controller is configured to open the discharge valve to open the pressing part to an atmosphere so that pressure in the pressing part is released.

11. The washing machine according to claim 9, wherein the pressurizing device is formed of a device configured to pressurize and depressurize the pressing part, and
the controller is configured to control the pressurizing device to perform a depressurizing operation to cause negative pressure in the pressing part.

12. The washing machine according to any one of claims 1 to 11, further comprising a pressure detector configured to measure an internal pressure of the pressing part,
wherein the controller is configured to control expansion and contraction of the pressing part in the washing step according to a value of the internal pressure of the pressing part in an expansion state or a contraction state of the pressing part detected by the pressure detector.

13. The washing machine according to claim 12, wherein the controller is configured to calculate various numerical values based on a value of the internal pressure of the pressing part detected by the pressure detector and estimate a volume of the washing object based on the various numerical values, and is configured to control the expansion and contraction of the pressing part in the washing step according to an estimation result.

14. The washing machine according to claim 12 or 13, wherein the controller is configured to control the pressurizing and depressurizing part so as to change a speed, a displacement magnitude, or a maximum pressure of the expansion and contraction of the pressing part in the washing step according to a maximum value $(\Delta P/\Delta T)$max within a predetermined time of an increased value per unit time of the internal pressure of the pressing part detected by the pressure detector.

15. The washing machine according to any one of claims 12 to 14, wherein the controller is configured to control the pressurizing and depressurizing part so as to change a speed, a displacement magnitude, or a maximum pressure of the expansion and contraction of the pressing part in the washing step according to a maximum value Pmax within a predetermined

time of the internal pressure of the pressing part detected by the pressure detector.

16. The washing machine according to any one of claims 12 to 15, wherein the controller is configured to detect the internal pressure of the pressing part by using the pressure detector before supplying water in the washing tub.

17. The washing machine according to any one of claims 1 to 6, wherein the pressurizing and depressurizing part includes:

a driver;
a rotary plate rotated by the driver; and
a pressing part joined to the rotary plate through a shaft.

18. The washing machine according to claim 1, wherein the washing machine comprises a plurality of the pressing parts, and
the pressurizing and depressurizing part is configured to press and release pressing against the washing object by using the pressing parts to cause the washing object to contract and expand, so that the water currents in multiple directions are generated inside the washing object.

19. The washing machine according to claim 18, wherein the washing machine comprises a plurality of the pressurizing and depressurizing parts,
each of the pressurizing and depressurizing parts includes:

one of the pressing parts configured to expand and contract;
a pressurizing pump configured to supply the fluid into corresponding one of the pressing parts; and
a discharge valve configured to discharge the fluid inside corresponding one of the pressing parts, and

the controller is configured to control the pressurizing and depressurizing parts so that each of the pressing parts expands and contracts at an arbitrary timing.

20. The washing machine according to claim 18, wherein the pressing parts include at least a first pressing part and a second pressing part,
the pressurizing and depressurizing part includes:

the pressing parts;
a plurality of discharge valves configured to discharge fluid inside the pressing parts, respectively;
a switching part including a plurality of switching valves; and
a pressurizing pump that is communicated with the pressing parts through the switching part and is configured to supply the fluid into the pressing parts, and

the controller is configured to control the pressurizing and depressurizing part in such a manner that the second pressing part contracts when the first pressing part expands.

21. The washing machine according to claim 20, wherein the pressurizing and depressurizing part further includes:

a suction path communicating the pressing parts with a suction side of the pressurizing pump;
a suction path switching part provided on the suction path;
a discharge path communicating the pressing parts with a discharge side of the pressurizing pump; and
a discharge path switching part provided on the discharge path, and

the controller is configured to control the pressurizing and depressurizing part in such a manner that air contained in the first pressing part in a contraction state moves into the second pressing part in an expansion state through the suction path switching part and the discharge path switching part.

22. The washing machine according to claim 18, wherein the pressurizing and depressurizing part includes:

an electric motor;
a rotary shaft having a plurality of cranks and rotated by the electric motor; and
the pressing parts respectively joined to the cranks through shafts that are rotatably joined to the pressing parts respectively.

FIG. 1

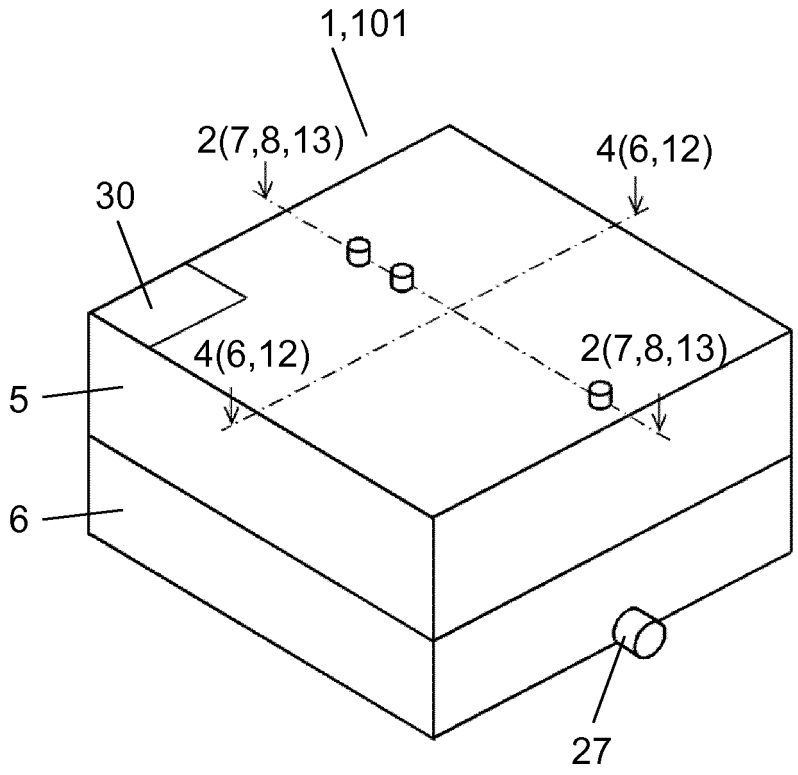


FIG. 2

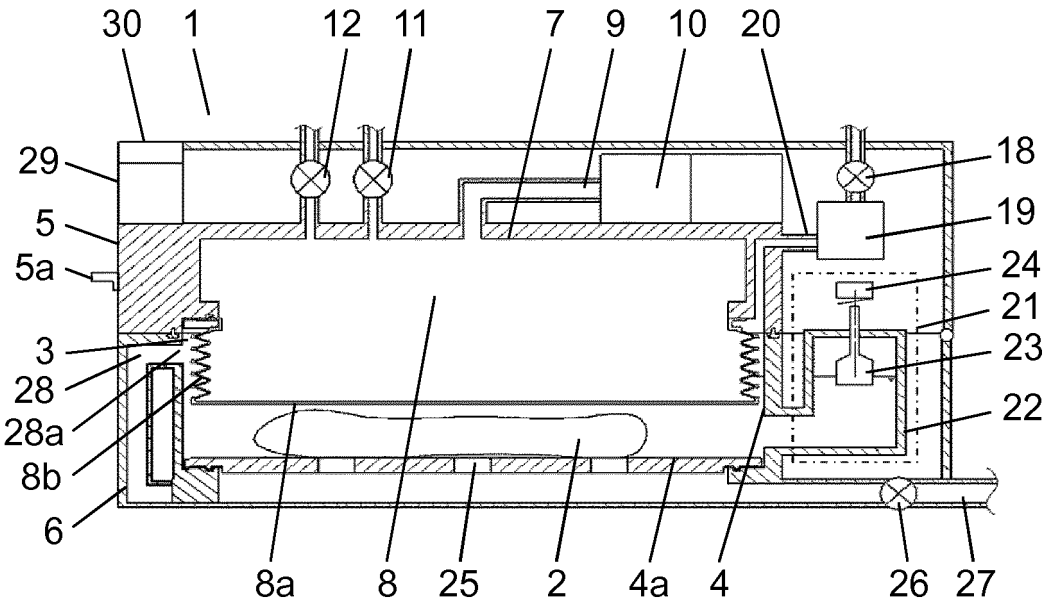

30
1
12
11
7
9
10
20
29
5
5a
3
28
28a
8b
6
18
19
24
21
23
22
8a
8
25
2
4a
4
26
27

FIG. 3

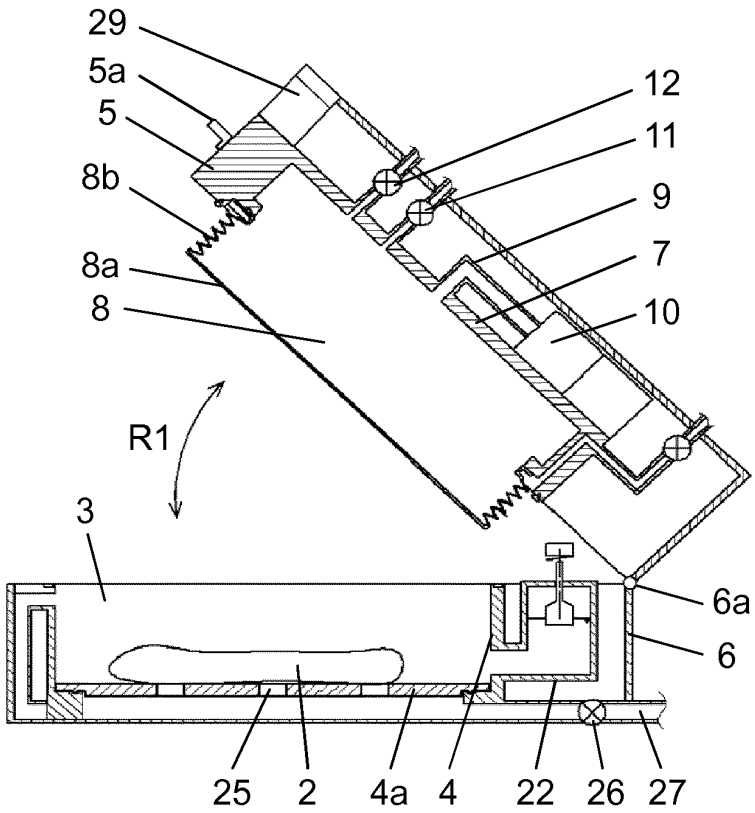

29
5a
5
8b
8a
8
R1
3
12
11
9
7
10
6a
6
25
2
4a
4
22
26
27

FIG. 4

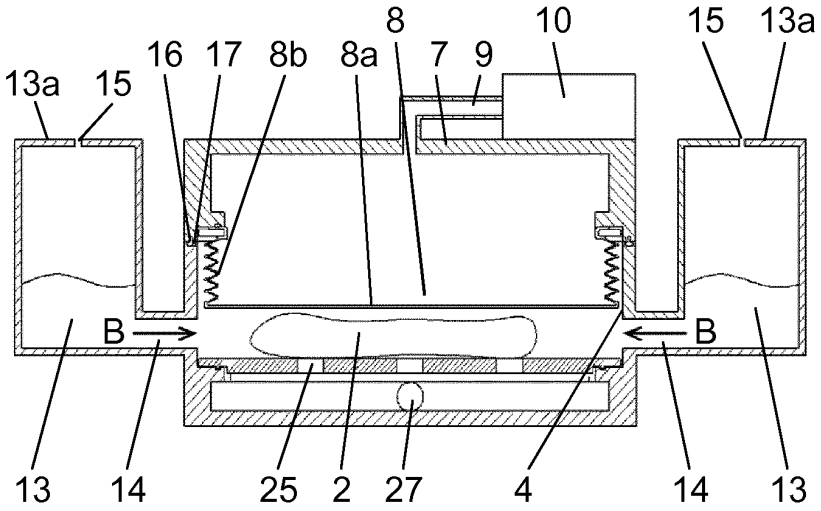

13a
15
16
17
8b
8a
8
7
9
10
15
13a
B
B
13
14
25
2
27
4
14
13

FIG. 5

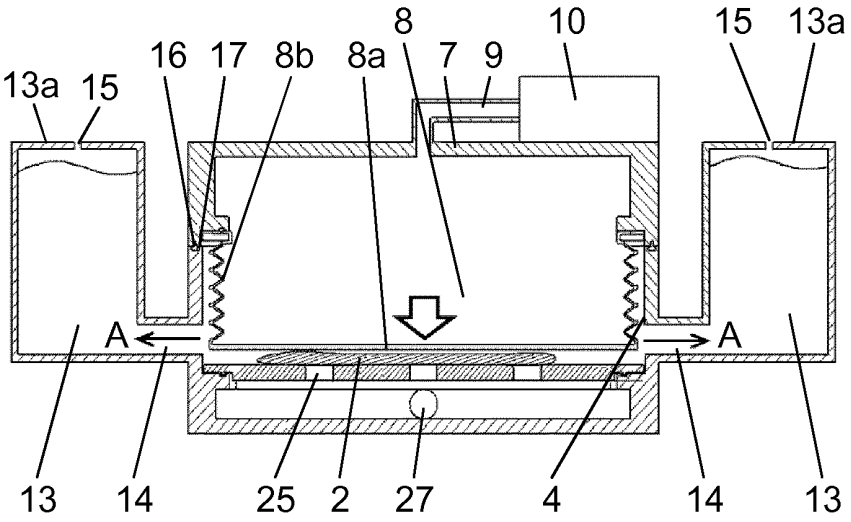

8
10
15
13a
16
17
8b
8a
7
9
13a
15
A
A
13
14
25
2
27
4
14
13

FIG. 6

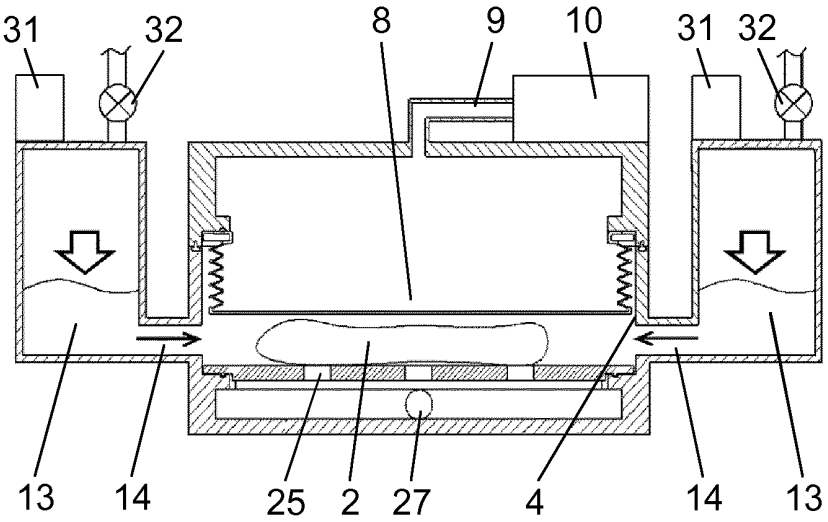

31
32
8
9
10
31
32
13
14
25
2
27
4
14
13

FIG. 7

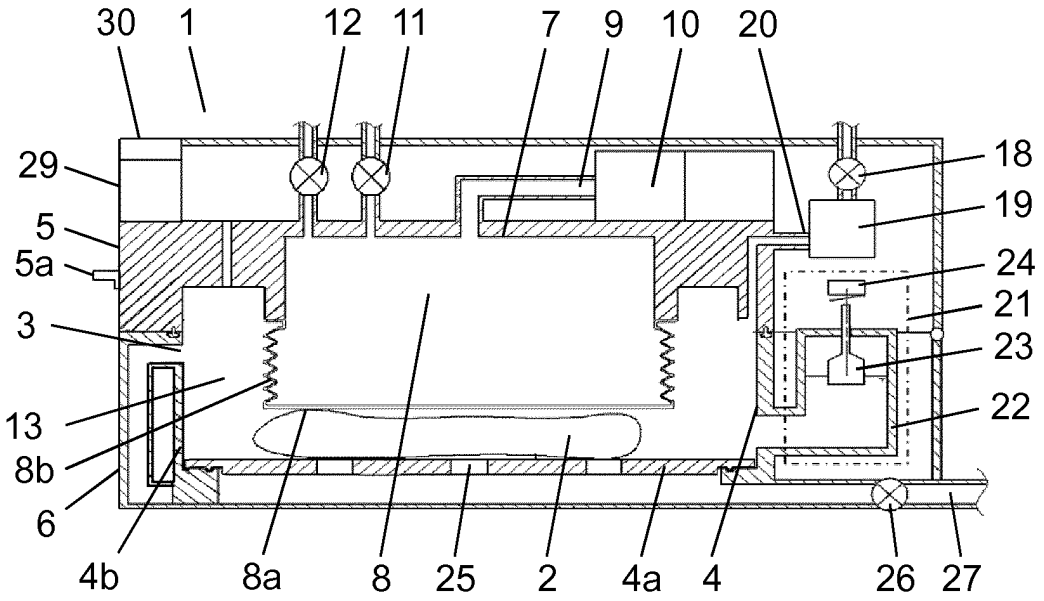

30
1
12
11
7
9
10
20
29
5
5a
3
13
8b
6
4b
8a
8
25
2
4a
4
26
27
18
19
24
21
23
22

FIG. 8

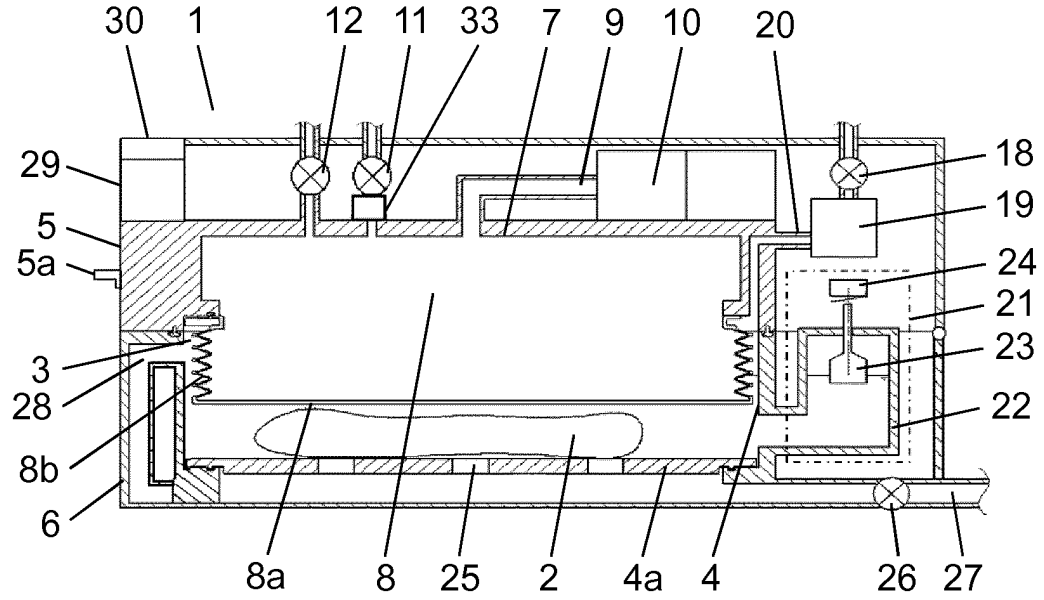

30
1
12
11
33
7
9
10
20
29
5
5a
3
28
8b
6
8a
8
25
2
4a
4
26
27
18
19
24
21
23
22

FIG. 9

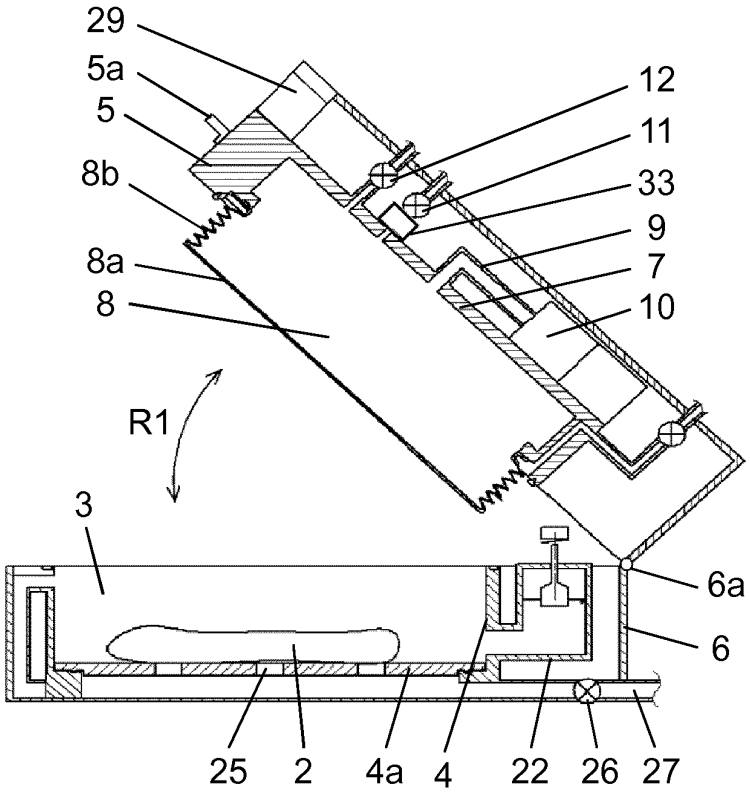

29
5a
5
8b
8a
8
R1
3
12
11
33
9
7
10
6a
6
25
2
4a
4
22
26
27

FIG. 10

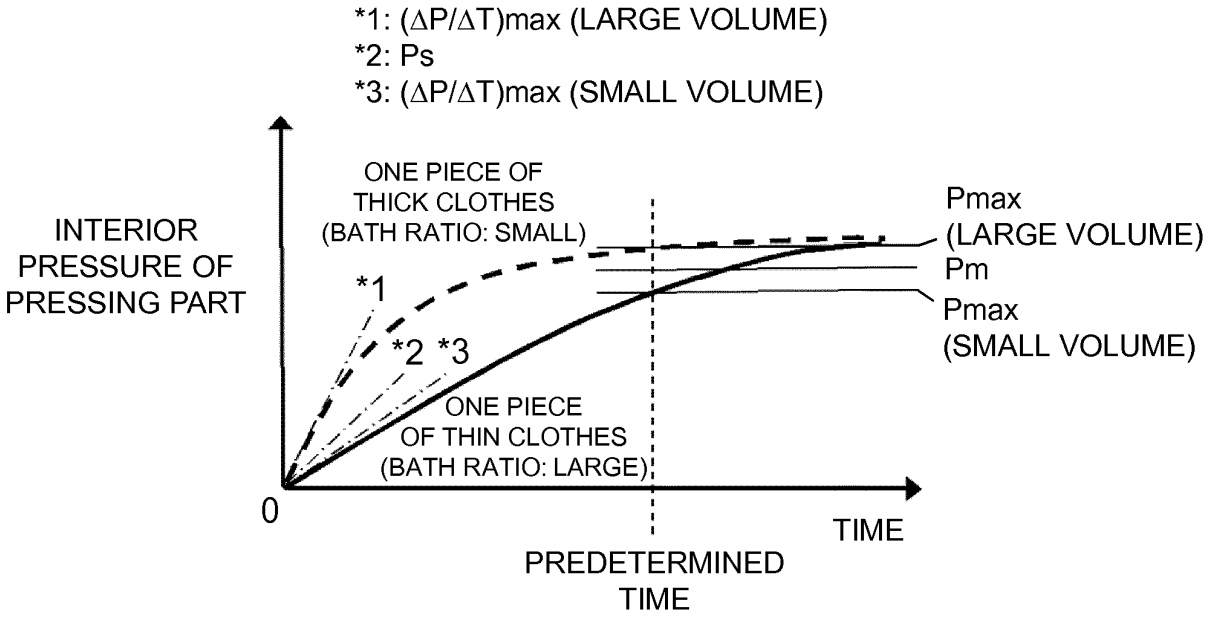

*1: (ΔP/ΔT)max (LARGE VOLUME)
*2: Ps
*3: (ΔP/ΔT)max (SMALL VOLUME)
INTERIOR PRESSURE OF PRESSING PART
ONE PIECE OF THICK CLOTHES (BATH RATIO: SMALL)
*1
*2 *3
ONE PIECE OF THIN CLOTHES (BATH RATIO: LARGE)
Pmax (LARGE VOLUME)
Pm
Pmax (SMALL VOLUME)
0
TIME
PREDETERMINED TIME

FIG. 11

		EXPANSION/CONTRACTION OF PRESSING PART IN WASHING STEP		
<VARIOUS NUMERICAL VALUES> (ΔP/ΔT)max Pmax, etc.	ESTIMATED VOLUME OF WASHING OBJECT	SPEED	DEVIATION	MAXIMUM PRESSURE
LARGE	LARGE	LARGE	LARGE	LARGE
SMALL	SMALL	SMALL	SMALL	SMALL

FIG. 12

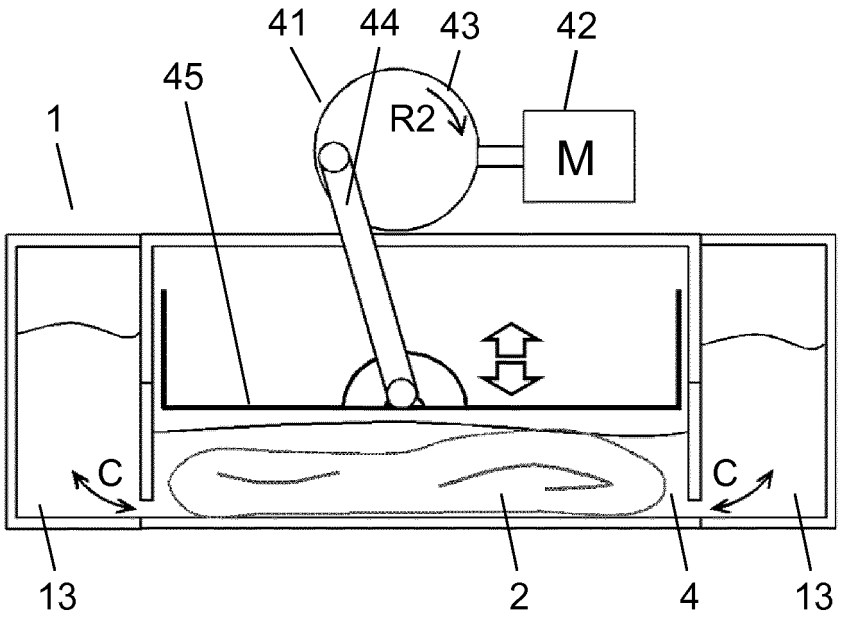


FIG. 13

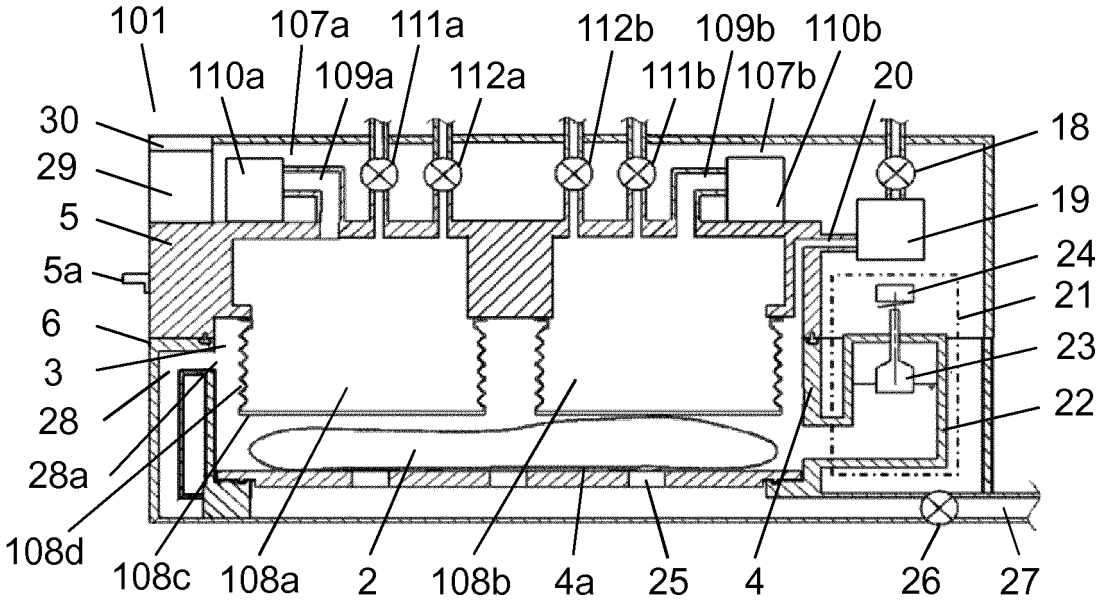

101
107a
111a
112b
109b
110b
110a
109a
112a
111b
107b
20
30
29
5
5a
6
3
28
28a
108d
18
19
24
21
23
22
108c
108a
2
108b
4a
25
4
26
27

FIG. 14

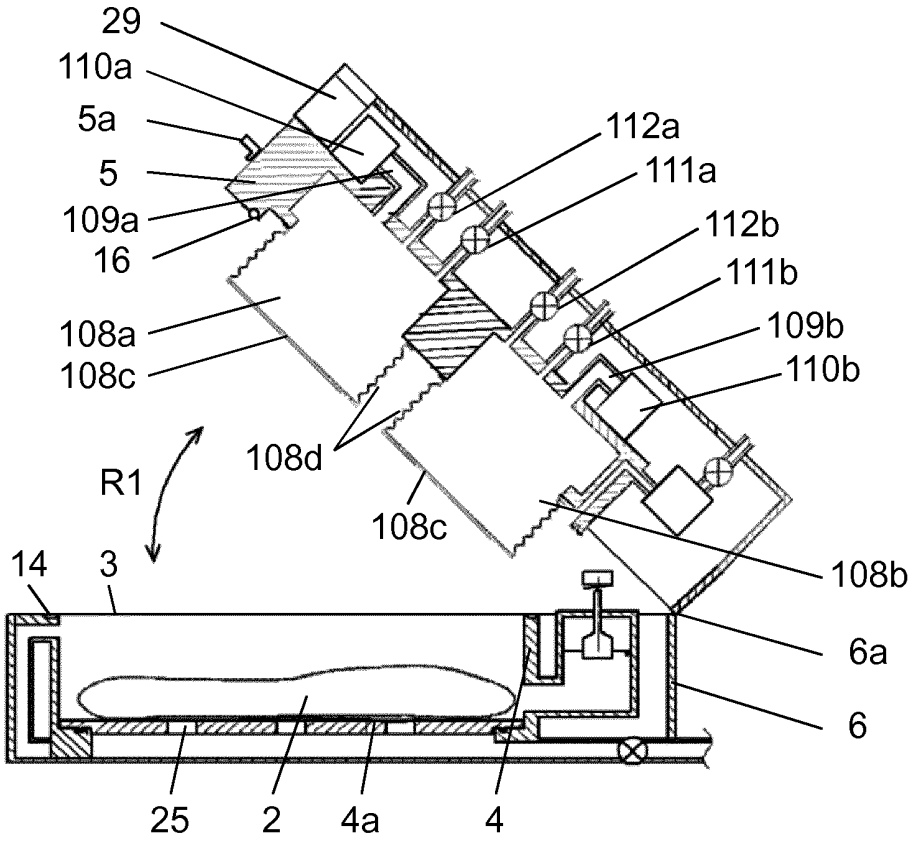

29
110a
5a
5
109a
16
108a
108c
R1
108d
112a
111a
112b
111b
109b
110b
108c
108b
14
3
6a
6
25
2
4a
4

FIG. 15

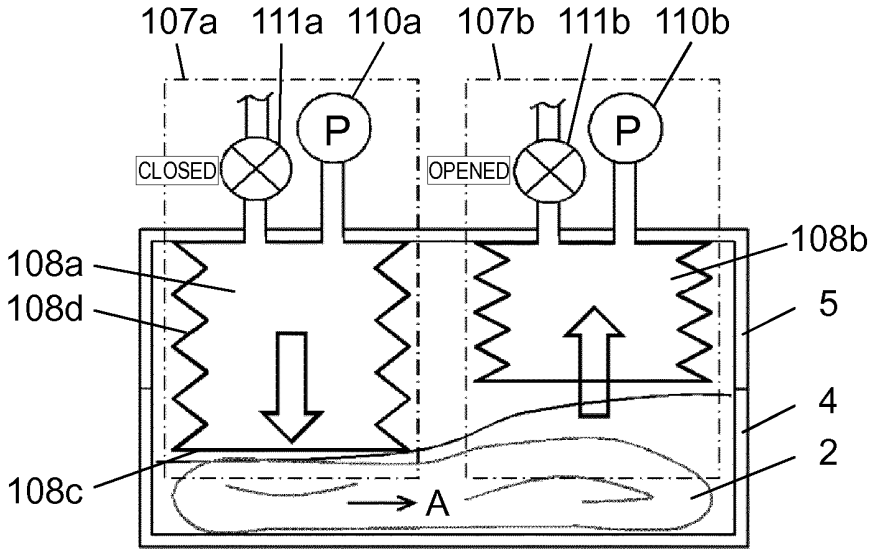

107a
111a
110a
107b
111b
110b
P
P
CLOSED
OPENED
108b
108a
108d
5
4
2
108c
A

FIG. 16

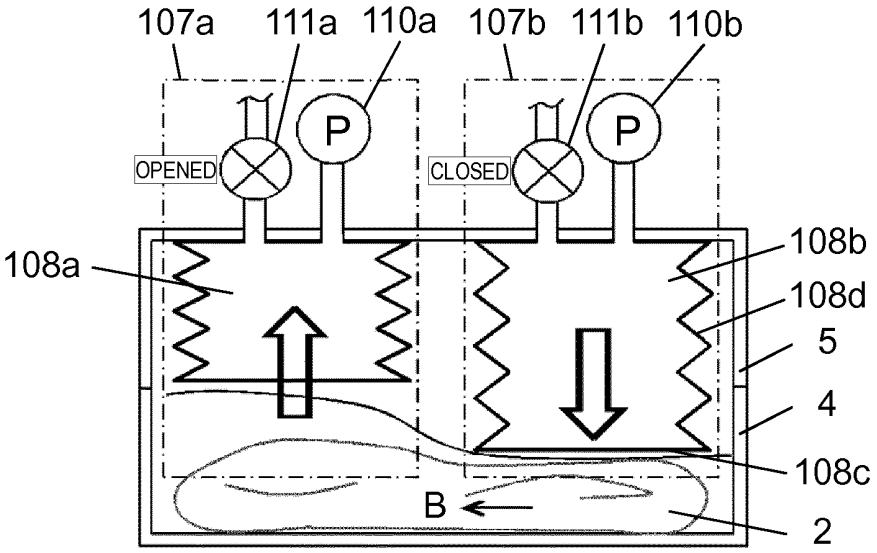

107a
111a
110a
107b
111b
110b
P
P
OPENED
CLOSED
108a
108b
108d
5
4
108c
B
2

FIG. 17

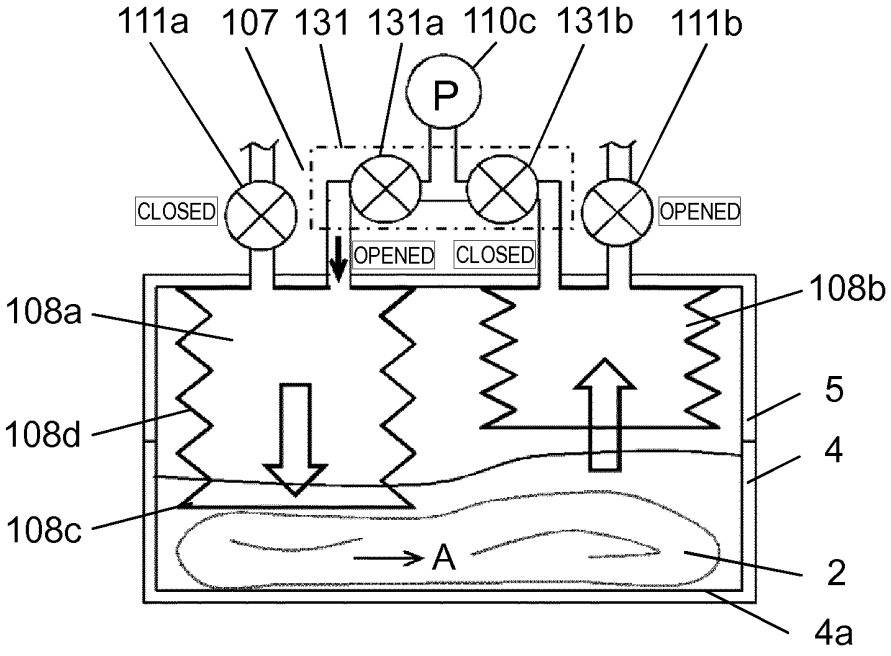

111a
107
131
131a
110c
131b
111b
P
CLOSED
OPENED
OPENED
CLOSED
108a
108b
5
108d
4
108c
A
2
4a

FIG. 18

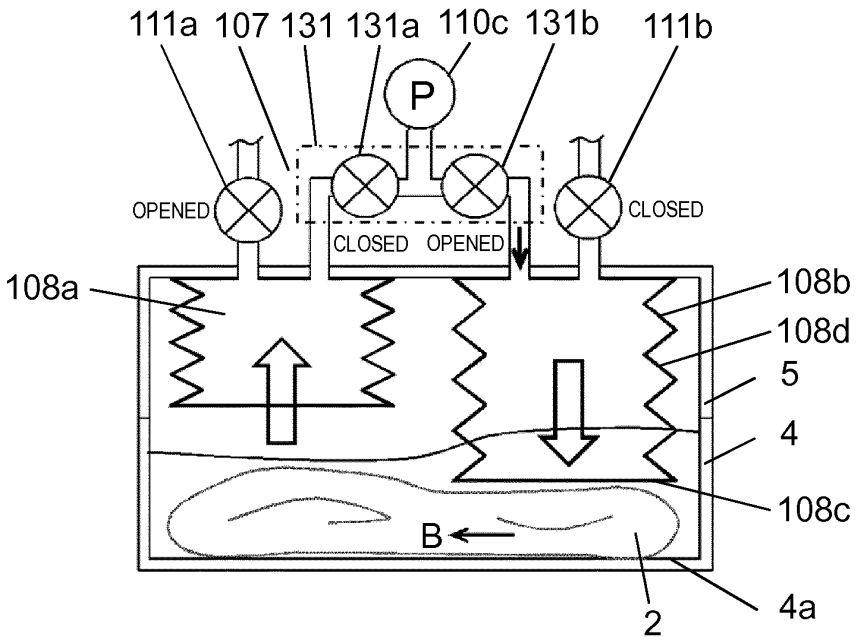

111a
107
131
131a
110c
131b
111b
P
OPENED
CLOSED
CLOSED
OPENED
108a
108b
108d
5
4
108c
B
2
4a

FIG. 19

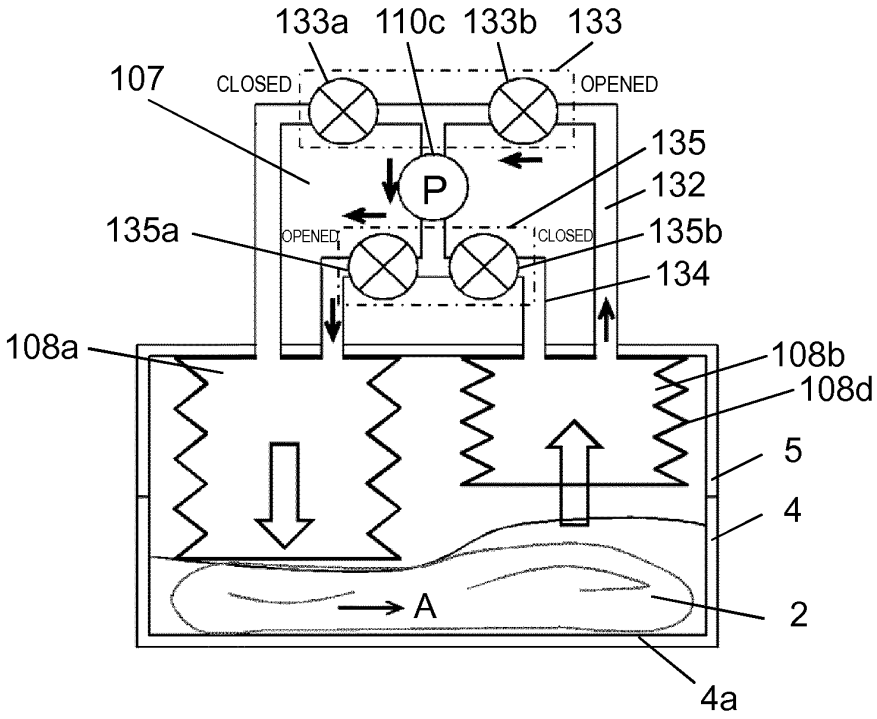

133a
110c
133b
133
107
CLOSED
OPENED
135
P
132
135a
OPENED
CLOSED
135b
134
108a
108b
108d
5
4
A
2
4a

FIG. 20

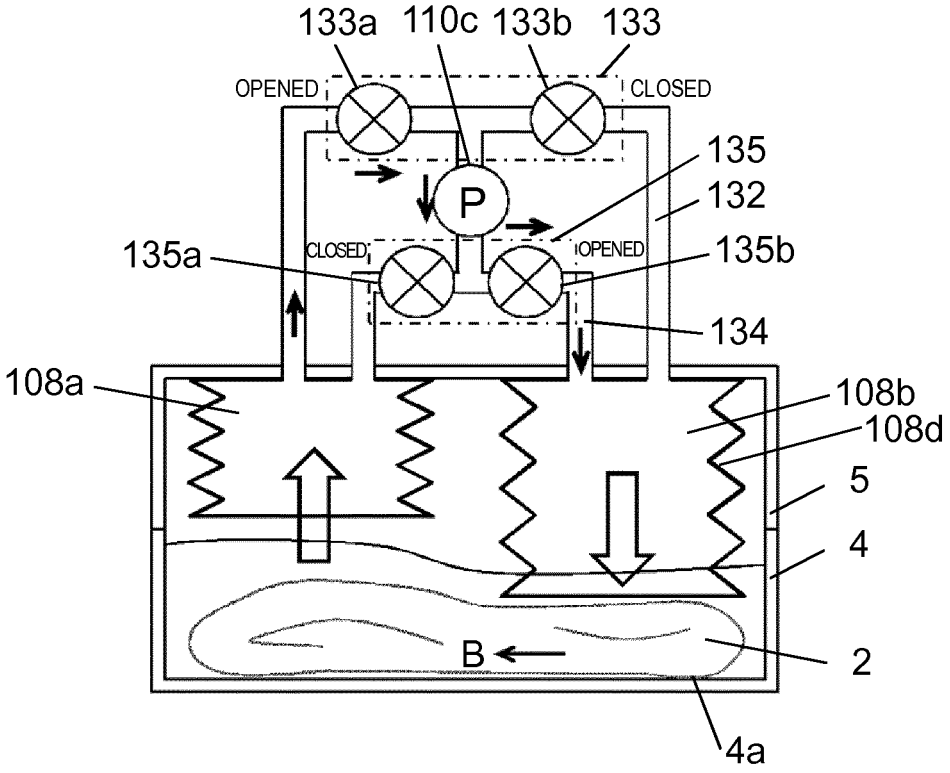

133a
110c
133b
133
OPENED
CLOSED
135
P
132
135a
CLOSED
OPENED
135b
134
108a
108b
108d
5
4
B
2
4a

FIG. 21

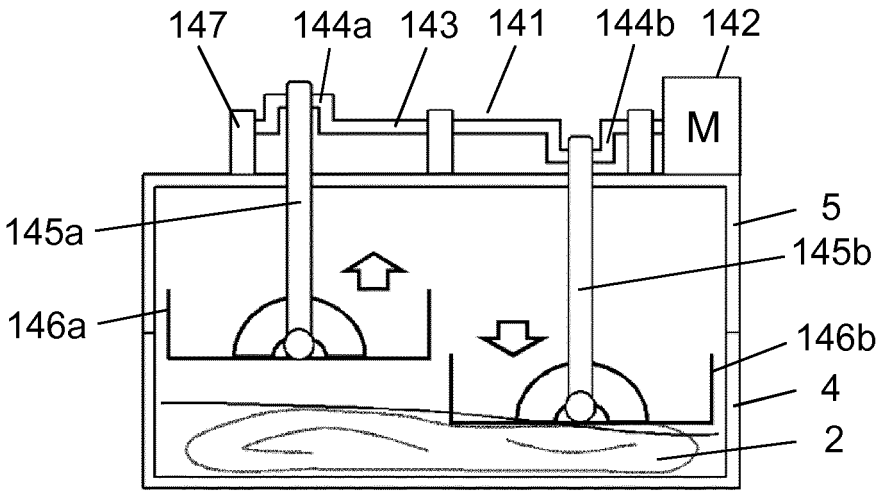
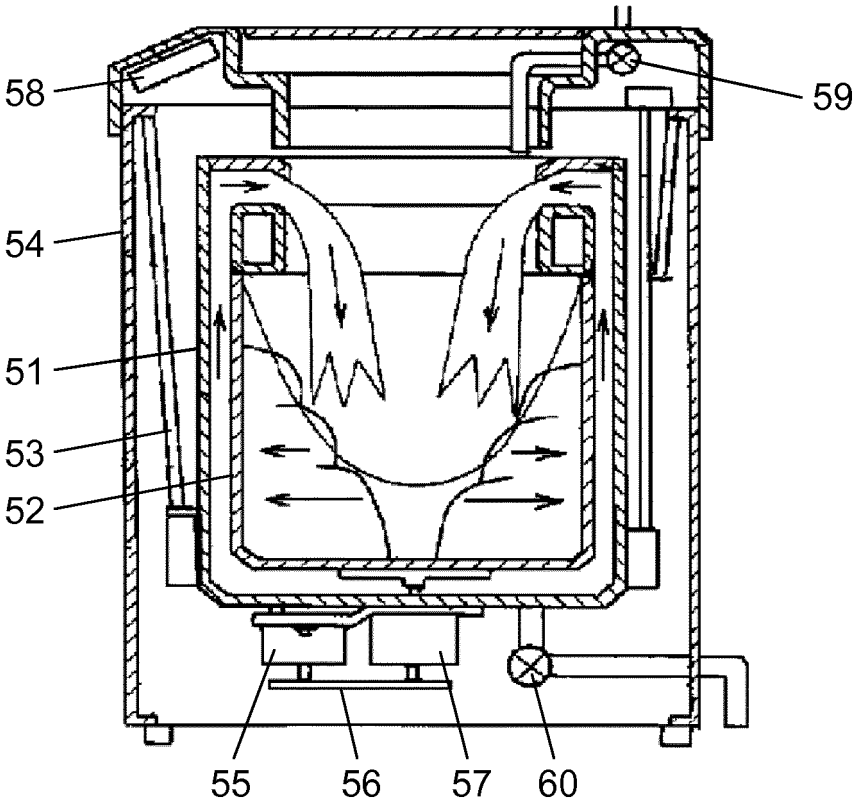

147
144a
143
141
144b
142
M
145a
5
145b
146a
146b
4
2

FIG. 22



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/024773

A. CLASSIFICATION OF SUBJECT MATTER
D06F15/02(2006.01)i, *D06F47/06*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F15/02, D06F47/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 029646/1980(Laid-open No. 131178/1981) (Matsushita Electric Industrial Co., Ltd.), 05 October 1981 (05.10.1981), specification, page 2, line 12 to page 5, line 9; fig. 1 to 2 (Family: none)	1-3,5,9-10 12-13,16-17 4,6-8,11, 14-15,18-22
X Y	JP 52-62970 A (Hirozo TANIMURA), 24 May 1977 (24.05.1977), page 1, lower right column, line 19 to page 2, lower right column, line 17; fig. 1 to 4 (Family: none)	1-2,4-5,7-11 12-13,16-17

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2017 (27.09.17)	10 October 2017 (10.10.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/024773

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-232094 A (Kabushiki Kaisha Inamoto Seisakusho), 28 August 2001 (28.08.2001), paragraphs [0016], [0018] to [0024]; fig. 1 to 2 (Family: none)	12-13,16
Y	JP 51-14766 A (Mitsubishi Electric Corp.), 05 February 1976 (05.02.1976), page 2, upper left column, line 10 to lower right column, line 4; fig. 1 (Family: none)	17,22
X Y	JP 52-94660 A (Matsushita Electric Industrial Co., Ltd.), 09 August 1977 (09.08.1977), page 1, lower right column, line 17 to page 2, lower right column, line 7; fig. 1 (Family: none)	18-20 22
A	JP 52-62973 A (Hirozo TANIMURA), 24 May 1977 (24.05.1977), page 1, lower right column, line 15 to page 3, lower left column, line 1; fig. 1 to 4 (Family: none)	1-22
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 66598/1977(Laid-open No. 160266/1978) (Sharp Corp.), 15 December 1978 (15.12.1978), specification, page 1, line 13 to page 4, line 5; fig. 1 to 2 (Family: none)	1-22
A	JP 11-33266 A (Kabushiki Kaisha Japan), 09 February 1999 (09.02.1999), paragraphs [0018] to [0035]; fig. 1 to 4 (Family: none)	1-22
A	JP 3-162893 A (Ko YOSHINO), 12 July 1991 (12.07.1991), page 2, lower right column, line 1 to page 4, lower left column, line 8; fig. 1 to 3 (Family: none)	1-22

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2000350883 A **[0010]**
- JP 9038376 A **[0010]**
- JP 10033884 A **[0010]**