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(54) **Washing machine**

(57) Washing machine (1) and method for operating a washing machine, wherein the washing machine comprises a tub (2), a draining circuit (16), wherein the draining circuit (16) is fluidly connected to a lower portion of the tub (2), a valve (26) arranged between the tub (2) and the draining circuit (16), a recirculation circuit (10) fluidly connected to the tub (2), wherein an inlet (14) of the recirculation circuit (10) is positioned downstream a valve seat (22) of the valve (26), and wherein the recir-

culation circuit comprises a recirculation pump (12) for re-circulating fluid from the lower portion of the tub into the tub, and a control unit adapted to control the washing machine to perform at least one washing cycle, wherein the valve (26) is adapted to be opened when the recirculation pump (12) is operated and is adapted to be closed when the recirculation pump (12) is not operated, and wherein the control unit is adapted to operate the recirculation pump (12) intermittently during the at least one washing cycle.

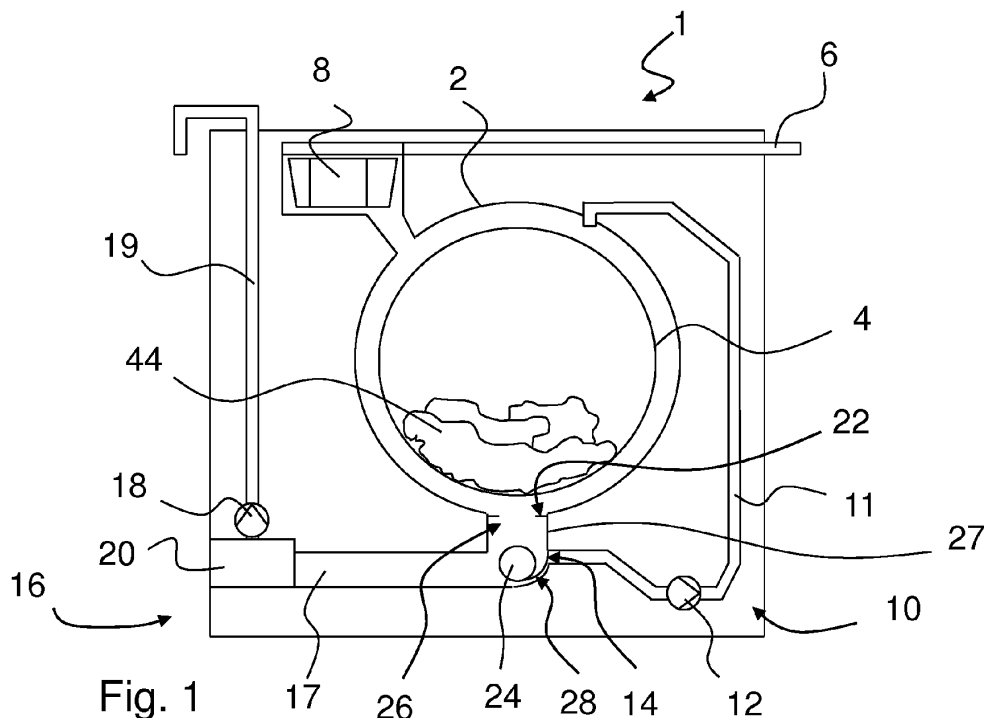


Fig. 1

Description

[0001] The invention relates to a washing machine (including a washing machine having a dryer function and/or a front- or top-loading washing machine) with a recirculation circuit and a draining circuit comprising a valve adapted to selectively open and close the passage of liquid from a tub to the draining circuit.

[0002] EP 1 204 792 B1 discloses a washing machine, wherein an inlet of a draining circuit is fluidly connected to a sump. A check valve is arranged between the sump and the inlet of the draining circuit. During a washing cycle the check valve shuts off the sump from the draining circuit by using a valve seat and a ball as closing element. A recirculation circuit is provided for circulating washing water from the sump to an upper portion of the tub.

[0003] It is an object of the invention to provide a washing machine and method which allow an improved and economic washing operation.

[0004] The invention is defined in claim 1 and 11, respectively. Particular embodiments are set out in the dependent claims.

[0005] In the following, when reference is made to 'water', the term 'water' may denote water as such, washing water, washing liquid, washing liquor or the like.

[0006] According to claim 1, a washing machine comprises a tub and a draining circuit, which is fluidly connected to the tub to drain water from the tub. E.g. the draining circuit is connected or attached to the tub or the tub may comprise a sump and the draining circuit is attached or connected to the sump. A valve is arranged between the tub and the draining circuit. E.g. the valve is adapted to shut off or seal the tub from the draining circuit, in particular during a heating phase of a washing cycle of the washing machine. A control unit of the washing machine is adapted to control the washing machine to perform one or more washing cycles, e.g. a washing cycle for cotton at 60°C or a cycle for delicate fabrics at 30°C. The washing machine further comprises a recirculation circuit having a recirculation pump, which is fluidly connected to the tub, wherein an inlet of the recirculation circuit is positioned downstream a valve seat of the valve. Thus when operating the recirculation pump, water from the bottom of the tub is re-circulated preferably to an upper or middle portion of the tub to be sprayed or sprinkled onto laundry in the tub. In particular when the valve is in the closed position to shut the tub off from the draining circuit, the inlet of the recirculation circuit is positioned or arranged to be fluidly connected to the draining circuit, preferably close to the valve.

[0007] The valve is adapted to be opened when the recirculation pump is operated and is adapted to be closed when the recirculation pump is not operated, in particular during a washing cycle. E.g. the valve is closed in dependency of a water level in the draining circuit and/or tub, for example by a closure element which is floating in or on the water and which is pressed against a valve seat when the water level in the draining circuit

and/or tub rises during a water supply phase. When the recirculation pump is operated, the suction force of the recirculation pump (with the inlet of the recirculation circuit placed below the valve or downstream the valve as seen from the tub) opens the valve, e.g. by removing the closure element from the valve seat. Thus the valve is actuated by the operation of the recirculation pump, for example due to a pressure difference of the water between the tub and the inlet of the recirculation circuit below the valve generated by the (operating) recirculation pump.

[0008] When the recirculation pump is operated, i.e. the valve is opened, the water level in the tub is lower than when the recirculation pump is not operated. This is due to the hoses and pipes of the recirculation circuit, which have to be filled with water from the tub before water is supplied through the recirculation circuit into the tub each time the recirculation pump is operated. Thus, during operation of the recirculation pump, the level of the washing water in the tub is reduced. It has been found, that the washing performance of a washing machine is improved when the laundry is wetted also by a certain amount of water present in the bottom of the tub and not only by the water coming from the recirculation circuit.

[0009] According to the invention, the control unit is adapted to operate the recirculation pump intermittently (in impulse mode) during the at least one washing cycle, such that a plurality of recirculation intervals are provided during the at least one washing cycle. I.e. a recirculation interval starts with switching-on of the recirculation pump and ends with the switching-off of the recirculation pump. Thus the recirculation pump is repeatedly (at least two times) switched-on and -off during a washing cycle, wherein correspondingly the valve is repeatedly opened and closed. In contrast to a continuous operation of the recirculation pump, during an intermittent operation, the water level in the tub is reduced only temporarily (during operation of the recirculation pump), such that during a great part of the washing cycle the level of water in the tub is high enough to efficiently wash or wet the laundry. Further, in comparison to a continuous operation of the recirculation pump, the energy consumption of the washing machine is reduced. Thus the washing machine allows an efficient and economic washing operation with respect to energy and water consumption.

[0010] According to a preferred embodiment, the control unit is adapted to operate the recirculation pump intermittently after operating the heater element, preferably during a washing phase of the at least one washing cycle. In particular during a heating phase the valve is preferably closed, i.e. the recirculation pump is not operated, such that the water in a sump area (sump container and/or draining duct to the draining pump) and the recirculation circuit is not heated. Heat energy is thus effectively restricted to the tub interior for washing purposes. Further, when re-circulating heated water, heat can get lost in the recirculation circuit, e.g. by thermal conduction. During intermittent operation of the recirculation pump hot water

is only temporarily flown through the recirculation circuit, thus the loss of heat/ energy through the recirculation circuit is significantly reduced in comparison to a continuous operation of the recirculation pump. I.e. most of the heat energy is maintained in the tub for an energy efficient washing operation.

[0011] Preferably the control unit is adapted to operate the recirculation pump less than 35% of the duration of a washing cycle, preferably less than 30%, more preferably less than 25%. E.g. when an exemplary washing cycle has a length of about 200 minutes, the recirculation pump is operated for about 70 to 50 minutes or less. Thus a washing machine having low energy consumption is provided.

[0012] According to a preferred embodiment, the control unit is adapted to operate or activate the recirculation pump for a recirculation interval every or about every 30 minutes, preferably every 20 minutes, more preferably every 10 minutes, in particular during a washing phase of the at least one washing cycle. E.g. every 20 minutes the recirculation pump is operated for a short interval or period, such that, e.g. during a washing phase of a washing cycle, water is repeatedly supplied to the laundry. At the same time in the 'pauses' between the recirculation intervals the water level in the tub is high enough to efficiently wet the laundry. Thereby the laundry is thoroughly wetted and detergent evenly distributed in the tub and laundry, respectively.

[0013] Preferably at least one recirculation interval has a length of less than 90 seconds, preferably less than 60 seconds, more preferably less than 30 seconds. I.e. the control unit is adapted to operate the recirculation pump for short intervals during the at least one washing cycle. The amount of water supplied or sprayed onto the laundry during the short recirculation periods or intervals is sufficient to thoroughly wet the laundry in the tub, while at the same time providing a low energy consumption of the at least one washing cycle, i.e. of the washing machine.

[0014] According to a preferred embodiment, the control unit is adapted to operate the recirculation pump for a recirculation interval of at least 10 minutes during operation of a water supply unit of the washing machine and/or directly after the end of an operation of a water supply unit. I.e. the recirculation circuit is preferably operated during a water supply phase of the at least one washing cycle and additionally or alternatively subsequent to a water supply phase. Advantageously, a recirculation interval of the recirculation pump during a water supply phase and/or directly after a water supply phase is preferably longer than during the remaining part of the at least one washing cycle. For example the recirculation pump is operated for a longer interval at the beginning of a washing cycle after the (first) supply of water and detergent into the tub, such that the supplied detergent is re-circulated during the recirculation interval through the recirculation circuit onto the laundry. Thereby the detergent is efficiently dissolved and distributed, such that

laundry in the tub is uniformly treated with detergent. Alternatively or additionally the recirculation pump is operated during a water supply phase and after a water supply phase, e.g. a water supply phase in a rinsing phase at the end of a washing cycle.

[0015] In the following an exemplary washing cycle with an intermittently operated recirculation pump is described. In a starting phase of the washing cycle water and detergent are supplied or flown into the tub of the washing machine. During the water supply phase and/or after the end of the water supply phase, the recirculation pump is operated for a first recirculation interval, wherein water and detergent is re-circulated from below (or downstream as seen from the tub) the valve to an upper portion of the tub, i.e. to laundry in the tub. E.g. the first recirculation interval lasts at least 16 minutes, such that the detergent is dissolved and the laundry thoroughly wetted. Subsequently to the first recirculation interval one or more short recirculation intervals can be executed, i.e. the recirculation pump is operated by the control unit for one or more short recirculation intervals, preferably each of these recirculation intervals lasts less than 90 seconds. Then a heater is operated to heat water in the tub, wherein during the heating phase the recirculation pump is preferably not operated, i.e. the valve is closed, such that the supplied heat is maintained in the tub and water in the draining circuit is not heated due to the closed valve. After the heating phase, i.e. during a washing phase, the recirculation pump is intermittently operated, i.e. a plurality of short recirculation intervals are provided, which are separated by non-operating or pause intervals of the recirculation pump. E.g. the recirculation pump is operated about every 10 minutes and each recirculation interval lasts less than 90 seconds. For example six recirculation intervals are provided during a washing phase of a washing cycle. The washing phase is followed by a spinning and draining phase, wherein washing water is removed from the laundry by spinning the drum of the washing machine at high rotation speed (e.g. 1600 rpm) and draining the water from the tub by operating a draining pump. During this phase the recirculation pump is not operated. Subsequently at least one rinsing phase is executed, wherein fresh water is supplied into the tub to rinse the laundry. During and/or after the supply of fresh water the recirculation pump is operated for a longer interval to thoroughly soak the laundry with fresh water, e.g. for 7 minutes. The (or each) rinsing phase preferably comprises spinning and draining phase(s) to remove excess water from the laundry and tub.

[0016] Preferably the valve comprises a valve body having the valve seat and a movable closure element adapted to be releasably engaged with the valve seat for closing the opening through the valve seat. E.g. the closure element floats on the water that fills the draining circuit or a sump and is eventually pressed towards the valve seat by the rising water level, i.e. by buoyant force, and seals thereby a valve opening in the valve seat. Thereby the tub is shut off from the draining circuit,

wherein a simple and robust valve is provided which is maintenance-free or is substantially maintenance-free.

[0017] Preferably the washing machine comprises a heater element within the tub, wherein the control unit is adapted to operate the recirculation pump intermittently before operating the heater element, in particular after flowing water and detergent into the tub. At the beginning of a washing cycle (during a water filling phase when detergent is flushed in to the tub) undissolved detergent might pass the valve due to a not perfect watertight sealing of the valve. This detergent collects in the draining circuit substantially below the valve seat around the valve opening in the tub. Each time when the recirculation circuit/ pump is operated, the detergent collected in this way below the valve seat will be sucked in through the inlet of the recirculation circuit below (or downstream seen from the tub) the valve, and is re-circulated back into the tub. Thus detergent is brought back into the tub for full or nearly full recovery of undissolved detergent. Thereby the washing effect is enhanced as detergent is more efficiently used instead of being drained from the washing machine.

[0018] Preferably the movable closure element has a spherical or substantially spherical shape, such that it may engage with the valve seat in any (rotated) position. This is advantageous when the closure element is freely floating within the sump or draining circuit. Alternatively the closure element is formed by a hinged flap, e.g. like in a swing check valve, which is closed by buoyant force and water pressure.

[0019] In an embodiment the valve body is formed by the sump container or a portion thereof or by a portion of a draining suction duct connecting the tub to a draining pump. Thus the number of elements for providing the valve is reduced as compared to a valve having a separate body. In case the inlet of the recirculation circuit is arranged at a bottom or lower region of the valve body, the recirculation circuit has an improved ability to suck in undissolved detergent that has collected at the lower region of the valve body (e.g. sump or draining suction duct) due to gravity.

[0020] A lug preferably protruding from the valve body facilitates mounting of a suction duct of the recirculation circuit to the valve body. Alternatively or additionally the valve body may have further ports for fluid connection, for example an opening in fluid connection to a duct which itself is connected for example to a pressure sensor for detecting the water level in the tub. Thus the valve body acts as a manifold for fluidly connecting a plurality of elements and functional components of the washing machine.

[0021] With respect to the method of the invention, full reference is made to above description of the washing machine and the described operation modes and advantages thereof as well as to the below detailed description. For embodiments of the washing machine or the method, each isolated feature of the claims or description can be added or any arbitrary combination of isolated or individ-

ual features can be added to the claims.

[0022] Reference is made in detail to a preferred embodiment of the invention, an example of which is illustrated in the accompanying figures, which show:

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Fig. 1 a schematic cross-sectional front view of a washing machine according to the invention,

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Fig. 2 a schematic cross sectional front view of the washing machine of Fig. 1 during filling of water into a tub thereof,

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Fig. 3 a schematic cross sectional view of the washing machine of Fig. 1, wherein the tub is partially filled with water,

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Fig. 4 a schematic cross sectional front view of the washing machine of Fig. 1 during a recirculation interval,

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Fig. 5 a schematic cross sectional front view of the washing machine of Fig. 1 during a draining phase,

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Fig. 6 a perspective, partially cross-sectional side view of a part of an exemplary internal structure of a washing machine,

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Fig. 7 a perspective, partially cross-sectional side view of the internal structure of the washing machine shown in Fig. 6,

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Fig. 8 a partial cross-sectional top view of a detail of the structure of the washing machine shown in Fig. 6,

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Figs. 9a-d perspective views and cross sectional views of a ball valve as shown in Fig. 6,

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Fig. 10 a cross-sectional side view of the ball valve of Figs. 9a-d in a closed state,

Fig. 11 a cross-sectional side view of the ball valve of Fig. 9a-d in an opened state, and

Fig. 12 a diagram of an exemplary washing cycle according to the invention.

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[0023] Fig. 1 depicts a schematic cross-sectional front view of a washing machine 1 comprising a tub 2 with a drum 4 rotatably arranged therein. A control unit (not shown) is provided to control one or more washing cycles or washing programs of the washing machine. A draining circuit 16 preferably comprises a draining pump 18, a draining suction pipe 17, a draining riser pipe 19 and a draining filter 20. The draining suction pipe 17 is fluidly connected to the tub 2 to drain water, washing water or fluid from the tub 2 during a draining phase when the

draining pump 18 is operated. A valve 26 comprising a valve body 27 and a valve seat 22 in form of a diaphragm with an opening is arranged between the tub 2 and the draining circuit 16. A ball 24 which is freely moveable or floatable between the valve seat 22 and a filter element 28 is adapted to engage with the valve seat 22 to shut the tub 2 from the draining circuit 16. The ball 24 is made of floatable material e.g. plastic and floats on the water depending on the water level in the draining suction pipe 17/ valve body 27. When the water level rises, the ball 24 is raised towards the valve seat 22 until the ball surface closes the opening at the valve seat 22. The valve seat 22 may be formed in a diaphragm or plate as shown in Fig. 1. In the depicted embodiment the draining suction pipe 17 is pipe-shaped and forms (at least part of) the sump and the valve body 27 connected to the lowest point for the tub 2. However in other embodiments the draining suction pipe 17 may have different shapes at least in the region directly below the opening to the tub.

[0024] In a heating phase of a washing cycle the water in the tub 2 is heated by a heating element (not shown) arranged in the tub. When the valve 26 is closed, only the water in the tub 2 is heated but not the water in the draining circuit 16, whereby the energy consumption of the washing machine is reduced.

[0025] A recirculation circuit 10 is provided to circulate water or washing water from a lower portion of the tub 2 to an upper portion of the tub 2 in the embodiment shown. The recirculation circuit 10 preferably comprises a suction pipe 13 fluidly connected to the draining suction pipe 17 (forming the sump), a recirculation pump 12 and a recirculation pipe 11. When the recirculation pump 12 is operated, the laundry 44 in the tub 2 is efficiently wetted without having to provide an amount of water in the tub 2 which completely covers the laundry 44. I.e. on the one hand the water consumption during a washing cycle is reduced and on the other hand, due to reduced water consumption less water has to be heated, whereby the energy consumption is reduced.

[0026] Advantageously, the recirculation pump 12 and the draining pump 18 are not completely watertight. Thus the water level in the recirculation pipe 11 and the draining riser pipe 19 corresponds to the water level in the tub 2 or draining suction pipe 17 when the pumps 12 and 18 are not operated and the ball valve 26 is open.

[0027] The filter element 28 is advantageously arranged downstream the ball valve seat 22 in front of an inlet 14 of suction pipe 13 of the recirculation circuit 10. When the recirculation pump 12 is operated, the water passes the filter element 28 before it enters the recirculation circuit 10. The filter element 28 prevents that fluff and foreign objects which may pass through the opened or partially opened valve 26 enter the recirculation circuit 10, where they might obstruct a nozzle at the outlet of the recirculation pipe 11 or the recirculation pump 12. When no water is in the draining circuit 16, the recirculation pump 12 is operated or the water level is low, the ball 24 rests on the filter element 28.

[0028] Figs. 2 to 5 show the washing machine in different phases during a washing cycle, which is controlled by the control unit. As shown in Fig. 12 an exemplary washing cycle preferably comprises a starting phase, wherein water and detergent are supplied into the tub, a heating phase, wherein water in the tub is heated, a washing phase, wherein laundry in the tub is treated/ washed, e.g. by repeatedly changing the rotation direction of the drum, and a rinsing phase, wherein laundry is rinsed with fresh water, i.e. washing water and detergent is removed from the laundry and the tub. During the washing cycle the recirculation pump 12 is intermittently operated, such that a plurality of recirculation intervals is provided throughout the washing cycle.

[0029] Fig. 2 depicts a schematic cross sectional front view of the washing machine of Fig. 1 at the beginning of a washing cycle, i.e. a starting phase of the washing cycle (Fig. 12). As depicted by arrows, tap water flows into the tub 2 via a water inlet 6. The tap water flows through the detergent drawer 8, from where it carries detergent into the tub 2 and drum 4 as indicated with the arrows. In this state the water level 42a is in a range where the ball 24 is not abutting the valve seat 22 such that the valve 26 is open. Thus the water fills the draining circuit 16 and partially the recirculation circuit 10.

[0030] Fig. 3 depicts a schematic cross sectional view of the washing machine of Fig. 1 at a later point in time of the starting phase, where a water supply phase is finished and the tub 2 is filled with water up to the maximum water level 42b for the selected washing program or cycle, respectively. In this phase the draining pump 16 and the recirculation pump 12 are not activated (Fig. 12), thus the valve 26 is closed. The washing water has reached maximum level 42b which partially covers the laundry 44 in the tub 2. While the water level was rising from level 42a to 42b and due to the hydrostatic buoyant force, the ball 24 is pushed or pressed against the valve seat 22 and closes thereby the valve 26. The valve 26 provides a simple and robust way for automatically shutting off the tub 2 from the draining circuit 16 during those phases of the washing cycle, in which the pumps 12, 18 are not operated and in which the water level has a minimum height to press the ball 24 against the valve seat 22. In particular the valve 26 is closed during a heating phase of the washing cycle when the water is filled to close the valve 26 and when no pumps 12, 18 are operated.

[0031] Fig. 4 depicts a schematic cross sectional front view of the washing machine 1 of Fig. 1 during one of a plurality of recirculation intervals of a washing cycle. The recirculation pump 12 is activated and consequently the valve 26 is opened. The recirculation pump 12 pumps the washing water from the sump or the draining suction pipe 17 to the outlet of the recirculation pipe 11 (which may have a nozzle) which is connected to the interior of the tub 2. While operating the recirculation pump 12, recirculation pipe 11 is filled with water and the water level drops from maximum level 42b to an intermediate level 42c. After the recirculation interval, i.e. after the recircu-

lation pump 12 is deactivated or switched off, the water level rises back or almost back from the intermediate level 42c to the maximum level 42b. I.e. after switching off the recirculation pump 12, which is not perfectly watertight, the water in the recirculation pipe 11 flows back into the tub 2 as long as the valve 26 is not completely closed. Thus, after a recirculation interval, the water level in the tub 2 is high enough for washing the laundry efficiently with the water in the tub 2.

[0032] As shown in the embodiment of Fig. 4, the recirculation circuit 10 feeds the water into the tub 2 and onto the drum 4. The drum 4 comprises holes or perforations through which the washing water enters the drum 4 and wets the laundry 44. Alternatively the recirculation circuit 10 feeds the water directly into the drum 4 through an outlet at a rotational axis of the drum 4 (Fig. 6). In another embodiment the outlet of pipe 11 or nozzle is arranged at a loading door of front-loader washing machine such that the re-circulated water can be sprayed or sprinkled through the loading opening of the drum directly into the drum and the laundry 44 therein (not shown).

[0033] It may happen that detergent, in particular powder detergent, is not completely dissolved at the beginning of a washing cycle. For example at the beginning of flushing in the detergent by flowing tap water through the detergent drawer 8 and before the water level is high enough to close the valve 26 (see e.g. water level 42a), some detergent may remain undissolved and can be flushed along the tub inner wall through the opening in the seat 22 into the sump or draining suction pipe 17. There it may collect due to gravity. Additionally, even if the water level is high enough to close the valve 26, undissolved detergent collecting at the lowest point of the tub 2 may enter the draining circuit if valve 26 not perfectly closes the opening in the seat 22. E.g. during drum rotation operation of the washing machine.

[0034] As indicated by Fig. 4, the activated recirculation pump 12 creates a suction force on its suction side which opens or partially opens the valve 26 due to the pressure difference acting on the ball from above and below and the ball's buoyant force. The ball 24 is moved away from its seat 22. Thereby water can be pumped from the tub 2 although the inlet 14 of the recirculation circuit 10 is placed downstream the valve seat 22. I.e. the valve 26 is automatically opened during a recirculation interval or phase of a washing cycle by the suction force of the recirculation pump 12. Referring to the collection of detergent in the sump or the draining suction pipe 17 described before, as the inlet 14 of the recirculation circuit 10 is placed below or downstream the valve seat 22, any detergent deposited or collected in the sump or pipe 17 is re-circulated back into the tub 2 when operating the recirculation circuit, whereby the detergent is effectively and efficiently used for the washing cycle.

[0035] Fig. 5 depicts a schematic cross sectional front view of the washing machine 1 of Fig. 1 during a draining phase of a washing cycle. The flow of the washing water

is depicted with arrows. The suction force of the draining pump 18 on its suction side opens the valve 26 and the draining pump 18 pumps water from the tub 2 and also from the recirculation circuit 10 through the draining riser pipe 19 and out of the washing machine 1. The washing water exiting the tub 2 and flowing past the filter element 28 cleans the filter element 28, i.e. washes or flushes the filter element 18. The filter element 28 is advantageously arranged in the draining flow, draining circuit 16 or valve body, such that the water flowing from the tub 2 in a draining phase hits the filter element 28 at an acute angle with respect to the upper surface 30 of the filter element 28. Thereby fluff and foreign objects caught by the filter element 28 are washed away from the filter element 28. In other words, the filter element 28 forms a deflector element which deflects or redirects the draining flow from the tub 2 to the draining circuit 16, in particular to the draining suction pipe 17. Further, in the flow or current of the washing water out of the tub 2, the ball 24 preferably moves mainly in a rotational movement (arrow). This movement of the ball 24 creates a vortex which assists in removing fluff and foreign objects from the filter element 28. In other words a "self-cleaning" filter element 28 is provided. Additionally the backflow of water from the recirculation circuit 10 and out of the recirculation pipe 11 (as indicated by the falling water level 42d) assists in washing any caught foreign objects away from the filter element 28. Foreign objects which are washed from the filter element 28 or out of the tub 2 are subsequently caught in the draining filter 20, which is accessible from the outside for a user for cleaning. This is particularly advantageous as the filter element 28 itself is not accessible for a user from outside the washing machine.

[0036] Fig. 6 depicts a perspective, partially cross-sectional side view of a part of an exemplary internal structure of a washing machine 1 as schematically depicted in Fig. 1, which in this embodiment is a top-loading washing machine. The same reference signs are used for the same features of the washing machine 1 as described above. Relating to technical details and functional operation, full reference is made to the above embodiment schematically shown. The drum 4 is rotationally supported in the tub 2. Below the tub 2 the valve 26 is shown in a partial cross-sectional view. The ball 24 is engaged in the valve seat 22 and shuts the tub 2 from the draining circuit 16 in the state as depicted. The inlet 14 of the recirculation circuit 10 is advantageously located below the valve 26, in particular below the valve seat 22. The suction side of the recirculation pump 12 is connected via suction pipe 13 to the sump or draining suction pipe 17. The output side of the pump 12 is connected via recirculation pipe 11 to a passage through and having an outlet at a rotational axis of the drum 4. The draining circuit 16 is fluidly connected to the tub 2 through the opening in the ball valve seat 22 (having the form of a diaphragm or plate) such that washing water can be drained from the tub 2 through pipe 17, draining filter 20, pump 18 and draining riser pipe 19 to the outside of the

machine with the draining pump 18 operating.

[0037] Fig. 7 shows a perspective, partially cross-sectional side view of the structure of Fig. 6. In this partial cross-sectional view, the filter element 28 can be seen, which is arranged at the inlet 14 of the recirculation circuit 10. Fig. 8 shows a partial cross-sectional top view of a detail of the structure of Fig. 6. The diaphragm or plate of the valve seat 22 is attached at the lower rim of an extension of the tub 2, extending at the bottom of the tub 2. The valve body 27 receiving the ball 24 is attached to the tub extension at the diaphragm and is forming part of the draining suction pipe 17. Both the suction pipe 13 and the draining suction pipe 17 have sections formed as a bellows. The bellows serve for damping vibrations of the tub 2 from being transferred to the pumps 12, 18.

[0038] Figs. 9a-d depict perspective, cross sectional views of the valve 26 as shown in Fig. 6. Fig. 9a shows a top view of the valve 26, wherein the diaphragm forming the valve seat 22 is shown from the tub side. A lug 29 is advantageously attached to and protruding from the valve body 27 which is used to attach one end of the suction pipe 13. The filter element 28 is attached to the lug 29; preferably the filter element 28 is made as a single or monolithic part with the lug 29. The lug 29 is used to mount the filter element 28 at an outlet in the valve body 27, wherein the outlet forms the inlet 14 to the suction circuit 10.

[0039] A further opening 37 in the valve body 27 fluidly connects the interior of the valve body 27 to a duct 36 depicted in Fig. 9a-d. The duct 36 is connected to a pressure control (pressostat; not shown) for detecting the water level 42 in the tub 2.

[0040] Fig. 9b shows a cross sectional view of the valve 26 along line A-A of Fig. 9a. The valve 26 is shut or closed by ball 24 which rests in its seat 22 and blocks thereby the opening in the valve 26. The filter element 28 is attached to the inlet 14 of the recirculation circuit 10 by the mounting portion or lug 29 which is connected to the recirculation circuit 10 by a plug connection. In particular the filter element 28 is attached to the lug 29 forming the inlet 14 in a cantilevered manner, such that the main body of the filter element 28 extends into inner volume of the valve body 27 in a free-standing manner. A portion of the filter element 28 facing the inner space of the valve body 27 comprises a bent shape which corresponds or basically corresponds to the shape of the ball 24.

[0041] Fig. 9d shows a cross sectional view from below along the line B-B shown in Fig. 9c. The filter element 28 has a fork-like shape with fingers and apertures between the fingers. The fingers of the filter form the teeth or pins of a rake. The fingers are parallel or essentially parallel to a flow path of water flowing from the tub 2 through the valve body 27 to the draining pump 18 in draining phases.

[0042] Fig. 10 shows a cross-sectional side view of the ball valve of Figs. 9a-d in a closed state, which has been described with respect to Fig. 3. The outer surface of the filter element 28 faces a portion of the inner surface of the valve body 27 and the filter element 28 is arranged

such that there is a gap 33 between the outer or lower surface 32 of the filter element and the inner surface of the valve body. The water filling the tub 2, the draining circuit 16 and partially the recirculation circuit 10 results in a buoyant force on the floatable ball 24, which presses the ball 24 against the valve seat 22 (both pumps 12, 18 are not operating).

[0043] Fig. 11 shows a cross-sectional side view of the ball valve of Figs. 9a-d in an opened state, which has been described with respect to Figs. 2, 4 and 5. Due to a low water level 42a (Fig. 2) or due to the suction force of the recirculation pump 12 (Fig. 4) or suction force of the draining pump 18 (Fig. 5) the valve 26 is opened. The ball 24 is in close proximity to the filter element 28 or is supported by the filter element, which comprises a curved shape which matches or substantially matches the shape of the ball 24. A rotational movement of the ball 24 due to the water flow during a draining phase assists the removal of e.g. fluff from the filter element 28 as described above.

[0044] Fig. 12 shows a time diagram of an exemplary washing cycle for a washing machine according to the invention, e.g. the one described above, which is controlled by the control unit and comprises phases as described above. First a user selects and starts a washing cycle or program, respectively, preferably via a control panel (not shown). In a starting phase of the selected washing cycle water and detergent is flown into the tub 2 (Fig. 2).

After this first water supply phase (Fig. 3) the drum 4 starts rotating and the recirculation pump 12 starts operating for a first of a plurality of recirculation intervals (Fig. 4), such that by spraying or sprinkling washing water on top of the laundry 44 in the tub 2 the laundry 44 is thoroughly wetted and the detergent dissolved and evenly distributed within the tub 2 and the laundry 44. In particular undissolved detergent at the bottom of the tub 2 is re-circulated through the valve 26 back to the tub 2 and laundry as described above (Fig. 4). The length of the first recirculation interval after the first water supply phase is preferably selected such that at the end of the interval the laundry is thoroughly wetted and the detergent is completely or almost completely dissolved. Among others, the length of the first recirculation interval is preferably dependent on the amount of laundry within the tub, i.e. the load, as well as the type of fabric. For example for a load of 5 kg of cotton laundry the first recirculation interval lasts at least 16 minutes. After the first recirculation interval, i.e. after the recirculation pump is switched-off, a non-operating period (pause) of the recirculation pump 12 follows. I.e. the recirculation pump 12 is operated intermittently (non-continuously) during the washing cycle. As after switching-off the recirculation pump the valve seat 22 is not immediately closed by the ball 24 and as the recirculation pump is not perfectly watertight, the water in the recirculation pipe 11 (Fig. 4) flows back into the tub 2. Thus, after switching-off the recirculation pump 1, the water level in the tub 2 (which drops

during the recirculation interval (Fig. 4)) rises back or almost back to the level shown in Fig. 3. It has been found that the washing performance is better when - additionally to re-circulating water - the laundry is wetted by water present at the bottom portion of the tub. During the non-operating period of the recirculation pump 12 the detergent/ washing water is distributed in the laundry by rotating the drum, preferably by repeatedly reversing the rotation direction (tumble mode). After the operating pause of the recirculation pump a further (short) recirculation interval follows, having e.g. a length of 60 seconds.

[0045] The starting phase is followed by a heating phase, wherein a heating element within the tub 2 is operated. During the heating phase the recirculation pump 12 as well as the draining pump 18 are not operated, such that the valve 26 is closed. Thus only the water in tub 2 is heated and not the water within the draining circuit 16, i.e. an energy efficient heating phase is provided. During the heating phase the drum 4 is rotated to distribute the heated water in the tub and laundry.

[0046] After the heating phase a washing phase is executed during which the actual "washing" of the laundry is performed, i.e. the laundry is treated with the detergent or washing water at the selected temperature. For example the drum is rotated alternating in forward and backward direction to work the detergent into the laundry. During the washing phase a plurality of recirculation intervals are provided, i.e. the recirculation pump 12 is intermittently operated. For example six recirculation intervals are provided in the washing phase, wherein the recirculation pump 12 is activated about every 10 minutes for a recirculation interval of or of about 90 seconds. The intermittent operation of the recirculation pump 12 combines two advantages: first, as described above with respect to Fig. 1, the amount of water necessary to efficiently wash laundry in the tub is reduced due to the use of a recirculation pump, second, as described above, between recirculating intervals the water level in the tub 2 is high enough to provide an improved washing performance by wetting and washing the laundry with the washing water at the bottom of the tub 2. A further advantage is that the valve is actuated by the intermittent operation of the recirculation pump 12, which is advantageously controlled by the control unit. Thus additional cost- and maintenance-intensive (electrical) control or switching means for the valve are not needed to perform the above and below described washing cycle. At the end of the washing phase a spinning phase is preferably executed, wherein the drum rotation speed is increased to remove washing water from the laundry by centrifugal force. During and/or after a spinning phase of the drum the draining pump 18 is activated to drain water from the tub 2.

[0047] The washing phase is preferably followed by a rinsing phase. The rinsing phase preferably comprises several water supply phases, spinning phases and draining phases. The rinsing phase starts with a water supply phase, wherein fresh water is supplied to the tub 2 to rinse the laundry, i.e. to remove detergent from the laundry.

dry. With the beginning of the (second) water supply phase the recirculation pump 12 is operated for a recirculation interval, which has a length such that the laundry is thoroughly sprinkled and soaked with the fresh water.

After the recirculation interval, in particular subsequent to the end of the recirculation interval, a spinning and draining phase is advantageously executed, such that the supplied water is removed from the laundry 44 and the tub 2. Finally a last (third) water supply phase is preferably executed, wherein fresh water is supplied to the tub/ laundry and wherein the recirculation pump 12 is operated as described above. Then advantageously a last spinning and draining phase follows. Thereafter the washing cycle is finished and the laundry ready to take out of the washing machine or ready for further treatment, e.g. for drying in the washing machine, in case the washing machine has a dryer function.

20 Claims

1. Washing machine (1) comprising:

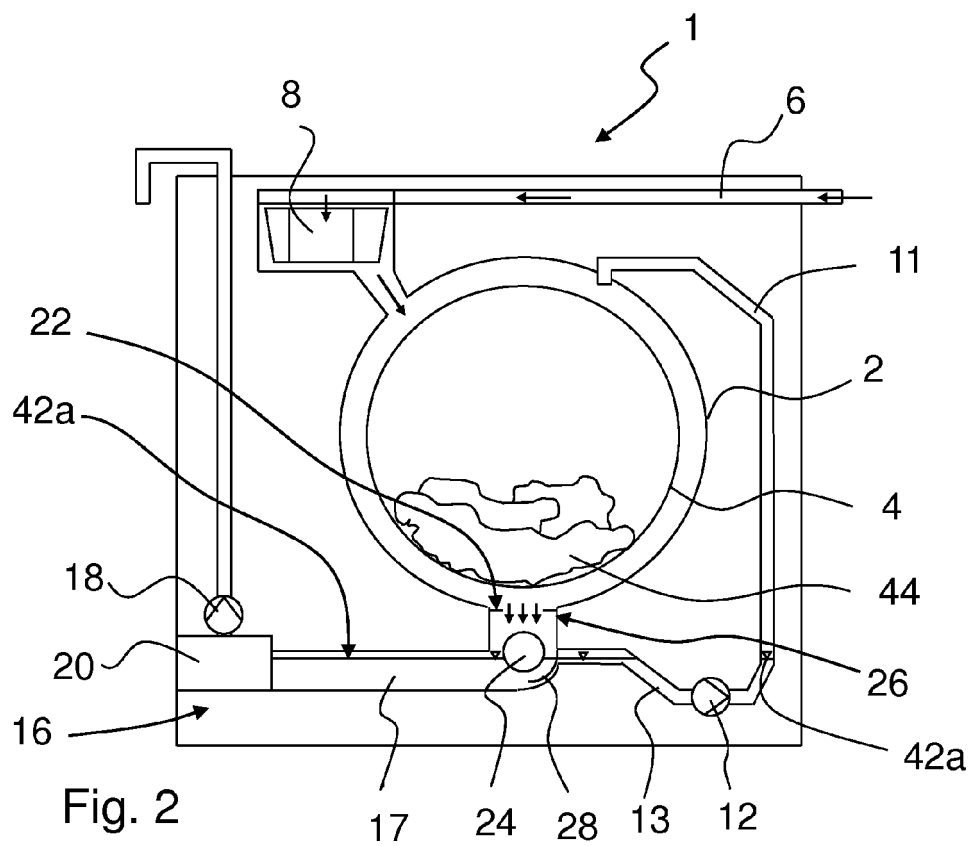
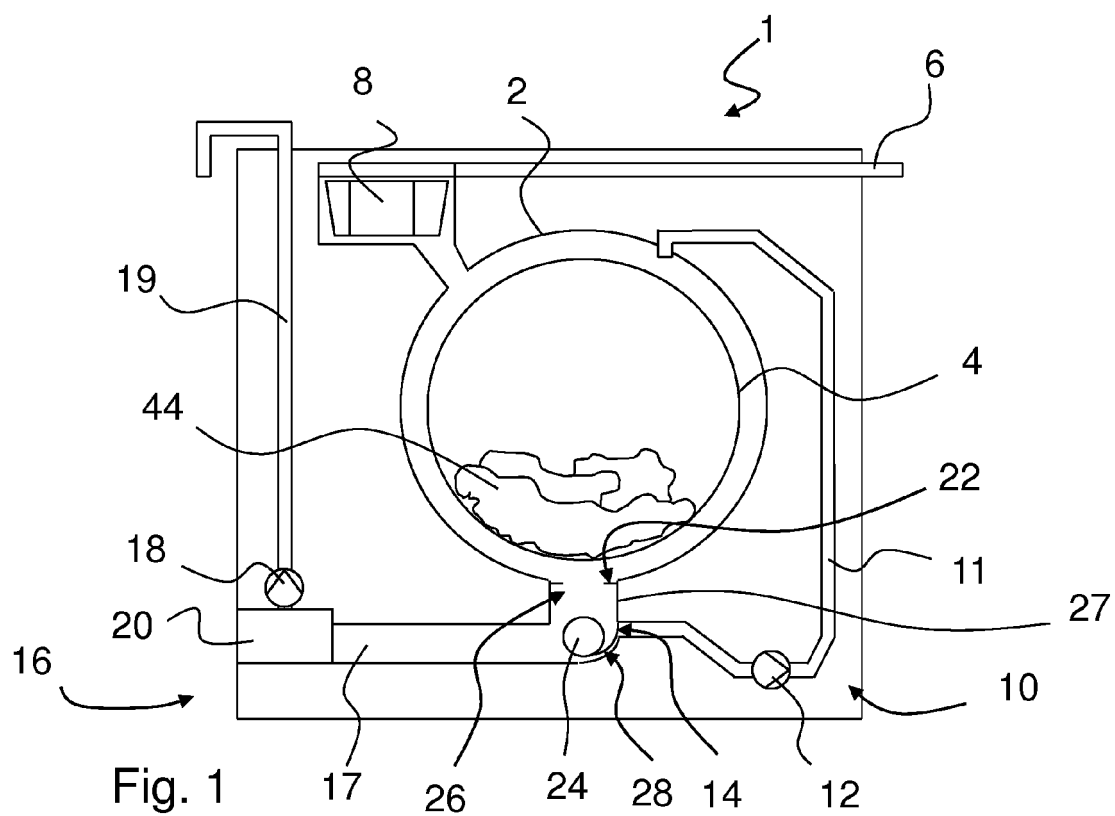
a tub (2),
a draining circuit (16), wherein the draining circuit (16) is fluidly connected to a lower portion of the tub (2),
a valve (26) arranged between the tub (2) and the draining circuit (16),
a recirculation circuit (10) fluidly connected to the tub (2), wherein an inlet (14) of the recirculation circuit (10) is positioned downstream a valve seat (22) of the valve (26), and wherein the recirculation circuit comprises a recirculation pump (12) for re-circulating fluid from the lower portion of the tub into the tub, and
a control unit adapted to control the washing machine to perform at least one washing cycle, wherein said valve (26) is adapted to be opened when the recirculation pump (12) is operated and is adapted to be closed when the recirculation pump (12) is not operated,

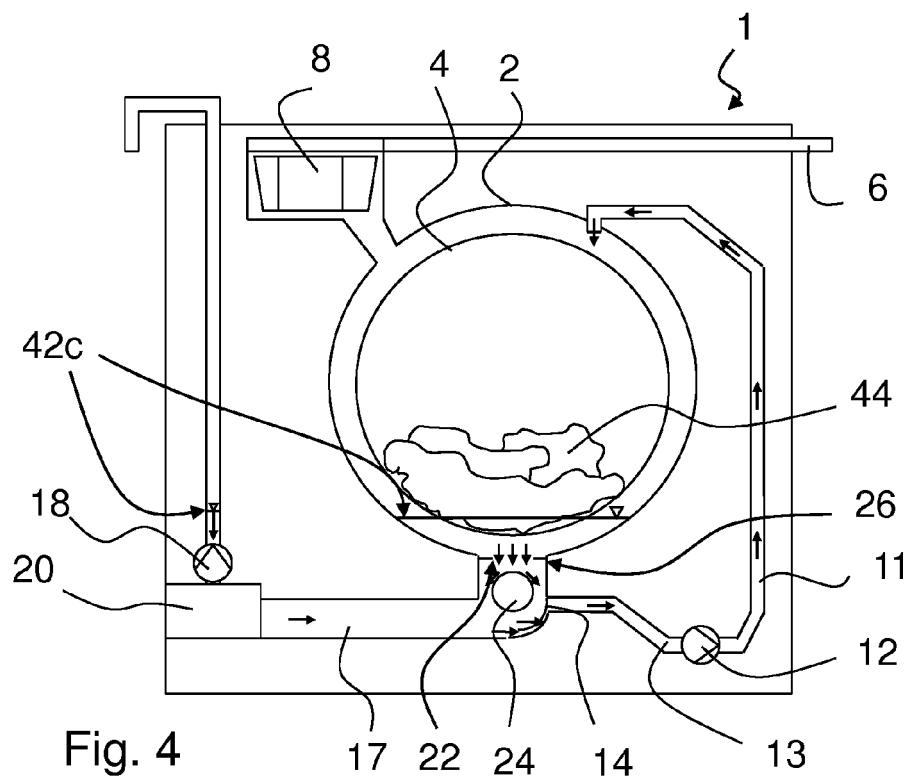
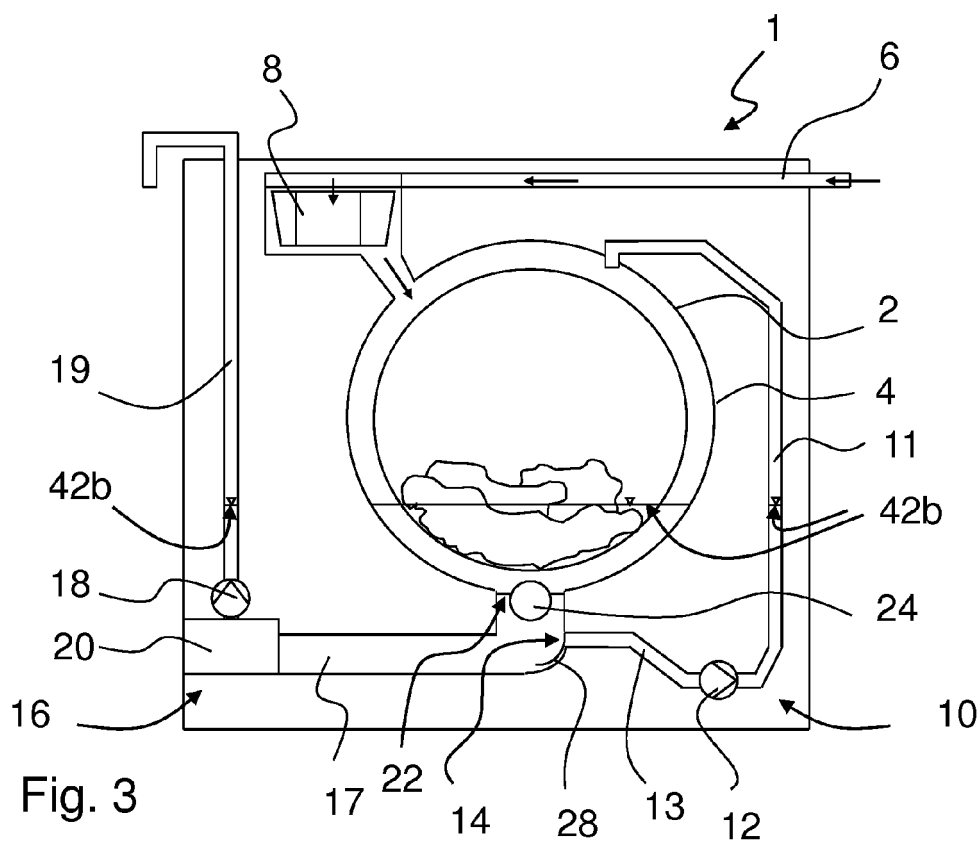
characterized in that

said control unit is adapted to operate said recirculation pump (12) intermittently during the at least one washing cycle.

2. Washing machine according to claim 1, wherein the washing machine comprises a heater element within the tub, and wherein the control unit is adapted to operate the recirculation pump intermittently after operating the heater element and/or wherein the control unit is adapted to operate the recirculation pump (12) for at least four recirculation intervals after operating the heater element, preferably at least six recirculation intervals, more preferably at least ten recirculation intervals.

3. Washing machine according to claim 1 or 2, wherein the control unit is adapted to operate the recirculation pump (12) less than 35% of the operating time of the at least one washing cycle, preferably less than 30%, more preferably less than 25%. 5
4. Washing machine according to any of the previous claims, wherein the control unit is adapted to activate the recirculation pump (12) for a recirculation interval every or about every 30 minutes, preferably every 20 minutes, more preferably every 10 minutes. 10
5. Washing machine according to any of the previous claims, wherein the control unit is adapted to operate the recirculation pump (12) during intermittent operation such that at least one recirculation interval has a length of less than 90 seconds, preferably less than 60 seconds, more preferably less than 30 seconds, in particular to operate the recirculation pump (12) intermittently in this way after a heating phase of the at least one washing cycle. 15
20
6. Washing machine according to any of the previous claims, wherein the washing machine comprises a water supply unit and wherein the control unit is adapted to operate the recirculation pump (12) for a recirculation interval of at least 5 minutes during an operation of the water supply unit and/or subsequent to an end of an operation of the water supply unit, preferably at least 10 minutes, more preferably at least 18 minutes. 25
30
7. Washing machine according to any of the previous claims, wherein the valve comprises a valve body (27) and the valve body has a movable closure element (24) adapted to be releasably engaged with the valve seat (26) to close or open the valve. 35
8. Washing machine according to any of the previous claims, wherein the movable closure element (44) is a floatable element, preferably of a spherical, cylindrical or ellipsoidal shape or a shape substantially representing the same or a combination therefrom. 40
9. Washing machine according to any of the previous claims, wherein the valve (26) is a check valve, in particular a ball check valve or a swing check valve. 45
10. Washing machine according to claim 1, wherein the control unit is adapted to operate the recirculation pump intermittently before operating a or the heater element and/or wherein the control unit is adapted to operate the recirculation pump (12) for at least two recirculation intervals before operating a or the heater element, in particular after flowing water and detergent into the tub. 50
55
11. Method of operating a washing machine, in particular a washing machine according to any of the previous claims, wherein the washing machine (1) comprises:
 - a valve (26) arranged at a bottom region of a tub (2),
 - a recirculation circuit (10) comprising a recirculation pump (12) for recirculating water, wherein an inlet (14) of the recirculation circuit is connected to a valve body (27) of the valve, the inlet being arranged below a valve seat (22) of the valve, and
 - a control unit adapted to control at least one washing cycle of the washing machine, wherein the valve (26) is adapted to be opened when the recirculation pump (12) is operated and is adapted to be closed when the recirculation pump (12) is not operated;
 - characterized by** comprising: intermittently operating the recirculation pump during the at least one washing cycle.
12. Method according to claim 11, comprising heating the water in the tub using a heating element arranged within the tub, and intermittently operating the recirculation pump (12) after the heating phase and/or operating the recirculation pump (12) for at least four recirculation intervals after operating the heater element, preferably at least six recirculation intervals, more preferably at least ten recirculation intervals.
13. Method according to claim 11 or 12, comprising activating the recirculation pump (12) for a recirculation interval every or about every 30 minutes, preferably every 20 minutes, more preferably every 10 minutes.
14. Method according to any of claims 11 to 13, comprising operating the recirculation pump intermittently such that a recirculation interval has a length of at least 90 seconds, preferably at least 60 seconds, more preferably at least 30 seconds.
15. Method according to any of claims 11 to 14, comprising intermittently operating the recirculation pump (12) before starting a or the heating phase and/or operating the recirculation pump (12) for at least two recirculation intervals before starting a or the heating phase, in particular after flowing water and detergent into the tub.





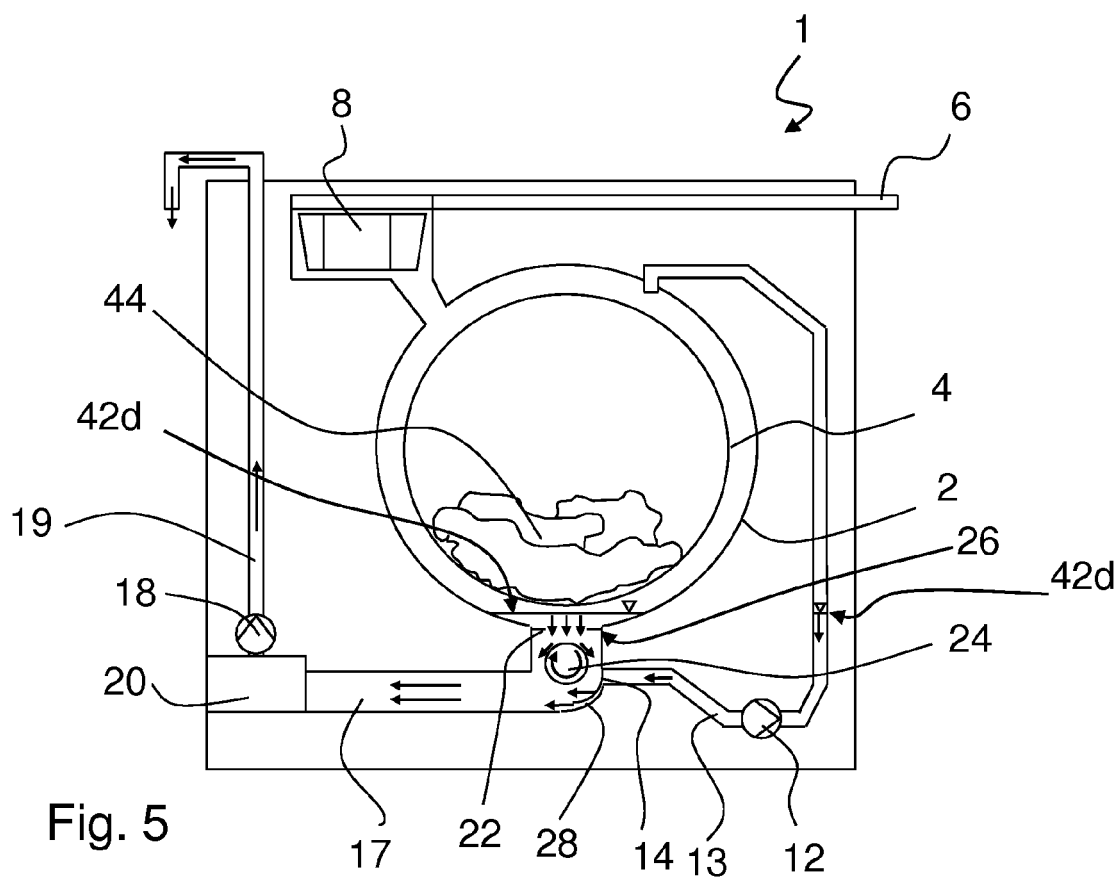


Fig. 8

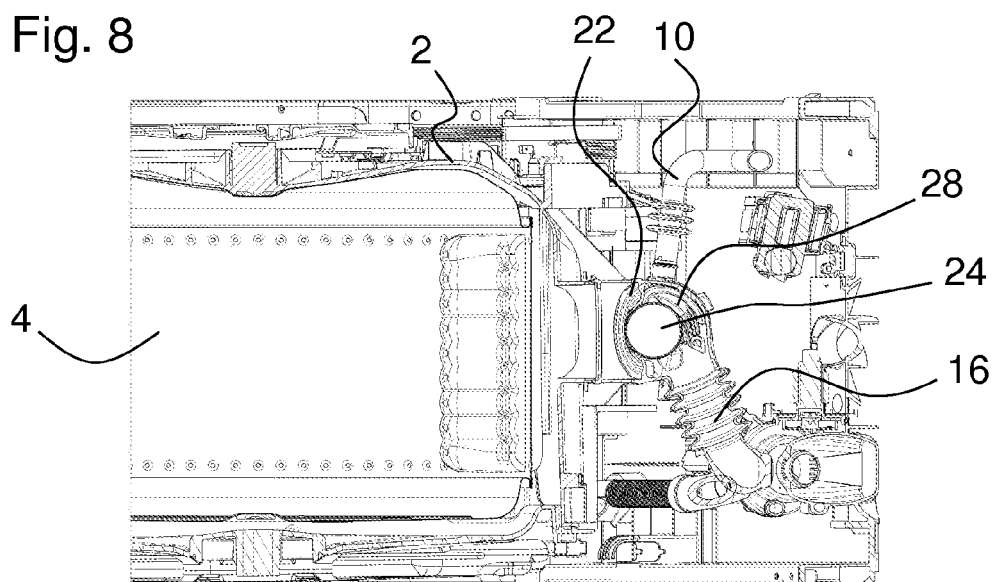


Fig. 6

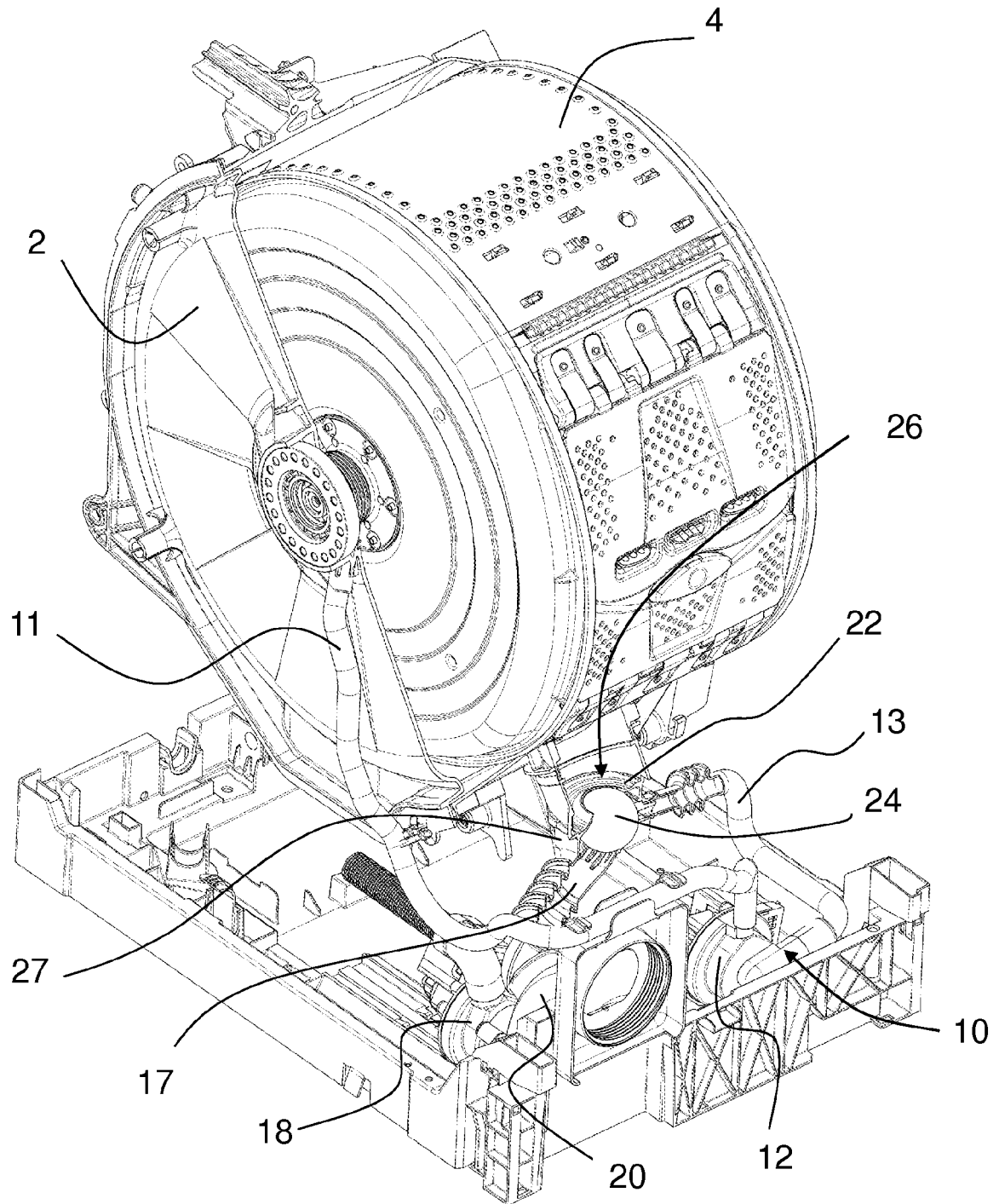
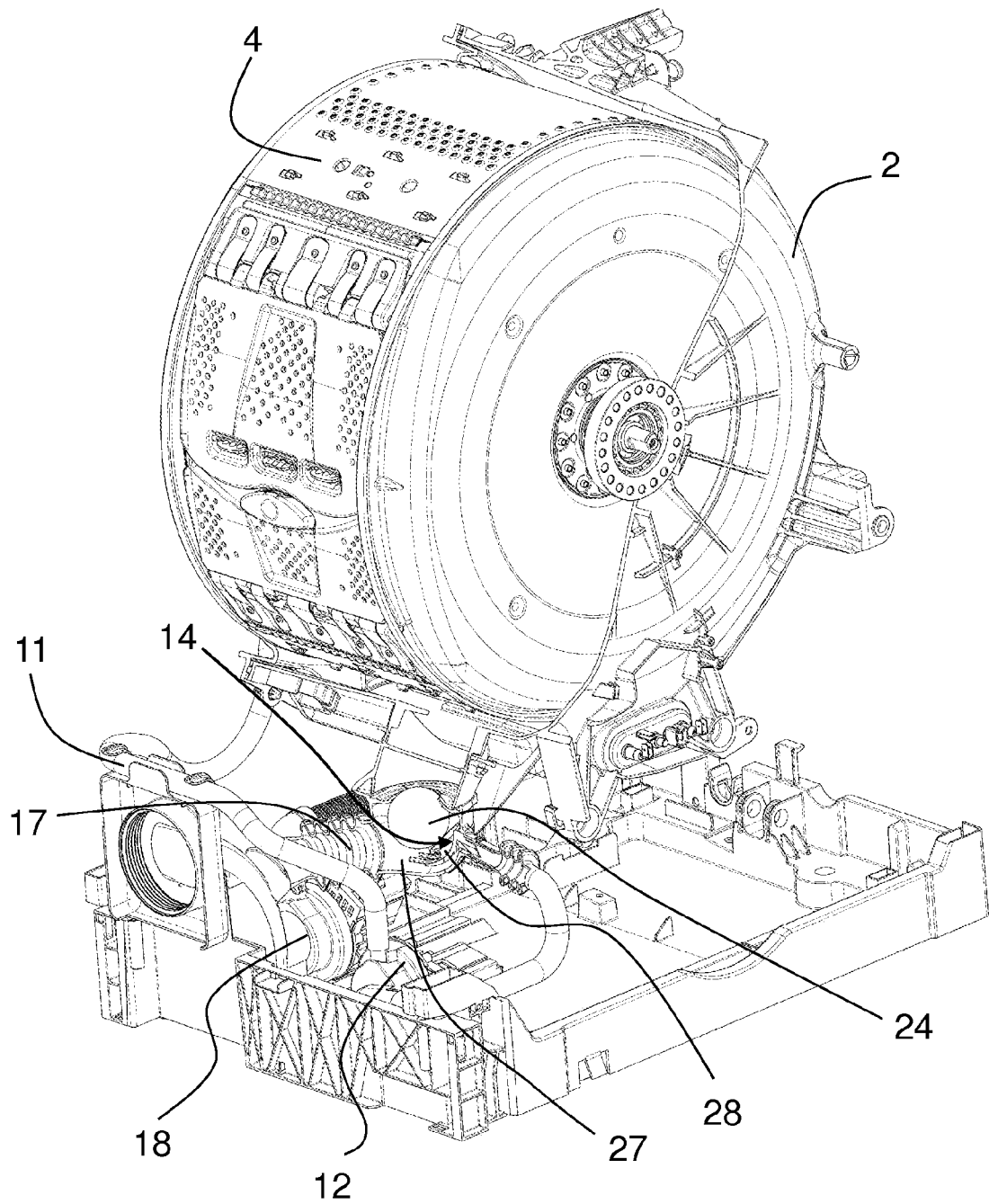
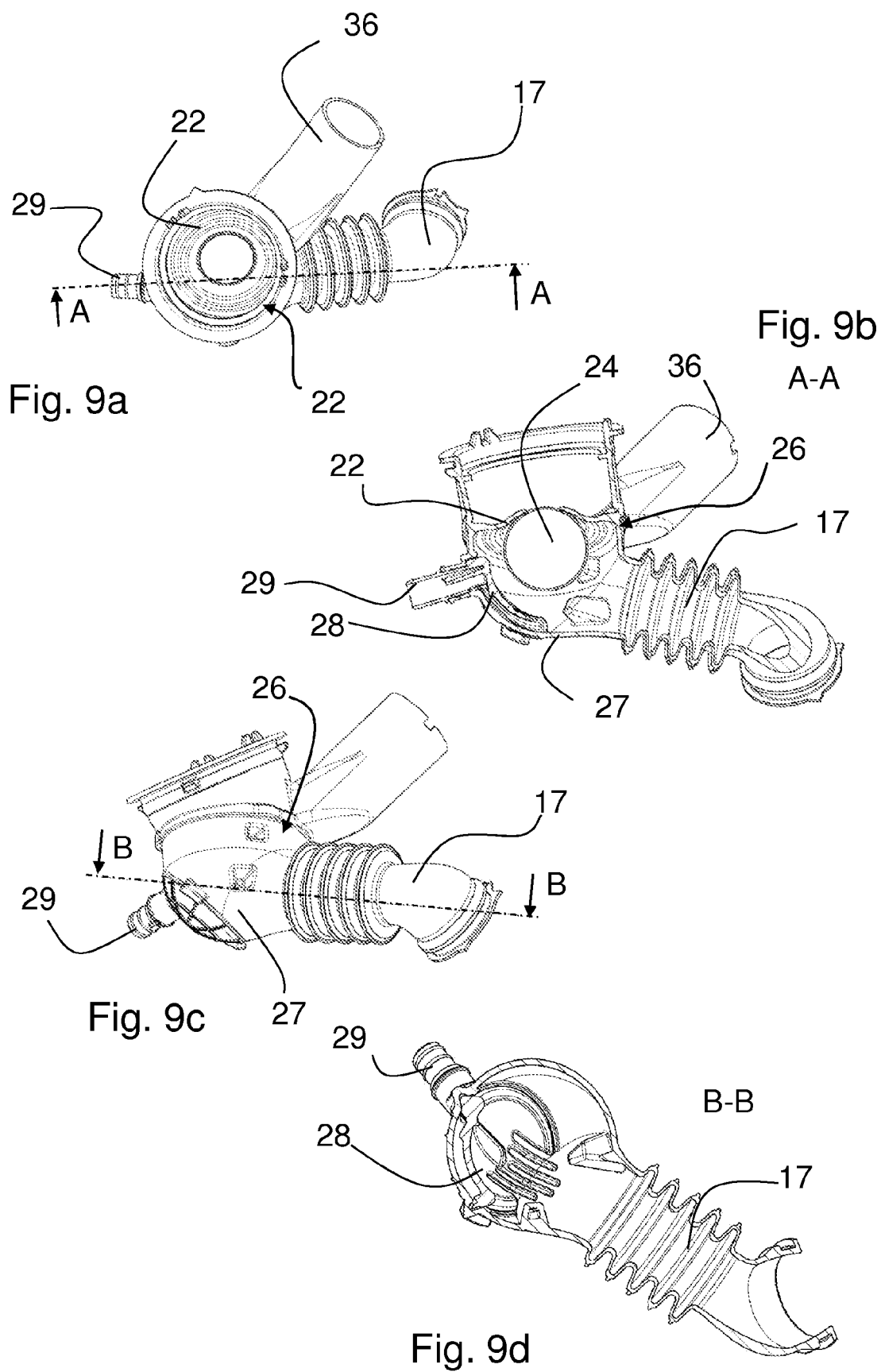


Fig. 7





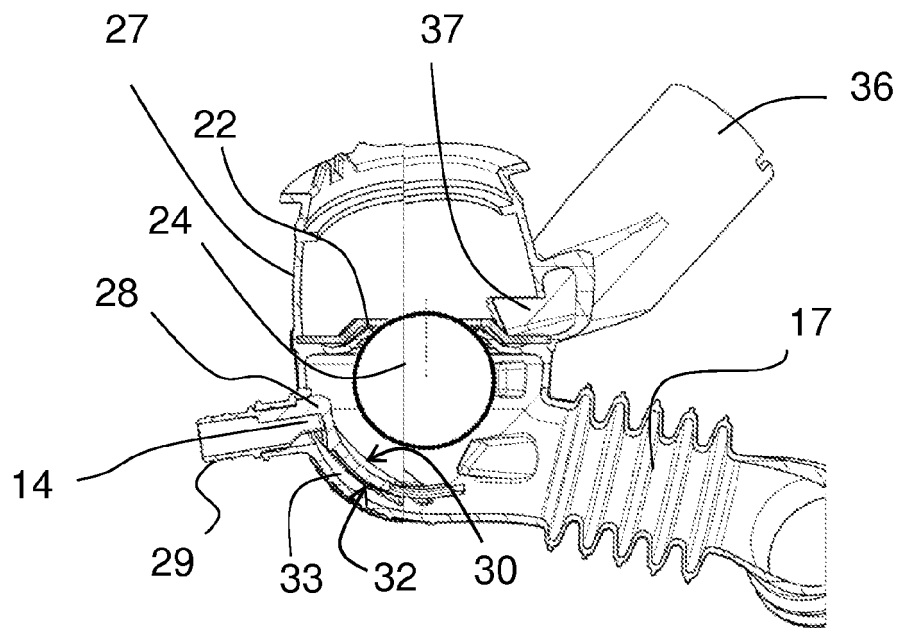


Fig. 10

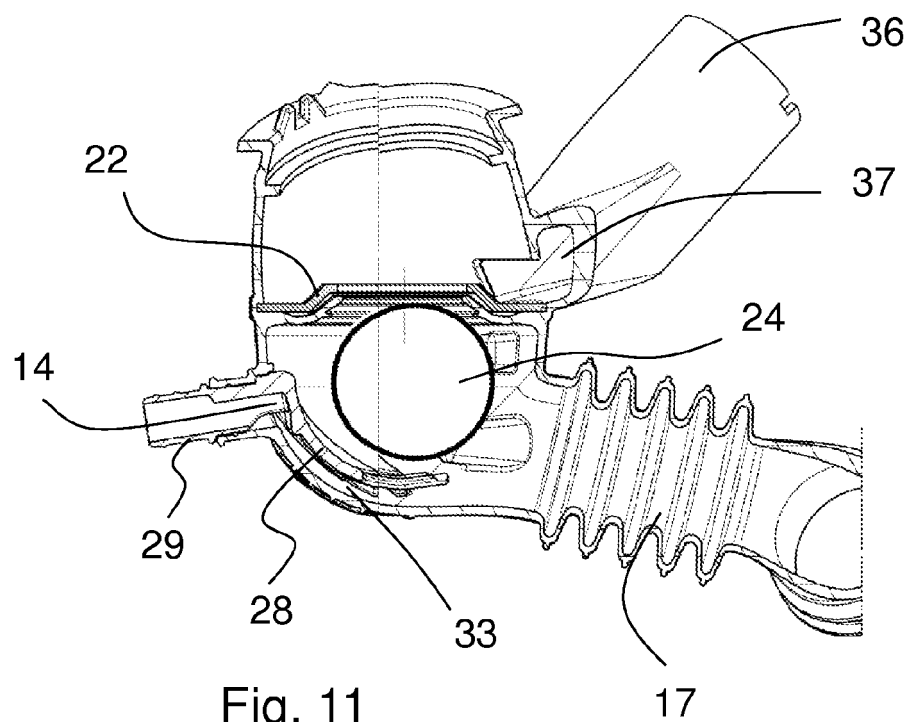


Fig. 11

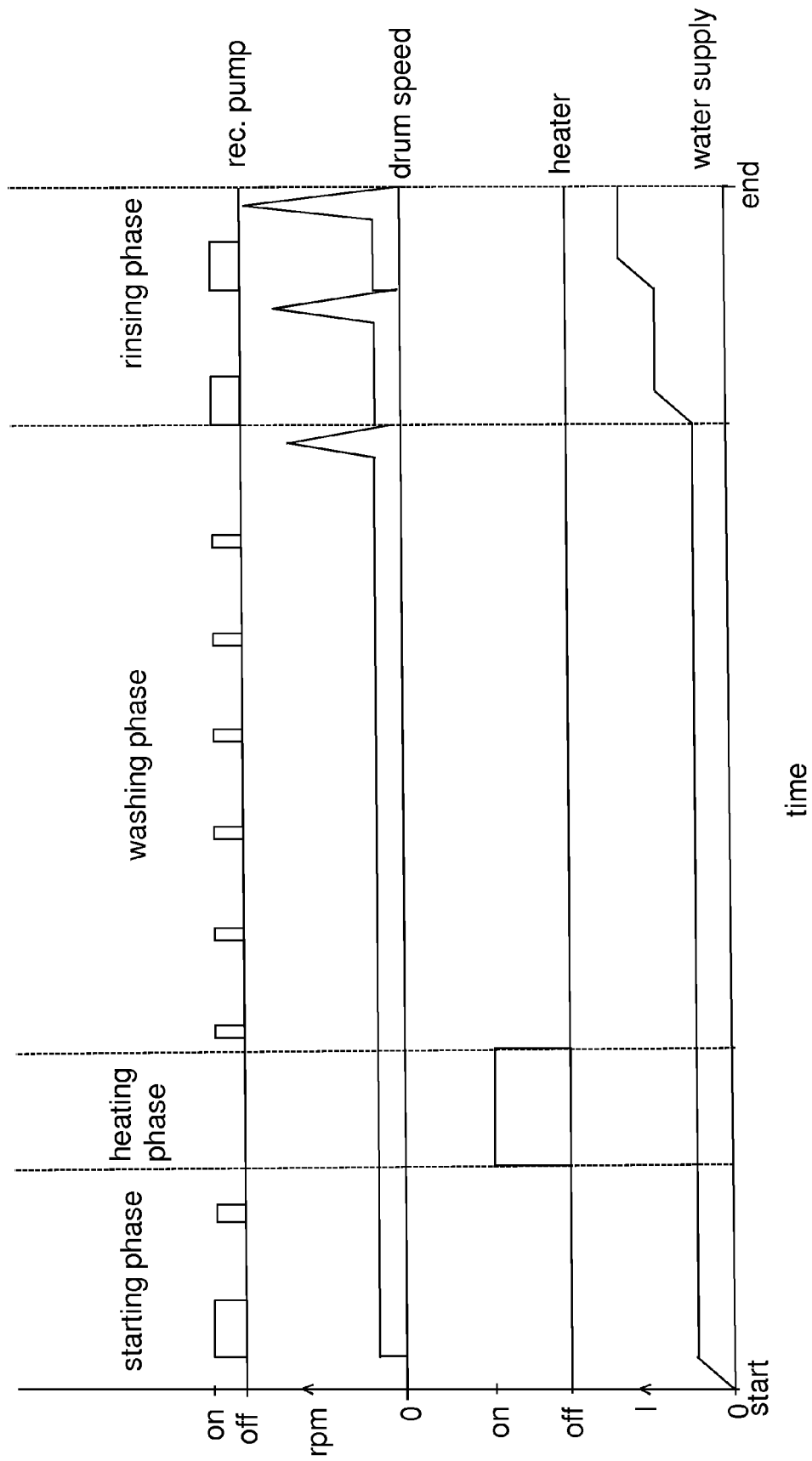


Fig. 12



EUROPEAN SEARCH REPORT

Application Number
EP 11 16 9846

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2006/000030 A1 (SHAFFER TIMOTHY S [US] SHAFFER TIMOTHY SCOTT [US]) 5 January 2006 (2006-01-05) * abstract * * paragraphs [0019], [0027], [0028], [0029], [0033]; figures 1, 2 *	1,11	INV. D06F39/08
A	EP 2 314 753 A1 (ELECTROLUX HOME PROD CORP [BE]) 27 April 2011 (2011-04-27) * claims 1, 8 *	1-15	
A	FR 2 789 451 A1 (SIEBE APPLIANCE CONTROLS SA [FR]) 11 August 2000 (2000-08-11) * claim 1; figure 1 *	1,7-9	
A	DE 199 60 265 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 21 June 2001 (2001-06-21) * column 3, line 3 - line 13 * * column 4, line 17 - line 31 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 4 November 2011	Examiner Westermayer, Wilhelm
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 16 9846

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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04-11-2011

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 2006000030	A1	05-01-2006	CA	2482375 A1	30-12-2005
			US	2006000030 A1	05-01-2006

EP 2314753	A1	27-04-2011	CN	102041654 A	04-05-2011
			EP	2314753 A1	27-04-2011

FR 2789451	A1	11-08-2000	NONE		

DE 19960265	A1	21-06-2001	DE	19960265 A1	21-06-2001
			EP	1604058 A1	14-12-2005
			JP	2003516837 A	20-05-2003
			US	2002178764 A1	05-12-2002
			WO	0144557 A1	21-06-2001

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1204792 B1 [0002]