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(54) **A METHOD FOR OPERATING A WASHING MACHINE AND WASHING MACHINE**

(57) A washing machine (11) comprises a drum (28) for washing laundry therein, a drive motor (30) for the drum, and a drum receiving container in which the drum is arranged rotatably about an axis of rotation. Protrusions (42) are provided on the inside of the circumferential wall of the drum receiving container, each protrusion having a closable inside space which is accessible by openings (45). The openings can be opened and closed

by controllable closing means (48). A washing machine control is connected with the pump (21) and with a drive motor control for the drive motor of the drum. The rotational position of the drum is exactly determined. An unbalance is detected and located exactly. By letting water out of one or more of the protrusions in defined manner, the unbalance can be reduced or even eliminated.

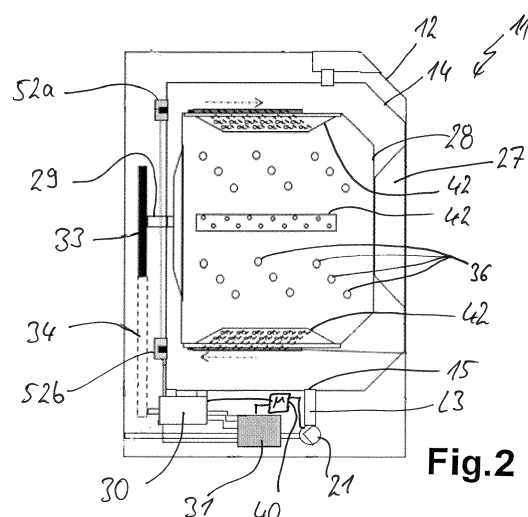


Fig.2

Description

Field of application and prior art

[0001] The invention relates to a method for operating a washing machine and also to such a washing machine.

Problem and solution

[0002] It is an object of the invention to provide a method for operating a washing machine as well as to provide a washing machine adapted to apply this method, with which method and washing machine problems of the prior art can be solved and, in particular, it is possible to realize an advantageous way of balancing the drum of the washing machine so that only minimum or no vibration is caused by an uneven distribution of laundry in the drum.

[0003] This problem is solved by a method for operating a washing machine having the features of claim 1 and also by a washing machine having the features of claim 14. Advantageous and preferred embodiments of the invention are the subject-matter of the further claims and will be explained in more detail below. In so doing, some of the features will be explained only for the method or only for the washing machine. However, irrespective of this, they are intended to be able to be applied both to the method and also to the washing machine on their own and independently of one another. The wording of the claims is incorporated into the description by express reference.

[0004] The washing machine comprises a drum for washing laundry therein and a drive motor for the drum, wherein preferably this drive motor is formed as a direct drive, being directly connected to the drum without any drive belt or the like. Even more preferably, the drive motor is digitally controlled, in particular a DC or a BLDC brushless motor. A drum receiving container is provided in which the drum is arranged rotatably about an axis of rotation, preferably being a horizontal axis. The washing machine further has a water guide comprising a water inlet from an external water supply pipe or supply connection into the washing machine, water pipes and valves, a water outlet out of the washing machine, an inlet device for letting water into the drum, and a container outlet at the drum receiving container. A pump is provided, this pump being connected by means of water pipes on the one hand to the container outlet and on the other hand to the inlet device. On the inside of the circumferential wall of the drum receiving container, protrusions are provided, preferably being longitudinally extended parallel to the axis of rotation. Each protrusion has a closable inside space, which inside space can be accessed and closed by means of openings, the openings being openable and closable by means of controllable closing means, such that water can flow into the inside spaces of the protrusions or flow out of them. A washing machine control is provided being connected with the pump and

with a drive motor control for the drive motor of the drum. The washing machine control is adapted to monitor operational parameters of the drive motor, in particular the drive motor current, and to determine if an unbalance occurs in the drum during the rotation of the drum, wherein this unbalance is visible in these operational parameters of the drive motor. The washing machine control is also connected to the controllable closing means for the protrusions for controlling the same, so they can be opened or closed on demand by the washing machine control. In particular, they can be opened to let out water stored therein.

[0005] For reducing or eliminating the above-mentioned unbalance, the washing machine control controls the closing means according to one of two options described in the following. In a first option, a part of the water that has been stored in the inside spaces of the protrusions is let out by selectively and at least partially opening the closing means until the unbalance has been reduced below a previously determined unbalance threshold, or until the unbalance has been eliminated. In a second option, water is let into the inside spaces of the protrusions by selectively and at least partially opening the closing means until the unbalance has been reduced below a previously determined unbalance threshold, or until the unbalance has been eliminated. In a further third option, both the first and the second option can be combined such that water is let out of one or two protrusions, and at the same time water is let into one or two protrusions. This third option allows for a wider range of total unbalanced weight to be compensated for. The advantage of the invention lies not only in providing a method for operating a washing machine as well as such a washing machine that provides for any option to reduce an unbalance in the drum, but also to do this during turning the drum, even with high rotational speed. There is no need to slow down the drum or to even stop it to rearrange the laundry inside the drum, which often cannot be achieved in a satisfying manner, and also takes considerable amount of time and energy to slow down the drum and to speed it up again after having tried to rearrange the laundry.

[0006] In an embodiment of the invention, the washing machine control knows from the motor control the exact rotational position of the drum and thus the position of each protrusion and compares it with indications of an unbalance in the operating parameters or, more specifically, in the motor current of the drive motor. The washing machine control determines therefrom out of which protrusion water must be let out and/or into which protrusion water must be let in to reduce or to remove the unbalance.

[0007] In a further embodiment of the invention, the washing machine control determines the unbalance as a concrete weight indication, in particular as a number together with a weight indication in grams.

[0008] It can further be determined, preferably by monitoring the motor current and the position of the drum as mentioned before, where this unbalance exists or in

which exact position of the drum the unbalance is present. This serves to determine therefrom out of which protrusion water must be let out and/or into which protrusion water must be let in to eliminate this unbalance.

[0009] In a further embodiment of the invention an external position sensor is provided on the drum or on the drive motor of the drum to know the exact position of the drum, preferably the rotational position. From the rotational position of the drive motor the rotational position of the drum can be derived due to their mechanical connection, so the easier way of providing the sensor on the drive motor can be chosen. Such a sensor can for example be an incremental encoder, which can easily be integrated into the drive motor, for example onto the motor shaft or onto the rotor. The position sensor can be connected either to the washing machine control or to the motor control, wherein in the end this position information is given to the washing machine control.

[0010] In a refined embodiment of the invention a calibration of the drum rotational position is made via the motor control, in particular the calibration is made by turning the drum slowly for two to four turns and then calibrating a zero position of the drum. This zero position is then passed on to the washing machine control for use of this zero position to determine the drum position.

[0011] In a further embodiment of the invention the protrusions are designed in such a way that the openings with the closing means either point into the interior of the drum or point outwards into an intermediate space between the drum and the drum receiving container. This can serve for a different way in which water is let into them and let out of them. Furthermore, when the closing means point into the interior of the drum, water let out of the protrusions can be dispensed onto the laundry below them simply by gravity, which allows for a selective or directed wetting of laundry with water. Of course this can only be made when the drum does not rotate very fast or, even better, when it stands still. With high rotational speed of the drum, water will not leave the protrusions through such closing means even if they are fully open due to the centrifugal force. But, when the closing means point outwards into an intermediate space between the drum and the drum receiving container, the water can be let out when the drum rotates so fast that the centrifugal force throws the water out or when the closing means are in a rotational position so low that the water will simply flow out and drop downwards by gravity.

[0012] It is possible that the protrusions are designed separate as separate parts from the drum. Preferably, they are detachably arranged on the inside of the drum such that they can be removed for repair or cleaning purposes.

[0013] In a further embodiment of the invention, the closing means and the protrusions are designed in such a way that a closing means closes or opens all openings on one single protrusion simultaneously and in the same way and/or to the same degree. This may facilitate the construction and assembly of the protrusion. Preferably,

all the protrusions are of the same type and/or are identical.

[0014] It may be provided that the closing means can be actuated magnetically, an activation magnet for the closing means preferably being arranged on the outside of the drum receiving container in such a way that it interacts with the magnetically actuatable closing means when the magnetically actuatable closing means moves past the activation magnet during rotation of the drum. The activation magnet should be mounted in a fixed position in the washing machine close to the drum, preferably on the drum receiving container or on its outside. The activation magnet can be an electro-magnet for better control of it, so the closing means can be actuated exactly when they are passing the activation magnet. As in practice only one or at most two closing means should be actuated to let out water, the magnetic activation should be quickly started and quickly stopped again.

[0015] In an advantageous embodiment of the invention it may be provided, before the start of reducing or eliminating an unbalance by opening any of the closing means, that all the protrusions are filled with water, preferably filled to the maximum. In this case, in particular for reducing or eliminating the unbalance, water is only let out of any one of the protrusions, and none is let in.

[0016] In a further embodiment of the invention the filling of the protrusions with water takes place in such a way that water is present in the lower region of the drum receiving container, and one protrusion is moved into this water. Then the closing means open the openings and water flows into the inside spaces of the protrusions. This is made such that the protrusions are successively brought into the lower region of the drum receiving container by rotation of the drum. This may preferably be done successively for all protrusions, wherein in particular the drum and the protrusion are not moved when the water is let into each protrusion.

[0017] In an embodiment of the invention, the protrusions may be filled with water from the outside through water lines which form distribution lines and which extend into each of the protrusions. In similar manner, such water lines which form distribution lines and which extend into each of the protrusions may be used to let water out of a protrusion or out of all the protrusions. The distribution lines may be provided with valves that can be controlled by the washing machine control to open or to close and, in this way, to assist in letting water in or out. Preferably a further water line is running to the distribution lines through a rotary shaft of the drum, which rotary shaft serves for bearing the drum in the drum receiving container. Such a construction may in fact make some mechanical effort, but it allows for a direct, controlled and very exact way of filling or emptying the protrusions.

[0018] In an embodiment of the invention water is introduced into the interior of the drum via the protrusions or through the protrusions and their openings into the interior of the drum for a washing process. In this case, the protrusions may form at least a part of or comprise

the inlet device. This can be especially be made with the distribution lines and the further water line described before. It is also possible to let in water which is already mixed with washing substances. This may mean that two ways for letting water into the drum are provided.

[0019] In a possible embodiment of the invention either the drum is rotated at a rotational speed of less than 20 rpm or less than 10 rpm, wherein a protrusion is moved into the upper region or into the uppermost region of the drum receiving container. Alternatively, the drum may stand still with a protrusion in the upper region or in the uppermost region of the drum receiving container. Then water may be discharged from out of the protrusion onto the laundry located thereunder in the drum, wherein the water simply falls down by gravity. This may be repeated several times with one protrusion after the other, wherein in particular the inside spaces of the protrusions are filled with water by rotating the drum in such a way that, when a protrusion is in the lower region or lowermost region of the drum receiving container, water being present there enters the inside space of the protrusion to fill the protrusion.

[0020] In another possible embodiment of the invention at least three similar or identical protrusions are arranged on the inside of the drum. Preferably, no more than four protrusions are provided.

[0021] These and further features may be gathered from the claims and also from the description and the drawings, with the individual features being capable of being implemented in each case by themselves or severally in the form of sub-combinations in an embodiment of the invention and in other fields and being capable of constituting advantageous and independently patentable versions for which protection is claimed here. The subdivision of the application into individual sections and intermediate headings does not restrict the general validity of the statements made under these.

Brief description of the drawings

[0022] Exemplary embodiments of the invention are schematically illustrated in the drawings and will be explained in more detail below. In the drawings show:

- Fig. 1 a schematic side view of a washing machine according to the invention with basic construction,
- Fig. 2 a detailed side view on the washing machine of Fig. 1,
- Fig. 3 a side view onto a protrusion mounted to the inside of the drum, the protrusion having water holes and closure arms,
- Fig. 4 a front view onto the protrusion of Fig. 3,
- Fig. 5 a side view of a closure arm of Fig. 3,

- Fig. 6 a front view onto the drum with three protrusions,
- Fig. 7 a detailed side view on the washing machine similar to Fig. 2 showing an alternative of providing the protrusions with water,
- Fig. 8 a front view onto the drum of Fig. 7,
- Fig. 9 another front view onto the drum similar to Fig. 6 with an unbalance due to a piece of laundry,
- Fig. 10 a diagram of the current of the drive motor, and
- Fig. 11 a part diagram of Fig. 10 with explanation to the course of the current due to an unbalance.

Detailed description of the embodiments

[0023] In Fig. 1 a washing machine 11 according to the invention is shown in a schematic side view. The washing machine 11 has a housing 12, in which a drum receiving container 14 is arranged. The drum receiving container 14 has a container outlet 15 with a water pipe L4 at its lowest region as is known in the art. A valve V3 is arranged shortly beneath and after this container outlet 15 in the water pipe L3. Valve V3 serves to let out water of the drum receiving container 14 via container outlet 15 and water pipe L3 or not, depending on the washing process.

[0024] A filter 17 is arranged after valve V3, being connected with an inlet. Another inlet of the filter 17 is connected via a water pipe L5 to an inlet valve V1 which is connected to a fresh water inlet 19 into the washing machine 11. An outlet of the filter 17 is connected via a water pipe L4 to a pump 21. The pump 21 is connected via a water pipe L2 to a three-way valve V2. One outlet of the valve V2 is connected to a wastewater outlet 23 for letting water out of the washing machine 11. Another outlet of the valve V2 goes via a water pipe L1 to a water inlet device 25 that serves to bring or spray water into the drum receiving container 14 or, more specifically, into a drum 28 being arranged inside the drum receiving container 14 in well-known manner. Specific embodiments of the water inlet device 25 are basically also known in the art. The water inlet device 25 may for example be a kind of spray device. Access to the drum 28 is possible via a conventional door, which is not shown here.

[0025] In Fig. 1, the drum 28 is schematically shown with a door 27. The drum 28 is driven by a drive motor, which in this embodiment not shown but could be a so-called direct drive motor. A washing machine control 40 is also shown in Fig. 1, which is connected to the pump 21 and to the drive motor. Furthermore, the control 40 is of course connected to all the valves in the washing machine 11 as well as to the water inlet device 25.

[0026] The more detailed drawing of Fig. 2 shows in more detail on the one hand the drum 28 inside the drum

receiving container 14. The drum 28 is shown with its rotary shaft 29, on which in this embodiment a pulley 33 is mounted. The pulley 33 is driven via a belt 34, which again is driven by a drive motor 30. In this case, the drum 28 is not driven via a direct drive as is also optional here, but via a so-called belt drive. The drive motor 30 is powered by a motor control 31, which is also connected with the washing machine control 40. In the view of Fig. 2, most of the water pipes and the valves are left aside for better and easier understanding.

[0027] As described before, position sensors which are not shown here are either provided in the drive motor 30 as integrated position sensors, which is basically known in the art. Alternatively, such position sensors could be provided together with the drum 28, for example by providing permanent magnets on the outside of drum 28 and, with a little distance to them, Hall sensors or other magnetic sensors on the drum receiving container 14. These magnetic sensors can sense when the permanent magnets pass them by with the drum 28 rotating.

[0028] The drum 28 is provided with drum holes 36 for letting water out of the drum 28 and into the drum receiving container 14, where it may be let out via the container outlet 15 and the water pipe L3. Furthermore, protrusions 42 are shown being mounted to the inside of the drum 28. These protrusions 42 will be shown in more detail hereinafter in the following figures. Basically, such protrusions 42 are known in the art and are provided in most washing machines. They serve to mechanically move and also to divide pieces of laundry in the drum 28 when the drum 28 is rotated. As has been described before, the protrusions 42 in this case are provided with more functionalities. For this reason, Fig. 3 is a more detailed view of one such protrusion 42. The protrusion 42 is mounted to the inside of the drum 28, for example screwed to it, wherein the drum 28 has for this purpose a cutout with a certain shape. On the one hand, the protrusion 42 is hollow and thus has a specific inner volume in its inside space 43. As can be seen from the front view of Fig. 4 onto the protrusion 42, its shape is a kind of truncated pyramid. This shape could of course also be different, and mainly as is being viewed advantageous for the above-mentioned mechanical function of the protrusion 42 in the washing process. A number of openings 45 arranged along two rows are provided on each lateral side of each protrusion 42. These openings 45 connect the inside space 43 to the outside or, respectively, water can flow through these openings 45 into the inside space 43 or out of it. This shows that the inside space 43 is basically accessible via the openings 45.

[0029] It is easily recognized that various ways to close and open the openings 45 are conceivable. One option would be a radio control with a battery actuated actor or valve, respectively, being provided on or in the protrusions. In the embodiment shown here, a slide 47 is provided, which is mounted in a guided manner for a linear movement on the outside of the drum 28. On top of slide 47, a number of closing arms 48 is provided, which arms

are pointing into the drum 28. The closing arms 48 are arranged such that in one position according to Fig. 3 they do not block the openings 45, such that the inside space 43 is kind of open to the outside. Water may freely flow in or flow out. If the slide 47 according to Fig. 3 is moved linearly to the left, the closing arms 48 move from their position shown in dashed lines to the left to cover and consequently close the openings 45 from and to the inside. In this scenario, the inside space 43 of the protrusion 42 is closed and water may neither leave nor enter this inside space 43.

[0030] An actuation of the slide 47 may be effected in various ways again, for example with an electromagnet or with a motor. In this example, it is made with the help of a magnet 50, which is a permanent magnet in this case. When attracting the magnet 50 from the left, the slide 47 moves to the left for the closing arms 48 to close the openings 45. If the magnet 50 is repelled, the slide 47 moves back again to the right into the position according to Fig. 3, and the closing arms 48 open the openings 45 again. Of course, other ways of moving the slide 47 or opening and closing the openings 45 can be easily found by a person skilled in the art. It is also possible to provide a spring means pulling the slide 47 into the open position of Fig. 3, such that only when the slide 47 is pulled to the left via the magnet 50 the openings 45 are closed. This of course could also easily be reversed, such that a spring serves to hold the closing arms 48 basically in a closing position for the openings 45 and a force is needed for opening them.

[0031] Fig. 5 shows the slide 47 with the closing arms 48 in isolated form. The magnet 50 is fixed to its left end, which also points to the left in Fig. 2. The sectional view of Fig. 4 shows that the closing arms 48 are arranged directly on the inside of the openings 45. They must protrude through the drum 28, for which reason the drum 28 may have respective cutouts or slits. They must be watertight to the outside such that water may not enter or leave the inside space 43 other than through the openings 45.

[0032] As will be explained later on, the openings 45 according to Fig. 3 point inside the drum 28, such that water leaving the inside space 43 of the protrusion 42 will fall down onto any laundry being present in the drum 28 beneath it. This may be used, as has been explained before, specifically to bring water onto the laundry in a very targeted or defined way. On the other hand, it does not allow letting water out of the protrusion 42 without wetting the laundry, which especially for a dry spinning process of the washing machine would be rather negative. Furthermore, if water shall be let out of the protrusions 42 to reduce or eliminate an unbalance due to unevenly distributed laundry inside the drum 28, the centrifugal force will most probably not allow for water to leave at least through the upper row of openings 45. So, when looking at Fig. 2, only a part of all the water inside the protrusion 42 can be left out, which would limit the function of this reduction of an unbalance. In this regard,

any openings into the inside space 43 should be on a radial outside location of protrusion 42, for example as an opening in the drum 28. Such an opening could also be closed or opened via a slide 47 similar to the one shown in Figs. 3 to 5, forming a kind of linear valve.

[0033] From Fig. 2 a way of actuating the slide 47 can be taken. On the drum receiving container 14, two actuation magnets 52 are located which are situated as close to the point where the slides 47 with the respective magnets 50 will pass them with the rotating drum 28 in a direction parallel to the rotary shaft 29. The upper actuating magnet 52a serves mainly for opening or closing the openings 45 to let out water in a controlled way to reduce or eliminate any unbalance of the drum 28. Of course, the actuating magnet 52a can also serve to let water out of the protrusion 42 if the drum stands still or moves only very slowly to bring this water onto laundry located underneath it in a defined way. This is less for the purpose of reducing any unbalance, but for a way to specifically wet the laundry inside the drum 28.

[0034] The lower actuation magnet 52b can also open or close the openings 54. When the drum 28 is rotating fast, it can of course also be used to let out water in a controlled way to reduce any unbalance. Furthermore, it may be used when the drum 28 stands still or is rotating very slowly to open the openings 45 and to fill the inside space 43 with water that is present in the lower region of the drum receiving container 14, for example 3cm to 8 cm high. For this reason, the valve V3 in the water pipe L3 can be closed. It is for example possible to slowly move each of the protrusions 42 into the lowermost position and then to open the openings via the actuating magnet 52b. After some seconds, if the protrusions 42 are fully submersed and filled with water, they can be moved on. This is an easy way to fill them rather quickly. Before rotating the drum 28 further, the actuating magnet 52b will close the openings 45 via the movable slide 47 with the arms 48, and the drum 28 is rotated somewhat for the next protrusion 42 that has to be filled to come into the lowermost region. Such a filling of the protrusions 42 with water can be done before a spinning process is started, wherein of course the water present in the lower region of the drum receiving container 14 should be let out via the container outlet 15.

[0035] The magnets 50 of the slides 47 may also for example serve as the above-mentioned magnets for position sensors for determining the exact rotational position of the drum 28.

[0036] In Fig. 6, a front view onto the drum receiving container 14 with the drum 28 inside it is shown. The drum 28 is mounted inside the drum receiving container 14 via the rotary shaft 29. The drum receiving container 14 is fixed inside the housing 12 of the washing machine 11 by two springs 16a in its upper region. Furthermore, two dampers 16b are provided in the lower region, which serve to dampen the movement of the drum receiving container 15 with the drum 28 inside it. This is known in the art.

[0037] The position of the drum 28 with the three protrusions 42a, 42b and 42c is such that the protrusion 42c is in the lowermost region of the drum receiving container 14. This position may be used to let water inside the protrusion 42c, preferably as has been explained before. The drum 28 may then be rotated for 120° for the next protrusion to be in this position to also be filled with water.

[0038] It can also be taken from Fig. 6 how water being left out of the openings 45 of the protrusions 42a or 42b would fall down on any laundry being positioned below them. This may be used according to what has been explained before, or avoided, alternatively.

[0039] From the side view of Fig. 7, which is similar to the one of Fig. 2, another option to bring water into the protrusions 142 or to let it out is shown. In this embodiment of a washing machine 111, a further water pipe L6 from an outlet of the filter 131 with a valve V4 leads to the rotary shaft 129 of the drum 128, which in this case is hollow. The water pipe L6 goes through this hollow rotary shaft 129 and inside the drum 128. It is therein connected to three distribution pipes 154a, 154b and 154c with radial direction. Each of these distribution pipes leads into the inside space 143 of each of the protrusions 142 in a manner not shown here, which is easily realized by the person skilled in the art. These distribution pipes may be used to fill the inside spaces 143 of the protrusions 142 with water. This can be made at any time, such that the dipping process described in connection with Fig. 6 is not necessary. So water can be let into the protrusions 142 even when the drum 128 is rotating. Apart from this, the protrusions 142 can be of the same type as described before, in particular according to Figs. 3 to 5 with the openings that can be slidably closed.

[0040] In an alternative embodiment, another valve may be situated inside the hollow rotary shaft 129 or at the point where the three distribution pipes 154a to 154c are connected to the water pipe L6. This may serve for the purpose of better control of letting water inside any of the protrusions 142.

[0041] In the embodiment of Fig. 7, the distribution pipes 154 are situated inside the drum 128. They can of course also be arranged on the outside of the drum 128 and could be connected with the inside spaces 143 of the protrusions 142 all the while.

[0042] In Fig. 9 a schematic view similar to Fig. 6 shows how one piece of laundry 38 is placed close to one protrusion 42a. Fig. 9 is a view during a spinning process, for example with a speed of 400 or 600 rpm. This piece of laundry 38 is still wet and full of water, and accordingly has a significant weight. In reality, of course more laundry would be distributed on the inside of drum 28, and any distribution of this laundry may lead to any unbalance. The view of Fig. 9 shall simplify this for easier understanding.

[0043] The piece of laundry 38 situated according to Fig. 9, when all the protrusions 42 are filled with water or would be empty, instead, would lead to an obvious unbalance of the drum 28. This is negative or even detri-

mental during a spinning process with high rotational speed. Such an unbalance can, for example, be detected via various methods known in the art. One such method is shown in Fig. 10, where the current I of the drive motor 30 is monitored. The thin line is the motor current phase, and the motor current envelope is shown in a thicker line. This is a clear sign that the drum and, consequently, also the drive motor 30 rotate unbalanced. The turn time is also shown here.

[0044] In Fig. 11, an explanation is indicated why the course of the current I of the motor varies. As a help, the rotating position of the drum 28 with a piece of laundry 38 is also shown. One point with the peak of the motor current envelope is connected to the piece of laundry 38 being at the highest point and now beginning to move downward. The movement downward needs less power from the drive motor, so the motor current envelope becomes less. The other point with the bottom of the motor current envelope is when the piece of laundry 38 starts to be moved upwards again, so more power from the drive motor is needed and the motor current envelope starts to rise again. The turn time is also indicated.

[0045] Other methods could include vibration sensors on the drum receiving container 14, for example. The advantage of monitoring the motor current phase is that the motor control 31 together with a position sensor being present in the drive motor 30 can relate the unbalance exactly to a certain rotating position or a certain position inside the drum, respectively. This is due to the fact that, when the drum 28 during its rotation is in such a rotational position that the laundry 38 is being lifted from a lowermost position upwards, additional effort is needed for this lifting up. In this case, the drive motor 30 must have more than average power for this additional effort. If again, after a rotation of about 180°, the laundry 38 starts to move downwards, the drive motor 30 needs less than average power. This can be taken from the motor current according to Fig. 10 and 11, and the motor control 31 can relate this to the rotational position of the drive motor 30, which again is in fixed and known relation to the rotational position of the drum 28. This allows the motor control 31 and/or the washing machine control 40 to exactly locate the laundry 38 or the location of any unbalance inside the drum. In this case, the laundry 38 has been located close to the protrusion 42a. For this reason, water is let out of the inside space 43 of the protrusion 42a. In one embodiment of the invention, the motor control 31 and/or the washing machine control 40 may determine a weight of the unbalance, for example in gram. Connected with the rotational speed of the drum 28, the washing machine control 40 can actuate the slide 47 of protrusion 42a such that a known volume of water with a known mass can be let out. This cannot be done in one single instance, for it can only be done when the protrusion 42a passes by the actuation magnet 52 or any actuating magnet 52. So several turns are necessary, which does not pose a problem.

[0046] In an alternative method, only the location of

the unbalance needs to be determined and the protrusion next to it or, alternatively, the two protrusions out of which water should be let to reduce or eliminate the unbalance. This is then being done also slowly and with a little amount of water during each rotation of the drum. The unbalance is continuously being monitored and measured, and should be reduced continuously by letting water out. If the unbalance would not be reduced or maybe should even increase, water should be let out of other combinations of protrusions. If, in the way wanted, the unbalance is being reduced, water is let out until no more unbalance can be detected. After this, the spinning process can continue. Alternatively, the spinning process could be continued with a higher rotational speed. As the unbalance has been reduced for the lower rotational speed, it should also be reduced or eliminated for a higher rotational speed. If, however, when performing the rotation with higher rotational speeds, the unbalance should start to be detectable again, the same process as described before should be used to reduce or eliminate the unbalance again. This can be repeated several times, at least until one of the protrusions is empty, from which water should be let out. In this case, either the drum has to be slowed down to fill the protrusion again with water or the embodiment with the distribution pipes of Fig. 8 could be used.

Claims

1. A method for operating a washing machine, the washing machine comprising:
 - a drum for washing laundry therein,
 - a drive motor for the drum, preferably formed as a direct drive,
 - a drum receiving container in which the drum is arranged rotatably about an axis of rotation,
 - a water guide comprising:
 - a water inlet from an external water supply pipe into the washing machine,
 - water pipes and valves,
 - a water outlet out of the washing machine, an inlet device for letting water into the drum, a container outlet at the drum receiving container,
 - a pump being connected by means of water pipes on the one hand to the container outlet and on the other hand to the inlet device,
 - protrusions on the inside of the circumferential wall of the drum receiving container, each protrusion having a closable inside space which is accessible and closable by means of openings, the openings being openable and closable by means of controllable closing means,
 - a washing machine control being connected with the pump,

- a drive motor control for the drive motor of the drum, wherein the washing machine control is connected with the drive motor control and is adapted to monitor operational parameters of the drive motor, in particular the drive motor current, and to determine if an unbalance occurs in the drum during the rotation of the drum and this unbalance is visible in the operational parameters of the drive motor,
 - wherein the washing machine control is connected to the controllable closing means for the protrusions for controlling the same, wherein for reducing or eliminating the unbalance the washing machine control controls the closing means according to one of two options, wherein:
 - in a first option, a part of the water present in the inside spaces of the protrusions is let out by selectively and at least partially opening the closing means until the unbalance has been reduced below a previously determined unbalance threshold or has been eliminated,
 - in a second option, water is let into the inside spaces of the protrusions by selectively and at least partially opening the closing means until the unbalance has been reduced below a previously determined unbalance threshold or has been eliminated.
- 2. Method according to claim 1, wherein the washing machine control knows from the motor control the position of the drum and thus the position of each protrusion and compares it with indications of an unbalance in the operating parameters or in the motor current of the drive motor and determines therefrom out of which protrusion water must be let out and/or into which protrusion water must be let in.
- 3. Method according to claim 1 or 2, wherein the washing machine control determines the unbalance as a concrete weight indication, in particular in grams, and further determines, preferably by monitoring the motor current and the position of the drum, where this unbalance exists in order to determine therefrom out of which protrusion water must be let out and/or into which protrusion water must be let in to eliminate this unbalance.
- 4. Method according to one of the preceding claims, wherein an external position sensor is provided on the drum or on the drive motor of the drum to know the exact position of the drum, preferably the rotational position, wherein this position information is given to the washing machine control.
- 5. Method according to one of the preceding claims, wherein a calibration of the drum rotational position is made via the motor control, in particular by running the drum slowly for two to four turns and then calibrating a zero position of the drum, wherein this zero position is passed on to the washing machine control for use of this zero position to determine the drum position.
- 6. Method according to one of the preceding claims, wherein the openings with the closing means point into the interior of the drum or point outwards into an intermediate space between the drum and the drum receiving container.
- 7. Method according to one of the preceding claims, wherein the closing means and the protrusions are designed in such a way that a closing means closes or opens all openings on the protrusion simultaneously and in the same way and/or to the same degree.
- 8. Method according to one of the preceding claims, wherein the closing means are adapted to be magnetically actuatable, an activation magnet for the closing means preferably being arranged on the outside of the drum receiving container in such a way that it interacts with the magnetically actuatable closing means when the magnetically actuatable closing means moves past the activation magnet during rotation of the drum.
- 9. Method according to one of the preceding claims, wherein, before the start of reducing or eliminating an unbalance by opening the closing means, all the protrusions are filled with water, preferably filled to the maximum, in which case, in particular for reducing or eliminating the unbalance, only water is let out of at least one of the protrusions.
- 10. Method according to one of the preceding claims, wherein the filling of the protrusions with water takes place in such a way that the closing means open the openings and water being present in the lower region of the drum receiving container flows into the inside spaces of the protrusions, wherein the protrusions are successively brought into the lower region of the drum receiving container by rotation of the drum, this preferably being done successively for all protrusions, wherein in particular during the letting of the water into the protrusion, the drum and the protrusion are not moved.
- 11. Method according to one of the preceding claims, wherein, for filling the protrusions with water, water is fed into the protrusions from the outside through water lines which form distribution lines and which extend into each of the protrusions, wherein preferably a water line to the distribution lines is running through a rotary shaft of the drum for bearing the

drum in the drum receiving container.

12. Method according to one of the preceding claims, wherein, for a washing process, water is introduced into the interior of the drum via the protrusions or through the protrusions and their openings into the interior of the drum, wherein the protrusions form or comprise the inlet device, wherein in particular also water is introduced which is mixed with washing substances. 5
13. Method according to one of the preceding claims, wherein either the drum is rotated at a rotational speed of less than 20 rpm or less than 10 rpm and a protrusion is moved into the upper region or into the uppermost region, or that the drum stands still with a protrusion in the upper region or in the uppermost region, and then water is discharged from the interior of the protrusion onto the laundry located thereunder in the drum, wherein preferably this is repeated several times with one protrusion after the other, wherein in particular the inside spaces of the protrusions are filled with water by rotating the drum in such a way that a protrusion is in the lower region or lowermost region of the drum receiving container and water being present there enters the inside space of the protrusion. 10 15 20 25
14. Washing machine comprising:
- a drum for washing laundry therein,
 - a drive motor for the drum, preferably formed as a direct drive,
 - a drum receiving container in which the drum is arranged rotatably about an axis of rotation,
 - a water guide comprising:
 - a water inlet from an external water supply pipe into the washing machine,
 - water pipes and valves,
 - a water outlet out of the washing machine, an inlet device for letting water into the drum, a container outlet at the drum receiving container,
 - a pump being connected by means of water pipes on the one hand to the container outlet and on the other hand to the inlet device,
 - protrusions on the inside of the circumferential wall of the drum receiving container, each protrusion having a closable inside space which is accessible and closable by means of openings, the openings being openable and closable by means of controllable closing means,
 - a washing machine control being connected with the pump,
 - a drive motor control for the drive motor of the drum, wherein the washing machine control is

connected with the drive motor control and is adapted to monitor operational parameters of the drive motor, in particular the drive motor current, and to determine if an unbalance occurs in the drum during the rotation of the drum and this unbalance is visible in the operational parameters of the drive motor,

- wherein the washing machine control is connected to the controllable closing means for the protrusions for controlling the same, wherein for reducing or eliminating the unbalance the washing machine control controls the closing means according to one of two options, wherein:

- in a first option, a part of the water present in the inside spaces of the protrusions is let out by selectively and at least partially opening the closing means until the unbalance has been reduced below a previously determined unbalance threshold or has been eliminated,

- in a second option, water is let into the inside spaces of the protrusions by selectively and at least partially opening the closing means until the unbalance has been reduced below a previously determined unbalance threshold or has been eliminated.

15. Washing machine according to claim 14, wherein at least three similar or identical protrusions are arranged on the inside of the drum. 30

16. Washing machine according to claim 14 or 15, wherein an external position sensor is provided on the drum or on the drive motor of the drum to know the exact position of the drum, preferably the rotational position, to give this position information to the washing machine control. 35 40 45 50 55

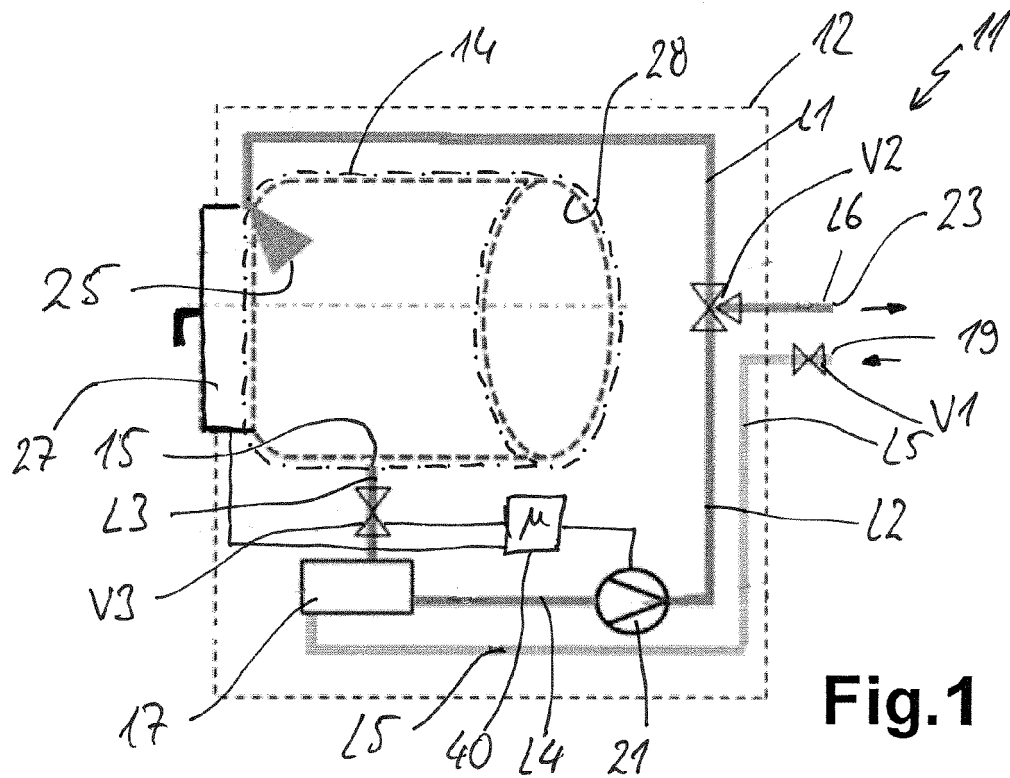


Fig.1

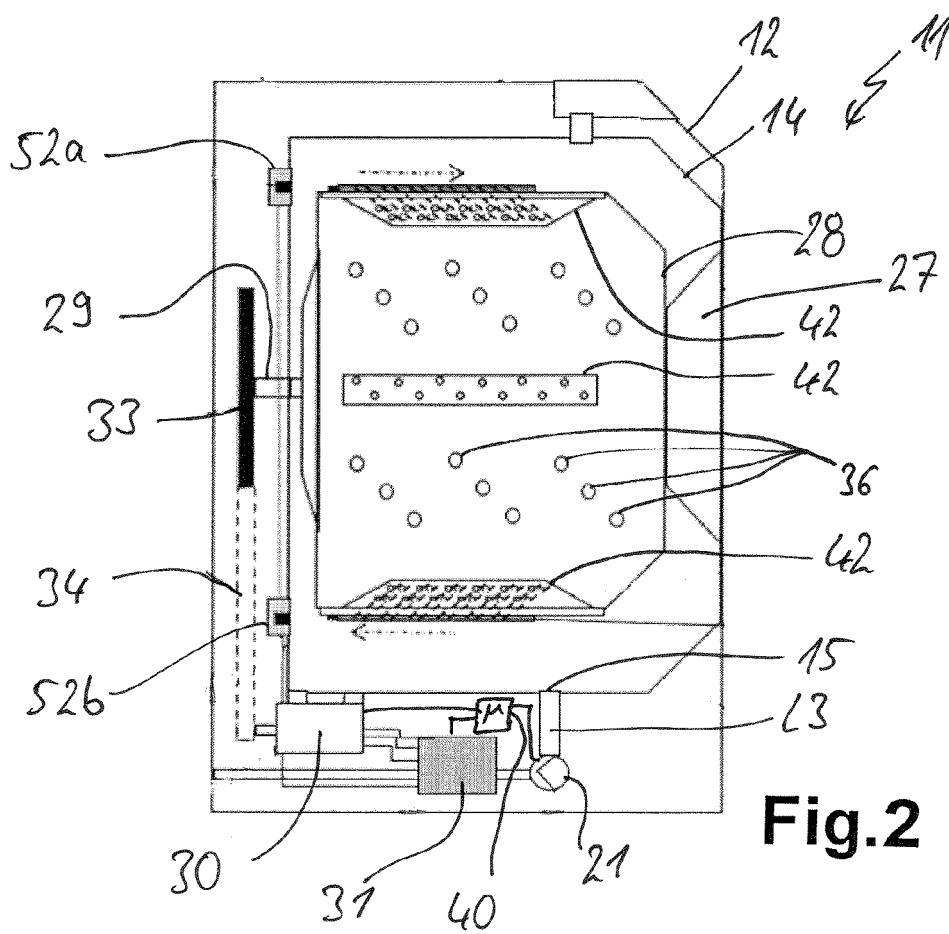
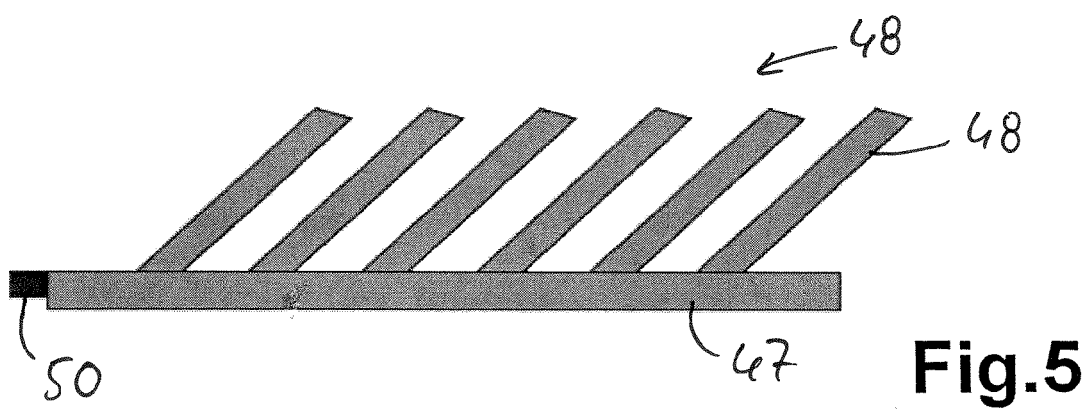
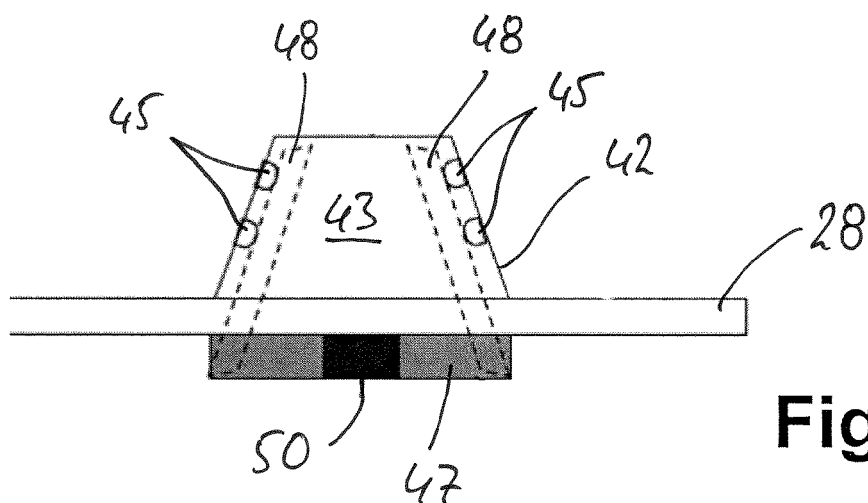
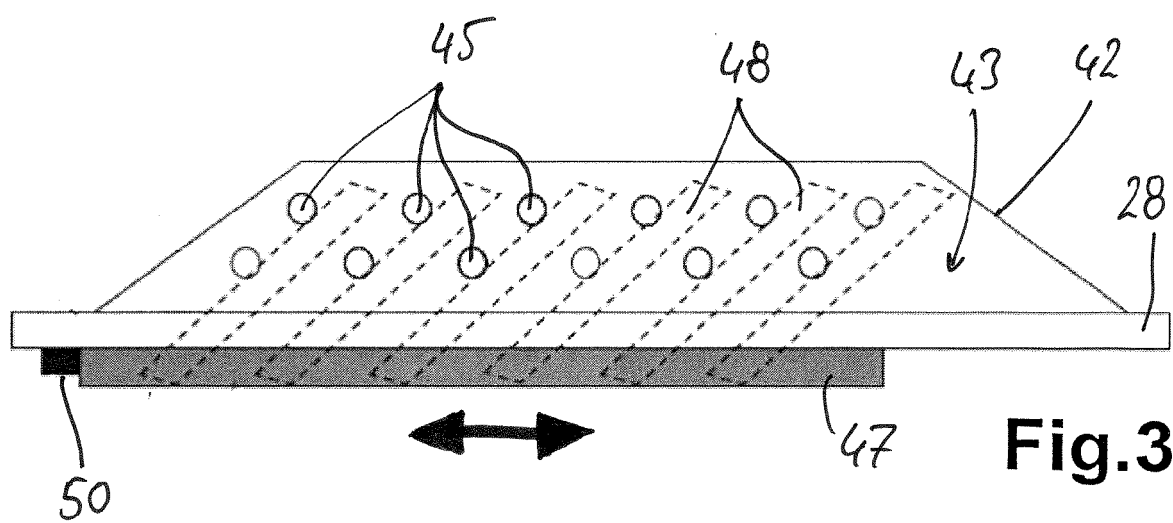


Fig.2



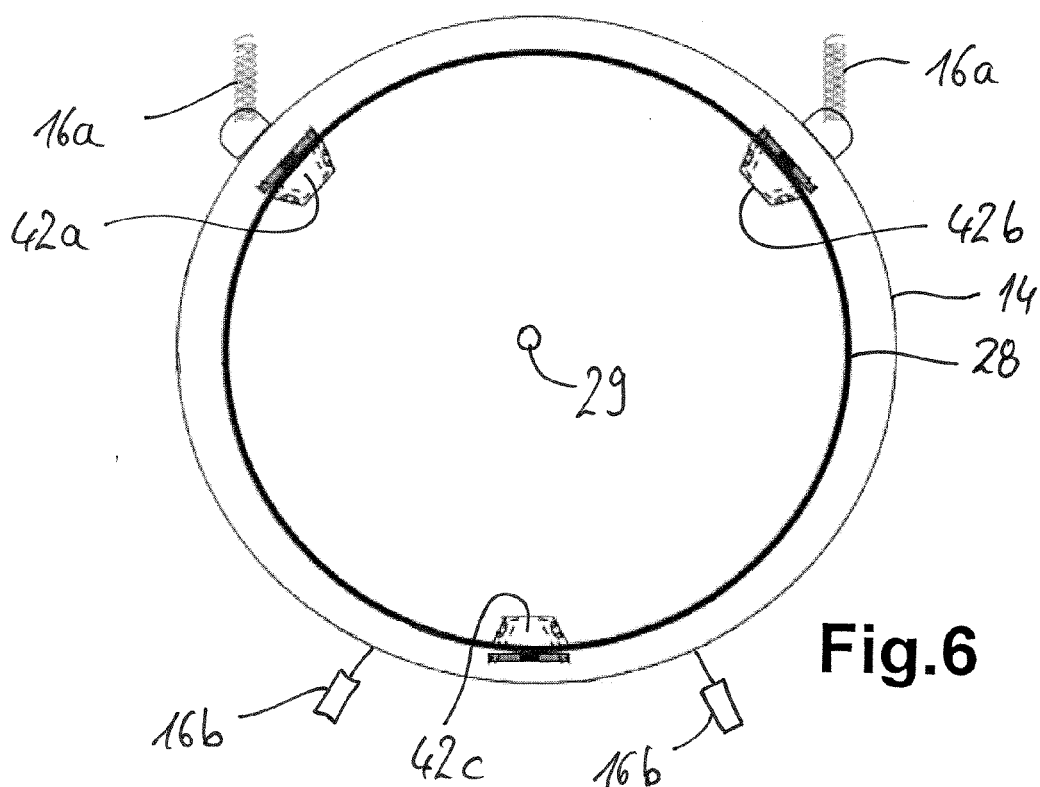


Fig.6

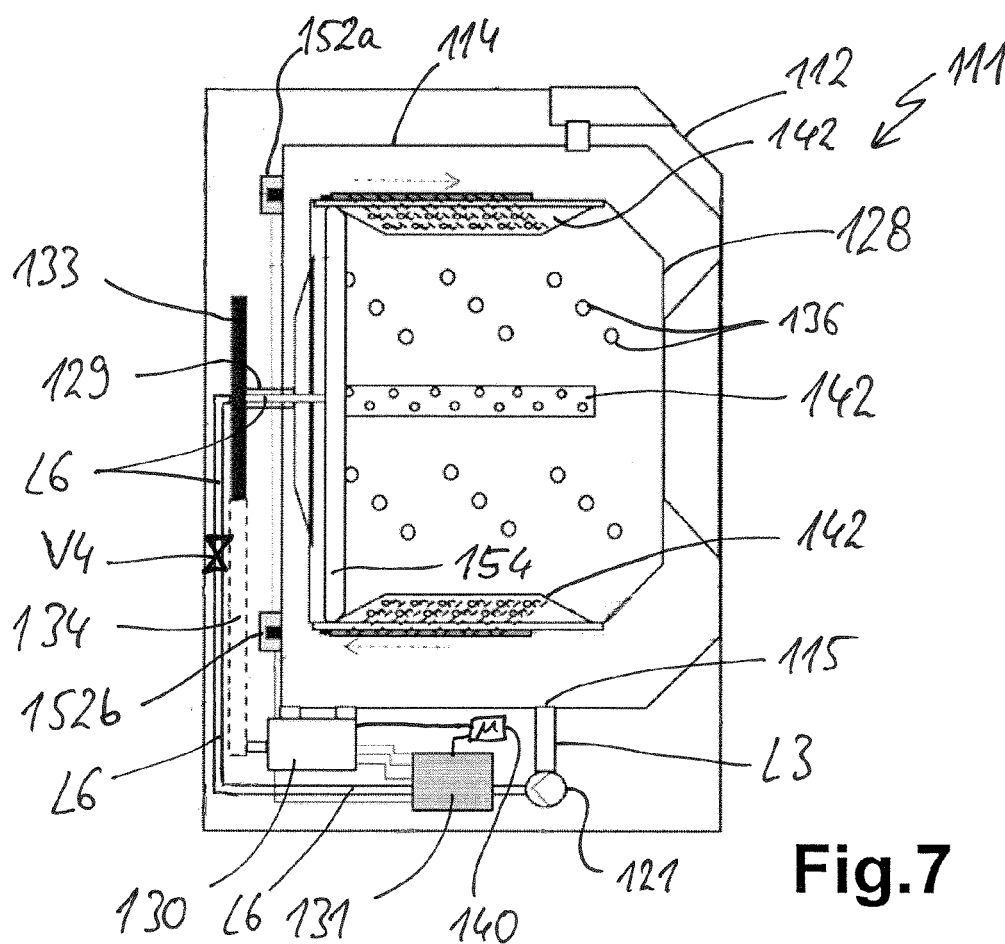


Fig.7

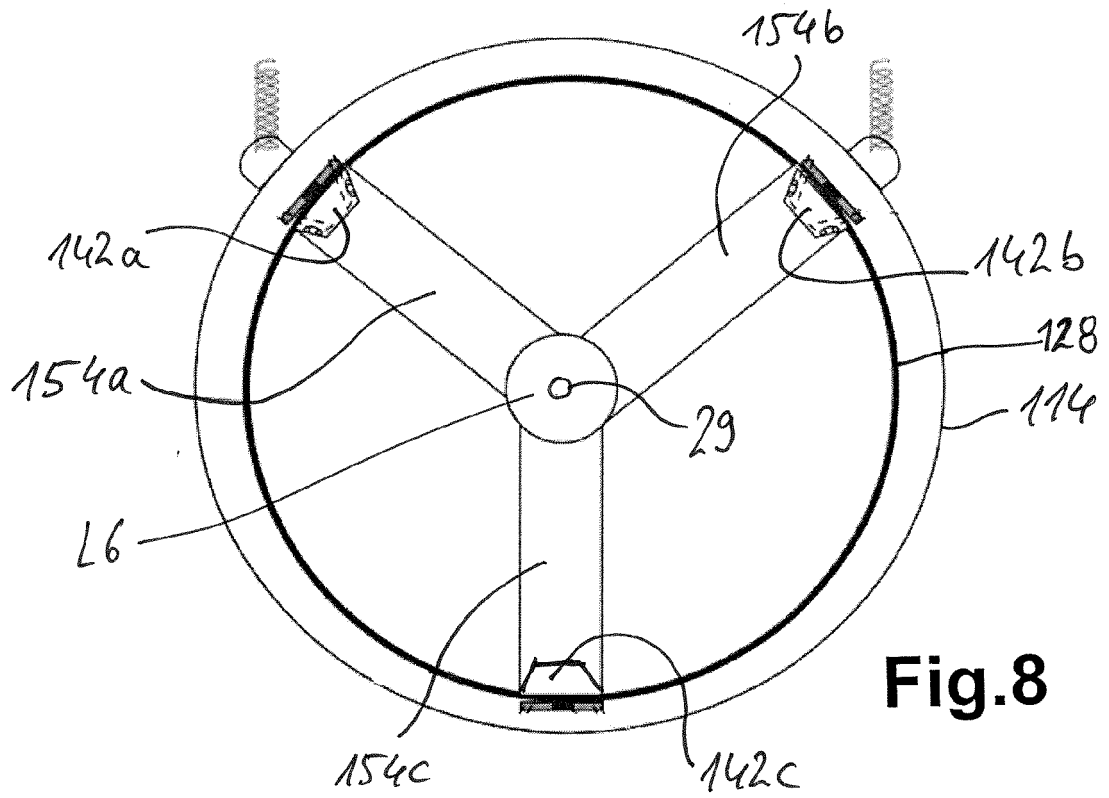


Fig. 8

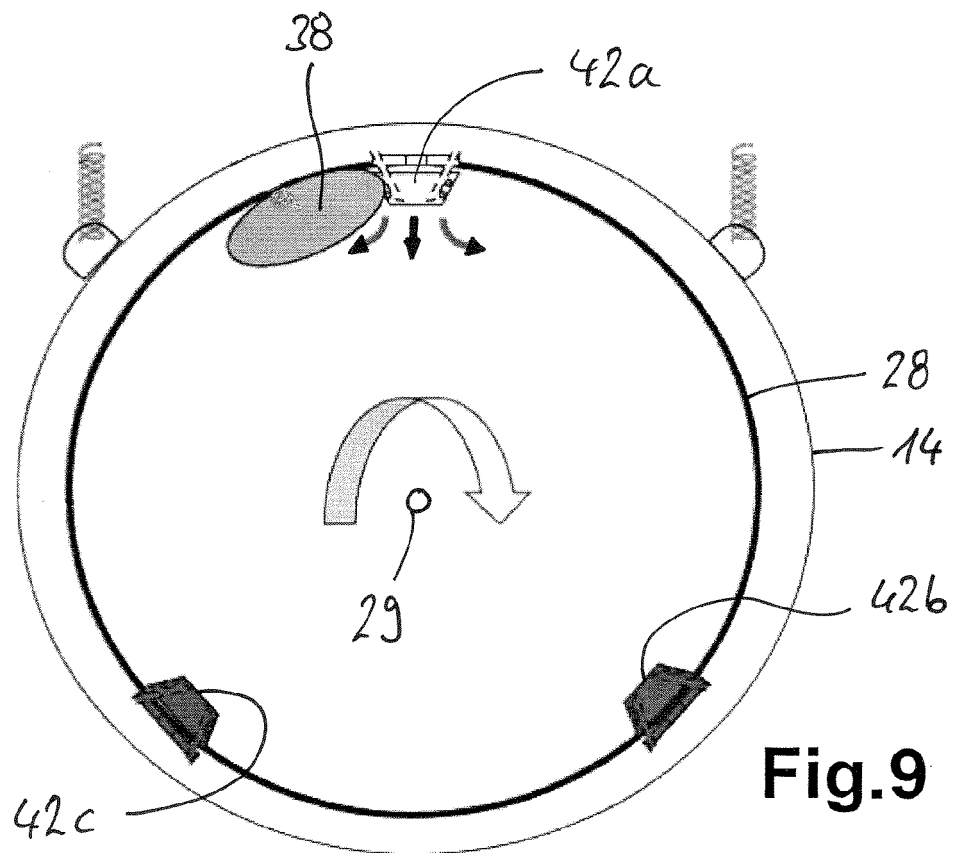


Fig. 9

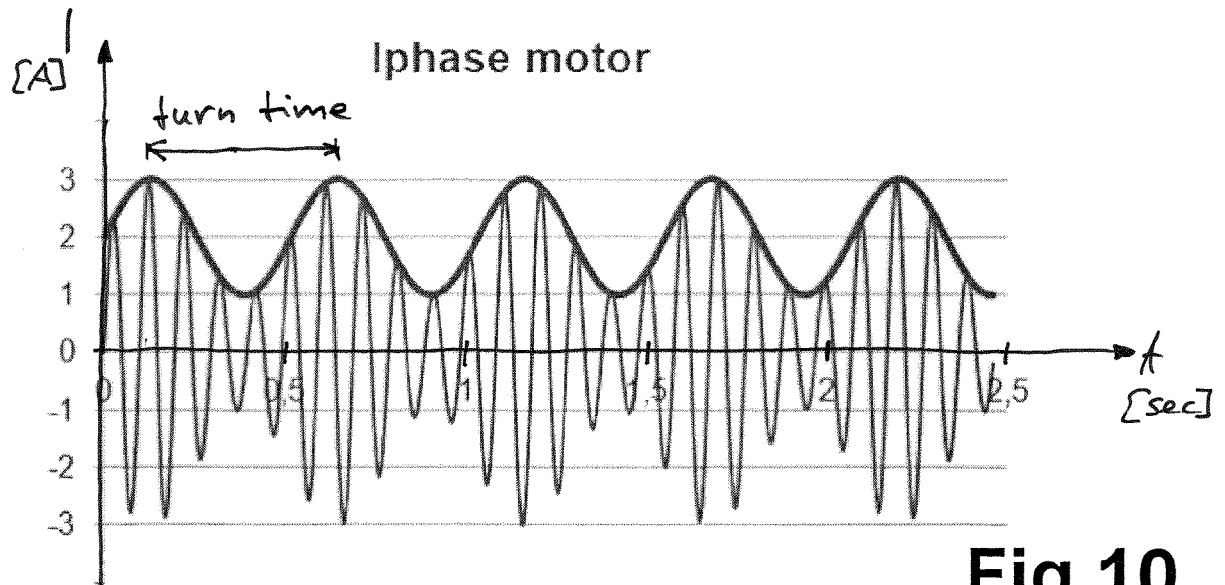


Fig.10

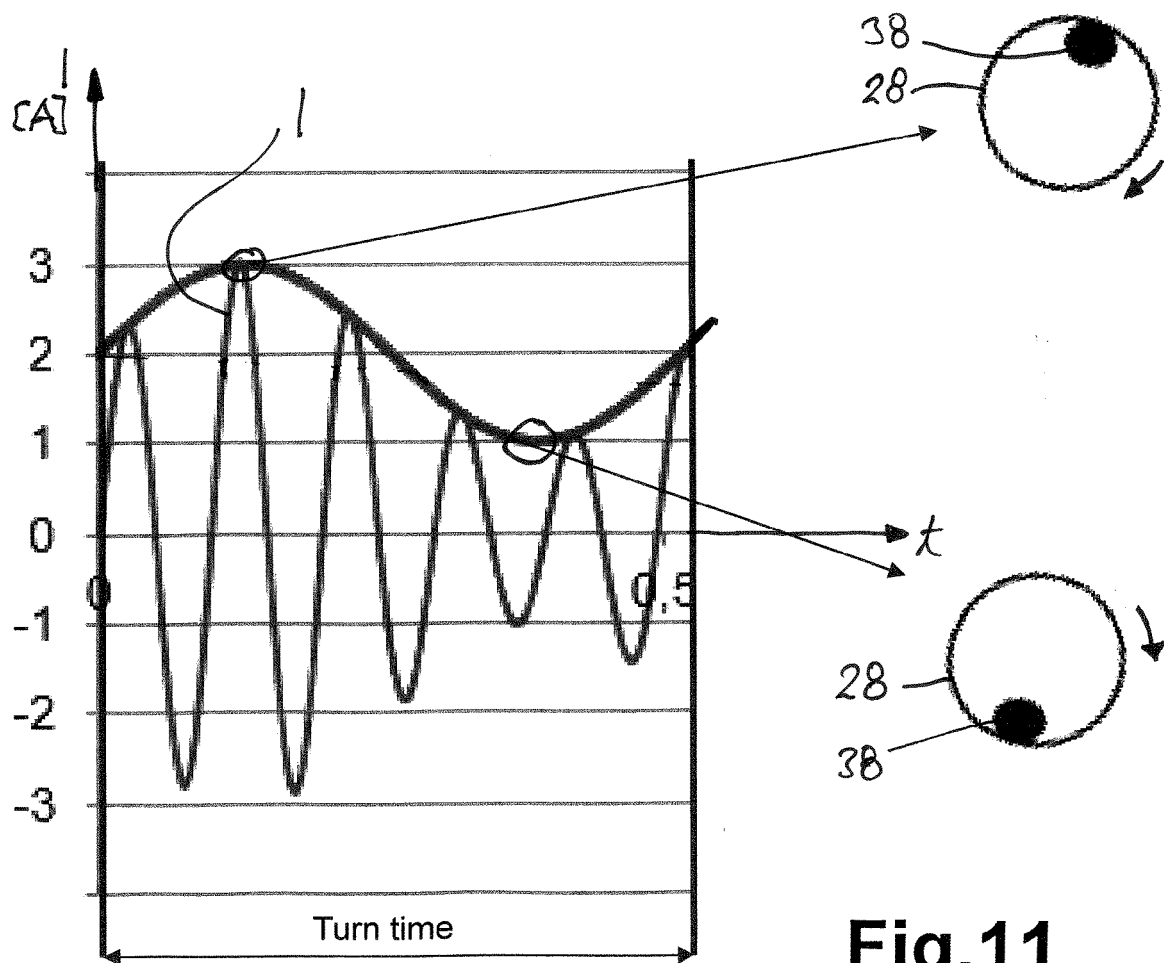


Fig.11



EUROPEAN SEARCH REPORT

Application Number

EP 22 38 2980

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
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X	EP 2 025 797 B1 (ELECTROLUX HOME PROD CORP [BE]) 3 October 2012 (2012-10-03)	1-11, 14-16	INV.
Y	* figures 1-4 *	12	D06F33/48
A	* paragraphs [0001] - [0009], [0012] - [0062] *	13	D06F23/02
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Y	US 2011/005277 A1 (HASANREISOGLU LEVENT [TR]) 13 January 2011 (2011-01-13)	12	D06F37/22
	* figures 1-4 *		D06F103/26
	* paragraphs [0001] - [0014], [0037] - [0057] *		D06F105/08

A	EP 3 754 090 B1 (HAIER GERMANY GMBH [DE]) 31 August 2022 (2022-08-31)	1-16	
	* figures 1-9 *		
	* paragraphs [0001] - [0028], [0030] - [0060] *		

			TECHNICAL FIELDS SEARCHED (IPC)
			D06F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		24 March 2023	Rakotonanahary, S
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P : intermediate document			
		& : member of the same patent family, corresponding document	

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

EP 22 38 2980

5 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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24-03-2023

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