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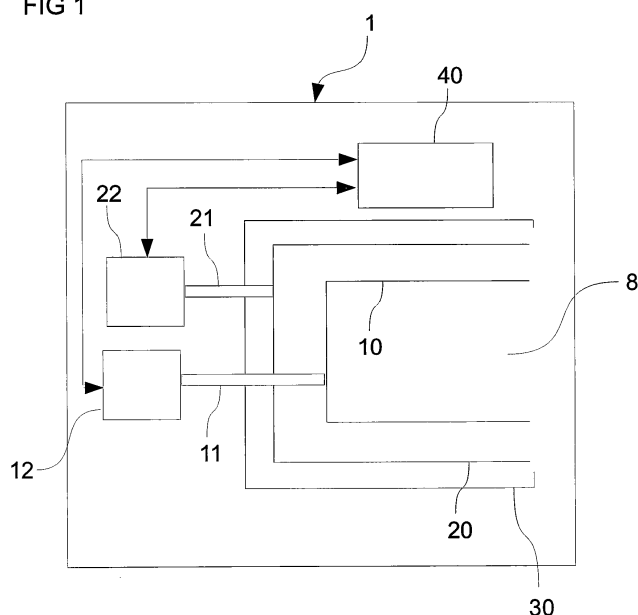
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(54) **A TECHNIQUE FOR BALANCING DURING DRUM ROTATION IN A WASHING MACHINE**

(57) A technique for balancing in a drum-type washing machine (2) is presented. The technique uses an arrangement (1) having an inner drum (10) driven by a first drive motor (12), an outer drum (20) driven by a second drive motor (22), a detergent solution tub (30), and a controller (40). The drums (10, 20) are rotatably mounted co-axially within the tub (30), the outer drum (20) positioned concentrically in-between the inner drum (10) and the tub (30).

The drive motors (12, 22) are positioned outside the tub (30). The controller (40) determines an imbalance of the inner drum (10) when rotating, and then determines a balancing parameter for the outer drum (20). The balancing parameter includes a rotational speed and direction for the outer drum (20) relative to the rotational speed and direction of the inner drum (10), such that the outer drum (20) when rotated at the balancing parameter counters the imbalance of the rotating inner drum (10).

FIG 1



Description

[0001] The invention refers to an arrangement for balancing during drum rotation in a drum-type washing machine according to claim 1, a drum-type washing machine according to claim 7, and a method for balancing during drum rotation in a drum-type washing machine according to claim 8.

Background of the Invention

[0002] In front loading washing machines, i.e. washing machines which have a drum that rotates around a substantially horizontal axis, the load i.e. the laundry to be washed is placed inside the drum. The drum is rotated, with variable speeds, along with the load in different steps of the washing program, while the load i.e. the laundry is washed and spin dried. While the drum is being rotated, the load is not distributed homogeneously inside the drum. In some regions of the drum the laundry may be piled up whereas in some other regions of the drum there may not be any laundry at all. This uneven distribution of the laundry i.e. the load causes imbalance in the drum during rotation. Such imbalance is greater when the drum is rotated at higher speeds such as during the spin-drying step where the drum is being rotated at very high speeds. The imbalance causes vibrations in the drum and thus in the washing machine, decreased efficiency of rotation, decreased speed of rotation, and increases noise. In long run the vibrations may also result on increased strain on the motor rotating the drum and thus resulting into decrease in component life of the washing machine components such as the motor.

[0003] Presently, the above mentioned problem of imbalance is solved in various ways. A well known way is to add weights to the machine and increasing its inertia. However, this results into heavier washing machines that may be difficult to transport and is inefficient. Furthermore although the vibrations are reduced due to increased weight the problem of imbalance remains unsolved and thus the adverse effect of imbalance on the motor rotating the drum are still existent. In another way, fluids i.e. water mostly, are added to the drum by using baffles associated with the drum for example in US Pat no. 9187858. Similar approach of using liquid masses for balancing of washing machines is used in US Patent no. 3799348 which presents a device for rebalancing the rotary baskets of washing machines and the like, of the kind in which liquid masses are used for balancing the basket. The rear wall of the basket is elastically deformed and the deformations are transferred to a valve, which feeds with liquid a number of peripheral chambers mounted on the basket.

[0004] US Patent no. 5862553 present another approach to address the problem of imbalance. In US Patent no. 5862553 a clothes washing machine is provided with an oscillating washing assembly including a rotating drum capable of being driven at various rotating speeds and provided with a plurality of annular hollow bodies

secured to the drum. A plurality of moving masses are capable of freely moving within the hollow bodies. Before at least one spin-extraction phase, the drum is driven to rotate in a continuous manner at a variable, relatively low speed which is lower than the resonance frequency of the oscillating washing assembly, but is adequate to cause the washload in the drum to keep adhering against the inner peripheral surface of the drum. As soon as the moving masses succeed in distributing themselves in such a manner that their center of gravity locates itself in a position that is substantially opposite to the unbalance condition of the washload, the drum is started to rotate at the desired spin-extraction rate.

[0005] The aforementioned conventional techniques use additional weight and/or adding of fluids, which result into increase of overall weight of the washing machine or usage of extra water. The increased weight makes the washing machine difficult to move, and more power is needed to rotate the washing machine drum due to increased weight additionally added or attained by adding of water into containers or chambers associated with the drum. Furthermore, due to increased strain on the motor rotating the drum of the washing machine, component life of the motor is reduced and probability of motor failure is increased.

[0006] Thus there exists a need to provide a technique for balancing of drum of washing machine, primarily during high speed rotational stages of the drum, without using additional weights that may be added to the drum by adding movable masses or filling up baffles with water.

Object of the Invention

[0007] It is therefore an object of the present invention to provide a technique for balancing during drum rotation in a drum-type washing machine, which reduces or obviates requirement of using additional weights or liquid filled baffles to balance the washing machine.

Description of the Invention

[0008] The aforementioned object is achieved by an arrangement according to claim 1 of the present technique, which presents a first aspect of the present technique.

[0009] In the first aspect of the present technique, as recited in claim 1 of the present disclosure, the arrangement for balancing during drum rotation in a drum-type washing machine is presented. The arrangement includes an inner drum, a first drive motor, an outer drum, a second drive motor, and a detergent solution tub. The inner drum is rotatably mounted within the detergent solution tub, whereas the first drive motor is positioned outside the detergent solution tub. The first drive motor drives rotation of the inner drum at a desired speed and in a desired rotation direction. The outer drum is rotatably mounted within the detergent solution tub and outside of the inner drum, i.e. the inner drum, the outer drum and

the detergent solution tub are co-axially arranged around a rotational axis of the two drums. The outer drum is sandwiched between the inner drum and the detergent solution tub and the inner drum, the outer drum, and the detergent solution tub, respectively, are concentrically arranged. The second drive motor is positioned outside the detergent solution tub and drives rotation of the outer drum at a desired speed and in a desired rotation direction. The arrangement also includes a controller. The controller determines an imbalance of the inner drum during a rotation of the inner drum. Based on the determined imbalance the controller determines a balancing parameter for the outer drum. The balancing parameter includes a speed and a direction of rotation of the outer drum relative to a speed and a direction of the rotation of the inner drum. The balancing parameter is such that when the outer drum is rotated at the balancing parameter the rotation of the outer drum counters, i.e. acts in opposition to, the imbalance of the inner drum. The controller instructs the second drive motor to rotate the outer drum at the balancing parameter. As a result of the rotation of the outer drum at the balancing parameter the imbalance in the rotation of the inner drum is balanced. Since the present technique uses rotational speed and rotational direction of the outer drum to generate force to counter the imbalance of the rotating inner drum, the mass of the outer drum may be kept low, and thus requirement of using additional load or baffles that may be filled with liquid is reduced or obviated.

[0010] In the present technique, the outer drum is used to create an imbalance equal to but in opposite direction of the imbalance of the inner drum, and thus the result of the rotation of the outer drum and the inner drum is a two oppositely directed albeit equal in magnitude imbalances that cancel out each other and result into balancing of the washing machine. The imbalance in the outer drum rotation may be introduced by swiftly and continually changing rotational parameters of the outer drum or by designing the outer drum with an internal nonhomogeneous mass distribution, or by adding any external mass that may introduce desired imbalance in the outer drum. As aforementioned, the added external mass or the non-homogeneous mass distribution of the outer drum is required to be low, if any, as the present technique uses the rotational speed and the rotational direction of the outer drum to generate force to counter the imbalance of the rotating inner drum.

[0011] In an embodiment of the arrangement, the balancing parameter includes an amount of load to be moved from the inner drum to the outer drum, or vice versa. Thus, requirement of having any external mass or liquid filled baffles to generate imbalance in the outer drum is obviated. The washing machine with the arrangement thus uses its own load i.e. the laundry to be washed to counter the imbalance of the inner drum by generating an equal but oppositely directed imbalance through rotation of the outer drum and by using different amounts of laundry in the different drums, i.e. in the inner drum

and in the outer drum.

[0012] In another embodiment of the arrangement, the inner drum and the outer drum are configured to be separately and independently provided with laundry. This may be achieved by having a common door for the drums and thus laundry can be loaded in the inner and the outer drum by opening the common door, or by having a door for the inner drum as is present in conventionally known front loading washing machines and an annular-shaped outer door surrounding door of the inner drum. The two doors may be operated independently.

[0013] In a further embodiment of the arrangement, the inner drum includes a slot configured to move the amount of load from the inner drum to the outer drum, or vice versa. The slot can be understood as a window between the inner and the outer drum. The slot may be used to align such that a part of load, i.e. some of the laundry, may pass from the inner drum to the outer drum under gravity, or vice versa. The rotation of the inner drum and/or the outer drum is required to be ceased or kept at very low speed to allow the passage of the some of the clothes from the inner drum to the outer drum, or vice versa. In a related embodiment of the arrangement, the slot includes an electronically controlled slot cover. The controller controls opening and closing of the slot cover and determines a measure of load moved from the inner drum and into the outer drum, or vice versa. Thus an amount of load moved from the inner drum to the outer drum or an amount of load moved from the outer drum to the inner drum through the slot is precisely controllable.

[0014] In another embodiment of the arrangement, the controller determines the imbalance of the inner drum during the rotation of the inner drum by using deviations in energy requirement, in torque and in speed of rotation of the inner drum as driven by the first drive motor relative to desired energy requirement, torque and speed of rotation of the inner drum driven by the first drive motor as programmed for the rotation of the inner drum for the given stage of washing cycle.

[0015] The aforementioned objective is also achieved by a drum-type washing machine according to claim 7, which presents a second aspect of the present technique. The drum-type washing machine includes an arrangement according to the aforementioned first aspect.

[0016] The aforementioned objective is also achieved by a method for balancing during drum rotation in a drum-type washing machine according to claim 8, which presents a third aspect of the present technique. The drum-type washing machine includes an arrangement according to the aforementioned first aspect. In the method of the present technique, first the inner drum is rotated driven by the first drive motor at a rotational speed and in a rotational direction. The controller determines an imbalance of the inner drum during the rotation of the inner drum. Then a balancing parameter for the outer drum is determined. The balancing parameter includes a speed and a direction of rotation of the outer drum relative to the rotational speed and the rotational direction of the

inner drum. The balancing parameter is such that when the outer drum is rotated at the balancing parameter the rotation of the outer drum counters the imbalance of the inner drum. Thereafter, the controller instructs the second drive motor to rotate the outer drum at the balancing parameter, and finally the outer drum is rotated at the balancing parameter driven by the second drive motor. As a result of the rotation of the outer drum at the balancing parameter the imbalance in the rotation of the inner drum is balanced. Since the present technique uses rotational speed and rotational direction of the outer drum to generate force to counter the imbalance of the rotating inner drum, the mass of the outer drum may be kept low, and thus requirement of using additional load or baffles that may be filled with liquid is reduced or obviated.

[0017] In an embodiment of the method, the balancing parameter includes an amount of load to be moved from the inner drum to the outer drum or an amount of load to be moved from the outer drum to the inner drum. In this embodiment, the method further includes transferring the amount of the load according to the balancing parameter from the inner drum to the outer drum, or vice versa, before instructing the second drive motor to rotate the outer drum. Thus, requirement of having any external mass or liquid filled baffles to generate imbalance in the outer drum is obviated. The method as applied for the washing machine with the arrangement thus uses its own load i.e. the laundry to be washed to counter the imbalance of the inner drum by generating an equal but oppositely directed imbalance through rotation of the outer drum and by using different amounts of laundry in the different drums, i.e. in the inner drum and in the outer drum. In a related embodiment of the method, the amount of the load is transferred from the inner drum to the outer drum, or vice versa, manually. In another related embodiment, but alternative to the preceding embodiment, the amount of the load is transferred from the inner drum to the outer drum, or vice versa, automatically by using the slot and the slot cover, wherein the controller controls opening and closing of the slot cover and determines a measure of load moved from the inner drum into the outer drum or determines a measure of load moved from the outer drum into the inner drum.

[0018] In another embodiment of the method, the imbalance of the inner drum during the rotation of the inner drum is determined through deviations in energy requirement, in torque and in speed of rotation of the inner drum driven by the first drive motor relative to desired energy requirement, torque and speed of rotation of the inner drum driven by the first drive motor as programmed for the rotation of the inner drum.

[0019] Further benefits, goals and features of the present invention will be described by the following specification of the attached figures, in which components of the invention are exemplarily illustrated. Components of the devices and method according to the inventions, which match at least essentially with respect to their function can be marked with the same reference sign, wherein

such components do not have to be marked or described in all figures.

[0020] The invention is just exemplarily described with respect to the attached figures in the following.

Brief Description of the Drawings

[0021]

- Fig. 1 schematically presents an exemplary embodiment of an arrangement for balancing during drum rotation in a drum-type washing machine;
- Fig. 2 depicts a flow chart of an exemplary embodiment of a method for balancing during drum rotation in the drum-type washing machine;
- Fig. 3 schematically presents a side view of positioning of an inner drum, an outer drum and a detergent solution tub with respect to a rotational axis in the arrangement of Fig. 1;
- Fig. 4 schematically presents a front view of positioning of the inner drum, the outer drum and the detergent solution tub with respect to the rotational axis in the arrangement of Fig. 1;
- Fig. 5 schematically depicts a common door for the inner drum and the outer drum;
- Fig. 6 schematically depicts a door for the inner drum and an annular door for the outer drum;
- Fig. 7 schematically depicts an exemplary load distribution during working of the arrangement of Fig. 1 and during the method of Fig. 2;
- Fig. 8 schematically presents an exemplary embodiment of a drum-type washing machine having the arrangement of Fig. 1;
- Fig. 9 schematically presents a front view of an exemplary embodiment of the drum-type washing machine depicting working principle for the arrangement of Fig. 1 and for the method of Fig. 2; and
- Fig. 10 schematically depicts an exemplary embodiment of a slot and a slot cover in the inner drum of the drum-type washing machine; in accordance with aspects of the present technique.

Detailed Description of the Drawings

[0022] Fig. 2 presents a flow chart representing an exemplary embodiment of a method 100 of the present in-

vention. The method 100 is explained hereinafter in combination with an arrangement 1 of Fig. 1 and a drum-type washing machine 2 of Fig. 8 in which the arrangement 1 is present.

[0023] As shown in Fig. 8, the drum-type washing machine 2, hereinafter also referred to as the washing machine 2, includes the arrangement 1 of Fig. 1. The arrangement 1 includes a detergent solution tub 30, also referred to as an external tub or suds container, a first drum 10 for accommodating laundry through an opening 8 at the front side of the washing machine 2. The first drum 10 is rotatably mounted within the detergent solution tub 30, hereinafter also referred to as the tub 30. The arrangement 1 also includes a first drive motor 12. From the first drive motor 12 extends a first drive shaft 11. The first drive shaft 11 passes through the tub 30 and connects to the first drum 10. The first drive shaft 11 rotationally couples the first drum 10 with the first drive motor 12. The first drum 10 is rotated around a rotational axis 9 shown in Fig. 3. As shown in Fig. 8, the washing machine 2, besides having the arrangement 1 also has other necessary or conventional components, for example a detergent delivery mechanism 50 that carries out addition of the detergent to the tub 30, and a wash solution discharge system 60 through which wash liquor is drained out of the washing machine 2. The washing machine 2 also comprises other parts (not shown) that are required for functioning of such washing machines, such as inlet water pipe, water heating elements, foam detection mechanisms, etc.

[0024] The arrangement 1 also includes a second drum 20 also capable of accommodating laundry. The second drum 20 is rotatably mounted within the detergent solution tub 30, but outside of the first drum 10. The first drum 10, the second drum 20 and the tub 30 are coaxially and concentrically arranged around the rotational axis 9 as shown in Figs. 3 and 4. The order of positioning as moving radially outward from the rotational axis 9 is the first drum 10, the second drum 20 and the tub 30, respectively. The arrangement 1 also includes a second drive motor 22. From the second drive motor 22 extends a second drive shaft 21. The second drive shaft 21 passes through the tub 30 and connects to the second drum 20. The second drive shaft 21 rotationally couples the second drum 20 with the second drive motor 22. The second drum 20 is rotated around the rotational axis 9 shown in Fig. 3. It may be noted that due to presence of the second drum 20, the first drive shaft 11 while extending from the first drive motor 12 to the first drum 10, passes through the second drum 20 in addition to passing through the tub 30. The rotation of the first drum 10 as driven by the first drive motor 12 and the rotation of the second drum 20 as driven by the second drive motor are mutually independent.

[0025] The first and the second drums 10, 20 are generally made of perforated metallic sheets and have a circular cross-section, i.e. have a generally cylindrical shape. The drive motors 12, 22 are independently oper-

able. The construct of a drive motor and a shaft extending from it to connect to a rotating drum in drum-type washing machines, i.e. front loading washing machines is well known and thus not explained herein in further details for sake of brevity. In the present technique, as opposed to conventionally known washing machines, there are two drums, namely the first and the second drum 10, 20 and two drive motors namely, the first and the second drive motors 12, 22. The outer drum 20 is sandwiched between the inner drum 10 and the tub 30 and the inner drum 10, the outer drum 20, and the tub 30, respectively, are concentrically arranged around the rotational axis 9.

[0026] As shown in Figs 1 and 8, the controller 40 is also included in the arrangement 1. The controller 40 determines an imbalance of the inner drum 10 during a rotation of the inner drum 10, for example during a spin cycle of the washing machine 2. The imbalance of the rotating inner drum 10 may be determined by a variety of ways, for example by measuring the amount of vibrations produced by the rotating inner drum 10. In an exemplary embodiment, the controller 40 determines the imbalance by using deviations in energy requirement, in torque and in speed of rotation of the inner drum 10 as driven by the first drive motor 12 relative to desired energy requirement, torque and speed of rotation of the inner drum 10 as desired by programming of the washing machine 2 for a particular stage of washing cycle.

[0027] Based on the determined imbalance the controller 40 determines a balancing parameter for the outer drum 20. The balancing parameter includes a speed and a direction of rotation of the outer drum 20, relative to a rotational speed and direction of the rotation of the inner drum 10, at which the outer drum 20 ought to be rotated in order to generate an imbalance of the rotating outer drum 20 that counteracts on the imbalance of the rotating inner drum 10 to reduce or eliminate the imbalance of the rotating inner drum 10. In other words, the balancing parameter includes a calculated rotational speed and direction for the outer drum 20, taking into account a mass of the outer drum 20, and presence of any additional mass in the outer drum 20, such that when the outer drum 20 is rotated at the balancing parameter the rotation of the outer drum 20 counters the imbalance of the rotating inner drum 10, i.e. the imbalance generated by the rotating outer drum 20 at the balancing parameter cancels out, completely or partially, the imbalance of the rotating inner drum 10.

[0028] The controller 40 then instructs the second drive motor 22 to rotate the outer drum 20 at the balancing parameter. As a result of the rotation of the outer drum 20 at the balancing parameter the imbalance in the rotation of the inner drum 10 is balanced. The balancing parameter is such that the outer drum 20 when rotated at values of the balancing parameter create an imbalance equal to, or substantially equal to, but in opposite direction of the imbalance of the inner drum 10, and thus the result of the rotations of the outer drum 20 and the inner drum 10 are two oppositely directed albeit equal in mag-

nitude imbalances that cancel out each other and result into balancing of the washing machine 2. The imbalance in the outer drum 20 rotation may be introduced by swiftly and continually changing rotational parameters of the outer drum 20 or by designing the outer drum 20 with an internal nonhomogeneous mass distribution, or by adding any external mass that may introduce desired imbalance in the outer drum 20.

[0029] Fig. 9 shows a front view of the washing machine 2 having a front panel 7 that may include a display and control buttons for programming the washing machine operation. For the purposes of explanation, it is assumed that during a high speed spin cycle, the inner drum 10, along with any load contained inside the inner drum 10, is rotated at an angular velocity say, ω_1 . If the radius of the inner drum is r_1 , an imbalance in rotating inner drum 10 resulting from non-homogeneously distributed laundry in the inner drum 10, for example by piling up of the laundry in one region the inner drum 10 while presence of no laundry at all in another region of the inner drum 10, is say F_1 i.e. the imbalance force resulting from the rotation of the inner drum 10. Then the controller 40 calculates ω_2 i.e. angular velocity for the outer drum 20 having a radius r_2 and taking into consideration a mass of the outer drum 20 along with any imbalance in the load contained in the outer drum 20 to determine the balancing parameter such that when the outer drum 20 is rotated, the outer drum 20 generates a force F_2 i.e. imbalance force generated by the outer drum 20 such that the force F_2 is equal or substantially equal to in magnitude to the force F_1 but opposite in direction, as schematically depicted in Fig 9. Thus when the outer drum 20 is rotated at the balancing parameter the imbalance forces F_1 and F_2 cancel out each other, at least partially and preferably completely, resulting into balancing of the washing machine 2.

[0030] In an embodiment of the arrangement 1, the balancing parameter includes an amount of load to be moved from the inner drum 10 to the outer drum 20, or vice versa. As shown in Fig. 7, the balancing parameter takes into consideration an amount 91 of the load that ought to be present in the inner drum 10 and an amount 92 of the load that ought to be present in the outer drum 20, such that the force F_2 generated by the rotation of the outer drum 20 cancels out or reduces the imbalance force F_1 , resulting into balancing of the washing machine 2. The transfer of the load into the different drums 10, 20 may be achieved through different ways. In an embodiment of the arrangement 1, the inner drum 10 and the outer drum 20 are configured to be separately and independently provided with laundry. This may be achieved by having a common door 3 for the drums 10, 20, as shown in Fig. 5, and thus laundry can be loaded in the inner and the outer drums 10, 20 by opening the common door 3. Alternatively, as shown in Fig. 6, the arrangement 1 may include a door 3a for the inner drum 10 and an annular-shaped outer door 3b surrounding the door 3a of the inner drum 10. The annular shaped door 3b is the

door for the outer drum 20. The two doors 3a, 3b may be operated independently and laundry can be inserted into the drums 10, 20 as desired. By using the embodiments of the arrangement 1 depicted in Figs. 5 and 6, the different amounts of laundry can be separately loaded in the drums 10, 20, or can be transferred from one of the drum 10, 20 to the other drum 10, 20.

[0031] As shown in Fig. 10, in another embodiment of the arrangement 1, the inner drum 10 includes a slot 15, i.e. an opening or a window in the wall of the inner drum 10. Through the slot 15 part of the load, i.e. some of the laundry may be moved from the inner drum 10 to the outer drum 20. The slot 15 can be understood as an opening between the inner and the outer drums 10, 20. In a related embodiment of the arrangement 1, the slot 15 includes an electronically controlled slot cover 16. The controller 40 controls opening and closing of the slot cover 16, and thus opening and closing of the slot 15, and also determines a measure of load moved from the inner drum 10 and into the outer drum 20.

[0032] Referring to Fig. 2 in combination with the Fig. 1 and Figs. 3 to 10, the method 100 of the present technique is explained. The method 100 is for balancing during drum rotation in a drum-type washing machine 2. The drum-type washing machine 2, as shown in Fig. 8, includes the arrangement 1 as shown in Fig. 1. In the method 100 of the present technique, in a step 110 the inner drum 10 is rotated driven by the first drive motor 12 at a rotational speed and in a rotational direction, as explained hereinabove in relation to Fig. 1. Subsequently, in a step 120, the controller 40 determines an imbalance of the inner drum 10 during the rotation of the inner drum 10 as explained hereinabove in reference to Fig 1 and Figs. 3 to 10, and particularly in reference to Figs. 7 and 9. Thereafter, in a step 130, the controller 40 determines a balancing parameter for the outer drum 20 as explained hereinabove in reference to Figs 7 and 9. Then, the controller 40 in a step 140 instructs the second drive motor 22 to rotate the outer drum 20 at the balancing parameter, and finally in a step 150 the outer drum 20 is rotated at the balancing parameter driven by the second drive motor 22.

[0033] In an embodiment of the method 100, the balancing parameter includes an amount of load to be moved from the inner drum 10 to the outer drum 20, as explained hereinabove in reference to Figs 7 and 9. In this embodiment, the method 100 further includes a step 135 of transferring the amount of the load according to the balancing parameter from the inner drum 10 to the outer drum 20 before the step 140 is performed. The amount of the load may be transferred 135 from the inner drum 10 to the outer drum 20 manually, as explained in reference to Figs 5 and 6. Alternatively, the amount of the load may be transferred 135 from the inner drum 10 to the outer drum 20 automatically by using the slot 15 and the slot cover 16, and being controlled by the controller 40, as explained hereinabove in reference to Fig 10.

[0034] The controller 40 may be a processor, a FPGA or a microprocessor, and may be present in the washing machine 2 as a separate processor or may be part of the control module of the washing machine 2, i.e. the control module (not shown) of the washing machine 2 that operates the washing machine through different washing programs may further include the functionality of the controller 40 of the present technique.

[0035] Thus, the present invention refers to a technique for balancing in a drum-type washing machine 2 is presented. The technique uses an arrangement 1 having an inner drum 10 driven by a first drive motor 12, an outer drum 20 driven by a second drive motor 22, a detergent solution tub 30, and a controller 40. The drums 10, 20 are rotatably mounted co-axially within the tub 30, the outer drum 20 positioned concentrically in-between the inner drum 10 and the tub 30. The drive motors 12, 22 are positioned outside the tub 30. The controller 40 determines an imbalance of the inner drum 10 when rotating, and then determines a balancing parameter for the outer drum 20. The balancing parameter includes a rotational speed and direction for the outer drum 20 relative to the rotational speed and direction of the inner drum 10, such that the outer drum 20 when rotated at the balancing parameter counters the imbalance of the rotating inner drum 10.

List of reference numbers

[0036]

1	arrangement	
2	drum-type washing machine	
3	common door	
3a	door of the inner drum	
3b	annular door of the outer drum	
7	front panel of the washing machine	
8	openings of the drums / front side of the washing machine	
9	rotational axis of the drums of the washing machine	
10	inner drum	
11	first drive shaft	
12	first drive motor	
15	slot	
16	slot cover	
20	outer drum	
21	second drive shaft	
22	first drive motor	
30	detergent solution tub	
40	controller	
50	detergent delivery mechanism	
60	wash solution discharge system	
91	part of the load in the inner drum	
92	part of the load in the outer drum	
100	method	
110	rotating the inner drum	
120	determining imbalance in the inner drum	

130	determining the balance parameter
135	transferring the amount of the load according to the balancing parameter from the inner drum to the outer drum
140	instructing the second drive motor
150	rotating the outer drum
r_1	radius of the inner drum
r_2	radius of the outer drum
ω_1	angular velocity of the inner drum
ω_2	angular velocity of the outer drum
F_1	imbalance force generated by the inner drum
F_2	imbalance force generated by the outer drum

15 Claims

1. An arrangement (1) for balancing during drum rotation in a drum-type washing machine (2), the arrangement (1) comprising:

- an inner drum (10) rotatably mounted within a detergent solution tub (30);
- a first drive motor (12) positioned outside the detergent solution tub (30) and configured to rotate the inner drum (10);
- an outer drum (20) rotatably mounted within the detergent solution tub (30) and outside of the inner drum (10), wherein the inner drum (10), the outer drum (20) and the detergent solution tub (30) are concentrically arranged;
- a second drive motor (22) positioned outside the detergent solution tub (30) and configured to rotate the outer drum (20); and
- a controller (40) configured

- to determine an imbalance of the inner drum (10) during a rotation of the inner drum (10),
- to determine a balancing parameter for the outer drum (20), wherein the balancing parameter includes a speed and a direction of rotation of the outer drum (20) relative to a rotational speed and direction of the inner drum (10), and wherein the balancing parameter is such that when the outer drum (20) is rotated at the balancing parameter the rotation of the outer drum (20) counters the imbalance of the inner drum (10), and
- to instruct the second drive motor (22) to rotate the outer drum (20) at the balancing parameter.

2. The arrangement (1) according to claim 1, wherein the balancing parameter includes an amount of load to be moved from the inner drum (10) to the outer drum (20) or an amount of load to be moved from the outer drum (20) to the inner drum (10).

3. The arrangement (1) according to claim 2, wherein the inner drum (10) and the outer drum (20) are configured to be separately and independently provided with laundry.
4. The arrangement (1) according to claim 2 or 3, wherein the inner drum (10) comprises a slot (15) configured to move the amount of load from the inner drum (10) to the outer drum (20) or the amount of load from the outer drum (20) to the inner drum (10).
5. The arrangement (1) according to claim 5, wherein the slot (15) comprises an electronically controlled slot cover (16), and wherein the controller (40) is configured to control an opening and a closing of the slot cover (16) and to determine a measure of load moved from the inner drum (10) and into the outer drum (20) or to determine a measure of load moved from the outer drum (20) and into the inner drum (10).
6. The arrangement (1) according to any of claims 1 to 5, wherein the controller (40) is configured to determine the imbalance of the inner drum (10) during the rotation of the inner drum (10) through deviations in energy requirement, in torque and in speed of rotation of the inner drum (10) driven by the first drive motor (12) relative to desired energy requirement, torque and speed of rotation of the inner drum (10) driven by the first drive motor (12) as programmed for the rotation of the inner drum (10).
7. A drum-type washing machine (2) comprising an arrangement (1) according to any of claims 1 to 6.
8. A method (100) for balancing during drum rotation in a drum-type washing machine (2) having an arrangement (1) according to any of claims 1 to 6, the method (100) comprising:
 - rotating (110) the inner drum (10) driven by the first drive motor (12) at a rotational speed and in a rotational direction;
 - determining (120), by the controller (40), an imbalance of the inner drum (10) during the rotation (110) of the inner drum (10);
 - determining (130) a balancing parameter for the outer drum (20), wherein the balancing parameter includes a speed and a direction of rotation of the outer drum (20) relative to the rotational speed and the rotational direction of the rotation (110) of the inner drum (10), and wherein the balancing parameter is such that when the outer drum (20) is rotated at the balancing parameter the rotation of the outer drum (20) counters the imbalance of the inner drum (10);
 - instructing (140), by the controller (40), the second drive motor (22) to rotate the outer drum (20) at the balancing parameter, and
- rotating (150) the outer drum (20) at the balancing parameter driven by the second drive motor (22).
9. The method (100) according to claim 8, wherein the balancing parameter includes an amount of load to be moved from the inner drum (10) to the outer drum (20), and wherein the method (100) further includes transferring (135) the amount of the load according to the balancing parameter from the inner drum (10) to the outer drum (20) before instructing (140) the second drive motor (22) to rotate the outer drum (20).
10. The method (100) according to claim 8, wherein the balancing parameter includes an amount of load to be moved from the outer drum (20) to the inner drum (10), and wherein the method (100) further includes transferring (135) the amount of the load according to the balancing parameter from the outer drum (20) to the inner drum (10) before instructing (140) the second drive motor (22) to rotate the outer drum (20).
11. The method (100) according to claim 9 or 10, wherein the amount of the load is transferred (135) manually.
12. The method (100) according to claim 9 or 10, wherein the amount of the load is transferred (135) automatically by using the slot (15) and the slot cover (16) and wherein the controller (40) controls an opening and a closing of the slot cover (16) and determines a measure of load moved between the inner drum (10) and the outer drum (20).
13. The method (100) according to any of claims 8 to 12, wherein the imbalance of the inner drum (10) during the rotation of the inner drum (10) is determined (120) through deviations in energy requirement, in torque and in speed of rotation of the inner drum (10) driven by the first drive motor (12) relative to desired energy requirement, torque and speed of rotation of the inner drum (10) driven by the first drive motor (12) as programmed for the rotation of the inner drum (10).

FIG 1

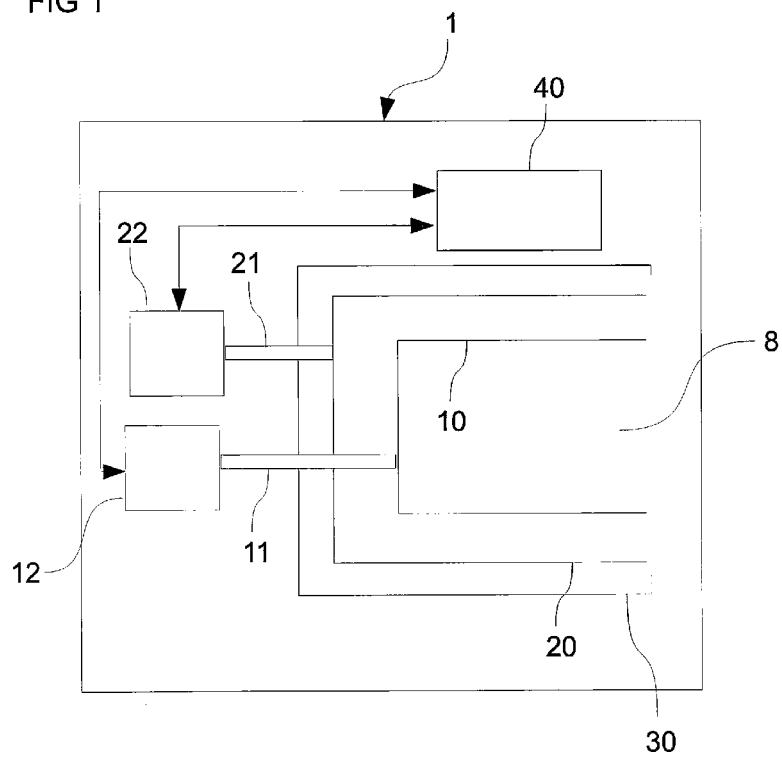


FIG 2

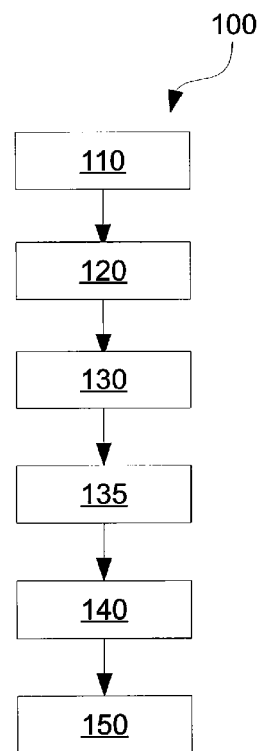


FIG 3

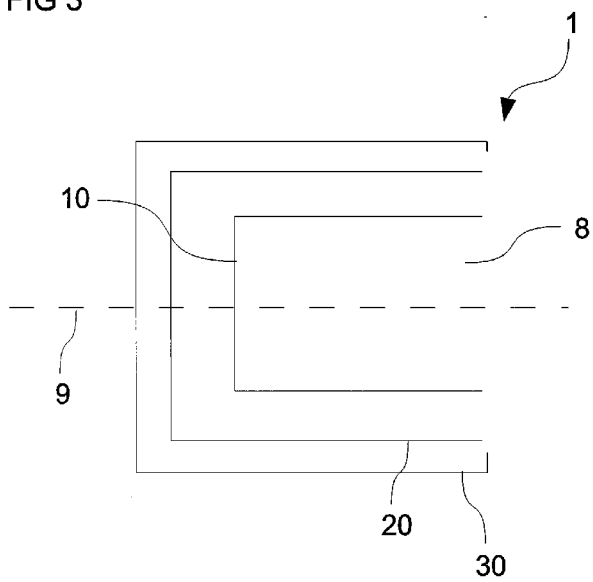


FIG 4

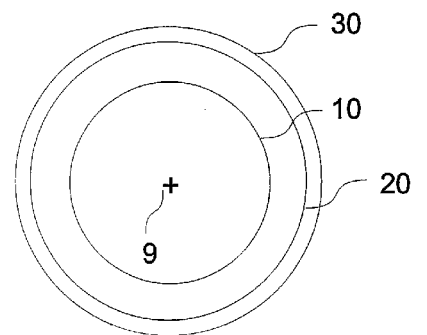


FIG 5

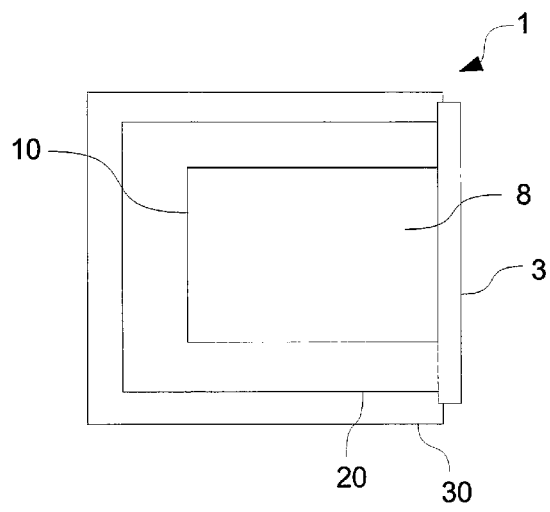


FIG 6

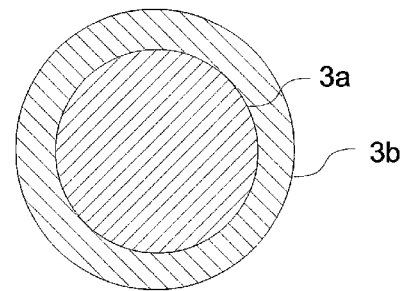


FIG 7

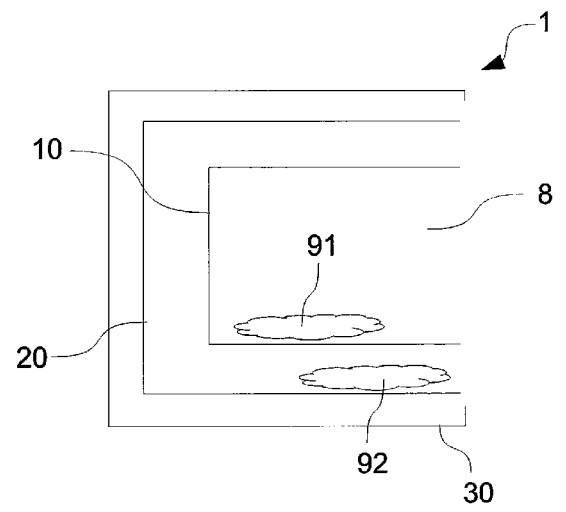


FIG 8

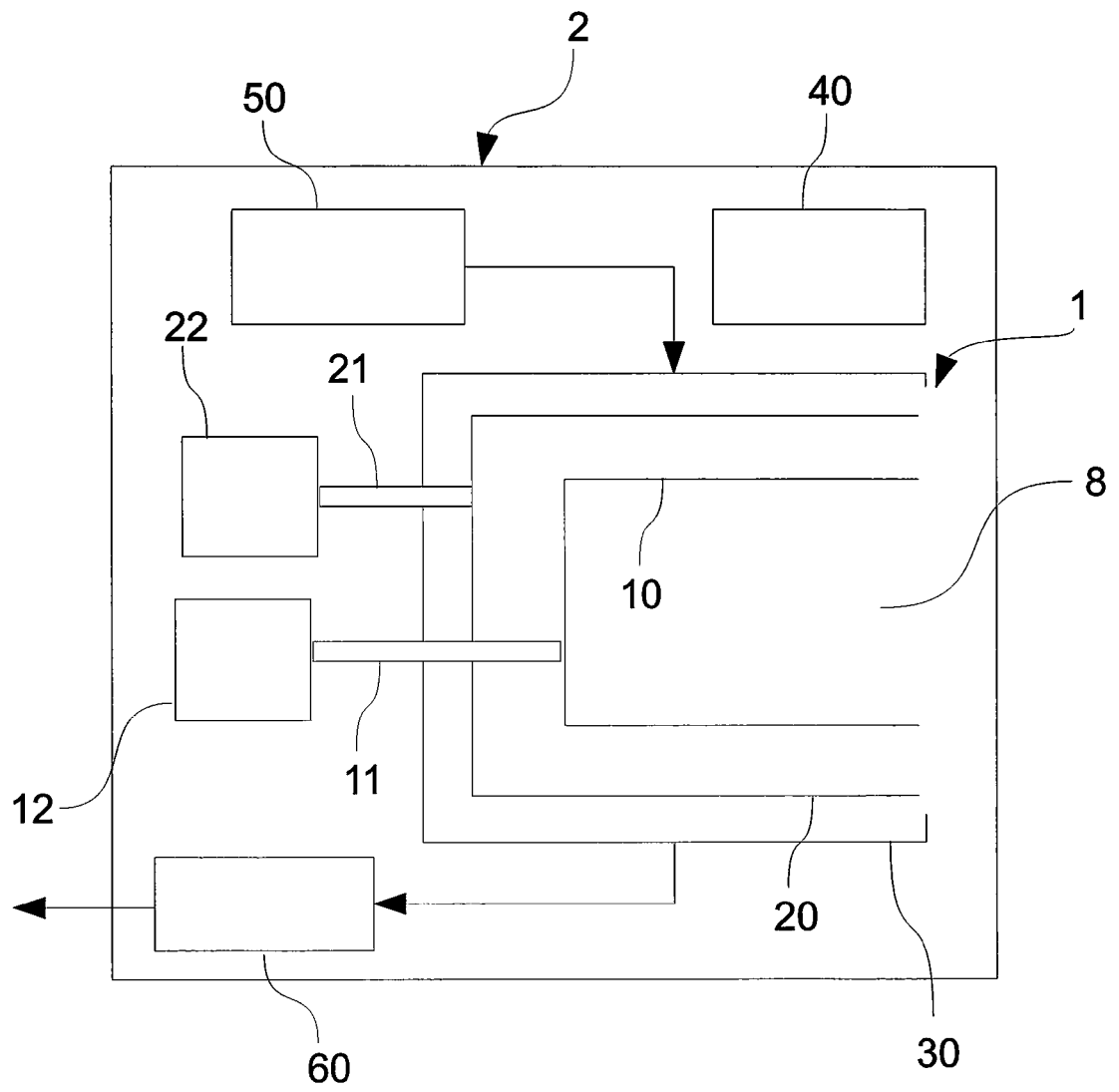


FIG 9

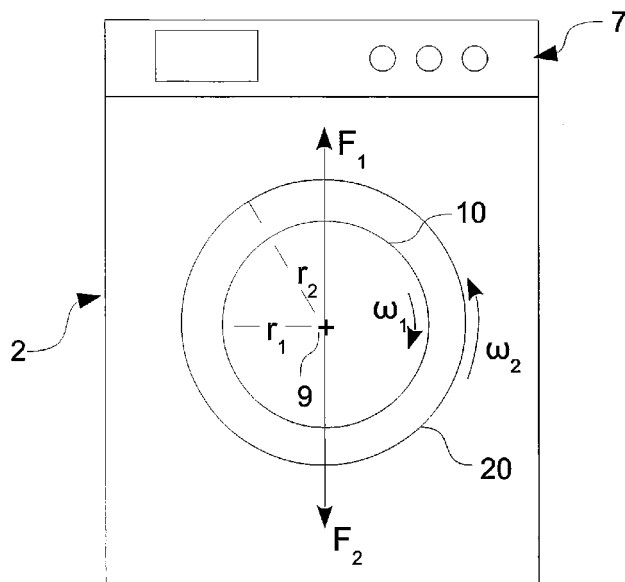
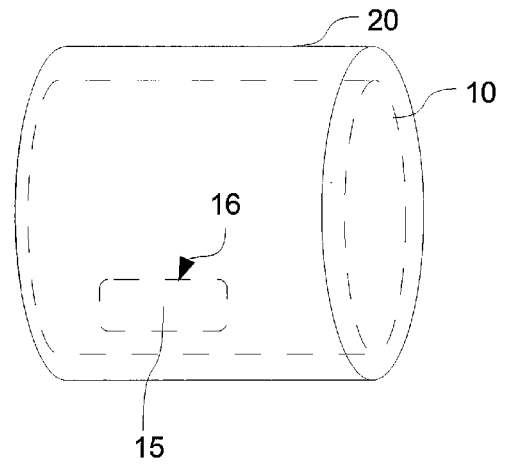


FIG 10





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Application Number
EP 17 17 0007

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