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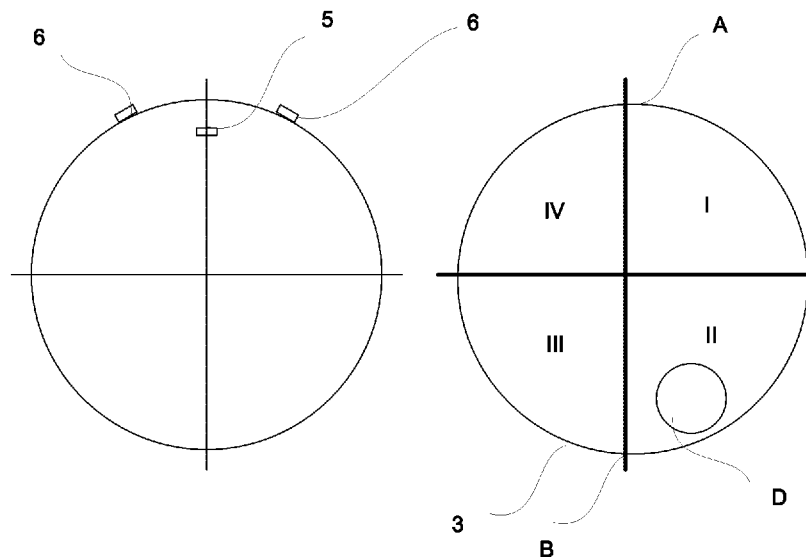
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(54) Title: A WASHING MACHINE AND THE OPERATING METHOD THEREOF

Figure 4



(57) Abstract: The present invention relates to a washing machine (1) comprising a tub (2); a drum (3) which is disposed in the tub (2), wherein the laundry is loaded and which rotates around an axis; a motor (4) which provides the rotation of the drum (3); an actuator (5) which is disposed on the drum (3); a sensor (6) which is provided on the tub (2), which generates a signal in the rotation of the drum (3) with the effect of the actuator (5) and which detects the position of the actuator (5); and a control unit (7), wherein the unbalanced load (D) in the drum (3) can be detected, and also relates to the operating method thereof.

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
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A WASHING MACHINE AND THE OPERATING METHOD THEREOF

- [0001] The present invention relates to a washing machine wherein the position of the unbalanced load is detected and the unbalanced load is distributed, and relates to the operating method thereof.
- [0002] The laundry placed in the drum in the washing machines sticks onto the inner walls of the drum, especially under the effect of centrifugal force during high-speed spinning. Unbalanced load may occur in the machine since the capacity, type, amount and water absorption potential of the textile that the user loads into the drum during the washing/drying process of the washing machine are not known. Depending on the position of the unbalanced laundry load, displacements occur in the axis of rotation of the drum. This causes the machine to vibrate and make unwanted movements.
- [0003] Various unbalanced load detection algorithms are used by using the motor speed and current in order to eliminate the problems of the machine moving during the washing cycle before the spin-drying step. In case of unbalanced load, if the unbalanced load exceeds a threshold value predetermined by the producer, spin-drying step does not start and load distribution motion is applied. Unbalanced load control is performed after the load distribution motion, before re-spin-drying, and if appropriate, spin-drying step is started. In this case, the unbalanced load must be spontaneously dispersed during the rotation of the drum by delaying the spin-drying process. Thus, since the proper distribution motion cannot be made, the spin-drying step of the machine cannot be started at the desired time and the program duration prolongs. Therefore, there is a need for a solution to eliminate unbalanced load.
- [0004] Moreover, since the position of the load in the drum changes constantly with the movement of the drum, it is difficult to determine the exact position of the unbalanced load in the drum. In order to protect the machine, if a certain amount of unbalanced load is above the predetermined threshold value and if an effective distribution cannot be carried out after a certain number of trials, spin-drying process is not performed to prevent damage

to the machine. In this case, the user may encounter wet laundry which has not been spin-dried after the washing or drying program.

[0005] In the state of the art Japanese Patent Document No. JP2006311884, a vibration sensor system is used, which makes detection in two directions in order to determine the unbalanced load.

[0006] In another state of the art European Patent Document No. EP2340325, a washer/dryer is disclosed, wherein the position and amount of the unbalanced load is detected by means of a magnet disposed on the drum, a position sensor disposed located on the tub and generating an impact signal on each rotation of the drum with the effect of the magnet, and a vibration sensor generating sinusoidal signals with the rotation frequency of the drum.

[0007] The aim of the present invention is the realization of a washing machine wherein the position of the unbalanced load is properly detected and the unbalanced load is distributed without delaying the spin-drying process.

[0008] The washing machine of the present invention comprises at least one sensor which is positioned on the tub and an actuator which is provide on the drum and which generates a signal for the sensor to detect. The actuator is a magnet in a preferred embodiment of the present invention. A full rotation time of the magnet from the apex of the drum is determined by the sensor and the control unit.

[0009] In another preferred embodiment of the present invention, the actuator is a mechanical switch and comes into contact with the sensor during the rotation of the drum such that the sensor makes detection.

[0010] Since the unbalanced load occurring by the laundry during the washing process makes an additional weight on the drum, the rotation speed of the drum differs. In normal conditions when no unbalanced load occurs, the drum rotates at a constant speed in accordance with the constant speed of the motor, but completes its rotation at different speeds in each zone of the drum in case of unbalanced load.

[0011] In the washing machine of the present invention, the control unit correctly detects in which zone of the drum the unbalanced load is from the deviations between the fixed reference speed and changing speeds of the

drum and the deviations in the position of the actuator in the reference period.

[0012] When the unbalanced load detected by the control unit reaches the apex of the drum, a command is given by the control unit to stop the motor with a sudden brake and distribute the unbalanced load.

[0013] In the washing machine of the present invention, the control unit also calculates the instantaneous speed data at any position around the drum by calculating the rotation time of the drum using the rotational speed and the reference speed thereof.

[0014] The control unit calculates the oscillation of the drum using the sum of the differences between said instantaneous speed and the reference speed at different moments during the rotation of the drum. The oscillation of the drum is caused by unbalanced load. Therefore, the increase in the oscillation value is directly associated with the presence of an unbalanced load or an excessive amount.

[0015] The control unit also contains the oscillation data predetermined by the producer caused by the unbalanced load of different weights in the drum. For example, the oscillation coefficient created by an unbalanced load of 250 grams is 2, while the oscillation value created by a load of 1 kg is 5.

[0016] The amount of unbalanced load is determined by comparing the oscillation value determined by the control unit with the oscillation-unbalanced load data in the memory.

[0017] By means of the present invention, a washing machine is realized, wherein the position of the unbalanced load is precisely determined, the load is distributed, the washing performance is improved and the spin-drying step is started in a short time.

[0018] The model embodiments relating to the washing machine realized in order to attain the aim of the present invention are illustrated in the attached figures, where:

[0019] **Figure 1** - is the front view of the washing machine of the present invention.

[0020] **Figure 2** - is the perspective view of the washing machine of the present invention with the top and front panel being removed.

[0021] **Figure 3** - is the perspective view of the part containing the motor and the tub in the washing machine of the present invention.

[0022] **Figure 4** - is the schematic view of the virtual zones of the drum, the actuator and the sensor in the washing machine of the present invention.

[0023] **Graphic 1** - is the graphic showing of the change in speed by time in the virtual zones of the drum in the washing machine of the present invention.

[0024] The elements illustrated in the figures are numbered as follows:

1. Washing machine
2. Tub
3. Drum
4. Motor
5. Actuator
6. Sensor
7. Control unit

[0025] A. Drum apex point

[0026] B. Drum lowest point

[0027] Ç: Drum circumference

[0028] D: Unbalanced load

[0029] V: Drum instantaneous rotation speed

[0030] V_{ref} : Drum fixed rotation speed in case of no unbalanced load

[0031] t: Time

[0032] t_{ref} : Full turn time of the drum in case of no unbalanced load

[0033] x: Oscillation

[0034] n: Revolution

[0035] I. Drum first zone

[0036] II. Drum second zone

[0037] III. Drum third zone

[0038] IV. Drum fourth zone

[0039] The washing machine (1) comprises a tub (2); a drum (3) which is disposed in the tub (2), wherein the laundry is loaded and which rotates around an axis; a motor (4) which provides the rotation of the drum (3); an actuator (5) which is disposed on the drum (3); and a sensor (6) which is provided on the tub (2), which generates a signal in the rotation of the

drum (3) with the effect of the actuator (5) and which detects the position of the actuator (5).

[0040] The washing machine (1) of the present invention comprises a control unit (7)

- which determine the reference time (t_{ref}) which is one full rotation of the drum (3) by means of the actuator (5) and the sensor (6),
- which calculates in which region (I, II, III or IV) of the drum (3) the unbalanced load (D) is positioned by using the deviations in the expected position of the actuator (5) in the reference time (t_{ref}) determined during the rotation of the drum (3) which are caused by the speed (V) variations by time occurring between the apex (A) of the drum (3) where the speed of the drum (3) is the lowest during the clockwise rotation thereof and the lowest point (B) of the drum (3) where the speed of the drum (3) is the highest due to the weight created by the unbalanced load (D) on the drum (3) and also caused by the variations in the drum (3) speed, and
- which sends a command for braking the motor (4) when the unbalanced load (D) is at the apex (A) of the drum (3) by calculating the time required for the unbalanced load (D) to reach the apex (A) of the drum (3) from the zone (I, II, III or IV) where the unbalanced load (D) is located.

[0041] The washing machine (1) of the present invention comprises the actuator (5) which is provided located in the drum (3) and at least one sensor (6) which operates by the detection of the actuator (5). When there is no unbalanced load (D) in the washing machine (1) of the present invention, the speed of the motor (4) and hence the speed of the drum (3) is constant (V_{ref}) and the drum (3) makes a full rotation in a time predetermined by the producer. However, in case the laundry sticks onto the drum (3) in the washing cycle and creates an unbalanced load (D), the rotation speed of the drum (3) differs in each virtual zone (I, II, III and IV) of the drum (3) due to the unbalanced weight generated. In the washing machine (1) of the present invention, a full turn of the actuator (5) in the drum (3) starting from the apex (A) of the drum (3) is accepted as the reference time (t_{ref}). In

case of unbalanced load (D) in the region I or II during the rotation of the drum (3) from the apex (A) to the lowest point (B), the drum (3) accelerates with the effect of weight and gravity, and completes the half rotation including the regions I and II in a shorter time than the case of no unbalanced load (D) in the drum (3). In case of unbalanced load (D) in the region III or IV during the rotation of the drum (3) from the lowest point (B) to the apex (A), the drum (3) slows down, and completes the half rotation including the regions III and IV in a longer time than the case of no unbalanced load (D). The control unit (7) precisely calculates in which zone (I, II, III or IV) in the drum (3) the unbalanced load (D) is by using the variations in the speed (V) by time and the deviations in the expected position of the actuator (5) in the reference time while the drum (3) rotates at a constant speed. The control unit (7) also calculates the arrival time of the actuator (5) at the apex (A) of the drum (3) when the sensor (6) detects the position of the actuator (5) on the drum (3) during the rotation of the drum (3), and the time required for the unbalanced load (D) to reach the apex (A) of the drum (3) is calculated by comparing the distance between the position of the unbalanced load (D) and the position of the actuator (5). Thus, when the unbalanced load (D) is at the apex (A) of the drum (3), the control unit (7) provides that the motor (4) is stopped with a sudden brake and the unbalanced load (D) is distributed.

[0042] In an embodiment of the present invention, the washing machine (1) comprises the control unit (7) which calculates the oscillation (x) of the drum (3) by using the total of differences during a full rotation time of the drum (3) between the instantaneous speed (V) of the drum (3) and the reference speed (V_{ref}) predetermined by the producer. Thus, the oscillation (x) caused by the unbalanced load (D) in the drum (3) is calculated. The control unit (7) calculates the oscillation value by using the formulas $x =$

$$\begin{cases} \min < x < \max & \sum_{t=0}^{8s} (|V_{tambur}(t) - V_{ref}|) \\ x < \min & \min \\ x > \max & \max \end{cases}$$

$$, t = n \frac{V_{ref}}{60000} \text{ (ms)}, \varphi = 2\pi r \text{ and}$$

$$\varphi = V_{tambur} * t$$

. The revolution time (t) is calculated by using the known circumference (C) and revolution (n) of the drum, which is in turn used for calculating the instantaneous speed (V_{tambur}) of the drum (3).

- [0043] In an embodiment of the present invention, the washing machine (1) comprises the control unit (7) which stores in the memory thereof the oscillation (x) values generated by unbalanced loads (D) with different weights in the drum (3). Thus, the vibration coefficients created by the unbalanced loads (D) of different amounts in the drum (3) are known.
- [0044] In an embodiment of the present invention, the washing machine (1) comprises the control unit (7) which calculates the weight value of the unbalanced load (D) by comparing the measured drum oscillation (x) and the unbalanced load (D) values of different weight in the memory thereof. Thus, the weight of the unbalanced load (D) can be easily determined by using the oscillation value (x).
- [0045] In an embodiment of the present invention, the washing machine (1) comprises the control unit (7) which stores in the memory thereof the times required for the unbalanced loads (D) of different weights to reach the apex (A) of the drum (3). By means of said stored data, the arrival time of known amounts of unbalanced load (D) to the apex (A) of the drum (3) is calculated faster and easier.
- [0046] In an embodiment of the present invention, the washing machine (1) comprises the actuator (5) comprising a magnet or a switch to interact with the sensor (6).
- [0047] A method used for determining and distributing the unbalanced load (D) in the washing machine (1) of the present invention comprises the steps of
- [0048] - determining the reference time (t_{ref}) which is one full rotation of the drum (3) by means of the actuator (5) and the sensor (6),
- [0049] - calculating by the control unit (7) in which region (I, II, III or IV) of the drum (3) the unbalanced load (D) is positioned by using the deviations in the expected position of the actuator (5) in the reference time (t_{ref}) determined during the rotation of the drum (3) which are caused by the speed (V) variations by time occurring between the apex (A) of the drum (3) where the speed of the drum (3) is the lowest during the clockwise

rotation thereof and the lowest point (B) of the drum (3) where the speed of the drum (3) is the highest due to the weight created by the unbalanced load (D) on the drum (3) and also caused by the variations in the drum (3) speed, and

- [0050] - sending a command by the control unit (7) for braking the motor (4) when the unbalanced load (D) is at the apex (A) of the drum (3) by calculating the time required for the unbalanced load (D) to reach the apex (A) of the drum (3) from the zone (I, II, III or IV) where the unbalanced load (D) is located.
- [0051] Said method further comprises the steps of calculating by the control unit (7) the oscillation (x) of the drum (3) by using the total of differences during a full rotation time of the drum (3) between the instantaneous speed (V) of the drum (3) and the reference speed (V_{ref}) predetermined by the producer and of calculating the weight value of the unbalanced load (D) by comparing the calculated drum oscillation (x) and the unbalanced load (D) values of different weight in the memory thereof predetermined by the producer.
- [0052] By means of the present invention, the actual zone of the drum (3) where the unbalanced load (D) occurring in the drum (3) is located and the amount thereof is calculated, thus providing the distribution of the unbalanced load (D).

Claims

1. A washing machine (1) **comprising** a tub (2); a drum (3) which is disposed in the tub (2), wherein the laundry is loaded and which rotates around an axis; a motor (4) which provides the rotation of the drum (3); an actuator (5) which is disposed on the drum (3); and a sensor (6) which is provided on the tub (2), which generates a signal in the rotation of the drum (3) with the effect of the actuator (5) and which detects the position of the actuator (5), characterized by a control unit (7)
 - which determine the reference time (t_{ref}) which is one full rotation of the drum (3) by means of the actuator (5) and the sensor (6),
 - which calculates in which region (I, II, III or IV) of the drum (3) the unbalanced load (D) is positioned by using the deviations in the expected position of the actuator (5) in the reference time (t_{ref}) determined during the rotation of the drum (3) which are caused by the speed (V) variations by time occurring between the apex (A) of the drum (3) where the speed of the drum (3) is the lowest during the clockwise rotation thereof and the lowest point (B) of the drum (3) where the speed of the drum (3) is the highest due to the weight created by the unbalanced load (D) on the drum (3) and also caused by the variations in the drum (3) speed, and
 - which sends a command for braking the motor (4) when the unbalanced load (D) is at the apex (A) of the drum (3) by calculating the time required for the unbalanced load (D) to reach the apex (A) of the drum (3) from the zone (I, II, III or IV) where the unbalanced load (D) is located.
2. A washing machine (1) as in Claim 1, characterized by the control unit (7) which calculates the oscillation (x) of the drum (3) by using the total of differences during a full rotation time of the drum (3) between the instantaneous speed (V) of the drum (3) and the reference speed (V_{ref}) predetermined by the producer.
3. A washing machine (1) as in Claim 1 or 2, characterized by the control unit (7) which stores in the memory thereof the oscillation (x) values generated by unbalanced loads (D) of different weights in the drum (3).
4. A washing machine (1) as in Claim 3, characterized by the control unit (7) which calculates the weight value of the unbalanced load (D) by comparing the

measured drum oscillation (x) and the unbalanced load (D) values of different weight in the memory thereof.

5. A washing machine (1) as in any one of the above claims, characterized by the control unit (7) which stores in the memory thereof the times required for the unbalanced loads (D) of different weights to reach the apex (A) of the drum (3).
6. A washing machine (1) as in any one of the above claims, characterized by the actuator (5) comprising a magnet or a switch to interact with the sensor (6).
7. A method used for determining and distributing the unbalanced load (D) in the washing machine (1), characterized by the steps of
 - determining the reference time (t_{ref}) which is one full rotation of the drum (3) by means of the actuator (5) and the sensor (6),
 - calculating by the control unit (7) in which region (I, II, III or IV) of the drum (3) the unbalanced load (D) is positioned by using the deviations in the expected position of the actuator (5) in the reference time (t_{ref}) determined during the rotation of the drum (3) which are caused by the speed (V) variations by time occurring between the apex (A) of the drum (3) where the speed of the drum (3) is the lowest during the clockwise rotation thereof and the lowest point (B) of the drum (3) where the speed of the drum (3) is the highest due to the weight created by the unbalanced load (D) on the drum (3) and also caused by the variations in the drum (3) speed, and
 - sending a command by the control unit (7) for braking the motor (4) when the unbalanced load (D) is at the apex (A) of the drum (3) by calculating the time required for the unbalanced load (D) to reach the apex (A) of the drum (3) from the zone (I, II, III or IV) where the unbalanced load (D) is located.
8. A method used for determining and distributing the unbalanced load (D) in the washing machine (1) as in Claim 7, characterized by the steps of calculating by the control unit (7) the oscillation (x) of the drum (3) by using the total of differences during a full rotation time of the drum (3) between the instantaneous speed (V) of the drum (3) and the reference speed (V_{ref}) predetermined by the producer and of calculating the weight value of the unbalanced load (D) by comparing the calculated drum oscillation (x) and the unbalanced load (D) values of different weight in the memory thereof predetermined by the producer.

Figure 1

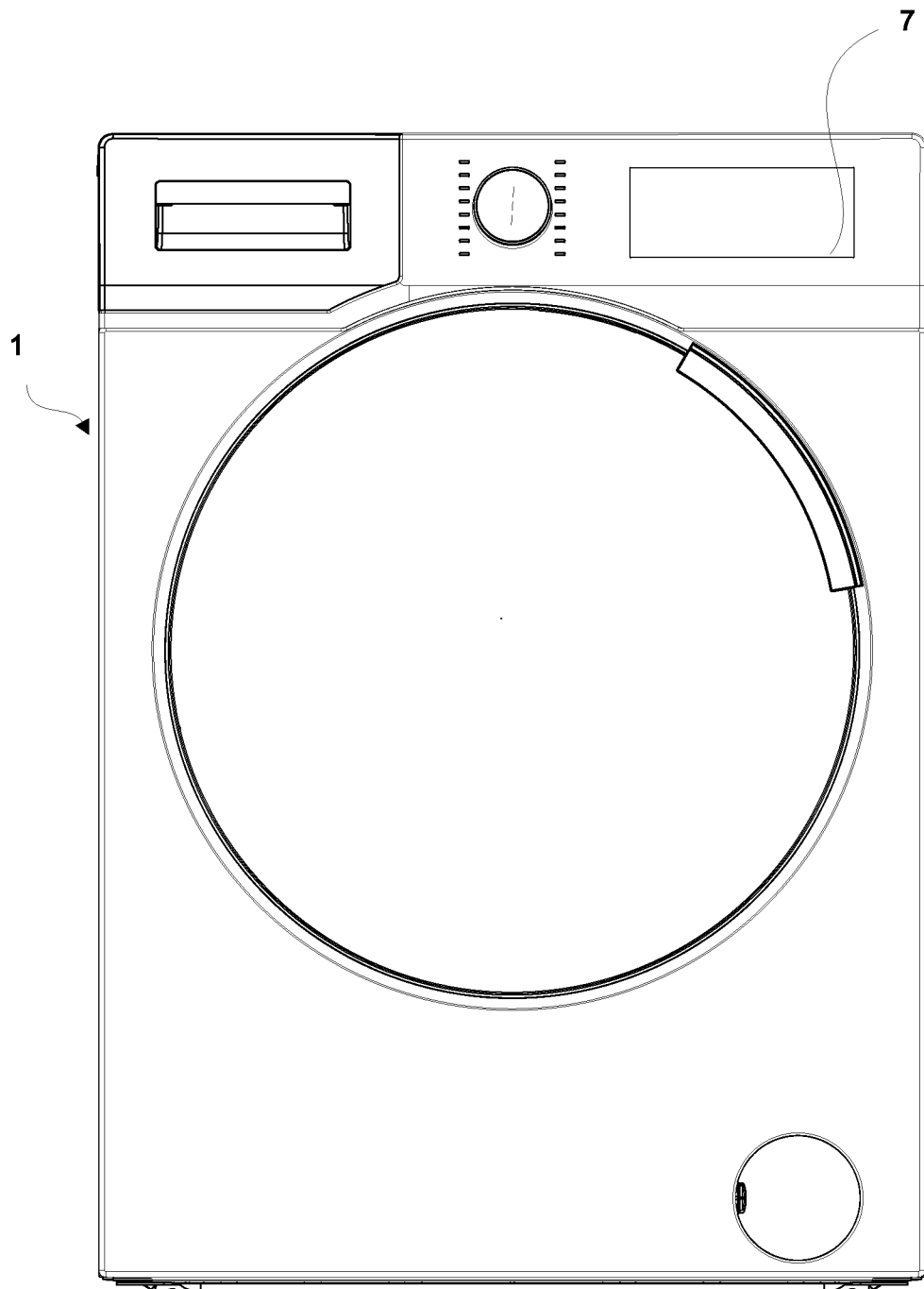


Figure 2

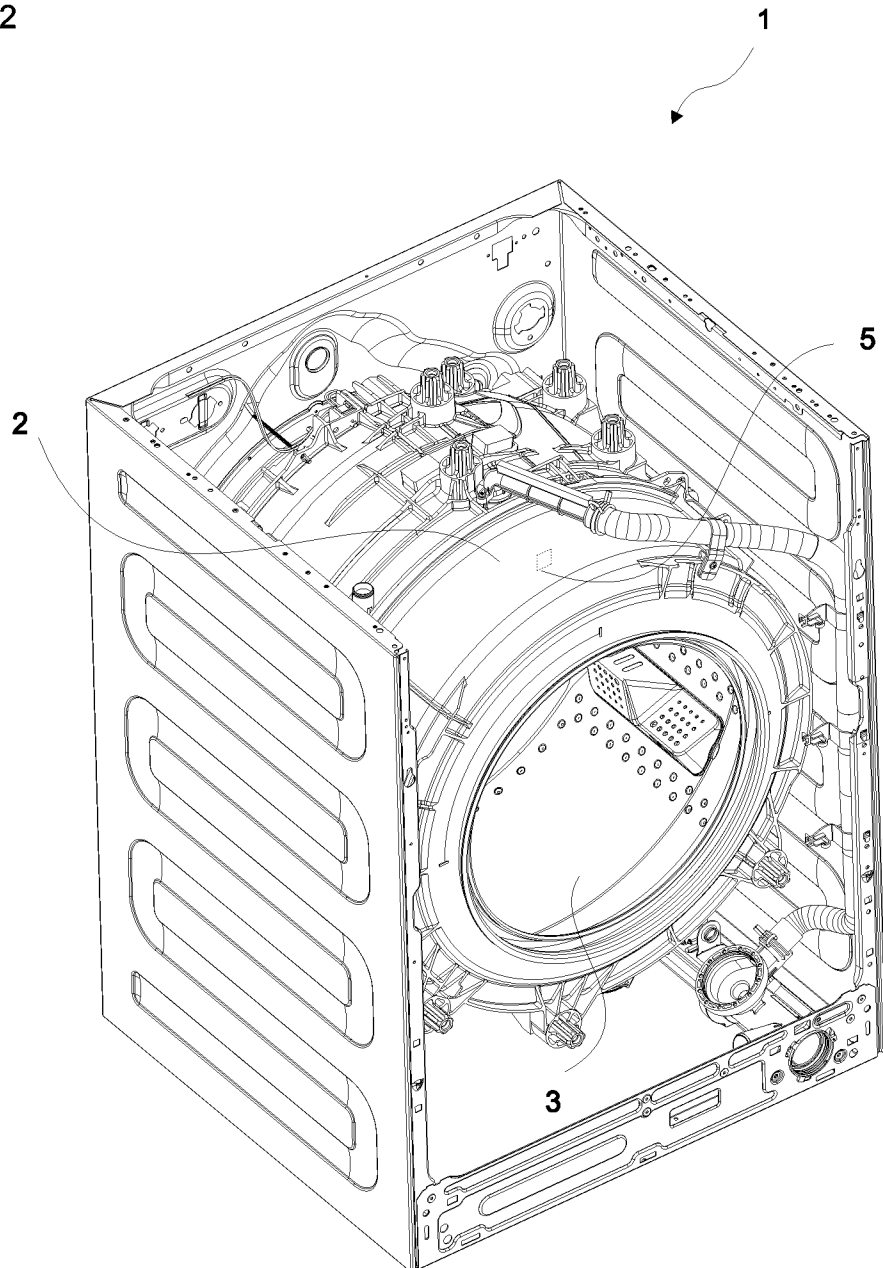


Figure 3

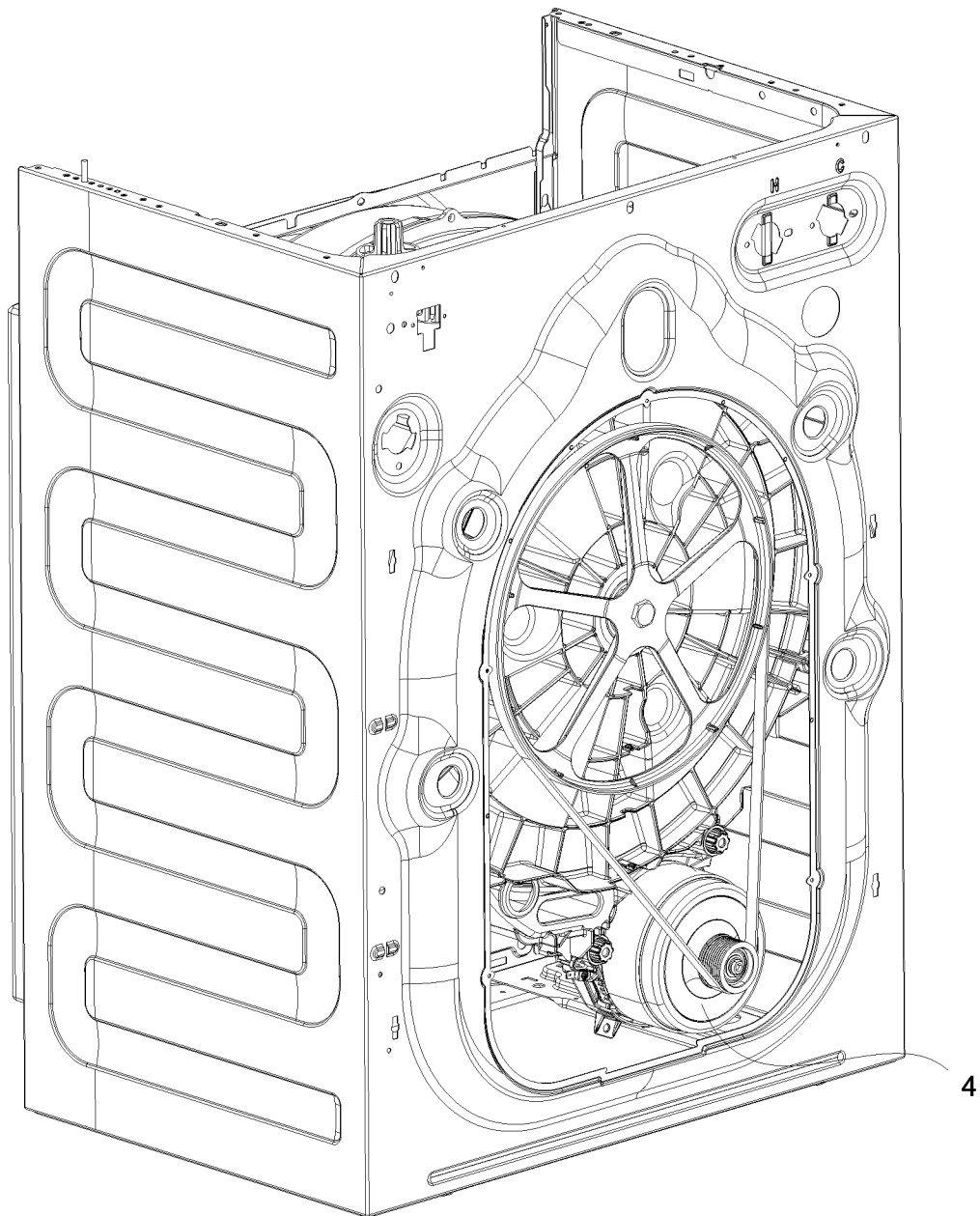
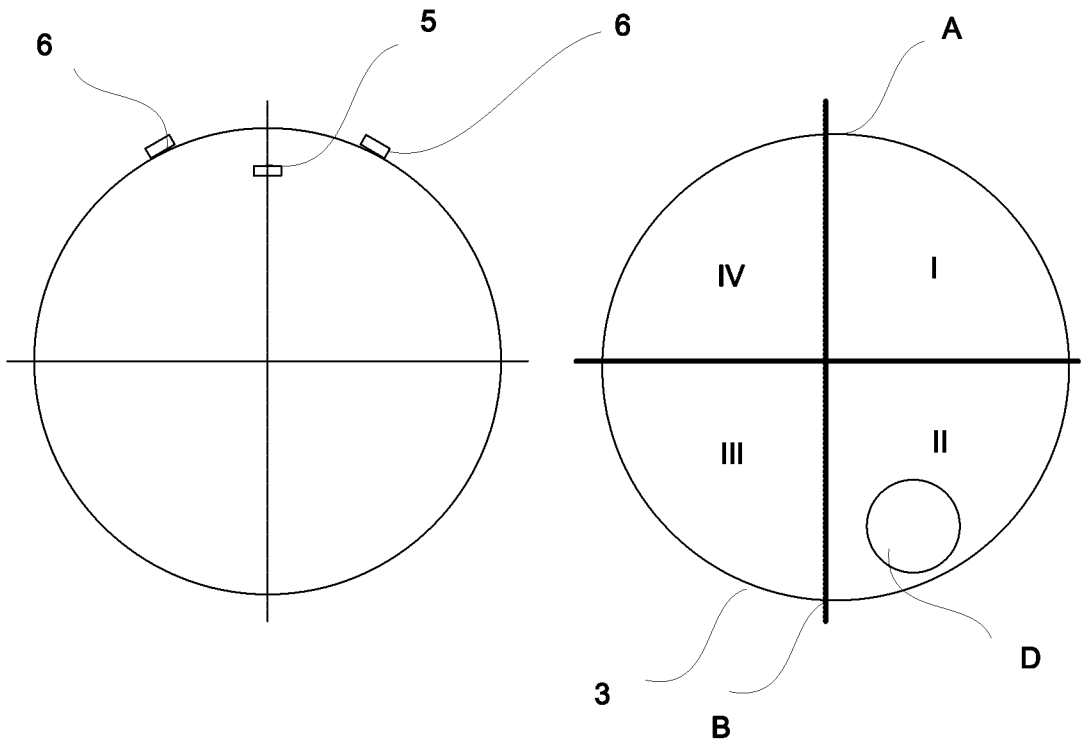
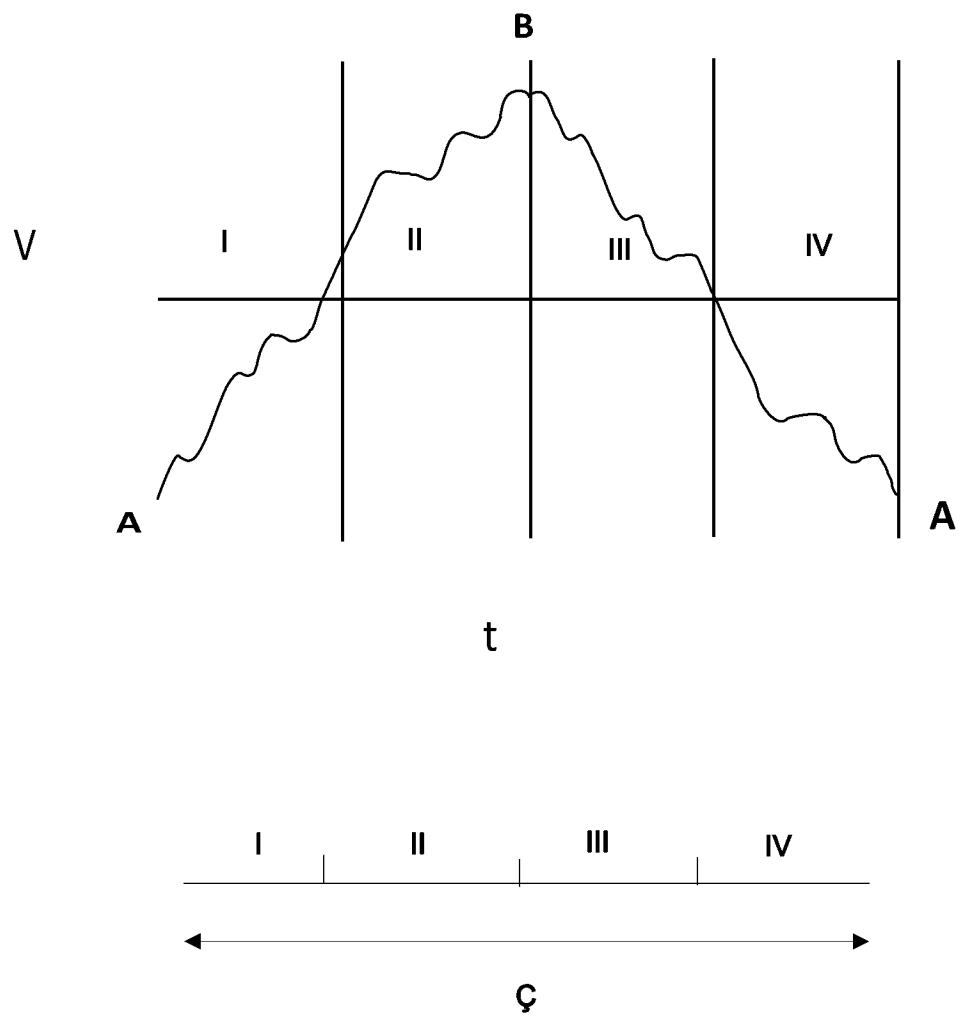


Figure 4



Graphic 1



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2020/058144

A. CLASSIFICATION OF SUBJECT MATTER

INV. D06F33/48

ADD. D06F34/16

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/145614 A1 (WHIRLPOOL CORP) 25 May 2017 (2017-05-25)	1,4,5,7
Y	paragraph [0046] - paragraph [0084] paragraphs [0109], [0110]; claims; figures	2,3,6,8
Y	----- US 2012/151688 A1 (LG ELECTRONICS INC [KR]) 21 June 2012 (2012-06-21)	2,3,8
A	paragraph [0065] - paragraph [0086]; claims; figures	1,4-7
Y	----- EP 2 520 700 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 7 November 2012 (2012-11-07)	6
A	paragraph [0029] - paragraph [0038]; figures	1-5,7,8
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

27 April 2020

Date of mailing of the international search report

08/05/2020

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/058144

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 322 141 A (TOSHIBA KK [JP]) 19 August 1998 (1998-08-19) page 11, line 19 - line 23; claims; figures -----	1-8
A	EP 0 921 226 A2 (AKO WERKE GMBH & CO [DE]) 9 June 1999 (1999-06-09) paragraph [0008]; claims; figures -----	1-8
A	WO 2006/072907 A1 (ARCELIK AS [TR]) 13 July 2006 (2006-07-13) paragraph [0019]; figure 5 -----	1-8
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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