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(54) **METHOD FOR DETERMINING WEIGHT OF THE LOAD IN A WASHER DRYER USING THE NATURAL FREQUENCY RESPONSE OF THE LOADED DRUM**

VERFAHREN ZUR BESTIMMUNG DES GEWICHTS DER LAST IN EINER WASCHMASCHINE MIT TROCKNER ANHAND DER EIGENFREQUENZREAKTION DER BELADENEN TROMMEL

LAVE-LINGE/SÈCHE-LINGE

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Description

[0001] The present invention relates to a washer/dryer wherein the amount of laundry contained therein is detected.

[0002] In washer/dryers, particularly in washing machines, one of the most important parameters that affect the washing performance is the amount of the laundry (the load) emplaced in the drum by the user. If this load is known, then the amount of water and detergent to be used and the washing duration can be determined. Respectively the washing machine can be operated with the minimum amount of energy, water and detergent as possible.

[0003] In some of the conventional applications, various sensors are used for measuring the load embraced in the drum by the user. For example, in the German Patent Application No DE10104682, an electrically insulated surface, functioning as a capacitor between the drum and the body, is utilized as a load sensor.

[0004] However, the use of a sensor is an application that both increases the cost of the machine and also has various difficulties. Therefore, various solutions are devised in the technique relating to load sensing without sensors. One of these solutions is explained in the International Patent Application No WO05085511. According to this method, the duration that passes from going down to a second speed less than the pre-spin speed is detected. The load is calculated by using this value.

[0005] In the International Patent Application No WO03046271, a method is described wherein the values measured at high speeds are compared with the prerecorded values to determine the unbalanced load.

[0006] In the United States of America Patent No US6029299, the load is detected by looking at the speed profiles obtained during washing. The amount of load is determined by rising and falling of the laundry while the drum rotates.

[0007] In the state of the art European Patent Application No EP1113102 the total load and the unbalanced load is determined by the signals received from the motor.

[0008] EP 0709512 A1 concerns a washing machine and a process for using the washing machine. The washing machine comprises a rotating drum for the washing, a motor for driving the drum, and a device for the display of a rotation speed signal. The loading stage is determined by an evaluator circuit in accordance with the vibration behaviour of the speed signal during the reversing cycle in a first program cycle.

[0009] An object of the present invention is to provide a method of controlling a washer/dryer wherein the amount of load in the drum is determined easily.

[0010] The object of the present invention is achieved by the method for controlling a washer/dryer according to claim 1. The object of the present invention is also achieved by the methods for controlling a washer/dryer according to the dependent claims. In the said washer/dryer, after the user loads the laundry in the drum, the drum is accelerated up to a speed that is greater than the angular speed corresponding to the estimated value of natural frequency. Simultaneously, the angular speed of the system corresponding to the natural frequency present in the load is measured by using the measurements received from the speed sensor utilized in measuring the motor speed. This value is compared with the natural frequency values for known loads measured and previously recorded in the control unit by the producer. As a result, the load amount corresponding to the said natural frequency is determined as the weight of the load contained in the drum.

[0011] The angular speed value corresponding to the natural frequency is detected by determining the angular speed wherein the difference between the minimum and maximum angular speed values is greatest that is realized during a full revolution with the data received from the speed sensor.

[0012] The greatest angular speed value to which drum should be accelerated for determining the load is decided by the producer as a result of a study made while the machine is empty. The natural frequency value is greatest while laundry is not loaded in the machine. For this reason the angular speed value corresponding to the natural frequency determined by tests done while the machine is empty can be used together with a safety margin as the highest speed value to which the drum has to accelerate.

[0013] In an embodiment of the present invention, the load determining process is made while dry before receiving water. Thus the dry weight of the laundry can be determined more precisely.

[0014] In another embodiment of the present invention, a certain amount of water is received into the tub in order to prevent fraying of the laundry as a result of rotating at high speed. This amount is preferably less than the water amount required for washing, just sufficient for reducing the friction between the drum and the clothes. In this embodiment, as the weight of the load is detected, subtracting the weight of water received into the tub will be adequate.

[0015] In another embodiment of the present invention, the producer records the same values in the control unit of all the washer/dryers produced of a certain type. Thus the producer does not have to apply tests to every washer/dryer separately. Particularly, the natural frequency value reduction corresponding to a certain load value increase has been ascertained to be approximately the sane for the same type of machines. In other words, in machines of a certain series, even if the natural frequency value is different while the drum is empty, for example when 3 kg of load is placed in the drum, the reduction quantity according to the natural frequency of the empty machine corresponding to the angular speed is the same. Such a table wherein the reduction observed in natural frequency values ascertained while the drum is empty corresponding to different loads can be recorded to all machine having similar dynamic properties.

[0016] In an embodiment of the present invention, the producer tests each washer/dryer separately and the machine specific values are recorded in the control unit of each washer/dryer. Consequently, the amount of laundry the user places in the drum can be measured more precisely taking into account the differences relating to production. The producer can measure these values during the speed tests currently applied to the machines.

[0017] The washer/dryer designed to fulfill the objective of the present invention is illustrated in the attached figures, where:

[0018] Figure 1 - is the schematic view of a washer/ dryer.

[0019] Figure 2 - is the graph of the angular speed - drum angle of a washer/dryer.

[0020] The elements illustrated in the figures are numbered as follows:

1. Washer/dryer
2. Body
3. Tub
4. Drum
5. Motor
6. Control unit
7. Sensor

[0021] The washer/dryer (1) can be a washing machine used in cleaning laundry by washing with water, a dryer used for drying wet laundry or a washer-dryer that can perform both washing and drying. The washer/dryer (1) functions according to a program.

[0022] The washer/diyer (1), basically comprises

- a body (2),
- a tub (3) disposed inside the body (2),
- a drum (4) that rotates in the tub (3) and wherein the laundry (L) is emplaced,
- a motor (5) providing the required drive for rotating the drum (4) and
- a speed sensor (7) that measures the angular speed of the drum (4) and/or the motor (5) (Figure 1).

[0023] The washer/dryer (1) of the present invention furthermore comprises a control unit (6) wherein the natural frequency values (Wni, i=1, ..., k) corresponding to a series of known load amounts (Li, i=1, ..., k) are recorded by the producer. After the user loads an amount (Li) of laundry (L) into the drum (4), the control unit (6) accelerates the motor (5) to a higher revolution than the probable natural frequency values, finds out the natural frequency (Wni) from the speed values measured by the sensor (7) during this process and compares this with the values (Li-Wni; i=1, ..., k) prerecorded by the producer and determines the load value (Li) corresponding to this angular speed (Wni) values.

[0024] While the drum (4) is accelerated from zero up to a certain value, during each full revolition (2p) of rotation (j=1,...,m), the momentary angular speed (W) of the drum (4) in different angular positions (a) fluctuates to change from a minimum (Wminj) to a maximum value (Wmaxj). The reason for this is because the drum (4) slows down while the laundry moves from the lowest position to the highest position and accelerates while moving downwards from there. The control unit (6) calculates the differences (DWj=Wmaxj-Wminj) between the minimum and maximum angular speed values for each rotation of the drum (4). While passing from the resonance, this difference reaches its highest due. Therefore, the greatest of the differences (Dwmax) corresponding to whichever rotation (j), the natural frequency (Wn) for the said load (L) is accepted to be equal to the average angular speed (Wj) of this rotation (j) (Figure 2).

[0025] In order to explain mathematically the matching between the load (L) and the natural frequency (Wn), we can assume that the washer/dryer (1) is basically formed of two main groups. The first is the tub group including the motor (5), transmission components such as the belt-pulley, the drum (4), the tub (3) and balance weights (not shown in the figures). The second is the body group including the door, detergent dispenser, control panel, feet and the body (2). The tub group and the body group are dynamically connected to each other by means of springs, dry friction shock absorbers and a viscoelastic bellows. For simplification of the mathematical modeling, if we assume that the damping coefficient (c) and the spring coefficient (k) between the two groups is constant, the whole of the system can be thought of as making a damped forced vibration movement in a two dimensional plane. As a result, the natural frequency value (resonance value) at which the tub group realizes the maximum displacement, hence the maximum speed change, is inversely proportional to the mass of this group (Wn a $(k/m)^{1/2}$). Accordingly, the natural frequency value (Wn) will also change depending on the amount of laundry (L) placed in the drum (4), being a part of the tub group. In the washer/dryer (I) of the present invention, this correction between the natural frequency (Wn) and mass is utilized for determining the amount of the laundry (L).

[0026] In the washer/dryer (1) of the present invention, the producer places a known load (Li) into the drum (4) each time for determining the natural frequency (Wni) value generated under that load during the production of the washer/dryer (1). For example, the producer places loads of L1=0.5, L2=1, L3=1.5, L4=2 and L4=3 kg respectively into the drum (4). Then the drum (4) is accelerated separately for each load and the angular speed (for example Wnl=185 rev/min, Wn2=184 rev/min, Wn3=183 rev/min, Wn4=182 rev/min and Wn5=181 rev/min) corresponding to the natural frequency of each is determined. The results are recorded in the control unit (6) as a table or as a function.

[0027] While the user is operating the washer/dryer (1), a certain amount of laundry (L) is loaded into the drum (4). Then the control unit (6) accelerates the motor (5) from a static state up to a certain speed. This speed is greater than the probable natural frequency values of the washer/dryer (1). Consequently, the washer/dryer (1) is ensured to pass through the resonance during acceleration. The sensor (7) detects the angular speed (Wn) at which the resonance is realized (for example 182 rev/min). This angular speed (Wn) value includes the effect of the laundry (L) weight placed in the drum (4) by the user. The control unit (6) finds out the load amount (L) (for ex. 2 kg.) corresponding to this angular speed (Wn) value from the table (Li-Wni; i=1, ..., k) or function previously recorded by the producer. The said Value (L) is accepted as the weight of the laundry loaded into the drum (4) by the user. Various parameters of the operational program such as the detergent quantity, water amount, spinning speed are determined according to this value (L).

[0028] In an embodiment of the present invention, the drum (4) is accelerated in dry conditions before receiving water into the tub (3). Thus the amount of load (L) placed in the drum (4) can be directly calculated.

[0029] In another embodiment, the drum (4) is accelerated while the laundry is wet after a certain amount of water is received into the tub (3). Thus, the laundry is prevented from fraying by being subjected to high friction. The amount of water received into the tub (3) is preferably less than the amount required for the main washing. The water amount is sufficient for reducing the friction between the laundry and the drum (4). In this embodiment, since the amount of water received into the tub (3) is known, subtracting the weight of the water will suffice while calculating the amount of the laundry load (L).

[0030] In an embodiment, the maximum value (Wm) to which the drum (4) will be accelerated is a constant value preset by the producer, in another embodiment, it is a value determined dynamically by the control unit (6). In the first embodiment, the producer determines the highest speed value that the drum (4) should accelerate by adding a certain safety margin to the natural frequency that is assessed while the machine is empty. In the second embodiment, the control unit (6) that records the natural frequency values realized in various operations determines a maximum angular speed corresponding to these. The control unit (6) in this way prevents the drum (4) from accelerating to very high speeds by determining a value according to the routines of the user.

[0031] In an embodiment of the present invention, the sensor (7) is a tachogenerator having a revolution that can detect the variations in the angular speed (W) during a full revolution (2p) of the drum (4). The sensor (7) can either be a tachogenerator included in the motor (5) or a specific tachogenerator for measuring the angular speed of the drum (4). This tachogenerator can be a multi-pole, optical or magnetic tachogenerator. It is preferable that the tachogenerator has approximately 30-60 poles for effectively monitoring the speed changes during one full revolution.

[0032] In another embodiment of the present invention, the producer records the same values (Wi-Li) in the control unit (6), regarding the fact that the dynamic properties of washer/dryers (1) belonging to a certain series are similar hence possess proximate natural frequency values. Consequently, the producer does not have to apply tests to each washer/dryer (1) separately.

[0033] In another version of this embodiment, the producer records to the control unit (6) the load difference (DLi) and the corresponding angular speed difference (DWi) values wherein the natural frequency is observed. With the assumption that the springs present in the system act linearly, in all the machine of a certain series the DLi-DWi pairs are approximately the same. Thus the sane table (DLi-DWi, i=1,..., k) can be recorded in the control units (6) of all washer/dryers (1) having similar features. In this embodiment, furthermore, the angular speed value (Wn_e) corresponding to the natural frequency detected while the machine is empty should also be recorded in the control unit (6). In this case, the control unit (6) determines the angular speed value (Wn_f) corresponding to the natural frequency as explained above by accelerating the drum (4), after the user has loaded the laundry. Then the difference between the two angular speed values (DW=Wn_e-Wn_f) is calculated. Lastly, the obtained value (DW) is compared with the values in the table (DLi-DWi) for determining the load (L).

[0034] In an embodiment of the present invention, the producer records in the control unit (6) the values (Wi-Li) exclusive to the machine obtained from the test results by testing each washer/dryer (1) separately. Consequently, the amount of laundry (L) placed in the drum (4) by the user can be determined more precisely by tasking into account the differences of each machine and the variations due to the production.

[0035] With the washer/dryer (1) of the present invention, the laundry load can be determined by using the data of the available speed sensors (7), without a dedicated sensor designed exclusively for this process. Consequently, contribution is provided for decreasing the costs.

Claims

1. Method of controlling a washer/dryer (1) used in cleaning the laundry by washing or for drying, comprising
   a body (2), a tub (3) disposed inside the body (2), a drum (4) that rotates in the tub (3) and wherein the laundry (L) is emplaced,
   a motor (5) providing the required drive for rotating the drum (4),
   a speed sensor (7) that measures the angular speed of the drum (4) and/or the motor (5), and a control unit (6),
   characterized by
   recording the natural frequency values (Wni, i=1, ..., k) corresponding to a series of known load amounts (Li, i=1, ..., k) in the control unit (6) by the producer, the control unit (6) accelerates the motor (5) to a

higher revolution than the probable natural frequency values after the user loads the laundry (L) into the drum (4),
the control unit (6) simultaneously finds out the angular speed value corresponding to the natural frequency (Wn) by using the momentary angular speed (Wj) values measured by the speed sensor (7), and the control unit (6) compares this value with the values (Li-Wni; i=1, ..., k) prerecorded by the producer to determine the amount of the load (L).

2. Method of controlling according to Claim 1,
characterized by
a control unit (6) that performs the load amount determining process before water is received into the tub (3).

3. Method of controlling according to Claim 1,
characterized by
a control unit (6) that performs the load amount determining process after a certain amount of water is received into the tub (3).

4. Method of controlling according to one of the Claims 1 to 3,
characterized by
a control unit (6) that calculates the differences (DWj=Wmaxj-Wminj) between the minimum (Wminj) and the maximum (Wmaxj) values of the momentary angular speed (W) during each full revolution (2p) while the drum (4) is accelerated from zero up to a certain speed, and determines the greatest of these differences (Dwmax) corresponding to whichever rotation (j) to be the value of the angular speed (Wj) corresponding to the natural frequency (Wn) for the said load (L).

5. Method of controlling according to one of the Claims 1 to 4,
characterized by
a control unit (6) wherein the maximum value (Wm) to which the drum (4) is accelerated is predetermined and recorded by the producer.

6. Method of controlling according to Claim 5, wherein the maximum value (Wm) to which the drum (4) is accelerated is determined by the producer by adding a certain safety margin to the natural frequency detected while the drum (4) is empty.

7. Method of controlling according to one of the Claims 1 to 6,
characterized by
a control unit (6) that dynamically determines the maximum value (Wm) to which the drum (4) is accelerated by monitoring the natural frequency values generated in various operations.

8. Method of controlling according to one of the Claims 1 to 3,
characterized by
a control unit (6) wherein the same values are recorded to all of those belonging to a certain series.

9. Method of controlling according to Claim 8,
characterized by
a control unit (6) wherein the load difference (DLi) values of the angular speed (Wn_e) value corresponding to the natural frequency detected and corresponding angular speed difference (DWi) values where the natural frequency observed are recorded while the machine is empty; that determines the angular speed value (Wn_f) corresponding to the natural frequency by accelerating the drum (4) after the user loads the laundry, and
determines the load (L) by comparing the difference (DW=Wn_e-Wn_f) between the two angular speed values corresponding to the natural frequencies detected while the drum (4) is empty and loaded with the recorded values (DLi-DWi).

Patentansprüche

1. Verfahren zum Steuern einer Wasch-/Trockenmaschine (1) die zum Reinigen der Wäsche durch Waschen oder zum Trocknen benutzt wird, umfassend einen Gehäusekörper (2), einen Laugenbehälter (3), der im Gehäusekörper (2) angeordnet ist, eine Trommel (4), die sich im Laugenbehälter (3) dreht, und in die die Wäsche (L) gegeben wird,
einen Motor (5), der den erforderlichen Antrieb zum Drehen der Trommel (4) bereitstellt,
einen Geschwindigkeitssensor (7), der die Winkelgeschwindigkeit der Trommel (4) und/oder des Motors (5) misst, und eine Steuereinheit (6), **gekennzeichnet durch**
Aufzeichnen der natürlichen Frequenzwerte (Wni, i=1, ..., k), die einer Folge von bekannten Beladungsmengen (Li, i=1, ..., k) entsprechen, in der Steuereinheit (6) **durch** den Hersteller,
Beschleunigen des Motors (5) auf eine höhere Drehzahl als die möglichen natürlichen Frequenzwerte **durch** die Steuereinheit (6), nachdem der Benutzer die Wäsche (L) in die Trommel (4) gegeben hat,
gleichzeitiges Ermitteln des Winkelgeschwindigkeitwerts, der der natürlichen Frequenz (Wn) entspricht, **durch** die Steuereinheit (6), indem die momentanen Winkelgeschwindigkeitswerte (Wj) benutzt werden, die vom Geschwindigkeitssensor (7) gemessen werden, und
Vergleichen dieses Wertes mit den Werten (Li-Wni; i=1, ..., k), die vom Hersteller im Voraus aufgezeichnet wurden, **durch** die Steuereinheit (6), um die Beladungsmenge (L) zu bestimmen.

2. Verfahren zum Steuern nach Anspruch 1, **gekennzeichnet durch** eine Steuereinheit (6), die den Vorgang zum Bestimmen der Beladungsmenge durchführt, bevor Wasser in den Laugenbehälter (3) gelangt.

3. Verfahren zum Steuern nach Anspruch 1, **gekennzeichnet durch** eine Steuereinheit (6), die den Vorgang zum Bestimmen der Beladungsmenge durchführt, nachdem eine bestimmte Menge an Wasser in den Laugenbehälter (3) gelangt ist.

4. Verfahren zum Steuern nach einem der Ansprüche 1 bis 3, **gekennzeichnet durch** eine Steuereinheit (6), die bei jeder vollständigen Umdrehung (2p) die Differenzen (DWj=Wmaxj-Wminj) zwischen dem Minimalwert (Wminj) und dem Maximalwert (Wmaxj) der momentanen Winkelgeschwindigkeit (W) berechnet, während die Trommel (4) von Null auf eine bestimmte Geschwindigkeit beschleunigt wird, und die größte dieser Differenzen (Dwmax), die einer jeweiligen Drehung (j) entspricht, als den Wert der Winkelgeschwindigkeit (Wj) bestimmt, der der natürlichen Frequenz (Wn) für diese Beladung (L) entspricht.

5. Verfahren zum Steuern nach einem der Ansprüche 1 bis 4, **gekennzeichnet durch** eine Steuereinheit (6), wobei der Maximalwert (Wm), auf den die Trommel (4) beschleunigt wird, vom Hersteller im Voraus festgelegt und aufgezeichnet wird.

6. Verfahren zum Steuern nach Anspruch 5, wobei der Maximalwert (Wm), auf den die Trommel (4) beschleunigt wird, wird vom Hersteller festgelegt, indem ein bestimmter Sicherheitstoleranzwert zu der natürlichen Frequenz, die ermittelt wird, während die Trommel (4) leer ist, hinzuaddiert wird.

7. Verfahren zum Steuern nach einem der Ansprüche 1 bis 6, **gekennzeichnet durch** eine Steuereinheit (6), die den Maximalwert (Wm), auf den die Trommel (4) beschleunigt wird, dynamisch bestimmt, indem sie die bei verschiedenen Vorgängen erzeugten natürlichen Frequenzwerte überwacht.

8. Verfahren zum Steuern nach einem der Ansprüche 1 bis 3, **gekennzeichnet durch** eine Steuereinheit (6), wobei für alle diejenigen, die einer bestimmten Modellreihe angehören, dieselben Werte aufgezeichnet werden.

9. Verfahren zum Steuern nach Anspruch 8, **gekennzeichnet durch** eine Steuereinheit (6), wobei die Ladungsdifferenzwerte (DLi) der Winkelgeschwindigkeit (Wn_e), die der erkannten natürlichen Frequenz entsprechen, und entsprechende Winkelgeschwindigkeitswerte (DWi), bei denen die natürliche Frequenz beobachtet wird, aufgezeichnet werden, während die Maschine leer ist;
und die den Winkelgeschwindigkeitswert (Wn_f) bestimmt, der der natürlichen Frequenz entspricht, indem sie die Trommel (4) beschleunigt, nachdem Benutzer die Wäsche geladen hat, und
die die Beladung (L) bestimmt, indem sie die Differenz (DW=Wn_e-Wn_f) zwischen zwei Winkelgeschwindigkeitswerten, die den natürlichen Frequenzen entsprechen, die erkannt werden, während die Trommel (4) leer und geladen ist, mit den aufgezeichneten Werten (DLi-DWi) vergleicht.

Revendications

1. Méthode de contrôle d'une machine à laver/sécher (1) utilisée dans le nettoyage du linge par lavage ou pour le séchage, comprenant
un corps (2), une cuve (3) disposée dans le corps (2), un tambour (4) qui tourne dans la cuve (3) et où le linge (L) est placée,
un moteur (5) fournissant l'entraînement nécessaire pour faire tourner le tambour (4),
un capteur de vitesse (7) qui mesure la vitesse angulaire du tambour (4) et/ou du moteur (5), et une unité de contrôle (6),
caractérisée en ce que
les valeurs de fréquences naturelles (Wni, i=1, ..., k) correspondant à une série de montants de charge connue (Li, i=1, ..., K) sont enregistrées dans l'unité de contrôle (6) par le producteur,
l'unité de contrôle (6) accélère le moteur (5) à une plus grande révolution que les valeurs probables de fréquence naturelle après que l'utilisateur charge le linge (L) dans le tambour (4),
l'unité de contrôle (6) trouve simultanément la valeur de vitesse angulaire correspondant à la fréquence naturelle (Wn) en utilisant les valeurs de la vitesse momentané angulaire (Wj) mesurées par le capteur de vitesse (7), et
l'unité de contrôle (6) compare cette valeur avec les valeurs (Li-Wni; i=1, ..., k) préenregistrées par le producteur pour déterminer le montant de la charge (L).

2. Méthode de contrôle selon la Revendication 1, **caractérisée par** une unité de contrôle (6) qui effectue le processus de déterminer le montant de la charge avant que l'eau est reçue dans la cuve (3).

3. Méthode de contrôle selon la Revendication 1, **caractérisée par** une unité de contrôle (6) qui effectue le processus de déterminer le montant de la charge après que une certaine quantité d'eau est reçue dans la cuve (3).

4. Méthode de contrôle selon l'une quelconque des revendications de 1 à 3, **caractérisée par** une unité de contrôle (6) qui calcule la différence (DWj=Wmaxj-Wminj) entre les valeurs minimales (Wminj) et maximales (Wmaxj) de la vitesse momentanée angulaire (W) lors de chaque tour complet (2p) tandis que le tambour (4) est accéléré de zéro jusqu'à une certaine vitesse, et donc qui détermine que la vitesse angulaire (Wj) correspondant à la fréquence naturelle (Wn) pour ladite charge (L) est égale à la vitesse angulaire (j) à laquelle la plus grande de ces différences (Dwmax) correspond.

5. Méthode de contrôle selon l'une quelconque des revendications de 1 a 4, **caractérisée par** une unité de contrôle (6) où la valeur maximale (Wm) à laquelle le tambour (4) est accélérée est prédéterminée et enregistrée par le producteur.

6. Méthode de contrôle selon la Revendication 5, où la valeur maximale (Wm) à laquelle le tambour (4) est accélérée est déterminée par le producteur en ajoutant une certaine marge de sécurité à la fréquence naturelle détectée alors que le tambour (4) est vide.

7. Méthode de contrôle selon l'une quelconque des revendications de 1 a 6, **caractérisée par** une unité de contrôle (6) qui détermine dynamiquement la valeur maximale (Wm) à laquelle le tambour (4) est accélérée en surveillant les valeurs de la fréquence naturelle produites dans des opérations diverses.

8. Méthode de contrôle selon l'une quelconque des revendications de 1 a 3, **caractérisée par** une unité de contrôle (6) où les mêmes valeurs sont enregistrées dans tous ceux qui appartiennent à une certaine série.

9. Méthode de contrôle selon la Revendication 8, **caractérisée par** une unité de contrôle (6) où les valeurs de la différence de la charge (DLi) de la valeur de la vitesse angulaire (Wn_e) correspondant à la fréquence naturelle détectée et les valeurs de la différence de la vitesse angulaire (DWi) correspondantes où la fréquence naturelle observée sont enregistrées alors que la machine est vide ;
qui détermine la valeur de la vitesse angulaire (Wn_f) correspondant à la fréquence naturelle en accélérant le tambour (4) après que l'utilisateur charge le linge, et
détermine la charge (L) en comparant la différence (DW=Wn_e-Wn_f) entre les deux valeurs de la vitesse angulaire correspondant aux fréquences naturelles détectées alors que le tambour (4) est vide et chargée avec les valeurs enregistrées (DLi-DWi).

[Fig.]

Figure 1

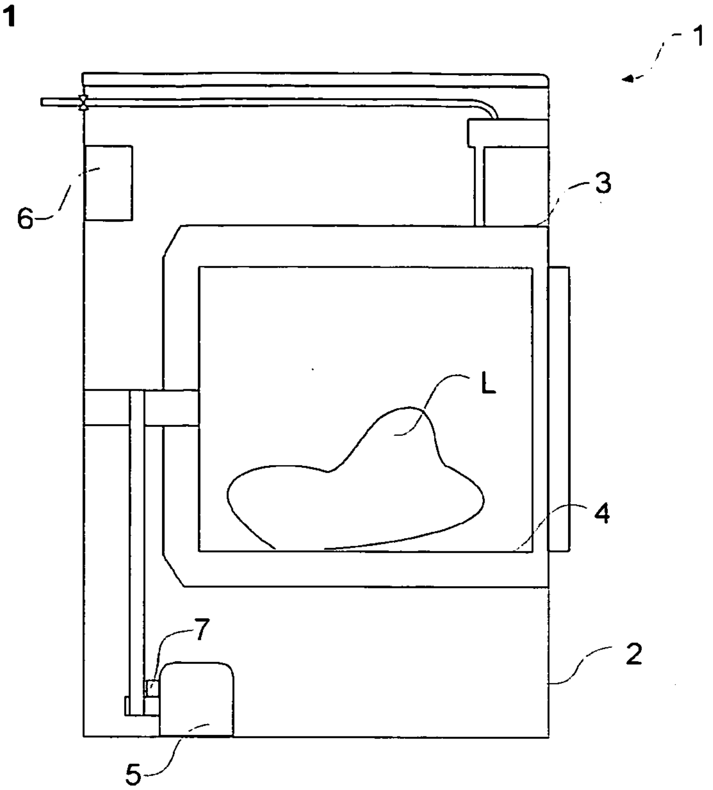
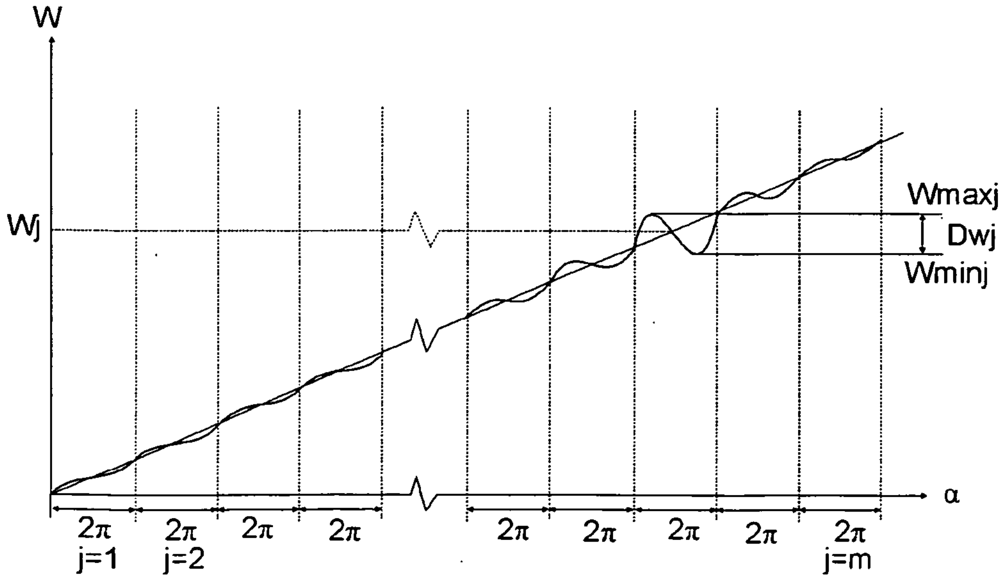


Figure 2



REFERENCES CITED IN THE DESCRIPTION

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