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(54) **Method for limiting the imbalance of a washing unit of a clothes washer**

Verfahren zum Begrenzen der Unwucht in einer Wäschewaschmaschine

Procédé pour limiter le balourd dans une machine à laver le linge

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- **PATENT ABSTRACTS OF JAPAN vol. 015, no. 302 (C-0855), 2 August 1991 (1991-08-02) -& JP 03 111096 A (SHARP CORP), 10 May 1991 (1991-05-10)**

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Description

[0001] The invention concerns a method for limiting the imbalance of a washing unit of a clothes washer that has a laundry drum rotatably mounted in a tub of a clothes washer and is suspended to permit oscillation with springs, weights for inertia, vibration dampers and a drive motor in the machine housing. Several sensors distributed on the perimeter of the tub detect the displacements due to imbalance in the spin cycle in relation to the machine housing and independently undertake compensatory measures.

[0002] There is such a prior-art device in DE 42 01 904 C2. In this prior-art device, the sensors only detect the displacement paths of the tub perpendicular to the rotary axis of the laundry drum and control force-generating elements that counteract the displacement paths and limit them to permissible values. A great deal of effort is required for the force-generating elements since each sensor must be assigned one force-generating element attached to the machine housing and one attached to the tub.

[0003] As is known, an evenly distributed ring of laundry in the laundry drum is ideal in the spin cycle. The dimensions of the clothes washer, the geometrical and other physical properties of the laundry itself frequently prevent such an ideal distribution of laundry, and an imbalanced load arises which sometimes only occurs when the water is draining because various items of laundry drain differently. The result is that more-or-less static conditions arise or a decreasing or increasing imbalance depending to the laundry distribution and/or various water drainage properties over time.

[0004] The washing unit suspended in the machine housing to permit oscillation allows clothes washers to spin imbalanced laundry loads by using the detected imbalance to influence the spin cycle and protect the washing unit from mechanical damage and overloading.

[0005] For technical reasons, such prior-art oscillation systems have several degrees of freedom since the fastening points of the springs and vibration dampers represent articulations capable of vibrating. Depending on the position of the imbalance(s) and the excitation frequency, i.e. the speed of the laundry drum, additional vibration systems arise with related resonances corresponding to the degrees of freedom that are not parallel to the rotary axis.

[0006] These vibration systems that are not parallel to the rotary axis can generate dominant displacements of the washing unit that not only prevent the efficient spinning of laundry but also can damage the washing unit despite the normal, prior-art imbalance system. Depending on the position of the imbalance(s) in the laundry drum, different displacements arise perpendicular to the rotary axis that can also be of varying size in the lengthwise direction of the rotary axis. The displacement can be parallel to the rotary axis and phase shifted at both ends of the laundry drum, i.e., partially to completely reversed. Such irregularities arise in particular when the laundry drum holds just individual or a few pieces of laundry.

[0007] With this prior-art imbalance measuring procedure, the breaking or accelerating effect of the imbalance that occurs when it rises or falls as the laundry drum rotates is measured in the form of speed fluctuations or motor current fluctuations primarily at low laundry drum speeds below and/or above the critical vibration frequency. However, it is not always possible to clearly detect the actual position of the imbalance from this. When the imbalance is rotationally symmetrical, the prior-art measuring methods do not work since the imbalances partially or completely compensate for each other. The result is imbalances that are too low or small.

[0008] Furthermore, it is nearly impossible in other prior-art imbalance measuring methods to measure certain factors with sufficient precision and cover them in the spin cycle, that is, measure the speed-dependent or time-dependent water drainage properties of the imbalanced load within small speed ranges or measure them close to the critical speed. The result is that the washing machine and vibration system of the washing unit becomes overtaxed with such loads which generates extremely loud noise, mechanical damage, and causes the washer to travel.

[0009] Another method for limiting the imbalance is disclosed in WO 99/53130 A using two sensors in front and two in the rear of the drum structure assembly to determine the movements in two separate axis perpendicular to the rotational axis.

[0010] The problem of the invention is to create a method for limiting all arising imbalances of a clothes washer with a washing unit of the initially-cited kind by changing the spin cycle to prevent damage and the machine parts from overloading.

[0011] As part of the invention, sensors are provided that detect the displacements perpendicular and/or parallel to the rotary axis of the laundry drum and phase shifts between displacements. Control and/or regulating parameters can be supplied to the spin cycle depending on the detected displacements and phase shifts as well as the speed of the laundry drum or the drive motor.

[0012] This embodiment of the invention has a path-limiting and speed-limiting system that describes the mechanical load of the washing unit caused by the actual imbalance. You only need to determine the measuring point with the largest displacement path upon a change in the spin cycle in relation to the rotational speed, i.e. rotational frequency, to influence the spin cycle with the control and/or regulating parameters.

[0013] If the two sensors are preferentially in the front and rear of the washing unit in relation to the lengthwise direction of the rotary axis, then the displacement paths to be measured are larger, and less sensitive sensors can be used. This is also the case when the sensors are at a great distance from the rotary axis, preferably on the perimeter of the washing unit and/or diametrically

opposed to each other.

[0014] The direction of the displacements caused by an imbalance (both perpendicular and parallel to the rotary axis) can be more precisely determined by also measuring the phase position of the detected displacement paths and deriving the displacement of the washing unit in the axial direction of the washing unit from the relationship between the detected displacement paths perpendicular to the rotary access and the phase shifts between them; this allows the control and/or regulating parameters for the spin cycle to be determined. The device can be simplified when one sensor measures the displacement path perpendicular to the rotary axis, while the other sensor measures the displacement path parallel to the rotary axis.

[0015] Acceleration sensors, optical and/or electromechanical position sensors can be advantageously used.

[0016] The invention will be further explained with reference to an exemplary embodiment shown in the drawing. Shown are:

Fig. 1 a schematic cross-section of a front-loading washing machine, and

Fig. 2 a schematic cross section of the front-loading washing machine in Fig. 1.

[0017] A tub 2 that contains a laundry drum 12 is arranged in a machine housing 1. Weights providing inertia 3 designed as ring weights are on the tub 2. The laundry drum 12 is rotatably mounted in the rear mount 11 that is in the rear of the machine housing 1. The rear mount 11 and the electric motor serving as the drive motor 5 coupled via a belt 13 to the belt pulley 9 of the rotary axis 8 act as weights providing inertia. The laundry drum 2 is loaded with laundry 10 from the door 4 in the front of housing 1. The door 4 is a component of the machine housing 1.

[0018] The tub 2, the laundry drum 12 and the inertia-providing weight (ring weights 3,drive motor 5,rear mount 11) form a washing unit WE together with the springs 7 and the vibration dampers 6 that is suspended in the machine housing 1 so as to permit oscillation; it can be displaced both radially and axially in relation to the rotary axis 8 depending on the load of the laundry drum 12. When the washing drum 12 is approximately evenly loaded with laundry 10, the laundry 10 forms a kind of laundry ring as illustrated in Fig. 1 and 2. However, this ideal distribution of laundry seldom occurs. Usually when loads are small, there is an uneven distribution in reference to the rotary axis 8 that leads to imbalances. The imbalance can arise in the front, middle, and rear of the laundry drum 12 and assume one or more positions that may be diametrically opposed to each other. The size of the radial displacement along the rotary axis 8 can vary. It can be an axially parallel, dominant displacement, and the front and rear of the rotary axis 8 can have equal or unequal displacements with a phase shift.

[0019] These displacements that are perpendicular and parallel to the rotary axis 8 are detected by sensors 14 as shown in Fig. 1 and 2 on the front and rear of the washing unit WE placed diametrically opposed across the periphery of the washing unit WE. The displacement paths are the largest here so that insensitive sensors 14 can be used. The axial displacement paths of the washing unit WE are detected with two sensors 14, and the higher displacement value and speed of the laundry drum 12 or drive motor 5 are used to change the spin cycle.

[0020] By measuring the radial displacement and phase positions of the displacements in relation to each other, you can determine the resulting imbalance with components in both radial and axial directions and its effect on the oscillatable washing unit and correspondingly influence the spin cycle. Since the geometry of the washing unit WE is known, the resulting displacement can be calculated from the displacement paths and their phase shift. The overall movement of the washing unit is therefore known, and collisions between the washing unit and rest of the machine can be avoided by correspondingly changing the spin cycle.

[0021] Similar results can be obtained if just one sensor 14 is used that measures both the radial and axially parallel displacement of the washing unit WE. A disadvantage, however, is that it is not possible to determine the position of the imbalance in the lengthwise direction of the rotary axis 8 by measuring the phase position of the displacements.

[0022] A characteristic can be stipulated using the measured imbalance and/or phase shift along with a speed of the laundry drum or the electronic motor to reliably prevent overloading the washing unit in the spin cycle independent of the load in the laundry drum 12 and the arising imbalance.

Claims

1. A method for limiting the imbalance of a washing unit (WE) of a clothes washer that has a laundry drum (12) rotatably mounted in a tub (2) and is suspended in the machine housing (1) to allow oscillation with springs (7) weights (3) providing inertia, vibration dampers (6) and a drive motor (5), whereby several sensors (14) distributed on the perimeter of the tub (2) detect the displacements due to imbalance in the spin cycle and undertake related countermeasures to limit the arising paths and forces,
characterised in that
the sensors (14), detect the displacements as well as the phase shifts between the displacements perpendicular and/or parallel to the rotary axis (8) of the laundry drum (12), and
controlling and/or regulating parameters for the spin

cycle are calculated depending on the detected displacements and phase shifts as well as the speed of the laundry drum (12) and the drive motor (5).

2. A method according to claim 1, **characterised in that** the speed of the laundry drum (12) is limited by the set relationship to the displacements and/or phase shifts.

3. A method according to claim 1 or 2, **characterised in that** there are sensors (14), preferably one at the front and one at the rear of the washing unit (WE) viewed in the lengthwise direction of the rotary axis (8).

4. A method according to one of claims 1 - 3, **characterised in that** the displacement of the washing unit (WE) in the axial direction of the washing unit (WE) can be derived from the relationship between the detected displacement paths perpendicular to the rotary access (8) and the phase shifts between them, and control and/or regulating parameters for the spin cycle can be calculated from this.

5. A method according to one of claims 1 - 4, **characterised in that** one sensor (14) measures the displacement path perpendicular to the rotary axis (8), while another sensor (14) measures the displacement path parallel to the rotary axis.

6. A method according to one of claims 1 -5, **characterised in that** the sensors (14) are on the perimeter of the tub (2) and diametrically opposed to each other.

7. A method according to one of claims 1 - 6, **characterised in that** acceleration sensors, optical and/or electro-mechanical position sensors are used as the sensors (14).

Patentansprüche

1. Verfahren zum Begrenzen der Unwucht einer Wascheinheit (WE) einer Waschmaschine, die eine Wäschetrommel (12) aufweist, welche drehbar in einer Wanne (2) befestigt und in dem Maschinengehäuse (1) aufgehängt ist, um die Oszillation mit Federn (7), Masseträgheit zur Verfügung stellenden Gewichten (3), Vibrationsdämpfern (6) sowie einem Antriebsmotor (5) zu ermöglichen, wobei verschiedene Sensoren (14) am Umfang der Wanne (2) verteilt die Verschiebungen aufgrund der Unwucht in dem Drehkreis detektieren und diesbezügliche Gegenmaßnahmen unternehmen, um die entstehenden Verlagerungen und Kräfte zu begrenzen,
dadurch gekennzeichnet, dass
die Sensoren (14) die Verschiebungen sowie die Phasenverschiebungen zwischen den Verschiebungen senkrecht und/oder parallel zur Rotationsachse (8) der Wäschetrommel (12) detektieren und Kontroll- und/oder Regulierungs-Parameter für den Drehkreis abhängig von den detektierten Verschiebungen und Phasenverschiebungen sowie der Geschwindigkeit der Wäschetrommel (12) und des Antriebsmotors (5) berechnet werden.

2. Verfahren gemäß Anspruch 1,
dadurch gekennzeichnet, dass
die Geschwindigkeit der Wäschetrommel (12) durch die festgelegte Beziehung mit den Verschiebungen und/oder Phasenverschiebungen begrenzt ist.

3. Verfahren gemäß Anspruch 1 oder 2,
dadurch gekennzeichnet, dass
Sensoren (14), vorzugsweise einer an der Vorderseite und einer an der Rückseite der Wascheinheit (WE), wenn in Längsrichtung der Rotationsachse (8) gesehen, vorliegen.

4. Verfahren gemäß einem der Ansprüche 1 bis 3,
dadurch gekennzeichnet, dass
die Verschiebung der Wascheinheit (WE) in Axialrichtung der Wascheinheit (WE) von der Beziehung zwischen den detektierten Verschiebungs-Verlagerungen senkrecht zur Rotationsachse (8) und den Phasenverschiebungen zwischen diesen hergeleitet werden können und Kontroll- und/oder Regulierungs-Parameter für den Drehkreis von diesem berechnet werden können.

5. Verfahren gemäß einem der Ansprüche 1 bis 4,
dadurch gekennzeichnet, dass
ein Sensor (14) die Verschiebungs-Verlagerung senkrecht zur Rotationsachse (8) misst, während ein anderer Sensor (14) den Verschiebungs-Pfad parallel zur Rotationsachse misst.

6. Verfahren gemäß einem der Ansprüche 1 bis 5,
dadurch gekennzeichnet, dass
die Sensoren (14) am Umfang der Wanne (2) und diametral einander gegenüber vorliegen.

7. Verfahren gemäß einem der Ansprüche 1 bis 6,
dadurch gekennzeichnet, dass
Beschleunigungssensoren, optische und/oder elektromechanische Positionssensoren als Sensoren (14) verwendet werden.

Revendications

1. Procédé pour limiter le balourd d'une unité de lavage (WE) d'une machine à laver le linge qui possède un tambour de lavage (12) monté de manière rotative dans une.cuve (2) et est suspendue dans la carcasse (1) de la machine pour permettre l'oscillation avec des ressorts (7), des poids (3) proposant l'inertie, des amortisseurs de vibrations (6) et un moteur d'entraînement (5), moyennant quoi plusieurs capteurs (14) répartis sur le périmètre de la cuve (12) détectent les déplacements dus au balourd dans le cycle d'essorage et prennent les contre-mesures relatives pour limiter l'occurrence des trajectoires et des forces, **caractérisé en ce que** :

   les capteurs (14) détectent les déplacements ainsi que les déphasages entre les déplacements perpendiculaires et/ou parallèles par rapport à l'axe de rotation (8) du tambour de lavage (12), et
   des paramètres de commande et/ou de réglage pour le cycle d'essorage sont calculés selon les déplacements et les déphasages détectés ainsi que la vitesse du tambour de lavage (12) et du moteur d'entraînement (5).

2. Procédé selon la revendication 1, **caractérisé en ce que** la vitesse du tambour de lavage (12) est limitée par la relation réglée par rapport aux déplacements et/ou aux déphasages.

3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** l'on trouve des capteurs (14), de préférence un à l'avant et un à l'arrière de l'unité de lavage (WE) observée dans la direction de la longueur de l'axe de rotation (8).

4. Procédé selon l'une des revendications 1 à 3, **caractérisé en ce que** le déplacement de l'unité de lavage (WE) dans la direction axiale de l'unité de lavage (WE) peut être dérivé de la relation entre les trajectoires de déplacement détectées perpendiculaires à l'axe de rotation (8) et aux déphasage entre eux, et les paramètres de commande et/ou de réglage pour le cycle d'essorage peuvent être calculés à partir de cela.

5. Procédé selon l'une des revendications 1 à 4, **caractérisé en ce qu'**un capteur (14) mesure la trajectoire de déplacement perpendiculaire à l'axe de rotation (8), alors qu'un autre capteur (14) mesure la trajectoire de déplacement parallèle à l'axe de rotation.

6. Procédé selon l'une des revendications 1 à 5, **caractérisé en ce que** les capteurs (14) se trouvent sur le périmètre de la cuve (2) et diamétralement opposés entre eux.

7. Procédé selon l'une des revendications 1 à 6, **caractérisé en ce que** des capteurs d'accélération, des capteurs de position optiques et/ou électromécaniques sont utilisés en tant que capteurs (14).

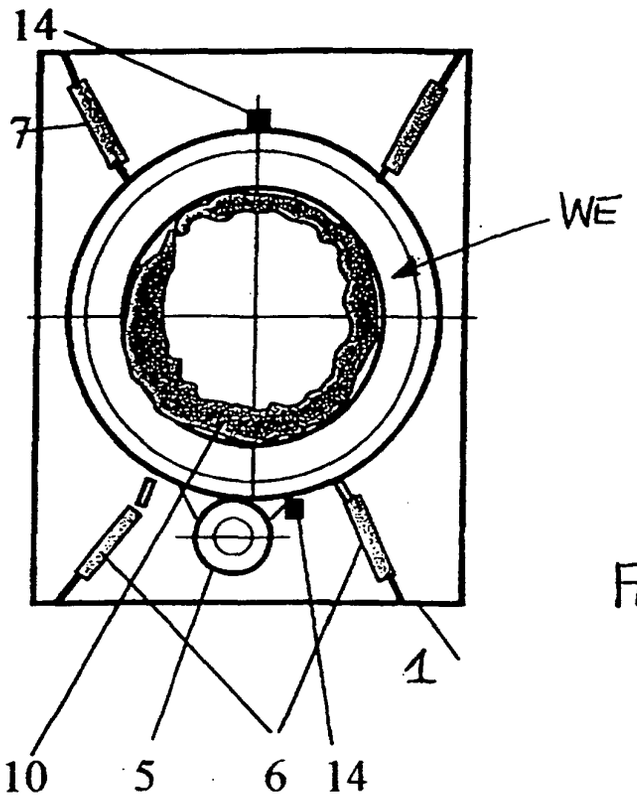

Fig. 1

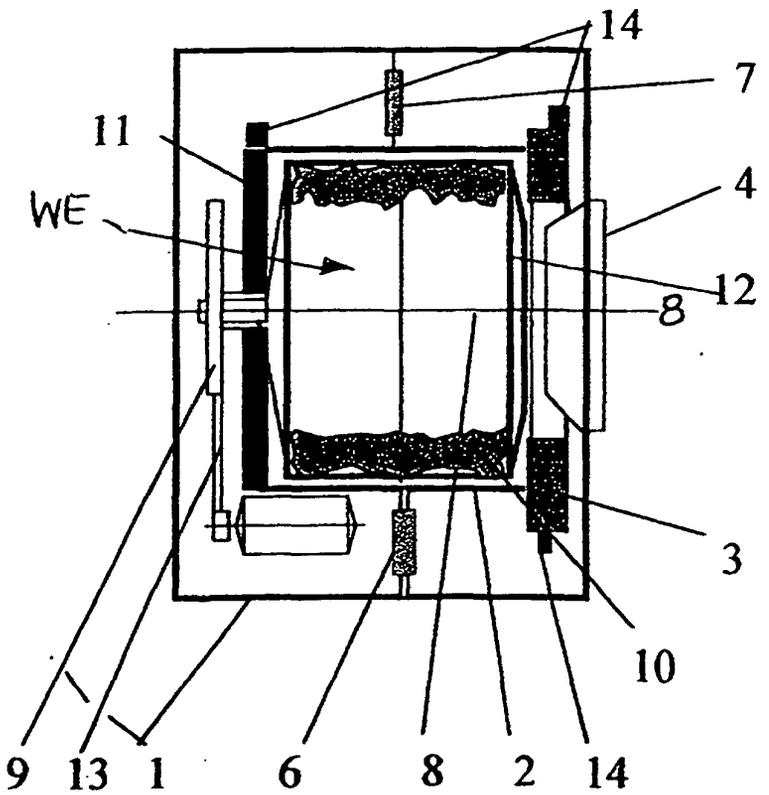

Fig. 2