Device to limit the imbalance of a washing unit of a clothes washer

The invention concerns a device to limit the imbalance of a washing unit of a clothes washer that has a laundry drum rotatably mounted in a tub and is suspended in the machine housing to allow oscillation with springs, weights providing inertia, vibration dampers and the drive motor, whereby several sensors distributed on the perimeter of a tub detect the deflections due to imbalance in the spin cycle, and undertake related countermeasures to limit the arising paths and forces. The washing unit is prevented from overloading due to imbalances in the spin cycle independent of the load in the laundry drum as follows: The sensors are perpendicular and/or parallel to the rotary axis of the laundry drum, and they detect the displacements as well as the phase shifts between the displacements, and control and/or regulating parameters are fed to the spin cycle depending on the detected displacements and phase shifts as well as the speed of the laundry drum and the drive motor.
Description

[0001] The invention concerns a device to limit 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 drum corresponds to the degrees of freedom that are not parallel to the rotary axis. The displacement paths of the tub perpendicular to the rotary axis (both perpendicular and parallel to the rotary axis) can be more precisely determined by also measuring the phase position of the detected displacement due to imbalance (both perpendicular and parallel to the rotary axis) can be more precisely determined by also measuring the phase position of the detected displacement. The direction of the displacements caused by the displacement paths of the tub perpendicular to the rotary axis can be parallel to the rotary axis and phase shifted depending to the laundry distribution and/or static conditions arise or a decreasing or increasing imbalance arises which sometimes only occurs when the water is draining because various items of laundry drain differently. The result is that more-or-less imbalanced load arises which sometimes only occurs when the water is draining because various items of laundry drain differently. 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.

[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 complete-ly 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] The problem of the invention is to create a device of the initially-cited kind that limits all arising imbalances by changing the spin cycle to prevent damage and the machine parts from overloading.

[0010] This problem is solved according to the invention with sensors that are perpendicular and/or parallel to the rotary axis of the laundry drum and detect the displacements 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.

[0011] 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.

[0012] 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.

[0013] 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 displace-
ment 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.

**[0014]** Acceleration sensors, optical and/or electromagnetic position sensors can be advantageously used.

**[0015]** 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.

**[0016]** 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.

**[0017]** 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.

**[0018]** 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.

**[0019]** 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.

**[0020]** 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.

**[0021]** 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 device to limit the imbalance of a washing unit of a clothes washer that has a laundry drum rotatably mounted in a tub and is suspended in the machine housing to allow oscillation with springs, weights providing inertia, vibration dampers and a drive motor, whereby several sensors distributed on the perimeter of a tub detect the deflections due to imbalance in the spin cycle and undertake related countermeasures to limit the arising paths and forces, characterised in that the sensors (14) are perpendicular and/or parallel to the rotary axis (8) of the laundry drum (12), and they detect the displacements as well as the phase shifts between the displacements, and controlling and/or regulating parameters are fed to the spin cycle 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 device 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 device 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 device 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 de- 

erived from the relationship between the detected 
displacement paths perpendicular to the rotary ac- 
cess (8) and the phase shifts between them, and 
control and/or regulating parameters for the spin cy- 
cle can be calculated from this.

5. A device 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 paral- 
lel to the rotary axis.

6. A device according to one of claims 1 -5, 
characterised in that 
the sensors (14) are at a great distance from the 
rotary axis (8) preferably on the perimeter of the tub 
(2) and diametrically opposed to each other.

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