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(54) **Washing machine with improved control of the dynamic trim of the suspended washing assembly**

Waschmaschine mit Auswuchtvorrichtung

Machine à laver avec dispositif d'équilibrage

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EP-A- 0 750 065 **DE-A- 19 616 635**
DE-U- 6 916 091 **DE-U- 8 905 565**
GB-A- 2 079 791

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Description

[0001] The present invention generally refers to washing machines, in particular, although not limited to, residential-type clothes washing and combined clothes washing and drying machines, that are provided with a suspended washing assembly including a rotating drum mounted inside an outer stationary structure.

[0002] The market is increasingly demanding washing machines, usually those with a substantially horizontal-axis drum, the operating programmes of which comprise washing phases performed at drum rotating speeds comprised between 50 and 60 rpm, as well as spin-extraction phases performed at a considerably higher speed, which may reach up to 1800 to 2000 rpm. An unbalance condition in the distribution of the wash-load items along the periphery of the rotating drum, especially during spin-extraction phases performed at such a high speed, may cause the washing assembly of the machines to undergo fluctuating or oscillatory displacements with respect to the outer stationary structure of the washing machine, said oscillatory displacements, further to giving rise to an undesired level of noise, being capable of even causing parts of the machine to suffer damages due to shocks and bumps.

[0003] In GB-A-2 079 791 a washing machine is disclosed comprising means to detect the oscillatory displacements in excess of a predetermined amount and associated switching means that can be resetted only by the service personnel. Moreover there is no association between the said means and the pressure-switch means ensuring the level control of the washing liquor.

[0004] DE-U-69 16 091 discloses a protecting device for a washing machine which consists of a piezoelectric switch which switches off automatically the actuating motor of the rotational drum in case of a much too big unbalancing of the oscillating assembly.

[0005] Many solutions have been proposed in the art in view of solving the technical problem associated with the possibility for the oscillating assembly to be constantly and under all circumstances ensured a correct dynamic trim and, therefore, the washing machine to be ensured a regular operation.

[0006] In particular, it is known from EP-A-0 750 065 a washing machine comprising means adapted to ensure a correct dynamic trim of the oscillating assembly and consisting of at least a transducer which is capable of converting the oscillatory displacements of the oscillating assembly with respect to the outer stationary structure of the machine into corresponding pressure variations and an associated pressure sensor so as to separately ensure also the level control of the washing liquor in the oscillating assembly. More specifically, the transducer consists of a riser which is not in contact with the outer stationary structure of the machine and contains at least one diaphragm loaded with a predetermined weight so as to have a natural frequency corresponding to a given rotating speed of the drum. While

the use of a single pressure sensor actually simplifies the construction, an unbalance control of the oscillating assembly is only possible at the said given speed, i.e. not throughout the operation cycle of the machine.

[0007] An even more recent solution to the above mentioned technical problem has been proposed by the same Applicant (Italian patent application no. PN97A000030 filed on May 21. 1997). Such a solution is based on the direct conversion of the oscillatory displacements of the oscillating assembly relative to the outer casing into corresponding pressure variations. These pressure variations are used in a manometric-type measurement and control arrangement which is provided separately from the level control arrangement for the washing liquor inside the oscillating washing assembly and is adapted to accordingly modify process parameters of the washing machine if pre-determined limits are detected to have been exceeded. In this manner, the causes of said oscillatory displacements of the oscillating assembly relative to the outer casing are removed and/or the negative effects thereof are minimized.

[0008] It is a purpose of the present invention to provide a washing machine that represents a further improvement with respect to the above cited prior documents and that, though retaining a simple construction, permits a continuous unbalance control of the oscillating assembly throughout the operation cycle of the machine.

[0009] The above purpose is achieved by a washing machine according to the appended claim 1.

[0010] The features and advantages of the present invention will anyway be more readily understood from the description of a preferred embodiment thereof, which is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a laterally open, partially sectioned view, limited to the basic parts thereof, of a household-type front-loading washing machine along the vertical plane passing through the rotation axis of the drum;
- Figure 2 is an enlarged-scale view of the items enclosed in the circle defined by the chain-like line in Figure 1.

[0011] As it can be noticed in the illustration appearing in Figure 1, a washing machine of the above indicated kind generally comprises a stationary parallelepiped-shaped outer structure comprising a base 1, a worktop 2, a front wall 3 with control panel 4 for the control and regulation members of the machine, among which a particular important role is played by the microprocessor-based programme sequence control device 5, and the drawer-like detergent dispenser (not shown). The stationary structure of the washing machine further comprises a rear wall 6 and two side walls, of which only the

right-hand one is shown in the Figure, as indicated generally at 7. The front wall 3 of the stationary structure is provided with a circular aperture capable of being shut by a porthole-like door 9, which is used to load and unload the washload into and from the machine and is hinged on to the same front wall 3. The stationary outer structure of the washing machine encloses an oscillating suspended assembly which comprises a substantially cylindrical wash tub 10 which is elastically connected to the outer stationary structure through upper suspension springs 11 and lower friction-type shock-absorber struts 12. The oscillating assembly further comprises a drum 13 which is supported inside the tub 10 by its rear flange 14 by means of ball bearings (not shown) and a shaft 15 on which a pulley 16 is shrink-fitted. Said pulley, and therefore the drum 13, which is firmly secured to it, are driven through a drive belt 17 by the shaft 18 of an electric motor 19 attached to the lower portion of the tub 10.

[0012] The result is that, in the washing machine, the whole oscillating assembly enjoys a certain freedom to displace with respect to the outer structure and the drum 13 is furthermore rotating about a substantially horizontal axis X. A bellows-like gasket element 20 ensures a sealing connection between the above cited circular aperture 8 in the front wall 3 of the outer stationary structure and an associated aperture 21 provided in the front flange 22 of the tub 10, so as to enable the washload to be loaded into and unloaded from the drum 13 through the front aperture 23 thereof, which is arranged in a line with the afore cited apertures 8 and 21.

[0013] The water inlet circuit carrying the water from the supply mains into the oscillating assembly of the washing machine comprises a supply pipe and a detergent dispenser (not shown), whereas the washing liquor is discharged from the same assembly of the machine through an extensible pipe 24 coming out of the bottom of the tub 10, a drain pump 25 associated to a lint filter 26 that is accessible from the front wall 3 of the washing machine, and an outlet hose 27, of which only the initial portion is actually shown in Figure 1.

[0014] The construction of the washing machine as described hitherto is fully conventional and largely known to those skilled in the art, so that no need is actually felt for further details to be given here in that connection, the more so considering that such details would anyway be irrelevant to the purpose of ensuring a better understanding of the present invention.

[0015] According to the present invention the washing machine comprises, associated to a pressure transducer 28, a differential manometric measurement and control device 30 which is preferably arranged in the uppermost portion of the machine, immediately below the worktop 2.

[0016] The pressure transducer 28, according to the afore mentioned Italian patent application no. PN97A000030 filed by the same Applicant, is adapted to convert the oscillatory displacements of the oscillating

assembly with respect to the outer stationary structure of the machine into corresponding pressure variations. To this purpose, the body of the transducer 28 is made in the shape of an elastically deformable bellows, with a vent hole (not shown), and its end portions are fixed to the rear wall 6 of the outer stationary structure and the rear flange 14 of the tub 10, respectively (see Figure 1).

[0017] As it can be noticed in Figure 2, the differential manometric device 30, which may be appropriately attached on to the side wall 5 by means of a metal bracket or similar means (not shown) in a position behind the control panel 4, essentially consists of two chambers 31 and 32, into which two small-diameter tubes 34 and 35, respectively, are leading. The chambers 31 and 32 are separated from each other by an impermeable diaphragm 33 associated to a generator (not shown) of analogue electric signals. A part of said manometric device 30 is finally an output 36 adapted to transmit the so generated electric signals to the microprocessor-based programme sequence control unit 5 of the washing machine through wires 38, as this will be explained in a more detailed manner further on.

[0018] The differential manometric device 30 may consist basically of a piezoresistive-type pressure switch, ie. a pressure switch that is adapted to generate voltage-modulated output signals, for instance of a type belonging to the series MPX2010 and MPX2012 (Case 352-02) supplied by Motorola.

[0019] Alternatively, the differential manometric device 30 may consist basically of an inductive-type pressure switch, ie. a pressure switch that is adapted to generate frequency-modulated output signals, for instance of a type similar to the Type 764 supplied by Elbi.

[0020] In all cases, the first small tube 34 which, as this has already been said above, leads into the first chamber 31 of the differential manometric device 30, extends vertically over almost the whole length thereof and connects to the extensible pipe 24 for letting the washing liquor off the tub 10 through the bottom thereof. It therefore ensues that the pressure of the air in the small tube 34 and the chamber 31 varies with the level of the washing liquor inside the oscillating assembly of the washing machine, ie. with the static pressure on the bottom of the tub.

[0021] In turn, the second small tube 35, which leads into the second chamber 32 of the differential manometric device 30, comes from the transducer 28 and extends both horizontally and vertically. The pressure of the air in the small tube 35 and the chamber 32 is exactly the dynamic pressure which, during the operation of the washing machine, gets established inside the transducer 28. The value of such a dynamic pressure is mathematically correlated to the dynamic trim of the oscillating assembly of the washing machine and, more precisely, to the amplitude of the oscillatory displacements of said oscillating assembly with respect to the stationary structure of the washing machine.

[0022] Thanks to the present invention, therefore, it just takes the above described differential manometric device 30 to make it possible for both the variations in the static pressure due to the washing liquor and the variations in the dynamic pressure due to the oscillatory displacements of the oscillating assembly with respect to the outer stationary structure of the washing machine to be measured and controlled separately and simultaneously.

[0023] The differential manometric device 30 will of course be so set and regulated as to ensure that an adequately wide variation range is available for both types of pressure involved, so that the respective signals are definitely clear and adequate under any possible operating and use condition of the washing machine.

[0024] The signals relating to the above cited pressures are sent by the output 36 of the differential manometric device 30 through the wires 38 to the programme sequence control unit 5 of the washing machine, where the detected values are compared on a continuously, throughout the operation cycle of the machine, with the reference values duly stored in the memory of the microprocessor, on a real-time basis. Should a need in this sense arise, ie. should any departure from pre-set limit conditions be so detected, corresponding modifications are introduced in the process parameters of the washing machine in the manner as substantially described in the afore cited Italian patent application no. PN97A000030 filed by the same Applicant.

[0025] The advantages offered by the present invention can be summarized as follows: the control of the dynamic trim of the oscillating assembly is performed directly and continuously, without any risk for the machine to suffer damages owing to an excessive extent of the oscillatory displacements of the oscillating assembly with respect to the stationary structure of the machine; the particular component part required to implement the invention, ie. the differential manometric device, is a well-proven, reliable and relatively low-cost one; and the space requirements of the same component part and the associated small tubes 34 and 35 are definitely modest and, therefore, fully compatible with any washing machine design for a simpler overall construction.

Claims

1. Washing machine comprising an outer stationary structure including a front wall (3) and a rear wall (6); an oscillating assembly connected to the outer stationary structure by means of elastic connection means (11, 12) and comprising a tub (10) and a rotating drum (13) driven by an electric motor (19) and rotating about a substantially horizontal axis (X); a preferably electronic programme sequence control unit (5); and means adapted to ensure a correct dynamic trim of the oscillating assembly and consist-

ing of at least a transducer (28), which is capable of converting the oscillatory displacements of the oscillating assembly with respect to the outer stationary structure of the machine into corresponding pressure variations, and an associated manometric-type measurement and control device (30), said manometric-type measurement and control device being a differential pressure switch adapted to separately ensure at the same time also the level control of the washing liquor in the tub (10) of the oscillating assembly **characterized in that** the transducer (28) is made in the shape of an elastically deformable bellows with a vent hole, the end portions of which being fixed to the rear wall (6) of the outer stationary structure and the rear flange (14) of the tub (10) respectively, and that the manometric-type measurement and control device comprises two chambers (31, 32) separated from each other by an impermeable diaphragm (33) associated to a generator of electric signals, the first one (31) of said chambers being connected through a first small-diameter tube (34) to the bottom of the tub (10) and the second one (32) of said chambers being connected through a second small-diameter, prevalently horizontal tube (35) to said transducer (28).

2. Washing machine according to claims 1, **characterized in that** said manometric-type device (30) is arranged in the uppermost portion of the stationary structure of the machine.
3. Washing machine according to claims 1 or 2, **characterized in that** said manometric-type device (30) is a piezoresistive-type analogue device, i.e. a device adapted to issue at its output (36) voltage-modulated signals transmitted through connecting wires (38) to the programme sequence control unit (5).
4. Washing machine according to claim 1 or 2, **characterized in that** said manometric-type device (30) is an inductive-type analogue device, ie. a device adapted to issue at its output (36) frequency-modulated signals transmitted through connecting wires (38) to the programme sequence control unit (5).

Patentansprüche

1. Eine Waschmaschine, umfassend:

einen äußeren feststehenden Aufbau, die eine Vorderwand (3) und eine Rückwand (6) beinhaltet;
einen schwingenden Aufbau, der mit dem äußeren feststehenden Aufbau mittels eines elastischen Verbindungsmittels (11,12) verbunden ist und einen Kübel (10) und eine von einem Elektromotor (19) angetriebene

und um eine im wesentlichen horizontale Achse (x) drehende Drehtrommel (13) umfaßt; eine vorzugsweise elektronische Einheit zur Steuerung der Programmabfolge (5); und ein Mittel, angepaßt um eine korrekte dynamische Feinabstimmung des schwingenden Aufbaus sicherzustellen, und welche aus wenigstens einem Wandler (28), welcher in der Lage ist, die Schwingungsverschiebungen des schwingenden Aufbaus bezüglich des äußeren feststehenden Aufbaus der Maschine in entsprechende Druckschwankungen umzuwandeln, und einer zugehörigen manometrischen Meß- und Steuereinrichtung (30) besteht, die ein Differenzdruckschalter ist, der angepaßt ist, um unabhängig, gleichzeitig auch die Pegelsteuerung der Waschflüssigkeit im Kübel (10) des schwingenden Aufbaus sicher zu stellen,

dadurch gekennzeichnet, daß der Wandler (28) die Form eines elastisch verformbaren Balgs mit einem Luftloch hat, wobei dessen Enden in der Rückwand (6) des äußeren feststehenden Aufbaus beziehungsweise dem rückwärtigem Flansch (14) des Kübels (10) befestigt sind, und daß diese manometrische Meß- und Steuervorrichtung zwei Kammern (31,32) umfaßt, die voneinander durch eine undurchlässige Membran (33) getrennt sind, die zu einem elektrischen Signalgenerator gehört, wobei die erste der Kammern (31) durch eine erste Röhre mit kleinerem Durchmesser (34) mit dem Boden des Kübels verbunden ist, und die zweite der Kammern (32) durch eine zweite vorwiegend horizontale Röhre (35) mit dem Wandler (28) verbunden ist.

2. Waschmaschine nach Anspruch 1, **dadurch gekennzeichnet, daß** die manometrische Vorrichtung (30) im obersten Bereich des feststehenden Aufbaus der Maschine angeordnet ist.
3. Waschmaschine nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** die manometrische Vorrichtung (30) eine analoge Vorrichtung piezoresistiver Art ist, das heißt eine Vorrichtung, die angepaßt ist, um ihre spannungsmodulierten, durch Verbindungsdrähte (38) gesendeten Ausgabesignale (36) an die Einheit zur Steuerung der Programmabfolge auszugeben.
4. Waschmaschine nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** die manometrische Vorrichtung (30) eine analoge Vorrichtung induktiver Art ist, das heißt eine Vorrichtung, die angepaßt ist, um ihre frequenzmodulierten, durch Verbindungsdrähte (38) gesendeten Ausgabesignale (36) an die Einheit zur Steuerung der Programmabfolge auszugeben.

Revendications

1. Machine à laver comportant une structure extérieure stationnaire comprenant une paroi avant (3) et une paroi arrière (6) ; un ensemble oscillant relié à la structure extérieure stationnaire par des moyens de liaison élastiques (11, 12) et comprenant une cuve (10) et un tambour rotatif (13) entraîné par un moteur électrique (19) et tournant autour d'un axe (X) sensiblement horizontal ; une unité (5) de commande de séquence de programme de préférence électronique ; et des moyens adaptés pour assurer un déclenchement dynamique correct de l'ensemble oscillant et constitué d'au moins un transducteur (28), qui est capable de convertir les déplacements oscillatoires de l'ensemble oscillant par rapport à la structure extérieure stationnaire de la machine en des variations de pression correspondantes, et un dispositif (30) de mesure et contrôle de type manométrique associé, ledit dispositif de mesure et contrôle de type manométrique étant un contacteur de pression différentielle adapté pour assurer séparément et en même temps également le contrôle de niveau de la liqueur de lavage dans la cuve (10) de l'ensemble oscillant, **caractérisée en ce que** le transducteur (28) est réalisé sous forme d'un soufflet déformable élastiquement avec un orifice d'aération, dont les parties d'extrémité sont fixées à la paroi arrière (6) de la structure extérieure stationnaire et à la bride arrière (14) de la cuve (10) respectivement, et **en ce que** le dispositif de mesure et contrôle de type manométrique comprend deux chambres (31, 32) séparées l'une de l'autre par un diaphragme imperméable (33) associé à un générateur de signaux électriques, la première (31) des dites chambres étant reliée par un premier tube (34) de petit diamètre au fond de la cuve (10) et la deuxième (32) des dites chambres étant reliée par un deuxième tube (35) de petit diamètre principalement horizontal audit transducteur (28).
2. Machine à laver selon la revendication 1, **caractérisée en ce que** ledit dispositif de type manométrique (30) est agencé dans la partie supérieure de la structure stationnaire de la machine.
3. Machine à laver selon la revendication 1 ou 2, **caractérisée en ce que** ledit dispositif de type manométrique (30) est un dispositif analogique de type piézorésistif, c'est-à-dire un dispositif adapté pour émettre à sa sortie (36) des signaux modulés en tension transmis par des fils de liaison (38) à l'unité (5) de commande de séquence de programme.
4. Machine à laver selon la revendication 1 ou 2, **caractérisée en ce que** ledit dispositif de type manométrique (30) est un dispositif analogique de type inductif, c'est-à-dire un dispositif adapté pour émet-

tre à sa sortie (36) des signaux modulés en fréquence transmis par des fils de liaison (38) à l'unité (5) de commande de séquence de programme.

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Fig. 2

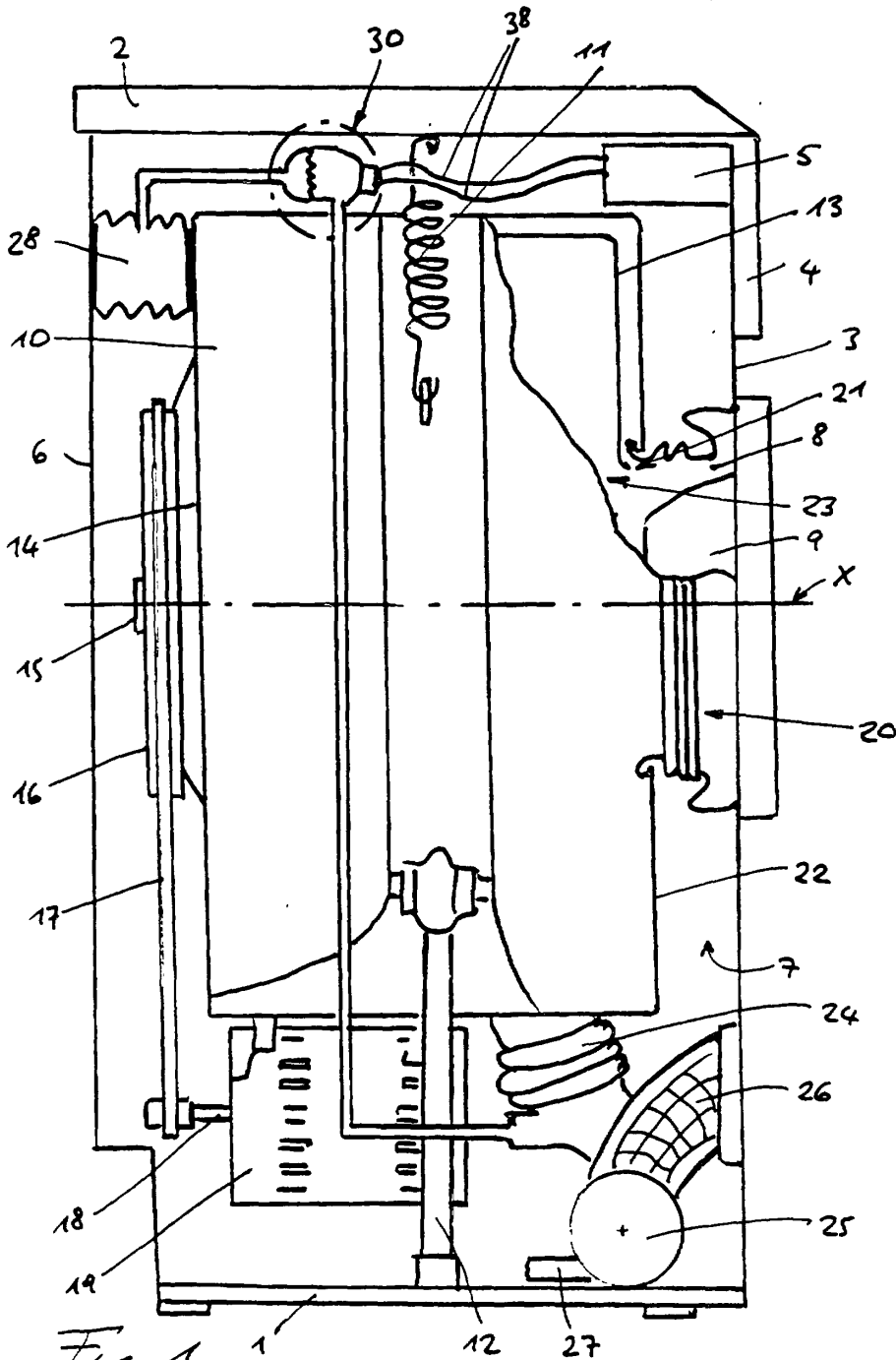
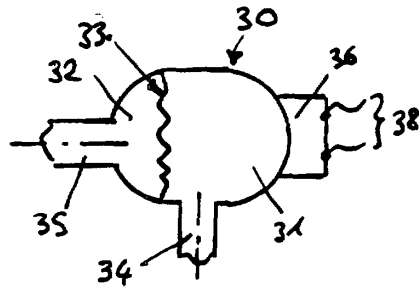


Fig. 1