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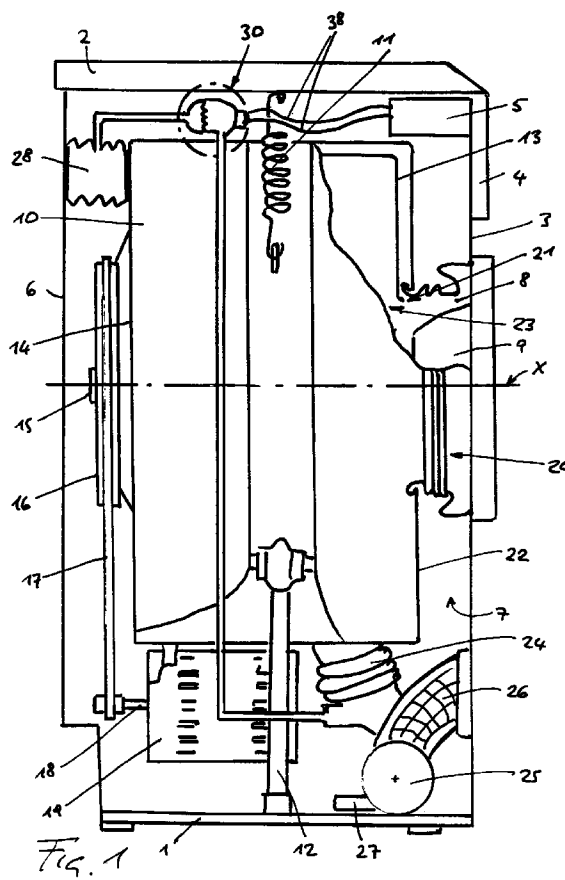
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(54) **Washing machine with improved control of the dynamic trim of the suspended washing assembly**

(57) Washing or similar machine, the oscillating washing assembly of which comprises a tub (10) and a rotating drum (13). The dynamic trim of the oscillating assembly is monitored by a transducer (28), which is adapted to convert the relative oscillating displacements of the oscillating assembly with respect to the outer stationary structure of the machine into corresponding pressure variations, and a therewith associated manometric device (30). According to the invention, the latter is a differential pressure switch with which also the level of the washing liquor in the oscillating group is at the same time controlled separately.



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Description

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.

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 washload 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.

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.

A 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.

It is a purpose of the present invention to provide a washing machine that represents a further improvement with respect to the above cited patent application, filed by the Applicant.

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.

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.

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.

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.

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.

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.

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).

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.

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.

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.

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 con-

nects 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.

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.

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.

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.

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.

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

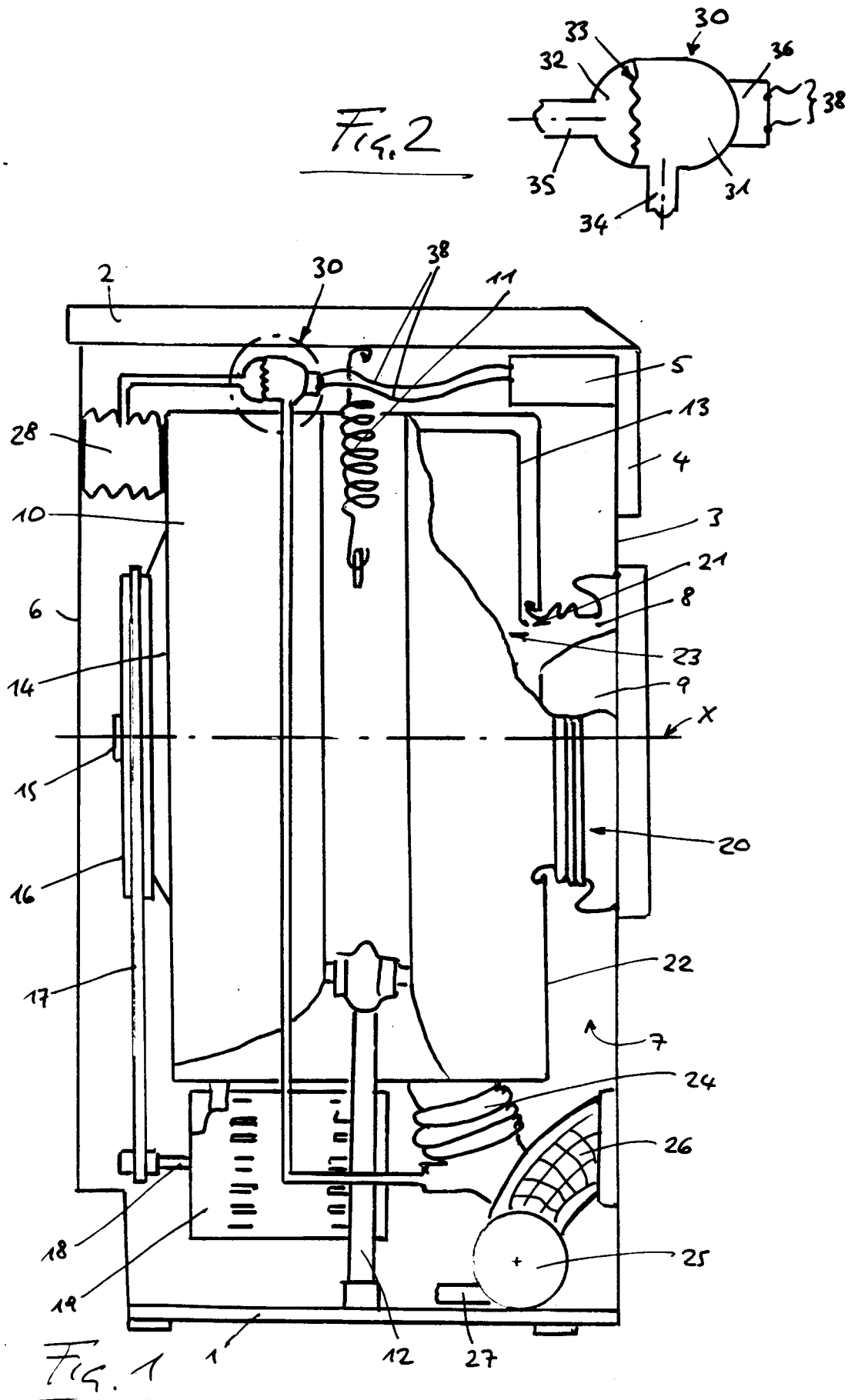
device, is a well-proven, reliable and relatively low-cost one; and the space requirements of the same component part and the associated small tubes 34 and 35 are definitely modest and, therefore, fully compatible with any washing machine design for a simpler overall construction.

Claims

1. Washing machine with a preferably electronic programme sequence control unit (5), 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); means adapted to ensure a correct dynamic trim of the oscillating assembly and consisting 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), **characterized in that** said manometric-type measurement and control device (30) is a differential pressure switch or similar device adapted to separately ensure at the same time also the level control of the washing liquor in the tub (10) of the oscillating assembly.
2. Washing machine according to claim 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 claim 1 or 2, **characterized in that** said manometric-type device (30) includes two chambers (31, 32) separated from each other by an impermeable diaphragm (33) associated to a generator of electric signals, wherein a first small-diameter tube (34) coming from the bottom of the tub (10) leads into the first one (31) of said chambers, while a second small-diameter, prevalingly horizontal tube (35) coming from said transducer (28) leads into the second one (32) of said chambers.
4. Washing machine according to claim 3, **characterized in that** said manometric-type device (30) is a piezoresistive-type analogue device, ie. a device adapted to issue at its output (36) voltage-modulated signals directed at the programme sequence control unit (5) to which it is connected through wires (38).
5. Washing machine according to claim 3, **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 directed at the programme sequence control unit (5) to which it is connected through wires (38).

6. Washing machine according to any of the preceding claims, in which the drum is rotating about a substantially horizontal axis (X), **characterized in that** said 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.





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EUROPEAN SEARCH REPORT

Application Number
EP 98 10 7393

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 750 065 A (MIELE & CIE) 27 December 1996 * column 3, line 5 - column 5, line 1; figures 1,2 *	1	D06F37/20 D06F39/08
X,P	DE 196 16 635 A (AEG HAUSGERAETE GMBH) 30 October 1997 * the whole document *	1	
A	GB 2 079 791 A (LICENTIA GMBH) 27 January 1982 * abstract; figure 1 *	1,6	
A	DE 89 05 565 U (BSG-SCHALTTECHNIK) 31 August 1989 * the whole document *	1,3,5	
A	DE 69 16 091 U (MIELE&CIE) 27 December 1969 * the whole document *	1,3,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			D06F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 September 1998	Examiner Norman, P
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