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(54) Title: A WASHING MACHINE HAVING A DRUM WHEREIN THE UNBALANCED LOAD IS BALANCED

(57) Abstract: The present invention relates to a washing machine (1) having a body, a drum (2) wherein the laundry is placed and which rotates around a horizontal axis, a motor which moves the drum (2), a tub wherein the drum (2) moves, and a shaft (3) which transmits the movement received from the motor to the drum (2) and determines the rotational axis (E) of the drum (2), and balancing units (5) which are fixed at the front and back of the drum (2) concentrically with the drum (2) and have a hollow annular shape, and wherein compartments (4) are located.
Description

A WASHING MACHINE HAVING A DRUM WHEREIN THE UNBALANCED LOAD IS BALANCED

[0001] The present invention relates to a washing machine wherein the unbalanced load inside the drum is balanced by performing dynamic balancing.

[0002] In washing machines, the laundry to be washed is placed into a drum that rotates around a horizontal axis. In different steps of the washing program, the laundry is cleaned with water and detergent by rotating the drum at different speeds. While the drum is being rotated, the laundry is not distributed homogeneously inside the drum, causing an uneven distribution of the laundry by piling up in some areas. Particularly in the spinning step wherein the drum is rotated at very high speeds, the unbalanced loads cause centrifugal forces to occur and as a result of this, cause vibration and noise.

[0003] In the state of the art, various solutions have been developed for balancing the unbalanced load. For example, the method of adding balancing weight to the tub group and thus, balancing by increasing the inertia is widely used. Since balancing weights make the transportation of the washing machine difficult, in some of the state of the art embodiments, dynamic balancing is performed and a fluid, for example water is used as the balancing material. The water used as balancing material is generally filled into the receptacles fixed on the drum of the washing machine. Furthermore, in the state of the art, viscous liquids are used as the balancing liquid, and spherical or cylindrical elements such as balancing balls that move around the drum by the effect of the centrifugal force are placed in the viscous liquids in order to improve the balancing process. The said dynamic balancing systems occupy much space inside the washing machine body and due to the big masses of the used balancing materials, these materials themselves create an additional imbalance and the increase of noise cannot be prevented.

[0004] In the washing machine explained in the United States of America Patent No US5893280, a water guiding chamber which is assembled to the drum
and wherein water is added, and a balancing chamber which provides balancing by collecting the water being distributed from this chamber by the effect of the centrifugal force during the rotation of the drum are located.

[0005] In the washing machine explained in the United States of America Patent No US6418758, plural water-holding chambers are located wherein water is added for balancing and which are arranged on the drum rear wall and around the drum rotation axis.

[0006] In the horizontal axis washing machine explained in the United States of America Patents No US5850748 and US5850749, dynamic balancing mechanisms located on the panels in front of and behind the drum are explained. Each dynamic balancing mechanism is concentric to the axis of rotation of the drum and is annular, and inside them a viscous liquid for balancing and inside this liquid moving balls are situated.

[0007] The aim of the present invention is the realization of a washing machine having a balancing unit that performs precise balancing process and occupies less space.

[0008] The washing machine realized in order to attain the aim of the present invention is explicated in the claims.

[0009] The washing machine of the present invention comprises a drum wherein the laundry is placed and which rotates around a horizontal axis, and hollow annular balancing units, which are fixed at the front and back of the drum, and the inner volume of which is divided into compartments and wherein the compartments extend in the radial direction side by side as segments and into these compartments electrorheological fluid is placed as the balancing fluid. The electrorheological fluid placed in the compartments is solidified when electric field is applied thereon, and is liquefied when the electric field is removed. In the washing machine of the present invention, the electrorheological fluid placed in the balancing unit performs the balancing process by being activated, that is, by its viscosity being increased and reduced in the compartments that need balancing.

[0010] The washing machine, furthermore, comprises an unbalanced load sensor that detects the unbalanced load occurring during the rotation of the drum,
and a control card that provides an electric current to be applied to the compartment or compartments wherein the balancing process will be performed, or the applied electric field to be removed, according to the unbalanced load data received from the sensor.

[0011] Around the rotational axis of the drum, the balancing unit has a circular inner wall that surrounds the inner side of the drum, a circular outer wall that surrounds the outer side thereof, and compartment walls that form the compartments by extending in the radial direction between the inner wall and the outer wall.

[0012] In the washing machine, in the situation that no unbalanced load is detected by the sensor, the control card provides the electrorheological fluid to be solidified around the inner wall of the compartment by applying electric field to all of the compartments in the balancing unit.

[0013] In the washing machine, in the situation that an unbalanced load is detected by the sensor, the control card removes the electric field it applies to the compartment or compartments, which will perform the function of balancing the detected unbalanced load, according to the unbalanced load data received from the sensor and thus, the electrorheological fluid that is kept in the solid state around the inner wall is liquefied and moves to the outer wall by the effect of the centrifugal force. The control card again applies electric field to the electrorheological fluid that reaches the outer wall and solidifies it, and provides the electrorheological fluid to form a counterweight there.

[0014] The washing machine, furthermore, has ring-shaped conductive commutators which provide an electric field to be applied to the electrorheological fluid and to be removed therefrom, and which are peripherally insulated and mounted onto the drum shaft, rotate with the drum shaft, and provide the electric current that will be applied to the electrorheological fluid to be transmitted to the compartments by means of cables; brushes which provide the electric current generated in a power source to be transmitted to the commutators and electrodes which are located inside the compartments and transmit the electric current received from the commutators to the electrorheological fluid in the compartments.
[0015] In an embodiment of the present invention, nano-electrorheological fluid, to which nano-particle is added that provides it to reach a solidity close to solid materials when electric field is applied, is used in the balancing unit.

[0016] In the washing machine of the present invention, the balancing unit occupies a very small space by means of the electrorheological fluid placed therein, and a more effective and precise balancing in comparison to the balancing mechanisms with big masses is performed.

[0017] The washing machine realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

[0018] Figure 1 - is the schematic view of a washing machine.

[0019] Figure 2 - is the schematic view of a drum, at the front and back of which balancing units are mounted.

[0020] Figure 3 - is the schematic view of a balancing unit in the passive position.

[0021] Figure 4 - is the schematic view of a balancing unit in the active position.

[0022] Figure 5 - is the schematic view of the brushes, commutators and electrodes that transmit electric current to a balancing unit through the drum shaft.

[0023] The elements illustrated in the figures are numbered as follows:

[0024] 1 - Washing machine

[0025] 2 - Drum

[0026] 3 - Shaft

[0027] 4 - Compartment

[0028] 5 - Balancing unit

[0029] 6 - Sensor

[0030] 7 - Control card

[0031] 8 - Inner wall

[0032] 9 - Outer wall

[0033] 10 - Compartment wall

[0034] 11 - Commutator

[0035] 12 - Brush

[0036] 13 - Electrode

[0037] The washing machine (1) comprises a body, a drum (2) wherein the laundry is placed and which rotates around a horizontal axis, a motor
which moves the drum (2), a tub wherein the drum (2) moves, and a shaft (3) which transmits the movement received from the motor to the drum (2) and determines the rotational axis (E) of the drum (2).

[0038] The washing machine (1) of the present invention comprises one or more balancing units (5)
- which are fixed at the front and/or back of the drum (2) concentrically with the drum (2),
- which have a hollow annular shape,
- which have more than one compartment (4) that are provided by dividing the inner volume preferably into equal pieces and arranged all around the rotational axis (E) of the drum (2),
- wherein electrorheological fluid (ER), which becomes gel-like or solidified from the liquid state by its viscosity being increased when an electric field is applied and which returns to the liquid state when the electric field is removed, is placed into the compartments (4).

[0039] In the washing machine (1) of the present invention, preferably two balancing units (5) are mounted to the drum (2) as one to the front side wherein the laundry loading port is situated and one to the rear side wherein the actuating elements are situated.

[0040] The term electrorheological fluid (ER) is used for fluids which become gel-like or solidified from the liquid state in a very short time, for example in a couple of milliseconds by their viscosity being increased according to the magnitude of the electric field when an electric field is applied, and which return to the liquid state when the applied electric field is removed. The electrorheological fluid (ER) is sometimes called the electroviscous fluid, too. Alteration of the viscosity by the effect of the electric field, and accordingly of the mechanical features such as the yield stress of the electrorheological fluid (ER) is known as the Winslow effect. In the state of the art, electrorheological fluids (ER) are used in brake mechanisms, hydraulic valves, clutches and shock absorbers.

[0041] In the washing machine (1) of the present invention, the electrorheological fluid (ER) is filled into the balancing units (5), which rotate together with the drum (2), as the balancing fluid. The electrorheological fluid (ER)
provides the balancing process to be performed by being activated, that is, by its viscosity being increased and reduced in the compartment (4) or compartments (4) that need balancing.

[0042] The washing machine (1), furthermore, comprises a sensor (6) that detects the unbalanced load occurring during the rotation of the drum (2), and a control card (7) that provides an electric field to be applied to the electrorheological fluid (ER) in the compartments (4) and that provides an electric current to be applied to the compartment (4) or compartments (4) wherein the balancing process will be performed, or the applied electric field to be removed, according to the unbalanced load data received from the sensor (6).

[0043] Around the rotational axis (E) of the drum, the balancing unit (5) comprises a circular inner wall (8) that surrounds the inner side of the drum (2), a circular outer wall (9) that surrounds the outer side thereof, and more than one compartment wall (10) that extend in the radial direction between the inner wall (8) and the outer wall (9) and thus, form the compartments (4).

[0044] During the operation of the washing machine (1), in the situation that no unbalanced load is detected by the sensor (6), the electrorheological fluid (ER) in the compartments (4) inside the balancing unit (5) is collected around the inner wall (8) and the electrorheological fluid (ER) is provided to be solidified by applying electric field to all of the compartments (4) by the control card (7). During normal operation wherein no imbalance is detected, the electrorheological fluid (ER) takes a proper annular shape around the inner wall (8) that is close to the center of the balancing unit (5), and does not create an additional imbalance.

[0045] During the operation of the washing machine (1), in the situation that an unbalanced load is detected by the sensor (6), the control card (7) removes the electric field it applies to the compartment (4) or compartments (4), which will perform the function of balancing the detected unbalanced load, according to the unbalanced load data received from the sensor (6) and thus, liquefies the electrorheological fluid (ER) which is initially kept in the solid state around the inner wall (8), that is, releases it. The electrorheological fluid (ER) liquefied in the compartment
(4) moves towards the outer wall (9) by the effect of the centrifugal force, and is solidified by the control card (7) applying an electric field again at the moment it reaches the outer wall (9). The electrorheological fluid (ER) that is solidified by adhering to the inner surface of the outer wall (9) in the compartment (4) performs the function of balancing by forming a counterweight for the unbalanced load.

[0046] During the operation of the washing machine (1), when the sensor (6) detects that the existing imbalance is removed, the balancing function of the electrorheological fluid (ER), which is connected by being solidified on the outer wall (9) in the compartment (4), ends and the control card (7) removes the electric field it applies to the electrorheological fluid (ER) in the compartment (4) when the compartment (4) comes near the upper position during the rotation of the drum (2), and releases the electrorheological fluid (ER), and the liquefied electrorheological fluid (ER) reaches the inner wall (8) by flowing from the outer wall (9) of the balancing unit (5) towards its inner wall (8) by the effect of the centrifugal force and is kept in the solid state here by being applied electric field again.

[0047] The washing machine (1) of the present invention, furthermore, comprises more than one ring-shaped conductive commutator (11) which provide an electric field to be applied to the electrorheological fluid (ER) and to be removed therefrom, and which are peripherally insulated and mounted onto the shaft (3), rotate with the shaft (3) and provide the electric current applied to the electrorheological fluid (ER) to be transmitted to the compartments (4) by means of cables; more than one brush (12) which provide the electric current generated in a power source to be transmitted to the commutator (11) and which are fixed to the body of the drum or of the washing machine (1) and produced from thin copper or steel wire; and more than one electrode (13) which are located inside the compartments (4) in the balancing unit (5) and transmit the electric current received from the commutators (11) to the electrorheological fluid (ER) in the compartments (4).

[0048] The control card (7) detects in which compartment (4) or compartments (4)
the balancing process will be performed according to the unbalanced load data received from the sensor (6), and the current generated in the power source is transmitted to the commutators (11), which rotate on the shaft (3), by means of the brushes (12), and from the commutators (11) to the electrodes (13) by means of the cables passing through the drum (2) or shaft (3), and from the electrodes (13) to the electrorheological fluid (ER) in the related compartment (4) or compartments (4).

[0049] In an embodiment of the present invention, in the compartment (4), the electrodes (13) are disposed between the compartment walls (10) and on the inner wall (8), and extend in the radial direction from the inner wall (8) towards the outer wall (9) (Figures 3, 4). The electrodes (13) provide the electrorheological fluid (ER), which is liquefied around the inner wall (8) when the electric field is removed and which is under the influence of the centrifugal force, to be directed towards the outer wall (9) in a proper manner.

[0050] In another embodiment of the present invention, the washing machine (1) has a balancing unit (5) wherein nano - electrorheological fluid (NER), to which nano - particles are added that provides it to reach a solidity close to solid materials such as plastic materials when electric field is applied, is used. In this embodiment, silicone oil is used as the electrorheological fluid and Barium Titanyl Oxalate (BaTiO(C2O4)2) nano-particles having a size of approximately 50 - 70 nm are added to the electrorheological fluid (ER). The provided nano - electrorheological fluid (NER) is solidified from the liquid state in 1/100 of a second by the applied electric field of 1 - 2 kV/mm, and is liquefied from the solid state in the same period of time when the electric field is removed.

[0051] In the washing machine (1) of the present invention, the balancing unit (5) occupies a very small space by means of the electrorheological fluid (ER) placed therein, and provides a more effective and precise balancing in comparison to the balancing mechanisms with big masses to be performed. The balancing unit (5), furthermore, does not form a source of imbalance itself. The compartments (4) forming the balancing unit (5) are shaped as a closed box each, and once the electrorheological fluid (ER) is
filled into the compartments (4), the compartments (4) are completely closed and the electrorheological fluid (ER) remains in the compartment (4) permanently. Thus, processes such as filling fluid from the outside or discharging fluid to the outside like for example in the mechanisms wherein water is used as the balancing fluid are not required.

[0052] It is to be understood that the present invention is not limited by the embodiments disclosed above and a person skilled in the art can easily introduce different embodiments. These should be considered within the scope of the protection postulated by the claims of the present invention.
Claims

1. A washing machine (1) comprising a drum (2) wherein the laundry is placed and which rotates around a horizontal axis, and a shaft (3) which transmits the movement received from the motor to the drum (2) and determines the rotational axis (E) of the drum (2), characterized by one or more balancing units (5) comprising more than one compartment (4) arranged all around the rotational axis (E) of the drum (2), and wherein electrorheological fluid (ER), which becomes gel-like or solidified from the liquid state by its viscosity being increased when an electric field is applied and which returns to the liquid state when the electric field is removed, is placed into the compartments (4).

2. A washing machine (1) as in Claim 1, characterized by a sensor (6) that detects the unbalanced load occurring during the rotation of the drum (2), and a control card (7) that provides an electric field to be applied to the electrorheological fluid (ER) in the compartments (4) and that provides an electric current to be applied to the compartment (4) or compartments (4) wherein the balancing process will be performed, or the applied electric field to be removed, according to the unbalanced load data received from the sensor (6).

3. A washing machine (1) as in Claim 1 or 2, characterized by the balancing unit (5) which is fixed at the front and/or back of the drum (2) concentrically with the drum (2) and has a hollow annular shape, and wherein compartments (4) are provided by dividing the inner volume thereof into pieces and wherein these compartments (4) are arranged all around the rotational axis (E) of the drum (2), and which, around the rotational axis (E) of the drum (2), has a circular inner wall (8) that surrounds the inner side of the drum (2), a circular outer wall (9) that surrounds the outer side thereof, and more than one compartment wall (10) that extend in the radial direction between the inner wall (8) and the outer wall (9), and form the compartments (4).

4. A washing machine (1) as in any one of the above Claims, characterized by the control card (7) that provides the electrorheological fluid (ER) collected around the inner wall (8) to be solidified by applying electric field to it in all compartments (4) in the balancing unit (5) in the situation that no unbalanced load is detected by the sensor (6).
5. A washing machine (1) as in any one of the above Claims, characterized by the control card (7) that, in the situation that an unbalanced load is detected by the sensor (6), removes the electric field it applies to the compartment (4) or compartments (4), which will perform the function of balancing the detected unbalanced load, according to the unbalanced load data received from the sensor (6) and releases the electrorheological fluid (ER), which is kept in the solid state around the inner wall (8), by liquefying it, and that solidifies the electrorheological fluid (ER), which is liquefied in the compartment (4), by applying electric field at the moment it reaches the outer wall (9) by the effect of the centrifugal force.

6. A washing machine (1) as in any one of the above Claims, characterized by the control card (7) which, when the sensor (6) detects that the imbalance is removed, releases the electrorheological fluid (ER) in the compartment (4) by removing the electric field applied thereto when the compartment (4) comes near the upper position during the rotation of the drum (2).

7. A washing machine (1) as in any one of the above Claims, characterized by more than one ring-shaped conductive commutator (11) which are peripherally insulated and mounted onto the shaft (3), rotate with the shaft (3) and provide the electric current applied to the electrorheological fluid (ER) to be transmitted to the compartments (4) by means of cables; more than one brush (12) which provide the electric current generated in a power source to be transmitted to the commutator (11) and which are fixed to the body of the drum or of the washing machine (1) and produced from thin copper or steel wire; and more than one electrode (13) which are located inside the compartments (4) in the balancing unit (5) and transmit the electric current received from the commutators (11) to the electrorheological fluid (ER) in the compartments (4).

8. A washing machine (1) as in any one of the above Claims, characterized by the electrodes (13) which are disposed between the compartment walls (10) and on the inner wall (8), and extend in the radial direction from the inner wall (8) towards the outer wall (9) in the compartment (4).

9. A washing machine (1) as in any one of the above Claims, characterized by the balancing unit (5) wherein nano-electrorheological fluid (NER) including nano-particles that provides it to reach a solidity nearly solid materials when
electric field is applied.
INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/056468

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F37/22 D06F37/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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