Figure 1

Abstract: The present invention relates to a washing machine (1) comprising a body (2), a tub (3) situated in the body (2), a drum (4) mounted into the tub (3) so as to rotate around an axis and which provides the laundry to be loaded therein to be washed and at least one vibration damper (5) which provides the vibrations that occur as a result of the rotation of the drum (4) to be decreased.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
Description

A WASHING MACHINE COMPRISING A VIBRATION DAMPER

[0001] The present invention relates to a washing machine that comprises a vibration damper.

[0002] In washing machines, the laundry to be washed is loaded into the drum and the drum starts rotating in the tub after the washing program is started. While the drum performs rotational movement, the laundry moves in the drum in an unbalanced manner and causes vibration by hitting the side wall of the drum. Moreover, at the starts in the washing and spin-drying steps, while the drum rotates at the speed of angular rotation which corresponds to the natural frequency of the system consisting of the tub and the connection members, the system enters in resonance and the maximum vibration occurs at this moment. The intensity of the said vibration shows variability according to the amount of the laundry in the drum and can cause the tub to hit the side walls of the body and to be damaged from time to time. Moreover, the washing machine creates a disturbing sound in the meantime and moves since it can not balance the oscillations of the tub. This causes customer dissatisfaction.

[0003] For the solution of this problem, the mass of the vibrating system is increased and the natural frequency thereof is tried to be decreased by placing balance weights over the tub. However this causes the costs and the total weight of the washing machine to increase.

[0004] Another method used for the solution of the problem is to use a dynamic vibration damper. By mounting a balancing system with the same natural frequency and which generally consists of the spring and the block to the system consisting of the tub and the connection members, the degree of freedom and hence the natural frequency number thereof are increased. The new formed system has two natural frequencies, one of which is lower than the former natural frequency while the other of which is higher, and does not enter in resonance at its former natural frequency.

[0005] In the state of the art International Patent Application No. WO2007147869, a front loading washing machine is described, comprising a spring block system suspended under the tub. While the system rotates at its natural
frequency, the block applies a force towards the tub and the spring minimizes the vibration of the tub by damping the said force.

[0006] In the state of the art European Patent Application No. EP2072653, a washing machine is described, comprising vibration prevention devices situated at more than one place on the tub. In this embodiment, the vibration prevention devices consist of the spring, the block and the damping apparatuses connected to each other in series.

[0007] The aim of the present invention is the realization of a washing machine wherein the vibrations caused by the drum while rotating are decreased.

[0008] In the washing machine realized in order to attain the aim of the present invention, explicated in the first claim and the respective claims thereof, a vibration damper is disposed which dynamically damps the vibrations that occur. The vibration damper consists of at least two electromagnets disposed in a receptacle and a balancing member situated between said electromagnets.

[0009] In an embodiment of the present invention, two electromagnets are disposed in the vibration damper. The electromagnets are situated at each end of the receptacle, and the balancing member between the electromagnets. The vibration damper which consists of two electromagnets can damp vibration in a single direction. A great amount of the vibration dampers in this embodiment can be used in the washing machine. Each vibration damper damps the vibration in the direction at which it is placed. In the vibration damper of this configuration, the width of the receptacle is equal to the length of the electromagnet. When the electromagnet is placed in the receptacle, no space remains at its sides.

[0010] In an embodiment of the present invention, four electromagnets are disposed in the vibration damper. The electromagnets are placed in two pairs facing each other in the horizontal and vertical directions. Each edge of the preferably square shaped balancing member faces one electromagnet. The vibration damper in this embodiment can damp vibration in two different directions and is placed on the surface of the tub preferably symmetrically.

[0011] In an embodiment of the present invention, six electromagnets are
disposed in the vibration damper. The vibration damper in this embodiment can damp vibration in three different directions.

[0012] In an embodiment of the present invention, permanent magnet is used as the balancing member. While the permanent magnet is placed between the electromagnets, the poles thereof are positioned so as to be subjected to the pushing force by the electromagnets.

[0013] In another embodiment of the present invention, metal block is used as the balancing member. The metal block can be placed between the electromagnets in an isotropic way.

[0014] In an embodiment of the present invention, the angular speed of the drum that corresponds to the natural frequency of the washing machine is detected in advance and when this speed is reached voltage is supplied to the electromagnets. In this embodiment, the tachogenerator on the motor is utilized for detecting the rotation speed.

[0015] In another embodiment of the present invention, a vibration gauge, which is disposed on the tub, is present. The vibration gauge measures the vibrations acting on the tub throughout the whole program and transmits the data to the control unit. The control unit calculates the suitable voltage for the received vibration data and sends the said voltage to the electromagnets.

[0016] In a version of this embodiment, the control unit activates the vibration damper only for the vibrations above a certain threshold value.

[0017] In another embodiment of the present invention, the vibration values of the drum that correspond to certain speed intervals and the magnitude of the voltage required to be supplied to the electromagnets for the said vibration values are recorded in the memory of the control unit. These speed intervals are determined preferably at equal intervals. (For example 200-400rpm, 400-600rpm, 600-800rpm, 800-1000rpm). The control unit, which receives speed data from the tachogenerator throughout the program, sends to the electromagnets the voltage recorded in its memory for the related interval according to the rotation speed of the drum at that moment.

[0018] The vibration dampers are preferably placed on the tub. The rotational
movement of the drum, which is the source of the vibration, causes the greatest oscillations to occur in the tub. While the vibration dampers comprising two electromagnets can be placed in any desired region of the tub, the vibration dampers comprising four electromagnets are placed on the tub symmetrically.

[0019] In another embodiment of the present invention, balance weights are placed on the tub and vibration dampers are placed on the balance weights.

[0020] By means of the present invention, the vibrations that occur in the washing and spin-drying steps are minimized. Since the intensity of damping can be changed dynamically according to the magnitude of the vibration that occurs in the washing machine and/or to the speed of the drum, an effective damping is provided. Thus the washing machine is better protected and the lifespan of the machine is extended.

[0021] A washing machine realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

[0022] Figure 1 - is the schematic view of the washing machine of the present invention.

[0023] Figure 2 - is the schematic view of the washing machine of the present invention from another angle.

[0024] Figure 3 - is the schematic view of the vibration damper when the vibration damper related to an embodiment of the present invention is activated.

[0025] Figure 4 - is the schematic view of the vibration damper when the vibration damper related to an embodiment of the present invention is deactivated.

[0026] Figure 5 - is the sideways schematic view of the washing machine related to another embodiment of the present invention.

[0027] Figure 6 - is the schematic view of the washing machine related to another embodiment of the present invention.

[0028] Figure 7 - is the schematic view of the vibration damper when the vibration damper related to another embodiment of the present invention is activated.

[0029] Figure 8 - is the schematic view of the vibration damper when the vibration damper related to another embodiment of the present invention is
deactivated.

[0030] Figure 9 - is the schematic view of the washing machine related to another embodiment of the present invention.

[0031] Figure 10 - is the sideways schematic view of the washing machine related to another embodiment of the present invention.

[0032] Figure 11 - is the schematic view of the washing machine related to another embodiment of the present invention.

[0033] The elements illustrated in the figures are numbered as follows:

1. Washing machine
2. Body
3. Tub
4. Drum
5. Vibration damper
6. Receptacle
7. Electromagnet
8. Balancing member
9. Control unit
10. Vibration gauge
11. Balance weight

[0034] The washing machine (1) comprises a body (2), a tub (3) situated in the body (2), a drum (4) mounted into the tub (3) so as to rotate around an axis and wherein the laundry to be washed is loaded and at least one vibration damper (5) which provides the vibrations that occur as a result of the rotation of the drum (4) to be decreased (Figure 1, Figure 2).

[0035] In the washing machine (1) of the present invention, the vibration damper (5) comprises a receptacle (6), at least two electromagnets (7) placed in the receptacle (6) so as to face each other and such that a distance remains therebetween and a balancing member (8) situated between the electromagnets (7) and which displaces with the effect of the magnetic field created by the electromagnets (7). When the vibration damper (5) is desired to be activated, voltage is sent to the electromagnets (7) and the electromagnets (7) are provided to be magnetized. The electromagnets (7) apply pushing force to the balancing member (8) disposed therebetween.
The mass of the balancing member (8) is selected by taking into consideration the features, operation frequency and capacity of the components of the washing machine (1) such as the drum (4), the tub (3) and the body (2). When the washing machine (1) starts to vibrate, the balancing member (8) starts to move between the electromagnets (7) and moves closer to the electromagnet (7) in the direction where the vibration is greatest. Since, as the distance between the electromagnet (7) and the balancing member (8) decreases, the pushing force therebetween increases, the balancing member (8) shows a behavior similar to the spring characteristics between the electromagnets (7) and provides the vibration to be damped.

[0036] When the vibration damper (5) is desired to be deactivated, voltage is supplied to only one of the electromagnets (7) and the balancing member (8) is provided to stick on that electromagnet (7). In this situation, the balancing member (8) and the electromagnet (7) move as a single mass and do not perform vibration damping.

[0037] In an embodiment of the present invention, the vibration damper (5) comprises two electromagnets (7) and can damp vibrations in a single direction. In this embodiment, the balancing member (8), which is disposed between the two electromagnets (7) situated oppositely, moves as a spring which oscillates in the linear direction when the vibration damper (5) is activated. The vibration damper (5) of this configuration can damp vibrations only in the direction at which it is placed. When vibration damping in more than one direction is desired to be realized, a great number of vibration dampers (5) can be placed in various regions of the tub (3) and/or the body (2) in different directions (Figure 3, Figure 4, Figure 5, Figure 6).

[0038] In another embodiment of the present invention, the vibration damper (5) comprises four electromagnets (7) and can damp vibrations in two different directions. The electromagnets (7) are placed in two pairs facing each other in the horizontal and vertical directions. The balancing member (8) is situated in the middle of the electromagnets (7). The vibration damper (5) of this configuration can damp vibration in two directions and is
preferably placed at the periphery of the tub (3) symmetrically (Figure 7, Figure 8, Figure 9).

[0039] In another embodiment of the present invention, the vibration damper (5) comprises six electromagnets (7) and can damp vibrations in three different directions. In this embodiment, not only the vibrations in the horizontal and vertical directions but also the vibrations in the direction of the axis of the washing machine (1) can be damped.

[0040] In an embodiment of the present invention, the balancing member (8) is a permanent magnet. In this embodiment, while the balancing member (8) is placed between the electromagnets (7), the directions of the poles are selected so as to be subjected to the pushing force by the electromagnets (7).

[0041] In another embodiment of the present invention, the balancing member (8) is a metal block. In this embodiment, the balancing member (8) can be placed between the electromagnets (7) without taking any pole direction into consideration.

[0042] In an embodiment of the present invention, the vibration damper (5) is activated when a predetermined rotation speed is reached. The rotation speed at which the washing machine (1) enters in resonance is determined in advance and voltage is supplied to the electromagnets (7) when this speed is reached. The rotation speed of the drum (4) is detected by means of the tachogenerator on the motor that rotates the drum (4). The voltage supplied to the electromagnets (7) is cut off after the washing machine (1) passes the natural frequency value.

[0043] In another embodiment of the present invention, the washing machine (1) comprises a vibration gauge (10) situated on the tub (3) and a control unit (9) which adjusts the magnitude of the voltage to be supplied to the electromagnets (7) according to the data received from the vibration gauge (10). In this embodiment, the vibration gauge (10) is placed on the tub (3) and detects the vibration of the tub (3) and transmits that data to the control unit (9). The control unit (9) provides the voltage, which is suitable for the data received from the vibration gauge (10), to be calculated and sent to electromagnets (7). The electromagnets (7) supplied by voltage
apply a magnetic pushing force to the balancing member (8) disposed therebetween, thus providing the vibration to be damped. By means of this embodiment, the vibrations can be damped in an active manner (Figure 10).

[0044] In a version of this embodiment, the control unit (9) activates the vibration damper (5) at the vibrations above a predetermined value. A vibration value, which does not damage the washing machine (1) and does not disturb the user, is predetermined and recorded in the control unit (9). The control unit (9), which evaluates the data received from the vibration gauge (10), activates the vibration damper (5) only when the said value is exceeded. Thus the vibration damper (5) is prevented from operating when vibration damping is not necessary and thus energy saving is obtained.

[0045] In another embodiment of the present invention, the control unit (9) supplies a voltage, the magnitude of which is predetermined, to the electromagnets (7) for each rotation speed. The vibration that the washing machine (1) creates at each rotation speed and the voltage to be supplied to the electromagnets (7) for damping this vibration are calculated in advance and recorded in the memory of the control unit (9). During the operation of the washing machine (1), the motor rotation speed is detected by means of the tachogenerator and the vibration is provided to be damped by supplying to the electromagnets (7) the voltage that corresponds to this value. Thus, an effective damping is obtained throughout the whole washing program.

[0046] In an embodiment of the present invention, the vibration damper (5) is placed on the tub (3). Thus the vibration damper (5) increases the mass of the tub (3) and provides the natural frequency thereof to decrease.

[0047] In another embodiment of the present invention, the washing machine (1) comprises a balance weight (11) placed on the tub (3) and which provides the natural frequency thereof to decrease by increasing the mass of the tub (3) and a vibration damper (5) placed on the balance weight (11). By means of the balance weight (11), the natural frequency of the washing machine (1) is decreased and thus the maximum vibration amplitude is
decreased. Thus a lighter balancing member (8) can be selected to be disposed in the vibration damper (5) and accordingly the electromagnets (7) are supplied with a lower voltage. This provides less energy to be consumed (Figure 11).

[0048] By means of the present invention, the vibrations that occur in certain steps of the washing program are decreased and these vibrations are prevented from damaging the components of the washing machine (1) in long term. Consequently, both the malfunction ratio is decreased and the lifespan of the washing machine (1) is extended. Moreover customer satisfaction is provided by minimizing the operation sound heard by the user and preventing the washing machine (1) from moving.

[0049] It is to be understood that the present invention is not limited to 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 body (2), a tub (3) situated in the body (2), a drum (4) mounted into the tub (3) so as to rotate around an axis and wherein the laundry is loaded and at least one vibration damper (5) which provides the vibrations that occur as a result of the rotation of the drum (4) to be decreased and characterized by the vibration damper (5) having a receptacle (6), at least two electromagnets (7) placed in the receptacle (6) so as to face each other and such that a distance remains therebetween and a balancing member (8) situated between the electromagnets (7) and which displaces with the effect of the magnetic field created by the electromagnets (7).

2. A washing machine (1) as in Claim 1, characterized by the vibration damper (5) comprising two electromagnets (7) and which can damp vibrations in a single direction.

3. A washing machine (1) as in Claim 2, characterized by the vibration damper (5) placed in the body (2).

4. A washing machine (1) as in Claim 1, characterized by the vibration damper (5) comprising four electromagnets (7) and which can damp vibrations in two different directions.

5. A washing machine (1) as in Claim 1, characterized by the vibration damper (5) comprising six electromagnets (7) and which can damp vibrations in three different directions.

6. A washing machine (1) as in any one of the above claims, characterized by the balancing member (8) which is a magnet.

7. A washing machine (1) as in any one of the Claims 1 to 5, characterized by the balancing member (8) which is a metal block.

8. A washing machine (1) as in any one of the above claims, characterized by the vibration damper (5) that is activated when the predetermined rotation speed is reached.

9. A washing machine (1) as in any one of the Claims 1 to 7, characterized by a vibration gauge (10) situated on the tub (3) and a control unit (9) which adjusts the magnitude of the voltage to be supplied to the electromagnets (7) according to the data received from the voltage gauge (10).
10. A washing machine (1) as in Claim 9, characterized by the control unit (9) which activates the vibration damper (5) for the vibrations above a predetermined value.

11. A washing machine (1) as in any one of the Claims 1 to 7, characterized by the control unit (9) which supplies a voltage, the magnitude of which is predetermined, to the electromagnets (7) for each rotation speed.

12. A washing machine (1) as in any one of the Claims 1 to 2 and the Claims 4 to 11, characterized by the vibration damper (5) placed on the tub (3).

13. A washing machine (1) as in any one of the Claims 1 to 2 and the Claims 4 to 12, characterized by a balance weight (11) placed on the tub (3) and which provides the natural frequency thereof to decrease by increasing the mass of the tub (3) and the vibration damper (5) placed on the balance weight (11).
### A. CLASSIFICATION OF SUBJECT MATTER

**INV. D06F37/20**

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 practicable, search terms used):

**EPO-Internal**

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>EP 2 072 653 AI (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 24 June 2009 (2009-06-24) cited in the application on figures 1,5,8, 13,15</td>
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<td>JP 2003 144792 A (HITACHI LTD) 20 May 2003 (2003-05-20) abstract</td>
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**X** Further documents are listed in the continuation of Box C.  
**X** See patent family annex.

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Date of the actual completion of the international search:

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Name and mailing address of the ISA:

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