DAMPER FOR DAMPING VIBRATION AND WASHING MACHINE HAVING THE SAME

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ABSTRACT

A damper for damping vibration and a washing machine having the same are disclose. The damper includes a damper cylinder; a shaft inserted into the damper cylinder through one end of the damper cylinder, and reciprocating in the lengthwise direction of the damper cylinder; and a friction member provided on the shaft for damping vibration generated by friction with the inner wall of the damper cylinder, and moving vertically to the lengthwise direction of the damper cylinder. The damper adjusts damping force thereof according to vibrated states of an object to be vibrated, and has an improved vibration-damping effect.
FIG. 2

![Graph showing vibration vs spin speed with lines for low and high damping forces.]

FIG. 3

![Graph showing TR force vs spin speed with lines for low and high damping forces.]

- Damping force (Low)
- Damping force (High)
DAMPER FOR DAMPING VIBRATION AND WASHING MACHINE HAVING THE SAME


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a damper for damping vibration, and more particularly, to a damper, the damping force of which is adjustable, and a washing machine having the same.

[0004] 2. Discussion of the Related Art

[0005] Generally, a washing machine performs washing, rinsing, and dehydrating operations by filling the lower portion of the inside of a tub with water and detergent, placing laundry in a drum installed in the tub, and rotating the drum.

[0006] Such a washing machine is an apparatus for eliminating dirt from laundry using proper detergent and mechanical force.

[0007] Accordingly, the washing machine usually comprises a cabinet forming an external appearance, an outer tub provided in the cabinet for containing washing water, and an inner tub rotatably provided in the outer tub for containing laundry.

[0008] Particularly, a washing machine in which a rotary shaft of the outer tub is approximately horizontal with the ground is referred to as a drum washing machine.

[0009] With reference to FIG. 1, the drum washing machine is an apparatus for eliminating dirt from laundry by rotating a drum using the driving force of a motor under the condition that detergent, washing water and laundry are placed in the drum installed horizontally with the bottom of a cabinet. The drum washing machine minimizes entanglement of the laundry and damage to the laundry, consumes a small quantity of the washing water, and has laundry-beating and rubbing effects.

[0010] More specifically, the drum washing machine comprises the cabinet 10 forming an external appearance, a tub 20 provided in the cabinet 10, and the drum 30 rotatably provided in the tub 20.

[0011] Here, an opening for placing the laundry in the cabinet 10 is formed through the front surface of the cabinet 10, and a door 11 for opening and closing the opening is installed at the opening.

[0012] A rotating device 40, such as a motor, for rotating the drum 30 is installed in the rear of the tub 20.

[0013] The tub 20 is horizontally installed in the cabinet 10 by suspension springs 50 for connecting the ceiling of the cabinet 10 and the upper part of the tub 20, and a damper 60 for connecting the bottom of the cabinet 10 and the lower part of the tub 20 is installed on the lower part of the cabinet 10.

[0014] The damper 60 is a unit for damping the vibration of the tub 20 generated due to the rotation of the drum 30. The damper 60 usually comprises a damper cylinder having a cylindrical shape, a shaft inserted into the damper cylinder and reciprocating, and a friction member fixed to the shaft.

[0015] Here, the friction member reduces the vibration of the tub 20 by means of the friction with the damper cylinder.

[0016] The above drum washing machine sequentially or selectively performs washing, rinsing, and dehydrating operations, thereby washing the laundry.

[0017] When the dehydrating operation of the drum washing machine is started, the drum 30 is rotated at a high speed by the rotating device 40, thus dehydrating the laundry.

[0018] In an initial stage of the dehydrating operation, i.e., in the initial driving of the rotating device 40 and the drum 30, the tub 20 is excessively vibrated (hereinafter, referred to as “excessively vibrated state”).

[0019] As the spin speeds of the rotating device 40 and the drum 30 are gradually increased, the vibration of the tub 20 is gradually decreased.

[0020] Thereafter, when the rotating device 40 and the drum 30 reach normal spin speeds, the vibration of the tub 20 is greatly decreased compared to the initial stage of the dehydrating operation, and is stabilized to reach a normally vibrated state.

[0021] The shaft of the damper 60 reciprocates in the lengthwise direction of the damper cylinder in the damper cylinder by means of the vibration of the tub 20, and the friction member reciprocates together with the reciprocation of the shaft and rubs against the inner wall of the damper cylinder.

[0022] The vibration of the tub 20 is damped by the frictional force between the friction member and the damper cylinder.

[0023] Hereinafter, the relation between the number of vibration of the tub and the spin speed of the drum and the relation between the vibration-transmitting force (hereinafter, referred to as TR force) of the damper and the spin speed of the drum according to variation of the damping force of the damper will be described with reference to FIGS. 2 and 3.

[0024] Here, FIG. 2 is a graph illustrating the relation between the number of vibration of the tub and the spin speed of the drum according to variation of the damping force, and FIG. 3 is a graph illustrating the relation between the TR force of the damper and the spin speed of the drum according to variation of the damping force.

[0025] With reference to FIG. 2, when the spin speed of the drum 30 is less than a designated value (e.g., in the initial stage of the dehydrating operation, the tub 20 to which a damper having a high damping force is applied and the tub 20 to which a damper having a low damping force are vibrated as illustrated in the graph of FIG. 2. The numbers of vibration of the tubs 20 are approximately the same after the excessively vibrated state, i.e., in the normally vibrated state, regardless of the damping forces of the dampers.

[0026] Further, with reference to FIG. 3, when the dehydrating operation is continued so that the number of rotation
of the motor, i.e., the number of rotation of the drum 30, is increased more than a designated value (ω₀), the tub 20 reaches the normally vibrated state.

[0027] When the tub 20 is supported by the damper having a low damping force in the normally vibrated state of the tub 20, the TR force transmitted to a main body of the washing machine by the damper having the low damping force is maintained less than a designated degree. On the other hand, when the tub 20 is supported by the damper having a high damping force, the TR force is increased as time goes by, thereby continuously increasing the vibration and noise.

[0028] Thus, in the excessively vibrated state of the tub, i.e., in the initial stage of the dehydrating operation, the damper having the high damping force is advantageous to damp the vibration and the noise. Further, in the normally vibrated state of the tub, the damper having the low damping force is advantageous.

[0029] Accordingly, the development of a damper for efficiently damping vibration using damping force varying according to a degree of the vibration of an object to be vibrated, such as a tub of a washing machine, has been required.

SUMMARY OF THE INVENTION

[0030] Accordingly, the present invention is directed to a damper for damping vibration and a washing machine having the same substantially obviating one or more problems due to limitations and disadvantages of the related art.

[0031] An object of the present invention is to provide a damper having a structure for minimizing the transmission of vibration and a washing machine having the same.

[0032] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0033] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a damper includes a damper cylinder; a shaft inserted into the damper cylinder through one end of the damper cylinder, and reciprocating in the lengthwise direction of the damper cylinder; and a friction member provided on the shaft for damping vibration by friction with the inner wall of the damper cylinder, and moving vertically to the lengthwise direction of the damper cylinder.

[0034] Preferably, the shaft may include a frictional force-adjusting device for moving the friction member to adjust the frictional force between the friction member and the inner wall of the damper cylinder.

[0035] More preferably, the frictional force-adjusting device may include a pressure unit for pressing the friction member to move the friction member towards the inner wall of the damper cylinder to a designated distance.

[0036] The pressure unit includes a first pressure member; a second pressure member provided at one side of the first pressure member, and positioned opposite to the first pressure member; and an interval adjuster for moving at least one of the first and second pressure members in the axial direction of the shaft in order to move the friction member.

[0037] When the first and second pressure members are close to each other, the frictional force between the friction member and the inner wall of the damper cylinder is increased.

[0038] For this reason, the first and second pressure members are disposed in the axial direction of the shaft, and at least one of the first and second pressure members includes at least one inclined portion inwardly inclined towards the other one of the first and second pressure members.

[0039] For example, the side surface of at least one of the first and second members is inclined such that the cross sectional area thereof is decreased close to the other one of the first and second members.

[0040] Preferably, the pressure unit may further include at least one slip member provided in the friction member to correspond to the inclined portion, and moving outwardly along the inclined portion to press the friction member when the first and second pressure members are close to each other.

[0041] The friction member moves towards the center of the shaft and is separated from the inner wall of the damper cylinder when the first and second pressure members are distant from each other.

[0042] Preferably, the slip member may include an elastic member for returning the friction member to the center of the shaft when the first and second pressure members are distant from each other.

[0043] The elastic member has a ring-shape, and is provided on the outer cylindrical surface of the slip member.

[0044] In the case that the pressure unit includes a plurality of slip members, the pressure unit may further include guide ribs provided on the outer cylindrical surface of at least one of the first and second pressure members for preventing the concentrated movement of the slip members in the circumferential direction.

[0045] The interval adjuster moves the second pressure member.

[0046] The interval adjuster includes at least one connection rod passing through the first pressure member fixed to a body of the shaft, and connected to the second pressure member; and a driving unit for driving the connection rod to move the second pressure member.

[0047] The driving unit rectilinearly may move the connection rod to move the second pressure member.

[0048] The driving unit includes an electromagnet provided at the other side of the first pressure member for rectilinearly moving the connection rod using magnetic force so that the second pressure member moves towards the first pressure member when current flows.

[0049] The connection rod includes a metal member provided between the first pressure member and the electromagnet.
The driving unit includes a wire connected to the connection rod; and an actuator connected to the wire.

The driving unit includes a motor for rotating the connection rod, and the second pressure member rectilinearly moves by the rotation of the connection rod.

The connection rod passes through the second pressure member, and is connected to the second pressure member by screws.

The pressure unit may further include a guide pin, one end of which is inserted into the first pressure member and the other end of which is inserted into the second pressure member, for guiding the movement of the second pressure member.

Alternately, the interval adjuster may include an electromagnet provided on the first pressure member; a metal member provided on the second pressure member; and a guide rod passing through the second pressure member for guiding the movement of the second pressure member.

Preferably, the guide rod may include a stopper, one end of which is connected to one side of the electromagnet and the other end of which prevents the second pressure member from being separated from the guide rod.

The friction member may have a ring shape surrounding the outer cylindrical surface of the shaft.

Further, preferably, the friction member may be made of an elastic material.

The friction member contacts the inner wall of the damper cylinder when the number of vibration of an object to be vibrated is more than a designated value, and is separated from the inner wall of the damper cylinder when the number of vibration of the object is less than the designated value.

The frictional force between the friction member and the inner wall of the damper cylinder when the spin speed of an object for generating vibration is more than a designated speed is lower than that when the spin speed of the object is less than the designated speed.

One of the damper cylinder and the shaft is connected to a tub of a washing machine, and the other one of the damper cylinder and the shaft is connected to a cabinet of the washing machine.

It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

**FIG. 1** is a schematic sectional view of a conventional drum washing machine;

**FIG. 2** is a graph illustrating the relation between the number of vibration of a tub and the spin speed of a drum according to variation of damping force;

**FIG. 3** is a graph illustrating the relation between the IR force of a damper and the spin speed of the drum according to variation of damping force;

**FIG. 4** is a sectional view of a damper in accordance with a first embodiment of the present invention;

**FIGS. 5A and 5B** are a partial and longitudinal sectional view and a transversal sectional view illustrating a friction member of the damper shown in **FIG. 4**, which is separated from the inner wall of a damper cylinder;

**FIGS. 6A and 6B** are a partial and longitudinal sectional view and a transversal sectional view illustrating the friction member of the damper shown in **FIG. 4**, which contacts the inner wall of the damper cylinder;

**FIG. 7** is a sectional view of one embodiment of a pressure unit of the damper of the present invention;

**FIG. 8** is a perspective view of another embodiment of the pressure unit of the damper of the present invention;

**FIGS. 9A and 9B** are sectional views of a damper in accordance with a second embodiment of the present invention;

**FIGS. 10A and 10B** are sectional views of a damper in accordance with a third embodiment of the present invention; and

**FIGS. 11A and 11B** are sectional views of a damper in accordance with a fourth embodiment of the present invention.

**DETAILED DESCRIPTION OF THE INVENTION**

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

First, with reference to **FIGS. 4 to 8**, a damper in accordance with a first embodiment of the present invention will be described.

Here, **FIG. 4** is a sectional view of the damper in accordance with the first embodiment of the present invention. **FIGS. 5A and 5B** are a partial and longitudinal sectional view and a transversal sectional view illustrating a friction member of the damper shown in **FIG. 4**, which is separated from the inner wall of a damper cylinder. **FIGS. 6A and 6B** are a partial and longitudinal sectional view and a transversal sectional view illustrating the friction member of the damper shown in **FIG. 4**, which contacts the inner wall of the damper cylinder. **FIG. 7** is a sectional view of another embodiment of a pressure unit of the damper of the present invention. **FIG. 8** is a perspective view of yet another embodiment of the pressure unit of the damper of the present invention.
The damper of the present invention, which will be described hereinafter, may be applied to general washing machines or apparatuses generating vibration as well as the above drum washing machine. In the following description of the present invention, a detailed description of known functions and configurations of a washing machine, to which the damper of the present invention is applied, will be omitted, and the same or similar elements of the washing machine are denoted by the same reference numerals as those of the conventional washing machine using a damper.

First, with reference to FIG. 4, the damper 600 in accordance with the first embodiment of the present invention comprises a damper cylinder 610, a shaft 620 inserted into the damper cylinder 610, and a friction member 630 provided on the shaft 620.

The damper cylinder 610 has a hollow cylindrical structure. One end of the shaft 620 is inserted into an opened end of the damper cylinder 610, and the shaft 620 reciprocates in the lengthwise direction of the damper cylinder 610 when the tub 20 is vibrated.

Here, the other end of the damper cylinder 610 is connected to the lower part of the tub 20, and the other end of the shaft 620 is connected to the bottom of the cabinet 10 to absorb the vibration generated from the tub 20.

Alternately, the other end of the damper cylinder 610 may be connected to the bottom of the cabinet 10, and the other end of the shaft 620 may be connected to the lower part of the tub 20.

Hereinafter, for convenience of description, the damper 600 provided with an upper portion 610a connected to the lower part of the tub 20 and a lower portion 610b connected to the bottom of the cabinet 10 will be described.

The friction member 630 is movable vertically to the lengthwise direction of the damper cylinder 610, and damp the vibration of the tub 20 by the friction with the inner wall of the damper cylinder 610.

Accordingly, the shaft 620 includes a frictional force-adjusting device for adjusting the frictional force between the friction member 630 and the inner wall of the damper cylinder 610 by moving the friction member 630.

With reference to FIGS. 5A and 5B and FIGS. 6A and 6B, the frictional force-adjusting device will be described in more detail, as follows. The frictional force-adjusting device of the damper 600 of the first embodiment includes a pressure unit 640 for pressing the friction member 630 towards the inner wall of the damper cylinder 610 to move the friction member 630 by a designated distance towards the inner wall of the damper cylinder 610.

In this embodiment, the pressure unit 640 includes a first pressure member 641, a second pressure member 642 provided at one side of the first pressure member 641, and an interval adjustor for adjusting the interval between the first pressure member 641 and the second pressure member 642.

The first pressure member 641 is provided on one end of the shaft 620, i.e., the upper end of the shaft 620, and the second pressure member 642 is provided above the first pressure member 641 such that the second pressure member 642 is positioned opposite to the first pressure member 641. Accordingly, the first pressure member 641 and the second pressure member 642 are disposed in the axial direction of the shaft 620, i.e., the longitudinal direction.

The interval adjustor moves at least one of the first pressure member 641 and the second pressure member 642 in the axial direction of the shaft 620 to adjust the interval between the first pressure member 641 and the second pressure member 642, thereby causing the friction member 630 to contact the inner wall of the damper cylinder 610 with designated force.

In this embodiment, the first pressure member 641 is fixed to a body of the shaft 620, and the second pressure member 642 is installed on the body of the shaft 620 such that the second pressure member 642 moves vertically. Thereby, when the first pressure member 641 and the second pressure member 642 are close to each other, the frictional force between the friction member 630 and the inner wall of the damper cylinder 610 is increased.

Alternately, the second pressure member 642 may be fixed to the body of the shaft 620, and the first pressure member 641 may be installed on the body of the shaft 620 such that the first pressure member 641 moves vertically.

Although this embodiment illustrates the first pressure member 641 and the second member 642, which are provided on the upper end of the body of the shaft 620, the positions of the first pressure member 641 and the second member 642 are not limited thereto.

At least one of the first pressure member 641 and the second pressure member 642 includes at least one inclined portion inwardly inclined towards the other one of the first pressure member 641 and the second pressure member 642.

For example, a plurality of inclined portions, which are inwardly inclined from the lower part of the first pressure member 641 to the upper part of the first pressure member 641, may be formed on the side surface of the first pressure member 641 such that the inclined portions are spaced by the same interval in the circumferential direction. A plurality of inclined portions having symmetrical shapes to those of the inclined portions of the first pressure member 641 may be formed on the side surface of the second pressure member 642.

In this embodiment, the first pressure member 641 has a shape such that the cross sectional area of the first pressure member 641 is decreased from the lower portion of thereof to the upper portion thereof on which the second pressure member 642 is provided, and has a side surface inwardly inclined from the lower portion thereof to the upper portion thereof. The second pressure member 642 is symmetrical with the first pressure member 641. Accordingly, inclined portions 641a and 642a are respectively formed on the side surfaces of the first and second pressure members 641 and 642.

Although not shown in the drawings, only one of the first pressure member 641 and the second pressure member 642 may have the above shape.

Here, the vertical cross sections of the inclined portions 641 and 642 may have various shapes, such as rectilinear and concave shapes. FIG. 7 illustrates one embodiment of the pressure unit including first and second
pressure members 741 and 742 having inclined portions 741a and 742a, the vertical cross sections of which have concave shapes.

[0099] Preferably, at least one slip member 643 for moving the friction member 630 outwardly so that the inclined portion 641a of the first pressure member 641 corresponds to the inclined portion 642a of the second pressure member 642 is provided in the friction member 630.

[0100] Each of the slip members 643 includes upper inclined planes corresponding to the inclined portions 642a of the second pressure member 642 and lower inclined planes corresponding to the inclined portions 641a of the first pressure member 641.

[0101] Accordingly, when the first pressure member 641 and the second pressure member 642 are close to each other, the lower and upper inclined planes of the slip members 643 are pressed by the inclined portions 641a of the first pressure member 641 and the inclined portions 642a of the second pressure member 642.

[0102] More specifically, when the first pressure member 641 and the second pressure member 642 are close to each other, the lower and upper inclined planes of the slip members 643 along the inclined portions 641a of the first pressure member 641 and the inclined portions 642a of the second pressure member 642.

[0103] Thereby, the slip members 643 outwardly move towards the inner wall of the damper cylinder 610, and press the inner surface of the friction member 630, thereby causing the friction member 630 to contact the inner wall of the damper cylinder 610 with designated force.

[0104] Preferably, the inclined portions 641a of the first pressure member 641, the inclined portions 642a of the second pressure member 642, and the upper and lower inclined planes of the slip members 643 are made of a material having a smoother surface than the friction member 630 and the inner wall of the damper cylinder 610.

[0105] When the first pressure member 641 and the second pressure member 642 are distant from each other, i.e., when the second pressure member 642 moves upwardly, it is preferable that the friction member 630 moves towards the center of the shaft 620. Thereby, the friction force between the friction member 630 and the inner wall of the damper cylinder 610 is gradually decreased, and thus the damping force of the damper 600 is reduced.

[0106] Preferably, at least one slip member 643 includes an elastic member 643e for returning the friction member 630 towards the center of the shaft 620 when the first pressure member 641 and the second pressure member 642 are distant from each other.

[0107] For example, the elastic member 643e may be a metal spring having a ring shape or a rubber band provided on the outer cylindrical surface of the slip member 643.

[0108] A groove 643f is formed in the outer cylindrical surface of the slip member 643 in the circumferential direction, and the ring-shaped elastic member 643e is inserted into the groove 643f.

[0109] When a plurality of the slip members 643 are provided in the friction member 630, as shown in FIG. 8, guide ribs 641b for preventing the concentrated movement of the slip members 643 in the circumferential direction are formed in the outer cylindrical surface of at least one of the first pressure member 641 and the second pressure member 642.

[0110] Preferably, the guide ribs 641b are separated from each other in the circumferential direction by the same interval. Thereby, it is possible to maintain the proper interval between the slip members 643.

[0111] The friction members 630 pressed and moved by the slip members 643 may be prepared in the same number as that of the slip members 643, or may be one ring-shaped elastic member surrounding the outer cylindrical surface of at least one slip member 643 as described in this embodiment.

[0112] The interval adjuster of the damper of the first embodiment, as described above, moves the second pressure member 642 towards the first pressure member 641.

[0113] For this reason, the interval adjuster includes connection rods 644 passing through the first pressure member 641 and vertically moving, and a driving unit for driving the connection rods 644.

[0114] Upper ends of the connection rods 644 are connected to the second pressure member 642, and vertically move along guide holes 641c formed through the first pressure member 641. When the connection rods 644 rectilinearly move downwardly or upwardly, the second pressure member 642 moves downwardly or upwardly.

[0115] Accordingly, the friction member 630 is pressed by the slip members 643, and moves towards the inner wall of the damper cylinder 610 or in the opposite direction. Thereby, the frictional force between the friction member 630 and inner wall of the damper cylinder 610 is adjusted.

[0116] In this embodiment, the driving unit of the interval adjuster moves the connection rods 644 by magnetic force.

[0117] More specifically, the driving unit includes an electromagnet 645 provided below the first pressure member 641.

[0118] The electromagnet 645 rectilinearly moves the connection rods 644 downwardly using magnetic force so that the second pressure member 642 moves towards the first pressure member 641 when current flows.

[0119] For this reason, the electromagnet 645 includes a core 645a installed on the upper part of the shaft 620, a bobbin 645b installed outside the core 645a, and a coil (not shown) wound on the bobbin 645b several times. When current is applied to the electromagnet 645 to generate magnetic force, the connection rods 644 are attracted downwardly by the magnetic force of the electromagnet 645.

[0120] Preferably, each of the connection rods 644 includes a metal member 644a formed at the lower end thereof between the first pressure member 641 and the electromagnet 645.

[0121] The first pressure member 641 is fixed to the core 645a. More specifically, the first pressure member 641 includes a fixing rod 641f, which passes through the metal members 644a of the connection rods 644 and is provided with the lower end connected to the core 645a.
The friction member 630 selectively contacts the inner wall of the damper cylinder 610 by the above-described frictional force-adjusting device.

That is to say, when the tub 20 is in the excessively vibrated state, the friction member 630 contacts the inner wall of the damper cylinder 610 so as to increase the damping force of the damper 600. Then, when the tub 20 reaches the normally vibrated state, the friction member 630 is separated from the inner wall of the damper cylinder 610 so as to decrease the damping force of the damper 600.

Hereinafter, a process for damping the vibration of a washing machine using the above damper of the present invention will be described.

First, when the washing machine is operated, the rotating device 40 rotates the drum 30, and laundry is washed by the rotation of the drum 30.

Then, the tub 20 is vibrated by the rotation of the rotating device 40 and the drum 30.

Here, the vibration of the tub 20 is damped by the damper 600, and the transmission of the vibration of the tub 20 to the cabinet 10 is minimized.

When the dehydrating operation of the laundry is started, the tub 20 is excessively vibrated in the initial stage of the dehydrating operation.

In the excessively vibrated state of the tub 20, power is supplied to the electromagnet 645 to generate magnetic force, and the metal members 643a installed on the lower parts of the connection rods 644 move towards the electromagnet 645 by the magnetic force.

Simultaneously, the second pressure member 642 connected to the upper ends of the connection rods 644 move downwardly, and force is applied to the slip members 643 by the first pressure member 641 and the second pressure member 642 so that the slip members 643 move towards the inner wall of the damper cylinder 610.

Accordingly, the friction member 630 is pressed by the slip members 643, and contacts the inner wall of the damper cylinder 610, and the vibration of the tub 20 is damped by the frictional force between the friction member 630 and the inner wall of the damper cylinder 610.

When the dehydrating operation is continued for a designated time so that the spin speed of the drum 30 rotated by the motor 40 is more than a designated speed, the tub 20 reaches a normally vibrated state.

In the normally vibrated state of the tub 20, when the friction member 630 is pressed towards the inner wall of the damper cylinder 610 by the same force as that of the excessively vibrated state, the vibration of the tub 20 transmitted to the cabinet 10 of the washing machine through the damper 600 is more increased.

Accordingly, when the tub 20 reaches the normally vibrated state, power is not supplied to the electromagnet 645, thereby eliminating the magnetic force applied to the metal members 643a.

Thereby, the force for pressing the friction member 630 provided outside the slip members 643 is eliminated, and the slip members 643 are returned to the original positions towards the center of the shaft 620 by the elastic members 623 provided on the outer cylindrical surfaces of the slip members 643. Further, the friction member 630 elastically contracts, and moves to its original position, i.e., towards the center of the shaft 620.

That is to say, the friction member 630 is separated from the inner wall of the damper cylinder 610, a designated distance (t) is formed between the friction member 630 and the inner wall of the damper cylinder 610, and the TR force of the tub 20 to a structure of the washing machine, particularly, the cabinet 10, through the damper 600 is decreased. Thereby, the dehydrating operation is quietly and smoothly performed.

In order to operate the above damper 600 in the optimum state, preferably, a vibration sensing device (not shown) for sensing the vibration of the tub 20 and a control unit (not shown) for controlling the damper 600 according to the vibrated state of the tub 20 are installed at designated positions of the washing machine.

When the vibration sensing device senses the vibration of the washing machine and transmits a signal to the control unit, the control unit controls current supplied to the electromagnet 645, thereby adjusting the damping force of the damper 600.

Otherwise, an alternate method for adjusting the damping force of the damper 600 may be employed. In this method, a time taken to reach the normally vibrated state of the tub 20 is input in advance to the control unit. Before the tub 20 reaches the normally vibrated state, current is supplied to the electromagnet 645 so as to increase the damping force of the damper 600, and after the tub 20 reaches the normally vibrated state, current is not supplied to the electromagnet 645 so as to decrease the damping force of the damper 600.

Hereinafter, dampers in accordance with other embodiments of the present invention will be described with reference to FIGS. 9A to 11B.

Some parts of dampers in these embodiments, which are substantially the same as those of the damper in the first embodiment, are denoted by the same reference numerals even though they are depicted in different drawings, and a detailed description thereof will thus be omitted because it is considered to be unnecessary.

First, a damper 600c in accordance with the second embodiment of the present invention will be described with reference to FIGS. 9A and 9B.

With reference to FIGS. 9A and 9B, the damper 600c comprises a connection rod 744 passing through the first pressure member 641 and the second pressure member 642 and vertically moving.

For this reason, vertical guide holes (not shown) are respectively formed through central portions of the first and second pressure members 641 and 642.

Here, the diameter of the guide holes formed through the first and second pressure members 641 and 642 is larger than that of the connection rod 744.

The lower end of the connection rod 744 is connected to an actuator (not shown), and is connected to a wire 745 for drawing the connection rod 744 downwardly.
A head 744a having a diameter larger than that of the guide hole of the second pressure member 642 is formed on the upper end of the connection rod 744.

Accordingly, when the wire 745 draws the connection rod 744 by means of the driving of the actuator, the upper surface of the second pressure member 642 is pressed by the head 744a so that the second pressure member 642 moves downward.

Then, the slip members 643 are pressed by the first pressure member 641 and the second pressure member 642, slid outwardly along the inclined portions 641a and 642a of the first and second pressure members 641 and 642, and press the friction member 630 towards the inner wall of the damper cylinder 610.

The connection rod 744 may be fixed to the second pressure member 642. In this case, the connection rod 744 does not include the head 744a.

Other configurations and operating method of the damper 600a are substantially the same as those of the damper of the first embodiment, and a detailed description thereof will thus be omitted because it is considered to be unnecessary.

Hereinafter, a damper 600b in accordance with the third embodiment of the present invention will be described with reference to FIGS. 10A and 10B.

With reference to FIGS. 10A and 10B, the damper 600b comprises a connection rod 844 passing through the first pressure member 641 and connected to the second pressure member 642 in order to vertically move the second pressure member 642.

More specifically, the connection rod 844 vertically passes through the second pressure member 642.

For this reason, vertical guide holes (not shown) are respectively formed through central portions of the first and second pressure members 641 and 642.

Particularly, a female screw thread is formed in the guide hole of the second pressure member 642, and a male screw thread corresponding to the female screw thread is formed on the outer cylindrical surface of the connection rod 844. The female screw thread of the guide hole of the second pressure member 642 is engaged with the male screw thread of the outer cylindrical surface of the connection rod 844.

The connection rod 844 is rotated by a rotating device, such as a motor 845.

Although this embodiment illustrates the motor 845 provided below the first pressure member 641, the position of the motor 845 is not limited thereto. For example, the motor 845 may be fixed to the inside of the first pressure member 641.

Although the connection rod 844 is directly connected to a rotary shaft (not shown) of the motor 845, the connection method of the connection rod 844 is not limited thereto. For example, the connection rod 844 may be connected to the rotary shaft of the motor 845 by a belt.

In order to prevent the first pressure member 641 from being influenced by the connection rod 844 when the connection rod 844 is rotated by the motor 845, preferably, the diameter of the guide hole formed through the first pressure member 641 is larger than that of the connection rod 744.

The first pressure member 641 and the second pressure member 642 are connected by a guide pin 846, one end of which is inserted into the first pressure member 641 and the other end of which is inserted into the second pressure member 642.

For this reason, a first groove (not shown) having a designated depth, into which the lower end of the guide pin 846 is inserted, is formed in the upper surface of the first pressure member 641, and a second groove (not shown) having a designated depth, into which the upper end of the guide pin 846 is inserted, is formed in the lower surface of the second pressure member 642.

Preferably, the diameter of at least one of the first and second grooves is larger than that of the guide pin 846.

The guide pin 846 guides the vertical movement of the second pressure member 642, and simultaneously prevents the second pressure member 642 from being rotated together with the rotation of the connection rod 844.

Accordingly, when the connection rod 844 rotates in one direction, the second pressure member 642 is not rotated by the guide pin 846, but moves upwardly or downwardly, i.e., rectilinearly moves in the longitudinal direction of the damper cylinder 610.

As described in the damper of the first embodiment, the frictional force between the friction member 630 and the inner wall of the damper cylinder 610 is adjusted by the vertical movement of the second pressure member 642.

Other configurations and operating method of the damper 600b are substantially the same as those of the damper of the first embodiment, and a detailed description thereof will thus be omitted because it is considered to be unnecessary.

Hereinafter, a damper 600c in accordance with the fourth embodiment of the present invention will be described with reference to FIGS. 11A and 11B.

With reference to FIGS. 11A and 11B, the second pressure member 642 of the damper 600c moves by the magnetic force of an electromagnet 945, similarly to the damper 600 of the first embodiment.

More specifically, the damper 600c includes the electromagnet 945 provided on the first pressure member 641, and a first metal member 946 provided on the second pressure member 642.

Here, the electromagnet 945 passes through the first pressure member 641 so that the surface of the upper end of the electromagnet 945 coincides with the surface of the upper end of the first pressure member 641.

The electromagnet 945 includes a core 945a installed on a body of the shaft 620, a bobbin 945b installed outside the core 945a, and a coil (not shown) wound on the bobbin 945b several times.

Although the core 945a of the damper 600c of this embodiment is fixed to the upper end of the body of the shaft 620, the position of the core 945a is not limited thereto.
[0174] The electromagnet 945 further includes a second metal member 945c surrounding the outer cylindrical surface of the bobbin 945b provided with the coil wound thereon.

[0175] The second metal member 945c uniformly distributes the magnetic force generated when current flows along the coil, and improves the magnetic force of the electromagnet 945.

[0176] The first metal member 946 serves to move the second pressure member 642 towards the first pressure member 641 when current flows along the electromagnet 945.

[0177] For this reason, preferably, the first metal member 946 is fixed to the second pressure member 642. More preferably, the first metal member 946 is fixed to the lower part of the second pressure member 642.

[0178] In order to guide the vertical movement of the second pressure member 642 according to the supply of current to the electromagnet or cut-off of the supply of current, a guide rod 944, which passes through the second pressure member 642 so that one end of the guide rod 944 is connected to one end of the electromagnet 945, is provided.

[0179] More specifically, the guide rod 944 vertically passes through the central portion of the second pressure member 642 so that the lower end of the guide rod 944 is fixed to the core 945a of the electromagnet 945.

[0180] In order to smoothly move the second pressure member 642, preferably, a guide hole, through which the guide rod 944 passes, is formed through the second pressure member 642. Here, the guide hole has a larger diameter than that of the guide rod 944.

[0181] Preferably, a stopper 944z for preventing the separation from the second pressure member 642 is formed on the guide rod 944.

[0182] The stopper 944z is provided on the other end of the guide rod 944, i.e., the upper end of the guide rod 944, and has a larger diameter than that of the guide hole.

[0183] Accordingly, when the supply of current to the electromagnet 945 is cut off, the second pressure member 642 is distant from the first pressure member 641 by force applied to the friction member 630, and a designated distance between the second pressure member 642 and the first pressure member 641 is maintained by the stopper 944z. That is, the second pressure member 642 moves upwardly to a designated distance, and is then stopped by the stopper 944z.

[0184] Other configurations and operating method of the damper 600c are substantially the same as those of the damper of the first embodiment, and a detailed description thereof will thus be omitted because it is considered to be unnecessary.

[0185] Although the above embodiments illustrate the friction member separated from the inner wall of the damper cylinder in the normally vibrated state of the tub, the position of the friction member is not limited thereto.

[0186] That is, according to vibration characteristics of an object to be vibrated, the friction member may contact the inner wall of the damper cylinder by a small force in the normally vibrated state of the object rather than in the excessively vibrated state of the object.

[0187] Effects of the damper of the present invention will be described, as follows.

[0188] First, the damper of the present invention adjusts the damping force thereof according to the vibration degree of an object to be vibrated and/or the number of rotation of the object, thereby improving a vibration-damping effect and a noise-preventing effect.

[0189] Second, the damper of the present invention decreases the transmission of the vibration of the object, thereby preventing peripheral components from being damaged.

[0190] Third, the damper of the present invention has the simple configuration of a pressure unit for pressing a friction member, thereby being easily manufactured.

[0191] Fourth, the damper of the present invention does not require a power device for reducing the damping force of the damper, thereby reducing production costs.

[0192] Fifth, the damper of the present invention reduces or eliminates frictional force between a damper cylinder and the friction member in the normally vibrated state of a tub, thereby lengthening the life span of the friction member.

[0193] It will be apparent to those skilled in the art that various modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:
1. A damper comprising:
   a damper cylinder;
   a shaft inserted into the damper cylinder through one end of the damper cylinder, and reciprocating in the lengthwise direction of the damper cylinder; and
   a friction member provided on the shaft for damping vibration by friction with the inner wall of the damper cylinder, and moving vertically to the lengthwise direction of the damper cylinder.
2. The damper as set forth in claim 1, wherein the shaft includes a frictional force-adjusting device for moving the friction member to adjust the frictional force between the friction member and the inner wall of the damper cylinder.
3. The damper as set forth in claim 2, wherein the frictional force-adjusting device includes a pressure unit for pressing the friction member to move the friction member towards the inner wall of the damper cylinder to a designated distance.
4. The damper as set forth in claim 3, wherein the pressure unit includes:
   a first pressure member;
   a second pressure member provided at one side of the first pressure member, and positioned opposite to the first pressure member; and
an interval adjuster for moving at least one of the first and second pressure members in the axial direction of the shaft in order to move the friction member.

5. The damper as set forth in claim 4, wherein, when the first and second pressure members are close to each other, the frictional force between the friction member and the inner wall of the damper cylinder is increased.

6. The damper as set forth in claim 4, wherein the first and second pressure members are disposed in the axial direction of the shaft, and at least one of the first and second pressure members includes at least one inclined portion inwardly inclined towards the other one of the first and second pressure members.

7. The damper as set forth in claim 6, wherein the side surface of at least one of the first and second members is inclined such that the cross sectional area thereof is decreased close to the other one of the first and second members.

8. The damper as set forth in claim 6, wherein the pressure unit further includes at least one slip member provided in the friction member to correspond to the inclined portion, and moving outwardly along the inclined portion to press the friction member when the first and second pressure members are close to each other.

9. The damper as set forth in claim 8, wherein the friction member moves towards the center of the shaft and is separated from the inner wall of the damper cylinder when the first and second pressure members are distant from each other.

10. The damper as set forth in claim 9, wherein the slip member includes an elastic member for returning the friction member to the center of the shaft when the first and second pressure members are distant from each other.

11. The damper as set forth in claim 10, wherein the elastic member has a ring-shape, and is provided on the outer cylindrical surface of the slip member.

12. The damper as set forth in claim 8, wherein, in the case that the pressure unit includes a plurality of slip members, the pressure unit further includes guide ribs provided on the outer cylindrical surface of at least one of the first and second pressure members for preventing the concentrated movement of the slip members in the circumferential direction.

13. The damper as set forth in claim 4, wherein the interval adjuster moves the second pressure member.

14. The damper as set forth in claim 13, the interval adjuster includes:

- at least one connection rod passing through the first pressure member and connected to the second pressure member;
- a driving unit for driving the connection rods to move the second pressure member.

15. The damper as set forth in claim 14, wherein the driving unit rectilinearly moves the connection rod to move the second pressure member.

16. The damper as set forth in claim 15, wherein the driving unit includes an electromagnet provided at the other side of the first pressure member for rectilinearly moving the connection rod using magnetic force so that the second pressure member moves towards the first pressure member when current flows.

17. The damper as set forth in claim 16, wherein the connection rod includes a metal member provided between the first pressure member and the electromagnet.

18. The damper as set forth in claim 15, wherein the driving unit includes:

- a wire connected to the connection rod; and
- an actuator connected to the wire.

19. The damper as set forth in claim 14, wherein the driving unit includes a motor for rotating the connection rod, and the second pressure member rectilinearly moves by the rotation of the connection rod.

20. The damper as set forth in claim 19, wherein the connection rod passes through the second pressure member, and is connected to the second pressure member by a screw.

21. The damper as set forth in claim 18, wherein the pressure unit further includes a guide pin, one end of which is inserted into the first pressure member and the other end of which is inserted into the second pressure member, for guiding the movement of the second pressure member.

22. The damper as set forth in claim 13, wherein the interval adjuster includes:

- an electromagnet provided on the first pressure member;
- a metal member provided on the second pressure member;
- and
- a guide rod passing through the second pressure member for guiding the movement of the second pressure member.

23. The damper as set forth in claim 22, wherein the guide rod includes a stopper, one end of which is connected to one side of the electromagnet and the other end of which prevents the second pressure member from being separated from the guide rod.

24. The damper as set forth in claim 1, wherein the friction member has a ring shape surrounding the outer cylindrical surface of the shaft.

25. The damper as set forth in claim 24, wherein the friction member is made of an elastic material.

26. The damper as set forth in claim 1, wherein the friction member contacts the inner wall of the damper cylinder when the number of vibration of an object to be vibrated is more than a designated value, and is separated from the inner wall of the damper cylinder when the number of vibration of the object is less than the designated value.

27. The damper as set forth in claim 1, the frictional force between the friction member and the inner wall of the damper cylinder when the spin speed of an object for generating vibration is more than a designated speed is lower than that when the spin speed of the object is less than the designated speed.

28. The damper as set forth in claim 1, wherein one of the damper cylinder and the shaft is connected to a tub of a washing machine, and the other one of the damper cylinder and the shaft is connected to a cabinet of the washing machine.

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