WASHING MACHINE HAVING DYNAMIC VIBRATION ABSORBER

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ABSTRACT
A washing machine having a device for directly reducing vibration of an external structure serving as a direct factor for causing a user to feel vibration. The washing machine includes an external structure forming an external casing; a washing tub installed in the external structure; a driving device for driving the washing tub; a support device for supporting the washing tub; and dynamic vibration absorbers for directly reducing vibration transmitted to the external structure.
FIG 2

--- INSTALLED ON CONCRETE GROUND
--- INSTALLED ON WOOD FLOOR

VIBRATION LEVEL

RESONANCE POINT

OPERATING FREQUENCY REGION

FREQUENCY (Hz)
FIG 4
FIG 8

--- WASHING MACHINE HAVING DYNAMIC VIBRATION ABSORBER
--- WASHING MACHINE WITHOUT DYNAMIC VIBRATION ABSORBER

VIBRATION LEVEL

1000

100

10

5

10 20 30 40

FREQUENCY (Hz)

RESONANCE POINT
REDUCTION OF VIBRATION LEVEL
OPERATING FREQUENCY REGION
WASHING MACHINE HAVING DYNAMIC VIBRATION ABSORBER

CROSS-REFERENCE TO RELATED APPLICATION


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a washing machine having dynamic vibration absorbers and, more particularly, to a vibration-isolating structure for directly reducing vibration of an external structure.

[0004] 2. Description of the Related Art

[0005] FIG. 1 schematically illustrates a structure of a conventional washing machine. As shown in FIG. 1, the conventional washing machine comprises an external structure 10 forming an external casing, a washing tub 11 for containing laundry and wash water for performing a washing operation, suspension springs 12 for elastically supporting the washing tub 11, and dampers 13 installed at the lower part of the washing tub 11 for reducing vibration of the washing tub 11. The suspension springs 12 and the dampers 13 form a support device for supporting an external portion of the washing tub 11 under the condition that an internal portion of the washing tub 11 is rotatable. Although not shown in the drawings, the conventional washing machine further comprises a driving device installed on the rear part of the washing tub 11 for driving the washing tub 11 and forming an internal assembly with the washing tub 11, a device for supplying the wash water to the washing tub 11, a device for discharging the wash water from the washing tub 11, and a diaphragm made of rubber for flexibly connecting an inlet of the washing tub 11 and the external structure 10.

[0006] The external structure 10 supports the weight of the internal assembly, and includes mounts 14, which are made of an elastic material and contact the ground of an installation area, formed on the bottom surface thereof. Ends of the suspension springs 12 are fixed to the upper portion of the inner surface of the external structure 10 and the other ends of the suspension springs 12 are fixed to the external portion of the washing tub 11, thereby supporting the weight of the washing tub 11 and the driving device. Ends of the dampers 13 are fixed to the lower portion of the inner surface of the external structure 10 and the other ends of the dampers 13 are fixed to the external portion of the washing tub 11, thereby reducing vibration generated from the washing tub 11.

[0007] The internal portion of the washing tub 11 is rotated by the driving device, and performs a washing operation. An imbalance inside the washing tub 11 occurs by the distribution of laundry in the washing tub 11, and generates a vibration level when the internal portion of the washing tub 11 is rotated. The vibration level serves to vibrate the washing tub 11 suspended by the suspension springs 12 and the driving device, thereby causing vibration of the internal assembly in all directions.

[0008] The vibration of the internal assembly including the washing tub 11 and the driving device is partially absorbed by the dampers 13, but is still transmitted to the external structure 10 through the suspension springs 12, the dampers 13, and the diaphragm (not shown). The external structure 10 is placed on the ground at the installation area by the mounts 14, and has specific vibration characteristics according to the rigidity of the ground.

[0009] FIG. 2 is a graph illustrating vibration characteristics of the above conventional washing machine. In the case that the ground at the installation area is a wood floor having a low rigidity, a hard mode (characteristic frequency), in which the whole of the washing machine is vibrated, exists in an operating frequency region, thereby generating excessive vibration of the washing machine. In the case that the ground at the installation area is formed of concrete having a high rigidity, as shown in FIG. 2, a characteristic frequency does not exist in the operating frequency region, thereby not generating excessive vibration of the washing machine.

[0010] The vibration of the washing machine, which is felt directly by a user, is mainly caused by the vibration of the external structure 10. Conventionally, several methods for reducing the vibration of the external structure 10 have been used, as follows.

[0011] First, in order to reduce the vibration of the internal assembly including the washing tub 11 and the driving device in the washing machine, the washing machine further comprises a balance weight for reducing the vibration or a dynamic vibration absorber, or reduces the imbalanced weight of the laundry in the washing tub 11.

[0012] Second, in order to reduce a quantity of the vibration of the internal assembly transmitted to the external structure 10, the suspension springs 12 and the dampers 13 are optimally designed to optimize the internal assembly, oil dampers are used as the dampers 13, or elements for transmitting the vibration, such as the diaphragm, are designated to have the optimal strength.

[0013] Third, the strength of the external structure 10 is reinforced.

[0014] However, in spite of the above vibration-reducing designs, it is impossible to prevent the vibration of the internal assembly from being transmitted to the external structure 10. Accordingly, effective means for directly reducing the vibration of the external structure 10 is required.

SUMMARY OF THE INVENTION

[0015] Therefore, one aspect of the invention is to provide a washing machine having units for directly reducing vibration of an external structure serving as a direct factor for causing a user to feel vibration.

[0016] In accordance with one aspect, the present invention provides a washing machine comprising: an external structure forming an external casing; a washing tub installed in the external structure; a driving device for driving the washing tub; a support device for supporting the washing tub; and at least one dynamic vibration absorber for directly reducing vibration transmitted to the external structure.
The at least one dynamic vibration absorber may be installed directly on the external structure.

Further, the at least one dynamic vibration absorber may comprise a plurality of dynamic vibration absorbers, with at least one of the dynamic vibration absorbers being installed at at least one position on the external structure.

Moreover, the dynamic vibration absorbers may be installed at an upper portion or a side portion of the inside of the external structure.

Each of the dynamic vibration absorbers may include: a vibrating poise having a weight; an elastic member having an elastic restoring member; and a damping member for reducing vibration.

Further, the support device may include: suspension springs for elastically supporting the washing tub; and dampers for reducing vibration of the washing tub.

**BRIEF DESCRIPTION OF THE DRAWINGS**

These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with the accompanying drawings, in which:

**FIG. 1** is a longitudinal sectional view schematically illustrating a structure of a conventional washing machine;

**FIG. 2** is a graph illustrating vibration characteristics of the washing machine of **FIG. 1**;

**FIG. 3** is a longitudinal sectional view schematically illustrating a structure of a washing machine in accordance with an exemplary embodiment of the present invention;

**FIG. 4** is a schematic view illustrating an installation structure of a conventional dynamic vibration absorber;

**FIG. 5** is a graph illustrating vibration characteristics of a structure having the dynamic vibration absorber of **FIG. 4**;

**FIGS. 6A and 6B** are schematic views respectively illustrating structures of a dynamic vibration absorber of the washing machine in accordance with the exemplary embodiment of the present invention;

**FIGS. 7A to 7C** are sectional views respectively illustrating springs and damping members of the dynamic vibration absorbers shown in **FIGS. 6A and 6B**;

**FIG. 8** is a graph illustrating vibration characteristics of the washing machine in accordance with the exemplary embodiment of the present invention.

**DETAILED DESCRIPTION OF THE ILLUSTRATIVE, NON-LIMITING EMBODIMENTS OF THE INVENTION**

Reference will now be made in detail to an illustrative, non-limiting embodiment of the present invention, an example of which is illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The exemplary embodiment is described below to explain the present invention by referring to the annexed drawings.

As shown in **FIG. 3**, a washing machine in accordance with an exemplary embodiment of the present invention comprises an external structure 10 serving as an external casing, an internal assembly including a washing tub 11 and a driving device (not shown) installed in the external structure 10, suspension springs 12 for elastically supporting the internal assembly, dampers 13 installed at the lower part of the washing tub 11 for reducing vibration of the washing tub 11, and mounts 14 formed on the bottom surface of the external structure 10. Here, elements, which are the same as or similar to those of the related art, are denoted by the same reference numerals even though they are depicted in different drawings, and a detailed description thereof will thus be omitted to facilitate an understanding of the subject matter of the present invention.

The washing machine of the present invention further comprises dynamic vibration absorbers 20 installed at upper and side portions of the inside of the external structure 10 for reducing the vibration of the external structure 10. The positions and number of the dynamic vibration absorbers 20 are not limited thereto. That is, if necessary, one dynamic vibration absorber 20 may be installed at one position inside the external structure 10, or a plurality of dynamic vibration absorbers 20 may be installed at plural positions inside the external structure 10.

The dynamic vibration absorbers 20 per se of the washing machine of the present invention have the same basic structure as that of a conventional dynamic vibration absorber. Generally, the dynamic vibration absorber includes a vibrating poise having a weight (inertia), a spring member having an elastic restoring force, and a damper for reducing vibration. **FIG. 4** is a schematic view illustrating a conventional dynamic vibration absorber, having a weight of m, an elastic modulus of k, and a damping modulus of c, attached to a main structure having a weight of M and an elastic modulus of K. **FIG. 5** is a graph illustrating vibration characteristics of the main structure having the above dynamic vibration absorber attached thereto. With reference to **FIG. 5**, a main structure not having the dynamic vibration absorber has a comparatively high peak of vibration level at a resonance point, but the main structure having the dynamic vibration absorber has reduced vibration level at a resonance point.

**FIGS. 6A and 6B** are schematic views respectively illustrating structures of a dynamic vibration absorber applied to the washing machine in accordance with an exemplary embodiment of the present invention. As shown in **FIG. 6A**, one end of a spring and damping member 21 is fixed, and a vibrating poise 22 is fixed to the other end of the spring and damping member 21. Alternately, as shown in **FIG. 6B**, both ends of the spring and damping member 21 are fixed, and the vibrating poise 22 is fixed to the central portion of the spring and damping member 21. **FIGS. 7A to 7C** illustrate various examples of the spring and damping member 21. As shown in **FIG. 7A**, a damping material 21b is applied or attached to both surfaces of a plate spring 21a. The damping material 21b may comprise at least one of viscous elastic materials, rubber, polymer, and asphalt. The spring member may be a general coil spring, or may be made...
of rubber simultaneously having elasticity and damping effects. As shown in FIG. 7B, the damping material 21b may be applied to one surface of the plate spring 21a. As shown in FIG. 7C, two plate springs 21a may be stacked, thereby having damping effects using friction generated at a contact plane therebetween. FIGS. 6A and 6B and FIGS. 7A to 7C illustrate examples of the dynamic vibration absorber 20, and the configuration of the dynamic vibration absorber 20 may be variously modified.

[0036] FIG. 8 is a graph illustrating vibration characteristics of a washing machine, to which the above-described dynamic vibration absorber 20 is applied. In the case that the rigidity of the ground in the installation area is deteriorated and a resonance mode of the washing machine exists in an operating frequency region, and particularly, a vibration level at a designated frequency is excessive, i.e., the dynamic vibration absorber 20 designed at a target frequency, for example, 16.5 Hz, is directly fixed to the external structure 10 of the washing machine, the vibration level at a resonance point is largely reduced.

[0037] As apparent from the above description, the present invention provides a washing machine having dynamic vibration absorbers for directly reducing vibration of an external structure, thereby preventing excessive vibration at an operating frequency region.

[0038] Although an exemplary embodiment of the invention has been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:
1. A washing machine comprising:
   an external structure forming an external casing;
   a washing tub installed in the external structure;
   a driving device for driving the washing tub;
   a support device for supporting the washing tub; and
   at least one dynamic vibration absorber for directly reducing vibration transmitted to the external structure.
2. The washing machine as set forth in claim 1, wherein the at least one dynamic vibration absorber is installed directly on the external structure.
3. The washing machine as set forth in claim 2, wherein the at least one dynamic vibration absorber comprises a plurality of dynamic vibration absorbers, with at least one of the dynamic vibration absorbers being installed at at least one position on the external structure.
4. The washing machine as set forth in claim 3, wherein the dynamic vibration absorbers are installed at one of an upper portion and a side portion of an inside of the external structure.
5. The washing machine as set forth in claim 1, wherein the at least one dynamic vibration absorber includes:
   a vibrating poise having a weight;
   an elastic member having an elastic restoring member; and
   a damping member for reducing vibration.
6. The washing machine as set forth in claim 1, wherein the support device includes:
   suspension springs for elastically supporting the washing tub; and
   dampers for reducing vibration of the washing tub.

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