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(54) **Eigenfrequency oscillation dampering unit**

(57) An eigenfrequency oscillation dampering unit (1) for a tall construction is disclosed. It comprises a support structure (3) under a mass member (5) and receiving the mass member (5), and the support structure (3) presenting a first spherical feature(7). The mass member (5) presents a second spherical feature (9) matching the first spherical feature. The first and second spherical features (7, 9) present a radius corresponding to a length of a mathematical pendulum, wherein the radius is related to an eigenfrequency of the tall construction. The first spherical feature (7) and the second spherical feature (9) presents an essentially common center point. A contact means (11) is arranged on one of the mass member (5) and the support structure (3), and between the first spherical feature (7) and the second spherical feature (9), allowing the mass member (5) to move in relation to the support structure (3). Non limiting Applications of the present invention include a windmill, a chimney, and a building.

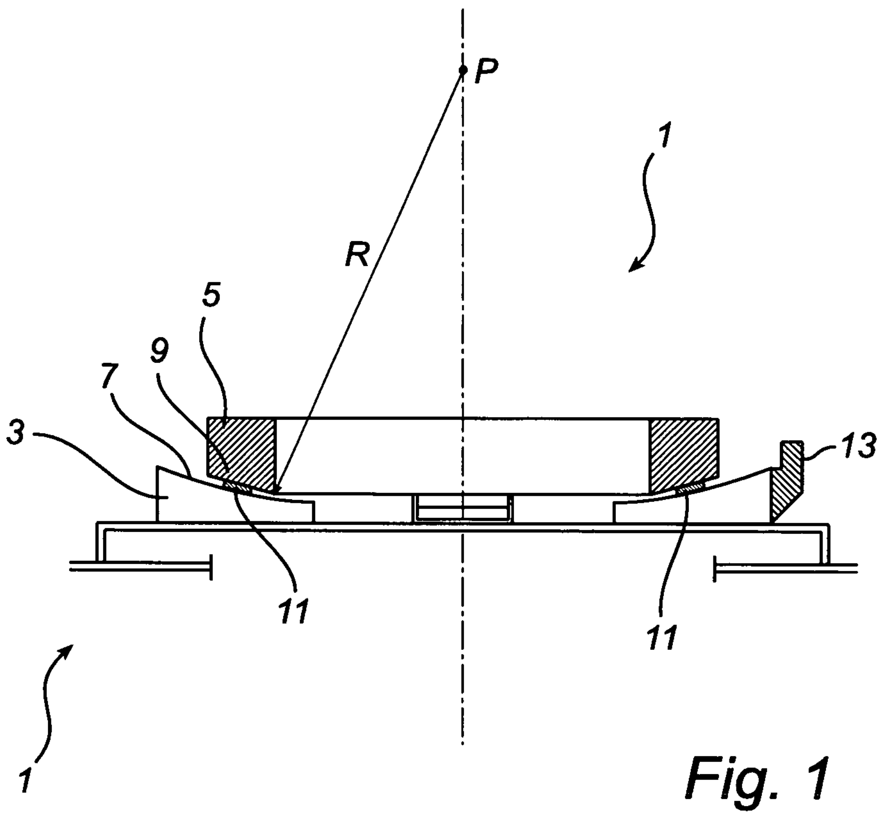

Fig. 1

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Description

Technical field

[0001] The present invention relates to an eigenfrequency oscillation dampering unit.

Background of invention

[0002] In various fields, attempts have been made to decrease the effects of oscillations, e.g. caused by earth quakes or other types of vibrations. It may be particularly important to decrease the effects of oscillations at an eigenfrequency of a construction.

[0003] In US 3,329,472, a structural bearing unit comprising a pair of spaced members that have opposed bearing surfaces bearing surfaces, a movable pad element disposed between and coacting with the bearing surfaces of the members whereby the members may move parallel or angularly relative to each other when subjected to certain bearing load. This bearing unit deals with how to accommodate movement between structural members, such as a bridge. The invention disclosed in the document above does mention dampering an oscillation at an eigenfrequency.

[0004] In US 4,320,549, a rocker-sliding bearing for bridges or similar structures and a method of lining the concave top side surface of a curved base plate of a rocker-slider bearing is disclosed. The rocker-slider bearing includes a flat top plate, an intermediate plate having a flat top side and a convex curved underside surface, a bedplate and a base plate having a correspondingly concave curved top side surface in turn secured to the bedplate, the curved surface on the top of the base plate including a lining of corrosion-resistant material and the curved surface of the intermediate plate including a lining with a low coefficient of friction relative to the highly corrosion-resistant material on the curved surface of the base plate wherein the lining on the curved surface of the base plate includes a preformed curved disc positioned on the base plate and secured to the concave top side thereof. The invention disclosed in the document above does mention dampering an oscillation at an eigenfrequency.

[0005] In US 6,085,473, a three-dimensional guiding apparatus capable of bearing large loads and suitable for use in a vibration isolating structure for buildings is disclosed. The three-dimensional guiding apparatus comprises a base, a first curved guiding apparatus disposed above the base and having an arcuate track, a second curved guiding apparatus disposed above the first curved guiding apparatus and having a plane of movement along an arcuate track which crosses the plane of movement of the first curved guiding apparatus, and an intermediate member positioned between the first curved guiding apparatus and the second curved guiding apparatus and interconnecting the first curved guiding apparatus and the second curved guiding apparatus. Each of the first and second curved guiding apparatuses has a track rail, a bearing block, lids, and a number of balls. The invention disclosed in the document above does mention dampering an oscillation at an eigenfrequency. Also, in order for the three-dimensional guiding apparatus to isolate a vibration, a movement along two arcuate tracks may be required. Thus the function of the invention disclosed in the document is to isolate a vibration by operating as an intermediate feature to decrease the vibration in the structure above the invention disclosed in the document.

[0006] In US 6,682,849, a bi-directional sliding pendulum seismic isolation system for reducing seismic force acting on a structure by sliding pendulum movements is disclosed. Each system comprises a lower sliding plate forming a sliding path in a first direction, an upper sliding plate forming a sliding path in a second direction, and a sliding assembly for reducing the seismic force of the structure by performing a pendulum motion by sliding along the lower and upper sliding plates. In order for the bi-directional sliding pendulum seismic isolation system to isolate a vibration, a movement along two arcuate tracks may be required. Thus the function of the invention disclosed in the document is to isolate a vibration by operating as an intermediate feature to decrease the vibration in the structure above the invention disclosed in the document.

Summary of invention

[0007] The purpose of the present invention is to solve the problem of dampering an oscillation at an eigenfrequency of a tall construction. This purpose is achieved by an eigenfrequency oscillation dampering unit that comprises a support structure placed under a mass member and that receives the mass member. The support structure presents a first spherical feature. The mass member presents a second spherical feature that matches the first spherical feature. The first and second spherical features present radii corresponding to a length of a mathematical pendulum, T=2pisqrt(l/g), where T is the period, L is the pendulum length, and g is the acceleration of gravity, wherein the radius is essentially corresponding to the movement of an imaginary pendulum motion, i.e. the movement of the pendulum would be along the radius. The relation f = 1/T relates frequency and period, where f is an eigenfrequency of the tall construction. Thus there is a relation between the radius of the first and second spherical features and the length of the mathematical pendulum. Also, the first and second spherical features are either identical or at least essentially identical.

[0008] The first spherical feature and the second spherical feature present an essentially common center point. This means that when viewing each one of the spherical features, it constitutes a part of a sphere. The center points of the spheres of the first and second spherical features are essentially the same.

[0009] A contact means is on one of the mass member and the support structure, and between the first spherical feature and the second spherical feature, allowing the mass member to move in relation to the support structure for dampering an eigenfrequency oscillation. Thus the mass member functions like a pendulum. The contact means may be constituted by one of a sliding means and a ball housing arrangement.

[0010] An effect of the present invention is that there is no need to actually use an actual pendulum to damper an eigenfrequency oscillation since this is, according to the present invention, accomplished by the mass member moving in relation to the support structure. The movement of the first and second spherical features presents a function similar to a pendulum. An advantage is that the dampering unit is significantly more compact.

[0011] Also, the moving at least partly balances out the eigenfrequency oscillation. Thus in this partially out balancing, the mass member moves in relation to the support structure. Also, the contact means in combination with the first and second spherical features allow similar moving capabilities regardless of direction, even including rotational moving.

[0012] In an embodiment, the mass member is located at an upper portion of the tall construction.

[0013] In an embodiment, at least one of the first spherical feature and the second spherical feature is constituted by a plurality of spherical partial surface elements. This means that the elements may be perceived as parts of a single sphere.

[0014] In an embodiment, the mass member is unloaded from above, e.g. it does not support a part of a bridge or a building.

[0015] In an embodiment, the contact means provides a friction coefficient in the interval of 0.03 to 0.07.

[0016] In an embodiment, the contact means is constituted by a plurality of contact arrangements located between the spherical partial surface elements of the first and second spherical features.

[0017] In an embodiment, a mass member movement limiting means is arranged on the support structure. This means limits the movement of the mass member in relation to the support structure.

[0018] In an embodiment, the support structure presents cut outs to decrease its mass and to save material.

[0019] In an embodiment, the mass member is a ring. This offers the advantage that the hole through the ring may be used for receiving a mechanical object. A ring presents the advantage that dampering unit is space effective since it may be designed to quite low.

[0020] In an embodiment, the mass member is a disk. Also a disk presents the advantage that dampering unit will be space effective. It should be noted that a ring may be considered a disk provided with a hole.

[0021] In an embodiment, the mass member comprises iron. In an embodiment, the mass member is constituted by a container comprising a fluid.

[0022] In an embodiment, the mass member is made of cement or concrete.

[0023] In an embodiment, the mass member is additionally provided in the tall construction, i.e. the mass member is intended to solely damper eigenfrequency oscillations. Also, the mass member is unloaded in the sense that it is not an original part of the tall construction.

[0024] In an embodiment, the mass member is constituted by a plurality of smaller mass members. When the smaller mass members are combined, the mass member is created. This leads to an easier mounting of the mass member since the need of transporting a high mass is more difficult than transporting a plurality of smaller masses. Also, the advantage that the mass of the mass member becomes a variable in e.g. installation, or calibrating since one or more of the smaller mass members may be added or removed.

[0025] In an embodiment, at least one of the first and second spherical features presents at least one of an anticorrosion coating and a lubricant.

[0026] It is also lies within the scope of the present invention to combine dampering units to an arrangement comprising a plurality of eigenfrequency oscillation dampering units according to the present invention. One or more units comprised by the plurality may present different radii. Also, the eigenfrequency oscillation dampering units may be arranged at the same height of the tall construction. Alternatively, the eigenfrequency oscillation dampering units may be arranged at different heights of the tall construction.

[0027] Now turning to applicability of the present invention, a non limiting selection of applications will now be given.

- A windmill comprising one or more eigenfrequency oscillation dampering units according to the present invention.
- A chimney comprising one or more eigenfrequency oscillation dampering units according to the present invention.
- A building comprising one or more eigenfrequency oscillation dampering units according to the present invention.

Brief description of drawings

[0028] In Figure 1, a schematic cross section illustration of an embodiment of an eigenfrequency oscillation dampering unit is disclosed.

[0029] In Figure 2, a schematic illustration of a mass member presenting cut outs is disclosed.

[0030] In Figure 3, a schematic cross section illustration of an embodiment of an eigenfrequency oscillation dampering unit is disclosed.

Description of embodiments

[0031] In Figure 1, an embodiment of an eigenfrequency oscillation dampering unit 1 for a tall construction is given. It comprises a support structure 3 under a mass member 5 and the support structure 3 receives the mass member 5. The support structure 3 presents a first spherical feature 7.

[0032] The mass member 5 presents a second spherical feature 9 matching the first spherical feature 7. The first and second spherical features 7, 9 present a radius, R, corresponding to a length of a mathematical pendulum, wherein the radius is related to an eigenfrequency of the tall construction.

[0033] The first spherical feature 7 and the second spherical feature 9 present an essentially common center point. The common center point is indicated with P.

[0034] A contact means, here a sliding means 11, is arranged on one of the mass member 5 and the support structure 3 and between the first spherical feature 7 and the second spherical feature 9, allowing the mass member 5 to move in relation to the support structure 3 for dampering an eigenfrequency oscillation. In this embodiment, the sliding means presents a friction coefficient in the interval of 0.03 to 0.07. In the Eigenfrequency oscillation dampering unit a mass member movement limiting means 13, here in the form of a bumper, is arranged on the support structure 3.

[0035] In Figure 2, an eigenfrequency oscillation dampering unit is shown in which the support structure 3 presents cut outs 15 and sliding means 11.

[0036] In the embodiment given in Figure 1 and 2, the mass member 5 is a ring.

[0037] In figure 3, an embodiment of a dampering unit is disclosed. In this embodiment, the support structure 3 receives the mass member 5. The mass member 5 and the support structure 3 present spherical features, that essentially matches. However, a difference between this embodiment and the above embodiment is the arrangement of the spherical features in relation to the tall construction. In Figure 3, the point P is below the mass dampering unit 1. The mass member slides on sliding means 11. Two mass member movement limiting means 13 are also present in Figure 3 in the form of taps, directed downwards, that in case the mass member is in the risk sliding too far, the tap will come into contact with the support structure 3 and accordingly limit the movement of the mass member 5.

[0038] An embodiment non-limitingly indicating the application of the present invention will now be given. In this embodiment, the mass member 5 is additionally provided in the tall construction, i.e. the unit has been provided there with the sole purpose of dampering eigenfrequeny oscillations. In this embodiment, the eigenfrequency of the tall building is 0,2 Hz, and the frequency for the pendulum shall be the same. The length, equivalent to the spherical feature radius, is calculated from the formula for mathematical pendulum:

$$T = 2pi(L/g)½$$

where T is the period, L the pendulum length, and g acceleration of gravity. Thus the length of the imaginary pendulum, i.e. the height of the space otherwise required in the tall construction, is 7 meters.

Claims

1. Eigenfrequency oscillation dampering unit (1) for a tall construction, comprising

   - a support structure (3) under a mass member (5) and receiving the mass member (5),
   - the support structure (3) presenting a first spherical feature(7),

   characterized by

   - the mass member (5) presenting a second spherical feature (9) matching the first spherical feature (7),
   - the first and second spherical features (7, 9) presenting a radius corresponding to a length of a mathematical pendulum, wherein the radius is related to an eigenfrequency of the tall construction,
   - the first spherical feature (7) and the second spherical feature (9) presenting an essentially common center point, and
   - a contact means (11) on one of the mass member (5) and the support structure (3), and between the first spherical feature (7) and the second spherical feature (9), allowing the mass member (5) to move in relation to the support structure (3).

2. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the contact means (11) presents a friction coefficient in the interval of 0.03 to 0.07.

3. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein a mass member movement limiting means (13) is arranged on the support structure (3).

4. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the support structure (3) presents cut outs.

5. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) is a ring.

6. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) is a disk.

7. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) comprises iron.

8. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) is constituted by a container comprising a fluid.

9. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) is additionally provided in the tall construction.

10. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) is made of cement or concrete.

11. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein the mass member (5) is constituted by a plurality of smaller mass members.

12. Eigenfrequency oscillation dampering unit (1) according to claim 1, wherein at least one of the first and second spherical features (7, 9) present at least one of an anticorrosion coating and a lubricant.

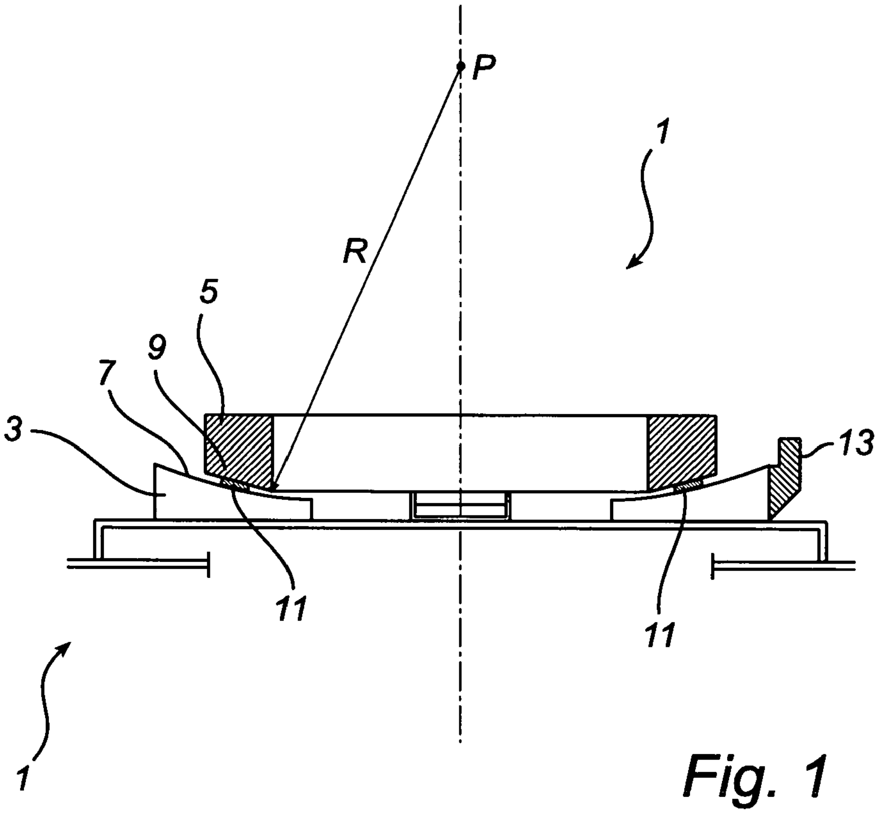

Fig. 1

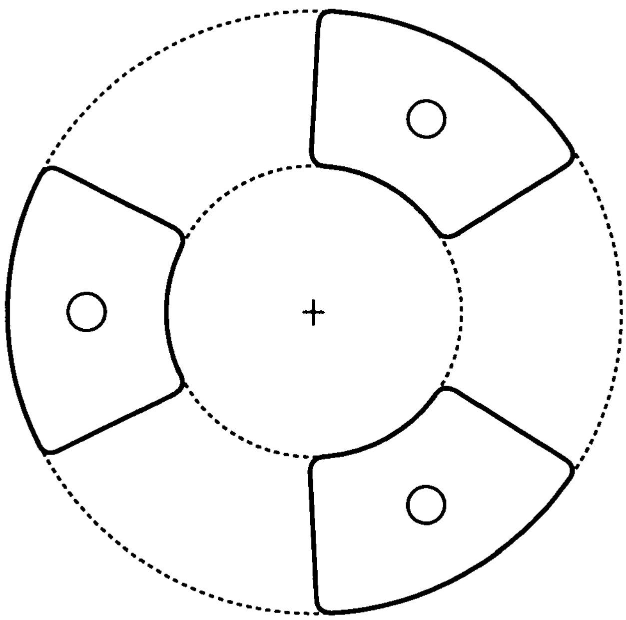

Fig. 2

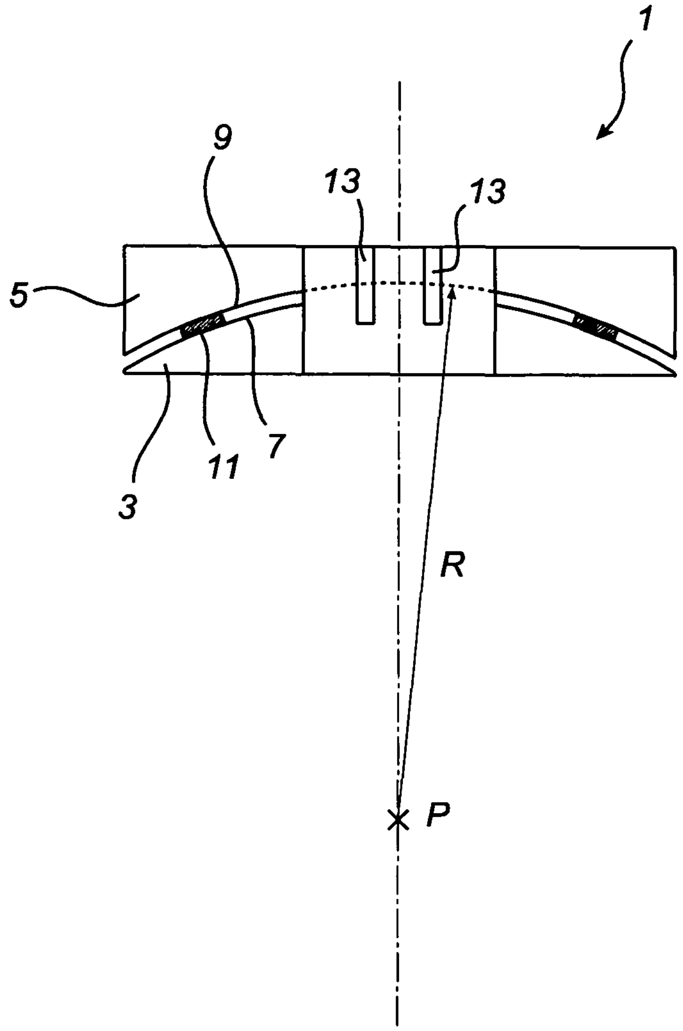

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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