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VIBRATION REDUCING DEVICE

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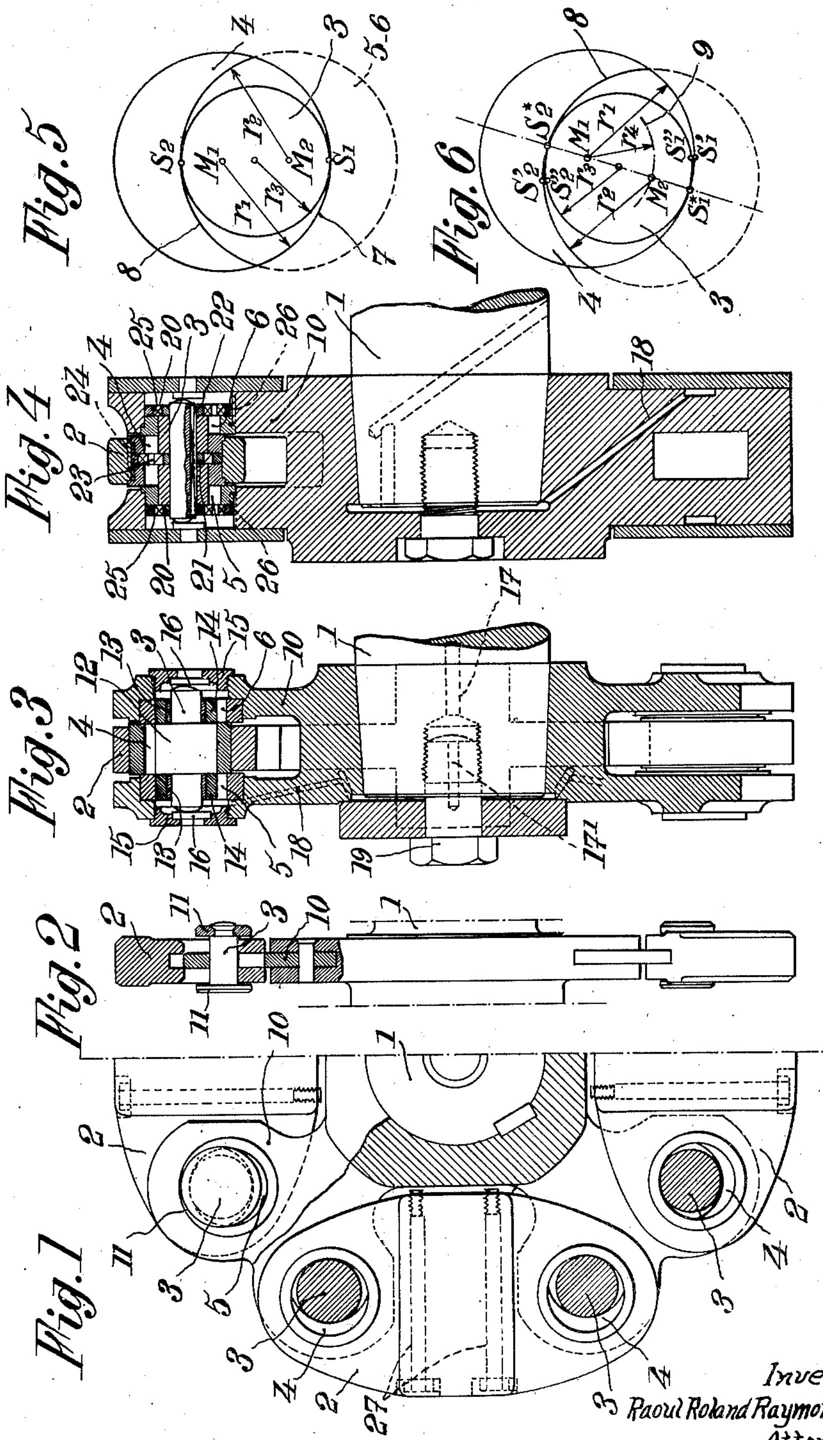

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VIBRATION REDUCING DEVICE

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1 Claim. (Cl. 74—574)

The present invention relates to vibration reducing devices of the kind including at least one movable mass connected to the vibrating part in such manner as to be able to oscillate with respect thereto. The invention is more especially, although not exclusively concerned, with devices of this kind in which the movable masses are suspended on the vibrating part in a manner analogous to the arrangement of bifilar pendulums.

The object of the present invention is to provide a device of this kind which is better adapted to meet the requirements of actual practice than devices of the same kind used up to this time.

According to the essential feature of the present invention, the two elements above referred to, to wit, the vibrating part and the movable mass, are connected together by means of a rolling body cooperating with runways carried by these two elements, the runway carried by one element extending from one face to the other face thereof, while the other element includes two lugs or similar parts provided on either side of said first mentioned element close to said faces thereof respectively, runways overlapping the first mentioned runway being carried by said lugs respectively, whereby the rolling body or analogous structure can extend on either side of the first mentioned runway into the two other runways with a certain play.

According to another feature of the invention this rolling structure includes at least two distinct parts adapted to turn freely with respect to each other about a common axis, one of these parts being adapted to cooperate with the runway carried by the vibrating part and the other with the runway carried by the movable mass.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described with reference to the accompanying drawing, given merely by way of example, and in which:

Fig. 1 shows, partly in elevation and partly in cross section, a device for reducing vibrations made according to a first embodiment of the invention;

Figs. 2, 3 and 4 are longitudinal sectional views showing three analogous devices made according to three other embodiments of the invention, respectively;

Figs. 5 and 6 are diagrammatical views illustrating the principle of working of the device according to the invention and which will be hereinafter referred to in the following detailed description.

The examples of the invention hereinafter described refer to the case of a device for reducing the vibrations of the shaft 1 of a multi-cylinder engine.

This device includes a plurality of masses 2, each connected to shaft 1 through at least one rolling body 3 adapted to roll, on the one hand, along a runway connected to the shaft, and, on the other hand, along a runway connected to the mass.

According to the invention, the runway carried by one of the elements to be connected together is a runway 4 extending from one side to the other of said element.

On the other hand, the other element includes two parts forming lugs extending on either side of said runway respectively, each of said lugs carrying a runway 5 or 6 overlapping the first mentioned runway.

Finally, a rolling body or structure 3 extends through the overlapping parts of the spaces limited by these runways, so as to be able to cooperate with these three runways.

The section of the portion of this rolling body that cooperates with runway 4 may be either identical to the sections of the portions adapted to cooperate with runways 5 and 6 or different therefrom. With this arrangement, under the effect of the centrifugal force, this rolling body is held and maintained in position between the runway carried by one of these elements and the runways carried by the other element.

Runways 4, 5 and 6 may be given any suitable outline. For instance this outline may be a portion of a curve of sufficient length in order that the mass may move with the desired amplitude with respect to the vibrating part to which it is to be connected, such runways being, for instance carried by open hooks. However I consider that it is more advantageous to give these outlines the shape of closed curves, the runways being, in this case, formed in holes provided in the elements to be connected together.

Of course, the rolling body must fit with a certain play in these holes (say a play of some millimeters in the case of a rolling body of a diameter equal to 10 millimeters).

Owing to the provision of this play, masses 2 shall oscillate when the rotary movement of shaft 1 is not regular and their movements shall depend upon the shape of the runways and that of the rolling bodies cooperating therewith.

In the diagrammatical views of Figs. 5 and 6, it has been assumed that the outline 7 of runway 4 is a circular cylindrical surface of a radius equal to r_1, that the outline 8 of runways 5 and 6 also is a cylindrical circular surface the radius r_2 of which is equal to r_1, and finally that the rolling body 3 is a portion of a circular cylinder of the same diameter over its whole length and of a radius equal to r_3. The center of curvature M_1 is rigidly connected to the mass and the center of curvature M_2 is rigidly connected to the shaft. The contact between rolling body 3 and the outlines 7 and 8 of the runways takes place, for the position of rest, at points S_1 and S_2.

In order to determine the radius of the pendular movement of mass 2, it is necessary to follow, in the course of the oscillation, the movement of point M_2.

While, in Fig. 5, the relative position of the outlines of the runways corresponds to the state of equilibrium, in Fig. 6, this relative position is shown in the case of a pendular deviation of mass 2. The latter rolls through the outline 7 of its runway and with the interposition of rolling body 3 on the outline 8 of the runway of the shaft. The rolling body 3 and the runways corresponding to outlines 7 and 8 are maintained in contact together at new points of contact S_1 and S_2. The points that were in contact together in the position of rest shown by Fig. 5 have moved away from one another and are now located at S'_1, S''_1 and S'_2, S''_2. The center of curvature M_2 has moved along a circle 9 the center of which coincides with the center of curvature M_1 corresponding to outline 7, the radius of this circle 9 being r_4. Assuming that:

$$r_1=r_2,$$

then the value of radius r_4 is

$$r_4=2(r_1-r_3).$$

It follows that if radii r_1, r_2 and r_3 are suitably chosen, it is possible to obtain a radius of curvature r_4 as small as it is desired, if radii r_1, r_2 and r_3 are given the value necessary for high centrifugal forces.

Although the specific arrangement of the device may vary widely, I consider that it is particularly advantageous to use an embodiment corresponding to one of the specific examples shown by Figs. 1 to 4.

In these embodiments, runways 5 and 6 are provided in two lugs carried either by a plate 10 rigidly connected to shaft 1 (as in the examples of Figs. 1, 3 and 4) or by mass 2 (as in the case of Fig. 2). These two lugs are disposed at an interval from each other sufficient for fitting between them at least one part of the other element. For instance the runways consist of rings of tempered metal driven with a force fit into said lugs and into the element disposed between said lugs.

In the embodiment of Fig. 1, the rolling bodies 3 are mere cylinders consisting of a single piece, for instance of steel, which are kept in position transversely through any suitable means, such as small end plates 11. The two lugs are rigid with plate 10 and masses 2 are disposed between these lugs.

On the contrary, in the embodiment of Fig. 2, plate 10 is fixed to the crank pin of a crankshaft and masses 2 are recessed so as to fit on either side of said plate. The rolling bodies are made as in the embodiment of Fig. 1.

In the embodiment of Fig. 3, the rolling bodies consist of two different parts which can turn freely with respect to each other about a common axis, one of these parts being adapted to roll on runway 4 and the other one on runway 5, 6. Each of these rolling bodies includes a central part 12 adapted to run along runway 4. This central portion is provided, on either side thereof, with coaxial trunnions on which two rollers 14 adapted to roll on runways 5, 6 are mounted freely. Preferably, bushings 13 are interposed between these trunnions and these rollers. Any lateral displacement of the composite rolling body thus formed is prevented for instance by small plates 15 which screw from the outside on the lugs of plate 10 and which are provided with stops 16 of tempered metal so as to avoid wear and tear.

In order to ensure the lubrication of this mechanism, oil under pressure is fed through a conduit 17 provided in shaft 1 and then through a conduit 17′ communicating with the preceding one and advantageously provided inside the very mass of the bolt 19 through which the vibration damper is secured to shaft 1, a conduit 18 conveying the lubricant to the runways themselves.

This arrangement prevents any wedging as might take place when the rolling bodies are made of a single part due to friction under the action of very high centrifugal stresses.

Such wedging may occur under the following circumstances: Although the runways occupy a position such as that shown by Fig. 5, the rollers may be located in unsymmetrical position. If the rolling bodies are made of a single part, they are then wedged in the space common to both runways and, in view of the frictional stresses that are developed, said rolling bodies cannot be disengaged and come back into symmetrical position. The provision of rolling bodies made of several parts rotatable with respect to one another fully avoids this drawback since one of these parts can roll on the runway corresponding to the mass independently of the rolling movement of the other part with reference to the runway of the plate.

In the embodiment of Fig. 4, the rolling bodies are not made of several distinct parts movable with respect to one another. But they are provided with toothed rings 20 and 21, in such manner that the rolling bodies cannot slide with respect to the runways. The toothed rings 20, as well as toothed ring 21 are fixed on a central rod by means of a key 22 which prevents them from turning with respect to said rod. Furthermore they are so devised as to prevent any axial displacement. The internal gear 23 which coacts with toothed ring 21 is keyed with respect to mass 2 by means of a key 24, while the internal gears 25 which coact with toothed ring 20 are maintained by means of keys 26 so as to prevent them from rotating with respect to plate 10. The pitch circles of the internal gears have the same respective diameters as the runways to which they correspond.

The rolling bodies may also have a shape different from that of the cylinders shown in the drawing. They may consist, for instance, of any type of cylinder or of any other shape, the generatrix of which is a curve.

In a similar manner, the shape of the runways is not necessarily that of a cylinder. It may also be of any other kind. Some shapes have the advantage that the center of the oscillation of the masses that damp the vibrations may be displaced in a predetermined way during the oscillation and that the pendular curve may be given any desired curvature. This advantage may also be obtained when the cylindrical runways have different radii of curvature, respectively.

Of course, the rolling bodies may consist of members which are of any suitable shape.

In all cases, in order to prevent undesirable movements of the masses during the periods of starting or of stopping of the machine on which the vibration reducing device is fitted, I may provide suitable stops such as screws 27 adapted to bear, through their ends, against the hub of plate 10, thus limiting the movement of the mass.

Of course, in addition to its application to devices for reducing the torsional vibrations of shafts, the principle of the invention may also be applied to any devices whatever which are intended to reduce vibrations and for instance to devices for absorbing the longitudinal vibrations of bodies moving along a rectilinear path.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition, and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claim.

What I claim is:

A device for reducing the vibrations of a moving part which comprises in combination two elements including a mass and a member connected to said moving part, a runway carried by one of the two aforesaid elements extending from one side of said last mentioned element to the other side thereof, two lugs carried by the other element, one disposed on each side of said runway respectively, a runway carried by each of said lugs respectively on each side of the first mentioned runway and overlapping it, a cylindrical rolling body of less diameter than the least dimension of either runway adapted to cooperate with these three runways and extending longitudinally thereof, and two stops for preventing axial displacements of the rolling body, said stops being secured respectively to each of said lugs on either side of said rolling body

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