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H. L. BURNAT
DAMPING FLY-WHEELS
Filed Feb. 1, 1943

Serial No. 474,319
2 Sheets-Sheet 1

Fig. 3

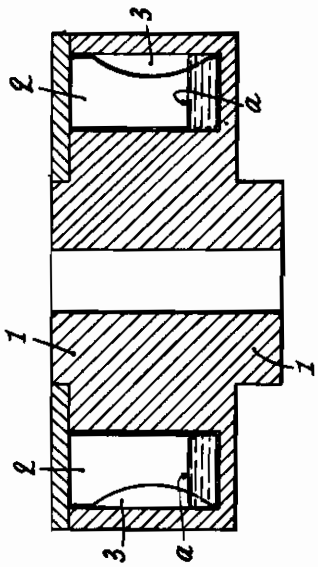

Fig. 1

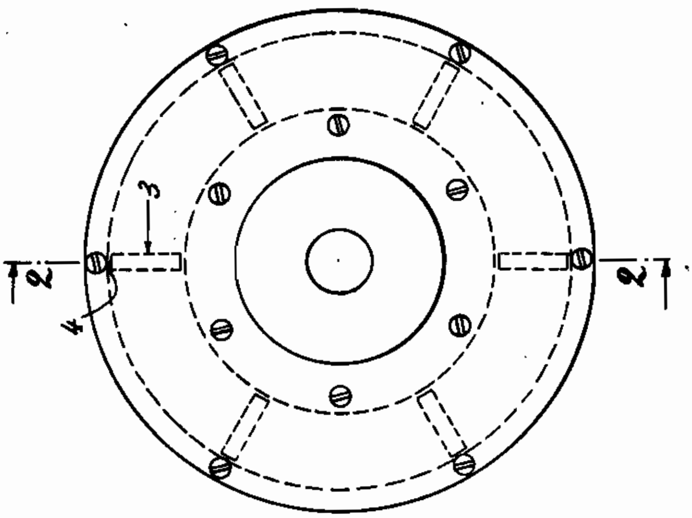

Fig. 2

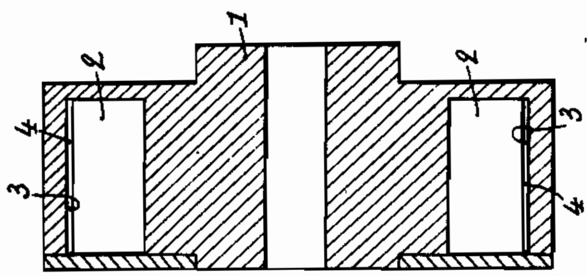

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Fig. 4

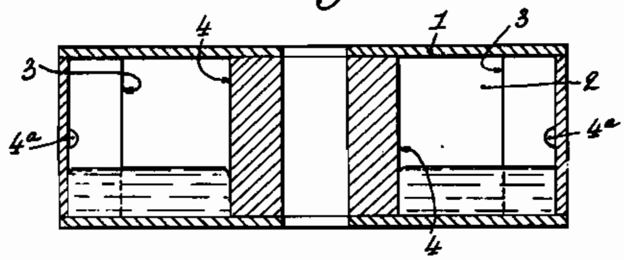


Fig. 5

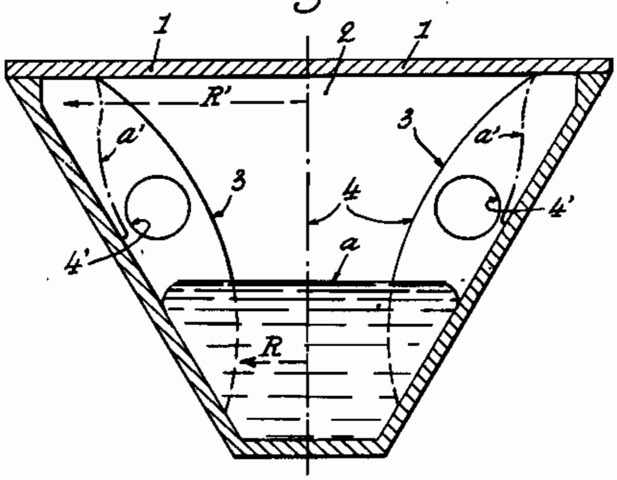
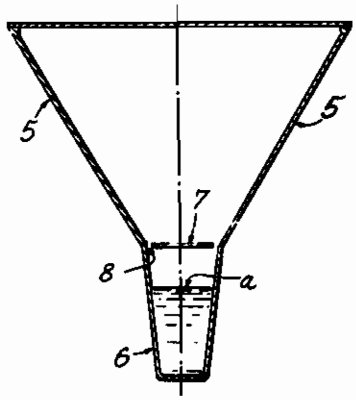


Fig. 6



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ALIEN PROPERTY CUSTODIAN

DAMPING FLY-WHEELS

Henri Louis Burnat, Paris, France; vested in the Alien Property Custodian

Application filed February 1, 1943

The present invention has for object a fly-wheel of variable inertia, intended to damp the tangential vibrations transmitted by a rotary shaft, and of the type comprising a cavity containing a liquid, the mobility of which relatively to the solid part of the fly-wheel creates by friction, an absorption of energy which produces the damping of the tangential vibrations.

Preferably, the liquid must have a specific weight as great as possible, which practically leads to the use of mercury.

The mobility of the liquid mass relatively to the solid part of the fly-wheel can be varied, according to this invention, by the fact that the passage for the liquid in said cavity is variable as to shape and/or cross section either in the circumferential direction, or in the axial direction, or in both said directions. It is for instance possible to cause the liquid to flow circularly through calibrated orifices formed in partitions symmetrically arranged in a cavity having the shape of a body of revolution, the braking action on the liquid being so much the more intense as the speed variation is more important. Certain important effects might be obtained by using viscous liquids, in order to increase the friction effect of the liquid on the walls of the cavity or through the calibrated orifices in the partitions of said cavity.

When the fly-wheel is mounted on a shaft which rotates at a single definite working speed, the cavity in the shape of a body of revolution is preferably completely filled with the heavy liquid, so as to have the maximum inertia, therefore the maximum efficiency.

When the fly-wheel is mounted on a shaft having a plurality of working speeds, the cavity in the shape of a body of revolution can be only partly filled, so that the inertia of the structure can vary according to the speed used, by the displacement of the centre of inertia of the liquid.

In the case of a fly-wheel intended to operate at several different working-speeds, use can be made of a fly-wheel having a vertical axis, the cavity of which in the shape of a body of revolution is only partly filled with the liquid, so that the inertia of the whole varies according to the speed. The cavity in the shape of a body of revolution can even be given a suitable profile for increasing this effect, or its generatrix can be given a certain inclination relatively to the axis of the fly-wheel, so that the liquid mass, under the action of centrifugal force, moves vertically and that the radius of rotation of its centre of inertia varies in function of the instantaneous speed, thereby causing the total inertia of the fly-wheel to vary.

In fly-wheels constructed according to the principles above set forth, the liquid, upon starting, facilitates the latter, by only gradually acquiring the working speed of the fly-wheel; likewise, upon stopping, the latter is facilitated by the fact that the speed of the liquid is always greater than that of the fly-wheel. Upon starting, there is absorption of energy, and the latter is restituted upon stopping.

Likewise, during operation, when the working speed has been attained for some time, the two solid and liquid masses of the fly-wheel rotate at the same speed; if, at this instant, a disturbance takes place in the speed, the liquid mass immediately moves to act in antagonism to said disturbance; the disturbing energy is braked by the absorption of energy produced by the friction effects of the liquid on the walls or in the calibrated orifices.

The invention will be more clearly understood by referring to the accompanying drawings, which show, by way of example, various embodiments for carrying the invention into practice based on these main principles, and in which:

Fig. 1 is an elevation of a fly-wheel having a horizontal axis, according to the invention;

Fig. 2 is a section according to line **2—2** in Fig. 1;

Fig. 3 is a section similar to Fig. 2 showing a fly-wheel having a vertical axis;

Fig. 4 diagrammatically shows a modification of Fig. 3;

Fig. 5 is a section similar to Fig. 3, showing a fly-wheel having a vertical axis and a conical wall;

Fig. 6 diagrammatically shows a modification of Fig. 5.

Referring to Figs. 1 and 2, **1** designates the solid part of the fly-wheel, which comprises, near its periphery, a cavity **2** in the shape of a body of revolution containing a liquid, such as mercury, which completely fills the cavity **2**.

The cavity **2** is obstructed at intervals by blades or solid portions **3**, leaving between them and the walls of the cavity calibrated orifices **4**. These blades are uniformly spaced apart along the circumference so as to obtain a static and dynamic equilibrium.

The fly-wheel can be directly mounted on the shaft the vibrations of which are to be damped, when the speed of said shaft is sufficient, or it can be mounted on an intermediate shaft mechanically connected to the main shaft and to which is imparted a sufficient speed of rotation by any suitable transmission members, so that it is possible to proportion the efficiency of the fly-wheel by its own mass, by that of the mercury and by its speed of rotation.

In the example of Fig. 3, the fly-wheel rotates about a vertical axis and the mercury only partly fills the internal cavity, *a* designating the free surface of the mercury. Moreover, the shape of the openings **3** is such that the section of passageway for the circumferential flow of the mercury is greater when the mercury is projected by centrifugal force against the cylindrical wall than at slow speeds, for which the mercury occupies the bottom of the cavity **2**.

The arrangement of the fly-wheel, the cross section of the blades, the various openings formed therein, can be such that said elements are in contact or not with the mercury in position of rest, and that the effect of the openings in the blades intervenes in totality or in part only for certain speeds, determining the distance separating the mass of mercury from the axis of rotation.

The efficiency of the fly-wheel is, by this means, function of the speed of rotation of the shaft.

The result to be obtained being to cause the vibrations of the rotating spindle or shaft to be damped by corresponding displacements of the mercury, displacements which are in their turn braked by the openings formed in the obturating blades, the shape and cross section of said openings will be adjusted in function of the frequency and of the amplitude of the vibrations to be damped.

In the example of Fig. 4, the openings **4** are located towards the centre, so that the section of passageway is maximum at slow speeds and becomes reduced to that of the openings **4**ᵃ at high speeds, when the mercury is projected by centrifugal force against the cylindrical walls.

The openings **4**ᵃ might even be done away with, in which case the mass of mercury will form a block with that of the solid portions of the fly-wheel for a sufficiently high uniform speed of rotation. In this latter arrangement of the fly-wheel of variable inertia, the damping effect on the vibrations results from the mobility of the mercury in the space comprised between two consecutive blades **3**, the instantaneous accelerations or decelerations resulting in a rush of the mercury against the down-side or up-side blade, respectively, with correlative modification of the radius of rotation of the mass of mercury.

In the example of Fig. 5, the variation of the radius of rotation of the mercury in function of the speed is amplified by giving a conical shape to the outer wall of the cavity **2**.

Upon starting, the radius of rotation of the mass of mercury is R. When the speed of rotation of the fly-wheel is sufficient, the entire mass of mercury is projected by centrifugal force towards the large base of the cone and the free surface of the mercury is at *a'*, the radius of rotation becoming R'.

Each particle of mercury is subjected to a variable force representing the resultant of its weight and of centrifugal force. To each speed of rotation corresponds a different free surface *a'* and a radius of rotation R', so that the variation of inertia of the fly-wheel is progressive. The openings **4'** are arranged in such a manner that they enter in action for the normal working speed of rotation of the fly-wheel.

In the example of Fig. 6, the fly-wheel comprises a conical part **5** and a cylindrical appendix **6** or of less conicity, so as to modify the law of progressivity of the variation of inertia in function of the speed. A screen **7**, providing calibrated openings **8**, can also be arranged to brake the flow of the liquid from part **8** into part **5** under the action of centrifugal force.

In this example, the mercury is drawn along by friction against the walls of the cavity. The surface condition of said walls determines the importance of the friction of the mercury.

It is to be understood that the invention is not limited to the few examples above described and a large number of arrangements can be devised based on the same principle and consequently are included in the scope of the invention.

HENRI LOUIS BURNAT.