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F. M. M. B. SALOMON
OSCILLATION DAMPING MEANS
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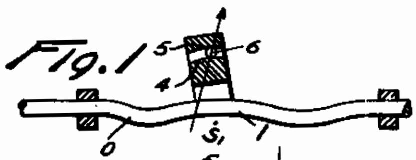

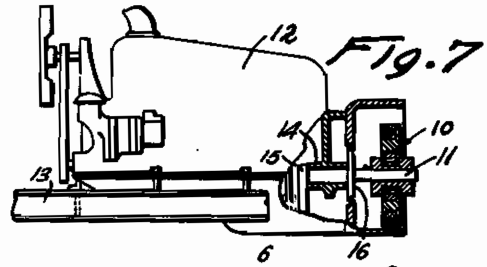

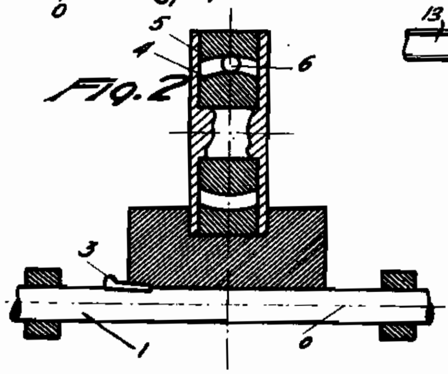

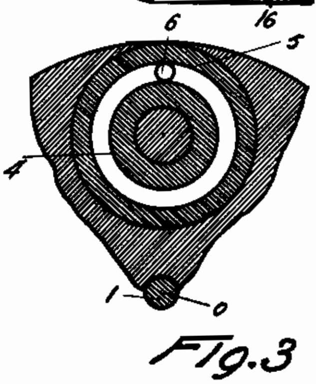

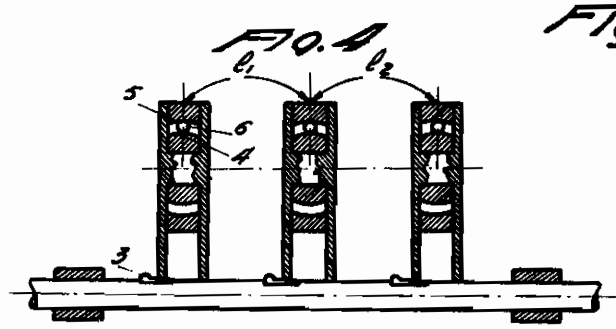

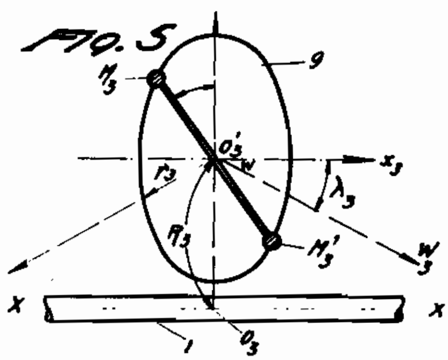

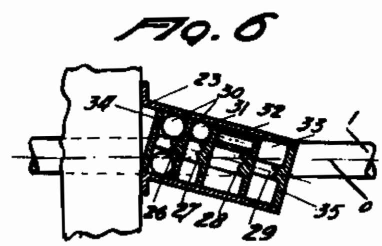

INVENTOR
Francois Marie Michel Bernard Salomon
BY
F. Bascom Smith
ATTORNEY

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ALIEN PROPERTY CUSTODIAN

OSCILLATION DAMPING MEANS

Francois Marie Michel Bernard Salomon, Paris, France; vested in the Alien Property Custodian

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My invention has for its object devices adapted to eliminate or to reduce the vibrations in machine parts submitted to disturbing, chiefly periodical, forces. More particularly these devices are adapted to eliminate or to reduce the flexional oscillations or transversal vibrations of shafts, said oscillations or vibrations appearing alone or together with other oscillations or vibrations such as torsional oscillations of the shaft considered.

These devices are based on the use of auxiliary centrifugal pendular masses, the centrifugal forces being produced by the rotation of the shaft on which are mounted the movable masses. The auxiliary masses may rock in a manner such that their speeds of oscillation have a component parallel to the axis of the shaft and, to this end, the auxiliary masses may rock in planes parallel to the axis of the shaft or passing through same, or oblique with reference to said axis. The auxiliary masses may also rock after the manner of spherical pendulums or pendulums oscillating in space.

Under such conditions, the movements of the auxiliary masses may oppose different vibrations in the machine parts and chiefly flexional oscillations of the shaft, or else simultaneously, torsional and flexional oscillations of said shaft.

I have proved it is of essential interest to make use of auxiliary solid masses, which are not submitted to elastic action, such as the action of springs nor to frictional action, and which are moreover entirely free.

It is often of advantage for the movements of the auxiliary masses to be a rolling motion. In fact, the auxiliary masses may themselves form rolling parts rolling directly on races integral with the shaft generating the centrifugal forces.

These races may show a simple or a double curvature and the auxiliary masses may move without sliding on their races after the manner of pendulums in space.

It is of interest for obtaining the maximum efficiency against periodical disturbing forces, to provide certain constructional conditions which are substantially equivalent for the auxiliary centrifugal masses to conditions of resonance with reference to the disturbing forces.

In other words, the system of auxiliary masses must, under the action of centrifugal forces, have natural periods such that at least one of them has a value at least approximatively equal to one at least of the periods of the disturbing forces. Generally speaking, the auxiliary masses may have any shape. However, when rolling auxiliary masses are used, their rolling surfaces, directly carried by these masses, are advantageously surfaces of revolution and, in particular, cylindrical or spherical surfaces.

More particularly, the auxiliary masses or certain of them may be completely formed by bodies of revolution and, in particular, by cylinders or spheres.

If the shaft generating the centrifugal forces carries races on which the auxiliary masses roll, these races are advantageously of cylindrical shape and may, for instance, be ring-shaped or else they may form spheres or portions of spheres.

I may also use movable ring-shaped masses cooperating advantageously with cylindrical races or else spherical or ball-shaped movable masses cooperating with spherical races.

In accompanying drawings, Fig. 1 shows diagrammatically a half cross-section of an arrangement adapted to reduce the vibrations of machines and more particularly flexional oscillations of shaft 1 having an axis 0.

Fig. 2 is a corresponding view of a modification and Fig. 3 is a cross-section of the same perpendicular to the plane of Fig. 2.

Fig. 4 shows how a plurality of such arrangements may be mounted on a shaft.

Fig. 5 is a diagrammatic view relating to the case where two identically shaped interconnected masses are equilibrated with reference to their axis of rotation and move in a plane oblique with reference to a shaft 1.

Fig. 6 shows the mounting on a shaft of several rolling masses moving in planes oblique with reference to the axis of the shaft.

As shown in Fig. 1 a mass 6 may oscillate while it rocks on an incurved race, which may in fact show a double curvature the concavity of which is directed towards the shaft. The mass may rock in a main direction incurved in the direction of the shaft and lying approximately in a plane parallel to the axis 0 of the shaft 1 or else in a plane containing this axis. The mass may however also execute at the same time different movements in different directions and in particular a pivotal motion around its own axis. I obtain thus an arrangement adapted to reduce flexional oscillations. The mass 6 is shown by way of example as a ball. It may produce, during oscillation, varying torques with reference to the virtual axis S_1 and if the proportions are suitably chosen with reference to the conditions of resonance, these torques may act against the causes which have a tendency to produce transverse oscillations of the shaft.

The mass 6 acting as a pendulum in space or a spherical pendulum may be efficient both against flexional and torsional oscillations of the shaft 1.

In the case of Fig. 2 the oscillating system which protects the shaft 1 against periodical disturbances of period T, comprises an inner guiding stubshaft carrying a part showing a substantially torus-shaped surface 4 having a double curvature. This part guides a ball 6 rolling under the action of the centrifugal forces over the outer double curvature surface **5**. These elements are shown in section in Fig. 3. Washers prevent the ball from escaping laterally.

Fig. 4 relates to the case where a certain number of devices similar to the device just mentioned are arranged along the shaft **1** at distances l_1, l_2 . . . from one another, which distances may be equal or not. These devices give the shaft a sort of centrifugal rigidity similar to the well known gyroscopic rigidity.

I have shown in Fig. 4, the double curvature races **5**, the balls **6** and the inner guiding surfaces **4**. The different members are secured through keys **3** to the shaft **1**.

Fig. 5 shows two equal masses M_3 and M'_3 rigidly secured together and adapted to oscillate along the circle **9** the radius of which is r_3, to either side of their position of equilibrium under the action of the centrifugal forces generated by the rotation of the shaft **1**. The normal $0'_3w$ to the circle **9** at its center $0'_3$ forms an angle λ_3 with the axis $0'_3x_3$ parallel to the axis XX' of the shaft **1**. I will suppose $\overline{8_3 0'_3} = R_3$, $0_3 8'_3$ being perpendicular to XX'.

The frictional stresses being supposed negligible, I have shown analytically the optimum or tuning condition is:

$$\frac{W}{u'} = \sin \lambda_3$$

u' being the angular speed of the shaft **1** and w the pulsation of the disturbing torsional torque acting on shaft **1**.

For eliminating certain disturbances, it is of advantage to use movable masses according to invention which are adapted to rock inside a tube the axis of which is arranged obliquely with reference to the axis of the shaft the rotation of which generates centrifugal forces.

Fig. 6 shows such a tube **23** in horizontal projection with the stubshafts **26—27—28—29** contained therein. These stubshafts guide respectively the balls **30—31**, the tubular roller **32** and the solid rollers **33**.

The tube is closed by washers or partitions **34** and **35**.

Obviously the different systems described may be arranged at any points of the shafts to be protected against irregularities of angular speeds or vibrations.

Thus, for instance, a flywheel provided with such devices may, in an automobile motor, be placed in front of the motor, near the starting crank or else near the clutch at the point where the shaft passes out of the motor or else in the middle of the motor.

However for an efficient elimination of the oscillations of the crankshaft, it is often of interest to place the different arrangements according to my invention near the points where the oscillations arise, i. e. near the head of each connecting rod.

FRANÇOIS MARIE MICHEL
BERNARD SALOMON.