PUBLISHED
MAY 4, 1943.
BY A. P. C.

F. M. M. B. SALOMON
OSCILLATIONS REDUCING DEVICE
Filed May 14, 1940

Serial No.
335,081
6 Sheets-Sheet 1

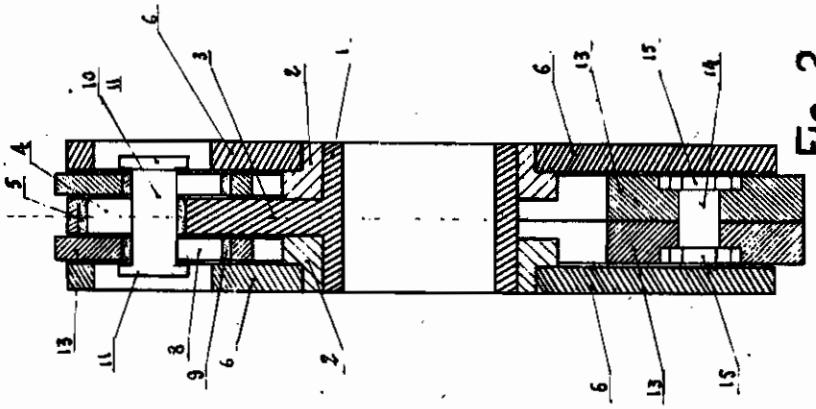

Fig. 2

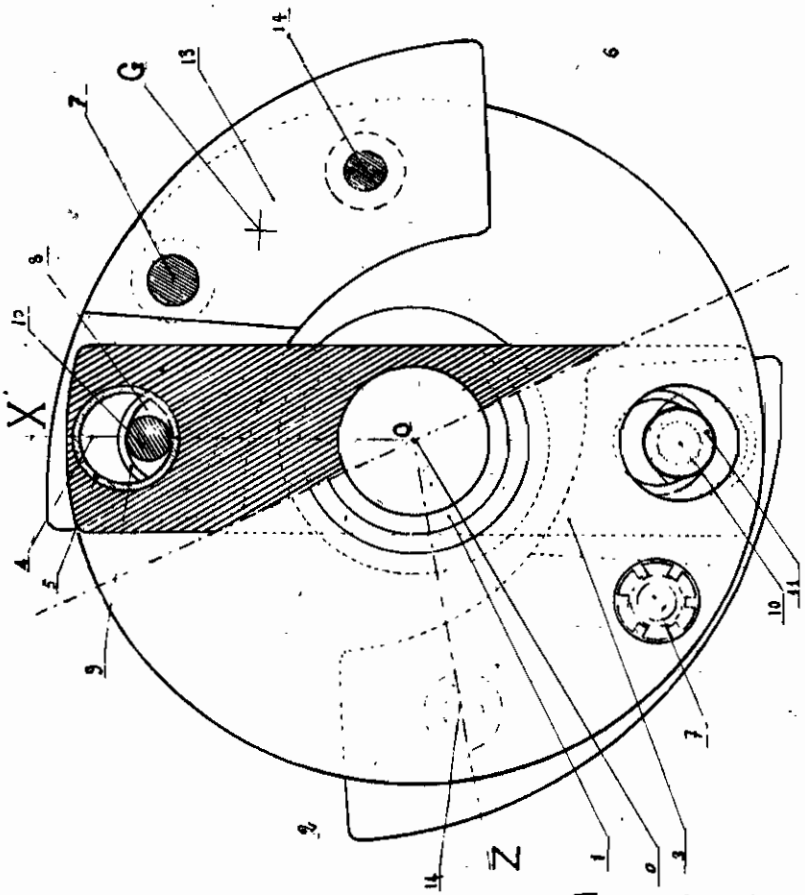

Fig. 1

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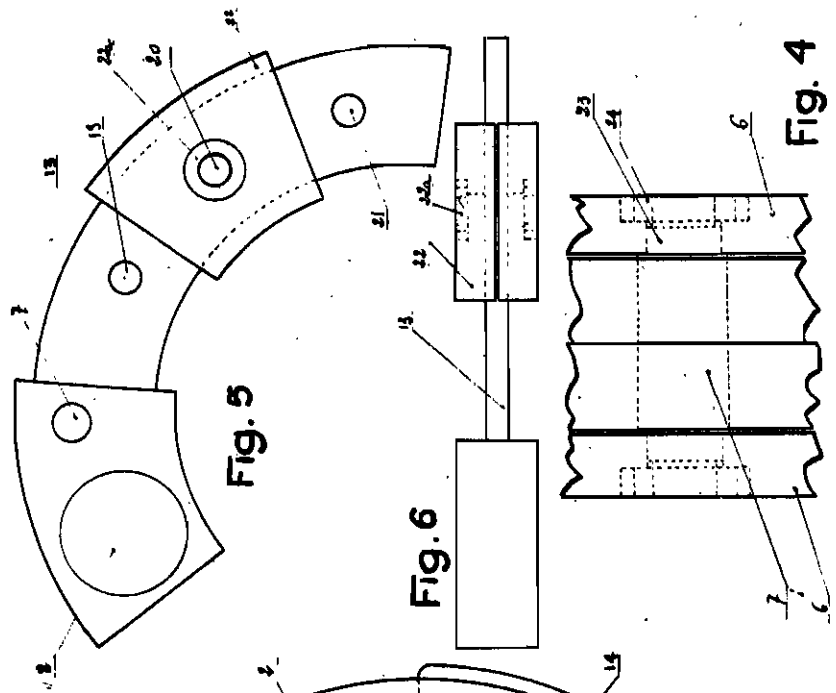

Fig. 5

Fig. 6

Fig. 4

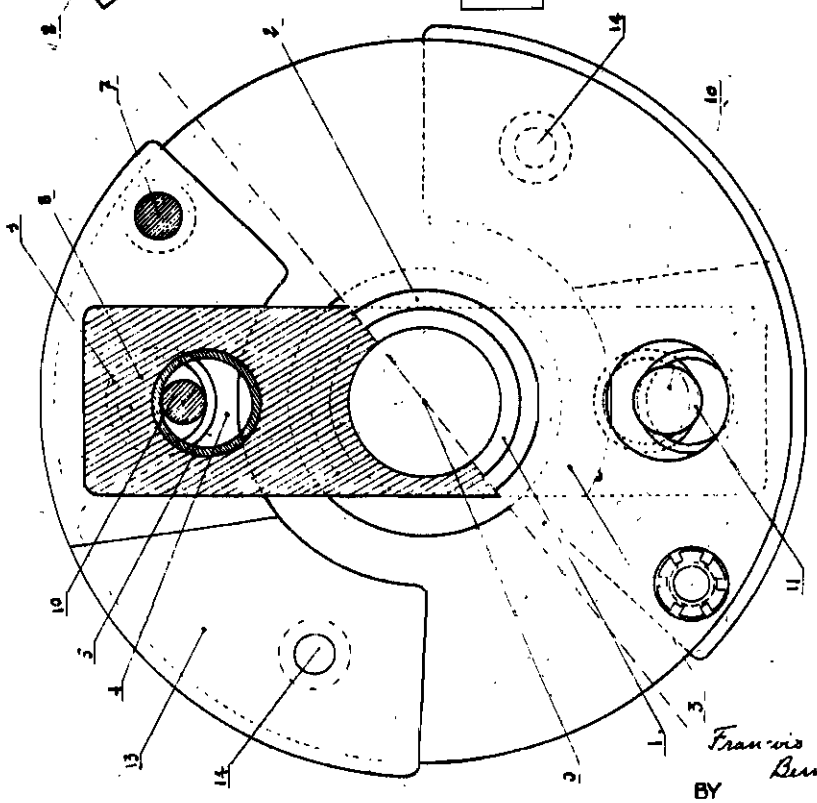

Fig. 3

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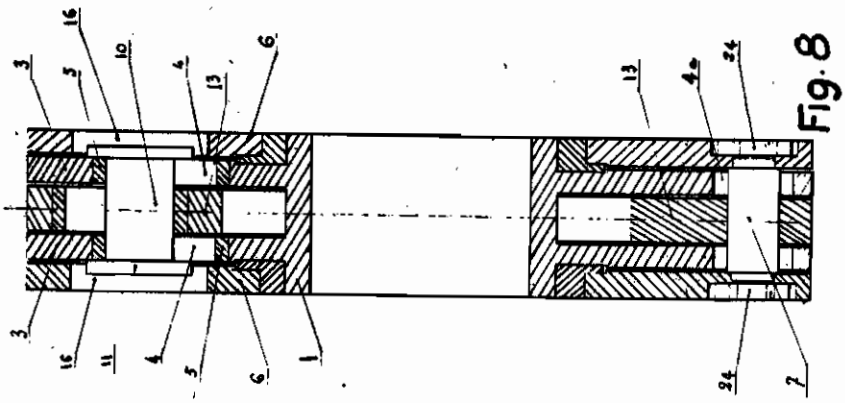

Fig. 8

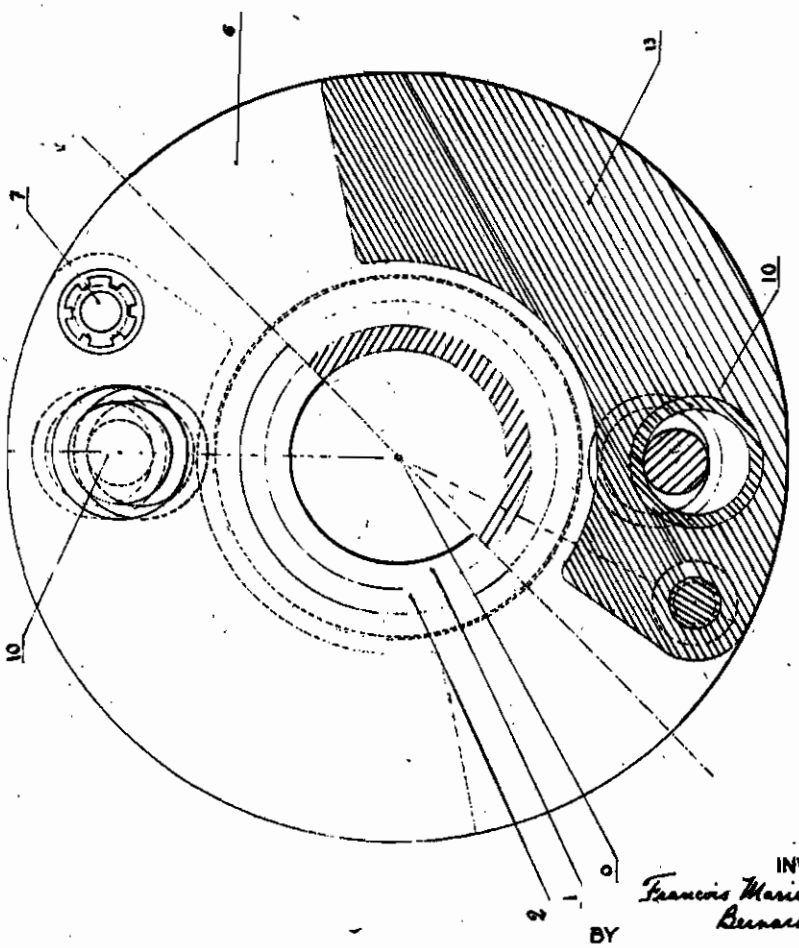

Fig. 7

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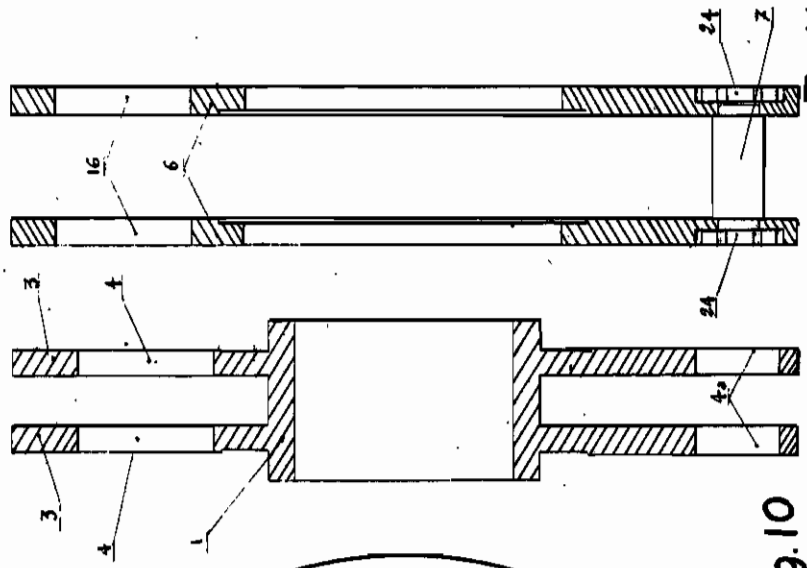

Fig. 11

Fig. 10

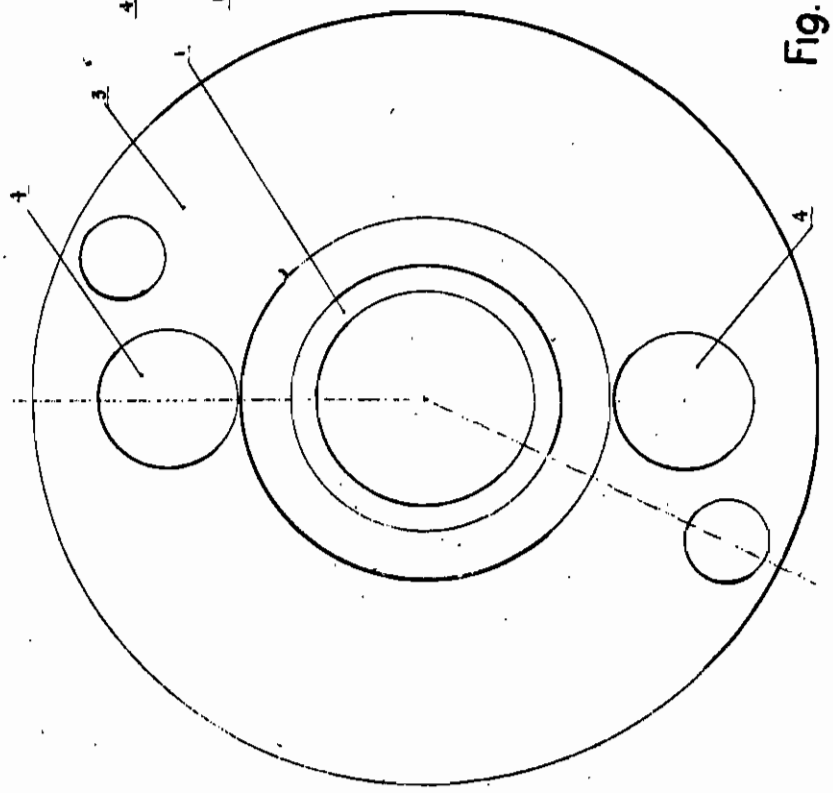

Fig. 9

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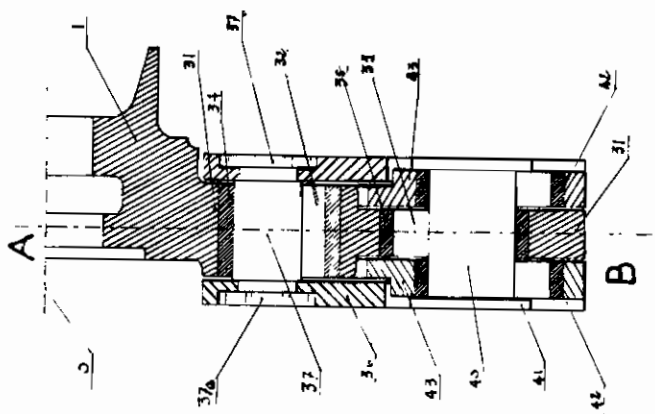

Fig. 14

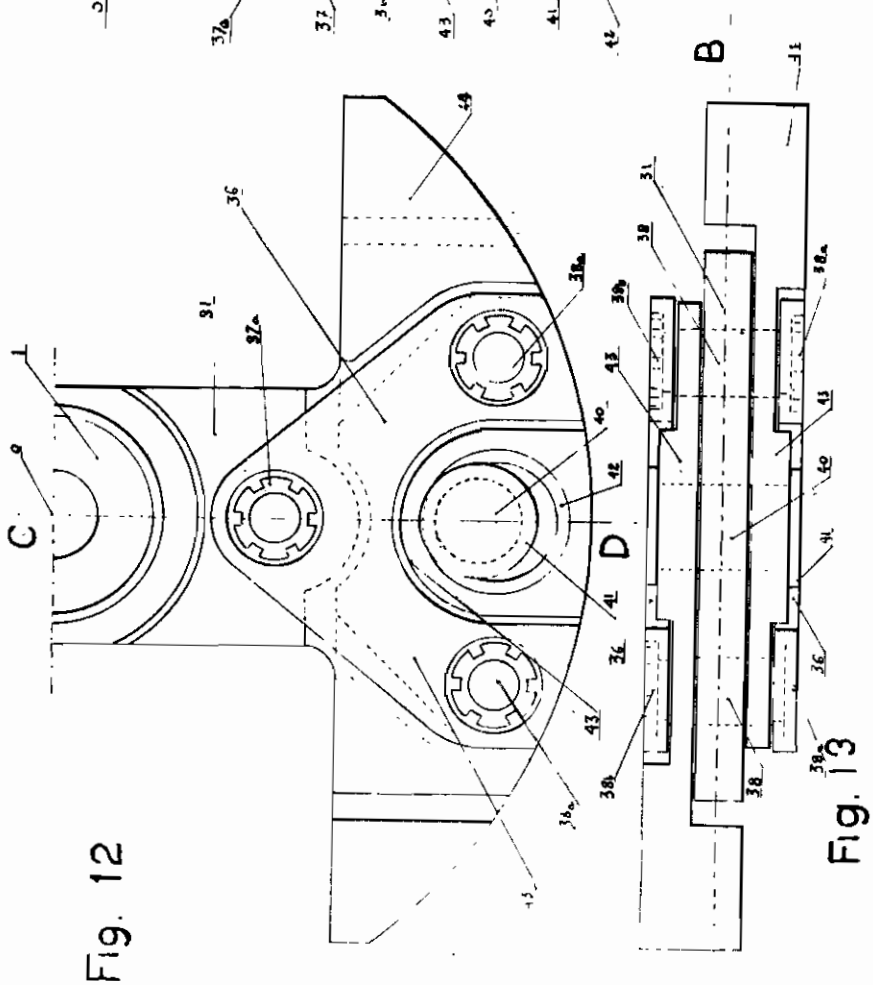

Fig. 12

Fig. 13

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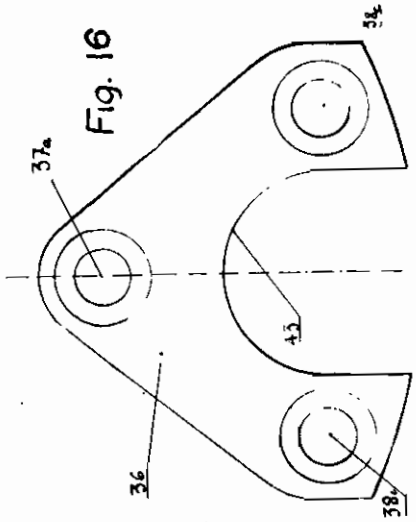

Fig. 16

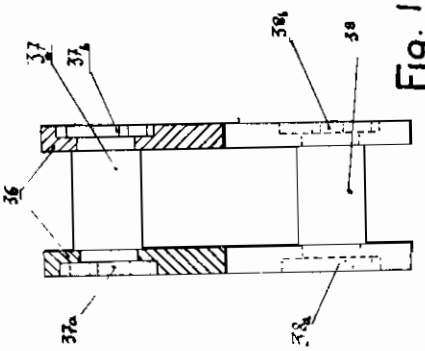

Fig. 17

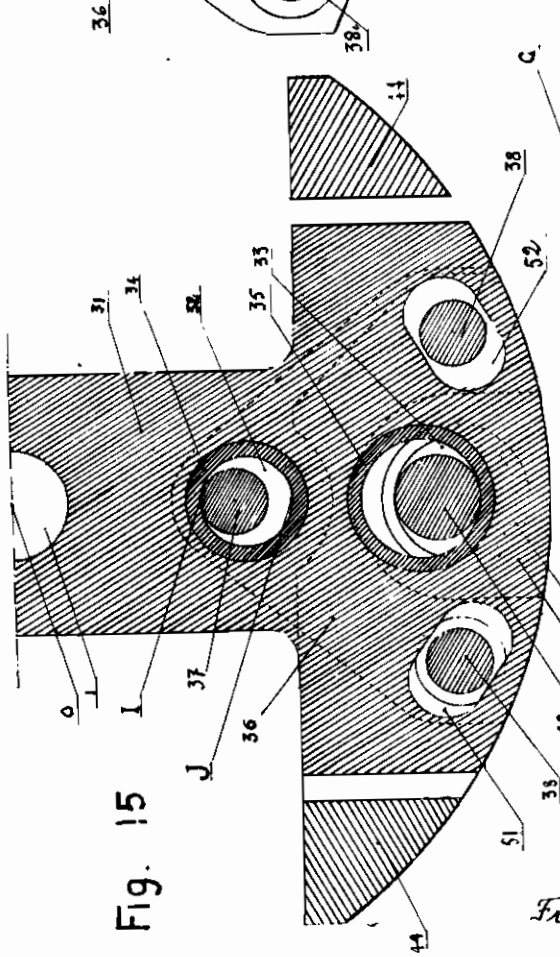

Fig. 15

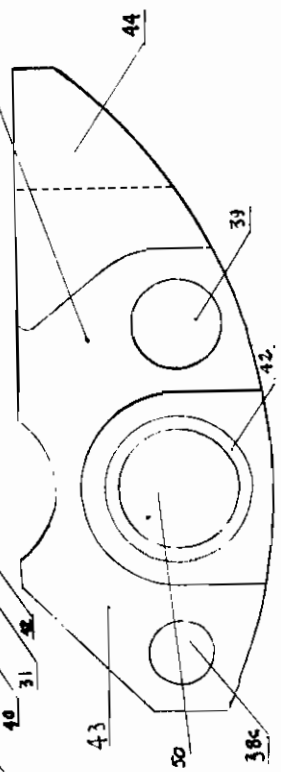

Fig. 18

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ALIEN PROPERTY CUSTODIAN

OSCILLATIONS REDUCING DEVICE

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

Application filed May 14, 1940

My invention relates to devices for reducing speed oscillations, in general, vibrations and jerks in the members of any structures but more particularly in machine shafts.

It is applicable to the damping of torsional, flexional and lateral oscillations, etc.

The devices according to my invention can be placed in any part of the machines, and, namely, of the machine shafts, for instance, at the front or at the rear of the crankshafts, in the crankshafts, in engine balance-weights, on ventilators or ventilator pulleys, in the arrangements of connecting rods, in propeller hubs, on aero shafts, on marine shafts, etc.

The devices according to my invention are absolutely different from the centrifugal pendulums already used as vibration dampers.

Indeed, in the centrifugal pendular systems, the auxiliary centrifugal masses are submitted to the restoring force of the centrifugal forces acting on themselves.

On the contrary, a device according to my invention comprises at least one member rotatively carried with a shaft, rocking under the action of the disturbances, and restored to its mean position by at least one centrifugal restoring member carried by said oscillating member and resting on a member rotatively movable with the shaft, and, more particularly, integral with said shaft: the reaction of this part is the force which produces the restoring force.

In those conditions, the force restoring the oscillating member to its mean position is due—not, as in the case of centrifugal pendulums—to the action of the centrifugal forces acting on the masses themselves, but entirely, or almost entirely, to the restoring forces due to the action exerted by the restoring member carried by the oscillating member.

The centrifugal restoring member is more particularly acting as a restoring lever, whereof the axis is carried by the oscillating member, and restores it to its mean position by resting on a member integral with the rotary shaft.

In general, the restoring member is effectively a lever (of the 1st, 2nd or 3rd gender) but the same can also act differently, for example as cam, ramp, screw, etc.

The oscillating member can be centered or not on the axis of the shaft which creates the centrifugal forces, shaft which can or cannot be the shaft submitted to the disturbances.

The oscillating member can be, namely, a plate, a disk, or a fraction of disk or a flywheel. (In a general way, it may be called: "Harmonic disk", even if, propery speaking, it is not affecting a shape of "disk".)

Its working is entirely different from the one of centrifugal pendulums, as it has already been seen.

It has been known, at least for twenty five years, that in any device intended for regularizing the torques, it may be advantageous to realise, more or less exactly certain "tuning" conditions between the frequency of the disturbances and the natural frequency of the oscillating masses.

It is quite obvious that the advantage of this "tuning" is also existing in general, for the devices according to my invention, the natural frequency of the oscillating weight member being the one resulting from the action of the restoring member in determined conditions.

The connection between the restoring member and the corresponding oscillating member can be of any nature; cylindrical or spheric articulations, cams, balls or rollers (any rolling body, connecting rods, chains, etc.).

According to my invention, the oscillating member is preferably rocking with little or very little friction; preferably, also, the restoring effects are substantially due solely to the action of the centrifugal forces, without elastical means.

However, the scope of my invention would not be exceeded, in the case when frictions or elastical means, fluid means, etc. would be used, either for the restoring of the mass, or for any other reason.

The advantages of the devices which the invention has for its object relatively to the known devices, and specially to dampers utilizing centrifugal pendulums, are very considerable and that for many different reasons.

Those advantages can be substantially summed up as follows:

(1) They can be very easily adapted to the elimination of the lowest and highest harmonics.

(2) They are more efficient than the known dampers and, specially, than the dampers with centrifugal pendulums, in given conditions and for a given weight for the oscillating members.

(3) They enable to utilize to the best and, in the simplest conditions, the available room;

(4) The conditions of resonance are depending of numerous and very different factors, which gives great facilities;

(5) For given conditions, they are efficient until rotation speeds much lower that all known dampers.

(6) They avoid the use of noisy abutments and their working is always absolutely noiseless.

(7) They are of a very simple construction and of a very low cost price.

(8) They afford in a very simple and efficient manner the elimination of two or several harmonics, simultaneously, with only one oscillating member and this often in better conditions than the known devices.

Certain constructions in accordance with my invention are, by way of example non limitative, illustrated diagrammatically in the accompanying drawings, of which:

Figs. 1 to 11 inclusive, relate to devices comprising an oscillating member centered on the axis of the shaft; the following figures refer to an oscillating member which is not centered on said axis.

Fig. 1 gives a partial front-view and a partial cross-section of a device centered on the axis of the shaft 1, of which Fig. 2 is a cross-section.

The oscillating member 6 (Figs. 1 and 2) is a cylindrical disk formed by two cheeks connected by the axis 7 forming stays and centered on the rings 2, (of steel, cast iron, bronze or any other metal) which are themselves centered on the shaft 1. (Those rings could be replaced by any bearing of a known type, ball, roller, needle bearing, etc.)

The mass 6 carries the axis 7 for the masses 13 shaped as circular crowns, acting, relatively to the mass 6, as centrifugal restoring levers restoring said mass to its mean position, when it moves away to the right or to the left, under the action of the disturbances.

In order to obtain said restoring action, the levers 13 are resting on the web 3, integral with the shaft 1, which has in Fig. 1 a rectangular shape, but could have any other shape, and namely the shape of a cylindrical plate.

This web is provided on one hand, at 180° with cylindrical recesses 4 fitted with rings 5, and, on the other hand, the restoring levers 13 are provided with corresponding cylindrical recesses 8, fitted with rings 9.

Rings 5 or rings 9—or still, rings 5 and rings 9—are preferably loose in their housings.

The two restoring devices of the rocking mass 6 (rocking disk) being symmetrical relatively to the axis 0, it is sufficient to describe one of them (top of Fig. 2).

A roller 10 whereof the cheeks are 11 is resting at the same time on rings 5 and 9 and acts as an intermediate member between the mass 6 and the restoring lever 13. It is capable of double rolling motion without sliding, or without substantial sliding motion on those rings.

As regards this lever, it is provided with two cheeks connected by stays 14, (Fig. 2) whereof the bolts are 15.

The working is as follows: under the action of the disturbances, the disk 6 rocks about a mean position, and the restoring levers 13 are restoring it to said mean position.

Indeed, if for instance the lever 13 of the top of Figures 1 and 2 is considered, the resultant of the centrifugal forces created by the rotation of the shaft acts on its center of gravity G and is always tending to make this lever 13 turn around its axis 7 in the opposite than the one of a hand-watch.

Consequently, the lever 13 rests on the roller 18 by its ring 9, and through its intermediary, rests on the ring 5 of the recess 4, so that it always tends to restore the mass 6 to its mean position.

Of course, the working is the same for the symmetrical restoring system: the two restoring actions are added, while the two radial components of the restoring efforts are opposite and equal.

The result is that the pressure on the disk 6 on its centering bearings 2 is very small.

The device represented in Fig. 3 is only differing from the previous one for the restoring lever is acting on the rocking mass 6 (disk 6) by traction on the disk, instead of acting on said mass by pushing as in the device of Figs. 1, 2.

The inversion of this action is achieved by inverting the disposition of the restoring lever 13 (Fig. 3) where the centrifugal forces are tending to make this lever turn around its axis 7 in the same direction than the one of a hand-watch.

No side-view of the device of Fig. 3 has been given as those represented in Fig. 2 are sufficient to make the structure of this device understood; it is quite similar to the one of the device of Figs. 1 and 2.

Fig. 4 shows, in detail, the axis 7 of a restoring lever; this axis can be seen to be carried by the two cheeks 6 and fixed by screws 24.

In all cases, and for any arrangements—if it refers to the ones already described or to the ones which will be described further on—it may be advantageous to gradually regulate the restoring action of the levers such as 13.

This can be achieved by displacing the center of gravity, for instance by moving a slide which can be fixed at will on any part of the lever.

Figs. 5 and 6 show the slide 22 which can be fixed, through the intermediary of a bolt 22_a in various points 19, 20, 21, etc. in any number (three only have been represented).

The position of the center of gravity could be changed by any other means, for instance, by mounting an appropriate number of plates of a suitable thickness clamped by bolts, on the lever.

The principles are quite similar regarding the device represented in Figs. 7, 8 and of which the main parts are shown in Figs. 9, 10, 11.

The rocking mass 6, constituted by two cylindrical cheeks, as above, is also carrying the axis 7 for the restoring levers 13. The web 3, is constituted by two cylindrical plates integral with the shaft 1 and provided with holes 4_a through which the axis 7 (Figs. 9 and 10) are passing.

According to Fig. 10, the two plates are integral with the shaft 1.

Fig. 11 shows, aside, the rocking mass 6 constituted by two plates connected by stays; the axis 7 of the restoring levers are namely acting as stays.

Fig. 12 is a front-view of a device according to my invention, mounted on the balance-weight of a machine shaft; said machine could be, namely an engine, for any application (radial or line engine, etc.).

Fig. 13 is a bottom view; Fig. 14 a section by the plane CD of Fig. 12; Fig. 15 a section by the plane AB of Fig. 13.

It is convenient to refer at the same time to Figs. 12, 13, 14, 15.

The shaft 1 whereof the axis is O, is integral with a web (or arm 31), in which are bored (Fig. 15) two recesses 32 and 33 fitted with rings 34 and 35, preferably of tempered cemented steel.

Preferably also, the ring 34 is forced into the web; the ring 35 can be loose.

The oscillating member 36 carried, as in previous devices, restoring levers restoring it to its

mean position, when it moves away to the right or to the left, under the action of disturbances.

Said rocking mass is constituted by two plates shown aside in Figs. 16 and 17 and connected by three stays forced into the plates, and even eventually keyed on them, and consequently, unable to turn relatively to them.

One of those stays is constituted by the cylinder **37** (Fig. 17); the other two by the cylinders **38** (Figs. 15 and 17). The bolts 37_a, 37_b, 38_a, 38_8 are completing the arrangement (Fig. 17).

The cylinder **37** (Fig. 17) is engaged into the recess **32** of the web **31** (Figs. 14 and 15) and constantly lifted up by the restoring levers on the side of the axis, and, in those conditions, it is constantly bearing against the generatrice I of the ring **34** (Fig. 15).

The two other stays act as axis for the restoring levers **43**, visible on Figs. 12, 13, 14, 15, and shown aside in Fig. 18.

Each of those restoring levers (Fig. 18) is constituted by a long plate, having one extremity thicker **44**, as it can be seen, in Fig. 13, which tends to make the center of gravity of the lever go away from its axis carried by the oscillating member **36**.

This axis is constituted by one of the stays **38** (Fig. 13 and 17) and, to ensure the centering of the lever on said axis, the lever **43** is provided with cylindrical hole 38_c (Fig. 18) which could be fitted with a ring.

Besides, the lever **43** is presenting a recess **50** (Fig. 18) fitted with a ring **42** and a hole **39**. This hole let pass the axis **38** corresponding to the second restoring lever, placed symmetrically on the other side of the balance-weight, as shown in Fig. 13.

In effect, this figure shows that one of the restoring levers **43**, the one on the front, is articulated on the left cylindrical stay **38**, while the restoring lever at the back is articulated on the right cylindrical stay **38**.

The hole **39** let this last stay pass.

Likewise the long holes **51** and **52**, bored in the web **31** (Fig. 15) let pass the two axes **38**, when the member **36** is rocking.

As to the recess **50** (Fig. 18), the ring **42** transmits the restoring action to the rocking mass **36**, through the intermediary of the roller **40**, whereof the cheeks are **41** (Fig. 14).

The working is as follows: the mass **36** rocks about its mean position in a plane perpendicular to the axis of the shaft, under the action of the disturbances and under the restoring action of the levers **43** of which, as it has been seen, the mass **36** carries the axis.

The action of those levers is the following: each of them, under the action of centrifugal forces, exerts a pressure on the roller **40**, and, through the intermediary of said roller, a pressure on the wall of the recess **33** (on the ring **35** of this recess **33**) carried by the web **31**.

Consequently, said web **31** is exerting a reaction. Said reaction of the web is always tending to bring back to its mean position the structure constituted by the member **36** and the restoring levers **43** carried by the member **36**.

The reactions due to the two restoring levers give restoring torques which are added one to another and forces directed towards the axis O of the shaft, which are tending to send the mass **36** to the side of said axis; it results that the cylindrical stay **37** bears on the generatrice I (Fig. 15) with a force equal to the difference of this radial component due to the web and the centrifugal force exerted on the structure constituted by the member **36** and the restoring levers **43**.

So, the oscillating member **36** is rolling with direct rolling on the ring **34** around the generatrice I.

So the working is substantially the same that in the case of the previous figures, where the oscillating member is centered on the axis O of the rotary shaft **1**. with the only difference that the oscillation around the generatrice I (or around generatrices quite close to the generatrice I) replaces the oscillations around O.

This operation is quite different from the one of pendular systems.

The restoring torque thus obtained is depending of very varied factors, such as: positions and dimensions of the recesses, relative values of the diameters of the rings and of the roller **40**, weight of the rocking mass **36**, radius of gyration of said mass, weights of the restoring levers, position of the center of gravity of each of those restoring levers, etc.

As a different embodiment, the restoring levers can rest on the web **31** in the opposite direction, the reaction of this web tending, on the contrary to keep the movable structure away from the axis O of the shaft **1**.

In this case, the cylinder **37** rocks while rolling around the generatrice T of the ring **34** (Fig. 15), the working being substantially the same.

As a particular case, the axis I can coincide with the axis O; the centering of the oscillating member **36** on said axis can be achieved, as it is shown in Figs. 1, 2, 3, or by any known process, eventually using ball, roller, needle bearings, or any rolling device.

Besides, for the purpose of compensating flexional or lateral oscillations, similar devices can be used, but in which the oscillating member is rocking, not in a plane perpendicular to the axis of the shaft, but in a plane of any orientation relatively to said axis, namely, containing it.

The previous devices can, in many cases, be tuned simultaneously on two or several harmonics.

The described devices could be varied without exceeding the scope of my invention.

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