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R. MATTEUCCI

UNIVERSAL DAMPER FOR THE TORSIONAL VIBRATIONS OF COAXIALLY REVOLVING SHAFTS

Filed Nov. 16, 1939

Serial No. 304,835

3 Sheets-Sheet 1

Fig. 1

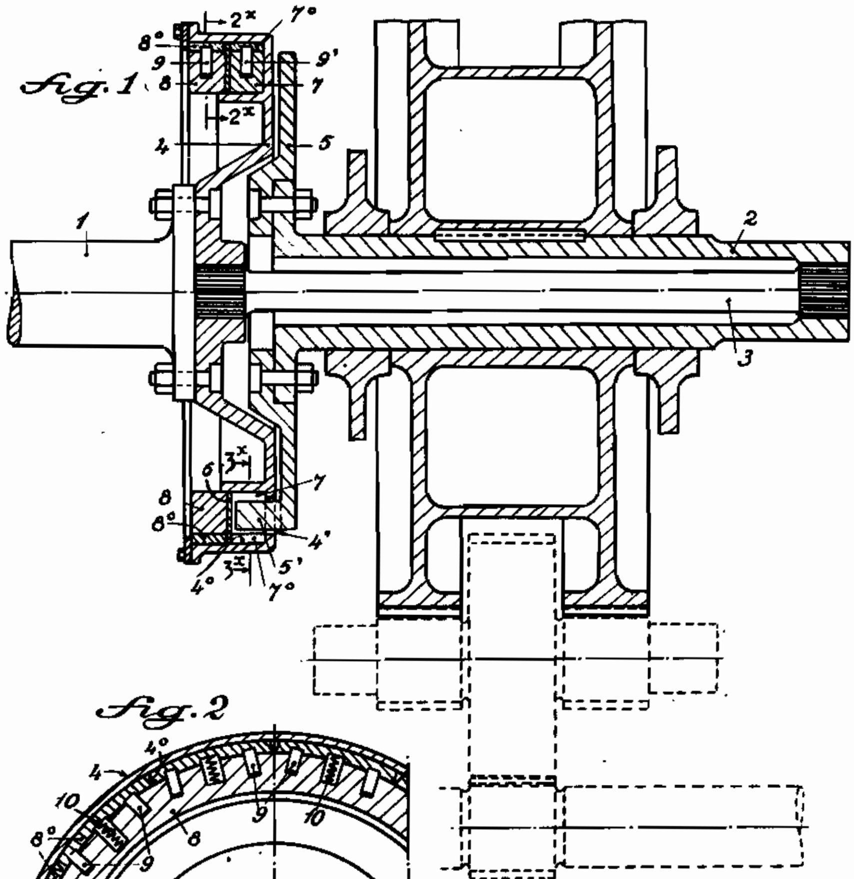

Fig. 2

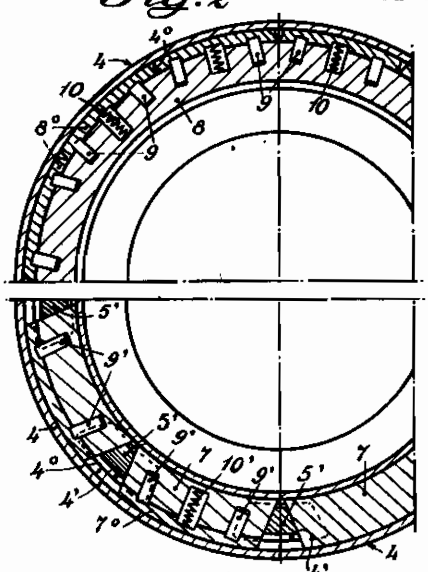

Fig. 3

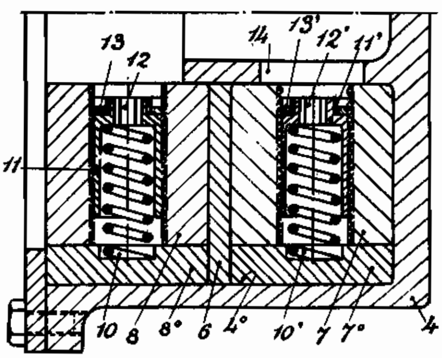

Fig. 4

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Fig. 5

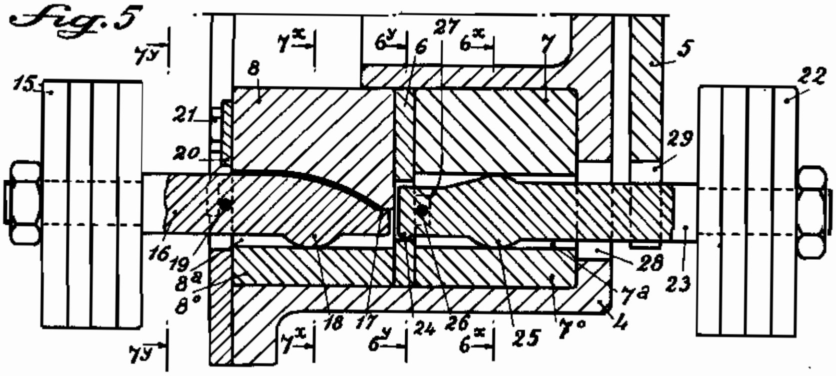


Fig. 6

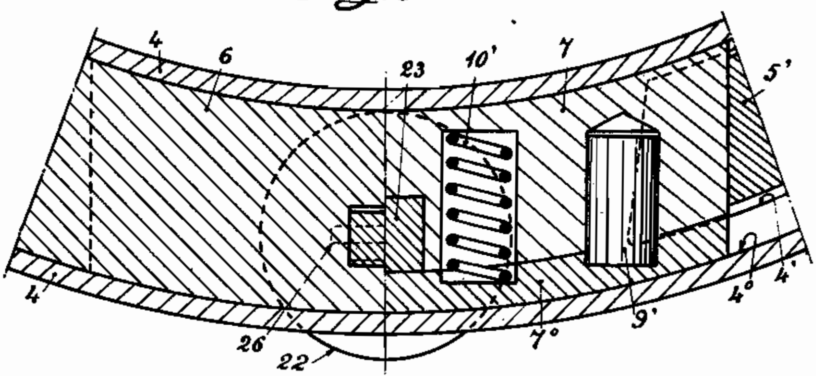


Fig. 8

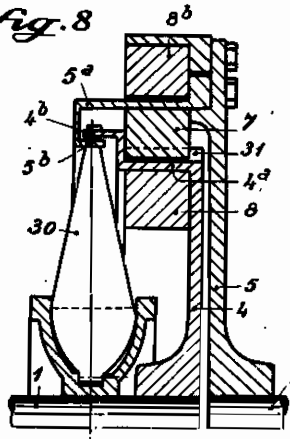
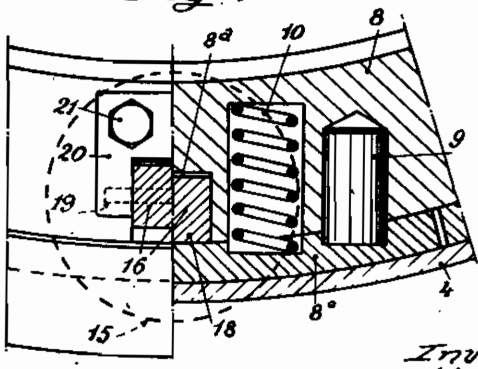


Fig. 7



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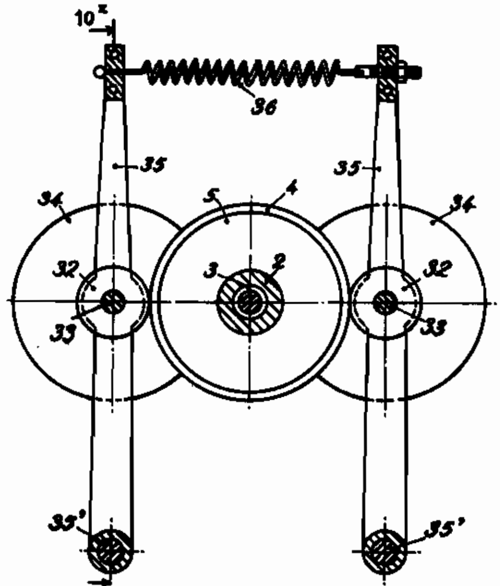


Fig. 9

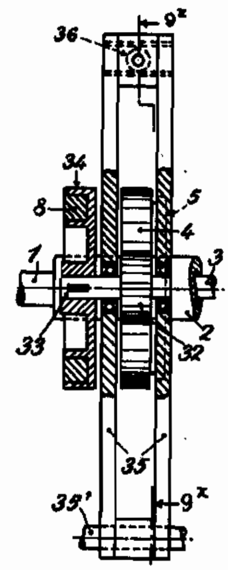
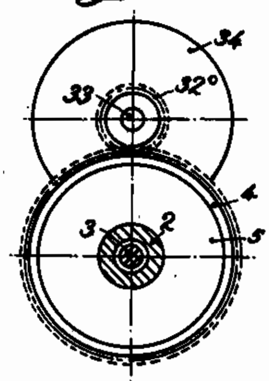


Fig. 10

Fig. 11



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ALIEN PROPERTY CUSTODIAN

UNIVERSAL DAMPER FOR THE TORSIONAL VIBRATIONS OF COAXIALLY REVOLVING SHAFTS

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Application filed November 16, 1939

Dampers of the torsional vibrations of rotating shafts are known in which the passive work for the damping effect, done at the expense of the energy transmitted by them, is effected in dependence on angular displacements of masses, with regard to the shaft, set up by their inertia reactions to the disturbances of the rotary motion set up by the said torsional vibrations.

It is also a known practice to fit to the resilient joints of revolving shafts, dampers of the oscillatory deformations of the resilient parts producing passive work at the expense of the said deformations.

Neither of these types of damper is able to damp out all the torsional vibrations of shafts. The former damp out only those vibrations which present to them the loop zone in which, as it is known, the rotary motion of the shaft is disturbed angularly, whilst they are not responsive to those vibrations which present to them the node where the rotary motion is not disturbed. The latter behave in exactly the opposite manner, being, that is, quite insensible to those vibrations which occur to them in the loop, as they do not modify the couple acting on the resilient joint, but come into action if, at the point at which they are mounted, there happens to be a node or a prevalently nodal zone of vibrations, as in such zones the torsional vibrations develop in the shaft torsional stresses.

Now the present invention has for its object the creation of a damper capable of acting universally on all torsional vibrations whether in a node or nodal zone, or in a loop or loop zone. Another object of the invention is to automatically vary the intensity of the damping effort in direct ratio to the variations in the speed of rotation. Yet another object is to be able to regulate the sensitiveness of the damper, while yet a further object is to be able to regulate this sensitiveness independently for the vibrations which act upon the damper in the loop zones and for those which act on it in the nodal zones.

This damper, which forms a group intended to be inserted between two coaxially rotating shafts, one driving and the other driven, is characterized by a selector consisting of an elastically deformable member mounted on the centre line of the shafts in such a manner as to be deformed in an oscillatory sense by the vibrations acting upon it with a node or with their nodal components, and by inertia masses angularly moveable around the shaft and arranged in such a way as to be moved in an oscillatory sense by those vibrations which act upon it by a loop or with their loop components; the said selector is in combination with damping members which transform the collected energy into passive work through the oscillatory deformations of the elastic member, and through the oscillatory displacements of the inertia masses.

Thanks to the selector formed by the elastically deformable member and the masses moving by inertia, there are collected on the cynetic energy transmitted along the centre line by all the torsional vibrations without distinction, two distinct and continuous currents of energy which are progressively transformed into passive work by the two transformer damper members, so that all the vibrations, without exception, are damped by the dissipation of the cynetic energy set up in them by the exciting impulses, or by opposing in other manner to the resonance.

This passive work, which can be performed in various ways: by friction, by the throttling of fluids under pressure, etc., will, hereafter, be called "damping effort".

The inertia masses of the selector may be fitted to one or both of the shafts connected by the resilient joint, seeing that the torsional vibrations which present to the damper loop zones produce in both shafts oscillatory disturbances of the rotary motion.

The damping transformer members which produce the damping effort are preferably blocks arranged in a circle coaxially around the shaft; these blocks, under the influence of centrifugal force or a combination of this and the action of springs or other known suitable means, press against the inner surface of an annular member which surrounds them and produce their effect by sliding on is, backwards and forwards, under the influence of the elastically deformable member, or, as the case may be, of the inertia masses.

Some forms of realization of the object of the invention are shown, merely by way of information, in the annexed drawing in which: fig. 1 is a longitudinal section of one form of the universal damper; figs. 2 and 3 are partial cross sections on the lines $2x$—$2x$ and $3x$—$3x$ of fig. 1; fig. 4 shows, on a larger scale, in longitudinal section, one form of execution of the damping members fitted with adjustable elastic means for regulating the intensity of their action; fig. 5 shows, still to a large scale, in longitudinal section, a form of execution of the damping organs provided with centrifugal means of regulating the intensity of their action; fig. 6 is, in its right half, a section on the line $6x$—$6x$, and in the left half, a section on the line $6y$—$6y$ of fig. 5; fig. 7 is, in the right half, a section on the line $7x—7x$, and in the left half, a section on the line $7y—7y$ of fig. 5; fig. 8 shows in longitudinal section a second form of the universal damper; fig 9 shows a modification in cross section on the line $9x—8x$ of fig. 10; fig. 10 shows a section on the line $10x—10x$ of fig. 9; fig. 11 shows in cross section another modification. In all these figures the same numbers are used to denote similar or corresponding parts.

In the form of execution shown, by way of example, in Fig. 1, the damper is applied on the line shafting of a turbine driven ship. The propellor shaft 1 is driven round by the shaft 2 of an ordinary reducing gear driven by the turbine. In this application, the driving torque being constant and the resistant or load couple being also substantially constant and only disturbed by the rythmic impulses of the screw in the water, the amount of cynetic energy transmitted by the torsional vibrations is relatively small and therefore the elastic deformable member which serves to select and collect by its deformations the cynetic energy of the vibrations acting with a nodal character, has but a slight elastic work to perform. It is therefore constituted only by a bar 3, stressed by the driving torque to a high specific torsion load and which therefore effects fairly ample torsional deflections in consequence of the disturbances of the rotary moment set up in it by the torsional vibrations of nodal character. This bar 3 is arranged inside the shaft 2 of the reducing gear, which is hollow, and coaxially with it; its right hand end engages angularly with the shaft 2 by means of grooves and its left hand end engages in a similar manner with a hub of a drum 4 fixed to the end of the propellor shaft 1. At the left hand end of the reducing gear shaft 2, opposite the bottom of the drum 4, is fixed a disc 5 which presents a certain number of teeth 5′ regularly spaced and projecting from its left face. The teeth 5′, through an equal number of slots 4′ in the bottom of the drum, penetrate for a certain distance into an annular recess 4° arranged in the periphery of the drum 4, which recess is preferably divided into two compartments by an intermediate diaphragm 6, loose with regard to the drum. Between the said teeth 5′ are engaged angularly with regard to the centre line of the shaft, but free to move radially, an equal number of friction blocks 7 lodged in one of the two compartments of the recess 4°. These blocks 7, which form together a crown, make contact, with their faces furthest from the axis, with the inner surface of the peripheral recess 4° of the drum against which they are pressed in the manner which will be described later.

The nodal action vibrations disturbing the intensity of the driving torque applied to the elastic member 3, set up in it fluctuations of the deformations of the torsion and consequently cause a corresponding oscillatory displacement of the blocks 7 in the recess 4° of the drum 4. As these blocks are pressed against the inner surface of the recess 4° of the drum by centrifugal force, they produce, in their to and fro sliding on the said surface, the passive damping work on the nodal action vibrations.

Within the said recess 4° of the drum 4 is located, alongside the crown of blocks 7, a loose ring 8 which, reacting by inertia to the disturbances of the rotary motion set up in the drum 4 by the loop action vibrations, moves on it angularly with an oscillating motion. On this ring 8 is fitted a series of blocks 8° retained on the ring 8 in the direction of rotation of moveable pins 9 lodged in substantially radial slots cut partly in the thickness of the ring 8 and partly in the thickness of the blocks 8°, which are thus free to move in a radial direction under the influence of centrifugal force and are pressed against the internal surface of the recess 4° of the drum 4. When, by reason of loop action torsional vibrations, the inertia ring 8 is subjected to oscillatory angular movements with reference to the drum 4, the blocks 8° rub with a reciprocating motion against the inner surface of the recess 4° and perform the passive work of damping the said vibrations. The pressure exerted by the blocks 8° on the inner surface of 4° by the action of the centrifugal force developed in them and on the moveable pins 8, can be eventually integrated by springs 10 also located in suitable recesses in the ring 8 and in the blocks 8°.

The blocks 7 are pressed against the inner surface of the recess 4° by the action of the centrifugal force set up in them during rotation These blocks 7 can be provided, on their periphery, with a friction shoe 7°, similar to the blocks 8° of the inertia ring 8 and similarly retained on the relative block 7 by moveable pins 8′ lodged in slots cut in part in the thickness of the block 7 and in part in the friction shoe 7°. In this case the pressure exerted by the block on the inner surface of the recess 4° is equal to the sum of the centrifugal actions developed in the block 7, in the friction shoes 7° and in the pins 9′. Also in this case the pressure exerted by the blocks 7 can be integrated by springs 10′ lodged in suitable recesses in the block and in the friction shoe.

Thanks to the above described conformation the pressure with which both the blocks 8° of the inertia ring 8, and the blocks 7 with their friction shoes 7° are pressed against the inner surface of the recess 4°, abstraction made of the pressure exerted by the eventual springs 10 and 10′, is furnished by centrifugal force and is therefore proportional to the square of the speed of rotation of the whole, so that also the damping effort is proportional, the displacement of the blocks being equal, to the square of the said speed.

In fig. 4 is represented a form of an execution in which the eventual springs 10 and 10′, both on the inertia ring 8 and on the blocks 7, are adjustable, being mounted in threaded casings 11 and 11′, provided with a hole 12 and 12′ for a spanner, and screwed into threaded seatings 8 and 7 where they are then locked by the lock-nuts 13 and 13′. The aperture 14 made in the drum 4 allows of the passage of the spanner.

In fig. 5 is presented, on the left, the application of additional centrifugal means 15 acting on the blocks 8° actuated by the inertia ring 8 and acting through the levers 16 of continuous rectangular section located in the ring 8 in corresponding niches 8^a, fulcrumed on it at 17, abutting on the block through the protuberance 18, held in place axially by the pin 19 and by the cooperating plate 20 fixed by the screws 21 on the ring 8. Adjustment is effected by increasing or diminishing the weight of the masses 15.

In fig. 5, on the right, is represented the similar application of additional centrifugal masses 22 acting on the friction shoe 7° of the blocks 7 through the levers 23 of continuous rectangular section located in corresponding niches 7^a in the block 7, pivoted at 24 on the dividing wall 6, abutting on the friction shoe 7° of the block 7 through the protuberance 25, maintained axially in place by the pin **26** which engages in a corresponding recess **27** in the block **7** cooperating with the dividing wall **6**. The opening **28** made in the drum **4** and the opening **29** on the disc **5** allow the passage of the lever **23**. Adjustment is effected by increasing or decreasing the weight of the masses **22**.

It is therefore possible to regulate, whilst working, the tension of the springs **10**, **18'** and the intensity of the centrifugal pressure of all the blocks.

In the form of execution in Fig. 1 the inertia mass **8** with its friction blocks **8°** is fitted only to the shaft **1**, but it is obvious that the application can also be made on the shaft **2**.

In fig. 8 is represented diagrammatically the application of the damper to two shafts **1**, **2**, subjected to a driving torque affected by strong cyclic irregularities, as would be the case, for instance, in the coupling together in tandem of two Diesel engines without a flywheel. As in this case the quantity of cynetic energy transmitted by the vibrations is very considerable, the elastically deformable member which serves to select and gather by its deformations the cynetic energy of the vibrations acting with a nodal character has to perform a very large amount of elastic work and has therefore to assume the constructional forms and dimensions of a real and true flexible coupling of considerable power. In this case, whilst one part of the elastic deformations is utilized to perform the work of damping the torsional vibrations, another part of it reduces the cyclic irregularities of the driving torque and of the rotary motion dependent upon it, thus attenuating the stresses set up by the torsional vibrations produced by the said irregularities.

In fig. 8 is represented a coupling of the known type described under British Patents nos 508,425 and 510,104, under the name of the present applicant, which lends itself well to this application. Any other known type of flexible coupling may, however, be employed in its stead.

The inertia rings **8** and **8b** with their relative blocks for the damping of loop action vibrations, in every way similar to those already described, are mounted respectively on the drums **4a** and **5a** of the discs **4** and **5** which carry respectively the lugs **4b** and **5b** engaging with the elastic members **30** of the joint.

The blocks **7** for the damping of nodal action vibrations, revolving together with the disc **4** by means of special engagement pieces **31** fixed to the drum **4a**, but free to move radially, act on the drum **5a** revolving together with the shaft **2**, through the joint action of oscillatory movements determined by the deformations of the elastic group caused by the nodal action vibrations, and by the pressure set up in them by any suitable means.

The assembly of the blocks which produce the damping effect forms three coaxial annular groups, located alongside the elastic group.

It is evident that, the lower the speed of the driving shaft, the larger must be the inertia masses of the selector intended to collect the cynetic energy of the vibrations acting on it with a loop or with loop components. In cases where the speed of the driving shaft is low it is therefore advantageous, in order to avoid the use of too large inertia masses, to increase the rotational speed of such masses, having recourse, for example, to the arrangement shown in figs. 9 and 10 where the drum **4**, solid with the driven shaft **1**, contains only the blocks for the damping of the nodal action vibrations. The drum **4** carries around with it in rotation one or more adherence rollers **32**, of smaller diameter, two in the example illustrated, held in close contact with its periphery by suitable means. For this purpose the rollers **32** are carried on the arms **35**, oscillating about **35'**, which tend to be drawn towards each other by a spring **36**, so that the two rollers are held in adherence with the drum **4** at diametrically opposite points. On the spindle **33** of each of the said rollers is mounted a secondary drum **34** containing the mobile inertia masses **8**. These masses, since they revolve at a higher speed than the driving shaft, are of a smaller size than they would have to be if they rotated at the same speed as the said shaft. Instead of rollers, toothed wheels **32°** may be employed, engaging with teeth on the periphery of the drum **4**, as is shown in the other variant of fig. 11, or other suitable mechanical drives.

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