US008287391B2

(12) United States Patent
Jung

(10) Patent No.: US 8,287,391 B2
(45) Date of Patent: Oct. 16, 2012

(54) TORSIONAL VIBRATION DAMPER

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 13/050,477

(22) Filed: Mar. 17, 2011

(65) Prior Publication Data

US 2011/0165949 A1 Jul. 7, 2011

Related U.S. Application Data

(63) Continuation of application No. PCT/DE2009/001235, filed on Sep. 3, 2009.

(30) Foreign Application Priority Data

Sep. 22, 2008 (DE) 10 2008 048 268

(51) Int. Cl.
F16F 15/123 (2006.01)
(52) U.S. Cl. 464/68.9; 464/67.1
(58) Field of Classification Search 464/67.1, 464/68.9, 68.91, 69.92, 68.921; 192/203
See application file for complete search history.

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(57) ABSTRACT

A torsional vibration damper, comprising at least two components which can be rotated counter to the resistance of at least one helical spring or bow spring precurved toward the rotational axis for compression of the at least one bow spring during a relative rotation among the components. The at least one bow spring is provided with support in the circumferential direction across the outside diameter thereof on a sliding shell. In order to reduce friction, the outside diameter of the at least one bow spring has a distance from the inside diameter of the sliding shell.
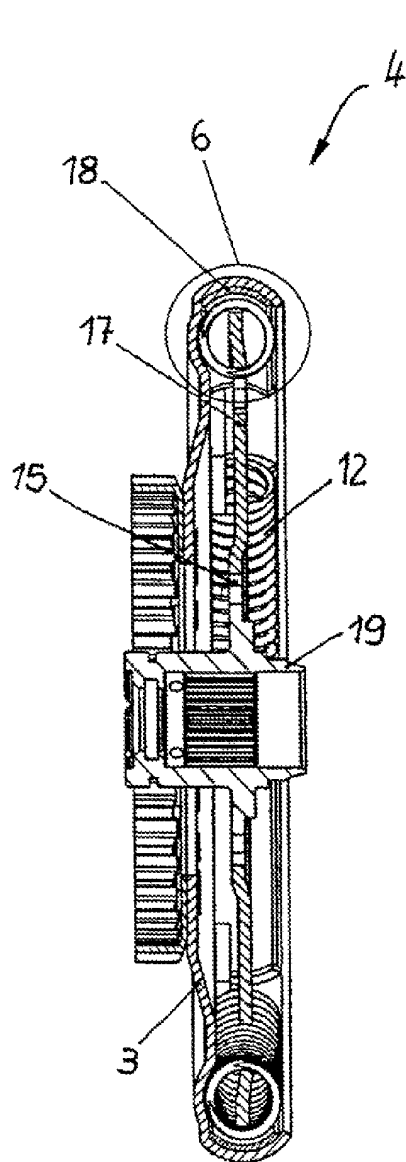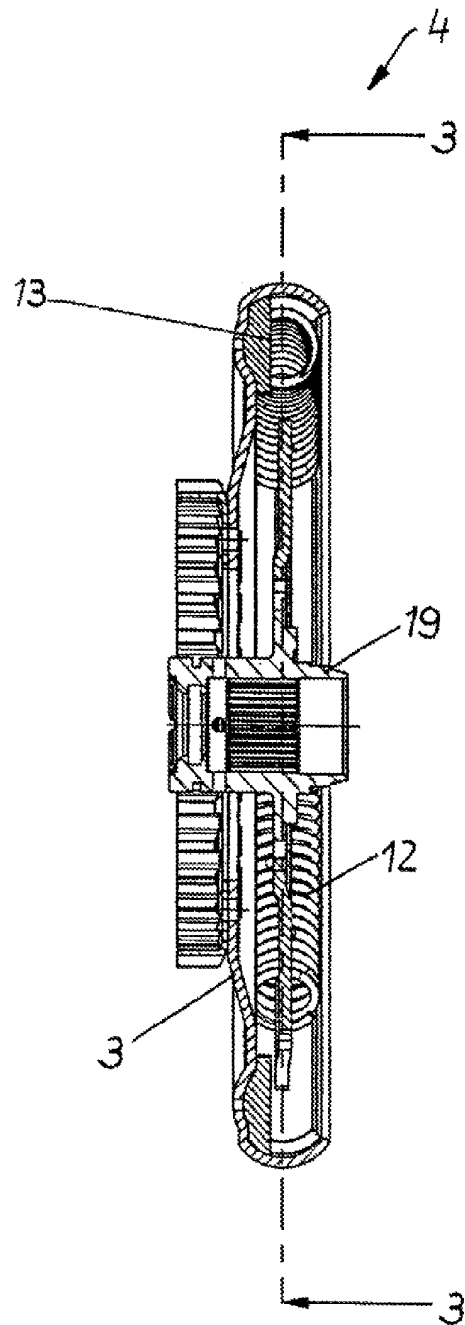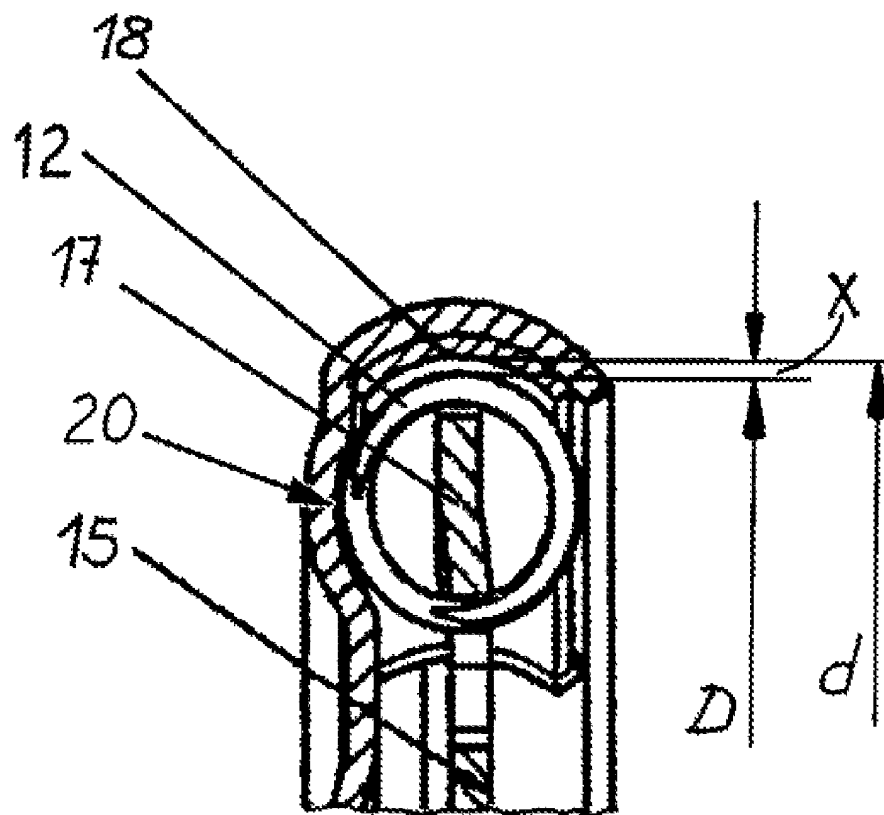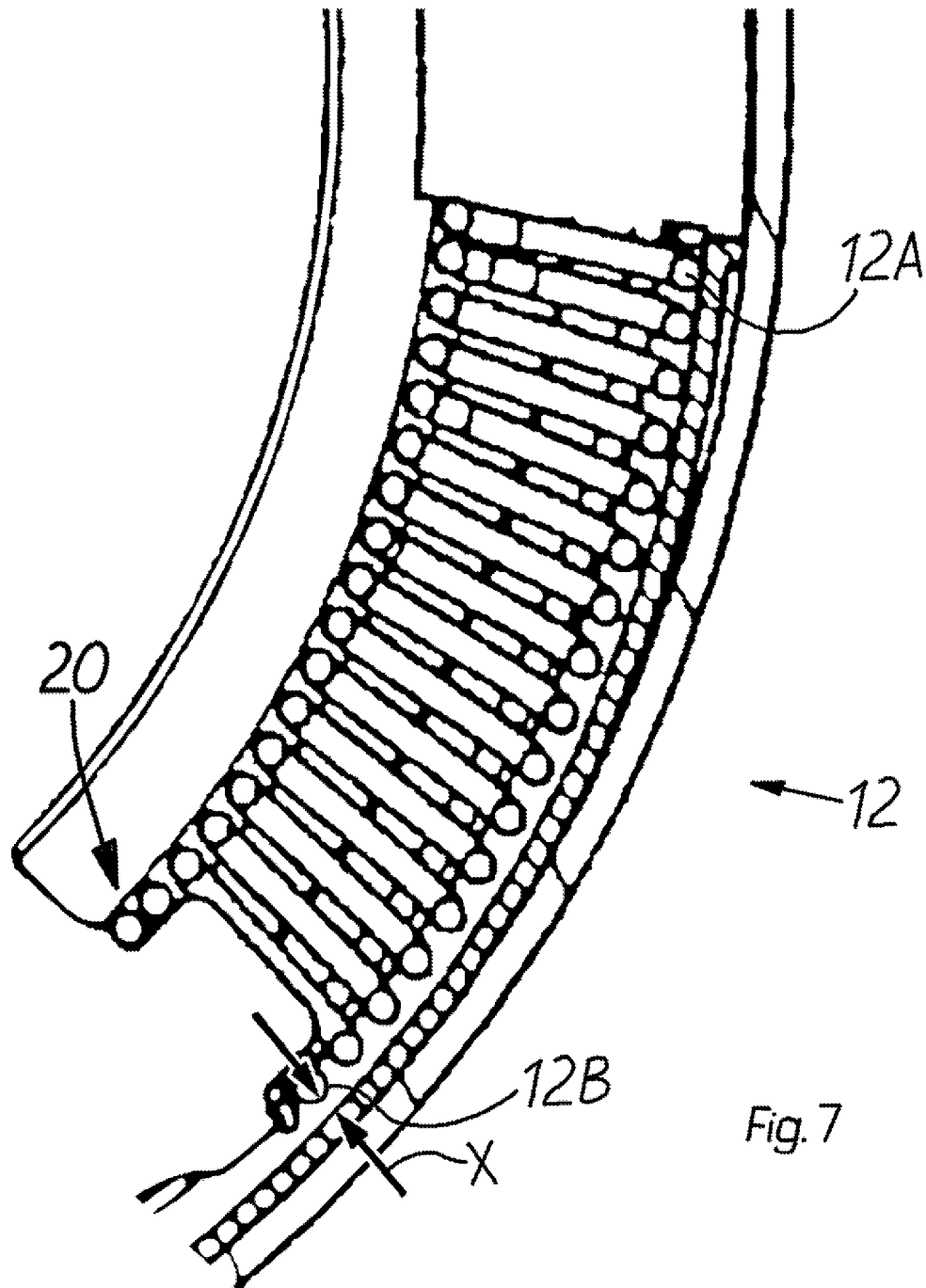
9 Claims, 5 Drawing Sheets

Fig.1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

12A

20

12

12B

X

Fig. 7
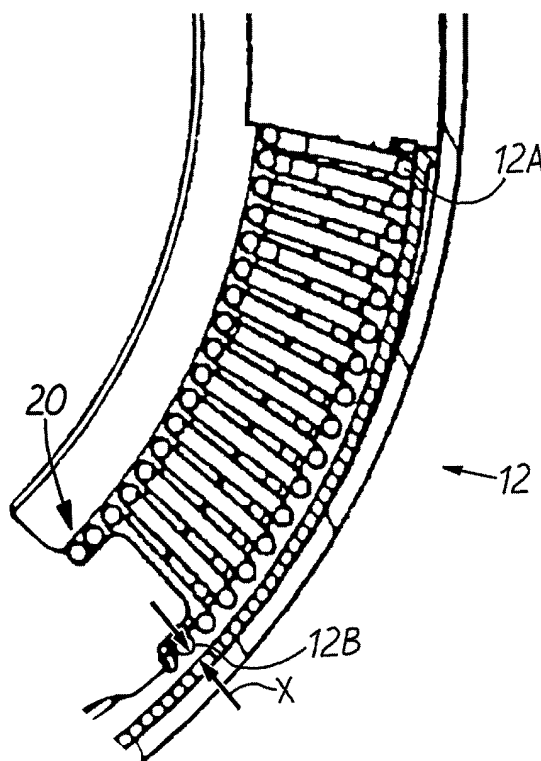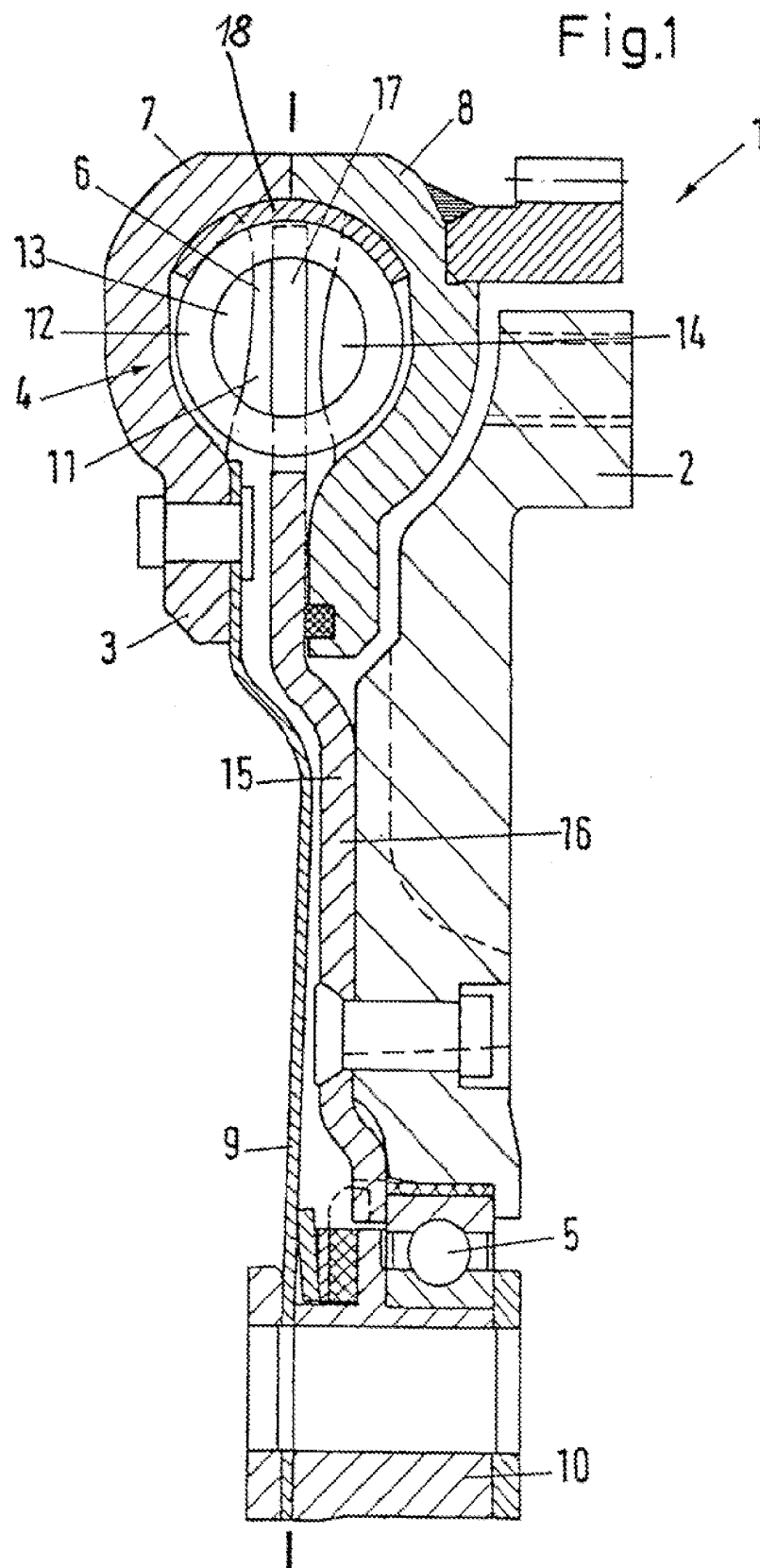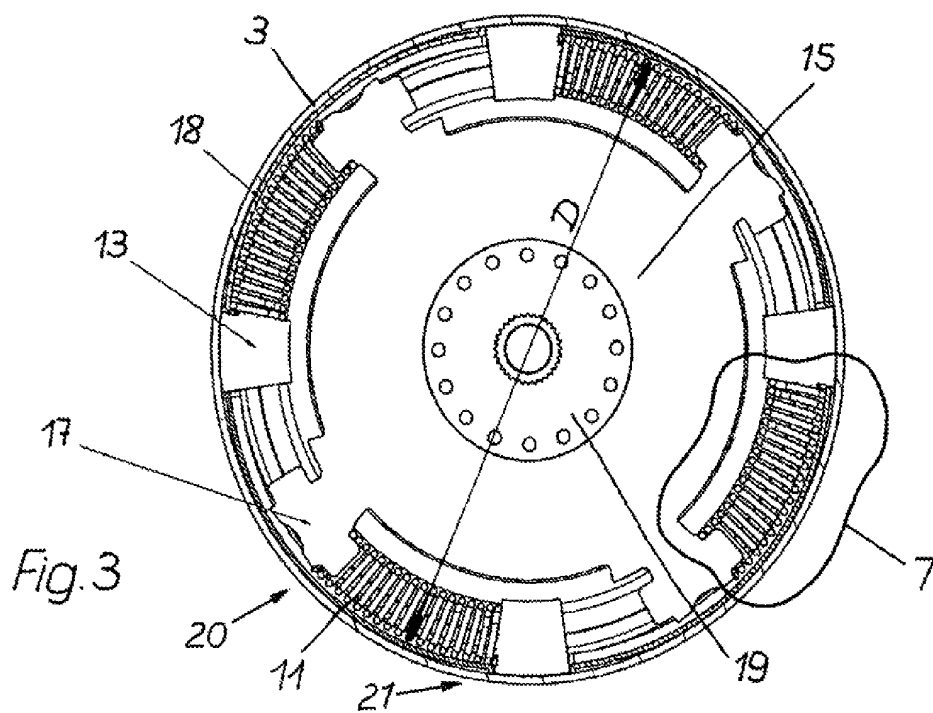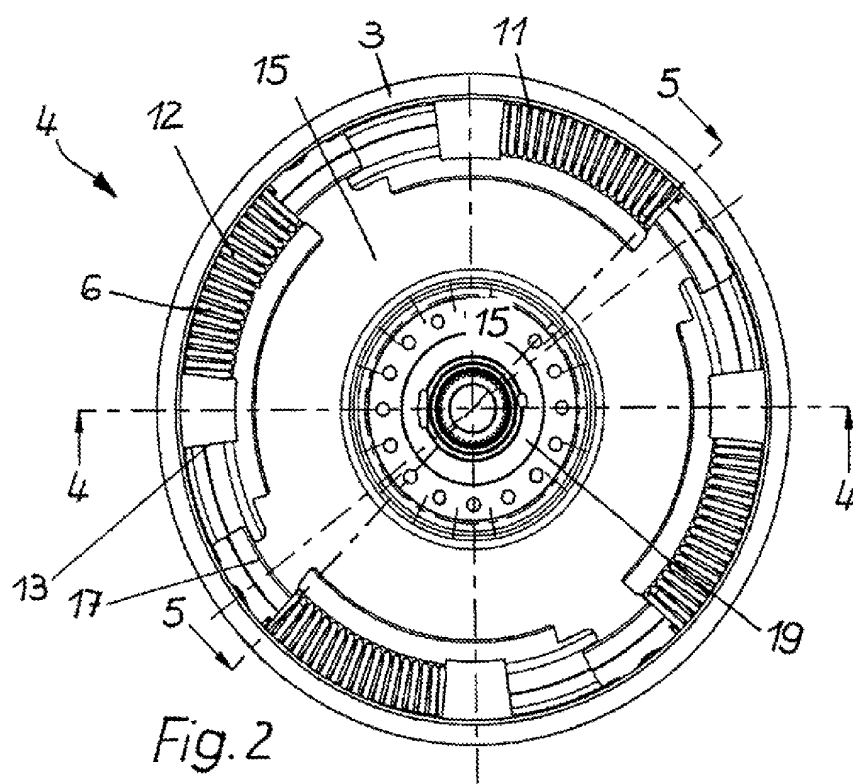
TORSIONAL VIBRATION DAMPER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is filed under 35 U.S.C. §120 and §365(c) as a continuation of International Patent Application PCT/DE2009/001235, filed Sep. 3, 2009, which application claims priority from German Patent Application No. 10 2008 048268.4, filed Sep. 22, 2008, which applications are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

The invention relates to a torsional vibration damper with at least two components that are rotatable against the resistance of at least a coil spring and/or an arc spring precurved towards the axis of rotation, at whose ends compression sections are provided for the compression of at least one arc spring during relative rotation between both components, whereby at least one arc spring in circumferential direction is supported over its outer diameter on a guide shell.

BACKGROUND OF THE INVENTION

DE-OS 37 21 711, FR-OS 2 653 513 and WO 91/06785 teach respective torsional vibration dampers used preferably for damping vibrations in the drive train of a vehicle between the engine and torque transmission device. Through the application of springs featuring a precurved form, coil compression springs can be assembled advantageously in a simple manner prior to installation, with a large length-diameter ratio. Moreover, in operation condition while the springs are at least compressed partially with their outer diameter on correspondingly assigned guide shells, favorable material stress occurs in this area of the spring. However, this spring's contact on the guide shells also causes friction. If the spring is compressed through angular momentum, single turns of the spring are pushed along the respective guide shell until they adjoin one another at least over a section. Depending upon the action of centrifugal forces, friction will be very high from a certain value based on the rotational speed, so that the turns no longer move relatively to the guide shell and hence the springy function decreases. Therefore, the ratio of static to dynamic spring rate increases with the increase of rotational speed of the torsional vibration damper. That means that the proportion of the dynamic spring rate decreases.

BRIEF SUMMARY OF THE INVENTION

The object of the invention is therefore to create a torsional vibration damper with an improved dynamic spring rate.

The object is met by means of a torsional vibration damper with at least two components rotatable against the resistance of at least a coil spring and/or an arc spring precurved towards the axis of rotation, at whose ends compression sections are provided for the compression of at least one arc spring during a relative rotation between both components. Thereby, at least one arc spring is provided with a support over its outer diameter on a guide shell in the circumferential direction. In accordance with the invention, the outer diameter of at least one arc spring has a distance from the inner diameter of the guide shell. The friction between guide shell and arc spring is reduced through this distance.

In an advantageous improvement of the invention, the rotatable component is formed as a flange that is rotatable around the axis.

Moreover, it is advantageous that the flange comprises several arms disposed over its circumference, oriented radially outwards. Furthermore, it is advantageous that every cross arm is formed at the end such that it surrounds the outer diameter of the arc spring in a shell-shaped manner.

It is advantageous that the difference between the inner diameter of the cross arm and the outer diameter of the arc spring corresponds to a distance.

An advantageous embodiment of the invention provides that the rotatable components be formed as an arc spring guide and/or flywheel elements.

It is advantageous moreover, that the rotatable components are provided with several arc spring supports distributed over the circumference.

In an advantageous embodiment of the invention, the inner diameter surrounds at least one of the rotatable components, the outer diameter of at least one arc spring in a shell-shaped manner. Thereby, it is advantageous that a distance remains between the inner diameter of one rotatable component and the outer diameter of an arc spring.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The invention is illustrated in detail based on an exemplary embodiment with accompanying drawings as follows:

FIG. 1 is a partial section of a torsional vibration damper in the form of a dual massflywheel;

FIG. 2 is a plan view of the damping device of a torsional vibration damper containing energy accumulators;

FIG. 3 is a representation of the damping device according to the sections 3-3 of FIG.5;

FIG. 4 is a section 4-4 through the damping device according to FIG. 2;

FIG. 5 is a section 5-5 through the damping device in accordance with FIG. 2;

FIG. 6 is a magnification of area 6 in FIG. 4; and,

FIG. 7 is a magnification of area 7 in FIG. 3.

A damping device containing energy accumulator in accordance with the invention can for instance find application in a torsional vibration damper in the form of a so-called dual mass flywheel. Therefore, its design is described in detail based on a dual mass flywheel 1 in FIG. 1. The dual mass flywheel 1 consists of two components, rotatable around an axis of rotation—not represented—that consists essentially of the flywheel elements 2 and 3. The flywheel element 3 is also designated as a primary mass that can be connected with the driveshaft of an engine—not represented in detail—for example via a screw connection. With the flywheel element 2 and/or also designated as a secondary mass, a torque transmission device with shifting capability is connectable, through which this flywheel element 2 can be coupled to and decoupled from the input shaft of a transmission. A damping device 4 is disposed between flywheel elements 2 and 3, which facilitates relative rotation between the flywheel elements 2 and 3. Both flywheel elements 2 and 3 are rotatable relatively to each other via a roller bearing 5.

The flywheel element 3 forms a housing that limits a ring-shaped chamber 6 in which the damping device 4 is accommodated. Ring-shaped chamber 6 consists essentially of two shell-shaped housing parts 7, 8 that are interconnected radially outside, for example, by welding. The housing side 7 turned towards the engine is connected radially inside via rivet connections with a torque transmission plate 9, on which an axial extension 10 is provided radially inside. The roller bearing 5 is accommodated on this axial extension 10, which carries the flywheel element 2 over its external bearing ring.

The shell-shaped housing parts **7**, **8** form a ring channel like and/or torus like receptacle **11** radially outside, which when observed in circumferential direction of the torsional vibration damper **1**, is subdivided into single ring-arc-shaped and/or sector-shaped receptacles in which springs, for example, arc springs, are received. The housing parts **7** and **8** possess compression sections **13**, **14** formed by axial embossed surfaces and/or pockets of housing parts **7**, **8**. Through these compression sections **13**, **14**, the sector-shaped receptacles are limited in circumferential direction for arc springs **12**. The output part of damper **4** is formed through flange-like component **15** that extends axially between housing parts **7** and **8**. Flange-like component **15** is fixed radially inside with flywheel element **2**, for examle, by means of rivet connections. Component **15** has a base body **16** that comprises cross arms **17** radially outwardson its outside circumference. The cross arms **17** extend, viewed in circumferential direction, between neighboring arc springs **12**. For unloaded torsional vibration damper **1**, the cross arms **17** are located axially between the compression sections **13**, **14** of the housing parts **7**, **8**, respectively assigned them.

At least the radial cross arms **17** of the flange **15** engage into the ring-shaped chambers **6**. The flange **15** can be fastened with radial internal areas, for example, by means of rivet connections on a driven flywheel element **2**.

The arc springs **12** acting between both flywheel elements **2** and **3** are already bent prior to the installation and/or prior to insertion into the sector-shaped receptacles **11** of the flywheel element **3**, in the relaxed state. Therefore, the springs possess an arc-shape that corresponds at least approximately to the shape of the torus-shaped receptacle **11**.

The drive-side flywheel element **3** possesses flange **15** in the interior, which, on its radial internal area, carries and/or comprises a sleeve-shaped axial extension **10**, on which a driven side flywheel **2** can be supported rotatably. In an advantageous manner, as depicted in FIG. **1**, the bearing required for this can be formed by a roller bearing **5**. To fasten the drive flange **15** on the drive shaft of an engine, screw openings are provided in the drive flange **15**, radially outside the extension **10**, and therefore also outside the radial bearing between both flywheel elements **2** and **3**.

The radial drive flange **15** and a shell-shaped housing part **8** limit the ring-shaped room **6** that can advantageously be at least partially filled with a viscous medium, for example, grease. In the ring-shaped room **6**, damping device **4** containing an energy accumulator is disposed.

The axial extension **10** carries the torque transmission plate **9**, which is connected with the flywheel element **3** formed as shell-shaped housing part **7**.

The driven-side transmission element **2** and/or the flywheel element is connectable in a known manner by means of a friction clutch—not depicted in detail—by which the clutch plate is mountable on a transmission input shaft, connectable with a transmission.

In FIG. **2**, the damping device **4** of torsional vibration damper **1** is visible. For simplification, the reference signs from FIG. **1** are retained for parts with the same function for the description of the following FIGS. **3** to **6**. FIG. **2** shows the angular position of different components of the damping device **4** in the unloaded state, i.e. several energy accumulators formed by coil compression and/or arc springs **12**.

Therefore, essential components of the damping device **4**, like the flywheel element and/or the primary mass **3** in the form of a shell-shaped plate as well as a guide shell **18** are visible, in whose inner diameter the arc springs **12** are disposed, which are supported on the primary mass **3** in axial direction. The arc springs **12** lie at the same time in segment

areas and/or receptacles **11** of the primary mass **3** and are spaced apart in a circumferential manner by means of several embossed compression sections **13**, which fix the arc springs **12** in circumferential direction. In the exemplary embodiment represented in FIG. **2**, four energy accumulators are provided, which are preferably respectively spaced at an angle 90° to each other. The number of compression sections **13** corresponds at the same time with the number of arc springs **12**. It should be understood that other numbers of energy accumulators and compression sections are possible.

Between compression sections **13** of the primary mass **3**, as already mentioned in FIG. **1**, the ring-shaped chambers **6** for supporting the arc springs **12** are located. The chambers **6** are filled with grease for the reduction of friction of the turns of the arc springs to each other, what positively affects noise damping of the damping device **4** and has positive effect on the torsional vibration damper. In the resting state of the damping device **4** represented in FIG. **2**, the cross arm **17**, that like the arc springs **12** are also arc-shaped, are located axially between the compression sections **13**, which are embossed in housing parts **7** and **8**. The compression sections **14** embossed in the secondary mass, which are not visible in this representation, also have an arc-shaped formation. In the center, the primary mass **3** is provided with a hub **19**, which has a hub-profile on its inner circumference. In FIG. **2**, the flange **15** comprises four cross arms **17** that respectively lie at an end winding of the respective arc spring **12** and/or extend with its protrusion in its inner space in order to guide the arc spring **12** in circumferential direction. In the operation state of the torsional vibration damper, the components of the damping device **4** are set in rotary motion. Thereby, the torque is transmitted from the drive to the primary flywheel **3**, which again transmits the torque by means of its compression sections **13** to the arc springs **12**. Via the cross arms **17** of the flange **15** in connection with the "free" end turns of the arc springs **12**, the torque is transmitted further into a second flywheel element and/or a secondary mass, whereby the arc springs **12** are compressed in circumferential direction. At the same time, the relative rotation between primary mass and secondary mass and/or between a driven flywheel element and the drive-side flywheel element **3** is limited. The rotation angle can be limited also when the turns of the spring go solid.

FIG. **3** shows the damping device **4** in accordance with FIG. **2**, in that the section **3-3** extends through the flange **15** and the hub **19** connected with the latter, in order to highlighten the cross arm **17** extending radially outwards from said hub. From this figure, the engagement of the cross arm **17** into the free end turns of the arc springs **12** is particularly visible. Laterally formed noses for the cross arms dip into the end turns of the arc springs **12** and lead in this area on the same radius. Otherwise, the arc springs **12** lie in their receptacles **11**, whereby, with their other end turns, they lie on the compression sections **13** (and/or **14** not represented), which simultaneously function as arc spring supports. From this figure, it follows that the guide shell **18**, with its outer diameter, lies on the inner diameter of the primary mass **3** and is spaced from the outer diameter D of the arc springs **12**, so that a distance X is formed between both components (see also FIG. **6**). Upon introduction of rotary motion into the arc springs **12**, to drive the other rotatable component—not represented—and/or the secondary mass by means of the cross arm **17** provided on the flange, single turns of the arc spring are compressed, whereby the arc spring approaches the inner diameter of the guide shell **18** with outer diameter D. To prevent both diameters from contact at end **20** of the arc spring, and thus avoid friction between both components, the distance X must be selected such that contact is avoided

between both components. End **21** of the arc spring is in contact with the inner diameter of the guide shell **18**.

In FIG. **4**, the damping device **4** is represented in section **4-4** from FIG. **2**. From here, the flywheel element **3** as well as the hub **19** fixedly connected with the flange **15** is visible; just as the cross arm **17** of the flange **15** and the arc springs **12** whose outer diameter D is spaced towards the inner diameter d of the guide shell **18**. Through section **5-5** in accordance with FIG. **2**, through the damping device **4**, besides the components already cited in FIG. **4**, the arc spring support **13** is visible in FIG. **5**.

By way of illustration of the distance X between the outer diameter D of the arc spring **12** and the inner diameter d of the guide shell **18**, this section is represented in FIG. **6** from FIG. **4** in a magnified scale. Moreover, the flange **15** engaging between the turns of arc spring **12** with its cross arm **17** are visible. Through this distance X, friction is reduced respectively between the arc spring **12** and guide shell **18**.

FIG. **7** is a magnification of area **7** in FIG. **3**. In FIG. **7**, end **12**A of spring **12** is in contact with guide shell **18** and end **12**B of spring **12** is separated by guide shell **18** by distance X.

List of Reference Symbols
1 dual mass flywheel/torsional vibration damper
2 flywheel element/secondary mass/arc spring guide
3 flywheel element/primary mass/arc spring guide
4 damping device
5 bearing/roller bearing
6 ring-shaped chamber
7 shell-shaped housing part
8 shell-shaped housing part
9 torque transmission plate
10 extension
11 receptacle
12 coil spring/arc spring
13 compression section/arc spring support
14 compression section/arc spring support
15 flange type component/flange
16 base body
17 cross arm
18 guide shell
19 hub
D outer diameter of arc spring
d inner diameter of guide shell

What we claim is:

1. A torsional vibration damper, comprising:
at least one coil spring or arc spring precurved towards an axis of rotation for the vibration damper;
a guide shell; and,
at least two components rotatable against resistance of the at least one coil spring or arc spring and including respective compression sections for the compression of said at least one coil spring or arc spring during relative rotation between the at least two components, wherein:
a radially outward portion of a first end of the at least one coil spring or arc spring, is in contact with the guide shell; and,
a radially outward portion of a second end of said at least one coil spring or arc spring is separated, in a radial direction, by a distance from said guide shell.

2. The torsional vibration damper according to claim **1** wherein a component from the at least two components is formed as a flange that is rotatable around the axis of rotation.

3. The torsional vibration damper according to claim **2**, wherein the flange comprises a plurality of cross arms distributed over a circumference of the flange and aligned radially outwards.

4. The torsional vibration damper according to claim **1** wherein at least one component from the at least two components is formed as an arc spring guide and flywheel element.

5. The torsional vibration damper according to claim **4** wherein the at least one component is provided with a plurality of arc spring supports distributed over a circumference of the at least one component.

6. The torsional vibration damper according to claim **1** wherein at least one component from the at least two components is formed as an arc spring guide or flywheel element.

7. The torsional vibration damper according to claim **6** wherein the at least one component is provided with a plurality of arc spring supports distributed over a circumference of the at least one component.

8. A torsional vibration damper, comprising:
a guide shell with a smooth curved shape in a cross-section taken along a line orthogonal to an axis of rotation for the torsional vibration damper;
an input component;
at least one spring with:
a first end engaged with the input component and in contact with the guide shell; and,
a second end wholly separated from the guide shell in a radial direction; and,
a flange forming an output for the torsional vibration damper and including;
an inner circumference arranged to transmit torque from the torsion vibration damper; and,
at least one radially outwardly extending protrusion engaged with the second end for the at least one arc spring.

9. A torsional vibration damper, comprising:
an input component;
a guide shell;
at least one spring with:
a central space formed by coils for the at least one spring;
a first end engaged with the input component and in contact with the guide shell; and,
a second end wholly separated from the guide shell in a radial direction; and,
a flange with;
at least one radially outwardly extending protrusion; and,
at least one protrusion extending circumferentially from the at least one radially outwardly extending protrusion and engaged with the second end.

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