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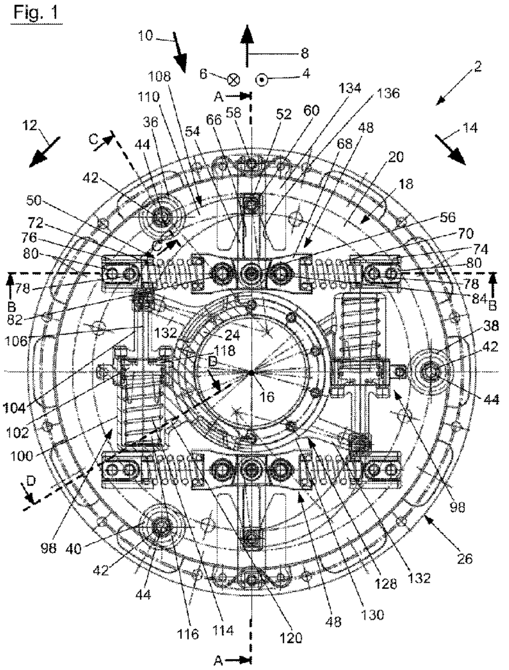
(54) **Title:** ROTATIONAL VIBRATION ABSORBER AND DRIVETRAIN FOR A MOTOR VEHICLE COMPRISING SUCH A ROTATIONAL VIBRATION ABSORBER

Fig. 1



(57) **Abstract:** The present invention relates to a rotational vibration damper (2) comprising a base part (18) rotatable about an axis of rotation (16) and an inertial mass part (26) which is rotatable relative to the base part (18) counter to the reset force of a reset device (48}, which has a spring device (50) for generating a set force and at least one lever element (54) pivotable about a pivot point (52), via which lever element the set force is transmittable from a set force engagement point (56) of the lever element (54) to the inertial mass part (26) by generating the reset force affecting the inertial mass part (26) via. a reset force engagement point (58) of the lever element (54). The present invention further relates to a drivetrain comprising such a rotational vibration damper (2).

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ROTATIONAL VIBRATION ABSORBER AND DRIVETRAIN FOR A MOTOR VEHICLE COMPRISING SUCH A ROTATIONAL VIBRATION ABSORBER

Description

[0001] The present invention relates to a rotational vibration damper comprising a base part rotatable about an axis of rotation and an inertial mass part which is rotatable relative to the base part counter to the reset force of a reset device, wherein the reset device has a spring device for generating a set force. The present invention further relates to a drivetrain for a motor vehicle with a rotational vibration damper of this type.

[0002] A rotational vibration damper is known from DE 199 07 216 C1 which has a base part in the form of a support plate rotatable about an axis of rotation. An inertial mass is arranged on the support plate which may rotate relative to the base part counter to the reset force of a reset device. The reset device has a bending spring extending in a radial direction which is arranged on the one side on the base part and on the other side on the inertial part. The bending spring functions to generate a set force which directly affects the inertial mass when the inertial mass is rotated relative to the base part such that the set force equals the reset force affecting the inertial mass. The known torsional vibration damper is disadvantageous insofar as that a relatively large bending spring requiring a large installation space is necessary for the reset device, especially as this reset device must be arranged on the one side on the inertial mass and on the other side on the support plate. The last-stated necessity of supporting the bending spring on the support plate on the one side and on the inertial mass on the other side also has the result that the arrangement of the bending spring on the rotational vibration sensor is largely predefined. Consequently, no flexible arrangement of the bending spring is possible for rotational vibration dampers of the type described. In addition, it has been shown that the base part in the form of the support plate may be subject to relatively strong deformations so that the rotational vibration damper may also be subjected to undesired vibrations in the axial direction which adversely affect the interaction of the components of the rotational vibration damper and thus its function.

[0003] It is therefore the object of the present invention to create a rotational vibration damper that overcomes the previously listed disadvantages. In addition, the underlying object of the present invention is to create a drivetrain with such an advantageous rotational vibration damper.

[0004] This problem is solved by the features listed in Patent Claims 1 or 11. Advantageous embodiments of the invention are the subject matter of the subclaims.

[0005] The rotational vibration damper according to the invention has a base part rotatable about an axis of rotation. The base part may be formed for example by a base plate or support plate extending essentially in the radial direction, wherein it is preferred if the base part is formed sandwich-like from two disks lying opposite one another and spaced apart from one another, as this will be explained again later in greater detail. In addition, the rotational vibration damper has an inertial mass part which may be rotated about an axis of rotation relative to base part counter to the reset force of a reset device. To distinguish the rotational vibration damper from a torsional vibration damper, it is mentioned in this context that said inertial mass part is not arranged in the torque transmission path of a drivetrain, whereas in the case of a torsional vibration damper, both the primary element, the secondary element and the intermediary spring arrangement are arranged in the torque transmission path. The reset device has a spring device for generating a set force, wherein the spring device may have, for example, one or multiple spring elements. In addition, the reset device has a lever element pivotable about a pivot point. Thus, the pivotable lever element may, for example, be pivotable indirectly via the pivot point or directly on the base part. It is hereby preferred if the lever element is pivotable in a plane spanned by the radial directions of the rotational vibration damper and is consequently pivotable about an axis extending through the pivot point in the axial directions of the rotational vibration damper. In addition, the pivotable lever element is preferably a bend-proof or rigid lever element. The lever element is arranged between the spring device on the one side and the inertial mass part on the other side in such a way that the set force generated by the spring device may be transmitted to the inertial mass part while generating the reset force affecting the inertial mass part via a reset force engagement point of the lever element. This has the advantage that the spring device of the reset device generating the set force does not have to directly affect the inertial mass part, but instead may be arranged in fact at another point on the base part of the rotational vibration damper, by which means a space-saving and flexible arrangement of the spring device on the rotational vibration damper is possible. On the other hand, a lever ratio may be set or specified due to the lever element, based on which lever ratio the reset force acting on the inertial mass part is larger or smaller than the set force generated by the spring device of the reset device. Thus, the stiffness of the reset device may be increased in a targeted way by specifying the lever ratio without necessitating a particularly stiff spring device for generating the set force. It should thus initially be maintained that the spring device has only a low spring rigidity and consequently may be formed in an especially installation space-saving way, wherein in addition a flexible arrangement of the spring device on the base part of the rotational vibration damper is possible.

[0006] In one advantageous embodiment of the rotational vibration damper according to the invention, the spring device has at least one spring element, preferably at least one helical spring, and a support shoe, wherein the set force of the spring element may be transmitted to the set force engagement point via the support shoe. In order to keep the friction low between the support shoe, which is preferably manufactured from a plastic material, and the base part, on which the support shoe is supported, the support shoe is supported or supportable on the base part via at least two rollers. It has hereby proven advantageous, in the sense of a simple and secure support of the support shoe on the base part, if the at least two rollers are fixed on the support shoe so that it may also be considered as a roller shoe. In order to improve the support of the support shoe on the base part even more, it is additionally preferred in this embodiment if the axles of the at least two rollers are spaced apart from the set force engagement point. In this context, it has proven particularly advantageous if the axles of the at least two rollers are arranged on opposite sides of the set force engagement point. The two rollers hereby preferably have the same distance to the set force engagement point.

[0007] Basically, the spring element might be directly supported on the side facing away from the support shoe via a support point formed by a section of the base part. However, to simplify the production of the base part and the application of the spring element of the spring device, the spring element is supported or supportable on the side facing away from the support shoe on the base part via a retaining shoe in one preferred embodiment of the rotational vibration damper according to the invention. The retaining shoe, consequently formed separately from the base part, is preferably formed from a plastic part. It is also preferred in this embodiment if the retaining shoe is arranged between the base part and the spring element pretensioned by the spring element. To prevent having to design the base part in such a way that this has a section aligning with the retaining shoe in the extension direction of the spring element, the retaining shoe in this embodiment is preferably fixed on the base part via another fixing means. In particular, pin or screw connections, optionally a pin connection and a screw connection, have hereby proven particularly advantageous and easy to produce.

[0008] In order to eliminate vibrations occurring in the area of the base plate formed from a support plate in the rotational vibration damper according to DE 199 07 216 C1, the base plate in one particularly preferred embodiment of the rotational vibration damper according to the invention is formed sandwich-like from two disks lying opposite one another and spaced apart from one another. Even if disks are always discussed here, these may also be designated as plates. It has been shown that, due to said sandwich-like structure of the base part from two disks lying opposite one another and spaced apart from one another, a high rigidity of the rotational vibration damper may be achieved in the area of the base part, which also prevents undesired vibrations of the base part in the axial direction. The two disks lying opposite one another are thereby preferably coupled rotationally fixed to one another, wherein this may be carried out particularly preferably by a ring or connecting ring lying inward in the radial direction.

[0009] In one particularly advantageous embodiment of the rotational vibration damper according to the invention in which the base part has the previously mentioned sandwich-like structure, the reset device is arranged at least partially between the opposing disks of the base part. In this way, the disks of the base part may have a greater spacing from one another, which increases stability, while the partial arrangement between the disks still guarantees a compact structure. Thus, it is particularly preferred if the spring device of the reset device is arranged at least partially between the disks of the base part lying opposite one another. It is thus additionally preferred if the spring element of the spring device is arranged, preferably completely, between the disks of the base part lying opposite one another. Alternatively or supplementally, the support shoe and/or the retaining shoe may also be arranged partially, preferably completely, between the two disks of the base part lying opposite one another. In addition, it is alternatively or supplementally possible in this embodiment, if the lever element of the reset device is arranged at least partially, preferably completely, between the two disks of the base part lying opposite one another. In particular, a complete arrangement of each component of the reset device between the disks lying opposite one another ensures that each component may be positioned relatively easily between the two disks of the base part in the context of the assembly, which significantly simplifies manufacturing. This is particularly advantageous for the spring element, especially as this is to be set by pretensioning the same in the rotational vibration damper or its spring device.

[0010] To configure the support of the support shoe on the base part via the at least two rollers particularly easily and securely, in another particularly advantageous embodiment of the rotational vibration damper according to the invention, at least one of the rollers extends into recesses in the two opposing disks of the base part designed like a sandwich so that said roller is supported or supportable on the base part via a recess edge of the recesses. In this embodiment, it is preferred if the two said rollers of the support shoe each extend on both sides into a recess in the opposing disks of the base part in order to be supported or supportable on the base part in the manner described.

[0011] According to another preferred embodiment of the rotational vibration damper according to the invention, whose base part is designed from two disks lying opposite one another in a sandwich-like way, the retaining shoe, on which the spring element is supported on the base part on the side facing away from the support shoe, is fixed on the two disks of the sandwich-like base part. The previously mentioned pin connection has proven particularly advantageous here, especially as a corresponding pin may extend through the retaining shoe in the axial direction in order to extend on the one side into a recess in the one disk and on the other side into a recess of the opposing disk of the base part. In this context, it has proven advantageous to provide another pin of this type to prevent pivoting of the retaining shoe.

However, instead of said second pin, a simple and/or unilateral screw connection might also be provided to prevent rotation of the retaining shoe.

[0012] In another advantageous embodiment of the rotational vibration damper according to the invention, said rotational vibration damper has an adjusting device by means of which the reset device may be adjusted by changing a reset force characteristic curve of the reset force acting on the inertial mass part, in that the pivot point is adjustable and/or displaceable to change the lever ratio of the lever element. Thus, the pivot point may be arranged, for example, to be movable on the base part, wherein a movement of the pivot point in the radial direction relative to the base part or along a radial is preferred.

[0013] According to another advantageous embodiment of the rotational vibration damper according to the invention, the adjusting device has a drivable hydraulic piston which may be impinged with hydraulic pressure, optionally on both sides. The hydraulic piston, optionally also the cylinder accommodating the hydraulic piston, is preferably arranged between the opposing disks of the base part designed like a sandwich to achieve a compact and rigid structure. By designing the hydraulic piston as a hydraulic piston which may be impinged with hydraulic pressure on both sides, a certain centrifugal oil compensation is additionally ensured. Consequently, in the case of the adjusting device of this embodiment, it may also be considered as a hydraulic adjusting device.

[0014] To be able to transmit the movement of the hydraulic piston of the adjusting device relatively easily, securely, and directly to the pivot point, and thus to create an adjusting device with a low susceptibility to malfunction, in another particularly preferred embodiment of the rotational vibration damper according to the invention, the movement of the hydraulic piston is transmittable to the pivot point of the lever element in a ratio of 1:1 and/or in the same direction. It has hereby proven advantageous if the movement of the hydraulic piston and the movement of the pivot point are respectively carried out along a straight line, wherein the two straight lines are spaced apart from one another, yet extend in parallel, so that a relatively flexible and installation space saving positioning of the hydraulic piston is possible. In this context, a transmission link between the hydraulic piston and the pivot point has proven particularly advantageous, by means of which transmission link the movement of the hydraulic piston may be transmitted to the pivot point, wherein it is preferred if this transmission link moves only translationally and is consequently not pivoted.

[0015] In another particularly advantageous embodiment of the rotational vibration damper according to the invention, the transmission link between the hydraulic piston and the pivot point is arranged between the opposing disks of the base part designed like a sandwich. Alternatively or supplementally, the transmission link has an oppositely arranged link section, between which the spring element of the spring device extends. In this way, the spring device or spring element and transmission link may be arranged together in a relatively small space, without negatively impacting the functioning of the transmission link on the one side and the spring element on the other side. The two transmission links lying opposite one another, which may basically be designated as partial links of the transmission link, are preferably fastened to one another, wherein the mutual fastening may be carried out, for example, at the attachment point on the hydraulic piston and/or at the attachment point on the pivot point. It is also preferred if the link sections are designed to be structurally identical.

[0016] To be able to integrate the previously mentioned transmission link into the rotational vibration damper in a space saving way, it is designed as curved in another preferred embodiment of the rotational vibration damper according to the invention, wherein this is carried out, if necessary, to prevent a collision of the movable support shoe with the transmission link. In this way, it is ensured with the curved transmission link or the curved link sections, that even if a support shoe is displaced into an end position, it does not collide with the transmission link or the link sections, wherein the transmission link and spring device may still be arranged in the smallest space.

[0017] In another advantageous embodiment of the rotational vibration damper according to the invention, a spring element is assigned to the hydraulic piston to reset the hydraulic piston into an end position of the same. The spring element is thereby preferably arranged in a pressure chamber assigned to the hydraulic piston in order to achieve a compact structure of the adjusting device. Said spring element for resetting the hydraulic piston thereby preferably essentially has a fail safe function, which causes the resetting of the hydraulic piston into the end position in the case of a switching off or a failure of the hydraulic supply device. In the end position of the hydraulic piston, the pivot point interacting with the hydraulic piston also preferably assumes an end position, in which the reset force acting on the inertial mass part is the greatest. Alternatively, the inertial mass part may also be locked relative to the base part in this end position of the hydraulic piston or the of the pivot point, as this is addressed again later.

[0018] In another advantageous embodiment of the rotational vibration damper according to the invention, a throttle or restriction is provided in at least one hydraulic line that leads to a pressure chamber assigned to the hydraulic piston.

[0019] According to another preferred embodiment of the rotational vibration damper according to the invention, a synchronizing means for synchronizing and/or coupling the movement of the hydraulic piston with the movement of a hydraulic piston of another adjusting device is provided, wherein the other adjusting device may function for adjusting another reset device. The synchronizing means may hereby be designed as a synchronizing ring extending in the circumferential direction, which is rotatable relative to the base part about the axis of rotation of the rotational vibration damper and interacts with or is coupled to the two actuating pistons. Thus, for example, one support arm may be provided per piston on such a synchronizing ring, said support arm interacting with the respective hydraulic piston so that a linear displacement of the respective hydraulic piston causes a rotation of the synchronizing ring which interacts with the other hydraulic piston via the other support arm. Due to the synchronizing means, it is ensured that the two reset devices are synchronized and may essentially exert the same reset force on the inertial mass part.

[0020] In another preferred embodiment of the rotational vibration damper according to the invention, the pivot point is essentially formed by an adjustable and/or displaceable projection, wherein a stop is provided on the inertial mass part which is supported or supportable on the projection while limiting the maximum rotational angle between the inertial mass part and the base part. In this embodiment, it is preferred if the stop is supported or supportable on the projection in the two opposing rotational directions while limiting the maximum rotational angle between the inertial mass part and the base part. Due to the stop and its interaction with the projection, the maximum rotational angle between the inertial mass part and the base part is thus limited so that, for example, a complete compression of the spring elements of the spring device may be prevented when the spring elements are adjusted in a corresponding way to the limit of the maximum rotational angle. In this embodiment, it is additionally preferred if the maximum rotational angle varies as a function of the position of the projection relative to the base part. Thus, the maximum rotational angle may, for example, undergo the greatest limitation when the reset force is the greatest due to the adjusted reset force characteristic curve, thus, when the latter has the greatest slope. It is also possible to design the projection and the stop in such a way that the inertial mass part is locked relative to the base part in a position of the adjustable and/or displaceable projection, wherein said position is preferably the previously mentioned end position of the hydraulic piston or the pivot point, which is then particularly preferably assumed when the hydraulic pressure fails or is switched off, wherein in this case the previously mentioned spring element is used to reset the hydraulic piston into the end position. To achieve the limitation of the maximum rotational angle across the largest possible operating range of the rotational vibration damper in another embodiment of the rotational vibration damper according to the invention, the projection and the stop are supported or supportable on the projection across at least one-fourth of the maximum travel path of the projection relative to the base part, across at least half of the maximum travel path of the projection relative to the base part, or across the entire maximum travel path of the projection relative to the base part.

[0021] In another advantageous embodiment of the rotational vibration damper according to the invention, the inertial mass part is supported or supportable in the radial direction and/or in the axial direction via at least three rollers. It is thereby preferred if the rollers are rotatably fixed on the base part. To additionally achieve a particularly secure support of the inertial mass part on the base part, the rollers are particularly preferably pretensioned in the radial direction against the inertial mass part and/or against the base part. In addition, it has proven advantageous if the rollers, which are rotatably fixed on the base part, each extend into a guide groove in the inertial mass part. The guide groove may thereby be designed as encompassing in the circumferential direction in order to accommodate all rollers present in a common guide groove.

[0022] To be able to particularly easily determine the adjustment of the reset device, optionally to be able to control the adjusting device for adjusting the reset device in a targeted way, detectable means are arranged on the pivot point, optionally on the projection, which may be detected by a detection device while determining the position of the pivot point relative to the base part. Thus, the detectable means or the detection device may be, for example, optically detectable means and an optical detection device. However, other detectable means, that may be detected via a corresponding sensor of the detection device, are also conceivable. Basically, the detection device with a corresponding sensor may be arranged on the base part. However, to be able to detect the position of the pivot point relative to the base part particularly easily, the detection device is preferably fixed to a stationary component. The stationary component may be, for example, a non-rotating component within the drivetrain adjacent to the rotational vibration damper. Thus, the detection device including the corresponding sensor might, for example, be arranged on a stationary housing of the rotational vibration damper or an adjacent component within the drivetrain.

[0023] According to another advantageous embodiment of the rotational vibration damper according to the invention, the inertial mass part is designed at least partially or completely as a shaped sheet metal part and/or a cast part. The shaped sheet metal part has the advantage in this context that the previously mentioned guide groove in the inertial mass part may be generated relatively easily by sheet metal shaping. Two or more shaped sheet metal parts designed separately from one another may, for example, also be joined together into the inertial mass part, wherein it is preferred in this case if the guide groove is generated between the shaped sheet metal parts by the joining. The combination of one or more shaped sheet metal parts with a cast part, for example, a cast ring, may also be advantageous here.

[0024] The drivetrain according to the invention for a motor vehicle has at least one embodiment of a rotational vibration damper of the previously described type according to the invention.

[0025] In one advantageous embodiment of the drivetrain according to the invention, the base part of the rotational vibration damper is fastened in a rotationally fixed way on a component arranged in the torque transmission path, while the inertial mass part is arranged outside of the torque transmission path of the drivetrain, which distinguishes the rotational vibration damper in the installed state from a torsional vibration damper, in which both the primary and also the secondary elements are arranged in the torque transmission path.

[0026] In one particularly preferred embodiment of the drivetrain according to the invention, the previously mentioned component of the drivetrain, which is arranged in the torque transmission path and on which the base part is fastened in a rotationally fixed way, is formed by a primary or secondary element, thus an input side or an output side of a torsional vibration damper.

[0027] The invention will be subsequently described in greater detail with the aid of an exemplary embodiment with reference to the appended drawings. As shown in:

Figure 1 a front view of one embodiment of a rotational vibration damper in a partially cutaway view,

Figure 2 a depiction of the rotational vibration damper from Figure 1 cutaway along line A-A,

Figure 3 a perspective depiction of the rotational vibration damper from Figure 1 in a cutaway view along line B-B and with an inertial mass part deviating from the inertial mass part in Figures 1 and 2,

Figure 4 a partially perspective depiction of the rotational vibration damper from Figures 1 to 3 in a cutaway view along line C-C,

Figure 5 a partially perspective depiction of the rotational vibration damper from Figures 1 to 4 in a cutaway view along line D-D.

[0028] The figures show one embodiment of the rotational vibration damper 2 according to the invention. In the figures, the opposite axial directions 4, 6, the opposite radial directions 8, 10, and the opposite circumferential directions 12, 14, which may also be designated as opposing rotational directions, of rotational vibration damper 2 are indicated by corresponding arrows, wherein rotational vibration damper 2 has an axis of rotation 16 extending in axial directions 4, 6.

[0029] Rotational vibration damper 2 has a base part 18 rotatable around axis of rotation 16. Base part 18 is – as is particularly clear from Figures 2 and 4 – formed sandwich-like from two disks 20, 22 lying opposite one another in axial directions 4, 6 and spaced apart from one another in said axial directions 4, 6, said disks being connected to one another rotationally fixed via a central ring 24. The two disks 20, 22 each extend essentially in a plane spanned by radial directions 8, 10 and parallel to one another. In the installed state within a drivetrain, base part 18 is fastened in a rotationally fixed way on a component arranged in the torque transmission path, wherein said component within the torque transmission path is preferably the primary or secondary element of a torsional vibration damper. The rotationally fixed fastening on the component arranged in the torque transmission path of a drivetrain may be carried out here, for example, via said ring 24.

[0030] Rotational vibration damper 2 additionally has an inertial mass part 26 which is formed in the depicted embodiment as essentially annular and extending in circumferential directions 12, 14. Inertial mass part 26 surrounds the installation space, formed in axial directions 4, 6 between disks 20, 22 of base part 18, outwardly in radial direction 8. Annular inertial mass part 26 is thereby formed from one or more joined cast parts, as this is indicated in particular in Figures 1 and 2. Alternatively, inertial mass part 26 may, however, be formed as a shaped sheet metal part or joined from multiple shaped sheet metal parts, as this is indicated, for example, in Figures 3 and 4. Thus, inertial mass part 26 in Figures 3 and 4 is formed from two shaped sheet metal parts 28, 30, fastened to one another, which are themselves designed as extending in circumferential directions 12, 14, wherein another annular shaped sheet metal part 32 or an annular cast part extending in circumferential directions 12, 14 is arranged between shaped sheet metal parts 28, 30 fastened to one another. The two shaped sheet metal parts 28, 30 are designed on the end pointing inward in radial direction 10 in such a way that a guide groove 34 extending in circumferential directions 12, 14 and open inward in radial direction 10, is formed by the joining together of the two shaped sheet metal parts 28, 30.

[0031] Inertial mass part 26 is supported on base part 18 in radial directions 8, 10 via rollers 36, 38, 40, as this may be gathered in particular from Figures 1 and 4. Rollers 36, 38, 40 are thereby rotatably fixed on base part 18, wherein rollers 36, 38, 40 extend outward in radial direction 8 into guide groove 34 of inertial mass part 26. By this means, inertial mass part 26 is supported or supportable on base part 18 not only in radial directions 8, 10, but also in axial directions 4, 6, especially as rollers 36, 38, 40 are also supported or supportable on the groove walls of guide groove 34 in said axial directions 4, 6. As is shown in Figure 4 using roller 36 as an example, rollers 36, 38, 40 are rotatably mounted on a stationary roller axle 44 by means of a roller bearing 42, wherein roller axle 44 is fixed on the one side on disk 20 and on the other side on disk 22 of base part 18, wherein roller axle 44 extends not only through roller bearing 42, but also spacer sleeves 46 arranged on both sides of roller bearing 42. Spacer sleeves 46 hereby provide the central arrangement of rollers 36, 38, 40 in axial directions 4, 6 between disks 20, 22 of base part 18. Consequently, rollers 36, 38, 40 are arranged at least partially between disks 20, 22 of base part 18 in order to advantageously use the available installation space. It is also preferred if rollers 36, 38, 40 are pretensioned against inertial mass part 26 in radial direction 8, and thus into guide groove 34, which may be caused by a flexible support of roller axle 44 in radial directions 8, 10 or by rollers 36, 38, 40 which have a certain elasticity in radial directions 8, 10. Even if reference was made in the preceding essentially to guide groove 34 between shaped sheet metal parts 28, 30 and their interaction with rollers 36, 38, 40, these embodiments also apply in a corresponding way for a likewise present guide groove in inertial mass part 26 according to Figures 1 and 2, which is joined together from one or more cast parts.

[0032] Rotational vibration damper 2 additionally has two reset devices 48, which are arranged on base part 18 of rotational vibration damper 2 opposite one another in radial directions 8, 10 and spaced equally apart from one another in circumferential directions 12, 14. Reset devices 48 are thereby designed substantially identical in construction such that they are subsequently described with reference to only one of the reset devices 48, wherein the description equally applies to the other reset device 48.

[0033] Reset device 48 has a spring device 50 for generating a set force and a lever element 54 pivotable about a pivot point 52 and via which the set force of spring device 50 may be transmitted to inertial mass part 26 from a set force engagement point 56 of lever element 54 while generating the reset force acting on inertial mass part 26 via a reset force engagement point 58 of lever element 54. In other words, inertial mass part 26 is rotatable about axis of rotation 16 in circumferential directions 12, 14 relative to base part 18 counter to the reset force of reset device 48.

[0034] As already indicated, lever element 54 may be pivoted relative to base part 18 about a pivot axis extending in axial directions 4, 6 through pivot point 52, wherein lever element 54 is arranged completely between the two disks 20, 22 of base part 18 in axial directions 4, 6. Pivot point 52 is thereby substantially formed by an adjustable and/or displaceable projection 60 which is designed substantially as a pin, as is clear in Figure 2. Projection 60 and consequently pivot point 52 is thereby adjustable and/or displaceable relative to base part 18 along a displacement path extending in radial directions 8, 10, wherein to implement such a displacement path, a guide 62 is provided on the one side in disk 20 and a guide 64 on the other side in disk 22 of base part 18, wherein projection 60 extends into guide 64 or 62 in axial directions 4, 6. Consequently, projection 60 is essentially arranged between disks 20, 22 in axial directions 4, 6, wherein the two guides 62, 64 ensure a secure and exact displacement of projection 60 and thus also of pivot point 52. To thereby guarantee a relative displacement of pivot point 52 or of projection 60 toward lever element 54, a longitudinal guide 66 is also provided in lever element 54, which is formed here as a longitudinal recess, and extends in the extension direction of lever element 54.

[0035] It is clear from the preceding description that reset device 48 may be adjusted by changing a reset force characteristic curve of the reset force acting on inertial mass part 26, in that projection 60 and thus pivot point 52 are adjusted or displaced along guides 62, 64 and along guide 66 in lever element 54 by changing the lever ratio of lever element 54.

[0036] Spring element 50 has a support shoe 68 on which the spring force is applied on both sides by a spring element 70, 72 respectively, which are here designed as helical springs, more precisely, as straight line helical springs. Thus, the set force of spring elements 70, 72 is transmitted to set force engagement point 56 of lever element 54 via support shoe 68. Support shoe 68 is thereby preferably designed as a molded plastic part, wherein this may be composed from multiple molded plastic parts. Both support shoe 68 and also spring elements 70, 72 are thereby arranged, – like lever element 54 – completely between disks 20, 22 of base part 18 in axial directions 4, 6, as this may be gathered in particular from Figure 3.

[0037] In addition, spring elements 70, 72 are supported on base part 18 on the side facing away from support shoe 68 via a retaining shoe 74 or 76 respectively, wherein the respective retaining shoe 74 or 76 is arranged pretensioned by the respective spring element 70 or 72 between base part 18 and the respective spring element 70 or 72. To effect the support of spring elements 70, 72 on base part 18, retaining shoes 74, 76 are likewise arranged completely between disks 20, 22 of base part 18 in axial directions 4, 6, and fixed on base part 18. Stated more precisely, retaining shoes 74, 76 are each fixed or fastened both on disk 20 and also on disk

22 of base part 18, wherein this is carried out in the embodiment shown in each case via two pins 78, 80 which are fixed on the one side to disk 20 and on the other side to disk 22 and extend through bore holes within the respective retaining shoe 74, 76. Retaining shoes 74, 76 hereby provide - as is particularly clear from Figure 3 - the exact spacing of the two disks 20, 22 of base part 18 in axial directions 4, 6 to one another, thus they function similarly to spacers. Alternatively to pins 78, 80 shown here, screw connections might also be provided, even if the shown pin connections are quite easily implementable in a space saving way.

[0038] Even if support shoe 68 is displaceable between disks 20, 22 of base part 18 in the extension direction of spring elements 70, 72, this is still likewise supported or supportable on base part 18. Thus, a support of support shoe 68 is particularly guaranteed outward in radial direction 8 on base part 18. Support shoe 68 is supported or supportable on base part 18 via two rollers 82, 84, wherein rollers 82, 84 are rotatably fixed on support shoe 68. Stated more precisely, the two rollers 82, 84 extend in axial directions 4, 6 through recesses within support shoe 68, wherein the two rollers 82, 84 are rotatably supported on support shoe 68 via roller bearing 86. As is particularly clear from Figures 1 and 3, the two axes 88, 90 are thereby arranged spaced apart from set force engagement point 56 and thereby on opposite sides of set force engagement point 56. The two rollers 82, 84 extend in axial direction 4 into longitudinal recesses 92 in disk 22, while they extend in opposite axial direction 6 into longitudinal recesses 94 in disk 22 of base part 18 so that rollers 82, 84 and also support shoe 68 via rollers 82, 84 are supported or supportable on base part 18 via a recess edge 96 of recesses 92, 94.

[0039] To cause the previously mentioned displacement or adjustment of projection 60 by changing the reset force characteristic curve of the reset force acting on inertial mass part 26, an adjusting device 98 is respectively assigned to the two reset devices 48. Adjusting device 98 thereby respectively has a piston-cylinder arrangement with a hydraulic cylinder 100 and a hydraulic piston 102 guided in hydraulic cylinder 100. Hydraulic pressure is thereby applicable on both sides of drivable hydraulic piston 102 so that cylinder 100 may also be considered a double-acting cylinder 100. As is particularly clear in Figures 1 and 5, cylinder 100 is fixed on base part 18, in the embodiment depicted in particular in that cylinder 100 is formed as one piece with ring 24 for connecting the two disks 20, 22 of base part 18. Even if this embodiment variant is advantageous, respective cylinder 100 may also be designed separately from ring 24 or from disks 20, 22 in order to be subsequently fixed on ring 24 and/or on at least one of disks 20, 22 of base part 18. A piston rod 104 is provided on hydraulic piston 102 and is preferably rigidly fixed on hydraulic piston 102 or is designed as one piece with the same, and extends in a movement direction of hydraulic piston 102 out of cylinder 100. The movement axis 106 of hydraulic piston 102 and piston rod 104 is displaced outward in radial direction 8 with respect to axis of rotation 16 of rotational vibration damper 2, wherein movement axis 106 is here analogously formed by a tangent of a circumferential circle extending in circumferential directions 12, 14.

[0040] To transfer the straight line movement of hydraulic piston 102 at a ratio of 1:1 and in the same direction to projection 60, and thus to pivot point 52, a transmission link 108 is fixed on the end of piston rod 104 and interacts, using its end facing away from piston rod 104, with projection 60 or pivot point 52. To be able to arrange transmission link 108, which is, like hydraulic piston 102 and piston rod 104, arranged in axial directions 4, 6 between plates 20, 22 of base part 18, in a particularly space saving way in the intermediate space between disks 20, 22, transmission link 108 is essentially composed of two link sections 110, 112. The two link sections 110, 112 are arranged opposite one another in axial directions 4, 6 and spaced apart from one another in said axial directions 4, 6. In general, link sections 110, 112 are essentially structurally identical. As is particularly clear in Figure 3, spring element 72 extends through between the two link sections 110, 112 to be supported or supportable on retaining shoe 76. Consequently, transmission link 108 is designed in such a way to enable an arrangement in the smallest spaces with spring device 50, without negative influences on their functions. A particularly compact structure is thus achieved. To enable a compact structure of rotational vibration damper 2, transmission link 108 or its link sections 110, 112 is additionally designed as curved to prevent a collision of support shoe 68 with transmission link 108, so that support shoe 68 may indeed be displaced in the direction of transmission link 108; however, due to the curvature of transmission link 108, a displacement of said support shoe up to a collision with transmission link 108 is prevented.

[0041] Due to the hydraulic pressure being applicable on both sides of hydraulic piston 102, a spring element for resetting hydraulic piston 102 is basically not necessary. However, to ensure a resetting of hydraulic piston 102 during shut down or in case of failure of the hydraulic pressure, a spring element 114 is assigned to hydraulic piston 102 to reset hydraulic piston 102 into an end position of the same. Spring element 114 may be any elastic element; however, it is preferably a helical spring, as is clear in Figure 1. To be able to thereby arrange spring element 114 in a particularly space saving way and to create a compact adjustment device 98 in this way, spring element 114 is arranged in a pressure chamber 116 assigned to hydraulic piston 102, thus in one of the two pressure chambers for double-sided impingement of hydraulic piston 102 within cylinder 100. Spring element 114 also interacts with hydraulic piston 102 in such a way that the previously mentioned reset force characteristic curve has the largest slope in said end position of hydraulic piston 102. Hydraulic lines also lead into pressure chamber 116 and into opposite pressure chamber 118 within cylinder 100 in order to be able to apply hydraulic pressure to respective pressure chamber 116 or 118. In at least one of the hydraulic lines, here, for example, in hydraulic line 120, which leads into pressure chamber 116, a throttle or restriction 122 is provided as this is indicated in Figure 5.

[0042] It is also clear from Figure 5 that cylinder 100 - unless otherwise provided - is not arranged completely between disks 20, 22 of base part 18, but rather cylinder 100 extends in the latitudinal direction into recesses 124, which shall still enable an arrangement of cylinder 100 essentially between disks 20, 22, wherein cylinder 100 may be supportable in its latitudinal direction also on a recess edge 126 within recesses 124.

[0043] In addition, synchronizing means 128 are provided which provide synchronization and/or coupling of the movement of hydraulic piston 102 of first adjusting device 98 with the movement of hydraulic piston 102 of the other adjusting device 98. In the present example, synchronizing means or coupling means 128 are formed by a synchronizing ring 130 which is formed extending in circumferential directions 12, 14 and is rotatable about axis of rotation 16 relative to base part 18, wherein support arms 132 are arranged on synchronizing ring 130 projecting outward in radial direction 8 and interact with hydraulic piston 102, more precisely with piston rod 104 of hydraulic piston 102, in such a way that the displacement of one of hydraulic pistons 102 equally causes a rotation of synchronizing ring 130. Synchronizing ring 130 and its support arms 132 are also thereby arranged in axial direction 4, 6 between disks 20, 22 of base part 18.

[0044] Basically, the maximum rotational angle of inertial mass part 26 relative to base part 18 is limited by spring elements 70, 72 of spring device 50 in that said spring elements are compressed into blocking at the maximum deflection of inertial mass part 26. However, to determine the maximum rotational angle of inertial mass part 26 with respect to base part 18 in a targeted way, and optionally without necessitating a blocking compression of spring elements 70, 72, a stop 134 is fixed on inertial mass part 26; said stop starts from inertial mass part 26 and extends inward in radial direction 10 between disks 20, 22 of base part 18, as may be gathered in particular from Figure 2. As is additionally clear from Figure 2, two essentially structurally identical stops 134 are provided in the embodiment depicted, of which the one is arranged in axial direction 4 to the side of lever element 54 and the other is arranged in axial direction 6 to the side of lever element 54. Stop 134 is supported or supportable on pin-shaped projection 60 in the two opposing rotational directions while limiting the maximum rotational angle between inertial mass part 26 and base part 18. For this purpose, the two stops 134 essentially have a recess 136, open inward in radial direction 10 and tapering outward in radial direction 8, in which pin-shaped projection 60 extends so that inertial mass part 26 is supportable on projection 60 and thus on base part 18 via stops 134 at a corresponding relative rotation in circumferential directions 12, 14 with respect to base part 18 while limiting the maximum rotational angle. It is hereby preferred if recess 136 is designed as narrow on the end facing in radial direction 8 in such a way that the maximum rotational angle is reduced essentially to 0°, which amounts to a fixing of inertial mass part 26 on base part 18 while preventing further rotation. Projection 60 preferably assumes this position within recess 136 when hydraulic piston 102 was transitioned into the previously mentioned end position - optionally by means of spring element 114.

[0045] To achieve an advantageous limitation of the maximum rotational angle in the different operating ranges of rotational vibration damper 2, stop 134 is designed in such a way that the maximum rotational angle varies as a function of the position of projection 60 relative to base part 18. In the embodiment depicted, this is achieved in that recess 136 in stop 134 tapers outward in radial direction 8 so that the maximum rotational angle is greater the farther projection 60 is pushed inward in radial direction 10 relative to base part 18. In addition, to achieve a particularly advantageous limitation of the maximum rotational angle over a majority of the operating range of rotational vibration damper 2, stop 134 is designed in such a way that it is supported or supportable on projection 60 over at least one-fourth of the maximum travel path of stop 60, over at least half of the maximum travel path of projection 60, or over the entire maximum travel path of projection 60 relative to base part 18. In the depicted embodiment, stop 134 extends in such a way inward in radial direction 10 such that said stop is supported or supportable on projection 60 over the entire maximum travel part of projection 60 relative to base part 18.

[0046] To be able to easily detect the respective operating state of rotational vibration damper 2, detectable means 138 are arranged on pivot point 52, in this case projection 60, as this is indicated in Figure 2. Detectable means 138, which are displaceable together with projection 60 in radial direction 8, 10 along guides 62, 64, 66, may be detected by a detection device 140 while determining the position of pivot point 52 relative to base part 18. Detection means 138 are thereby preferably not arranged between disks 20, 22 of base part 18, but instead adjacent thereto in axial direction 4, as this may be gathered from Figure 2. Detection device 140 is thereby not fixed on a component of rotational vibration damper 2 itself, but instead on a stationary or non-rotating component 142 within the drivetrain, wherein component 142 may be, for example, an adjacent housing or the like. Due to the determined position of pivot point 52, the operating state of rotational vibration damper 2 may thus be detected and optionally regulated or controlled via adjusting device 98. Detection device 140 may itself have a corresponding sensor which may be designed, for example, as optical or inductive.

[0047] Inertial mass part 26 is arranged in the installed state within the drivetrain and outside the torque transmission path of the drivetrain in contrast to base part 18.

Reference sign list

2	Rotational vibration damper
4	Axial direction
6	Axial direction
8	Radial direction
10	Radial direction
12	Circumferential direction
14	Circumferential direction
16	Axis of rotation
18	Base part
20	Disk
22	Disk
24	Ring
26	Inertial mass part
28	Shaped sheet metal part
30	Shaped sheet metal part
32	Shaped sheet metal part/Cast part
34	Guide groove
36	Roller
38	Roller
40	Roller
42	Roller bearing
44	Roller axle
46	Spacer sleeves
48	Reset device
50	Spring device
52	Pivot point
54	Lever element
56	Set force engagement point
58	Reset force engagement point
60	Projection

62	Guide
64	Guide
66	Guide
68	Support shoe
70	Spring element
72	Spring element
74	Retaining shoe
76	Retaining shoe
78	Pin
80	Pin
82	Roller
84	Roller
86	Roller bearing
88	Axis
90	Axis
92	Recesses
94	Recesses
96	Recess edge
98	Adjusting device
100	Cylinder
102	Hydraulic piston
104	Piston rod
106	Movement axis
108	Transmission link
110	Link section
112	Link section
114	Spring element
116	Pressure chamber
118	Pressure chamber
120	Hydraulic line
122	Throttle/Restriction
124	Recesses

126	Recess edge
128	Synchronizing means
130	Synchronizing ring
132	Support arms
134	Recess
138	Detectable means
140	Detection device
142	Component

Claims

1. A rotational vibration damper (2) comprising a base part (18) rotatable about an axis of rotation (16) and an inertial mass part (26) which is rotatable relative to the base part (18) counter to the reset force of a reset device (48), which has a spring device (50) for generating a set force and at least one lever element (54) pivotable about a pivot point (52), via which lever element the set force is transmittable from a set force engagement point (56) of the lever element (54) to the inertial mass part (26) by generating the reset force affecting the inertial mass part (26) via a reset force engagement point (58) of the lever element (54).

2. The rotational vibration damper (2) according to Claim 1, **characterized in that** the spring device (50) has at least one spring element (70, 72) and a support shoe (68), wherein the set force of the spring element (70; 72) is transmittable to the set force engagement point (56) via the support shoe (68), and the support shoe (68) is supported or supportable on the base part (18) preferably via at least two rollers (82, 84) which are particularly preferably fixed on the support shoe (68) and/or the axes (88, 90) thereof are optionally spaced apart from the set force engagement point (56) and/or are arranged on opposite sides of the set force engagement point (56).

3. The rotational vibration damper (2) according to Claim 2, **characterized in that** the spring element (70; 72) is supported on the base part (18) on the side facing away from the support shoe (68) via a retaining shoe (74; 76), wherein the retaining shoe

(74) is preferably arranged between the base part (18) and the spring element (70; 72) pretensioned by the spring element (70; 72) and is particularly preferably fixed on the base part (18), optionally via a pin or screw connection.

4. The rotational vibration damper (2) according to one of Claims 1 through 3, **characterized in that** the base part (18) is formed sandwich-like from two disks (20, 22) lying opposite one and other and spaced apart from one another, wherein the reset device (48), optionally its spring device (50) and it its lever element (54) and/or its spring element (70; 72) and/or its support shoe (68) and/or its retaining shoe (74; 76), is arranged preferably at least partially between the disks (20, 22), and/or at least one of the rollers (82; 84) extends particularly preferably into recesses (92, 94) in the two disks (20, 22) and is supported or supportable on the base part (18) via a recess edge (96) of the recesses (92, 94), and/or the retaining shoe (74; 76) is particularly preferably fixed on the two disks (20, 22).

5. The rotational vibration damper (2) according to one of the preceding claims, **characterized in that** the reset device (48) is adjustable by means of an adjusting device (98) by changing a reset force characteristic curve of the reset force acting on the inertial mass part (26), in that the pivot point (52) is adjustable and/or displaceable by changing the lever ratio of the lever element (54), wherein the adjusting device (98) has a drivable hydraulic piston (102) on which hydraulic pressure can be applied, optionally on both sides, the movement of said hydraulic piston is transmittable preferably in

a ratio of 1:1 and/or in the same direction to the pivot point (52), optionally by means of a transmission link (108), wherein the transmission link (108) is arranged particularly preferably between the disks (20, 22) and/or has two opposite link sections (110, 112) between which the spring element (70; 72) extends, and/or is designed as curved, if necessary, to prevent a collision of the support shoe (68) with the transmission link (108).

6. The rotational vibration damper (2) according to Claim 5, **characterized in that** a spring element (114) is assigned to the hydraulic piston (102) for resetting the hydraulic piston (102) into an end position of the same, said spring element is preferably arranged in a pressure chamber (116) assigned to the hydraulic piston (102), and/or a throttle or restriction (122) is provided in at least one hydraulic line (120) leading to the pressure chamber (116) assigned to the hydraulic piston (102), and/or a synchronizing means (128), optionally a synchronizing ring (130) is provided for synchronizing and/or coupling the movement of the hydraulic piston (102) to the movement of a hydraulic piston (102) of another adjusting device (98).

7. The rotational vibration damper (2) according to one of Claims 5 or 6, **characterized in that** the pivot point (52) is essentially formed by an adjustable and/or displaceable projection (60), wherein a stop (134) is provided on the inertial mass part (26), said stop is supported or supportable on the projection (60) to limit the maximum rotational angle between the inertial mass part (26) and the base part (18), preferably in both opposing rotational direction, and said stop is formed particularly prefera-

bly in such a way that the maximum rotational angle varies as a function of the position of the projection (60) relative to the base part (18), and/or the stop (134) is supported or supportable on the projection (60) over at least one-fourth of the maximum travel path of the projection (60) relative to the base part (18), over at least half of the maximum travel path of the projection (60) relative to the base part (18), or over the entire maximum travel path of the projection (60) relative to the base part (18).

8. The rotational vibration damper (2) according to one of the preceding claims, **characterized in that** the inertial mass part (26) is supported or supportable on the base part (18) in radial directions (8, 10) and/or in axial directions (4, 6) via at least three rollers (36, 38, 40), wherein the rollers (36, 38, 40) are preferably rotatably fixed on the base part (18) and are particularly preferably pretensioned in radial directions (8, 10), wherein the rollers (36, 38, 40) optionally extend into a guide groove (34) in the inertial mass part (26).

9. The rotational vibration damper (2) according to one of the preceding claims, **characterized in that** detectable means (138) are arranged on the pivot point (52) optionally on the projection (60), said detectable means are detectable by a detection device (140) while determining the position of the pivot point (52) relative to the base part (18), wherein the detection device (140) is preferably fixed on a stationary component (142).

10. The rotational vibration damper (2) according to one of the preceding claims, **characterized in that** the

inertial mass part (26) is designed as a shaped sheet metal part and/or a cast part.

11. A drivetrain for a motor vehicle, **characterized in that** the drive train has a rotational vibration damper (2) according to one of the preceding claims, wherein the base part (18) is preferably fastened in a rotationally fixed way on a component arranged in the torque transmission path, while the inertial mass part (26) is arranged outside of the torque transmission path of the drivetrain, and the component is formed particularly preferably by a primary or secondary element of a torsional vibration damper.

Fig. 1

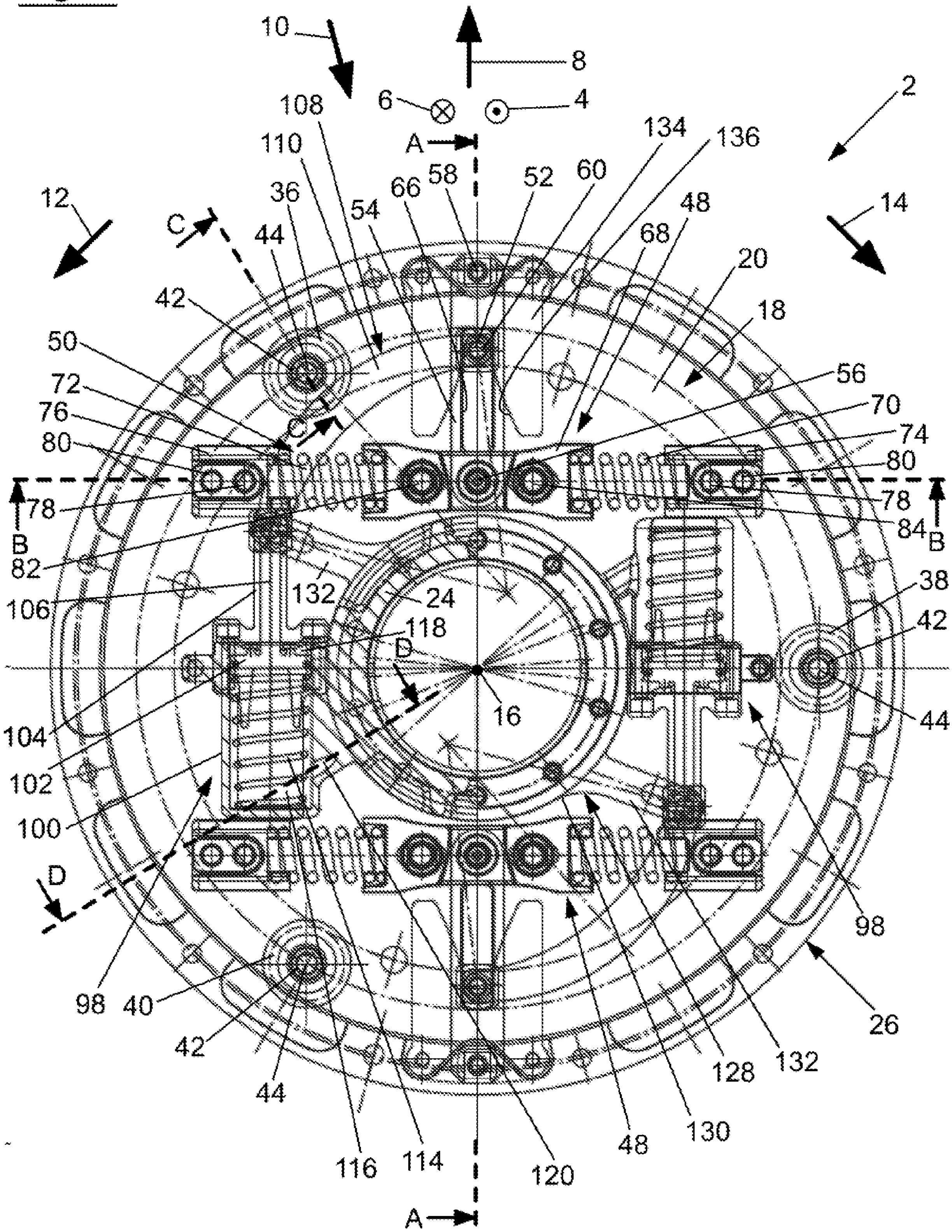
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Fig. 2

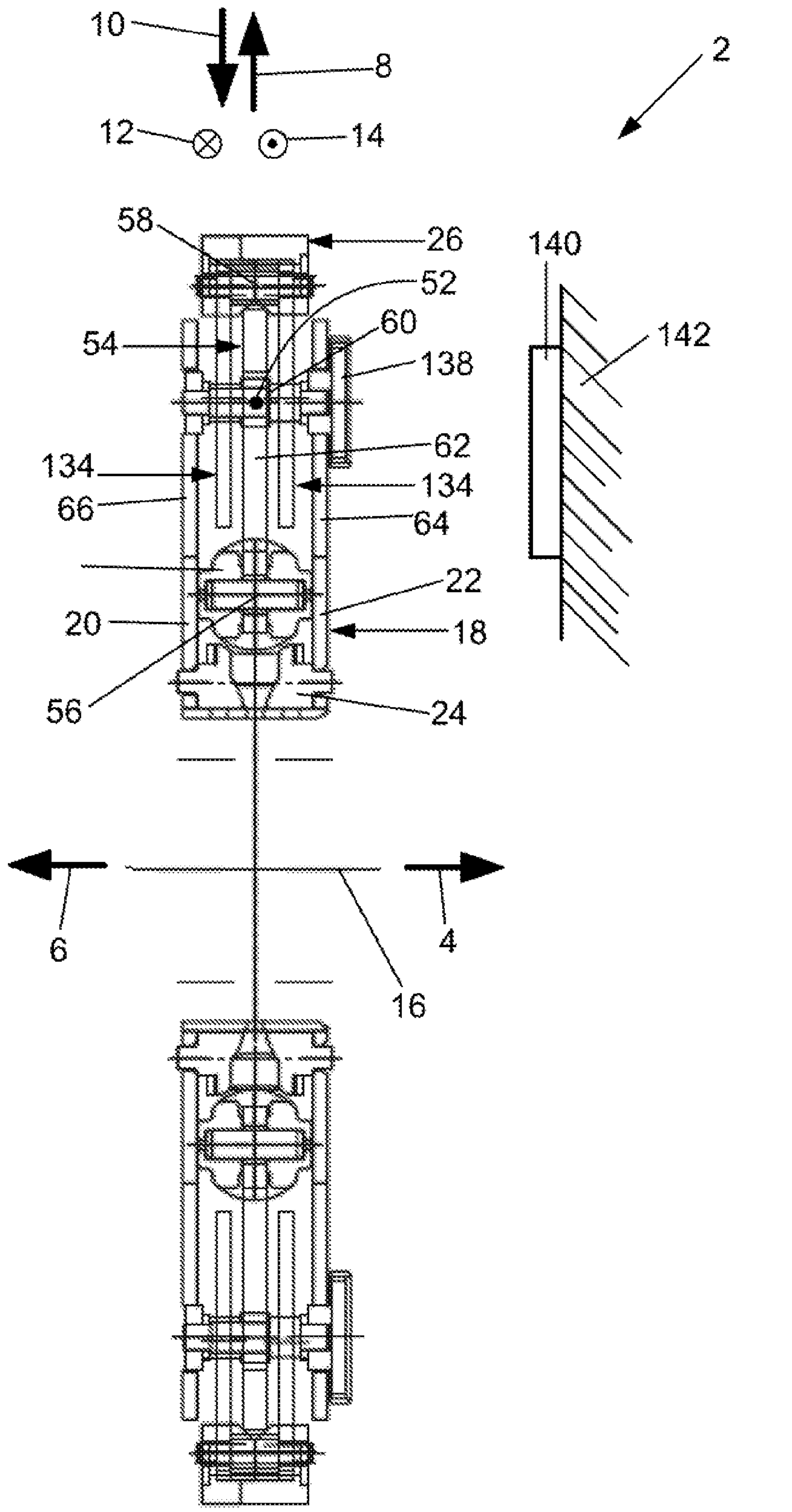
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Fig. 3

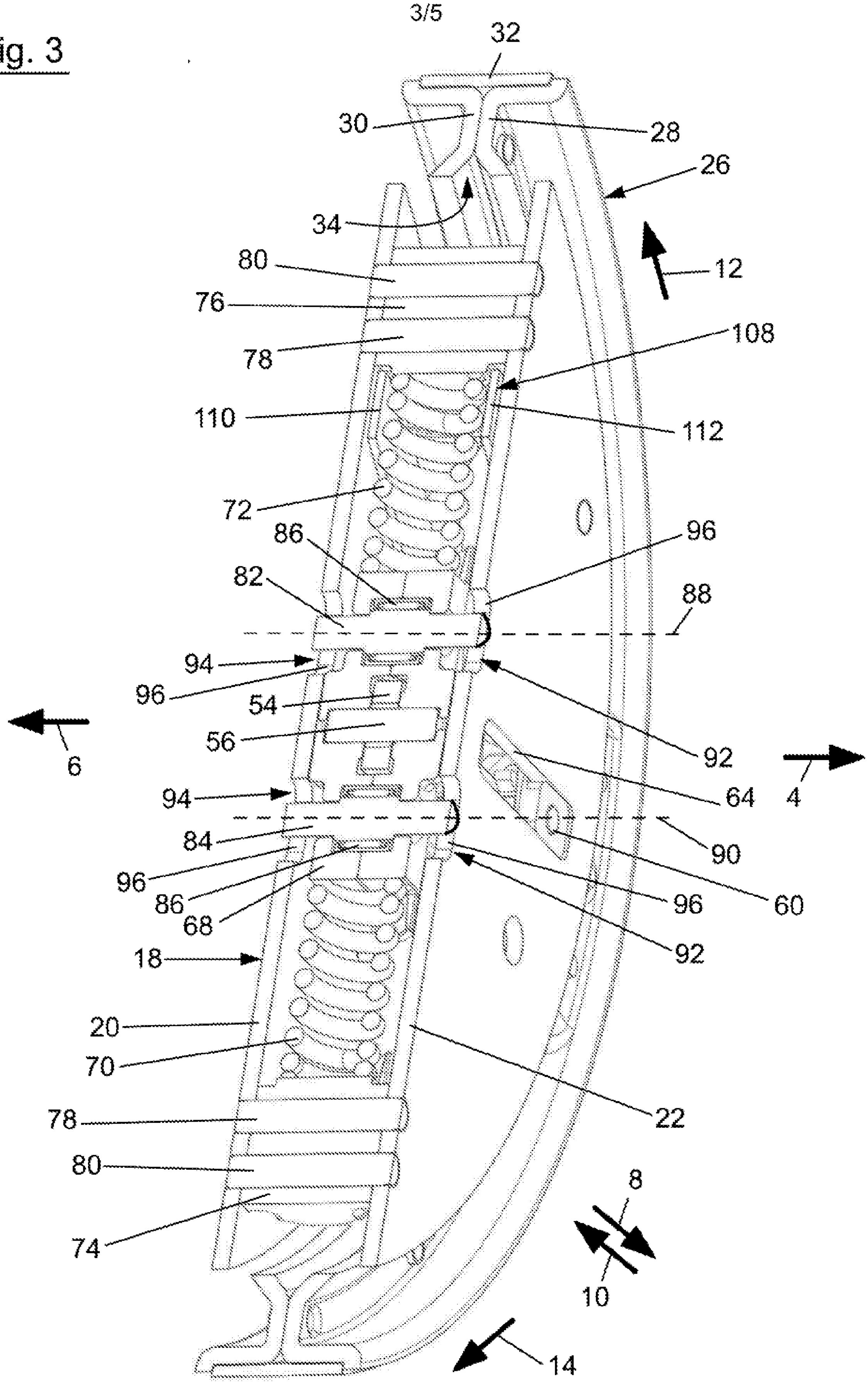
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Fig. 4

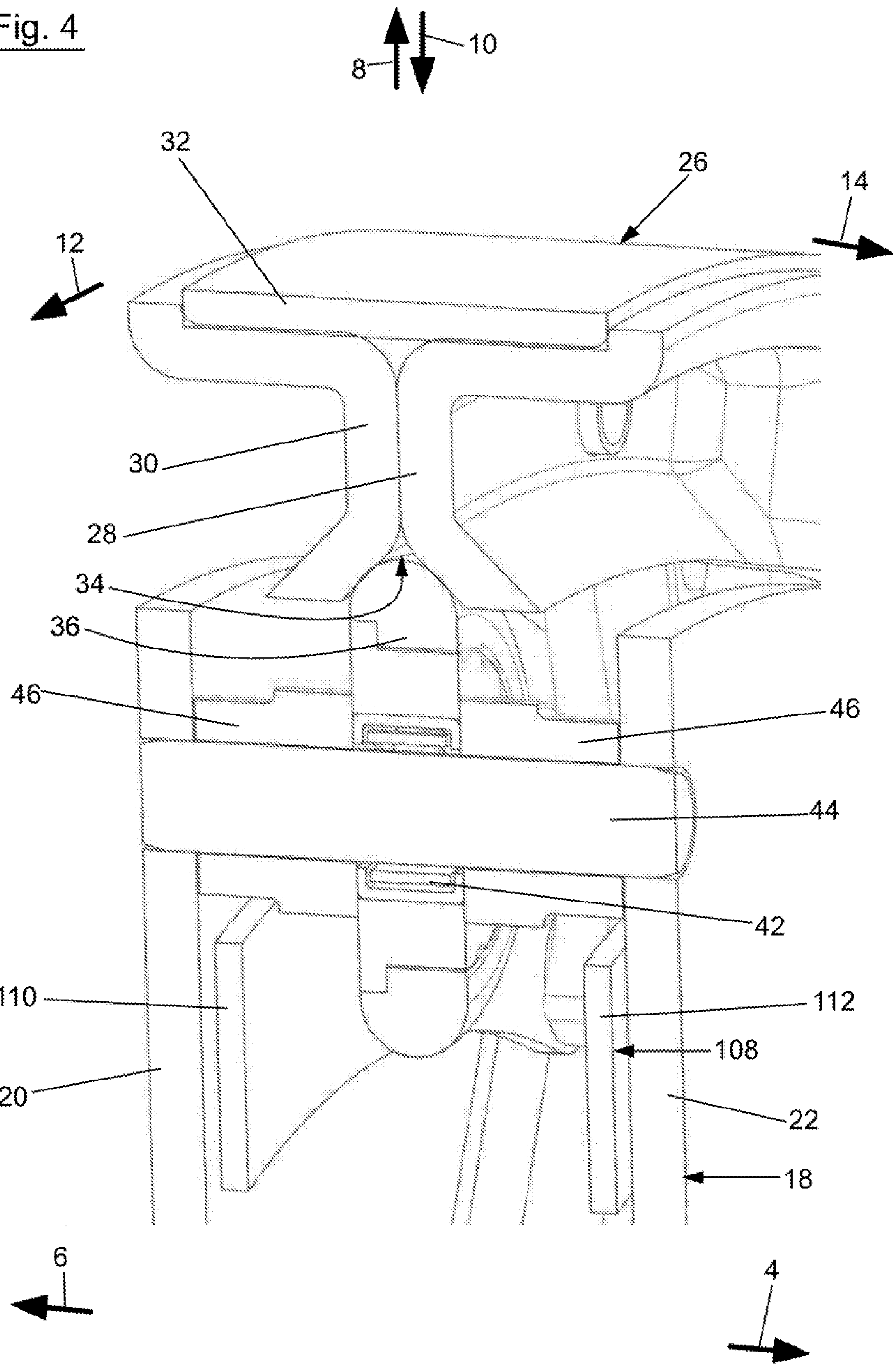
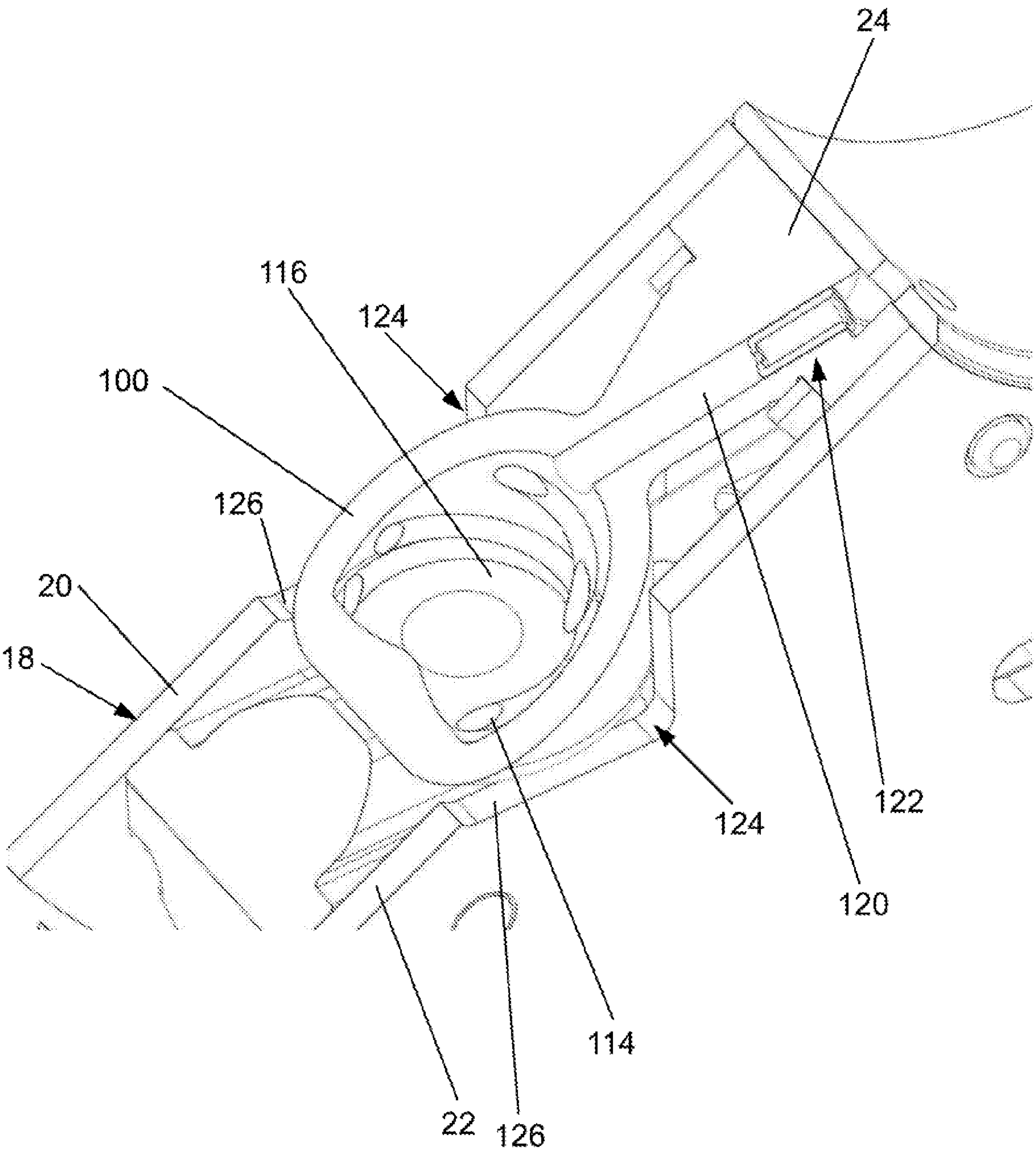


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/057489

A. CLASSIFICATION OF SUBJECT MATTER

F16F 15/14(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16F 15/14; F16F 15/134; F16F 15/121; F16D 3/50; F16D 3/64; F16D 47/02; F16F 15/12; F16D 3/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: rotational, vibration, damper, inertial, set force, reset force, lever

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2016-073842 A1 (BORGWARNER INC.) 12 May 2016 See claims 1, 3-4; and figure 1.	1-2 3-4
Y	US 2013-0231195 A1 (TAKENAKA, TETSUHIRO) 05 September 2013 See paragraphs [0082], [0089]-[0092]; and figures 1-4.	3-4
A	US 2014-0302937 A1 (LORENZ et al.) 09 October 2014 See paragraphs [0061], [0065]; and figure 11.	1-4
A	US 2010-0133060 A1 (BOELLING, JOCHEN) 03 June 2010 See paragraphs [0055]-[0056]; and figure 3.	1-4
A	US 2013-0165240 A1 (GRIMMER, MICHAEL J.) 27 June 2013 See paragraphs [0023]-[0029]; and figures 3-4.	1-4

☐ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 January 2018 (29.01.2018)	**30 January 2018 (30.01.2018)**

Name and mailing address of the ISA/KR
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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 6
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 6 is regarded to be not clear because it refers to claim 5, which does not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 5, 7-11
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/057489

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