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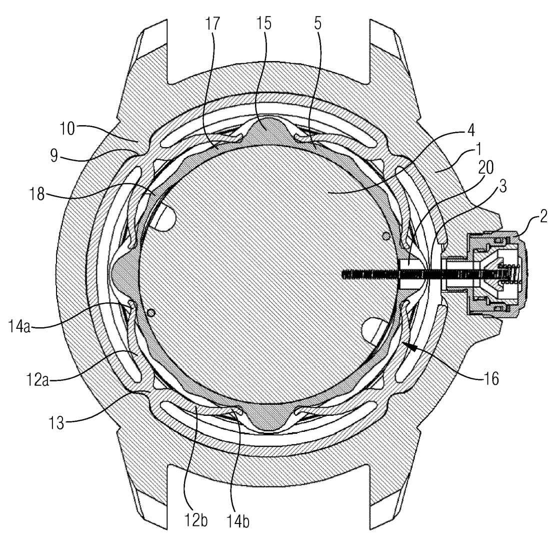
(54) SHOCK ABSORBER DEVICE FOR A MOVEMENT OF A WATCH

(57) A shock absorber device for a movement (4, 104, 204) of a watch adapted to be housed between a case middle (1, 101, 201, 301, 401) of a watch case and said movement (4, 104, 204), the device comprising a casing ring (5, 105, 205, 305, 405) for said movement and a plurality of elastic elements (16, 116, 216, 316, 416) distributed over the perimeter of said casing ring and arranged between said casing ring (5, 105, 205, 305, 405) and the case middle (1, 101, 201, 301, 401) of the watch case, wherein said elastic elements are configured as double leaf spring elements (12a, 12b, 112a, 112b, 212a, 212b) having a central root portion (13, 113, 213, 313) fixedly secured to said middle of the watch case and two free tip portions (14a, 14b, 114a, 114b, 214a, 214b) resting on said casing ring. In particular, said leaves are arranged in cantilever position carrying loads from said free tips to said fixedly secured root portion. In an embodiment, said double leaf spring elements are discrete spaced apart workpieces (216, 316) whose central portions (213, 313) are shaped to be fitted into conjugated receiving portions of the wall of the middle of the watch case. In other embodiments, said double leaf spring elements (16, 116, 416) are carried inwards by a supporting ring (8, 108, 408) fitted within the middle of the watch case.

Fig.1



EP 3 396 473 A1

Description

Field of the invention

[0001] The present invention pertains to the field of shock absorbing systems for watches.

[0002] More specifically the invention relates to a shock absorber device for a movement of a watch comprising a casing ring for said movement and a plurality of elastic elements distributed over the perimeter of said casing ring, and arranged between said casing ring and the inner wall of the middle of the watch case.

Background of the invention and state of the art

[0003] Several shock absorbing systems known in the art are based on the deformability of a ring-shaped elastic rubber-like material disposed between the watch case and an enveloping piece, in particular a casing ring, of the movement.

[0004] CH 346825 discloses an annular O-ring-like rubber shock absorber positioned between the casing ring and the watch case. The O-ring presents a hole for passage of the crown stem.

[0005] CH 700383 discloses an elastic O-ring joint for the watch glass acting also as a shock absorber positioned between the casing ring and the glass. The crown stem is separated into two parts that are connected via a coupling mechanism.

[0006] US 3 735 584 discloses a watch wherein the movement is mounted by means of a pair of support elements and a pair of shock absorbing rings made of a resilient material which are disposed between each of the support elements and the watch case.

[0007] FR 1 569 309 discloses a watch comprising a generally cylindrical elastic shock absorbing ring arranged between the watch case and the movement. The internal surface of the watch case middle has an internal groove for enabling greater deformation of the elastic ring. The elastic ring may have an inward, that is to say directed towards the movement, internal groove for receiving a projecting element of the casing ring.

[0008] The rubber rings of the kind disclosed in the above cited documents occupy a major part of the space allocated between the middle of the watch and the casing ring; thus, upon a shock, the possibility of displacement of the casing ring and the deformation of the rubber material are very limited and the efficiency of shock absorption is poor. A further disadvantage of using rubber is due to its aging behaviour, which often leads to embrittlement of the material over time.

[0009] Other prior art solutions use a plurality of discrete shock absorber elements distributed around the watch movement.

[0010] CH 701 549 discloses a watch wherein four independent shock absorber elements are arranged between the watch case and the movement for absorbing the energy from shocks and vibrations. Each of these elements comprises a helical spring and a piston and the rigidity of these shock absorber elements may be adjusted from outside the watch.

[0011] FR 1 512 017 discloses a watch case comprising an outer frame and an inner frame connected by a plurality of spaced apart substantially radially extending elastic elements intended to absorb forces that act on the outer frame. These elastic elements may be cylindrical and made of rubber.

[0012] WO 2010/019028 discloses a watch case comprising an outer frame and an inner frame connected by a plurality of spaced apart substantially radially extending elastic elements intended to absorb forces that act on the outer frame. These elastic elements may be cylindrical, made of rubber and further comprise a helical spring. The outer frame is provided with openings, such that an elastic element can be positioned in each of the openings from the outside and effect a detachable connection between the frames.

[0013] Still other prior art solutions use a plurality of blade-shaped elements distributed around the watch movement.

[0014] US 4,204,396 discloses a shock absorbing system specifically designed for a watch comprising a moulded watchcase of plastic material and a movement having a moulded baseplate. A plurality of resiliently deformable arms or blades have one of their ends moulded in the watchcase material and the other end moulded in the baseplate material. Since these blades are fixed both in the watch case and the movement, their shock absorbing effect is limited.

[0015] CH 171 429 discloses an anti-shock device comprising a plate attached to a surface of the movement, parallel to the dial. The plate presents a number of cut-outs so as to form at least two elastic resilient blades. The external extremities of the blades are fixed to the watchcase. The plate thus forms a suspension system of the movement inside the watch case. A drawback of this solution resides in the large size, footprint and relative weight of the plate, providing an additional sprung mass to the sprung mass of the movement in the event of sudden deceleration, as happens upon a shock.

[0016] DE 1 690 177 U teaches to form cut-outs in the thin cylindrical wall of a casing ring of a movement so as to form wedge-tailed and arc-shaped blades distributed over the perimeter of the casing ring, and to bend said blades outwards, so that the blades come to rest resiliently against the inner surface of the watch middle. A drawback of this solution again resides in the weight of the casing ring, which must be relatively thick for providing sufficient resiliency of the arc-shaped blades, generating an additional sprung mass to the sprung mass of the movement in the event of sudden deceleration. In addition, the formation of the blades by cutting and bending may be imprecise and affect their ability to provide the required resiliency. A further drawback of this solution resides in the fact that the outer surface of the blades and the inner surface of the watch case middle are tangential to each other, and as a result the moment arm of the blade is not well defined and varies upon compression.

Objectives of the invention

[0017] It is the object of the present invention to overcome or at least reduce the above mentioned drawbacks of the shock absorbing systems of the prior art and to realize a device that is

- capable of protecting a watch movement from repeated side impacts against very hard surfaces,
- capable of providing unrepeatable, i.e., at least one-time, protection from even greater drop heights, and
- capable of being easily produced, mounted and disassembled in a cost-effective manner.

Solution according to the invention

[0018] To this effect, the present invention proposes a shock absorber device which is defined by the features set forth in claim 1 and which allows to achieve the objectives identified above.

[0019] Under a further aspect, the present invention proposes a movement casing ring for a shock absorber device, as defined in claim 15.

[0020] Under a still further aspect, the invention provides a suspension ring for a shock absorber device for a movement of a watch, as defined in claim 17.

[0021] Thus, the present invention provides a shock absorber device for a movement of a watch comprising a casing ring for said movement and a plurality of elastic elements distributed over the perimeter of said casing ring and arranged between said casing ring and the middle of the watch case wherein said elastic elements are configured as double leaf spring elements having a central root portion fixedly secured to said middle of the watch case and two free tip portions resting on said casing ring.

[0022] In particular, said leaves are arranged in cantilever position carrying loads from said free tips to said fixedly secured root portion.

[0023] In an embodiment, said leaves present a curved shape, said shape being inwards concave over the major part of their length, with an inwards convex tip.

[0024] In an embodiment, said leaves taper from the central root portion to the tips.

[0025] In an embodiment, the thickness of each leaf increases with the square root of the distance from the tips.

[0026] In an embodiment, said movement casing ring presents outwards protrusions arranged to lie between two neighbouring double leaf spring elements.

[0027] In an embodiment, the shock absorber device comprises stiffening means, said stiffening means being configured to stiffen said leaf spring system in the last fractions of potential displacement of said leafs upon a shock.

[0028] In an embodiment, said double leaf spring elements are discrete spaced apart workpieces whose central portions are shaped to be fitted into conjugated receiving portions of the wall of the middle of the watch case.

[0029] In an embodiment, said double leaf spring elements are carried inwards by a supporting ring fitted within the middle of the watch case.

[0030] In an embodiment, said double leaf spring elements are made of one piece with said supporting ring.

[0031] In an embodiment, said supporting ring presents positioning means configured to fit with conjugated stopping means present on the inner wall of the middle of the watch case.

[0032] In an embodiment, said supporting ring presents an interruption arranged versus said positioning means so as to surround a winding crown stem of the watch.

[0033] In an embodiment, said stiffening means comprise outwards bumps configured on the movement casing ring so as to contact said leaves towards the end of their displacement, before the movement casing ring contacts any rigid element integral with the middle.

[0034] In an embodiment, said stiffening means comprise leaflet shaped springs, wherein one leaflet shaped spring is arranged between each said leaf spring and said supporting ring, and wherein said leaflet shaped springs are configured to contact said leaf springs towards the end of the displacement of said leaf springs before the movement casing ring contacts any rigid element integral with the middle.

[0035] In an embodiment, said elastic elements, including said supporting ring if present, are made from a material selected from maraging steels and amorphous metals.

[0036] Under a further aspect, the invention provides a movement casing ring for a shock absorber device as defined above, wherein said movement casing ring presents outwards protrusions arranged to lie between two neighbouring double leaf spring elements.

[0037] In an embodiment, said casing ring comprises stiffening means, said stiffening means comprising outwards bumps configured on the casing ring so as to contact said leaves towards the end of their displacement, before the casing ring contacts any rigid element integral with the middle.

[0038] Under a further aspect, the invention provides a suspension ring for a shock absorber device for a movement of a watch, comprising a supporting ring configured to be fitted within a middle of a watch case and a plurality of elastic elements distributed over the inner perimeter of said supporting ring, wherein said elastic elements are configured as double leaf spring elements projecting inwardly in cantilever position, having a central root portion integral with said supporting ring and two free tip portions resting on a casing ring of said movement.

[0039] In an embodiment of the suspension ring according to invention said leaves present a curved shape, said shape being inwards concave over the major part of their length, with an inwards convex tip.

[0040] Preferably, said leaves taper from the central root portion to the tips, wherein the thickness of each leaf increases with the square root of the distance from the tips.

[0041] In an embodiment of the suspension ring, said supporting ring presents positioning means configured to fit with conjugated stopping means present on the inner wall of the middle of the watch case and in that said supporting ring presents an interruption arranged in respect of said positioning means so as to surround a winding crown stem of the watch.

[0042] In an embodiment of the suspension ring, it comprises stiffening means, said stiffening means being configured to stiffen said leaf spring system in the last fractions of potential displacement of said leafs upon a shock. In one embodiment said stiffening means comprises leaflet shaped springs, wherein one leaflet shaped spring is arranged between each said leaf spring and said supporting ring, and wherein said leaflet shaped springs are configured to contact said leaf springs towards the end of the displacement of said leaf springs before the casing ring contacts any rigid element integral with the middle.

[0043] Other features and advantages of the present invention will appear to those skilled in the art in the following detailed description disclosing, with reference to the figures, preferred embodiments of the invention.

Short description of the figures

[0044] The attached figures exemplarily and schematically illustrate the principles as well as several embodiments of the present invention.

Figure 1 is a schematic transverse sectional view passing through the axis of a crown stem of a watch, said watch comprising a first embodiment of a shock absorber device according to the invention.

Figure 2 is a perspective view of the shock absorber device of figure 1.

Figure 3 is a schematic transverse sectional view passing through the axis of a crown stem of a watch, said watch comprising a second embodiment of a shock absorber device according to the invention.

Figure 4 is a perspective view of the shock absorber device of figure 3.

Figure 5 is a schematic transverse sectional view of a watch, said watch comprising a third embodiment of a shock absorber device according to the invention.

Figure 6 is an exploded view of a watch comprising a variant of the third embodiment of the shock absorber device.

Figure 7 is an exploded view of a watch comprising a suspension ring according to the invention.

Figure 8 is an enlarged schematic view showing the displacement of one leaf spring of the first embodiment of a shock absorber device according to the invention upon a shock, and the stresses exerted on said leaf.

Figure 9 is a plot representing stress versus displacement for a leaf spring of the first embodiment of a shock absorber device of figure 8.

Detailed description of the invention

[0045] In the following, specific embodiments of the invention shall be described in detail with reference to the above mentioned figures.

[0046] A first embodiment of the shock absorber device is described hereinafter in conjunction with figures 1 and 2.

[0047] Figure 1 is a schematic view of a watch comprising a watch case middle part 1 (hereinafter referred to as the case middle 1), a winding crown 2, a crown stem 3 and a movement 4. Typically, the case middle forms part of a watch case together with a case back and a bezel, however it will be appreciated that the case middle can also be formed unitarily with one or both of the bezel and case back parts in alternative constructions. For the sake of simplicity, the horologic electronic or mechanical functional components of the movement, whose description is not relevant here, are not shown in the drawings. The movement 4 is surrounded by a casing ring 5 and rests on a baseplate 6 (figure 2) which is fixed to the casing ring 5, for example by means of screws (not shown in the drawings). The casing ring 5 comprises an opening 20 that allows free passage to the crown stem 3 in such a way that the stem 3 does not grind or rub against the walls of opening 20. This prevents particles that would result from any grinding from falling into the watch movement 4 and also avoids possible reductions of the water resistance of the crown 2 caused by a lateral force exerted on the stem 3. The casing ring 5 further comprises a cylindrical sidewall 17 covered by a top portion 19 which may accommodate a dial.

[0048] A structure forming a suspension ring 7 is positioned between the case middle 1 and the casing ring 5. The suspension ring structure comprises an outer supporting ring 8 fitted within the case middle 1. Said supporting ring 8 presents positioning means configured to fit with conjugated stopping means present on the inner wall of the middle of the watch case. As may be seen from figure 1, the positioning means and the stopping means may, for example, be realised by means of conjugated recesses 9 in the supporting ring 8 and protrusions 10 of the inner wall of the case middle 1. Further, the supporting ring 8 presents an interruption 21 to allow passage of the winding crown stem 3 of the watch.

[0049] The supporting ring 8 carries a plurality of elastic elements 16 that project inwardly and which are integral and preferably made in one monolithic piece with the supporting ring 8. Elements 16 are distributed over the inner periphery of ring 8 and thus over the perimeter of said casing ring. These elastic elements 16 are configured as double leaf spring elements, having a central root portion 13, two leaves 12a, 12b extending laterally in opposite directions, and two free tip portions 14a, 14b resting on the outer surface of the sidewall 17 of the casing ring 5. The leaves present a curved shape, said shape being inwards concave over the major part of their length, and reversing to an inwards convex tip. Since the radius of curvature of the major leaf portion is of the same order of magnitude as the radius of curvature of the sidewall 17 of the casing ring 5, but the radius of curvature of a tip 14a, 14b is significantly smaller, the contact point between a leaf spring and the casing ring tends to remain at almost the same point on the leaf spring, that is to say at the tip, as this leaf spring deflects, and therefore the moment arm of the leaf spring advantageously presents relatively minor changes as the spring is loaded. The above-mentioned positioning means 9 and stopping means 10 prevent any movement, in particular any relative rotation, between the root portions 13 of the double leaf spring elements and the case middle 1. Thus, the tips 14a, 14b in contact with the casing ring behave as cantilever beams. In the embodiment shown in figures 1 and 2, the leaves taper from the central root portion to the tips and the thickness of a leaf increases with the square root of the distance from the tips.

[0050] In the embodiment shown in figures 1 and 2, there are four elastic elements 16 acting to securely surround the casing ring. In other embodiments, three such elastic elements may be sufficient. Alternatively five or more elastic elements could be used, notably in the case of very large watchcases and casing rings, or with watch cases and/or casing rings of specific geometries.

[0051] The cylindrical sidewall 17 of the casing ring 5 is made of thin wall portions over the majority of its perimeter to save weight and thereby reduce its sprung mass. However, the sidewall 17 of casing ring 5 also presents several thicker portions. A first type of thicker portions appear as outwardly projecting protrusions 15 arranged to lie between two neighbouring elastic double leaf spring elements 16, and, more specifically, between respective tips 14a and 14b of these neighbouring double leaf spring elements 16, forming thus abutments for these tips. The protrusions 15 may also house threaded bores (not shown) receiving the screws tightening the baseplate 6 to the casing ring 5.

[0052] A second type of thicker portions of the casing ring wall appear as outwardly projecting bumps 18 configured on the sidewall 17 of the casing ring so that each bump 18 faces one leaf 12a, 12b, and so as to contact that leaf towards the end of its displacement when the leaves deflect after a shock, preventing the casing ring 5 from coming into contact with any rigid element integral with the case middle. Thus, the bumps 18 act as stiffening means which stiffen said leaf spring system during the last fractions of potential displacement of the movement 4 after a shock. Those skilled in the art will appreciate the stiffening function of bumps 18 by referring to figures 8 and 9.

[0053] Figure 8 is an enlarged schematic view of one leaf spring 12a and the opposing bump 18 in four successive states corresponding to a range of drop heights, the distribution of stresses in the materials as shown being calculated by finite element analysis:

A: Starting state, before any relative displacement between the casing ring 5 and the case middle 1.

B: After a lateral shock of the watchcase against a surface, the casing ring 5 begins to move relative to the case middle 1 and the leaf spring 12a deflects elastically under normal working conditions; if the shock is moderate, the process ends at this state.

C: At higher impact strength, the point where the bump 18 contacts the leaf spring 12a is reached.

D: After the bump 18 is in contact with the leaf spring 12a, the more elastic free end portion of the leaf spring is bypassed, the system becomes much stiffer and the stress develops mostly between the bump contact point and the portion near the root of the spring element 16. This provides an additional measure of protection, preventing sudden impact of the casing ring with the watch case, at the cost of plastic deformation of the elastic element 16.

[0054] Figure 9 is an illustrative plot of the load force (in Newton) versus the relative travel between the pieces (in mm) illustrating the change of behaviour of the shock absorber device after contact between bumps and leaf springs.

[0055] A second embodiment of the shock absorber device is described hereinafter in conjunction with figures 3 and 4. This second embodiment differs from the first embodiment principally by the construction of the stiffening means.

[0056] Figure 3 is a schematic view of a watch comprising a watch case middle 101, a winding crown 102, a crown stem 103 and a movement 104. The horologic functional components of the movement, either electronic or mechanical, are not shown in the drawings. The movement 104 is surrounded by a casing ring 105 and rests on a baseplate 106 which is fixed to the casing ring 105, for example by means of screws (not shown in the drawings). The casing ring 105 comprises a cylindrical sidewall 117 covered by a top portion 119 which may accommodate a dial. The sidewall 117 comprises an opening 120 through which the crown stem 103 passes.

[0057] A structure forming a suspension ring 107 is positioned between the case middle 101 and casing ring 105. The suspension ring structure comprises an outer supporting ring 108 fitted within the case middle 101. Said supporting ring 108 presents positioning means configured to fit with conjugated stopping means present on the inner wall of the middle of the watch case. As may be seen from figure 3, the positioning means and the stopping means may for example be realised by means of conjugated recesses 109 in the supporting ring 108 and protrusions 110 of the inner wall of the case middle 101. Further, the supporting ring 108 presents an interruption 121 to allow passage of the winding crown stem 103.

[0058] The supporting ring 108 carries a plurality of inwardly extending elastic elements 116, distributed over its inner periphery and thus over the perimeter of the casing ring. These elastic elements 116 comprise double leaf spring elements 112a, 112b having a central root portion 113 and two free tip portions 114a, 114b resting on the sidewall 117 of said casing ring 105. Each elastic element 116 further comprises a pair of leaflet shaped springs 118, starting from the root portion 113 and extending in opposite directions, wherein one leaflet shaped spring 118 is arranged between each leaf spring 112a, 112b and said supporting ring 108. Each leaf spring and its associated leaflet spring are in substantially parallel arrangement, and preferably the overall length of the leaflet shaped spring 118 being between about 1/3 and 1/2 of the length of the leaf spring 112a, 112b. In this manner, said leaflet shaped springs 118 are configured to contact said leaf springs 112a, 112b towards the end of the displacement of said leaf springs when the latter deflect under a load exerted by the casing ring 105 onto the tips 114a, 114b, this happening before the casing ring contacts any rigid element integral with the middle.

[0059] Similarly as in the first embodiment, the leaves 112a, 112b present a curved shape, said shape being inwards concave over the majority of their length, and reversing to an inwards convex tip. Since the radius of curvature of the major leaf portion is of the same order of magnitude as the radius of curvature of the sidewall 117 of the casing ring 105, but the radius of curvature of a tip 114a, 114b is significantly smaller, the contact point between a leaf spring and the casing ring remains at almost the same point on the leaf spring, that is to say at the tip, as this leaf spring deflects, and therefore the moment arm of the leaf spring advantageously presents relatively minor changes as the spring is loaded. The above-mentioned positioning means 109 and stopping means 110 prevent any movement, in particular any relative rotation, between the root portions 113 of the double leaf spring elements and the case middle 101. Thus, the tips 114a, 114b in contact with the casing ring behave as cantilever beams. Similarly to the leaf springs shown in figures 1 and 2, the leaves taper from the central root portion to the tips, and the thickness of a leaf increases with the distance from the tips.

[0060] In this second embodiment, the leaflets 118 act as stiffening means configured to stiffen the leaf spring system in the last fractions of potential displacement of the movement 104 upon a shock. After a lateral shock of the watchcase against a surface, the casing ring 105 begins to move versus the case middle 101 and the leaf springs 112a, 112b deflect elastically under normal working condition; if the shock is moderate, the process ends at this state. At higher impact strength, due to the deflection of a loaded leaf spring, said leaf spring contacts the corresponding leaflet spring 118. After the leaflet spring 118 is in contact with the leaf spring 112a, the system is much stiffer and additional stress develops in the portion of the leaf spring 112a near the contact point with the leaflet spring 118. This provides an additional measure of protection, preventing sudden impact of the casing ring with the watch case, at the cost of plastic deformation of the elastic element 116.

[0061] The cylindrical sidewall 117 of the casing ring 105 is made of thin wall portions over the majority of its perimeter to save weight and thereby reduce its sprung mass. The casing ring 105 however presents outwards thicker protrusions 115 arranged to lie between two neighbouring double leaf spring elements, and, more specifically, between the respective tips 114a and 114b of these neighbouring double leaf spring elements, forming thus abutments for these tips. The protrusions 115 may also house threaded bores (not shown) receiving the screws tightening the baseplate 106 to the casing ring 105.

[0062] Figure 5 illustrates a third embodiment of a shock absorber device according to the invention and figure 6 shows a variant of the third embodiment of the shock absorber device.

[0063] Figure 5 is a schematic transverse sectional view of a watch, said watch comprising a watch case middle 201, and a movement 204. A hand axis 202 is schematically indicated. For the sake of simplicity, the horologic electronic or mechanical functional components of the movement, whose description is not relevant here, are not shown in the drawing. The movement 204 is surrounded by a casing ring 205 and rests on a baseplate 206, which is fixed to the casing ring 205. The casing ring 205 comprises a cylindrical sidewall 217.

[0064] The case middle 201 carries a plurality of inwardly extending elastic elements 216, namely four elements in the embodiment shown, distributed over its inner periphery and thus over the perimeter of the casing ring 205. These elastic elements 216 are discrete, spaced apart, workpieces whose central portions 213 are shaped to be firmly fitted into conjugated receiving portions of the inner wall of the middle 201 of the watch case. These elastic elements 216 are configured as double leaf spring elements, having a central root portion 213, two leaves 212a, 212b extending laterally in opposite directions, and two free tip portions 214a, 214b resting on the outer surface of the sidewall 217 of the casing ring 205. The leaves present a curved shape, said shape being inwards concave over the majority of their length, and reversing to an inwards convex tip. The leaves taper from the central root portion to the tips. Since the radius of curvature of the major leaf portion is of the same order of magnitude as the radius of curvature of the sidewall 217 of the casing ring 205, but the radius of curvature of a tip 214a, 214b is significantly smaller, the contact point between a leaf spring and the casing ring remains at almost the same point on the leaf spring, that is to say at the tip, as this leaf spring deflects. Therefore the moment arm of the leaf spring advantageously presents relatively minor changes as the spring is loaded. On the other hand, any lateral movement, in particular any relative rotation, between the root portions 213 of the double leaf spring elements and the case middle 201 is prevented as explained above. Thus, the tips 214a, 214b in contact with the casing ring behave as cantilever beams. In the embodiment shown in figure 5, a number of four such elastic elements 216 is chosen to securely surround the casing ring 205, but that number may vary.

[0065] This third embodiment thus comprises four discrete elastic elements 216 that can be individually mounted into the watch case middle 201 instead of one single suspension ring 7, 107 as in the first and second embodiments. Due to the simple shape of the elastic elements 216, a variety of materials are suitable for their manufacture, and thus an appropriate elasticity modulus may be selected by those skilled in the art for providing protection against shocks to the movement, with due consideration of the weight of said movement and the targeted drop heights. In this third embodiment, stiffening means as described above for the first and second embodiments are omitted, however in variants of this third embodiment such stiffening means may also be present.

[0066] The cylindrical sidewall 217 of the casing ring 205 is made of thin wall portions over the majority of its perimeter to save weight and thereby reduce its sprung mass. But the sidewall 217 of casing ring 205 presents also four thicker portions appearing as outwardly projecting protrusions arranged to lie between two neighbouring elastic double leaf spring elements 216, and, more specifically, between respective tips 214a and 214b of these neighbouring double leaf spring elements 216, forming thus abutments for these tips.

[0067] Figure 6 shows an exploded view of a variant which is similar in several aspects to the embodiment shown in figure 5 but whose construction has been simplified to a greater extent for the sake of illustration. In particular, the shape and function of the individual elastic elements 316 is closely similar to the construction of the elastic elements 216 in figure 5 and will not be described again. But in this variant, only three elastic elements 316 are used instead of four ones. They are fitted by their root portions 313 in conjugated recesses of the case middle 301 and further held in place by means of a sealing ring and the back of the watch case. Once again, stiffening means as described above for the first and second embodiments have been omitted in the embodiment of figure 6, but such stiffening means may also be included in variants.

[0068] Figure 7 shows an exploded view of a fourth embodiment of the invention, which is similar in several aspects to the first embodiment but whose construction also has been simplified for illustrative purposes, this embodiment making use of a suspension ring according to the invention in conjunction with known elements of the watchmaking art to provide a shock absorber device for protecting the movement of the watch.

[0069] Referring to figure 7, the case middle 401 of the watch accommodates a movement surrounded by a thin casing ring 405 presenting a simple cylindrical shape with an opening for the crown stem. A suspension ring 407 is disposed between the case middle 401 and the casing ring 405. That suspension ring 407 comprises a supporting ring 408 carrying a plurality of inwardly projecting elastic elements 416, namely four elements 416 in the embodiment as shown. The structure and function of the individual elastic elements 416 is closely similar to the structure and function of the elastic elements 16 of the first embodiment and therefore will not be described here again. The supporting ring 408 is securely positioned within the case middle 401 by means of outwards facing recesses 409 cooperating with corresponding protrusions of the inner wall of the middle 401.

[0070] As shown in figure 7, the height of the supporting ring 408 is less than the height of the cantilever springs which it supports, and furthermore that this supporting ring is made continuous without an interruption, since at the level that it occupies it does not interfere with the crown stem. This construction may advantageously use the supporting ring 408 as a sealing ring in conjunction with the bottom of the watch case, as shown by the upper part of figure 7.

[0071] In general, in all of the above embodiments, minor twisting/rotational movements of the casing ring and the movement are possible upon a shock and may have an adverse effect for the crown stem and its related parts. It is thus advisable to equip the crown system with means introducing some flexibility and to use the shock absorber devices according to the present invention in conjunction with specific crown protection devices, as are known in the art.

[0072] Preferably, in order to provide effective spring shock absorbing within the small space between middle and casing ring, a device according to the present invention preferably has the following material properties:

- sufficient stiffness, i.e. the Young's modulus must be large, preferably greater than 37 GPa, which excludes elastomers;
- high strain to failure/yield, i.e. this parameter should be close to the yield strength/Young's modulus, which should be maximised;
- toughness, i.e. the material must withstand impact loading in bending, this excluding ceramic materials.

[0073] Few materials achieve all of these specifications, however the inventors identified maraging steel and amorphous metals as suitable materials. The table below gives representative property values of these materials in comparison to brass.

Material	Youngs Modulus (GPa)	Yield Stress (MPa)	Strain to failure (%)
Brass (best found in Matweb search)	110	683	0.6
Maraging steel	180	1990	1.1
Amorphous metal	81	1620	2.0

[0074] Concerning the casing ring, the inventors identified titanium as a possible suitable material. This enables the casing ring to be rather lighter than if made from steel. Furthermore, in the casing rings according to the present invention, superfluous material is preferably removed from the ring wherever possible, by rendering the walls as thin as possible and introducing cut outs.

[0075] In light of the above description of the structure and of the operating mode of embodiments of the present invention, its advantages are clear.

[0076] Primarily, the elastic elements 16, 116, 216, 316, 416 are carried by the case middle, either directly or via a supporting ring. This allows a lightweight construction of the casing ring a reduction of its sprung mass, and thereby an easier deceleration of the same containing the movement upon a drop or other severe shock.

[0077] Second, the design of the shock absorber device according to the present invention makes an optimal use of the available space between the middle and the casing ring.

[0078] Furthermore, lateral shocks to a watch often tend to impart rotation and angular displacement to the movement. The protrusions 15, 115 present on the casing ring between two neighbouring cantilever spring elements prevent such rotation from occurring in order to prevent any lateral shift and a force being exerted on the crown stem crown as explained above.

[0079] Moreover, those skilled in the art will appreciate upon considering the various embodiments described herein above that the invention may be realised either by the combined use of a specific casing ring and a specific suspension ring in its most sophisticated embodiments, or by using a specific suspension ring together with a standard casing ring, or by adapting a plurality of double leaf spring cantilever elements to the middle of a watch case.

Claims

1. A shock absorber device for a movement (4, 104, 204) of a watch adapted to be housed between a case middle (1, 101, 201, 301, 401) of a watch case and said movement (4, 104, 204), the device comprising a casing ring (5, 105, 205, 305, 405) for said movement and a plurality of elastic elements (16, 116, 216, 316, 416) distributed over the perimeter of said casing ring and arranged between said casing ring and said case middle (1, 101, 201, 301, 401) of the watch case, **characterised by the fact that** said elastic elements are configured as double leaf spring elements (12a, 12b, 112a, 112b, 212a, 212b) having a central root portion (13, 113, 213, 313) fixedly secured to said middle of the watch case and two free tip portions (14a, 14b, 114a, 114b, 214a, 214b) resting on said casing ring.

2. Device according to the preceding claim, **characterised by the fact that** said leaves (12a, 12b, 112a, 112b, 212a, 212b) are arranged in opposite cantilever position carrying loads from said free tips (14a, 14b, 114a, 114b, 214a, 214b) to said fixedly secured root portion (13, 113, 213, 313).

3. Device according to the preceding claim, **characterised by the fact that** said leaves (12a, 12b, 112a, 112b, 212a, 212b) present a curved shape, said shape being inwards concave over the majority of their length, with an inwards convex tip (14a, 14b, 114a, 114b, 214a, 214b).

4. Device according to the preceding claim, **characterised by the fact that** said leaves (12a, 12b, 112a, 112b, 212a, 212b) taper from the central root portion (13, 113, 213, 313) to the tips (14a, 14b, 114a, 114b, 214a, 214b), wherein the thickness of each leaf increases with the square root of the distance from the tips.

5. Device according to any one of the preceding claims, **characterised by the fact that** said casing ring (5, 105, 205, 305, 405) presents outwardly extending protrusions (15, 115) arranged to lie between the tips (14a, 14b, 114a, 114b, 214a, 214b) of two neighbouring double leaf spring elements (12a, 12b, 112a, 112b, 212a, 212b).

6. Device according to any one of the preceding claims, **characterised by the fact that** said double leaf spring elements are discrete, spaced apart workpieces (216, 316) whose central root portions (213, 313) are shaped to be fitted into conjugated receiving portions of the wall of the middle of the watch case.

7. Device according to one of claims 1 to 5, **characterised by the fact that** said double leaf spring elements (16, 116, 416) are carried inwards by a supporting ring (8, 108, 408) fitted within the case middle of the watch case.

8. Device according to claim 7, **characterised by the fact that** said double leaf spring elements (16, 116, 416) are made as one monolithic piece with said supporting ring (8, 108, 408).

9. Device according to one of claims 7 or 8, **characterised by the fact that** said supporting ring (8, 108, 408) presents positioning means (9, 109, 409) configured to fit with conjugated stopping means (10, 110) present on the inner wall of the middle of the watch case.

10. Device according to one of claims 7 to 9, **characterised by the fact that** said supporting ring (8, 108) presents an interruption (21, 121) arranged to allow a winding crown stem of the watch to pass through it.

11. Device according to any one of the preceding claims, **characterised by the fact that** the device comprises stiffening means (18, 118), said stiffening means being configured to stiffen said leaf spring system in the last fractions of potential displacement of said leaves (12a, 12b, 112a, 112b, 212a, 212b) upon a shock.

12. Device according to claim 11, **characterised by the fact that** said stiffening means comprise outwards bumps (18) configured on the casing ring (5) so as to contact said leaves (12a, 12b) towards the end of their displacement, before the casing ring contacts any rigid element integral with the middle.

13. Device according to claim 11, **characterised by the fact that** said stiffening means comprise leaflet shaped springs (118), wherein one leaflet shaped spring (118) is arranged between each of said leaf spring (112a, 112b) and said supporting ring (108), and wherein said leaflet shaped springs (118) are configured to contact said leaf springs (112a, 112b) towards the end of the displacement of said leaf springs, before the casing ring (105) contacts any rigid element integral with the middle.

14. Device according to any one of the preceding claims, **characterised by the fact that** said elastic elements, (16, 116, 216, 316, 416) including said supporting ring (8, 108, 408), if present, are made from a material selected from the group consisting of maraging steels and amorphous metals.

15. A movement casing ring for a shock absorber device according to claim 1, **characterised by the fact that** said movement casing ring (5, 105, 205) presents outwardly projecting protrusions (15, 215) arranged to lie between two neighbouring double leaf spring elements.

16. A movement casing ring according to claim 15, **characterised by the fact that** said casing ring (5) comprises stiffening means, said stiffening means comprising outwardly projectings bumps (18) configured on the casing ring (5) so as to contact said leaves (12a, 12b) towards the end of their displacement, before the casing ring contacts

any rigid element integral with the case middle.

17. A suspension ring (7, 107, 407) for a shock absorber device for a movement of a watch, **characterised by the fact that** it comprises a supporting ring (8, 108, 408) configured to be fitted within a case middle (1, 101, 401) of a watch case and a plurality of elastic elements (16, 116, 416) distributed over the inner perimeter of said supporting ring (8, 108, 408), wherein said elastic elements (16, 116, 416) are configured as double leaf spring elements (12a, 12b, 112a, 112b) arranged inwards in cantilever position, having a central root portion (13, 113, 413) integral with said supporting ring (8, 108, 408) and two free tip portions resting on a casing ring (5, 105, 405) of said movement.

Fig.1

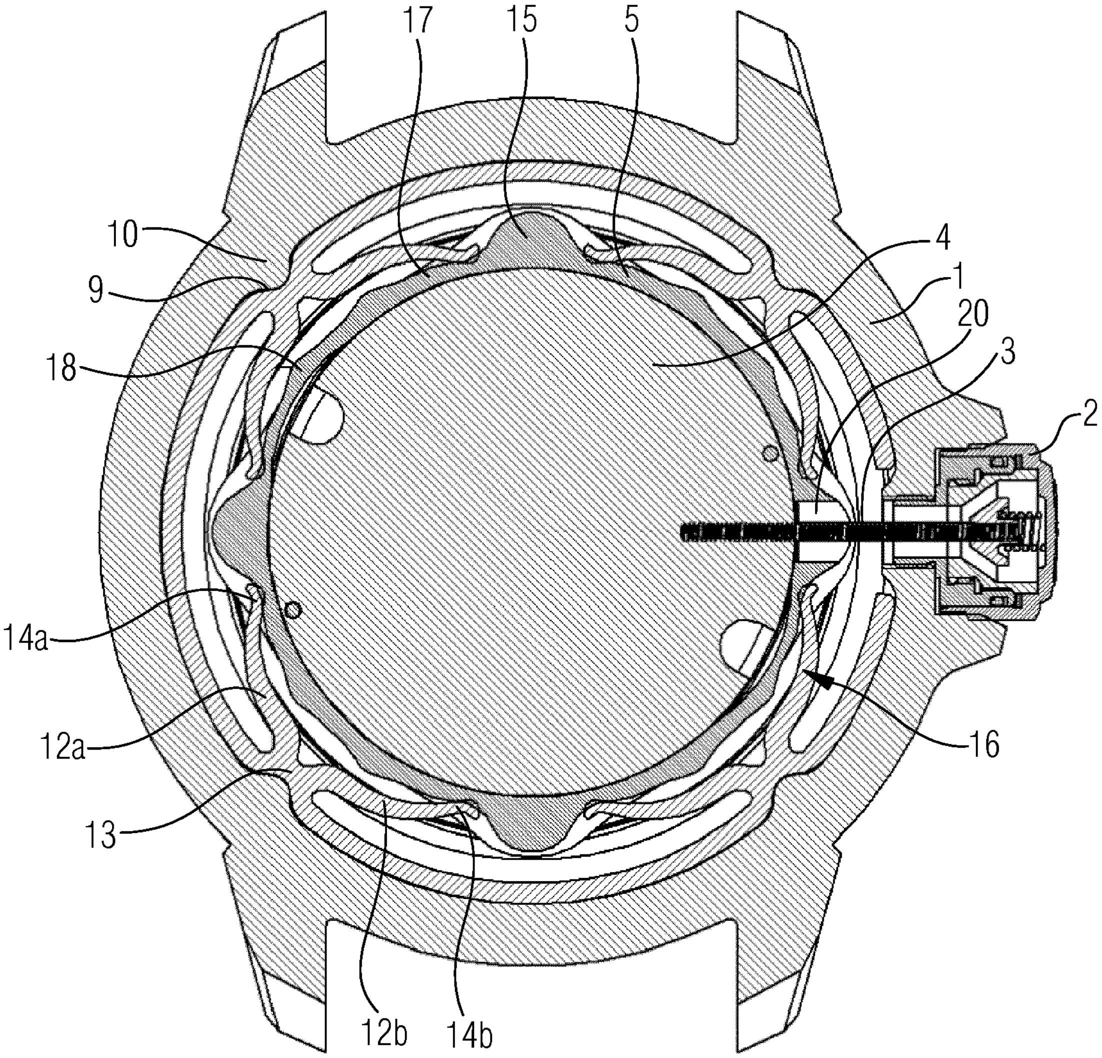


Fig.2

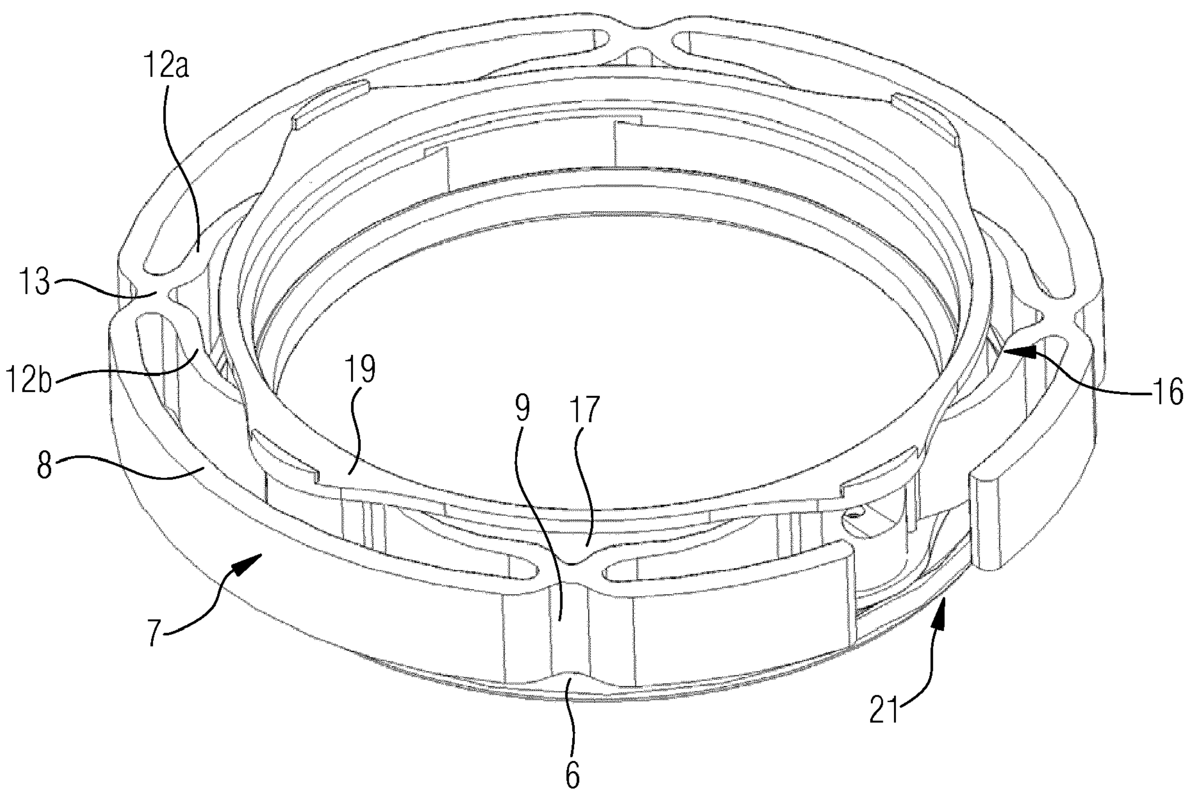
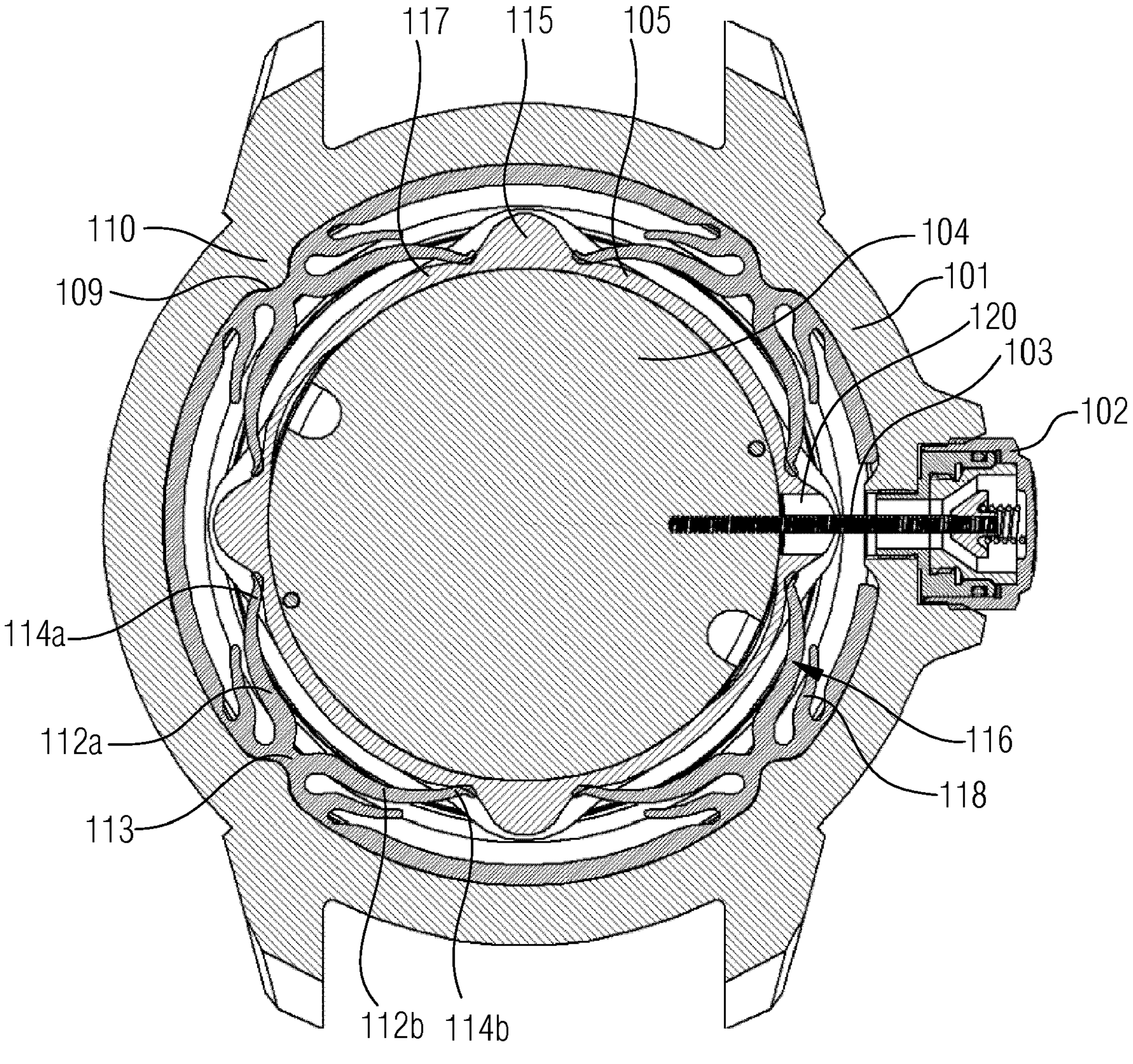


Fig.3


117
115
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110
104
101
109
120
103
102
114a
116
112a
118
113
112b
114b

Fig.4

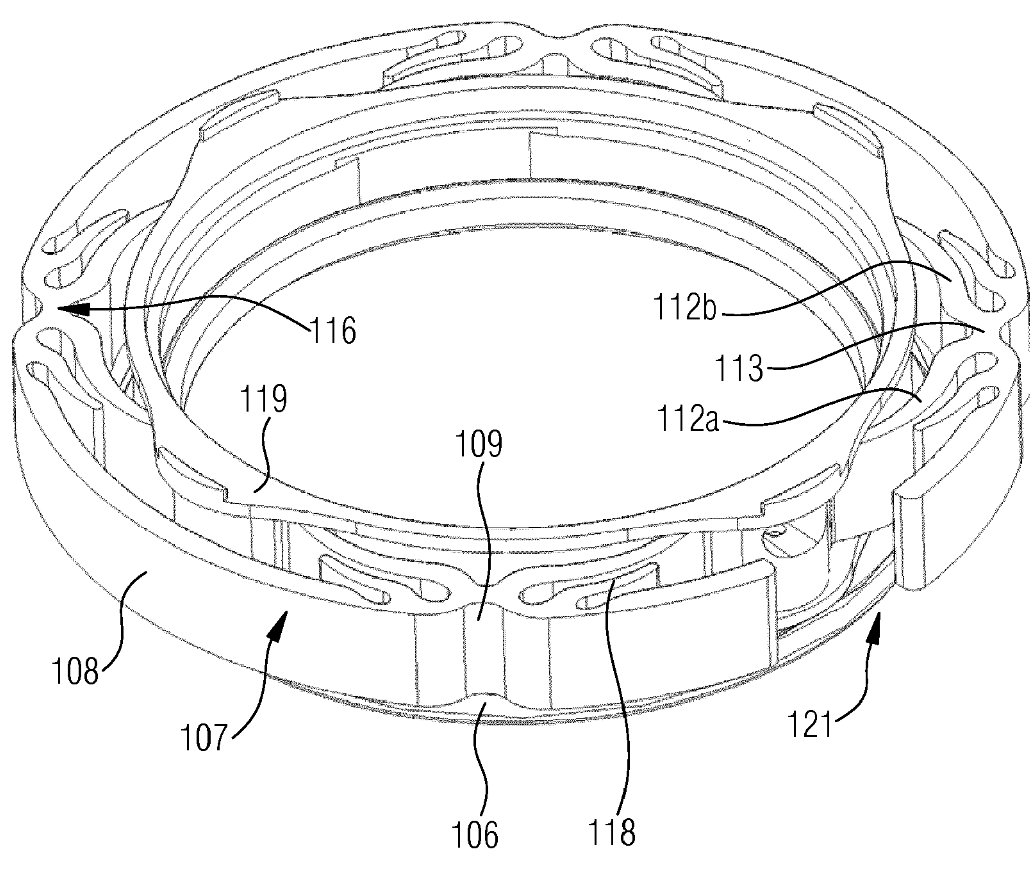


Fig.5

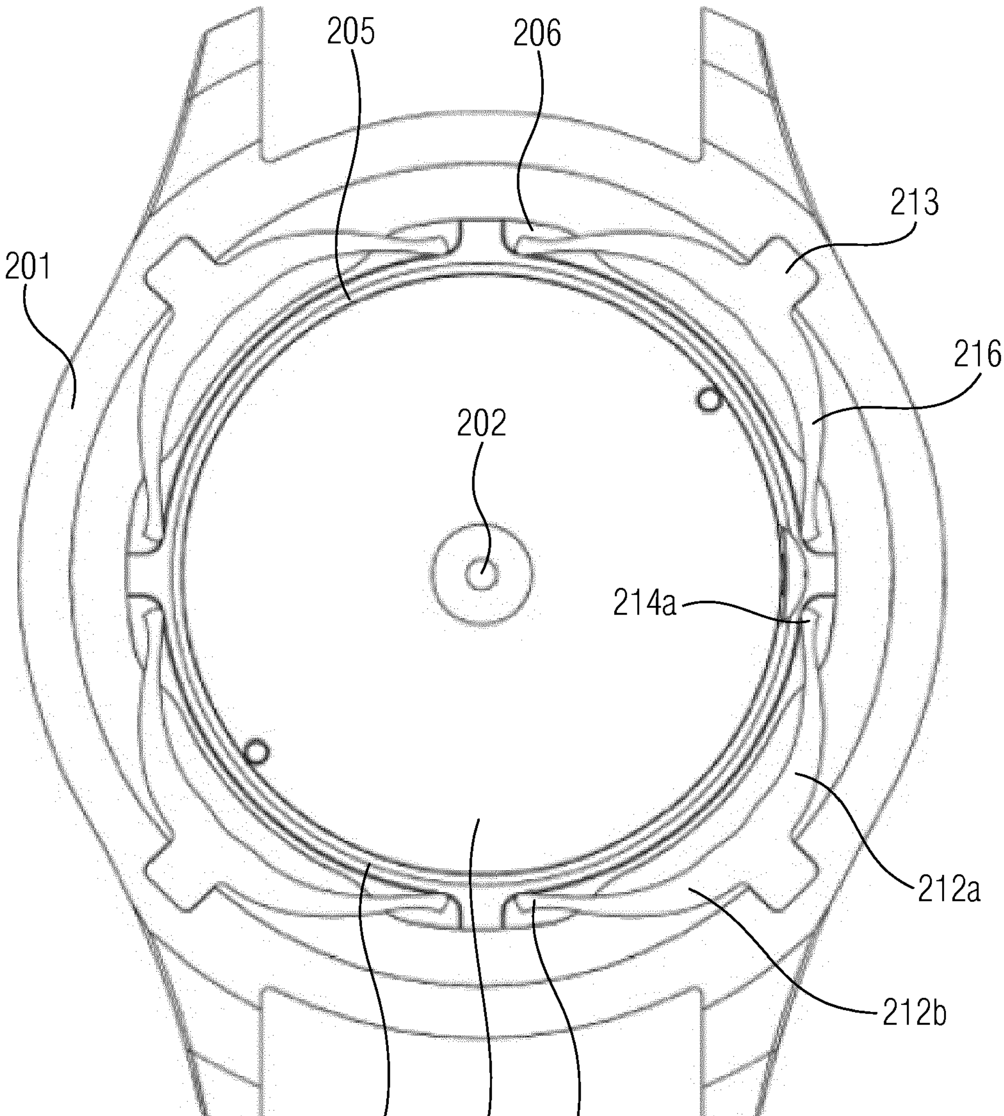


Fig.6

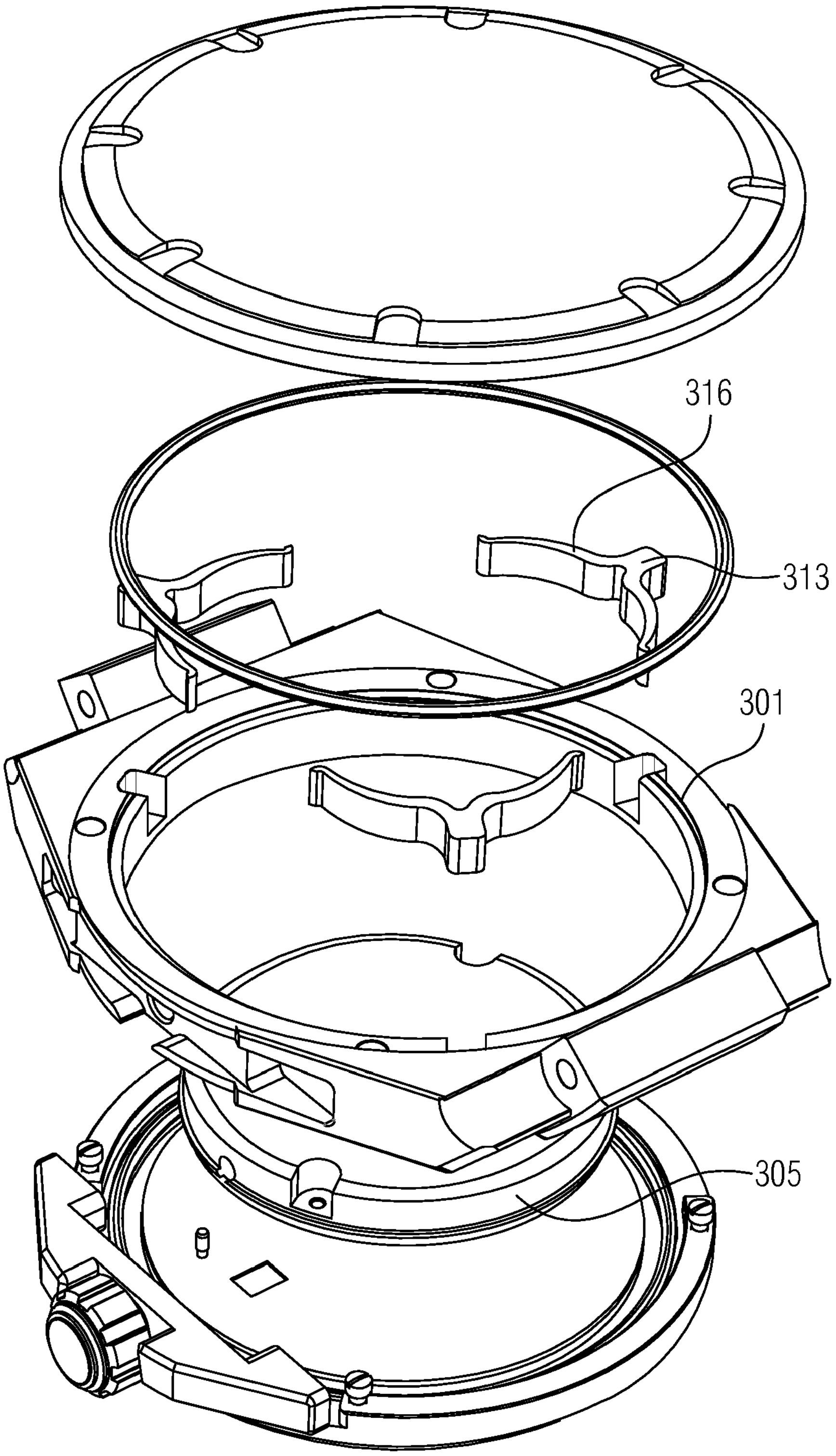


Fig.7

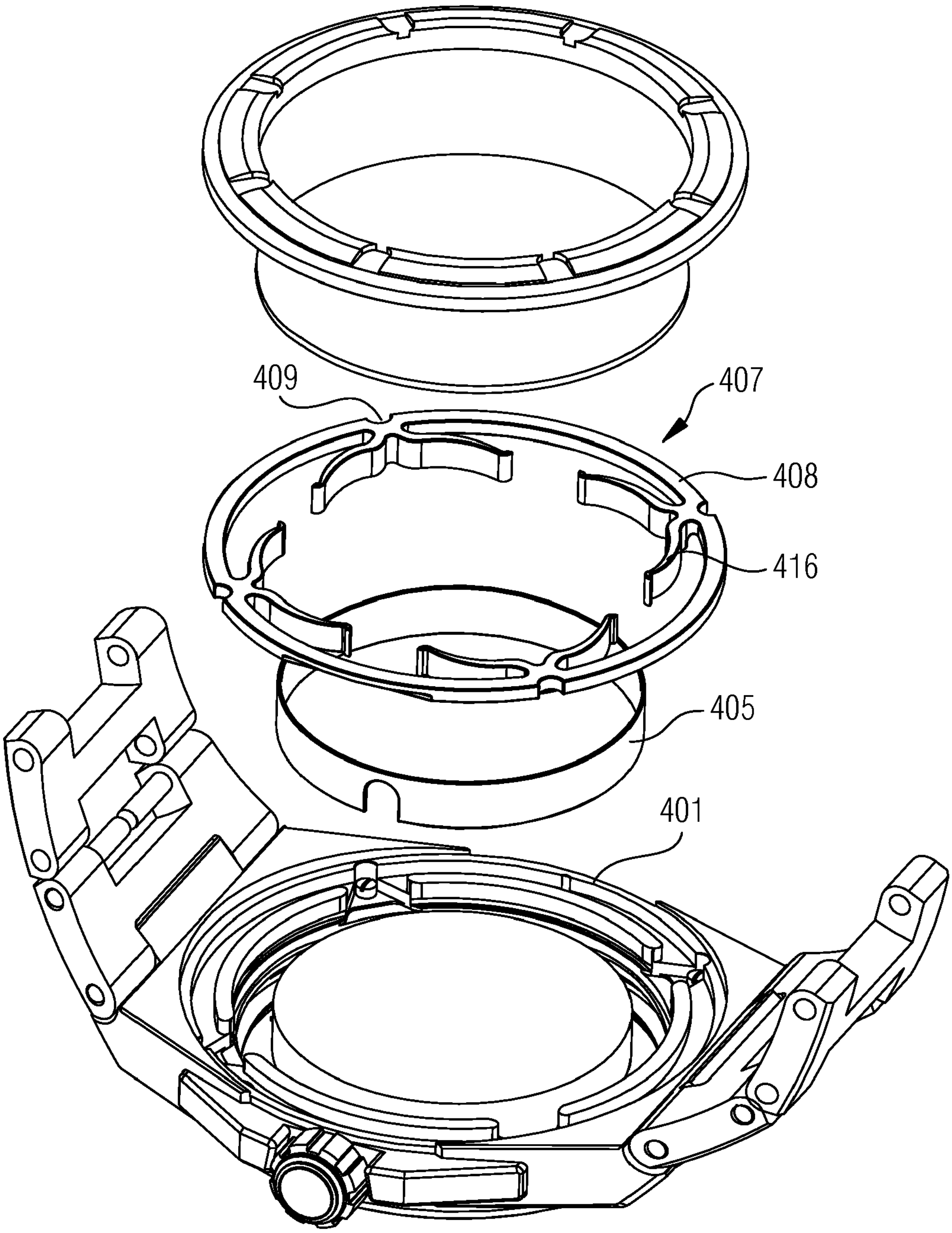


Fig.8

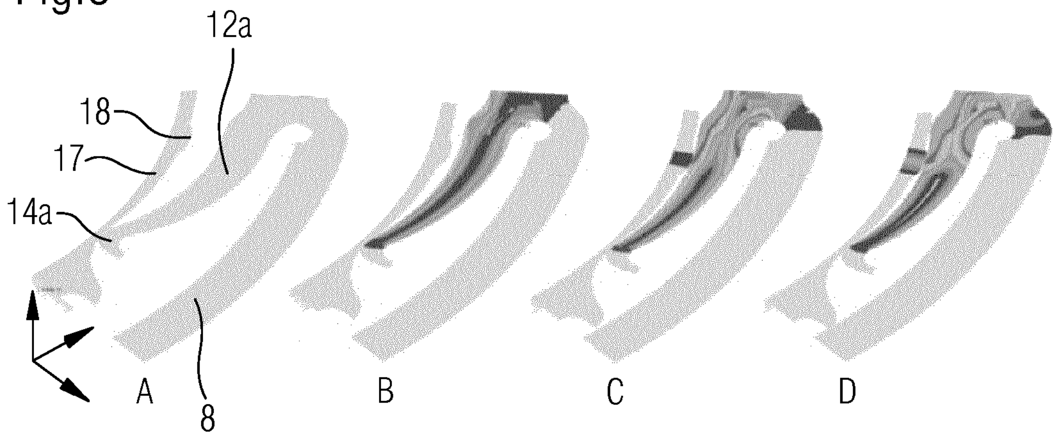
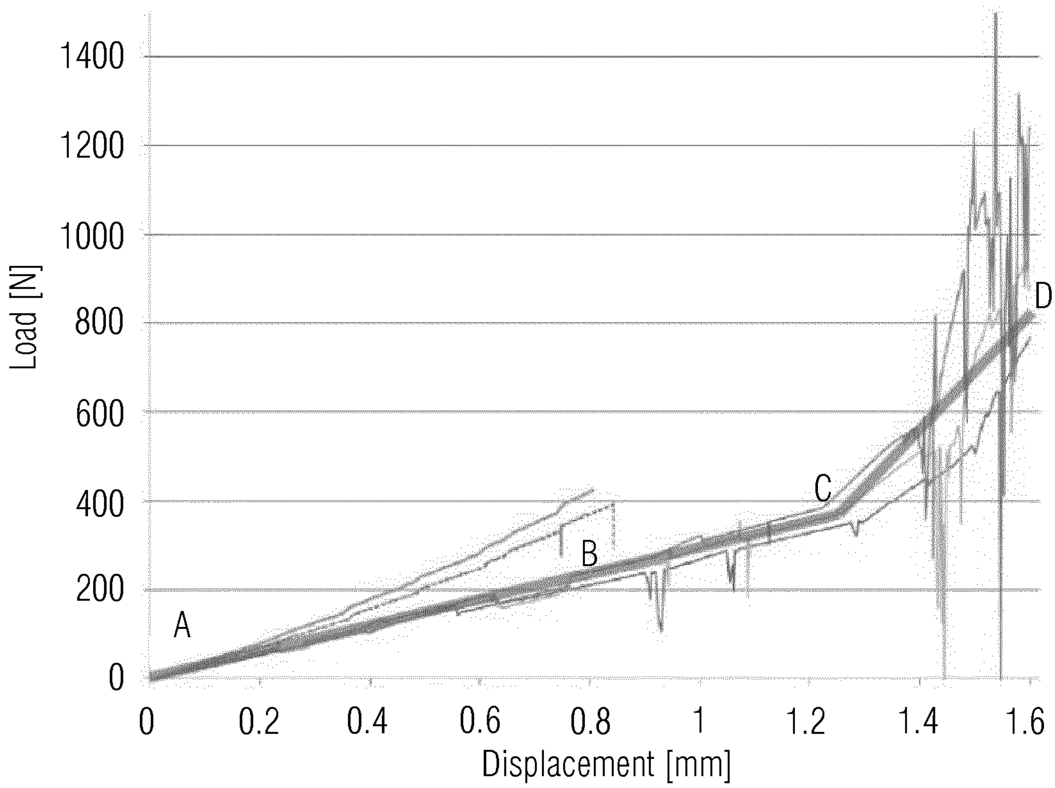

12a
18
17
14a
A
8
B
C
D

Fig.9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1.4
1.6
Displacement [mm]
A
B
C
D

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 8128

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G04B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	18 October 2017	Cavallin, Alberto

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