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(54) **MECHANICAL PART FOR A MOVEMENT FOR A WATCH**

(57) The invention relates to a mechanical part (1) for a movement for a watch, which part (1) is made of a brittle material and has at least three cantilevered and resilient arms (3), and an opening (4) for receiving and holding a shaft. The distal ends (5) of the cantilevered and resilient arms (3) define the opening (4).

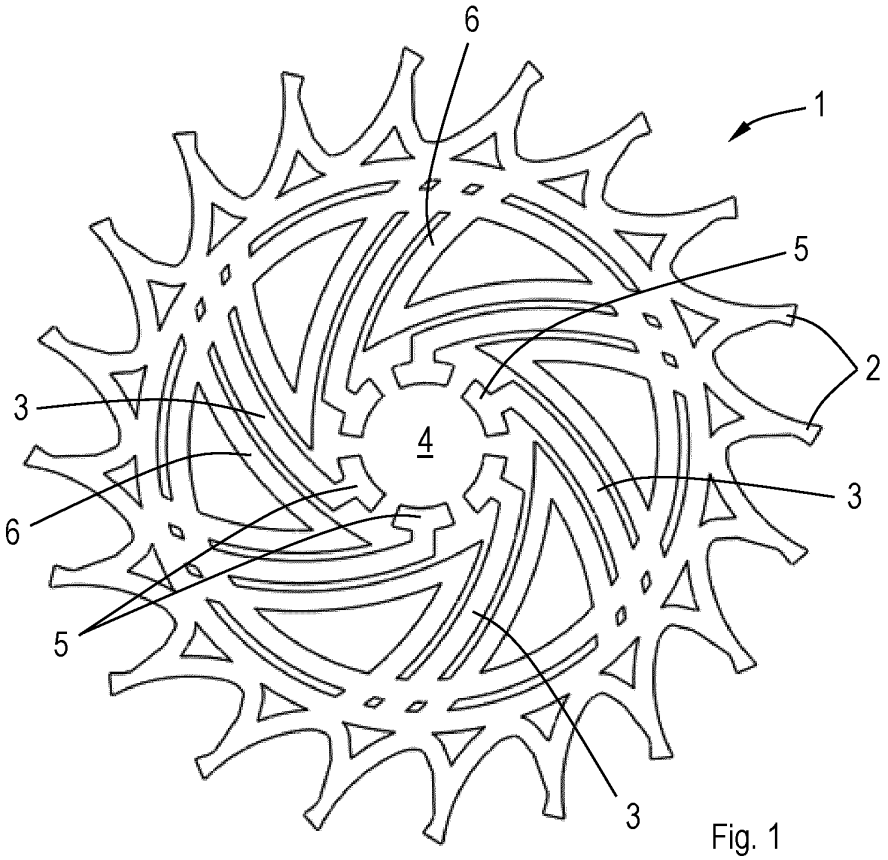

Fig. 1

EP 4 471 505 A1

Description

[0001] The invention relates to a mechanical part, such as a geared wheel, an escape wheel - also known as escapement wheel -, an anchor, an oscillator, or a mount for a tuning weight, for a movement for a watch, which part is made of a brittle material, such as silicon, and has at least three cantilevered and resilient arms, and an opening, e.g. a central opening, for receiving and holding a shaft, such as a rotary shaft. The invention also relates to a mechanical part with a shaft inserted in the opening and to a movement comprising a mechanical part according to the present invention.

[0002] More specifically, the invention relates to an escapement wheel which is mounted on a shaft (axle) via elastic members, also known as flexures. Traditionally, escapement wheels are fabricated from metal, but in the last two decades silicon has proven itself as a suitable alternative material due to its excellent tribological properties, low density, and its ability to be manufactured to extremely high tolerances. However, using silicon introduces challenges in the assembly of the wheel onto the shaft. Conventional (metal) escapement wheels are assembled onto a shaft by press fitting. Press fitting is not possible with silicon since the material is too brittle, therefore silicon wheels are usually glued onto a shaft with a diameter slightly smaller than the hole in the wheel. As a result, alignment issues are introduced - there are two critical metrics in the assembly of a wheel on a pinion, viz. concentricity and tilt -, and a complex new assembly step (gluing) is needed.

[0003] EP 1 991 916 A1 relates to a micro-mechanical part, such as a moving part of a watch movement, produced from a plate made from a brittle material, such as glass, quartz or silicon, and includes at least one opening for driving in a spindle. The part has an opening (numeral 2 in the drawings of EP 1 991 916 A1) alternatively forming zones (8) for rigidification and positioning elastic deformation zones (10). The zones (10) are formed by a tab (12) of the part. The tab is formed of recesses (13, 15) opening into the opening and delimiting the tab whose end (14) extends above a theoretical contour of a cylindrical shaft (5) and provides a locking function when the shaft is placed.

[0004] CH 717 005 A2 relates to an anchor escapement, in which an escapement wheel and/or an anchor (6) is springloaded against a shaft (4, 8) and positioned via a multipoint and rigid support. Also disclosed are an anchor (6) and an escapement wheel (2), which are each clamped to a shaft (4, 8). The escapement wheel (2) and the anchor (6) are preferably made of silicon.

[0005] EP 3 418 815 A2 relates to a mechanical part, a timepiece having the mechanical part, and a method of manufacturing a mechanical part that suppresses separation from and rotation on a staff member of a rotating member. An escape wheel and pinion (35) as an example of a mechanical part has a staff member (102); an escape wheel (101) with a hole (115) to which the staff member (102) is inserted, and ribs (112) that extend toward the staff member (102); and an annular fastening member (130) that affixes the escape wheel (101) to the staff member (102). The fastening member (130) is disposed touching the ribs (112) and deforming to protrude into the hole (115).

[0006] It is an object of the present invention to simplify assembly and/or improve accuracy of positioning a horological part on a shaft.

[0007] To this end, the part has at least three cantilevered and resilient arms, and an opening, e.g. a central opening, for receiving and holding a shaft, such as a rotary shaft, and the distal ends of the cantilevered and resilient arms define the opening.

[0008] I.e., when a shaft, such as a shaft with e.g. a substantially round, oval, or polygonal, e.g. triangular, square or hexagonal, cross-section, with or without a notch or protrusion for form lock, has been inserted in the opening, the shaft will be contacted, clamped, and held in position exclusively by the distal ends of the elastically deformed, e.g. elastically bent, cantilevered and resilient arms and, optionally, an adhesive that is added after insertion of the shaft and positioning of the part on the shaft. The cantilevered and resilient arms according to the present invention on the one hand facilitate insertion of the shaft as the arms will resiliently deflect during insertion and, on the other hand, will clamp and hold in place an inserted shaft by elastic averaging, which was found to enable, in principle, almost perfect positioning, e.g. centring of the part, such as a escape wheel, on the shaft as well as to reduce or even prevent tilt.

[0009] In an embodiment, the bending stiffness of the arms, measured at the distal ends and in radial direction and away from the center, is at least substantially equal for each of the arms.

[0010] The mechanical properties, such as the modulus of elasticity, in silicon wafers that are commonly used for MEMS and horological parts, e.g. silicon 100 wafers, are anisotropic, i.e. direction dependent.

[0011] In an embodiment, the thickness, length, position relative to the center of the opening, and/or the shape of the arms is different between at least two arms. Such configurations can be used e.g. to provide a bending stiffness of all of the arms that is at least substantially equal for each of the arms, also in anisotropic materials, or to provide a bending stiffness of the arms that is unequal, e.g. providing a (slight) shift between the center of the opening before insertion of the shaft and the position of the opening when the shaft has been inserted and (thus) the arms tensioned.

[0012] In an embodiment, the part has an even number of arms, arranged in pairs of arms working in opposite directions.

[0013] In an embodiment, the arms are configured to allow a deflection of at least 2 μm, preferably at least 5 μm and preferably at least in range from 5 to 50 μm and/or to generate, upon deflection a force of at least 0.2 Newton (N), preferably at least in a range from 0.2 to 2 N.

[0014] In an embodiment, the mechanical part is made from a material, such as silicon 111, having one or more isotropic mechanical properties, in particular an isotropic modulus of elasticity.

[0015] In another embodiment, the arms are evenly distributed around the opening.

[0016] In an embodiment, the arms extend in a direction of which the tangential component is larger than the radial component, as this enables relatively low stiffness of the arms in the radial direction in a small or compact space. In a refinement, the arms extend at least substantially tangentially.

[0017] Another embodiment comprises rigid structures and/or resilient structures, e.g. further resilient arms, located radially behind the resilient arms defining the opening.

[0018] Such rigid structures provide stops and/or shock protection, e.g. preventing the arms from breaking in case of a severe shock. Additional resilient structures provide the option of 'stiffness ramping', wherein the effective bending stiffness is relatively low upon initial deflection and increases when the arm contact the further arms, such that deflection beyond that point deflects both the (central) arms and the further arms.

[0019] To provide a larger area of contact between the arms and the shaft clamped between them, in an embodiment, the distal ends of the resilient arms are arcshaped, preferably in such a way that, after elastic averaging, the arcshapes are concentric with the shaft.

[0020] In another embodiment, at least one of the arms comprises a protrusion or recess to provide a form fit between that arm (and thus the part) and an inserted shaft, which e.g. comprises a complementary recess or protrusion, respectively.

[0021] In another embodiment, at least one of the arms comprises a recess, such as a chamfer or notch, for receiving an adhesive between that arm (and thus the part) and an inserted shaft.

[0022] The invention further relates to a mechanical part with a shaft inserted in the opening. In such a part, with the shaft inserted, the arms are tensioned and center the part on the shaft through elastic averaging.

[0023] The invention also relates to a movement for a watch comprising a base, an energy storage, typically a mainspring, in particular a spiral spring in a geared barrel, a gear train, e.g. comprising a center wheel, a third wheel (carrying or coupled to the minute and hour hands of the watch), and a fourth wheel (carrying or coupled to the second hand) of the watch, to transmit torque and energy to an escape wheel, an oscillator, and anchor teeth on an anchor or on the oscillator, which anchor teeth are controlled by the oscillator to alternately block and release the teeth of the escape wheel. At least one of the wheels in the gear train, the escape wheel, the anchor, and the oscillator is a mechanical part as described above.

[0024] In an embodiment, the escape wheel has a torque of less than 300 nanoNewtonmeter, preferably less than 200 nNm, preferably less than 150 nNm, and/or the oscillator (1) has and/or the anchor teeth have an amplitude smaller than 30°, preferably smaller than 20°, preferably smaller than 15°, e.g. in range from 3° to 10°, and/or the oscillator has a natural frequency of 3 Hertz (Hz) or higher, preferably 4 Hz or higher, preferably 10 Hz or higher, preferably 25 Hz or higher, preferably 35 Hz or higher. In extreme instances, natural frequencies could be up to 100 Hz or even higher.

[0025] The mechanical part, such as an escape wheel, may have a thickness smaller than 700 μm, preferably smaller than 550 pm, preferably in a range from 50 μm to 500 pm, preferably in a range from 100 μm to 300 μm. In an embodiment, at least the distal ends of the arms have a thickness (height) that is larger than the thickness of the rest or other sections of the part, in particular the circumference of the part.

[0026] It is preferred that the mechanical part is monolithic, i.e. made from a single piece, and/or has been shaped by means of laser cutting or by means etching, in particular reactive ion etching, such as RIE or DRIE, and preferably from silicon.

[0027] In general, a cantilevered arm has a supported end and an unsupported end. Within the framework of the present invention the distal end refers to the unsupported end of the cantilevered arm. Further, "axial" refers to the direction along the center of the shaft or horological part or along the axis of rotation of the part (the latter typically coincides with the former) and "radial" to a direction pointing along a radius from the center of the shaft or horological part.

[0028] The invention also relates to a watch, in particular a wristwatch, comprising a movement as described above.

[0029] EP 1 331 528 A2 related to a dart (15) that is press fitted to a fork (14) of an anchor by insertion of a male component (20) on the dart into a female feature (30) on the fork. An irregularity (22) ensures that the dart may only be fitted in one position and that it will remain there for it's working life. The dart and fork assembly is made sufficiently flexible to resist breakage during the pressing operation and are apparently made of metal. The male and female configurations may be widely varied, e.g. Figures 14 and 15 show a round opening and three or four resilient and cantilevered arms.

[0030] US 2021/149343 relates to an escape wheel serving as a watch component that constitutes a drive mechanism of a watch includes a tooth portion, and a base mainly composed of silicon. A contact surface where the tooth portion makes contact with another component includes a recess.

[0031] Below, the invention will be explained further, which reference to the appended figures in which an embodiment of the invention is shown.

[0032] Figure 1 is a top view of an escape wheel according to the present invention.

[0033] Figures 2 to 6 are top views of other escape wheels according to the present invention.

[0034] Figures 7 and 8 are respectively a top view and a perspective view of an anchor according to the present invention.

[0035] Elements in different embodiments that are similar or identical or that perform a similar or identical function are referred to by the same reference number.

[0036] Figures 1 and 2 show an escape wheel 1 for use in an escapement of a watch movement (not shown), such as disclosed in WO 2019/156552.

[0037] The escape wheel is made from a brittle material, e.g. silicon, e.g. etched by means of DRIE from a 100 silicon wafer, and comprises, along its circumference, a plurality of teeth 2 that in an escapement cooperate with anchor teeth on an anchor or on an oscillator. I.e., the anchor teeth are controlled by the oscillator to alternately block and release the teeth of the escape wheel, in a manner known in itself and not specific to the present invention.

[0038] The escape wheel has at least three cantilevered and resilient arms, more specifically six arms 3 in the example shown in Figure 1, and a central opening 4 for receiving a shaft (not shown), which central opening is defined by the distal ends 5 of the cantilevered and resilient arms, i.e. the spaces between the distal ends of the resilient arms are free from rigid positioning elements, and the like. In this example, the distal ends of the resilient arms are arc-shaped and thus define an at least substantially round opening for a round shaft.

[0039] The arms 3 are evenly distributed around the central opening 4 and extend primarily tangentially. Further, the arms are arranged in pairs of arms working in opposite directions at equal force. More specifically, the arms of the different pairs exert slightly different forces as a result of the anisotropy of the material (the arms is one pair will be slightly stiffer or less stiff than the arms in another pair), but the opposing arms in a pair exert the same force in opposite direction, providing effective elastic averaging and ensuring that, when a shaft is inserted in the central opening, the escape wheel is concentric with the (imaginary) center line of the shaft.

[0040] Further, the escape wheel comprises rigid structures 6 located radially behind the resilient arms 3 defining the central opening 4, providing stops for the resilient arms, in particular to prevent failure during insertion of a shaft or when a severe shock occurs.

[0041] Figure 2 shows a similar embodiment, albeit with three resilient arms 3 instead of six. The thickness of the arms is slightly different (not discernible from the present drawing) to ensure that the bending stiffness of all three arms is equal.

[0042] Figures 3 and 4 show embodiment provided with both a rigid structure and a further resilient arms, located radially behind the central resilient arms defining the central opening. These configurations provide, in addition to the tops, 'stiffness ramping', e.g. low stiffness during insertion of a shaft and higher stiffness and thus stronger elastic averaging and clamping after the shaft has been installed.

[0043] Figure 5 shows an embodiment wherein one of the arms 3 comprises a protrusion 8 to provide a form fit between that arm 3 and an inserted shaft.

[0044] The part, such as the escape wheel discussed above, provides self-alignment, for both concentricity and tilt, reduced sensitivity to fabrication errors compared with configuration comprising e.g. one flexure urging a shaft against two rigid points, and simplified assembly. In principle, the reaction force of the arms (flexures) on the shaft can be designed high enough so that no glue is required.

[0045] The advantages, in particular the concentricity resulting from elastic averaging and suppression of tilt, provided by the present invention are particularly pronounced in escapements wherein the amplitude of the anchor teeth is at least substantially equal to the amplitude of the oscillator and/or in escapements with low torque escape wheels, such as escape wheels having a torque of less than 300 nanoNewtonmeter, less than 200 nNm or even less than 150 nNm. Torque is typically generated by a main spring and transmitted via a gear train.

[0046] The invention is not limited to the described embodiments and can be varied within the scope of the claims. For instance, as shown in Figure 6, the distal ends can be configured to define a triangular opening for a triangular shaft or to define e.g. a square or hexagonal opening. Also, as shown in Figures 7 and 8, elastic averaging in accordance with the present invention can be applied in other horological parts, such as a "Swiss" anchor, comprising anchor teeth 9, a fork slot 10, and guard pin 11.

Claims

1. Mechanical part (1) for a movement for a watch, which part (1) is made of a brittle material and has at least three cantilevered and resilient arms (3), and an opening (4) for receiving and holding a shaft, **characterized in that** the distal ends (5) of the cantilevered and resilient arms (3) define the opening (4).

2. Mechanical part (1) according to claim 1, wherein the bending stiffness of the arms (3) is at least substantially equal for each of the arms (3).

3. Mechanical part (1) according to claim 1 or 2, wherein the thickness, length, position relative to the center of the opening, and/or the shape of the arms (3) is different between at least two arms (3).

4. Mechanical part (1) according to any one of the preceding claims, wherein the part (1) has an even number of arms (3), arranged in pairs of arms (3) working in opposite directions.

5. Mechanical part (1) according to any one of the pre-

ceding claims, which is made from a material having one or more isotropic mechanical properties, in particular an isotropic modulus of elasticity.

6. Mechanical part (1) according to any one of the preceding claims, wherein the arms (3) are evenly distributed around the opening (4).

7. Mechanical part (1) according to any one of the preceding claims, wherein the arms (3) arms extend in a direction of which the tangential component is larger than the radial component.

8. Mechanical part (1) according to any one of the preceding claims, comprising rigid structures (6) and/or resilient structures (7) located radially behind the resilient arms (3) defining the central opening (4).

9. Mechanical part (1) according to any one of the preceding claims, wherein the distal ends (5) of the resilient arms (3) are arc-shaped.

10. Mechanical part (1) according to any one of the preceding claims, wherein at least one of the arms (3) comprises a protrusion (8) or recess to provide a form fit between that arm (3) and an inserted shaft.

11. Mechanical part (1) according to any one of the preceding claims, wherein at least one of the arms (3) comprises a recess for receiving an adhesive between that arm (3) and an inserted shaft.

12. Mechanical part (1) according to any one of the preceding claims, having a thickness smaller than 700 μm, preferably smaller than 550 pm, preferably in a range from 50 μm to 500 pm, preferably in a range from 100 μm to 300 μm and/or at least the distal ends (5) of the arms (3) have a thickness (height) that is larger than the thickness of the rest or other sections (2; 3; 6; 7) of the part.

13. Movement for a watch comprising a base, an energy storage, a gear train to transmit torque and energy to an escape wheel (1), an oscillator, and anchor teeth on an anchor or on the oscillator, which anchor teeth are controlled by the oscillator to alternately block and release the teeth of the escape wheel (1), and wherein at least one of: the wheels in the gear train, the escape wheel (1), the anchor, and the oscillator, is a mechanical part according to any one of the preceding claims.

14. Movement according to claim 13, wherein the escape wheel (1) has a torque of less than 300 nanoNewtonmeter (nNm), preferably less than 200 nNm, preferably less than 150 nNm, and/or the oscillator (1) has and/or the anchor teeth have an amplitude smaller than 30°, preferably smaller than 20°, preferably smaller than 15°, e.g. in range from 3° to 10°, and/or the oscillator has a natural frequency of 3 Hertz (Hz) or higher, preferably 4 Hz or higher, preferably 10 Hz or higher, preferably 25 Hz or higher, preferably 35 Hz or higher.

15. Wristwatch (20) comprising a movement (21) according to claim 13 or 14.

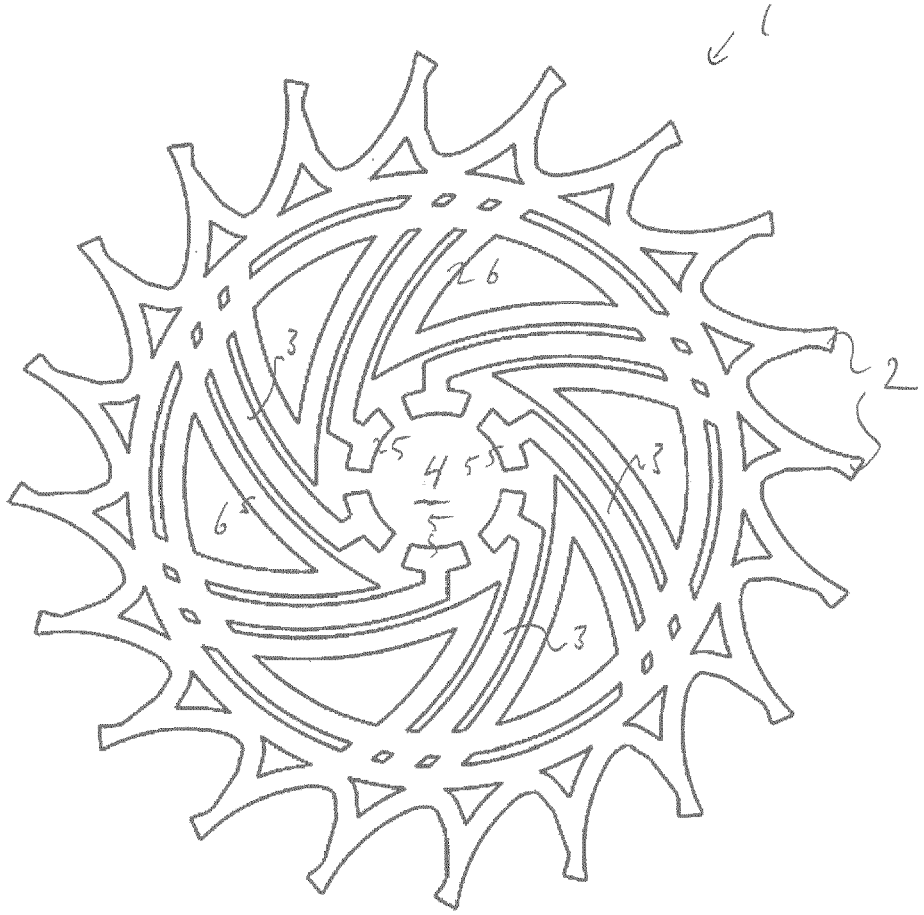

Fig. 1

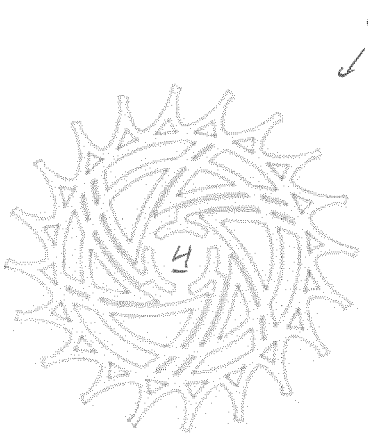

Fig. 2

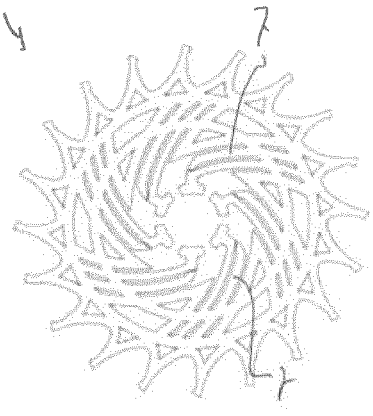

Fig. 3

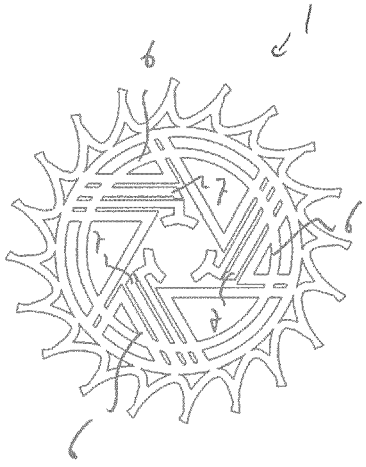

Fig. 4

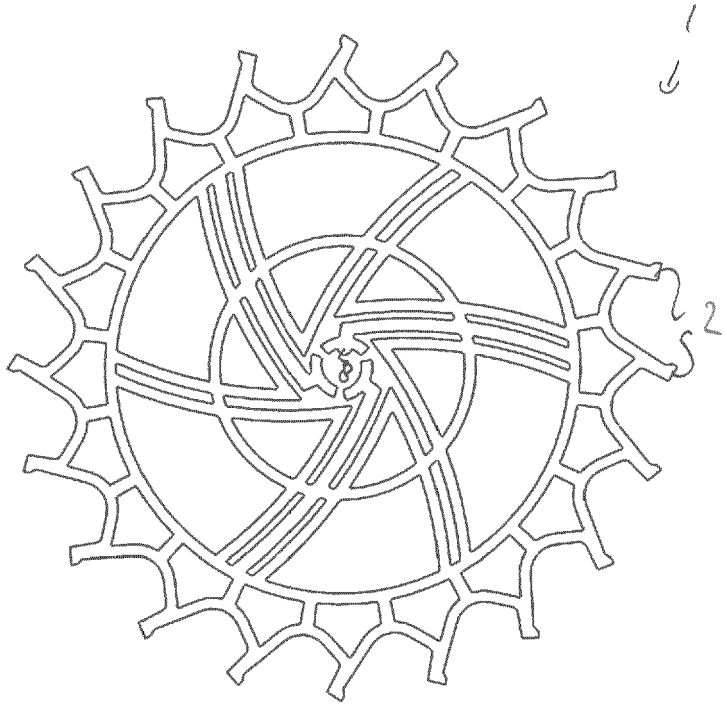

Fig. 5

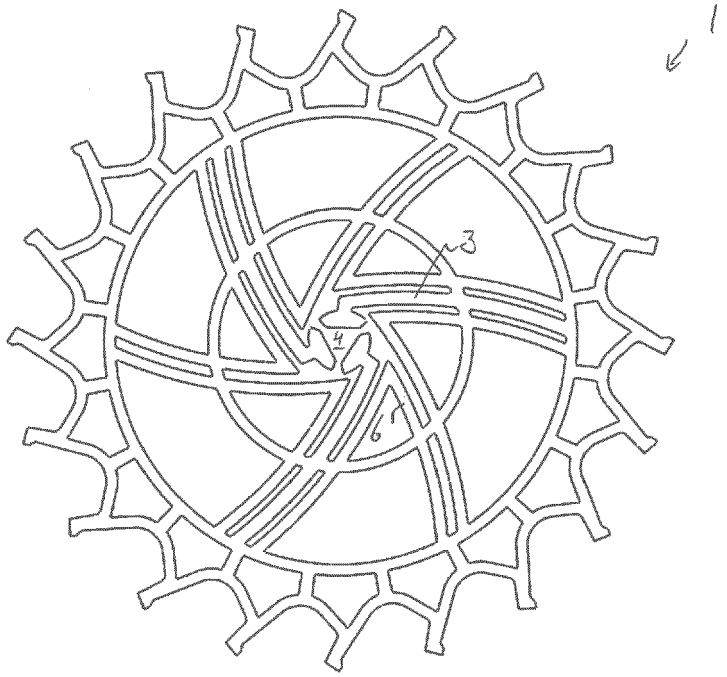

Fig. 6

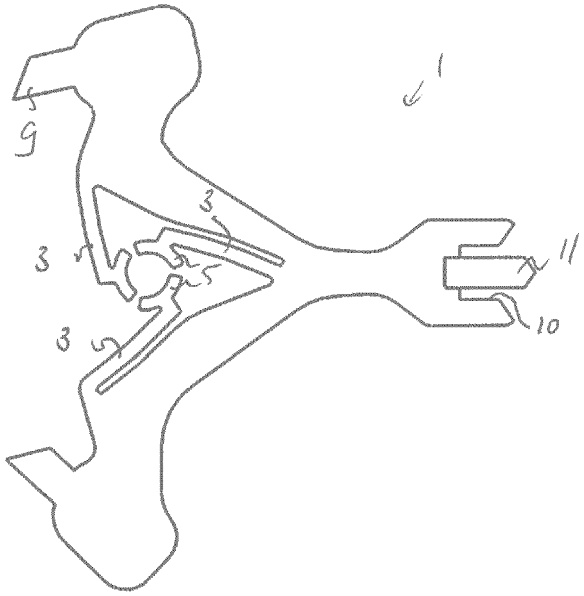

Fig. 7

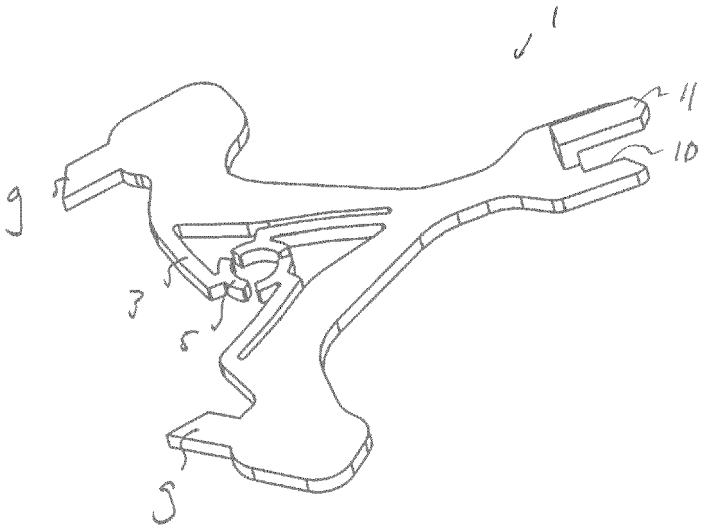

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 6839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2022/283544 A1 (MALLET DANIEL [FR] ET AL) 8 September 2022 (2022-09-08) * paragraphs [0032] - [0036] * * figures 1-5 *	1-15	INV. G04B13/02
X	US 2018/150029 A1 (SHIBUYA MUNEHIRO [JP] ET AL) 31 May 2018 (2018-05-31) * paragraphs [0091] - [0112]; figure 6 * * paragraphs [0114] - [0119]; figure 8 * * paragraphs [0128] - [0130]; figure 11 *	1-15	
X	US 2012/090933 A1 (CONUS THIERRY [CH] ET AL) 19 April 2012 (2012-04-19) * figures 5-8 * * column 5, line 1 - column 6, line 3 *	1-15	
X	US 2008/112274 A1 (BITTERLI ROLAND [CH] ET AL) 15 May 2008 (2008-05-15) * paragraphs [0032] - [0040]; figure 5 * * paragraphs [0041] - [0047]; figures 6-8 * * paragraph [0049] *	1-15	TECHNICAL FIELDS SEARCHED (IPC) G04B
X	US 2017/176935 A1 (DUBOIS PHILIPPE [CH] ET AL) 22 June 2017 (2017-06-22) * paragraph [0069]; figure 6 *	1-15	
X	US 7 926 355 B2 (ROLEX SA [CH]) 19 April 2011 (2011-04-19) * column 4, line 30 - column 5, line 9 * * column 8, lines 18-51 * * figure 5 *	1-15	
X	CH 716 511 A2 (NIVAROX SA [CH]) 26 February 2021 (2021-02-26) * paragraphs [0015] - [0022]; figures 1-4 *	1-15	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 November 2023	Pirozzi, Giuseppe

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 6839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 382 472 A1 (ROLEX SA [CH]) 3 October 2018 (2018-10-03) * paragraphs [0037], [0038]; figures 5, 6 * * paragraph [0057] *	1-15	
A	FR 3 128 953 A1 (SILMACH [FR]) 12 May 2023 (2023-05-12) * paragraphs [0054] - [0095]; figures 1-11 *	11	
A	US 2011/103200 A1 (CUSIN PIERRE [CH]) 5 May 2011 (2011-05-05) * the whole document *	11	
			TECHNICAL FIELDS SEARCHED (IPC)

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 17 6839

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02-11-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2022283544 A1	08-09-2022	CN 114341748 A	12-04-2022
		EP 3779607 A1	17-02-2021
		EP 4014095 A1	22-06-2022
		JP 2022538090 A	31-08-2022
		KR 20220026598 A	04-03-2022
		US 2022283544 A1	08-09-2022
		WO 2021032388 A1	25-02-2021
US 2018150029 A1	31-05-2018	CN 108121190 A	05-06-2018
		EP 3327514 A2	30-05-2018
		JP 6772790 B2	21-10-2020
		JP 2018087736 A	07-06-2018
		US 2018150029 A1	31-05-2018
US 2012090933 A1	19-04-2012	CH 704016 A2	30-04-2012
		CN 102537026 A	04-07-2012
		EP 2442189 A1	18-04-2012
		EP 2442190 A1	18-04-2012
		HK 1172941 A1	03-05-2013
		JP 5282134 B2	04-09-2013
		JP 2012088315 A	10-05-2012
		TW 201238881 A	01-10-2012
		US 2012090933 A1	19-04-2012
US 2008112274 A1	15-05-2008	AT E467860 T1	15-05-2010
		CN 101183238 A	21-05-2008
		EP 1921517 A1	14-05-2008
		HK 1120872 A1	09-04-2009
		JP 5175523 B2	03-04-2013
		JP 2008122385 A	29-05-2008
		KR 20080042700 A	15-05-2008
		SG 143145 A1	27-06-2008
		US 2008112274 A1	15-05-2008
US 2017176935 A1	22-06-2017	CN 106896695 A	27-06-2017
		EP 3182211 A1	21-06-2017
		EP 3182212 A1	21-06-2017
		JP 6364062 B2	25-07-2018
		JP 2017111126 A	22-06-2017
		KR 20170072819 A	27-06-2017
		TW 201732465 A	16-09-2017
		US 2017176935 A1	22-06-2017
US 7926355 B2	19-04-2011	CN 101566826 A	28-10-2009
		EP 2112565 A1	28-10-2009
		HK 1133931 A1	09-04-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 17 6839

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-11-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		JP 5451162 B2	26-03-2014
		JP 2009265097 A	12-11-2009
		US 2009263182 A1	22-10-2009
CH 716511 A2	26-02-2021	NONE	
EP 3382472 A1	03-10-2018	CN 108693761 A	23-10-2018
		CN 114089616 A	25-02-2022
		EP 3382472 A1	03-10-2018
		JP 7280018 B2	23-05-2023
		JP 2018200303 A	20-12-2018
		JP 2023065540 A	12-05-2023
		US 2018284698 A1	04-10-2018
FR 3128953 A1	12-05-2023	FR 3128953 A1	12-05-2023
		WO 2023079251 A1	11-05-2023
US 2011103200 A1	05-05-2011	CN 102053558 A	11-05-2011
		EP 2317406 A1	04-05-2011
		EP 2317407 A1	04-05-2011
		JP 5261459 B2	14-08-2013
		JP 2011094793 A	12-05-2011
		RU 2010144241 A	10-05-2012
		TW 201140259 A	16-11-2011
		US 2011103200 A1	05-05-2011

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1991916 A1 **[0003]**
- CH 717005 A2 **[0004]**
- EP 3418815 A2 **[0005]**
- EP 1331528 A2 **[0029]**
- US 2021149343 A **[0030]**
- WO 2019156552 A **[0036]**