

MICRO-MECHANICAL PART WITH A SHAPED APERTURE
FOR ASSEMBLY ON A SHAFT

Field of the invention

The present invention concerns a micro-mechanical part comprising a shaped aperture for facilitating assembly on a shaft for a moving part, or on a stud for a fixed part, and limiting or removing the risk of the part breaking when it is driven onto the shaft or stud, particularly when said part is made of a brittle material.

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Background of the invention

In the field of micro-mechanics, which will hereafter be more specifically illustrated by the field of horology, the driving in technique is very widely used, for example for fixing a wheel onto a shaft. When the material forming the part has a plastic region, which is the case of metals and alloys, the tolerances necessary for the shaft and bore can be calculated so as to obtain a tight fit without any risk of breaking the part, or deforming it. When the material does not have any, or very little, plastic region, which is the case of glass, quartz or silicon, there is a high risk of the part being broken during assembly.

15 These materials are used more and more frequently in horology, particularly because of their lack of sensitivity to magnetic fields, their very low thermal expansion coefficient and their density, which is much lower than that of metals or alloys. Moreover, modern machining techniques can achieve complex shapes with a high level of precision.

20 If a push fit is made to prevent stresses in the brittle material, there is then a risk of the part becoming detached or a moving element not being driven by the shaft. In order to overcome this drawback, one could employ the bonding technique that has long been used for securing a balance-spring onto a collet, as disclosed for example in FR Patent No. 1 447 142. US Patent No. 3 906 714 discloses an embodiment
25 wherein the dot of adhesive both secures the balance-spring to a ring forming the collet and said ring to the balance staff.

The use of an adhesive has, however, the drawback of requiring additional machining steps to provide recesses for the adhesive, and additional step during assembly. Further, the phenomenon of aging can lead to a certain play over time.

30 In EP Patent No. 1 331 528, which relates to an escapement mechanism pallet for a timepiece movement, for preventing the risk of breakage when the male part of a dart is mounted in the shaped aperture formed in a fork, it is proposed fitting resilient tongues to the aperture. Moreover, in certain embodiments such as that shown in

Figure 30 of the document, the rigid zones of the aperture comprise shoulder surfaces, which position the dart in relation to the fork along a predefined orientation.

The solutions envisaged in this document are not completely satisfactory since
5 they do not enable the male part to be precisely centred in the aperture.

Summary of the invention

It is thus an object of the present invention to overcome the drawbacks of the
aforecited prior art by providing a micro-mechanical part, in particular a horological
10 part, made of a brittle material that can be assembled by being driven onto a shaft or
a stud without any risk of breaking.

The invention therefore concerns a micro-mechanical part made from a plate
made of brittle material comprising an aperture into which a shaft or a stud will be
driven. A "brittle" material means a material with no plastic deformation region, such
15 as glass, quartz or silicon.

The invention is characterized in that the aperture is a "shaped aperture", i.e.
an aperture not having a perfectly circular contour, said aperture alternatively
including rigidifying and positioning zones and resilient deformation zones for gripping
or tightening around the shaft. The resilient deformation zones are formed of portions
20 of plate having a recess on either side(?) joining the aperture and the end of which
penetrates said aperture. These plate portions have the shape of a tongue that abuts
the shaft tangentially when the latter is driven in. The rigidifying and positioning zones
and the tongues are arranged alternately around the shaft, each tongue being
separated from the adjacent rigidifying zones by a recess, and the rigidifying and
25 positioning zones are distributed in a substantially regular manner around the
aperture.

According to other aspects of the invention:

- each rigidifying and positioning zone comprises at least one shoulder
provided to come into contact with the shaft, the shoulders are distributed in a
30 substantially regular manner around the aperture in order to centre the shaft in the
aperture;
- each rigidifying and positioning zone forms a shoulder, which is delimited by
the two recesses framing said rigidifying and positioning zone;
- each tongue describes an overall curve of determined profile, and the two
35 adjacent recesses are formed by two elongated slots of the same general profile as
the curve of said tongue;
- the brittle material is selected from among glass, quartz and silicon.

The invention also proposes an arrangement for immobilising a micro-mechanical part comprising an aperture by driving the same onto a support block including a positioning stud. The micro-mechanical part is made with any of the preceding features.

- 5 The invention further proposes an arrangement for driving a micro-mechanical part that is mobile in continuous or alternate rotation onto a shaft. The micro-mechanical part is made in accordance with any of the preceding claims.

According to variants of this arrangement:

- 10 - the micro-mechanical part forms part of a timepiece movement selected from among an escape wheel, a star wheel, a toothed wheel, a collet, a lever and a pallet;
- the shaft and the aperture also have contours providing an anti-rotational effect;
- the shape of the contour of the shaft and the aperture is oblong or triangular;
- the contact zones of the shaft and the aperture are rough or provided with
15 flutes;
- the micro-mechanical part comprises at least one weld point or one dot of adhesive securing the micro-mechanical part to the shaft.

Brief description of the drawings

- 20 Other features and advantages of the present invention will appear in the following description of various embodiments, given by way of non-limiting illustration with reference to the annexed drawings, in which:

- Figure 1 is a perspective diagram of a first embodiment of an assembly according to the invention;
- 25 - Figure 2 is a top view of the first embodiment applied to an escape wheel;
- Figure 3 is a top view, of a second embodiment applied to a star wheel, and
- Figure 4 is a top view of a third embodiment applied to a toothed wheel;
- Figure 5 is a similar view to that of Figure 2 showing a preferred embodiment
of the invention.

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Detailed description of the invention

- A first embodiment will be described with reference to Figures 1 and 2. Figure 1 shows a perspective view of a portion of plate 1 that has to be fixed to a support block 11 by means of a cylindrical stud 3 passing through an aperture 2 formed in said
35 plate 1.

 Plate 1 is formed of a brittle material, i.e. a material that has no plastic region within normal use temperatures, such as glass, quartz or silicon. Plate 1 can simply

form a construction element, for example a bottom plate, a bridge or a dial of a timepiece. It may also have a functional role, carrying a printed circuit board or a Micro-Electro-Mechanical Systems (MEMS) that has to be secured to block 11. In order to avoid breaking the part during a driving-in assembly, aperture 2 is a shaped
5 aperture shown in a larger scale top view in Figure 2.

Figure 2 shows by way of example a silicon escape wheel mounted on a cylindrical shaft 5 to be pivoted between two bearings. As can be seen, the contour of aperture 2 does not follow the circular contour of shaft 5 since it exhibits alternately rigidifying and positioning zones 8 and resilient deformation zones 10. It will be noted
10 that rigidifying zones 8 and resilient deformation zones 10 extend in the plane of plate 1, as shown in Figures 1 and 2, since they define the shape of aperture 2. Resilient deformation zones 10 will deform in the plane of plate 1.

In order to show that rigidifying zones 8 do not exert any tightening function on shaft 5, the space 9 between said zones 8 and shaft 5 has been greatly exaggerated.
15 Rigidifying zones 8 are used for centring the escape wheel in relation to shaft 5. As can be seen in Figure 2, rigidifying zones 8 are angularly distributed in a regular manner around aperture 2. There are three rigidifying zones 8 here.

Resilient deformation zones 10 are obtained by making recesses 13, 15 in plate 1, which open into the central aperture and delimit in this example a tongue 12
20 whose end 14 extends beyond the theoretic contour of shaft 5 and thus performs a tightening or gripping function when shaft 5 is set in place by driving in. Figure 2 also shows that each tongue 12 is separated from the adjacent rigidifying zones 8 by a recess 13, 15, such that each tongue 12 is connected to plate 1 in a zone distinct from rigidifying zones 8. As shown in Figure 2, tongues 12 are angular distributed in a
25 regular manner around shaft 5, between rigidifying zones 8. Aperture 2 thus alternately comprises, over its periphery, a rigidifying zone 8 and a tongue 12. As can be seen in Figure 2, each tongue 12 describes an overall curve of determined profile, here a curve in the arc of a circle. Moreover, the two adjacent recesses 13, 15 are formed by two elongated slots with the same general profile as the curve of said
30 tongue 12.

Figure 5 shows a preferred embodiment of the invention similar to that of Figure 2, in which rigidifying zones 8 are shown as they are in reality, i.e. without exaggerating space 9 between said zones 8 and shaft 5. It will be noted that each rigidifying zone 8 comprises at least one shoulder 16 that will be in contact with the
35 cylindrical wall of shaft 5. These shoulders 16 are distributed in a regular manner around aperture 2 in order to centre shaft 5 in aperture 2. More specifically, each rigidifying zone 8 forms a shoulder 16 that is delimited by the two recesses 13, 15

framing said zone 8. Each rigidifying zone 8 thus has here a profile in the arc of a circle that generally follows the radius of curvature of the cylindrical wall of shaft 5. Shoulders 16 position the wheel precisely in relation to shaft 5. Tongues 12 perform the function of radial tightening, the function of correcting any manufacturing play in the aperture, and they centre shaft 5 in aperture 2.

Of course, the number of rigidifying zones 8 and the number of tongues 12 could be greater than the number shown.

Figure 3 shows a second embodiment with a motion-work star wheel comprising at its centre a shaped aperture 4 providing an anti-rotational effect. Indeed, end 7 of shaft 5 is machined with a non-circular contour in the shape of a triangle with rounded angles. The shaped aperture 4 follows this contour, but, as in the first embodiment, has a succession of rigidifying and positioning zones 8 and resilient deformation zones 10.

Figure 4 shows a third embodiment in which the part, made for example of silicon, is a toothed wheel having at the centre thereof a shaped aperture 6, which, as previously, has an "anti-rotational" function. In this example the shaped aperture 7 is oblong.

It is of course possible to imagine any other non-circular contour able to provide an anti-rotational effect, without departing from the scope of the present invention.

It is also possible, in any of the embodiments that have just been described to provide the ends 14 of resilient deformation zones 10 and shaft 5 with surface roughness, for example flutes, to further reduce the risk of the part rotating on the shaft.

The examples given in the preceding description concern parts that rotate continuously, but it is clear that those skilled in the art could adapt the same principle to parts having an alternate movement, such as a lever, a pivoting part, a collet, a pallet or an escape wheel.

Depending upon the application for which the micro-mechanical part is intended, it is possible to finalise assembly of the part on its shaft with a bonding or welding step, which provides a more rigid attachment, if this is necessary. The adhesive or weld completes fixing by the resilient tongues. In such case, fixing by the tongues constitutes an intermediate fixing step guaranteeing precise centring of the shaft in the aperture, with correction of any play, and the bonding or welding step constitutes a final fixing step.

CLAIMS

1. Micro-machining part made from a plate (1) made of a brittle material including at least one aperture for driving in a shaft (3, 5), wherein the aperture is a shaped aperture (2, 4, 6) including rigidifying and positioning zones (8) and resilient deformation zones (10) for gripping the shaft (3, 5), wherein each resilient deformation zone (10) is formed by a portion (12) of plate (1) having a recess (13, 15) on either side joining the aperture and having the shape of a tongue whose end (14) opens tangentially into the aperture (14), characterized in that the rigidifying and positioning zones (8) and the tongues are arranged alternately around the shaft, each tongue being separated from the adjacent rigidifying zones (8) by a recess (13, 15), and in that the rigidifying and positioning zones (8) are distributed in a substantially regular manner around the aperture (2, 4, 6).

2. Micro-mechanical part according to claim 1, wherein each rigidifying and positioning zone (8) includes at least one shoulder (16) that will be in contact with the shaft (3, 5), characterized in that the shoulders (16) are distributed in a substantially regular manner around the aperture (2, 4, 6) in order to centre the shaft (3, 5) in the aperture (2, 4, 6)

3. Micro-mechanical part according to claim 2, characterized in that each rigidifying and positioning zone (8) constitutes a shoulder (16) which is delimited by the two recesses (13, 15) framing said rigidifying and positioning zone (8).

4. Micro-mechanical part according to any of the preceding claims, characterized in that each tongue (12) describes overall a curve of determined profile, and in that the two adjacent recesses (13, 15) are formed by two elongated slots with the same overall profile as the curve of said tongue (12).

5. Micro-mechanical part according to any of the preceding claims, characterized in that the brittle material is selected from among glass, quartz and silicon.

6. Arrangement for immobilising a micro-mechanical part including an aperture by driving said part onto a support block (11) including a positioning stud (3), according to claim, characterized in that the micro-mechanical part is made in accordance with any of the preceding claims.

7. Arrangement for securing a micro-mechanical part that is continuously or alternately mobile in rotation onto a shaft (5) by driving in, characterized in that the micro-mechanical part is made in accordance with any of the preceding claims.

8. Arrangement according to claim 7, characterized in that the micro-mechanical part constitutes a part in a timepiece movement selected from among an escape wheel, a star wheel, a toothed wheel, a collet, a lever and a pallet.

5 9. Arrangement according to claim 7, characterized in that the shaft and the aperture further have contours providing an anti-rotational effect.

10. Arrangement according to claim 9, characterized in that the shape of the contour of the shaft and the aperture is oblong or triangular.

11. Arrangement according to claim 9, characterized in that the contact zones of the shaft and the aperture are provided with surface roughness or flutes.

10 12. Arrangement according to any of claims 6 to 11, characterized in that the micro-mechanical part includes at least one weld point or dot of adhesive fixing the micro-mechanical part onto the shaft.