Torsion Spring Element

The present invention relates to a torsion spring element suitable for performing both rotational and translational movements.

Micro-electro-mechanical systems (MEMS) often use spring mechanisms that are highly specialized. Such spring mechanisms, for example, can enable a very well guided, straight-line movement with very good linearity of the force-displacement curve along one direction, while no movement is possible in directions perpendicular to this, to a first approximation. Similarly, torsion springs are well known that enable purely rotational movements without linear movement.

In modern and complex MEMS designs, however, spring mechanisms have to fulfill various tasks, which often cannot be achieved with the previously used spring mechanisms specialized in one type of movement. Rather, different spring mechanisms must be combined with each other, such as a torsion spring and a linear spring. This inevitably leads to a large space requirement. In addition, the individual spring mechanisms can block each other so that the optimally achievable deflections of the individual spring mechanisms cannot be achieved in this combination. The large space requirement also increases the risk of process fluctuations occurring over the surface of the combined spring mechanism during fabrication of the MEMS, e.g., by etching, due to which spring characteristics vary within the spring mechanism.

Embodiments of the present invention provide a compact torsion spring element that can perform a wide variety of movements.

According to an aspect of the present invention, there is provided a torsion spring element rotatably connected to a substrate and suitable for use in micro-electro-mechanical devices, wherein the torsion spring element can be twisted relative to the substrate, as well as moved linearly relative to the substrate; the torsion spring element is designed in one piece and includes: a frame structure; an anchor structure preferably arranged within the frame structure; and spring structures connecting the anchor structure to the frame structure; the anchor structure connects the spring structures and the frame structure to the substrate; the frame structure, with deformation of the spring structures, moves as a whole relative to the anchor structure to produce rotational movements and linear movements of the torsion spring element relative to the substrate; and the spring structure has at least one pairing of two bending beam springs which extend from the anchor structure at an angle not equal to 0°, each have a kink, converge towards each other after the kink, meet at the frame structure, and are connected to the frame structure at that point.

"Designed in one piece" means that the torsion spring element is not a combination of spring mechanisms that would also function on their own. It is therefore not possible to remove components or connecting elements from the torsion spring