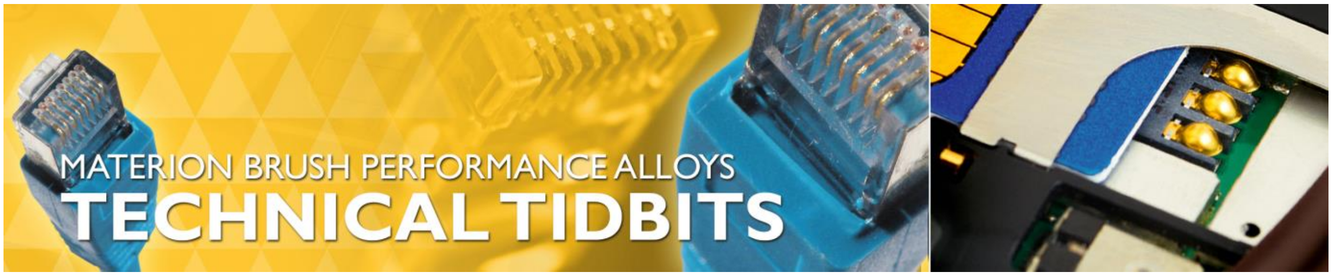

Issue No. 83 – November 2015 **New Publication**

Volutes and Garters and C-Rings, Oh My! – A discussion of some spring types worthy of mention.

- **Torsion Spring**
- **Spiral Spring/ Clock Spring**
- **Power Spring**
- **Constant Force Spring**
- **Volute Spring**
- **Garter Spring**
- **C-Ring**
- **Leaf Spring**

The next issue of Technical Tidbits will discuss what makes a "good" spring.

Spring Types Part 8 – Miscellaneous Springs

This edition of Technical Tidbits concludes our discussion on various types of springs used in electrical contacts or sensors, grouped into six broad categories of similar function (cantilever beams, simply supported beams, torsion bars, Belleville washers, coil springs, and bellows & diaphragms). This month we will focus on miscellaneous spring types that we have not yet covered.

A helical **torsion spring** (Figure 1 - far left) is loaded in torsion around the central axis of the coil. As with compression and extension springs, the load provided by the spring does not match the stress state. While the spring is deflected angularly by an applied torque, the wire inside the coils experiences a bending stress state.

A **spiral spring** (Figure 1 - far right) is also loaded by angular deflection (blue arrows) around the center, and provides a torque in response. As in the helical torsion spring, the strip or rectangular wire wound into this spring also experiences a bending stress during loading.

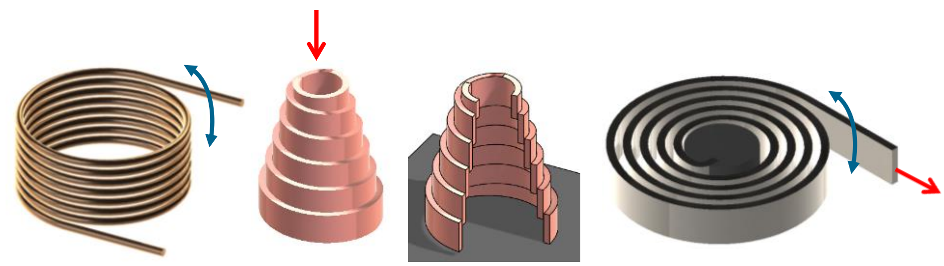

Figure 1. Torsion Spring (Left), Volute Spring – Whole and Cutaway View (Center), and Spiral/Power/Constant Force Spring (Right). The cutaway view of the volute spring shows the overlap of each successive coil, and how each may touch its nearest neighbor. In spiral or power springs, the inside end would be fixed, but would rotate freely in constant force springs. Rotational deflections are shown in blue, linear deflections in red.

Power springs or **clock springs** are spiral springs in which the inner end is fixed in place and the whole spring is retained in some kind of housing, with a protruding outer end. The spring is loaded by pulling the outer end tangentially away from the coil (red arrow), storing torque energy inside the housing. These are the springs that can be found in wind-up toys or watches. The torque vs. angular deflection response of these springs is maximum when fully wound, and gradually reduces nonlinearly as the spring unwinds.

A **constant force** spring is a spiral spring designed to provide an approximately constant linear force as the outside end is extended tangentially away from the spiral (red arrow). A self-retracting tape measure is good example of this type of spring.

A **volute spring** (Figure 1 - center left) is essentially a conical compression spring made with rectangular wire or strip, in which neighboring, nesting coils both touch and overlap each other, as seen in the cutaway view (Figure 2 - center right). In its fully compressed state, it would resemble a spiral spring, with a height equal to the width of the strip or rectangular wire used to wind the spring. Frictional forces between the wraps can add to the stiffness of the spring. Like other compression springs, even though the spring is loaded in compression, the metal is stressed in torsion (shear).

Table 1 on the next page contains the appropriate stiffness and stress calculations, for the helical and spiral torsion springs. No formula is provided for power springs, as the active length of the coils varies both within and between revolutions. Deflection is specified as number of full revolutions, not the actual angle.

Miscellaneous Springs (continued)

	Torque vs. Revolutions	Stress vs. Revolutions
Helical Torsion	$M = \frac{E \cdot d^4}{10.8 \cdot N_t \cdot D} \cdot Rev$	$S = \frac{2.96 \cdot E \cdot d}{\pi \cdot N_t \cdot D} \cdot Rev$
Spiral Torsion	$M = \frac{\pi \cdot E \cdot b \cdot t^3}{6 \cdot L} \cdot Rev$	$M = \frac{\pi \cdot E \cdot t}{L} \cdot Rev$

Table 1. Stiffness and Stress Behavior of Helical and Spiral Torsion Springs. The variables are moment/torque generated (*M*), Stress (*S*), Elastic Modulus (*E*), Number of revolutions or turns of the spring (*Rev*), diameter of wound wire (*d*), width of wound strip (*b*), thickness of wound strip (*t*), number of active coils in helical torsion spring (N_t), active length of spiral spring (*L*), and mean helical diameter of helical torsion spring (*D*).

There are other springs that are designed to clamp around or within cylindrical objects to hold them in place or to seal joints between cylindrical objects. These are C-rings (retaining rings), and garter springs. (See Figure 2). A **C-ring** is typically machined out of tube or flat plate, and provides inward radial pressure. Often they will fit into machined grooves. The key design characteristic here would be for the material to have sufficient strength to expand wide enough to fit around the cylindrical object and then snap back into place.

Figure 2. C-Ring (Left) and Garter Spring (Right). Both springs can provide inward radial pressure, while the garter spring can also provide outward radial pressure. Both are used to hold cylindrical components in place.

A **garter spring** serves a similar function. It is essentially a coils spring that is bent around into a complete circle with the ends joined, usually by interlocking specially configured ends. The garter spring can fit around a cylindrical groove on and outside surface and squeeze inward, or it can fit within a groove on an inside surface and apply outward pressure.

This concludes the introduction to the common spring types. There are other spring types, but most are just variations on a theme we have already discussed. For example, the **leaf springs** found in automotive and railroad suspensions are really nothing more than arch springs nested in series. Now that we have covered all this background, it is time to discuss in next month's edition what constitutes a "good" spring.

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TECHNICAL TIDBITS

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