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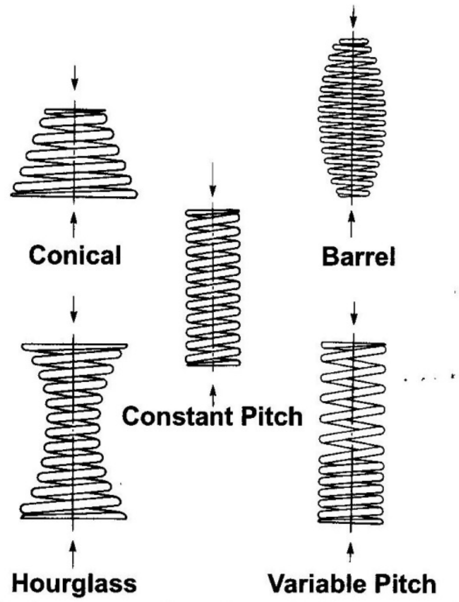
SPRING CONFIGURATIONS

It is extremely important in the design process to select the right spring configuration in order for the spring to properly perform the function that is intended.

Helical Compression

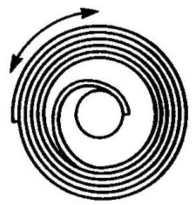
Round and Rectangular Wire



Push – wide load and deflection range – constant rate.

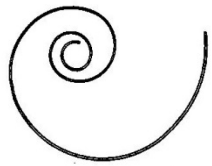
Push – wide load and deflection range. Conical spring can be made with minimum solid height and with constant or increasing rate. Barrel, hourglass, and variable-pitch springs used to minimize resonant surging and vibration.

Power, Motor or Clock



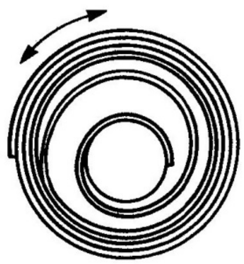
Twist – exerts torque over many turns.

Supplied in retainer.



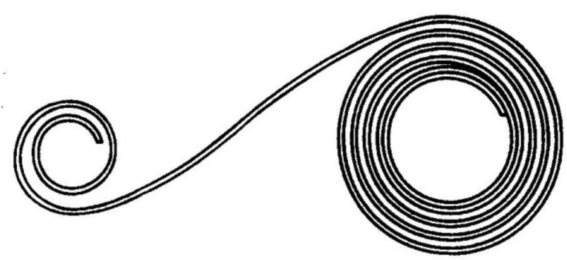
Removed from retainer.

Prestressed Power



Twist – exerts torque over many turns.

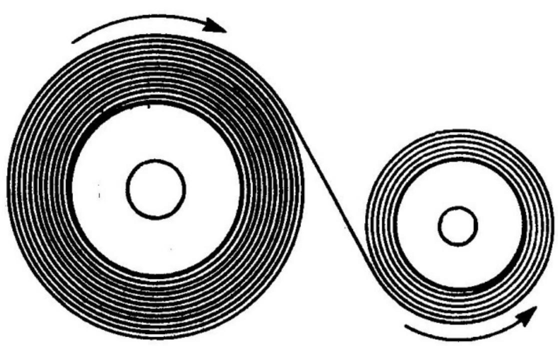
Supplied in retainer.



Removed from retainer.

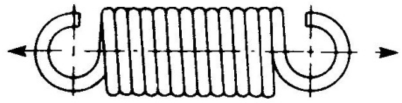
Constant Force Spring Motor

Level Torque



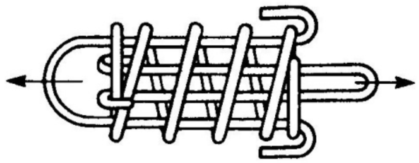
Twist – exerts close-to-constant torque over many turns.

Helical Extension



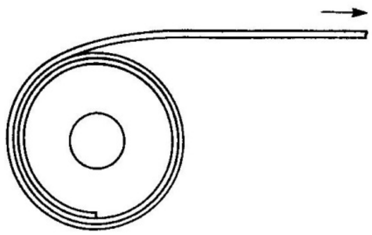
Pull – wide load and deflection range – constant rate.

Drawbar



Pull – extension to a solid stop.

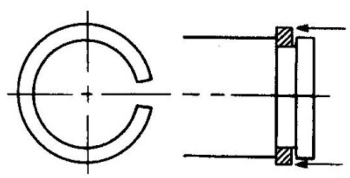
Constant Force



Pull – very long deflection at constant load or low rate.

Retaining Rings

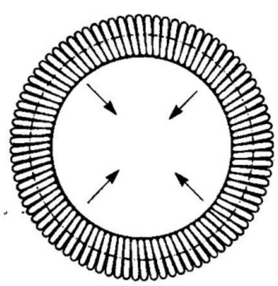
Round or Rectangular Wire



Pull or push – to resist axial loads.

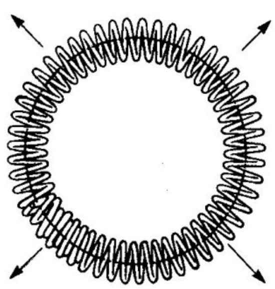
Garter

Extension



Pull with radial pressure.

Compression



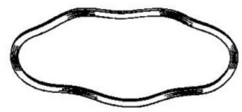
Push with radial pressure.

Spring Washer

Belleville

Push – high loads, low deflections – choice of rates (constant, increasing, or decreasing).

Wave

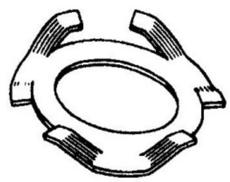


Push – light loads, low deflection-uses limited radial space.

Slotted

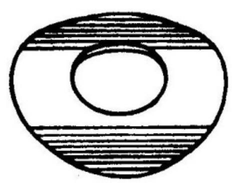
Push – higher deflections than bellevilles.

Finger



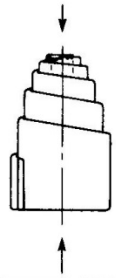
Push – for axial loading of bearings.

Curved



Push – used to absorb axial end play.

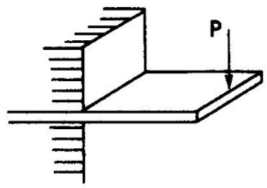
Volute



Push – may have inherently high friction damping.

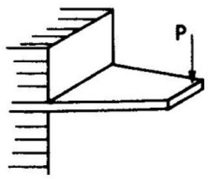
Beam

Cantilever, Rectangular Section

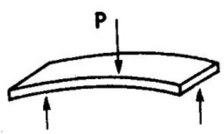


Push or pull – wide range of loads, low deflection range.

Cantilever, Trapezoidal Section

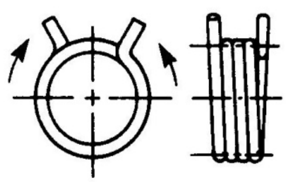


Simple Beam



Helical Torsion

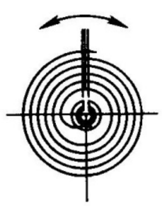
Round or Rectangular Wire



Twist – constant rate.

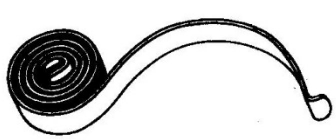
Spiral

Hairspring



Twist

Brush



Twist or Push.

Energy Storage Capacity (ESC) of Various Spring Configurations:

Type of Spring	Energy (1) Storage Capacity	Space (2) Efficiency	Notes	Typical Amounts of Energy Stored in Spring Space Envelope	
				J/mm^3	$ft\text{-}lbf/in^3$
Compression or Extension			Space efficiency does not apply to extension springs.		
Round Wire	$\frac{S^2}{4G}$	$\frac{\pi C}{(C+1)^2}$		$1.5 – 15 \times 10^{-4}$	1.8 – 18
Square Wire	$\frac{S^2}{6.5G}$	$\frac{4C}{(C+1)^2}$		$1.0 – 10 \times 10^{-4}$	1.2 – 12
Rectangular Cantilever & Simply supported Beam	$\frac{S^2}{18E}$	-	-	-	-
Cantilever Beam – Triangular Plan	$\frac{S^2}{6E}$	-	-	-	-
Helical Torsion Spring					
Round Wire	$\frac{S^2}{8E}$	$\frac{\pi C}{(C+1)^2}$		$1.0 – 5 \times 10^{-4}$	1.2 – 6
Square Wire	$\frac{S^2}{6E}$	$\frac{4C}{(C+1)^2}$		$1.5 – 8 \times 10^{-4}$	1.8 – 9.7
Spiral Torsion Spring (round Wire)	$\frac{S^2}{8E}$	-		-	-
Belleville Washer	$\frac{S^2}{10E}$ to $\frac{S^2}{40E}$	0.6 – 0.9	Ratio of O.D. to I.D. of 2 is preferred for most designs.	$0.5 – 5 \times 10^{-4}$	0.6 – 6
Power Spring	-	0.4 – 0.6	*	$10 – 17 \times 10^{-4}$	12 – 20
Pre stressed Power Spring	-	0.4 – 0.6	*	$25 – 30 \times 10^{-4}$	30 – 35

Energy storage capacity:

$= 1/V \int_0^f kf\,df$, where V = volume of active spring material. Note that stress correction factors due to spring geometry have been omitted.

* For most efficient design, the amount of space occupied by spring material equals half of the space occupied by the spring in the free position. Due to friction, there is difficulty in estimating the amount of active material and the number of turns in the free position. Determine the ESC by estimating or measuring the area under the torque revolution curve.