Machined springs and wire springs compared

is a wire spring or a machined spring the best fit for your application? We asked the experts at Abssac for a comparison

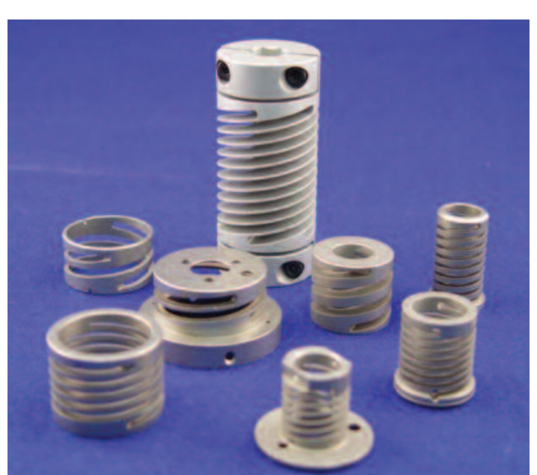
Wire springs date back to before the Industrial Revolution. They established their value immediately, and have not wavered from that most useful course. Certainly, enhancements in materials and manufacturing have been forthcoming, but the basic concept has not changed much. Spring wire coiled hot or cold with ends configured within the limits of coil wire has proven to be a very cost effective, industrial tool that exhibits elasticity within the bounds of known engineering understanding. Uses range from deep ocean applications to man's reach into the universe.

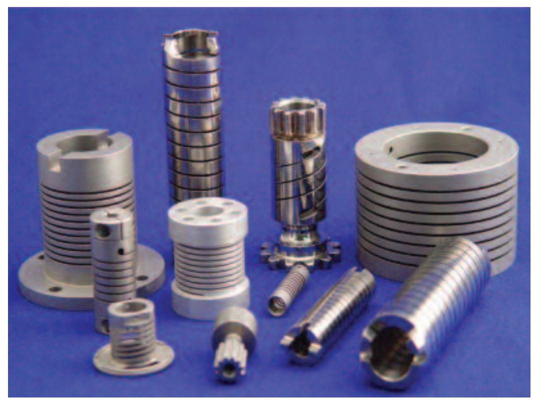
Machined springs are similar in function to wire wound springs, but they are manufactured in a different way. Although any machinable material including plastics can be used, metal in the form of bar stock is the most common starting point for machined springs. The bar stock is first machined into a thick wall tube form, attachment features are added and then a helical slot is cut revealing multiple coils. When deflected, these coils provide the desired elasticity.

The cost to manufacture machined springs exceeds that of winding wire springs. Wire wound springs can be created with just a few seconds of process time, where a machined spring requires minutes at a minimum. The machines used to create both forms are highly specialised and benefit from modern day CNC controls.

Configuration differences

Coils: The coils found on wire wound springs are typically round with sometimes rectangular and/or rectangular with rounded OD and ID surfaces. The two latter forms are less common due to cost, but when used, they provide increased stiffness and compactness of design. The rectangular coils are typically used so that the long leg is radial, but making the long leg longitudinal is possible. Rectangular wire comes in set sizes; venturing away from those sizes can be done but at an increased cost and lead time.





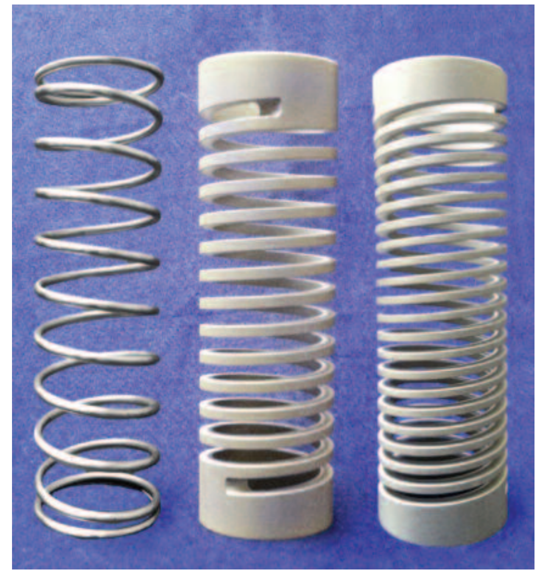
Coils used on machined springs are square, rectangular (radial or longitudinal) and trapezoidal. Trapezoidal coils are common to springs used in lateral bending and lateral translation. This shape allows for additional lateral motion without coil contact. The size of the coil is easily changed to fit the spring's needs. No standard sizes apply.

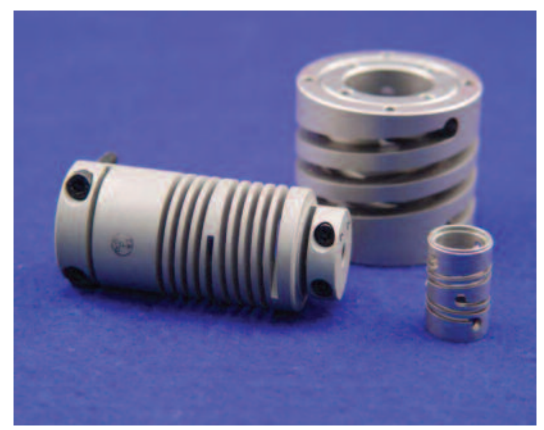
Slots: On wire wound springs the space between the coils (slots) is typically uniform for torsional springs. For compression springs, they are uniform also, but the end slots usually taper to zero. This process is called "closing" the ends, and is created by an additional forming process. Optional grinding then makes the ends nearly flat. Extension springs can have a uniform slot width from zero to most any size. If desired, the coils can be pre-stressed so that an extension spring exhibits a zero slot that furthermore requires a force threshold which needs to be overcome before the coils start to separate.

Currently, machined springs come with minimum slot of about 0.51mm. Wider slots, but generally not exceeding 6.35mm, are possible. The slot width can be closed to near zero using a stress relieving process, but no pre-stressing common to wire springs is currently available.

If a compression spring application requires the absolutely best repeatability to support calibration and/or high precision uses, it is best that the coils never touch. Even better, the minimum slot width needs to be wide enough to not permit any contamination between the coils from restricting and/or changing the compression motion. Machined springs are ideal for calibration and precision usages from this standpoint. The closed aspect of wire springs ends can result in elastic differences in the presents of common contamination.

Number of coils: Wire wound springs can be made very long. A good example of a long wire wound spring is exhibited by garter springs. The general length limitation is governed by the quantity of continuous wire available on the feed spool. Machined springs are limited to about 30 coils depending upon size, but machined springs with coil numbers above 20 are rare.





Length: In a wire spring, the entire length of the wire contributes to the elasticity of the spring because the forces and moments are distributed end to end with the ends providing the interface with adjoining equipment.

Machined springs are different. The flexure, the section providing the desired elasticity is captive between the end sections that provide structure and attachment features. The structure and attachment features have infinite stiffness when compared to the flexure. Furthermore, the slots on machined springs do not taper to zero at the ends; they do remain at the full or initial width, as seen at free length. As a result, to accomplish the same elastic performance, machined springs likely need to be longer than wire ones.

Precision

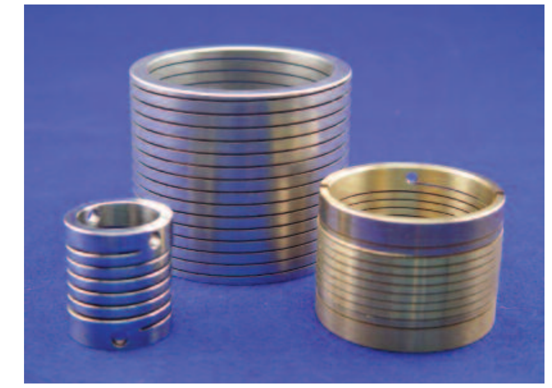
10% precision is readily available from both wire wound and machined springs. 1.0% precision is available from machined springs and possible from wire wound springs when statistical methods are used for selection. 0.1% precision is probably not available from wire wound springs and only available from machined springs using post-processing techniques.

The preceding precision discussion is general and uses a somewhat broad brush. The reality is that precise dimensions are easier to accomplish with machined springs than with wire springs, and precise dimensions are an important part of the foundation for precision performance.

Of course it is also relevant to look at cost, and as discussed production time is the major influence. Wire wound springs benefit greatly from short production times. Machined springs cannot approach the low cost of wire product. However, there are many value enhancements related to machined springs usage helps to validate their usage:

- Integrated attachments
- Enhanced performance or functionality
- Higher precision
- Reduced assembly and acquisition efforts
- No sound creation from coil contacts
- No debris created by coil contacts

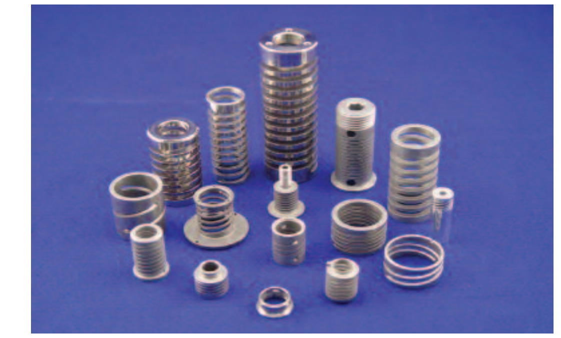
Without one or more of these benefits being present, there is usually little justification of pursuing the machined spring approach.



Custom attachments

Wire wound springs are somewhat limited in the possible attachments. Compression springs can be clipped end or natural, closed, or closed and ground. While the latter is a little more expensive, this is the most common because it provides the most perpendicular surface to the spring centreline. Extension springs can feature hooks or loops. While wire springs are limited to the use of wire form attachments, time has shown that creativity in the use of the wire has provided numerous, cost effective attachment solutions.

The options for machined springs are much greater. Indeed, they can posses any feature that can be machined. For compression springs, since the spring is fully machined, the ends, if selected to be flat, can be very perpendicular to the longitudinal axis of the spring. When machined springs are configured as extension springs,



machined studs, threaded holes, flanges and many other features are available. For torsion springs, if a tang similar to wire spring usage is desired, it can be accomplished in such a way to make the tang very rugged. This choice will eliminate the chance of a failure at the tang root. Tang usage is designed to provide a moment on a torsion spring. To accomplish this, a force at a distance is employed. The spring provides the moment reaction, but there needs to be an additional reaction to the force. Typically, torsion springs using a tang are called upon to rub on a guide on either the OD or ID to resolve this force. In a machined torsion spring, the application of a moment is possible using a pure couple.

Features that facilitate the use of a pure couple include double tangs (external, internal and longitudinal), slots, splines (internal and external) and bolt circle configurations. One can also resolve the moment by an integral torque restraint on the coil side.

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