

THIS ISSUE

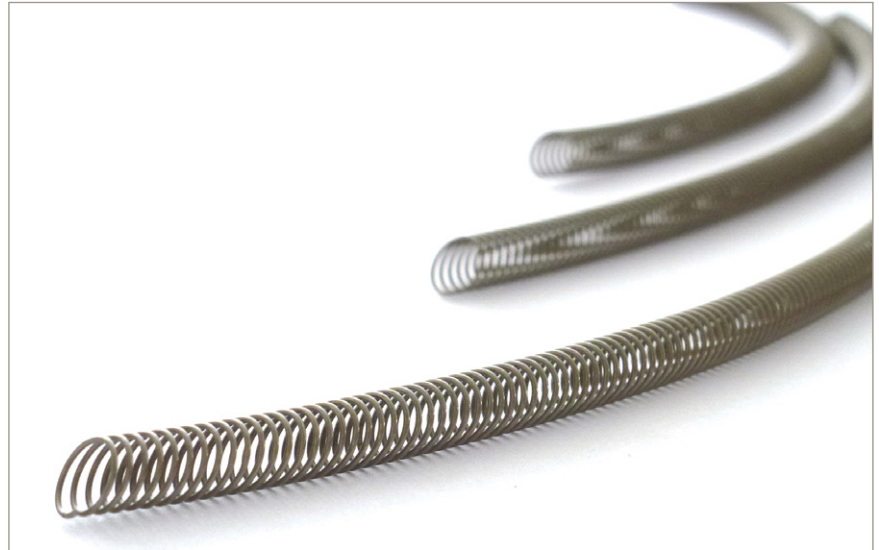
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The Challenge

- Join the ends of a canted coil spring without deforming the wire and changing its geometry.

Solution:

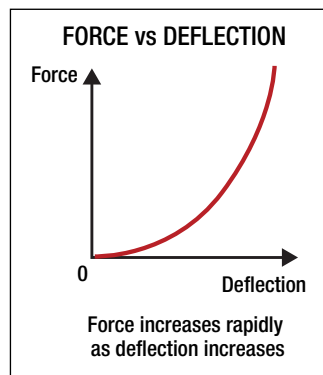
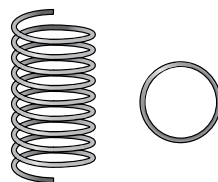
- Use laser welding and a butt-weld set-up to join wire ends flush, while maintaining roundness, a uniform cross-section, and consistent radial force.



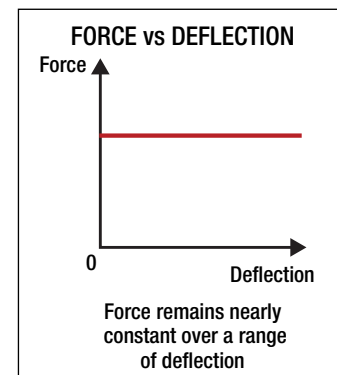
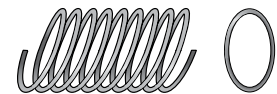
Canted coil springs

WHAT IS A CANTED COIL?

A canted coil spring is a precision spring that features an elliptical (oval) cross section, and coils that are angled relative to its axis. Cut and often welded into rings, these springs are used to create compliant, connecting, conducting, or shielding interfaces across a wide range of applications including medical devices, fuel pumps, battery sensors, and more. Unlike traditional, helical springs that increase in force with compression, canted coil springs maintain a consistent load, which helps reduce wear and improve overall service life and reliability.



Helical spring: Force increases rapidly with compression or deflection.



Canted coil spring: Progressively changes its shape and contact angle as it is deflected while maintaining constant force.

TYPICAL COIL PROPERTIES

When specifying a canted coil spring, several key design parameters must be considered. Two of the most important are **wire diameter** and **material selection**, as these characteristics directly influence spring force, durability, conductivity, and environmental resistance. Wire diameters range from as small as 0.0006 in. (0.016 mm) up to 0.125 in. (3.175 mm)*. Commonly used materials include 302 and 316 stainless steel, Elgiloy®, Inconel®, and beryllium copper. These alloys are selected for their corrosion resistance and ability to withstand high loads, although they can be susceptible to brittleness and surface defects that may contribute to failure over time. To enhance electrical performance and corrosion resistance, springs are often plated with gold, silver, nickel, or tin.

Coil diameter is another important characteristic and can vary considerably depending on the application. Coil diameters as small as 0.007 in (0.18 mm) may be made for medical and electronic devices, up to several inches. Additionally, when the coil is formed into a welded ring, the **overall spring diameter** can range from as small as 0.039 in (1 mm) used in medical and electronic devices up to 48 in (1219.2 mm)* for large industrial or aerospace applications.

The **cant angle** - the angle of each coil relative to the spring axis - is another defining property. This geometry influences the spring's load-deflection characteristics, contact forces, and overall performance, enabling canted coil springs to provide a unique combination of flexibility, force control, and electrical conductivity.



AMADA SH-3A Single Point Coiling Machine

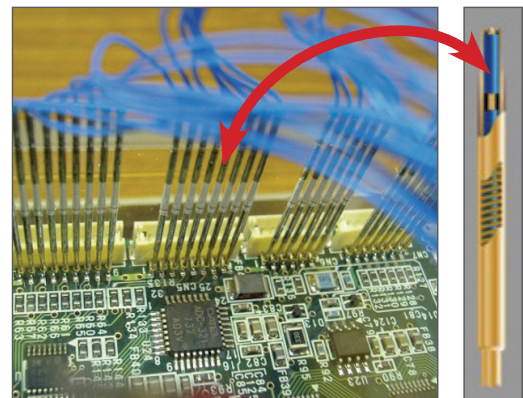
HOW ARE CANTED COILS USED?

Canted coil springs are used to:

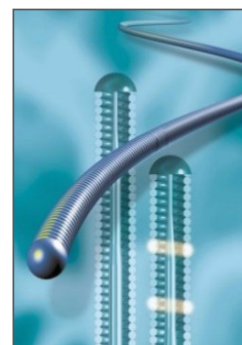
- Provide mechanical retention, latching, and locking
- Conduct electrical current in high shock and vibration environments
- Deliver EMI/RFI shielding
- Center and align mating components
- Facilitate thermal management and heat dissipation

As a mechanical component, a canted coil spring provides secure latching, locking, and retention with precisely controlled insertion and removal forces ranging from less than 1 lb to more than 10,000 lb (0.45 kg - 4536 kg). Its unique geometry distributes load evenly around the circumference, resulting in smooth engagement, predictable performance, and exceptional resistance to fatigue, wear, and compression set. These characteristics make canted coils ideal for quick-disconnect couplings, surgical instrument attachments, aerospace access panels, fuel line connectors, and other applications requiring reliable, repeatable retention over thousands of cycles.

As an electrical component, a canted coil spring serves as a conductive interface that maintains consistent, low-resistance



Contact probe (used for continuity inspection of semiconductor substrates)



Canted coil guide wire



Sample coil in tooling

*Wire and spring diameters shown represent industry-available sizes and are not intended to define the manufacturing limits of AMADA equipment.

contact between mating parts. The individual coils create multiple contact points that accommodate surface irregularities, misalignment, vibration, and thermal expansion while carrying substantial current in a compact space. This combination of high power density, consistent contact force, and long service life makes canted coils well suited for electrical connectors, battery interconnects, grounding systems, and EMI/RFI shielding applications. A common example is an RF or electronic enclosure, where a canted coil installed around the perimeter creates a continuous conductive path that preserves shielding effectiveness even under repeated cycling and harsh operating conditions.

WELDING CANTED COILS: KEY CHALLENGES IN PRODUCTION

Although canted coil springs are sometimes supplied as open-ended lengths, the majority are produced as welded rings. Joining the wire ends creates a continuous spring that provides uniform force and reliable performance around the entire circumference. As a result, the quality of the weld plays a critical role in the spring's overall function and durability. Welding the spring to produce the canted coil, however, presents several challenges because of its unique geometry and demanding performance requirements. Key challenges include:

Maintaining spring geometry:

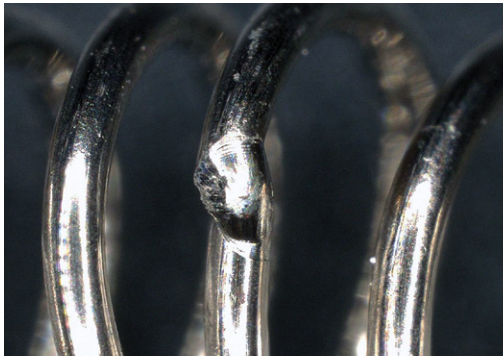
- The uniform force of the welded coil depends on consistent angle and pitch; maintaining alignment and roundness is critical.
- Wire ends must align precisely—misalignment creates steps or offsets that cause uneven compression.
- The heat generated during welding can cause shrinkage and distortion, affecting ring diameter, fit, and sealing force.
- Welding may create a “hard spot” that doesn’t deflect like the rest of the spring. This local stiffness can produce uneven force and sealing pressure at the weld location.

Controlling the heat-affected zone (HAZ):

- Excess heat during welding can create microcracks.
- Overheating may change spring temper, reducing fatigue life and altering elastic properties. Because canted coils operate under repeated compression cycles, even very small temper changes can negatively impact performance.

END JOINING STRATEGIES

Canted coils are typically joined using an end-to-end weld configuration which joins the wire ends flush helping to maintain roundness, a uniform cross-section, and consistent radial force. A side by side weld configuration, where one wire end slightly overlaps the other, may be used when a slight increase in joint thickness is acceptable, such as in some sealing or retention rings.



End to end weld of canted coil wire. Requires excellent cut quality/finish on coil.



Side by side weld of canted coil wire.

While both laser and resistance welding can be used, laser welding is generally preferred because it is a non-contact process that offers precise energy control, a small heat-affected zone, and smooth, low-profile joints that help preserve spring performance and electrical contact. Achieving consistent results depends on high-quality end preparation—cut quality is critical—and precise tooling to maintain alignment and position during welding. The use of argon shielding gas is recommended to protect the weld and improve consistency.

Resistance welding requires applied force that can deform the wire and typically uses overlap geometry, creating a thicker, stiffer “hard spot.” It may be suitable in select cases—such as larger wire diameters or non-sealing applications with post-processing—but is more limited in maintaining optimal spring characteristics.

Summary:

Producing canted coils requires precise control of joint quality to preserve spring function. At the weld, alignment is critical to maintain the coil angle and avoid steps or offsets that can disrupt fit, force and/or electrical performance. Many spring alloys are prone to brittleness, making them sensitive to surface defects and cracking. As designs shrink, precise fixturing and alignment are essential for repeatability. Surface condition also matters, as burrs or oxides can degrade the weld and increase contact resistance. Even with laser welding, careful heat control is required to prevent distortion, temper loss, or weakened joints. AMADA provides both the coiling machines and the welding machines. A one-stop shop for manufacturing canted coils.