HELI-CAL NEWS

NUMBER 8

# What is a *MACHINED SPRING*?

**Much more than "just" an alternative to traditional springs, the amazing HELI-CAL® Flexure, machined and utilized as a spring, u-joint or coupling, can achieve multiple design objectives and provide precise functions, features and performance.**

**By Gary L. Boehm**
**Senior Research Engineer**
**Helical Products Company, Inc.**

*Gary Boehm is considered by many to be one of industry's foremost authorities on the technological aspects of machined springs, having spent over 23 years in machined spring R&D. Following are questions frequently asked of Gary regarding machined springs, and his answers.*

Q: What is a machined spring?

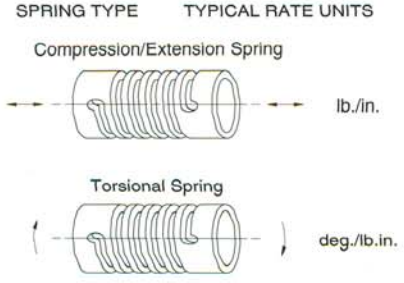
A: A Helical machined spring is a single piece of material machined into a spring configuration. Key to the versatility of the machined spring is the HELI-CAL Flexure, a flexible helix beam concept utilized in the manufacture of Helical machined springs. Because Helical springs are "machined" to specific design requirements, they provide more precise performance, features and functions than can other more traditional types of springs.

Q: Can I get a listing of "standard or stock" machined springs from which to choose a spring?

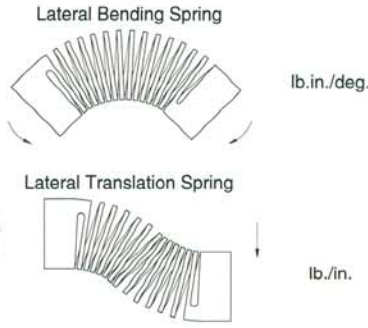
A: All machined springs are designed and manufactured for a specific application and purpose. There are no "stock" machined springs because each application is an individually engineered solution.

Q: What are the "basic elastic modes" applicable to machined springs?

A: Machined springs can be configured as: compression, extension, torsion, lateral translation and lateral bending springs.




**Just a few examples of the versatility and configuration variety available with Helical machined springs.**




Q: What are some of the advantages of machined springs over conventional springs?

A: With machined springs, desired features or functions can be made part of the spring, such as: special attachments, precise spring rates, multiple integral coils, and other special characteristics. These aspects are generally not possible with traditional springs.

Machined springs also support multiple design objectives such as reliability, repeatability, and integration of multiple parts, which results in a reduction of assembly complexity.

Q: How are machined springs different?

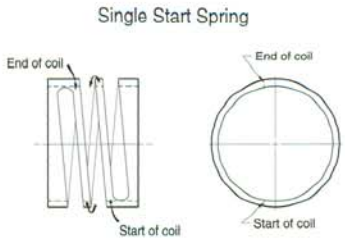
A: Machined springs also can be manufactured from a variety of materials such as high strength steel, stainless steel, aluminum, titanium, and machinable plastics.

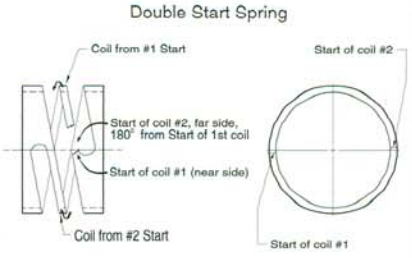
The ends of machined springs can be made very square, a beneficial feature for compression springs. Attachments for torsional springs can be integrated so that no forces act upon the spring, just the moment enabling torsional deflections. Extension (tension) springs can include robust attachments, that are resistant to breakage.

Machined springs can provide very precise, linear deflection rates because virtually all residual stresses are eliminated. As a result, there are no internal stresses to overcome before deflection occurs.

Q: Explain the terms "single start" and "multiple starts."

A: A single start spring is a single continuous coil element which starts at one end and terminates at the other end. This configuration is common to most springs. A "double start" spring has two intertwined continuous coil elements. In effect, this puts two independent helixes in the same cylindrical plane. Multiple start flexures, such as triple start etc., are similar extensions of the concept.

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Q: What are some of the benefits of multiple start flexures?

A: Multiple start flexures are beneficial because they not only provide redundant elastic elements should a failure occur, but a failed element (coil) will be physically trapped by the remaining one(s).

Another multi-start benefit applies to compression and tension springs. When compressed (or extended), single start springs provide a reaction force plus a moment. This moment is created because the line of action is through the longitudinal centerline of the spring, and the spring force is acting at the coil mean centerline. The distance between these centerlines provides the moment arm of the subject moment. On multiple start flexures, all internal moments are resolved within the spring. The big benefit is that these multiple start springs then compress (or extend) in a very straight manner. There is no tendency for the spring to squirm when deflected, and no restraint is necessary to resolve the free moment.

Sometimes there is a desire to have multiple elastic rates in a given spring. For instance, a compression, torsion and lateral bending rate may be specified. With most types of springs, accomplishing one of these rates can be a challenge, but three is impossible. Not so with multiple start Helical machined springs. A machined spring designer can choose coil size, number of coils and multiple start coil features to achieve specified, different, elastic rates.

Q: I understand that machined springs can be designed so that the coils don't touch. Does this mean that no sound would be generated by the spring?

A: Exactly. In those applications where resonance is desired for high efficiencies, the best choice is a machined spring of a multiple start configuration. In fact, machined springs may be the only choice under these circumstances. The linear rate and non-contact feature of the machined spring provide outstanding performance. The multiple start aspect prevents lateral bending and lateral translations from compromising in-line motions.

Q: How can I find out more about machined springs?

A: Helical Products Company, Inc. provides engineering assistance for anyone interested in machined spring applications.

Helical Products Company, Inc. is using its HELI-CAL Flexure technology to produce high performance, machined springs in a way that takes much of the guesswork and trial and error out of the design and manufacturing processes. Performance of machined springs has proven to be predictable, repeatable, and very reliable. □

If you would like to discuss possible spring applications with our engineers, we invite you to e-mail us at: Spring_Engineer@Heli-Cal.com or call, fax, or write:

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# FANTASTIC "FLEXURE FACTS"

**The versatility of the HELI-CAL Flexure is the "secret ingredient" in each design engineering application. You'll see how the flexibility of the HELI-CAL Flexure means unprecedented design opportunities for you.**

## SOLVED APPLICATION STORY 34

**CHALLENGE:** On the common twin engine turbo-prop commuter aircraft, a fuel control system utilizing a ground end wire wound spring was used. The spring and surrounding assembly required servicing after 50 hours of usage. The airline industry demanded an assembly with a longer service life.

**SOLUTION:** The alternative design developed by Helical's Application Group basically was the same envelope (OD/Length). The ID was a little smaller and some integrated attachments were added. It was found that the existing wound spring had its first mode frequency excited at normal engine running speeds, this action was a side to side motion. When excited at this mode, the spring would swing back and forth and wear out a diaphragm surrounding the spring. After extensive analysis at Helical, an alternative was found that exhibited its first mode excitation frequencies outside normal engine speeds. With this configuration, service intervals have been extended by 10 times and tests suggest that 100 times may be possible. This explains why the customer was willing to purchase a machined spring over a wire wound spring even with a price increase exceeding four times.

**ANSWER:** HELI-CAL Flexure "Machined" Spring # 2345.

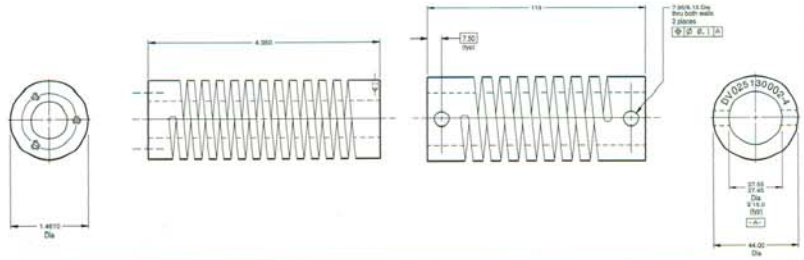
## SOLVED APPLICATION STORY 40

**CHALLENGE:** This application was for a constant force compression spring to connect two pipeline "PIGS" together. (A pipeline pig is a machine that enters into the actual pipeline from an offshore oil rig supplying oil or gas to the mainland.) The "pig" records data, such as the condition and reliability of the pipe wall, as it moves along with the flow of oil or gas.

Originally, a traditional wire wound spring was used, but the long term compression forces caused performance deterioration. Readings from the PIGS were becoming more and more unreliable as pulsing shock-waves in the pipeline hit the PIGS along their journey. The spring also needed guaranteed flat end surfaces and the piano wire material was corroding in the hostile atmosphere. Reliability was poor.

**SOLUTION:** The customer gave us the overall dimensions, we could then guarantee a fixed outside/inside diameter, length, an exact compression spring rate and flat end surfaces. All of these features could be supplied in a material that gave much better resistance to the corrosive atmosphere. The HELI-CAL Flexure also enabled far tighter manufacturing tolerances to be put into the design. "PIG" reading accuracy increased by 50%.

**ANSWER:** HELI-CAL Flexure "Machined" Spring # 2261X1.



"No Spring More Versatile"

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