ALL ABOUT SPRINGS

Comprehensive Guide to the History, Use and Manufacture of Coiled Springs

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What Are Springs?

As simple as they may seem, springs play a vital role in modern life. You can find springs just about everywhere, including in nature. A wide range of everyday items depend on springs to function: retractable pens, shock absorbers, clocks, keyboards, window blinds, mattresses (and box springs, of course), door knobs, HVAC systems, trampolines, garage doors, and just about anything with a push button.

In its most basic form, a spring is an elastic object, meaning that when someone, or something, pulls or pushes or hammers or otherwise manipulates it, it returns back to its original shape. Beyond that springs can take on many forms, and perform just as many roles in manufacturing, automotive design, electronics and consumer goods.

In this guidebook, we explore different types of coiled springs, along with their history, uses and manufacturing techniques.

Key Terms

Rate: rate is a measurement of the stiffness of a spring, or the force required to either compress or extend it.

Pitch: pitch is a measurement of the space between each coil of the spring.

Diameter: diameter is the linear width of a coil's cross section.

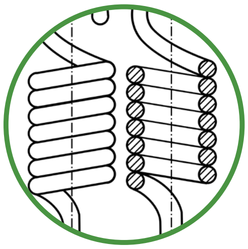
Wire Diameter: wire diameter measures the thickness of wire (or other material) used to coil the spring.

Index: index is the ratio of a spring's average diameter to its wire diameter.

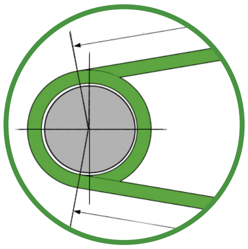
Free Length: free length, or resting length, is the length of a spring at rest.

Types of Coiled Springs

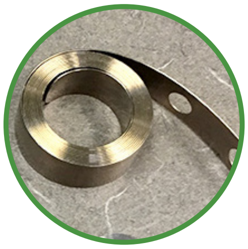
Compression Springs: Designed to exert a force in the opposite direction when compressed, compression springs are longest when at their free length. This is the most common type of helically wound spring; compression springs are present in thousands of products from shock absorbers to ballpoint pens.



Extension Springs: Designed to exert a force in the opposite direction when extended, extension springs are shortest when at their free length. They are often close wound, meaning that their coils are touching when the spring is at rest.

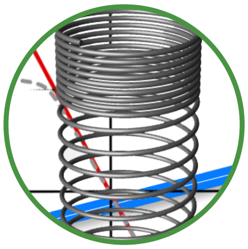


Torsion Springs: While also helically wound, torsion springs exert force in directions perpendicular to their cross-sectional axis. A common example is the spring inside a clothespin, which exerts rotational force to keep the pin closed.



Constant Force Springs: Functioning through a different paradigm of physics, constant force springs are wound but not helical. They are able to exert near-constant force when either coiled or uncoiled, and are often used to facilitate linear motion in heavy equipment.

Variable Diameter Springs: Conical springs, hourglass springs and barrel springs are all types of variable diameter springs, or springs that don't have a constantly sized cross section. These springs can have a number of advantages, from lower stacking height to greater stability.



Variable Pitch Springs: Any spring that doesn't have constant spacing between its coils is considered a variable pitch spring. These springs are designed to perform with specific force profiles, with closer-spaced coils exerting less force when deformed than farther-spaced coils. Variable pitch and variable diameter are often used together to closely control spring rate and overall performance.

How Springs Work

Set a **compression spring** next to a **leaf spring** and you'll see two very different objects. Springs come in a wide variety of shapes and sizes, but no matter how they look, they all work the same way. Every spring is an elastic object, meaning that it stores and releases energy. Spring design, and spring manufacturing, depends on a keen understanding of the physics of springs.

The spring manufacturing process, and spring manufacturing equipment, is a bit more complicated, but springs themselves are simple mechanisms that behave very predictably. By understanding the physics of springs, manufacturers can predict exactly how a spring will act in the real world before starting up the coiling machine.

Hooke's Law: The Physics of Springs


Robert Hooke, author of Hooke's Law

Beyond storing and releasing energy, another important aspect of the physics of springs is Hooke's Law. **Hooke's Law** states that the more you deform a spring, the more force it will take to deform it further. Using the example of a common compression spring, the more you compress the spring, the more force it will take to compress it further.

British Physicist Robert Hooke first published the law in 1678, though he claimed to have known about it for nearly two decades. The law was simply stated in Latin, ut tensio, sic vis, which roughly translates to "as the extension, so the force." The more modern, algebraic representation of the law is **F=kX**, where **F** is force, **k** is the **spring constant**, and **X** is the length of deformation.

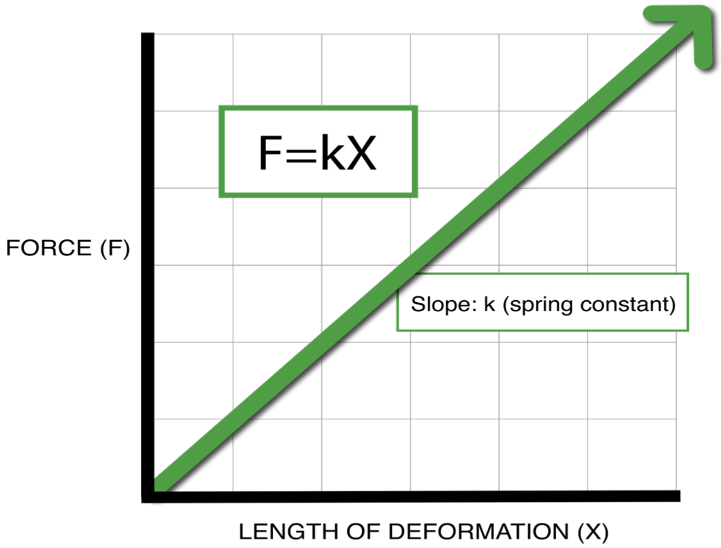
If you look at a graph of the equation, you'll see a straight, diagonal line, or a **linear force diagram**. Because of this trait, springs that obey Hooke's law fall into the category of "linear force" or "constant rate" springs.

The Spring Constant

The **spring constant** determines exactly how much force will be required to deform a spring. The standard international (SI) unit of measurement for spring constants is Newtons/meter, but in North America spring constants are often measured in pounds/inch. A higher spring constant means a stiffer spring, and vice-versa. The spring constant can be determined based on four parameters:

- **Wire diameter**
- **Coil diameter**
- **Free length**
- **Number of active coils**

The **material** making up the spring also plays a role in determining the spring constant, along with other physical properties of the spring.



Exceptions to Hooke's Law

In the world of springs, there are several exceptions to Hooke's Law. For example, an extension spring that's extended too far will cease to conform to the law. The length at which an otherwise standard spring stops following Hooke's law is called its **elastic limit**.

Variable diameter springs (like conical, convex or concave springs) can be coiled to conform to a variety of force profiles. If its pitch is constant, a conical spring's force will vary non-linearly, meaning that it will not follow Hooke's Law. However, pitch can also be varied to produce conical springs that do obey the law.

Variable pitch springs are a third example of a spring type that does not obey Hooke's Law. Variable pitch springs are often compression springs with constant coil diameters, but varying pitch.

Constant force springs, in relation to Hooke's Law, are often false exceptions. From their title and description, you would expect constant force springs not to follow Hooke's Law. After all, if the force they exert is constant, then the force isn't changing with the length of the spring. However, the material making up the constant force spring actually does conform to Hooke's Law. The difference is that the elastic portion of a constant force spring is only the part that is changing from coiled to straight. As the spring is pushed in or pulled out and the diameter of the coil changes, the force exerted also changes. This change, however, is often imperceptible because changes to the diameter of the coil are so small.

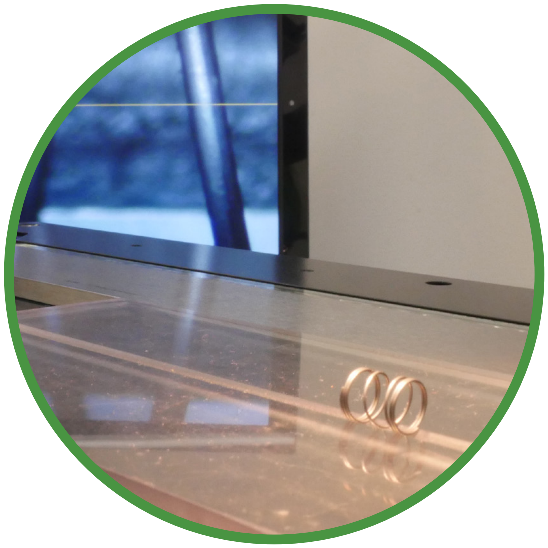
Using advanced **AIM CNC spring coiling equipment**, constant force springs can be designed so that the spring force can be kept constant or even be made to exhibit a negative gradient as the spring is extended. Negative gradients on the order of 35% have been accomplished.

The Importance of Spring Physics for Spring Design and Manufacturing

When manufacturers produce springs, they need to know how the spring will behave. It's obvious that the same spring used for a shock absorber wouldn't work in a ball-point pen, but for many mechanical applications, minute differences in spring behavior will determine whether the system functions or not.

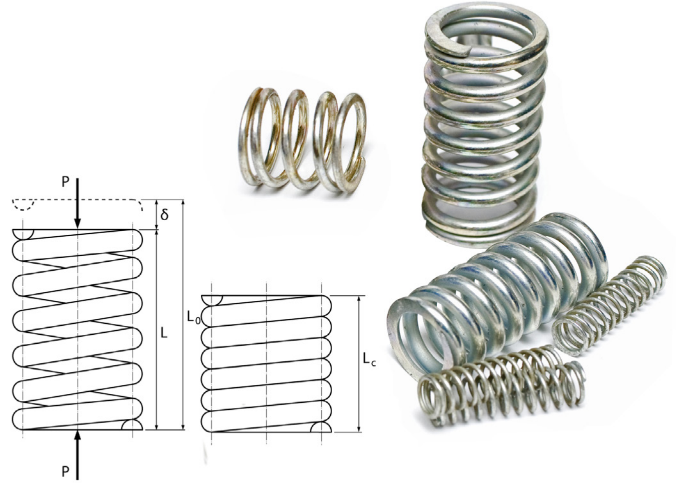
For example, springs are often used to enlarge blood vessels in medical applications. If the spring constant is too high, or the wire too thin, the spring could cause a life-threatening rupture. On a larger scale, automobile suspension systems rely on extremely precise springs to provide shock absorption without destabilizing the vehicle at high speeds.

All spring design characteristics play a role in determining the useful applications for any given spring. When a manufacturer dials in the settings on their spring coiling machines, they aren't just guessing. By understanding the physics of springs, manufacturers can ensure that they coil the right spring for the job.



Compression Springs

When you think of what a spring looks like, you're probably imagining a compression spring. These simple coiled springs come in the shape of open-wound helixes, but beyond that they can be conical, elliptical, circular or even rectangular in cross section (magazine springs, for example). Appropriately, compression is the main function of compression springs. When compressed, they exert force in the opposite direction as they try to return to their free lengths.



Compression springs officially date back to 1763, when British inventor R. Tradwell filed the first patent for a coiled spring. Replacing the leaf spring in an automotive suspension system, Tradwell's first spring was a compression spring.

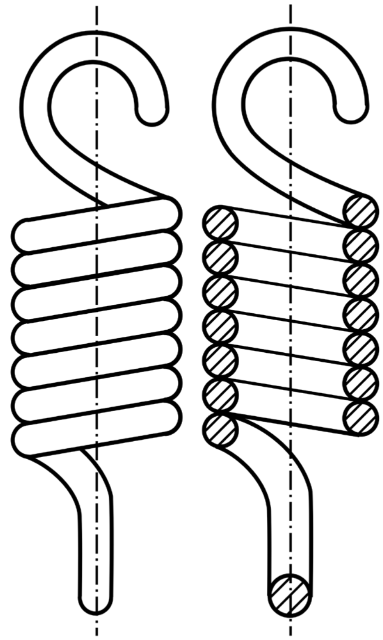
Today, compression springs are just about everywhere, and there are a wide variety of sub-types:

- **Conical compression springs (also known as tapered springs)** are used in applications where the fully compressed height of the spring needs to be minimized. Real-world uses for conical springs are everywhere, but you'll most often find springs of this shape in buttons and electrical contacts. Look inside the battery compartment of your remote control for an example.

- **Convex (barrel) or concave (hourglass)** springs provide additional stability for springs of increased length, and are often used in applications like automotive shock absorbers, mattresses, and mechanical equipment.

- **Magazine springs**, with an elliptical or rectangular cross section, are generally used in firearm magazines to push bullets toward the firing chamber. Their shape allows them to fit snugly into the rectangular magazines of most firearms. Surprisingly, magazine springs have another common use: when woven together, they create the basis for durable, flexible steel conveyor belts used in many industries.

Extension Springs



If you want to see a prime example of an extension spring, take a look at a trampoline. All around the parameter, attaching the canvas to the frame, are extension springs. When someone jumps on the trampoline, they extend the springs. When the springs do what springs do and return back to their original shape, they collectively pull the canvas upwards, bringing the trampolinist with them.

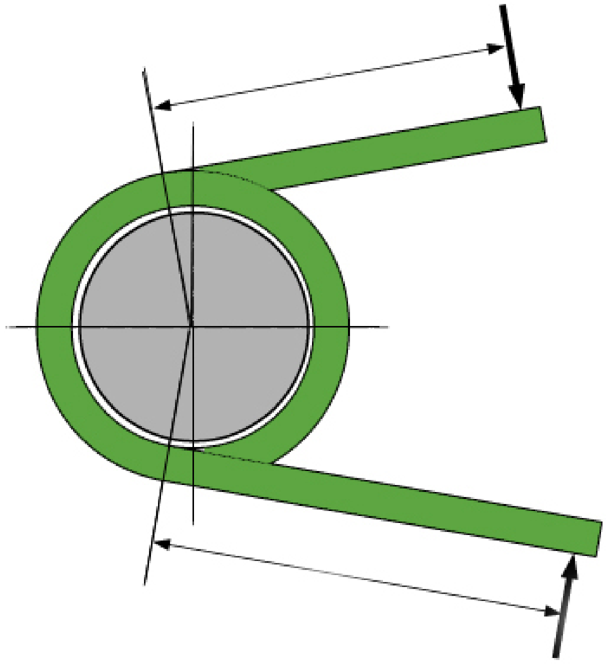
Like compression springs, extension springs usually come in helical coils. The main differences are the closeness of the coils, and the ends.

- **First, extension springs are usually close wound,** meaning that their spring pitch is equal to the wire diameter. In other words, their coils touch one another when they're in a resting state.

- **Next, both ends of extension springs almost always attach to something else.** Manufacturers bend the wire to create loops or hooks at both ends of each extension spring. In the trampoline, one loop attaches to the frame and the other attaches to the canvas.

Beyond trampolines, you'll find extension springs in a wide variety of manufactured products. You'll find them in screen doors that automatically close. They're also used as **garage door springs** to govern the up and down motion of the overhead doors. If you take apart your washing machine, you'll find extension springs that help balance the spinning apparatus. The list goes on: extension springs are widely used in automobiles, farm equipment, toys, electronics and a whole lot more.

Torsion Springs



Like compression springs and extension springs, you'll find torsion springs in a wide range of everyday products. Perhaps the most common example of a torsion spring in action is a clothespin. In a standard clothespin, the spring holding the two wooden clamps together is a torsion spring. The spring allows clothespins to clamp tightly on drying socks, chip bags or whatever other applications you might find for them.

You'll also find torsion springs in ATV suspension systems, clipboards, hinges and ratchet tools–and the list doesn't end there. Torsion springs work in a different way than compression and extension springs, but they're still one of the world's most common springs.

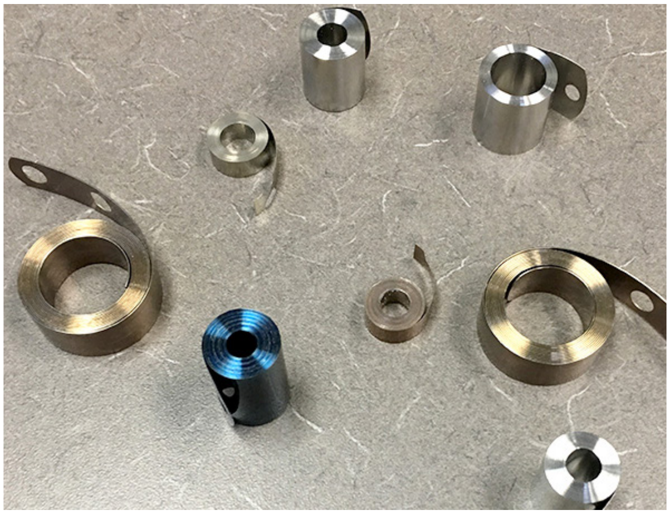
How Torsion Springs Work

Like extension springs, torsion springs are often close wound so that each coil touches the next. Their ends are also configured in different ways. Torsion springs must attach to other parts at both ends in order to work. When forces act on the spring ends, they tighten the coils of the torsion spring. As the spring returns to its resting coil diameter, it brings the attached parts with it.

To hold them in place, torsion springs are often placed on a mandrel, a small rod or peg, that fits inside the coils. The fixture must be snug enough to avoid excessive play, but loose enough to allow uninhibited motion. Alternatively, the spring can be placed in a blind hole to keep it in place. In other cases, as in the clothespin example, the spring ends are configured in such a way that they connect the spring securely to its adjacent parts.

Depending on the application, torsion springs can be left hand, right hand or double. The latter configuration is like two springs (left and and right hand) coiled from the same wire.

Constant Force Springs



Constant force springs don't have much in common, either in form or function, with standard helically wound springs. For starters, constant force springs are formed from pre-tensioned metal strips rather than wire.

At their most basic level, however, constant force springs do exactly what other springs do. That is, they conform to Hooke's Law. As described in the How Springs Work chapter, Hooke's Law essentially states that when an elastic object is deformed, the force it exerts is directly proportional to the amount of the deformation. In other words, the farther you extend an extension spring, the more force it takes to pull it even farther; the more you compress a compression spring, the more force it takes to push it down even more.

In theory, a "constant force" spring would not obey Hooke's Law, because the law mandates increasing force rather than constant force. In reality, the materials making up constant force springs do obey Hooke's Law. However, constant force spring systems are still able to approximate constant force. In order to do so, the diameter of the coil must remain constant, or close to constant.

In standard constant force spring behavior, the user must first overcome the spring's full load by extending the spring beyond 1.25 times its diameter. After that, the coil can be extended further by applying nearly constant force.

Common Uses for Constant Force Springs

Constant force springs' unique qualities make them the perfect counterbalance for heavy moving parts. One example is the door on a moving van. When you pull down an open door, it takes additional force to get the door going the first few inches–that's because the spring's full load (1.25 times its diameter) must be overcome. After that, the door slides up or down easily, with nearly constant force.

In addition to U-Haul doors, constant force springs are used in a wide variety of products. Some of the largest consumers are medical device manufacturers. MRI machines, dental X-ray equipment–and just about anything articulated and heavy–is equipped with constant force springs. Smaller constant force springs for medical devices are also part of syringes and drug infusers.

You'll find plenty of constant force springs in everyday products as well: retractable key holders, retractable dog leashes, vacuum cleaner cord reels, seatbelts, window balance systems, interior blinds and point-of-purchase displays, to name a few.

Variable Diameter Springs

Variable diameter springs are springs that do not have a constant cross-sectional diameter. Many springs actually are exceptions to Hooke's Law. Variable diameter springs are one category of springs that often don't follow the formula, F=kX. This in itself can be advantageous to manufacturers in certain cases, but a number of other properties make variable diameter springs necessary for a range of products. Their potential advantages include:

- Adjustability of force required to compress the spring
- Increase in travel because one coil can fit into the other
- Decrease in "solid height," or height of the spring at full compression
- Greater lateral stability for longer springs

Variable diameter springs include **conical springs**, **hourglass springs** and **barrel springs**. Conical springs are wider at one end than the other, and are also known as tapered springs. Hourglass springs, or concave springs, are wider at both ends and narrower in the middle. Barrel springs, or convex springs, are wider in the middle and narrower on both ends.

Uses of Variable Diameter Springs

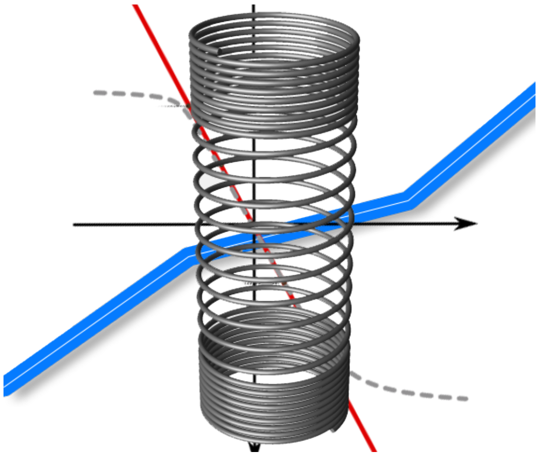
Battery compartments: Open your remote control and you'll most likely find a number of battery compartments with coiled springs at one end. Conical springs are often used in small spaces like this, because they can compress down to the height of their wire diameter.

Firearm Triggering Mechanisms: Because of their ability to modulate force and avoid buckling, conical and barrel springs can offer more precise control over triggering mechanisms.

High-End Mattresses: Mattresses advertising "pocket coils" often utilize individually wrapped barrel springs to provide support to sleepers. Other mattresses utilize hourglass springs, which are intended to flex laterally to provide support from any angle.

Automotive Suspension: Barrel springs, hourglass springs and conical springs are often used in automotive suspension systems, both because of their ability to compress without buckling and increase travel through coil telescoping.

Variable Pitch Springs



Variable pitch springs are springs that do not have constant coil spacing. If coil diameter and wire diameter are both constant, springs with higher pitch (more distance between adjacent coils) require more force to deflect. In variable pitch springs, the lower-pitch coils deflect first, requiring less force. As applied force increases, coils with higher pitch begin to deflect and the observed spring rate also increases.

Advantages of Variable Pitch Springs

Manufacturers find a number of advantages in the ability to vary spring pitch. For example, conical springs (and other types of variable diameter springs) can be made to deflect at a linear rate. Variable pitch can also be used to prevent coils from fully closing in “soft” springs, or springs with a low spring rate. Both extension and compression springs can sometimes benefit from the inclusion of several rows of closed coils, which still allows flexibility but prevents tangling.

A more technical advantage is the prevention of **spring surge**. Spring surge occurs when a spring’s natural frequency corresponds to the frequency of applied force, causing the spring to oscillate back and forth (similar to the way a slinky moves when held on both ends). Spring surge shortens the life of springs, and in some cases can cause immediate failure. By varying the spring pitch, manufacturers can prevent spring surge in high-frequency applications like valves and automatic weapons.

Uses for Variable Pitch Springs

High-Performance Vehicle Suspension: In high-performance automobiles, suspension must absorb bumps and dips in the road while keeping the driver in control. Variable pitch springs can offer a soft ride without negatively affecting performance, especially when cornering at high speeds.

Commercial Vehicle Suspension: Commercial vehicles, like delivery trucks and passenger vans, need to provide smooth suspension under a variety of payloads. Variable pitch springs can be designed to offer similar performance under multiple tiers of deflection, corresponding to how empty or full the vehicle is.

High-End Mattresses: Functioning under the same principle, mattress coils also take advantage of variable pitch springs to create a softer, more responsive mattress that still provides a high degree of underlying support.

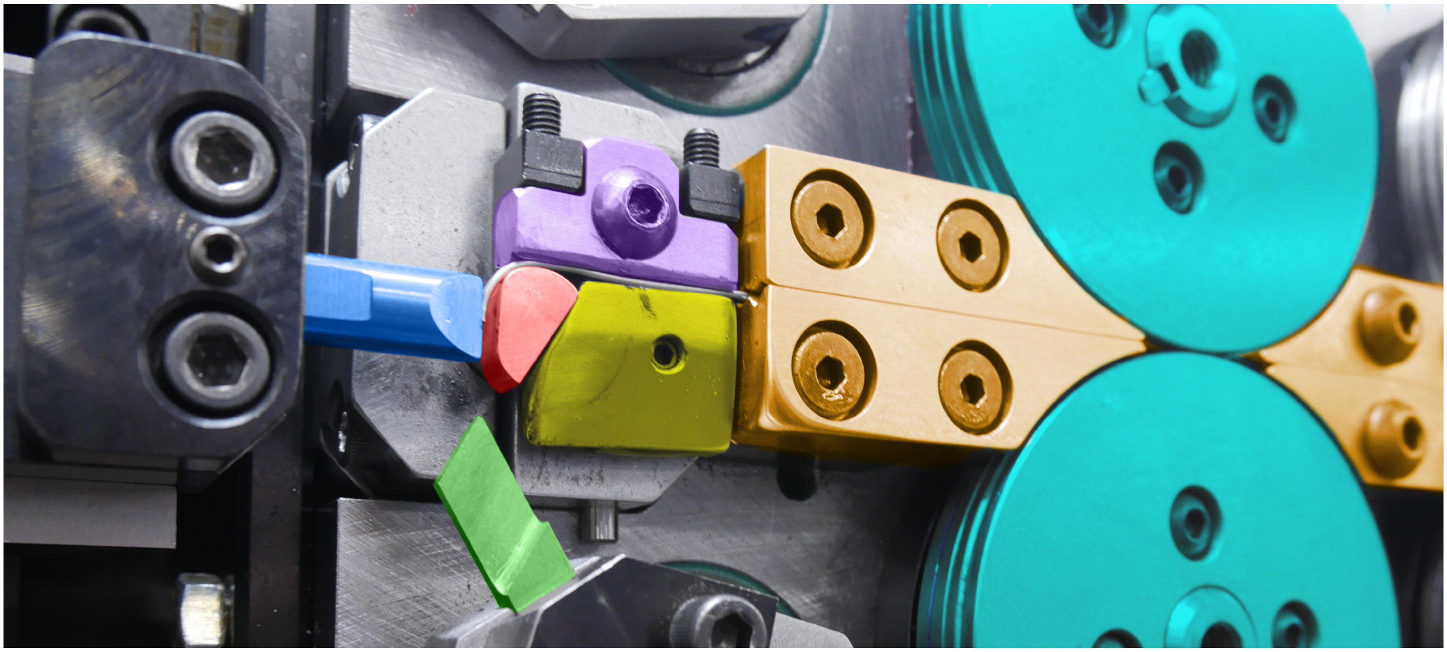
Valves: Because of their ability to minimize spring surge, variable pitch springs are often used in dynamic applications where the spring is rapidly compressed and decompressed at a rate close to the spring’s resonant frequency. Valve springs represent one such application.

How Spring Coilers Work

Spring coilers are necessary equipment for anyone attempting to manufacture springs with any degree of precision. Coiling equipment dates back to the first helically wound springs in the 1800s, but innovations over recent decades have vastly improved the capabilities and flexibility of spring coilers.

Today, spring coiling machines can be configured to produce a wide variety of spring shapes and sizes, but many of their basic components are the same across the board. Interchangeable cassette tooling allows for a high degree of versatility, so a single machine can produce many different springs. Even using the same tooling, operators can adjust spring parameters to a significant degree.

The following spring coiler components comprise the functional characteristics of most single-point spring coilers.



Feed Rollers: These circular components are one of the most prominent features on many spring coiling machines. As they turn, they pull the wire from the reel and into the wire guides. Feed rollers often feature three grooves of different sizes, corresponding to the same grooves in the wire guides.

Feed Guides: Wire guides are flat components containing grooves of varying size that match those on the feed rollers. The groove size doesn't have to match the wire exactly, but it does have to be within a specified range. Wire travels through wire guides before reaching the block guide, the arbor or the coiling point.

Block Guide: As wire exits the wire guides, it meets the block guide. This component ensures that the wire continues on the right path to the coiling point. The groove at the bottom of a block guide must be accurately machined to match the wire's diameter.

Arbor: At the same time that the wire passes through the groove of the block guide, it passes over and around the arbor. In single-point coilers, the arbor represents the third point of contact at the point of coiling. Spring physics demand at least three points to coil wire; dual-point coilers have a third point in the additional coiling point, and so the arbor is not as necessary.

Pitch Tool: By sliding up and down and moving the wire along a sloped surface, the pitch tool precisely controls the pitch of the spring. Like the arbor, this component is also carefully machined to fit each job.

Coiling Point: The coiling point is the component that pushes the wire into a coiled shape by deflecting its trajectory. Setup parameters determine exactly the angle at which the wire is deflected, which in turn determines the spring index, diameter and overall shape of the spring. One notable difference between spring coilers is the number of coiling points.

Cutter: When a coil has reached its desired length, the cutter slices the wire to create a separate spring. Depending on the coiling direction, the cutter may be positioned above or below the arbor.

Beyond the standard components, spring coiling systems often employ additional tools to ensure smooth operation and improve product quality.

Optional spring coiler accessories include:

Power Wire Payoff: Manual wire payoffs (or dereelers) can cause wire tension to vary as it travels from the reel into the spring coiler.

Wire Straightener: These systems straighten the wire before it enters the spring coiler.

Stress Relief Oven: Spring coiling systems can feed directly into a heat treatment oven for stress relief.

Spring Grinder: Often, spring grinders are configured as double-disc grinders, in which a plate holding a number of springs slowly rotates between two spinning discs that grind down the spring ends.

Comparing Dual and Single Point Spring Coilers

Modern CNC spring coiling machines can be divided into single-point or dual-point coilers. Dual-point coilers have two coiling points that make contact with the wire to coil it into the correct shape. Single-point spring coilers function with the same principles, but utilize only one coiling point.

In order to coil wire, all coilers must make contact with the wire in at least three areas. Since they have only one coiling point, single-point coilers require an arbor for coiling. Dual-point coilers only require an arbor for cutoff.

Dual-point spring coiling technology was developed in Europe, while single-point spring coiling technology was developed in North America. With the right setup, quality coiling machines of either type can produce springs with a variety of wire diameters, coil diameters, initial tensions and spring indexes. Beyond that, both single-point and dual-point coilers have different sets of strengths and weaknesses. The best choice for your spring manufacturing operation depends on the types, variety and requirements of the springs you plan to produce.

Advantages of single-point spring coilers

Single-point spring coilers are more versatile in the types of springs they can produce. Extension springs, for example, require higher amounts of initial tension than can usually be achieved with dual-point technology. Straight-leg torsion springs and magazine springs can also be produced on standard single-point coilers, whereas dual-point coilers would require modifications.

Because of the comparative simplicity of the coiling point setup, single-point coilers are more conducive to cassette tooling. Cassette tooling allows operators to easily and quickly change coiler setups by switching out the individual tools (chuck, arbor, coiling point, etc.).

For the same reason that single-point coilers work better with cassette tooling, they can be easier for inexperienced operators to learn. With fewer variables in the setup process, new-employee training time can be reduced overall.

Advantages of dual-point spring coilers

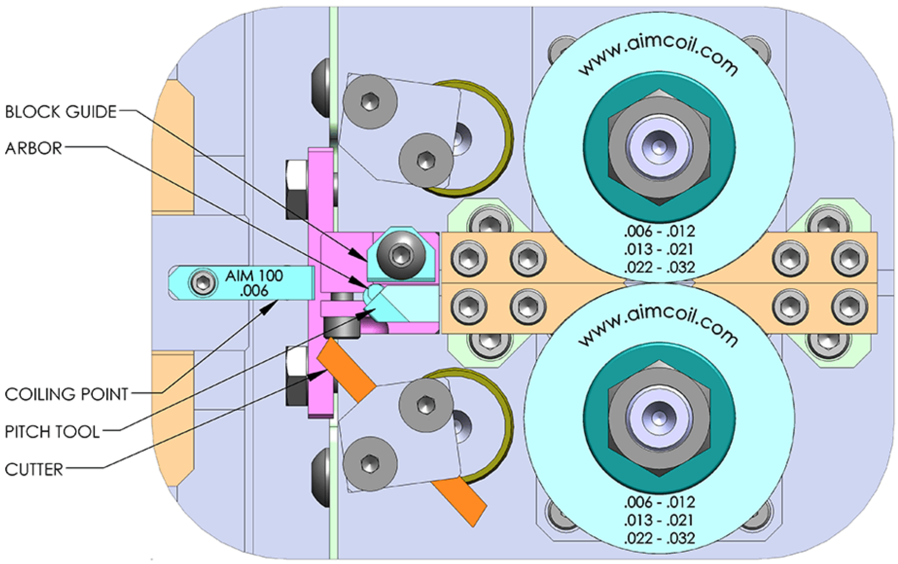
Dual-point spring coilers are well suited to producing straight compression springs. By adding another point of contact, the system can reduce coiling friction. This can result in smoother inner surfaces of coils that may lead to longer-lasting compression springs in extremely high usage scenarios.

While slightly more complex, dual-point spring coilers can also be adjusted with more precision. The second coiling point adds four dimensions of mobility that can affect coil diameter and pitch. The added point of contact can also reduce wear and tear on other tooling in the system.

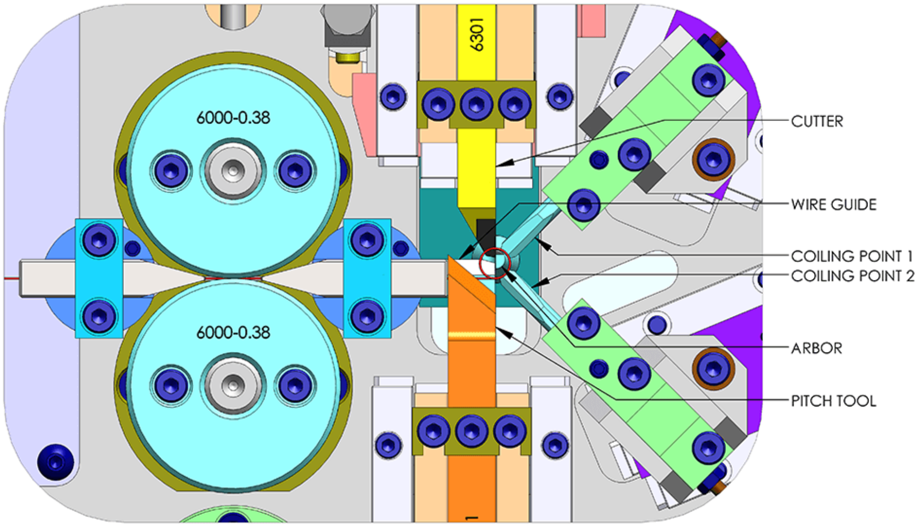
Furthermore, the need for a precisely formed arbor is eliminated by adding the second coiling point to the spring coiling system. In single-point coilers, the arbor is an important tool that must be carefully matched to each job.

Similarities between single and dual-point spring coilers

Despite their differences, single and dual point coilers are both theoretically capable of producing compression springs of the same quality. During the coiling process, the same stresses occur in the material in both coiler types. After springs are coiled, the same residual stresses remain, regardless of coiler type. According to SMI technical consultant Dan Sebastian (pp 20-21), “There is no difference between a single or dual point coiler when it comes to life expectancy of the spring…In the end, there is no substitute for the art and the skill of the setup person.”



SINGLE-POINT SPRING COILER



DUAL-POINT SPRING COILER

Manufacturing Springs

Different types of springs require different equipment capabilities, including tooling and in some cases point configurations (single instead of dual). Most CNC spring coilers can coil springs with a variety of wire diameters, but none can coil any size wire. For example, Automated Industrial Motion offers a line of seven spring coilers that can manufacture springs from wire as thin as .006” in diameter all the way up to wire as thick as .787” in diameter.

Spring designers also need to take different spring characteristics into consideration depending on the type of spring they’re designing. The following sections focus on the specific design requirements for different types of springs.

Compression Springs

For compression springs, the following parameters are key to designing springs that work:

- **Spring diameter:** the size of a circular spring’s cross section
- **Spring index:** a measure of the tightness of the spring coil
- **Spring rate:** a measure of the stiffness of the spring
- **Ends:** different ways to treat the ends of the wire after a spring is formed: closed, plain or ground, for example
- **Wire diameter:** along with material, wire diameter does a lot to determine the spring rate

Programmable spring coilers can be configured to produce compression springs with a wide variety of cross sections. For example, designers can program convex or concave springs with varying cross sections, or even magazine springs with rectangular cross sections. AIM also offers a pneumatic control option for the AIM 100, allowing manufacturers to produce springs on demand. The pneumatic coiler is programmed to produce one type of spring, and to fit seamlessly into an automation workflow.

Extension Springs

To design extension springs, designers must take the following characteristics into consideration:

Spring diameter: the size of a circular spring’s cross section
Free length: the length of the spring when at rest
Maximum extended length: the farthest the spring can be stretched without damaging or overstressing the spring
Ends: the loops or hooks at each end of the spring
Wire diameter: along with material, wire diameter does a lot to determine the behavior of the spring

CNC spring coilers are often capable of producing both compression and extension springs. As mentioned above, the main differences between the two spring types are the spring pitch and the ends. AIM coiling machines utilize looping attachments to improve extension-spring production, allowing each spring's back loop to be formed concurrently with the front end and body of the next spring.

The American standard for spring coiling is to use single-point coiling systems, which are able to create extension springs with higher initial tension rates.

Torsion Springs

In addition to general size and shape, designers of torsion springs must take the following into account:

Spring rate: a measure of the force necessary to act on the spring
Maximum deflection: the farthest a spring can be pushed before damage occurs
Pitch: while most torsion springs are close wound, some are wound with pitch to reduce friction
Ends: the wire forms at the ends of the coil that attach to external parts

In order to produce finished springs, coiling machines must be able to handle a variety of end configurations. The plain ends of a compression spring, for example, would not allow torsion springs to function.

Similar to extension springs, the American standard for spring coiling is to use a single-point coiling system. Single-point coilers are more versatile in terms of the work they can perform. Automated Industrial Motion (AIM) offers a range of CNC spring coilers that are capable of producing torsion springs to nearly any specification.

Constant Force Springs

Even though constant force springs are wound from completely different types of material, they can be manufactured using the same spring coiling machines used for helical springs. The coiler will have to be modified to accommodate the flat strip of metal that makes up the constant force spring.

Once the equipment is calibrated, constant force spring manufacturers have to decide on a number of parameters before beginning production:

Material, width and thickness of strips: these three parameters go a long way in determining the properties of constant force springs, much in the same way that wire material and diameter determine the properties of helical springs
Initial load: the force that must be overcome in order to reach "constant" force
Internal and External Diameter: the diameter inside the coil, which often surrounds a drum, and the diameter outside the coil
End type: The outside ends of constant force springs often attach to another part, which will act directly to coil and uncoil the spring

Variable Diameter Springs

Spring manufacturers using advanced coiling equipment can produce variable diameter springs of nearly limitless complexity, even combining characteristics of conical, hourglass and barrel springs into a single coil. In calculating characteristics like spring rate, spring manufacturers must treat each individual coil as a separate spring.

In addition to compression-spring variables like wire diameter and end treatment, manufacturers of variable diameter springs must also consider:

Spring rate: should the spring approximate linear force, constant force or otherwise variable force?
Spring pitch: should spring pitch be constant, or vary along with the diameter?
Telescoping: does one coil need to fit into the next, and how much clearance is required?
Linear deflection: how much barreling is required to prevent buckling?

CNC spring coilers are highly advantageous in manufacturing variable diameter springs. By keying in the starting diameter, middle diameter and end diameter, the operator can dependably produce thousands of springs with a high degree of precision. AIM's line of CNC spring coilers can be configured to manufacture compression springs with nearly any sequence of diameters.

Variable Pitch Springs

In addition to standard compression-spring variables like wire diameter and end treatment, manufacturers of variable pitch springs must also consider:

Spring rate: should the spring approximate linear force, constant force or otherwise variable force?
Spring diameter: should spring diameter be constant, or is a conical, barreled, or hourglass spring more desirable?
Resonant Frequency: in dynamic applications, at what frequency will the spring be compressed and decompressed?

With robust CNC spring coiling equipment, manufacturers can easily produce variable pitch springs with a wide range of custom parameters. AIM's line of CNC spring coilers can be configured to manufacture compression springs and extension springs with nearly any pitch configuration. CNC controls, like our PC-based controls systems, make it easy to dial in pitch parameters alongside other characteristics like diameter and length. Spring manufacturers may choose to clearly delineate sections of differing pitch, or to produce springs with a planned rate of variation.

AIM CNC Spring Coiling/ Wire Forming Equipment

AIM 100

The AIM 100 CNC spring coiler is our most compact spring coiler, designed for maximum precision and accuracy when coiling small-diameter wire.

Feed Speed (in./sec.): 135
Wire diameter range (in.): .006 - .032
Coil diameter range: 3 index to 1”
Size (in.): 30x24x60

AIM 1000

The AIM 1000 is a versatile and compact CNC spring coiler offering a wide variety of customization options and configurations.

Feed Speed (in./sec.): 100
Wire diameter range (in.): .018 - .080
Coil diameter range: 3 index to 1.75”
Size (in.): 36x28x60

AIM 1500

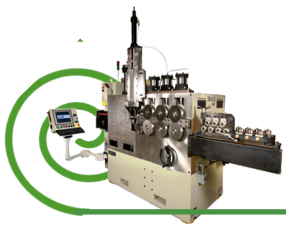
The AIM 1500 is built for medium-duty spring coiling and wire forming jobs, and is the largest of our 240-volt coiling machines.

Feed Speed (in./sec.): 85
Wire diameter range (in.): .032 - .135
Coil diameter range: 3 index to 2.5”
Size (in.): 60x36x72

AIM 2000

The AIM 2000 CNC spring coiler is a popular and well rounded coiling machine, and the most compact of our 480-volt machines.

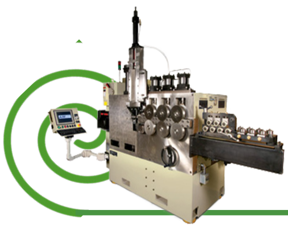
Feed Speed (in./sec.): 85
Wire diameter range (in.): .047 - .180
Coil diameter range: 3 index to 3”
Size (in.): 68x40x72



AIM 2500

The AIM 2500 CNC spring coiler can handle wire nearly twice as thick as the AIM 2000, allowing production of medium/ medium-heavy duty springs.

Feed Speed (in./sec.): 75
Wire diameter range (in.): .080 - .250
Coil diameter range: 3 index to 4”
Size (in.): 84x60x72



AIM 3000

The AIM 3000 CNC spring coiler is designed-for heavy-duty springs and built to last through millions of miles of wire.

Feed Speed (in./sec.): 60
Wire diameter range (in.): .125 - .375
Coil diameter range: 5 index to 5”
Size (in.): 84x60x72

AIM 4000

The AIM 4000 is the most powerful coiler in our lineup, capable of coiling heavy duty springs with speed, accuracy and precision.

Feed Speed (in./sec.): 60
Wire diameter range (in.): .250 - .787
Coil diameter range: 5 index to 7”
Size (in.): 108x96x96

AIM AUTOMATED INDUSTRIAL MOTION

WWW.AIMCOIL.COM

Automated Industrial Motion (AIM) is a world-class leader in the design, manufacture, and service of spring coiling machines and wire forming equipment.

Our primary product line includes seven CNC spring coiling machines that cover a wire range of 0.006″ to 0.787″ diameter. Spring coilers are available with up to six axes to produce a variety of springs and wire forms. AIM equipment is high speed, precise, and durable.

AIM also specializes in turn-key coiling systems and custom-designed wire forming machinery for manufacturers requiring unique spring coiling and wire forming solutions that significantly improve productivity.

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