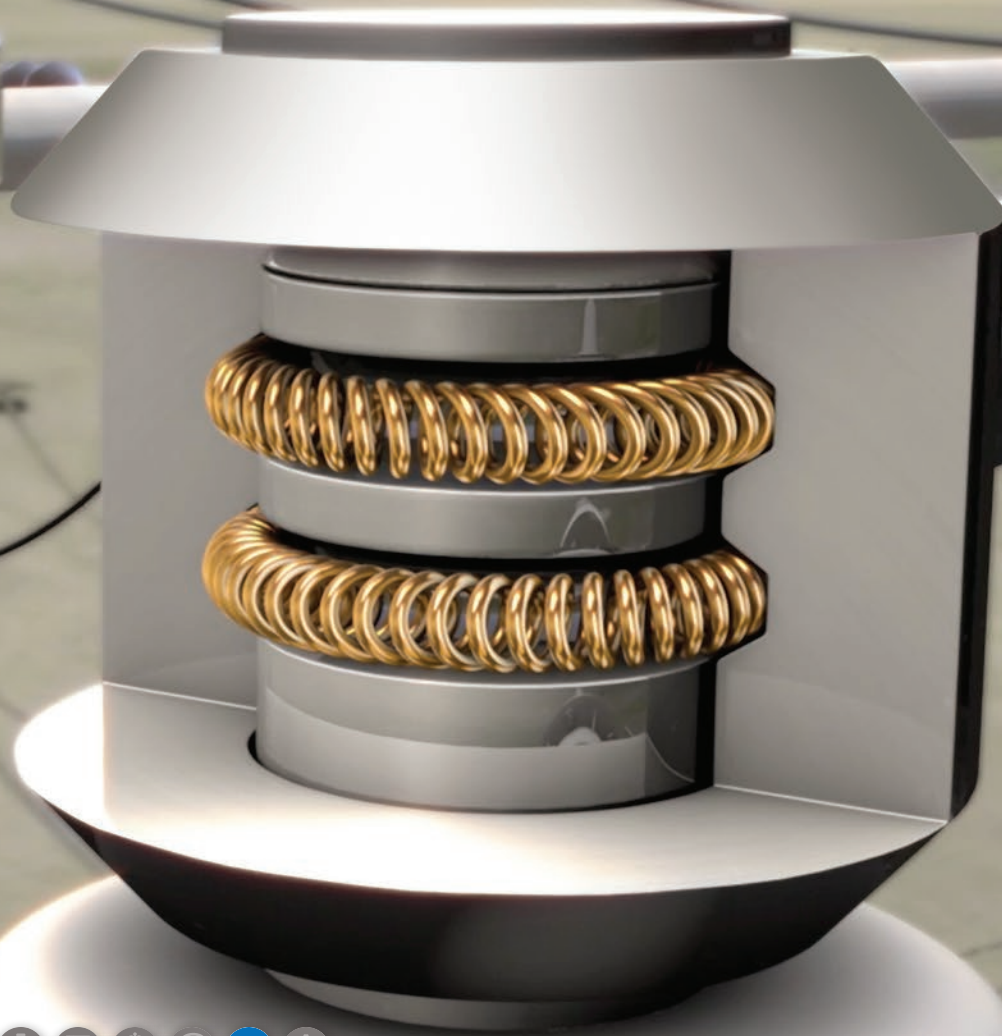


SWITCH GEAR  
CIRCUIT BREAKERS  
CURRENT  
TRANSFORMERS  
CABLE  
ACCESSORIES

TMB-13



## Connecting and Conducting Solutions for High-Current Power Transmission & Distribution

Custom components that drive tomorrow's technologies.™

**BAL SEAL**  
ENGINEERING, INC.®



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## Smart Solutions for High-Current Challenges

When manufacturers of power transmission and distribution equipment need smart solutions to tough design challenges, they turn to Bal Seal Engineering.

As a designer of critical power transmission and distribution equipment, you're always seeking new ways to reduce costs, eliminate maintenance issues and provide your end customers with better, more reliable products.

Our Bal Spring® canted coil spring is a proven electrical contact technology that can help you accomplish all this—simply and elegantly. For more than a decade, we've been providing power T&D equipment engineers with innovative and reliable solutions to the toughest conducting and connecting challenges. We apply our vast application knowledge base and 50+ years of manufacturing expertise to help you push your designs to the next performance level.



- High-contact power density
- Easy installation
- Built-in shock and vibration resistance
- Customizable insertion and sliding forces

### The Bal Spring® canted coil spring: Technology at the Core

The solutions we develop begin with Bal Spring canted coil spring technology. In electrical conducting applications, our spring's individual coils provide multi-point contact, and they compensate for mating surface irregularities and misalignment. As a contact component, the spring offers superior conductivity and power density.

Since the canted coil spring is capable of performing both mechanical and electrical functions, it helps eliminate unnecessary components and can reduce system size and weight. Its highly customizable design allows for precise control of insertion and sliding forces. As a contact element, the canted coil spring is ideal for use in applications that require:

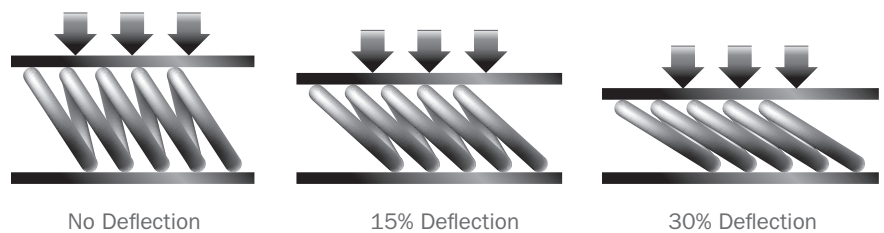
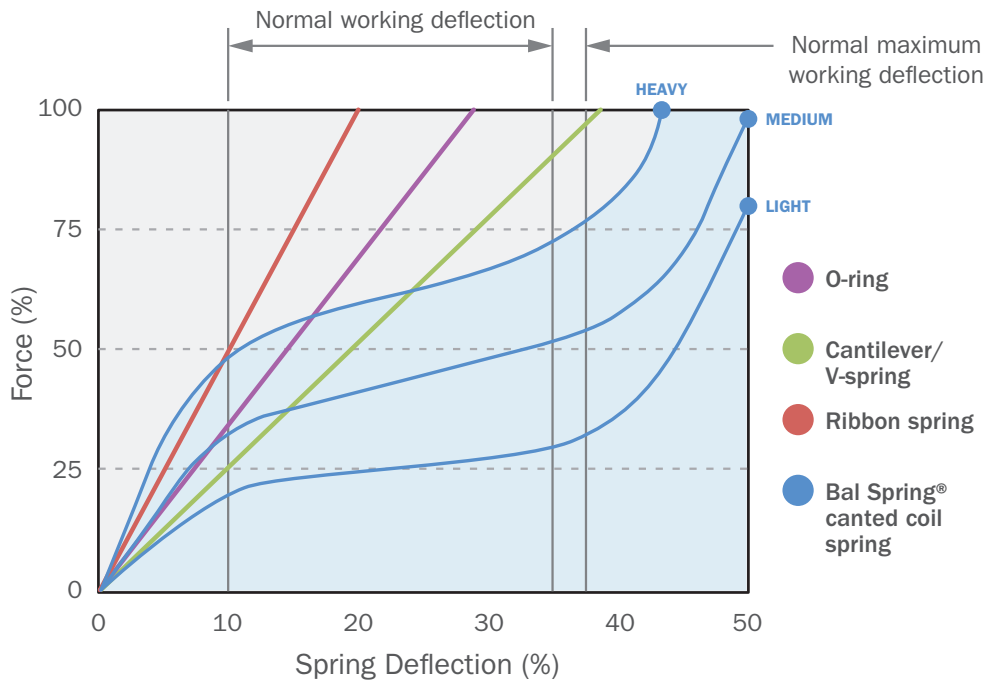
- Centering
- Conducting
- EMI/RFI shielding
- Grounding
- Holding
- Latching/locking
- Tolerance compensation

## Better Conductivity by Design



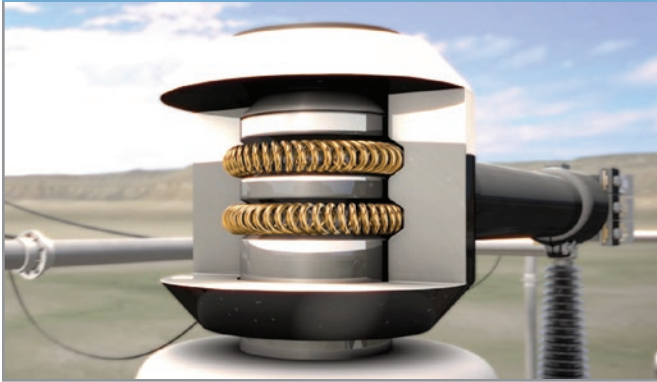
Unlike typical contact solutions, Bal Spring® canted coil springs maintain nearly constant force over a wide range of working deflections. Even under extreme temperature variations, the springs exhibit minimal change from their initial force. They maintain positive contact with minimal change in contact force. As a result, contact resistance remains relatively constant.

### Force Deflection Chart



## High-Current Applications

Disconnects



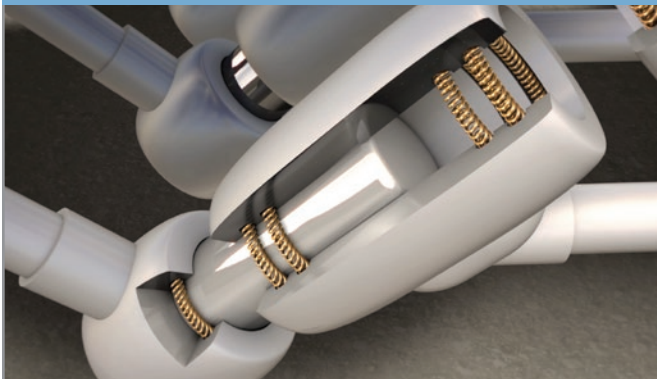
In disconnects like this one, the Bal Spring® provides stable electrical contact resistance and connection for rotating parts. In normal operation, the spring's individual coils provide multi-point contact, ensuring consistent transmission of electricity. During the quick disconnect, which isolates one part of the station from the transmission line in the event of an overload, the spring design allows for unimpeded rotation of the conducting blade.

Current Transformers



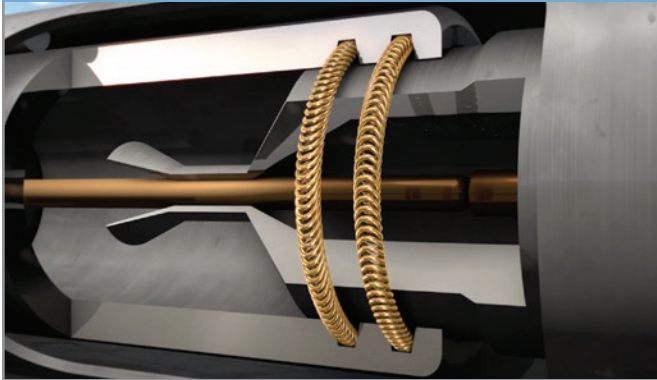
In current transformers, the Bal Spring reliably isolates current and grounds components with large mechanical tolerances. The spring's unique canted coil design enables it to compensate for misalignment and surface irregularities—a benefit that's critical in grounding applications.

Switchgear



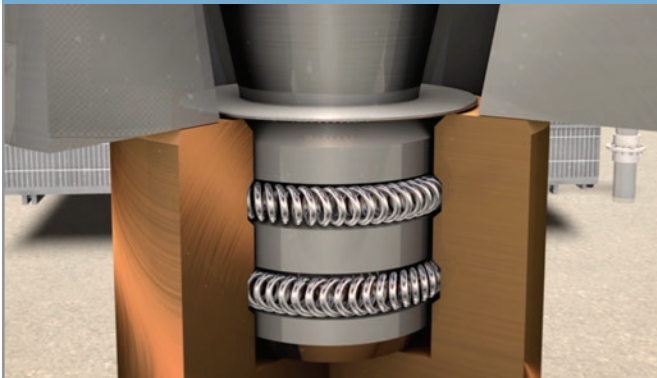
Because the Bal Spring is inherently resistant to compression set, it provides consistent, repeatable performance in three-point switches and other similar switchgear applications. Spring wire thickness and coil angle, as well as plating types and thicknesses, can all be customized to precisely control breakout and sliding forces, ensure optimal conductivity, and provide long service life.

### Circuit Breakers



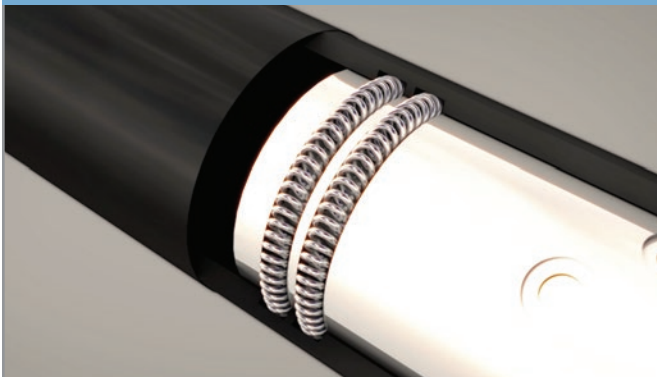
The same properties that allow for tens of thousands of consistent cycles in switches make the spring ideal for use in high-speed circuit breakers, where it can protect against surges during peak-current and short-circuit current conditions.

### Transformer Bushings



In transformer bushings, the Bal Spring facilitates easy assembly and maintenance. It provides excellent conductivity, and it also offers a simple mechanical latching solution. Depending on application requirements, the spring's insertion and removal forces can be precisely controlled from tens to thousands of pounds.

### Cable Terminals



The cables that transmit high voltage to and from the substation can also be made more efficient with the Bal Spring canted coil spring. Shown here in series, the spring electrically connects lengths of cable at the termination, and works in concert with the insulator elements to minimize voltage stress and potential breakdown due to thermal cycling.

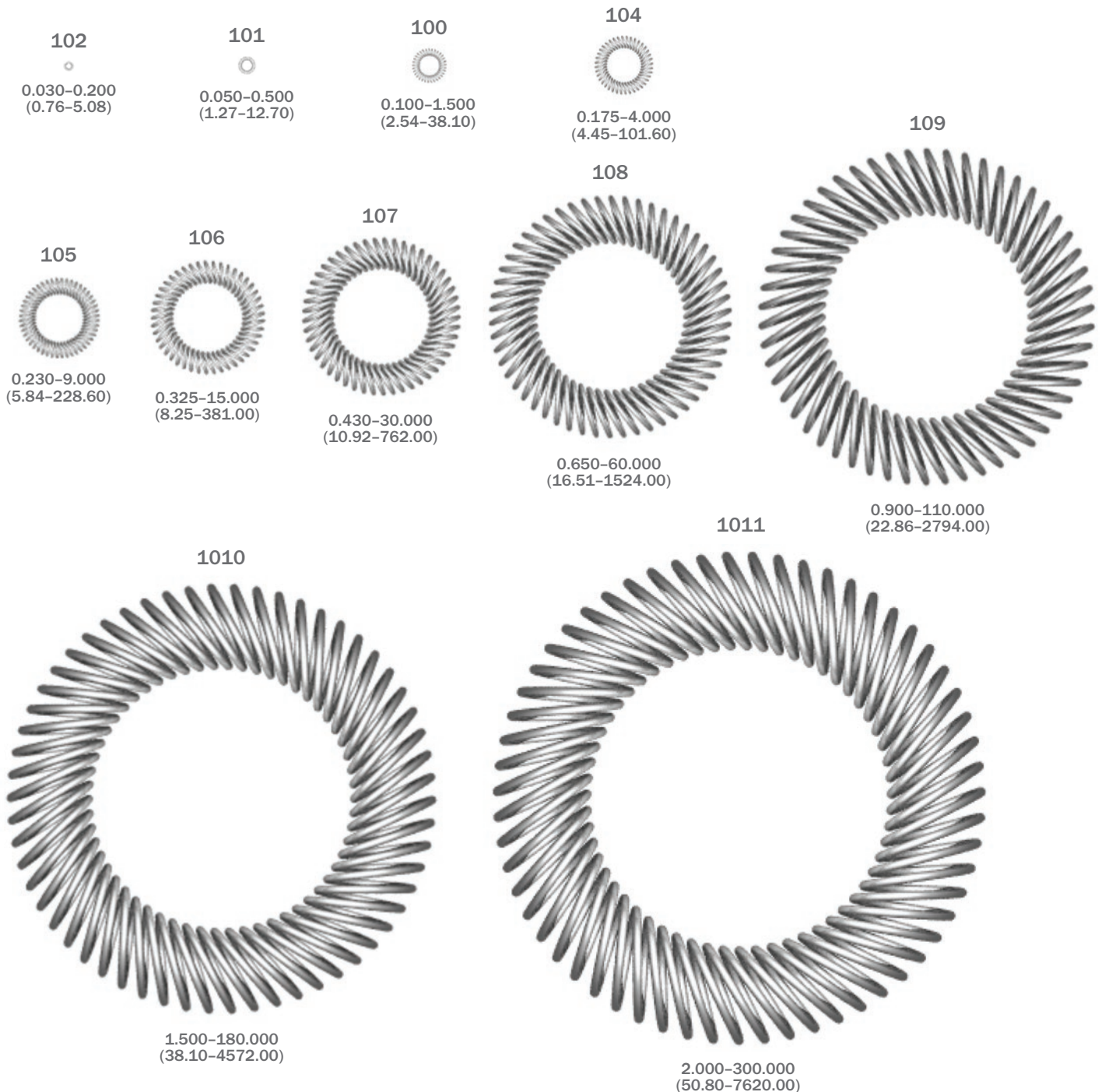
*The Bal Spring® canted coil spring can also be used to improve the performance and reliability of renewable power-generation equipment, including wind turbines and solar arrays. Application examples include busbars, busbar ducts, slip rings, and cable connections.*



## Spring Sizes and Specifications

While contact dimensions can vary greatly, there are some “typical” cross sections used in high-current applications. Each cross section is available in a wide range of suggested inside diameters as indicated by the dimensional information below the images. Other inside diameters available upon request.

Note: Springs are shown at approximate size in inches (mm).





## Connecting and Conducting Solutions for High-Current Power Transmission & Distribution

50 mm (ID)	Spring Series	Coil Width (mm)	Coil Height (mm)	Wire Diameter (mm)	Inside Diameter (mm)	Typical Number of Coils	Continuous Current (A)	Short Circuit Current (kA/3s)
	105	3.28	2.77	0.406	50.0	190	1200	10.4
	106	4.42	4.11	0.508	50.0	140	1500	11.6
	107	5.94	5.46	0.787	50.0	100	2000	20.7
	108	8.76	8.26	1.040	50.0	80	2500	26.8
	109	12.70	10.50	1.500	50.0	55	2900	36.7
	1010	17.40	15.20	1.830	50.0	50	3600	51.7
	1011	19.30	16.70	2.080	50.0	45	3900	65.4

70 mm (ID)	Spring Series	Coil Width (mm)	Coil Height (mm)	Wire Diameter (mm)	Inside Diameter (mm)	Typical Number of Coils	Continuous Current (A)	Short Circuit Current (kA/3s)
	105	3.28	2.77	0.406	70.0	260	1600	14.3
	106	4.42	4.11	0.508	70.0	190	2000	16.0
	107	5.94	5.46	0.787	70.0	140	2700	28.2
	108	8.76	8.26	1.040	70.0	105	3200	36.2
	109	12.70	10.50	1.500	70.0	70	3600	48.7
	1010	17.40	15.20	1.830	70.0	65	4400	67.6
	1011	19.30	16.70	2.080	70.0	60	4800	84.7

90 mm (ID)	Spring Series	Coil Width (mm)	Coil Height (mm)	Wire Diameter (mm)	Inside Diameter (mm)	Typical Number of Coils	Continuous Current (A)	Short Circuit Current (kA/3s)
	105	3.28	2.77	0.406	90.0	330	2000	18.3
	106	4.42	4.11	0.508	90.0	240	2400	20.3
	107	5.94	5.46	0.787	90.0	175	3300	35.6
	108	8.76	8.26	1.040	90.0	130	3900	45.2
	109	12.70	10.50	1.500	90.0	85	4400	60.7
	1010	17.40	15.20	1.830	90.0	80	5200	83.6
	1011	19.30	16.70	2.080	90.0	75	5700	105.0

Information is based on silver-plated BSE 11 material at pre-defined conditions. Values presented are calculated estimates. Actual values will vary depending on specific applications.



## Performance Characteristics

Bal Spring® canted coil springs provide reliable, consistent electrical conductivity, even in applications where angular misalignment or surface irregularities could compromise typical contact performance.

Spring Series	Maximum Allowable Tolerances (mm)	Maximum Angular Misalignment (mm)	Force Per Spring cm at 5% Deflection		Force Per Spring cm at 20% Deflection		Maximum Force Per Spring cm	
			kg	N	kg	N	kg	N
<b>105</b>	0.6	12.6	0.4	4	0.9	9	1	10
<b>106</b>	1.4	19	0.7	7	1.3	13	1.4	14
<b>107</b>	1.4	14.8	1.6	16	3.2	32	3.4	34
<b>108</b>	2.6	17.8	1.6	16	3.1	31	3.3	33
<b>109</b>	2.7	13.2	1.0	10	2.6	26	3	30
<b>1010</b>	4.2	15.2	0.9	9	2.2	22	2.5	25
<b>1011</b>	5.4	16	0.7	7	1.7	17	2	20

Bal Seal Engineering offers several copper alloys that exhibit superior electrical and mechanical properties.

Copper Alloys*	% of IACS	Specific Heat (J/kg-K°)	Electrical Conductivity (S/m)	Thermal Conductivity (W/m-K°)	Resistivity (μΩ-cm)	Hardness (HV)
<b>BSE 9</b>	15.7	420	9.35E+06	118	10.70	280
<b>BSE 11</b>	76.6	323	4.57E+07	324	2.19	134
<b>BSE 12</b>	76.6	381	4.57E+07	320	2.19	165

\* Other material composites available upon request.

Bal Spring® canted coil springs can be plated with gold, silver, or tin to improve conductivity and resistance to abrasion and corrosion.

Plating Material	Plating Thickness (μm)	Hardness (HV)	Advantage
<b>Gold</b>	0.25–5	22	Excellent corrosion protection
<b>Silver</b>	1–45	26	Excellent electrical conductivity
<b>Tin</b>	1–15	5	Excellent heat conductivity

Silver Plating (μm)	Dynamic Cycles**
<b>5</b>	2500
<b>10</b>	5000
<b>20</b>	10000

\*\*Reciprocating tests were run at 1016 mm/min, with a stroke length of 50.8 mm, using a conductive lubricant on a 50.8 mm diameter shaft.

## Design Request Form

In order to design your Bal Spring® canted coil spring solution, we need to know more about your application requirements. Please complete this form and e-mail it to us at [sales@balseal.com](mailto:sales@balseal.com), or fax it to (949) 460-2300.

Name	Date
Company	Title
Address	Department
City, State & Zip	Telephone
E-mail	Fax

Product data		Service
Equipment type		<input type="checkbox"/> Static <input type="checkbox"/> Dynamic
Application is used for <input type="checkbox"/> Prototype <input type="checkbox"/> Production <input type="checkbox"/> Retrofit <input type="checkbox"/> Other		Application type (check all that apply) <input type="checkbox"/> Holding <input type="checkbox"/> Electrical <input type="checkbox"/> User undefined <input type="checkbox"/> Latching <input type="checkbox"/> EMI Shielding <input type="checkbox"/> Garter <input type="checkbox"/> Locking <input type="checkbox"/> Isolating <input type="checkbox"/> Thermal <input type="checkbox"/> Loading <input type="checkbox"/> Pre-load <input type="checkbox"/> Other
Annual usage	Target price (per unit)	Media type

Mechanical application conditions		Electrical application conditions
Operating temperature	<input type="checkbox"/> °C <input type="checkbox"/> °F <input type="checkbox"/> °K	Continuous current <input type="checkbox"/> A <input type="checkbox"/> kA
Allowable increase	<input type="checkbox"/> °C <input type="checkbox"/> °F <input type="checkbox"/> °K	Short circuit current <input type="checkbox"/> A <input type="checkbox"/> kA
Number of cycles		Short circuit duration (seconds)
Stroke length	<input type="checkbox"/> inches <input type="checkbox"/> mm	Resistance <input type="checkbox"/> Ohms <input type="checkbox"/> Micro ohms
Insertion force	<input type="checkbox"/> grams <input type="checkbox"/> lbs. <input type="checkbox"/> N	Other
Removal force	<input type="checkbox"/> grams <input type="checkbox"/> lbs. <input type="checkbox"/> N	
Sliding force	<input type="checkbox"/> grams <input type="checkbox"/> lbs. <input type="checkbox"/> N	
Compression force	<input type="checkbox"/> grams <input type="checkbox"/> lbs. <input type="checkbox"/> N	

Dimensional information				Housing Information	
	<input type="checkbox"/> Inches <input type="checkbox"/> mm	Tolerance (+/-)	Can be modified	Material	
Piston diameter			<input type="checkbox"/>	Plating/coating	
Piston groove diameter (PGD)			<input type="checkbox"/>	Hardness (Rc)	
Housing bore diameter (HBD)			<input type="checkbox"/>	Surface finish <input type="checkbox"/> RMS <input type="checkbox"/> Ra	
Housing groove diameter (HGD)			<input type="checkbox"/>	<b>Piston Information</b>	
Housing outer diameter (HOD)			<input type="checkbox"/>	Material	
Groove width (GW)			<input type="checkbox"/>	Plating/coating	
Groove depth (GD)			<input type="checkbox"/>	Hardness (Rc)	
Inner diameter (ID)			<input type="checkbox"/>	Surface finish <input type="checkbox"/> RMS <input type="checkbox"/> Ra	
Length			<input type="checkbox"/>		
Gap			<input type="checkbox"/>		

Special requirements			
(Check all that apply)			
<input type="checkbox"/> DFARS	<input type="checkbox"/> Passivation	<input type="checkbox"/> Spring plating (check type)	<input type="checkbox"/> Gold
<input type="checkbox"/> FDA Compatible	<input type="checkbox"/> Biocompatible/implantable		<input type="checkbox"/> Silver
<input type="checkbox"/> ITAR			<input type="checkbox"/> Nickel
			<input type="checkbox"/> Tin

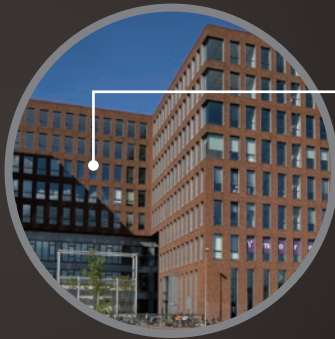
Gland configurations			
<input type="checkbox"/> Piston mounted 	<input type="checkbox"/> Housing mounted 	<input type="checkbox"/> Face mounted 	<input type="checkbox"/> Cut-to-length 

Bal Seal Engineering is more than a component manufacturer. By applying our canted coil spring technology and material science expertise, we provide OEMs and tier suppliers everywhere with innovative, custom-engineered sealing, connecting, conducting and EMI shielding and grounding solutions.



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