TMB-13

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

Custom components that drive tomorrow's technologies.®

BAL SEAL® ENGINEERING, INC.

Contents

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 60+ 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.

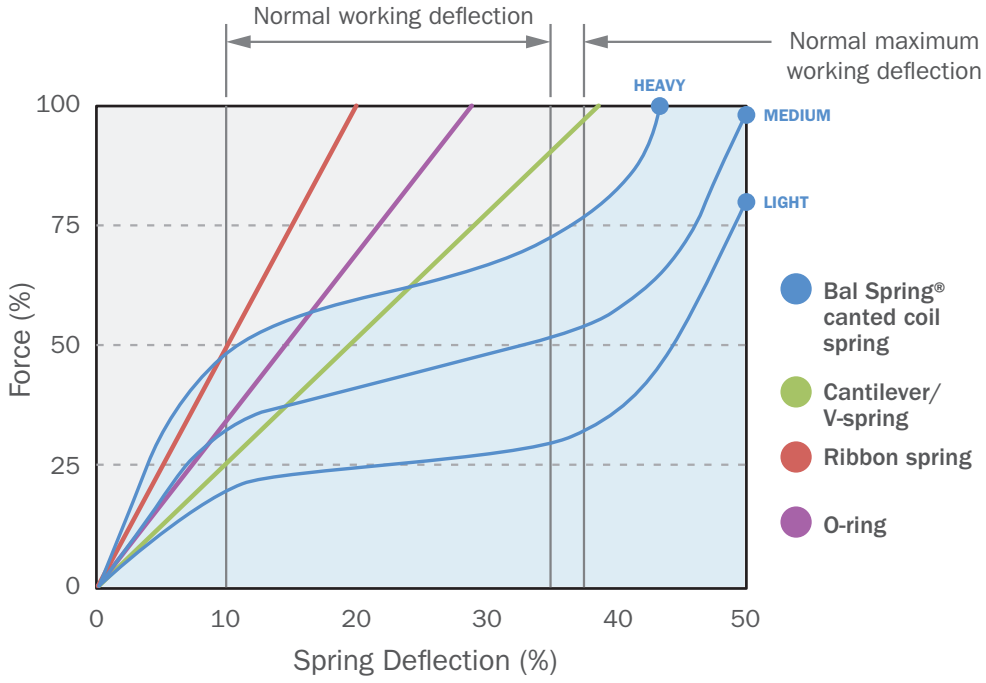
Since the canted coil spring is capable of performing both mechanical and electrical functions, it helps eliminate unnecessary components and can reduce system size and weight. Its highly customizable design allows for precise control of insertion and sliding forces. As a contact element, the canted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

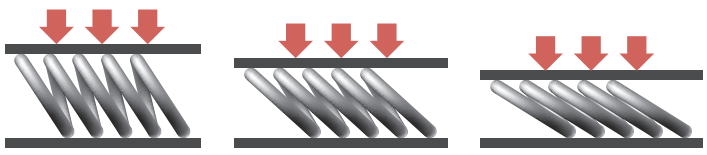
- Centering
- Conducting
- EMI/RFI shielding
- Grounding
- Holding
- Latching/locking
- Tolerance compensation

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. This allows them to maintain positive contact and relatively constant contact resistance over time.

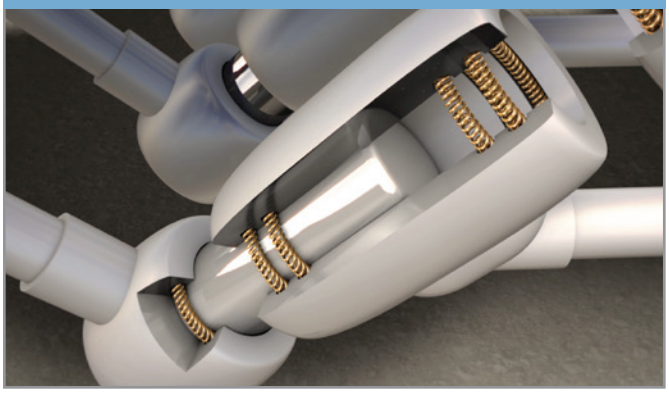
Force Deflection Chart





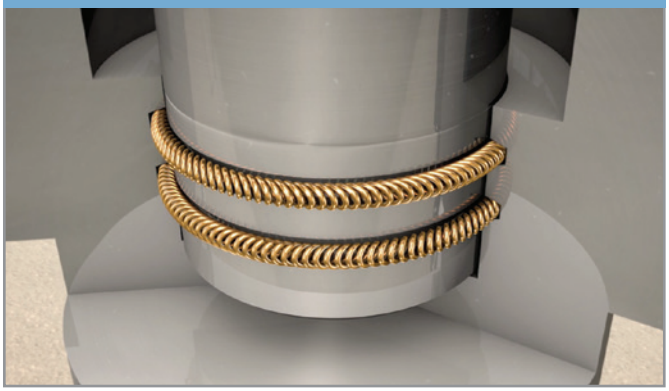
High-Current Applications

Switchgear



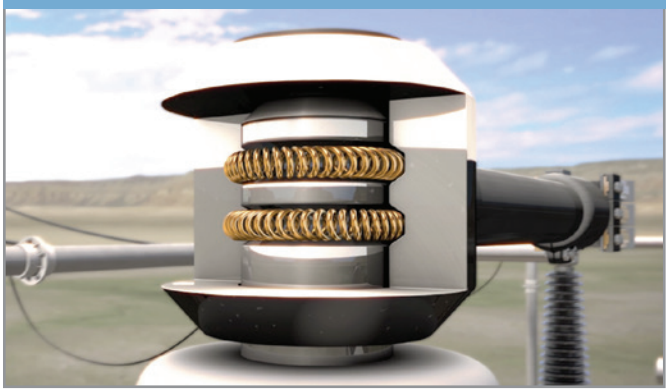
Because the Bal Spring® is inherently resistant to compression set, it provides consistent, repeatable performance in three-point switches and other similar switchgear applications. Spring wire thickness and coil angle, as well as plating types and thicknesses, can all be customized to precisely control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

Current Transformers



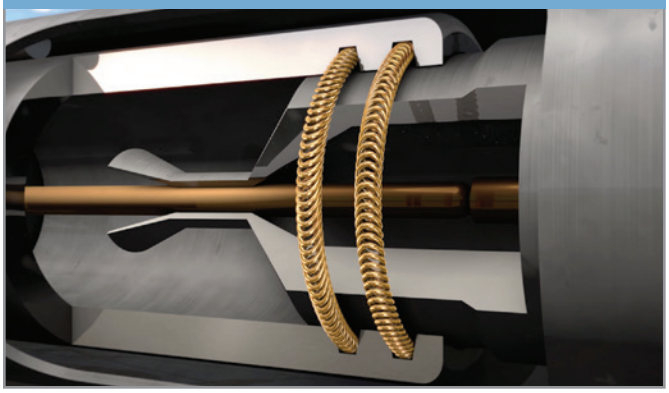
In current transformers, the Bal Spring reliably isolates current and grounds components with large mechanical tolerances. The spring's unique canted coil design enables it to compensate for misalignment and surface irregularities—a benefit that's critical in grounding applications.

Disconnects



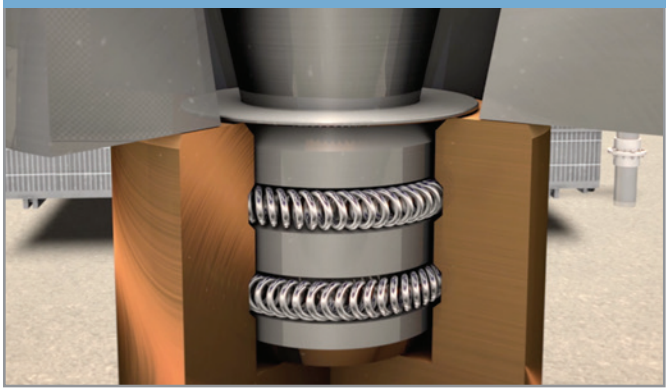
In disconnects like this one, the Bal Spring provides stable electrical contact resistance and connection for rotating parts. In normal operation, the spring's individual coils provide multi-point contact, ensuring consistent transmission of electricity. During the quick disconnect, which isolates one 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.

Circuit Breakers



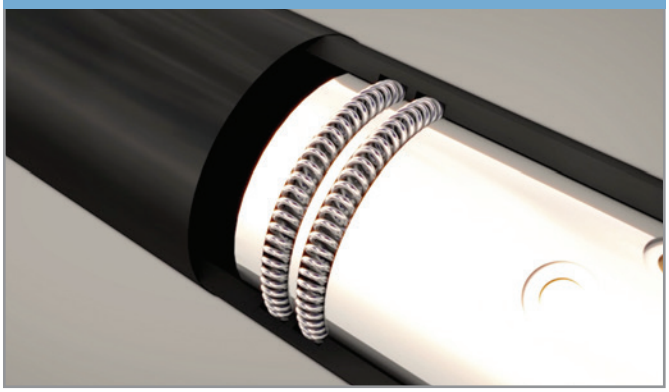
The same properties that allow for tens of thousands of consistent cycles in switches make the spring ideal for use in high-speed circuit breakers, where it can protect against surges during peak-current and short-circuit current conditions.

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 are available upon request.

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

102

0.030–0.200
(0.76–5.08)

101

0.050–0.500
(1.27–12.70)

100

0.100–1.500
(2.54–38.10)

104

0.175–4.000
(4.45–101.60)

105

0.230–9.000
(5.84–228.60)

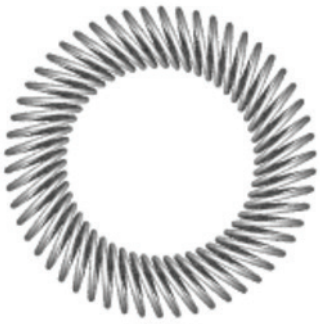
106

0.325–15.000
(8.25–381.00)

107

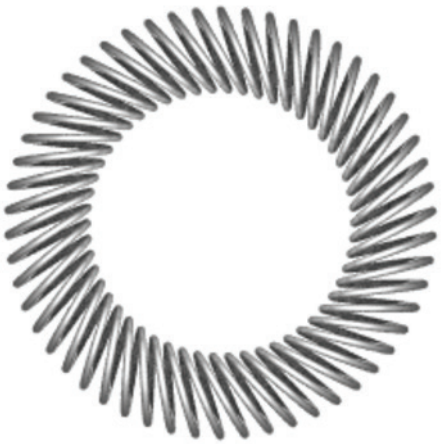
0.430–30.000
(10.92–762.00)

108



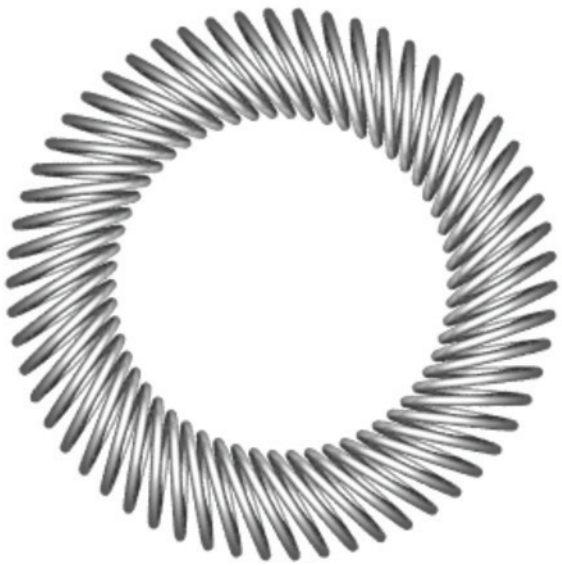
0.650–60.000
(16.51–1524.00)

109



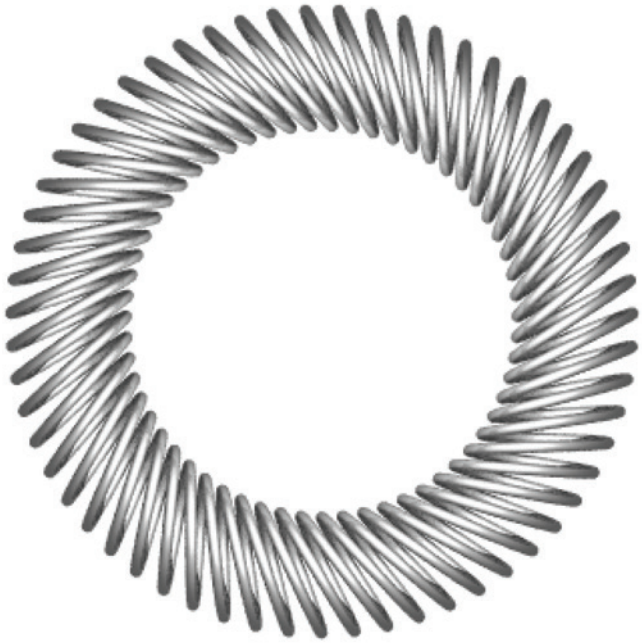
0.900–110.000
(22.86–2794.00)

1010



1.500–180.000
(38.10–4572.00)

1011



2.000–300.000
(50.80–7620.00)

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 copper alloy (BSE11) 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
105	0.6	12.6	0.4	4	0.9	9	1	10
106	1.4	19	0.7	7	1.3	13	1.4	14
107	1.4	14.8	1.6	16	3.2	32	3.4	34
108	2.6	17.8	1.6	16	3.1	31	3.3	33
109	2.7	13.2	1.0	10	2.6	26	3	30
1010	4.2	15.2	0.9	9	2.2	22	2.5	25
1011	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)
BSE9	15.7	420	9.35E+06	118	10.70	280
BSE11	76.6	323	4.57E+07	324	2.19	134
BSE12	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
Gold	0.25–5	22	Excellent corrosion protection
Silver	1–45	26	Excellent electrical conductivity
Tin	1–15	5	Excellent heat conductivity

Silver Plating (μm)	Dynamic Cycles**
5	2500
10	5000
20	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.

Important Information

CLEANING

Bal Seal Engineering products may require cleaning and/or sterilization before use, depending on the application.

TESTING

It is essential that the customer run evaluation tests to determine if the proposed, supplied, or purchased Bal Seal Engineering products are suitable for the intended purpose. Run tests under actual service conditions with an adequate safety factor.

Welded springs have an increased probability of breaking or failing at or near the weld. This probability is magnified if the spring is used in an application involving extension of the spring. In addition, temperature affects the properties of the spring (i.e., tensile strength, elongation, etc.) Failure of Bal Seal Engineering products can cause equipment failure, property damage, personal injury, or death. Equipment containing Bal Seal Engineering products must be designed to provide for any eventuality that may result from a partial or total failure of Bal Seal Engineering products.

Bal Seal Engineering products must be tested with a sufficient safety factor after installation and they must be subjected to a program of regular maintenance and inspection. The customer, through analysis and testing, is solely responsible for making the final selection of the products and for ensuring that all performance, safety, and other requirements of the application are met.

All information and recommendations contained herein are based on tests Bal Seal Engineering believes to be reliable, but the accuracy or completeness is not guaranteed. Any such information or recommendation is given solely for purposes of illustration and is not to be construed as a warranty that any goods will conform to such information or recommendation. No one, including Bal Seal Engineering employees, salespersons, representatives, wholesalers, or distributors is authorized to make any warranty or representation, and no customer or other user may rely on any such warranty or representation. Bal Seal Engineering reserves the right to make any changes (such as dimensional data, force, torque, materials, pressures, temperatures, surface finishes, surface speed, etc.) without notice to its products and to the contents of this document.

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The liability of Bal Seal Engineering, whether as a result of breach of any warranty, failure to provide timely delivery products, product malfunction, negligence or otherwise, shall be limited to repairing or replacing the non-conforming products or any part thereof, or, at Bal Seal Engineering's option, to the repayment to the customer all sums paid by the customer upon return to Bal Seal Engineering of the non-conforming products or part thereof. It is expressly agreed that the customer's remedy, as stated above, shall be exclusive and that under no circumstances shall Bal Seal Engineering be liable for any other damages, including direct, indirect, incidental, or consequential damages (LE-173-5 Rev. 0).

PATENTS

The products described herein include those which are the subject of pending and issued patents, both foreign and domestic, including patents 8,167,285; 8,297,662; 8,375,543; 8,561,274; 9,267,526; 9,534,625; (LE-173 Rev. 0) (Report#621-7).

We're more than just a component maker. In early development or existing product improvement stages, we combine our proven seals, springs, and contacts with engineering, material science, and precision manufacturing expertise to produce solutions that break down performance barriers.

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