SPRINGTECH

Partners for innovation and performance

THE ESSENTIAL GUIDE TO SPRING TECHNOLOGY

www.springs.co.uk

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INTRODUCTION

The Essential Guide to Spring Technology provides important technical information concerning the specification, behavioural and design characteristics that should be considered when formulating spring technology products.

The incorporation of spring design in the early stages of any new product development project is essential if later compromises, which can negatively impact application performance and reliability, are to be avoided.

Helical spring engineering has become increasingly specialised as advances in design software have enabled ever more sophisticated products to be conceived. At Springtech our Design Engineers provide the specialist expertise to support your new product development project.

If you have any technical questions, or are looking for a design partner for your spring project, please contact us at:

Tel: **+44 (0) 1494 556 700**
Email: **enquiries@springs.co.uk**

SPRINGTECH

Partners for innovation and performance

Springtech - Spring Technology Experts

We specialise in designing, developing and manufacturing high performance, quality-driven springs, wireforms and pressings. Customers select Springtech as a supply partner because they trust us to consistently deliver innovatively designed, precision-made components at a competitive price and shipped on time.

- Full-service solution: design, tooling, manufacture & finishing
- Specialised product & material engineering expertise
- Design & development for new concepts or existing products
- Rigorous quality & inspection management
- Extensive inventory of high-quality materials

Our capabilities

We are proud to offer all our customers a fully integrated service spanning product and tooling design, engineering, manufacture and finishing services all certified to ISO9001.

Materials: Our Engineers have a wealth of experience in designing products for demanding applications across a number of performance -critical industries. As well as carbon and stainless steels, we also hold inventories of Hastelloy, Inconel, Titanium, Monel, Tantalum, Nimonic etc.

Products: We supply a huge range of wire and flat products from tailor-made, small batches to high volume call-off orders. Our spring range includes compression, extension, torsion, garter, wave and

flat springs. Wireforms and pressings are custom designed to customer specifications and tooled in-house.

Engineering: As advances in design technology enable ever more sophisticated products to be conceived, we are continually investing in new engineering and production plant to raise capacity and optimise throughput.

Quality: Commitment to, and implementation of, exacting quality standards are hard-wired into all our processes. When sourcing materials we never purchase from suppliers who could compromise our product performance or quality.

Our customers

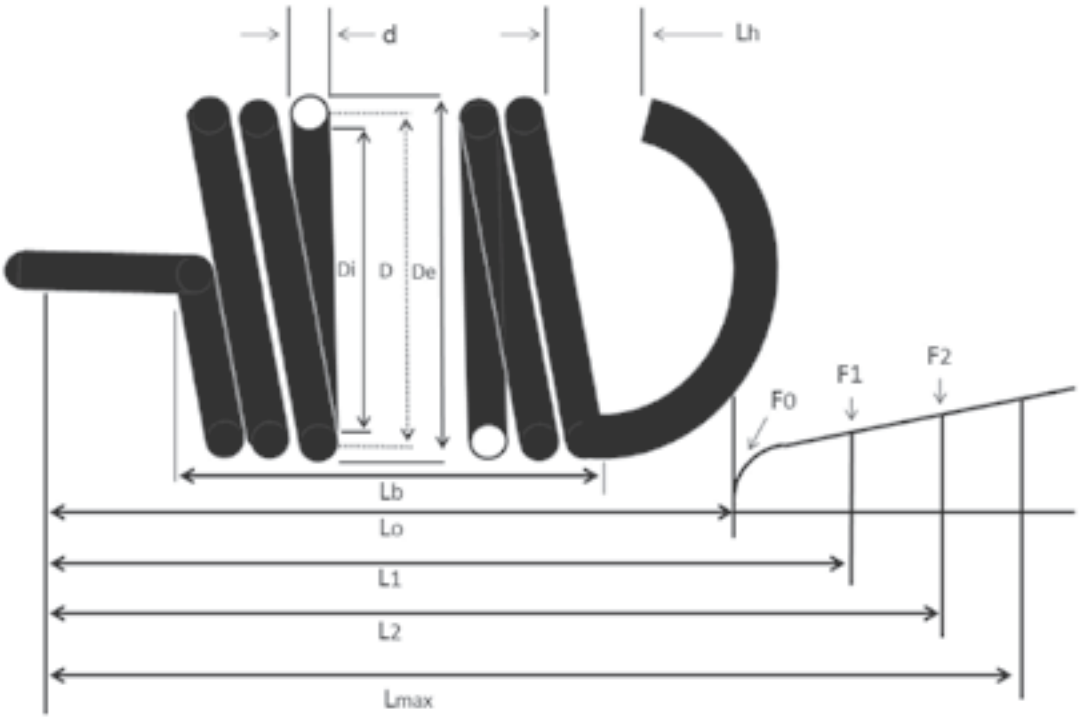
We serve a highly diverse and truly international customer-base. Many of our customers require our specialist engineering expertise to ensure that product design and material selection are fit for purpose for applications operating in highly demanding working environments.

- Aerospace & Defense
- Oil & Gas
- Medical
- Marine
- Energy & Renewables
- Engineering
- Construction
- Electronics & Telecoms
- Automotive





EXTENSION SPRINGS



Extension Spring Loop Configurations

MACHINE LOOP | D-LOOP | CROSSOVER LOOP | MACHINE LOOP X2 | LOOP AT SIDE | EXTENDED LOOP | LOOP AT ANGLE

Designed and manufactured to the following standards:

Manufacture: BS 1726-2:2002

- Cylindrical helical springs made from round wire and bar
- Guide to methods of specifying, tolerances and testing
- Part 2: Extension springs

Extension Spring Design Definitions

Use this as a guide on information to be supplied to your spring maker so they can ensure the resulting spring meets your requirements. From this information they can determine the stress characteristics and advise on potential operating problems.

Unless otherwise specified all tolerances will be to BS1726-2 latest edition.

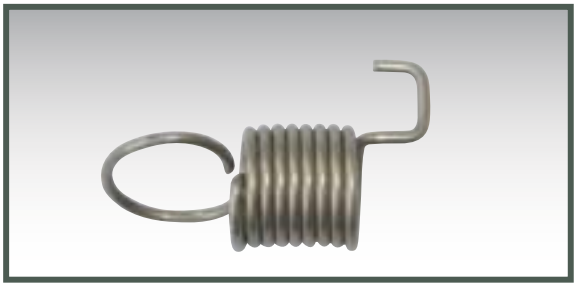
Symbol	Term	Unit	Required
Material Type			
d	diameter of wire	mm	
De	Outside diameter of spring	mm	
Di	Inside diameter of spring	mm	
D	Mean diameter of spring	mm	
F0	Initial Tension	N	
F1	Spring forces for the spring lengths L1 (at ambient temperature of 20°C)	N	
F2	Spring forces for the spring length L2 (at ambient temperature of 20°C)	N	
Lb	Body Length	mm	
L0	Spring length inside loops	mm	
L1	Length of smallest test load F1	mm	
L2	length for the spring force F2	mm	
Lmax	Maximum spring extension	mm	
n	Number of active coils	Num.	
nt	Total number of coils	Num.	
R	Spring rate	N/mm	

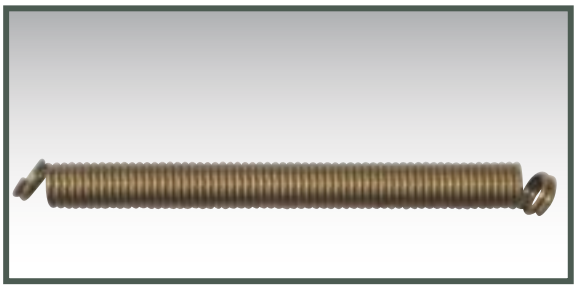
Additional Information				
Hook Type				
Lh Hook Gap				
Hook Gap Angle	Same Side	Opposite	90 degrees	Unimportant

Surface Finish	
Operating Environment	
No. Cycles	
Other Requirements	

Extension Spring End Configurations

CENTRE LOOPS + FORMED SIDE LEG





LAYED BACK LOOPS AT ANGLE

ELONGATED CENTRE HOOKS WITH GAP

Should you require any of the above the following information should also be provided to the spring maker.

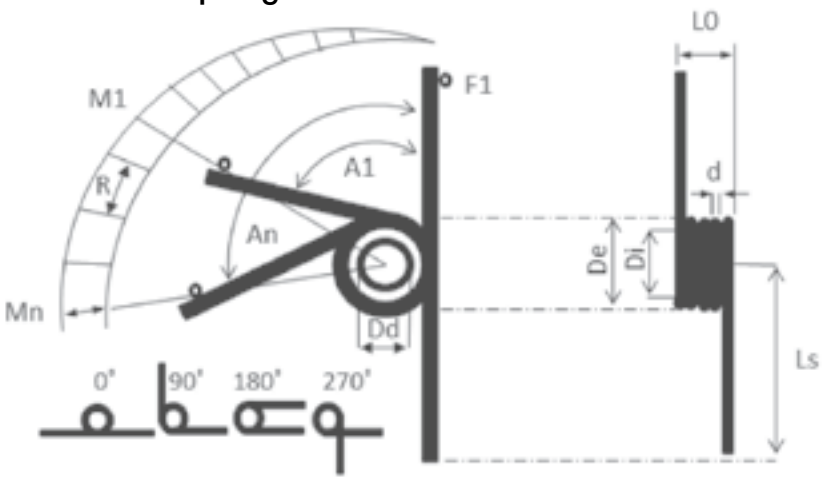
Symbol	Term	Unit	Required
Hook Type		mm	
Hook Position		mm	
Leg Type	Side – Centre – Opposite		
Leg Length	1- 2 -	mm	
Hook / Leg Description			

TORSION SPRINGS

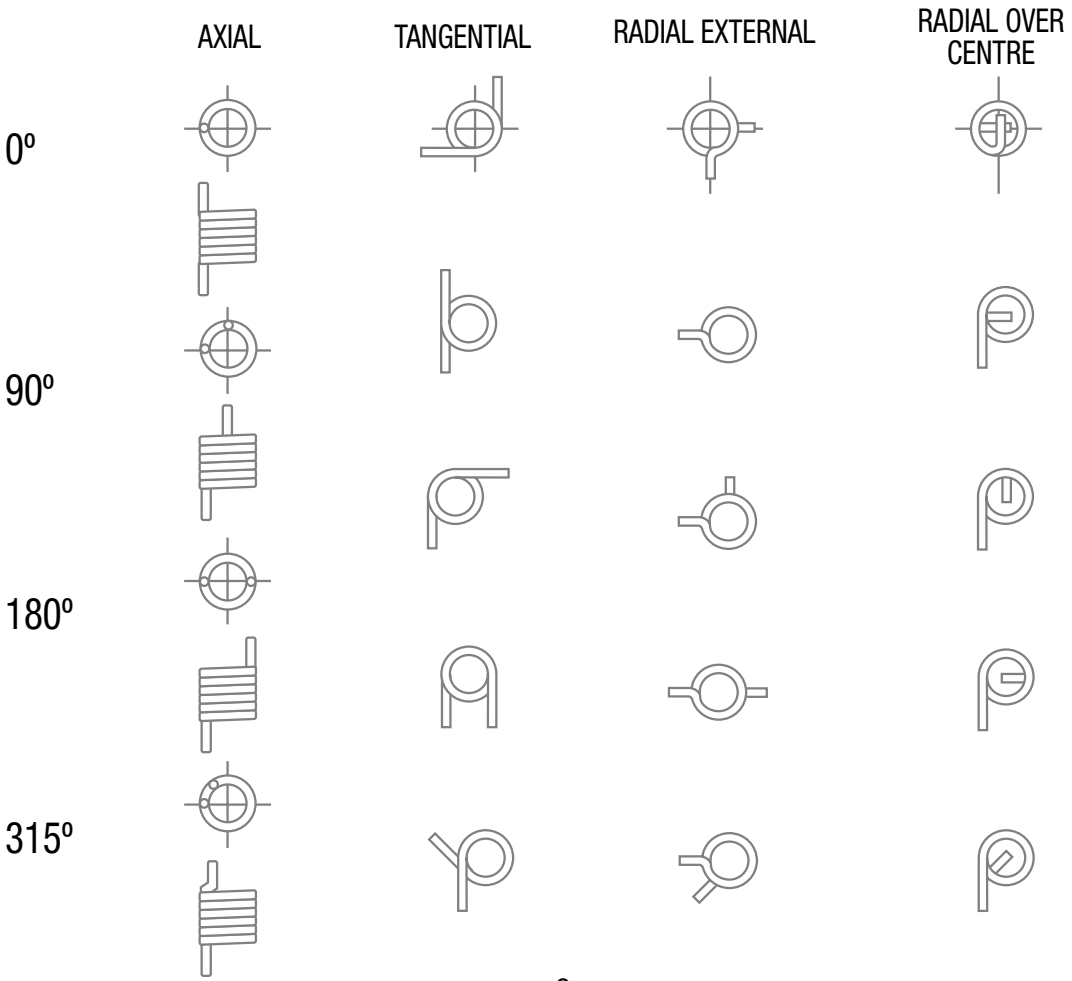
Designed and manufactured to the following standards:

Manufacture: BS 1726-3:2002

- Cylindrical helical springs made from round wire and bar
- Guide to methods of specifying, tolerances and testing
- Part 3: Torsion springs



Leg Configurations and Angles



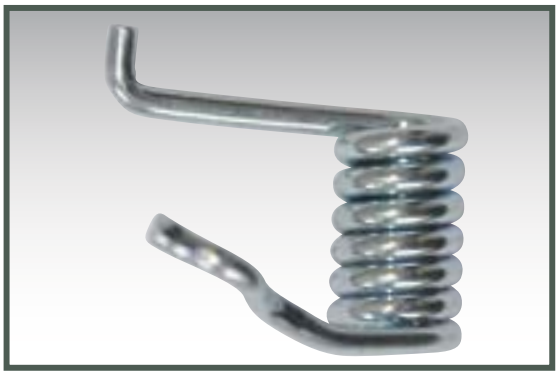
Torsion Spring Design Definitions

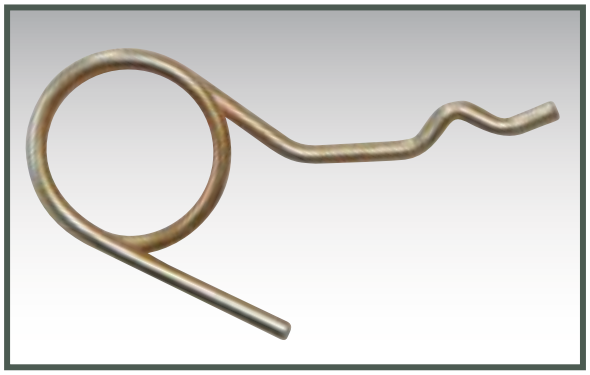
Use this as a guide on information to be supplied to your spring maker so they can ensure the resulting spring meets your requirements. From this information they can determine the stress characteristics and advise on potential operating problems.

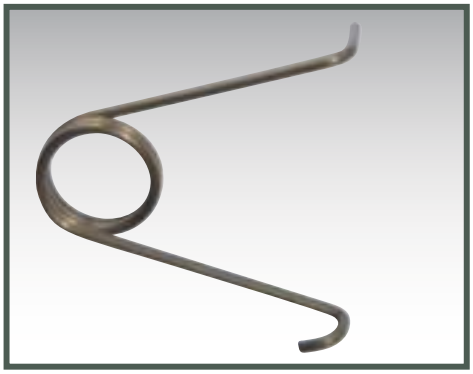
Unless otherwise specified all tolerances will be to BS1726-3 latest edition.

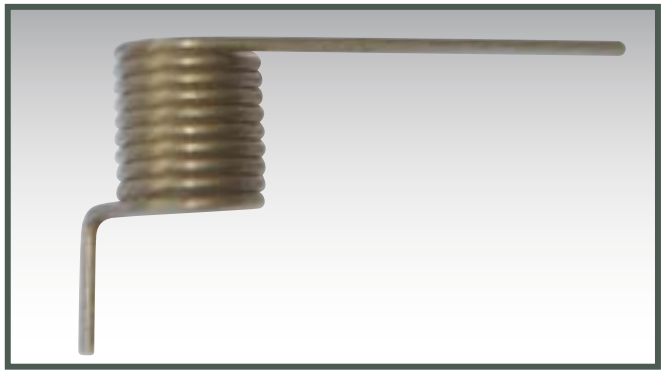
Symbol	Term	Unit	Required
Material Type			
d	diameter of wire	mm	
De	Outside diameter of spring	mm	
Di	Inside diameter of spring	mm	
Dd	Max diameter of shaft spring fits over	mm	
Free Angle		Degrees	
F0	Fitted Position		
A1	Deflection 1	Degrees	
M1	Spring Force	N	
An	Max Deflection	Degrees	
Mn	Spring Force	N	
nt	Total number of coils	Num.	
R	Spring rate	N/degree	
s	Spring deflections for the spring forces F1, F2	mm	
nt	Total number of coils	Num.	
R	Spring rate	N/degree	

Additional Information	
Ends	
Surface Finish	
Operating Environment	
No. Cycles	
Other Requirements	

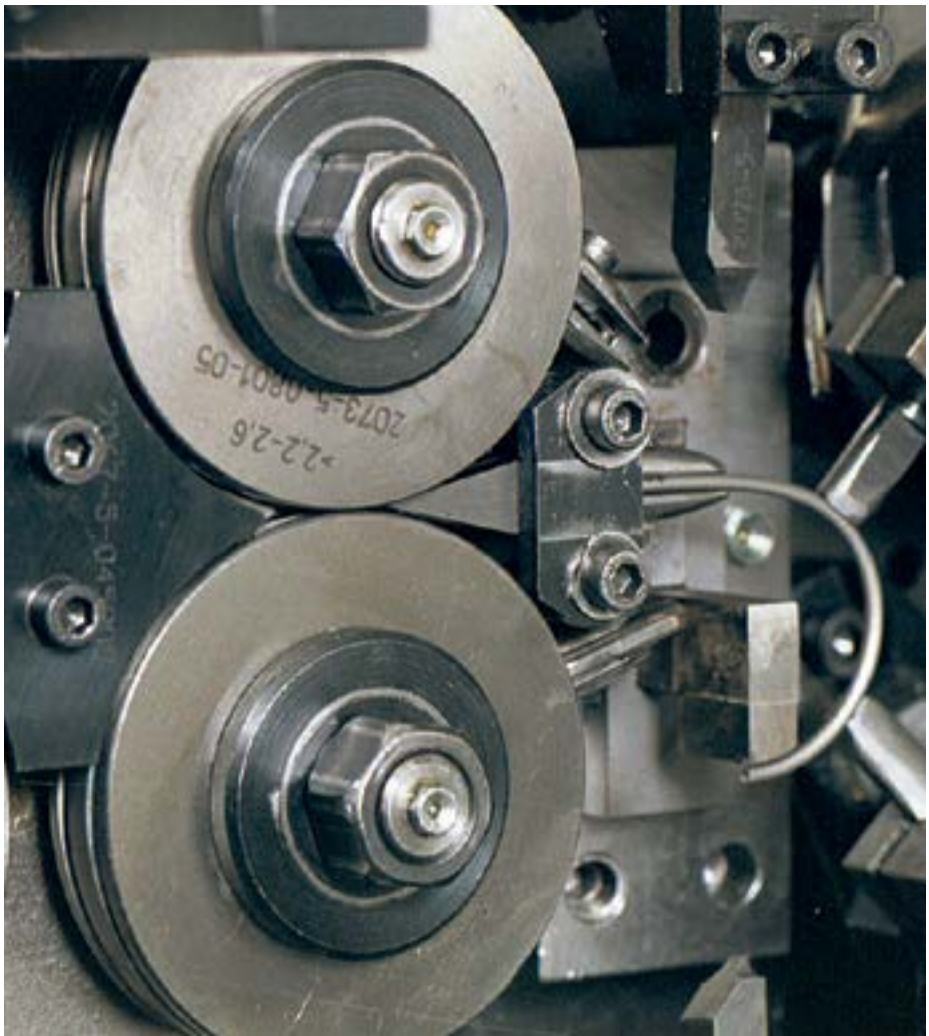








Examples of Torsion Springs with shaped and formed ends for location and fixing purposes.

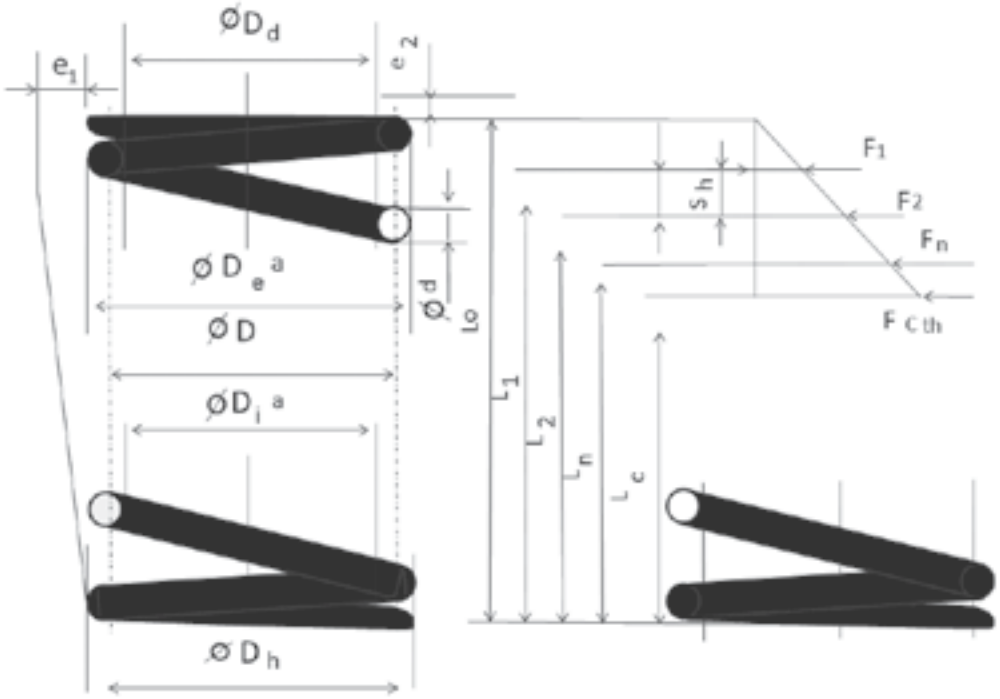


COMPRESSION SPRINGS

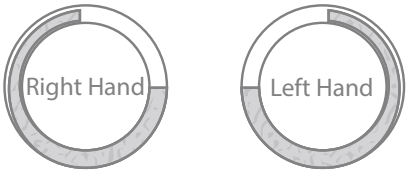
Designed and manufactured to the following standards:

Manufacture: BS 1726-1:2002

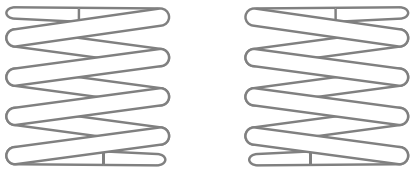
- Cylindrical helical springs made from round wire and bar
- Guide to methods of specifying, tolerances and testing
- Compression Springs Part 1



Direction of Winding



End Types



OPEN ENDS

CLOSED SQUARE END

CLOSED SQUARE & GROUND ENDS

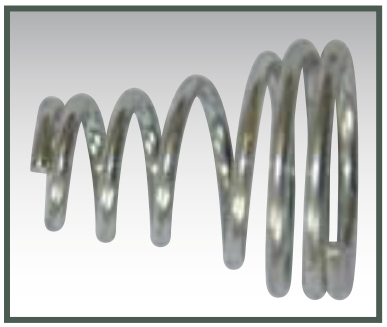
Compression Spring Design Definitions

Use this as a guide on information to be supplied to your spring maker so they can ensure the resulting spring meets your requirements. From this information they can determine the stress characteristics and advise on potential operating problems.

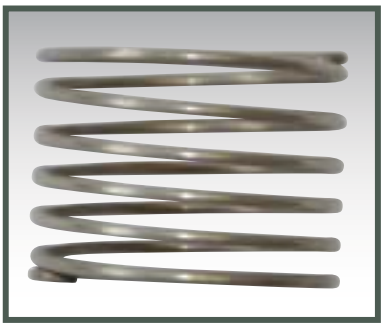
Unless otherwise specified all tolerances will be to BS1726-1 latest edition.

Symbol	Term	Unit	Required
Material Type			
d	diameter of wire	mm	
De	Outside diameter of spring	mm	
Di	Inside diameter of spring	mm	
D	Mean diameter of spring	mm	
Dh	Min diameter of pocket spring fits into	mm	
Dd	Max diameter of shaft spring fits over	mm	
F	Spring Force	N	
F1	Spring forces for the spring lengths L1, L2 (at ambient temperature of 20°C)	N	
Fc th	Theoretical spring force at solid length Lc	N	
L0	Spring length	mm	
L1	Length of smallest test load F1	mm	
L2	Spring lengths for the spring forces F1, F2	mm	
Lc	Solid Length	mm	
n	Number of active coils	Num.	
nt	Total number of coils	Num.	
R	Spring rate	N/mm	
s	Spring deflections for the spring forces F1, F2	mm	
Sc	Spring deflection for the solid length Lc	mm	
w	Spring Index		
Additional Information			
Ground Ends	Yes/No		
e1	Squareness (If yes)		
e2	Parallelism (If yes)		
Surface Finish			
Operating Environment			
No. Cycles			
Other Requirements			
Pre-stressing	See definitions		

Other examples and configurations of Compression Springs



CONICAL
COMPRESSION SPRING

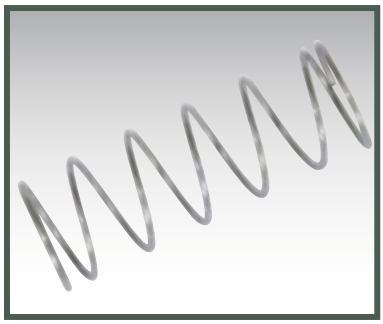


COMPRESSION SPRING
WITH RADIAL LEG

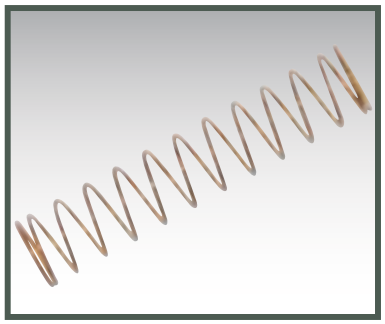
CONICAL COMPRESSION
SPRING WITH AXIAL
LEG & HOOK

Should you require any of the above, the following information should also be provided to the spring maker.

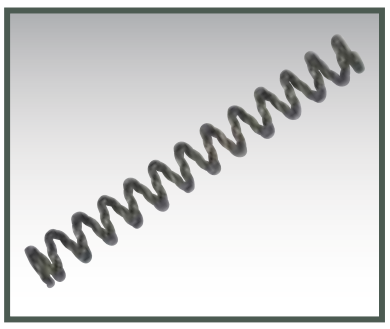
Symbol	Term	Unit	Required
Large O/D		mm	
Small O/D		mm	
Leg Type	Radial – Axial – Tangential		
Leg Length	1- 2 -	mm	
Hook / Leg Description			



STAINLESS STEEL



PHOSPHOR BRONZE



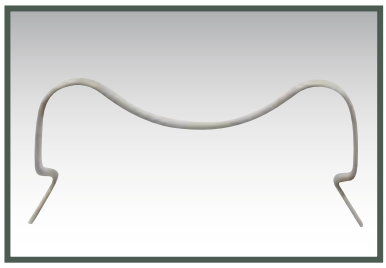
STRANDED WIRE

PRESSED STRIP SPRINGS

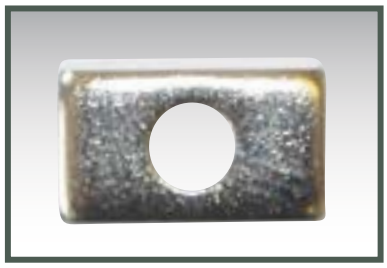
Springtech manufacture components, from various strip materials incorporating multislide and single action presses.

Springtech have their own tool room, where customer tools are designed, manufactured and maintained, allowing for complete in house manufacturing and maintenance control, ensuring deadlines are met.

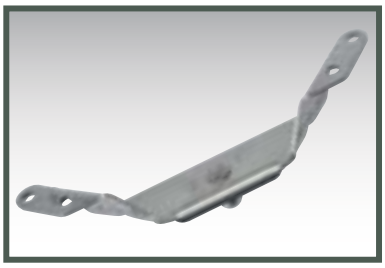
Below are some examples of the infinite materials, shapes, & components available from Springtech.



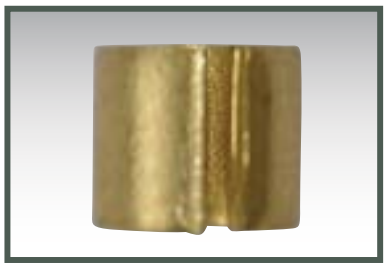
STAINLESS STEEL



MILD STEEL



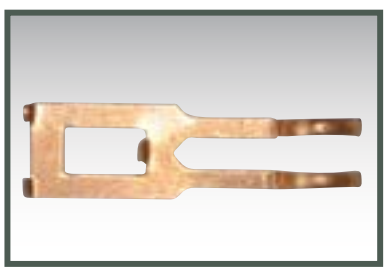
SPIN RIVETED ASSEMBLY



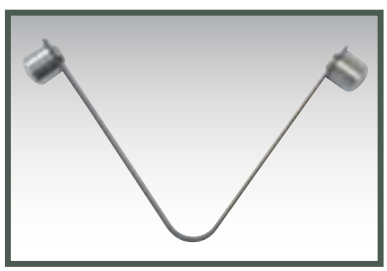
BRASS

BRASS

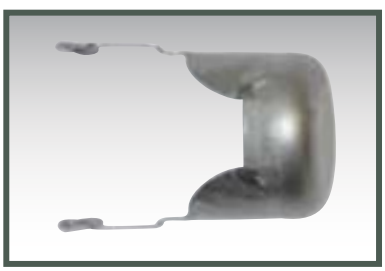
BERYLLIUM COPPER



PHOSPHOR BRONZE



HARDENED & TEMPERED SPRING STEEL WITH STEEL RIVETED STUDS



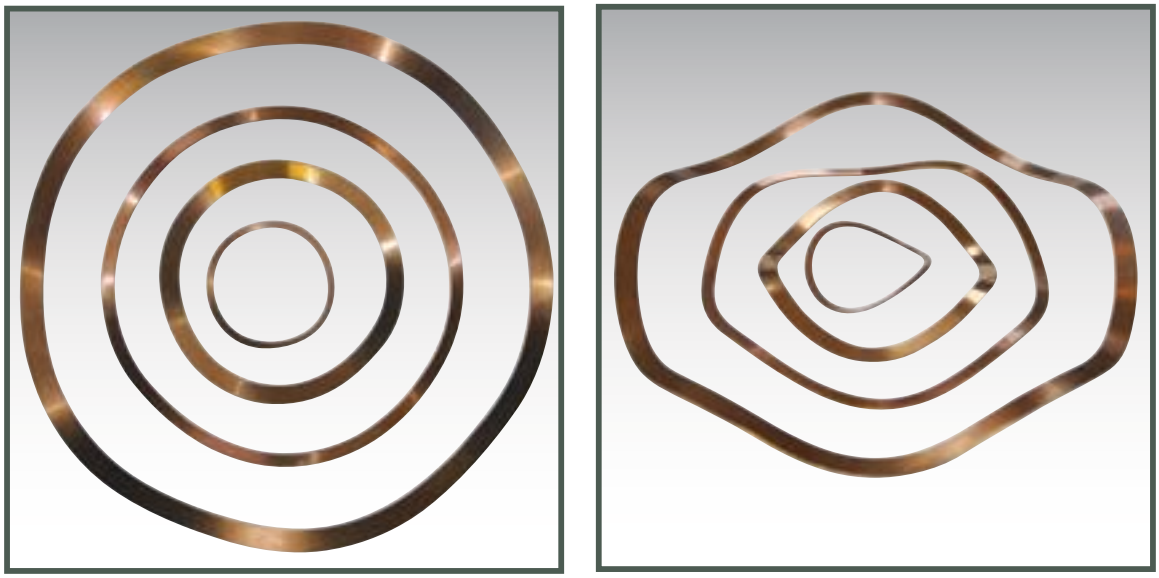
DEEP DRAWN MILD STEEL SHIELD

WAVE SPRING WASHERS

Manufactured typically, but not exclusively from Stainless or Carbon Spring Steel.

Wave Washers are used mainly for applications where high spring forces are required with low movement between the two working faces.

Circular in shape with the diameters and number of waves adjusted to obtain the loading requirements.

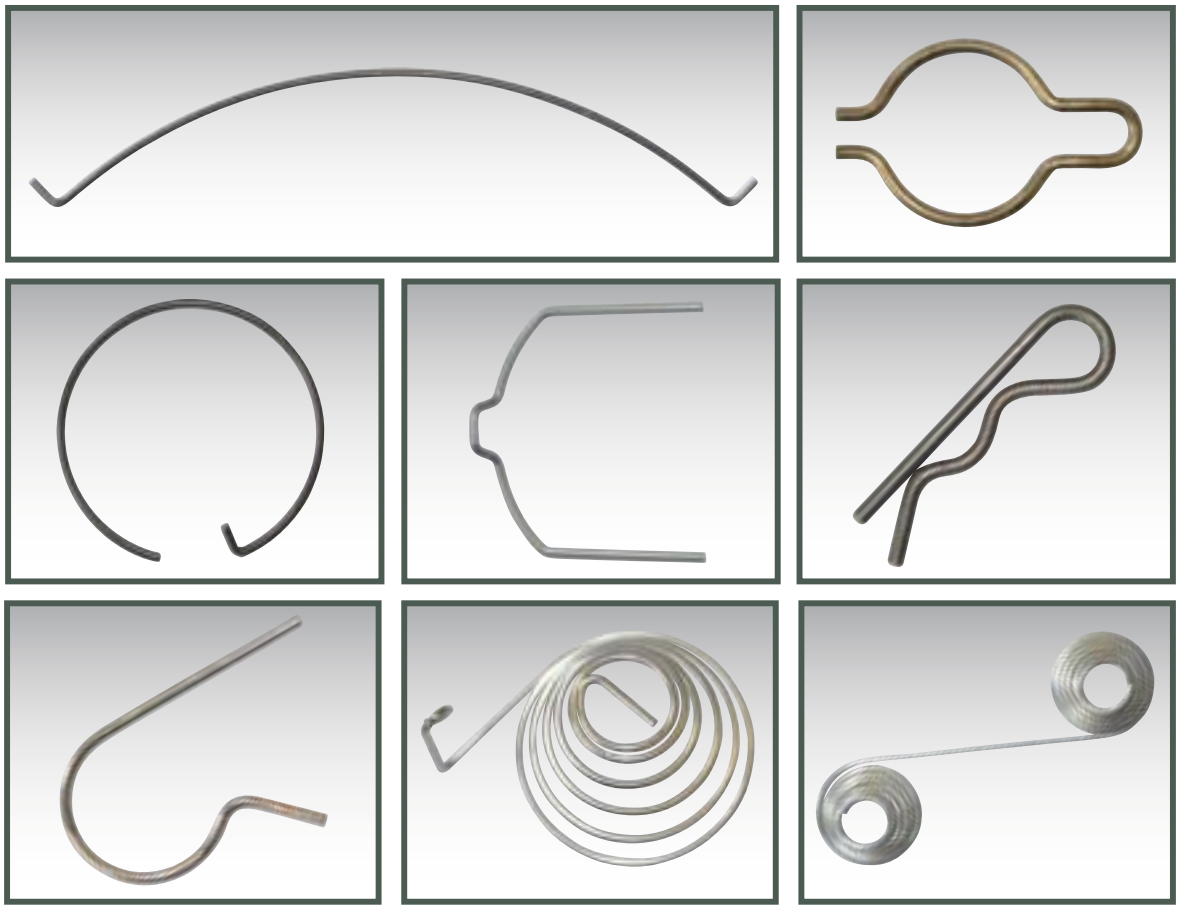


SOME EXAMPLES OF WAVE SPRING WASHERS

WIRE FORMS

With wire sizes ranging from 0.1 – 3.8 mm diameter Springtech has the capacity to manufacture many wireform shapes and sizes both automatically and where required by hand.

CNC machinery enables volume complex parts to be produced with minimal tooling costs, and greater accuracy making use of sensors to ensure variations in recovery of materials can be overcome.



SOME EXAMPLES OF WIREFORMS

Whilst complex small quantity parts can be produced off standard tooling utilising the skill and accuracy of trained staff each part being engineered conforms to drawing specification and tolerances.

Customers are encouraged to bring their ideas and requirements to our wire forming and prototype engineers where designs and loading characteristics can be explored prior to final production.

Often Parts requiring electrical conductivity are tin plated, these parts can often be produced from pre plated wire saving post manufacturing plating processes which are likely to damage the parts if bulk processed, or expensive individual jigging processes.

STANDARD WIRE GAUGES

Gauge	Metric	Imperial	Gauge	Metric	Imperial
7/0	12.7	0.500”	15	1.829	0.072”
6/0	11.79	0.464”	15.5	1.727	0.068
5/0	10.97	0.432	16	1.626	0.064
4/0	10.16	0.4	16.5	1.524	0.06
3/0	9.45	0.372	17	1.422	0.056
2/0	8.839	0.348	17.5	1.321	0.052
0	8.23	0.324	18	1.219	0.048
1	7.62	0.3	18.5	1.118	0.044
2	7.01	0.276	19	1.016	0.04
2.5	6.706	0.264	19.5	0.965	0.038
3	6.401	0.252	20	0.914	0.036
4	5.893	0.232	20.5	0.864	0.034
4.5	5.639	0.222	21	0.813	0.032
5	5.385	0.212	21.5	0.762	0.03
6	4.877	0.192	22	0.711	0.028
7	4.47	0.176	22.5	0.66	0.026
7.5	4.267	0.168	23	0.61	0.024
8	4.064	0.16	23.5	0.584	0.023
8.5	3.861	0.152	24	0.559	0.022
9	3.658	0.144	25	0.508	0.02
9.5	3.454	0.136	26	0.457	0.018
10	3.251	0.128	27	0.417	0.0164
10.5	3.099	0.122	28	0.376	0.0148
11	2.946	0.116	29	0.345	0.0136
11.5	2.794	0.11	30	0.315	0.0124
12	2.642	0.104	31	0.295	0.0116
12.5	2.489	0.098	32	0.274	0.0108
13	2.337	0.092	33	0.254	0.01
13.5	2.184	0.086	34	0.234	0.0092
14	20.32	0.08	35	0.213	0.0084
14.5	1.93	0.076	36	0.193	0.0076

Preferred Metric sizes for Wires (mm)

0.200	0.224	0.250	0.280	0.315	0.355	0.400
0.45	0.50	0.56	0.63	0.71	0.80	0.90
1.00	1.12	1.25	1.40	1.60	1.80	2.00
2.24	2.50	2.80	3.15	3.55	4.00	4.50
5.00	5.60	6.30	7.10	8.00	9.00	10.00
11.20	12.50					

Quantity	To Convert From	To	Multiply By
Force	Newton's	Kilograms	0.102
		Pounds	0.22487
		Grams	102
		Ounces	3.5979
		Drams	57.5667
	Kilograms	Newton's	9.807
		Pounds	2.2046
		Grams	1000
		Ounces	35.27
		Drams	564.37
	Pounds	Newton's	4.448
		Kilograms	0.4536
		Grams	453.6
		Ounces	16
		Drams	256
	Grams	Newton's	0.009807
		Kilograms	0.001
		Pounds	0.0022046
		Ounces	0.03527
		Drams	0.56437
	Ounces	Newton's	0.278
		Kilograms	0.2835
		Pounds	0.0625
		Grams	28.35
		Drams	16
	Drams	Newton's	0.017375
		Kilograms	0.001772
		Pounds	0.003906
		Grams	1.772
		Ounces	0.0625

Quantity	To Convert From	To	Multiply By
Length	Metres	Feet	3.208
		Inches	39.3701
		Millimetres	1000
	Feet	Metres	0.3048
		Inch	12
		Millimetres	304.8
	Inches	Metres	0.0254
		Feet	0.08333
		Millimetres	25.4
	Millimetres	Metres	0.001
		Feet	0.003281
		Inches	0.0393701

Conversion Tables

Quantity	To Convert From	To	Multiply By
Rate	Kg/mm	Lb/in N/mm kN/m ozs/in	55.998 9.807 9.807 895.97
	Lb/in	Kg/mm N/mm kN/m ozs/in	0.017858 0.175133 0.175133 16
	kN/m or N/mm	Kg/mm Lb/in Ozs/in	0,0101968 5.7099 91.358
	Ozs/in	Kg/mm Lb/in kN/m N/mm	0.0011612 0.0625 0.0109458 0.0109458
Torque	Kg/mm	Lb/in N/mm Ozs/in	0.086796 0.009807 1.3887
	Lb/in	Kg/mm N/mm Ozs/in	11.52125 0.1129889 16
	N/mm	Kg/mm Lb/in Ozs/in	101.968 8.850413 141.6069
	ozs/in	Lb/in Kg/mm N/mm	0.0625 0.72 0.007062
Stress	Lb/in^2	Kg/mm^2 Hectobars N/mm^2 T/in^2	0.000703 0.000689 0.000689 0.000446
	Kg/mm^2	Lb/in^2 Hectobars N/mm^2 T/in^2	1421.933 0.9807 9.807 0.6348
	Hectobars	Lb/in^2 Kg/mm^2 N/mm^2 T/in^2	1449.92 1.01968 10 0.6473
	N/mm^2 or Mn/m^2	Lb/in^2 Kg/mm^2 Hectobars T/in^2	145.038 0.101968 10 0.06473

Quantity	To Convert From	To	Multiply By
Stress	T/in^2	Lb/in^2	2240
		Kg/mm^2	1,5752
		Hectobars	1.54488
		N/mm^2	15.4488
Area	In^2	mm^2	645.16
	mm^2	In^2	0.00155
Volume	In^3	mm^3	16387
	mm^3	In^3	0.000061024

Approximate Coil Spring Weight Calculations

1. Length of Wire

= π x Mean Diameter x total coils + leg lengths

2. Weight of spring in KG per 1000 =

Length of wire x πr2 x Density kg/mm3
(r = radius of wire)

Strip Component weights in KG per 1000 =

1. Length x Width x Thickness x Density above kg/mm3

Manufacture

For reference, the Scope of Springtech's Quality Standard BS EN ISO 9001 is below:-

Design, Development and Manufacture of Coil Springs, Light Metal Pressings, Automatic Wire and Strip Forms, Light Electrical and Mechanical Sub-Assemblies, Heat Treatment, De-Greasing, Cleaning and Passivation.

Some basic statistical information

Capability = The Difference Between

The mean plus 4 standard deviations

And

The mean minus 4 standard deviations

Capability Index =

From measured data of 50 or so consecutively produced parts.

Comparison of the natural spread of the distribution & the total tolerance band (upper tolerance limit - lower tolerance limit)

$$\textbf{Machine Capability}, Cm = \frac{\text{Total Tolerance Band}}{6 \times \text{Standard Deviation}}$$

If the mean does not fall precisely on the target value (middle of spec. limit), most defects will occur at the tolerance limit nearest the mean.

Consequently:

Machine capability,

$$Cmk = \frac{\text{Difference between the nearest tolerance limit \& the mean}}{3 \times \text{Standard Deviation}}$$

For processes which can be readily adjusted so that the mean falls on target you can use Cm.

Where processes cannot be easily adjusted and the mean falls away from the mean use Cmk, likewise if the specification is single sided ie a Max or Min only specified use Cmk.

Where the mean is precisely on target, Cm = Cmk

For long runners, where lots of data, or sets of data, are collected.

Use:-

$$Cp = \frac{\text{Total Tolerance Band}}{6 \times \text{Standard Deviation}}$$

Or:

$$Cpk = \frac{\text{Difference between the nearest tolerance limit \& the mean}}{3 \times \text{Standard Deviation}}$$

The corresponding percentage of defects in relation to the capability index will be as below.

Capability index = 1	Reject percentage 0.27%	+/- 3 SD
Capability index = 1.33	Reject percentage 0.006%	+/- 4 SD
Capability index = 2	Reject percentage 0.0000002%	+/- 6 SD

Industry Terminology

Active Coils	The Coils of a spring which at any instant are contributing to the rate of the spring, otherwise known as working coils Those coils which are free to deflect under load.
Ageing	See Precipitation Hardening
Allow for Set	The spring is supplied longer than specified to compensate for length loss when fully compressed.
Buckling	The unstable or lateral distortion of the major axis of a spring when compressed.
Cicrlip	A discontinuous ring made from round or sectional material which snaps onto a shaft or into a hole also called a Spring Ring or Locking Ring
Closed End	The name given to the end of an open coiled spring in which the helix angle of the end coil has been progressively reduced until the end coil touches the adjacent coil
Closed Ends	Ends of compression springs where pitch of the end coils is reduced so that the end coils touch.
Closed Length	See Solid Height
Close Wound	Coiled with adjacent coils touching
Coils	The coils of a spring – Single lengths of wire (rod) formed into a series of nominally circular turns in approximately the same plane about the same axis
Compression Spring	A spring whose dimension, in the direction of the applied load, reduced under the action of that load
Conical Spring	A spring made from bar, rod or wire formed into a conical helix
Dead Coils	The coils of a spring, which do not affect the rate of the spring. These are usually at the ends of the spring
Deflection	The relative displacement of the ends of a spring on the application of a load
Diameter	Diameter is the chord of a circle, which passed through the centre of that circle. – BAR Diameter, the diameter of the cross-section of a bar. – INSIDE Diameter of a spring, the diameter of the cylindrical envelope formed by the inside surfaces of the coils of a spring.

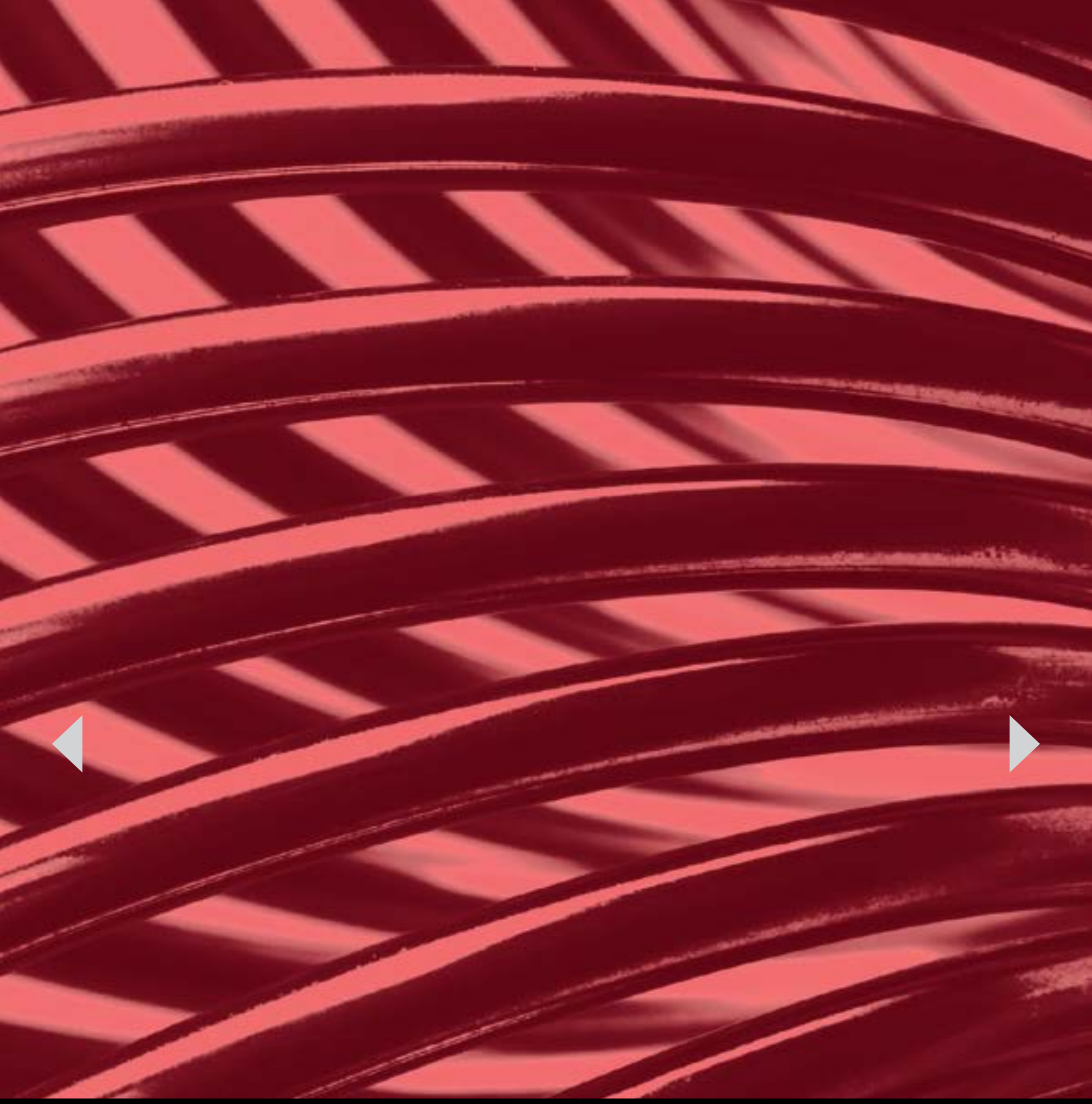
	– MEAN Diameter of a spring, the diameter of a coil of a helical spring from the centre area to the centre of area of the section of the material, measured at right angles to the axis of the spring. – Outside Coil Diameter, the diameter of the cylindrical envelope formed by the outside surface of the coils of a spring. – ROD Diameter, the diameter of the cross-section of a round rod. – WIRE Diameter, the diameter of the cross-section of a round wire.
Effective Coils	See also Active Coils
Elastic Limit	The highest stress that can be applied to a material without producing permanent deformation.
Electro-galvanising	The process of depositing zinc by means of electrolysis
Extension Spring	A spring whose dimension, in the direction of the applied load, increases under the action of that load.
Fatigue	The phenomenon that gives rise to a type of failure which takes place under conditions involving repeated of fluctuating stresses below the ultimate stress of the material
Fitted Length	The length of a spring when assembled into the position, within a mechanism, from which it is required to function.
Free Angle	Angle between the legs of a torsion spring when the spring is not loaded.
Free Length	The length of a spring when it is not loaded. In the case of extension springs this includes the anchor points.
Gauge	The diameter or thickness of strip, rod or wire - A device against which a dimension of form can be compared
Grinding	The removal of metal from the end faces of a spring by the use of abrasive wheels to obtain a flat surface, which is square with the spring axis.
Ground Ends	The end of a spring is ground to provide a flat plane.
Handing	The direction in which the helix of a spring is formed.
Hooks	Open loops or ends of extension springs.
Hydrogen Embrittlement	Brittleness in a material caused by the absorption of hydrogen usually during pickling or electroplating.
Index	The index of a spring is the ration of the mean coil diameter to the wire, bar or rod diameter for circular sections or radial width of cross-section for rectangular or trapezoidal sections.

Initial Tension	The force that tends to keep the coils of an extension spring closed and which must be overcome before the coils start to open.
Leaf Spring	A flat spring operated as a cantilever or beam supported at each end.
Load	The force applied to a spring that causes a deflection.
Load Test	A test on a spring to determine either the load at a given length or the length under a given load.
Loop	See bow 2.
Low Temperature Heat Treatment	See stress relieving
Mean Coil Diameter	Outside spring diameter (O.D.) minus one wire diameter
Music Wire	A high tensile patented, cold drawn, plain carbon steel wire suitable for highly stressed static applications.
Open End	The end of an open coiled helical spring in which the angle of the end coil has been progressively reduced
Outside Grinding	The grinding of the outside of the end coil of a spring to ensure that the diameter is within the specified tolerance.
Overall Length	See free length
Parallelism	The degrees to which the two grand ends of a spring are parallel to each other.
Passivating	Acid treatment of stainless steel to remove contaminants and improve corrosion resistance.
Permanent Set	A material that is deflected so far that its elastic properties have been exceeded and it does not return to its original condition upon release of load is said to have taken a “permanent set”.
Permanent Set	The permanent deformation of a body after the application and removal of a load.
Pitch	The pitch of a spring is the distance from any point in the section of one coil to the corresponding point in the next coil when measured parallel to the axis of the spring.
Preset	See also remove set
Prestressing	A process during which internal stresses are induced into a spring, which have the effect of increasing the apparent elastic limit of

	the material. It is achieved by subjecting the spring to a stress greater than that to which it is subjected under working conditions and higher than elastic limit of the material. The plastically deformed areas resulting from this stress cause an advantageous redistribution of the stresses within the spring. Since stress is a vector quantity, advantage from prestressing can only be obtained from springs, which are loaded so that the algebraic sum of the prestress and the applied stress is less than the applied stress.
Rate	The rate of a spring is the load or force which must be applied to it in order to produce unit deflection
Scragging	An expression applied loosely and therefore sometimes confusingly, to cover both prestressing and scrag test – see also Prestressing and Scrag Test
Setting	The adjustment of a helical spring to conform to drawing dimensions. This operation can be carried out at any stage of processing after coiling.
Shot Peening	A cold working process in which shot is impinged on to the surfaces of springs thereby inducing residual stresses in the outside fibres of the material. The effect of this is that the algebraic sum of the residual and applied stresses in the outside fibres of the material is lower than the applied stress, resulting in improved fatigue life of the component.
Solid Height	Length of a compression spring when under sufficient load to bring all coils into contact with adjacent coils.
Solid Length	Is the overall length of a helical spring when each and every coil is in contact with the next
Spring	A spring is an elastic body designed to deflect under the action of a load, thereby storing mechanical energy. When the load is removed the energy stored in the spring is released and the spring returns to its original unstrained condition.
Spring Index	Ratio of mean coil diameter (D) to wire diameter (d).
Squareness	This is the deviation from a right angle that the ground end of helical spring in its free state makes with its longitudinal

	axis. The deviation is normally expressed in units of length over the free length of the spring.
Stress Relieving	A low temperature heat treatment carried out at temperatures where there is no apparent change in metallurgical structure of the material. The purpose of the treatment is to relieve stresses induced during the manufacturing processes.
Stroke	The distance between the minimum and maximum working positions of a spring.
Tensile Test	A test in which the two ends of a standard test piece are pulled until fracture of the test piece occurs. From this test the following properties of the material may be obtained, Young's modulus, limit of proportionality, yield stress, proof stress, ultimate tensile test, percentage elongation and percentage reduction of area.
Torsion Spring	A helical coiled spring designed to give an angular deflection of its ends about its longitudinal axis when subjected to an applied load.
Total Number of Coils	The sum of the active and dead coils in a coiled spring
Wire	Wire is metal section whose dimension has been changed by cold work. It can be obtained in coil or straight lengths and a number of metallurgical conditions.
Working Coils	See Active Coil

NOTES



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Partners for innovation and performance

Contact the spring experts today

Head Office: High Wycombe, Buckinghamshire:
Tel: +44 (0)1494 556700 Fax: +44 (0) 1494 511002

Email: enquiries@springs.co.uk
Web: www.springs.co.uk