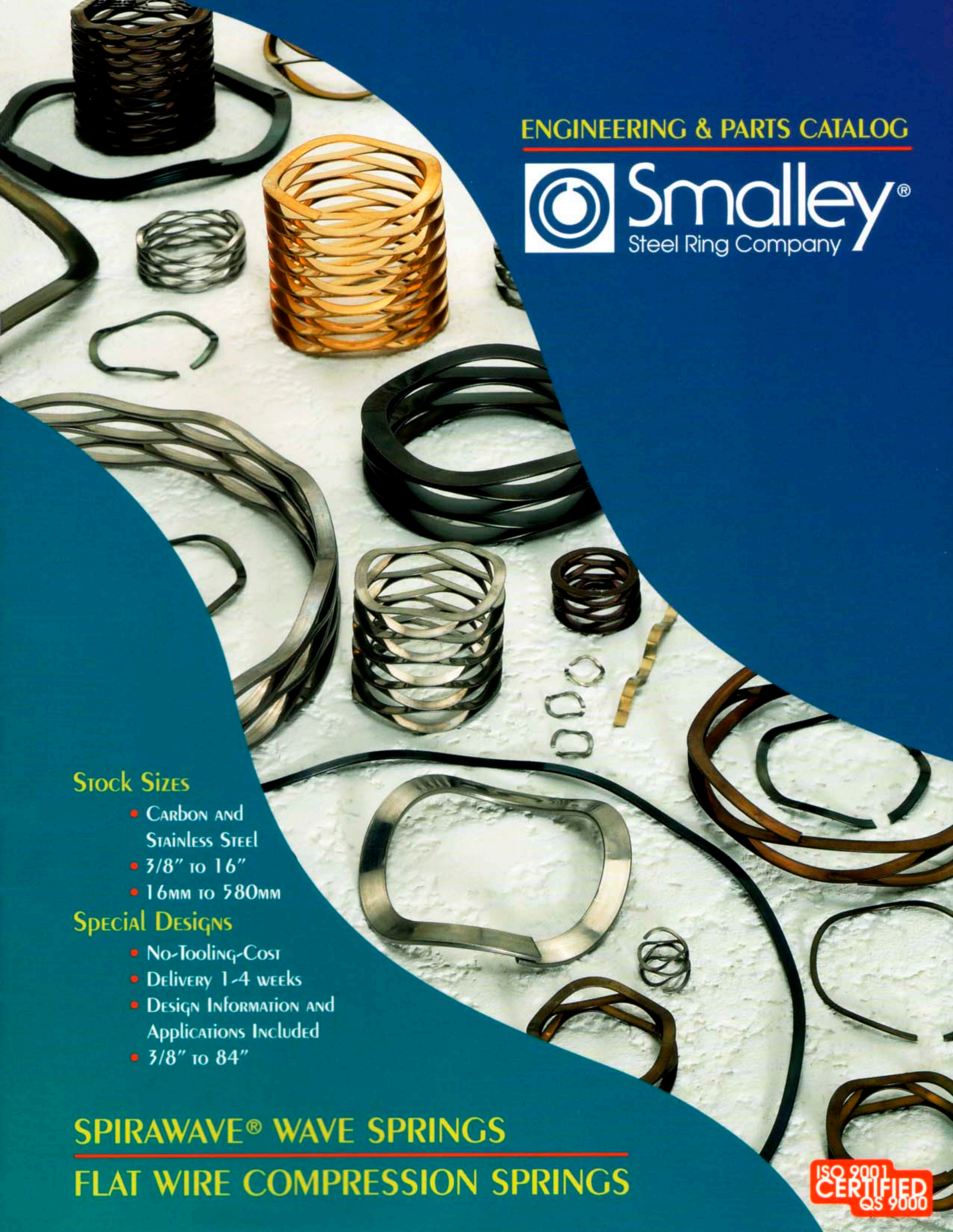
ENGINEERING & PARTS CATALOG

Smalley®
Steel Ring Company



Stock Sizes

- Carbon and Stainless Steel
- 3/8" to 16"
- 16mm to 580mm

Special Designs

- No-Tooling-Cost
- Delivery 1-4 weeks
- Design Information and Applications Included
- 3/8" to 84"

SPIRAWAVE® WAVE SPRINGS

FLAT WIRE COMPRESSION SPRINGS

ISO 9001 CERTIFIED QS 9000

Smalley Steel Ring Company

The Company

Founded in 1918 as a supplier of precision automotive piston rings, today's Smalley Steel Ring Company has earned a unique position in the industrial retaining ring and wave/compression spring business.

Every Smalley ring, shim and spring is engineered to the highest standards of quality and manufactured using skills and processes perfected over half a century. This stubborn insistence on quality, coupled with nearly 100% on-time delivery, has made Smalley the preferred source in the most demanding applications from automotive and aerospace to appliance and industrial.

The Circular-Grain® Process

Smalley's exclusive Circular-Grain process edgewinds pre-hardened spring tempered flat wire to exact tolerances. Unlike wave washers which are stamped through the metal grain, edge-wound wave springs have a circumferential grain structure which provides exceptional strength, dimensional stability and predictable, uniform loading.

In applications where axial and radial space is limited and precise loading is critical, Smalley wave springs have performed where other springs cannot. The Circular-Grain process is the key to producing consistently high performance springs.

The No-Tooling-Cost Process

The Circular-Grain process does not require any special tooling. Low quantity custom orders and development prototypes are produced quickly and economically. Accommodating design changes and/or optimizing prototypes requires no tooling modifications and no-tooling-charges.

In high quantities, the edge-winding process maximizes flexibility and minimizes material waste. Flexibility allows for tight control and statistical monitoring for consistent high quality. A process which is inherently efficient allows us to offer superior products at competitive prices.

Smalley recognizes the increasing value of a timely response to the urgent delivery needs of its' customers. Smalley is dedicated to providing a prompt, professional and courteous response in every facet of design, manufacturing, sales and customer service.

INDEX

STOCK SPRINGS

for Same-Day Shipment

Over 1000 Wave Springs and Flat Wire Compression Springs are stocked at Smalley for immediate shipment. Your orders are processed and shipped as requested or within 24 hours.

Smalley springs are available standard in SAE 1070-1090 carbon steel and 17-7 PH stainless steel.

They are stocked in diameters ranging from 3/8" to 16" and metric sizes 16mm to 580mm.

Smalley can split shipments to suit your "just-in-time" delivery requirements. Orders for annual, higher usage requirements let you take advantage of Smalley's lower prices. Contact Smalley direct for complete details and ideas on how you can purchase economically.

SPECIAL SPRINGS

Made-To-Order

It's easy to get a custom spring from Smalley. With **No-Tooling-Charges**, die costs or other fixture charges a new spring design can be manufactured in one week, or as required to meet your delivery schedules.

Smalley's engineering staff would like to assist with your application requirements. Over the past 35 years, Smalley engineers have built an extensive library of over 5000 applications designing springs in mechanical assemblies. Computer-aided spring design is at our finger tips and only minutes away from your fax machine.

Fast, precise and economical; Smalley springs are available for short-run quantities or in high-volume production. If you can't find a standard spring in our catalog that meets your needs, please contact our engineering department to assist with your special spring design requirements. Smalley springs are available from 3/8" to 84" in diameter.

Quality Assurance

Smalley's Total Quality Management philosophy dictates our commitment to Quality and Customer Satisfaction. Quality Assurance and Customer Satisfaction are traditions at Smalley and are the foundation from which we have built our company. From the beginning, we have never lost sight of our goal - **"to supply Smalley customers with uncompromising quality and service."** We have established and are continuously improving upon a program that is geared to meet the following objectives:

- Total product conformance in terms of drawings, specifications and contractual requirements.
- 100% on-time delivery performance.
- To provide superior products with exceptional value.
- Dedication to providing a prompt, professional and courteous response in every facet of design, manufacturing, sales and customer service.
- Continued development and use of the latest technology.

Smalley's history of quality and strict compliance with military and aerospace standards has earned Smalley an approved supplier status with many leading original equipment manufacturers, worldwide. This has established Smalley as the preferred source for spiral retaining rings and wave springs.

In accordance with the requirements of ISO 9001, QS 9000 and AS 9000, we have established and are continuously improving upon our quality systems. Use of the latest technology, which includes statistical tools, has helped us achieve and maintain world-class quality associated with the Smalley name for more than 35 years.

SPECIAL QUALITY REQUIREMENTS

Special quality requirements are available and should be requested when ordering.

Typical requirements include:

Certifications
- Material certification
- Certification of conformance
- Special process certification

Quality Requirements
- MIL-DTL-27426
- AS 3219
- MA 4035
- ANSI Z1.4
- SPC

Non-destructive testing
- Fluorescent penetrant inspection
- Magnetic particle inspection

ISO 9001 CERTIFIED QS 9000

Smalley®
Steel Ring Company

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(847) 719-5900 • Fax: (847) 719-5999
www.smalley.com • info@smalley.com

Manufactured in U.S.A.

ORDERING

STOCK SPRINGS (For special springs refer to pages 36-37)

(847) 719-5900 • FAX: (847) 719-5999

FOR STANDARD CATALOG SPRINGS SPECIFY ALL 3 REQUIREMENTS:

1. SERIES/SIZE	PREFIX
(See series options & page numbers below)	
A. STANDARD SINGLE-TURN	SSR
B. BEARING PRELOAD	SSB
C. NARROW SECTION SINGLE-TURN	SSR-N
D. CREST-TO-CREST	C
E. CREST-TO-CREST, SQUARED-SHIM ENDS	CS
F. SHIM	SSRS

2. MATERIAL	SUFFIX
STANDARD	
A. CARBON STEEL SAE 1070-1090	—
B. 17-7 PH C/CH-900 STAINLESS STEEL	S17
SPECIAL	
A. 302 STAINLESS STEEL	S02
B. INCONEL X-750	INX
C. A-286	A86
D. 316 STAINLESS STEEL	S16
E. ELGILOY	LGY

3. FINISH	SUFFIX
STANDARD	
A. CARBON STEEL-**OIL DIP**	-
B. STAINLESS STEEL-**VAPOR DEGREASE AND ULTRASONIC CLEAN**	-
SPECIAL	
A. PASSIVATION	PA
B. BLACK OXIDE	BA
C. PHOSPHATE COAT	PS
D. VIBRATORY DEBURR	DV

	SERIES	PAGES
SINGLE TURN STOCK SPRINGS — 1/2" to 16" Diameters, 16mm to 580mm Diameters	SSR	12 - 13
	SSB	14 - 17
	SSR-N	18
CREST-TO-CREST STOCK SPRINGS — 3/8" to 2" Diameters	C	20 - 25
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SINGLE TURN

STOCK SPRINGS

1/2" to 16" Diameters
16mm to 580mm Diameters

Overlap Type

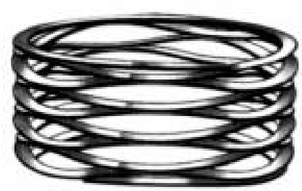
Gap Type

CREST-TO-CREST

STOCK SPRINGS

3/8" to 2" Diameters

Plain Ends



Squared-Shim Ends

NESTED

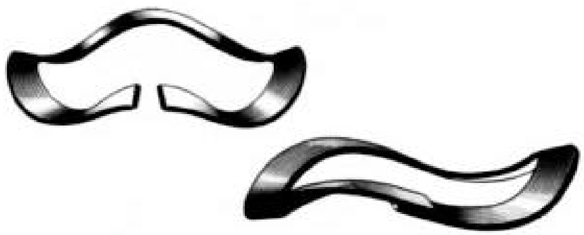
LINEAR EXPANDER

SHIM

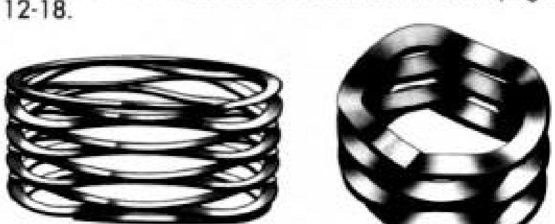
ENGINEERING DESIGN DATA AND APPLICATIONS

for Edgewound Wave/Compression Springs

Smalley wave/compression springs are load bearing, non-binding axial compression springs that function in static and/or dynamic conditions. They are ideal for limited space applications.



Single turn gap or overlap type wave springs, illustrated above, are standard Smalley catalog items. They can be ordered from stock, and are suitable for a majority of applications. The wide range of bore and rod diameters, loading capacities, work and free heights, number of waves and thicknesses available are described on pages 12-18.



Flat Wire Compression Springs (Crest-To-Crest Springs, series stacked), illustrated above, are available from stock in a wide variety of loads, deflections and diameters. They are compact in size, will replace conventional round wire springs and occupy 1/3 to 1/2 the axial space of round wire springs. Ideal for the tightest load/deflection specifications, please refer to pages 20-25 for complete stock parts tables.

Nested Spirawave® Wave Spring (Parallel-Stacked). This multiple turn wave spring increases the spring rate proportionally to the number of turns. It exerts tremendous force and often replaces Belleville spring washers. Spirawave wave springs, stacked in parallel, are specified where high but accurate force must be maintained.

Spirawave wave springs —stacked either nested or crest-to-crest, are edgewound like a spring into an integral one-piece unit; not stamped individually and then assembled into a stack composed of many pieces. Smalley's proprietary edgewinding process forms Spirawave springs from pre-tempered round-edge flat wire into a single stacked unit. The number of turns are governed by the load/deflection specification. Secondary manual assembly operations such as shimming, riveting or welding are eliminated by the edgewinding process. Spirawave springs are superior functioning compression/wave springs.

SMALLEY'S NO TOOLING METHOD

Circular-Grain® metallurgy. Figure 1 shows how Smalley's proprietary edgewinding manufacturing process forms the flat wire – and consequently its grain – so it flows circumferentially, conforming to the circular shape and wave contour of the wave spring. This Circular-Grain metallurgy permits Smalley to attain closer tolerances, superior mechanical properties and uniform dimensional stability.

Edgewinding is a precise manufacturing method. It eliminates tooling. Smalley's proprietary edgewinding process is also the most flexible method of manufacturing springs. Diameters and wave forms are not dependent on fixed die diameters or wave form tooling. Should your requirements or specifications change, at Smalley there's no costly re-tooling charges for changing or replacing special dies or fixtures.

Wave/compression springs are formed from one continuous length of spring pretempered flat wire; an "infinite" number of turns is possible. Springs are manufactured in diameters from 3/8" to 84".

In applications where product designers encounter important or critical tolerances, they many times revise their designs from the stamped type wavy washer to the Smalley Circular-Grain wave/compression spring. The Smalley method is ideal for prototypes, developments and short runs.

Smalley flat wire edgewinding process. (Circular-Grain®) Available from stock

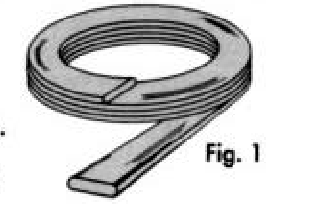


Fig. 1

The process of edgewinding pretempered round edge flat wire produces wave springs with uniform circular-grain micro structures and smooth exterior surfaces free of pits, scratches, cracks, seams and other imperfections. Deburring or tumbling is not required. The use of pretempered flat wire eliminates distortion due to hardening heat treatment. Wave/compression springs are edgewound from hardened/spring temper flat wire.

Sheet or strip stamping process. (Cross-Grain)

The stamping process produces a washer that is bent or formed into a wavy washer with cross-cut grains. Hardening at high temperatures tends to distort the annealed material. Tumbling is usually required to remove burrs and sharp edges.

DEFINING THE SMALLEY EDGEWOUND SPIRAWAVE® SPRING

Smalley's unique edgewound wave/compression springs are distinguished from traditional die stamped wavy washers by a proprietary manufacturing process. All Smalley springs are continuous-coiled from a single filament of pre-tempered, round-edge flat wire into a precisely dimensioned end product. Note that this coiling process results in a *circumferential flow* of the metal grain, versus the cross-cut grain of the die stamped washer.

This exclusive procedure is known as "edgewinding" and also as Smalley's No-Tooling-Cost process. By comparison to the traditional method of die stamping wavy washers, the Smalley process has offered industry; (1) a wave spring of superior quality and performance and (2) significant advantages in terms of flexibility for design, prototype work, rework and production.

PRODUCT DESCRIPTION

Wave springs operate as load bearing devices. They take up play and compensate for dimensional variations within assemblies. A virtually unlimited range of forces can be produced whereby loads build either gradually or abruptly to reach a predetermined working height. This establishes a precise spring rate in which load is proportional to deflection.

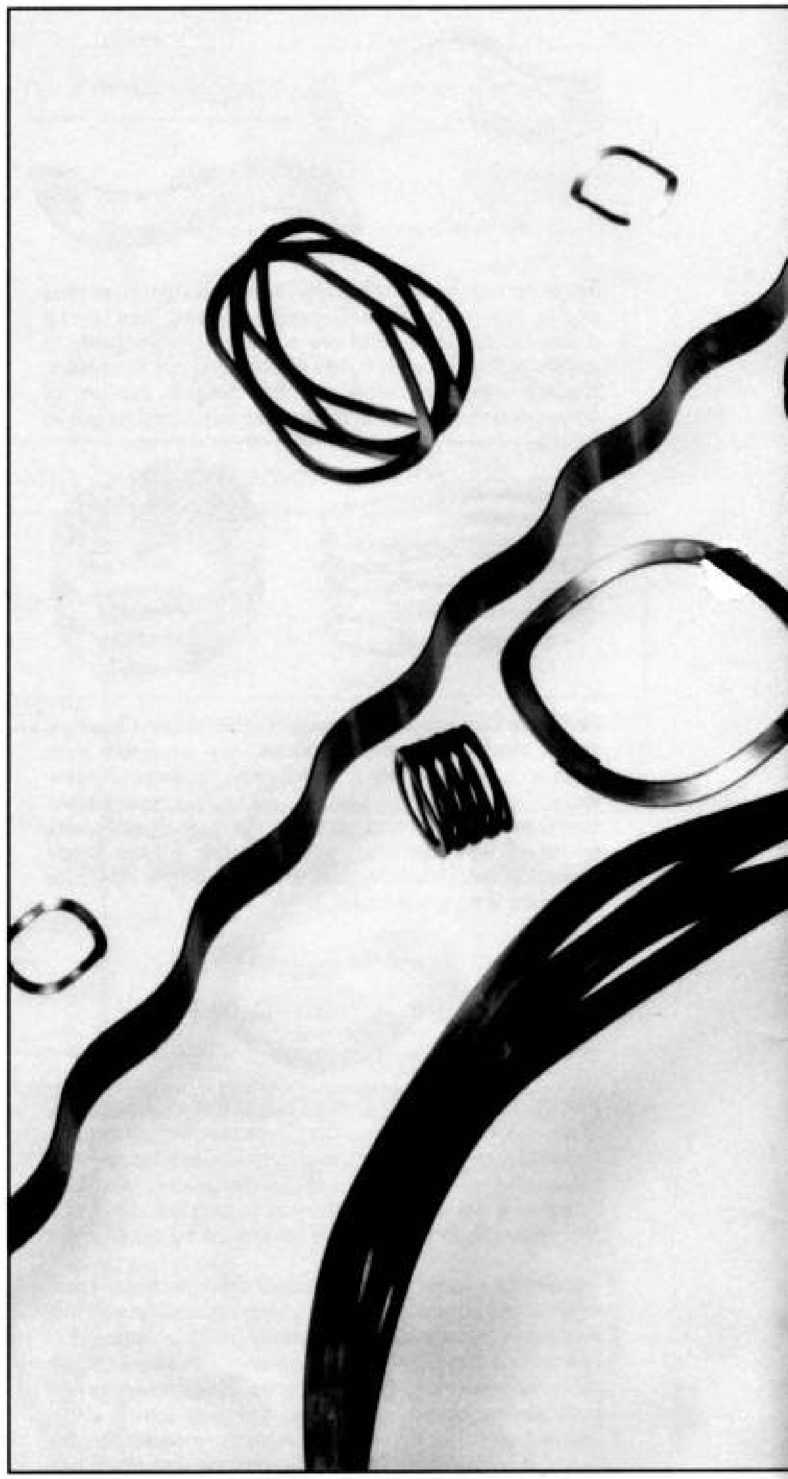
Functional requirements are necessary for both dynamic and static spring applications. Special performance characteristics are individually built into each spring to satisfy a variety of precise operating conditions. Typically, a wave spring will occupy an extremely small area for the amount of work it performs. The use of this product is demanded, but not limited to tight axial and radial space restraints.

PRODUCT PERFORMANCE

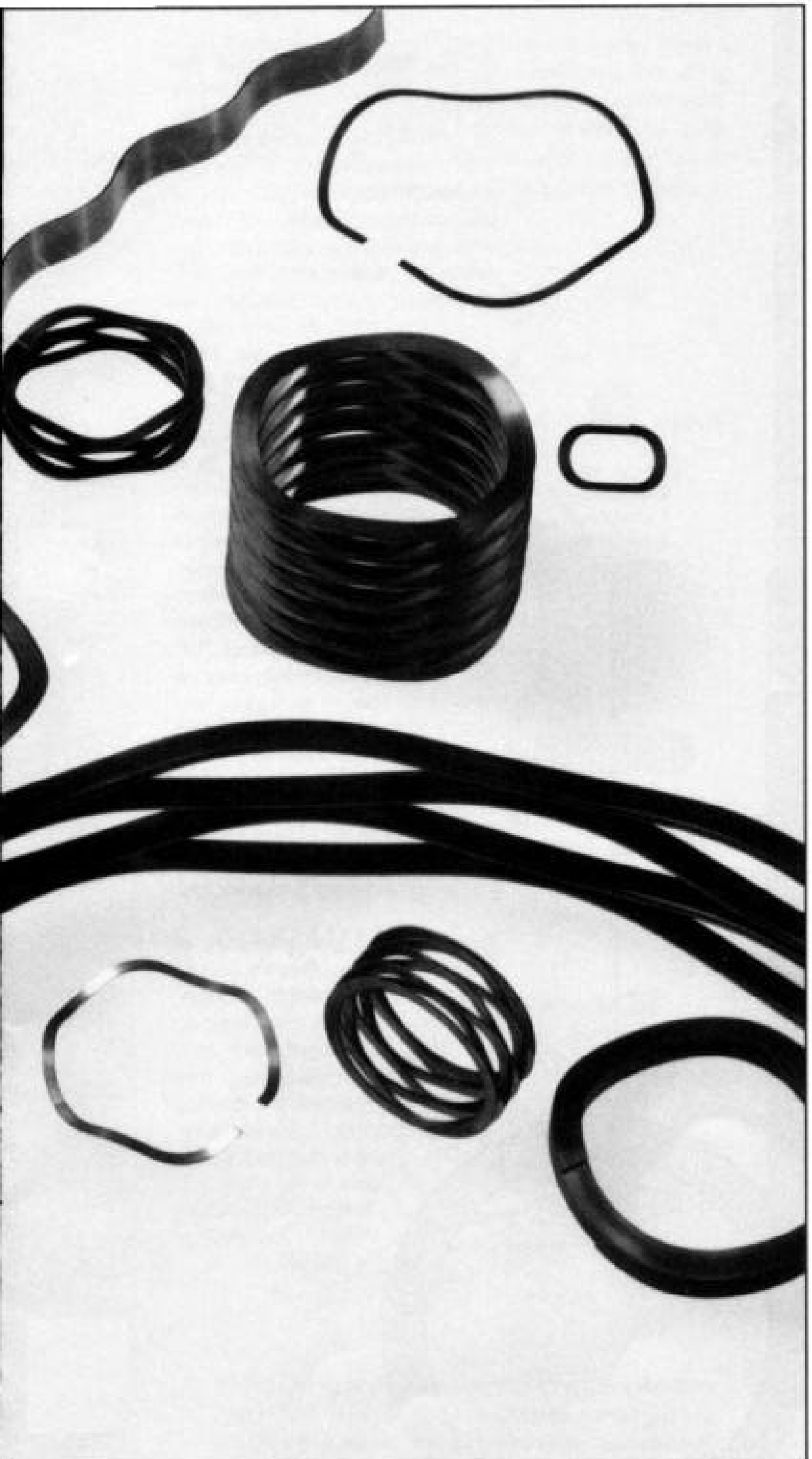
Given their smooth, circular coiled sinusoidal waveform, and rolled round edges of the pre-tempered raw material, the advantages of Smalley edgewound wave springs over die stamped products are many.

Loads and spring rates are more accurate, more predictable, and may be toleranced better than 50 percent tighter than stampings. The force of a Smalley wave spring will increase at a uniform rate throughout most of its available deflection.

By any criteria, Smalley wave springs offer their users higher dependability and better performance. Since they are produced from full hard, pre-tempered raw material, there is no risk of distorting the spring due to a hardening heat treatment. Wave springs produced by the edgewinding process are characterized by smooth, exterior surfaces free of pits, scratches, cracks and other minute imperfections. By contrast, subsequent manufacturing procedures for stamped wavy washers can lead to problems such



as fatigue cracking and inaccurate or inconsistent loading between springs. All told, the metallurgy, the mechanical properties and the uniform dimensional stability of the Smalley edgewound wave spring provide a component for precision quality applications.



ADDED BENEFITS OF THE 'NO-TOOLING-COST' PROCESS

While resulting in wave springs of precision quality, the No-Tooling-Cost process offers our customers the further advantages of manufacturing flexibility. The edgewinding process allows low to high production without the need for stamping dies. The time, costs and limiting factors of initial tooling (or subsequent retooling) never enter the picture. Instead, the dimensions of the springs to be edgewound are established *by making precise machine adjustments.*

Clearly, this capability also eliminates the many problems that normally accompany design, development and prototype work. Prototypes can be designed and tested on a trial-and-error basis with relatively little cost. The prototype may be economically produced, tried, modified and reproduced many times.

Once a design is established, a subsequent need to change dimensions may be accomplished with similar ease. Again, no special tooling or die charges are incurred. Changes in design are accomplished with simple machine adjustments. Any spring dimension can be altered to obtain the new spring rate requirement or operating characteristic. For example, if O.D. clearance becomes a problem, the raw material width (radial wall) is changed to allow for a proper fit. Then by adjusting any other dimension, the spring rate specified can be matched. Number of waves, number of turns, free height, material thickness and radial wall are easily adjusted to virtually any specification.

GAP AND OVERLAP TYPE WAVE SPRINGS

Conventional gap and overlap type wave springs are used in a wide variety of applications. For short deflections and low-medium forces, they function with precision and dependability.

These two types of Smalley wave springs permit radial expansion or growth in diameter within a cavity, without the binding or hang-up normally associated with die stamped wavy washers. Just as their terms imply, the gap type is split to retain a gap between the ends; while the overlap type has overlapping split ends. Thus, the ends are free to move circumferentially as the spring outside diameter grows during compression.

In an example situation, the O.D. of a gap type wave spring would fit .020 loose per side in a bore. Its I.D. clears a shaft by .010 per side. As the spring is deflected, the O.D. and I.D. grow larger until the O.D. contacts the bore. Continued deflection causes the gap ends to move closer together while the O.D. presses against the bore. An overlap type wave spring permits this type of cycling action in a similar manner.

NESTED AND CREST-TO-CREST SPIRAWAVE® FLAT WIRE COMPRESSION SPRINGS

"Spirawave" Springs are circle-coiled, either in parallel or series, as integral units. With this design, the older methods of mechanically attaching wave springs together, by means of special keys, rivets, spot welds or other procedures are no longer necessary. The continuous-coiled Spirawave provides a precise and accurate package that has eliminated the need for additional, cumbersome production steps.

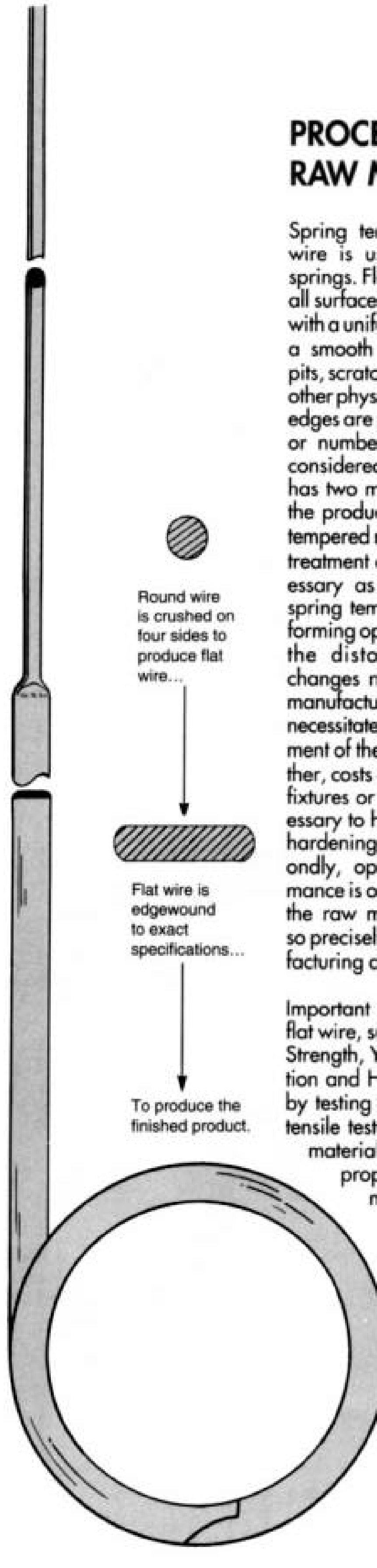
The Spirawave design has introduced a new concept in spring applications, creating a broader selection of configurations. With limited radial and axial space, wave spring load/deflection characteristics can be multiplied and divided to obtain a wider range of spring rates. This results from the multiple-turn Nested Spirawave, and multiple-turn Crest-to-Crest Spirawave configurations. Both configurations are constructed from a *continuous filament* of pre-tempered flat wire, similar in style to a helical compression spring.

NESTED SPIRAWAVES are pre-stacked in parallel, *increasing* the spring rate proportional to the number of turns. They can exert tremendous forces, yet maintain the precision of a circular-grain wave spring. In many applications, Nested Spirawaves replace Belleville spring washers, particularly in cases in where high but accurate forces are specified.

CREST-TO-CREST SPIRAWAVES are pre-stacked in series, *decreasing* the spring rate proportional to the number of turns. Uses are typically, (1) applications requiring low-medium spring rates and (2) large deflections with low-medium forces. Among major advantages, this design eliminates the need to keep the wave crests aligned. The need to use a key locating device, or to insert a shim between individual springs is not necessary. Because the spring is integrally formed, the wave peaks hold their configuration.

As a replacement for helical compression springs, the Crest-to-Crest Spirawave can develop similar forces, yet occupy one-third (1/3) or less the axial space. This allows for strict axial space constraints. The Crest-to-Crest Spirawave will maintain the same deflection and load specifications of a conventional round wire spring, but with the advantages of resultant lowered and compacted operating heights and solid height.

It is necessary to calculate the O.D. growth for Nested and Crest-to-Crest Spirawave springs. The O.D. should not contact the bore in which it operates at the maximum deflection, which is normally the working height.



PROCESSING OF RAW MATERIAL

Spring temper round-edge flat wire is used in forming wave springs. Flat wire is cold rolled on all surfaces to produce a material with a uniform microstructure and a smooth outer surface free of pits, scratches, cracks, seams and other physical discontinuities. The edges are rolled round (number 1 or number 4 round edges are considered normal). Cold rolling has two main advantages. First, the product is formed from pre-tempered materials. A hardening treatment after forming is unnecessary as the material is in a spring temper state prior to any forming operations. This prevents the distortion and physical changes normally seen in other manufacturing processes which necessitate a hardening heat treatment of the finished product. Further, costs are kept minimal as no fixtures or special tooling is necessary to hold the parts during a hardening heat treatment. Secondly, optimum spring performance is obtained. By controlling the raw material characteristics so precisely, a high spring manufacturing accuracy is obtainable.

Important physical properties of flat wire, such as Ultimate Tensile Strength, Yield Strength, Elongation and Hardness are obtained by testing equipment, such as a tensile tester. All incoming raw materials are certified to these properties. Lab test equipment is certified traceable to the National Institute of Standard and Technology (NIST).

MATERIALS

The table below presents alloys available and most commonly used for **Smalley Wave/Compression Springs**:

MATERIAL	MATERIAL THICKNESS, IN.	MINIMUM TENSILE STRENGTH, PSI	SHEAR STRENGTH, PSI	RECOMMENDED OPERATING LIMIT TEMP, °F(3)	MODULUS OF ELASTICITY, PSI
CARBON SPRING	.006 -.014	269,000	153,000		
TEMPER STEEL	.0141-.021	255,000	145,000	250	30×10^6
SAE 1070-1090	.0211-.043	221,000	126,000		
	.0431 & larger	211,000	120,000		
AISI 302	.008 -.022	210,000	119,000		
AMS-5866	.0221-.047	200,000	114,000		
	.0471-.062	185,000	105,000	400	28×10^6
	.0621-.074	175,000	100,000		
	.0741-.089	165,000	94,000		
	.0891-.095	155,000	88,000		
AISI 316	.008 - .023	195,000	111,000		
ASTM A313 (1)	.0231-.048	190,000	108,000	400	28×10^6
	.0481-.061	175,000	99,000		
	.0611 & larger	170,000	97,000		
17-7 PH CONDITION C/CH-900 AMS-5529		240,000 (2)	137,000 (2)	650	29.5×10^6
BERYLLIUM COPPER ALLOY NO. 25 ASTM B197 (1)		185,000 (2)	128,000 (2)	400	18.5×10^6
PHOSPHOR					
BRONZE	.010 -.025	106,000	61,000	200	16×10^6
GRADE A	.0251-.036	95,000	54,000		
QQ-B-750 (1)	.0361 & larger	90,000	51,000		
INCONEL X-750* AMS-5699 (4)		SPRING TEMPER 220,000, R_C 50 MAX (2)	125,000 (2)	700	31×10^6
AMS-5699 (1)		R_C 35 MAX 136,000 REF	77,000	700	
AMS-5699 (5)		150,000 (2)	85,000 (2)	1300	
AMS-5698		# 1 TEMPER 155,000 (2)	88,000 (2)	1000	
A286 AMS-5810		180,000 (2)	105,000 (2)	1000	31×10^6
ELGILOY*	.0043-.025	280,000 (2)	160,000 (2)		
AMS-5876 (1)(4)(5)	.0251-.047	255,000 (2)	145,000 (2)	800	30×10^6
	.0471-.075	205,000 (2)	117,000 (2)		
	.0751-.100	160,000 (2)	91,000 (2)		
MONEL K-500		R_C 25 MIN	68,000	550	26×10^6
QQ-N-286 (1)		170,000 (2)	97,000 (2)	550	

(1) Referenced for chemical composition only.
(2) Values obtained after precipitation hardening .
(3) Exceeding these temperatures will cause increased relaxation.
(4) Use in H_2S service. Conforms to NACE Standard MR-01-75.
(5) High Temperature Service. Consult Smalley Engineering.

MATERIALS SELECTION GUIDE

Selecting the proper material for an application requires a general knowledge of what is commonly available for use in Smalley flat wire products. Specifying the correct material can prevent additional cost and failure in operation. Carbon steel is the most commonly specified material. Stainless steels, although more costly than carbon steel, provide far superior corrosion resistance and have higher temperature operating limits.

In addition to these standard materials Smalley *produces in-house* a wide selection of alloys.

MATERIAL TYPES

CARBON STEEL

Carbon Spring Temper Steel
SAE 1070-1090 high carbon blue tempered polished spring steel is a standard material for wave/compression springs. It is best suited for applications that have a protected environment, as carbon steel corrodes if not lubricated or atmospherically sealed. Additional corrosion protection can be added with special finishes, as shown on page 11. Products are normally supplied with an oil dip finish providing adequate protection for shipment and shelf storage.

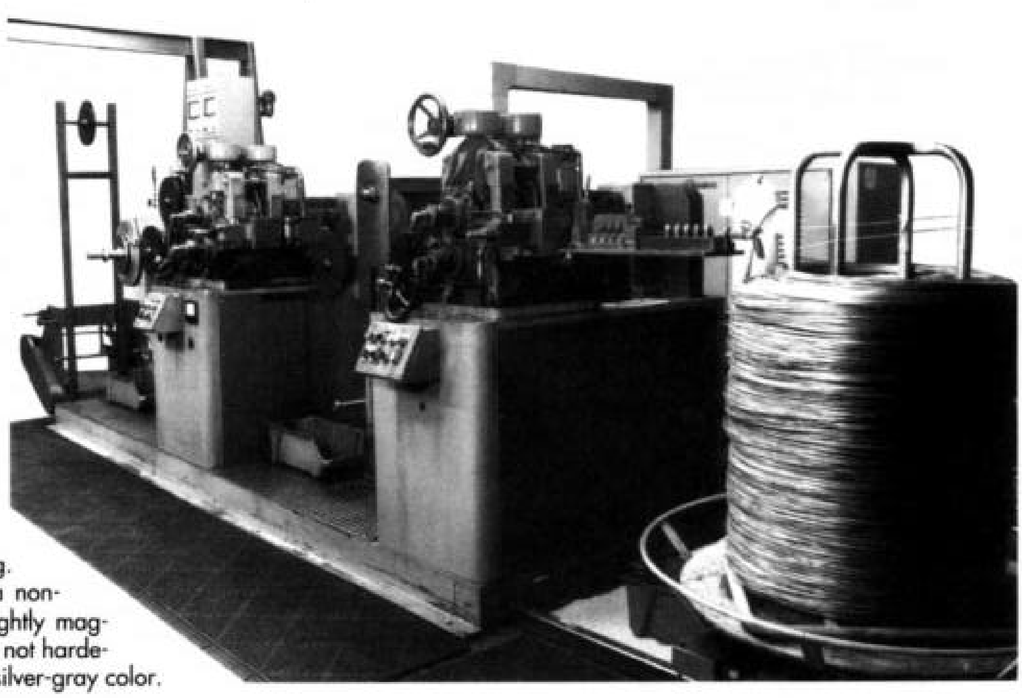
Carbon steel is highly magnetic and is typically blue in color.

STAINLESS STEELS

17-7 PH/C Stainless Steel
Similar in corrosion resistance to type 302, this standard alloy is used almost exclusively for wave/compression springs and offers both high tensile and yield strengths for special spring applications. In fatigue and high stress applications 17-7 out performs even the finest grade of carbon steel.

Spring properties are achieved by precipitation hardening Condition C to Condition CH-900. As a result, the material may be subjected to a temperature of 650°F without a loss of spring properties. 17-7 PH C/CH-900 exhibits magnetism similar to high carbon steel. After precipitation hardening, 17-7 has a blue to brown color from heat treatment, although atmosphere controlled heat treatments provide a bright color.

302 Stainless Steel
302 is the standard stainless steel for Spiral Retaining Rings, although it may be specified for certain spring applications. This widely used material is specified because of its combination of corrosion resistance and physical properties. 302 obtains its spring temper condition by cold working. Though it is categorized as being a non-magnetic stainless, 302 becomes slightly magnetic as a result of cold working. It is not hardenable by heat treatment. 302 has a silver-gray color.



316 Stainless Steel
Nearly identical in physical properties and heat resistance to 302, 316 provides additional corrosion resistance, particularly against pitting, due to its molybdenum chemical content. 316 is generally used in food, chemical and sea water applications.

316 shows less magnetism than 302. However, as with 302, magnetism increases as the wire is cold reduced. This stainless grade is also not hardenable by heat treatment. 316 has a silver-gray color.

SUPER ALLOYS

Inconel X-750*
This nickel-chromium alloy is used most commonly in high temperature and corrosive environments. Two commonly specified tempers of inconel are described below.

Most commonly, inconel X-750 is precipitation heat treated to a **spring temper** condition. In this state, it has temperature resistance to 700° F. The National Association of Corrosion Engineers **(NACE)** approves this hard temper to Specification MR-01-75 (R_c 50 maximum) for spiral retaining rings and wave/compression springs.

#1 temper, which requires a longer heat treatment than spring temper, has a lower tensile strength but provides temperature protection to 1000° F.

Continued on next page

Both spring temper and #1 temper may be heat treated in either an open air or atmosphere controlled furnace. Open air heat treatment may produce oxidation which often results in a black ash residue. An atmosphere controlled environment eliminates oxidation and produces a component with no residue. Springs and rings manufactured from this grade of inconel have a blue/silver-gray color and exhibit no magnetism.

A286 Alloy

In applications up to 1000°F, this alloy exhibits similar properties to inconel X-750. Its spring temper condition is obtained by precipitation hardening. A286 may be heat treated similar to spring temper and #1 temper inconel. This material exhibits no magnetism and has a blue/silver-gray color.

Elgiloy*

Known for its excellent resistance to corrosive environments and use at elevated temperatures, this relatively new spring material is now readily available to Smalley. Commonly used in Oil Industry applications, Elgiloy shows improved reliability over other NACE approved materials by resisting Sulfide Stress Cracking. Additionally, Elgiloy is said to out perform "over 600% better than 17-7 PH in load retention at 650°F and provide over 100% more cycles (in fatigue resistance) than carbon steel, without breakage."

Elgiloy exhibits no-magnetism and is blue/brown in color as a result of heat treatment.

COPPERS

Beryllium Copper, Alloy #25

Normally specified in a $^{1}/_{2}$ hard temper, this alloy produces excellent spring properties due to a combination of low modulus of elasticity and high ultimate tensile strength. The alloy gains its physical properties by precipitation hardening. In contrast to other copper alloys, beryllium copper has the highest strength and offers remarkable resistance to loss of physical properties at elevated temperatures.

Beryllium copper is nonmagnetic. Its electrical conductivity is about 2-4 times as great as phosphor bronze.

Phosphor Bronze, Grade A

Phosphor bronze offers fair spring properties, fair electrical conductivity and is rated a step below beryllium copper in performance. It is purchased in a spring temper condition to maximize spring characteristics.

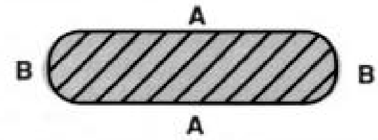
Phosphor bronze is hardenable only by cold working. This material is also magnetic.

SPECIFICATIONS

Federal, aerospace and other regulating agencies have prepared several specifications for sheet and strip materials, but few have been published for flat wire. Smalley procures its material to internally generated specifications. In addition to controlling tensile strength, rigid inspection procedures have been established to check for edge contour, physical imperfections, camber, cross-section and chemical composition.

ULTIMATE TENSILE STRENGTH

Ultimate tensile strength is the preferred test method over hardness because spring temper flat wire develops different hardnesses at various indentation points. As a result of cold rolling, the top and bottom surfaces ("A") become harder as they are more severely worked than the round edge areas ("B"). Tensile tests are more consistent as they evaluate the entire cross-section, not a single-point as in a hardness test.



MATERIAL FINISHES

Black Oxide Coating

MIL-DTL-13924, class 1 (carbon steel).
This finish provides a flat black finish. Black oxide is intended more for cosmetic appearance than for corrosion resistance.

Oil Dip

This is the standard finish for all Smalley products produced from carbon steel. The oil provides resistance to corrosion in transport and normal storage. The oil dip finish should not be considered a permanent finish.

Passivation

AMS-QQ-P-35, type II.
Passivation is an optional cleaning operation for stainless steel. It provides a bright finish and increased corrosion resistance.

Passivation dissolves iron particles and other substances which have become imbedded in the surface of stainless steel during production. If not dissolved, these foreign particles could promote rusting, discoloration or pitting.

In theory, the corrosion resistance of stainless steel is due to the thin, invisible oxide film that completely covers the surface of the spring and prevents further oxidation. Removing the contaminates prevents breaks in the oxide film for optimum corrosion resistance.

Phosphate Coating

MIL-DTL-16232, Type Z, class 2.
This finish is sometimes referred to as "parkerizing" and appears gray/black in color. The corrosion resistance of phosphate is superior to black oxide but inferior to stainless steel. Phosphate cannot be applied to stainless steel.

Vapor Degrease/Ultrasonic Clean

This is the standard cleaning and finish for all stainless steels. The process removes oil and other organic compounds from the material surface by use of a chlorinated solvent. The solvent effectively removes oil and grease from the exposed surfaces of the ring. Ultrasonics are used in forcing the solvent to act between the turns of the spring.

Vibratory Deburr/Hand Deburr

Though all circumferential surfaces and edges of Smalley Springs are smooth, sharp corners are always present on the gap ends due to the cut-off operation. To break the sharp corners achieving a blended/smooth surface finish, rings may be either vibratory or hand deburred to meet your specifications.

*Elgiloy is a registered trademark of The Elgiloy Company.
Inconel X-750 is a registered trandemark of Inco Alloys Int'l.

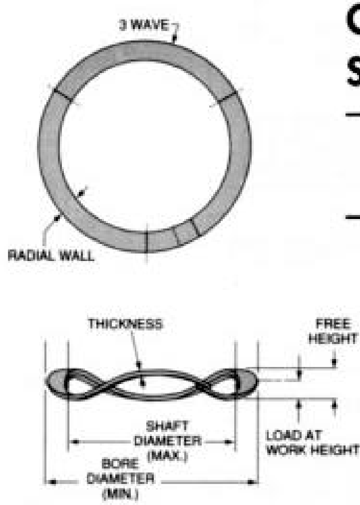
SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

STANDARD SECTION SPRINGS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel

OVERLAP TYPE 3 WAVES
SSR-0050 THRU SSR-0162

SSR series



SMALLEY PART NUMBER*	OPERATES IN BORE DIAMETER	CLEARS SHAFT DIAMETER	WAVE SPRING LOAD (LBS.)	WORK HEIGHT	FREE HEIGHT**	NUMBER OF WAVES	THICK-NESS ***	RADIAL WALL ***	"V" RING PACKING ROD	GLAND
SSR-0050	.50	.40	7	.050	.085	3	.008	.040	–	–
SSR-0062	.62	.48	10	.050	.095	3	.010	.058	–	–
SSR-0075	.75	.50	14	.062	.16	3	.010	.078	1/4	3/4
SSR-0087	.87	.62	16	.062	.13	3	.012	.094	3/8	7/8
SSR-0100	1.00	.78	18	.062	.16	3	.012	.094	1/2	1
SSR-0112	1.12	.84	20	.078	.13	3	.016	.133	5/8	1 1/8
SSR-0125	1.25	.96	22	.078	.15	3	.016	.133	3/4	1 1/4
SSR-0137	1.37	1.09	24	.078	.19	3	.016	.133	7/8	1 3/8
SSR-0150	1.50	1.17	26	.078	.17	3	.018	.143	1	1 1/2
SSR-0162	1.62	1.31	28	.078	.20	3	.018	.143	1 1/8	1 5/8

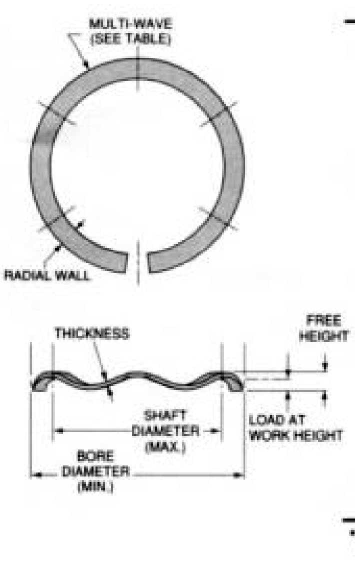
*ADD SUFFIX -S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THICKNESS AND RADIAL WALL SUBJECT TO CHANGE

STANDARD SECTION SPRINGS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel

GAP TYPE 4 WAVES & UP
SSR-0175 THRU SSR-1600

SSR series



SMALLEY PART NUMBER*	OPERATES IN BORE DIAMETER	CLEARS SHAFT DIAMETER	WAVE SPRING LOAD (LBS.)	WORK HEIGHT	FREE HEIGHT**	NUMBER OF WAVES	THICK-NESS ***	RADIAL WALL ***	"V" RING PACKING ROD	GLAND
SSR-0175	1.75	1.44	30	.078	.14	4	.018	.143	1 1/4	1 3/4
SSR-0187	1.87	1.56	32	.078	.15	4	.018	.143	1 1/4	1 7/8
SSR-0200	2.00	1.68	34	.093	.14	4	.024	.150	1 3/8	2
SSR-0212	2.12	1.80	36	.093	.15	4	.024	.150	1 1/2	2 1/8
SSR-0225	2.25	1.93	38	.093	.17	4	.024	.150	1 5/8	2 1/4
SSR-0237	2.37	1.99	40	.093	.16	4	.024	.178	1 3/4	2 3/8
SSR-0250	2.50	2.12	42	.093	.17	4	.024	.178	1 7/8	2 1/2
SSR-0262	2.62	2.24	44	.093	.19	4	.024	.178	2	2 5/8
SSR-0275	2.75	2.34	46	.109	.17	4	.030	.188	2 1/8	2 3/4
SSR-0287	2.87	2.47	48	.109	.18	4	.030	.188	2 1/4	2 7/8
SSR-0300	3.00	2.59	50	.109	.19	4	.030	.188	2 3/8	3
SSR-0312	3.12	2.71	52	.109	.21	4	.030	.188	2 1/2	3 1/8
SSR-0325	3.25	2.75	54	.109	.20	4	.030	.233	2 1/2	3 1/4
SSR-0337	3.37	2.84	56	.109	.22	4	.030	.233	2 5/8	3 3/8
SSR-0350	3.50	3.00	58	.109	.23	4	.030	.233	2 3/4	3 1/2
SSR-0362	3.62	3.12	60	.109	.24	4	.030	.233	2 7/8	3 5/8

*ADD SUFFIX -S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THICKNESS AND RADIAL WALL SUBJECT TO CHANGE

SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

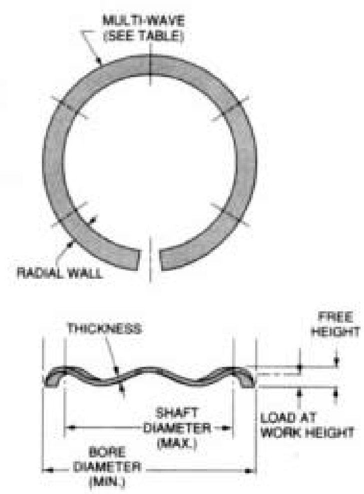
STANDARD SECTION SPRINGS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel

SSR series

GAP TYPE 4 WAVES & UP
SSR-0175 THRU SSR-1600

SMALLEY PART NUMBER*	OPERATES IN BORE DIAMETER	CLEARS SHAFT DIAMETER	WAVE SPRING LOAD (LBS.)	WORK HEIGHT	FREE HEIGHT**	NUMBER OF WAVES	THICK-NESS ***	RADIAL WALL ***	"V" RING PACKING ROD	GLAND
SSR-0375	3.75	3.25	62	.109	.26	4	.030	.233	3	3 3/4
SSR-0387	3.87	3.37	64	.109	.30	4	.030	.233	3 1/8	3 7/8
SSR-0400	4.00	3.50	66	.109	.19	5	.030	.233	3 1/4	4
SSR-0412	4.12	3.62	67	.109	.20	5	.030	.233	3 3/8	4 1/8
SSR-0425	4.25	3.74	69	.109	.21	5	.030	.233	3 1/2	4 1/4
SSR-0437	4.37	3.86	70	.109	.21	5	.030	.233	3 5/8	4 3/8
SSR-0450	4.50	3.99	72	.109	.23	5	.030	.233	3 3/4	4 1/2
SSR-0462	4.62	4.11	73	.125	.27	5	.030	.233	3 7/8	4 5/8
SSR-0475	4.75	4.24	75	.125	.31	5	.030	.233	3 7/8	4 3/4
SSR-0487	4.87	4.37	76	.125	.29	5	.030	.233	4	4 7/8
SSR-0500	5.00	4.49	78	.125	.31	5	.030	.233	4 1/8	5
SSR-0512	5.12	4.61	80	.125	.34	5	.030	.233	4 1/4	5 1/8
SSR-0525	5.25	4.74	82	.125	.37	5	.030	.233	4 3/8	5 1/4
SSR-0537	5.37	4.86	84	.125	.38	5	.030	.233	4 1/2	5 3/8
SSR-0550	5.50	4.99	86	.125	.25	6	.030	.233	4 5/8	5 1/2
SSR-0562	5.62	5.11	88	.125	.27	6	.030	.233	4 3/4	5 5/8
SSR-0575	5.75	5.24	90	.125	.28	6	.030	.233	4 7/8	5 3/4
SSR-0587	5.87	5.36	92	.125	.30	6	.030	.233	5	5 7/8
SSR-0600	6.00	5.49	94	.125	.30	6	.030	.233	5 1/8	6
SSR-0612	6.12	5.61	96	.125	.31	6	.030	.233	5 1/4	6 1/8
SSR-0625	6.25	5.73	98	.125	.34	6	.030	.233	5 3/8	6 1/4
SSR-0637	6.37	5.86	100	.125	.35	6	.030	.233	5 1/2	6 3/8
SSR-0650	6.50	5.98	102	.125	.39	6	.030	.233	5 5/8	6 1/2
SSR-0675	6.75	6.23	104	.125	.42	6	.030	.233	5 3/4	6 3/4
SSR-0700	7.00	6.16	106	.156	.32	6	.032	.375	6	7
SSR-0725	7.25	6.44	108	.156	.35	6	.032	.375	6 1/4	7 1/4
SSR-0750	7.50	6.69	110	.156	.36	6	.032	.375	6 1/2	7 1/2
SSR-0775	7.75	6.94	114	.156	.38	6	.032	.375	6 3/4	7 3/4
SSR-0800	8.00	7.19	118	.156	.39	6	.032	.375	7	8
SSR-0825	8.25	7.44	122	.156	.43	6	.032	.375	7 1/4	8 1/4
SSR-0850	8.50	7.68	126	.156	.34	7	.032	.375	7 1/2	8 1/2
SSR-0875	8.75	7.93	130	.156	.34	7	.032	.375	7 3/4	8 3/4
SSR-0900	9.00	8.18	134	.156	.29	8	.032	.375	8	9
SSR-0950	9.50	8.68	142	.156	.24	9	.032	.375	8 1/2	9 1/2
SSR-1000	10.00	9.17	150	.156	.29	9	.032	.375	9	10
SSR-1050	10.50	9.67	158	.156	.31	9	.032	.375	9 1/2	10 1/2
SSR-1100	11.00	10.17	166	.156	.35	9	.032	.375	10	11
SSR-1150	11.50	10.66	174	.156	.36	9	.032	.375	10 1/2	11 1/2
SSR-1200	12.00	11.16	182	.156	.44	9	.032	.375	11	12
SSR-1250	12.50	11.66	190	.156	.35	10	.032	.375	11 1/2	12 1/2
SSR-1300	13.00	12.16	198	.156	.41	10	.032	.375	12	13
SSR-1350	13.50	12.65	206	.156	.43	10	.032	.375	12 1/2	13 1/2
SSR-1400	14.00	13.15	214	.156	.30	12	.032	.375	13	14
SSR-1450	14.50	13.65	221	.156	.32	12	.032	.375	13 1/2	14 1/2
SSR-1500	15.00	14.13	230	.156	.35	12	.032	.375	14	15
SSR-1550	15.50	14.64	239	.156	.31	13	.032	.375	14 1/2	15 1/2
SSR-1600	16.00	15.14	248	.156	.34	13	.032	.375	15	16

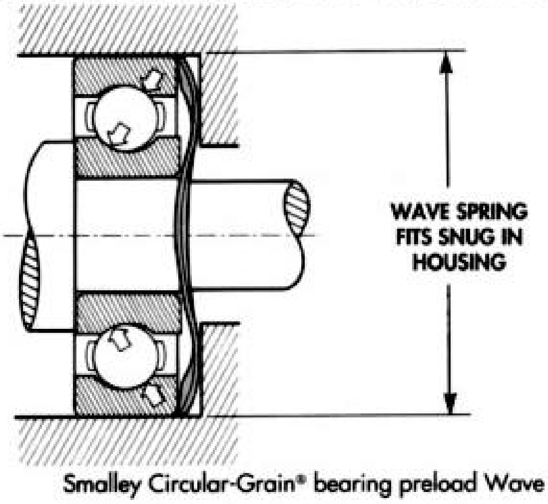


*ADD SUFFIX –S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THICKNESS AND RADIAL WALL SUBJECT TO CHANGE

SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

BEARING PRELOAD SPRINGS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel



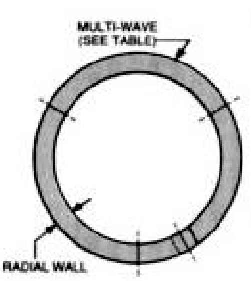
Smalley Circular-Grain® bearing preload Wave Springs eliminate play and minimize bearing noise.

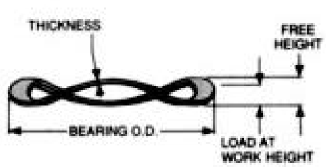
The constant light/medium pressure they apply removes play between the ball bearings and the bearings' inner and outer races.

Preloading can reduce the possibility of bearing damage due to vibration (vibratory loading) and wear due to repetitive and non-repetitive runout.

SSB series (All dimensions in metric)

OVERLAP TYPE 3 & 4 WAVES SSB-0063 THRU SSB-0374





SMALLEY PART NUMBER*	BEARING O.D. ** (mm)	WAVE SPRING SPECIFICATIONS LOAD NEWTONS	WORK HEIGHT	FREE HEIGHT ***	NUMBER OF WAVES	THICK-NESS	RADIAL WALL	SPRING RATE ****
SSB-0063	16	44.5	1.57	2.29	3	.25	1.98	65
SSB-0075	19	53.4	1.57	3.05	3	.25	1.98	35
SSB-0087	22	62.3	1.57	2.79	3	.30	2.39	48
SSB-0095	24	66.7	1.57	3.56	3	.30	2.39	35
SSB-0102	26	71.2	1.98	2.54	3	.41	3.38	111
SSB-0110	28	75.6	1.98	2.79	3	.41	3.38	85
SSB-0118	30	84.5	1.98	3.30	3	.41	3.38	66
SSB-0126	32	89.0	1.98	3.81	3	.41	3.38	52
SSB-0138	35	97.9	1.98	4.57	3	.41	3.38	38
SSB-0146	37	102.3	1.98	3.81	3	.46	3.63	58
SSB-0158	40	111.2	1.98	5.08	3	.46	3.63	37
SSB-0165	42	115.7	1.98	3.05	4	.46	3.63	99
SSB-0185	47	129.0	1.98	3.81	4	.46	3.63	68
SSB-0205	52	142.4	2.36	3.56	4	.61	3.81	121
SSB-0217	55	151.3	2.36	3.81	4	.61	3.81	100
SSB-0244	62	169.1	2.36	4.32	4	.61	4.52	85
SSB-0268	68	186.9	2.77	4.32	4	.76	4.78	131
SSB-0276	70	191.3	2.77	4.32	4	.76	4.78	119
SSB-0284	72	195.8	2.77	4.57	4	.76	4.78	108
SSB-0295	75	204.7	2.77	5.08	4	.76	4.78	94
SSB-0315	80	218.0	2.77	5.59	4	.76	4.78	76
SSB-0335	85	231.4	2.77	5.59	4	.76	5.92	83
SSB-0354	90	249.2	2.77	6.35	4	.76	5.92	68
SSB-0374	95	262.5	2.77	7.37	4	.76	5.92	57

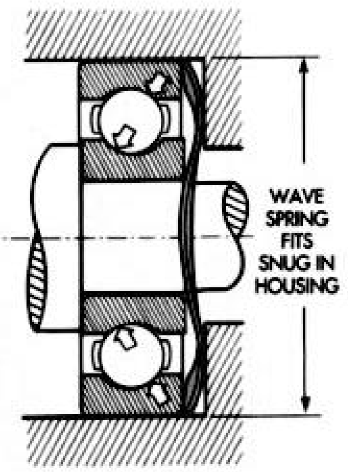
* ADD SUFFIX – S17 FOR STAINLESS STEEL ** WAVE SPRINGS FIT SNUG IN HOUSING ***REFERENCE ****THEORETICAL (N/mm) FOR REFERENCE ONLY

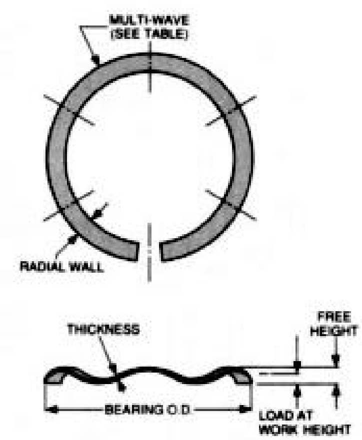
BEARING PRELOAD SPRINGS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel

GAP TYPE 5 WAVES AND UP SSB series

SMALLEY PART NUMBER*	BEARING O.D.** (mm)	WAVE SPRING SPECIFICATIONS LOAD NEWTONS	WORK HEIGHT	FREE HEIGHT ***	NUMBER OF WAVES	THICK-NESS	RADIAL WALL	SPRING RATE ****
SSB-0394	100	275.9	2.77	4.57	5	.76	5.92	157
SSB-0413	105	289.2	2.77	5.08	5	.76	5.92	134
SSB-0433	110	302.6	2.77	5.33	5	.76	5.92	115
SSB-0453	115	315.9	3.18	6.35	5	.76	5.92	99
SSB-0472	120	329.3	3.18	7.11	5	.76	5.92	86
SSB-0492	125	342.6	3.18	7.62	5	.76	5.92	76
SSB-0512	130	356.0	3.18	8.64	5	.76	5.92	67
SSB-0532	135	369.3	3.18	9.40	5	.76	5.92	59
SSB-0551	140	382.7	3.18	6.86	6	.76	5.92	108
SSB-0571	145	396.0	3.18	7.37	6	.76	5.92	97
SSB-0591	150	404.9	3.18	7.87	6	.76	5.92	87
SSB-0630	160	440.5	3.18	9.40	6	.76	5.92	71
SSB-0650	165	453.9	3.18	10.41	6	.76	5.92	64
SSB-0669	170	467.2	3.18	11.18	6	.76	5.92	58
SSB-0689	175	480.6	3.96	8.13	6	.81	9.53	116
SSB-0709	180	493.9	3.96	8.64	6	.81	9.53	105
SSB-0728	185	507.3	3.96	9.14	6	.81	9.53	97
SSB-0748	190	520.6	3.96	9.91	6	.81	9.53	88
SSB-0787	200	547.3	3.96	7.11	7	.81	9.53	174
SSB-0807	205	560.7	3.96	7.37	7	.81	9.53	161
SSB-0827	210	578.5	3.96	7.87	7	.81	9.53	149
SSB-0847	215	591.8	3.96	8.38	7	.81	9.53	138
SSB-0866	220	605.2	3.96	8.64	7	.81	9.53	128
SSB-0886	225	618.5	3.96	7.11	8	.81	9.53	203
SSB-0906	230	631.9	3.96	6.10	9	.81	9.53	303
SSB-0925	235	645.2	3.96	6.35	9	.81	9.53	283
SSB-0945	240	658.6	3.96	6.35	9	.81	9.53	265
SSB-0984	250	685.3	3.96	6.86	9	.81	9.53	232
SSB-1024	260	712.0	3.96	7.37	9	.81	9.53	205
SSB-1043	265	725.3	3.96	7.62	9	.81	9.53	193
SSB-1063	270	743.1	3.96	8.13	9	.81	9.53	182
SSB-1102	280	769.8	3.96	8.64	9	.81	9.53	162
SSB-1142	290	796.5	3.96	9.40	9	.81	9.53	144
SSB-1181	300	823.2	3.96	10.41	9	.81	9.53	129
SSB-1221	310	849.9	3.96	7.11	9	1.07	9.53	264
SSB-1260	320	876.6	3.96	7.62	9	1.07	9.53	239
SSB-1339	340	934.5	3.96	8.64	9	1.07	9.53	198
SSB-1378	350	961.1	3.96	9.40	9	1.07	9.53	180
SSB-1417	360	987.9	3.96	7.62	10	1.07	9.53	271
SSB-1457	370	1014.6	3.96	8.13	10	1.07	9.53	249
SSB-1496	380	1041.3	3.96	8.64	10	1.07	9.53	229
SSB-1535	390	1072.4	3.96	9.14	10	1.07	9.53	211
SSB-1575	400	1099.1	3.96	9.65	10	1.07	9.53	196
SSB-1614	410	1125.8	3.96	8.38	10	1.07	12.70	251
SSB-1654	420	1152.5	3.96	8.89	10	1.07	12.70	233
SSB-1693	430	1179.2	3.96	7.62	11	1.07	12.70	317
SSB-1732	440	1205.9	3.96	8.13	11	1.07	12.70	295
SSB-1811	460	1263.7	3.96	8.89	11	1.07	12.70	256
SSB-1890	480	1317.1	3.96	8.13	12	1.07	12.70	318
SSB-1969	500	1370.5	3.96	8.89	12	1.07	12.70	280
SSB-2126	540	1481.8	3.96	8.89	13	1.07	12.70	303
SSB-2284	580	1593.0	3.96	8.89	14	1.07	12.70	327





* ADD SUFFIX – S17 FOR STAINLESS STEEL ** WAVE SPRINGS FIT SNUG IN HOUSING *** REFERENCE **** THEORETICAL (N/mm) FOR REFERENCE ONLY

CROSS-REFERENCE GUIDE

For Bearing Preload Applications, Using Smalley Wave Springs

Use the table below to select the appropriate wave spring for your bearing size. The numbers represent typical standard bearing part numbers and/or the suffix of a standard bearing size.

SMALLEY PART NUMBER*	BEARING O.D.** (mm)	BEARING PART NUMBERS						
		EXTRA SMALL	EXTREMELY LIGHT	EXTRA LIGHT	NARROW	LIGHT	MEDIUM	HEAVY
SSB-0063	16	34	-	-	-	-	-	-
SSB-0075	19	35,36	-	-	-	-	-	-
SSB-0087	22	37,38	00	-	-	-	-	-
SSB-0095	24	38KV	01	-	-	-	-	-
SSB-0102	26	39	-	100	-	-	-	-
SSB-0110	28	-	02	101	-	-	-	-
SSB-0118	30	-	03	-	-	200	-	-
SSB-0126	32	-	-	102	02	201	-	-
SSB-0138	35	-	-	103	-	202	300	-
SSB-0146	37	-	04	-	03	-	301	-
SSB-0158	40	-	-	-	-	203	-	-
SSB-0165	42	-	05	104	04	-	302	-
SSB-0185	47	-	06	105	-	204	303	-
SSB-0205	52	-	-	-	05	205	304	-
SSB-0217	55	-	07	106	-	-	-	-
SSB-0244	62	-	08	107	06	206	305	403
SSB-0268	68	-	09	108	-	-	-	-
SSB-0276	70	-	-	-	07	-	-	-
SSB-0284	72	-	10	-	-	207	306	404
SSB-0295	75	-	-	109	-	-	-	-
SSB-0315	80	-	11	110	08	208	307	405
SSB-0335	85	-	12	-	09	209	-	-
SSB-0354	90	-	13	111	10	210	308	406
SSB-0374	95	-	-	112	-	-	-	-
SSB-0394	100	-	14	113	11	211	309	407
SSB-0413	105	-	15	-	12	-	-	-
SSB-0433	110	-	16	114	-	212	310	408
SSB-0453	115	-	-	115	13	-	-	-
SSB-0472	120	-	17	-	14	213	311	409
SSB-0492	125	-	18	116	-	214	-	-
SSB-0512	130	-	19	117	15	215	312	410
SSB-0532	135	-	-	-	16	-	-	-
SSB-0551	140	-	20	118	-	216	313	411
SSB-0571	145	-	21	119	17	-	-	-
SSB-0591	150	-	22	120	18	217	314	412
SSB-0630	160	-	-	121	19	218	315	413
SSB-0650	165	-	24	-	20	-	-	-
SSB-0669	170	-	-	122	-	219	316	-

*ADD SUFFIX – S17 FOR STAINLESS STEEL **WAVE SPRINGS FIT SNUG IN HOUSING ***CHECK BEARING DIMENSIONS

CROSS-REFERENCE GUIDE

For Bearing Preload Applications, Using Smalley Wave Springs

Use the table below to select the appropriate wave spring for your bearing size. The numbers represent typical standard bearing part numbers and/or the suffix of a standard bearing size.

(CONTINUED)

SMALLEY PART NUMBER*	BEARING O.D.** (mm)	BEARING PART NUMBERS: EXTRA SMALL	EXTREMELY LIGHT	EXTRA LIGHT	NARROW	LIGHT	MEDIUM	HEAVY
SSB-0689	175	-	-	-	22***	-	-	-
SSB-0709	180	-	26	124	21	220	317	414
SSB-0728	185	-	-	-	22***	-	-	-
SSB-0748	190	-	28	-	24	221	318	415
SSB-0787	200	-	-	126	-	222	319	416
SSB-0807	205	-	-	-	26	-	-	-
SSB-0827	210	-	30	128	-	-	-	417
SSB-0847	215	-	-	-	-	224	320	-
SSB-0866	220	-	32	-	28	-	-	-
SSB-0886	225	-	-	130	-	-	321	418
SSB-0906	230	-	34	-	-	226	-	-
SSB-0925	235	-	-	-	30	-	-	-
SSB-0945	240	-	-	132	-	-	322	-
SSB-0984	250	-	36	-	32	228	-	419
SSB-1024	260	-	38	134	-	-	324	-
SSB-1043	265	-	-	-	34	-	-	420
SSB-1063	270	-	-	-	-	230	-	-
SSB-1102	280	-	40	136	36	-	326	-
SSB-1142	290	-	-	138	-	232	-	421
SSB-1181	300	-	-	-	38	-	328	-
SSB-1221	310	-	-	140	-	234	-	-
SSB-1260	320	-	-	-	40	236	330	422
SSB-1339	340	-	-	144	42	238	332	-
SSB-1378	350	-	-	-	44	-	-	-
SSB-1417	360	-	-	148	-	240	334	-
SSB-1457	370	-	-	-	46	-	-	-
SSB-1496	380	-	-	-	-	-	336	-
SSB-1535	390	-	-	-	48	-	-	-
SSB-1575	400	-	-	152	-	244	338	-
SSB-1614	410	-	-	-	50	-	-	-
SSB-1654	420	-	-	156	-	-	340	-
SSB-1693	430	-	-	-	52	-	-	-
SSB-1732	440	-	-	-	-	248	342	-
SSB-1811	460	-	-	160	56	-	344	-
SSB-1890	480	-	-	164	-	252	-	-
SSB-1969	500	-	-	-	64	256	348	-
SSB-2126	540	-	-	-	-	260	352	-
SSB-2284	580	-	-	-	-	264	356	-

*ADD SUFFIX – S17 FOR STAINLESS STEEL **WAVE SPRINGS FIT SNUG IN HOUSING ***CHECK BEARING DIMENSIONS

SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

NARROW SECTION SPRINGS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel

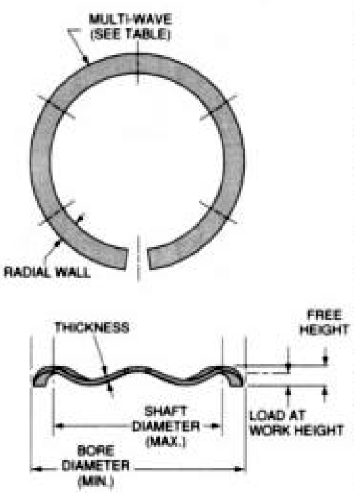
SSR-N series

GAP TYPE 4 WAVES & UP

NARROW SECTION WAVE SPRINGS

Smalley narrow section wave springs were originally designed to pre-load packings in telescoping hydraulic cylinders. They have also found other applications where working space is highly limited. This Smalley wave spring series is designed to fit into a bore with a light snap to assure perfect concentricity between the wave spring and assembly. When these narrow section wave springs are compressed, radial expansion is taken up by the gap in the spring to eliminate binding. Clearances between the inner and outer parts of an assembly can be maintained without danger of the wave spring coming into contact with the inner rod.

Smalley stocks narrow section wave springs in carbon steel and 17-7 stainless steel. Many popular metric sizes are also available.



SMALLEY PART NUMBER*	OPERATES IN BORE DIAMETER	CLEARS SHAFT DIAMETER	WAVE SPRING LOAD (LBS.)	WORK HEIGHT	FREE HEIGHT**	NUMBER OF WAVES	THICK-NESS ***	RADIAL WALL ***
SSR-0325-N	3.25	2.82	54	.109	.20	4	.030	.188
SSR-0337-N	3.37	2.94	56	.109	.22	4	.030	.188
SSR-0350-N	3.50	3.07	58	.109	.26	4	.030	.188
SSR-0362-N	3.62	3.19	60	.109	.27	4	.030	.188
SSR-0375-N	3.75	3.32	62	.109	.28	4	.030	.188
SSR-0387-N	3.87	3.44	64	.109	.31	4	.030	.188
SSR-0400-N	4.00	3.57	66	.109	.20	5	.030	.188
SSR-0412-N	4.12	3.69	67	.109	.20	5	.030	.188
SSR-0425-N	4.25	3.82	69	.109	.24	5	.030	.188
SSR-0437-N	4.37	3.94	70	.109	.21	5	.030	.188
SSR-0450-N	4.50	4.07	72	.109	.28	5	.030	.188
SSR-0462-N	4.62	4.19	73	.125	.27	5	.030	.188
SSR-0475-N	4.75	4.32	75	.125	.32	5	.030	.188
SSR-0487-N	4.87	4.44	76	.125	.32	5	.030	.188
SSR-0500-N	5.00	4.57	78	.125	.35	5	.030	.188
SSR-0512-N	5.12	4.69	80	.125	.35	5	.030	.188
SSR-0525-N	5.25	4.82	82	.125	.36	5	.030	.188
SSR-0537-N	5.37	4.94	84	.125	.44	5	.030	.188
SSR-0550-N	5.50	5.07	86	.125	.28	6	.030	.188
SSR-0562-N	5.62	5.19	88	.125	.29	6	.030	.188
SSR-0575-N	5.75	5.32	90	.125	.34	6	.030	.188
SSR-0587-N	5.87	5.44	92	.125	.34	6	.030	.188
SSR-0600-N	6.00	5.57	94	.125	.34	6	.030	.188
SSR-0612-N	6.12	5.69	96	.125	.28	7	.030	.188
SSR-0625-N	6.25	5.82	98	.125	.28	7	.030	.188
SSR-0637-N	6.37	5.94	100	.125	.30	7	.030	.188
SSR-0650-N	6.50	6.07	102	.125	.30	7	.030	.188
SSR-0675-N	6.75	6.32	104	.125	.30	7	.030	.188
SSR-0700-N	7.00	6.48	106	.156	.32	7	.030	.233
SSR-0725-N	7.25	6.73	108	.156	.33	7	.030	.233
SSR-0750-N	7.50	6.98	110	.156	.36	7	.030	.233
SSR-0775-N	7.75	7.23	114	.156	.38	7	.030	.233

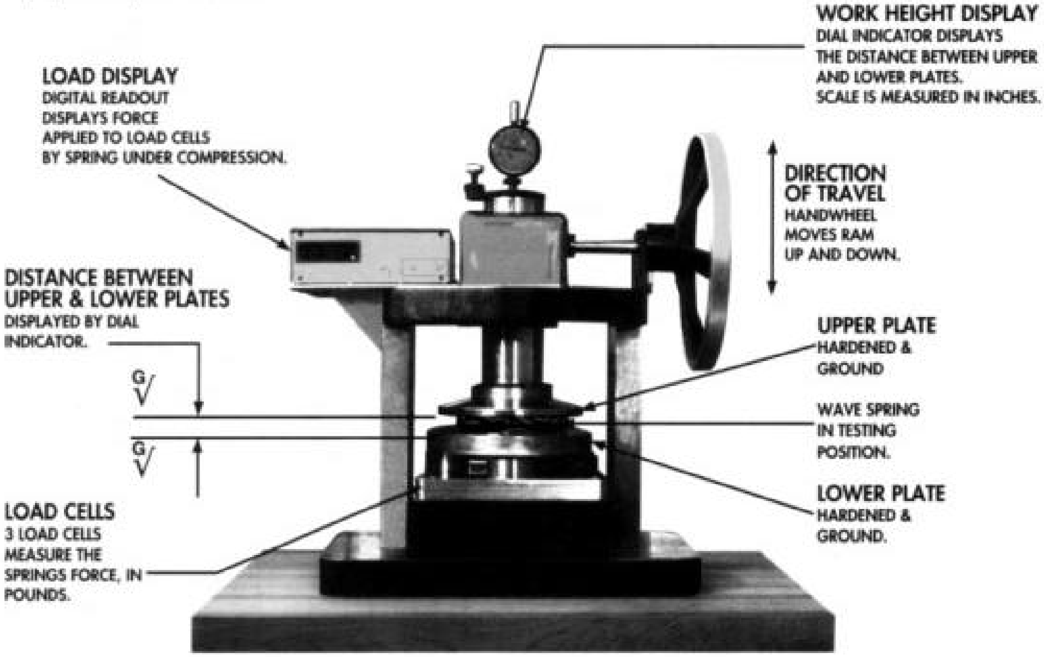
*ADD SUFFIX -S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THICKNESS AND RADIAL WALL SUBJECT TO CHANGE

SPRING TESTER

Springs are inspected for load, deflection, free height and spring rate with this compression spring tester, designed and built by Smalley. Main components of the tester are described below.

The accuracy in checking spring load/deflection characteristics is dependant on the accuracy and precision of the testing device itself. The concept of accurate compression testing relies greatly on the following tester features:

1. Upper and lower plates must remain parallel throughout the test. Generally, the distance between upper and lower plates must be within .002 at any point, from zero to full load.
2. Upper and lower plates must be rigid in that they should not misalign with the spring positioned at any point on the lower plate (note that placing a spring off-center induces a moment, which tends to both tip the plates and cause frictional drag).
3. The load system must be free of friction, which can cause hysteresis in the load values obtained in the test.
4. Testing surfaces of both the lower and upper plates must be smooth and free of scratches, cracks or other physical imperfections.



FATIGUE TESTER

Fatigue cycling is often a consideration when designing compression springs. Using the equations on page 29, an approximate cycle life can be predicted. Testing provides a more accurate prediction of actual cycle life and is recommended whenever cycle life is critical or when calculations show little margin over the cycle requirement.

Ideally, springs should be cycle tested in the actual assembly. Where this is not feasible, Smalley offers testing on high speed cycle machinery. The cycle test machinery can be adjusted to various work heights and stroke lengths to simulate the actual application.

SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

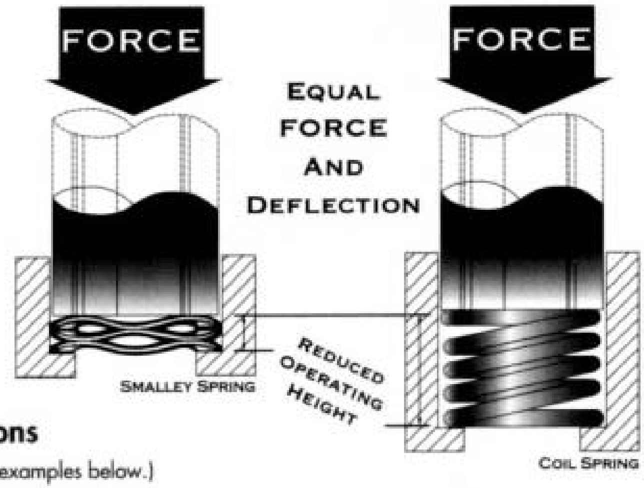
CREST-TO-CREST SPRINGS

STOCK SIZES

in Carbon Steel and Stainless Steel

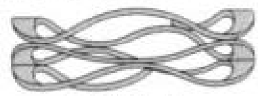
Reduce Spring Heights By 50%

Flat wire reduces the springs solid height allowing lower operating heights, while maintaining the same deflection and spring rate obtained with a round wire spring.



Optional End Configurations

(Specify correct prefix when ordering, following the examples below.)



PLAIN ENDS

(Part Number EXAMPLE: CO62-L1)

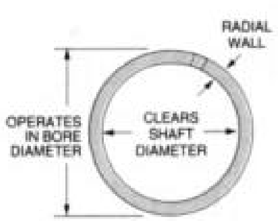
SQUARED-SHIM ENDS

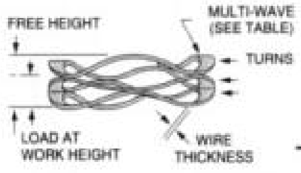
(Part Number EXAMPLE: CSO62-L1)

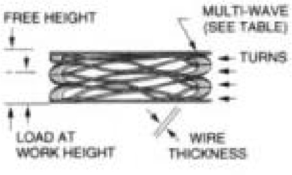
SMALLEY Spirawave®

FLAT WIRE COMPRESSION SPRINGS

C SERIES
CS SERIES







SMALLEY PART NUMBER*†	OPERATES IN BORE DIAMETER (IN.)	CLEARS SHAFT DIAMETER (IN.)	LOAD (LBS.)	WORK HEIGHT (IN.)	FREE HEIGHT ** (IN.)	NUMBER OF TURNS	NUMBER OF WAVES	WIRE THICKNESS X RADIAL WALL (IN.)	SPRING RATE ***
C037-L1				.062	.150	3			45
C037-L2				.098	.200	4			39
C037-L3				.108	.250	5			28
C037-L4				.135	.300	6		.008	24
C037-L5	.375	.250	4	.150	.350	7	2½	X	20
C037-L6				.184	.400	8		.032	19
C037-L7				.195	.450	9			16
C037-L8				.228	.500	10			15
C037-L9				.240	.550	11			13
C037-M1				.081	.150	3			101
C037-M2				.119	.200	4			86
C037-M3				.145	.250	5			67
C037-M4				.180	.300	6		.011	58
C037-M5	.375	.250	7	.202	.350	7	2½	X	47
C037-M6				.240	.400	8		.032	44
C037-M7				.262	.450	9			37
C037-M8				.298	.500	10			35
C037-M9				.327	.550	11			31
C043-L1				.063	.165	3			39
C043-L2				.093	.220	4			31
C043-L3				.109	.275	5			24
C043-L4				.143	.330	6		.008	21
C043-L5	.437	.281	4	.160	.385	7	2½	X	18
C043-L6				.195	.440	8		.040	16
C043-L7				.210	.495	9			14
C043-L8				.240	.550	10			13
C043-L9				.260	.605	11			12
C043-M1				.082	.165	3			96
C043-M2				.115	.220	4			76
C043-M3				.142	.275	5			60
C043-M4				.179	.330	6		.011	53
C043-M5	.437	.281	8	.198	.385	7	2½	X	43
C043-M6				.231	.440	8		.046	38
C043-M7				.255	.495	9			33
C043-M8				.290	.550	10			31
C043-M9				.319	.605	11			28

*ADD SUFFIX – S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THEORETICAL FOR REFERENCE ONLY (LBS/IN)
†(use CS prefix for squared-shim ends/use C prefix as shown above for plain ends)

CREST-TO-CREST SPRINGS

STOCK SIZES

in Carbon Steel and Stainless Steel

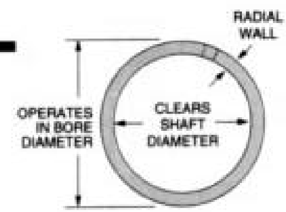
SMALLEY Spirawave®

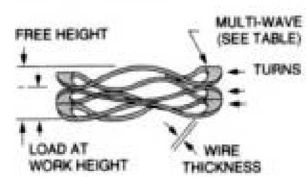
FLAT WIRE COMPRESSION SPRINGS

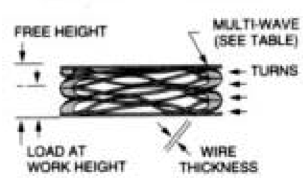
C SERIES
CS SERIES

SMALLEY PART NUMBER*†	OPERATES IN BORE DIAMETER (IN.)	CLEARS SHAFT DIAMETER (IN.)	LOAD (LBS.)	WORK HEIGHT (IN.)	FREE HEIGHT ** (IN.)	NUMBER OF TURNS	NUMBER OF WAVES	WIRE THICKNESS X RADIAL WALL (IN.)	SPRING RATE ***
C050-L1				.062	.180	3			42
C050-L2				.090	.240	4			33
C050-L3				.107	.300	5			26
C050-L4				.136	.360	6			22
C050-L5	.500	.312	5	.150	.420	7	2½	.008 X .056	19
C050-L6				.180	.480	8			17
C050-L7				.195	.540	9			14
C050-L8				.220	.600	10			13
C050-L9				.240	.660	11			12
C050-M1				.065	.180	3			87
C050-M2				.092	.240	4			68
C050-M3				.114	.300	5			54
C050-M4				.147	.360	6			47
C050-M5	.500	.312	10	.162	.420	7	2½	.010 X .058	39
C050-M6				.196	.480	8			35
C050-M7				.207	.540	9			30
C050-M8				.246	.600	10			28
C050-M9				.264	.660	11			25
C056-L1				.080	.195	3			43
C056-L2				.125	.260	4			37
C056-L3				.135	.325	5			26
C056-L4				.180	.390	6			24
C056-L5	.562	.375	5	.190	.455	7	2½	.009 X .058	19
C056-L6				.230	.520	8			17
C056-L7				.260	.585	9			15
C056-L8				.285	.650	10			14
C056-L9				.315	.715	11			13
C056-M1				.086	.195	3			101
C056-M2				.123	.260	4			80
C056-M3				.145	.325	5			61
C056-M4				.187	.390	6			54
C056-M5	.562	.375	11	.209	.455	7	2½	.012 X .060	45
C056-M6				.253	.520	8			41
C056-M7				.273	.585	9			35
C056-M8				.318	.650	10			33
C056-M9				.343	.715	11			30
C062-L1				.055	.180	3			48
C062-L2				.068	.240	4			35
C062-L3				.085	.300	5			28
C062-L4	.625	.450	6	.106	.360	6	2½	.010 X .058	24
C062-L5				.128	.420	7			21
C062-L6				.165	.540	9			16
C062-L7				.202	.660	11			13
C062-L8				.238	.780	13			11
C062-M1				.104	.180	3			158
C062-M2				.130	.240	4			109
C062-M3				.175	.300	5			96
C062-M4	.625	.450	12	.206	.360	6	3½	.010 x .058	78
C062-M5				.246	.420	7			69
C062-M6				.317	.540	9			54
C062-M7				.386	.660	11			44
C062-M8				.454	.780	13			37
C075-L1				.142	.250	3			65
C075-L2				.187	.333	4			48
C075-L3				.246	.417	5			41
C075-L4	.750	.550	7	.285	.500	6	3½	.008 X .071	33
C075-L5				.348	.583	7			30
C075-L6				.446	.750	9			23
C075-L7				.580	1.000	12			17

*ADD SUFFIX – S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THEORETICAL FOR REFERENCE ONLY (LBS/IN)
†(use CS prefix for squared-shim ends/use C prefix as shown above for plain ends)







SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

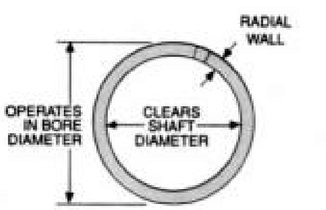
CREST-TO-CREST SPRINGS

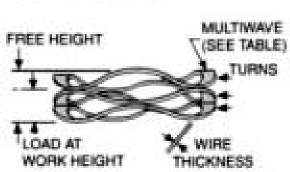
STOCK SIZES

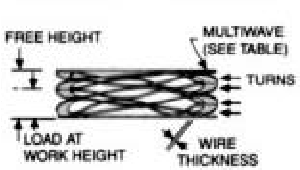
in Carbon Steel and Stainless Steel

SMALLEY Spirawave®
FLAT WIRE COMPRESSION SPRINGS

C SERIES
CS SERIES







SMALLEY PART NUMBER*†	OPERATES IN BORE DIAMETER (IN.)	CLEARS SHAFT DIAMETER (IN.)	LOAD (LBS.)	WORK HEIGHT (IN.)	FREE HEIGHT ** (IN.)	NUMBER OF TURNS	NUMBER OF WAVES	WIRE THICKNESS X RADIAL WALL	SPRING RATE ***
C075-M1				.159	.250	3			143
C075-M2				.203	.333	4			100
C075-M3				.270	.417	5		.010	88
C075-M4	.750	.550	13	.314	.500	6	3½	X	70
C075-M5				.381	.583	7		.078	64
C075-M6				.489	.750	9			50
C075-M7				.649	1.000	12			37
C075-H1				.169	.250	3			272
C075-H2				.215	.333	4			186
C075-H3				.291	.417	5		.013	175
C075-H4	.750	.550	22	.335	.500	6	3½	X	133
C075-H5				.405	.583	7		.079	124
C075-H6				.526	.750	9			98
C075-H7				.699	1.000	12			73
C087-L1				.117	.250	3			90
C087-L2				.158	.333	4			69
C087-L3				.207	.417	5		.010	57
C087-L4	.875	.600	12	.242	.500	6	3½	X	47
C087-L5				.287	.583	7		.086	41
C087-L6				.378	.750	9			32
C087-L7				.498	1.000	12			24
C087-M1				.124	.250	3			148
C087-M2				.164	.333	4			108
C087-M3				.214	.417	5		.012	89
C087-M4	.875	.600	18	.252	.500	6	3½	X	76
C087-M5				.296	.583	7		.094	66
C087-M6				.385	.750	9			50
C087-M7				.509	1.000	12			38
C087-H1				.166	.250	3			298
C087-H2				.214	.333	4			210
C087-H3				.278	.417	5		.015	180
C087-H4	.875	.600	25	.327	.500	6	3½	X	145
C087-H5				.395	.583	7		.094	133
C087-H6				.510	.750	9			104
C087-H7				.670	1.000	12			78
C100-L1				.084	.250	3			72
C100-L2				.108	.333	4			53
C100-L3				.145	.417	5			44
C100-L4				.165	.500	6			36
C100-L5				.201	.583	7		.010	31
C100-L6	1.000	.730	12	.258	.750	9	3½	X	24
C100-L7				.342	1.000	12		.086	18
C100-L8				.445	1.250	15			15
C100-L9				.519	1.500	18			12
C100-L10				.633	1.750	21			11
C100-L11				.710	2.000	24			9
C100-M1				.087	.250	3			110
C100-M2				.113	.333	4			82
C100-M3				.148	.417	5			67
C100-M4				.175	.500	6			55
C100-M5				.212	.583	7		.012	49
C100-M6	1.000	.730	18	.276	.750	9	3½	X	38
C100-M7				.360	1.000	12		.094	28
C100-M8				.452	1.250	15			23
C100-M9				.549	1.500	18			19
C100-M10				.650	1.750	21			16
C100-M11				.720	2.000	24			14
C100-H1				.131	.250	3			210
C100-H2				.174	.333	4			157
C100-H3				.227	.417	5			132
C100-H4				.266	.500	6			107
C100-H5				.319	.583	7		.015	95
C100-H6	1.000	.730	25	.406	.750	9	3½	X	73
C100-H7				.541	1.000	12		.094	54
C100-H8				.688	1.250	15			45
C100-H9				.813	1.500	18			36
C100-H10				.957	1.750	21			32
C100-H11				1.083	2.000	24			27

*ADD SUFFIX – S17 FOR STAINLESS STEEL **FREE HEIGHT IS A REFERENCE DIMENSION ***THEORETICAL FOR REFERENCE ONLY (LBS/IN)
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CREST-TO-CREST SPRINGS

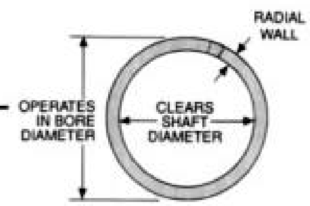
STOCK SIZES

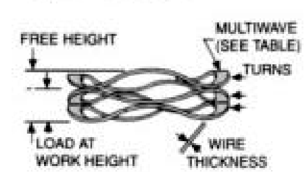
in Carbon Steel and Stainless Steel

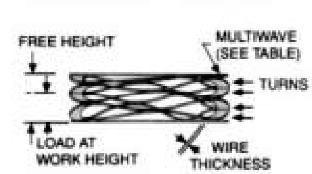
SMALLEY Spirawave® FLAT WIRE COMPRESSION SPRINGS

C SERIES
CS SERIES

SMALLEY PART NUMBER*†	OPERATES IN BORE DIAMETER (IN.)	CLEARS SHAFT DIAMETER (IN.)	LOAD (LBS.)	WORK HEIGHT (IN.)	FREE HEIGHT ** (IN.)	NUMBER OF TURNS	NUMBER OF WAVES	WIRE THICKNESS X RADIAL WALL (IN.)	SPRING RATE ***
C112-L1				.146	.300	3			78
C112-L2				.186	.400	4			56
C112-L3				.250	.500	5			48
C112-L4				.295	.600	6		.012	39
C112-L5	1.125	.850	12	.344	.700	7	3½	X	34
C112-L6				.392	.800	8		.094	29
C112-L7				.488	1.000	10			23
C112-L8				.659	1.300	13			19
C112-L9				.807	1.600	16			15
C112-L10				1.017	2.000	20			12
C112-M1				.160	.300	3			143
C112-M2				.202	.400	4			101
C112-M3				.270	.500	5			87
C112-M4				.318	.600	6		.015	71
C112-M5	1.125	.850	20	.381	.700	7	3½	X	63
C112-M6				.427	.800	8		.094	54
C112-M7				.536	1.000	10			43
C112-M8				.708	1.300	13			34
C112-M9				.861	1.600	16			27
C112-M10				1.088	2.000	20			22
C112-H1				.178	.300	3			246
C112-H2				.229	.400	4			175
C112-H3				.303	.500	5			152
C112-H4				.350	.600	6		.018	120
C112-H5	1.125	.850	30	.421	.700	7	3½	X	108
C112-H6				.470	.800	8		.094	91
C112-H7				.593	1.000	10			74
C112-H8				.787	1.300	13			58
C112-H9				.956	1.600	16			47
C112-H10				1.202	2.000	20			38
C125-L1				.084	.300	3			56
C125-L2				.113	.400	4			42
C125-L3				.149	.500	5			34
C125-L4				.172	.600	6		.012	28
C125-L5	1.250	1.000	12	.207	.700	7	3½	X	24
C125-L6				.227	.800	8		.094	21
C125-L7				.301	1.000	10			17
C125-L8				.395	1.300	13			13
C125-L9				.467	1.600	16			11
C125-L10				.591	2.000	20			9
C125-M1				.124	.300	3			114
C125-M2				.165	.400	4			85
C125-M3				.215	.500	5			70
C125-M4				.253	.600	6		.015	58
C125-M5	1.250	1.000	20	.303	.700	7	3½	X	50
C125-M6				.341	.800	8		.094	44
C125-M7				.427	1.000	10			35
C125-M8				.577	1.300	13			28
C125-M9				.692	1.600	16			22
C125-M10				.866	2.000	20			18
C125-H1				.158	.300	3			210
C125-H2				.210	.400	4			158
C125-H3				.272	.500	5			132
C125-H4				.320	.600	6		.019	107
C125-H5	1.250	1.000	30	.384	.700	7	3½	X	95
C125-H6				.433	.800	8		.094	82
C125-H7				.538	1.000	10			65
C125-H8				.717	1.300	13			51
C125-H9				.878	1.600	16			42
C125-H10				1.103	2.000	20			33







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†(use CS prefix for squared-shim ends/use C prefix as shown above for plain ends)

SPECIAL DESIGNS DELIVERED QUICK & ECONOMICALLY, see pages 36-37

CREST-TO-CREST SPRINGS

STOCK SIZES

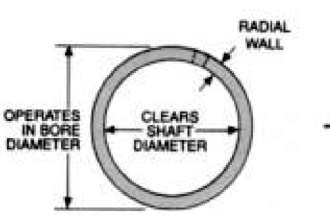
in Carbon Steel and Stainless Steel

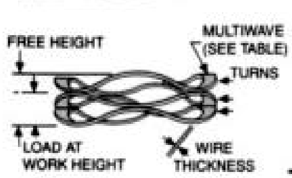
SMALLEY *Spirawave*®

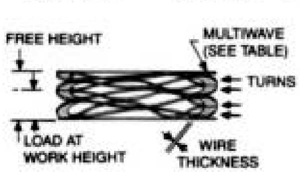
FLAT WIRE COMPRESSION SPRINGS

C SERIES
CS SERIES

SMALLEY PART NUMBER*†	OPERATES IN BORE DIAMETER (IN.)	CLEARS SHAFT DIAMETER (IN.)	LOAD (LBS.)	WORK HEIGHT (IN.)	FREE HEIGHT ** (IN.)	NUMBER OF TURNS	NUMBER OF WAVES	WIRE THICKNESS X RADIAL WALL (IN.)	SPRING RATE ***
C137-L1				.075	.300	3			67
C137-L2				.099	.400	4			50
C137-L3				.129	.500	5			40
C137-L4				.155	.600	6		.012	34
C137-L5	1.375	1.030	15	.179	.700	7	3½	X	29
C137-L6				.206	.800	8		.122	25
C137-L7				.256	1.000	10			20
C137-L8				.341	1.300	13			16
C137-L9				.424	1.600	16			13
C137-L10				.530	2.000	20			10
C137-M1				.142	.300	3			158
C137-M2				.186	.400	4			117
C137-M3				.240	.500	5			96
C137-M4				.281	.600	6		.016	78
C137-M5	1.375	1.030	25	.340	.700	7	3½	X	69
C137-M6				.384	.800	8		.133	60
C137-M7				.486	1.000	10			49
C137-M8				.632	1.300	13			37
C137-M9				.788	1.600	16			31
C137-M10				.982	2.000	20			25
C137-H1				.149	.300	3			232
C137-H2				.189	.400	4			166
C137-H3				.247	.500	5			138
C137-H4				.287	.600	6		.018	112
C137-H5	1.375	1.030	35	.343	.700	7	3½	X	98
C137-H6				.390	.800	8		.133	85
C137-H7				.490	1.000	10			69
C137-H8				.646	1.300	13			54
C137-H9				.793	1.600	16			43
C137-H10				1.000	2.000	20			35
C150-L1				.129	.300	3			117
C150-L2				.164	.400	4			85
C150-L3				.213	.500	5			70
C150-L4				.247	.600	6		.016	57
C150-L5	1.500	1.140	20	.301	.700	7	3½	X	50
C150-L6				.337	.800	8		.133	43
C150-L7				.430	1.000	10			35
C150-L8				.565	1.300	13			27
C150-L9				.694	1.600	16			22
C150-L10				.866	2.000	20			18
C150-M1				.122	.300	3			197
C150-M2				.158	.400	4			145
C150-M3				.206	.500	5			119
C150-M4				.241	.600	6		.018	97
C150-M5	1.500	1.140	35	.291	.700	7	3½	X	86
C150-M6				.324	.800	8		.133	74
C150-M7				.409	1.000	10			59
C150-M8				.540	1.300	13			46
C150-M9				.657	1.600	16			37
C150-M10				.835	2.000	20			30
C150-H1				.166	.300	3			448
C150-H2				.216	.400	4			326
C150-H3				.278	.500	5			270
C150-H4				.329	.600	6		.018	221
C150-H5	1.500	1.140	60	.390	.700	7	4½	X	194
C150-H6				.443	.800	8		.133	168
C150-H7				.555	1.000	10			135
C150-H8				.726	1.300	13			105
C150-H9				.890	1.600	16			85
C150-H10				1.119	2.000	20			68







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CREST-TO-CREST SPRINGS

STOCK SIZES

in Carbon Steel and Stainless Steel

SMALLEY Spirawave®

FLAT WIRE COMPRESSION SPRINGS

C SERIES
CS SERIES

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C175-L1				.155	.375	3			114
C175-L2				.200	.500	4			83
C175-L3				.265	.625	5			69
C175-L4				.310	.750	6		.018	57
C175-L5	1.750	1.340	25	.367	.870	7	3½	X	50
C175-L6				.415	1.000	8		.143	43
C175-L7				.523	1.250	10			34
C175-L8				.638	1.500	12			29
C175-L9				.737	1.750	14			25
C175-L10				.844	2.000	16			22
C175-M1				.188	.375	3			267
C175-M2				.244	.500	4			195
C175-M3				.315	.625	5			161
C175-M4				.374	.750	6		.018	133
C175-M5	1.750	1.340	50	.452	.870	7	4½	X	120
C175-M6				.505	1.000	8		.143	101
C175-M7				.629	1.250	10			81
C175-M8				.768	1.500	12			68
C175-M9				.899	1.750	14			59
C175-M10				1.026	2.000	16			51
C175-H1				.232	.375	3			629
C175-H2				.314	.500	4			484
C175-H3				.409	.625	5			417
C175-H4				.482	.750	6		.024	336
C175-H5	1.750	1.340	90	.577	.870	7	4½	X	307
C175-H6				.651	1.000	8		.148	258
C175-H7				.813	1.250	10			206
C175-H8				.980	1.500	12			173
C175-H9				1.147	1.750	14			149
C175-H10				1.317	2.000	16			132
C200-L1				.094	.375	3			89
C200-L2				.120	.500	4			66
C200-L3				.158	.625	5			54
C200-L4				.179	.750	6		.018	44
C200-L5	2.000	1.600	25	.217	.870	7	3½	X	38
C200-L6				.243	1.000	8		.143	33
C200-L7				.306	1.250	10			26
C200-L8				.365	1.500	12			22
C200-L9				.433	1.750	14			19
C200-L10				.490	2.000	16			17
C200-M1				.140	.375	3			213
C200-M2				.184	.500	4			158
C200-M3				.245	.625	5			132
C200-M4				.278	.750	6		.018	106
C200-M5	2.000	1.600	50	.345	.870	7	4½	X	95
C200-M6				.395	1.000	8		.143	83
C200-M7				.498	1.250	10			66
C200-M8				.593	1.500	12			55
C200-M9				.694	1.750	14			47
C200-M10				.800	2.000	16			42
C200-H1				.197	.375	3			506
C200-H2				.258	.500	4			372
C200-H3				.332	.625	5			307
C200-H4				.389	.750	6		.024	249
C200-H5	2.000	1.600	90	.465	.870	7	4½	X	222
C200-H6				.525	1.000	8		.148	189
C200-H7				.661	1.250	10			153
C200-H8				.781	1.500	12			125
C200-H9				.941	1.750	14			111
C200-H10				1.069	2.000	16			97

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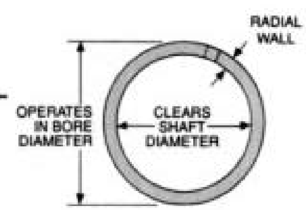
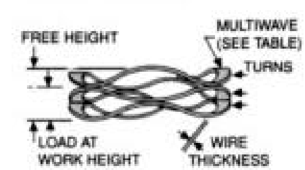
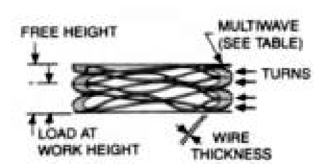






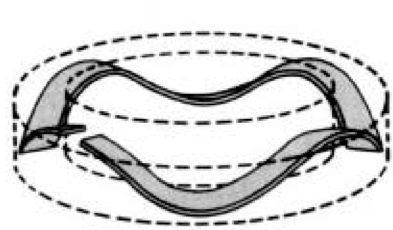
SPRING DESIGN

INTRODUCTION

DEFINING THE SPRING REQUIREMENTS

Although wave spring applications are extremely diverse, there is a consistently basic pattern for defining spring requirements. Those requirements are used to select a stock/standard spring or design a special spring to meet the specifications.

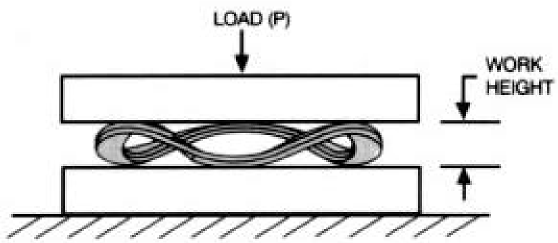
WORKING CAVITY



The working cavity usually consists of a **bore** the spring operates in and/or a **shaft** the spring clears. The spring stays positioned by piloting in the bore or on the shaft.

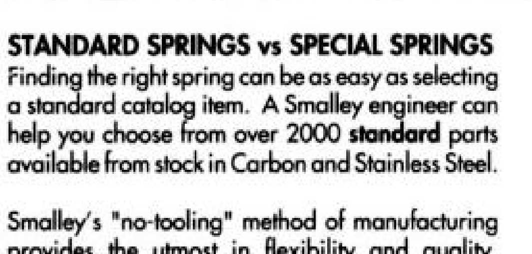
The distance between the loading surfaces defines the axial working cavity or **work height** of the spring.

LOAD REQUIREMENT



The load requirement is defined by the amount of axial force the spring must produce when installed at the work height. Some applications require multiple working heights, where loads at 2 or more operating heights are critical and must be considered in the design. Often minimum and/or maximum loads are satisfactory solutions, particularly where tolerance stack-ups are inherent in the application.

OPERATING ENVIRONMENT



Dynamic loading (fatigue), high temperature, a corrosive media or other unusual operating conditions must be considered in spring applications. Solutions to various environmental conditions typically require selection of the optimal raw material and operating stress.

STANDARD SPRINGS vs SPECIAL SPRINGS

Finding the right spring can be as easy as selecting a standard catalog item. A Smalley engineer can help you choose from over 2000 **standard** parts available from stock in Carbon and Stainless Steel.

Smalley's "no-tooling" method of manufacturing provides the utmost in flexibility and quality. Whether the requirement is for 1 spring or 1,000,000 consider Smalley for your **special** spring requirments.

LET SMALLEY DESIGN YOUR SPRING

Over 50% of Smalley's business is in the design and manufacture of special springs to suit individual applications. Whether it's a technical question, or the most complex spring design, Smalley engineers are always available and welcome the opportunity to assist you.

Simply phone in your requirements or fax a copy of the application checklist found on pages 36 and 37. An engineer will recommend a standard catalog item or provide you with design options for a special spring.

SPRING DESIGN

NOMENCLATURE

b	Radial Width of Material, in. [(O.D.– I.D.)÷2]	**P**	Load, lbs.
D_m	Mean Diameter, in. [(O.D.+I.D.)÷2]	**S**	Bending Stress, psi.
E	Modulus of Elasticity, psi (see page 9)	**t**	Thickness of Material, in.
f	Deflection, in.	**W.H.**	Work Height, in. (H-f)
H	Free Height, in.	**Z**	Number of turns
I.D.	Inside Diameter, in.		
K	Multiple Wave Factor, see Table 1		
L	Length, Overall Linear, in.		
N	Number of Waves (per turn)		
O.D.	Outside Diameter, in.		

TABLE 1

MULTIPLE WAVE FACTOR (K)				
N	2.0-4.0	4.5-6.5	7.0-9.5	10.0 & Over
K	3.88	2.90	2.30	2.13

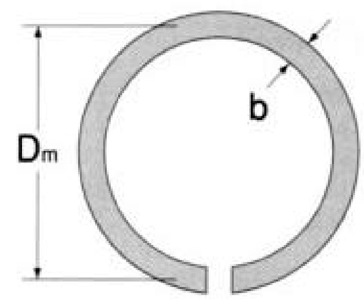
SINGLE TURN GAP OR OVERLAP TYPE

APPLICATIONS

1. Low–Medium Force
2. Low–Medium Spring Rate
3. Short Deflection
4. Precise Load/Deflection Characteristics

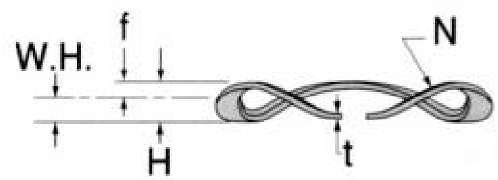
Single Turn Wave Springs are the basic and most common wave spring product. They are used in the widest variety of spring applications due to their lower cost and simplified design configuration.

Single Turn Wave Springs provide the most flexibility to designers. There are few restrictions in their design. They are specified in the majority of small axial and radial space constraint applications.

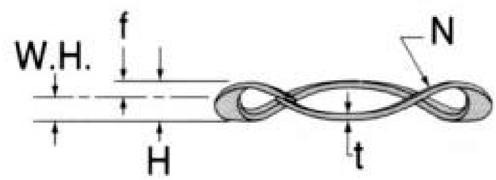


formulas:

$$\text{Deflection}= f = \frac{P K D_m^3}{E b t^3 N^4} * \frac{I.D.}{O.D.}$$



$$\text{Stress}= S = \frac{3 \pi P D_m}{4 b t^2 N^2}$$

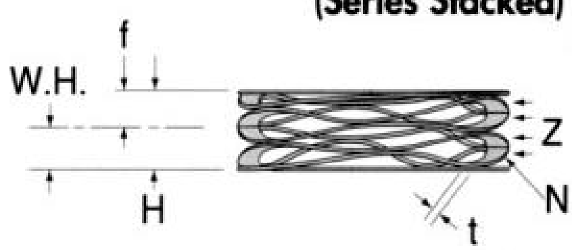


CREST-TO-CREST SPIRAWAVE (Series Stacked)

APPLICATIONS

1. Low–Medium Force
2. Low–Medium Spring Rate
3. Long Deflection
4. Precise Load/Deflection Characteristics

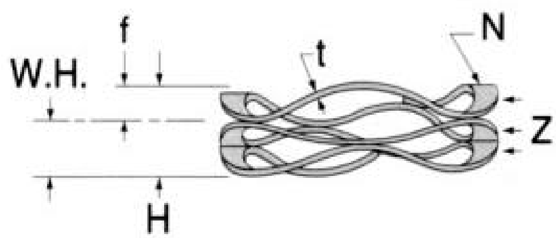
Crest-to-Crest Spirawave flat wire compression springs are pre-stacked in series, decreasing the spring rate by a factor related to the number of turns.



formulas:

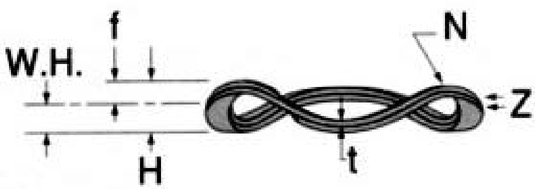
$$\text{Deflection}= f = \frac{P K D_m^3 Z}{E b t^3 N^4} * \frac{I.D.}{O.D.}$$

$$\text{Stress}= S = \frac{3 \pi P D_m}{4 b t^2 N^2}$$



NOTE: N must be in 1/2 wave increments
Z= Number of active turns

MULTIPLE TURN NESTED SPIRAWAVE® (Parallel Stacked)



APPLICATIONS

1. Higher Force
2. Higher Spring Rate
3. Short Deflection
4. Precise Load/Deflection Characteristics

Nested Spirawave Wave Springs are pre-stacked in parallel, *increasing* the spring rate by a factor related to the number of turns.

formulas:

$$\text{Deflection}= f = \frac{P\,K\,D_m^3}{E\,b\,t^3\,N^4\,Z} * \frac{I.D.}{O.D.}$$

$$\text{Stress}= S = \frac{3\,\pi\,P\,D_m}{4\,b\,t^2\,N^2\,Z}$$

EXAMPLE

Calculate free height and operating stress for Smalley part number SSR-0200 (Gap Type, Single Turn, Carbon Spring Temper Steel.)

WHERE:

P = 34 Lbs.
t = .024 in.
b = .150 in.
O.D. = 1.985 in.
I.D. = 1.685 in.
D_m = 1.835 in.
N = 4
E = 30×10^6 psi
K = 3.88
W.H. = .093 in.

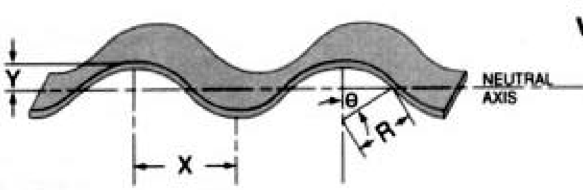
$$\text{Deflection}= f = \frac{(34)(3.88)(1.835)^3}{(30\times10^6)(.150)(.024)^3(4)^4} * \frac{1.685}{1.985} = .043 \text{ in.}$$

Free Height= H = (W.H.+ f)=.093+.043= .136 in.

$$\text{Stress}= S = \frac{(3)(\pi)(34)(1.835)}{(4)(.150)(.024)^2(4)^2} = 106{,}339 \text{ psi}$$

DIAMETER EXPANSION

NESTED & CREST-TO-CREST SPIRAWAVES ONLY: Multiple turn Spirawaves expand in diameter when compressed. The formula shown below is used to predict the maximum fully compressed diameter.



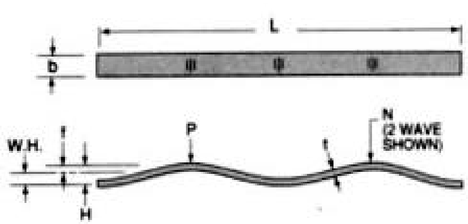
WHERE:
R = Wave Radius = $(4Y^2+X^2)\div8Y$
N = Number of Waves
Θ = Angle, degrees = ArcSin $(X\div2R)$
b = Radial Wall
X = ½ Wave Frequency = $\pi D_m\div2N$
Y = ½ Mean Free Height = $(H-t)\div2$
Where H= Per Turn Free Height

Maximum outside diameter at 100% deflection (solid height) = $.02222 * R * N * \Theta + b$

LINEAR EXPANDERS

Linear Expanders are a continuous wave formed (marcelled) wire length produced from spring temper materials. They act as a load bearing device having approximately the same load/deflection characteristics as a wave spring.

Forces act axially or radially depending on the installed position. Axial pressure is obtained by lying the expander flat in a straight line. Circular wrapping the expander (around a piston for example) produces a radial force or outward pressure.



formula: (single wave expander where N=1)

$$\text{Deflection}= f = \frac{P\,L^3}{4\,E\,b\,t^3} \qquad \text{Stress}= S = \frac{3\,P\,L}{2\,b\,t^2}$$

formula: (2 or more wave expander where N>1)

$$\text{Deflection}= f = \frac{P\,L^3}{16\,E\,b\,t^3\,N^4} \qquad \text{Stress}= S = \frac{3\,P\,L}{4\,b\,t^2\,N^2}$$

STRESS

OPERATING STRESS

Compressing a wave spring creates bending stresses similar to a simple beam in bending. These compressive and tensile stresses limit the amount a spring can be compressed before it yields or "takes a set". Although spring set is sometimes not acceptable, load and deflection requirements will often drive the design to accept some set or "relaxation" over time.

RESIDUAL STRESS/PRE-SETTING

Increasing the load capacity and/or fatigue life can be achieved by compressing a spring beyond it's yield point or "presetting". Preset springs are manufactured to a higher than normal free height and then compressed solid. The free height is reduced and the material surfaces now exhibit residual stresses which enhance spring performance.

MAXIMUM DESIGN STRESS

Unlike coil springs which are limited by shear stresses, wave springs are limited by the tensile strength of the material–usually almost double the shear strength. Table 2 below provides guidelines for maximum design stress. For cyclic service, also refer to the discussion on fatigue.

TABLE 2

DESIGN STRESSES FOR CIRCULAR-GRAIN WAVE SPRINGS

Static/Low Cycles	
No Preset	100% of tensile strength
Preset Springs	150% of tensile strength
Cyclic Service	
10^4 cycle life	80% of tensile strength
10^5 cycle life	53% of tensile strength
10^6 cycle life	50% of tensile strength
10^7 cycle life	48% of tensile strength

FATIGUE

Fatigue cycling is an important consideration in wave spring design. The tensile strength percentages shown in Table 2 can be used to approximate cycle life for a spring that cycles between the free height and the work height.

The fatigue guidelines in Table 3 provide a slightly more conservative approach and allow for calculation of cycle life between 2 work heights. Although these methods of fatigue analysis have proven to be a good approximation, testing is recommended whenever cycle life is critical.

formula:

$$X = \frac{(\sigma - S_1)}{(\sigma - S_2)}$$

WHERE: X = Fatigue stress ratio, refer to Table 3
σ = Material tensile strength
S_1 = Calculated stress at lower work height (must be less than σ)
S_2 = Calculated stress at upper work height

TABLE 3

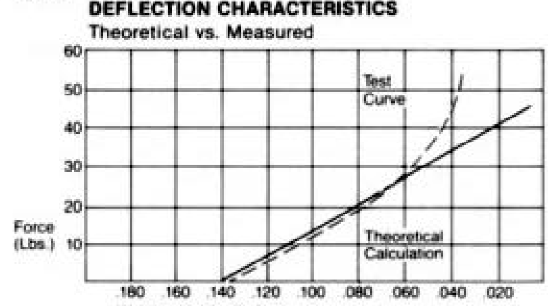
X	Estimated Cycle Life
< .40	UNDER 30,000
.40 - .49	30,000 - 50,000
.49 - .55	50,000 - 75,000
.55 - .60	75,000 - 100,000
.60 - .67	100,000 - 200,000
.67 - .70	200,000 - 1,000,000
>.70	OVER 1,000,000

LOAD/DEFLECTION

A comparison of the actual spring rate to the theoretical (calculated) spring rate provides practical limits for the working range of the spring. Spring rate (P/f) can be calculated by manipulating the deflection equations on pages 27 and 28.

Figure 1 shows a graph of theoretical and tested spring rate. Typically, theoretical rate is accurate until the spring starts to bottom out or reach it's "solid height".

FIG. 1



As a general rule, the calculated spring rate is accurate through the first 80% of available deflection and for work heights down to 2 times the solid height. Although the spring can operate beyond this "linear" range, measured loads will be much higher than calculated.

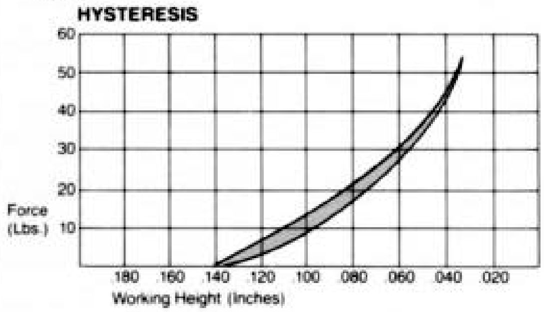
SPRING DESIGN

HYSTERESIS

Wave springs exert a greater force upon loading and lower force upon unloading. This effect is know as hysteresis. A graphic representation is shown by the shaded area between the curves in Figure 2.

In a single turn spring, friction due to circumferential and radial movement are the prime causes. Spirawaves also contribute to the frictional loss as adjacent layers rub against each other. Sufficient lubrication will minimize this effect.

FIG. 2



DESIGN GUIDELINES

MATERIAL CROSS-SECTION

Material cross-section plays an important role in Wave Spring design. The most economical materials are those used in manufacturing Smalley standard springs and retaining rings. In addition, many other material cross sections are commonly used in special spring manufacture and are readily available. Smalley engineering can provide assistance in selecting an economical alloy and cross section.

As a basic guideline, use our standard 'SSR'-Wave Spring series for cross-section/diameter relationships. Lighter material sections are usually acceptable. Heavier sections for a given diameter may be incorporated using the following information:

Special Wave Spring design criteria for selecting material cross-sections:
Maximum material thickness=standard ('SSR-') thickness • 2
Maximum radial wall=material thickness (any value) • 10
Minimum radial wall=material thickness (any value) • 3

For Overlap Type Wave Springs and multiple turn Spirawaves, the Radial Wall must be sufficient to prevent misalignment between adjacent layers. For springs with a narrow Radial Wall, radial misalignment can occur during handling or during operation if the spring is not contained or closely piloted.

Solutions to this problem include dimensioning the spring to pilot closely on the I.D. and/or O.D. or designing the spring as a single turn Gap Type.

DIAMETERS

Figure 3 illustrates the preferred method of specifying diameters. In either case, the spring diameter is developed to provide proper operation between the bore and the shaft.

NOTE: Smalley's manufacturing process of edge-winding controls **either** the O.D. **or** the I.D. The material radial wall is also tightly controlled. Therefore whenever possible, tolerance only one diameter and the radial wall instead of tolerancing both the O.D. and I.D.

BORE PILOT

For springs that pilot in the bore as shown in figure 3a, the bore and shaft diameters should be included in the spring specifications. Commonly used requirements would read:

"Spring must pilot and operate in a (minimum bore) bore diameter."

Spring must clear a (maximum shaft) shaft diameter."

The actual spring diameter is then developed at time of manufacture to provide the best fit and prevent binding due to expansion.

For gap type and overlap type springs, the outside diameter can be specified because binding is not a concern. The outside diameter can be toleranced to provide a minimum clearance in the bore or provide cling in the bore, as do the Smalley Bearing Preload springs (refer to page 14).

SHAFT PILOT

For springs that pilot on a shaft as shown in Figure 3b, the inside diameter can be toleranced to provide a minimum clearance from the shaft. Since wave springs expand during compression, interference with the shaft is generally not a concern.

To insure proper operation, include shaft and bore diameters in the spring specifications.
Commonly used requirements would read:

"Spring pilots over and clears a (maximum shaft) shaft diameter."

"Spring operates in a (minimum bore) bore diameter."

FIG. 3a

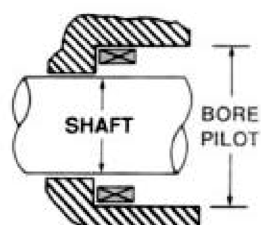
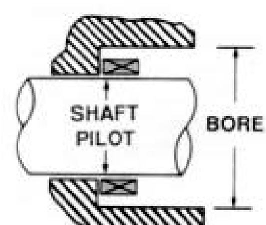


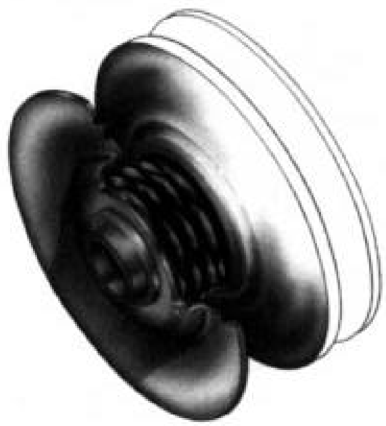
FIG. 3b



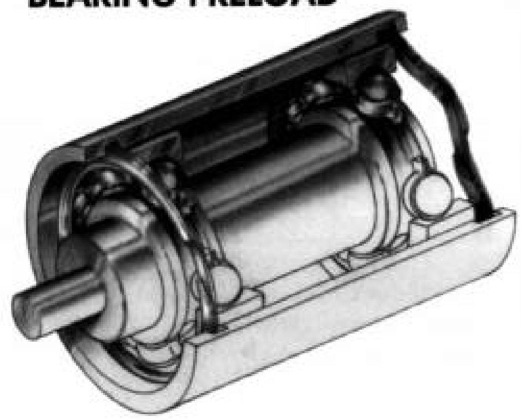
COMMON APPLICATIONS

ADJUSTABLE SHEAVE

Low axial height Crest-to-Crest Spirawave replaces a conventional round wire spring. The Crest-to-Crest Flat wire compression spring allows the floating sheave half to adjust axial position in an adjustable speed belt drive. Low spring rate insures constant pressure throughout total stroke.



BEARING PRELOAD



Spiral retaining ring provides shoulder in bore. Shaft, contained between bearing inner races is free to oscillate. 2-Turn Nested WaveRing preloads bearing assembly through outer race, taking up play in both bearings.

BAYONET CONNECTOR

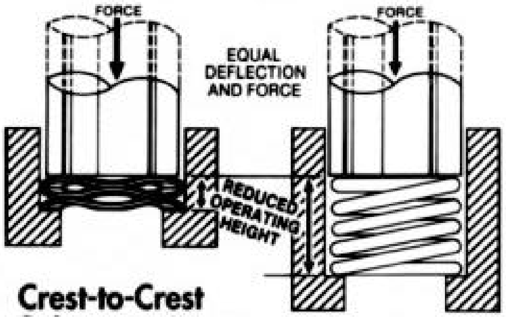
Smalley single turn overlap type wave spring installed in an electronic connector assembly. As male and female components are rotated together into final assembly, the wave spring is compressed to its working height. In this position it exerts a constant force that locks both components together.

CYLINDER GLAND PACKING

Smalley single turn gap type wave spring installed in a hydraulic cylinder. Spring functions as a self-compensating, self-adjusting device to preload gland packings. Improved tight sealing is provided for low or zero pressure conditions.

COMMON APPLICATIONS

SPRING COMPARATOR



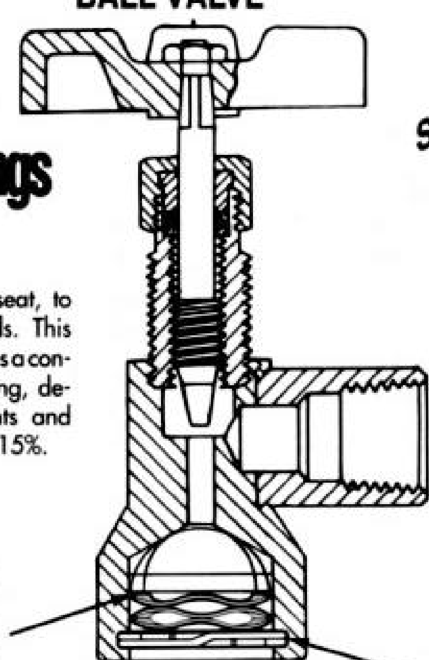
Crest-to-Crest Spirawave® gets the same results in 1/3 the space

Space savings is an advantage using a Crest-to-Crest Spirawave compression spring. Reduced operating height, solid height and stroke range are shown in identical assemblies.

CLUTCH

2-Turn Nested Spirawave wave springs are used to disengage clutch plates. Pneumatic pressure overcomes the wave springs force allowing plates to contact. With pressure released, springs separate the plates allowing a zero contact–idle position.

BALL VALVE



Spirawave® Wave Springs

Application:
BALL LOAD SPRING
Pushes sealing ball into seat, to prevent backflow of fluids. This compression spring replaces a conventional round wire spring, decreasing operating heights and overall valve size by over 15%.

5-Turn Crest-to-Crest Spirawave®

Smalley® Retaining Rings

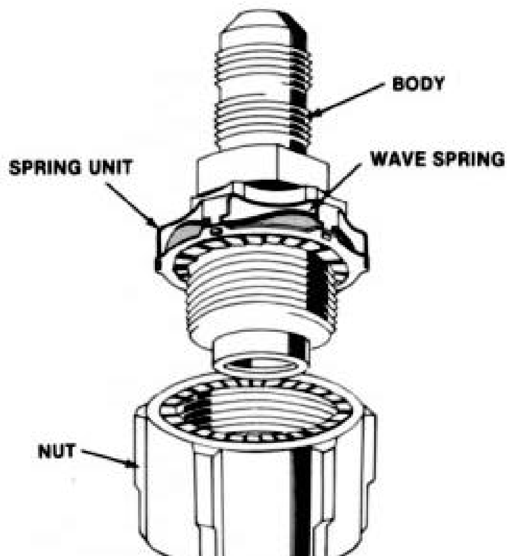
Application:
SPRING RETAINER
Provides a removable shoulder in the bore, trapping the wave spring in its operating position. The ring is easily removed with a screwdriver, making the valve field serviceable.

Medium Duty, 2-Turn Configuration

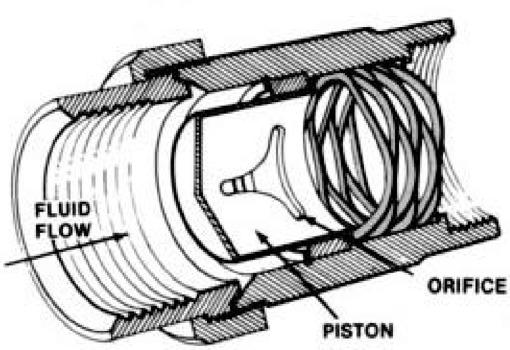
COMMON APPLICATIONS

COUPLING

Nut face and spring unit face have interlocking teeth. When nut is threaded down body, toward spring unit, faces engage. Continued threading forces nut against spring unit, compressing the wave spring. Wave spring provides interlocking force between faces. A quick reversal of the nut further depresses the wave spring thereby permitting disassembly.



FLOW VALVE



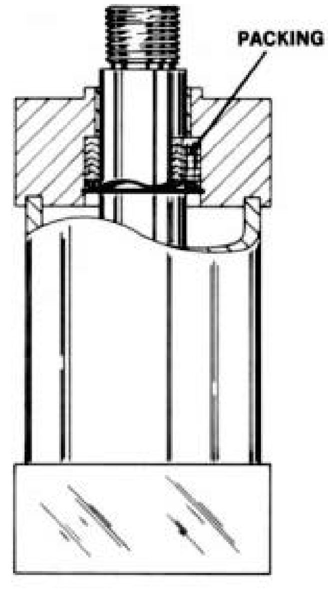
Wave spring resists movement of the variable orifice piston. As fluid pressure increases piston moves, which compresses the Crest-to-Crest Spirawave® Spring. The spring precisely controls the linear displacement of the piston which positions the orifice for proper fluid flow.

SLIP CLUTCH

Clutch drives when the "V"-detents are in the "V"-slots. Smalley wave spring maintains pressure to hold this position. As torque is increased the "V"-detents will ride up and out the "V"-slots, depressing the wave spring and developing the slip mechanism. When torque is decreased, the wave spring forces the "V"-detents firmly into the "V"-slots to drive.

HYDRAULIC CYLINDER

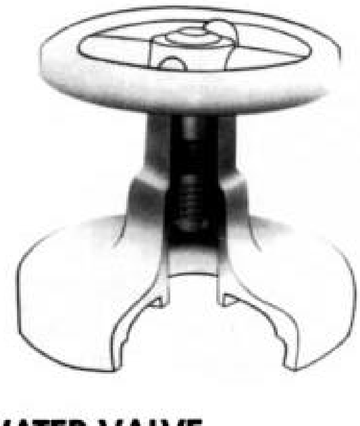
Wave Spring and Spiral Retaining Ring are utilized in a packing set. Packing is loaded by the wave spring to provide a 360° fluid seal between the cylinder rod, housing and packing set.



COMMON APPLICATIONS

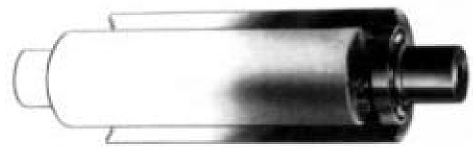
FACE SEAL

Wave Spring applies pressure, to precisely load the carbon face against a mating surface, to properly seal fluids. The spring operates over a fixed working range and provides an exact force, unlike the stamped wavy washer it replaced which could not maintain the necessary spring rate. Exact pressure of the carbon face against the sealing surface is essential to avoid excessive wear, yet maintaining a good seal.



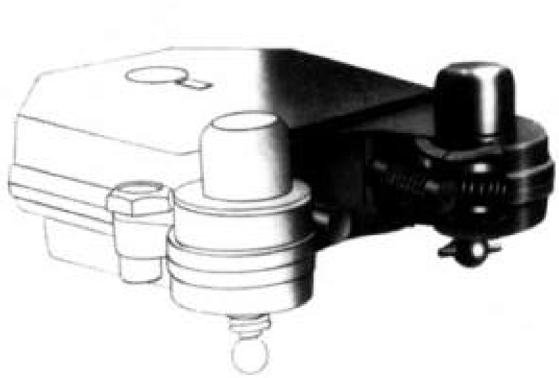
WATER VALVE

A Smalley Flat Wire (Crest-to-Crest) Compression Spring prevents the valve handle from rotating, by maintaining a constant load and engaging the threads on the main shaft. As the handle is rotated counter-clockwise, spring resistance increases and rotation is less likely.



HIGH-SPEED SPINDLE

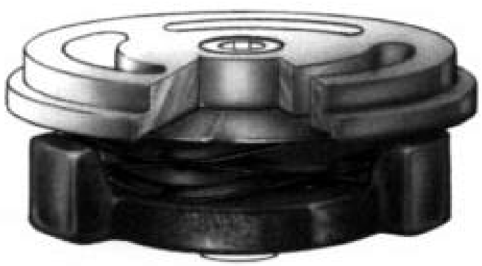
Spinning at 20,000 rpm, a spindle manufacturer required a wave spring with a tight load tolerance to fit in a tight radial space. Smalley was specified as the preferred source because of its reputation for quick deliveries and competitive prices. A special spring was designed and delivered within 1 week. 3 weeks later production quantities were shipped.



GEAR BOX DRIVE

Designed in a plastic housing, this Smalley Wave Spring keeps constant pressure on a pinion gear which is driven by a worm gear. The assembly is subject to excessive vibration. The spring absorbs the vibration and takes up tolerances which accumulate in the plastic non-critical components used in the box.

COMMON APPLICATIONS

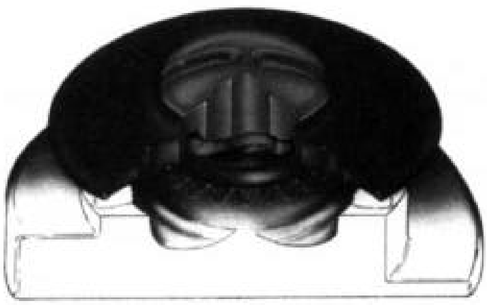


PRESSURE RELIEF VALVE

An exact load applied to the top sealing plate was accomplished using a Flat Wire Compression Spring. Air pressure entering the top slots forces the plate away from the sealing surface providing the pressure relief mechanism

PIN CONNECTOR

Wave Spring in a retaining application is designed with overlapping ends while seated on a deep groove in connector. Spring applies tension between the connector and the hole in which it is placed.



RATCHET SLACK ADJUSTER

Overlap Type Wave Spring located under plastic screw head holds constant pressure between plastic gear teeth. In operation, the spring compresses permitting the gear teeth to disengage and engage as either side of the assembly is rotated.

GEAR BRACKET

Worm gear shaft is held in place and preloaded using a single turn Smalley WaveRing. The WaveRing fits an internal groove and the waveform in the ring allows the gear/shaft to float axially as the gear rotates.

MULTI–TOOTH CUTTER

Specially designed Wave Spring with locating tabs is contained in housing. Spring applies pressure to the two cutter halves, holding them together with enough pressure allowing them to oscillate.

FAX TO: (847) 719-5999

CHECK LIST for Special Spring Designs

COPY THIS PAGE

APPLICATION CHECKLIST FOR WAVE SPRINGS & FLAT WIRE COMPRESSION SPRINGS

Your Name ______________________ Title ______________ Date ________

Company ______________________ Fax (   ) __________ Phone (   ) __________

Address ____

City ______________________ State ______________ Zip ________

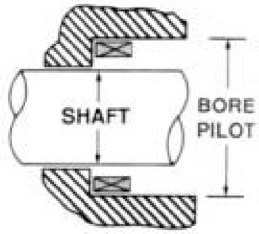
Please complete known information. We'll make suggestions for all other dimensions.

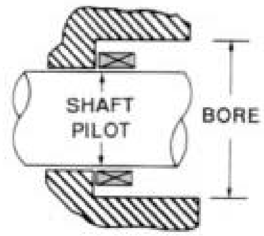
OPERATES IN ________ bore diameter

Inside diameter clears ________ shaft

Specify which diameter the spring should pilot closest to:

☐ **BORE or** ☐ **SHAFT**





Now, select ONE of the following load/deflection groups

Group A

________ lbs. @ ________ inches
Min - Max Load @ Work Height

Free Height ______________ Approx.

Group B

(No load specified and spring rate is theoretical)

Free Height ______ - ______
Min - Max

Number of Waves ____________

Material Thickness ____________

Radial Wall ____________

Group C

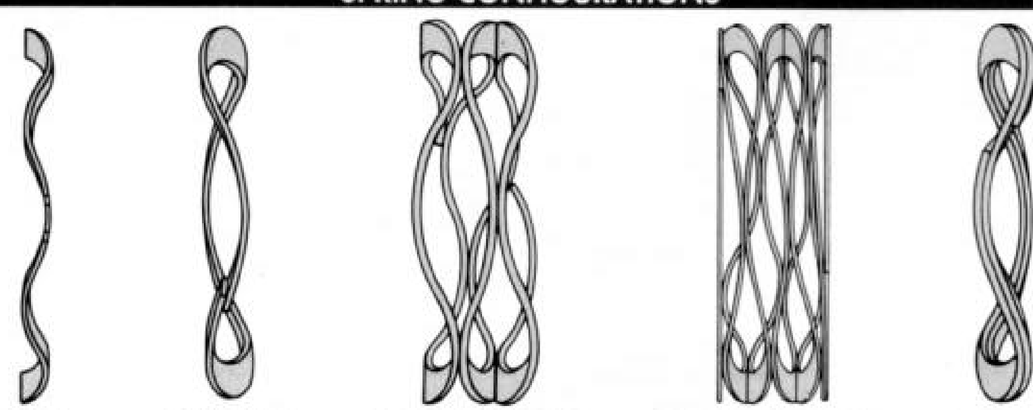
__________ @ __________
Minimum Load   Work Height 1

__________ @ __________
Maximum Load   Work Height 2

Free Height __________ Approx.

Group D
Other specifications

SPRING CONFIGURATIONS



GAP **OVERLAP** **CREST-TO-CREST** Plain Ends **CREST-TO-CREST** Squared–Shim Ends **NESTED**

FAX TO: (847) 719-5999

CHECK LIST for Special Spring Designs

COPY THIS PAGE

FATIGUE Specify the estimated cycle life

Note:
Spring failure under cyclic operation is best determined by actual testing. Theoretical calculations for fatigue are based on operating stress and only approximate the cycle life. Cycle testers at Smalley can be utilized to assist in determining anticipated cycle life.

- ☐ **Static Application**
- ☐ **Under 10^4 Cycle Life**
- ☐ **10^5 Cycle Life**
- ☐ **10^6 Cycle Life**
- ☐ **Over 10^6 Cycle Life**

MATERIAL Consider the environment: Temperature ____°F Corrosive Media______

- * Carbon Steel ☐
- * 17-7 PH/C Stainless Steel ☐
- 302 Stainless Steel ☐
- Inconel X-750 ☐
- 316 Stainless Steel ☐
- Other______________________

FINISH

- * Carbon Steel is oil dipped ☐
- * Stainless Steel is vapor degreased and ultrasonic cleaned ☐

☐ Passivate ☐ Black Oxide ☐ Phosphate Coat ☐ Vibratory Deburr

Other______________________________

* STANDARDS

APPLICATION

Description:

Sketch

Quantity:______________________

We'll recommend the appropriate spring configuration to best suit your requirements.

GENERAL INFORMATION

SIZE RANGE:

Diameters: 3/8 inch to 84 inches.
Material Thickness: .008 to .125
Width (Radial Wall): .030 to .750

PACKAGING:

Springs 1 3/8 O.D. and over tube (coin) packed in lengths 10 to 18 inches.
Springs 1 5/16 and under, bulk packed.
Other arrangements may be made on request.

QUALITY CONTROL:

Smalley inspection conforms with specification ISO 9001, QS 9000 and AS 9000. A Quality Control manual is available to our customers upon written request.

STRESS RELIEF/PRECIPITATION HARDENING

All springs are heat treated prior to shipment.

Non-precipitation hardenable materials (i.e.: 302,316, carbon steel) are stress relieved to remove coiling strains.

Precipitation hardenable materials are hardened to specification, in an open atmosphere furnace.

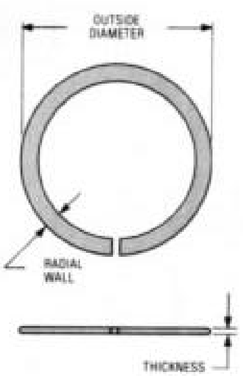
☐ Or optional atmosphere controlled heat treatments may be done on request.

CIRCULAR-GRAIN® SHIMS

STOCK SIZES in Carbon Steel and 17-7 PH/C Stainless Steel

Smalley shims are commonly used in conjunction with wave springs where a back-up plate is needed for housings made of softer metals like aluminum or bronze, and for packings made of leather, neoprene or similar materials. Shims can function as spacers to change wave spring operating heights. Adding or subtracting shims is an excellent method of adjusting load on a wave spring. Tolerance buildups can also be controlled by using a shim spacer.

Carbon steel and 17-7 PH/C stainless steel are the standard shim construction materials. However, Smalley can make them to order in nearly any size or material.

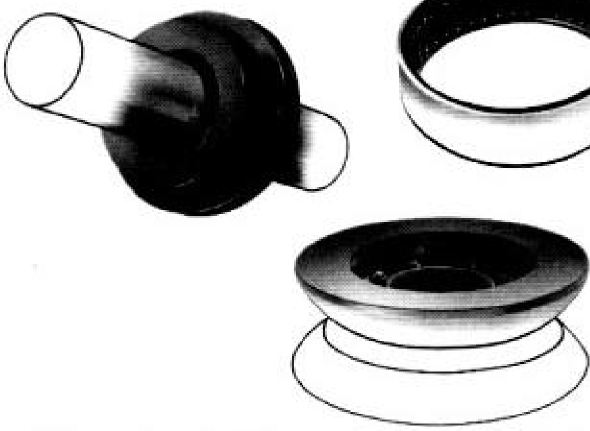


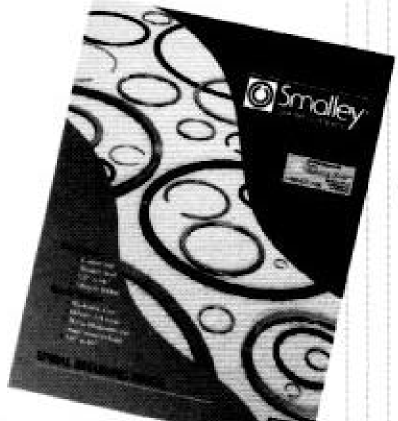
SMALLEY PART NUMBER*	OUTSIDE DIAMETER		THICK-NESS	RADIAL WALL	SMALLEY PART NUMBER*	OUTSIDE DIAMETER		THICK-NESS	RADIAL WALL
SSRS-0075	.750	+.000/-.015	.024	.093	SSRS-0525	5.250	+.000/-.035	.030	.233
SSRS-0087	.875	+.000/-.015	.024	.093	SSRS-0537	5.375	+.000/-.035	.030	.233
SSRS-0100	1.000	+.000/-.015	.024	.103	SSRS-0550	5.500	+.000/-.045	.030	.233
SSRS-0112	1.125	+.000/-.015	.024	.138	SSRS-0562	5.625	+.000/-.045	.030	.233
SSRS-0125	1.250	+.000/-.015	.024	.138	SSRS-0575	5.750	+.000/-.045	.030	.233
SSRS-0137	1.375	+.000/-.015	.024	.138	SSRS-0587	5.875	+.000/-.045	.030	.233
SSRS-0150	1.500	+.000/-.015	.024	.150	SSRS-0600	6.000	+.000/-.045	.030	.233
SSRS-0162	1.625	+.000/-.020	.024	.150	SSRS-0612	6.125	+.000/-.045	.030	.233
SSRS-0175	1.750	+.000/-.020	.024	.150	SSRS-0625	6.250	+.000/-.045	.030	.233
SSRS-0187	1.875	+.000/-.020	.024	.150	SSRS-0637	6.375	+.000/-.045	.030	.233
SSRS-0200	2.000	+.000/-.020	.024	.150	SSRS-0650	6.500	+.000/-.045	.030	.233
SSRS-0212	2.125	+.000/-.020	.024	.150	SSRS-0675	6.750	+.000/-.045	.030	.233
SSRS-0225	2.250	+.000/-.025	.024	.150	SSRS-0700	7.000	+.000/-.045	.032	.375
SSRS-0237	2.375	+.000/-.025	.024	.178	SSRS-0725	7.250	+.000/-.045	.032	.375
SSRS-0250	2.500	+.000/-.025	.024	.178	SSRS-0750	7.500	+.000/-.060	.032	.375
SSRS-0262	2.625	+.000/-.025	.024	.178	SSRS-0775	7.750	+.000/-.060	.032	.375
SSRS-0275	2.750	+.000/-.025	.030	.188	SSRS-0800	8.000	+.000/-.060	.032	.375
SSRS-0287	2.875	+.000/-.025	.030	.188	SSRS-0825	8.250	+.000/-.060	.032	.375
SSRS-0300	3.000	+.000/-.025	.030	.188	SSRS-0850	8.500	+.000/-.060	.032	.375
SSRS-0312	3.125	+.000/-.025	.030	.188	SSRS-0875	8.750	+.000/-.060	.032	.375
SSRS-0325	3.250	+.000/-.030	.030	.233	SSRS-0900	9.000	+.000/-.060	.032	.375
SSRS-0337	3.375	+.000/-.030	.030	.233	SSRS-0950	9.500	+.000/-.070	.032	.375
SSRS-0350	3.500	+.000/-.030	.030	.233	SSRS-1000	10.000	+.000/-.070	.032	.375
SSRS-0362	3.625	+.000/-.030	.030	.233	SSRS-1050	10.500	+.000/-.070	.032	.375
SSRS-0375	3.750	+.000/-.030	.030	.233	SSRS-1100	11.000	+.000/-.070	.032	.375
SSRS-0387	3.875	+.000/-.030	.030	.233	SSRS-1150	11.500	+.000/-.070	.032	.375
SSRS-0400	4.000	+.000/-.030	.030	.233	SSRS-1200	12.000	+.000/-.080	.032	.375
SSRS-0412	4.125	+.000/-.030	.030	.233	SSRS-1250	12.500	+.000/-.080	.032	.375
SSRS-0425	4.250	+.000/-.030	.030	.233	SSRS-1300	13.000	+.000/-.080	.032	.375
SSRS-0437	4.375	+.000/-.035	.030	.233	SSRS-1350	13.500	+.000/-.080	.032	.375
SSRS-0450	4.500	+.000/-.035	.030	.233	SSRS-1400	14.000	+.000/-.080	.032	.375
SSRS-0462	4.625	+.000/-.035	.030	.233	SSRS-1450	14.500	+.000/-.090	.032	.375
SSRS-0475	4.750	+.000/-.035	.030	.233	SSRS-1500	15.000	+.000/-.090	.032	.375
SSRS-0487	4.875	+.000/-.035	.030	.233	SSRS-1550	15.500	+.000/-.090	.032	.375
SSRS-0500	5.000	+.000/-.035	.030	.233	SSRS-1600	16.000	+.000/-.090	.032	.375
SSRS-0512	5.125	+.000/-.035	.030	.233					

*ADD SUFFIX – S17 FOR STAINLESS STEEL

RETAINING RINGS, SPIRAL WOUND

TYPICAL APPLICATIONS

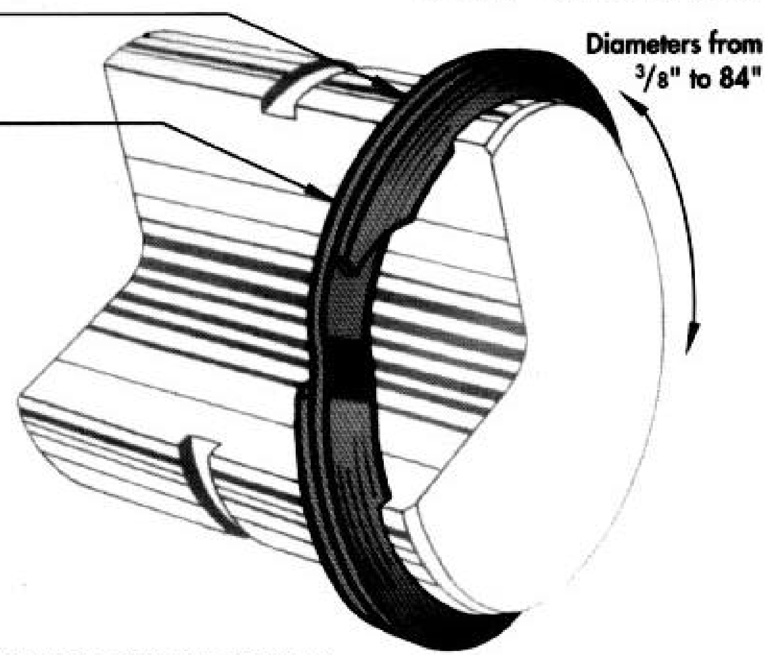




For complete stock part tables and Retaining Ring design information, Call for your FREE GUIDE... (847) 719-5900

360° Retaining Surface
No Gap—No Protruding Ears

Diameters from 3/8" to 84"



Spiral Wound in Multiple Turns

- Increases load capacity yet allows easy assembly by hand or as an automated process.

Uniform Radial Section

- Provides a pleasant appearance on the assembled product.
- Beneficial when radial clearance is limited.

Simplify Assembly

- Wind into groove.
- No special pliers/tools needed to install or remove.
- Removal notch provided for easy removal using a screwdriver.

Design Flexibility

- Ring thickness can be changed to accommodate most any application by either varying material thickness and/or number of turns.
- Meets military and aerospace specifications.
- Special designs quick and economical.
- Exotic alloys.

INTERCHANGE LISTING SMALLEY® SPIRAL RETAINING RINGS

SMALLEY®	SPIRAL EQUIVALENT	MILITARY MIL-DTL-27426	AEROSPACE AS 3219	METRIC AEROSPACE MA 4035	EUROPEAN SPECIFICATION DIN	WALDES TRUARC	EATON	INDUSTRIAL RETAINING RING	ANDERTON
VH	UR	—	—	—					
VS	US	—	—	—					
WH	RR	/3	AS 4299 AS 3217	—					
WS	RS	/1	AS 4299 AS 3218	—					
WHT	RRT	—	—	—	—	—	NAN	—	—
WST	RST	—	—	—	—	—	XAN	—	—
WHM	RRN	/4	AS 4299 AS 3215	—	—	N5000 5008	I-N	3000 4000	N1300
WSM	RSN	/2	AS 4299 AS 3216	—	—	5100 5108	E-N	3100 4100	N1400
DNH	—	—	—	—	DIN 472	—	—	—	D1300
DNS	—	—	—	—	DIN 471	—	—	—	D1400
EH	—	—	—	MA 4017		—	—	—	—
ES	—	—	—	MA 4016		—	—	—	—

GROOVE INTERCHANGE ONLY
Use a Smalley Retaining Ring to fit into the same groove of these stamped Retaining Rings

Smalley®
Steel Ring Company

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(847) 719-5900 • Fax: (847) 719-5999
www.smalley.com • info@smalley.com

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- Reduces Spring Height By 50% With Equal Deflection
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- Factory Direct
- Hundreds Of Stock Sizes
- No-Tooling-Charge On Special Designs

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FLAT WIRE COMPRESSION SPRINGS
SPIRAWAVE® WAVE SPRINGS
SPIRAL RETAINING RINGS
LAMINAR SEAL RINGS
EXPANDERS
SPRINGS
SHIMS

Catalog #WS-2002