DESIGN GUIDE

FOR CONSTANT FORCE, CONSTANT TORQUE,
CONPOWER® & POWER, MOTOR BRUSH AND TWIN SPRINGS

VULCAN SPRINGS WORK!

VULCAN SPRING
Vulcan Spring & Manufacturing Co.
215.721.1721

THE COMPANY TO RELY ON...

Vulcan Spring & Mfg. Co., founded in 1967, is dedicated not only to manufacturing the finest possible custom-made parts but to making sure that each customer's specific desires are fully realized in the final product.

Vulcan offers our customers the services of a fully integrated, financially sound manufacturing organization, specializing in the design and production of constant force springs and related products. Conforce®, Contorque®, Conpower®, motor brush, twin springs, mechanical reels, the original Pullbox® line, spring assemblies and printed plastic scrolls are all manufactured in our Telford, Pennsylvania, USA factory.

Conforce® Constant Force Springs

Constant force springs offer high force output with very small space requirements, making them ideal for a wide variety of applications where constant force is needed. Able to store power indefinitely when extended, Conforce® springs provide long linear reach without force buildup. Variable force springs are also available.

Contorque® Constant Torque Springs

Constant torque springs provide high amounts of torque in a small package. Because of their unique design, Contorque® springs allow numerous turns without a change in force. The smooth rolling action of Contorque® springs is ideal for cable extensions and provides an alternative to battery motors or dead weights.

Conpower® Power Springs

Pre-stressed power springs are reverse wound on to an arbor and enclosed in a case to create a compact power source. This unique construction provides a high number of turns with a low torque gradient. It provides rotational energy from either the arbor or the case. It can also provide linear motion with the use of a pulley or cable.

Motor Brush Twin Springs

Whether single or twin brush springs are required, motor brush springs are the ideal method of ensuring consistent, dependable force on the brushes for electric motor commutators. Motor brush springs minimize brush wear for improved motor performance.

CONFORCE®, CONTORQUE®, PULLBOX® and VULCAN SPRING are trademarks of Vulcan Spring & Mfg. Co.

Vulcan Spring is uniquely equipped to be your partner for custom spring solutions. Manufacturing to the exact specifications of designers and engineers, Vulcan provides extensive expertise, premium materials selection and leading edge manufacturing capabilities.

The vast majority of the springs Vulcan Spring produces are flat springs made from Type 301 stainless steel. Other materials such as Elgiloy, Inconel and high-carbon steel are also utilized. By focusing on one type of spring and not trying to become “everything to everybody”, Vulcan Spring has developed greater application knowledge and expertise than anyone else in the flat spring industry. Flat steel spring products include:

Mechanical Reels

Mechanical reels provide power for applications requiring counterbalancing, retrieving or returning. In applications requiring long deflection, mechanical reels provide reliable force and high cycle life. Vulcan’s mechanical reels are extremely rugged and designed for maximum life.

Spiral Torsion Springs

Spiral torsion springs are produced from flat steel and are characterized by the requirement that their coils typically do not touch during operation. A spiral torsion spring will exert a rotational torque, usually through 360° rotation or less. The torque curve of a spiral torsion spring is linear to the degree of rotation. They are used in brush motors and applications where short rotation is required.

Cross Curve & Snap Bracelets

Cross curve material is a flat strip of steel which is cross curved along the width, making the strip rigid. It is used in various specialty applications including aerospace, defense and general industrial.

Snap bracelets are produced from a uniquely shaped material that locks when straight and coils upon the release of cross curve tension.

Other Custom Springs

From stampings and slot closers to wire forms, torsion springs, cross-curve snap tapes and custom flat spring designs, Vulcan is equipped to meet all your spring needs.

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CONFORCE® SPRING DESIGN

CONSTANT FORCE SPRINGS

Since the introduction of constant force springs to industry, design engineers have been using these components to solve problems requiring a constant force or torque. Every constant force spring is produced to provide a specific force which is exerted through the entire extension of the spring. The force is constant as long as the radius remains constant. In longer springs this change in radius, due to diameter build-up, causes the spring to increase in force slightly as it is extended. Constant force springs deliver more force per pound of material than gravity devices.

VARIABLE FORCE SPRINGS

In some applications it is desirable for the spring to have less force as it is extended while in others it is preferable to have more force. A spring that produces less force as it is extended is said to have a negative gradient. Negative gradients up to 25% are possible. A spring that products more force as it is extended has a positive gradient. Positive gradients of 500% are possible. Our computer controlled machines allow us to manufacture springs with the variable forces required to meet the needs of your application.

MATERIALS

Several materials are used to make constant force springs including stainless steel, high carbon steel, Inconel, Elgiloy, plastic and others as required. Type 301 stainless steel has proven to be superior for consistent quality, life, availability, stress retention and lowest product cost.

Note: 1. Type 301 stainless steel, in its hardened condition, is magnetic.
2. Passivation is not required or recommended.

TESTING AND INSPECTION

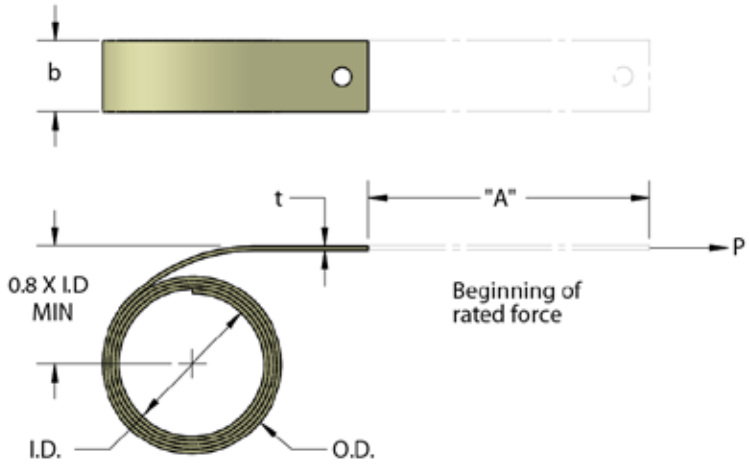
Inspection expertise is a key part of our success. Our modern metrology tools are designed to accurately and consistently measure the force and many other characteristics of our products. All of our tools are routinely calibrated to National Institute of Standards and Technology requirements.

Our quality control team works closely with our sales team and our customers to clearly define the inspection criteria. We have experience working with quality programs from many industries including aerospace, automotive and defense.

NORMAL FORCE TEST PROCEDURE

1. The force is usually measured at ½ the full extension length.
2. The spring is cycled across the test length at least three times.
3. The spring is then extended to the test length and locked to provide a nominal force reading that is neither extending nor retracting.
4. Normal tolerances are ± 10% in both force and diameter.

As a specialty, Vulcan has the capability to provide dynamic force readings throughout a spring's extension and retraction, giving a full view of the spring's performance. This is especially helpful when measuring variable force springs.



"A" Minimum extension needed to achieve rated force = O.D. + PICKUP END
NOTE - No torque may be obtained from the storage spool of the spring.

Conforce® Spring

Contorque® Spring

Twin Spring

Back Plate Assembly

Variable Force Spring

The following parameters affect the design: life, force, space available, length and environmental factors. Other factors which may be unique to a particular application should be discussed with your Vulcan Spring engineer so they can be considered in the final design.

The following pages include a few pre-engineered designs to simplify the task of the design engineer.

These tables should be used only as a guide and are not a list of stock springs.

For available stock springs, view page 10.

Vulcan Spring works with our clients at various stages of their product development process with DFM (Design For Manufacturing) principles. We will help you utilize standard steel sizes and optimal manufacturing techniques to offer the best spring design possible at the lowest cost. Due to variables in the raw materials, a tolerance of ± 10% in both force and diameter is required.

DESIGN CONSIDERATIONS

Review the tables in this guide to assist you with the following design parameters:

1. **Select material –** Most of the flat steel springs that Vulcan Spring produces are made from Type 301 Stainless Steel. This material is readily available and predictable. A Vulcan Engineer can assist in choosing a standard size to expedite the process. Other materials we have used to manufacture constant force springs include high carbon steel, Inconel and Elgiloy.

2. **Estimate the life** – The life of a constant force spring is very predictable, making it one of the most important considerations. The design must be realistic however, since estimating a high life cycle can lead to a larger, more expensive part while underestimating the life cycle can lead to premature failure. The Design Guide has charts that range from 4,000 to 100,000 life cycles. If a high life cycle is needed, considerations have to be made for increased tolerances of the spring's diameter and force due to the low stress level and slight variances in material.

3. **Establish the force –** The force of a constant force spring should be equal to the requirement of the application. Standard tolerance for the force of a constant force spring is ± 10%.

4. **Determine the space –** When reviewing the charts in our Design Guide, it will become obvious that there are several thickness and width combinations that will result in the same force. The inside diameter (I.D.) of the spring is dependent on the thickness, life cycle and force required. The outside diameter (O.D.) is dependent on the above with overall length as an additional consideration. Note that a constant force spring does not extend tangent to the body of the spring. To allow for proper operation, a minimum distance of .80" X I.D. is required and should be considered during initial design. The standard tolerance for the I.D. and O.D. is ± 10%.

5. **Calculate the total length –** The total length of the spring should take into account the actual extension of the spring in the application. Additionally, allow for at least 1 ½ turns to remain when the spring is fully extended. If mounting the spring on an oversized spool, additional material may be required. The basic formula for this estimation is:

   (I.D. X 3.14159 X 1.5) + maximum extension length.

   When using a spool diameter greater than the I.D., substitute the spool diameter in place of the I.D. for this calculation.

   If there is a leader on the front of the spring (commonly called a pickup), that length should be added to the overall length.

6. **Select the end detail –** Vulcan Spring has many standard end details available. Drawings on pages 10 and 11 show some that are available. Special end designs may be obtained for an additional charge.

7. **Consider the environment** – Corrosive atmospheres or extreme temperatures will affect a spring's performance. A Vulcan engineer can assist in these situations which often can be addressed with alternate material choices.

8. **Finalize the design –** Once all of the above criteria have been reviewed, and the spring can be located or extrapolated from the design charts, a spring part number can be introduced. Vulcan's system is quite easy when assigning part numbers to designs. Be aware however, that a part number does not include the end detail, pickup length or any other special requirements. The part number identifies the following:

   a. The letter from the selected life table
   b. The thickness of the spring in mils
   c. The letter code of the width of the spring (taken from the charts)
   d. The overall length in inches

***Example**: Conforce Spring #J12G21 specifies type 301 stainless steel, 8,000 cycle, .012" thick, ½" wide, 21" long spring, producing force of 3.42 pounds, with a 1.05" I.D. Further customer specific requirements such as end details would be added to the part number.*

CONFORCE® SPRING DESIGN GUIDE

GUIDE H
SPRING LIFE
4,000 CYCLES

b →		D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2	V 3	W 4
t	ID	FORCE P											
.002	.13	.39	.49	.58	.77								
.003	.20	.58	.72	.86	1.15	1.44							
.004	.27	.77	.96	1.15	1.54	1.92	2.30						
.005	.34	.96	1.20	1.44	1.92	2.40	2.88	3.84					
.006	.41	1.15	1.44	1.73	2.30	2.88	3.45	4.61	5.76				
.008	.54	1.54	1.92	2.31	3.07	3.84	4.61	6.14	7.68	9.22			
.010	.68	1.92	2.40	2.88	3.84	4.80	5.76	7.68	9.59	11.5	15.4		
.012	.81		2.88	3.45	4.61	5.76	6.91	9.21	11.5	13.8	18.4	26.2	
.014	.95			4.03	5.37	6.72	8.06	10.8	13.4	16.1	21.5	30.6	38.7
.016	1.08				6.14	7.68	9.21	12.3	15.4	18.4	24.6	35.0	44.2
.018	1.22					8.63	10.4	13.8	17.3	20.7	27.6	39.4	49.7
.020	1.35						11.5	15.4	19.2	23.0	30.7	43.8	55.3
.022	1.49							16.9	21.1	25.3	33.8	48.1	60.8
.025	1.69								24.0	28.8	38.4	54.7	69.1
.031	2.09									35.7	47.6	67.8	85.7

GUIDE J
SPRING LIFE
8,000 CYCLES

b →		D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2	V 3	W 4
t	ID	FORCE P											
.002	.18	.29	.36	.43	.57	.71							
.003	.26	.43	.53	.64	.86	1.07							
.004	.35	.57	.71	.86	1.14	1.43	1.71						
.005	.44	.72	.89	1.07	1.43	1.79	2.15	2.86					
.006	.53	.86	1.07	1.28	1.71	2.14	2.57	3.42	4.28				
.008	.70	1.14	1.43	1.71	2.28	2.85	3.42	4.56	5.70	6.84			
.010	.88	1.42	1.78	2.14	2.85	3.56	4.28	5.70	7.13	8.55	11.4		
.012	1.05	1.71	2.14	2.57	3.42	4.28	5.13	6.84	8.55	10.3	13.7	20.5	
.014	1.23			2.99	3.99	4.99	5.99	7.98	9.98	12.0	16.0	23.9	30.3
.016	1.40				4.56	5.70	6.84	9.12	11.4	13.7	18.2	27.4	34.7
.018	1.58					6.41	7.70	10.3	12.8	15.4	20.6	30.8	39.0
.020	1.75						8.55	11.4	14.3	17.1	22.8	34.2	43.3
.022	1.93							12.5	15.7	18.8	25.1	37.6	47.7
.025	2.19								17.8	21.4	28.5	42.8	54.2
.031	2.71									26.5	35.3	53.0	67.1

GUIDE K
SPRING LIFE
12,000 CYCLES

b →		D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2	V 3	W 4
t	ID	FORCE P											
.002	.21	.22	.27	.32	.43	.54							
.003	.31	.32	.40	.48	.65	.81							
.004	.41	.43	.54	.65	.86	1.08	1.29						
.005	.51	.54	.68	.81	1.08	1.35	1.62	2.15					
.006	.62	.65	.81	.97	1.29	1.61	1.94	2.58	3.23				
.008	.82	.86	1.08	1.29	1.72	2.15	2.58	3.44	4.30	5.16			
.010	1.03	1.08	1.34	1.61	2.15	2.69	3.23	4.30	5.38	6.45	8.60		
.012	1.23	1.29	1.61	1.94	2.58	3.23	3.87	5.16	6.45	7.74	10.3	15.5	
.014	1.44			2.26	3.01	3.76	4.52	6.02	7.53	9.03	12.0	18.1	24.1
.016	1.64				3.44	4.30	5.16	6.88	8.60	10.3	13.8	20.6	27.5
.018	1.85					4.84	5.81	7.74	9.68	11.6	15.5	23.2	31.0
.020	2.05						6.45	8.60	10.8	12.9	17.2	25.8	34.4
.022	2.26							9.46	11.8	14.2	18.9	28.4	37.8
.025	2.56								13.4	16.1	21.5	32.3	43.0
.031	3.18									20.0	26.7	40.0	53.3

Symbols used in Design Guide:

t = material thickness (inches)
b = material width (inches)
ID = coil diameter (inches) ± 10%
P = force (pounds)
normal force tolerance ± 10%

AISI TYPE 301 STAINLESS STEEL

VIEW END DETAILS ON PAGE 20

GUIDE L

SPRING LIFE
25,000 CYCLES

b →	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2	V 3	W 4
t	ID	FORCE P										
.002	.28	.13	.16	.19	.26	.32						
.003	.41	.19	.24	.29	.38	.48						
.004	.55	.26	.32	.38	.51	.64	.77					
.005	.69	.32	.40	.48	.64	.80	.96	1.28				
.006	.83	.38	.48	.57	.77	.96	1.15	1.53	1.91			
.008	1.10	.51	.64	.77	1.02	1.28	1.53	2.04	2.55	3.06		
.010	1.38	.64	.80	.96	1.28	1.60	1.92	2.56	3.20	3.84	5.12	
.012	1.65	.77	.96	1.15	1.53	1.91	2.30	3.06	3.83	4.59	6.12	9.18
.014	1.93			1.34	1.79	2.24	2.69	3.58	4.48	5.37	7.16	10.7	14.3
.016	2.20				2.04	2.55	3.06	4.08	5.10	6.12	8.16	12.2	16.3
.018	2.48					2.87	3.44	4.59	5.74	6.89	9.18	13.8	18.4
.020	2.75						3.83	5.10	6.38	7.65	10.2	15.3	20.4
.022	3.03							5.60	7.01	8.42	11.2	16.8	22.4
.025	3.44								7.97	9.56	12.8	19.1	25.5
.031	4.26									11.9	15.8	23.7	31.6

GUIDE M

SPRING LIFE
50,000 CYCLES

b →	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2	V 3	W 4
t	ID	FORCE P										
.002	.37	.07	.09	.11	.15	.18						
.003	.56	.11	.14	.16	.22	.27						
.004	.75	.15	.18	.22	.29	.36	.44					
.005	.93	.18	.23	.27	.36	.45	.56	.73				
.006	1.12	.22	.27	.33	.44	.54	.65	.87	1.09			
.008	1.49	.29	.36	.44	.58	.72	.87	1.16	1.45	1.74		
.010	1.86	.36	.45	.54	.73	.91	1.09	1.45	1.81	2.18	2.90	
.012	2.24	.44	.54	.65	.87	1.09	1.31	1.74	2.18	2.61	3.48	5.22
.014	2.61			.77	1.02	1.28	1.53	2.04	2.55	3.06	4.08	6.12	8.16
.016	2.98				1.16	1.45	1.74	2.32	2.90	3.48	4.64	6.96	9.28
.018	3.35					1.63	1.96	2.61	3.26	3.92	5.22	7.83	10.4
.020	3.73						2.18	2.90	3.63	4.35	5.80	8.70	11.6
.022	4.10							3.19	3.99	4.79	6.38	9.57	12.8
.025	4.66								4.53	5.44	7.25	10.9	14.5
.031	5.77									6.75	8.99	13.5	18.0

GUIDE N

SPRING LIFE
100,000 CYCLES

b →	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2	V 3	W 4
t	ID	FORCE P										
.002	.44	.05	.07	.08	.11	.13						
.003	.66	.08	.10	.12	.16	.20						
.004	.89	.11	.13	.16	.21	.26	.32					
.005	1.11	.13	.16	.20	.26	.33	.40	.53				
.006	1.33	.16	.20	.24	.32	.39	.47	.63	.79			
.008	1.77	.21	.26	.32	.42	.53	.63	.84	1.10	1.26		
.010	2.21	.26	.33	.39	.53	.66	.79	1.05	1.31	1.58	2.10	
.012	2.66	.32	.39	.47	.63	.79	.95	1.26	1.58	1.89	2.52	3.78
.014	3.10			.55	.74	.92	1.10	1.47	1.84	2.20	2.94	4.41	5.88
.016	3.54				.84	1.05	1.26	1.68	2.10	2.52	3.36	5.04	6.72
.018	3.98					1.18	1.42	1.89	2.36	2.84	3.78	5.68	7.56
.020	4.43						1.58	2.10	2.63	3.16	4.20	6.32	8.40
.022	4.87							2.31	2.89	3.47	4.62	6.94	9.24
.025	5.53								3.28	3.94	5.25	7.88	10.5
.031	6.86									4.89	6.51	9.77	13.0

Symbols used in Design Guide:

t = material thickness (inches)
b = material width (inches)
ID = coil diameter (inches) ± 10%
P = force (pounds)
normal force tolerance ± 10%

CONFORCE® SPRING DESIGN GUIDE - METRIC

GUIDE H
SPRING LIFE
4,000 CYCLES

b →		D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8	V 76.2	W 101.6
t	ID	FORCE P											
.05	3.3	1.73	2.18	2.58	3.43								
.08	5.1	2.58	3.20	3.83	5.12	6.41							
.10	6.9	3.43	4.27	5.12	6.85	8.54	10.23						
.13	8.6	4.27	5.34	6.41	8.54	10.68	12.81	17.08					
.15	10.4	5.12	6.41	7.70	10.23	12.81	15.35	20.51	25.62				
.20	13.7	6.85	8.54	10.28	13.66	17.08	20.51	27.31	34.16	41.01			
.25	17.3	8.54	10.68	12.81	17.08	21.35	25.62	34.16	42.66	51.15	68.50		
.30	20.6		12.81	15.35	20.51	25.62	30.74	40.97	51.15	61.39	81.85	116.5	
.36	24.1			17.93	23.89	29.89	35.85	48.04	59.61	71.62	95.64	136.1	172.1
.41	27.4				27.31	34.16	40.97	54.71	68.50	81.85	109.4	155.7	196.6
.46	31.0					38.39	46.26	61.39	76.95	92.08	122.8	175.3	221.1
.51	34.3						51.15	68.50	85.41	102.3	136.6	194.8	246.0
.56	37.8							75.17	93.86	112.5	150.3	214.0	270.5
.64	42.9								106.8	128.1	170.8	243.3	307.4
.79	53.1									158.8	211.7	301.6	381.2

GUIDE J
SPRING LIFE
8,000 CYCLES

b →		D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8	V 76.2	W 101.6
t	ID	FORCE P											
.05	4.6	1.29	1.60	1.91	2.54	3.16							
.08	6.6	1.91	2.36	2.85	3.83	4.76							
.10	8.9	2.54	3.16	3.83	5.07	6.36	7.61						
.13	11.2	3.20	3.96	4.76	6.36	7.96	9.56	12.72					
.15	13.5	3.83	4.76	5.69	7.61	9.52	11.43	15.21	19.04				
.20	17.8	5.07	6.36	7.61	10.14	12.68	15.21	20.28	25.35	30.43			
.25	22.4	6.32	7.92	9.52	12.68	15.84	19.04	25.35	31.72	38.03	50.71		
.30	26.7	7.61	9.52	11.43	15.21	19.04	22.82	30.43	38.03	45.82	60.94	91.19	
.36	31.2			13.30	17.75	22.20	26.64	35.50	44.39	53.38	71.17	106.3	134.8
.41	35.6				20.28	25.35	30.43	40.57	50.71	60.94	80.96	121.9	154.4
.46	40.1					28.51	34.25	45.82	56.94	68.50	91.63	137.0	173.5
.51	44.5						38.03	50.71	63.61	76.06	101.4	152.1	192.6
.56	49.0							55.60	69.84	83.63	111.7	167.3	212.2
.64	55.6								79.18	95.19	126.8	190.4	241.1
.79	68.8									117.9	157.0	235.8	298.5

GUIDE K
SPRING LIFE
12,000 CYCLES

b →		D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8	V 76.2	W 101.6
t	ID	FORCE P											
.05	5.3	.98	1.20	1.42	1.91	2.40							
.08	7.9	1.42	1.78	2.14	2.89	3.60							
.10	10.4	1.91	2.40	2.89	3.83	4.80	5.74						
.13	13.0	2.40	3.02	3.60	4.80	6.01	7.21	9.56					
.15	15.7	2.89	3.60	4.31	5.74	7.16	8.63	11.48	14.37				
.20	20.8	3.83	4.80	5.74	7.65	9.56	11.48	15.30	19.13	22.95			
.25	26.2	4.80	5.96	7.16	9.56	11.97	14.37	19.13	23.93	28.69	38.25		
.30	31.2	5.74	7.16	8.63	11.48	14.37	17.21	22.95	28.69	34.43	45.82	68.95	
.36	36.6			10.05	13.39	16.73	20.11	26.78	33.50	40.17	53.38	80.51	107.2
.41	41.7				15.30	19.13	22.95	30.60	38.25	45.82	61.39	91.63	122.3
.46	47.0					21.53	25.84	34.43	43.06	51.60	68.95	103.2	137.9
.51	52.1						28.69	38.25	48.04	57.38	76.51	114.8	153.0
.56	57.4							42.08	52.49	63.16	84.07	126.3	168.1
.64	65.0								59.61	71.62	95.64	143.7	191.3
.79	80.8									88.96	118.8	177.9	237.1

Symbols used in Design Guide:

t = material thickness (mm)
b = material width (mm)
ID = coil diameter (mm) ± 10%
P = force (Newtons)
normal force tolerance ± 10%

AISI TYPE 301 STAINLESS STEEL

VIEW END DETAILS ON PAGE 21

GUIDE L
SPRING LIFE
25,000 CYCLES

b →		D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8	V 76.2	W 101.6
t	ID	FORCE P											
.05	7.1	.58	.71	.85	1.16	1.42							
.08	10.4	.85	1.07	1.29	1.69	2.14							
.10	14.0	1.16	1.42	1.69	2.27	2.85	3.43						
.13	17.5	1.42	1.78	2.14	2.85	3.56	4.27	5.69					
.15	21.1	1.69	2.14	2.54	3.43	4.27	5.12	6.81	8.50				
.20	27.9	2.27	2.85	3.43	4.54	5.69	6.81	9.07	11.34	13.61			
.25	35.1	2.85	3.56	4.27	5.69	7.12	8.54	11.39	14.23	17.08	22.77		
.30	41.9	3.43	4.27	5.12	6.81	8.50	10.23	13.61	17.04	20.42	27.22	40.83	
.36	49.0			5.96	7.96	9.96	11.97	15.92	19.93	23.89	31.85	47.60	63.61
.41	55.9				9.07	11.34	13.61	18.15	22.69	27.22	36.30	54.27	72.51
.46	63.0					12.77	15.30	20.42	25.53	30.65	40.83	61.39	81.85
.51	69.9						17.04	22.69	28.38	34.03	45.37	68.06	90.74
.56	77.0							24.91	31.18	37.45	49.82	74.73	99.64
.64	87.4								35.45	42.52	56.94	84.96	113.4
.79	108.2									52.93	70.28	105.4	140.6

GUIDE M
SPRING LIFE
50,000 CYCLES

b →		D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8	V 76.2	W 101.6
t	ID	FORCE P											
.05	9.4	.31	.40	.49	.67	.80							
.08	14.2	.49	.62	.71	.98	1.20							
.10	19.1	.67	.80	.98	1.29	1.60	1.96						
.13	23.6	.80	1.02	1.20	1.60	2.00	2.49	3.25					
.15	28.4	.98	1.20	1.47	1.96	2.40	2.89	3.87	4.85				
.20	37.8	1.29	1.60	1.96	2.58	3.20	3.87	5.16	6.45	7.74			
.25	47.2	1.60	2.00	2.40	3.25	4.05	4.85	6.45	8.05	9.70	12.90		
.30	56.9	1.96	2.40	2.89	3.87	4.85	5.83	7.74	9.70	11.61	15.48	23.22	
.36	66.3			3.43	4.54	5.69	6.81	9.07	11.34	13.61	18.15	27.22	36.30
.41	75.7				5.16	6.45	7.74	10.32	12.90	15.48	20.64	30.96	41.28
.46	85.1					7.25	8.72	11.61	14.50	17.44	23.22	34.83	46.26
.51	94.7						9.70	12.90	16.15	19.35	25.80	38.70	51.60
.56	104.1							14.19	17.75	21.31	28.38	42.57	56.94
.64	118.4								20.15	24.20	32.25	48.49	64.50
.79	146.6									30.03	39.99	60.05	80.07

GUIDE N
SPRING LIFE
100,000 CYCLES

b →		D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8	V 76.2	W 101.6
t	ID	FORCE P											
.05	11.2	.22	.31	.36	.49	.58							
.08	16.8	.36	.44	.53	.71	.89							
.10	22.6	.49	.58	.71	.93	1.16	1.42						
.13	28.2	.58	.71	.89	1.16	1.47	1.78	2.36					
.15	33.8	.71	.89	1.07	1.42	1.73	2.09	2.80	3.51				
.20	45.0	.93	1.16	1.42	1.87	2.36	2.80	3.74	4.89	5.60			
.25	56.1	1.16	1.47	1.73	2.36	2.94	3.51	4.67	5.83	7.03	9.34		
.30	67.6	1.42	1.73	2.09	2.80	3.51	4.23	5.60	7.03	8.41	11.21	16.81	
.36	78.7			2.45	3.29	4.09	4.89	6.54	8.18	9.79	13.08	19.62	26.16
.41	89.9				3.74	4.67	5.60	7.47	9.34	11.21	14.95	22.42	29.89
.46	101.1					5.25	6.32	8.41	10.50	12.63	16.81	25.27	33.63
.51	112.5						7.03	9.34	11.70	14.06	18.68	28.11	37.37
.56	123.7							10.28	12.86	15.44	20.55	30.87	41.10
.64	140.5								14.59	17.53	23.35	35.05	46.71
.79	174.2									21.75	28.96	43.46	57.83

Symbols used in Design Guide:

t = material thickness (mm)
b = material width (mm)
ID = coil diameter (mm) ± 10%
P = force (Newtons)
normal force tolerance ± 10%

STOCK CONSTANT FORCE SPRINGS

Every constant force spring is produced to provide a specific force which is exerted through its full extension. The force is constant as long as the radius remains constant.

In longer springs this change in radius, due to diameter build-up, causes the spring to increase in force slightly as it is extended.

Constant force springs deliver more force per pound of material than gravity devices.

SH6G25

SH12K39

SL6G25

	Part #	Thickness	Width	Length	Load +/- 10%	I.D. +/- 10%	O.D. +/- 10%	End Holes
SERIES H SPRING LIFE 4,000 CYCLES	SH3C12	.003"	.187"	12"	.37 lbs	.21"	.30"	1-.096
	SH4C15	.004"	.187"	15"	.49 lbs	.29"	.40"	1-.096
	SH4D15	.004"	.250"	15"	.66 lbs	.25"	.40"	1-.130
	SH4E15	.004"	.312"	15"	.83 lbs	.28"	.40"	1-.130
	SH5E17	.005"	.312"	17"	1.03 lbs	.37"	.50"	1-.130
	SH6F24	.006"	.375"	24"	1.48 lbs	.45"	.62"	1-.196
	SH6G25	.006"	.500"	25"	1.97 lbs	.45"	.65"	1-.196
	SH8G30	.008"	.500"	30"	2.63 lbs	.59"	.82"	1-.196
	SH8J30	.008"	.625"	30"	3.29 lbs	.61"	.83"	1-.196
	SH8K24	.009"	.750"	24"	4.00 lbs	.62"	.82"	1-.196
	SH10J33	.010"	.625"	33"	4.12 lbs	.73"	.99"	1-.196
	SH10K33	.010"	.750"	33"	4.95 lbs	.71"	.97"	1-.196
	SH12K39	.012"	.750"	39"	5.94 lbs	.88"	1.19"	1-.196
	SH12P39	.012"	1.00"	39"	7.92 lbs	.88"	1.20"	1-.196
	SH16P40	.016"	1.00"	40"	10.60 lbs	1.20"	1.52"	1-.196
	SH20R50	.020"	1.25"	50"	16.50 lbs	1.47"	1.89"	1-.196
	SH25S52	.025"	1.50"	52"	24.80 lbs	1.77"	2.23"	2-.265
	SH25U52	.025"	2.00"	52"	33.00 lbs	1.78"	2.22"	2-.265
	SH31U60	.031"	2.00"	60"	40.90 lbs	2.50"	3.03"	2-.265

SERIES L SPRING LIFE 25,000 CYCLES	SL4D18	.004"	.250"	18"	.23 lbs	.53"	.62"	1-.130
	SL5E18	.005"	.312"	18"	.36 lbs	.69"	.78"	1-.130
	SL5F25	.005"	.375"	25"	.43 lbs	.65"	.78"	1-.130
	SL6F25	.006"	.375"	25"	.52 lbs	.70"	.90"	1-.196
	SL6G25	.006"	.500"	25"	.70 lbs	.80"	.92"	1-.196
	SL8G33	.008"	.500"	33"	.93 lbs	1.07"	1.23"	1-.196
	SL10J35	.010"	.625"	35"	1.46 lbs	1.36"	1.53"	1-.196
	SL12K45	.012"	.750"	45"	2.09 lbs	1.60"	1.82"	1-.196
	SL12P45	.012"	1.00"	45"	2.80 lbs	1.60"	1.84"	1-.196
	SL15P48	.015"	1.00"	48"	3.50 lbs	1.96"	2.20"	1-.196
	SL15R48	.015"	1.25"	48"	4.37 lbs	2.03"	2.29"	1-.196
	SL16P46	.016"	1.00"	46"	4.10 lbs	1.96"	2.21"	1-.196
	SL20R55	.020"	1.25"	55"	5.83 lbs	2.53"	2.82"	1-.196
	SL25S60	.025"	1.50"	60"	8.40 lbs	3.35"	3.70"	2-.265
	SL25U60	.025"	2.00"	60"	11.70 lbs	3.37"	3.68"	2-.265
	SL31U70	.031"	2.00"	70"	14.40 lbs	4.35"	4.74"	2-.265

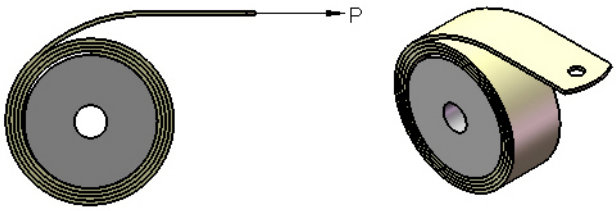
TO ORDER VISIT WWW.VULCANEXPRESS.COM

The Vulcan Spring and Manufacturing Express Online Store is provided as a convenience to our commercial customers. Springs and specifications are subject to change.

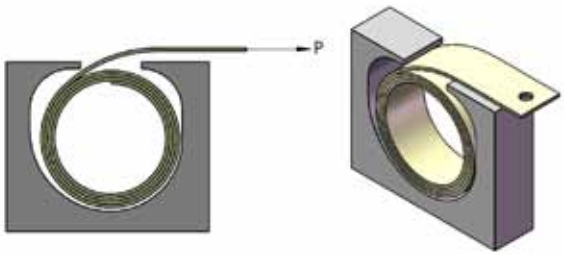
MOUNTING METHODS

SINGLE MOUNTING

NOTE: No torque may be obtained from the storage spool of the spring. For ideal operation, the diameter of the spool should be 15-20% greater than nominal spring I.D.



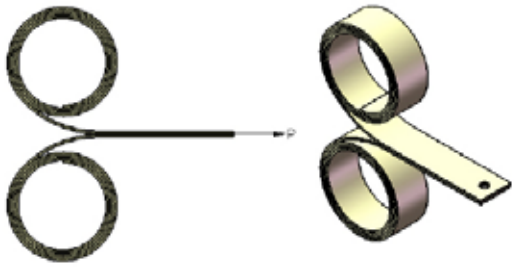
Spool Mounting - a common method



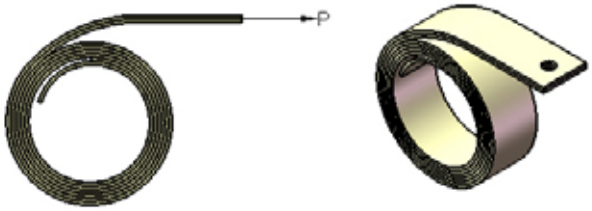
Cavity - Low cost, but friction is a limiting factor

MULTIPLE MOUNTING

Force is the sum of two or more springs.

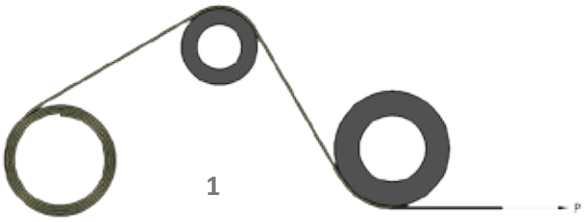


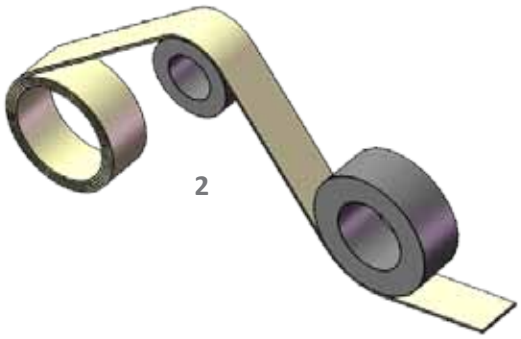
Back to Back - Most stable mounting



Laminar - Offers sum of forces in a limited space

Tandem - this configuration does not add stability





NOTE FOR ALL CONSTANT FORCE SPRINGS

1. Idler pulleys should not be used because life is reduced by as much as ⅔ at each pulley.
2. Backbending destroys a constant force spring.

SAMPLE END DETAILS

Z Bend

Hook End

Scallop End

Eyelet or Rivet

Looped & Welded

MOTOR BRUSH & TWIN SPRING DESIGN

1. **Select material** - Type 301 stainless steel is preferred.
   Special materials are required if current is to be carried through the spring.
2. **Establish the force** - The force of the spring should be equal to the spring force required to obtain the desired brush pressure. Normal spring tolerance is ± 10%.
3. **Determine the space** - For any given force there are several combinations of spring thickness and width that can be used. Select the one that best fits the space.
4. **Calculate the total length** - Include two full turns extra when the spring is fully extended, based on the length of the brush when new.

CONFORCE DESIGN GUIDE B

SPRING LIFE = 3,000 CYCLES (Single Coil)

b →		B 1/8	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4
t	ID	FORCE P							
.001	.06	.11	.16	.21	REFERENCE ONLY				
.0015	.09	.16	.24	.32					
.002	.12	.21	.32	.43	.53	.64			
.0025	.16	.27	.40	.53	.67	.80			
.003	.19	.32	.48	.64	.80	.96	1.28		
.0035	.22	.37	.56	.75	.93	1.12	1.49		
.004	.25	.43	.64	.86	1.07	1.28	1.71	2.14	2.56
.0045	.28	.48	.72	.96	1.20	1.44	1.92	2.40	2.88
.005	.32	.54	.80	1.07	1.33	1.60	2.13	2.66	3.20
.0055	.35		.88	1.17	1.47	1.76	2.34	2.93	3.51
.006	.38			1.28	1.60	1.92	2.56	3.20	3.84
.008	.51			1.71	2.13	2.56	3.41	4.26	5.12
.010	.64			2.13	2.66	3.20	4.26	5.33	6.39
.012	.77			2.56	3.20	3.84	5.12	6.39	7.67

Symbols used in Design Guide:

t = material thickness (inches) ID = coil diameter (inches) ± 10%

b = material width (inches) P = force (Pounds) *normal force tolerance ± 10%*

CONFORCE DESIGN GUIDE B

SPRING LIFE = 3,000 CYCLES (Single Coil) METRIC

b →		B 3.2	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1
t	ID	FORCE P							
.03	1.5	.49	.71	.93	REFERENCE ONLY				
.04	2.3	.71	1.07	1.42					
.05	3.0	.93	1.42	1.91	2.36	2.85			
.06	4.1	1.20	1.78	2.36	2.98	3.56			
.08	4.8	1.42	2.14	2.85	3.56	4.27	5.69		
.09	5.6	1.65	2.49	3.34	4.14	4.98	6.63		
.10	6.4	1.91	2.85	3.83	4.76	5.69	7.61	9.52	11.39
.11	7.1	2.14	3.20	4.27	5.34	6.41	8.54	10.68	12.81
.13	8.1	2.40	3.56	4.76	5.92	7.12	9.47	11.83	14.23
.14	8.9		3.91	5.20	6.54	7.83	10.41	13.03	15.61
.15	9.7			5.69	7.12	8.54	11.39	14.23	17.08
.20	13.0			7.61	9.47	11.39	15.17	18.95	22.77
.25	16.3			9.47	11.83	14.23	18.95	23.71	28.42
.30	19.6			11.39	14.23	17.08	22.77	28.42	34.12

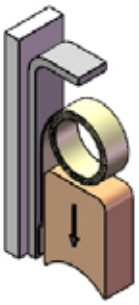
Symbols used in Design Guide:

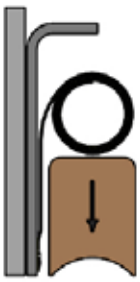
t = material thickness (mm) ID = coil diameter (mm) ± 10%

b = material width (mm) P = force (Newtons) *normal force tolerance ± 10%*

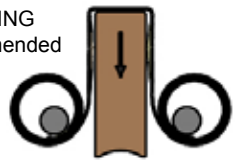
BENEFITS

1. **Constant pressure for the life of the brush**
   a. Eliminates pressure adjustment
   b. Increases brush life
   c. Reduces electrical wear
2. **Compact design**
   a. Allows longer brushes
   b. Permits a smaller motor O.D.
   c. Allows larger commutators



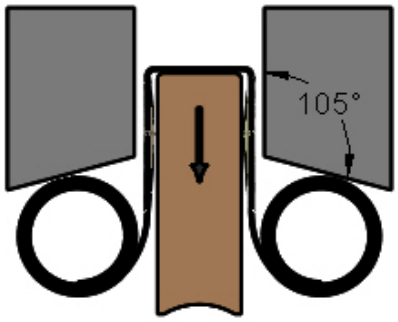


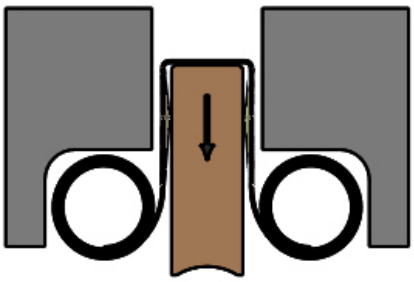
PIN MOUNTING
Not-Recommended

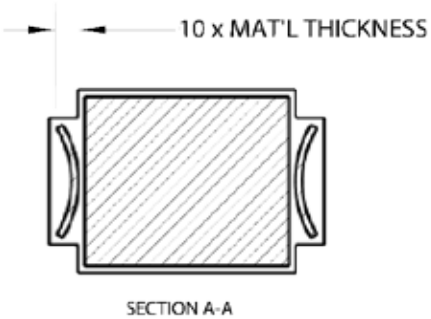


5. **Choose the configuration that fits your application best.**
   a. Straight extension springs - A single spring
   b. Laminated springs - Two or more springs, interwound. This allows an increased load in a small space.
   c. Twin coil springs - For maximum brush length and double the load of a single spring. This form allows maximum commutator diameter in a minimum overall motor diameter.

6. **Allow clearance for spring cross-curvature which varies with spring width.**
   Start at ten times the thickness of the spring. See the graphics below...







CONFORCE DESIGN GUIDE T

SPRING LIFE = 3,000 CYCLES (Twin Coil)

b ➡		A 1/16	B 1/8	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2
t	ID	FORCE P						
.001	.06	.11	.21	.32	.43	REFERENCE ONLY		
.0015	.09	.16	.32	.48	.64			
.002	.12	.21	.43	.64	.85	1.07	1.28	1.71
.0025	.16	.27	.53	.80	1.07	1.33	1.60	2.13
.003	.19		.64	.96	1.28	1.60	1.92	2.56
.0035	.22		.75	1.12	1.49	1.86	2.24	2.98
.004	.25			1.28	1.71	2.13	2.56	3.41
.0045	.28			1.44	1.92	2.40	2.88	3.84
.005	.32				2.13	2.66	3.20	4.26
.0055	.35				2.34	2.93	3.52	4.69
.006	.38				2.56	3.20	3.84	5.12
.008	.51				3.41	4.26	5.12	6.82

Symbols used in Design Guide:

t = material thickness (inches)
b = material width (inches)
ID = coil diameter (inches) ± 10%
P = force (Pounds) *normal force tolerance ± 10%*

CONFORCE DESIGN GUIDE T

SPRING LIFE = 3,000 CYCLES (Twin Coil) METRIC

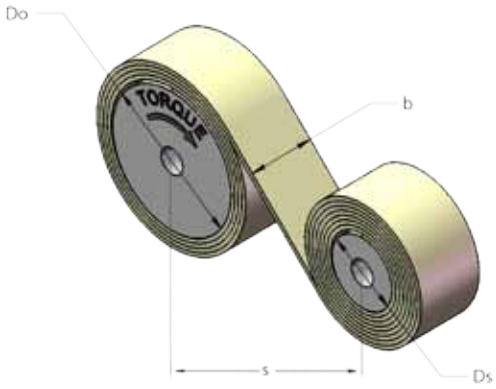
b ➡		A 1.6	B 3.2	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7
t	ID	FORCE P						
.03	1.52	.49	.93	1.42	1.91	REFERENCE ONLY		
.04	2.29	.71	1.42	2.14	2.85			
.05	3.05	.93	1.91	2.85	3.78	4.76	5.69	7.61
.06	4.06	1.20	2.36	3.56	4.76	5.92	7.12	9.47
.08	4.83		2.85	4.27	5.69	7.12	8.54	11.39
.09	5.59		3.34	4.98	6.63	8.27	9.96	13.26
.10	6.35			5.69	7.61	9.47	11.39	15.17
.11	7.11			6.41	8.54	10.68	12.81	17.08
.13	8.13				9.47	11.83	14.23	18.95
.14	8.89				10.41	13.03	15.66	20.86
.15	9.65				11.39	14.23	17.08	22.77
.20	12.95				15.17	18.95	22.77	30.34

Symbols used in Design Guide:

t = material thickness (mm)
b = material width (mm)
ID = coil diameter (mm) ± 10%
P = force (Newtons) *normal force tolerance ± 10%*

CONTORQUE® SPRING DESIGN

A constant torque spring is a specially stressed constant force spring traveling between two spools. The spring is stored on a storage spool and reverse wound onto an output spool. When released, torque is obtained from the output spool as the spring returns to its natural curvature on the storage spool. The spring does not need to be attached to the storage spool. The spring can be housed in a cavity, eliminating the need for a storage spool. However, friction is then introduced and can change the torque requirements.

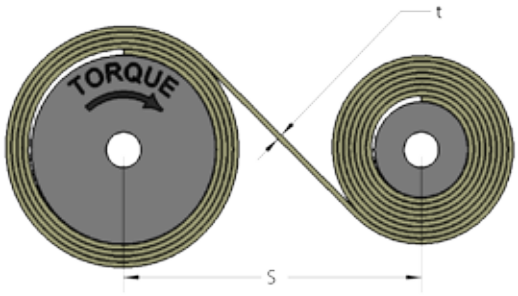


The torque produced by a constant torque spring will increase slightly over many turns. Constant torque, or even negative torque, is also possible. Negative gradients as much as 50% can be achieved in certain applications.

When considering the use of a constant torque spring it is highly recommended that you speak with a Vulcan engineer and work through various design parameters. However, it is possible to make some initial design calculations by following the steps described below.

DESIGN CONSIDERATIONS

The following parameters determine the design: material, width, thickness, length, spool diameters, and the natural diameter of the spring.



The following pages include a few pre-engineered designs to simplify the task of the design engineer. **These tables should be used only as a guide and are not a list of stock springs.** See available stock springs in the table below.

Vulcan Spring works with our clients at various stages of their product development process with DFM (Design For Manufacturing) principles. We will help you utilize standard steel sizes and optimal manufacturing techniques to offer the best spring design possible at the lowest cost.

Part Number	Torque ± 10%	Thickness (t)	Width (b)	Length	Turns	ID ± 10%	Storage Drum (Ds)	Output Drum (Do)	Center to Center (s)	Inner End Detail*
SV3D48	0.18 in-lbs	0.003”	0.250”	48”	20	0.30”	0.35”	0.61”	0.65”	4
SV4D64	0.33 in-lbs	0.004”	0.250”	64”	20	0.41”	0.47”	0.81”	0.90”	4
SV6D96	0.75 in-lbs	0.006”	0.250”	96”	20	0.61”	0.70”	1.22”	1.30”	4
SV4G64	0.67 in-lbs	0.004”	0.500”	64”	20	0.41”	0.47”	0.81”	0.90”	5
SV6G96	1.50 in-lbs	0.006”	0.500”	96”	20	0.61”	0.70”	1.22”	1.30”	5
SV10G160	4.17 in-lbs	0.010”	0.500”	160”	20	1.01”	1.17”	2.02”	2.25”	5
SV12J192	7.50 in-lbs	0.012”	0.625”	192”	20	1.22”	1.40”	2.43”	2.60”	5

*See page 20 for end detail drawings and specifications.

Springs are rolled and shipped reverse. Torque ± 10% at 10 turns. Recommended spool sizes. Spools not included. This table is designed to quickly choose and assist in ordering a constant torque spring as a sample or prototype.

TO ORDER VISIT WWW.VULCANEXPRESS.COM

The Vulcan Spring and Manufacturing Express Online Store is provided as a convenience to our commercial customers. Springs and specifications are subject to change.

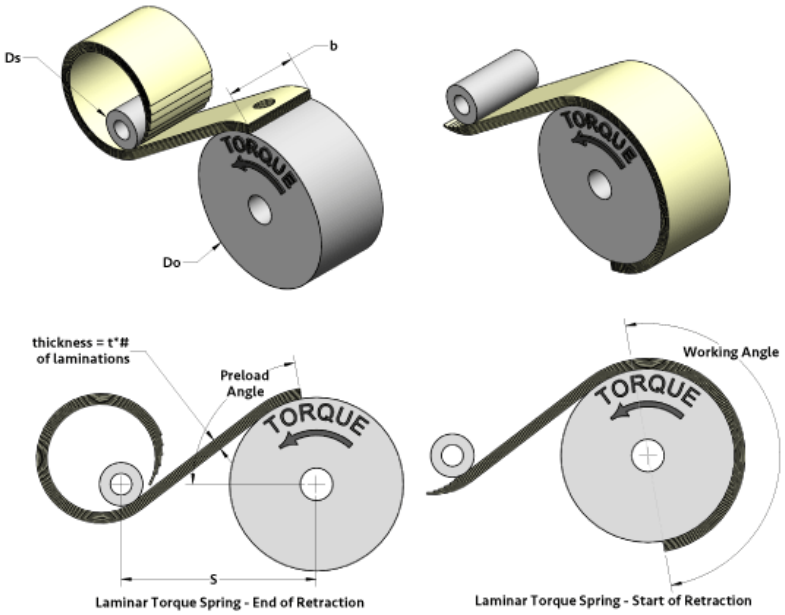
Review the tables in this guide to assist you with the following design parameters:

1. **Select material** - Most of the flat steel springs that Vulcan Spring produces are made from Type 301 Stainless Steel. This material is readily available and predictable. A Vulcan Engineer can assist in choosing a standard size to expedite the process. Other materials we have used to manufacture constant force springs include high carbon steel, Inconel and Elgiloy.

2. **Estimate the life** – The life of a constant torque spring is very predictable, making it one of the most important considerations. The design must be realistic however, since estimating a high life cycle can lead to a larger, more expensive part while underestimating the life cycle can lead to premature failure. The Design Guide has charts that range from 4,000 to 50,000 life cycles. If a high life cycle is needed, considerations have to be made for increased tolerances of the spring's diameter and force due to the low stress level and slight variances in material.

3. **Establish the torque** – The torque of the spring should be equal to the requirement of the application. Standard tolerance for the force of constant torque spring is ± 10%.

4. **Determine the space** – When reviewing the charts in the Design Guide it will become obvious that there are several thickness and width combinations that can be used to create the same torque. The inside diameter (I.D.) of the spring is dependent on the thickness, life cycle and torque required. Overall length is an additional factor that defines the outside diameter (O.D.) The standard tolerance for the I.D. and O.D. is ± 10%. Space requirements must also consider the fully wound outside diameters of the storage and output spools as well as the distance between the spools.



Drawing is of a Hinge Spring

5. **Calculate the total length** – The total length of the spring should take in account the actual number of turns of the spring on the output spool plus at least enough material to keep 1-½ turns on the spring when it is fully rotated. The formula for determining length is as follows:

   $L=\pi N (Do + Nt) + 10 Do$

   The above formula takes into account: diameter buildup, number of revolutions required (N), thickness of material (t) and output spool diameter (Do).

6. **Select the end detail** – The end detail will connect the spring to the output spool. Drawings on pages 10 and 11 show some that are available. Special end designs may be obtained for an additional charge.

7. **Calculate the minimum spool spacing** – The distance between spool centers (dimension "S") must be greater than the radius of the spring when fully wound on the storage spool, PLUS the radius of the spring when fully wound on the output spool.

8. **Consider the environment** – Corrosive atmospheres or extreme temperatures will affect a spring's performance. A Vulcan engineer can assist in these situations which often can be addressed with alternate material choices.

9. **Finalize the design** – Once all of the above criteria have been reviewed, and the spring can be located or extrapolated from the design charts, a spring part number can be introduced. Vulcan's system is quite easy when assigning part numbers to designs. Be aware however, that a part number does not include the end detail, pickup length or any other special requirements. The part number identifies the following:

   a. The letter from the selected life table
   b. The thickness of the spring in mils
   c. The letter code of the width of the spring (taken from the charts)
   d. The overall length in inches

***Example**: Contorque Spring #V5D46 specifies Type 301 stainless steel, 4,000 cycle, .005" thick, ¼" wide, and 46" long, producing a torque of .52 inch-pounds for 12 output turns, when mounted on a .58" diameter storage spool and a 1.01" diameter output spool.*

CONTORQUE® SPRING DESIGN GUIDE

GUIDE V
SPRING LIFE
4,000 CYCLES

			b →	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2
t	ID	Ds	Do	TORQUE M - Inch Pounds										
.002	.20	.23	.41	.06	.08	.10	.13	.17						
.003	.30	.35	.61	.14	.19	.23	.28	.38	.47					
.004	.41	.47	.81	.25	.33	.42	.50	.67	.83	1.00				
.005	.51	.58	1.01	.39	.52	.65	.78	1.04	1.30	1.56	2.08			
.006	.61	.70	1.22		.75	.94	1.13	1.50	1.88	2.25	2.99	3.75		
.008	.81	.93	1.62			1.66	2.00	2.66	3.33	4.00	5.33	6.66	8.00	
.010	1.01	1.17	2.02				3.13	4.17	5.21	6.25	8.33	10.4	12.5	16.7
.012	1.22	1.40	2.43					6.00	7.50	9.00	12.0	15.0	18.0	24.0
.014	1.42	1.63	2.84						10.2	12.3	16.3	20.4	24.5	32.7
.016	1.62	1.86	3.24							16.0	21.3	26.7	32.0	42.7
.018	1.82	2.10	3.65								27.0	33.8	40.5	54.0
.020	2.03	2.33	4.05								33.3	41.7	50.0	66.7
.022	2.23	2.56	4.46									50.4	60.5	80.7
.025	2.53	2.91	5.07									65.1	78.1	104
.031	3.14	3.61	6.28										120	160

GUIDE W
SPRING LIFE
8,000 CYCLES

			b →	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2
t	ID	Ds	Do	TORQUE M - Inch Pounds										
.002	.26	.30	.52	.05	.07	.09	.11	.14						
.003	.39	.45	.79	.12	.16	.20	.24	.32	.40					
.004	.52	.60	1.05	.21	.28	.35	.42	.57	.71	.85				
.005	.66	.75	1.31	.33	.44	.55	.66	.88	1.10	1.33	1.77			
.006	.79	.90	1.57		.64	.79	.95	1.27	1.59	1.91	2.54	3.18		
.008	1.05	1.21	2.10			1.41	1.70	2.26	2.82	3.39	4.52	5.65	6.78	
.010	1.31	1.51	2.62				2.65	3.53	4.42	5.30	7.07	8.83	10.6	14.1
.012	1.57	1.81	3.14					5.09	6.36	7.63	10.2	12.7	15.3	20.4
.014	1.83	2.11	3.67						8.65	10.4	13.8	17.3	20.8	27.7
.016	2.10	2.41	4.19							13.6	18.1	22.6	27.1	36.2
.018	2.36	2.71	4.72								22.9	28.6	34.3	45.8
.020	2.62	3.01	5.24								28.3	35.3	42.4	56.5
.022	2.88	3.31	5.76									42.7	51.3	68.4
.025	3.28	3.77	6.55									55.2	66.3	88.3
.031	4.06	4.67	8.12										102	136

GUIDE X
SPRING LIFE
12,000 CYCLES

			b →	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2
t	ID	Ds	Do	TORQUE M - Inch Pounds										
.002	.31	.35	.62	.05	.06	.08	.09	.13						
.003	.46	.53	.92	.11	.14	.18	.21	.28	.36					
.004	.62	.71	1.23	.19	.25	.32	.38	.51	.63	.76				
.005	.77	.88	1.54	.30	.40	.49	.59	.79	.99	1.19	1.58			
.006	.92	1.06	1.85		.57	.71	.85	1.14	1.42	1.70	2.28	2.84		
.008	1.23	1.42	2.46			1.26	1.52	2.02	2.53	3.03	4.04	5.06	6.06	
.010	1.54	1.77	3.08				2.37	3.16	3.95	4.74	6.32	7.90	9.48	12.6
.012	1.85	2.12	3.69					4.55	5.69	6.82	9.10	11.4	13.7	18.2
.014	2.15	2.48	4.31						7.74	9.29	12.4	15.5	18.6	24.8
.016	2.46	2.83	4.92							12.1	16.2	20.2	24.3	32.4
.018	2.77	3.18	5.54								20.5	25.6	30.7	41.0
.020	3.08	3.54	6.15								25.3	31.6	37.9	50.6
.022	3.38	3.89	6.77									38.2	45.9	61.2
.025	3.85	4.42	7.69									49.4	59.3	79.0
.031	4.77	5.48	9.54										91.1	121

Symbols used in Design Guide:

t = material thickness (inches)
b = material width (inches)
s = distance between spool axes
ID = coil diameter (inches) ± 10%
Do = output spool diameter (inches)
Ds = storage spool diameter (inches)

AISI TYPE 301 STAINLESS STEEL

VIEW END DETAILS ON PAGE 20

			b ➡	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2
t	ID	Ds	Do	TORQUE M - Inch Pounds										
.002	.41	.47	.82	.04	.05	.06	.07	.10						
.003	.62	.71	1.23	.08	.11	.13	.16	.22	.27					
.004	.82	.95	1.64	.14	.19	.24	.29	.38	.48	.57				
.005	1.03	1.18	2.05	.22	.30	.37	.45	.60	.75	.90	1.20			
.006	1.23	1.42	2.47		.43	.54	.65	.86	1.08	1.29	1.72	2.15		
.008	1.64	1.89	3.29			.96	1.15	1.53	1.91	2.29	3.06	3.82	4.60	
.010	2.05	2.36	4.11				1.80	2.39	2.99	3.59	4.78	5.98	7.18	9.57
.012	2.47	2.84	4.93					3.44	4.30	5.17	6.88	8.61	10.3	13.8
.014	2.88	3.31	5.75						5.86	7.03	9.37	11.7	14.1	18.8
.016	3.29	3.78	6.58							9.19	12.2	15.3	18.4	24.5
.018	3.70	4.25	7.40								15.5	19.4	23.3	31.0
.020	4.11	4.73	8.22								19.1	23.9	28.7	38.3
.022	4.52	5.20	9.04									28.9	34.8	46.3
.025	5.14	5.91	10.3									37.4	44.9	59.8
.031	6.37	7.33	12.7										69.0	92.0

GUIDE Y
SPRING LIFE
25,000 CYCLES

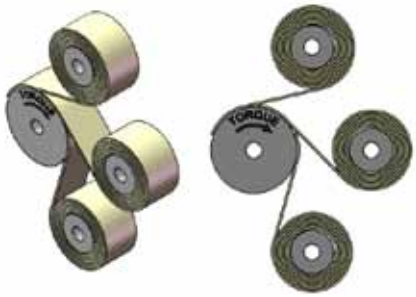
			b ➡	C 3/16	D 1/4	E 5/16	F 3/8	G 1/2	J 5/8	K 3/4	P 1	R 1 1/4	S 1 1/2	U 2
t	ID	Ds	Do	TORQUE M - Inch Pounds										
.002	.56	.64	1.12	.03	.04	.05	.06	.07						
.003	.84	.97	1.68	.06	.08	.10	.13	.17	.21					
.004	1.12	1.29	2.24	.11	.15	.19	.22	.30	.37	.45				
.005	1.40	1.61	2.80	.17	.23	.29	.35	.47	.58	.70	.93			
.006	1.68	1.93	3.36		.33	.42	.50	.67	.84	1.00	1.34	1.67		
.008	2.24	2.58	4.49			.74	.89	1.19	1.49	1.78	2.38	2.98	3.57	
.010	2.80	3.22	5.61				1.40	1.86	2.33	2.79	3.72	4.65	5.58	7.44
.012	3.36	3.87	6.73					2.67	3.35	4.02	5.35	6.70	8.04	10.7
.014	3.93	4.51	7.85						4.56	5.47	7.29	9.11	10.9	14.6
.016	4.49	5.16	8.97							7.14	9.52	11.9	14.3	19.0
.018	5.05	5.80	10.1								12.1	15.1	18.1	24.1
.020	5.61	6.45	11.2								14.9	18.6	22.3	29.8
.022	6.17	7.09	12.3									22.5	27.0	36.0
.025	7.01	8.06	14.0									29.1	34.9	46.5
.031	8.69	10.0	17.4										53.6	71.5

GUIDE Z
SPRING LIFE
50,000 CYCLES

Symbols used in Design Guide:

t = material thickness (inches)
b = material width (inches)
s = distance between spool axes
ID = coil diameter (inches) ± 10%
Do = output spool diameter (inches)
Ds = storage spool diameter (inches)

Single Contorque® Motor Assembly



Multiple Contorque® Motor Assembly

CONTORQUE® SPRING DESIGN GUIDE - METRIC

GUIDE V
SPRING LIFE
4,000 CYCLES

			b ➡	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8
t	ID	Ds	Do	TORQUE M - Newton meters										
.05	5.1	5.8	10.4	.007	.009	.011	.015	.019						
.08	7.6	8.9	15.5	.016	.021	.026	.032	.043	.053					
.10	10.4	11.9	20.6	.028	.037	.047	.056	.076	.094	.113				
.13	13.0	14.7	25.7	.044	.059	.073	.088	.118	.147	.176	.235			
.15	15.5	17.8	31.0		.085	.106	.128	.169	.212	.254	.338	.424		
.20	20.6	23.6	41.1			.188	.226	.301	.376	.452	.602	.752	.904	
.25	25.7	29.7	51.3				.354	.471	.589	.706	.941	1.175	1.412	1.887
.30	31.0	35.6	61.7					.678	.847	1.017	1.356	1.695	2.034	2.712
.36	36.1	41.4	72.1						1.152	1.390	1.842	2.305	2.768	3.695
.41	41.1	47.2	82.3							1.808	2.407	3.017	3.616	4.824
.46	46.2	53.3	92.7								3.051	3.819	4.576	6.101
.51	51.6	59.2	102.9								3.762	4.711	5.649	7.536
.56	56.6	65.0	113.3									5.694	6.836	9.118
.64	64.3	73.9	128.8									7.355	8.824	11.75
.79	79.8	91.7	159.5										13.56	18.08

GUIDE W
SPRING LIFE
8,000 CYCLES

			b ➡	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8
t	ID	Ds	Do	TORQUE M - Newton meters										
.05	6.6	7.6	13.2	.006	.008	.010	.012	.016						
.08	9.9	11.4	20.1	.014	.018	.023	.027	.036	.045					
.10	13.2	15.2	26.7	.024	.032	.040	.047	.064	.080	.096				
.13	16.8	19.1	33.3	.037	.050	.062	.075	.099	.124	.150	.200			
.15	20.1	22.9	39.9	.000	.072	.089	.107	.143	.180	.216	.287	.359		
.20	26.7	30.7	53.3			.159	.192	.255	.319	.383	.511	.638	.766	
.25	33.3	38.4	66.5				.299	.399	.499	.599	.799	.998	1.198	1.593
.30	39.9	46.0	79.8					.575	.719	.862	1.152	1.435	1.729	2.305
.36	46.5	53.6	93.2						.977	1.175	1.559	1.955	2.350	3.130
.41	53.3	61.2	106.4							1.537	2.045	2.553	3.062	4.090
.46	59.9	68.8	119.9								2.587	3.231	3.875	5.175
.51	66.5	76.5	133.1								3.197	3.988	4.791	6.384
.56	73.2	84.1	146.3									4.824	5.796	7.728
.64	83.3	95.8	166.4									6.237	7.491	9.977
.79	103.1	118.6	206.2										11.52	15.37

GUIDE X
SPRING LIFE
12,000 CYCLES

			b ➡	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8
t	ID	Ds	Do	TORQUE M - Newton meters										
.05	7.9	8.9	15.7	.006	.007	.009	.010	.015						
.08	11.7	13.5	23.4	.012	.016	.020	.024	.032	.041					
.10	15.7	18.0	31.2	.021	.028	.036	.043	.058	.071	.086				
.13	19.6	22.4	39.1	.034	.045	.055	.067	.089	.112	.134	.179			
.15	23.4	26.9	47.0		.064	.080	.096	.129	.160	.192	.258	.321		
.20	31.2	36.1	62.5			.142	.172	.228	.286	.342	.456	.572	.685	
.25	39.1	45.0	78.2				.268	.357	.446	.536	.714	.893	1.071	1.424
.30	47.0	53.8	93.7					.514	.643	.771	1.028	1.288	1.548	2.056
.36	54.6	63.0	109.5						.875	1.050	1.401	1.751	2.102	2.802
.41	62.5	71.9	125.0							1.367	1.830	2.282	2.746	3.661
.46	70.4	80.8	140.7								2.316	2.892	3.469	4.632
.51	78.2	89.9	156.2								2.859	3.570	4.282	5.717
.56	85.9	98.8	172.0									4.316	5.186	6.915
.64	97.8	112.3	195.3									5.581	6.700	8.926
.79	121.2	139.2	242.3										10.29	13.67

Symbols used in Design Guide:

t = material thickness (mm)
b = material width (mm)
s = distance between spool axes

ID = coil diameter (mm) ± 10%
Do = output spool diameter (mm)
Ds = storage spool diameter (mm)

AISI TYPE 301 STAINLESS STEEL

VIEW END DETAILS ON PAGES 21

			b ➡	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8
t	ID	Ds	Do	TORQUE M - Newton meters										
.05	10.4	11.9	20.8	.005	.006	.007	.008	.011						
.08	15.7	18.0	31.2	.009	.012	.015	.018	.025	.031					
.10	20.8	24.1	41.7	.016	.021	.027	.033	.043	.054	.064				
.13	26.2	30.0	52.1	.025	.034	.042	.051	.068	.085	.102	.136			
.15	31.2	36.1	62.7		.049	.061	.073	.097	.122	.146	.194	.243		
.20	41.7	48.0	83.6			.108	.130	.173	.216	.259	.346	.432	.520	
.25	52.1	59.9	104.4				.203	.270	.338	.406	.540	.676	.811	1.081
.30	62.7	72.1	125.2					.389	.486	.584	.777	.973	1.164	1.559
.36	73.2	84.1	146.1						.662	.794	1.059	1.322	1.593	2.124
.41	83.6	96.0	167.1							1.038	1.378	1.729	2.079	2.768
.46	94.0	108.0	188.0								1.751	2.192	2.633	3.503
.51	104.4	120.1	208.8								2.158	2.700	3.243	4.327
.56	114.8	132.1	229.6									3.265	3.932	5.231
.64	130.6	150.1	261.6									4.226	5.073	6.756
.79	161.8	186.2	322.6										7.796	10.39

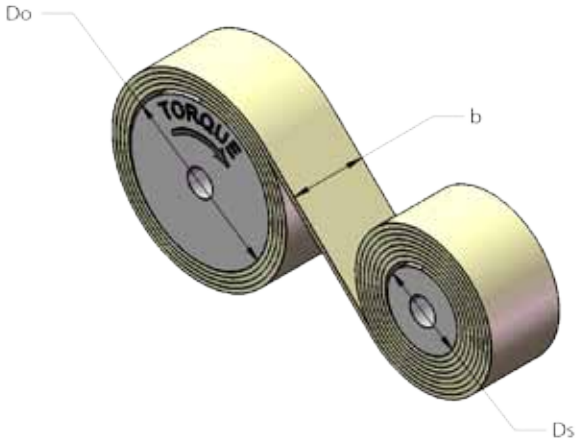
GUIDE Y
SPRING LIFE
25,000 CYCLES

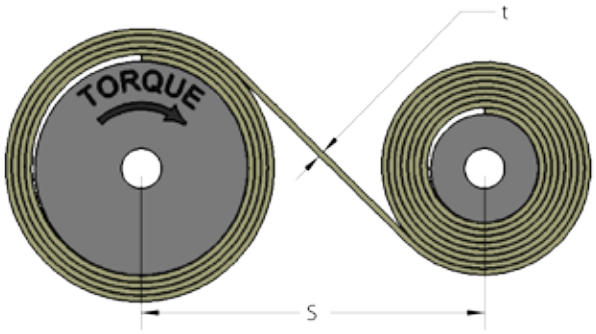
			b ➡	C 4.8	D 6.4	E 7.9	F 9.5	G 12.7	J 15.9	K 19.1	P 25.4	R 31.8	S 38.1	U 50.8
t	ID	Ds	Do	TORQUE M - Newton meters										
.05	14.2	16.3	28.4	.003	.005	.006	.007	.008						
.08	21.3	24.6	42.7	.007	.009	.011	.015	.019	.024					
.10	28.4	32.8	56.9	.012	.017	.021	.025	.034	.042	.051				
.13	35.6	40.9	71.1	.019	.026	.033	.040	.053	.066	.079	.105			
.15	42.7	49.0	85.3		.037	.047	.056	.076	.095	.113	.151	.189		
.20	56.9	65.5	114.0			.084	.101	.134	.168	.201	.269	.337	.403	
.25	71.1	81.8	142.5				.158	.210	.263	.315	.420	.525	.630	.841
.30	85.3	98.3	170.9					.302	.378	.454	.604	.757	.908	1.209
.36	99.8	114.6	199.4						.515	.618	.824	1.029	1.232	1.650
.41	114.0	131.1	227.8							.807	1.076	1.345	1.616	2.147
.46	128.3	147.3	256.5								1.367	1.706	2.045	2.723
.51	142.5	163.8	284.5								1.683	2.102	2.520	3.367
.56	156.7	180.1	312.4									2.542	3.051	4.067
.64	178.1	204.7	355.6									3.288	3.943	5.254
.79	220.7	254.0	442.0										6.056	8.078

GUIDE Z
SPRING LIFE
50,000 CYCLES

Symbols used in Design Guide:

t = material thickness (mm)
b = material width (mm)
s = distance between spool axes
ID = coil diameter (mm) ± 10%
Do = output spool diameter (mm)
Ds = storage spool diameter (mm)

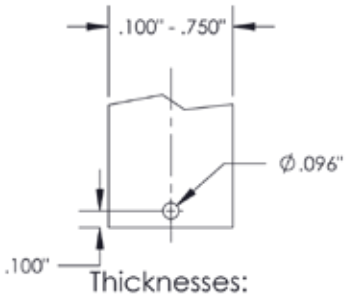




Single Spring Motor

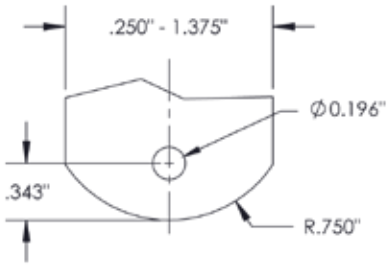
COMMONLY USED END DETAILS

Vulcan Spring has many standard dies to create the end detail necessary. These images show a few commonly used end details that are available. Special end designs can be made upon request.



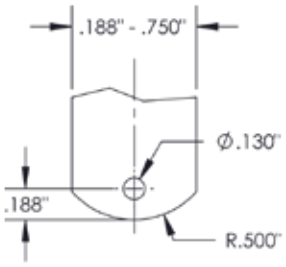
Thicknesses:
0.003" - 0.016"

1



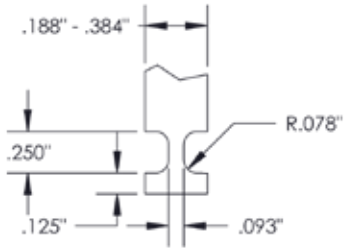
Thicknesses:
0.003" - 0.025"

2



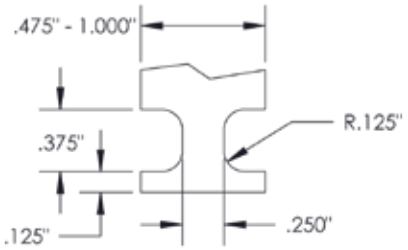
Thicknesses:
0.003" - 0.012"

3



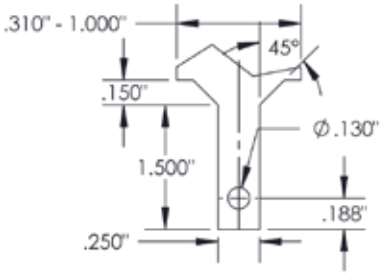
Thicknesses:
0.0025" - 0.010"

4



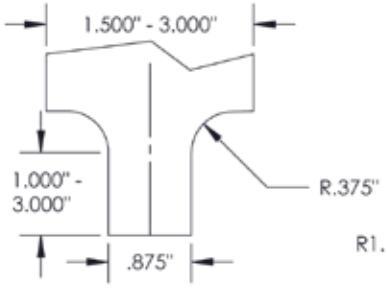
Thicknesses:
0.0025" - 0.014"

5



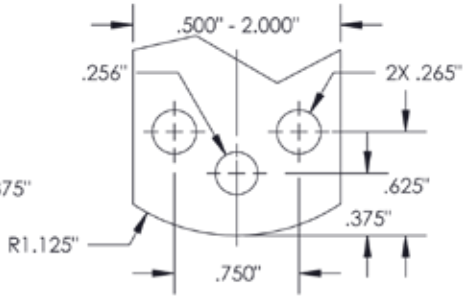
Thicknesses:
0.006" - 0.010"

6



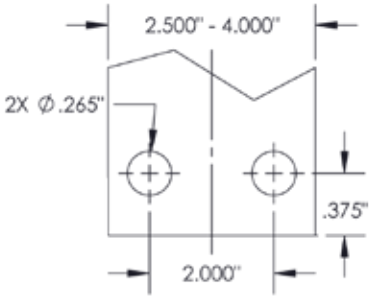
Thicknesses:
0.016" - 0.020"

7



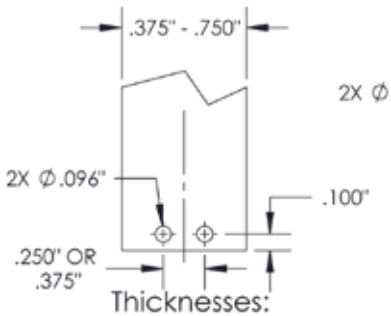
Thicknesses:
0.012" - 0.031"

8



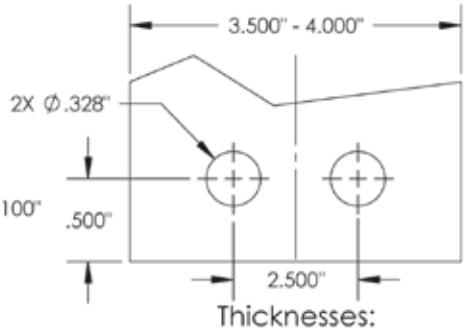
Thicknesses:
0.025" - 0.031"

9



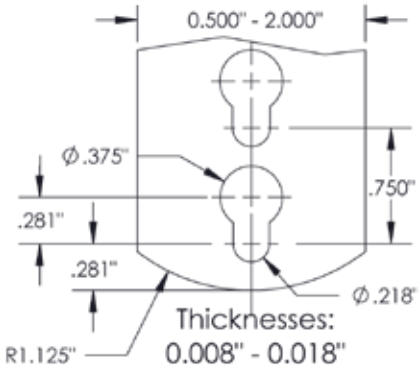
Thicknesses:
0.003" - 0.014"

10



Thicknesses:
0.025" - 0.031"

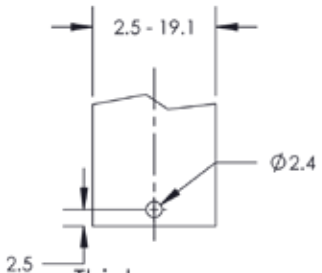
11



Thicknesses:
0.008" - 0.018"

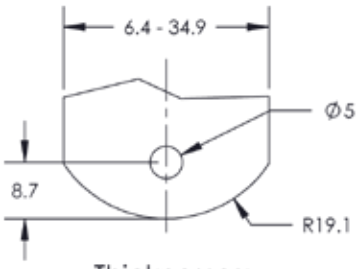
12

METRIC MEASUREMENTS



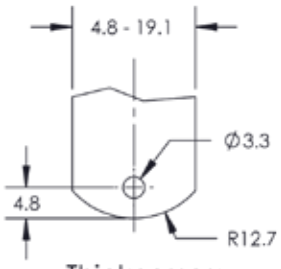
Thicknesses:
0.08 - 0.41

1



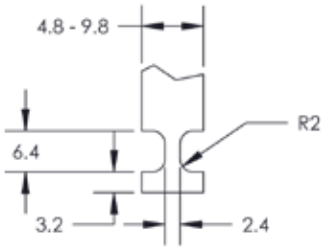
Thicknesses:
0.08 - 0.64

2



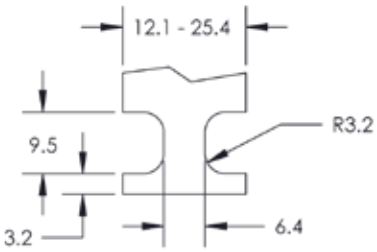
Thicknesses:
0.08 - 0.30

3



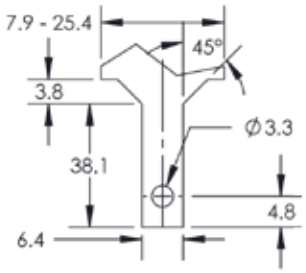
Thicknesses:
0.06 - 0.25

4



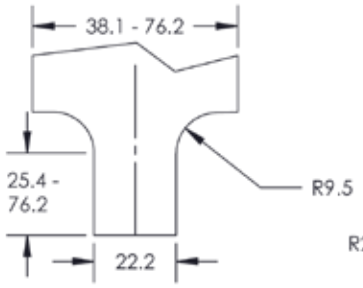
Thicknesses:
0.06 - 0.36

5



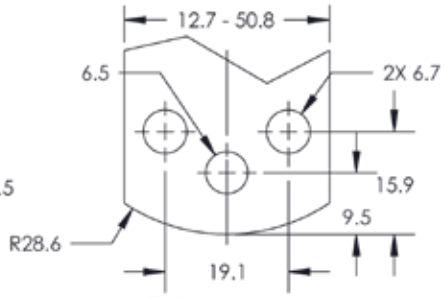
Thicknesses:
0.15 - 0.25

6



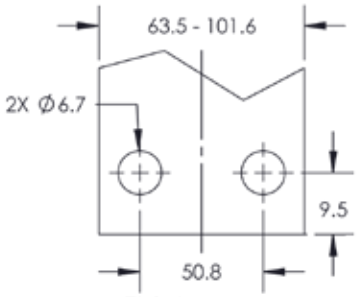
Thicknesses:
0.41 - 0.51

7



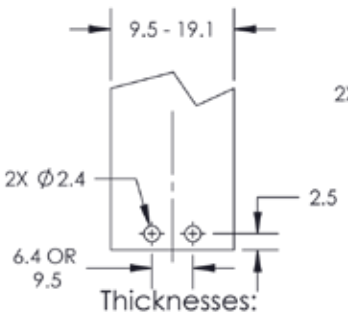
Thicknesses:
0.30 - 0.79

8



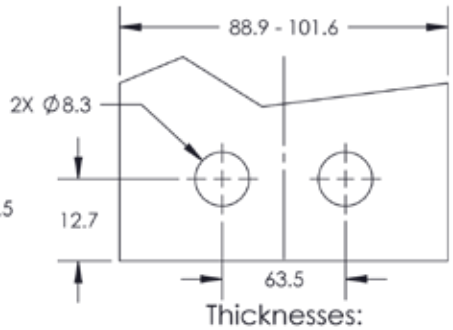
Thicknesses:
0.64 - 0.79

9



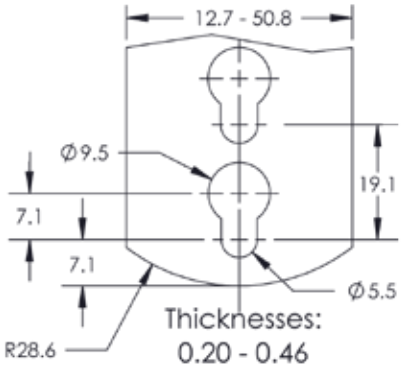
Thicknesses:
0.08 - 0.36

10



Thicknesses:
0.64 - 0.79

11



Thicknesses:
0.20 - 0.46

12

CONPOWER® AND POWER SPRING DESIGN

Conpower® and power springs, also known as clock springs, are formed by winding a strip of material on an arbor and into a case or retaining ring to create a compact power source. Rotational torque is obtained from a center arbor or from the case. This torque increases throughout the total winding of the spring.

CONPOWER® VS POWER SPRINGS

Conpower® springs differ from conventional power springs because they are pre-stressed to produce a flatter torque gradient. In addition, they can be used to increase the number of turns in a case of a given diameter.

Both Conpower® and conventional power springs provide rotational energy from either the arbor or the case, or linear motion with the use of a pulley or cable.

DESIGN CONSIDERATIONS

Design criteria for both types of power springs are the same. The decision to use a conventional power spring or Conpower® spring is based on the application. Important considerations for designing and manufacturing power springs include:

1. Arbor size *(see A in diagram on next page)*
2. Inside diameter (I.D.) of case *(see B in diagram on next page)*
3. Available case width *(see C in diagram on next page)*
4. Turns required
5. Torque required
6. Location (and tolerance) of center eye/tab
7. Life cycle requirement in total estimated uses
8. Environment in which the power spring will be used
9. Mounting requirements for case and arbor.

PRODUCTS AND APPLICATIONS THAT USE POWER SPRINGS

Conpower® and power springs are ideal for a wide variety of uses where smooth returning and retrieving, counterbalancing and tensioning are required.

Products that use power springs may include: cord retractors, counterbalances, wind-up toys and games, timers, and electrical and mechanical reels.

STOCK CONPOWER® & POWER SPRINGS

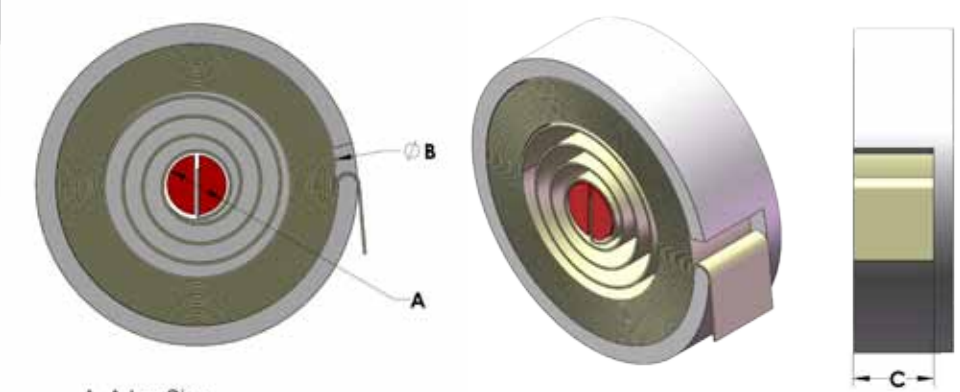
Part Number	Type	Torque (in-lbs)	Arbor Size (inches)	Number of Turns	Case I.D. (inches)	Width (inches)
SCP4G202VS	Conpower®	0.41	0.250	44.00	1.50	0.500
SCP7.5D50VS	Conpower®	0.73	0.250	11.50	1.00	0.250
SCP6G135VS	Conpower®	0.93	0.250	30.00	1.50	0.500
SCP8G108VS	Conpower®	1.65	0.250	22.00	1.50	0.500
SCP10G81VS	Conpower®	2.58	0.250	17.00	1.50	0.500
SCP18D162VS	Conpower®	4.20	0.625	14.00	2.80	0.250
SCP13G59VS	Conpower®	4.32	0.250	11.50	1.50	0.500
SPS16F77VS	Power	4.50	0.250	12.00	1.80	0.375
SPS20F65VS	Power	7.00	0.250	9.00	1.80	0.375
SCP18G198VS	Conpower®	8.30	0.625	16.50	3.00	0.500

This table is designed to quickly choose and assist in ordering a power spring as a sample or prototype. For this reason there are certain specifications which are uncontrolled. This includes, but is not limited to, the location of the inner tab of the spring.

It is recommended that you contact one of our design engineers at 215-721-1721 to discuss the specifications that are required for a specific project. Please handle the springs carefully as they are under stress and can cause injury.

TO ORDER VISIT WWW.VULCANEXPRESS.COM

The Vulcan Spring and Manufacturing Express Online Store is provided as a convenience to our commercial customers. Springs and specifications are subject to change.



A. Arbor Size
B. Inside Diameter (I.D) of case

SPIRAL TORSION SPRINGS

Spiral torsion springs are produced from flat steel and are characterized by their coils, which typically do not touch during operation.

A spiral torsion spring will exert a rotational torque, usually through 360° rotation or less. The torque curve is linear to the degree of rotation.

The inner end of the spring is typically bent to attach to an arbor or hub. The outer end is then attached to the object that is rotating or utilizing the torque of the spring.

Vulcan's highly qualified engineers are able to review the current design or work with a client to achieve the best possible solution. High speed manufacturing processes ensure fast time to market at a reasonable price.

APPLICATIONS AND USES

Spiral torsion springs are used in brush motors and in certain applications where a short rotation is required. Industries that use these springs include:

1. Electric Motors
2. Industrial Tools
3. Automotive & Transportation
4. Medical Devices and Healthcare

MANUFACTURING PROCESS

Vulcan Spring utilizes highly customized production equipment, lean manufacturing techniques and principles, and ISO 9001:2008 certified procedures to provide our customers with a streamlined and efficient manufacturing process to produce spiral torsion springs.

Benefits of working with Vulcan Spring include reduced lead times, high quality control and highly competitive costs.

TRUCK DOOR COUNTERBALANCE SPRINGS

This specialty counterbalance product provides the perfect amount of force for both easy-opening and closing of overhead doors. Major beverage truck manufacturers in the USA use Vulcan Spring's counterbalances. We are also the leading aftermarket counterbalance manufacturer.

CUSTOM COUNTERBALANCES

As completely customized solutions, truck door counterbalances are manufactured to the exact specification for each beverage truck manufacturer and refurbisher.

TECHNICAL CONSIDERATIONS

Image is shown as a cut-away view, displaying the inside of a counterbalance.

AVAILABLE SIZES

INNER	OUTER
29 ⅝"	20"
37 ½"	30"
39 ¾"	30"
41 ⅝"	30"
44 ⅝"	30"
49 ⅝"	30"
53 ⅝"	45"
65 ¼"	55"
69 ¼"	55"
85 ½"	75"

DOUBLE SPRING	
85 ½"	75"

Counterbalances for truck doors are available in sizes from 29" to 85".

Features include:

1. Handles up to 85 lbs. of force
2. Standard ends for most O.E.M. or retrofit applications
3. Zinc plated tubes
4. Highest quality .120" or .135" diameter spring wire
5. Rustproof bearings

Contact Vulcan Spring at 215-721-1721 for further assistance with beverage truck door counterbalances.

SERVICES OF VULCAN SPRING

Variable Force

Slot Closer

Power Spring

Reels

1. Production Facilities include:
   a. Laminating
   b. Assembly onto spools
   c. Riveting
   d. Spot welding
   e. Laser printing
   f. Silk screening (printing)
   g. Stampings
2. Part Identification - Available when required:
   a. Color coding
   b. Electro chemical etching
   c. Die stamping
   d. Laser engraving
3. Special packaging
4. Automatic production controls and equipment
5. Complete tooling manufacturing facilities
6. Surface coatings & laminates
7. Prototype capabilities
8. SPC reports available
9. Certifications as required
10. Design consultation

These facilities enable us to design and build our own tools and machines and allow more flexibility for the Vulcan customer.

Design engineers are continually finding ways to use printed constant force and constant torque springs in their projects. This is primarily because these springs provide a very accurate, dependable and economical form of digital readout or other visual indication. A simple concept utilizes the motor form of the spring to read out as well as to provide tension on a cord attached to the moving object.

Vulcan has complete temperature and humidity controlled facilities for surface coatings.

A partial list of coatings includes:
   a. Adhesive-backed laminates
   b. Painting
   c. Dry film lubricants
   d. Oiling

Printed Springs

Spring with Laminate

OTHER PRODUCTS OFFERED

Pullbox®

Line of custom manufactured retail display security tethers, known as recoilers & cable retractors

Versatile, rugged and dependable, the Pullbox® line of retractable tethers sets the standard for proven performance and customizable options. Pullboxes® are used for point of purchase security, product positioning, equipment counterbalancing, wire harness positioning in electronic equipment, product feeding, and signage support. This proven design uses Vulcan's constant force spring technology to provide constant, reliable tension at a variety of forces.

VS-1

Compact, attractive way to deliver theft-deterrence & convenience.

The VS-1 is the ideal product positioning solution. It can be mounted on the inside or outside of a display as a functional and aesthetic component of an effective point of purchase presentation. With seven designer colors available, the VS-1 blends in with any display to create a positive customer experience. It can swivel for 360° rotation using a screw or be mounted using double-sided tape.

MiniVS

Compact security cable retractors for positioning minimal levels of security.

The MiniVS is slightly larger than a quarter yet contains up to 36" of nylon-covered steel cable. The MiniVS' wide cable slot allows for maximum design flexibility and easy recoil. The ball end fitting accommodates a wide range of available fasteners, increasing the tether's versatility and simplifying installation.

V-Spring

Variable force springs, also known as variable tension springs.

V-Springs deliver dependable variable force to precisely match increased or decreased force requirements. As each product is removed, the v-spring reduces force, giving a minimal push when a display is nearly empty.

Plastic Scrolls

Printed with numbers or letters which provides the user with information.

Simple, versatile and cost effective - Vulcan's self coiling plastic scrolls are the ideal system for creating attractive displays that quickly communicate a variety of messages. Vulcan manufactures plastic scrolls to exact specifications, in widths up to 6" and lengths up to 30".

THE SOURCE FOR CONSTANT FORCE SPRINGS

Advanced Manufacturing Techniques

At Vulcan, we are totally involved in constant force spring technology. We design and automate our manufacturing machines. We maintain a rigid system of check points to monitor critical stages of production. We routinely review and modernize our manufacturing and quality control procedures. This focus and attention to detail assures every customer is getting the most consistent and highest quality product available today, all at a reasonable cost.

Design Assistance

Everyone at Vulcan is committed to making sure you get the best possible spring for your specific needs. To do this, we offer you our assistance in selecting the best materials and manufacturing procedures. For optimum designs, we recommend that you contact us and request the service of our engineers as early as possible in your project.

Delivery

Fast and dependable! ... for all production orders as well as prototypes. We have been complimented many times for maintaining the good business practice of keeping our promised delivery dates. You can depend on Vulcan Spring.

VULCAN SPRINGS WORK!

VULCAN
SPRING

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