WATROD Heating Elements

Multicoil Single- or Double-Ended Elements

Watlow's new tubular element with multiple coils and/or thermocouples inside one sheath answers the need for a versatile, innovative tubular heater. Our new, patent-pending method of packaging a thermocouple inside of a heater with one or more resistance coils, gives the ability to sense a heaters' internal temperature accurately, every time.

Moreover, this is the first tubular heater in the industry with three-phase capability. The three coil, three-phase heater will offer a lower amperage solution while delivering the full power required in a compact heater package.

Previously three separate heaters would have been required to do the same job; therefore Watlow's new multicoil heater capabilities save money.

Watlow has the capability to put up to two coils in a 0.375 or 0.430 diameter heater and up to three coils in a 0.475 or 0.490 diameter heater. Any one or more of these coils can be a resistance wire or a thermocouple. The bending formations are virtually limitless; while mounting options are similar to other Watlow tubular heaters. The three-phase multicoil heaters can be single ended with three leads for three-phase wye hook up. Watlow recommends using an epoxy moisture seal or silicone-based seal.

Watlow's multicoil heaters are available in all standard materials such as Incoloy®, 304 and 316 stainless steel, and can be formed into almost any configuration. Our five thermocouple and/or coil options for multicoil tubular configurations will meet most requirements; however, we are always interested in discussing the use of different materials or changing the number of coils and thermocouples.

Features and Benefits

- **Three-phase capability** results in one element versus three, lower amperage, reduced installation time and lower overall cost.
- **Internal thermocouple** allows responsive and accurate, internal, high-limit sensing and reduced assembly costs.
- **Single ended** allows for mounting in a ½ inch NPT or ¾ inch NPT fitting with three-phase capability.
- **Multiple coil options** reduce inventory by allowing dual voltage capability.
- **Versatile forming capabilities** can be formed into virtually any configuration.
- **Internal construction** allows space savings because drilling and tapping of flange is unnecessary; plus, the interior thermocouple eliminates contamination buildup around the external sensing tip, reducing the possibility of false readings.

Applications

- Foodservice
- Process
- Medical
- Milled groove
- Plastics
- Plating
- Oven heating
- Semiconductor

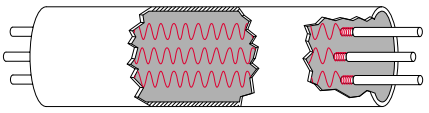
Tubular and Process Assemblies

WATROD Heating Elements

Multicoil Single- or Double-Ended Elements
Continued

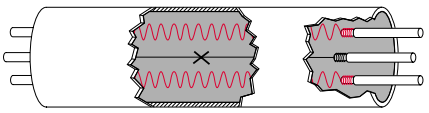
Options

Option A



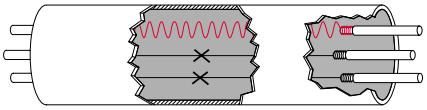
3-phase tubular, 0.475 and 0.490 inch diameter.

Option B



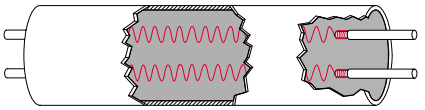
1-phase tubular with two resistance wires and one thermocouple, 0.475 and 0.490 inch diameter.

Option C



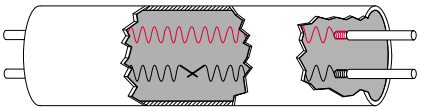
1-phase tubular with one resistance wire and two thermocouples, 0.475 and 0.490 inch diameter.

Option D



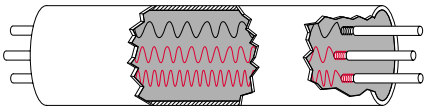
1-phase tubular with three different one phase circuits, 0.475 and 0.490 inch diameter.

Option E



1-phase tubular with two resistance coils, 0.375, 0.430, 0.475 and 0.490 inch diameter.

Option F



1-phase tubular with one resistance coil and one thermocouple, 0.375, 0.430, 0.475 and 0.490 inch diameter.

Specifications

Termination style is currently limited to lead wires 392°F (200˚C) Sil-A-Blend™ or 482°F (250˚C) GGS.

Moisture seals are required, options include:

- Standard epoxy with temperature rating to 266˚F (130°C). Typical applications include water/oil immersion.
- Lavacone with temperature rating to 300˚F (148.9°C). Typical application includes air heating.
- High-temp ceramic rated to 2800˚F (1537.8°C).
- Consult factory for other moisture seal options.
- ULTRAGARD with temperature rating to 700˚F (375˚C).

Mounting options include:

- Mounting brackets
- Locator washers
- Mounting collars
- Water-tight bulkheads

Maximum trim length is 237 inches (6020 mm). Heater designs with trim length greater than 120 inches (3048 mm) must be reviewed with factory.

Sheath materials: Incoloy®, 304 and 316 stainless steel, consult factory for other sheath material options.

Internal thermocouple options: Type K is used, consult factory for Type J thermocouple options.

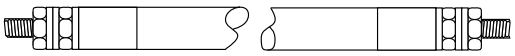
U.S. Patent Pending

Sil-A-Blend™ is a trademark of Radix Wire Company.

WATROD Heating Elements

Specifications

Double-Ended



Single-Ended

Applications	Direct immersion Hot runner mold (manifold) Forced air Ovens Radiant Clamp-on		Vacuums Semiconductor		Platens Forced air Deicing antennas Plastic wrap cutting Seal bars			
Watt Density	Stock:		up to 60	(9.3)	Stock:		up to 20	(3.1)
W/in² (W/cm²)	Made-to-Order (M-t-O):		up to 120	(18.6)	M-t-O:		up to 45	(6.9)
Element Diameters	**Dia.**	**in²**	**Dia. (mm)**	**cm²**	**Dia.**	**in²**	**Dia. (mm)**	**cm²**
inch (mm)	0.210	0.660	(5.3)	(4.26)	0.375	1.178	(9.5)	(7.600)
and Surface Area per Linear	0.260	0.817	(6.6)	(5.27)	0.430	1.351	(10.9)	(8.717)
inch (cm)	0.315	0.990	(8.0)	(6.38)	0.475	1.492	(12.0)	(9.626)
Diameter Tolerance	0.332	1.043	(8.4)	(6.73)	0.490	1.539	(12.4)	(9.930)
± 0.005 inch (0.13 mm)	0.375	1.178	(9.5)	(7.60)	0.625	1.963	(15.9)	(12.665)
	0.430	1.351	(10.9)	(8.72)				
	0.475	1.492	(12.0)	(9.63)				
	0.490	1.539	(12.4)	(9.93)				
	0.625	1.963	(15.9)	(12.66)				
Sheath Materials	Stock:	Incoloy®	1600°F	(870°C)	Stock:	Incoloy®	1200°F	(650°C)
Maximum Operating		316 stainless steel	1200°F	(650°C)				
Temperature		Steel	750°F	(400°C)				
		Copper	350°F	(175°C)				
	M-t-O:	Inconel® 600	1800°F	(980°C)	M-t-O:	Incoloy®	1600°F	(870°C)
		Incoloy®	1600°F	(870°C)		316 stainless steel	1200°F	(650°C)
		316 stainless steel	1200°F	(650°C)		304 stainless steel	1200°F	(650°C)
		304 stainless steel	1200°F	(650°C)		Steel	750°F	(400°C)
		Steel	750°F	(400°C)				
		Copper	350°F	(175°C)				
		Monel®		Consult Factory				
		Titanium		Consult Factory				
Sheath Length By Diameter		**Sheath**		**Sheath**		**Sheath**		**Sheath**
inch (mm)	**Dia.**	**Length**	**Dia.**	**Length**	**Dia.**	**Length**	**Dia.**	**Length**
	Stock:				Stock:			
	0.260	20 to 80	(6.6)	(510 to 2030)	0.375	15 to 40	(9.5)	(380 to 1015)
	0.315	12 to 100	(8.0)	(305 to 2540)				
	0.375	11 to 180	(9.5)	(275 to 4555)				
	0.430	15 to 120	(10.9)	(380 to 3050)				
	0.475	20 to 157	(12.0)	(510 to 3990)				
	M-t-O:				M-t-O:			
	0.210	9 to 130	(5.3)	(230 to 3300)	0.375	11 to 125	(9.5)	(280 to 3175)
	0.260	9 to 275	(6.6)	(230 to 6980)	0.430	11 to 106	(10.9)	(280 to 2690)
	0.315	9 to 270	(8.0)	(230 to 6850)	0.475	11 to 125	(12.0)	(280 to 3175)
	0.332	9 to 125	(8.5)	(230 to 3170)	0.490	11 to 125	(12.4)	(280 to 3175)
	0.375	11 to 325	(9.5)	(280 to 8255)	0.625	11 to 125	(15.9)	(280 to 3175)
	0.430	11 to 268	(10.9)	(280 to 6810)				
	0.475	11 to 275	(12.0)	(280 to 6985)				
	0.490	11 to 275	(12.4)	(280 to 6985)				
	0.625	11 to 275	(15.9)	(280 to 6985)				

Tubular and Process Assemblies

WATROD Heating Elements

Specifications

Double-Ended

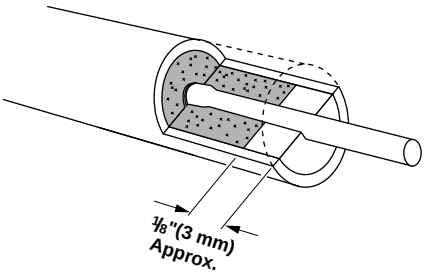
Single-Ended

Minimum No-Heat Length inch (mm)	**Sheath Length**	**No-Heat Length**	**Sheath Length**	**No-Heat Length**	**Sheath Length**	**No-Heat Length**	**Sheath Length**	**No-Heat Length**
	11 to 20	1	(280 to 510)	(25)	11 to 20	1½	(280 to 5100)	(38)
	21 to 50	1¼	(535 to 1270)	(32)	21 to 50	1¾	(533 to 1270)	(44)
	51 to 80	1½	(1295 to 2030)	(38)	51 to 80	2⅛	(1295 to 2030)	(54)
	81 to 110	1⅛	(2055 to 2795)	(42)	81 to 110	2⅜	(2055 to 2795)	(60)
	111 to 140	1¾	(2820 to 3555)	(44)	111 to 125	2⅝	(2820 to 3175)	(67)
	141 to 170	2	(3580 to 4320)	(51)				
	171 to 200	2¼	(4345 to 5080)	(57)				
	201 & up	2½	(5105 & up)	(64)	**½ inch (13 mm) No-heat length on all blunt ends**			
Maximum Voltage/Amperage By Dia. inch (mm)	**Dia.**	**Volts**	**Amps**		**Dia.**	**Volts**	**Amps**	
	0.260 (6.6)	250V~(ac)	15		0.375 (9.5)	480V~(ac)	30	
	0.315 (8.0)	480V~(ac)	30		0.430 (10.9)	480V~(ac)	30	
	0.332 (8.5)	480V~(ac)	30		0.475 (12.0)	480V~(ac)	30	
	0.375 (9.5)	480V~(ac)	30		0.490 (12.4)	480V~(ac)	30	
	0.430 (10.9)	600V~(ac)	40		0.625 (15.9)	480V~(ac)	30	
	0.475 (12.0)	600V~(ac)	40					
	0.490 (12.4)	600V~(ac)	40					
	0.625 (15.9)	600V~(ac)	40					
Ohms Per Heated Inch By Dia. inch	**Dia.**	**Minimum**	**Maximum**		**Dia.**	**Minimum**	**Maximum**	
	0.210	0.100Ω	16Ω					
	0.260	0.080Ω	25Ω		0.375	0.200Ω	34Ω	
	0.315	0.050Ω	25Ω		0.430	0.200Ω	34Ω	
	0.332	0.050Ω	23Ω		0.475	0.200Ω	34Ω	
	0.375	0.020Ω	18Ω		0.490	0.200Ω	34Ω	
	0.430	0.025Ω	30Ω		0.625	0.200Ω	34Ω	
	0.475	0.030Ω	30Ω					
	0.490	0.030Ω	30Ω					
	0.625	0.030Ω	25Ω					
Terminations	Stock:	Threaded stud			Stock:	Flexible lead wires		
	M-t-O:	Threaded stud Screw lug (plate) Quick connect (spade) Flexible lead wires Rubber overmolds			M-t-O:	Flexible lead wires Rubber overmolds		
Seals	Stock:	Silicone resin	390°F	(200°C)	Stock:	Silicone resin	390°F	(200°C)
	M-t-O:	Ceramic base	2800°F	(1535°C)	M-t-O:	Silicone rubber (RTV)	500°F	(260°C)
		ULTRAGARD	700°F	(375°C)		ULTRAGARD	700°F	(375°C)
		Ceramic-to-metal	500°F	(260°C)		Silicone resin	392°F	(200°C)
		Silicone rubber (RTV)	500°F	(260°C)		Epoxy resin	266/350°F	(130/177°C)
		Silicone resin	392°F	(200°C)				
		Epoxy resin	266/350°F	(130/177°C)				
Mounting Options	Threaded bulkheads Mounting brackets Locator washers Mounting collars				Threaded bulkhead Locator washers Mounting collars			
Surface Finish Options	Belt polishing Passivation	Bright Anneal			Belt polishing Passivation	Bright Anneal		
Agency Recognition	UL® Component to 480V~(ac) (file # E52951/E56488) CSA Component to 600V~(ac) (file # 31388)				UL® Component to 240V~(ac) (file # E52951) CSA Component to 240V~(ac) (file # 31388) ①			

① Not applicable to 0.375 inch diameter single-ended WATROD

WATROD Heating Elements

Options



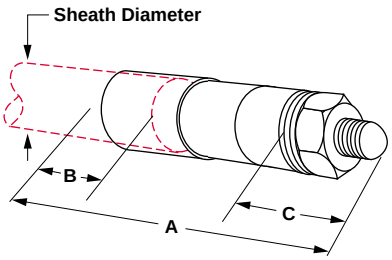
Moisture Resistant Seals

WATROD's MgO insulating material is hygroscopic. To prevent moisture contamination from entering the heater, an appropriate moisture seal must be used. Choosing the correct seal is important to the life and performance of the heater. Be sure the maximum continuous use temperature is not exceeded at the seal location. Most end seals are applied with a small cavity in the end of the heater. The seal will also help prevent arcing at the terminal ends.

End Seal Options

End Seal	Code Number	Color	Seal Depth	UL® Recognition	Max. Cont. Use Temperature	Typical or General Usage/Application
Standard Epoxy	**EC**	Cream	3/16"	Yes	266°F (130°C)	General purpose for moisture resistance
Intermediate Epoxy	**EB**	Blue	3/16"	Yes	350°F (177°C)	Intermediate temp. rating for moisture resistance
High-Temp. Epoxy	**HTE**	Amber	3/16"	No	450°F (232°C)	Higher temp. rating for moisture resistance
Silicone Resin	**SR**	Clear	1/16"	Yes	392°F (200°C)	General usage on tubular products
Silicone Fluid	**SF**	Clear	N/A	No	392°F (200°C)	Moisture resistance of the MgO, or High-Temp. ceramic seal (storage only)
Lavacone	**LC**	Dark Brown	3/16"	Yes	392°F (200°C)	Porous seal for the FIREBAR
Silicone Rubber RTV	**RTV**	Red-Orange	3/16"	Yes	500°F (260°C)	General usage on FIREBAR applications
ULTRAGARD	**UG**	Clear	3/16"	Yes	700°F (350°C)	High temp. around seal area and for vacuum applications
High-Temp. Ceramic	**HTC**	White	3/16"	No	2800°F (1538°C)	Very high temperature applications

Ceramic-to-Metal End Seal



Sheath Diameter		A		B		C		Thread Size
inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)	
0.260	(6.6)	1 11/16	(40)	½	(13)	13/32	(10)	#8-32
0.315	(8)	1⅞	(43)	½	(13)	13/32	(10)	#10-32
0.430	(10.9)	2⅛	(54)	½	(13)	21/32	(10)	#¼-28

To order specify, **ceramic-to-metal end seal**.

Ceramic-to-metal end seals with threaded stud terminations provide an air-tight seal for continuous terminal temperatures up to 500°F (260°C). Watlow does not recommend this seal if terminations are exposed to temperatures exceeding 500°F (260°C).

External Finishes

Belt Polishing

Belt polishing sands the oxidized sheath to a bright finish. This finish is available only on alloy sheath materials.

To order, specify **belt polishing**.

Bright Annealing

A process that produces a smooth, metallic finish. It is a special annealed finish created in a non-oxidizing atmosphere. This finish is popular in the pharmaceutical and food and beverage markets.

To order, specify **bright annealing**.

Passivation

During the manufacturing process, particles of iron or tool steel may become embedded in the stainless steel or alloy sheath. If not removed, these particles may corrode, produce rust spots and/or contaminate the process. For critical sheath applications, passivation will remove free iron from the sheath.

To order, specify **passivation**.

Tubular and Process Assemblies

WATROD Heating Elements

WATROD Terminations

Double-ended WATROD elements are available with a variety of terminations. Single-ended WATROD elements are available with only flexible lead wires.

The following table and illustrations detail the terminations available with double- or single-ended WATRODs—for each available sheath diameter.

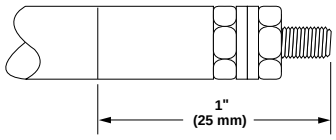
Standard flexible lead wires are 12 inches (305 mm), Sil-A-Blend™ 390°F (200°C) unless otherwise specified. Insulation options include TGGT (480°F/250°C) plus other temperature ratings. Consult factory for availability.

Overmolds are available for flexible lead wires only. Available in silicone rubber (390°F/200°C), neoprene (212°F/90°C) and other materials. Consult factory for details.

WATROD Element	Sheath Diameter inch	(mm)	Threaded Stud① A	Screw Lug (Plate) B	C	D	Quick Connect (Spade) E	F	G	Flexible Lead Wires H	Lead Wire Overmolds J
Double-Ended	0.260	(6.6)	#6-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.315	(8.0)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.335	(8.5)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	0.375	(9.5)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	0.430	(10.9)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.475	(12.0)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.490	(12.4)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	0.625	(15.9)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Single-Ended	0.375	(9.5)	No	No	No	No	No	No	No	Yes	No
	0.430	(10.9)	No	No	No	No	No	No	No	Yes	Yes
	0.475	(12.0)	No	No	No	No	No	No	No	Yes	Yes
	0.490	(12.4)	No	No	No	No	No	No	No	Yes	No
	0.625	(15.9)	No	No	No	No	No	No	No	Yes	Yes

Threaded Stud

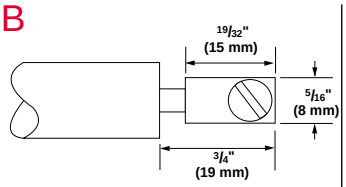
A



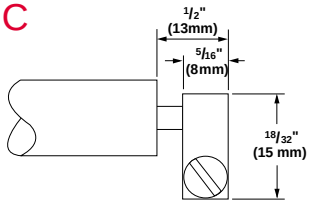
① Optional #8-32, ¼ inch and 4 or 5 mm studs available. Consult factory for details.

Screw Lug (Plate)

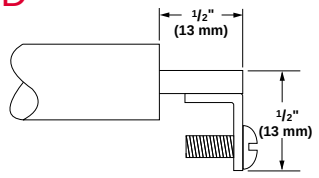
B



C

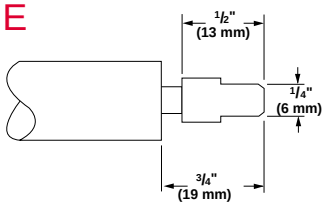


D

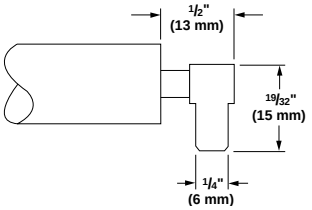


Quick Connect (Spade)

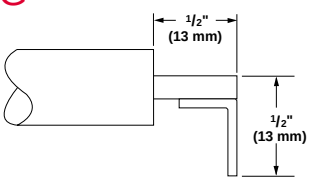
E



F

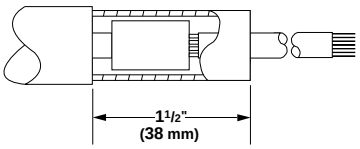


G



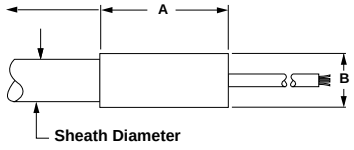
Flexible Lead Wires

H



Rubber Overmolds

J



Overmold Availability

Sheath Diameter inch	(mm)	A inch	(mm)	B inch	(mm)
0.260	(6.6)	2½	(63.5)	½	(13.0)
0.315	(8.0)	2½	(63.5)	½	(13.0)
0.375	(9.5)	2½	(63.5)	⅝	(15.9)
0.430	(10.9)	2½	(63.5)	⅝	(15.9)
0.475	(12.0)	2½	(63.5)	⅝	(15.9)
0.625	(15.9)	2½	(63.5)	⅞	(22.2)

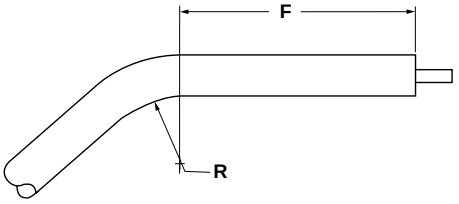
WATROD Heating Elements

Double-Ended WATROD Bend Formations

Double-ended WATROD heating elements can be formed into spirals, compounds, multi-axis and multi-planes from 36 common bend configurations. Custom bending with tighter tolerances can be made to meet specific application needs.

Formation is limited by the minimum bend radius (R) and the straight length (F) required beyond the bend. In order to locate the end of a heated length within a bend, the radius must be three inches (76 mm) or larger. Additionally, overall length tolerance (T) must be included in one or more of the straight lengths.

Minimum radius for various sheath diameters and lengths are shown in the *Bend Formations* chart below. Illustrated on **pages 282 to 286** are the 36 common bend configurations available on both stock and made-to-order WATROD heating elements.



Single-Ended WATROD Bend Formations

Watlow does not recommend field bending single-ended WATROD elements. Formation is limited by the minimum radius of a bend (R) and the straight length (F) beyond the bend. The radius must be three inches (75 mm) or more for the heated length's end to be inside a bend.

Additionally, the overall length tolerance (T) must be provided for in one or more of the specified lengths.

The four common bend configurations available for standard and made-to-order single-ended WATROD elements are Figures 1, 6, 22 and 28.

To order a common bend formation, specify the **bend figure number**, dimensions and critical tolerances.

WATROD Length Tolerance (T)

Sheath Length		Length Tolerance	
inch	(mm)	inch	(mm)
11-50	(280-1270)	±⅛	(±3)
51-110	(1295-2795)	±3⁄16	(±5)
111-170	(2820-4320)	±¼	(±6)
171-200	(4345-5080)	±⅜	(±10)
201 & up	(5105 & up)	±½	(±13)

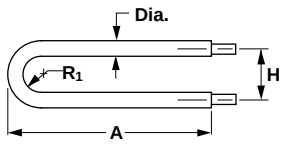
WATROD Minimum Radius

Sheath Diameter		Field Bend R①		Factory R①		F② Dimension	
inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)
0.260	(6.6)	¾	(19)	⅜	(10)	½	(13)
0.315	(8.0)	¾	(19)	½	(13)	½	(13)
0.335	(8.5)	1	(25)	½	(13)	1	(25)
0.375	(9.5)	1	(25)	½	(13)	½	(13)
0.430	(10.9)	1	(25)	½	(13)	¾	(19)
0.475	(12.0)	1	(25)	⅝	(16)	1	(25)
0.490	(12.5)	1	(25)	⅝	(16)	1	(25)
0.625	(15.9)	1½	(38)	¾	(19)	1 ½	(38)

① R is the inside radius of a bend.
② F is the distance from the sheath's end to the start of the first bend.

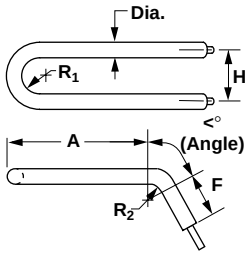
Bend Formations

Figure 1



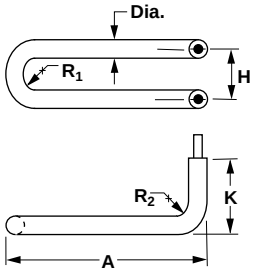
SL = 2A + 1.14R_1 - 0.43 Dia.
(For pricing, use 1 bend)

Figure 2



SL = 2A + 2F + 1.14R_1 + 0.0175 (<°)
(2R_2 + Dia.) - 0.43 Dia.
(For pricing, use 3 bends)

Figure 3

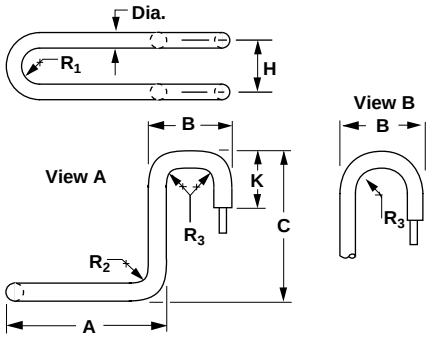


SL = 2K - 0.86R_2 - 2.86 Dia. + 2A + 1.14R_1
(For pricing, use 3 bends)

Tubular and Process Assemblies

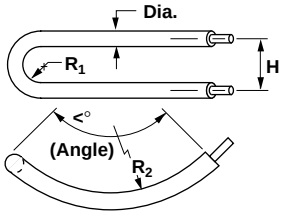
WATROD Heating Elements

Figure 4



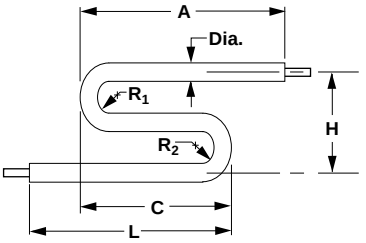
View A: SL = 2K- 1.72R_3 - 7.72 Dia. + 2C - 0.86R_2 + 2A + 1.14R_1
View B: SL = 2K- 2.28R_3 - 3.72 Dia. + 2C - 0.86R_2 + 2A + 1.14R_1
(For pricing, use 5 bends)

Figure 5



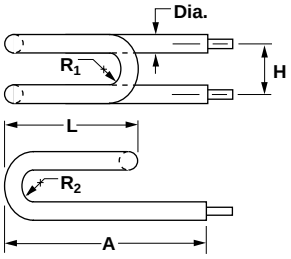
SL = 0.0175(<°) (2R_2 + Dia.) +1.14R_1 + 0.43 Dia.
(For pricing, use 3 bends)

Figure 6



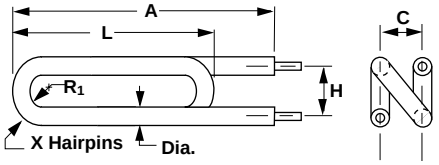
SL = L + 1.14R_2 - 0.86 Dia. + C + 1.14R_1 + A
(For pricing, use 2 bends)

Figure 7



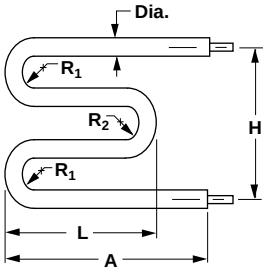
SL = 2A + 2.28R_2- 1.29 Dia. + 2L + 1.14R_1
(For pricing, use 3 bends)

Figure 8



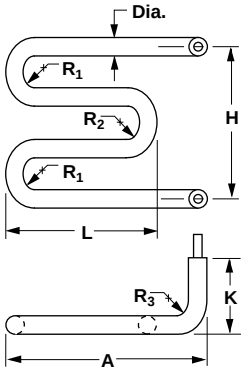
X = number of outside hairpins
SL = 2A + 3.42R_1 - 1.29 Dia. + 2L
(For pricing, use 5 bends)

Figure 9



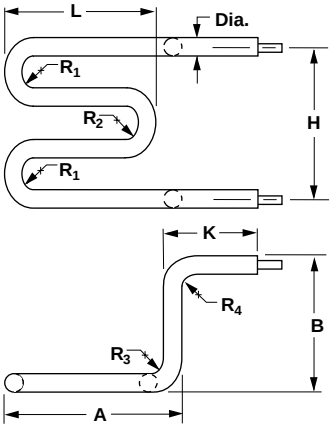
SL = 2A + 2.28R_1 - 1.29 Dia. + 2L + 1.14R_2
(For pricing, use 3 bends)

Figure 10



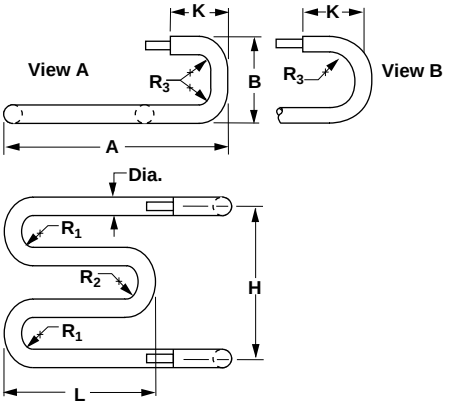
SL = 2K - 0.86R_3 - 3.72 Dia. + 2A + 2L + 2.28R_1 + 1.14R_2
(For pricing, use 5 bends)

Figure 11



SL = 2K - 086R_3 - 0.86R_4 - 6.15 Dia. + 2B + 2A + 2L + 2.28R_1 + 1.14R_2
(For pricing, use 7 bends)

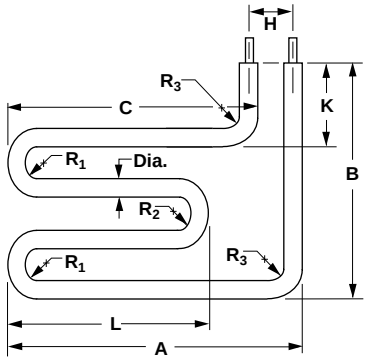
Figure 12



View A: SL = 2K + 2B + 2A + 2L + 2.28R_1 + 1.14R_2 - 1.72R_3 - 6.15 Dia.
View B: SL = 2K + 2A + 2L + 2.28R_1+ 1.14R_2 - 2.28R_3 - 2.15 Dia.
(For pricing, use 5 bends)

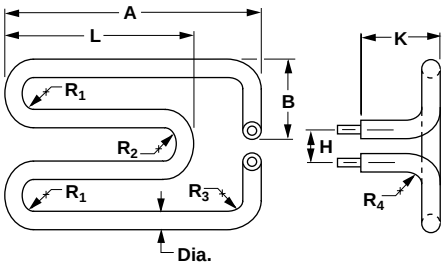
WATROD Heating Elements

Figure 13



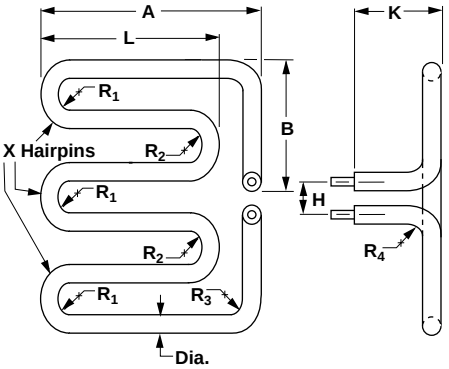
SL = 2B + 2A + 2L - 6.717 Dia. - 1.717R_1
- H - 0.858R_2 - 0.858R_3
(For pricing, use 5 bends)

Figure 14



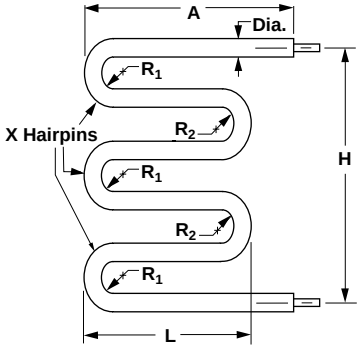
SL+2K+2A+2L+2.28R_1+1.14R_2+2B
-6.15 Dia. -0.86R_3+0.86R_4
(For pricing use 7 bends)

Figure 15



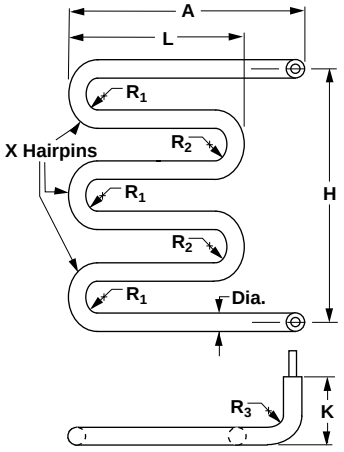
X = number of outside hairpins
SL = 2K + 2A + 2K(X - 1) + 2B - 0.86R_3 - 0.86R_4
+ 1.14R_1 (X) + 1.14R_2 (X - 1) - 4.86 Dia. - (2X - 1)
0.43 Dia.
(For pricing, use 9 bends if X = 3 hairpins)

Figure 16



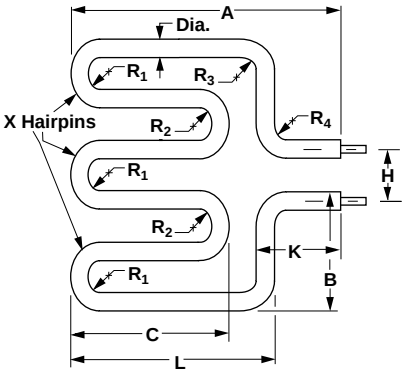
X = number of outside hairpins
SL = 2A + 0.43 Dia. (1 - 2X) + 2L (X - 1) + 1.14R_1
+ 1.14R_2 (X - 1)
(For pricing, use 5 bends if X = 3 hairpins)

Figure 17



X = number of outside hairpins
SL = 1.14R_2 X - 0.88 Dia. X - 1.14R_2 - 2 Dia.
+ 1.14R_1 X -0.86R_3 + 2L X - 2L + 2A + 2K
(For pricing, use 7 bends if X = 3 hairpins)

Figure 18

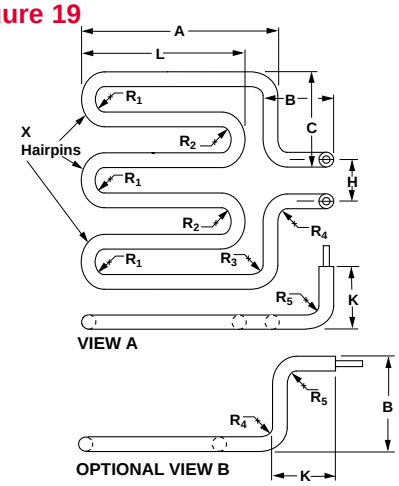


X = number of outside hairpins
SL = 2L + 2K + 2B + 2C (X - 1) - 0.86R_3
- 0.86R_4 - 4.86 Dia. + 1.14R_1 (X)
+ 1.14R_2 (X - 1) - (2X - 1) 0.43 Dia.
(For pricing, use 9 bends if X = 3 hairpins)

Tubular and Process Assemblies

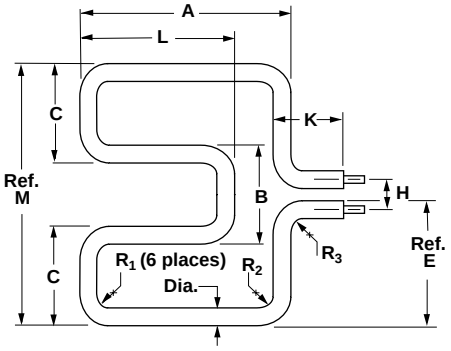
WATROD Heating Elements

Figure 19



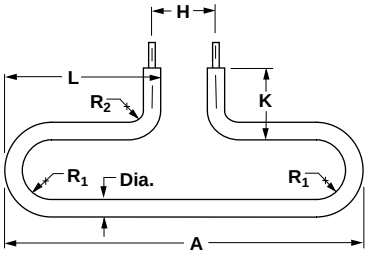
X = number of outside hairpins
View A and B: SL = 2K + 2A + 2B + 2C + 2L (X - 1) + 1.14R_1 (X) + 1.14R_2 (X - 1) - 0.86R_3 - 0.86R_4 - 0.86R_5 - 7.29 Dia. - (2X - 1) 0.43 Dia.
(For pricing, use 11 bends if X = 3 hairpins)

Figure 20



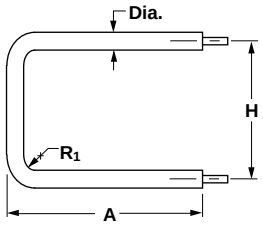
SL = 2K + 2C + B + 2A + 2L - 2.58R_1 - 0.86R_2 - 0.86R_3 - 12.15 Dia.
(For pricing, use 10 bends)

Figure 21



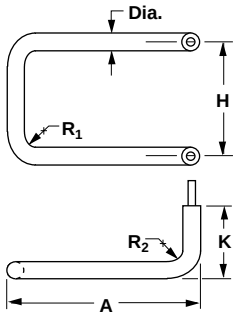
SL = 2A + 2K - H - 2.28R_1 - 0.86R_2 - 3.29 Dia.
(For pricing, use 4 bends)

Figure 22



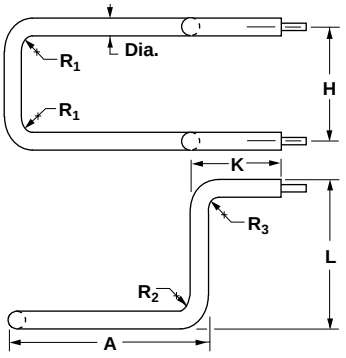
SL = 2A - 0.86R_1 - 1.43 Dia. + H
(For pricing, use 2 bends)

Figure 23



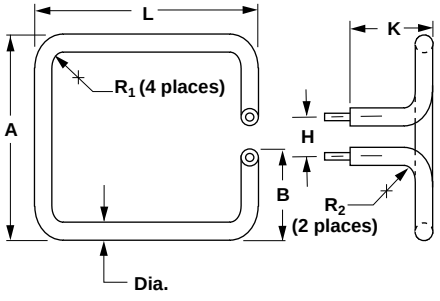
SL = 2K - 0.86R_2 - 3.86 Dia. + 2A - 0.86R_1 + H
(For pricing, use 4 bends)

Figure 24



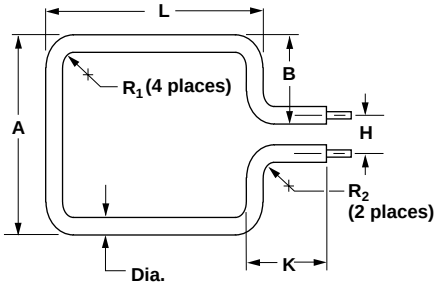
SL = 2K + 2L + H - 0.86R_1 - 0.86R_2 - 0.86R_3 - 7.29 Dia.
(For pricing, use 6 bends)

Figure 25



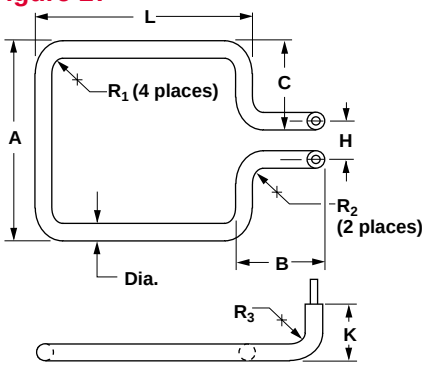
SL = 2K + 2A + 2L - H - 1.72R_1 - 0.86R_2 - 6.92 Dia.
(For pricing, use 6 bends)

Figure 26



SL = 2K + 2A + 2L - H - 1.72R_1 - 0.86R_2 - 6.29 Dia.
(For pricing, use 6 bends)

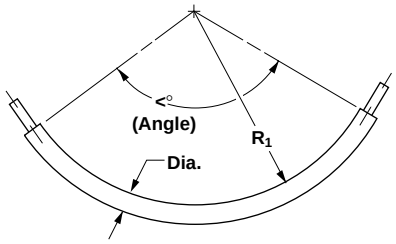
Figure 27



SL = 2K + 2A + 2L + 2B - H - 1.72R_1 - 1.72R_2 - 8.72 Dia.
(For pricing, use 8 bends)

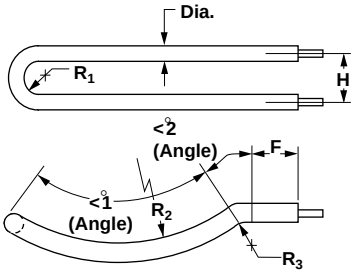
WATROD Heating Elements

Figure 28



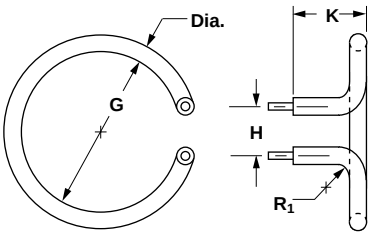
SL = 0.0175 <° (R_1 + 0.5 Dia.)
(For pricing, use 1 bend)

Figure 29



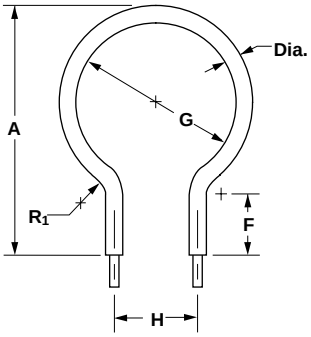
SL = 0.0175 <°1 ($2R_2$ + Dia.) + 2F + $1.14R_1$ + 0.0175 <°2 ($2R_3$ + Dia.) - 0.43 Dia.
(For pricing, use 5 bends)

Figure 30



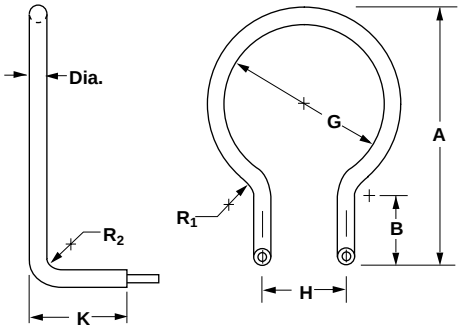
SL = (G + Dia.) 3.14 + $1.14R_1$ + 2K + 3.28 Dia. - H
(For pricing, use 4 bends)

Figure 31



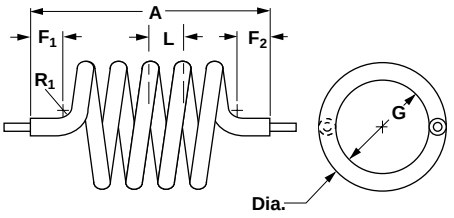
SL = (G + Dia.) 3.14 + $1.14R_1$ + 2F + 3.71 Dia. - H
(For pricing, use 4 bends)

Figure 32



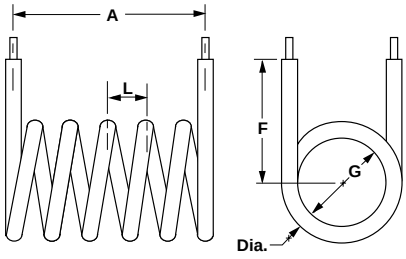
SL = (G + Dia.) 3.14 + $1.14R_1$ + 2B + $1.14R_2$ + 2K + 3.28 Dia. - H
(For pricing, use 6 bends)

Figure 33



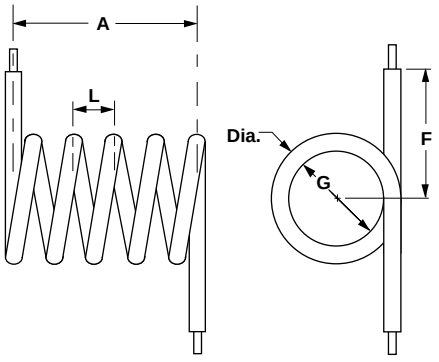
SL = [(G + Dia.) (3.14) (Number of 360°'s)] + F1 + F2
(For pricing, consult factory)

Figure 34



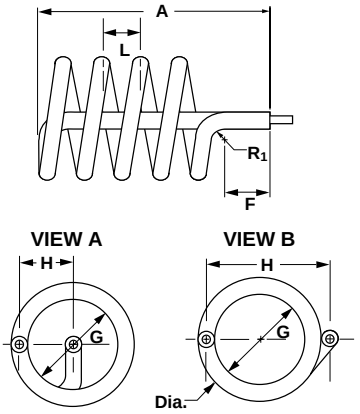
SL = [(G + Dia.) (3.14) (Number of 360°'s)] + 2F
(For pricing, consult factory)

Figure 35



SL = [(G + Dia.) (3.14) (Number of 360°'s)] + 2F
(For pricing, consult factory)

Figure 36



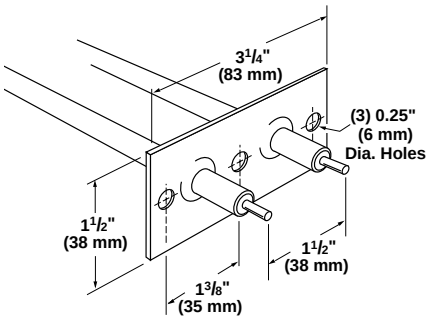
SL = [(G + Dia.) (3.14) (Number of 360°'s)] + (G ÷ 2) + A + F
(For pricing, consult factory)

Tubular and Process Assemblies

WATROD Heating Elements

Mounting Methods

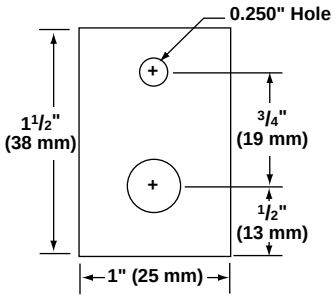
Brackets



A 0.065 inch (1.7 mm) thick stainless steel bracket provides element mounting in non-pressurized applications. Attached to the heater sheath, these brackets are not suited for liquid-tight mountings. The bracket is located ½ inch (13 mm) from the sheath's end, unless otherwise specified.

To order, specify **mounting bracket**.

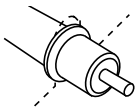
Single Leg Bracket



A 1 ½ inch (38 mm) x 1 inch (25 mm) wide x 16 gauge stainless steel bracket with one element hole and one mounting hole ½ inch from end.

To order, specify **single leg bracket**.

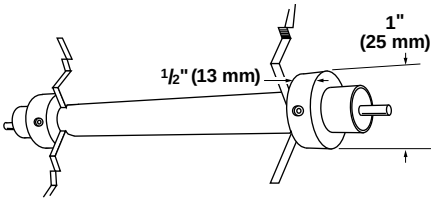
Locator Washers



Stainless steel locator washers retain the heated area of the sheath in the work zone, while allowing for expansion and contraction during cycling.

To order, specify **locator washer**, along with dimension from the heater's end.

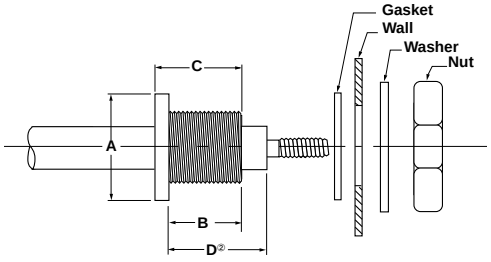
Mounting Collars



Plated steel mounting collars secure the heater sheath with set screws to serve as adjustable stops for through-the-wall mounting. Collars are shipped in bulk.

To order, specify **mounting collars**.

Threaded Bulkheads



A threaded bushing with flange on the heater sheath provides rigid, leak-proof mounting through the walls of tanks. A gasket, plated steel washer and hex nut are included. The threaded end of the bushing is flush with the sheath's end unless otherwise specified. Threaded bulkheads are available in brass, steel or stainless steel as indicated in the table.

To order, specify **threaded bulkheads** and the specifications from the table.

Threaded Bulkhead Specifications

Element Diameter inch	Element Diameter (mm)	Material	Thread Size	A① Flange Size/Style inch	A① Flange Size/Style (mm)	B Threaded Length inch	B Threaded Length (mm)	C Overall Length inch	C Overall Length (mm)
0.260	(6.6)	Brass	½ - 20 UNF	¾ Round	(19)	⅝	(15.9)	¾	(19)
0.260	(6.6)	Steel	½ - 20 UNF	¾ Hex	(19)	⅝	(15.9)	¾	(19)
0.260	(6.6)	S. Steel	½ - 20 UNF	¾ Round	(19)	⅝	(15.9)	¾	(19)
0.315	(8.0)	Brass	½ - 20 UNF	¾ Round	(19)	⅝	(15.9)	¾	(19)
0.315	(8.0)	Steel	½ - 20 UNF	¾ Hex	(19)	¾	(19.0)	15/16	(24)
0.315	(8.0)	S. Steel	½ - 20 UNF	¾ Round	(19)	¾	(19.0)	27/32	(21)
0.375	(9.5)	Brass	½ - 20 UNF	¾ Round	(19)	⅝	(15.9)	¾	(19)
0.375	(9.5)	Steel	½ - 20 UNF	¾ Hex	(19)	¾	(19.0)	15/16	(24)
0.375	(9.5)	S. Steel	½ - 20 UNF	¾ Round	(19)	¾	(19.0)	27/32	(21)
0.430	(10.9)	Brass	⅜ - 18 UNF	⅞ Hex	(22)	¾	(19.0)	15/16	(24)
0.430	(10.9)	Steel	⅜ - 18 UNF	⅞ Round	(22)	¾	(19.0)	15/16	(24)
0.430	(10.9)	S. Steel	⅜ - 18 UNF	1 Round	(25)	¾	(19.0)	15/16	(24)
0.475	(12.1)	Brass	⅜ - 18 UNF	⅞ Round	(22)	¾	(19.0)	15/16	(24)
0.475	(12.1)	Steel	⅜ - 18 UNF	1 Round	(25)	1	(25.0)	1⅛	(29)
0.475	(12.1)	S. Steel	⅜ - 18 UNF	1 Round	(25)	¾	(19.0)	15/16	(24)
0.490	(12.4)	Brass	¾ - 16 UNF	1 Round	(25)	¾	(19.0)	1	(25)
0.490	(12.4)	Steel	¾ - 16 UNF	1 Hex	(25)	¾	(19.0)	1	(25)
0.490	(12.4)	S. Steel	¾ - 16 UNF	1 Round	(25)	¾	(19.0)	1	(25)
0.625	(15.9)	S. Steel	⅞ - 14 UNF	1 Round	(25)	¾	(19.0)	1	(25)

① Designates the dimension across flats for hex flange style and outside diameter for round flange style.
② Equal to "B" Dimension unless otherwise specified.