SUPERIOR QUALITY. PROVEN WORLDWIDE.

BELLEVILLE
INTERNATIONAL

Flange Live Loading
HANDBOOK

High Temperature & Cryogenic

ISO 9001: 2015 CERTIFIED

www.bellevilleintl.com | 330 E Cunningham St., Butler, PA 16001 | (724) 431-0444

ABOUT US

BELLEVILLE INTERNATIONAL

The Belleville International Difference

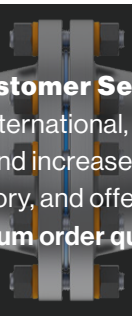
Belleville International was founded on the basis of honesty, integrity and superior quality. Our reputation for quality, on-time delivery, and exceptional customer service has made us the preferred manufacturer in the industry.

Among our loyal customer base are companies that require high precision parts with rigorous quality requirements. Many industry-leading companies in critical use markets have trusted us for over a decade. In a number of those relationships, we are depended upon with exclusivity. Our team is committed to providing your company with the same excellent service.

We excel in the production of Belleville springs and machined components from specialty alloy materials, challenging tolerances, special purpose finishing and testing procedures. Our team utilizes superior designs, processes and materials to help increase spring longevity and performance. We work from a wide range of spring steel and special alloy metal forms and offer complementary design help for your application.

Premier Quality

As an ISO 9001:2015 certified company, our products are produced using the highest quality materials sourced from reputable suppliers. All products are meticulously tracked from raw material heats, heat treatment cycles, testing certifications and job numbers at our full manufacturing facility in Butler, Pennsylvania. Our team is dedicated to providing all necessary quality documentation for critical and severe service applications.



Excellent Customer Service

At Belleville International, our lean culture and customer centric process ensures that we are focused on continuous improvement and increased efficiency for our customers. We specialize in attention to detail, excellent response time, a large on hand inventory, and offer expedited production for all of your shutdown and turnaround needs. **One part or thousands, we have no minimum order quantity.**

Complimentary Engineering Design

Our goal is to provide the best spring for your application. To make this happen, our team can provide engineering design help to maximize spring life and achieve the best performance at a competitive price.

Premier Manufacturer of Belleville Disc Springs & Precision Machined Components

Superior Quality · Exceptional Customer Service · On-time Delivery

Quick Turnaround · Prototypes · Engineering Support

24/7 Emergency Service

FLANGE LIVE LOADING

USING BELLEVILLE SPRING FLANGE WASHERS

What is Live Loading?

Adding Belleville springs to a bolted gasket assembly, or "live loading" it, helps to hold the joint together and maintain the necessary sealing pressure. If you have a high temperature, high pressure cyclic piping system, like what is found in a petrochemical facility, you probably have areas in that facility where a leaking flange can be a serious problem. These flange leaks can be a significant risk to worker's safety, the environment or to operating efficiency and profitability. Live loading these applications using Belleville spring flange washers can be of great benefit in reducing fugitive emissions.

Bolted gasketed flange joints leak when the stress on the gasket falls below the stress needed for it to seal properly. There are several factors working on the joint that can cause that to happen. They include:

- Embedment Relaxation
- Gasket Creep
- Bolt Creep / Stress Relaxation
- Vibration
- Differential Thermal Expansion
- Elastic Interaction / Cross Talk

Live Loading is used as a preventative measure to alleviate every one of these issues.

Embedment Relaxation happens when a new bolt and nut is tightened for the first time. New bolts and nuts have microscopic high points on their threads. On initial tightening, the bolt loads on these high points. This causes them to be stressed above their yield point and deform or relax. It has been reported that 50% or even more of the initial bolt preload can be lost in just the first 24 hours after the bolt or stud has been tightened. That is one reason some procedures require bolts to be retightened after 24 hours or even hot tightened.

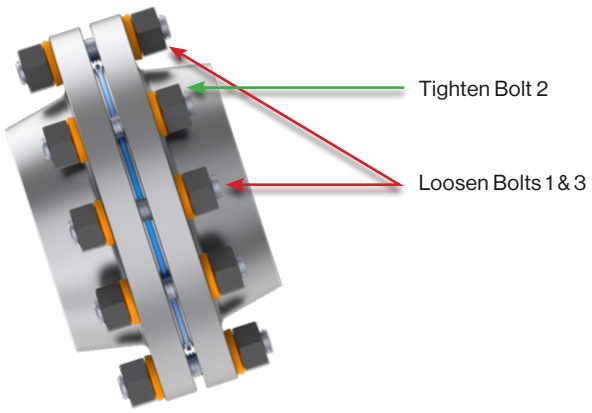
Gasket Creep happens after the initial tightening. Gaskets creep or flow to obtain a seal. They will continue to creep or flow, even after the load has been applied. This can decrease the amount of bolt preload on the gasket.

Bolt Creep / Stress Relaxation occurs at high temperatures causing the bolt to relax over time. The amount of loss is a factor of the bolt material, temperature and the time at temperature.

Vibration, is the hardest of all the factors working on a bolted flange joint to detect. Vibration takes a long time to reduce bolt preload, but when it does, the preload loss is rapid. With vibration, joints that remained tight for a very long time suddenly become loose.

Differential Thermal Expansion can happen when a flange heats up from the process media. Parts of the flange joint are made from different materials and heat and coil at different rates. The parts closest to the media or heat, expand faster than the parts further away from the heat. When the flange cools, the parts of the flange joint also cool at different rates. This can cause additional loss in preload.

Elastic Interaction / Cross Talk, occurs anytime you have multiple bolts used to tighten a joint. This can occur on any bolted joint not just flanges. When you tighten the first bolt, the bolt is stretched and the joint compressed. When you tighten the bolt next to it, the joint is further compressed, allowing the first bolt to relax. The greater number of bolts in the joint, the greater the elastic interaction or cross talk. Tightening all the bolts in the joint at the same time, would eliminate the problem. This can be difficult or impossible to do in some cases. One method to try to reduce the effects of elastic interaction or cross talk it to tighten the bolts in a star pattern and to tighten them in increments. The most common procedure is to tighten the bolts in at least 3 passes. The first being 30% of final bolt load. The second pass to 60% of final bolt load and the final pass at 100% of final desired bolt load. Some procedures require one more tightening pass in reverse order of the other 3 passes.



Example of Elastic Interactions / Cross Talk

FLANGE LIVE LOADING

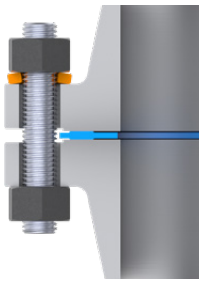
USING BELLEVILLE SPRING FLANGE WASHERS

Now that we know why bolted gasketed joints sometimes leak, how do we minimize the problem? By the addition of Belleville Spring Flange Washers. A Belleville spring will maintain the desired bolt stress, load or torque over a much longer period of time.

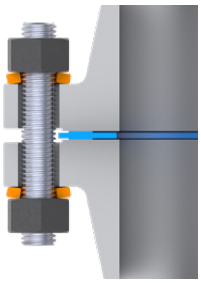
So what is a Belleville Spring Flange Washer? It is a conical shaped washer that provides a high spring force in a small space. This is why they work extremely well on bolted gasketed joints.

The addition of Belleville Spring Flange Washers to the bolts or studs changes the spring rate of the joint. This allows the joint to relax at a much slower rate and maintain the bolt load at a higher level for a much longer period of time. This reduces the effects of gasket / bolt creep, vibration, differential thermal expansion and elastic interaction.

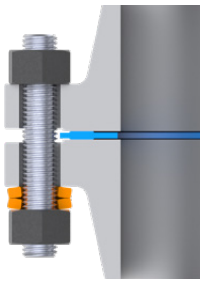
Typically a Belleville Spring Flange Washer is installed under the head of the nut or bolt, with the OD of the spring contacting the flange and the ID contacting the nut or bolt head. In some cases, multiple springs are used as shown below.



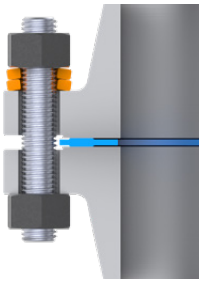
Single Flange Washers



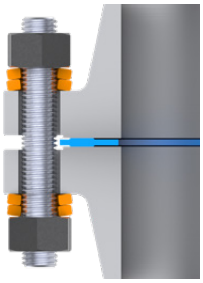
2 Flange Washers in Series One on Each Side



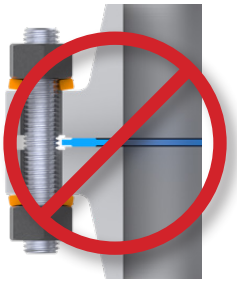
2 Flange Washers in Series Same Side when using Tensioners



Two Parallel Flange Washers



Two Parallel Flange Washers Both Sides



Incorrect Installation Spring Upside Down

When the use of Belleville Spring Flange Washers was first introduced, it was common practice to tighten flange bolts to 30,000, 45,000 and 60,000psi bolt stress. You will see this reflected in the part numbers. An H13-1-60 is a Belleville Spring Flange Washer that is made from H13 Tool Steel, for a 1/2" bolt. It was designed to produce approximately the same load that would be require to tighten a 1/2" B-7 or B16 bolt or stud to 60,000psi bolt stress. An H13-1-45 would be for the same size bolt or stud, but was designed to produce the load required when tightening a B-7 or B16 bolt or stud to 45,000psi bolt stress.

Belleville Spring Flange Washers are available in several different materials. The material used is determined by the environment of the application.

H13 Tool Steel is the most commonly used material for Belleville Spring Flange Washers due to its excellent strength and working temperature range, of ambient to 1100°F.

17-7PH Stainless Steel is typically used where the bolt loads are much lighter and for cryogenic applications. It has a working temperature range of -400°F to 550°F. 17-7PH Stainless Steel should not be used in chloride or fluoride applications.

Inconel 718 and X750 can be used in cryogenic applications, as well as high temperature and corrosive service applications. These materials are able to withstand working temperatures of -400°F to 1100°F and are suitable for chloride and fluoride applications.

Belleville International's engineering department can assist in selecting the correct material for your application. Please note that when discussing operating temperatures for the specific materials, actual temperatures the spring will see, not the operating temperature, are listed. The actual temperature the spring may see could be as little as 50% of the actual process temperature on an uninsulated flange.

For additional information, catalogs or design help, please contact Belleville International direct.

BELLEVILLE
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H-13 TOOL STEEL

BELLEVILLE SPRING FLANGE WASHERS

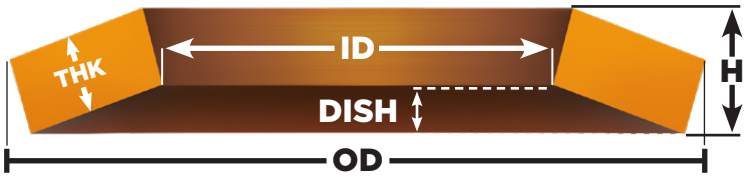
INCH SERIES

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
H13-1-30		1.010	0.529	0.116	0.015	4,488	30
H13-1-45	1/2	1.010	0.529	0.145	0.013	7,596	45
H13-1-60		1.010	0.529	0.154	0.012	8,540	60
H13-2-30		1.146	0.642	0.145	0.013	6,208	60
H13-2-45	5/8	1.146	0.642	0.175	0.012	10,073	90
H13-2-60		1.146	0.642	0.185	0.013	13,107	120
H13-3-30		1.368	0.760	0.175	0.016	9,360	100
H13-3-45	3/4	1.368	0.760	0.215	0.014	15,188	150
H13-3-60		1.368	0.760	0.222	0.014	19,428	200
H13-4-30		1.587	0.893	0.202	0.021	14,190	160
H13-4-45	7/8	1.587	0.893	0.245	0.018	21,701	240
H13-4-60		1.587	0.893	0.282	0.015	27,578	320
H 13-5-30		1.807	1.023	0.231	0.024	18,805	245
H13-5-45	1	1.807	1.023	0.280	0.020	27,909	368
H13-5-60		1.807	1.023	0.315	0.018	35,763	490
H13-6-30		2.022	1.148	0.265	0.023	21,784	355
H13-6-45	1-1/8	2.022	1.148	0.320	0.022	36,690	533
H13-6-60		2.022	1.148	0.368	0.018	45,655	710
H13-7-30		2.307	1.274	0.300	0.030	30,940	500
H13-7-45	1-1/4	2.307	1.274	0.366	0.024	44,945	750
H13-7-60		2.307	1.274	0.406	0.023	58,794	1000
H13-8-30		2.467	1.400	0.330	0.030	36,845	680
H13-8-45	1-3/8	2.467	1.400	0.400	0.026	56,869	1,020
H13-8-60		2.467	1.400	0.446	0.024	72,767	1,360
H13-9-30		2.680	1.525	0.363	0.032	44,432	800
H13-9-45	1-1/2	2.680	1.525	0.440	0.028	69,238	1,200
H13-9-60		2.680	1.525	0.505	0.024	89,725	1,600
H13-10-30		2.950	1.650	0.396	0.035	51,307	1,100
H13-10-45	1-5/8	2.950	1.650	0.484	0.031	82,969	1,650
H13-10-60		2.950	1.650	0.543	0.029	109,601	2,200
H13-11-30		3.170	1.775	0.431	0.039	63,891	1,500
H13-11-45	1-3/4	3.170	1.775	0.521	0.033	95,493	2,250
H13-11-60		3.170	1.775	0.591	0.029	122,491	3,000

-30 Denotes 30,000 lb Bolt Stress (Calculated)
-45 Denotes 45.000 lb Bolt Stress (Calculated)
-60 Denotes 60,000 lb Bolt Stress (Calculated)
Parts are not pre-set.

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
H13-12-30		3.390	1.902	0.465	0.041	73,882	2,000
H13-12-45	1-7/8	3.390	1.902	0.563	0.034	108,743	3,000
H13-12-60		3.390	1.902	0.616	0.031	*129,868	4,000
H13-13-30		3.598	2.025	0.542	0.035	88,808	2,200
H13-13-45	2	3.598	2.025	0.608	0.034	123,935	3,300
H13-13-60		3.598	2.025	0.635	0.032	*132,885	4,400
H13-14-30		4.038	2.281	0.559	0.047	104,308	3,108
H13-14-45	2-1/4	4.038	2.281	0.687	0.038	159,154	4,770
H13-14-60		4.038	2.281	0.708	0.037	*169,615	3,360
H13-15-30		4.480	2.530	0.635	0.050	132,115	4,400
H13-15-45	2-1/2	4.480	2.530	0.762	0.044	200,899	6,600
H13-15-60		4.480	2.530	0.782	0.043	*212,202	8,800
H13-16-30		4.918	2.778	0.693	0.055	156,780	5,920
H13-16-45	2-3/4	4.918	2.778	0.843	0.047	241,161	8,880
H13-16-60		4.918	2.778	0.869	0.045	*257,145	11,840
H13-17-30		5.358	3.028	0.760	0.062	196,477	7,720
H13-17-45	3	5.358	3.028	0.928	0.052	300,004	11,580
H13-17-60		5.358	3.028	0.974	0.045	*300,171	15,440
H13-18-60	3-1/4	5.810	3.306	1.037	0.050	*551,806	29,900
H13-19-30		6.130	3.525	0.841	0.060	240,354	14,020
H13-19-45	3-1/2	6.130	3.525	1.024	0.056	360,330	21,020
H13-19-60		6.130	3.525	1.175	0.046	*417,985	28,027
H13-20-30		6.665	3.818	0.871	0.077	274,250	17,140
H13-20-45	3-3/4	6.665	3.818	1.062	0.064	412,800	25,800
H13-20-60		6.664	3.818	1.215	0.052	*440,379	34,380
H13-21-30	4	7.130	4.050	0.970	0.080	321,415	21,428
H13-21-45		7.130	4.050	1.180	0.067	481,141	32,076

* 47,500 lb Bolt Stress



H-13 Tool Steel (ASTM A681)
Operating Temperature Range: 250°F to 1100°F
Parts are fully machined and Black Oxide Coated

METRIC H-13 TOOL STEEL

BELLEVILLE SPRING FLANGE WASHERS

METRIC SERIES

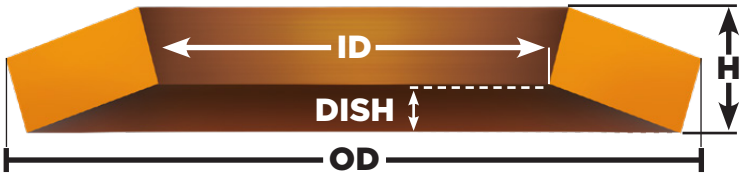
Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
H13-M10-45	M10	0.718	0.410	0.119	0.007	4,863	28
H13-M12-30		0.854	0.488	0.103	0.009	3,545	28
H13-M12-45	M12	0.854	0.488	0.125	0.008	5,318	42
H13-M12-60		0.854	0.488	0.144	0.007	7,090	56
H13-M16-30		1.148	0.644	0.142	0.015	6,780	60
H13-M16-45	M16	1.148	0.644	0.173	0.012	10,170	90
H13-M16-60		1.148	0.644	0.185	0.013	13,560	120
H13-M20-30		1.455	0.811	0.176	0.016	10,470	118
H13-M20-45	M20	1.455	0.811	0.214	0.014	15,705	177
H13-M20-60		1.455	0.811	0.242	0.012	20,940	236
H13-M24-30		1.709	0.977	0.212	0.021	15,090	208
H13-M24-45	M24	1.709	0.977	0.257	0.017	22,635	312
H13-M24-60		1.709	0.977	0.296	0.015	30,180	415
H13-M27-30		1.917	1.095	0.235	0.025	19,800	300
H13-M27-45	M27	1.917	1.095	0.286	0.021	29,700	451
H13-M27-60		1.917	1.095	0.330	0.019	39,720	600
H13-M30-30		2.123	1.213	0.267	0.025	24,120	420
H13-M30-45	M30	2.123	1.213	0.325	0.021	36,180	630
H13-M30-60		2.123	1.213	0.375	0.018	48,240	840
H13-M33-30		2.330	1.320	0.298	0.027	30,090	571
H13-M33-45	M33	2.330	1.320	0.363	0.023	45,135	856
H13-M33-60		2.330	1.320	0.418	0.020	60,180	1,141
H13-M36-30		2.580	1.449	0.322	0.033	35,307	720
H13-M36-45	M36	2.580	1.449	0.392	0.028	52,961	1,081
H13-M36-60		2.580	1.449	0.451	0.024	70,614	1,441
H13-M39-30		2.680	1.560	0.364	0.032	44,800	884
H13-M39-45	M39	2.680	1.560	0.443	0.027	67,117	1,396
H13-M39-60		2.680	1.560	0.510	0.023	89,520	1,768
H13-M42-30		2.906	1.687	0.404	0.033	53,400	1,193
H13-M42-45	M42	2.906	1.687	0.487	0.024	80,100	1,789
H13-M42-60		2.906	1.687	0.574	0.025	107,000	2,386

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
H13-M45-30		3.122	1.774	0.432	0.038	62,400	1,500
H13-M45-45	M45	3.122	1.744	0.526	0.031	93,600	2,250
H13-M45-60		3.122	1.774	0.605	0.028	124,800	3,000
H13-M48-30		3.390	1.902	0.465	0.041	73,882	2,000
H13-M48-45	M48	3.390	1.902	0.563	0.034	108,743	3,000
H13-M48-60		3.390	1.902	0.616	0.031	*129,868	4,000
H13-M52-30		3.600	2.079	0.513	0.036	89,575	2,375
H13-M52-45	M52	3.600	2.079	0.622	0.033	131,535	3,400
H13-M52-60		3.600	2.079	0.718	0.025	178,258	4,770
H13-M56-30	M56	3.99	2.235	0.575	0.038	94,890	2,820
H13-M56-45		3.99	2.235	0.674	0.036	144,783	4,225

* 47,500 lb Bolt Stress

-30 Denotes 30,000 lb Bolt Stress (Calculated)
-45 Denotes 45.000 lb Bolt Stress (Calculated)
-60 Denotes 60,000 lb Bolt Stress (Calculated)
Parts are not pre-set.

Please consult Belleville International for stocking questions.



H-13 Tool Steel (ASTM A681)
Operating Temperature Range: Ambient to 1100°F
Parts are fully machined and Black Oxide Coated

Torque values are for reference only and should be calculated for each application.

INCONEL 718

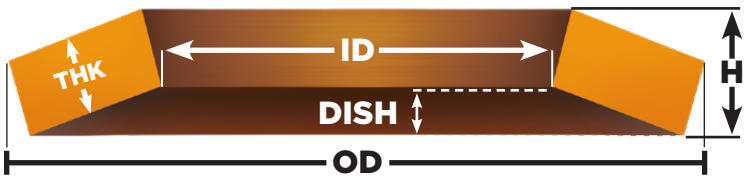
BELLEVILLE SPRING FLANGE WASHERS

INCH SERIES

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
X718-1-30		1.010	0.530	0.128	0.011	4,342	30
X718-1-45	1/2	1.010	0.530	0.156	0.009	6,432	45
X718-1-60		1.010	0.530	0.179	0.008	8,637	60
X718-2-30		1.146	0.640	0.160	0.011	6,904	60
X718-2-45	5/8	1.146	0.640	0.195	0.009	10,225	90
X718-2-60		1.146	0.640	0.223	0.008	13,594	120
X718-3-30		1.368	0.762	0.199	0.012	10,147	100
X718-3-45	3/4	1.368	0.762	0.242	0.010	15,207	150
X718-3-60		1.368	0.762	0.275	0.009	20,083	200
X718-4-30		1.588	0.890	0.232	0.004	13,992	160
X718-4-45	7/8	1.588	0.890	0.279	0.012	20,859	240
X718-4-60		1.588	0.890	0.326	0.010	27,730	320
X718-5-30		1.808	1.019	0.264	0.016	18,264	245
X718-5-45	1	1.808	1.019	0.324	0.013	27,431	368
X718-5-60		1.808	1.019	0.377	0.011	36,567	490
X718-6-30		2.023	1.145	0.304	0.017	23,753	355
X718-6-45	1-1/8	2.023	1.145	0.371	0.014	35,556	533
X718-6-60		2.023	1.145	0.430	0.012	47,451	710
X718-7-30		2.308	1.269	0.343	0.020	30,106	500
X718-7-45	1-1/4	2.308	1.269	0.414	0.017	45,030	750
X718-7-60		2.308	1.269	0.487	0.014	60,319	1000
X718-8-30		2.468	1.400	0.375	0.021	37,078	680
X718-8-45	1-3/8	2.468	1.400	0.461	0.017	55,765	1,020
X718-8-60		2.468	1.400	0.541	0.014	74,221	1,360
X718-9-30		2.680	1.525	0.415	0.022	44,770	800
X718-9-45	1-1/2	2.680	1.525	0.508	0.018	67,187	1,200
X718-9-60		2.680	1.525	0.582	0.016	89,807	1,600
X718-10-30		2.950	1.650	0.452	0.025	53,453	1,100
X718-10-45	1-5/8	2.950	1.650	0.558	0.020	80,454	1,650
X718-10-60		2.950	1.650	0.647	0.017	106,802	2,200
X718-11-30		3.170	1.775	0.493	0.026	62,525	1,500
X718-11-45	1-3/4	3.170	1.775	0.606	0.021	93,794	2,250
X718-11-60		3.170	1.775	0.702	0.018	124,975	3,000

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
X718-12-30		3.390	1.900	0.528	0.028	72,388	2,000
X718-12-45	1-7/8	3.390	1.900	0.646	0.023	108,901	3,000
X718-12-60		3.390	1.900	0.744	0.020	*144,662	4,000
X718-13-30		3.600	2.030	0.568	0.029	83,194	2,200
X718-13-45	1	3.600	2.030	0.693	0.024	125,042	3,300
X718-13-60		3.600	2.030	0.797	0.021	*166,433	4,400
X718-14-30		4.040	2.280	0.645	0.032	106,814	3,108
X718-14-45	2-1/4	4.040	2.280	0.792	0.026	160,675	4,770
X718-14-60		4.040	2.280	0.908	0.023	*214,182	6,360
X718-15-30		4.490	2.530	0.717	0.036	133,458	4,400
X718-15-45	2-1/2	4.490	2.530	0.882	0.029	200,119	6,600
X718-15-60		4.490	2.530	1.020	0.025	*266,824	8,800
X718-16-30		4.920	2.780	0.793	0.039	163,294	5,920
X718-16-45	2-3/4	4.920	2.780	0.969	0.032	244,459	8,800
X718-16-60		4.920	2.780	1.129	0.027	*326,235	11,840
X718-17-30		5.358	3.030	0.780	0.042	195,943	7,720
X718-17-45	3	5.358	3.030	1.068	0.034	293,437	11,580
X718-17-60		5.358	3.030	1.225	0.030	*390,707	15,440
X718-18-60	3-1/4	5.400	3.290	1.333	0.026	*462,290	
X718-19-60	3-1/2	6.130	3.540	1.435	0.033	*537,844	
X718-20-60	3-3/4	6.665	3.790	1.554	0.036	*621,561	
X718-21-60	4	7.130	4.050	2.038	0.032	1,087,913	

* 47,500 lb Bolt Stress



-30 Denotes 30,000 lb Bolt Stress (Calculated)
-45 Denotes 45.000 lb Bolt Stress (Calculated)
-60 Denotes 60,000 lb Bolt Stress (Calculated)
Parts are not pre-set.

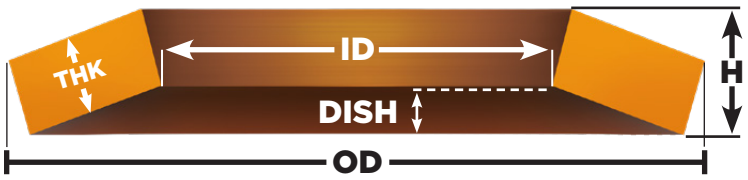
Inconel 718 (ASTM B637) (AMS 5596) (AMS 5662)
Operating Temperature Range: -400°F to 1100°F
For high temperature - cryogenic and/or corrosive service.

17-7 PH STAINLESS STEEL

BELLEVILLE SPRING FLANGE WASHERS - CRYOGENIC APPLICATIONS

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
17-7-1-30		1.010	0.531	0.130	0.010	4,070	30
17-7-1-45	1/2	1.010	0.531	0.148	0.010	6,006	45
17-7-1-60		1.010	0.531	0.156	0.010	7,033	60
17-7-2-30		1.146	0.640	0.152	0.012	6,333	60
17-7-2-45	5/8	1.146	0.640	0.180	0.011	9,640	90
17-7-2-60		1.146	0.640	0.198	0.010	11,665	120
17-7-3-30		1.368	0.762	0.190	0.013	9,391	100
17-7-3-45	3/4	1.368	0.762	0.224	0.012	14,204	150
17-7-3-60		1.368	0.762	0.238	0.012	17,089	200
17-7-4-30		1.587	0.891	0.220	0.015	12,566	160
17-7-4-45	7/8	1.587	0.891	0.265	0.013	19,033	240
17-7-4-60		1.587	0.891	0.294	0.013	25,991	320
17-7-5-30		1.807	1.020	0.260	0.016	17,155	245
17-7-5-45	1	1.807	1.020	0.305	0.015	26,139	368
17-7-5-60		1.807	1.020	0.344	0.014	34,765	490
17-7-6-30		2.022	1.145	0.285	0.020	22,629	355
17-7-6-45	1-1/8	2.022	1.145	0.345	0.017	34,120	533
17-7-6-60		2.022	1.145	0.358	0.016	35,882	710
17-7-7-30		2.307	1.270	0.325	0.023	28,975	500
17-7-7-45	1-1/4	2.307	1.270	0.396	0.019	43,325	750
17-7-7-60		2.307	1.270	0.441	0.018	56,654	1000
17-7-8-30		2.467	1.400	0.357	0.023	34,532	680
17-7-8-45	1-3/8	2.467	1.400	0.441	0.020	56,603	1,020
17-7-8-60		2.467	1.400	0.482	0.019	70,001	1,360
17-7-9-30		2.680	1.524	0.400	0.024	43,123	800
17-7-9-45	1-1/2	2.680	1.524	0.485	0.020	64,058	1,200
17-7-9-60		2.680	1.524	0.534	0.020	85,501	1,600
17-7-10-30		2.950	1.650	0.435	0.027	50,714	1,100
17-7-10-45	1-5/8	2.950	1.650	0.512	0.025	76,568	1,650
17-7-10-60		2.950	1.650	0.588	0.022	101,811	2,200
17-7-11-30		3.170	1.775	0.468	0.030	60,825	1,500
17-7-11-45	1-3/4	3.170	1.775	0.600	0.022	93,993	2,250
17-7-12-30		3.390	1.900	0.511	0.030	69,290	2,000
17-7-12-45	1-7/8	3.390	1.900	0.596	0.028	102,609	3,000
17-7-13-30	2	3.598	2.040	0.564	0.030	83,394	2,200

Part Number	Bolt Size	OD	ID	THK	Dish	Flat Load(lb)	Torque (ft-lb)
BIC-083-7	3/8	0.714	0.386	0.083	0.008	2,800	18
BID-083-7	7/16	0.820	0.450	0.083	0.010	2,800	21
BI1-083-7	1/2	0.900	0.515	0.083	0.011	2,775	23
BI1-091-7		0.900	0.515	0.095	0.010	3,700	30
BI2-095-7		1.140	0.644	0.095	0.015	3,585	37
BI2-112-7	5/8	1.148	0.644	0.117	0.013	6,500	60
BI2-125-7		1.148	0.640	0.125	0.012	6,400	60
BI3-117-7	3/4	1.370	0.773	0.117	0.018	5,500	69
BI3-131-7		1.370	0.773	0.136	0.016	8,500	90
BI4-150-7	7/8	1.590	0.901	0.155	0.019	12,500	160
BI5-168-7	1	1.810	1.030	0.168	0.023	8,600	143
BI5-193-7		1.810	1.030	0.193	0.017	18,000	250
BI6-187-7	1 1/8	2.025	1.155	0.193	0.025	20,000	330
BI7-193-7	1 1/4	2.310	1.281	0.193	0.031	20,000	410
BI7-270-7		2.310	1.281	0.270	0.026	30,000	625
BI8-250-7	1 3/8	2.470	1.406	0.250	0.028	25,000	500
BI8-375-7		2.470	1.406	0.375	0.019	58,000	1329
BI9-187-7	1 1/2	2.680	1.531	0.193	0.040	14,500	362
BI9-244-7		2.680	1.531	0.250	0.034	26,000	627
BI10-262-7	1 5/8	2.950	1.649	0.262	0.037	27,000	731
BI10-468-7		2.950	1.649	0.468	0.022	92,000	2,491
BI11-281-7	1 3/4	3.170	1.774	0.280	0.043	31,000	904
BI11-470-7		3.170	1.774	0.470	0.025	65,600	1916
BI12-300-7	1 7/8	3.389	1.910	0.300	0.045	33,000	1,031
BI13-318-7	2	3.600	2.063	0.318	0.050	40,000	1,333
BI13-500-7		3.600	2.024	0.512	0.030	110,000	3,650
BI14-356-7	2 1/4	4.040	2.281	0.356	0.052	51,000	1,900
BI15-394-7	2 1/2	4.483	2.531	0.394	0.058	62,000	2,590
BI16-431-7	2 3/4	4.920	2.781	0.431	0.063	75,000	3,400
BI17-468-7	3	5.360	3.031	0.468	0.069	88,000	4,377



17-7PH Stainless Steel (ASTM A693)
Operating Temperature Range: -400°F to 550°F
Should not be used in chloride or fluoride applications.

INSTALLATION PROCEDURES

BELLEVILLE SPRING FLANGE WASHERS

Technical Notes

The majority of bolted flange joint leaks are incorrectly referred to as gasket leaks. Most often, it is the gasket joint that is leaking due to the effects of temperature cycling, creep, and bolt relaxation on the joint.

EPA statistics show that 31% of uncontrolled VOC emissions from a petrochemical facility originates from flange connections. It is also estimated that 50% to 80% of all flange leaks are from loss of bolt load. When a bolt is initially tightened, it is stretched and the gasket yields or flows. At startup, the flange assembly heats up and the joint expands. Due to differences in the materials coefficient of thermal expansion, the flange and gasket expand more than the bolts. This can cause the gasket to yield further. As the bolt continues to heat up, additional preload is lost. This can cause the preload to fall below the minimum stress required for the gasket to seal properly, which causes the flange joint to leak.

Installing Belleville International's Flange Washers significantly increases the elasticity of the joint reducing the amount of preload loss when the joint yields. This is commonly known as "Live Loading". Most importantly, the preload is kept above required gasket sealing stress.

The following are examples of where Belleville International's Flange Washers are needed, specifically when the flange is exposed to:

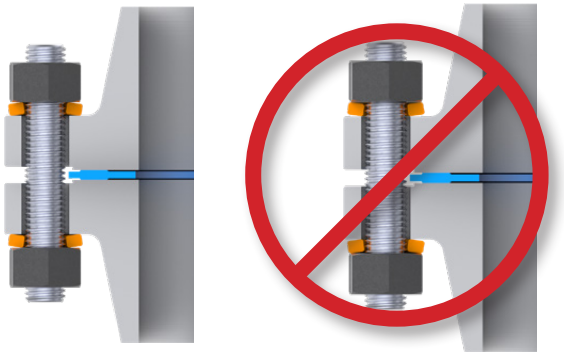
1. Temperature fluctuations
2. Gasket creep or bolt creep
3. Vibration and/or Elastic Interaction (Cross Talk)
4. Where emissions are a concern for health and safety

Originally, Belleville Flange Washers were designed around bolt stress, which is why the part numbers have a -30, -45 and a -60 designation. Most facilities used B-7 or B-16 bolts and tightened them to those stress levels regardless of the gasket requirements. We now recommend using the gasket stress to calculate the required bolt preload to ensure the gasket remains sealed. When a standard catalog part does not meet your requirements, custom designed parts are available. Please contact Belleville International's Engineering Department for design assistance.

Installation Procedures

Proper assembly of a gasketed flange joint, whether using Belleville Spring Flange Washers or not, is very important. You can have all the best parts, but if they are not installed correctly, you have wasted your time, money and effort. The following are steps to make sure you get the maximum benefit from your investment:

1. Bolts or studs should be new and the correct length to accommodate the added thickness of the Belleville Spring Flange Washers. If the bolts and studs are not being replaced, they should at least be cleaned, and the threads should be chased and lubricated.
2. Belleville Spring Flange Washers are designed to fit a standard flange. If the application is on a non-standard flange, the OD of the flange washers should not overhang the edge of the flange.
3. The Flange Washer should be installed in the correct orientation. The OD of the Flange Washers should contact the flange and the ID should contact the nut or bolt head.



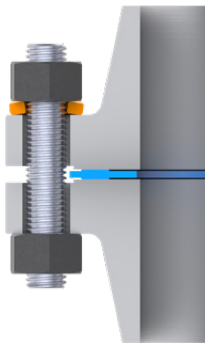
4. If a tensioner is used, the Flange Washers should be on the opposite side of the flange.
5. Regular flat washers are not usually required, but if a soft flange material, like aluminum, is used, a hardened flat washer may be required to prevent the Flange Washers from embedding in the material.
6. Contact our Engineering Department today to see if reuse of your flange washers is safe.

Belleville Spring Flange Washers are available in several types of materials. H-13 Tool Steel is typically used in applications where temperatures are between ambient and 1100°F. 17-7 Stainless Steel is used where temperatures are between -400°F and 550°F. Belleville International also specializes in Inconel 718 and X-750 for higher temperatures or corrosive environments.

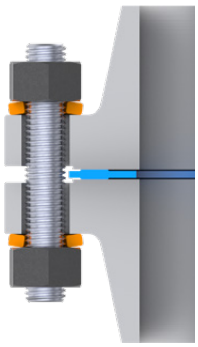
For additional information or questions contact Belleville International's Engineering Department.

COMMON FLANGE WASHER

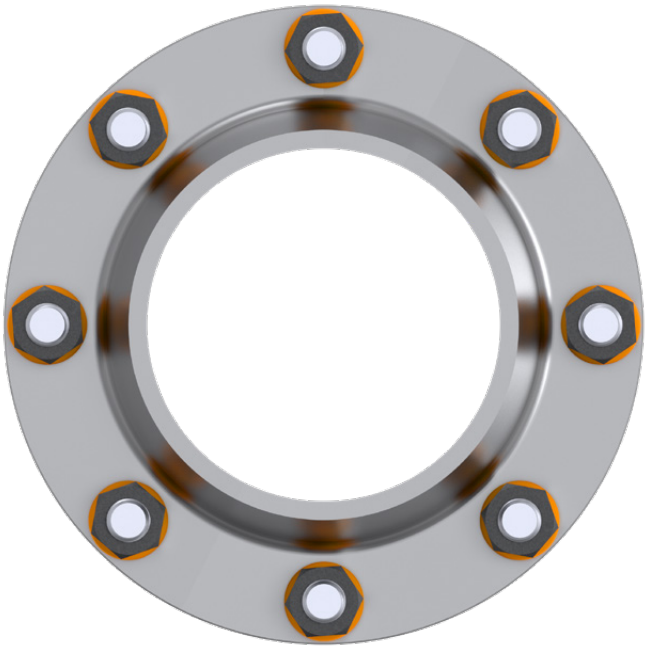
STACKING ARRANGEMENTS

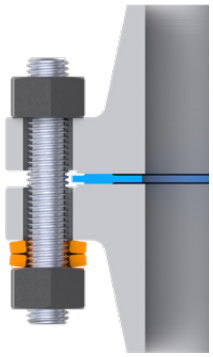


Single Flange Washers

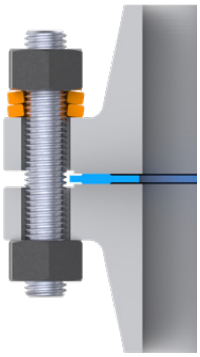


Two Flange Washers in Series One on Each Side

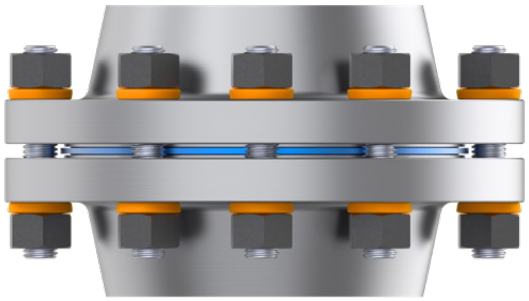


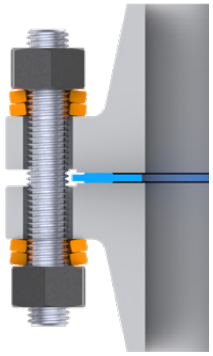


Two Flange Washers in Series Same Side when using Hydraulic Tensioners

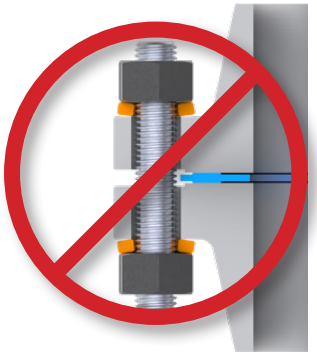


Two Parallel Flange Washers





Two Parallel Flange Washers Both Sides



Incorrect Installation Spring Upside Down

Belleville Spring Flange Washers shown here are ***Uncompressed & Exaggerated*** for display purposes.

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SUPERIOR QUALITY. PROVEN WORLDWIDE.

Belleville International is an independently-owned family business founded on honesty and integrity — two central principles that still guide our organization. Today, we're driven to succeed by a team with diverse knowledge, including experienced disc spring machinists, skilled engineers and manufacturing insiders. Our expertise, cutting-edge technology and unwavering commitment to customer service have helped us build a powerful reputation as industry leaders and innovators—a reputation we work hard to uphold.

With each order, we work hard to deliver total customer satisfaction from the initial specs to the final delivery. Utilizing the latest manufacturing technology, we design and develop standard and custom disc springs, spring washers and machined products.

For us, no job is too big or too small — and no job gets anything less than our total focus, commitment and promise to deliver high-quality products on-time, on-budget and designed for your unique specifications.

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