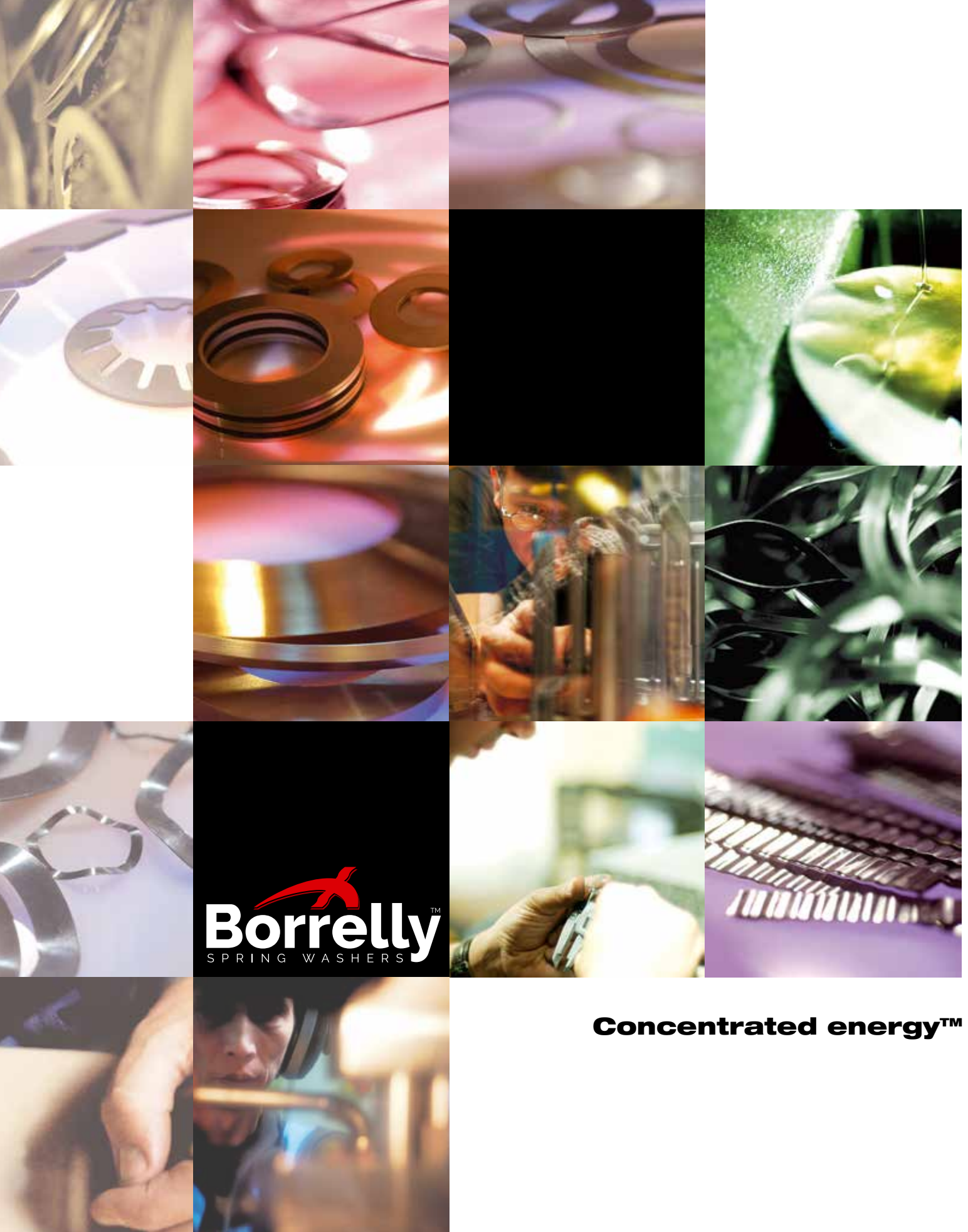




**Borrelly**TM
SPRING WASHERS

SPRING FOR INNOVATION



**Borrelly**TM
SPRING WASHERS

Concentrated energyTM



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Specific elasticity curves, special dimensions, particularly corrosive environments... Our special products provide innovative spring solutions



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An extensive range of spring materials, usable from -270°C to +1000°C.

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Simultaneously waved and rolled from flat wire to provide greater deflection than an ordinary waved washer by increasing the number of turns



34 ENGINEERING SHEET

Photocopy or download this sheet from our website to set out your basic requirements, so that our engineering department can check the feasibility of your ideas

INTRODUCTION

ALWAYS STRIVING TO INNOVATE

Borrelly has specialised in designing and producing spring washers since the early 1970s. Dominique Borrelly took the reins of the company in 1990 and has continued its growth through a policy of continual innovation. Numerous investments in human and technical resources ensure that the company's products are at the leading edge of technology.

Borrelly aims to achieve sustainable

national and international development, and has set up appropriate facilities to attain its objectives:

- Several functional production units suited to innovative manufacturing techniques.
- An inspection laboratory equipped with optical, static and dynamic measurement equipment.



**Borrelly**
SPRING WASHERS

Certifié par
BUREAU VERITAS
Certification

ISO 9001 - EN 9100

HIGH-TECH EXPERTISE

Borrelly designs and develops very high quality technical products. Its spring washers are round elastic parts which can store a maximal amount of energy for their unit volume and which are ideal for highly complex problems. The in-house engineering and research department studies every requirement and solution individually, and proposes tailored manufacturing and production processes right from the design stage.

The company's high-tech expertise is attested by EN 9100 and ISO 9001 certifications, obtained in 2004 and renewed in 2007.

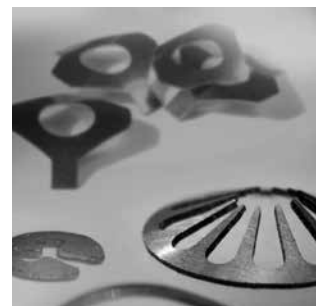
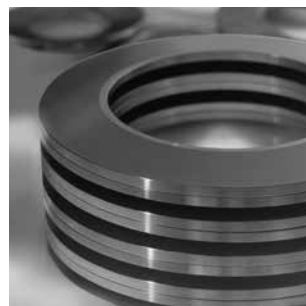
This is why Borrelly has been selected as a preferred partner by numerous major players in industries from aeronautics and aerospace to Formula 1 motorsport and nuclear power.

AN EXTENSIVE RANGE OF SPRING WASHERS

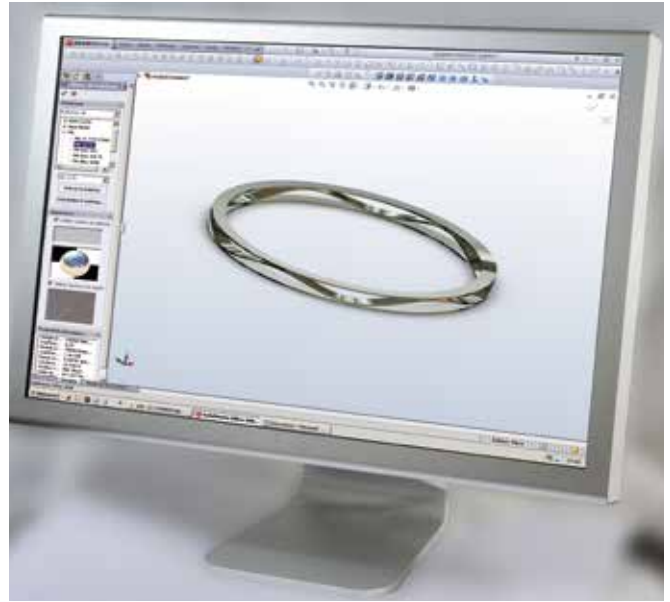
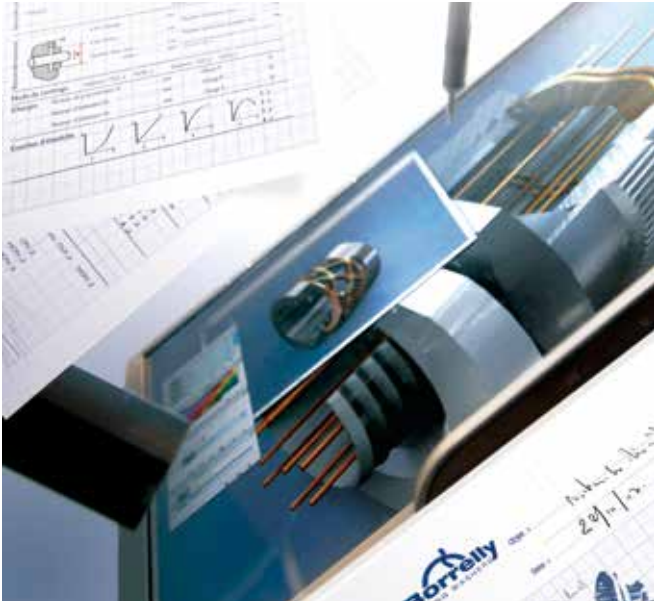
A well as offering custom design services, Borrelly has an extensive range of over 2,000 standard spring washers

available from stock in carbon and stainless steel base materials, and over 1,500 tools. From receipt of materials to domestic and international shipping,

all administrative and production operations are clearly defined and managed by Borrelly.



DESIGN AND ENGINEERING



FROM ANALYSIS OF YOUR REQUIREMENTS...

Designing a spring washer requires thorough knowledge of the product, acquired through years of experience. Our in-house engineering department builds on this experience through its familiarity with high-performance computational software.

In terms of energy stored per unit volume of material, spring washers are among the most efficient types of spring.

We work with you to consider your needs and draw up requirement

specifications in order to determine the most technically and economically suitable solution.

We analyse your environments and adapt the material used to suit even the harshest constraints.

We can very quickly manufacture prototypes which can be subjected to static and dynamic tests.

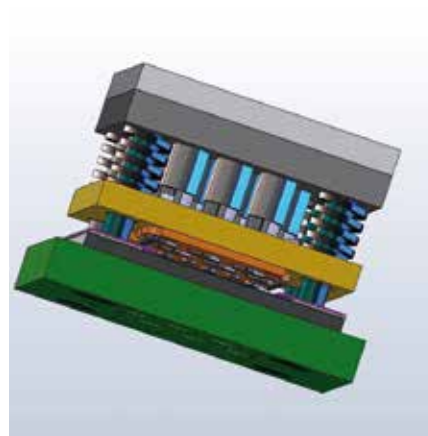
Forty years of experience guarantees that you can have confidence in our expertise.

Our in-house engineering department

works with you to determine the spring washer that best suits your requirements:

- Minimal dimensions
- Special environments
- Cryogenic or very high temperatures
- Static or dynamic fatigue
- Standard spring materials or super-alloys
- Development, testing
- Prototypes and large production runs

...TO CUSTOM INDUSTRIALISATION...



Our experience enables us to choose the most suitable spring for your needs from our existing range of products.

All phases in the manufacturing of our standard and special products are carried out in our factories:

- Design
- Manufacturing of tooling
- Cutting - stamping
- Heat treatment

GENERAL CHARACTERISTICS OF THE MATERIALS USED

The first phase in designing a spring washer entails determining the material that best meets the stipulated requirement specifications.

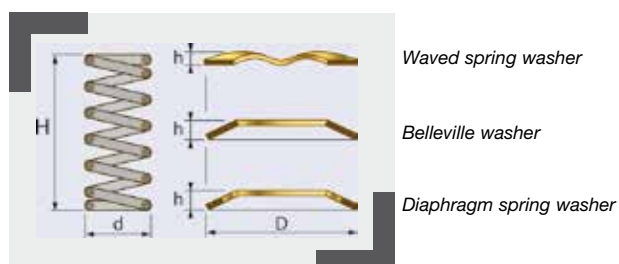
Usual description AFNOR symbol	Standard	Werkstoff Nr. (DIN) AISI	Young's modulus E (at 20°C). GPA dynamic method	Elastic limit (kgf/mm ² (at 20°C).) Mpa	Service temperature (°C)	Resistance to corrosive substances	Fatigue resistance
Carbon steel C75S / CK75	NF EN 10132-4	1.1248	21,000	1,400	-30 to +150	Very poor	Average
Chromium-molybdenum steel 51CrV4	NF EN 10132-4	1.8159	20,600	1,400	-20 to +150	Very poor	High
Lightly alloyed steel 45Si Cr Mo 6	NF EN 10-089	1.8062	21,000	1,500	-20 to +200	Very poor	Very high
Austenitic stainless steels	X10 Cr Ni 18-8	1.4310 Aisi 301	18,000	1,500 E4 work hardened	-180 to +300	Very high	Average <small>lower due to the fibre structure caused by work hardening</small>
	X10 Cr Ni 18-8	1.4310 Aisi 304	18,000	1,500 E4 work hardened	-180 to +300	Very high	Mediocre
	X6 Cr Ni MoTi 17-12-2	1.4571 Aisi 316	19,000	1,300 E4 work hardened	+300	Very high	Mediocre
	Structurally hardened stainless steel - 17-7 - Ph X7 Cr Ni Al 17-7	1.4568 Aisi 631	20,000	Min. 1,600 (cond C)	+350	Very high	Good
	Martensitic stainless steel - 17-4 - Ph X5 Cr Ni Cu Nb 16-4	1.4542 Aisi 630	20,000	1,200	-200 to +316	High	Good
Inconel X 750 super alloy Ni Cr15 Fe7 Ti Al	NF EN 10-302	2.4669	21,400	1,100	-200 to +400	Very high	Average
INCONEL 718 super alloy Ni Cr19 Fe19 Nb5 Mo3	NF EN 10-302	2.4668	20,300	1,300	-250 to +700	Very high	High
NIMONIC 90 super alloy Ni Cr20 Ti Al	NF EN 10-302	2.4969	21,600	1,100	-200 to +600	Very high	Mediocre
Beryllium copper CuBe 2		CM121C	13,000	1,300	-250 to +250	High	High

Other grades: 11 R 51 (Sandvik patent), Hastelloy, Monel, Phosphor bronze, Titanium, Waspaloy, Composite materials.

GENERAL CHARACTERISTICS AND ADVANTAGES OF SPRING WASHERS

Low volume

Spring washers, like wound wire springs such as coil springs, are round elastic parts.



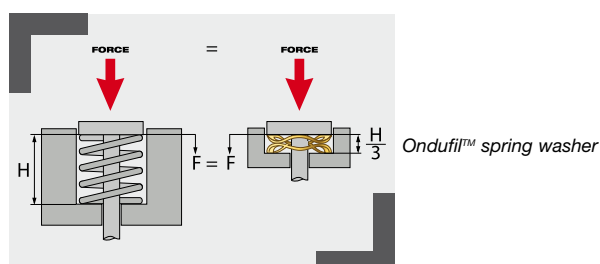
Unlike coil springs which are “tall” compared with their diameter, spring washers are “short” compared with their diameter.

Spring washers are therefore used when a “round elastic part” is needed in an assembly and there is space available for its diameter but not for height.

Our engineering department will determine the elastic part that best suits your requirements.

Comparison with a coil compression spring

Identical deflection and force are achieved in one-third of the volume.



This table is not intended to be exhaustive. It lists the materials regularly used which have a favourable ratio of elastic limit to longitudinal modulus of elasticity for relatively high elastic deformations.

Usual description AFNOR symbol	Magnetic permeability	Electrical or thermal conductivity	Field of use	Supply
Carbon steel C75S / CK75	Very good	Low	Waved spring washers, diaphragm spring washers, Ondufil™, spring rings, in a sealed, well lubricated housing	Always in stock
Chromium-molybdenum steel 51CrV4	Very good	Low	These steels are selected if high carbon steels are unsuitable due to fatigue resistance or special heat treatment requirements.	Regular
Lightly alloyed steel 45Si Cr Mo 6	Very good	Low	Thick Belleville washers requiring high internal stress ratios	Regular
Austenitic stainless steels	X10 Cr Ni 18-8	Low due to work hardening	Waved spring washers, Belleville washers, diaphragm spring washers, Ondufil™, spring rings, located in a non-waterproof housing and subject to even lightly corrosive substances.	Always in stock
	X5 Cr Ni 18-10	Low due to work hardening	Ondufil™ spring washers requiring low elasticity and good corrosion resistance.	Difficult
	X6 Cr Ni MoTi 17-12-2	Low due to work hardening	Ondufil™ spring washers in particularly corrosive environments.	Regular
	Structurally hardened stainless steel - 17-7 - Ph X7 Cr Ni Al 17-7	Good	Low	Waved spring washers, Ondufil™ in corrosive environments, high temperatures.
Martensitic stainless steel - 17-4 - Ph X5 Cr Ni Cu Nb 16-4	Zero	Low	Large Belleville washers in corrosive environments.	Difficult
Inconel X 750 super alloy Ni Cr15 Fe7 Ti Al	Zero	Low	Waved spring washers, Belleville, diaphragm spring washers, Ondufil™, high temperature parts.	Very difficult
Inconel 718 super alloy Ni Cr19 Fe19 Nb5 Mo3	Zero	Low	Waved spring washers, Belleville, diaphragm spring washers, Ondufil™, spring rings for nuclear, aeronautical, space, very high temperature.	Always in stock
NIMONIC 90 super alloy Ni Cr20 Ti Al	Zero	Low	Belleville washers only for high-temperature nuts and bolts, gas turbines, aeronautical.	Very difficult
Beryllium copper CuBe 2	Zero	Very high	Waved spring washers, Belleville, diaphragm spring washers, Ondufil™, spring rings. Cryogenic media.	Always in stock

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Using all possible means of compressing materials

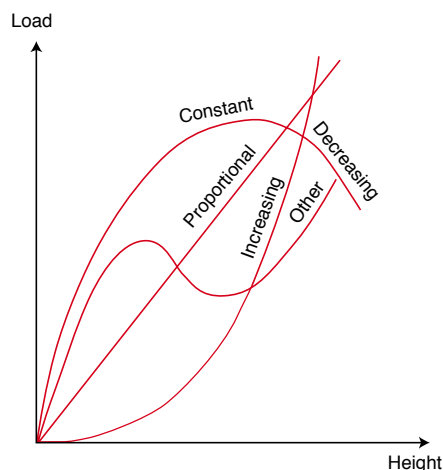
In a standard helical spring, the material is only compressed in torsion, which implies that force is always proportional to displacement (except if complex methods such as non-cylindrical windings, varied winding spacing or variable diameter wire are used).

The same does not apply to spring washers which, being flat springs, can use flexion, torsion and shear compression. By combining different compression types as the deformation varies, the forces obtained do not need to be proportional to displacement, enabling the elasticity curve to vary to achieve the desired force.

It is possible, for example, to design spring washers for which the force increases throughout the first part of deflection, then remains constant during the remaining displacement. Likewise, spring washers can be designed to have a force that increases to a maximum value then decreases. If only the falling part of the elasticity curve

is used, the result is a spring that “gets stronger as it releases”.

There are many applications for this specific feature.



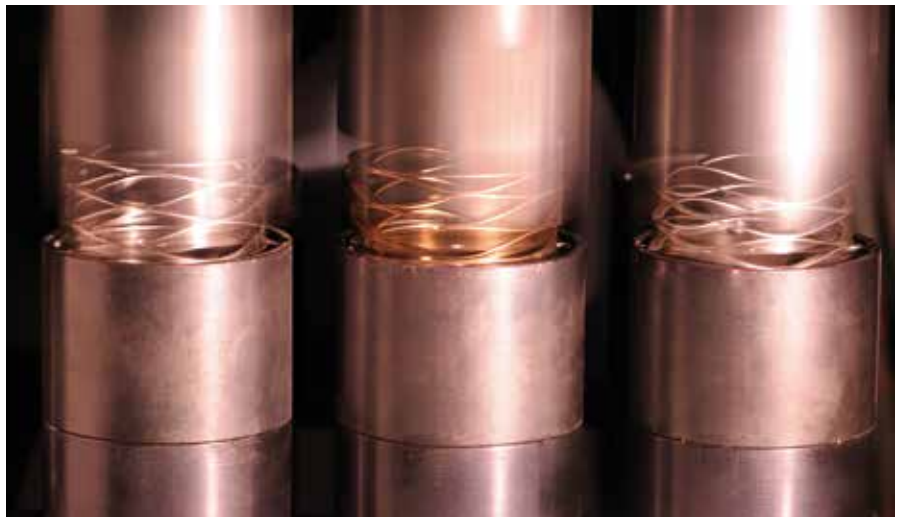
INSPECTION...



From dimensional inspection and appearance tests to materials resistance and static or dynamic loading tests, our laboratory is fully equipped to check that all products we supply comply with their specifications.

In accordance with ISO 9001:2000 and EN 9100 procedures, all our inspection equipment is traceable to national metrological standards and is regularly calibrated.

Total traceability is guaranteed and records can be archived indefinitely. Batch numbers are linked to full manufacturing details: materials, all production phases, intermediate inspections, final inspection and shipping.



...SHIPPING

Shipping your parts is of the utmost importance to us. Because appearance does indeed count, we use resistant, correctly labelled, easy to handle and secure packaging guaranteed to provide total protection for your products. We can adapt our packaging (GALIA), labelling and barcodes to cater for special requirements.





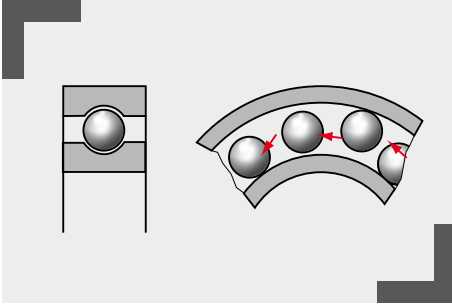
WAVED spring washers

WAVED SPRING WASHERS

GENERAL: BALL BEARING NOISE

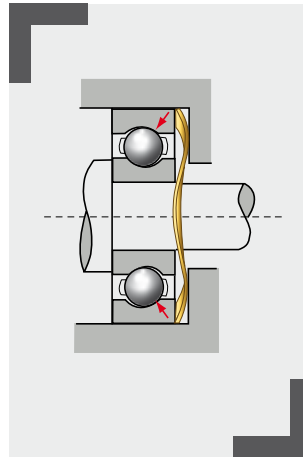
Non pre-stressed ball bearing

Internal clearance in ball bearings is essential but generates noise and vibrations.



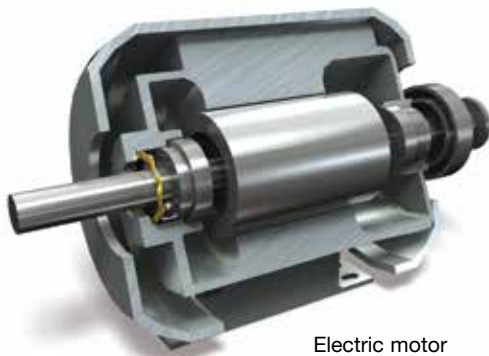
Pre-stressed ball bearing

Using spring washers to take up internal clearance reduces vibrations considerably and also decreases bearing noise. This has a beneficial effect on bearing service life.



APPLICATIONS

Examples of bearing applications



Electric motor



Tighter clearance, controlled force

Aerospace



- **Problem to be solved:**
Handle pre-stress in a high speed turbine.
- **Constraints:**
Cryogenic operating temperatures, particularly small overall dimensions, very tight load tolerance, zero hysteresis.
- **Solution:**
Beryllium copper waved spring washers.
- **Borrelly added value:**
Characterisation of the design parameters and parameters for manufacturing at 20°C, to achieve a result that fully met the customer's requirements at 50 K, right from the first prototype.



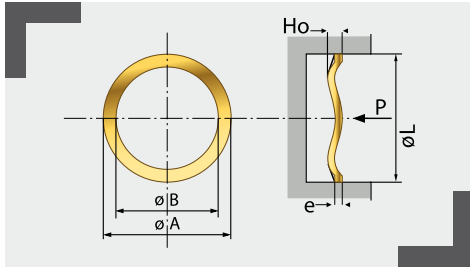
Civil aeronautics



- **Problem to be solved:**
Guarantee locking of a multi-pin connector ring.
- **Constraints:**
Very small overall dimensions, very high forces and deflections, stainless steel required. Zero defects guaranteed.
- **Solution:**
Ondufil™ stainless steel open spring washer.
- **Borrelly added value:**
Determination of geometry, industrialisation and inspection methods.



CN STANDARD XC 75 AND STAINLESS STEEL WAVED SPRING WASHERS



The values in the tables are not binding. Data is provided for information only and subject to change without notice.

Available from stock

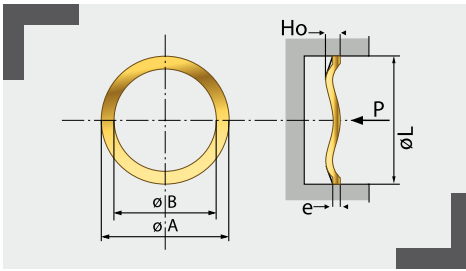


Borrelly references*	Standard references for the bearing				Bore dia. (mm)	Material thickness (mm)	Flat dia. (mm)		Approx. free ht. (mm)	Free dia. (mm) (approximate)		Working height (mm)		Load (daN)		Mean stiffness
	L	e	OD A	ID B	Ho	OD A	ID B	H1	H2	P(H1)	P(H2)	(daN/mm)				
PDD010008015XT	EL3-623				10.00	0.15	9.80	7.80	0.40	9.80	7.80	0.25	0.35	2.10	0.70	14.00
PDD013010015XT	EL4-624				13.00	0.15	12.80	10.00	0.55	12.60	9.80	0.30	0.50	2.50	0.50	10.00
PDD016012015XT	EL5-625	R4-634			16.00	0.15	15.80	12.40	0.70	15.70	12.30	0.30	0.50	2.30	1.20	5.50
PDD019015015XT	EL6-626	EL7-607	R5-635	AF	19.00	0.15	18.80	15.00	1.10	18.50	14.70	0.40	0.70	2.70	1.50	4.00
PCD019016025XT	EL6-626	EL7-607	R5-635	NF	19.00	0.25	18.60	15.60	1.10	18.50	15.60	0.40	0.70	2.70	1.50	4.00
PDD022017015XR	EL8-608	R7-627	AF		22.00	0.15	21.60	17.00	1.50	20.90	16.30	0.40	0.80	3.40	2.10	3.25
PCD022018025XT	EL8-608	R7-627	NF		22.00	0.25	21.60	18.00	1.50	21.40	17.80	0.40	0.80	3.40	2.10	3.25
PDD024019020XT	EL9-609		AF		24.00	0.20	23.60	18.60	1.30	23.40	18.40	0.50	0.90	4.40	2.40	5.00
PCD024019025XT	EL9-609		NF		24.00	0.25	23.60	18.60	1.30	23.30	18.30	0.50	0.90	4.40	2.40	5.00
PDD026021020XT	6000	R9-629			26.00	0.20	25.60	20.60	1.50	24.90	19.90	0.50	0.90	4.80	2.80	5.00
PDD028022020XT	6001				28.00	0.20	27.60	21.60	1.70	27.00	21.00	0.50	0.90	5.30	2.73	6.50
PDD030024020XT		6200	AF		30.00	0.20	29.50	23.50	2.00	28.70	22.70	0.50	1.10	5.60	3.70	3.20
PCD030022025XT		6200	NF		30.00	0.25	29.50	21.60	2.00	29.30	21.40	0.50	1.10	5.60	3.70	3.20
PDD032025020XT	6002	6201			32.00	0.20	31.50	24.50	2.20	30.50	23.50	0.50	1.10	6.10	4.00	3.50
PDD034026020XT	6003	6202	6300	AF	35.00	0.20	34.00	26.00	2.60	32.70	24.70	0.60	1.30	7.00	4.40	3.70
PCD034024025XT	6003	6202	6300	NF	35.00	0.25	34.00	23.60	2.60	33.40	23.00	0.60	1.30	7.00	4.40	3.70
PDD036028025XT			6301		37.00	0.25	36.00	28.00	2.40	35.20	27.20	1.00	1.50	7.40	4.90	5.00
PDD039030025XT		6203			40.00	0.25	39.00	30.00	2.70	37.80	28.80	1.10	1.70	8.00	4.90	5.20
PDD041032025XT	6004		6302		42.00	0.25	41.00	32.00	3.00	40.00	31.00	1.00	1.60	8.50	5.80	4.50
PDD046035025XT	6005	6204	6303	AF	47.00	0.25	46.00	35.00	3.45	44.80	33.80	1.10	1.80	8.80	6.20	3.70
PDD046034025XT	6005	6204	6303	NF	47.00	0.25	46.00	34.00	3.20	44.90	32.90	1.10	1.80	8.80	6.20	3.70
PDD051040030XT		6205	6304	AF	52.00	0.30	51.00	40.00	3.20	50.00	39.00	1.10	1.80	10.60	7.00	5.10
PED051039025XT		6205	6304	NF	52.00	0.25	51.00	39.00	3.20	50.50	38.50	1.10	1.80	10.60	7.00	5.10
PDD054042030XT	6006				55.00	0.30	54.00	42.30	3.60	52.60	40.90	1.10	1.80	11.60	8.10	5.00
PDD061049035XT	6007	6206	6305	AF	62.00	0.35	61.00	49.00	4.30	59.60	47.60	1.40	2.20	12.50	9.20	4.10
PDD061049025XT	6007	6206	6305	NF	62.00	0.25	61.00	49.00	4.30	59.00	47.00	1.40	2.20	12.50	9.20	4.10
PDD067053035XT	6008				68.00	0.35	67.00	53.00	4.60	65.20	51.20	1.40	2.20	12.80	9.70	3.90
PDD071055035XT		6207	6306	6404	72.00	0.35	71.00	55.00	4.90	69.30	53.30	1.40	2.20	13.30	10.50	3.50
PDD074060040XT	6009				75.00	0.40	74.00	60.00	5.10	72.30	58.30	1.50	2.30	15.00	11.70	4.10
PDD079064040XT	6010	6208	6307	6405	80.00	0.40	79.00	64.00	5.70	77.30	62.30	1.60	2.40	15.00	12.00	3.80
PDD085070050XT		6209			85.00	0.50	84.50	69.50	4.60	83.50	68.50	1.60	2.40	17.00	12.50	5.60
PDD089074050XT	6011	6210	6308	6406	90.00	0.50	89.00	74.00	5.30	87.60	72.60	1.60	2.40	18.00	14.20	4.80
PDD094079050XT	6012				95.00	0.50	94.00	79.00	6.10	92.60	77.60	1.60	2.40	19.00	15.60	4.20
PDD100085070XT	6013	6211	6309	6407	100.00	0.70	99.50	84.50	4.00	99.00	84.00	1.80	2.40	20.50	15.00	9.20
PDD109092060XT	6014	6212	6310	6408	110.00	0.60	109.00	92.00	6.80	107.00	90.00	1.80	2.40	25.00	22.40	4.30
PDD114098080XT	6015				115.00	0.80	114.00	98.00	7.70	113.20	97.20	1.60	2.20	27.00	22.00	8.30
PDD119103080XT		6213	6311	6409	120.00	0.80	119.00	103.00	5.00	117.90	101.90	1.60	2.20	34.00	23.60	8.30
PDD124109080XT		6214			125.00	0.80	124.00	109.00	7.00	122.50	107.50	1.60	2.20	36.00	32.00	6.60
PDD129112080XT	6017	6215	6312	6410	130.00	0.80	129.00	112.00	6.30	127.20	110.20	1.60	2.20	37.00	28.70	6.20
PDD139119100XT	6018	6216	6313	6411	140.00	1.00	139.00	119.00	5.30	138.30	118.30	2.00	2.80	41.00	31.00	12.50
PDD139126100XT	6018	6216	6313	6411	140.00	1.00	139.00	126.00	4.30	137.00	124.00	2.00	2.80	41.00	31.00	12.50
PDD144124100XT	6019				145.00	1.00	144.00	124.00	5.90	143.10	123.10	2.00	2.80	43.00	34.00	11.20
PDD149129100XT	6020	6217	6314	6412	150.00	1.00	149.00	129.00	6.60	147.70	127.70	2.00	2.80	45.00	37.00	10.00
PDD159139100XT	6021	6218	6315	6413	160.00	1.00	159.00	139.00	8.00	157.30	137.30	2.00	3.00	48.00	40.00	8.00
PDD169149100XT	6022	6219	6316		170.00	1.00	169.00	149.00	9.60	166.50	146.50	2.00	3.00	50.00	43.00	7.00
PDD179159100XT	6024	6220	6317	6414	180.00	1.00	179.00	159.00	11.50	175.80	155.80	2.00	3.00	52.00	47.00	5.00
PDD189169150TF		6221	6318	6415	190.00	1.50	189.00	169.00	6.10	187.50	167.50	2.50	3.50	55.00	41.00	14.00
PDD198178150TF	6026	6222	6319	6416	200.00	1.50	198.00	178.00	6.80	197.00	177.00	2.50	3.50	57.00	44.00	13.00
PDD208188150TF	6028		6417		210.00	1.50	208.00	188.00	7.80	206.50	186.50	3.00	4.20	58.00	43.60	12.00
PDD213188150TF		6224	6320		215.00	1.50	213.00	188.00	7.60	211.40	186.40	3.00	4.20	60.00	45.00	12.50
PDD223198150TF	6030		6321	6418	225.00	1.50	223.00	198.00	8.80	221.00	196.00	3.00	4.20	65.00	52.00	10.80
PDD228203150TF		6226			230.00	1.50	228.00	203.00	9.10	226.50	201.50	3.00	4.20	68.00	55.00	10.80
PDD238213150TF	6032		6322		240.00	1.50	238.00	213.00	10.30	236.00	211.00	3.00	4.20	71.00	60.00	9.20
PDD248218150TF		6228			250.00	1.50	248.00	218.00	10.10	246.50	216.50	3.00	4.20	75.00	62.00	10.80
PDD258228150TF	6034		6324		260.00	1.50	258.00	228.00	12.10	256.00	226.00	3.00	4.20	85.00	74.00	9.20
PDD268238150TF		6230			270.00	1.50	268.00	238.00	13.20	263.00	233.00	3.00	4.20	88.00	78.00	8.30
PDD278248150TF	6036		6326		280.00	1.50	278.00	248.00	14.80	274.00	244.00	3.00	4.20	91.00	82.00	7.50
PDD288258150TF	6038	6232			290.00	1.50	288.00	258.00	16.60	283.00	253.00	3.00	4.20	94.00	86.00	6.60
PDD298268150TF			6328		300.00	1.50	298.00	268.00	17.80	293.00	263.00	3.00	4.20	97.00	89.00	6.70
PDD308278200TF	6040	6234			310.00	2.00	308.00	278.00	11.80	306.00	276.00	4.00	5.40	102.00	85.00	12.10
PDD318288200TF		6236	6330		320.00	2.00	318.00	288.00	13.70	316.00	286.00	4.00	5.40	108.00	94.00	10.00
PDD338308200TF		6238	6332		340.00	2.00	338.00	308.00	16.50	335.00	305.00	4.00	5.40	117.00	104.00	9.30
PDD358328200TF		6240			360.00	2.00	358.00	328.00	19.90	354.00	324.00	4.00	5.40	125.00	114.00	7.80
PDD398358200TF	6044	6244			400.00	2.00	398.00	358.00	21.00	392.00	352.00	4.00	5.40	133.00	122.00	7.80

* For a stainless steel washer, replace the characters "XT" by "IX" at the end of a reference.

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C3 XC 75 AND STAINLESS STEEL WAVED SPRING WASHERS



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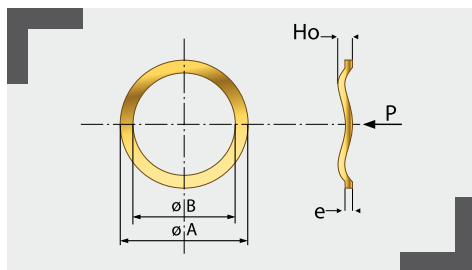
Available from stock



Borrelly references*	Standard references for the bearing		Bore dia. (mm)	Material thickness (mm)	Flat dia. (mm)		Approx. free ht. (mm)	Free dia. (mm) (approximate)		Working height	Load (daN)	Mean stiffness
			L	e	OD A	ID B	Ho	OD A	ID B	(mm)	P (H)=±10%	(daN/mm)
PCS022017020XR	EL8-608	C3	22	0.20	21.6	17.0	3.0	20.9	16.3	1.0	4.5	2.5
PCS024019030XR	EL9-609	C3	24	0.30	23.6	18.6	2.1	23.4	18.4	1.0	7.0	6.3
PCS026021030XR	R9-6000	C3	26	0.30	25.6	20.6	2.7	25.0	20.0	1.0	9.6	4.8
PES028022030XR	6001	C3	28	0.30	27.6	21.6	1.7	27.4	21.4	1.0	10	15
PDS030024030XR	6200	C3	30	0.30	29.5	23.5	2.6	29.2	23.2	1.5	7.6	12
PDS031024030XR	6201	C3	32	0.30	31.0	24.3	3.0	30.5	23.8	1.5	11.6	12
PCS034026040XT	6202	C3	35	0.40	34.0	26.0	2.8	33.7	25.7	1.5	12	8.3
PES036028040XT	6301	C3	37	0.40	36.0	28.0	2.3	35.7	27.7	1.5	16	21
PDS039030035XT	6203	C3	40	0.35	39.0	30.0	2.5	38.5	29.5	1.0	19.0	13
PDS041032040XT	6302	C3	42	0.40	41.0	32.0	2.4	40.7	31.7	1.0	19.0	17
PDS046035040XT	6204	C3	47	0.40	46.0	35.0	2.7	45.6	34.6	1.0	25.0	15
PES051039035XT	6205	C3	52	0.35	51.0	39.0	2.5	50.5	38.7	1.0	28.0	19
PES054042035XT	6006	C3	55	0.35	54.0	42.3	3.2	53.2	41.5	1.0	34	15
PFS061049035XT	6206	C3	62	0.35	61.0	49.0	3.2	60.0	48.0	1.0	39	22
PFS067053035XT	6008	C3	68	0.35	67.0	53.0	3.3	66.1	52.1	1.0	44	19
PDS071055080XT	6207	C3	72	0.80	71.0	55.0	3.3	70.7	54.7	2.0	51	45
PDS074060080XT	6009	C3	75	0.80	74.0	60.0	3.7	73.6	59.6	2.0	55	33
PDS079064080XT	6307	C3	80	0.80	79.0	64.0	4.2	78.5	63.5	2.5	48	29
PES079064060XT	6307	C3	80	0.60	79.0	64.0	4.1	78.2	63.2	2.0	62	29
PDS085070080XT	6209	C3	85	0.80	84.5	69.5	4.9	83.9	68.9	2.5	55	23
PDS089074080XT	6308	C3	90	0.80	89.0	74.0	5.8	88.1	73.1	3.0	55	20
PES089074080XT	6308	C3	90	0.80	89.0	74.0	2.8	88.7	73.7	2.0	50	48
PES094079080XT	6012	C3	95	0.80	94.0	79.0	3.5	93.6	78.6	2.0	60	40
PDS100085100XT	6309	C3	100	1.00	99.5	84.5	5.0	99.0	84.0	2.0	80	27
PES109089080XT	6310	C3	110	0.80	109.0	89.0	5.8	107.8	87.8	4.0	67	36
PFS109089080XT	6310	C3	110	0.80	109.0	89.0	3.0	108.6	88.6	2.0	74	74
PFS114098080XT	6015	C3	115	0.80	114.0	98.0	3.6	113.5	97.5	2.0	77	48
PFS119103080XT	6213/6311	C3	120	0.80	119.0	103.0	3.9	118.4	102.4	2.0	80	42
PFS124109080XT	6214	C3	125	0.80	124.0	109.0	4.4	123.2	108.2	2.0	83	34
PFS129109080XT	6312	C3	130	0.80	129.0	109.0	4.1	128.4	108.4	2.0	85	43
PES139119100XT	6313	C3	140	1.00	139.0	119.0	6.3	138.0	118.0	4.0	72.5	32
PFS139119100XT	6313	C3	140	1.00	139.0	119.0	4.2	138.5	118.5	2.5	98	65
PFS144124100XT	6019	C3	145	1.00	144.0	124.0	4.2	143.5	123.5	2.5	102	58
PFS149129100XT	6314	C3	150	1.00	149.0	129.0	4.2	148.4	128.4	2.5	106	52
PFS159139100XT	6315	C3	160	1.00	159.0	139.0	5.3	158.2	138.2	2.5	115	42
PFS169149100XT	6316	C3	170	1.00	169.0	149.0	6.5	167.7	147.7	2.5	140	35
PFS179159100XT	6317	C3	180	1.00	179.0	159.0	7.5	177.6	157.6	4.0	82.5	29
PGS179159100XT	6317	C3	180	1.00	179.0	159.0	5.4	177.9	157.9	2.5	160	54
PFS189169150TF	6318	C3	190	1.50	189.0	169.0	6.0	188.4	168.4	3.0	210	83
PFS198178150TF	6222/6319	C3	200	1.50	198.0	178.0	6.1	197.2	177.2	3.0	220	71
PFS208188150TF	6028/6417	C3	210	1.50	208.0	188.0	6.8	207.0	187.0	3.0	230	61
PFS214189150TF	6320	C3	215	1.50	214.0	189.0	6.5	213.2	188.2	3.0	240	75
PFS223198150TF	6030/6321	C3	225	1.50	223.0	198.0	7.0	222.0	197.0	3.0	250	64
PFS228203150TF	6226	C3	230	1.50	228.0	203.0	7.4	226.9	201.9	3.0	260	59
PFS238213150TF	6322	C3	240	1.50	238.0	213.0	9.3	236.5	211.5	3.0	280	52
PFS248218150TF	6228	C3	250	1.50	248.0	218.0	8.2	246.7	216.7	3.0	290	56
PFS258228150TF	6034/6324	C3	260	1.50	258.0	228.0	9.3	256.3	226.3	3.0	310	50
PFS268238150TF	6230	C3	270	1.50	268.0	238.0	10.5	265.8	235.8	3.0	330	44
PFS278248150TF	6036/6326	C3	280	1.50	278.0	248.0	12.0	275.1	245.1	3.0	350	39
PFS288258150TF	6038/6232	C3	290	1.50	288.0	258.0	13.6	284.3	254.3	3.0	370	35
PFS298268150TF	6328	C3	300	1.50	298.0	268.0	15.5	293.2	263.2	3.0	390	31
PFS308278200TF	6040/6234	C3	310	2.00	308.0	278.0	10.1	306.4	276.4	4.0	410	67
PFS318288200TF	6236/6330	C3	320	2.00	318.0	288.0	11.1	316.1	286.1	4.0	430	61
PFS338308200TF	6238/6332	C3	340	2.00	338.0	308.0	13.4	335.2	305.2	4.0	470	50
PFS358328200TF	6240	C3	360	2.00	358.0	328.0	16.2	353.9	323.9	4.0	510	42
PFS398358200TF	6044/6244	C3	400	2.00	398.0	358.0	17.2	393.7	353.7	4.0	550	42

* For a stainless steel washer, replace the characters "XT" by "IX" at the end of a reference.

OE SPECIAL WAVED SPRING WASHERS WITH EXISTING TOOLS



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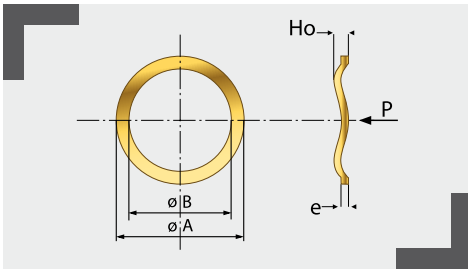


Borrelly references*	Flat dia. (mm)		Material thickness (mm)	Number of waves	Approx. free height (mm)	Approx. stiffness	Approx. flat force (daN)
	OD A	ID B	e		H _o	(daN/mm)	
PAS004002025UB	3.80	2.05	0.25	1	0.40	44.00	6.60
PAS005003020UB	5.20	3.20	0.20	1	0.60	8.80	3.50
PCS006005005XT	5.80	4.60	0.05	3	0.57	0.46	0.24
PCS006005005IX	5.80	4.60	0.05	3	0.57	0.40	0.20
PAS006002005XT	6.00	2.30	0.05	1	0.54	0.42	0.20
PAS006002010UB	6.00	2.30	0.10	1	0.50	2.10	0.84
PAS006003040UB	6.00	3.20	0.40	1	1.00	31.00	18.60
PAS008006020UB	8.00	6.40	0.20	1	1.10	1.40	1.30
PCS009007010IX	9.30	6.75	0.10	3	0.72	1.80	1.10
PCS009007010XT	9.30	6.75	0.10	3	0.82	2.10	1.50
PCS009007015IX	9.40	6.60	0.15	3	0.76	6.90	4.20
PCS010007008IX	9.50	7.00	0.75	3	0.90	0.70	0.58
PCS010008006XT	9.80	7.80	0.06	3	0.92	0.30	0.25
PCS010008020XT	9.80	7.80	0.20	3	1.40	10.00	12.00
PAS010005015IX	9.90	5.10	0.15	1	1.25	2.20	2.40
PAS010006008XT	10.20	6.20	0.08	1	1.10	0.25	0.25
PCS011009008XT	11.00	9.00	0.08	3	1.27	0.45	0.50
PBS011007020IX	11.40	7.10	0.20	2	1.70	3.00	4.50
PCS012006020XR	11.50	6.10	0.20	3	0.80	28.00	17.00
PAS012006008XT	12.20	6.20	0.08	1	1.55	0.26	0.38
PCS012009010XT	12.40	9.40	0.10	3	1.10	1.00	1.00
PCS013010015IX	12.80	10.00	0.15	3	1.00	2.40	2.00
PDS013008008XT	13.20	8.40	0.08	4	0.87	2.70	2.10
PCS013008020IX	13.20	8.40	0.20	3	0.80	11.50	7.00
PCS013008025XT	13.20	8.40	0.25	3	0.80	26.00	14.00
PCS014009025IX	13.50	9.10	0.25	3	1.10	18.00	15.00
PCS014009025IX	13.80	9.30	0.25	3	1.40	17.00	20.00
PAS015008050XR	15.00	8.20	0.50	1	1.70	36.00	43.00
PDS016011015IX	15.80	10.50	0.15	4	0.60	9.00	4.10
PBS016011060IX	15.80	10.50	0.60	2	1.40	37.00	30.00
PCS016012015IX	15.80	11.80	0.15	3	1.80	1.90	2.40
PCS016012025IX	15.80	12.40	0.25	3	1.50	7.00	8.70
PDS016013030IX	16.00	13.20	0.30	4	1.10	29.00	23.00
PAS017011080XR	17.00	11.00	0.80	1	1.35	74.00	41.00
PCS017012025IX	17.00	11.80	0.25	3	1.80	10.20	16.00
PDS019015025XR	18.80	14.80	0.25	4	1.40	18.00	21.00
PCS020013020IX	20.20	13.00	0.20	3	1.45	4.70	5.90
PCS021017030XR	21.40	17.00	0.30	3	1.90	7.40	12.00
PCS022017015UB	22.00	16.60	0.15	3	3.10	0.70	2.00
PBS022017050IX	22.00	16.60	0.50	2	2.70	7.00	15.00
PDS023019025IX	22.80	19.40	0.25	4	1.40	6.70	7.70
PCS023016015UB	23.00	16.30	0.15	3	3.10	0.80	2.40
PAS023016020IX	23.00	16.30	0.20	1	3.70	0.40	1.40
PBS023016060IX	23.00	16.30	0.60	2	1.90	14.20	18.40
PCS024018050XR	23.50	17.50	0.50	3	2.20	38.00	65.00
PDS024015050IX	23.70	14.50	0.50	4	1.50	56.00	196.00
PDS024020020IX	23.90	19.90	0.20	4	2.10	3.60	6.80
PCS024015100XR	24.00	15.00	1.00	3	2.20	166.00	200.00
PCS025017050IX	25.00	17.05	0.50	3	1.50	40.00	40.00
PDS027019020IX	26.50	19.20	0.20	4	2.10	5.80	11.00
PCS027014050XT	27.00	14.40	0.50	3	1.60	78.00	86.00
PDS028022020IX	28.20	22.20	0.20	4	2.00	3.60	6.40
PDS029017015IX	29.00	17.00	0.15	4	2.20	4.00	8.20
PCS031027030IX	31.10	27.30	0.30	3	3.40	1.50	4.70
PDS032025030XR	31.50	24.50	0.30	4	2.00	11.90	20.30
PDS038034030IX	37.90	33.50	0.30	4	3.00	3.10	8.40
PDS040036040XT	40.00	36.00	0.40	4	1.90	6.50	9.80
PDS041036060IX	40.70	35.90	0.60	4	3.00	22.00	52.00
PDS042037030IX	41.70	37.20	0.30	4	3.30	2.40	7.20
PDS045038030IX	45.00	38.20	0.30	4	3.50	3.00	9.60
PDS046036030IX	45.50	36.20	0.30	4	3.00	4.40	11.80
PDS046041050XT	46.20	40.50	0.50	4	2.50	12.10	24.00
PDS051040025XT	51.00	40.20	0.25	4	3.00	2.50	6.80
PDS051049050XT	51.00	48.70	0.50	4	2.30	3.20	5.80

* Other materials on request.

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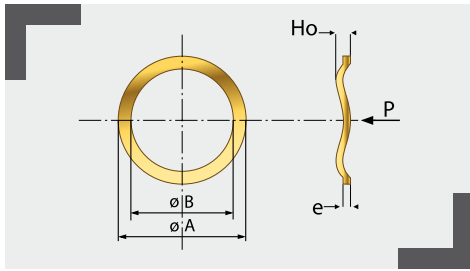


Borrelly references*	Flat dia. (mm)		Material thickness (mm)	Number of waves	Approx. free height (mm)	Approx. stiffness	Approx. flat force (daN)
	OD A	ID B	e		Ho	(daN/mm)	
PDS052044030XT	52.40	44.20	0.30	4	4.00	2.70	10.00
PDS056046040XT	55.50	46.00	0.40	4	3.60	6.40	20.50
PCS056050090XR	55.50	50.00	0.90	3	2.40	12.00	18.00
PDS057043025XT	57.00	43.00	0.25	4	4.50	2.40	10.20
PES057046030XT	57.00	45.50	0.30	5	3.00	7.80	21.00
PDS057046040XT	57.00	45.50	0.40	4	3.60	7.60	24.00
PES057046040XT	57.00	45.50	0.40	5	2.50	18.50	39.00
PCS057046070IX	57.00	45.50	0.70	3	5.80	11.00	56.00
PDS057049050XT	57.00	48.70	0.50	4	3.30	9.70	27.00
PES058050025IX	58.20	50.00	0.25	5	2.50	2.30	5.20
PDS058052040IX	58.20	51.50	0.40	4	3.50	3.10	9.60
PDS063053050XT	62.80	53.20	0.50	4	2.80	8.50	20.00
PDS063055040XT	63.20	54.80	0.40	4	4.70	3.60	15.50
PDS068056080XT	68.20	56.20	0.80	4	4.20	35.00	120.00
PDS068056090XT	68.20	56.20	0.90	4	3.90	50.00	150.00
PES069058040IX	68.50	57.50	0.40	5	4.00	8.20	29.00
PES069058040XT	68.50	57.50	0.40	5	3.70	9.50	31.00
PDS070058070XT	69.50	58.20	0.70	4	4.40	20.60	76.00
PDS074067080XT	73.50	67.30	0.80	4	2.70	12.60	24.00
PDS074066070IX	74.00	65.70	0.70	4	5.20	9.90	45.00
PDS076060070XT	75.50	60.00	0.70	4	3.90	24.00	77.00
PES079069100XR	78.50	68.70	1.00	5	5.60	83.00	382.00
PDS079063100XT	79.00	63.20	1.00	4	4.30	61.00	201.00
PDS079071060IX	79.00	71.00	0.60	4	6.30	4.90	28.00
PDS083064100XR	82.50	64.00	1.00	4	4.20	65.00	208.00
PCS083066200XR	82.50	65.70	2.00	3	5.50	144.00	504.00
PDS083067070XT	82.50	66.50	0.70	4	4.50	18.40	70.00
PFS083074035XT	82.50	74.00	0.35	6	3.50	5.30	17.00
PDS085070090XT	84.50	69.50	0.90	4	5.80	33.00	162.00
PDS085074070XT	84.50	74.20	0.70	4	5.10	9.80	43.00
PDS085074120XT	84.50	74.20	1.20	4	6.80	47.00	262.00
PDS085076080IX	84.50	76.20	0.80	4	5.20	9.70	43.00
PES085078070XT	84.50	78.00	0.70	5	3.60	14.10	41.00
PDS089081060IX	89.00	81.00	0.60	4	5.60	3.30	17.00
PDS090074100IX	90.20	74.00	1.00	4	3.90	35.00	101.00
PCS090076150XR	90.20	76.00	1.50	3	6.60	37.00	189.00
PCS090076200CV	90.20	76.00	2.00	3	6.10	84.00	344.00
PDS090081060XT	90.20	81.00	0.60	4	3.80	4.40	14.00
PES090081100XT	90.20	81.00	1.00	5	4.20	50.00	160.00
PES092083050IX	92.00	82.50	0.50	5	6.10	5.20	29.00
PDS094085050IX	94.00	84.50	0.50	4	8.00	2.00	15.00
PES094085080XT	94.00	84.50	0.80	5	4.20	23.10	79.00
PDS094085100XT	94.00	84.50	1.00	4	6.20	18.50	96.00
PDS098090080IX	98.00	90.20	0.80	4	6.60	5.70	33.00
PES100085100XT	99.50	84.50	1.00	5	4.10	65.00	202.00
PES100087050IX	99.50	86.50	0.50	5	4.00	5.90	21.00
PBS100089080XT	99.50	89.00	0.80	2	10.00	0.55	5.10
PDS100089120XT	99.50	89.00	1.20	4	6.50	29.00	154.00
PES100090070XT	100.30	90.20	0.70	5	4.60	13.60	53.00
PCS100090100IX	100.30	90.20	1.00	3	10.00	4.40	40.00
PES103083080XT	103.00	82.50	0.80	5	4.50	45.00	167.00
PDS103096080IX	103.00	96.00	0.80	4	6.40	4.30	24.00
PDS104087100IX	104.40	86.50	1.00	4	9.00	24.40	195.00
PES111098070XT	110.50	98.00	0.70	5	4.60	12.80	50.00
PDS112090100XT	112.00	90.20	1.00	4	4.50	29.00	102.00
PES112092080XT	112.00	92.00	0.80	5	5.40	33.00	152.00
PES112103080XT	112.00	103.00	0.80	5	4.60	12.50	48.00
PDS114104100IX	114.00	104.40	1.00	4	5.40	8.80	39.00
PDS115104080XT	115.40	104.40	0.80	4	8.20	5.90	44.00
PDS115104080IX	115.40	104.40	0.80	4	9.20	5.00	42.00
PFS115111070XT	115.40	110.50	0.70	6	1.90	8.20	9.80
PES119097100XT	119.00	96.50	1.00	5	4.00	60.00	180.00
PES124111100XT	124.30	111.20	1.00	5	4.70	27.00	100.00
PES126109100XT	126.00	109.00	1.00	5	3.80	35.40	99.00

* Other materials on request.

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OE SPECIAL WAVED SPRING WASHERS WITH EXISTING TOOLS



These tables are not restrictive. They are provided to avoid unnecessary expensive tooling costs. Unlike our standard range, we do not keep these washers in stock. They can however be manufactured on request with very short lead times.

The values in the tables are not binding. Data is provided for information only and subject to change without notice.



Borrelly references*	Flat dia. (mm)		Material thickness (mm)	Number of waves	Approx. free height (mm)	Approx. stiffness (daN/mm)	Approx. flat force (daN)
	OD A	ID B	e		H _o		
PDS136112100IX	136.00	112.00	1.00	4	4.00	14.90	45.00
PDS136114100XT	136.00	114.00	1.00	4	4.50	15.60	55.00
PES136126100IX	136.00	126.00	1.00	5	6.10	12.90	66.00
PDS136126150IX	136.00	126.00	1.50	4	4.80	17.80	59.00
PES149139100IX	149.00	139.00	1.00	5	7.80	9.70	66.00
PDS154124120XT	154.00	124.30	1.20	4	7.70	26.40	172.00
PDS164151100XT	164.00	151.00	1.00	4	12.50	4.60	53.00
PDS167154050XT	167.00	154.00	0.50	4	18.00	0.54	9.50
PDS167156050XT	167.00	156.00	0.50	4	18.20	0.45	8.00
PFS207182120XT	206.50	182.00	1.20	6	9.00	40.00	312.00

* Other materials on request.

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ONDUFIL™ spring washers

ONDUFIL™ WAVED SPRING WASHERS

GENERAL


ONDUFIL™ spring washers are round elastic parts, in the same family as our waved spring washers, Belleville or diaphragm spring washers. They are produced using a new manufacturing technology that entails simultaneously winding and rolling a flat wire corresponding to the width of the coil.

Based on this technology, ONDUFIL™ spring washers offer a solution for new requirements including ever smaller dimensions, ever higher deflections in elastic deformation and increasingly varied stiffnesses.

Borrelly has incorporated two additional structures to quickly and accurately meet your requirements:

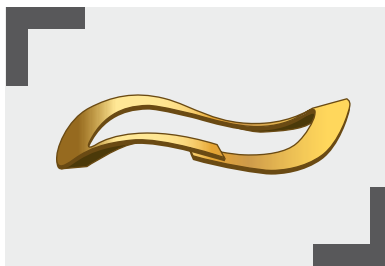
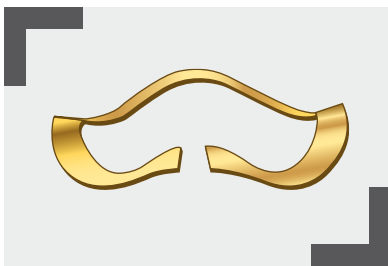
- An engineering department with high-performance computational software.
- A production workshop for ONDUFIL™ spring washers, equally capable of producing prototypes and large series production runs.

**Custom design,
no tooling expenses.
Manufacturing, inspection
and shipping included.,**

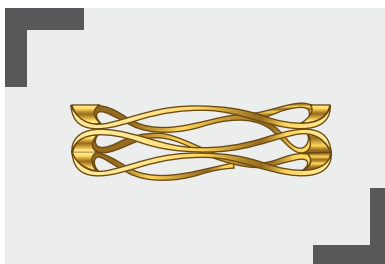
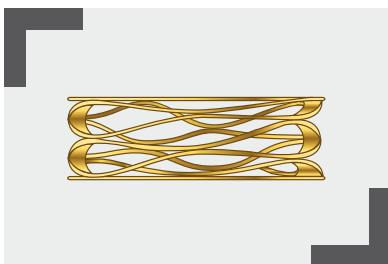


**within
8 days**

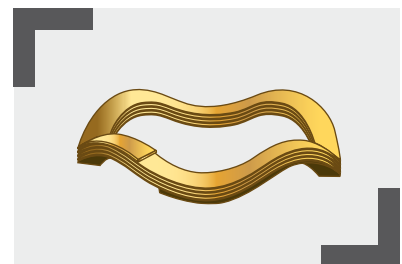
Single-turn spring washers



Inverted wave spring washers



Nested spring washers

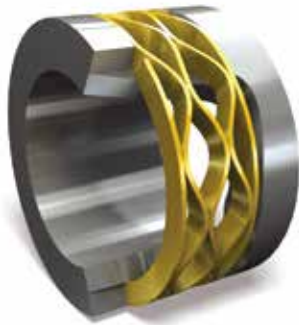


MATERIALS

Common uses	Carbon steels	<ul style="list-style-type: none"> • XC75
	Stainless steels	<ul style="list-style-type: none"> • Werkstoff 1.4310 (Aisi 301) Z10CN 18.08 • Werkstoff 1.4568 (17.7ph) Z7CNAL 17.7 • Werkstoff 1.4571 (Aisi 316Ti) Z6CNDT 17 12
Special applications	Cube 2 - Inconel - Monel - Hastelloy	Our engineering department will advise you regarding any specific requirements (environment, temperatures, conductivity, non-magnetism, etc.).

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ONDUFIL™ spring washers are used in numerous fields, including:



Sealing rings



Multi-pin connectors



Pre-stressed ball bearings



Clutch mechanisms

PRACTICAL EXAMPLES

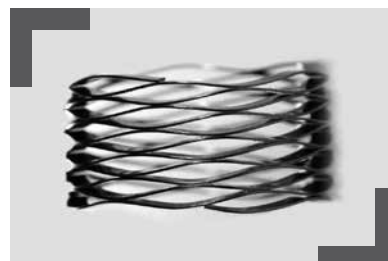
Sealing ring

- **Problem to be solved:**
Pre-stress a dynamic sealing ring in a chemical environment.
- **Constraints:**
Highly oxidising environment.
- **Solution:**
Hastelloy Ondufil™ spring washers.
- **Borrelly added value:**
Definition and production of prototypes parts within 8 days.

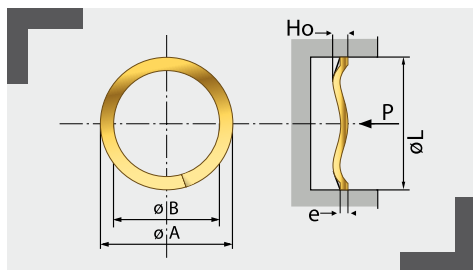


Automotive

- **Problem to be solved:**
Release a latch in the event of an intrusion.
- **Constraints:**
Compact, salt spray resistance.
- **Solution:**
Ondufil™ spring washers.
- **Borrelly added value:**
Study of a technical part using appropriate materials, production of prototypes within 8 days, start of series production within 15 to 20 days. Guarantee 4 PPM on series of 2,000,000 parts.



ONDUFIL™ STANDARD XC 75 AND STAINLESS STEEL SPRING WASHERS



For pre-stressed ball bearings

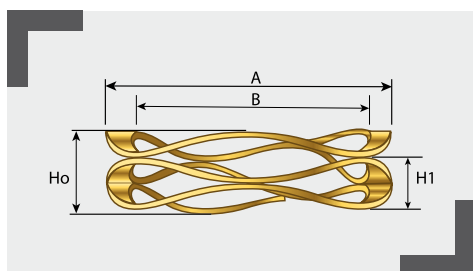


Borrelly references*	Standard references for the bearing	Bore dia. (mm)	Approx. dia. (mm)	Approx. dia. (mm)	Wire cross-section (mm)	Number of waves	Free ht approx. Ho (mm)	Height fitting H1 (mm)	Load P1 (daN) +/- 10%	Stiffness mean (daN/mm)	May be set to maximum compressed height (mm)
			OD A**	ID B***							
RD0223J124030XT	EL8-608 R7-627	22	22.0	17.2	2.4 x 0.30	3	2.8	1.45	5.8	4.3	0.7
RD0243J124030XT	EL9-609	24	24.0	19.2	2.4 x 0.30	3	3.4	1.50	7.0	3.7	0.7
RD0263J126045XT	R9-629 6000	26	26.0	20.8	2.6 x 0.45	3	3.0	2.00	7.0	7.0	1.0
RD0283J126045XT	6001	28	28.0	22.8	2.6 x 0.45	3	3.4	2.00	7.8	5.5	1.0
RD0303J126045XT	6200	30	30.0	24.8	2.6 x 0.45	3	3.7	2.00	8.6	5.0	1.0
RD0323J126045XT	6201 6002	32	32.0	26.8	2.6 x 0.45	3	3.8	2.00	9.2	5.1	1.0
RD0353J126045XT	6202 6300 6003	35	35.0	29.8	2.6 x 0.45	3	4.7	2.00	10.0	3.7	1.0
RD0373J126045XT	6301	37	37.0	31.8	2.6 x 0.45	3	5.2	2.00	10.2	3.2	1.0
RD0403J140060XT	6203	40	40.0	32.0	4.0 x 0.60	3	3.1	2.00	10.4	9.4	1.3
RD0423J140060XT	6302 6004	42	42.0	34.0	4.0 x 0.60	3	3.4	2.00	11.5	8.2	1.3
RD0473J140060XT	6204 6303 6004	47	47.0	39.0	4.0 x 0.60	3	4.1	2.00	12.6	6.0	1.3
RD0524J140060XT	6205 6304	52	52.0	44.0	4.0 x 0.60	4	3.4	2.35	13.0	12.4	1.3
RD0554J140060XT	6006	55	55.0	47.0	4.0 x 0.60	4	3.5	2.35	13.0	11.3	1.3
RD0624J140060XT	6206 6305 6007	62	62.0	54.0	4.0 x 0.60	4	4.1	2.35	16.0	9.1	1.3
RD0684J155070XT	6008	68	68.0	57.0	5.5 x 0.70	4	4.3	2.80	18.8	12.5	1.5
RD0704J155070XT		70	70.0	59.0	5.5 x 0.70	4	4.3	2.80	17.3	11.5	1.5
RD0724J155070XT	6207 6306 6404	72	72.0	61.0	5.5 x 0.70	4	4.6	2.80	20.9	11.6	1.5
RD0754J155070XT	6009	75	75.0	64.0	5.5 x 0.70	4	5.0	2.80	20.3	9.2	1.5
RD0804J155070XT	6208 6307 6010 6405	80	80.0	69.0	5.5 x 0.70	4	5.7	2.80	22.0	7.6	1.5
RD0854J160080XT	6209	85	85.0	73.0	6.0 x 0.80	4	5.3	2.80	26.6	10.6	1.7
RD0904J160080XT	6210 6308 6011 6406	90	90.0	78.0	6.0 x 0.80	4	6.0	2.80	24.9	7.8	1.7
RD0954J160080XT	6012	95	95.0	83.0	6.0 x 0.80	4	6.8	2.80	26.3	6.5	1.7
RD1005J160080XT	6211 6309 6013 6407	100	100.0	88.0	6.0 x 0.80	5	4.5	2.80	28.5	16.7	1.7
RD1055J160080XT	61915	105	105.0	93.0	6.0 x 0.80	5	4.8	2.80	29.1	14.6	1.7
RD1105J160080XT	6211 6310 6014 6408	110	110.0	98.0	6.0 x 0.80	5	5.2	2.80	30.5	12.7	1.7
RD1155J160080XT	6015	115	115.0	103.0	6.0 x 0.80	5	6.1	3.20	32.4	11.2	1.7
RD1205J160080XT	6213 6311 6409	120	120.0	108.0	6.0 x 0.80	5	6.6	3.20	33.4	9.8	1.7

* For a stainless steel washer, replace the characters "XT" by "IX" at the end of a reference. ** Adjusted in bore L *** Clearance for a shaft of dia. B - 0.5 mm
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STANDARD ONDUFIL™ MULTI-TURN SPRING WASHER RANGE



Available from stock in XC 75 and stainless steel

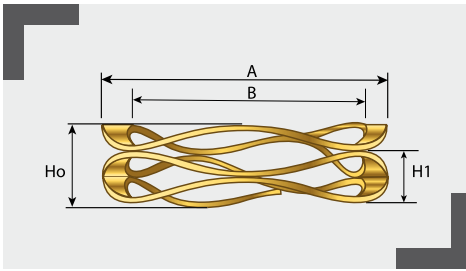


Borrelly references*	OD (mm)	ID (mm)	Wire cross-section (mm)	Number of waves per turn	Number of turns	Approx. free ht. (mm)	Working ht. (mm)	Load (daN)	Stiffness (daN/mm)
	Dia. A**	B***				Ho	H1	P1	
RD0223S320025IX	22.0	18.0	2.0 x 0.25	3.5	3	5.8	3.0	4.0	1.4
RD0223S420025IX					4	7.8	4.0	4.0	1.0
RD0223S520025IX					5	9.6	4.3	4.0	0.7
RD0223S620025IX					6	11.0	5.0	4.0	0.7
RD0223S720025IX					7	12.7	5.8	4.0	0.6
RD0223S920025IX					9	16.2	7.3	4.0	0.4
RD0223S1220025IX					12	20.8	9.0	4.0	0.3
RD0223S324030XT	22.0	17.2	2.4 x 0.30	3.5	3	5.4	2.5	9.0	3.1
RD0223S424030XT					4	7.3	3.4	9.0	2.3
RD0223S524030XT					5	9.1	4.4	9.0	1.9
RD0223S624030XT					6	10.7	5.0	9.0	1.6
RD0223S724030XT					7	12.3	6.0	9.0	1.4

* IX for stainless steel, XT for XC 75 ** For installation in a bore with diameter A *** Clearance for a shaft of diameter B - 1.0 mm
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STANDARD ONDUFIL™ MULTI-TURN SPRING WASHER RANGE

Available from stock in XC 75 and stainless steel



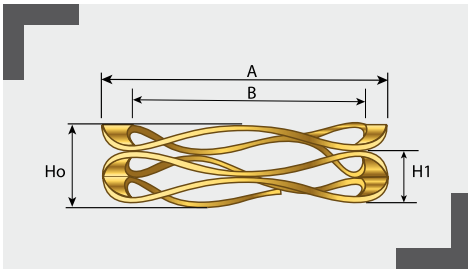
Borrelly references*	OD (mm)	ID (mm)	Wire cross-section (mm)	Number of waves per turn	Number of turns	Approx. free ht. (mm)	Working ht. (mm)	Load (daN) P1	Stiffness (daN/mm)
	Dia. A**	B***				Ho	H1		
RD0223S924030XT					9	16.1	7.9	9.0	1.0
RD0223S1224030XT					12	21.4	10.4	9.0	0.8
RD0223S320045IX	22.0	18.0	2.0 x 0.45	3.5	3	4.7	2.6	13.0	6.2
RD0223S420045IX					4	6.2	3.5	13.0	4.8
RD0223S520045IX					5	7.8	4.5	13.0	3.9
RD0223S620045IX					6	9.2	5.3	13.0	3.3
RD0223S720045IX					7	10.8	6.3	13.0	2.9
RD0223S920045IX					9	13.4	8.0	13.0	2.4
RD0223S1220045IX					12	18.2	10.6	13.0	1.7
RD0253S320025IX	25.0	21.0	2.0 x 0.25	3.5	3	6.4	2.0	4.0	0.9
RD0253S420025IX					4	8.2	3.5	4.0	0.8
RD0253S520025IX					5	10.4	4.1	4.0	0.6
RD0253S620025IX					6	12.8	5.0	4.0	0.5
RD0253S720025IX					7	14.8	5.7	4.0	0.4
RD0253S920025IX					9	19.0	7.1	4.0	0.3
RD0253S1220025IX					12	24.9	9.1	4.0	0.2
RD0253S324030XT	25.0	20.2	2.4 x 0.30	3.5	3	6.3	2.2	9.0	2.2
RD0253S424030XT					4	8.0	3.0	9.0	1.8
RD0253S524030XT					5	9.6	3.8	9.0	1.6
RD0253S624030XT					6	11.6	4.8	9.0	1.3
RD0253S724030XT					7	14.0	5.5	9.0	1.0
RD0253S924030XT					9	17.8	7.4	9.0	0.9
RD0253S1224030XT					12	23.5	9.9	9.0	0.7
RD0253S320045IX	25.0	21.0	2.0 x 0.45	3.5	3	5.6	2.7	13.0	4.5
RD0253S420045IX					4	7.2	3.5	13.0	3.5
RD0253S520045IX					5	9.1	4.5	13.0	2.8
RD0253S620045IX					6	10.8	5.3	13.0	2.4
RD0253S720045IX					7	12.8	6.2	13.0	2.0
RD0253S920045IX					9	16.3	8.1	13.0	1.6
RD0253S1220045IX					12	21.6	10.6	13.0	1.1
RD0283S324030XT	28.0	23.2	2.4 x 0.30	3.5	3	7.3	3.7	5.0	1.4
RD0283S424030XT					4	9.6	4.7	5.0	1.0
RD0283S524030XT					5	12.3	6.3	5.0	0.8
RD0283S624030XT					6	14.3	7.5	5.0	0.7
RD0283S724030XT					7	16.2	8.4	5.0	0.6
RD0283S824030XT					8	18.8	10.0	5.0	0.5
RD0283S1024030XT					10	23.6	12.4	5.0	0.4
RD0283S320045IX	28.0	24.0	2.0 x 0.45	3.5	3	6.4	3.2	10	3.1
RD0283S420045IX					4	9.0	4.5	10	2.2
RD0283S520045IX					5	10.8	5.5	10	1.9
RD0283S620045IX					6	13.3	6.9	10	1.6
RD0283S720045IX					7	15.2	7.8	10	1.4
RD0283S820045IX					8	17.6	9.0	10	1.2
RD0283S1020045IX					10	22.0	11.3	10	0.9
RD0283S326045XT	28.0	22.8	2.6 x 0.45	3.5	3	7.5	4.2	15	4.5
RD0283S426045XT					4	9.7	5.2	15	3.3
RD0283S526045XT					5	12.2	6.6	15	2.6
RD0283S626045XT					6	14.1	7.7	15	2.3
RD0283S726045XT					7	16.7	9.1	15	2.0
RD0283S826045XT					8	19.2	10.5	15	1.7
RD0283S1026045XT					10	24.2	13.3	15	1.4
RD0313S324030XT	31.0	26.2	2.4 x 0.30	3.5	3	7.1	2.7	5.0	1.1
RD0313S424030XT					4	9.2	3.6	5.0	0.9
RD0313S524030XT					5	11.9	4.7	5.0	0.7
RD0313S624030XT					6	13.8	5.6	5.0	0.6
RD0313S724030XT					7	16.1	6.4	5.0	0.5
RD0313S824030XT					8	18.6	7.4	5.0	0.4
RD0313S1024030XT					10	23.5	9.1	5.0	0.3
RD0313S326045XT	31.0	25.8	2.6 x 0.45	3.5	3	7.7	4.0	12	3.2
RD0313S426045XT					4	9.9	5.3	12	2.6
RD0313S526045XT					5	12.7	6.8	12	2.0
RD0313S626045XT					6	15.1	8.1	12	1.7
RD0313S726045XT					7	18.2	9.7	12	1.4
RD0313S826045XT					8	20.8	11.0	12	1.2

* IX for stainless steel, XT for XC 75 ** For installation in a bore with diameter A *** Clearance for a shaft of diameter B - 1.0 mm
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STANDARD ONDUFIL™ MULTI-TURN SPRING WASHER RANGE

Available from stock in XC 75 and stainless steel



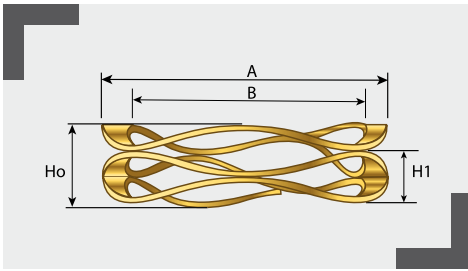
Borrelly references*	OD (mm)	ID (mm)	Wire cross-section (mm)	Number of waves per turn	Number of turns	Approx. free ht. (mm)	Working ht. (mm)	Load (daN) P1	Stiffness (daN/mm)
	Dia. A**	B***				Ho	H1		
RD0313S1026045XT					10	25.3	13.2	12	1.0
RD0353S335030XT	34.5	27.5	3.5 x 0.30	3.5	3	8.4	2.5	6	1.0
RD0353S435030XT					4	9.7	3.2	6	0.9
RD0353S535030XT					5	12.0	3.9	6	0.7
RD0353S635030XT					6	14.3	4.9	6	0.6
RD0353S735030XT					7	16.2	5.4	6	0.5
RD0353S835030XT					8	18.3	5.7	6	0.4
RD0353S1035030XT					10	23.5	7.7	6	0.3
RD0353S334048IX	34.5	27.7	3.4 x 0.50	3.5	3	7.0	3.7	13	3.9
RD0353S434048IX					4	9.1	4.9	13	3.0
RD0353S534048IX					5	11.1	6.2	13	2.6
RD0353S634048IX					6	13.4	7.3	13	2.1
RD0353S734048IX					7	15.5	8.6	13	1.9
RD0353S834048IX					8	18.0	10.0	13	1.6
RD0353S1034048IX					10	22.8	12.6	13	1.3
RD0373S334048IX	37.0	30.2	3.4 x 0.50	3.5	3	7.0	4.0	10	3.3
RD0373S434048IX					4	9.2	5.2	10	2.5
RD0373S534048IX					5	11.3	6.4	10	2.0
RD0373S634048IX					6	14.0	8.0	10	1.7
RD0373S734048IX					7	16.0	9.1	10	1.4
RD0373S834048IX					8	18.6	10.7	10	1.3
RD0373S1034048IX					10	23.5	13.4	10	1.0
RD0374S334048IX	37.0	30.2	3.4 x 0.50	4.5	3	5.3	2.7	25	9.6
RD0374S434048IX					4	6.7	3.6	25	8.0
RD0374S534048IX					5	8.3	4.5	25	6.6
RD0374S634048IX					6	10.2	5.5	25	5.3
RD0374S734048IX					7	11.8	6.3	25	4.5
RD0374S834048IX					8	13.7	7.4	25	3.9
RD0374S1034048IX					10	17.2	9.3	25	3.1
RD0443S334048IX	44.0	37.2	3.4 x 0.50	3.5	3	9.7	4.4	10	1.9
RD0443S434048IX					4	12.7	5.9	10	1.5
RD0443S534048IX					5	15.4	7.3	10	1.2
RD0443S634048IX					6	19.4	9.1	10	0.9
RD0443S734048IX					7	21.8	10.2	10	0.8
RD0444S334048IX	44.0	37.2	3.4 x 0.50	4.5	3	7.0	3.0	23	5.7
RD0444S434048IX					4	9.2	3.9	23	4.3
RD0444S534048IX					5	11.4	5.0	23	3.6
RD0444S634048IX					6	13.9	6.1	23	2.9
RD0444S734048IX					7	15.7	7.0	23	2.6
RD0444S340060XT	44.0	36.0	4.0 x 0.60	4.5	3	8.2	4.6	41	11.4
RD0444S440060XT					4	10.8	6.3	41	9.1
RD0444S540060XT					5	13.0	7.8	41	7.9
RD0444S640060XT					6	15.9	9.4	41	6.3
RD0444S740060XT					7	17.5	10.5	41	5.8
RD0444S840060XT					8	20.7	12.2	41	4.8
RD0503S334048IX	49.5	42.7	3.4 x 0.50	3.5	3	9.3	2.6	10	1.5
RD0503S434048IX					4	12.2	3.5	10	1.2
RD0503S534048IX					5	15.3	4.1	10	0.9
RD0503S634048IX					6	17.4	5.0	10	0.8
RD0503S734048IX					7	20.3	5.9	10	0.7
RD0504S334048IX	49.5	42.7	3.4 x 0.50	4.5	3	7.9	2.4	23	4.2
RD0504S434048IX					4	10.3	3.1	23	3.2
RD0504S534048IX					5	13.1	4.0	23	2.5
RD0504S634048IX					6	15.5	4.9	23	2.2
RD0504S734048IX					7	18.3	5.7	23	1.8
RD0504S340060XT	49.5	41.5	4.0 x 0.60	4.5	3	9.0	4.6	40	9.0
RD0504S440060XT					4	11.8	6.4	40	7.4
RD0504S540060XT					5	14.4	7.8	40	6.0
RD0504S640060XT					6	17.7	9.4	40	4.8
RD0504S740060XT					7	20.7	11.1	40	4.1
RD0504S840060XT					8	23.3	12.5	40	3.7
RD0553S340060XT	54.5	46.5	4.0 x 0.6	3.5	3	7.2	3.5	10	2.7
RD0553S440060XT					4	9.3	4.7	10	2.2
RD0553S540060XT					5	12.3	5.8	10	1.5

* IX for stainless steel , XT for XC 75 ** For installation in a bore with diameter A *** Clearance for a shaft of diameter B - 1.0 mm
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STANDARD ONDUFIL™ MULTI-TURN SPRING WASHER RANGE

Available from stock in XC 75 and stainless steel



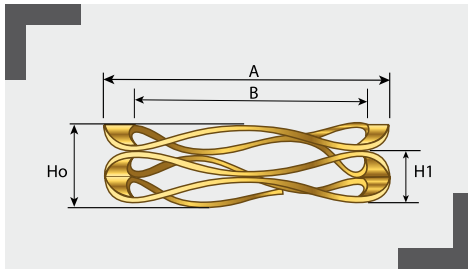
Borrelly references*	OD (mm)	ID (mm)	Wire cross-section (mm)	Number of waves per turn	Number of turns	Approx. free ht. (mm)	Working ht. (mm)	Load (daN) P1	Stiffness (daN/mm)
	Dia. A**	B***				Ho	H1		
RD0553S640060XT					6	14.6	7.0	10	1.3
RD0553S740060XT					7	17.4	8.1	10	1.0
RD0553S840060XT					8	19.6	9.3	10	0.9
RD0554S340060XT	54.5	46.5	4.0 x 0.60	4.5	3	9.4	5.7	24	6.5
RD0554S440060XT					4	12.4	7.6	24	5.0
RD0554S540060XT					5	15.7	9.5	24	3.8
RD0554S640060XT					6	18.3	11.4	24	3.5
RD0554S740060XT					7	20.7	13.3	24	3.3
RD0554S840060XT					8	24.6	15.2	24	2.6
RD0553S355070XT	54.5	43.5	5.5 x 0.70	3.5	3	9.4	3.4	40	6.6
RD0553S455070XT					4	12.1	4.3	40	5.1
RD0553S555070XT					5	14.5	5.2	40	4.3
RD0553S655070XT					6	18.1	6.3	40	3.4
RD0553S755070XT					7	21.1	7.5	40	2.9
RD0603S340060XT	59.5	51.5	4.0 x 0.60	3.5	3	8.6	3.5	10	2.0
RD0603S440060XT					4	11.2	4.4	10	1.5
RD0603S540060XT					5	14.0	5.5	10	1.2
RD0603S640060XT					6	16.8	6.6	10	1.0
RD0603S740060XT					7	20.7	7.7	10	0.8
RD0604S340060XT	59.5	51.5	4.0 x 0.60	4.5	3	10.3	5.9	23	5.2
RD0604S440060XT					4	13.4	7.8	23	4.1
RD0604S540060XT					5	17.1	9.8	23	3.1
RD0604S640060XT					6	20.2	11.7	23	2.7
RD0604S740060XT					7	23.3	13.7	23	2.4
RD0604S355070XT	59.5	48.5	5.5 x 0.70	4.5	3	7.9	4.6	40	12.2
RD0604S455070XT					4	10.2	6.0	40	9.5
RD0604S555070XT					5	12.5	7.2	40	7.5
RD0604S655070XT					6	15.3	8.8	40	6.2
RD0604S755070XT					7	17.5	10.1	40	5.4
RD0604S855070XT					8	20.1	11.7	40	4.7
RD0653S355070XT	64.5	53.5	5.5 x 0.70	3.5	3	8.9	5.6	10	3.0
RD0653S455070XT					4	11.2	7.0	10	2.4
RD0653S555070XT					5	14.2	8.7	10	1.8
RD0653S655070XT					6	17.0	10.6	10	1.6
RD0653S755070XT					7	20.1	12.5	10	1.3
RD0653S855070XT					8	23.2	14.5	10	1.1
RD0654S355070XT	64.5	53.5	5.5 x 0.70	4.5	3	8.0	5.4	23	8.8
RD0654S455070XT					4	10.7	7.2	23	6.5
RD0654S555070XT					5	13.1	8.8	23	5.3
RD0654S655070XT					6	15.8	10.7	23	4.5
RD0654S755070XT					7	18.1	12.2	23	3.9
RD0654S855070XT					8	20.8	14.2	23	3.5
RD0654S1055070XT					10	26.1	17.5	23	2.7
RD0654S360080XT	64.5	52.5	6.0 x 0.80	4.5	3	7.7	5.4	40	17.4
RD0654S460080XT					4	10.2	7.1	40	12.9
RD0654S560080XT					5	12.8	8.7	40	9.7
RD0654S660080XT					6	15.2	10.7	40	8.8
RD0654S760080XT					7	17.9	12.3	40	7.2
RD0654S860080XT					8	20.3	14.1	40	6.5
RD0654S1060080XT					10	25.2	17.5	40	5.2
RD0703S360080XT	69.5	57.5	6.0 x 0.80	3.5	3	8.6	6.3	10	4.3
RD0703S460080XT					4	11.2	8.2	10	3.3
RD0703S560080XT					5	14.3	10.6	10	2.7
RD0703S660080XT					6	17.5	12.9	10	2.2
RD0703S760080XT					7	20.8	15.2	10	1.8
RD0703S860080XT					8	23.5	17.4	10	1.6
RD0703S1060080XT					10	29.5	21.8	10	1.3
RD0704S360080XT	69.5	57.5	6.0 x 0.80	4.5	3	7.5	5.7	23	12.8
RD0704S460080XT					4	9.9	7.5	23	9.6
RD0704S560080XT					5	12.3	9.3	23	7.6
RD0704S660080XT					6	15.2	11.4	23	6
RD0704S760080XT					7	17.4	13.1	23	5.3
RD0704S860080XT					8	20.1	15.4	23	4.9
RD0704S1060080XT					10	25.3	19.3	23	3.8

* IX for stainless steel , XT for XC 75 ** For installation in a bore with diameter A *** Clearance for a shaft of diameter B - 1.0 mm
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STANDARD ONDUFIL™ MULTI-TURN SPRING WASHER RANGE

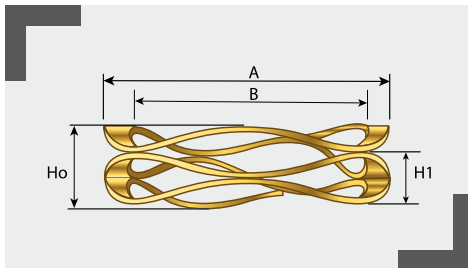
Available from stock in XC 75 and stainless steel



Borrelly references*	OD (mm)	ID (mm)	Wire cross-section (mm)	Number of waves per turn	Number of turns	Approx. free ht. (mm)	Working ht. (mm)	Load (daN)	Stiffness (daN/mm)
	Dia. A**	B***				Ho	H1		
RD0705S360080XT	69.5	57.5	6.0 x 0.80	5.5	3	7.2	5.6	40	25
RD0705S460080XT					4	9.4	7.4	40	20
RD0705S560080XT					5	12.4	9.1	40	12.1
RD0705S660080XT					6	14.0	10.9	40	12.9
RD0705S760080XT					7	16.2	12.7	40	11.4
RD0705S860080XT					8	18.4	14.5	40	10.2
RD0705S1060080XT					10	22.7	18.1	40	8.7

* IX for stainless steel, XT for XC 75 ** For installation in a bore with diameter A *** Clearance for a shaft of diameter B - 1.0 mm
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SPECIAL MULTI-TURN ONDUFIL™ SPRING WASHERS



These parts are not kept in stock but can be manufactured on request with very short lead times.



Borrelly references*	OD (mm)	ID (mm)	Wire cross-section (mm)	Material	Number of waves per turn	Number of turns	Approx. free height (mm)	Working height (mm)	Load (daN/mm)	Stiffness (daN/mm)
	Dia. A**	B***					Ho	H1	P1	
RS0223S324025IS	23	14	2.4 x 0.25	St. steel	3.5	3	5.7	2.0	5.0	1.35
RS0243S324025IS	25	16	2.4 x 0.25	St. steel	3.5	3	6.6	2.0	5.0	1.10
RS0263S324025IS	27	18	2.4 x 0.25	St. steel	3.5	3	8.0	2.0	5.0	0.80
RS0282S324046IS	29	20	2.4 x 0.45	St. steel	2.5	3	9.0	3.0	6.0	0.60
RS0302S324046IS	31	22	2.4 x 0.45	St. steel	2.5	3	12.0	3.0	6.5	0.70
RS0322S324046IS	33	24	2.4 x 0.55	St. steel	2.5	3	10.3	3.7	7.0	1.05
RS0332S334048IS	34	25	3.4 x 0.50	St. steel	2.5	3	9.5	3.0	7.5	1.10
RS0342S334046IS	35	26	3.4 x 0.50	St. steel	2.5	3	10.5	3.0	7.5	1.00
RS0362S334046IS	37	28	3.4 x 0.50	St. steel	2.5	3	13.9	3.5	8.0	0.80
RS0382S334046IS	39	30	3.4 x 0.50	St. steel	2.5	3	16.5	3.5	8.5	0.70
RS0402S338056IS	41	32	3.8 x 0.55	St. steel	2.5	3	12.0	3.5	9.0	1.05
RS0422S338056IS	43	33	3.8 x 0.55	St. steel	2.5	3	14.3	3.7	9.5	1.30
RS0442S338056IS	45	35	3.8 x 0.55	St. steel	2.5	3	16.2	4.0	10.0	0.80
RS0473S340045IS	48	38	4.0 x 0.45	St. steel	3.5	3	15.5	4.0	10.5	0.90
RS0513S340045IS	52	40	4.0 x 0.45	St. steel	3.5	3	15.0	3.5	11.0	0.95
RS0533S340045IS	54	43	4.0 x 0.45	St. steel	3.5	3	16.0	5.0	11.0	1.00
RS0543S340045IS	56	45	4.0 x 0.45	St. steel	3.5	3	16.5	5.2	11.0	0.95
RS0593S340056IS1	60	48	4.0 x 0.55	St. steel	3.5	3	17.0	5.0	12.0	1.00
RS0593S340056IS	61	50	4.0 x 0.55	St. steel	3.5	3	17.5	5.0	13.0	1.05
RS0633S340056IS	65	53	4.0 x 0.55	St. steel	3.5	3	20.0	5.0	13.0	0.85
RS0643S340056IS	66	55	4.0 x 0.55	St. steel	3.5	3	16.5	4.5	14.0	1.15
RS0663S340066IS	69	58	4.0 x 0.65	St. steel	3.5	3	17.0	4.5	20.0	1.60
RS0693S340066IS	71	60	4.0 x 0.65	St. steel	3.5	3	18.5	4.5	21.0	1.50
RS0763S350076IS	78	65	5.0 x 0.75	St. steel	3.5	3	17.4	5.0	22.0	1.75
RS0813S350076IS	83	70	5.0 x 0.75	St. steel	3.5	3	19.0	5.0	24.0	1.70
RS0883S351091IS	89	75	5.1 x 0.90	St. steel	3.5	3	16.0	5.5	24.0	2.30
RS0923S351091IS	93	80	5.1 x 0.90	St. steel	3.5	3	19.0	6.0	24.0	1.80
RS1034S450076IS	105	90	5.0 x 0.75	St. steel	4.5	4	23.0	6.0	28.0	1.60
RS1094S450076IS	111	95	5.0 x 0.75	St. steel	4.5	4	27.0	6.5	30.0	1.50
RS1144S450076IS	116	100	5.0 x 0.75	St. steel	4.5	4	28.0	6.5	32.0	1.50

* IS for 316 Ti stainless steel ** For installation in a bore with diameter A *** Clearance for a shaft of diameter B - 1.0 mm

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Other dimensions available on request.

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BELLEVILLE washers

BELLEVILLE SPRING WASHERS

GENERAL

High class manufacturing quality

Borrelly specialises in designing and manufacturing spring washers, including Belleville washers and special stackings. We offer our customers recognised expertise and a worldwide reputation in our field.

Our skilled teams can provide solutions for delicate problems in all high-tech fields, including the offshore, nuclear and aerospace industries.

For prototyping and small production runs, we regularly use materials designed to withstand extreme

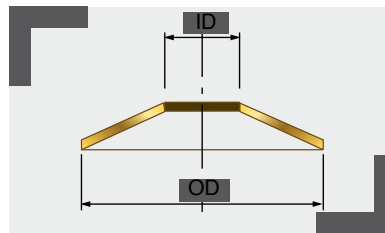
environments (high or cryogenic temperatures, chemical substances), such as:

- Inconel 718
- Beryllium copper
- Austenitic and martensitic stainless steels
- Structurally hardened stainless steels
- Special steels such as 45SCD6, 50CV4, XC75
- Composite materials
- Inconel 750
- Titanium
- Nimonic 90
- Hastelloy

Our in-house engineering department, equipped with high-performance computational software, quickly responds to your constraints and provides solutions tailored to your requirements.

Centring

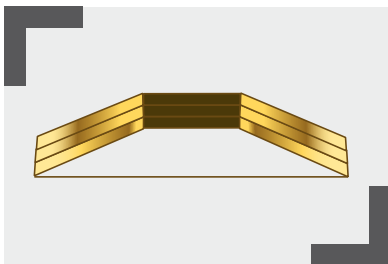
Belleville-type spring washers may be centred either by the inner or outer diameter.



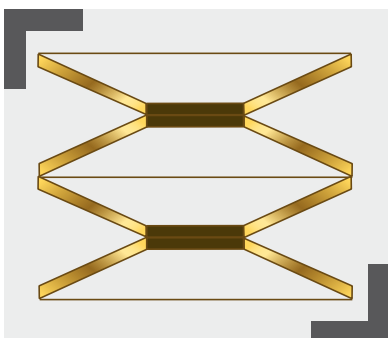
Stackings

- **Parallel:** forces are cumulative, deflection is equal to that of a single washer.
- **Series:** deflections are cumulative, force is equal to that of a single washer.

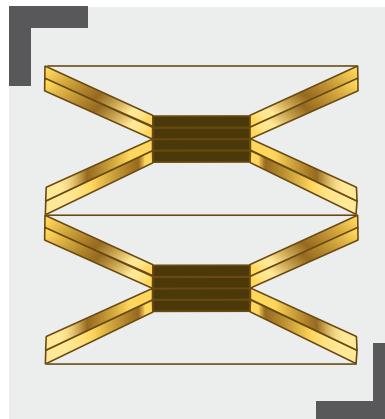
- **Mixed:** parallel-stacked groups of washers may in turn be stacked in series.



Parallel stacking



Series stacking



Mixed stacking

Industrial valves



- **Problem to be solved:**
Guarantee safety on petrol industry extraction valves.
- **Constraints:**
Very small overall dimensions, very short lead times, existing washers broke due to fatigue.
- **Solution:**
An innovative manufacturing process for stacking Belleville-type spring washers.
- **Borrelly added value:**
Borrelly was selected after proposing and creating an innovative solution which guaranteed operation complying with the customer's requirements.



Impact driver

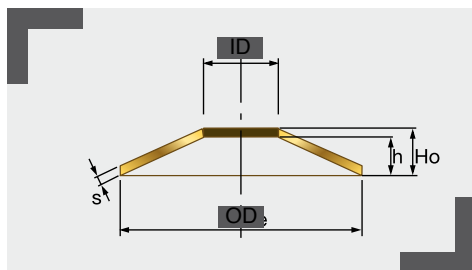


- **Problem to be solved:**
Attenuate noise from a rotary hammer on an impact driver, whilst delivering sufficient energy to operate the system.
- **Constraints:**
Combine spring function with reduced noise and improved comfort of use.
- **Solution:**
Belleville-type spring washer using composite materials.
- **Borrelly added value:**
Prototyping of washers followed by fatigue testing. Materials developed specifically for noise reduction and impact shock absorption applications.



BELLEVILLE SPRING WASHERS - DIN 2093

Available from stock, stainless steel on request



Borrelly references*	Dimensions (mm)					Load at 3/4 h	
	OD	ID	s	Ho	h	Deflection (mm)	Force (daN)
PVD008003030XD	8.0	3.2	0.3	0.55	0.25	0.187	10.4
PVD008003050XD	8.0	3.2	0.5	0.7	0.2	0.15	35.7
PVD008004030XD	8.0	4.2	0.3	0.55	0.25	0.187	11.8
PVD008004040XD	8.0	4.2	0.4	0.6	0.2	0.15	21
PVD010005040XD	10.0	5.2	0.4	0.7	0.3	0.225	21
PVD010005050XD	10.0	5.2	0.5	0.75	0.25	0.187	32.5
PVD013006050XD	12.5	6.2	0.5	0.85	0.35	0.262	29.4
PVD013006070XD	12.5	6.2	0.7	1.0	0.3	0.225	66
PVD016008060XD	16.0	8.2	0.6	1.05	0.45	0.337	41
PVD016008090XD	16.0	8.2	0.9	1.25	0.35	0.262	101
PVD018009070XD	18.0	9.2	0.7	1.2	0.50	0.375	57
PVD018009100XD	18.0	9.2	1.0	1.4	0.4	0.3	125
PVD020008090XD	20.0	8.2	0.9	1.5	0.6	0.45	105
PVD020010080XD	20.0	10.2	0.8	1.35	0.55	0.412	75
PVD020010110XD	20.0	10.2	1.1	1.55	0.45	0.337	152
PVD023011080XD	22.5	11.2	0.8	1.45	0.65	0.487	70.7
PVD023011125XD	22.5	11.2	1.25	1.75	0.5	0.375	193
PVD025012090XD	25.0	12.2	0.9	1.6	0.7	0.525	86.3
PVD025012150XD	25.0	12.2	1.5	2.05	0.55	0.412	293
PVD028010125XD	28.0	10.2	1.25	2.25	1.0	0.75	240
PVD028014100XD	28.0	14.2	1.0	1.8	0.8	0.6	111
PVD028014150XD	28.0	14.2	1.5	2.15	0.65	0.487	284
PVD032016125XD	31.5	16.3	1.25	2.15	0.9	0.675	191
PVD032016175XD	31.5	16.3	1.75	2.45	0.7	0.525	387
PVD036018125XD	35.5	18.3	1.25	2.25	1.0	0.75	170
PVD036018200XD	35.5	18.3	2.0	2.8	0.8	0.6	519
PVD040020150XD	40.0	20.4	1.50	2.65	1.15	0.862	262
PVD045022250XD	45.0	22.4	2.50	3.5	1.0	0.75	772
PVD050025200XD	50.0	25.4	2.00	3.4	1.4	1.05	476
PVD050025300XD	50.0	25.4	3.00	4.1	1.1	0.825	1198
PVD056029200XD	56.0	28.5	2.0	3.6	1.6	1.2	444
PVD056029300XD	56.0	28.5	3.0	4.3	1.3	0.975	1140
PVD060031300XD	60.0	30.5	3.0	4.7	1.7	1.275	1323
PVD060031350XD	60.0	30.5	3.50	5.0	1.5	1.125	1815
PVD063031250XD	63.0	31.0	2.50	4.25	1.75	1.312	719
PVD063031350XD	63.0	31.0	3.5	4.9	1.4	1.05	1503
PVD070041500XD	70.0	40.5	5.0	6.4	1.4	1.05	3941
PVD071036200XD	71.0	36.0	2.0	4.6	2.6	1.95	514

* For a stainless steel washer, replace the characters "XT" by "IX" at the end of a reference.

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SPECIAL products

SPRING RINGS

PRINCIPLE OF SPRING RINGS

Spring rings are waved spring strips, mounted between a bearing and its housing and used to control the clearance between the two.

The spring ring is pre-stressed on fitting, meaning that the bearing can only move radially if the pre-stress force is exceeded.

We can manufacture spring rings from steel, stainless steel, Cube 2, Inconel, etc. with short lead times and no tooling expenses.



BALL BEARING APPLICATION TABLE

Consult us for all special manufacturing and custom rings

Borrelly references*	Standard reference of bearing		Outer diameter (mm)	Thickness (mm)	Ring dimensions (mm)	
					Width	Length
PQD031004007XT	EL3-623		10.00	0.07	4.00	30.50
PQD040005007XT	EL4-624		13.00	0.07	5.00	40.00
PQD049005007XT	EL5-625	R4-634	16.00	0.07	5.00	49.00
PQD058006007XT	EL6-626	EL7-607 R5-635	19.00	0.07	6.00	58.00
PQD068007007XT	EL8-608	R7-627	22.00	0.07	7.00	67.50
PQD074007007XT	EL9-609		24.00	0.07	7.00	73.50
PQD080008007XT	6000	R9-629	26.00	0.07	8.00	79.50
PQD086008007XT	6001		28.00	0.07	8.00	86.00
PQD092009007XT		6200	30.00	0.07	9.00	92.00
PQD098009007XT	6002		32.00	0.07	9.00	98.00
PQD098010007XT		6201	32.00	0.07	10.00	98.00
PQD107010007XT	6003		35.00	0.07	10.00	107.00
PQD107011007XT		6202 6300	35.00	0.07	11.00	107.00
PQD114012007XT		6301	37.00	0.07	12.00	113.50
PQD123012007XT	6203		40.00	0.07	12.00	123.00
PQD129012007XT	6004		42.00	0.07	12.00	129.00
PQD129013007XT		6302	42.00	0.07	13.00	129.00
PQD144012007XT	6005		47.00	0.07	12.00	144.00
PQD144014007XT		6204 6303	47.00	0.07	14.00	144.00
PQD159015007XT		6205 6304	52.00	0.07	15.00	159.00
PQD169013007XT	6006		55.00	0.07	13.00	168.50
PQD190014007XT	6007		62.00	0.07	14.00	190.00
PQD190016007XT		6206	62.00	0.07	16.00	190.00
PQD190017007XT		6305 6403	62.00	0.07	17.00	190.00
PQD204015007XT	6008		68.00	0.07	15.00	204.00
PQD220017007XT		6207 6308 6404	72.00	0.07	17.00	220.00
PQD230016007XT	6009		75.00	0.07	16.00	230.00
PQD245016007XT	6010		80.00	0.07	16.00	245.00
PQD245018007XT		6208	80.00	0.07	18.00	245.00
PQD276018007XT	6011	6210 6308 6406	90.00	0.07	18.00	276.00
PQD291018007XT	6012		95.00	0.07	18.00	291.00
PQD306018007XT	6013	6211 6309 6407	100.00	0.07	18.00	306.00

* For a stainless steel washer, replace the characters "XT" by "IX" at the end of a reference.

SPECIAL SPRINGS

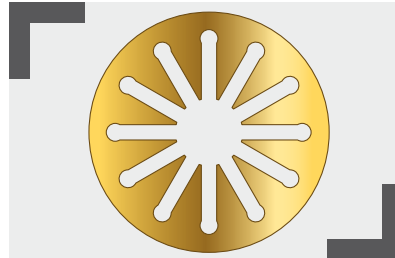
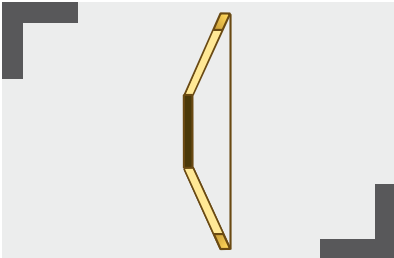
Special springs are elastic parts with specific shapes. They are used to obtain forces, retain mechanical parts and compensate for play with an extensive range of dimensions.

The examples below are not restrictive. Send us a description of your needs, with a diagram, requirement specifications or a prototype, and we will quickly inform you of the possible solutions we can offer.

DIAPHRAGM SPRING WASHERS

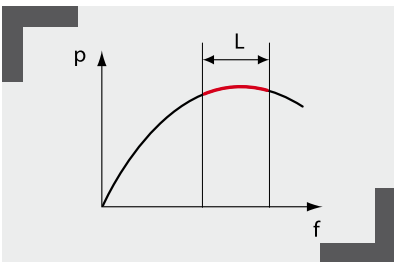
GENERAL

Diaphragm spring washers are a special type of Belleville washer.



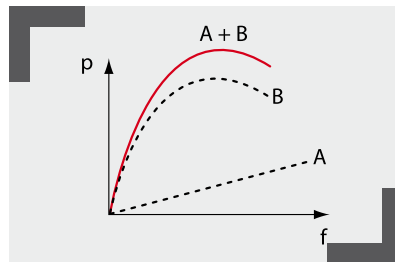
Elasticity curves

The elasticity curves are much the same as for Belleville washers, but with a much higher deflection.



Advantages

- Wide range of possible elasticity curves
- High force values
- Can perform the function of a multiple-turn spring, with an elasticity curve perfectly suited to the problem at hand.

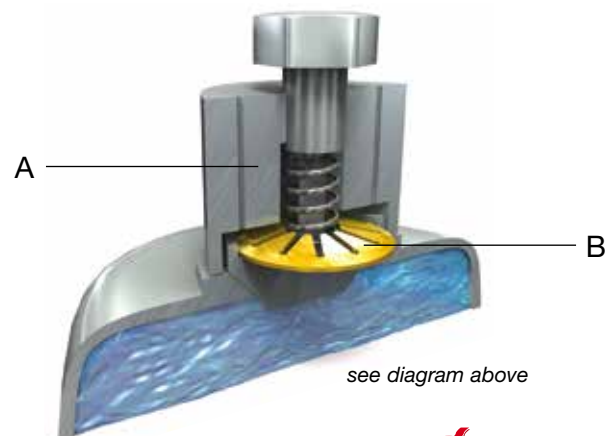


Centring and stacking

In principle diaphragm spring washers are not stacked; indeed, one of their primary purposes is to avoid stacking.

APPLICATIONS

Boiler safety valve



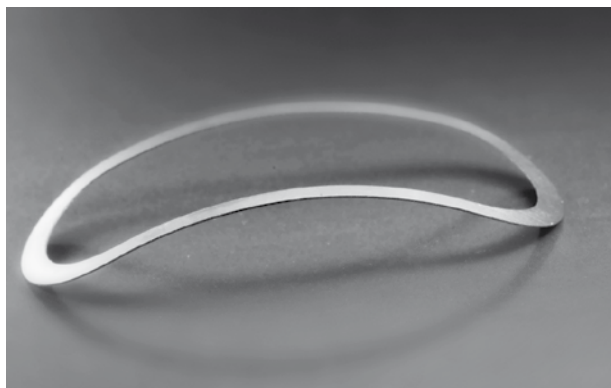
SPRING BLADES

GENERAL

If space is available for a contact surface, but not for height, spring blades can provide an elastic solution for rectangular, trapezoidal, and even oval shapes.

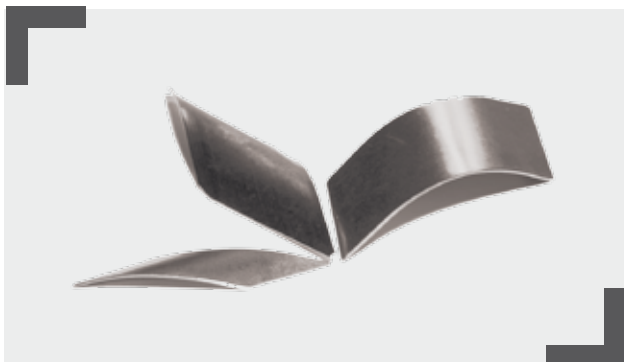
These blades store energy and reconstitute it in a very low volume.

We are specialised in designing and manufacturing spring blades in exotic materials such as Cube 2, Inconel and the like.



PRACTICAL EXAMPLES

Nuclear



- **Problem to be solved:**
Compensate for seal expansion on a heat exchanger in a nuclear environment.
- **Constraints:**
Small dimensions, radioactive environment.
- **Solution:**
Cube 2 spring blades determined from requirement specifications.
- **Borrelly added value:**
Determination of geometry, production of prototypes within one week, qualification within four weeks.

Automotive



- **Problem to be solved:**
Eliminate vibrations transmitted by the engine to the steering column.
- **Constraints:**
Obtain precisely defined mechanical characteristics for vehicle series.
- **Solution:**
Carbon-steel spring blades.
- **Borrelly added value:**
Prototypes entirely designed by Borrelly engineering department. Compatibility with existing parts was mandatory. Industrialisation.

FLAT WASHERS

Thickness 0.01 to 3 mm

The wide range of cutting tools used by Borrelly are also suitable for manufacturing flat washers in very short lead times for small or medium-sized production runs. We regularly manufacture thin shim washers, with thicknesses from 0.01 mm to 3 mm, in a variety of materials such as work-hardened soft steel, tempered steels, stainless steels or other more exotic materials.



GENERAL

RETAINING RINGS

Known as retaining rings, circlips, or even spring rings, these mechanical assembly components are generally fitted in grooves on cylindrical shafts or in bores. They are used for axial retaining, clearance take-up to reduce mechanical noise, and other similar functions. We are specialised in designing and manufacturing highly specialised retaining rings, in small and medium-sized production runs, from materials such as austenitic stainless steels, Inconel, Cube 2, and more.



GENERAL

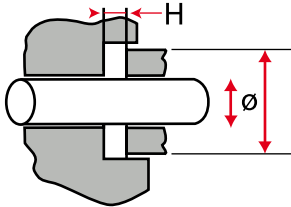


SPECIAL SPRING WASHERS STUDY FORM

Identification

Company : Date :
 Name :
 Address : Phone :
 Fax :
 E-mail :

Space required

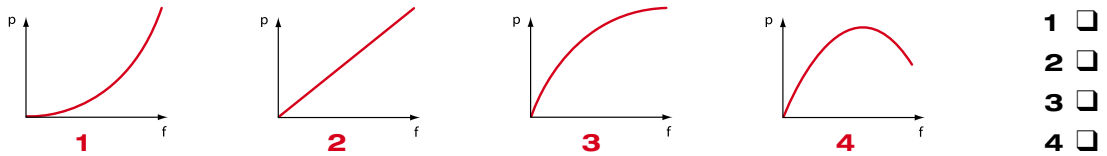


Boring diameter : mm
 Shaft diameter : mm
 Free height min : mm
 Free height max : mm
 Max. working height : mm
 Max. possible compressed height : mm
(Allows us to determine the material thickness or the elastic deformation field)

Centering mode inner : YES NO outer : YES NO

Loads
 Prestressed height H : mm Load P : N
 Working height H₁ : mm Load P₁ : N
 Working height H₂ : mm Load P₂ : N

Elasticity Curve



Fatigue Static : YES NO
 Dynamic : YES NO If yes, what is the working frequency ?
 Needed lifetime :

Environment Temperature min : °C Operating in oil : YES NO
 max : °C

Must the part be :
 Stainless : YES NO
 Non-magnetic : YES NO
 Current conducting : YES NO

Environmental Chemical Products :
 Wished material :
 Other :

Description of the application :

Estimated quantity :

We will determine the most suitable elastic item for your needs by selecting manufacture either a waved spring washer or a Belleville spring washer or a Diaphragm spring washer or a rolled spring washer (ONDUFIL™) or propose to you a washer derived from our extensive standard range.



Spring for innovation™
Tighter clearance, controlled force

Standard ranges and special designs

Tél. +33 (0) 478 483 130

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Borrelly™
SPRING WASHERS



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Certification



ISO 9001 - EN 9100

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