Edge Welded Bellows

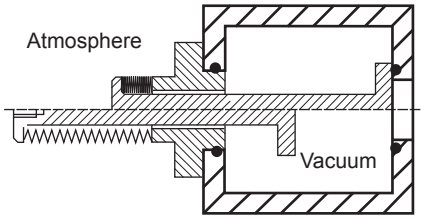
Standard Edge Welded Bellows

Special Edge Welded Bellows

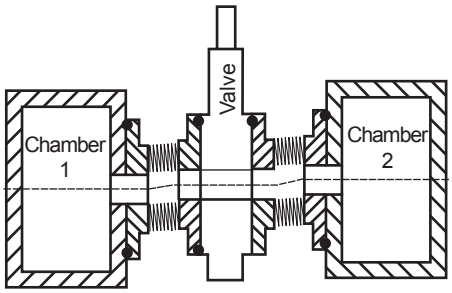
Contents

Basic Information – Applications

Edge welded bellows are flexible connecting elements between vacuum flanges or end fittings of any kind. The edge welded bellow is not a rigid body but can overcome a specified working stroke. Three main fields of application can be identified: as feedthrough, as expansion joint or as vibration isolator.



Edge welded bellows can serve as feedthroughs to introduce movements into the vacuum or to separate the vacuum chamber from mechanical parts.



Edge welded bellows can be used as compensators to balance thermal expansion and mounting tolerances (e.g. height differences or angular offsets).

Edge welded bellows are often used for vibration decoupling, e.g., between vacuum pump and measuring instrument. A special design of the compensator causes a better vibration isolation by an increased number of diaphragm pairs, but enlarges the risk of self-resonance.

Please find further applications in chapter 10 Mechanical Feedthroughs.

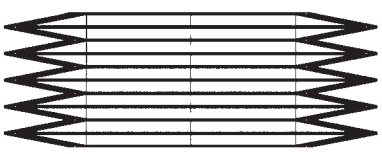
6

Advantages of Edge Welded Bellows

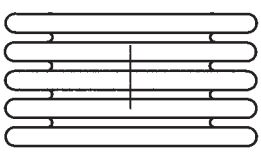
- High flexibility
- Lowest assembly dimension
- For highest demands in UHV applications
- Lower spring forces
- Variable web width (OD-ID)
- Almost unlimited bellow length
- Non-circular shapes available (racetrack, rectangular)

Comparison of Edge Welded Bellows and Flexible Hoses

In comparison to flexible hoses which are made of a thin-walled, partly bead welded and hydraulically formed tube, edge welded bellows can execute significantly larger lateral, axial, and angular motions in relation to their size. They also have a lower spring rate.



Edge welded bellow



Flexible hose

Types of Movements

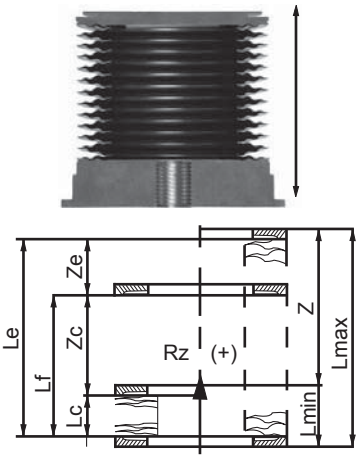
The following movements are possible:

- Axial
- Lateral
- Angular

Any combination of these kinds of movements is possible.
The individual types of movements are briefly explained below:

Axial

The flange surfaces are in parellel position and move towards each other. Thereby, no deflection in lateral direction is executed. The axial stroke is attenuated to achieve a higher service life, i. e., a streched stroke should not occur at high-cycle bellows.

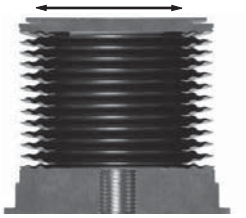


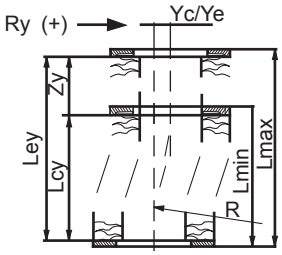
Abbreviations axial

Rz +	positive direction of force
Lf	free bellow length (without end fittings)
Lc	compressed bellow length = min. assembly dimension without end fittings
Le	stretched bellow length = max. assembly dimension without end fittings
Lmin	min. assembly dimension incl. end fittings from seal to seal
Lmax	max. assembly dimension incl. end fittings from seal to seal
Z	axial stroke according to specification

Lateral

The flange surfaces shift sideways during lateral movement while always remaining parallel. The maximal lateral stroke of an edge welded bellow depends on the assembly length.



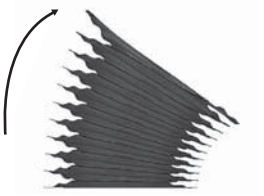


Abbreviations lateral

Ry +	positive direction of force
Yc	lateral stroke at Lcy
Ye	lateral stroke at Ley
Lcy	min. bellow length at given lateral stroke
Ley	max. bellow length at given lateral stroke
Lmin	min. assembly dimension incl. end fittings from seal to seal
Lmax	max. assembly dimension incl. end fittings from seal to seal
Zy	possible axial stroke at given lateral stroke Yc / Ye

Angular

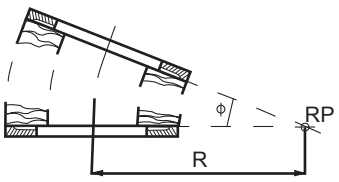
The center axis of the bellow forms a bend with the radius „R“ at angular movement (see figure). Not only the angle of rotation but also the location of the center of rotation is very important for dimensioning.



Key angular

RP	the center of the bow of the bellow axis results from lc and le
R	radius of the bellow axis
Φ	angle between the flange surfaces according to specification
φ / MP	angular stroke per convolution, catalog value
n	number of convolutions

Φ = φ / MP x n



Design and Connectors

Depending on the application, edge welded bellows consist of a number of moulded thin metal plates (diaphragms) which are welded together alternately at their inner or outer diameter. Two of these at the inner diameter welded plates form a convolution.

Usually, bellows will not be supplied without solid connections, so-called end fittings. The weld seam between the bellow and the end fitting needs a special preparation.

Materials

We offer edge welded bellows and the appropriate flanges and end fittings in different materials. We use stainless steel 1.4435 (AISI 316L) as standard for edge welded bellows. The flanges and end fittings can be made from stainless steel 304, 304L or 316L. If a very low magnetic permeability μr ≤ 1.005 is required, the flanges can be made of stainless steel 1.4429 in ESR quality. For edge welded bellows of AM350 we use flanges and end fittings from stainless steel 316L.

In addition, the special material Titanium Grade 1 can be used if the edge welded bellows are used in an especially corrosive environment. In this case the flanges have to be made of Titanium Grade 1. Edge welded bellows of a nickel-based alloy (Haynes 242) are applicable for processes with temperatures up to 600 °C, depending on the environmental conditions even up to 1000 °C. The appropriate flanges will be manufactured of the nickel-based alloy AU600.

Standard materials

1.4435 (AISI 316L): austenitic stainless steel (C: < 0.03 %; Cr: 16 % - 18 %; Ni: 10 % - 14 %)
magnetic permeability μr ≤ 1.1; good weldability; good corrosion resistance; operation temperature up to +450 °C; suitable for cryogenic applications; for applications up to 500,000 cycles

AM 350 (AISI 633): mostly austenitic Cr-Ni steel with ca. 10 % ferrite, thus higher magnetic permeability; good weldability; nonresistant to anorganic acids; operation temperature up to +250 °C; not suitable for cryogenic applications; due to high elasticity and stability suitable up to 10 million cycles

Special materials (longer delivery time than standard materials)

Titanium Grade 1: pure titanium, nonalloy; lowest magnetic permeability; cannot be welded to other materials; good corrosion resistance; embrittles at temperatures above +350 °C

Nickel-based alloys (Haynes 242, Hastelloy®, Inconel®, AU600): alloy on nickel basis; difficult to weld (if so, higher leak rates can result); excellent resistance in oxidizing and reductive media; operation temperature to +1000 °C, in corrosive environment to ca. + 600 °C

Important hint: The choice of material has to be made based on the specific requirements of the application.

Material 316L

For higher operating temperatures, up to 500,000 cycles, non-magnetic, highly corrosion resistant

Analysis

Element	Fe	C	Si	Mn	P	S	Cr	Mo	Ni
[%]	rest	≤ 0.03	≤ 1.0	≤ 2.0	≤ 0.045	≤ 0.03	16.0 - 18.0	2.0 - 3.0	10.0 - 14.0

Characteristics

Rp 0.2 [N/mm²]	Rm [N/mm²]	E-modul [N/mm²]	Density [kg/dm³]	Temp. [°C]	Magn. permeab.
300	600	200 000	8.0	-250 / +350	≤ 1.1

Nominal diameter	Inner diameter	Outer diameter	Compressed length	Free length	Axial stroke	Wall thickness of diaphragm	Effective surface	Spring rate axial	Welding edge
DN	ID [mm]	OD [mm]	lc [mm]	lf [mm]	z [mm]	t [mm]	EA [mm²]	SRCz [N/mm]	Size
	4.8	12.7	0.27	0.53	0.36	0.08	0.70	80.00	1
	6	13	0.27	0.50	0.32	0.08	0.80	105.00	1
	8	16	0.27	0.65	0.48	0.08	1.30	60.00	1
	8.6	16.2	0.20	0.55	0.55	0.05	1.30	25.00	1
	9	20	0.35	0.80	0.60	0.08	1.90	55.00	1
	9	31.5	0.36	1.35	1.18	0.1	4.30	55.00	3
10	10	20	0.33	0.60	0.50	0.1	2.00	45.00	1
	13	26	0.32	0.90	0.80	0.08	3.40	55.00	3
	16	31.5	0.45	1.20	1.15	0.13	5.00	95.00	3
16	16	35	0.43	1.15	1.35	0.13	5.90	49.00	3
	18.5	31.5	0.37	0.90	0.85	0.1	5.30	95.00	3
	19	37	0.40	1.60	1.55	0.13	6.90	70.00	3
	21	39	0.43	1.10	1.40	0.13	7.80	49.00	3
	21	41	0.50	1.85	1.90	0.13	8.40	75.00	3
	21	49	0.55	2.30	2.10	0.15	11.30	65.00	3
	21.1	34.9	0.35	1.05	1.10	0.1	6.60	75.00	3
	22	40.7	0.43	1.25	1.40	0.13	8.50	50.00	3
	24	35	0.33	0.70	0.70	0.1	7.20	82.00	3
	26	41	0.44	1.25	1.40	0.13	9.40	135.00	3
25	26	46	0.45	1.80	1.90	0.13	11.10	75.00	3
	31	49	0.43	1.10	1.40	0.13	13.40	48.00	3
	31	51	0.50	1.80	1.90	0.13	14.20	65.00	4
	33	46	0.32	1.20	1.10	0.08	12.80	40.00	3
	35	48	0.33	0.90	0.80	0.1	14.00	90.00	1
	35	49	0.33	0.90	0.90	0.1	14.40	90.00	3
	35.6	56	0.43	1.20	1.45	0.13	17.50	60.00	3
	36	56	0.50	1.80	2.00	0.13	17.60	65.00	4
	36	72	0.75	2.50	3.43	0.2	25.80	90.00	4
	38	51	0.35	1.10	1.05	0.1	16.10	85.00	3
40	39	59	0.50	2.00	2.00	0.13	19.90	65.00	4
	46	62.5	0.50	1.45	1.50	0.13	24.00	130.00	3
	46	71	0.50	2.30	2.40	0.13	28.50	60.00	4
	46	72	0.43	1.50	1.75	0.13	29.10	49.00	4
	46	88	0.70	3.30	3.00	0.2	39.20	96.00	4
50	51	76	0.50	2.40	2.60	0.15	33.30	85.00	4

Material 316L

Nominal diameter	Inner diameter	Outer diameter	Compressed length	Free length	Axial stroke	Wall thickness of diaphragm	Effective surface	Spring rate axial	Welding edge
DN	ID [mm]	OD [mm]	lc [mm]	lf [mm]	z [mm]	t [mm]	EA [mm^2]	SRCz [N/mm]	Size
	52	62	0.33	0.85	0.60	0.1	26.10	120.00	1
	52	95	0.75	3.60	3.40	0.2	46.70	75.00	4
	60	88	0.55	2.70	2.80	0.15	45.10	80.00	5
	65	90	0.50	2.40	2.80	0.15	49.00	95.00	4
63	65	108	0.80	2.65	2.75	0.2	63.20	35.00	5
	70	94	0.55	2.35	2.65	0.15	54.70	95.00	4
	75	100	0.60	2.40	2.90	0.15	62.20	95.00	4
	77.5	120	0.75	3.50	3.60	0.2	81.20	85.00	5
	80	108	0.55	2.25	2.50	0.15	71.90	80.00	5
	82	125	0.75	3.70	3.80	0.2	88.90	80.00	5
	90	110	0.50	1.45	1.40	0.15	80.40	145.00	5
	90	120	0.60	2.80	2.80	0.15	89.50	70.00	5
	90.5	135	0.70	4.20	4.20	0.2	105.10	80.00	5
	92	149	0.85	4.75	4.60	0.25	122.00	95.00	6
	100	150	0.66	2.20	2.50	0.2	129.30	66.00	5
	102	128	0.50	1.50	1.90	0.15	106.60	145.00	5
	102	132	0.60	2.60	3.10	0.15	110.70	75.00	5
100	102.5	150	0.90	4.40	4.60	0.25	131.40	135.00	5
	110	140	0.50	1.50	2.00	0.15	126.20	115.00	5
	110	160	0.80	4.25	3.00	0.2	150.00	40.00	5
	115	145	0.55	2.60	3.10	0.15	136.30	75.00	5
	120	140	0.50	1.25	1.70	0.15	135.30	125.00	5
	127	157	0.70	2.60	3.20	0.2	162.30	100.00	5
	135	165	0.66	1.90	2.00	0.2	180.90	140.00	5
	150	180	0.66	1.75	2.00	0.2	218.50	175.00	5
	150	185	0.75	2.60	3.40	0.2	225.70	140.00	5
160	156	186	0.75	2.60	3.30	0.2	234.50	200.00	5
	170	210	0.66	2.00	2.25	0.2	290.50	120.00	5
	173	203	0.65	2.50	3.20	0.15	283.10	100.00	5
	180	209	0.65	2.15	3.10	0.15	302.80	95.00	5
	180	215	0.75	2.80	3.40	0.2	312.90	148.00	5
200	200	235	0.75	3.00	3.50	0.2	379.00	160.00	5
	230	265	0.70	2.80	3.50	0.2	490.00	160.00	5
	250	280	0.66	2.00	2.00	0.2	560.70	333.00	5
250	250	285	0.80	3.20	3.20	0.2	572.00	200.00	5
	280	330	0.90	3.30	3.50	0.2	745.40	150.00	5
300	300	340	0.80	3.20	3.60	0.2	818.20	200.00	5
	360	440	2.00	7.50	6.00	0.3	1.286.20	150.00	6
400	400	480	1.45	5.00	4.50	0.4	1.553.60	350.00	6

The values are given per pair of membranes and refer to the following conditions:

Pressure difference	1 bar (Pi = 0; Pa = 1 bar)	Operating temperature	20 °C
Number of load cycles	Nz = 10,000 cycles	Max. bakeout temperature	80 °C

Material AM350

For higher operating temperatures, up to 500,000 cycles, non-magnetic, highly corrosion resistant

Analysis

Elem.	Fe	C	Si	Mn	P	S	Cr	Mo	Ni	N
[%]	rest	0.07 - 0.11	≤ 0.5	0.5 - 1.25	≤ 0.04	≤ 0.03	16.0 - 17.0	2.5 - 3.25	4.0 - 5.0	0.07 - 0.13

Characteristics

Rp 0.2 [N/mm²]	Rm [N/mm²]	E-modul [N/mm²]	Density [kg/dm³]	Temp. [°C]	Magn. permeab.
500	1150	200 000	8.0	+20 / +200	10 - 15

Nominal diameter	Inner diameter	Outer diameter	Compressed length	Free length	Axial stroke	Wall thickness of diaphragm	Effective surface	Spring rate axial	Welding edge
DN	ID [mm]	OD [mm]	lc [mm]	lf [mm]	z [mm]	t [mm]	EA [mm²]	SRCz [N/mm]	Size
	6	13	0.30	0.65	0.50	0.06	0.80	75.00	1
	8	20	0.30	1.20	1.10	0.08	1.80	49.00	1
	8.6	16.2	0.27	0.75	0.65	0.06	1.30	34.00	1
	9	19.05	0.27	1.05	1.00	0.06	1.80	37.00	1
	9	20	0.32	1.10	1.15	0.08	1.90	65.00	1
	9	31.5	0.40	1.75	1.80	0.1	4.30	60.00	3
10	9.4	23	0.27	1.35	1.40	0.06	2.50	25.00	1
	13	26	0.32	1.35	1.60	0.08	3.40	52.00	3
16	16	31.5	0.45	1.65	1.70	0.1	5.00	60.00	3
	18.5	31.5	0.32	1.30	1.60	0.08	5.30	55.00	3
	19	37	0.45	1.90	2.15	0.1	6.90	52.00	3
	21	41	0.50	2.40	2.60	0.1	8.40	52.00	3
	21	49	0.50	3.10	3.30	0.13	11.30	52.00	3
	23	43	0.45	2.40	2.65	0.1	9.50	47.00	3
	26	41	0.40	1.70	1.90	0.1	9.40	90.00	3
25	26	46	0.38	2.20	2.80	0.1	11.10	45.00	3
	31	51	0.50	2.40	2.80	0.1	14.20	45.00	4
	36	56	0.50	2.50	3.00	0.1	17.60	40.00	4
	38	51	0.40	1.50	1.85	0.1	16.10	100.00	3
40	39	59	0.50	2.50	3.00	0.1	19.90	40.00	4
	41	79	0.65	3.50	3.7	0.15	31.5	65.00	5
	45	59	0.40	1.60	1.90	0.1	21.9	65.00	3
	46	62.5	0.40	1.75	2.25	0.1	24.00	90.00	3
	46	71	0.50	2.85	3.60	0.13	28.50	60.00	4
	46	88	0.65	4.00	4.00	0.15	39.20	65.00	5
50	51	76	0.50	2.95	3.80	0.13	33.30	65.00	4
	60	88	0.50	3.20	4.20	0.13	45.10	60.00	5
	63.5	77	0.35	1.40	2.00	0.1	39.60	120.00	3
63	65	90	0.54	2.80	3.80	0.13	49.00	65.00	4

Material AM350

Nominal diameter	Inner diameter	Outer diameter	Compressed length	Free length	Axial stroke	Wall thickness of diaphragm	Effective surface	Spring rate axial	Welding edge
DN	ID [mm]	OD [mm]	lc [mm]	lf [mm]	z [mm]	t [mm]	EA [mm^2]	SRCz [N/mm]	Size
	70	94	0.50	2.70	3.50	0.13	54.70	70.00	4
	71.4	84.1	0.37	1.25	1.75	0.1	48.40	155.00	3
	75	100	0.54	2.80	3.80	0.13	62.20	65.00	4
	80	108	0.60	2.70	3.60	0.15	71.90	77.00	5
	89.6	133.4	0.85	4.50	5.00	0.2	102.80	85.00	6
	90	120	0.60	3.00	4.20	0.13	89.50	55.00	5
	90.5	135	0.85	4.90	5.20	0.2	105.10	80.00	5
	101.6	139.7	0.55	3.25	4.30	0.15	118.70	43.00	6
	102	132	0.70	3.00	4.40	0.15	110.70	80.00	5
100	102.5	150	0.85	5.10	6.00	0.2	131.40	90.00	5
	115	145	0.70	2.85	3.50	0.15	136.30	80.00	5
	127	157	0.75	2.95	4.20	0.15	162.30	85.00	5
	150	185	0.90	3.20	4.00	0.2	225.70	166.00	5
	160	185	0.65	2.65	3.80	0.13	238.10	87.00	4
160	160	210	1.10	5.15	5.80	0.25	277.40	120.00	6
	180	215	0.70	2.75	4.10	0.15	312.90	80.00	5
200	200	235	0.70	3.20	4.30	0.15	379.00	74.00	5
250	250	285	0.70	3.20	4.20	0.15	572.00	74.00	5
	270	310	0.80	3.30	4.00	0.2	672.60	140.00	5
320	300	340	0.80	3.50	4.60	0.2	818.20	90.00	5
400	430	480	1.10	4.50	5.60	0.25	1.652.70	280.00	6

The values are given per pair of membranes and refer to the following conditions:

Pressure difference	1 bar (Pi = 0; Pa = 1 bar)	Operating temperature	20 °C
Number of load cycles	Nz = 10,000 cycles	Max. bakeout temperature	80 °C

Standard Edge Welded Bellows for Your Vaccum Application

quick availability of standard dimensions, in stock
bellow material stainless steel 316L; flange material stainless steel 304, 304L, 316L

Order code	Flange	Inner-Ø [mm]	Axial stroke [mm]	Mounting length [mm]
KF Edge welded bellows				
KF16EWB-20	DN16KF	16	20	36.5 - 56.5
KF25EWB-10	DN25KF	26	10	31.0 - 41.0
KF25EWB-20			20	33.4 - 53.4
KF25EWB-30			30	35.5 - 65.5
KF25EWB-40			40	38.0 - 78.0
KF25EWB-50			50	41.0 - 91.0
KF40EWB-10	DN40KF	39	10	32.5 - 42.5
KF40EWB-20			20	35.0 - 55.0
KF40EWB-30			30	37.5 - 67.5
KF40EWB-40			40	40.0 - 80.0
KF40EWB-50			50	42.5 - 92.5
KF40EWB-60			60	45.0 - 105.0
KF40EWB-80			80	50.0 - 130.0
KF50EWB-10	DN50KF	51	10	39.0 - 49.0
KF50EWB-20			20	41.0 - 61.0
KF50EWB-40			40	45.0 - 85.0

CF Edge welded bellows*				
EWB16R-10	DN16CF	16	10	44.1 - 54.1
EWB16R-20			20	48.5 - 68.5
EWB16R-30			30	52.5 - 82.5
EWB16R-50			50	60.0 - 110.0
EWB16R-60			60	62.0 - 122.0
EWB40R-10	DN40CF	39	10	63.0 - 73.0
EWB40R-20			20	65.0 - 85.0
EWB40R-30			30	67.5 - 97.5
EWB40R-40			40	70.0 - 110.0
EWB40R-50			50	72.0 - 122.0
EWB40R-60			60	74.0 - 134.0
EWB40R-70			70	76.0 - 146.0
EWB40R-80			80	78.0 - 158.0
EWB40R-90			90	80.0 - 170.0
EWB40R-100			100	83.0 - 183.0
EWB63R-20	DN63CF	65	20	76.0 - 96.0
EWB100R-30	DN100CF	102	30	87.0 - 117.0
EWB160R-10	DN160CF	156	10	95.0 - 105.0
EWB160R-20			20	96.0 - 116.0

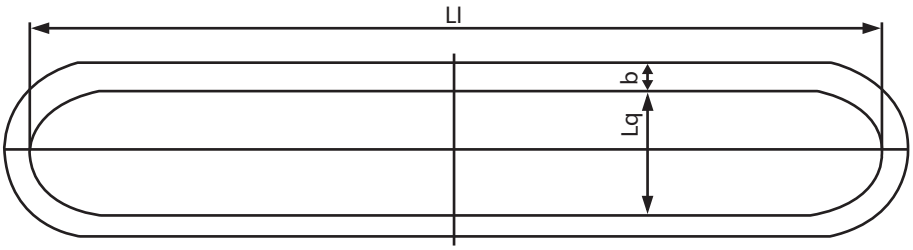
QCF Edge welded bellow**				
EWB16QCF-10	DN16QCF	16	10	52.2 - 62.2
EWB40QCF-10	DN40QCF	39	10	62.0 - 72.0
EWB63QCF-10	DN63QCF	65	10	65.0 - 75.0
EWB100QCF-10	DN100QCF	102	10	79.5 - 89.5

* one rotatable flange, ** Information to innovative Quick-CF-connections on page 3-90
The values given refer to the following conditions:

Pressure difference	1 bar (Pi = 0; Pa = 1 bar)	Operating temperature	20 °C
Number of load cycles	Nz = 10,000 cycles	Max. bakeout temperature	80 °C

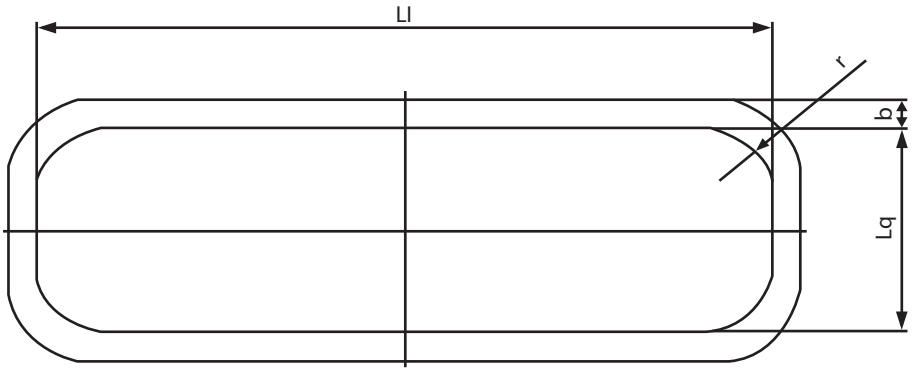
Non-Circular Bellows (Special Designs)

Racetrack bellows



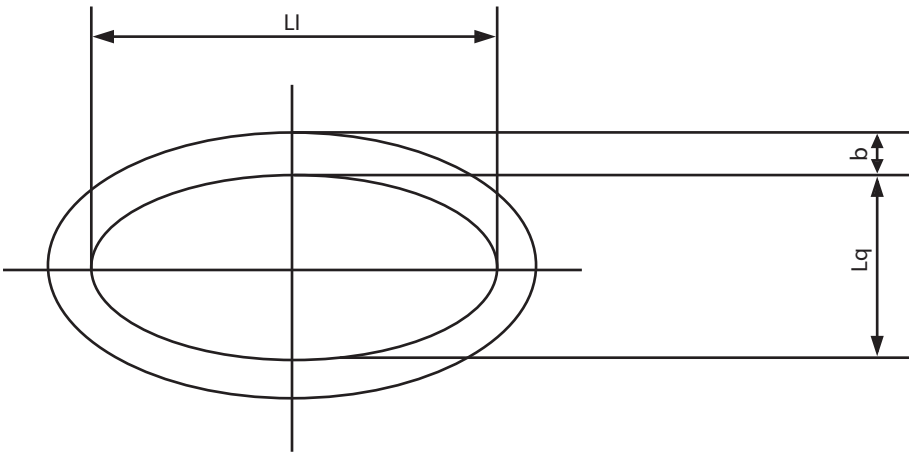
Length (longitudinal)	Length (diagonal)	Width of profile	Material
Ll	Lq	b	
150	80	9	316L
210	30	15	316L
240	120	15	316L
292	38	12.5	AM350
959	138	28	316L

Rectangle bellows



Length (longitundinal)	Length (diagonal)	Width of profile	Flanging radius	Material
Ll	Lq	b	r	
300	190	19.5	20	316L
836	231	35	60	316L

Elliptical bellows

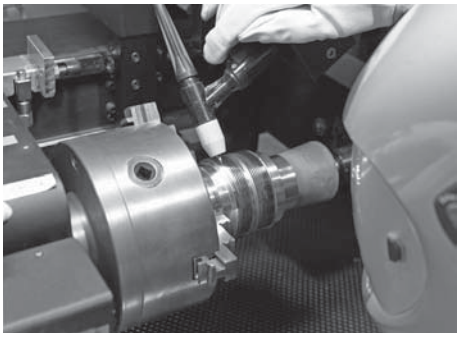


Length (longitudinal)	Length (diagonal)	Width of profile	Material
Ll	Lq	b	
127	57.16	12.7	316L

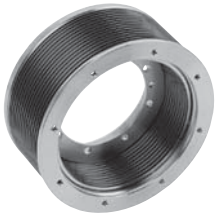
Edge Welded Bellows – Service and Repair

Besides the manufacturing of custom edge welded bellows, we deliver replacement bellows. In addition, we are able to offer the repair of damaged bellows. This includes bellow feedthroughs of valve drives, coupling elements, manipulators, etc.

A drawing, a precise sketch or a photo, if available, is essential for quotation. You can also send a sample or the damaged bellow for the estimation of costs. In this case, please contact us before shipping, so we can start working immediately on receipt of the goods.



Notes



The following criteria have to be considered:

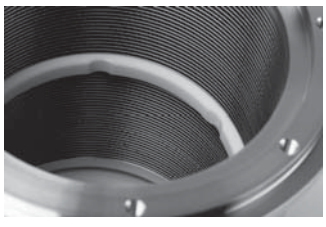
- Conditions of surrounding area
  Bake-out temperature, operating press ure, operating temperature, possible torsion and the inspection pressure affecting the life cycle directly.

- Vacuum inside the edge welded bellow (outside overpressure)
  Edge welded bellows are stabilized by the vacuum inside. They can be up to ten times as long as the outside diameter in case of horizontal installation.
  However, the bellow will become unstable in case of zero pressure difference.

- Vacuum outside the edge welded bellow (inside overpressure)
  In this case the bellow is very unstable and will buckle soon. The bellow needs to be axially stabilized by guiding elements.

- Horizontal installation of long edge welded bellows
  The deflection of the edge welded bellows has to be considered especially in this installation position. It is recommended to split the bellows with intermediate rings into fragment bellows and put up the intermediate rings into a guidance system.

- Vertical installation of long edge welded bellows
  It needs to be considered that the diaphragm on top always has to carry the weight of the whole edge welded bellow. Therefore, the edge welded bellow should also be split into segments by intermediate rings and should be released by rods or wire for traction relief.



Example of an inner guidance ring

Example of an edge welded bellow guidance