

BELLOWS

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BELLOWS

Bellows from Freudenberg Sealing Technologies (FST) are reliable, effective protective components which protect components from dirt, water spray, dust and atmospheric elements as well as external influences.

Because bellows are normally used for very specific application cases, the product range of the most diverse dimensions and geometric forms for the bellows and connecting elements are of particular importance. FST offers over 450 different dimensions that are available quickly and without additional tool costs. Over 250 dimensions of these are available immediately as stockable articles. Individual manufacturing per customer requirements sensibly completes the product range.

FUNCTIONS

- Bellows are protective components e.g. on axially moving rods and machine parts – for protection against soiling, water spray, dust and atmospheric elements
- Fast and cost-effective adaptation to the big variety of operating parameters
- Protection against soiling and corrosion
- Elastic connection of two components
- The protection of the sealed components increases their service life (less maintenance, less component wear (reduced component replacement), ...)
- Bellows can absorb spherical, axial and radial movements as well as axial offset
- Protection against injury of persons by moving machine parts. Visual and aesthetic requirements of the construction are also enhanced.
- Use as cable bushing.



FEATURES

- In addition to the proven standard materials, bellows made from high-performance and effective special materials are available e.g. for application in electrical engineering, medical technology and foodstuffs technology
- High economy thanks to the flexible application range
- Wide catalog programme with over 450 different bellows geometries
- The catalogue programme (single and multiple convolution bellows) is completed by disk bellows, which offer, through their modular concept, an enormous selection of dimensions without tool costs (freely selectable number of convolutions and connection diameters).

In addition to the catalog programme, customer-specific developments (amongst others) are available for the following applications:

- **Steering bellows:**
Multiple convolution bellows in adapted geometry for protection of steering rods used in e.g. agricultural and construction machinery. As material, TPE is used primarily but CR is also used.
- **Sealing bellows:**
Sealing bellows in the form of single convolution bellows, preferentially used on ball joints in steering rods and driving and coupled axles. CR is used as material.
- **Cardan shafts bellows:**
Also often known as axle seal formed component for use on cardan shafts e.g. on front or rear drive of construction machinery, commercial vehicles and in general vehicle construction. Cardan shaft bellows ensure permanent lubrication of the joints as well as reliable and long-term sealing against grease leakage and dirt ingress. Materials based on CR and TPE.

APPLICATION RANGE

FST bellows are indispensable in general industry as protective elements in the most diverse applications.

- Agricultural and construction machinery industry
- Mechanical engineering
- Materials handling
- Medical technology
- Hydraulic and pneumatic cylinders
- Trapeze spindles and ball screws
- Electrical engineering (e.g. cable bushings in white goods, for ship building and more).

BELLOWS FOR CABLE FEEDTHROUGHS

These multiple convolution bellows seal cable feed-throughs e.g. in the cabin wall of agricultural and construction machinery against dust, moisture and noise. The bellows can be installed quickly and easily with the fitting straps. Involved and insecure adhering with liquid sealing materials can thus be avoided.

USE OF BELLOWS

Bellows are protective components consisting of a movable bellows section and two connection components for fastening.

The movable bellows section has a cylindrical, conical or curved contours.

The connection components can be in the shape of ring beads, flat flanges, cylindrical couplings etc. Bellows are generally designed for special applications, which is why the bellows and connection components have very different shapes.

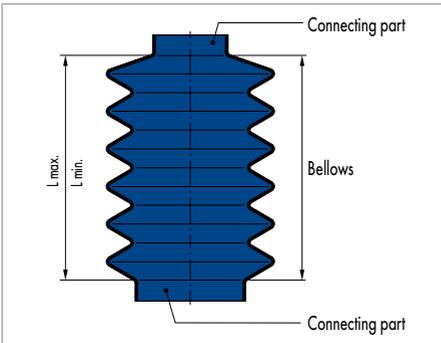


Fig. 1 Bellows structure

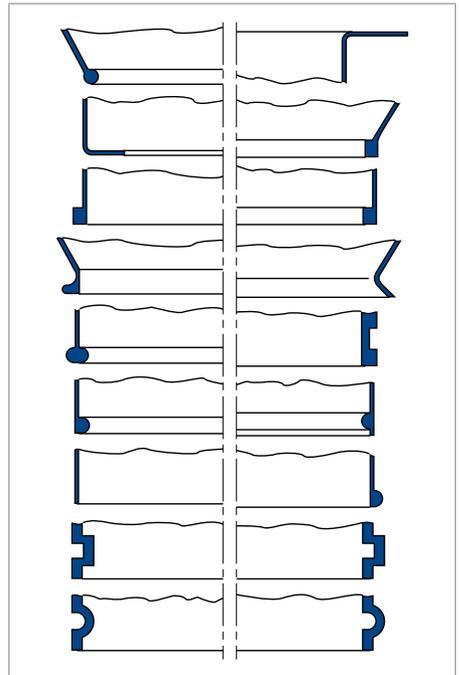


Fig. 2 Connection designs

EXAMPLES OF APPLICATIONS

The movements requiring compensation may be axial displacements and/or deflections around a pivot.

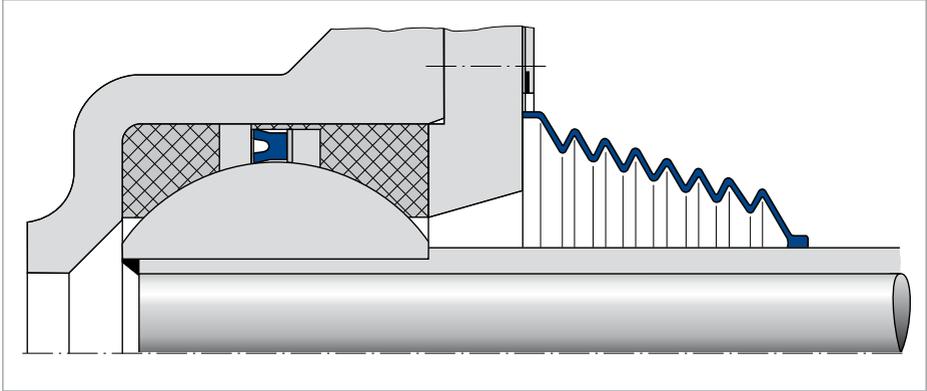


Fig. 3 Bellows protect ball-and-socket joint from dirt (spherical movement)

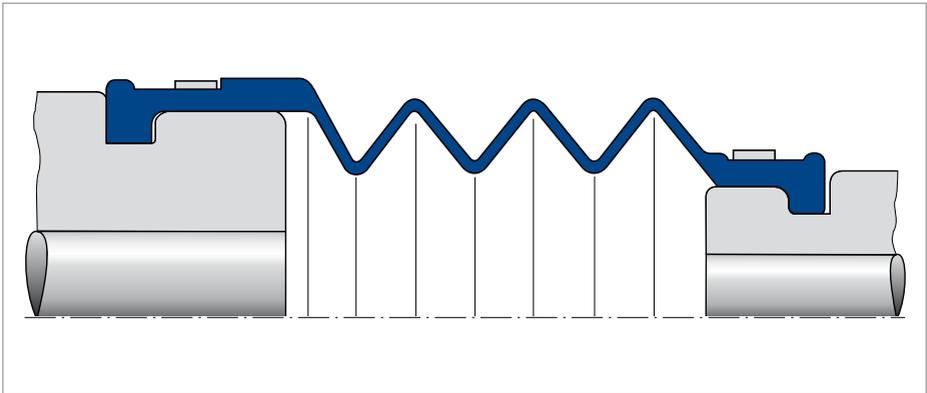


Fig. 4 Elastic connection of two pipe ends, bellows compensate for length variation as well as axial movement

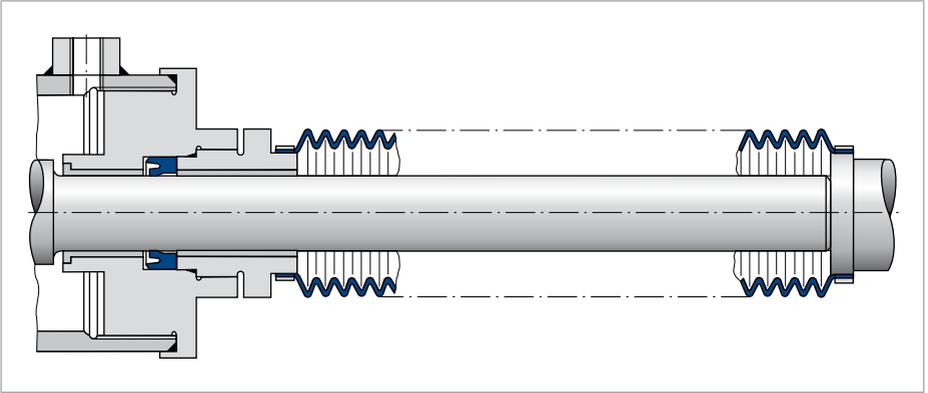


Fig. 5 Bellows protects push rod from dirt (axial movement)

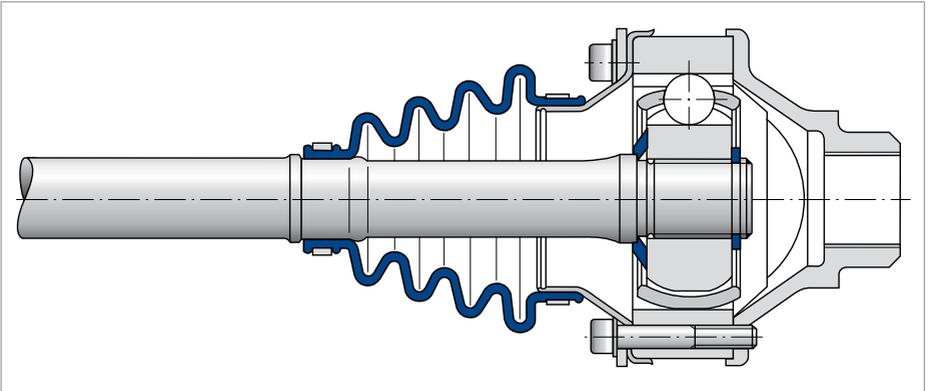


Fig. 6 Bellows protects rear-axle bearing from dirt (radial movement)

MATERIALS

- CR (based on chlorine-butadiene rubber) resistant to ageing, weathering and ozone. The resistance to water is very good, it is sufficiently resistant in mineral oils and greases for the specified applications.
Temperature range: 40 °C to +100 °C.
 - Based on NBR (acrylonitrile butadiene rubber) Good resistance to mineral oils and greases.
Temperature range: 30 °C to +100 °C.
- Other materials for special applications are available and can be supplied on enquiry (after clarification of the material requirement profile and the type).

OPERATING CONDITIONS

Bellows can move axially inside the limit values of L_{\min} (compressed length) and L_{\max} (extended length). If these limit values are exceeded, the bellows section will be deformed past the limits and the operation of the bellows will be compromised.

The values of L_{\min} and L_{\max} can be seen in the relevant drawings. If this information is unavailable, the bellows or protective cap can only follow minor movements.

Bellows cannot take significant overpressure or underpressure, otherwise they will be excessively deformed. Thicker sections at the transition radii of the individual folds do add some strength, but they also reduce the movability of the bellows.

Bracing the bellows section with metal rings with a circular cross section, which are placed in the fold valleys, are not always as successful as desired because of the danger of cutting or tearing.

To prevent pressure build-up inside the bellows during axial movements, a tongue-shaped section (bleeder flap) can be installed or a small hole can be made at an appropriate position in a bellows fold.

Torsional loading of the bellows should be avoided.

FITTING & INSTALLATION

Bellows must be firmly clamped to the machine parts that are to be protected. The type of fastening depends on the shaping of the connection component. If the connection components are hose-shaped or bead-shaped, the inside diameter should be approximately 1 to 2 mm less than the diameter of the metal mating part to ensure that the bellows connection components are firmly attached. If possible the connection components should be placed in a corresponding mounting groove.

Because of the natural reduction of the clamping force of stretched rubber an extra mechanical fastening with a hose clamp or similar should be planned.

The movable bellows section must not come into contact with sharp edges.

The folds of the bellows section must not be jammed during operation, and also the bellows section must never lie on the moving machine component.

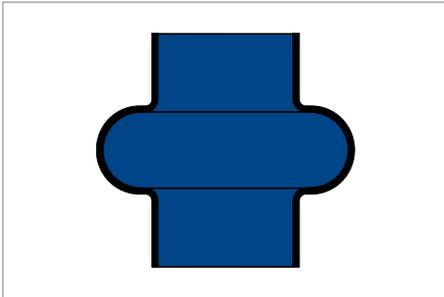
Where very long, horizontal bellows are installed, we recommend using a suitable support component for the bellows to prevent it from sagging and being abraded by the machine component that it is protecting.

PRODUCTS

BELLOWS

Single Convolution Bellows	711
Multiple Convolution Bellows	712
Disk Bellow	713
Bellows for Cable Bushing	719
Bellows Type 9000 made of PTFE	720
Bellows Type 9002 made of PTFE	721
Bellows Type 9020 to 9023 made of PTFE	722

SINGLE CONVOLUTION BELLOWS



Single Convolution Bellows

PRODUCT ADVANTAGES

Single convolution bellows prevent the escape of lubricant at shaft joints and protect the joints against soiling.

APPLICATION

Single convolution bellows are used when a short stroke and narrow angle are to be sealed.
Example: ball joint, connection of two tube ends.

MATERIAL

PRODUCT DESCRIPTION

Single convolution bellows are protective components for shaft joints that are primarily subjected to angular movement. The axial flexibility is limited.

Material	CR	NBR
Hardness	42/50 Shore A	approx. 45 Shore A

Other materials on enquiry (after clarification of the material-job specification and the type).

OPERATING CONDITIONS

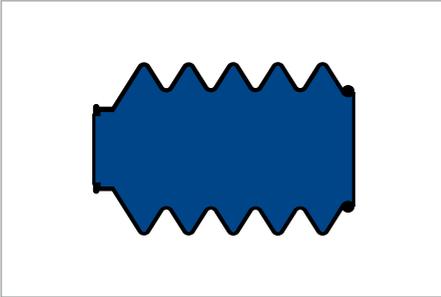
Material	CR	NBR
Temperature	-40 ... +100 °C	-30 ... +100 °C
Dynamic loading	very good	sufficient
Mineral oil and grease resistance	sufficient	good

The values listed in the table are recommended values.

FITTING & INSTALLATION

The moving section of the bellows must not come into contact with the sharp edges on the shaft joint or with the surrounding parts of the machine. Hose clips should be used on the bellows connections to fasten the bellows to the joint.

MULTIPLE CONVOLUTION BELLOWS



Multiple Convolution Bellows

PRODUCT DESCRIPTION

Bellows are protective elements comprising a moving section and two connection pieces for fastening. They protect axially moving rods and parts of machines against soiling, water spray, dust or the effects of the weather. Depending on their design, they can accommodate movements perpendicular to the axis or a combination of movements (e.g. gear levers).

Bellows are able to follow axial movements within their limits L_{\min} (compressed length) and L_{\max} (extended length). Special loads (non-axial movements, pressure loads etc.) affect the maximum working stroke and the flexibility.

PRODUCT ADVANTAGES

Depending on the application, bellows and connecting areas can have very different geometrical shapes and dimensions. More than 500 different bellows geometries are available to the user quickly and cost-effectively.

APPLICATION

There are many application cases for bellows, for example, the functional sealing of ball joints, connection of two tube ends, push rods (e.g. in hydraulic and pneumatic applications), axle bearings.

MATERIAL

Material	CR	NBR
Hardness	42/50 Shore A	approx. 45 Shore A

Other materials on enquiry (after clarification of the material-job specification and the type).

OPERATING CONDITIONS

Material	CR	NBR
Temperature	-40 ... +100 °C	-30 ... +100 °C
Dynamic loading	very good	sufficient
Mineral oil and grease resistance	sufficient	good

The values listed in the table are recommended values.

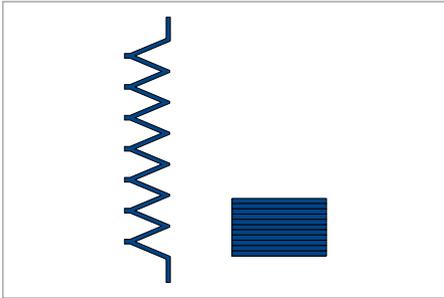
FITTING & INSTALLATION

The moving section of the bellows must not come into contact with any sharp edges. It is imperative that continuous chaffing against moving parts of the machine is avoided.

Bellows are not able to absorb major excess pressure or vacuum, as otherwise excessive deformation would occur.

To prevent a pressure build-up inside bellows on axial movements, a sufficient ventilation must be provided. Torsional loading of the bellows should be avoided.

DISK BELLOW



Disk Bellow

PRODUCT DESCRIPTION

Disk bellows can have an elongation ratio of up to 1:1.6. At the minimum length (in the compressed state) the bellows is reduced to a cylindrical block. Despite this small block size, a large L_{max} (maximum length) can be achieved.

Wherever round drive elements (piston rods or threaded spindles) need to be securely protected against soiling or where people need to be prevented from contact with moving machine parts, the disk bellows is the right choice.

MATERIAL

Material	CSM (chlorosulphonated polyethylene)	NBR (acrylonitrile-butadiene - rubber)	xTend

Other materials on enquiry.

PRODUCT ADVANTAGES

- Realises elongation ratios that no other bellows geometry can
- Medium of choice for bellows dimensions that are otherwise difficult to realise (e.g. 4 m manufactured length)
- Especially suited for applications where only a low number of pieces are needed as no forming costs arise for standard dimensions (see article overview)
- Freely-selectable connections: collar, flange or both.

APPLICATION

Especially for translation movements with large stroke, the disk bellows ensures the functional sealing of:

- Hydraulic and pneumatic cylinders
- Trapeze spindles or ball screws.

The disk bellows is used in drive technology (stroke or adjusting elements), in machines for special applications, as well as for many manufacturing technology applications.

OPERATING CONDITIONS

Material	CSM	NBR	xTend
Temperature	-15 ... +110 °C	0 ... +90 °C	-10 ... +60 °C
Standard thicknesses	0,5/0,75/1 mm	1 mm	0,6/1 mm
Ozone stability	very good	low	good
UV stability	very good	low	-
Oil and grease resistance	good	very good	sufficient
Other properties	Good chemical resistance up to 40 °C	Use with higher oil and grease loading Antistatic design	A specially developed, highly tear-resistant thermoplastic Advantage: significant price advantage over larger convolution depths compared to CSM, NBR

FITTING & INSTALLATION

L_{max} = Convolution depth (F_z) x No. of convolutions (F_t)

$$F_t = (D_a - D_i) : 2$$

$$F_z = L_{max} / F_t$$

$$F_z = \text{Stroke} / (F_t - 2,5)$$

$$L_{min} = F_z \times 2,5$$

Where:

L_{max} = maximum length

L_{min} = minimum length

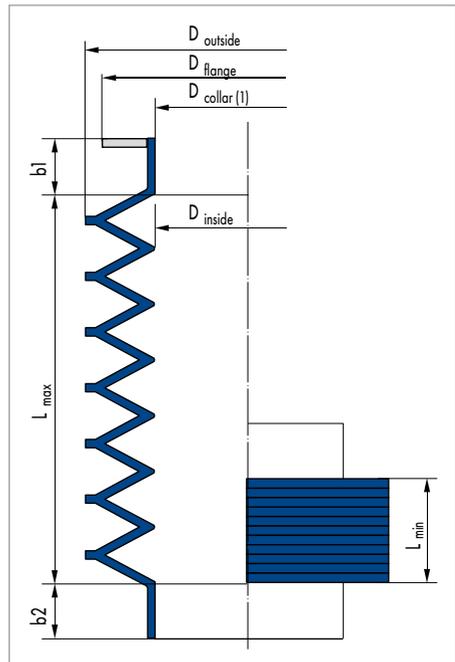
2,5 = L_{min} per convolution

For convolutions depths >33 mm, support disks are used on the inside.

The minimum length is increased in this case by 1 mm per convolution.

D_a = outside diameter

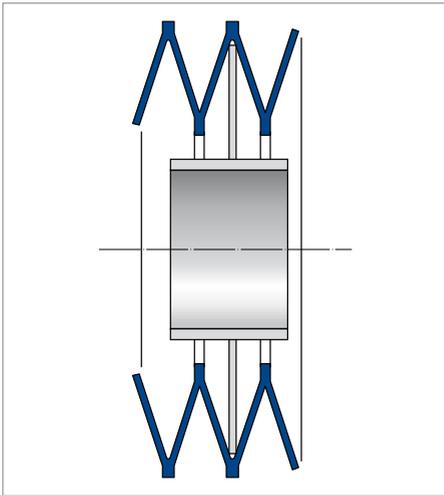
D_i = inside diameter.



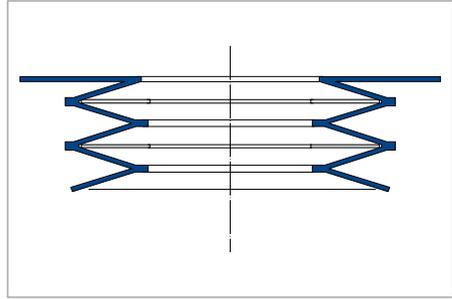
DESIGN NOTES

The disk bellows can be installed vertically, horizontally or at an angle. For some installation situations, special constructive requirements for the use of a disk bellows must be observed

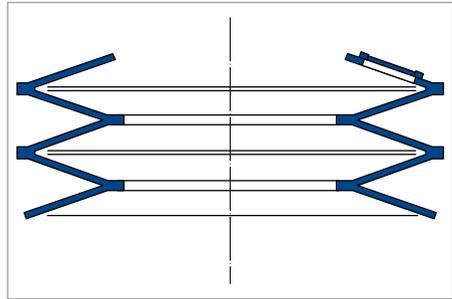
- Glide bushes can be used to prevent the bellows from jamming in the horizontal installation – especially for spindle drives.
- Support disks stabilise the bellows for convolution depths over 30 mm and lengths over 1500 mm. At the same time, the support disks serve as an extension stop. Lengths of up to 4 m can thus be realised.
- Disk bellows are fully sealed. For this reason, they must be sufficiently ventilated (through valves or air flaps) to prevent the bellows from bursting during use.



Disk Bellows with spindle drives for horizontal installation



Disk Bellows with flange and support disks



Disk Bellows with ventilation valve

These accessories can be supplied with the order.

DISK BELLOWS WITHOUT TOOL COSTS

Convolution depth	12	15	18	21	24	27	30
Inside Ø	Outside Ø						
18	42	48	54	60	66		
24	48	54	60	66	72		
30	54	60	66	72	78		
36	60	66	72	78	84		
42	66	72	78	84	90		
48	72	78	84	90	96	102	108
54	78	84	90	96	102	108	114
60	84	90	96	102	108	114	120
66	90	96	102	108	114	120	126
72	96	102	108	114	120	126	132
78	102	108	114	120	126	132	138
84	108	114	120	126	132	138	144
90	114	120	126	132	138	144	150
96	120	126	132	138	144	150	156
102		132	138	144	150	156	162
108		138	144	150	156	162	168
114		144	150	156	162	168	174
120		150	156	162	168	174	180
126		156	162	168	174	180	186
132		162	168	174	180	186	192
138		168	174	180	186	192	198
144		174	180	186	192	198	204
150		180	186	192	198	204	210
156			192	198	204	210	216
162			198	204	210	216	222
168			204	210	216	222	228
174			210	216	222	228	234
180			216	222	228	234	240
186				228	234	240	246
192				234	240	246	252
198				240	246	252	258
204					252	258	264
210						264	270
216							276
222							282
228							288

available at short notice in xTend available at short notice

Inside and outside diameters can be combined in 6 mm jumps (18 ... 384 mm), freely-selectable connections: collar, flange or both.

Convolution depth	12	15	18	21	24	27	30
Inside Ø	Outside Ø						
234				276			294
240							300
246							306
252							312
258							318
264							324
270							330
276							336
282							342
288						342	348
300					348		360
306							366
312							372
324							384
348			384				

 available at short notice in xTend
 available at short notice

Inside and outside diameters can be combined in 6 mm jumps (18 ... 384 mm), freely-selectable connections: collar, flange or both.

DISK BELLOWS WITHOUT TOOL COSTS

Convolution depth	33	36	39	42	45	48	51	60
Inside Ø	Outside Ø							
18								
24								
30								
36								
42								
48								
54								
60								
66								
72								
78								
84	150	156	162	168				
90	156	162	168	174	180			
96	162	168	174	180	186			
102	168	174	180	186	192	198	204	210
108	174	180	186	192	198	204	210	216

 available at short notice in xTend
 available at short notice

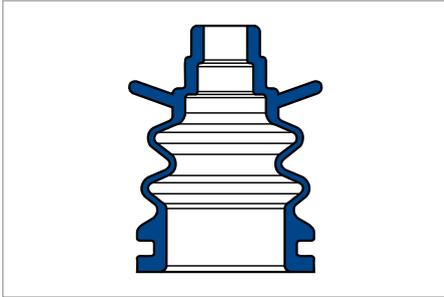
Inside and outside diameters can be combined in 6 mm jumps (18 ... 384 mm), freely-selectable connections: collar, flange or both.

Convolution depth	33	36	39	42	45	48	51	60
Inside Ø	Outside Ø							
114	180	186	192	198	204	210	216	222
120	186	192	198	204	210	216	222	228
126	192	198	204	210	216	222	228	234
132	198	204	210	216	222	228	234	240
138	204	210	216	222	228	228	240	246
144	210	216	222	228	234	240	246	252
150	216	222	228	234	240	246	252	258
156	222	228	234	240	246	252	258	264
162	228	234	240	246	252	258	264	270
168	234	240	246	252	258	264	270	276
174	240	246	252	258	264	270	276	282
180	246	252	258	264	270	276	282	288
186	252	258	264	270	276	282	288	294
192	258	264	270	276	282	288	294	300
198	264	270	276	282	288	294	300	306
204	270	276	282	288	294	300	306	312
210	276	282	288	294	300	306	312	318
216	282	288	294	300	306	312	318	324
222	288	294	300	306	312	318	324	330
228	294	300	306	312	318	324	330	336
234	300	306	312	318	324	330	336	342
240	306	312	318	324	330	336	342	348
246	312	318	324	330	336	342	348	354
252	318	324	330	336	342	348	354	360
258	324	330	336	342	348	354	360	366
264	330	336	342	348	354	360	366	372
270	336	342	348	354	360	366	372	378
276	342	348	354	360	366	372	378	384
282	348	354	360	366	372	378	384	
288	354	360	366	372	378	384		
300	366			384				
306								
312								
324								
348								

 available at short notice in xTend
 available at short notice

Inside and outside diameters can be combined in 6 mm jumps (18 ... 384 mm), freely-selectable connections: collar, flange or both.

BELLOWS FOR CABLE BUSHING



Bellows for Cable Bushing

- Flexibility of movement through convoluted design
- Simple cable replacement possible without damage, thus service-friendly
- High product service life.

APPLICATION

- Agricultural and construction machinery
 - Electrical cables are run in/through the inside of the cabin
- Boat building
 - Control cables for outboard motors are run through the inner shell
- White goods
 - Power cables are run from the inside of the machine to the outside.

PRODUCT DESCRIPTION

The Bellows for cable bushing is a bellows with flexible connection system. Cable bushings are located where cables, Bowden cables (or similar) must pass through chamber separations. Because of multiple connection diameters many different cable diameters can be sealed with a bellows for cable bushing. The sealing of chamber separation using bellows for cable bushings protects the inner area against dirt, dust, water, contaminants, amongst others.

PRODUCT ADVANTAGES

Ensures secure and continuous sealing of cable bushings and thus:

- Very good sealing properties through extensive sealing area in both connection areas
- Protection of technical or mechanical devices
- Noise reduction
- Low mechanical loading through friction for cables, Bowden cables or similar
- Easily installed with fitting straps
- Optically and aesthetically appealing sealing solution
- Installation and cost advantages through the of one bellows for different diameter dimensions to be sealed

MATERIAL

Material	PVC
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Other materials on enquiry.

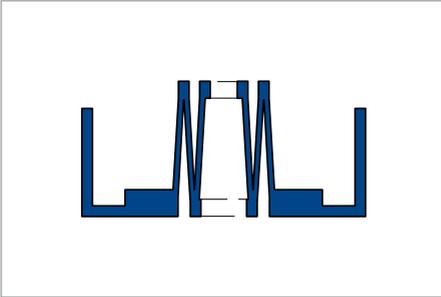
OPERATING CONDITIONS

Material	PVC
Temperature	-40 ... +70 °C
Ozone resistance and resistance to ageing	very good
Lubricant and fuel resistance	limited
Water resistance	good

FITTING & INSTALLATION

- Rounded metal edges (no burrs from punching)
- Tolerances of the bushings (d2) according to DIN ISO 2768-m
- Pre-treatment of the sheet metal surface not necessary.

BELLOWS TYPE 9000 MADE OF PTFE



Bellows Type 9000 made of PTFE

PRODUCT DESCRIPTION

Highly flexible, large elongation, small installed length.

- Design component with protection and/or compensation function
- The moving section of the bellows features highly flexible, punched convolutions
- Sleeve or flange connection on both ends; other combinations possible.

PRODUCT ADVANTAGES

- For various, special applications
- Universal chemical resistance
- High temperature resistant
- Highly flexible
- For special applications as special design.

APPLICATION

- Elongation and vibration compensation
- Rod protection in corrosive atmospheres
- Fluid flow for the chemical industry, pharmaceuticals, appliance manufacture including glass appliances, gas seals, exhaust air cabins and fans, metering pumps, regulation and shut-off valves.

MATERIAL

- Virgin, pure PTFE for general, industrial applications in chemistry
- Low pore, modified PTFE for applications in the food processing industry and pharmaceuticals
- Conductive PTFE to prevent static charging
- Pressure resistant PTFE compound (mineral/carbon additives).

OPERATING CONDITIONS

Abs. pressure	0,05 ... 0,2 MPa
Temperature	-120 ... +200 °C

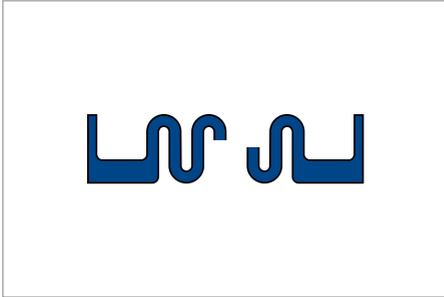
FITTING & INSTALLATION

Flanges must be very carefully fitted because the edge of the flange can easily damage the bellows. The mating surfaces must be flat and even. Over elongation of the bellows during installation and operation is to be avoided.

To suppress cold flow at the PTFE flange edge, soft seals must be used.

The soft seals are also used for the even distribution of the contact forces.

BELLOWS TYPE 9002 MADE OF PTFE



Bellows Type 9002 made of PTFE

PRODUCT DESCRIPTION

Stable walls, good flexibility and adequate elongation reserve.

- Design component with protection and/or compensation function
- The moving section of the bellows features stable, curved convolutions
- Sleeve or flange connection on both ends; other combinations possible.

PRODUCT ADVANTAGES

- For various, special applications
- Universal chemical resistance
- High temperature resistant
- Highly flexible
- For special applications as special design.

APPLICATION

- Elongation and vibration compensation
- Rod protection in corrosive atmospheres
- Fluid flow for the chemical industry, pharmaceuticals, appliance manufacture including glass appliances, gas seals, exhaust air cabins and fans, metering pumps, regulation and shut-off valves.

MATERIAL

- Virgin, pure PTFE for general, industrial applications in chemistry
- Low pore, modified PTFE for applications in the food processing industry and pharmaceuticals
- Conductive PTFE to prevent static charging
- Pressure resistant PTFE compound (mineral/carbon additives).

OPERATING CONDITIONS

Abs. pressure	0,025 ... 0,6 MPa
Temperature	-120 ... +200 °C

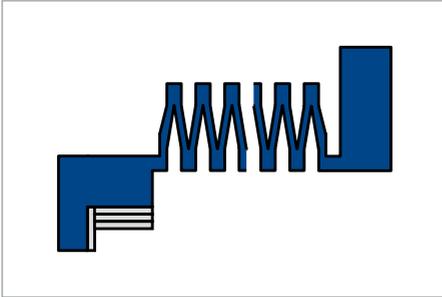
FITTING & INSTALLATION

Flanges must be very carefully fitted because the edge of the flange can easily damage the bellows. The mating surfaces must be flat and even. Over elongation of the bellows during installation and operation is to be avoided.

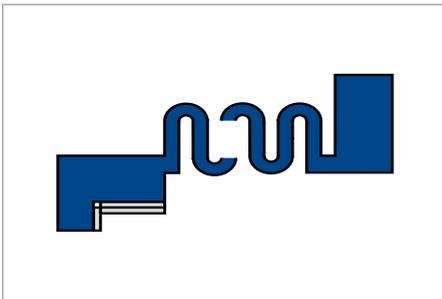
To suppress cold flow at the PTFE flange edge, soft seals must be used.

The soft seals are also used for the even distribution of the contact forces.

BELLOWS TYPE 9020 TO 9023 MADE OF PTFE



Bellows Type 9020



Bellows Typ 9022

PRODUCT DESCRIPTION

Bellows geometry as for Type 9000, 9002, sealing cone and flange fittings are often manufactured from more pressure resistant PTFE compound.

- Design component with protection and/or compensation function
- The moving section of the bellows features highly flexible, pointed or stable curved convolutions
- For fastening to spindles and rods, threaded sleeves are anchored in the cone on the bellows.

PRODUCT ADVANTAGES

- For various, special applications
- Universal chemical resistance
- High temperature resistant
- Highly flexible
- For special applications as special design.

APPLICATION

- Metering pumps
- Regulation and shut-off valves.

MATERIAL

- Virgin, pure PTFE for general, industrial applications in chemistry
- Low pore, modified PTFE for applications in the food processing industry and pharmaceuticals
- Conductive PTFE to prevent static charging
- Pressure resistant PTFE compound (mineral/carbon additives).

OPERATING CONDITIONS

Abs. pressure	0,05 ... 0,2 MPa (convolution type FBA-9000)
	vacuum ... 0,6 MPa (convolution type FBC-9002)
Temperature	-20 ... +200 °C

FITTING & INSTALLATION

Flanges must be very carefully fitted because the edge of the flange can easily damage the bellows. The mating surfaces must be flat and even. Over elongation of the bellows during installation and operation is to be avoided. To suppress cold flow at the PTFE flange edge, soft seals must be used.

The soft seals are also used for the even distribution of the contact forces.

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