



SEALING RINGS
RETAINING RINGS

This catalog "A9" was generated with great diligence based on the previous Fey laminar ring catalogs (A1 - A8) and all the information was checked for accuracy. However, we do not accept any liability for erroneous or incomplete information.

We are certified in accordance with:

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Those who have followed the development of Fey laminar rings since 1946 will remember that laminar rings were first produced in Germany in a single wound version. The "FK2 AS" was used to equip previously used pistons in internal combustion engines to re-establish the sealing or the compression in oval and "worn out" cylinders. These laminar rings were made from spring band steel or flat wire, including stainless steel and high-temperature alloys.

This first application of the Fey rings was successful for many years, however, it could not secure the economic future of Fey.

A significant condition for the further development of the Fey laminar ring sealings was the development of a cost effective manufacturing process, so that the rings could be manufactured individually in an oval format through thermal treatment, becoming round when installed in their working conditions as out-springing rings into bores or as in-springing rings on shafts by providing the highest possible gap sealing.

Using these arguments and the positive sealing effects of gap and labyrinth sealings, Fey was in a position to address the sealing problems of the industry and this resulted in increasing inquiries and requirements that led to a sealing program with a diameter range from 15 mm to 1,300 mm. In the meantime, Fey's manufacturing program consists of app. 16,800 ring types with different ring diameters, ring cross sections and different ring materials.

Successful users of Fey laminar rings include manufacturers of roller and plain bearings, exhaust pipes of internal combustion engines, axle bearings of rolling stock, continuous casting plants, transmission systems, power units and many more.

Our catalog is also available
on a CD-ROM.



Please contact us!

Fey Lamellenringe GmbH & Co. KG

Von der Bodenfräse zum Mars



1946

Die erste patentierte Erfindung der Firma Fey Lamellenringe:
eine landwirtschaftliche Bodenfräse.

DICHTUNGSRINGE
SICHERUNGSRINGE



2003

Die Firma Fey Lamellenringe landet auf dem Mars.
Im Greifarm „PLUTO“ des Landemoduls „Beagle 2“ vom
europäischen Marsprojekt „Mars Express“
sind Fey Lamellenringe mit an Bord.

Fey laminar rings used as sealing elements for rotating and static sealing applications:

Fey laminar rings combine a low contact multiple labyrinth with very little gap width and are especially effective for grease sealings and for the exclusion of fluid media, dirt and dust entry as well as other contaminations. In addition to their outstanding sealing characteristics for rotating components, the low contact laminar rings with low friction produce a significant reduction of internal heat and wear, which qualifies these sealing elements for high speed applications and applications in temperature and/or friction sensitive installations.

For static sealing applications such as axial compensators at screwed exhaust manifold systems for internal combustion engines, exhaust gas recirculation systems and power units with operating temperatures of up to +700°C, Fey laminar rings will be manufactured from chrome nickel materials, which are spring and heat resistant in the sealing area even at high temperatures.

Design types include single wound (FK3) and double wound (FK6/FK5/FK5-HFL) laminar rings:

Fey laminar rings are offered as single wound laminar rings (AS and IS) with joint gap and as double wound laminar rings (ASD and ISD) without joint gap. The use of the different laminar ring geometries and the design of the installation technology depend on the operating conditions, the motion sequence of the components to be sealed and on the leakage requirements of the customer. In addition to single outspringing or single inspringing ring sets, Fey laminar rings can also be combined as a ring set within a groove: outspringing rings with inspringing rings and vice versa. The additional coverage of the groove base plays within the bore of the housing or at the groove base of the shaft optimize the labyrinth effect and therefore the sealing effect. However, we must point out that these combinations cannot be recommended for all sealing tasks.

One thing which must be avoided at all costs is that the laminar ring seal sets are moved axially by the movement of the groove, which may result from the axial play in the bearings. Depending on the frequency involved, friction would be generated between the ring and the groove flanks which may lead to premature wear of the rings and adjacent components.

Questionnaire (page 41):

This catalog cannot show all potential applications for the laminar rings. This is why we refer to the questionnaire. The answers may put us into the position to address your sealing issues and to propose appropriate recommendations.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production can begin to determine, whether the desired sealing effects for laminar sealing rings or the retaining effects for laminar retaining rings can be achieved. We recommend to contact our technical office for clarification.

Laminar piston rings

for pistons of internal combustion engines, compressors, pneumatic and hydraulic equipment, shock absorbers, etc.

Laminar piston rings

for pistons of freeform and drop forging machine, hydraulic controls and presses



Single laminar sealing rings

Single wound laminar rings for the sealing of grease lubricated roller and plain bearings.



Single and/or double laminar sealing rings

Single and/or double laminar sealing rings are used to seal compensators at exhaust pipes for internal combustion engines, turbochargers and turbines. "FK5" rings are also used to seal bearing units for continuous casting plants.



Double laminar sealing rings

Double wound laminar rings for the sealing of grease lubricated roller and plain bearings for special requirements and also for high rotational speeds.



Laminar retaining rings

Single and double wound laminar retaining rings. DMS double laminar retaining rings with centrifugal force retainer for high shaft speeds.



Plastic laminar ring carrier seals

Plastic ring carriers with laminar sealing rings for the sealing of grease lubricated axle and machine bearings and conveyor belts.



Installation



Greasing



Questionnaire



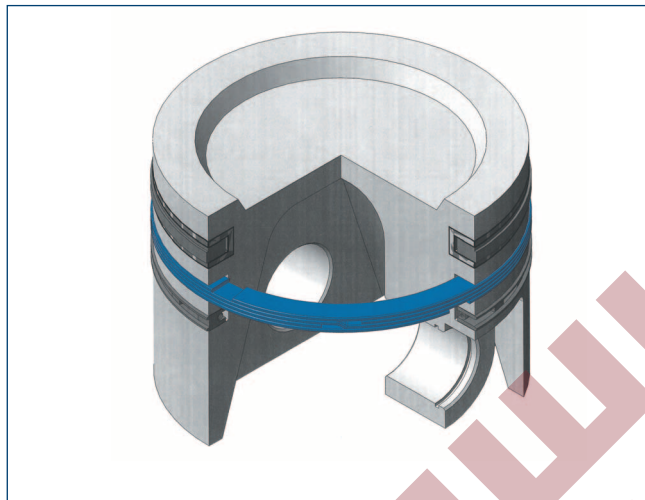
Application examples



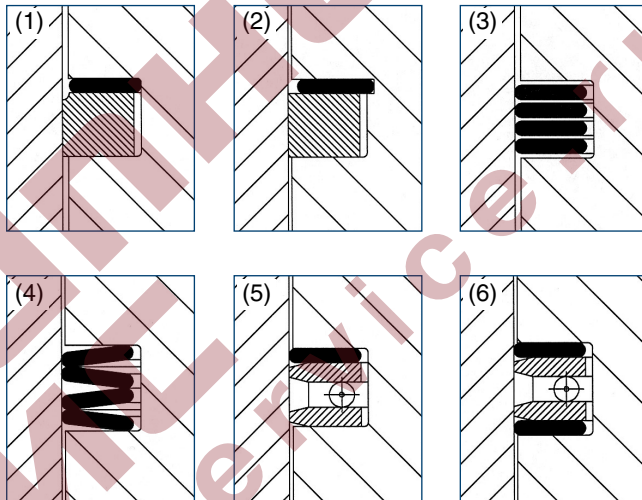
Application:

Laminar sealing rings "FK2" can be used for previously used and new internal combustion engines in connection with cast iron piston rings. Cast iron piston rings are not required for pistons of hydraulic and pneumatic equipment, compressors and shock absorbers. Please contact our technical office for information about ring dimensions, ring materials and groove geometries.

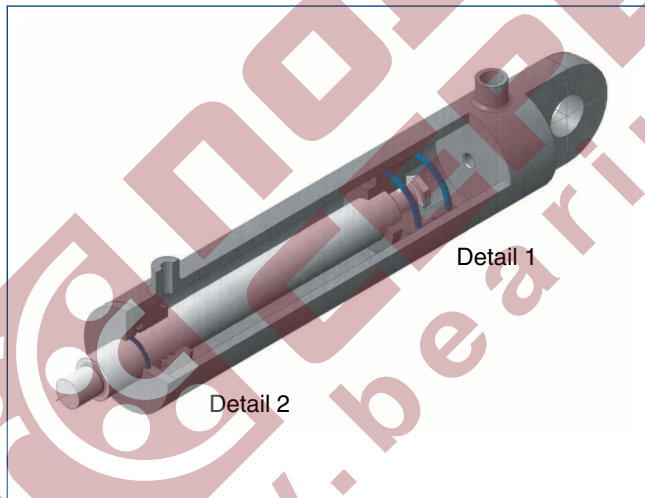
Piston sealings



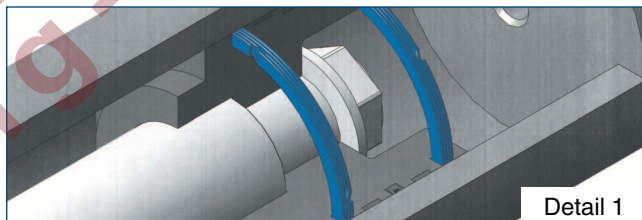
Application examples



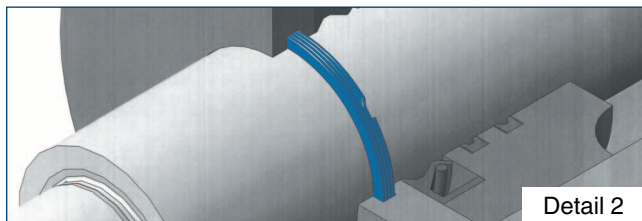
Hydraulic/pneumatic cylinder



Hydraulic/pneumatic piston sealings



Scraper for hydraulic/pneumatic piston rod



Installation information:

See pages 38 and 39.

Order information:

The ring diameter information must match the housing or shaft diameter dimensions exactly for inquiries and/or orders for all ring types.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.

Application:

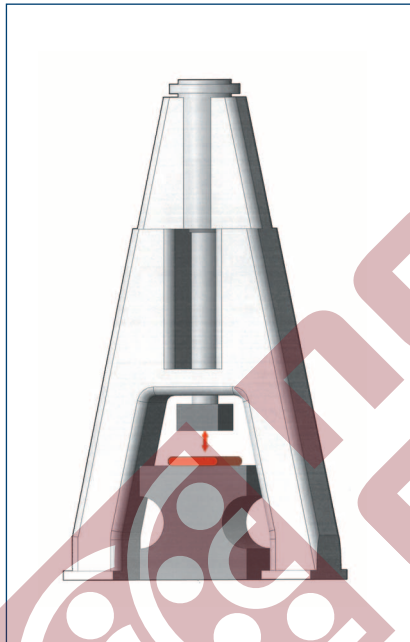
Laminar sealing rings "FK4" for pistons of freeform and drop forging machines, presses and hydraulic controls.
Please contact our technical office for information about ring dimensions, ring materials and groove geometries.

Ring materials

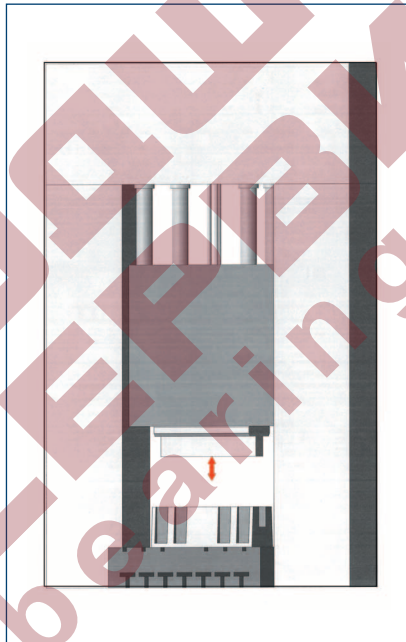
Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾

¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.
²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

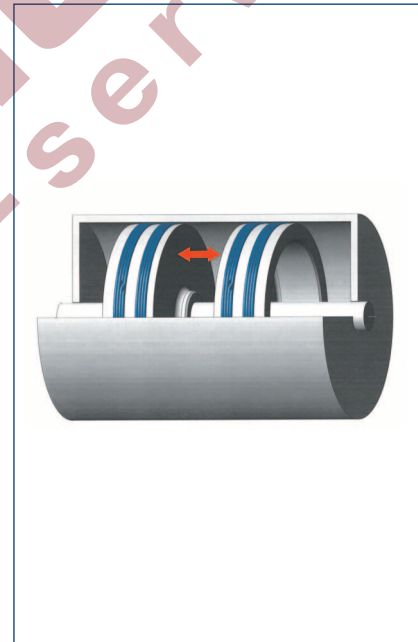
Freeform/drop forging machine



Presses



Hydraulic control



Installation information:

See pages 38 and 39.

Order information:

The ring diameter information must match the housing or shaft diameter dimensions exactly for inquiries and/or orders for all ring types.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.

Application "FK3 AS" Outside clamping single rings (3 rings = 1 set)

Single wound laminar sealing rings "FK3 AS" are used as a grease seal for roller and plain bearings and they protect, if greased, against dust entry and ambient moisture. The combined ring sets "FK3 ASK" (additional sealing of the groove base diameter) optimize the sealing effect due to the increased labyrinth effect.

The "FK3 AS" or "FK3 ASK" assemblies are normally preferred over the "FK3 IS" or "FK3 ISK" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

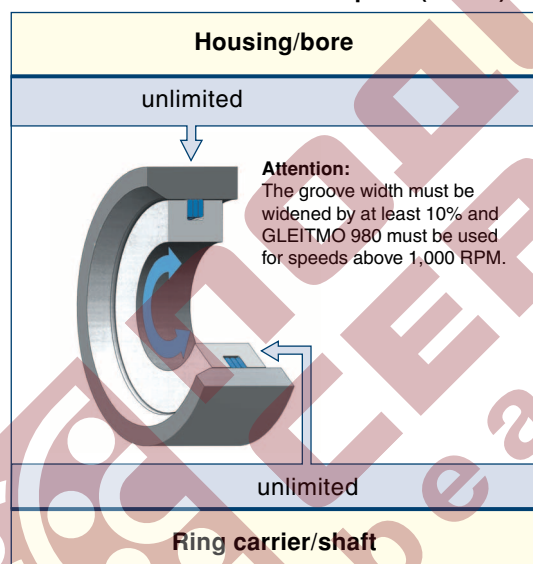
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

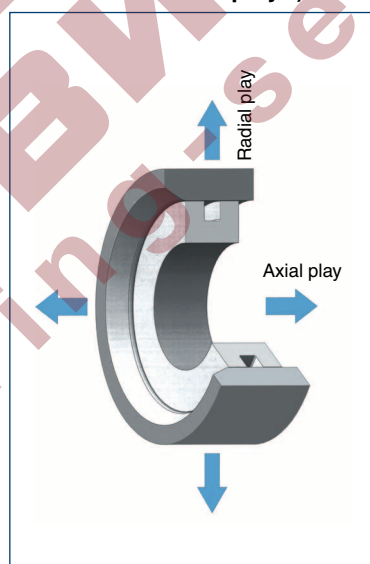
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial and/or radial play ³⁾



FK3 AS ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be reduced by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

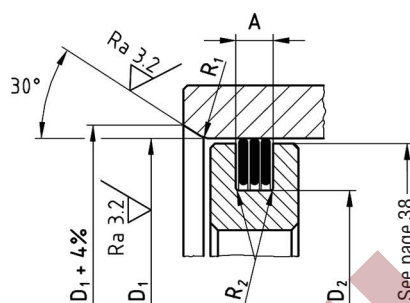
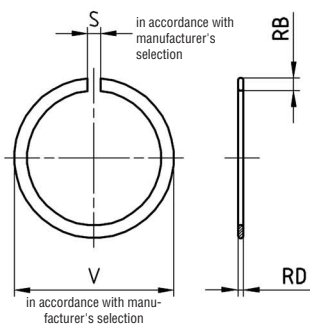
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match the housing or bore diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 3 AS rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Bore D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		0.65		- 2.6		2.2			
25 - 29.9		1.2		0.65		- 3.0		2.2			
30 - 35.9		1.5		0.65		- 3.6		2.2			
36 - 42.9		1.8		0.65		- 4.2		2.2			
43 - 48.9		2.2		0.72		- 5.0		2.4			
49 - 51.9		2.4		0.72		- 5.4		2.4			
52 - 59.9	H 6	2.6	+ 0.1	0.72	+ 0.04	- 5.8	+ 0	2.4	+ 0.1	min. 1	0.1
60 - 69.9	H 7	2.8	- 0.1	0.82	- 0.02	- 6.2	- 0.2	2.7	- 0		
70 - 74.9		3.1		0.82		- 6.8		2.7			
75 - 79.9		3.3		0.82		- 7.2		2.7			
80 - 89.9		3.5		0.82		- 7.6		2.7			
90 - 99.9		3.8		0.82		- 8.2		2.7			
100 - 104.9		4.1		0.82		- 8.8		2.7			
105 - 109.9		4.3		0.98		- 9.2		3.3			
110 - 119.9	H 7	4.6	+ 0.1	0.98	+ 0.05	- 9.8	+ 0	3.3	+ 0.15	min. 2	0.2
120 - 129.9	H 8	5.0	- 0.2	0.98	- 0.03	- 10.8	- 0.25	3.3	- 0		
130 - 149.9		5.5		0.98		- 11.8		3.3			
150 - 170.9		6.0		1.0		- 13.0		3.4			
150 - 170.9		*6.0		1.5		- 13.0		5.1			
171 - 199.9		7.0		1.0		- 15.0		3.4			
171 - 199.9	H 8	*7.0	+ 0.15	1.5	+ 0.06	- 15.0	+ 0	5.1	+ 0.2	min. 3	0.3
200 - 259.9	H 9	8.0	- 0.3	1.2	- 0.04	- 18.0	- 0.3	4.1	- 0		
200 - 259.9		*8.0		1.5		- 18.0		5.1			
260 - 319.9		9.0		1.5		- 20.0		5.1			
320 - 399.9		10.0		1.5		- 22.0		5.2			
400 - 439.9		11.0		1.5		- 24.0		5.2			
440 - 600.9		12.0		1.5		- 26.0		5.2			
440 - 600.9		*12.0		2.5		- 26.0		8.3			
601 - 699.9	H 9	14.0	+ 0.2	2.5	+ 0.07	- 32.0	+ 0	8.3	+ 0.25	min. 4	0.4
700 - 799.9	H 10	16.0	- 0.4	2.5	- 0.05	- 36.0	- 0.4	8.3	- 0		
800 - 899.9		18.0		2.5		- 40.0		8.3			
900 - 999.9		20.0		2.5		- 44.0		8.3			
1000 - 1300		22.0		2.5		- 48.0		8.4			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact bore or housing diameter "D₁ for all inquiries and orders!

FK 3 ASK

Single laminar sealing rings combined for bores

Application "FK3 ASK" Outside clamping combined single rings (5 rings = 1 set)

Single wound laminar sealing rings "FK3 ASK" are used as a grease seal for roller and plain bearings and they protect, if greased, against dust entry and ambient moisture. Due to the increased labyrinth effect, the sealing effect is optimized by the additional sealing of the groove base diameter.

The "FK3 AS" or "FK3 ASK" assemblies are normally preferred over the "FK3 IS" or "FK3 ISK" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

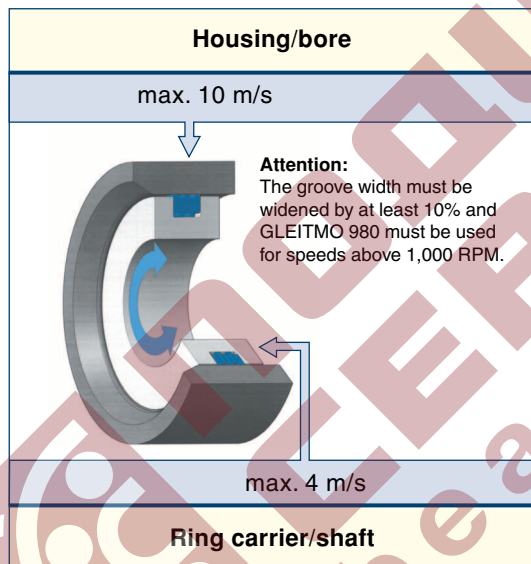
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

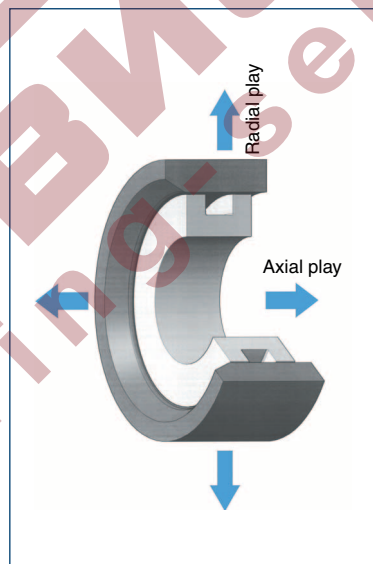
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial and/or radial play ³⁾



FK3 ASK ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be reduced by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

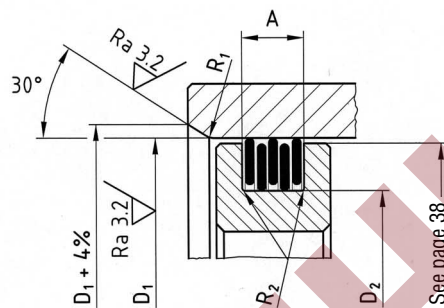
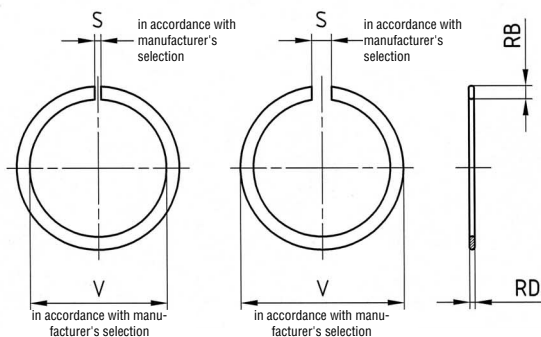
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match the housing or bore diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 3 AS rings + 2 IS rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



FK 3

ASK

Nominal dimension		Ring dimensions				Groove dimensions					
Bore D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		0.65		- 2.6		3.6			
25 - 29.9		1.2		0.65		- 3.0		3.6			
30 - 35.9		1.5		0.65		- 3.6		3.6			
36 - 42.9		1.8		0.65		- 4.2		3.6			
43 - 48.9		2.2		0.72		- 5.0		4.0			
49 - 51.9		2.4		0.72		- 5.4		4.0			
52 - 59.9	H 6	2.6	+ 0.1	0.72	+ 0.04	- 5.8	+ 0	4.0	+ 0.1	min. 1	0.1
60 - 69.9	H 7	2.8	- 0.1	0.82	- 0.02	- 6.2	- 0.2	4.5	- 0		
70 - 74.9		3.1		0.82		- 6.8		4.5			
75 - 79.9		3.3		0.82		- 7.2		4.5			
80 - 89.9		3.5		0.82		- 7.6		4.5			
90 - 99.9		3.8		0.82		- 8.2		4.5			
100 - 104.9		4.1		0.82		- 8.8		4.5			
105 - 109.9		4.3		0.98		- 9.2		5.5			
110 - 119.9	H 7	4.6	+ 0.1	0.98	+ 0.05	- 9.8	+ 0	5.5	+ 0.15	min. 2	0.2
120 - 129.9	H 8	5.0	- 0.2	0.98	- 0.03	- 10.8	- 0.25	5.5	- 0		
130 - 149.9		5.5		0.98		- 11.8		5.5			
150 - 170.9		6.0		1.0		- 13.0		5.6			
150 - 170.9		*6.0		1.5		- 13.0		8.2			
171 - 199.9		7.0		1.0		- 15.0		5.6			
171 - 199.9	H 8	*7.0	+ 0.15	1.5	+ 0.06	- 15.0	+ 0	8.2	+ 0.2	min. 3	0.3
200 - 259.9	H 9	8.0	- 0.3	1.2	- 0.04	- 18.0	- 0.3	6.6	- 0		
200 - 259.9		*8.0		1.5		- 18.0		8.2			
260 - 319.9		9.0		1.5		- 20.0		8.2			
320 - 399.9		10.0		1.5		- 22.0		8.3			
400 - 439.9		11.0		1.5		- 24.0		8.3			
440 - 600.9		12.0		1.5		- 26.0		8.3			
440 - 600.9		*12.0		2.5		- 26.0		13.5			
601 - 699.9	H 9	14.0	+ 0.2	2.5	+ 0.07	- 32.0	+ 0	13.5	+ 0.25	min. 4	0.4
700 - 799.9	H 10	16.0	- 0.4	2.5	- 0.05	- 36.0	- 0.4	13.5	- 0		
800 - 899.9		18.0		2.5		- 40.0		13.5			
900 - 999.9		20.0		2.5		- 44.0		13.5			
1000 - 1300		22.0		2.5		- 48.0		13.6			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact bore or housing diameter "D₁ for all inquiries and orders!

Application "FK3 IS" Inside clamping single rings (3 rings = 1 set)

Single wound laminar sealing rings "FK3 IS" are used as a grease seal for roller and plain bearings and they protect, if greased, against dust entry and ambient moisture. The combined ring sets "FK3 ISK" (additional sealing of the groove base diameter) optimize the sealing effect due to the increased labyrinth effect.

The "FK3 AS" or "FK3 ASK" assemblies are normally preferred over the "FK3 IS" or "FK3 ISK" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

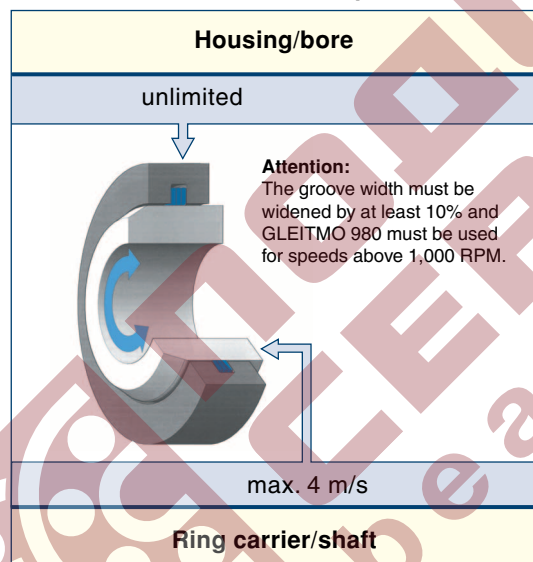
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

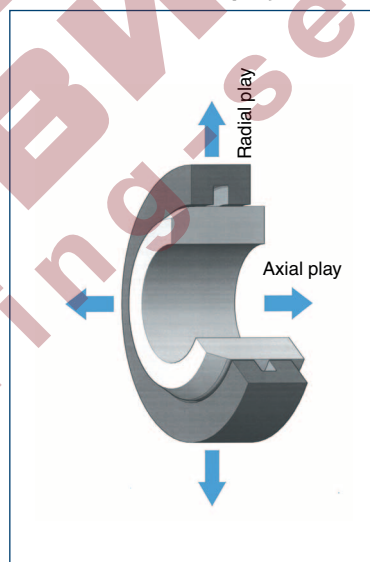
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial and/or radial play ³⁾



FK3 IS ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be increased by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

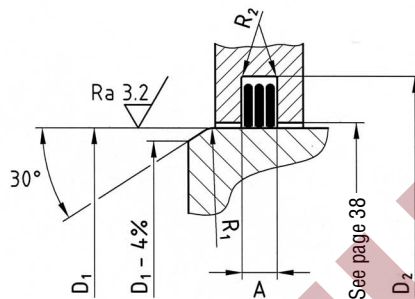
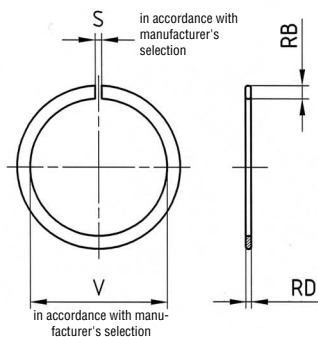
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match the shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 3 IS rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ plus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		0.65		+ 2.6		2.2			
25 - 29.9		1.2		0.65		+ 3.0		2.2			
30 - 35.9		1.5		0.65		+ 3.6		2.2			
36 - 42.9		1.8		0.65		+ 4.2		2.2			
43 - 48.9		2.2		0.72		+ 5.0		2.4			
49 - 51.9		2.4		0.72		+ 5.4		2.4			
52 - 59.9	h 6	2.6	+ 0.1	0.72	+ 0.04	+ 5.8	+ 0.2	2.4	+ 0.1	min. 1	0.1
60 - 69.9	h 7	2.8	- 0.1	0.82	- 0.02	+ 6.2	- 0	2.7	- 0		
70 - 74.9		3.1		0.82		+ 6.8		2.7			
75 - 79.9		3.3		0.82		+ 7.2		2.7			
80 - 89.9		3.5		0.82		+ 7.6		2.7			
90 - 99.9		3.8		0.82		+ 8.2		2.7			
100 - 104.9		4.1		0.82		+ 8.8		2.7			
105 - 109.9		4.3		0.98		+ 9.2		3.3			
110 - 119.9	h 7	4.6	+ 0.1	0.98	+ 0.05	+ 9.8	+ 0.25	3.3	+ 0.15	min. 2	0.2
120 - 129.9	h 8	5.0	- 0.2	0.98	- 0.03	+ 10.8	- 0	3.3	- 0		
130 - 149.9		5.5		0.98		+ 11.8		3.3			
150 - 170.9		6.0		1.0		+ 13.0		3.4			
150 - 170.9		*6.0		1.5		+ 13.0		5.1			
171 - 199.9		7.0		1.0		+ 15.0		3.4			
171 - 199.9	h 8	*7.0	+ 0.15	1.5	+ 0.06	+ 15.0	+ 0.3	5.1	+ 0.2	min. 3	0.3
200 - 259.9	h 9	8.0	- 0.3	1.2	- 0.04	+ 18.0	- 0	4.1	- 0		
200 - 259.9		*8.0		1.5		+ 18.0		5.1			
260 - 319.9		9.0		1.5		+ 20.0		5.1			
320 - 399.9		10.0		1.5		+ 22.0		5.2			
400 - 439.9		11.0		1.5		+ 24.0		5.2			
440 - 600.9		12.0		1.5		+ 26.0		5.2			
440 - 600.9		*12.0		2.5		+ 26.0		8.3			
601 - 699.9	h 9	14.0	+ 0.2	2.5	+ 0.07	+ 32.0	+ 0.4	8.3	+ 0.25	min. 4	0.4
700 - 799.9	h 10	16.0	- 0.4	2.5	- 0.05	+ 36.0	- 0	8.3	- 0		
800 - 899.9		18.0		2.5		+ 40.0		8.3			
900 - 999.9		20.0		2.5		+ 44.0		8.3			
1000 - 1300		22.0		2.5		+ 48.0		8.4			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact shaft diameter "D₁" for all inquiries and orders!

FK 3

IS

FK 3 ISK

Single laminar sealing rings combined for shafts

Application "FK3 ISK" Inside clamping combined single rings (5 rings = 1 set)

Single wound laminar sealing rings "FK3 ISK" are used as a grease seal for roller and plain bearings and they protect, if greased, against dust entry and ambient moisture. Due to the increased labyrinth effect, the sealing effect is optimized by the additional sealing of the groove base diameter.

The "FK3 AS" or "FK3 ASK" assemblies are normally preferred over the "FK3 IS" or "FK3 ISK" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

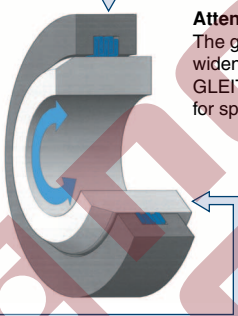
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

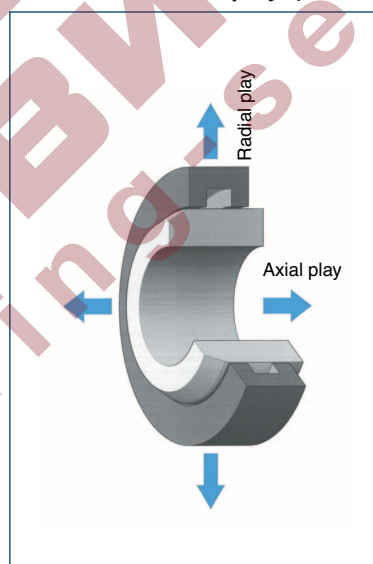
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)

Housing/bore
max. 10 m/s

max. 4 m/s
Ring carrier/shaft

Axial and/or radial play ³⁾



FK3 ISK ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be increased by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

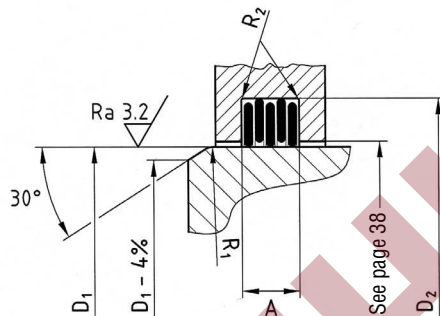
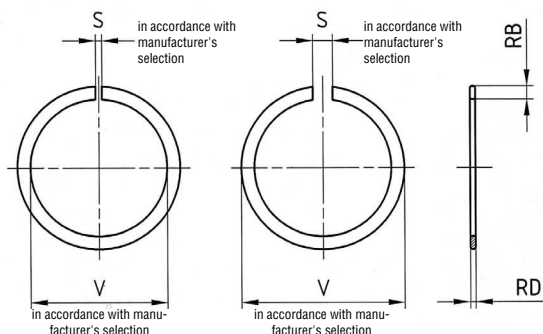
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 3 IS rings + 2 AS rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ plus	Tolerance	A	Tolerance	R ₁	7
15 - 24.9		1.0		0.65		+ 2.6		3.6			
25 - 29.9		1.2		0.65		+ 3.0		3.6			
30 - 35.9		1.5		0.65		+ 3.6		3.6			
36 - 42.9		1.8		0.65		+ 4.2		3.6			
43 - 48.9		2.2		0.72		+ 5.0		4.0			
49 - 51.9		2.4		0.72		+ 5.4		4.0			
52 - 59.9	h 6	2.6	+ 0.1	0.72	+ 0.04	+ 5.8	+ 0.2	4.0	+ 0.1	min. 1	0.1
60 - 69.9	h 7	2.8	- 0.1	0.82	- 0.02	+ 6.2	- 0	4.5	- 0		
70 - 74.9		3.1		0.82		+ 6.8		4.5			
75 - 79.9		3.3		0.82		+ 7.2		4.5			
80 - 89.9		3.5		0.82		+ 7.6		4.5			
90 - 99.9		3.8		0.82		+ 8.2		4.5			
100 - 104.9		4.1		0.82		+ 8.8		4.5			
105 - 109.9		4.3		0.98		+ 9.2		5.5			
110 - 119.9	h 7	4.6	+ 0.1	0.98	+ 0.05	+ 9.8	+ 0.25	5.5	+ 0.15	min. 2	0.2
120 - 129.9	h 8	5.0	- 0.2	0.98	- 0.03	+ 10.8	- 0	5.5	- 0		
130 - 149.9		5.5		0.98		+ 11.8		5.5			
150 - 170.9		6.0		1.0		+ 13.0		5.6			
150 - 170.9		*6.0		1.5		+ 13.0		8.2			
171 - 199.9		7.0		1.0		+ 15.0		5.6			
171 - 199.9	h 8	*7.0	+ 0.15	1.5	+ 0.06	+ 15.0	+ 0.3	8.2	+ 0.2	min. 3	0.3
200 - 259.9	h 9	8.0	- 0.3	1.2	- 0.04	+ 18.0	- 0	6.6	- 0		
200 - 259.9		*8.0		1.5		+ 18.0		8.2			
260 - 319.9		9.0		1.5		+ 20.0		8.2			
320 - 399.9		10.0		1.5		+ 22.0		8.3			
400 - 439.9		11.0		1.5		+ 24.0		8.3			
440 - 600.9		12.0		1.5		+ 26.0		8.3			
440 - 600.9		*12.0		2.5		+ 26.0		13.5			
601 - 699.9	h 9	14.0	+ 0.2	2.5	+ 0.07	+ 32.0	+ 0.4	13.5	+ 0.25	min. 4	0.4
700 - 799.9	h 10	16.0	- 0.4	2.5	- 0.05	+ 36.0	- 0	13.5	- 0		
800 - 899.9		18.0		2.5		+ 40.0		13.5			
900 - 999.9		20.0		2.5		+ 44.0		13.5			
1000 - 1300		22.0		2.5		+ 48.0		13.6			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 6, 38, 39, 40 and 41 (questionnaire).

Please list exact shaft diameter "D₁" for all inquiries and orders!

FK 3

ISK

"FK5" application single and double laminar sealing rings

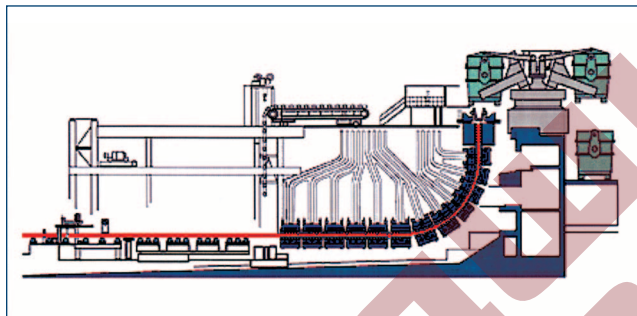
Single and double wound laminar sealing rings are used for sealing the roller and plain bearings on the segments rolls for continuous casting plants, industrial steam turbines, mobile and stationary power units. Basically everywhere the sealing system must meet severe requirements due to extreme operating conditions.

This includes corrosion or media resistance of the ring material, high operating temperatures and high contamination levels.

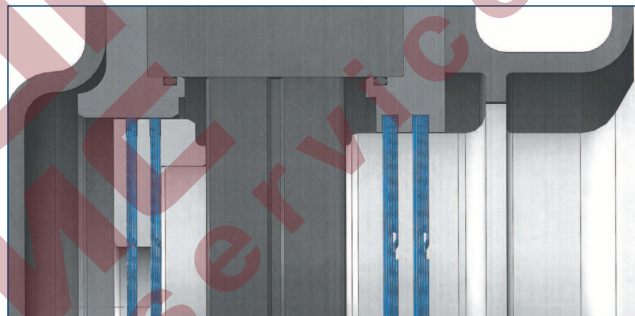
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
CrNi - DIN 1.4571	max. +500°C	on request ¹⁾	bright and dry	variable ²⁾
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC. ²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.				

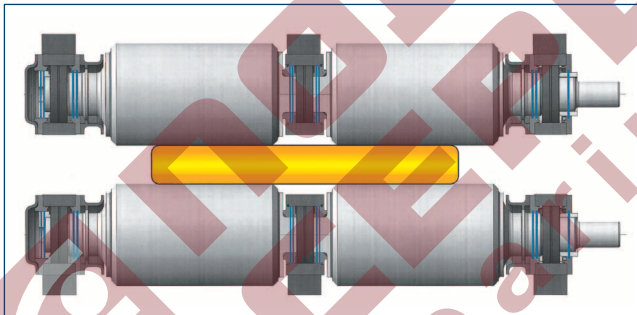
Continuous casting plant-diagram



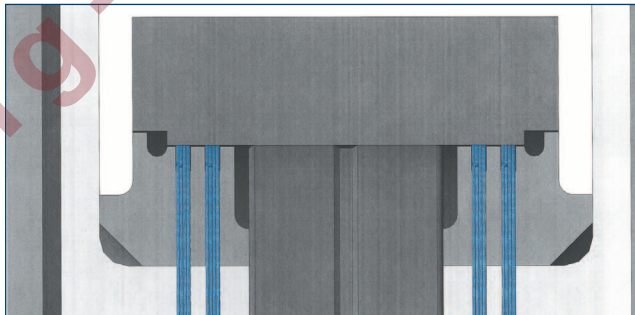
Floating bearing (example)



Drive roller (example)



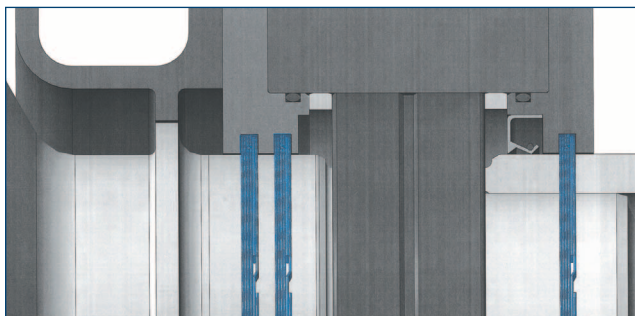
Support bearing (example)



Roller bed roller (example)



Fixed bearing (example)



Installation information:

See pages 38 and 39.

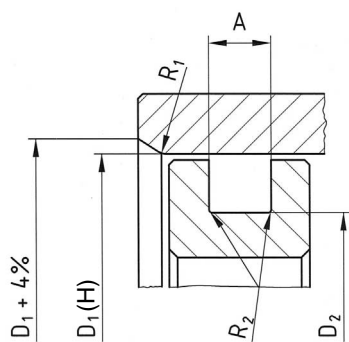
Order information:

The ring diameter information must match the housing or shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets.

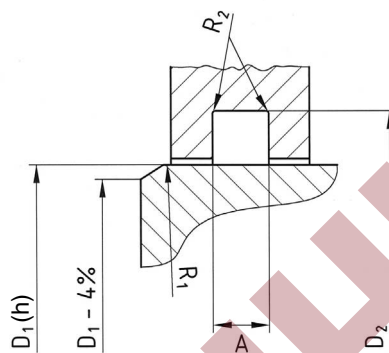
Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.

For bore sealing



For shaft sealing



Nominal dimension		Ring dimensions				Groove dimensions					
Bore/shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus/plus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		1.3							
25 - 29.9		1.2		1.3							
30 - 35.9		1.5		1.3							
36 - 42.9		1.8		1.3							
43 - 48.9		2.2		1.45							
49 - 51.9		2.4		1.45							
52 - 59.9	H/h 6	2.6	+ 0.1	1.45	+ 0.08						
60 - 69.9	H/h 7	2.8	- 0.1	1.65	- 0.04						
70 - 74.9		3.1		1.65							
75 - 79.9		3.3		1.65							
80 - 89.9		3.5		1.65							
90 - 99.9		3.8		1.65							
100 - 104.9		4.1		1.65							
105 - 109.9		4.3		1.96							
110 - 119.9	H/h 7	4.6	+ 0.1	1.96	+ 0.1						
120 - 129.9	H/h 8	5.0	- 0.2	1.96	- 0.06						
130 - 149.9		5.5		1.96							
150 - 170.9		6.0		2.0							
150 - 170.9		*6.0		3.0							
171 - 199.9		7.0		2.0							
171 - 199.9		*7.0		3.0							
200 - 259.9	H/h 8		+ 0.15		+ 0.12						
200 - 259.9	H/h 9	8.0	- 0.3	2.4	- 0.08						
200 - 259.9		*8.0		3.0							
260 - 319.9		9.0		3.0							
320 - 399.9		10.0		3.0							
400 - 439.9		11.0		3.0							
440 - 600.9		12.0		3.0							
440 - 600.9		*12.0		5.0							
601 - 699.9	H/h 9	14.0	+ 0.2	5.0	+ 0.14						
700 - 799.9	H/h 10	16.0	- 0.4	5.0	- 0.1						
800 - 900.0		18.0		5.0							

Groove dimensions on request

Please contact our technical office!

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact bore or shaft diameter "D₁" for all inquiries and orders!

"FK5-HFL" application single and double laminar sealing rings

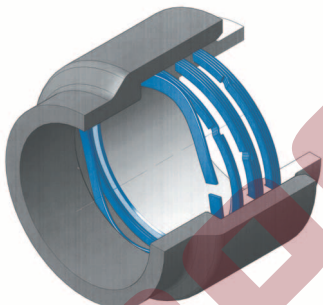
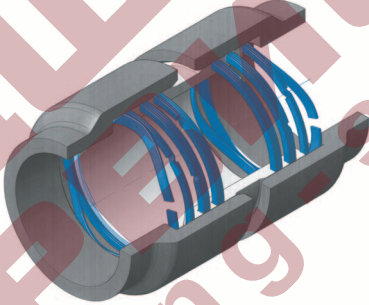
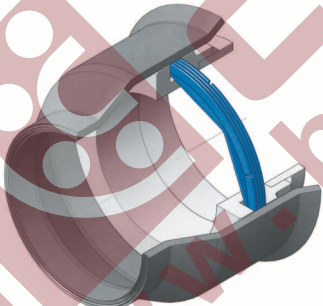
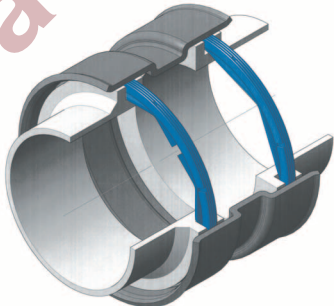
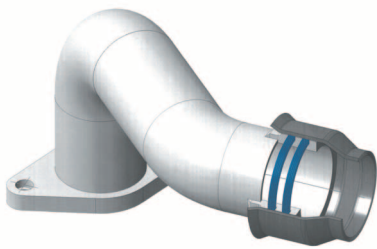
Single and double wound laminar sealing rings with the identification "FK5-HFL" are made from high-temperature chrome-nickel steels and are designed for the sealing for axial and radial compensators at exhaust pipes of internal combustion engines, exhaust gas recirculation systems, exhaust valves, turbochargers, mobile and stationary power units. Especially for applications that deal with high operating temperatures and high axial and radial movements due to thermal expansions.

Ring materials

Steel type	Spring resistant up to	Hardness	Surfaces-treatment	Surfaces-protection	Surfaces-color
CrNi - DIN 1.4571	max. +500°C	on request ¹⁾	Vibratory grinding	dry	variable ²⁾
CrNi - DIN 1.4980	max. +700°C	on request ¹⁾	Vibratory grinding	dry	variable ²⁾

¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Cast iron coupling examples		
Single side coupling	Double side coupling	90° arc coupling
		
Sheet metal coupling with centering expander examples		
Single side sheet metal pipe coupling	Double side sheet metal coupling	Angled sheet metal coupling
		

Expander dimensions on request

Installation information:

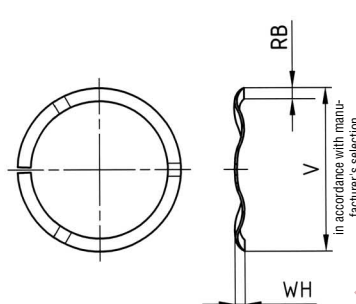
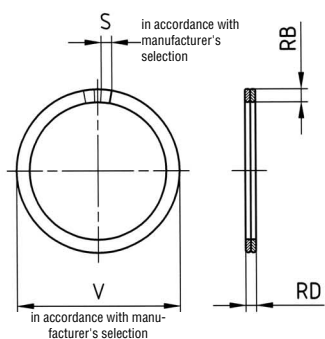
See pages 38 and 39.

Order information:

The ring diameter information must match housing diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production can begin to determine whether the desired sealing effects can be achieved.



Wave spring FK9

Dimensions and diameters on request.
Please contact our technical office for these questions!

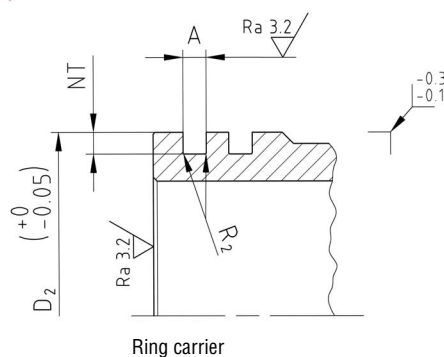
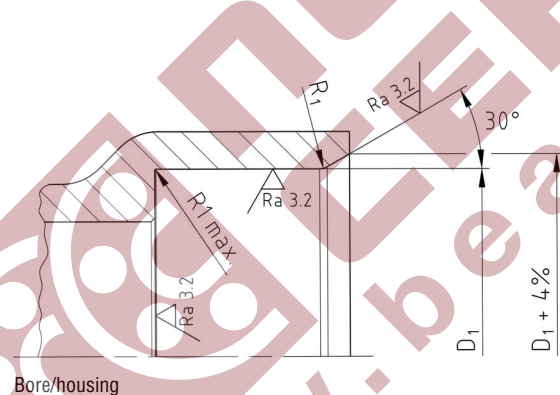
Nominal dimension		Ring dimensions				Groove dimensions					
Bore D_1	Tolerance	RB	Tolerance	RD	Tolerance	NT	Tolerance	A	Tolerance	R_1	R_2
30 - 39.9	H 7	2.2	+ 0.1 - 0.1	1.45	+ 0.06 - 0.04	Groove dimensions on request Please contact our technical office!					
40 - 49.9		2.2		1.45							
50 - 59.9		2.6		1.45							
60 - 69.9		2.8		1.65							
70 - 79.9		3.3		1.65							
80 - 89.9		3.8		1.65							
90 - 104.9		4.1		1.65							
105 - 119.9		4.5	+ 0.1 - 0.2	1.95							
120 - 140		5.0		1.95							

All dimensions in mm

Please contact our technical office for other dimensions.

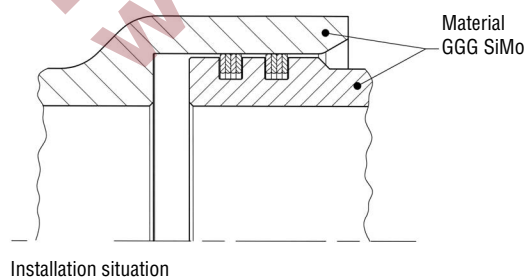
Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact bore diameter "D₁" for all inquiries and orders!

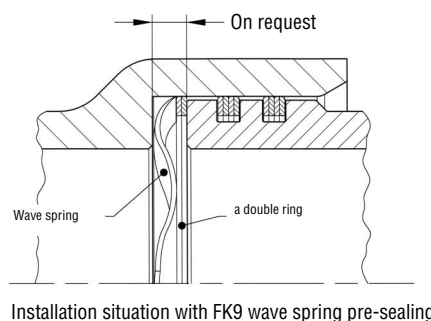


Bore/housing

Ring carrier



Installation situation



Installation situation with FK9 wave spring pre-sealing

FK 6 ASD

Double laminar sealing rings

for bores

Application "FK6 ASD" Outside clamping double rings (2 rings = 1 set)

In contrast to the single wound laminar sealing rings "FK 3", "FK6" laminar rings are double wound. They are used as grease seals for roller and plain bearings. They are also used as a protection seal in front of hermetically acting seal arrangements. The "FK 6" laminar rings must meet special sealing requirements against grease leakage and against dust, dirt and splash water ingress. "FK 6" laminar rings provide a uniform radial tension and, in contrast to the "FK 3" laminar rings, they have no axial joint gap. The combined ring sets "FK6 ASKD" (additional sealing of the groove base diameter) optimize the sealing effect due to the increased labyrinth effect.

The "FK6 ASD" or "FK6 ASKD" assemblies are normally preferred over the "FK6 ISD" or "FK6 ISKD" due to their easier ring installation into the grooves of the ring carriers. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

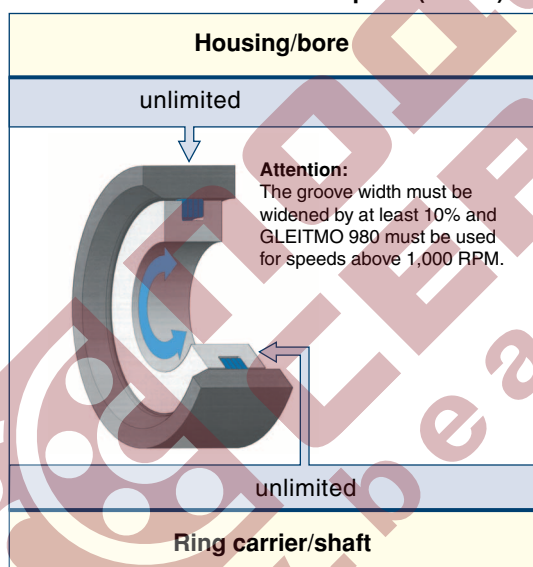
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

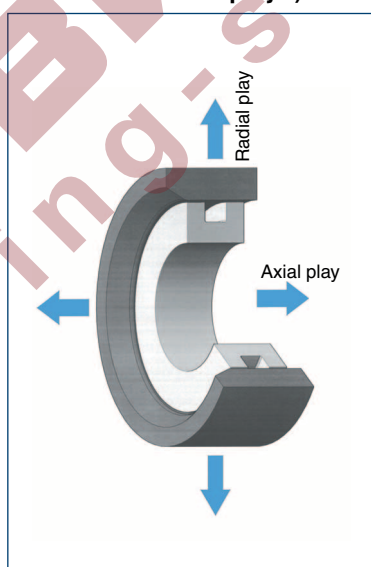
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial and/or radial play ³⁾



FK6 ASD ring set ⁴⁾

1 set = 2 ASD-rings



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be reduced by the radial play if radial play occurs. Damage to the rings and the surrounding components occur if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

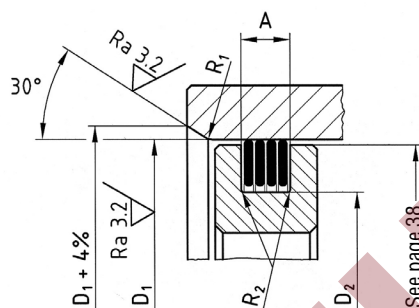
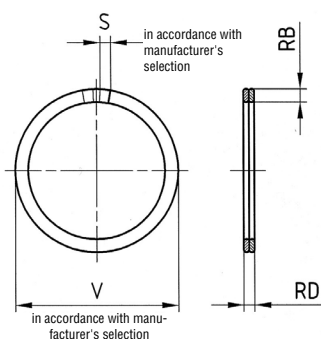
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match the housing or shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 2 ASD rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Bore D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		1.3		- 2.6		2.9			
25 - 29.9		1.2		1.3		- 3.0		2.9			
30 - 35.9		1.5		1.3		- 3.6		2.9			
36 - 42.9		1.8		1.3		- 4.2		2.9			
43 - 48.9		2.2		1.45		- 5.0		3.2			
49 - 51.9		2.4		1.45		- 5.4		3.2			
52 - 59.9	H 6	2.6	+ 0.1	1.45	+ 0.08	- 5.8	+ 0	3.2	+ 0.1	min. 1	0.1
60 - 69.9	H 7	2.8	- 0.1	1.65	- 0.04	- 6.2	- 0.2	3.6	- 0		
70 - 74.9		3.1		1.65		- 6.8		3.6			
75 - 79.9		3.3		1.65		- 7.2		3.6			
80 - 89.9		3.5		1.65		- 7.6		3.6			
90 - 99.9		3.8		1.65		- 8.2		3.6			
100 - 104.9		4.1		1.65		- 8.8		3.6			
105 - 109.9		4.3		1.96		- 9.2		4.3			
110 - 119.9	H 7	4.6	+ 0.1	1.96	+ 0.1	- 9.8	+ 0	4.3	+ 0.15	min. 2	0.2
120 - 129.9	H 8	5.0	- 0.2	1.96	- 0.06	- 10.8	- 0.25	4.3	- 0		
130 - 149.9		5.5		1.96		- 11.8		4.3			
150 - 170.9		6.0		2.0		- 13.0		4.4			
150 - 170.9		*6.0		3.0		- 13.0		6.5			
171 - 199.9		7.0		2.0		- 15.0		4.4			
171 - 199.9	H 8	*7.0	+ 0.15	3.0	+ 0.12	- 15.0	+ 0	6.5	+ 0.2	min. 3	0.3
200 - 259.9	H 9	8.0	- 0.3	2.4	- 0.08	- 18.0	- 0.3	5.3	- 0		
200 - 259.9		*8.0		3.0		- 18.0		6.5			
260 - 319.9		9.0		3.0		- 20.0		6.5			
320 - 399.9		10.0		3.0		- 22.0		6.6			
400 - 439.9		11.0		3.0		- 24.0		6.6			
440 - 600.9		12.0		3.0		- 26.0		6.6			
440 - 600.9		*12.0		5.0		- 26.0		10.6			
601 - 699.9	H 9	14.0	+ 0.2	5.0	+ 0.14	- 32.0	+ 0	10.8	+ 0.25	min. 4	0.4
700 - 799.9	H 10	16.0	- 0.4	5.0	- 0.1	- 36.0	- 0.4	10.8	- 0		
800 - 899.9		18.0		5.0		- 40.0		11.0			
900 - 999.9		20.0		5.0		- 44.0		11.0			
1000 - 1300		22.0		5.0		- 48.0		11.0			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact bore or housing diameter "D₁" for all inquiries and orders!

FK 6 ASKD

Double laminar sealing rings combined for bores

Application "FK6 ASKD" Outside clamping combined double rings (3 rings = 1 set)

Double wound laminar sealing rings "FK6 ASKD" are used as a grease seal for roller and plain bearings and they protect, if greased, against grease leakage as well as against dust, dirt and splash water ingress, especially if the sealing requirements are high. Due to the increased labyrinth effect, the sealing effect is optimized by the additional sealing of the groove base diameter.

The "FK6 ASD" or "FK6 ASKD" assemblies are normally preferred over the "FK6 ISD" or "FK6 ISKD" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

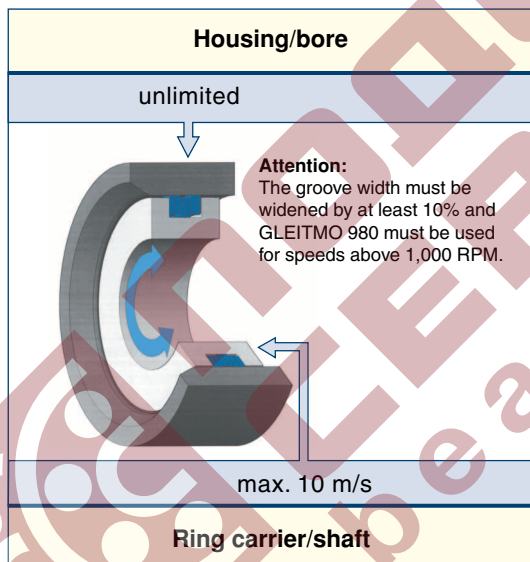
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

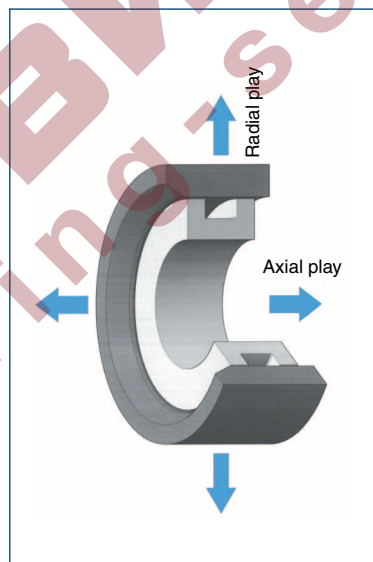
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial and/or radial play ³⁾



FK6 ASKD ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be reduced by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

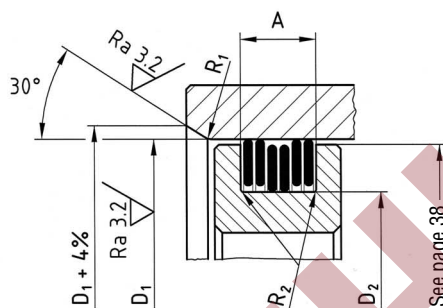
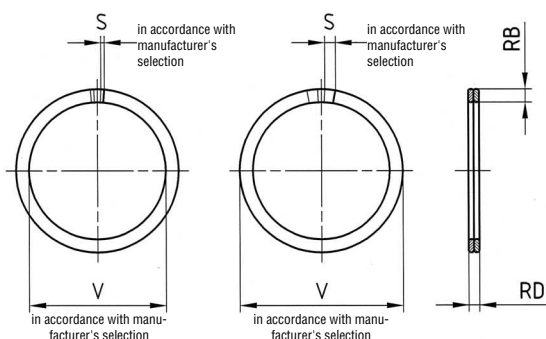
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match the housing or shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 2 ASD rings + 1 ISD rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Bore D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		1.3		- 2.6		4.3			
25 - 29.9		1.2		1.3		- 3.0		4.3			
30 - 35.9		1.5		1.3		- 3.6		4.3			
36 - 42.9		1.8		1.3		- 4.2		4.3			
43 - 48.9		2.2		1.45		- 5.0		4.8			
49 - 51.9		2.4		1.45		- 5.4		4.8			
52 - 59.9	H 6	2.6	+ 0.1	1.45	+ 0.08	- 5.8	+ 0	4.8	+ 0.1	min. 1	0.1
60 - 69.9	H 7	2.8	- 0.1	1.65	- 0.04	- 6.2	- 0.2	5.4	- 0		
70 - 74.9		3.1		1.65		- 6.8		5.4			
75 - 79.9		3.3		1.65		- 7.2		5.4			
80 - 89.9		3.5		1.65		- 7.6		5.4			
90 - 99.9		3.8		1.65		- 8.2		5.4			
100 - 104.9		4.1		1.65		- 8.8		5.4			
105 - 109.9		4.3		1.96		- 9.2		6.4			
110 - 119.9	H 7	4.6	+ 0.1	1.96	+ 0.1	- 9.8	+ 0	6.4	+ 0.15	min. 2	0.2
120 - 129.9	H 8	5.0	- 0.2	1.96	- 0.06	- 10.8	- 0.25	6.4	- 0		
130 - 149.9		5.5		1.96		- 11.8		6.4			
150 - 170.9		6.0		2.0		- 13.0		6.5			
150 - 170.9		*6.0		3.0		- 13.0		9.6			
171 - 199.9		7.0		2.0		- 15.0		6.5			
171 - 199.9	H 8	*7.0	+ 0.15	3.0	+ 0.12	- 15.0	+ 0	9.6	+ 0.2	min. 3	0.3
200 - 259.9	H 9	8.0	- 0.3	2.4	- 0.08	- 18.0	- 0.3	7.8	- 0		
200 - 259.9		*8.0		3.0		- 18.0		9.6			
260 - 319.9		9.0		3.0		- 20.0		9.6			
320 - 399.9		10.0		3.0		- 22.0		9.8			
400 - 439.9		11.0		3.0		- 24.0		9.8			
440 - 600.9		12.0		3.0		- 26.0		9.8			
440 - 600.9		*12.0		5.0		- 26.0		15.9			
601 - 699.9	H 9	14.0	+ 0.2	5.0	+ 0.14	- 32.0	+ 0	16.2	+ 0.25	min. 4	0.4
700 - 799.9	H 10	16.0	- 0.4	5.0	- 0.1	- 36.0	- 0.4	16.2	- 0		
800 - 899.9		18.0		5.0		- 40.0		16.5			
900 - 999.9		20.0		5.0		- 44.0		16.5			
1000 - 1300		22.0		5.0		- 48.0		16.5			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact bore or housing diameter "D₁ for all inquiries and orders!

FK 6

ASKD

FK 6 ISD

Double laminar sealing rings

for shafts

Application "FK6 ISD" Inside clamping double rings (2 rings = 1 set)

Double wound laminar sealing rings "FK6 ISD" are used as a grease seal for roller and plain bearings and they protect, if greased, against grease leakage as well as against dust, dirt and splash water ingress, especially if the sealing requirements are high. Double wound laminar rings provide a uniform radial tension and, in contrast to the single wound "FK3" laminar rings, they have no axial joint gap. The combined ring sets "FK6 ISKD" (additional sealing of the groove base diameter) optimize the sealing effect due to the increased labyrinth effect.

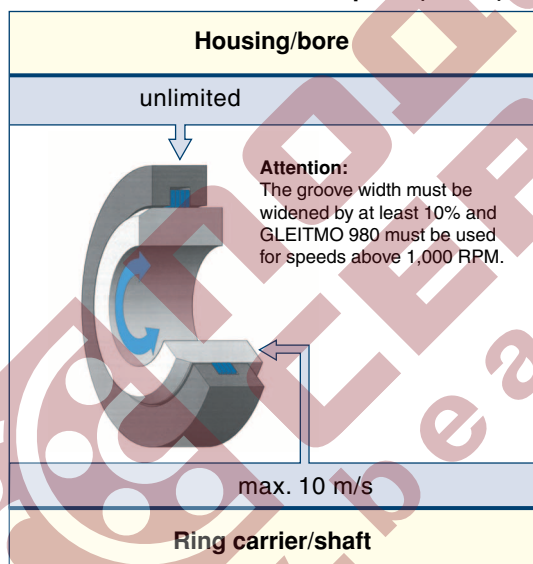
The "FK6 ASD" or "FK6 ASKD" assemblies are normally preferred over the "FK6 ISD" or "FK6 ISKD" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

Ring materials

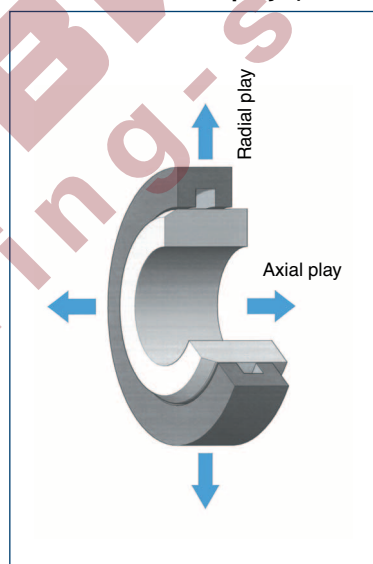
Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.
²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial and/or radial play ³⁾



FK6 ISD ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be increased by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

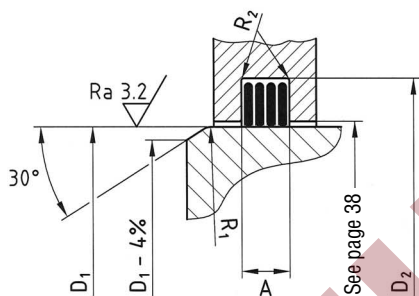
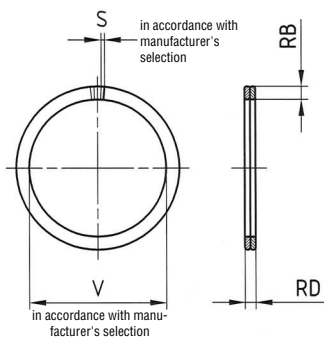
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 2 ISD rings).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ plus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		1.3		+ 2.6		2.9			
25 - 29.9		1.2		1.3		+ 3.0		2.9			
30 - 35.9		1.5		1.3		+ 3.6		2.9			
36 - 42.9		1.8		1.3		+ 4.2		2.9			
43 - 48.9		2.2		1.45		+ 5.0		3.2			
49 - 51.9		2.4		1.45		+ 5.4		3.2			
52 - 59.9	h 6	2.6	+ 0.1	1.45	+ 0.08	+ 5.8	+ 0.2	3.2	+ 0.1	min.	0.1
60 - 69.9	h 7	2.8	- 0.1	1.65	- 0.04	+ 6.2	- 0	3.6	- 0	1	
70 - 74.9		3.1		1.65		+ 6.8		3.6			
75 - 79.9		3.3		1.65		+ 7.2		3.6			
80 - 89.9		3.5		1.65		+ 7.6		3.6			
90 - 99.9		3.8		1.65		+ 8.2		3.6			
100 - 104.9		4.1		1.65		+ 8.8		3.6			
105 - 109.9		4.3		1.96		+ 9.2		4.3			
110 - 119.9	h 7	4.6	+ 0.1	1.96	+ 0.1	+ 9.8	+ 0.25	4.3	+ 0.15	min.	0.2
120 - 129.9	h 8	5.0	- 0.2	1.96	- 0.06	+ 10.8	- 0	4.3	- 0	2	
130 - 149.9		5.5		1.96		+ 11.8		4.3			
150 - 170.9		6.0		2.0		+ 13.0		4.4			
150 - 170.9		*6.0		3.0		+ 13.0		6.5			
171 - 199.9		7.0		2.0		+ 15.0		4.4			
171 - 199.9	h 8	*7.0	+ 0.15	3.0	+ 0.12	+ 15.0	+ 0.3	6.5	+ 0.2	min.	0.3
200 - 259.9	h 9	8.0	- 0.3	2.4	- 0.08	+ 18.0	- 0	5.3	- 0	3	
200 - 259.9		*8.0		3.0		+ 18.0		6.5			
260 - 319.9		9.0		3.0		+ 20.0		6.5			
320 - 399.9		10.0		3.0		+ 22.0		6.6			
400 - 439.9		11.0		3.0		+ 24.0		6.6			
440 - 600.9		12.0		3.0		+ 26.0		6.6			
440 - 600.9		*12.0		5.0		+ 26.0		10.6			
601 - 699.9	h 9	14.0	+ 0.2	5.0	+ 0.14	+ 32.0	+ 0.4	10.8	+ 0.25	min.	0.4
700 - 799.9	h 10	16.0	- 0.4	5.0	- 0.1	+ 36.0	- 0	10.8	- 0	4	
800 - 899.9		18.0		5.0		+ 40.0		11.0			
900 - 999.9		20.0		5.0		+ 44.0		11.0			
1000 - 1300		22.0		5.0		+ 48.0		11.0			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact shaft diameter "D₁" for all inquiries and orders!

FK 6

ISD

FK 6 ISKD

Double laminar sealing rings combined for shafts

Application "FK6 ISKD" Inside clamping combined double rings (3 rings = 1 set)

Double wound laminar sealing rings "FK6 ISKD" are used as a grease seal for roller and plain bearings and they protect, if greased, against grease leakage as well as against dust, dirt and splash water ingress, especially if the sealing requirements are high. Due to the increased labyrinth effect, the sealing effect is optimized by the additional sealing of the groove base diameter.

The "FK6 ASD" or "FK6 ASKD" assemblies are normally preferred over the "FK6 ISD" or "FK6 ISKD" assemblies due to their easier installation into the grooves. Depending on the applications or the technical requirements, the ring carriers can be manufactured from steel, cast iron, light alloy or plastics.

Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

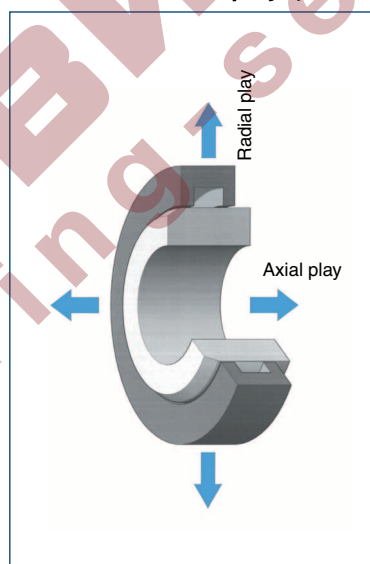
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)

Housing/bore
unlimited
 max. 10 m/s
Ring carrier/shaft

Axial and/or radial play ³⁾



FK6 ISKD ring set ⁴⁾



Axial and/or radial play ³⁾:

The groove width "A" must be widened by twice the play if play occurs in the area of the rings. The groove base diameter "D₂" must be increased by the radial play if radial play occurs. Damage to the rings and the surrounding components occurs if this is not adhered to. It is recommended to use the full groove width tolerances, especially in the case of thermal expansion.

Installation information:

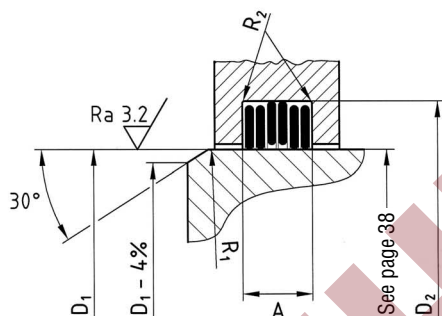
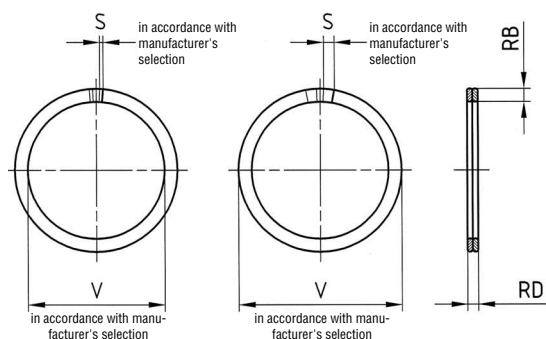
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match shaft diameter dimensions "D₁" for all inquiries and/or orders. The rings can be ordered individually or in sets (1 set = 2 ISD rings + 1 ASD ring).

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the desired sealing effects can be achieved.



Nominal dimension		Ring dimensions				Groove dimensions					
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ plus	Tolerance	A	Tolerance	R ₁	R ₂
15 - 24.9		1.0		1.3		+ 2.6		4.3			
25 - 29.9		1.2		1.3		+ 3.0		4.3			
30 - 35.9		1.5		1.3		+ 3.6		4.3			
36 - 42.9		1.8		1.3		+ 4.2		4.3			
43 - 48.9		2.2		1.45		+ 5.0		4.8			
49 - 51.9		2.4		1.45		+ 5.4		4.8			
52 - 59.9	h 6	2.6	+ 0.1	1.45	+ 0.08	+ 5.8	+ 0.2	4.8	+ 0.1	min.	0.1
60 - 69.9	h 7	2.8	- 0.1	1.65	- 0.04	+ 6.2	- 0	5.4	- 0	1	
70 - 74.9		3.1		1.65		+ 6.8		5.4			
75 - 79.9		3.3		1.65		+ 7.2		5.4			
80 - 89.9		3.5		1.65		+ 7.6		5.4			
90 - 99.9		3.8		1.65		+ 8.2		5.4			
100 - 104.9		4.1		1.65		+ 8.8		5.4			
105 - 109.9		4.3		1.96		+ 9.2		6.4			
110 - 119.9	h 7	4.6	+ 0.1	1.96	+ 0.1	+ 9.8	+ 0.25	6.4	+ 0.15	min.	0.2
120 - 129.9	h 8	5.0	- 0.2	1.96	- 0.06	+ 10.8	- 0	6.4	- 0	2	
130 - 149.9		5.5		1.96		+ 11.8		6.4			
150 - 170.9		6.0		2.0		+ 13.0		6.5			
150 - 170.9		*6.0		3.0		+ 13.0		9.6			
171 - 199.9		7.0		2.0		+ 15.0		6.5			
171 - 199.9	h 8	*7.0	+ 0.15	3.0	+ 0.12	+ 15.0	+ 0.3	9.6	+ 0.2	min.	0.3
200 - 259.9	h 9	8.0	- 0.3	2.4	- 0.08	+ 18.0	- 0	7.8	- 0	3	
200 - 259.9		*8.0		3.0		+ 18.0		9.6			
260 - 319.9		9.0		3.0		+ 20.0		9.6			
320 - 399.9		10.0		3.0		+ 22.0		9.8			
400 - 439.9		11.0		3.0		+ 24.0		9.8			
440 - 600.9		12.0		3.0		+ 26.0		9.8			
440 - 600.9		*12.0		5.0		+ 26.0		15.9			
601 - 699.9	h 9	14.0	+ 0.2	5.0	+ 0.14	+ 32.0	+ 0.4	16.2	+ 0.25	min.	0.4
700 - 799.9	h 10	16.0	- 0.4	5.0	- 0.1	+ 36.0	- 0	16.2	- 0	4	
800 - 899.9		18.0		5.0		+ 40.0		16.5			
900 - 999.9		20.0		5.0		+ 44.0		16.5			
1000 - 1300		22.0		5.0		+ 48.0		16.5			

All dimensions in mm

*= reinforced ring design

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

Please list exact shaft diameter "D₁" for all inquiries and orders!

FK 6

ISKD

FK 7 ESB

Single laminar retaining rings

for bores

Application "FK7 ESB" Single retaining ring bore

The application range for the single wound laminar retaining rings "FK7 ESB" for bores includes applications where the components need to be axially retained, e.g. for transmission systems, construction equipment and agriculture machinery, for fastening elements in the automotive industry and mechanical engineering, in the roller and plain bearing industry, for ship and aircraft building, winches, pulleys, etc.

Assembly/disassembly features are special options for single wound laminar retaining rings (see sketch on page 27).

Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

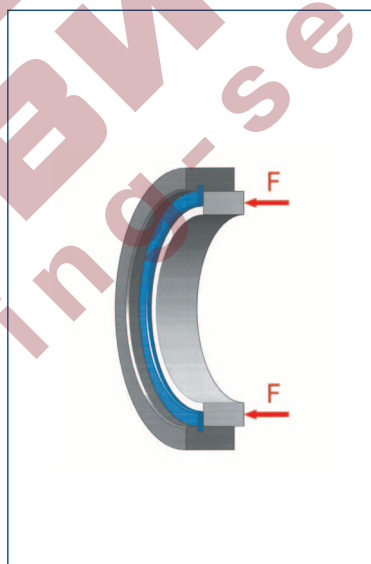
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

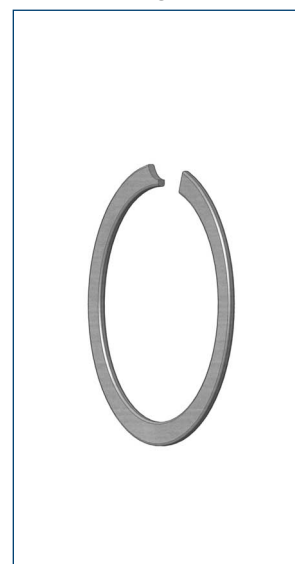
Permissible circumferential speed (in m/s)

Housing/bore
unlimited
 Attention: For inquiries and orders, please provide exact bore diameter "D₁", operating temperature and speed!

Axial stress ³⁾



FK7 ESB ring ⁴⁾



Axial stress ³⁾:

Shearing tests under operating conditions must be performed to determine the axial shearing capacity of the retaining rings. The secure position of the retaining rings in the groove cannot be guaranteed if the surrounding components thrust uncontrollable against the laminar rings during operation (coupling effect) or if the components vibrate extremely.

Installation information:

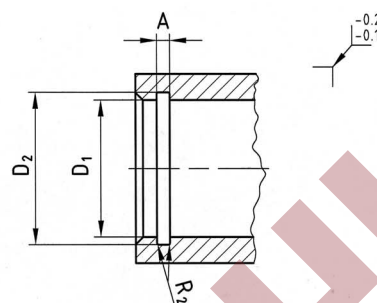
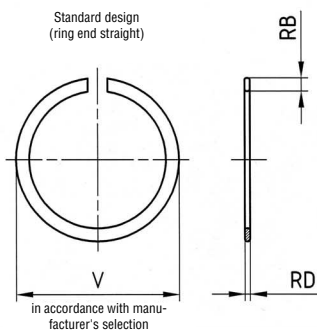
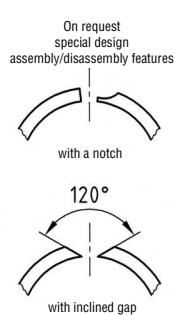
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match bore diameter dimensions "D₁" for all inquiries and/or orders.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the retaining rings can withstand the required stress.



Nominal dimension		Ring dimensions				Groove dimensions				
Bore D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ plus	Tolerance	A	Tolerance	R ₂
15 - 20.9	H 6 H 7	1.5	+ 0.1 - 0.2	0.65	+ 0.05 - 0.02	+ 0.8	+ 0.1 - 0	0.75	+ 0.05 - 0	0.1
21 - 29.9		1.8		0.65		+ 0.9		0.75		
30 - 35.9		2.2		0.72		+ 1.2		0.85		
36 - 42.9		2.8		0.82		+ 1.6		0.95		
43 - 51.9		3.1		0.82		+ 1.8		0.95		
52 - 59.9		3.5		0.82		+ 2.0		0.95		
60 - 69.9	H 7 H 8	3.8	+ 0.1 - 0.2	0.82	+ 0.06 - 0.03	+ 2.0	+ 0.2 - 0	0.95	+ 0.1 - 0	0.2
70 - 74.9		4.1		0.82		+ 2.5		0.95		
75 - 79.9		4.3		0.98		+ 2.5		1.1		
80 - 89.9		4.6		0.98		+ 2.8		1.1		
90 - 99.9		5.0		0.98		+ 3.0		1.1		
100 - 109.9		5.5		0.98		+ 3.0		1.1		
110 - 129.9	H 7 H 8	6.0	+0.1/-0.2 +0.15/-0.3	1.0	+0.06/-0.03 +0.08/-0.04	+ 3.5		1.15	+0.1/-0 +0.15/-0	0.3
130 - 149.9		6.0		1.5		+ 3.5		1.65		
150 - 169.9	H 8 H 9	7.0	+ 0.15 - 0.3	1.5	+ 0.08 - 0.04	+ 4.0	+ 0.3 - 0	1.65	+ 0.15 - 0	0.4
170 - 199.9		8.0		1.5		+ 5.0		1.65		
200 - 259.9		9.0		1.5		+ 5.0		1.65		
260 - 319.9		10.0		1.5		+ 5.5		1.65		
320 - 399.9	H 8 H 9	11.0		1.5		+ 6.0		1.65		
400 - 439.9		12.0		1.5		+ 7.0		1.65		
440 - 599.9	H 9 H 10	12.0	+ 0.2 - 0.4	2.5	+ 0.1 - 0.05	+ 7.0	+ 0.4 - 0	2.7	+ 0.2 - 0	0.4
600 - 699.9		14.0		2.5		+ 8.0		2.7		
700 - 799.9		16.0		2.5		+ 9.0		2.7		
800 - 899.9		18.0		2.5		+ 10.0		2.7		
900 - 999.9	H 9 H 10	20.0		2.5		+ 11.0		2.7		
1000 - 1300		22.0		2.5		+ 12.0		2.7		

All dimensions in mm

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

For inquiries and orders, please provide the exact bore diameter "D₁", operating temperature and speed!

FK 7 ESW

Single laminar retaining rings

for shafts

Application "FK7 ESW" Single retaining ring shaft

The application range for the single wound laminar retaining rings "FK7 ESW" for shafts includes applications where the components need to be axially retained, e.g. for transmission systems, construction equipment and agriculture machinery, for fastening elements in the automotive industry and mechanical engineering, in the roller and plain bearing industry, for ship and aircraft building, winches, pulleys, etc.

Assembly/disassembly features are special options for single wound laminar retaining rings (see sketch on page 29).

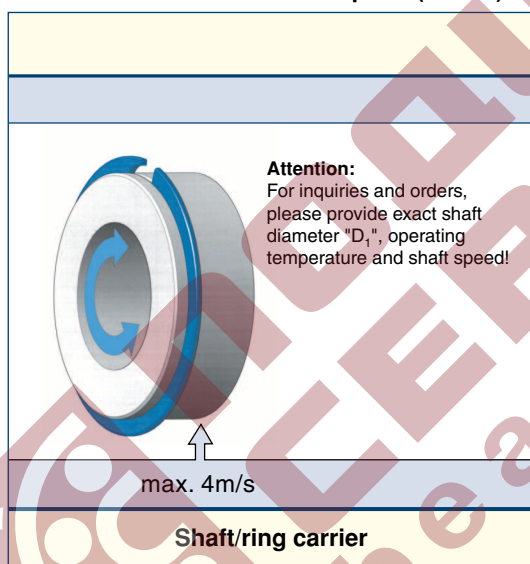
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

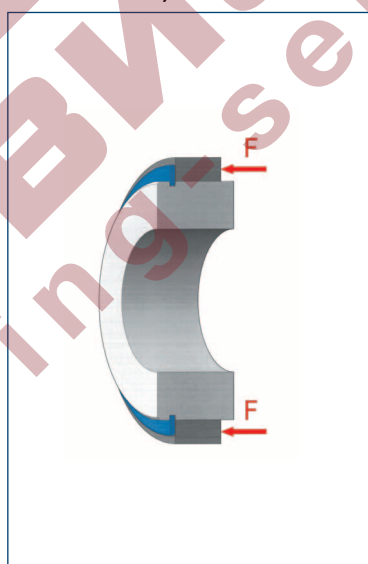
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

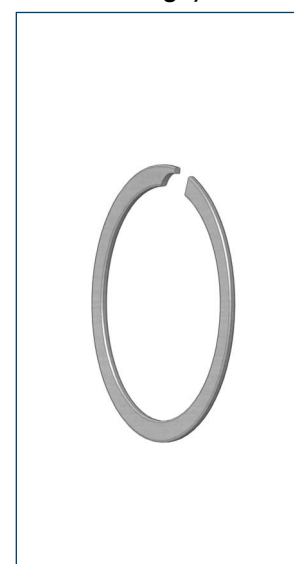
Permissible circumferential speed (in m/s)



Axial stress ³⁾



FK7 ESW ring ⁴⁾



Axial stress ³⁾:

Shearing tests under operating conditions must be performed to determine the axial shearing capacity of the retaining rings. The secure position of the retaining rings in the groove cannot be guaranteed if the surrounding components thrust uncontrollable against the laminar rings during operation (coupling effect) or if the components vibrate extremely.

Installation information:

See pages 38 and 39.

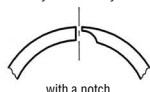
Order information ⁴⁾:

The ring diameter information must match shaft diameter dimensions "D₁" for all inquiries and/or orders.

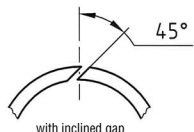
Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the retaining rings can withstand the required stress.

On request
special design
assembly/disassembly features

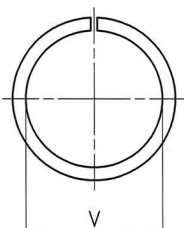


with a notch

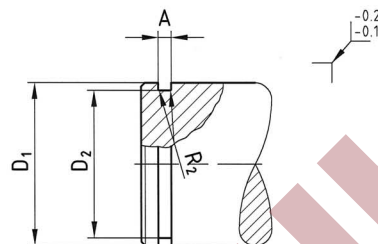
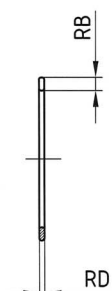


with inclined gap

Standard design
(ring end straight)



in accordance with manu-
facturer's selection



Nominal dimension		Ring dimensions				Groove dimensions				
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	R ₂
15 - 20.9	h 6 h 7	1.5	+ 0.1 - 0.2	0.65	+ 0.05 - 0.02	- 0.8	+ 0 - 0.1	0.75	+ 0.05 - 0	0.1
21 - 29.9		1.8		0.65		- 0.9		0.75		
30 - 35.9		2.2		0.72		- 1.2		0.85		
36 - 42.9		2.8		0.82		- 1.6		0.95		
43 - 51.9		3.1		0.82		- 1.8		0.95		
52 - 59.9		3.5		0.82		- 2.0		0.95		
60 - 69.9	h 7 h 8	3.8	+ 0.1 - 0.2	0.82	+ 0.06 - 0.03	- 2.0	+ 0 - 0.2	0.95	+ 0.1 - 0	0.2
70 - 74.9		4.1		0.82		- 2.5		0.95		
75 - 79.9		4.3		0.98		- 2.5		1.1		
80 - 89.9		4.6		0.98		- 2.8		1.1		
90 - 99.9		5.0		0.98		- 3.0		1.1		
100 - 109.9		5.5		0.98		- 3.0		1.1		
110 - 129.9	h 8 h 9	6.0	+ 0.15/-0.3	1.0	+ 0.08/-0.04	- 3.5	+ 0 - 0.3	1.15	+ 0.15/-0	0.3
130 - 149.9		6.0		1.5		- 3.5		1.65		
150 - 169.9		7.0		1.5		- 4.0		1.65		
170 - 199.9		8.0		1.5		- 5.0		1.65		
200 - 259.9		9.0		1.5		- 5.0		1.65		
260 - 319.9		10.0		1.5		- 5.5		1.65		
320 - 399.9	h 9 h 10	11.0	+ 0.2 - 0.4	1.5	+ 0.1 - 0.05	- 6.0	+ 0 - 0.4	1.65	+ 0.2 - 0	0.4
400 - 439.9		12.0		1.5		- 7.0		1.65		
440 - 599.9		12.0		2.5		- 7.0		2.7		
600 - 699.9		14.0		2.5		- 8.0		2.7		
700 - 799.9		16.0		2.5		- 9.0		2.7		
800 - 899.9		18.0		2.5		- 10.0		2.7		
900 - 999.9	h 10	20.0		2.5		- 11.0		2.7		
1000 - 1300		22.0		2.5		- 12.0		2.7		

All dimensions in mm

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

For inquiries and orders, please provide the exact shaft diameter "D₁", operating temperature and shaft speed!

Application "FK7 DSB" Double retaining ring bore

The double wound laminar retaining rings "FK7 DSB" for bores are a valuable addition to the single wound laminar retaining rings "FK7 ESB".

The application range for the double wound laminar retaining rings "FK7 DSB" for bores includes applications where the components need to be axially retained, e.g. for transmission systems, construction equipment and agriculture machinery, for fastening elements in the automotive industry and mechanical engineering, in the roller and plain bearing industry, for ship and aircraft building, winches, pulleys, etc.

Advantages of the double wound laminar retaining rings:

- Roundness of the closed winding over a range of 360° guarantees fixed contact to the groove base and full circumferential tightness
- Uniform dynamic weight during rotation
- Higher axial resilience as compared to the single wound laminar retaining rings "FK7 ESB"

Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

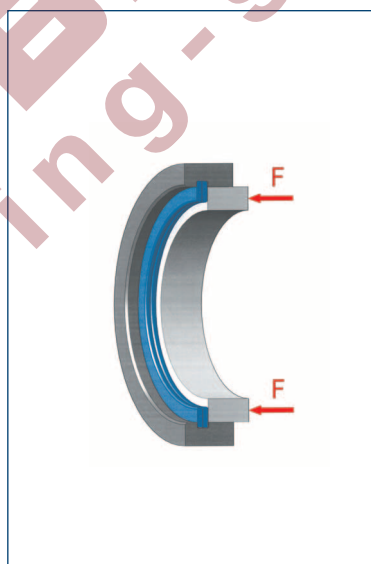
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)

Housing/bore
unlimited
 Attention: For inquiries and orders, please provide exact bore diameter "D₁", operating temperature and speed!

Axial stress ³⁾



FK7 DSB ring ⁴⁾



Axial stress ³⁾:

Shearing tests under operating conditions must be performed to determine the axial shearing capacity of the retaining rings. The secure position of the retaining rings in the groove cannot be guaranteed if the surrounding components thrust uncontrollable against the laminar rings during operation (coupling effect) or if the components vibrate extremely.

Installation information:

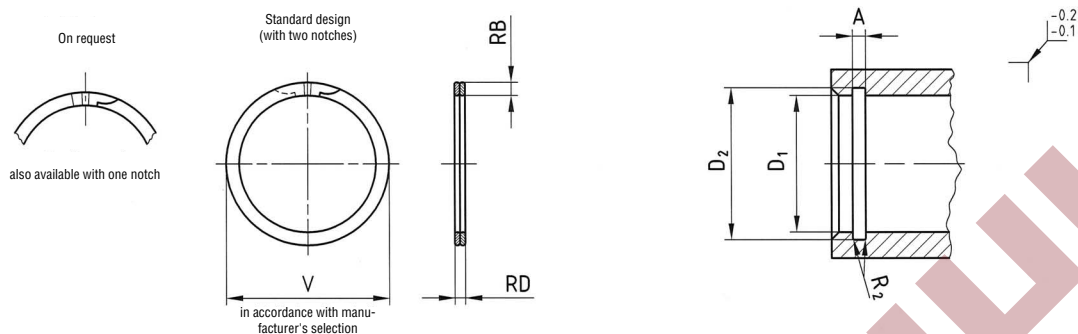
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match bore diameter dimensions "D₁" for all inquiries and/or orders.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the retaining rings can withstand the required stress.



Nominal dimension		Ring dimensions				Groove dimensions				
Bore D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ plus	Tolerance	A	Tolerance	R ₂
15 - 20.9	H 6 H 7	1.5	+ 0.1 - 0.2	1.3	+ 0.1 - 0.04	+ 0.8	+ 0.1 - 0	1.45	+ 0.05 - 0	0.1
21 - 29.9		1.8		1.3		+ 0.9		1.45		
30 - 35.9		2.2		1.45		+ 1.2		1.6		
36 - 42.9		2.8		1.65		+ 1.6		1.8		
43 - 51.9		3.1		1.65		+ 1.8		1.8		
52 - 59.9		3.5		1.65		+ 2.0		1.8		
60 - 69.9	H 7 H 8	3.8	+ 0.1 - 0.2	1.65	+ 0.12 - 0.06	+ 2.0	+ 0.2 - 0	1.8	+ 0.1 - 0	0.2
70 - 74.9		4.1		1.65		+ 2.5		1.8		
75 - 79.9		4.3		1.98		+ 2.5		2.15		
80 - 89.9		4.6		1.98		+ 2.8		2.15		
90 - 99.9		5.0		1.98		+ 3.0		2.15		
100 - 109.9		5.5		1.98		+ 3.0		2.15		
110 - 129.9	H 8 H 9	6.0	+ 0.15/-0.3	2.0	+ 0.15/-0.08	+ 3.5	+ 0.3 - 0	2.2	+ 0.15/-0	0.3
130 - 149.9		6.0		3.0		+ 3.5		3.2		
150 - 169.9		7.0		3.0		+ 4.0		3.2		
170 - 199.9		8.0		3.0		+ 5.0		3.2		
200 - 259.9		9.0		3.0		+ 5.0		3.2		
260 - 319.9		10.0		3.0		+ 5.5		3.2		
320 - 399.9	H 9 H 10	11.0	+ 0.2 - 0.4	3.0	+ 0.2 - 0.1	+ 6.0	+ 0.4 - 0	3.2	+ 0.2 - 0	0.4
400 - 439.9		12.0		3.0		+ 7.0		3.2		
440 - 599.9		12.0		5.0		+ 7.0		5.3		
600 - 699.9		14.0		5.0		+ 8.0		5.3		
700 - 799.9		16.0		5.0		+ 9.0		5.3		
800 - 899.9		18.0		5.0		+ 10.0		5.3		
900 - 999.9	H 10	20.0		5.0		+ 11.0		5.3		
1000 - 1300		22.0		5.0		+ 12.0		5.3		

All dimensions in mm

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

For inquiries and orders, please provide the exact bore diameter "D₁", operating temperature and speed!

FK 7 DSW

Double laminar retaining rings

for shafts

Application "FK7 DSW" Double retaining ring shaft

The double wound laminar retaining rings "FK7 DSW" for shafts are a valuable addition to the single wound laminar retaining rings "FK7 ESW".

The application range for the double wound laminar retaining rings "FK7 DSW" for shafts includes applications where the components need to be axially retained, e.g. for transmission systems, construction equipment and agriculture machinery, for fastening elements in the automotive industry and mechanical engineering, in the roller and plain bearing industry, for ship and aircraft building, winches, pulleys, etc.

Advantages of the double wound laminar retaining rings:

- Roundness of the closed winding over a range of 360° guarantees fixed contact to the groove base and full circumferential tightness
- Uniform dynamic weight during rotation
- Higher axial resilience as compared to the single wound laminar retaining rings "FK7 ESW"

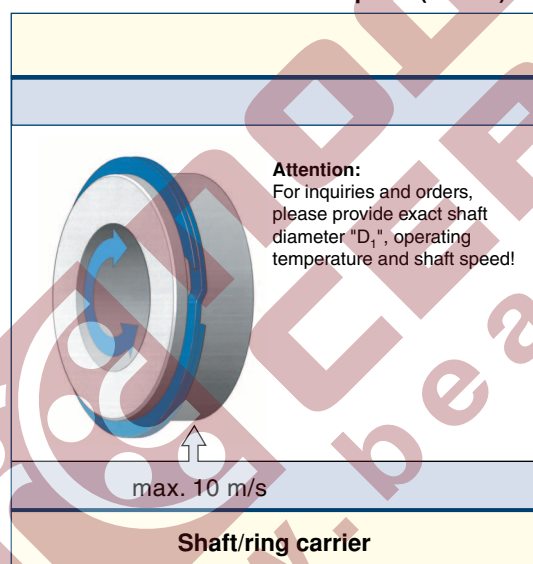
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

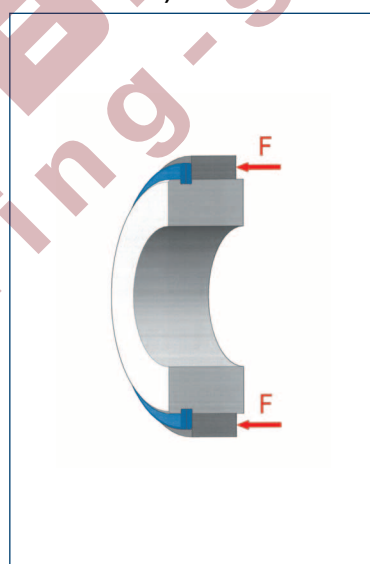
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial stress ³⁾



FK7 DSW ring ⁴⁾



Axial stress ³⁾:

Shearing tests under operating conditions must be performed to determine the axial shearing capacity of the retaining rings. The secure position of the retaining rings in the groove cannot be guaranteed if the surrounding components thrust uncontrollable against the laminar rings during operation (coupling effect) or if the components vibrate extremely.

Installation information:

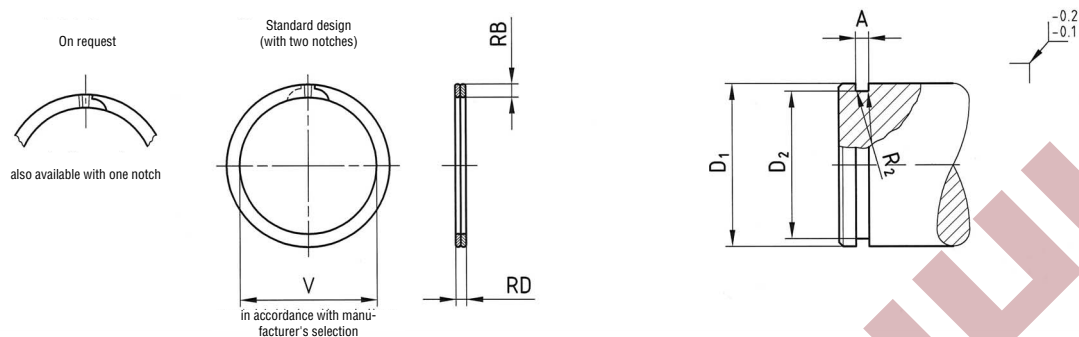
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match shaft diameter dimensions "D₁" for all inquiries and/or orders.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the retaining rings can withstand the required stress.



Nominal dimension		Ring dimensions				Groove dimensions				
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	R ₂
15 - 20.9	h 6 h 7	1.5	+ 0.1 - 0.2	1.3	+ 0.1 - 0.04	- 0.8	+ 0 - 0.1	1.45	+ 0.05 - 0	0.1
21 - 29.9		1.8		1.3		- 0.9		1.45		
30 - 35.9		2.2		1.45		- 1.2		1.6		
36 - 42.9		2.8		1.65		- 1.6		1.8		
43 - 51.9		3.1		1.65		- 1.8		1.8		
52 - 59.9		3.5		1.65		- 2.0		1.8		
60 - 69.9	h 7 h 8	3.8	+ 0.1 - 0.2	1.65	+ 0.12 - 0.06	- 2.0	+ 0 - 0.2	1.8	+ 0.1 - 0	0.2
70 - 74.9		4.1		1.65		- 2.5		1.8		
75 - 79.9		4.3		1.98		- 2.5		2.15		
80 - 89.9		4.6		1.98		- 2.8		2.15		
90 - 99.9		5.0		1.98		- 3.0		2.15		
100 - 109.9		5.5		1.98		- 3.0		2.15		
110 - 129.9	h 8 h 9	6.0	+ 0.15 - 0.3	2.0	+ 0.15 - 0.08	- 3.5	+ 0 - 0.3	2.2	+ 0.15 - 0	0.3
130 - 149.9		6.0		3.0		- 3.5		3.2		
150 - 169.9		7.0		3.0		- 4.0		3.2		
170 - 199.9		8.0		3.0		- 5.0		3.2		
200 - 259.9		9.0		3.0		- 5.0		3.2		
260 - 319.9		10.0		3.0		- 5.5		3.2		
320 - 399.9	h 9 h 10	11.0	+ 0.2 - 0.4	3.0	+ 0.2 - 0.1	- 6.0	+ 0 - 0.4	3.2	+ 0.2 - 0	0.4
400 - 439.9		12.0		3.0		- 7.0		3.2		
440 - 599.9		12.0		5.0		- 7.0		5.3		
600 - 699.9		14.0		5.0		- 8.0		5.3		
700 - 799.9		16.0		5.0		- 9.0		5.3		
800 - 899.9		18.0		5.0		- 10.0		5.3		
900 - 999.9	h 10	20.0		5.0		- 11.0		5.3		
1000 - 1300		22.0		5.0		- 12.0		5.3		

All dimensions in mm

Note: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

For inquiries and orders, please provide the exact shaft diameter "D₁", operating temperature and shaft speed!

FK 7

DSW

FK 7 DMS

Double laminar retaining rings for shafts (with centrifugal force protection)



Application "FK7 DMS" Double retaining ring shaft with centrifugal force protection

"FK7 DMS" double laminar retaining rings with centrifugal force protection can be used for rotational speeds that cannot be achieved by "FK7 DSW" retaining rings.

Diameter range for DMS rings:

Ø 45 mm to Ø 310 mm.

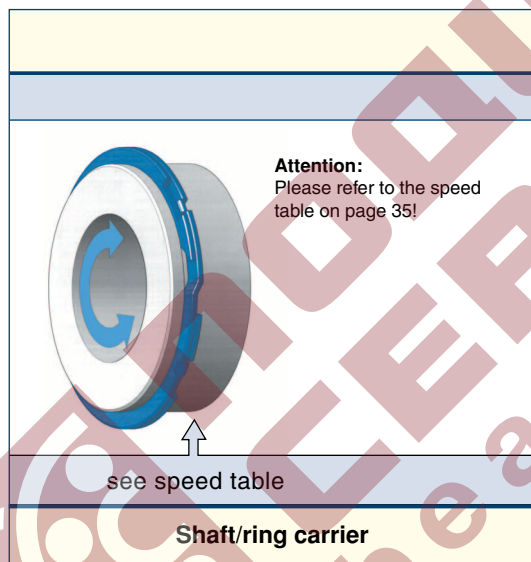
Ring materials

Steel type	Spring resistant up to	Hardness	Surface protection	Surface color
C75S - DIN 1.0605	max. +300°C	on request ¹⁾	oiled	variable ²⁾
C60E - DIN 1.1221	max. +300°C	on request ¹⁾	oiled	variable ²⁾
50CrV4- DIN 1.8159	max. +400°C	on request ¹⁾	oiled	variable ²⁾
CrNi - DIN 1.4310	max. +450°C	on request ¹⁾	bright and dry	variable ²⁾

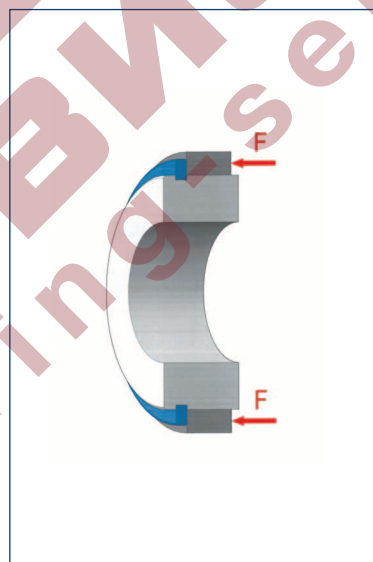
¹⁾ Variable depending on the thermal treatment type! Hardness values depending on ring cross section measured in Rockwell HRA or HRC.

²⁾ The surface color can vary depending on the thermal treatment type: bright, light brown or blackened.

Permissible circumferential speed (in m/s)



Axial stress ³⁾



FK7 DMS ring ⁴⁾



Axial stress ³⁾:

Shearing tests under operating conditions must be performed to determine the axial shearing capacity of the retaining rings. The secure position of the retaining rings in the groove cannot be guaranteed if the surrounding components thrust uncontrollable against the laminar rings during operation (coupling effect) or if the components vibrate extremely.

Installation information:

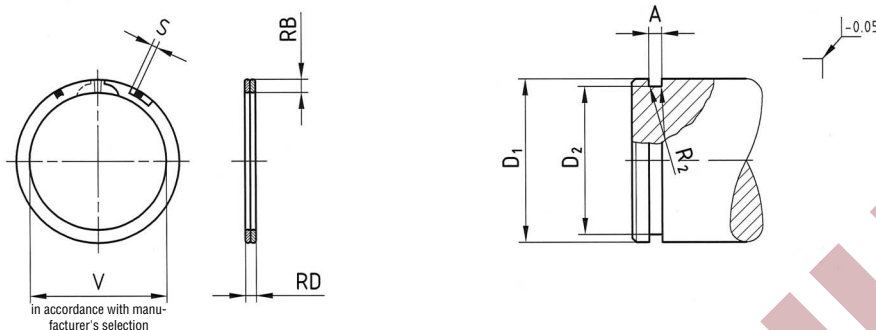
See pages 38 and 39.

Order information ⁴⁾:

The ring diameter information must match shaft diameter dimensions "D₁" for all inquiries and/or orders.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our laminar rings can begin to determine whether the retaining rings can withstand the required stress.

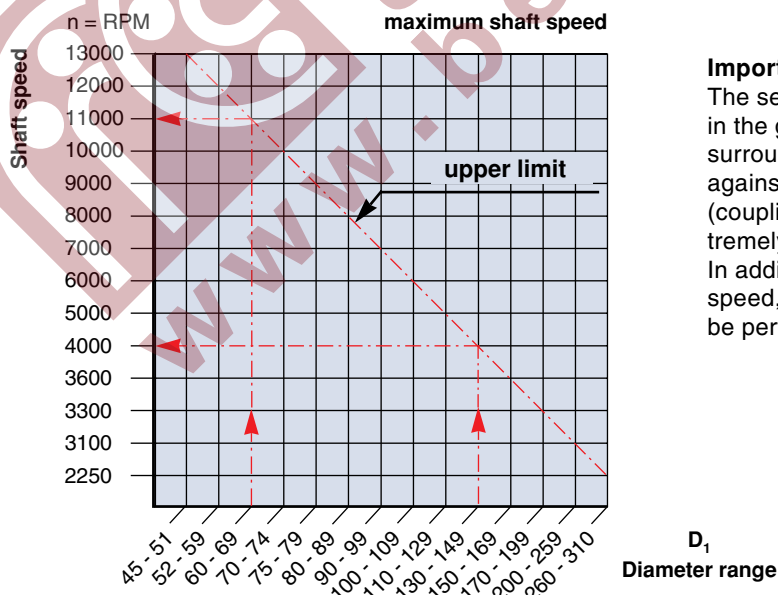


Nominal dimension		Ring dimensions				Groove dimensions					
Shaft D ₁	Tolerance	RB	Tolerance	RD	Tolerance	D ₂ = D ₁ minus	Tolerance	A	Tolerance	S	R ₂
45 - 51.9 52 - 59.9 60 - 69.9	h 7	3.5 3.5 3.8	+ 0.1 - 0.1	1.65 1.65 1.65		- 2.0 - 2.0 - 2.0		1.8 1.8 1.8		max. 1.0	max. 0.1
70 - 74.9 75 - 79.9 80 - 89.9		4.1 4.3 4.6		+ 0.1 - 0.2		1.65 1.98 1.98		- 2.5 - 2.5 - 2.8			
90 - 99.9 100 - 109.9 110 - 129.9		5.0 5.5 6.0	+ 0.15 - 0.3		1.98 1.98 2.0	+ 0.1 - 0	- 3.0 - 3.0 - 3.5	+ 0 - 0.05	2.15 2.15 2.15		
130 - 149.9 150 - 169.9 170 - 199.9		6.0 7.0 8.0		3.0 3.0 3.0	- 3.5 - 4.0 - 5.0	3.15 3.15 3.15					
200 - 259.9 260 - 310		9.0 10.0		3.0 3.0	- 5.0 - 5.5	3.15 3.15					

All dimensions in mm

Attention: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

For inquiries and orders, please provide the exact shaft diameter "D₁", operating temperature and shaft speed!



Important information:

The secure position of the "FK7 DMS" rings in the groove cannot be guaranteed if the surrounding components thrust uncontrollable against the laminar rings during operation (coupling effect) or if the shafts vibrate extremely.

In addition to the stated max. permissible shaft speed, installation and long term run tests must be performed under operating conditions.

FK 8

Plastic laminar ring carrier seals

as seals and spacers for grease lubricated roller bearings

Application "FK8" plastic laminar ring carrier seals

Outside clamping plastic ring carrier seals made from Polyamide 6 (PA6), also available with mineral fibre fortification, are used to seal roller bearings against grease leakage or dirt and splash water ingress in vehicle axles as well as rollers and wheels for all equipment types, engines in transport technology, motion sequences in construction equipment and agriculture machines.

Ring carrier seals in accordance with design 01 and 02 have spring-loaded, flexible sealing lips. This has advantages if splash water can frequently be expected in the sealing area.

Plastic ring carrier seals are also suitable as a protection seal in front of radial shaft seal arrangements.

Materials

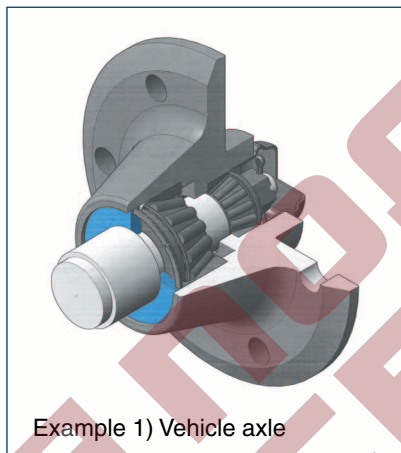
Plastic type	reinforced design	Application temperature	Laminar ring material
PA6 (Polyamide 6)	-	-40°C to 120°C ¹⁾	C75S - DIN 1.0605 ³⁾ CrNi - DIN 1.4310 ³⁾
PA6 ²⁾ (Polyamide 6)	Mineral fibre reinforced	-40°C to 120°C ¹⁾	CrNi - DIN 1.4571 ³⁾

¹⁾ Temperature resistance at -40°C to +120°C unlimited, short term temperature resistance at max. +150°C.

²⁾ Not all ring carrier sizes are available with the reinforced design; for details please contact our technical office.

³⁾ Depending on the requirements, the following laminar ring materials are available; please include the laminar ring material in your order.

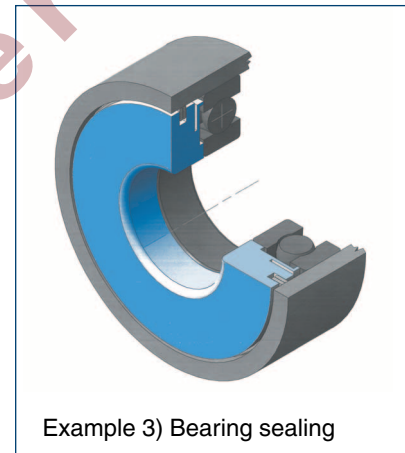
Application examples:



Example 1) Vehicle axle

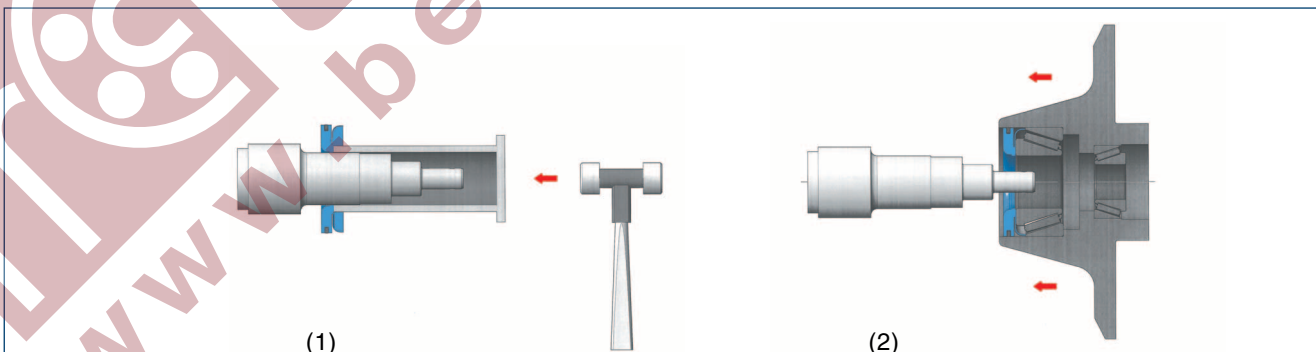


Example 2) Conveyor belt roller



Example 3) Bearing sealing

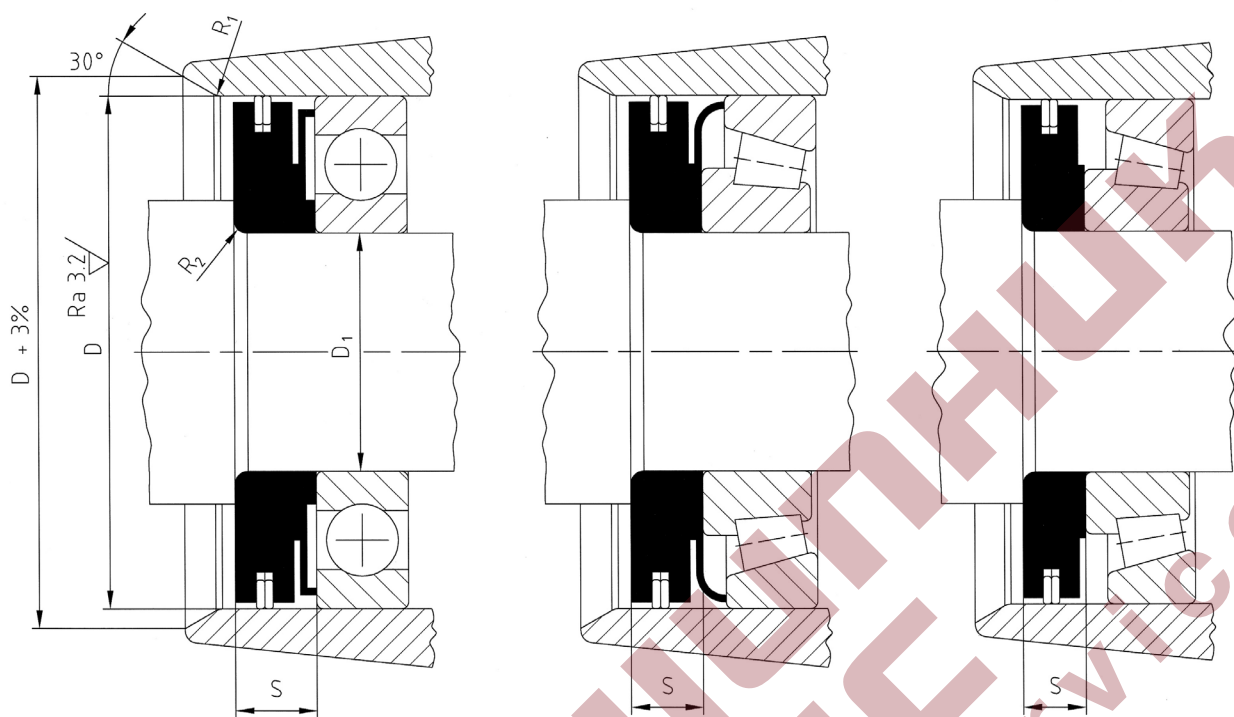
Installation:



In general, the ring carriers can be moved by hand by lightly tapping with a mallet (1) onto the axle stub. The ring carrier should initially be moved onto the hub (2) if an installation slope is undesired or only a small slope is available.

Run and installation tests:

Run and installation tests under operating conditions must be performed in each case before standard production of our ring carrier seals can begin to determine whether the desired sealing effects can be achieved.



Design 01:
Ring carrier with a short
sealing lip for symmetrical
roller bearings

Design 02
Ring carrier with a long
sealing lip for tapered
roller bearings

Design 03:
Ring carrier without
sealing lip

Design			Bore		Shaft		Ring carrier		Order information
01	02	03	D	R ₁	D ₁	R ₂	S	Material	Product number
●			47		20	1	7.7	PA6 (Polyamid 6)	472077 R1
●			47	1	25	2	7.7		472577 R1
●			52		25		6		52256 R1
●			62	2	30		7		62307 R1
●			72		35		7		72357 R1
	●		52	1	25	3	6		52256 K1
	●		55		30		7		55307 K1
	●		62		30		7		62307 K1
	●		62		35		7		62357 K1
	●		72		35		7		72357 K1
		●	80	2	40	3.5	7		80407
		●	85		45	4	7		85457
		●	90		50	3.5	6		90506
		●	90		50		7.5		905075
		●	100		55	4	8		100558
		●	110		60		8		110608
		●	120		65	4.5	9		120659
		●	125		70		10		1257010
		●	125	3	80	5	10		1258010
		●	140		80		9		140809
		●	150		85		14		1508514
		●	150		100	6	14		15010014

All dimensions in mm

Attention: Please refer to the information on pages 2, 38, 39, 40 and 41 (questionnaire).

For inquiries and orders, please provide the bore diameter "D" and the product number; additionally, please provide information about the operating temperature.

Fig. 1

The design for gaps (A) must be as small as possible. The smaller the gap the larger the labyrinth or sealing effect.

Please refer to the information in the respective data sheets for the different ring designs under "Axial and/or radial play" if radial play and/or tilting motions are detected!

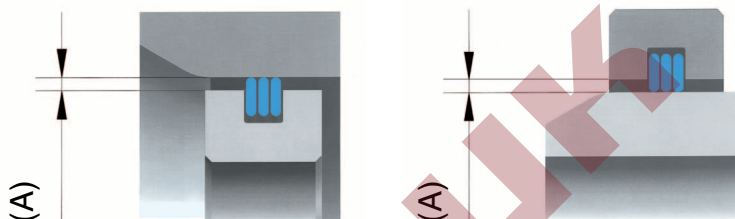


Fig. 2

The use of attachable installation tools for the housings and removable installation tools for shafts are recommended if the specified installation chamfers are not possible at the housing or shaft for space reasons.

Do not only press when assembling the parts equipped with rings but overcome the slip resistance by radial motion and axial tapping.

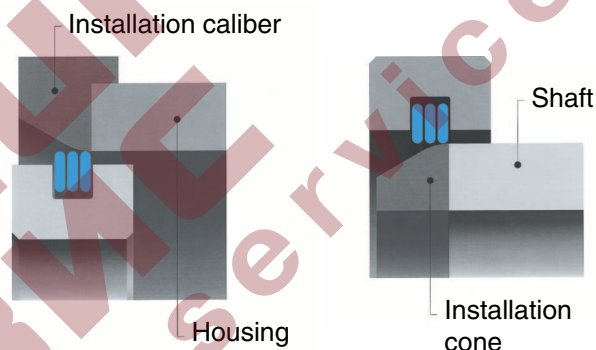


Fig. 3:

- 1) Single and double wound laminar rings are spiraled into the grooves by axially spreading the rings.
- 2) Care must be taken to ensure the rings are not over stretched, as they will be permanently deformed.

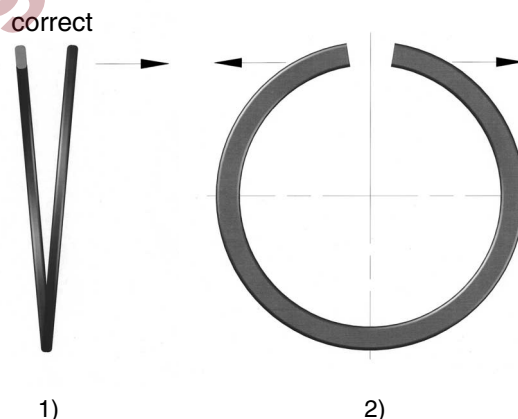
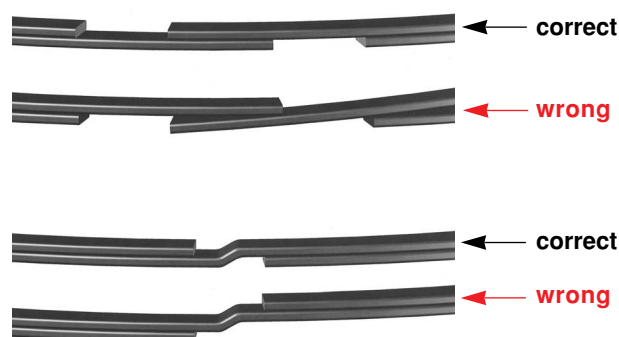


Fig. 4:

Do not spiral the ring ends into each other or jam them when the single wound laminar rings are spiraled into the grooves.



Do not spiral the ring ends or the windings into each other or jam them when the double wound laminar rings are spiraled into the grooves.

Fig. 5

As shown, inside and outside clamping laminar rings can be installed through spiraling by hand.

Spread ring slightly axially

- 1) Insert one ring end into the groove
- 2) Slide remaining part of the ring spirally

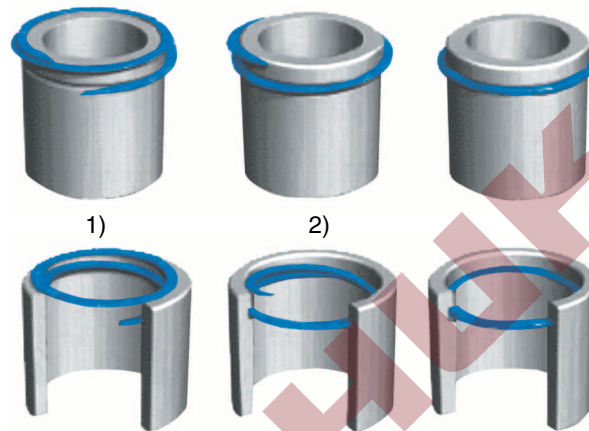


Fig. 6

The shaft retaining rings can also be installed with a support tool (see figure) to replace spiraling by hand.

- 1) Attach installation cone and retaining ring.
- 2) Slide the retaining ring with the help of the push sleeve over the installation cone.
- 3) Check the secure installation of the ring in the groove.

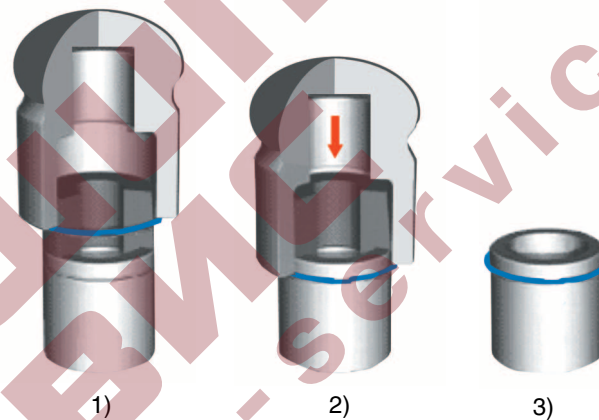


Fig. 7:

The bore retaining rings can also be installed with a support tool (see figure) to replace spiraling by hand.

- 1) Attach installation tapered sleeve and retaining ring.
- 2) Slide the retaining ring with the help of the push sleeve over the installation tapered sleeve.
- 3) Check the secure installation of the ring in the groove.

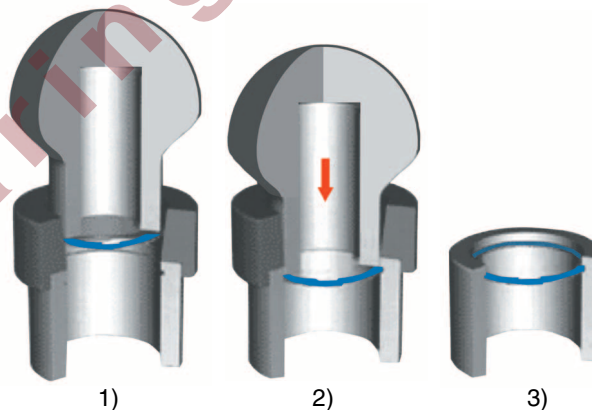
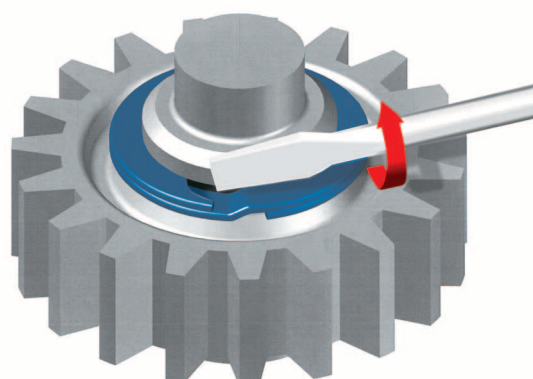


Fig. 8:

Disassembly of the retaining rings with the help of a flat-bladed screwdriver. The screwdriver is inserted into the disassembly notch and rotated slightly so that one ring end of the retaining ring slides out of the groove.

The ring will be removed spirally from the groove.



General information for greasing:

Greased laminar rings provide a better seal arrangement than dry running rings, greased laminar rings are required when the application is subject to splash water, dirt and scale. In order to allow sufficient transfer of grease throughout arrangement and prevent over pressure during application, it is recommended that grease application bores and grease relief bores are provided. Where possible the ring carrier should be supplied by 4 off 3 to 5 mm diameter bores equally distributed around the circumference and also into the groove base, this will allow easy application and exchange of grease during re-lubrication.

Greasing options:

Listed below are three different and proven greasing options with greasing bores or grease relief bores, which can be arranged depending on the available space. Leakes from the outside are not possible because the bores are filled with grease.

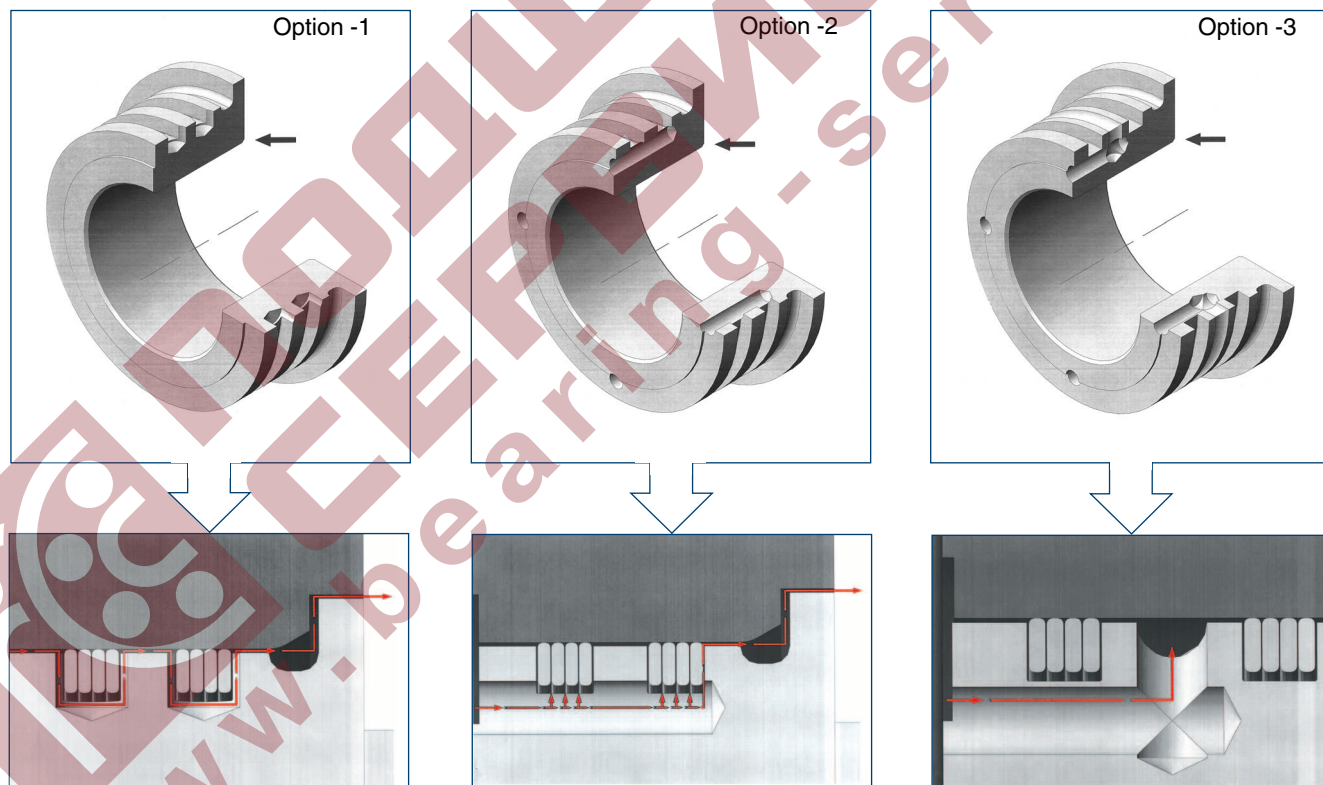
Lubrication recommendation:

We cannot make any recommendations for the selection of the lubricant or provide information about the greasing frequency. The type and quantity of an appropriate lubricant must be determined and specified by the customer depending on the operating conditions such as speed, operating temperatures, contamination level and ambient conditions. Bearing and lubricant manufacturers may be able to provide information.

Note:

The "FK5-HFL" ring types are the exception with respect to greasing. They must be installed dry and without any additional lubricants. The surrounding components, which come in contact with the laminar rings must also not be greased. The lubricants carbonize due to the high operating temperatures and the laminar rings will fail.

Application examples:



Option -1:

Grease relief bores, arranged vertically to the groove base, four for each groove circumferentially distributed at 90°. The bore diameter depends on the groove width. The grease pressed by the bearings can flow in next to the rings or can flow out upwards under the rings.

Option -2:

Grease relief bores, arranged horizontally to the groove base, four for each groove circumferentially distributed at 90°. The bore diameter should be between 3 and 5 mm. The grease pressed by the bearings can flow out upwards under the rings (groove base diameter) and next to the rings.

Option -3:

This greasing option is a combination of the above mentioned option 1 and 2. A so-called "grease chamber" is placed between the two sealing ring sets, this will act as a grease reservoir in the groove and therefore optimize the sealing effect.

Company address
 Person in charge
 Phone
 E-mail
 Machine type
 Department
 Fax
 Date
 Project No.

- The laminar rings must seal against?

☐ Splash water entry ☐ Severe contamination ☐ Cooling lubricant entry ☐ Dust entry

☐ Oil leakage ☐ Grease leakage ☐ Other media:

- Protect other seals ☐ yes / which ☐ no

- Operating temperature (in ring area °C)

- Housing speed (RPM / rotational direction)

- Shaft speed (RPM / rotational direction)

- Axial movement ☐ yes / in mm ☐ no

- Radial movement ☐ yes / in mm ☐ no

- Angular movement ☐ yes / in ° ☐ no

- Operating pressure (Medium) ☐ yes / in bar ☐ no

- Re-greasing option ☐ yes / which ☐ no

- Stainless steel laminar rings ☐ yes ☐ no

- Housing materials (hardened) ☐ yes / hardness ☐ no

- Shaft material (hardened) ☐ yes / hardness ☐ no

- New design ☐ yes ☐ no

- Changeover to laminar rings ☐ yes ☐ no

- Which type of sealing was used before?

- Permissible leakage

- Lifespan

- What would the demand be: ☐ one time (pieces/set)

☐ monthly (pieces/set)

☐ annually (pieces/set)

Additional questions for the use of Fey retainer rings:

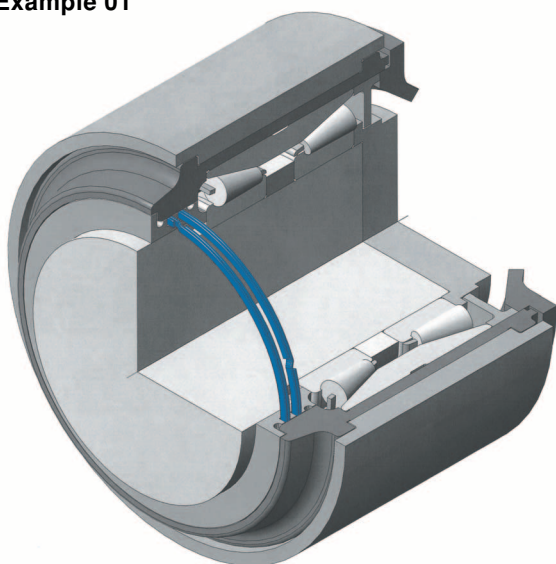
- Will the retaining rings be axially loaded (against)

- How large is the axial load against the rings (in N)

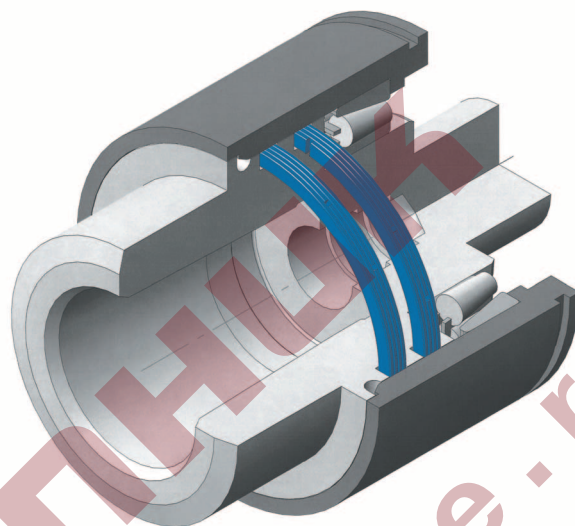
- Will the disassembly notches be required?

➤ Please make a CAD drawing or a dimensioned sketch available so that we can analyze the installation situation!

Example 01



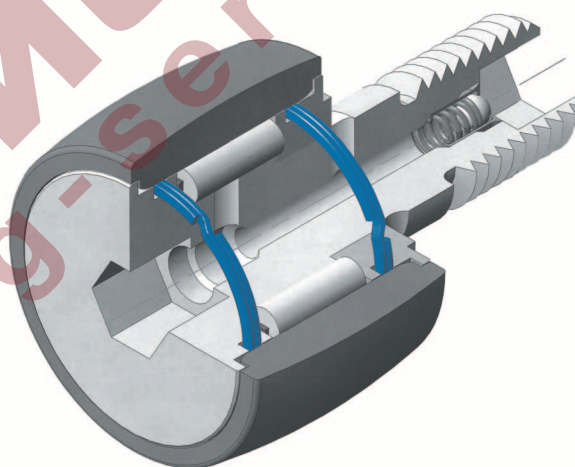
Example 02



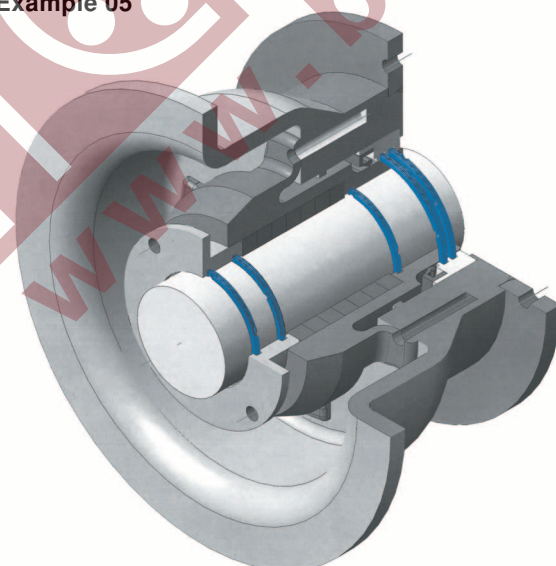
Example 03



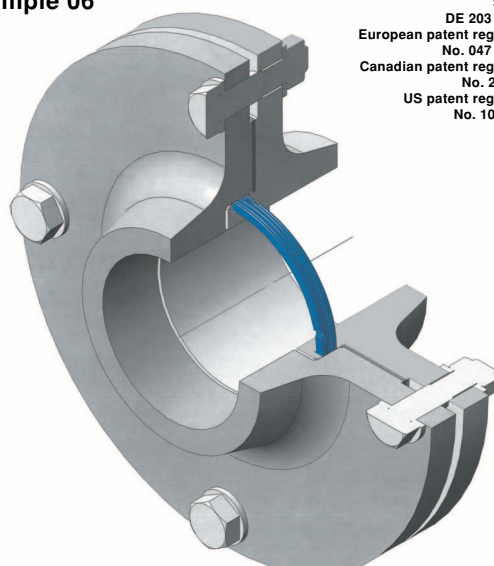
Example 04



Example 05

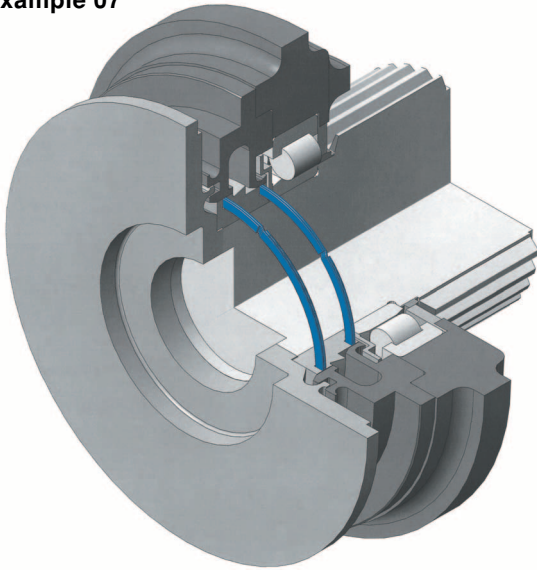


Example 06

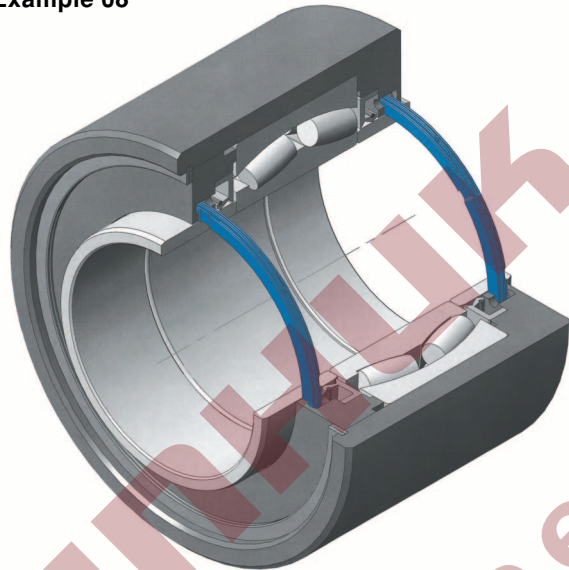


Samples
DE 203 16 372.9
European patent registration
No. 047 868 59.1
Canadian patent registration
No. 254 22 42
US patent registration
No. 10/576,869

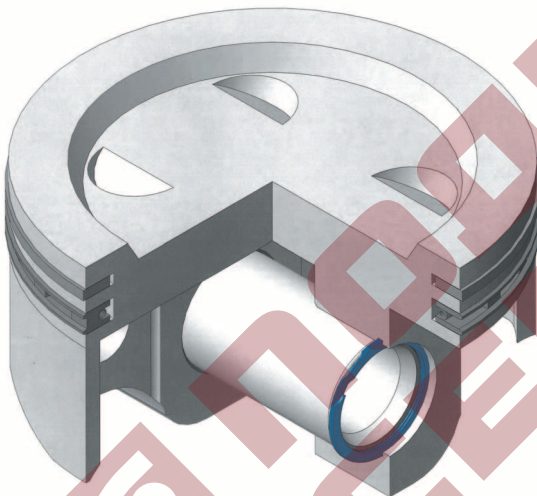
Example 07



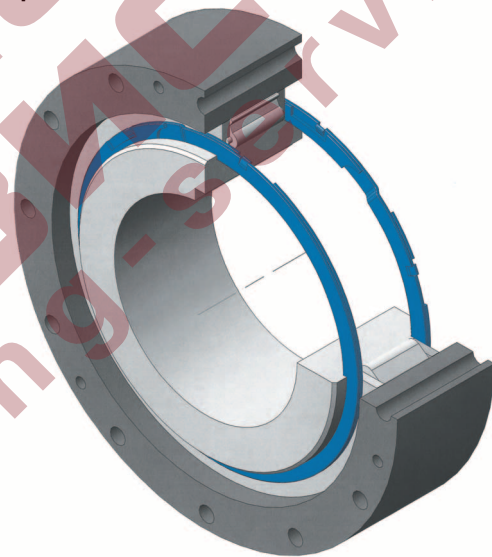
Example 08



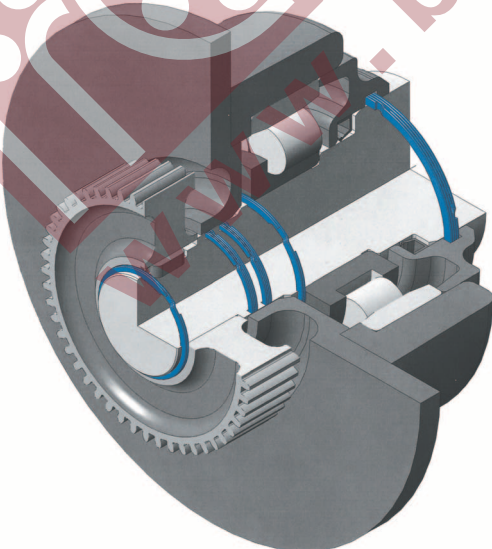
Example 09



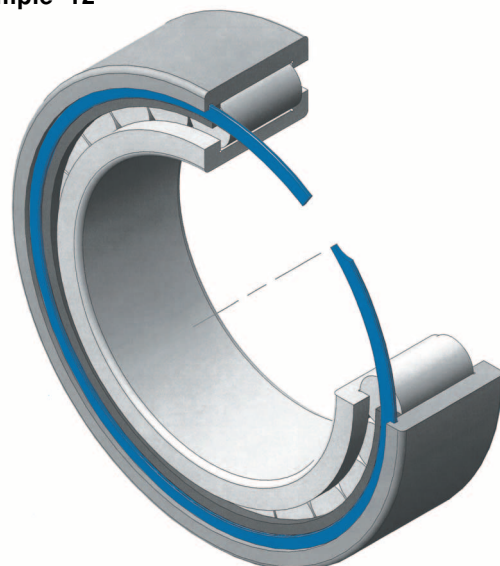
Example 10



Example 11



Example 12



We only deliver based on and in accordance with the requirements of the general business terms and conditions in their latest revision; they can be found at www.fey-lamellenringe.de. The following version has the status 01. August 2007.

§ 1 Contract closing/scope

- (1) Our sales conditions are applicable exclusively; other conditions or sales conditions of the customer that deviate from our conditions are not accepted by us, except if we agree explicitly in writing to the deviations. Our sales conditions are also valid if we know about other conditions or sales conditions of the customer that deviate from our conditions and execute the delivery to the customer without reservation.
- (2) All agreements between us and the customer for the execution of this contract must be made in writing (written format requirement).
- (3) Our sales conditions are only valid for corporations in accordance with § 310 para. 1 BGB.

§ 2 General

- (1) The data listed in the Fey product catalogs and the sealing ring arrangements or the retainer ring dimensioning proposed by our technical office in drawing related formats are based on long term experience values with the same or similar operating conditions. We refer explicitly to the information in our catalogs in connection with our technical questionnaire as well as to the information about the correct technical design and installation of the laminar rings. If questions arise please contact in each case our technical office.
- (2) If the customer does not request any special processing and machine requirements that have been accepted by us in writing, all the laminar rings we manufacture shall be based on our production standards and factory standards.
All inquiries, quotations, production processes and quality-relevant actions for our products will be treated and documented pursuant to the quality guidelines of ISO/TS 16949:2002.
- (3) Acquisition and durability guarantees of any kind will explicitly not be accepted, except if a different agreement was established explicitly and in writing.

§ 3 Proposal/proposal documentation

- (1) Our proposal is subject to change, except if the order confirmation documents include deviating information.
- (2) Every inquiry and every order will be confirmed by us with price and lead time details. Order text, dimension information and drawings provided by the customer are binding to us; we are not obligated to review the information.
- (3) We reserve the ownership rights and the copyrights for all figures, drawings, calculations, technical and other documents. All documents and the documentation must be kept confidential and must not be copied or transferred to third parties without our written release.

§ 4 Prices/payment terms and conditions

- (1) The prices set out in our written order confirmation shall apply.
- (2) Prices are ex-works excluding packing cost, except if different information is included in the order confirmation; packaging cost will be charged separately.
- (3) We reserve the right to change our prices if cost reductions or cost increases are experienced after contract closing, especially due to labor agreements or material price changes. On request by the customer, we will provide proof for the price changes.
- (4) The value added tax is not included in our prices. It will be charged separately on the invoice in its then legal amount.
- (5) The following applies, if the order confirmation does not include different information:
A discount of 2% will be granted for payments within 14 days after issuing an invoice. The purchase price is due for payment after delivery / handover. The information about payment terms on the invoice does not represent a deferment of payment.
- (6) The customer has offset rights only if his counter claims have been legally established, are undisputed or are recognized by us. In addition, the customer can only take advantage of a right of retention if his counter claim is based on the same contractual relationship.

§ 5 Delivery time

- (1) The start of the stated delivery time assumes the clarification of all technical questions and implementation details.
- (2) Our delivery obligation assumes the on time and orderly completion of the obligations of the customer. The exception of the unfulfilled contract are reserved.
- (3) The shipment will be made without scheduled announcement assumed no other special agreement was made. We will decide about the method of shipment if no other special agreement was made.
- (4) We reserve the right for partial shipments.
- (5) We have the right to request the reimbursement of accruing damages including possible additional expenditures, if the customer delays acceptance or if he violates culpably other cooperation obligations. All other claims are reserved.
- (6) The danger of an accidental risk of loss or a coincidental deterioration of the purchased good are transferred to the customer at a time at which the customer delays acceptance or delays payments if the conditions of paragraph (5) exist.
- (7) We are liable in accordance with the legal regulations if the underlying purchase contract is a firm deal in accordance with § 286 para. 2 No. 4 BGB or § 376 HGB. We are also liable in accordance with the legal regulations if the customer, due to a delivery delay for which we are responsible, has the right to declare that his interest for a further contract fulfilment is in discontinuance.
- (8) We are liable in accordance with the legal regulations if the delivery delay is based on an intentional or gross negligent behavior by us; we are also liable for a fault of our representatives or our support partners. Our damage liability is limited to the predictable, typically generated damages if the delivery delay is not based on a contract violation for which we are responsible.
- (9) We are liable in accordance with the legal regulations if the delivery delay for which we are responsible is based on a culpable violation of a major contract obligation; in this case the compensation liability is limited to the predictable, typically generated damages.
- (10) Otherwise, in case of a delivery delay, we are liable for a liquidated delay compensation of 3% for each completed week of the delay, however, not more than 15% of the total delivery value.
- (11) Other legal claims and rights of the customer are not affected.

§ 6 Transfer of perils/ packaging

- (1) Delivery "ex-works" is agreed if the order confirmation does not include different information:
- (2) The packaging is invoiced at net cost. The packagings are recyclable and will not be taken back.
- (3) All laminar rings to be shipped will be subject to transport insurance against loss and/or damages; the incidental costs will be covered by the customer.

§ 7 Warranty

- (1) Warranty claims of the customer assume that he has fulfilled his investigation and reproval obligations in accordance with § 377 HGB in an orderly manner.
- (2) The customer has the right at his choosing to request supplementary performance in form of a deficiency resolution or the delivery of a new product free of deficiencies. In case of a deficiency resolution, we are obligated to accept all expenditures for the deficiency resolution, especially transport, shipping and handling, labor and material cost, assuming they do not increase due to the fact that the purchased goods are at a different location than the agreed upon place of fulfillment.
- (3) The customer has the right at his choosing to request cancellation or reduction if the supplementary performance does not resolve the problem.
- (4) We are liable in accordance with the legal regulations if the customer requests compensation claims, which are based on intention or gross negligence including intention or gross negligence by our representatives or our support partners. The compensation liability is limited to the predictable, typically generated damages if we are not accused of intentional contract violation.
- (5) We are liable in accordance with the legal regulations if we culpably violate a major contract obligation; in this case the compensation liability is limited to the predictable, typically generated damages.
- (6) As part of paragraph (4), our liability is also limited to the predictable, typically generated damages if the customer has a claim for replacement of the damages instead of the services.
- (7) The liability for the culpable violation of life, body or health is not affected; this also applies to the mandatory liability in accordance with the product liability law.
- (8) The liability is excluded if no other provisions were made above.
- (9) The period of limitation for warranty claims is 12 months after transfer of perils, assumed mandatory legal regulations do not exist.
- (10) The period of limitations in case of a delivery recourse in accordance with §§ 478, 479 BGB is not affected; it is five years after delivery of the deficient goods.

§ 8 Joint liability

- (1) A further liability for compensation than stated in §§ 5 and 7 is excluded, independent of the legal nature of the claim. This applies especially for compensation claims based on culpability at contract closing, other obligation violations or tortious claims for the replacement of property damages in accordance with § 823 BGB.
- (2) The limitation in accordance with paragraph (1) also applies if the customer requests the replacement of useless expenditures instead of a claim for the replacement of the damage.
- (3) If the compensation liability against us is excluded or limited, then this also applies to the personal compensation liability of our employees, job holders, co-workers, representatives and support partners.

§ 9 Retention of title

- (1) We retain the title to the delivered goods, especially for the laminar rings, until all payments from the delivery contract have been received. We have the right to redeem the goods if the customer violates the contract especially if he delays payment. Redeeming the goods also implies that we cancel the contract. We can utilize the goods otherwise after we redeem them; the sales proceeds - minus appropriate utilization cost - will be credited to the liabilities of the customer.
- (2) The customer is obligated to handle the delivered goods with care; he is especially obligated to insure the goods on his expense at their replacement value against fire, water and theft damages. The customer must execute all required maintenance and inspection work in time and on his expense.
- (3) The customer must inform us immediately in writing about garnishments or other interventions of third parties so that we can take care of our rights in time and if required. The customer is liable for our incidental loss if the third party is not in a position to reimburse the required legal cost.
- (4) The customer has the right to resell the laminar rings as part of an orderly business; however, he already now transfers all receivables for our final invoice amount (including VAT), which he has obtained as a result of the resale to his customers or third parties independent of the fact whether the laminar rings were resold with or without further production. The customer maintains the right for the collection of these receivables after the transfer. Our right to collect the receivables is not affected. However, we agree to not collect the receivable as long as the customer meets his payment obligations from the received income, does not delay payment and especially as long as the opening of insolvency proceedings have not been filed or bankruptcy has been declared. In this case, we can request that the client informs us about the assigned claims and its debtor, that he provides all the information required to collect these claims, that he hands over all related documents to us and that he informs the debtor (third party) about the assignment.
- (5) The processing or alteration of the delivered goods by the customer will also be done on our behalf. If the delivered goods, especially the laminar rings, are processed or inseparably commingled with other objects that do not belong to us, then we receive a co-ownership at the new object at a ratio of the value of the laminar rings (final invoice amount plus VAT) to the other processed / commingled objects at the time of processing or commingling. The same regulations apply for objects produced by processing and for purchased objects subject to retention.
- (6) On the request of the customer, we agree to release the securities that we have a right to if the value of our securities to be realized exceeds the receivables to be secured by more than 10%; we have the right to choose the securities to be released.

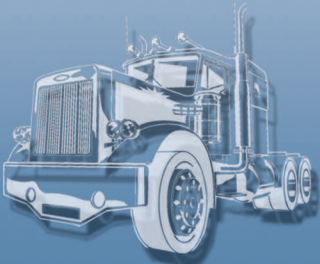
§ 10 Place of jurisdiction/Place of fulfilment

- (1) Our place of jurisdiction is Germany if the customer is a merchant.
- (2) The laws of the Federal Republic of Germany apply, the application of the UN sales law is excluded.
- (3) The business headquarter is also the place of fulfilment if the order confirmation does not include different information.

§ 11 Commercial registry registration

- (1) HRA 14657
- (2) HRB 19868

**We support you worldwide with
22 agencies**



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