UDC 621.887.6 : 621.824
:001.4 : 003.62 : 620.1

September 1981

Retaining rings with lugs
for use on shafts (external circlips)

DIN 983

Sicherungsringe mit Lappen (Halteringe) für Wellen

Supersedes March 1965 edition and parts of DIN 995, January 1970 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Dimensions in mm

1 Concept

For the purpose of this standard, retaining rings with lugs are circlips for use on shafts. They have an eccentric form and a number of lugs of equal depth uniformly distributed around the circumference. Circlips are suitable for retaining machine components which have non-square (radiused or chamfered) edges, and for concealed installation as illustrated in figure 10.

2 Quantities and symbols

a depth of lug
b beam
c distance between plates in the determination of spiral flatness error (helical pitch)
d_1 shaft diameter
d_2 groove diameter
d_3 external diameter of circlip in the unstressed condition
d_4 minimum external clearance during fitting
d_5 diameter of lug hole
E modulus of elasticity
F_N loadbearing capacity of groove assuming a yield strength of the grooved material of 200 N/mm^2 (see subclause 7.1)
F_R loadbearing capacity of circlip when in contact with square edge of component (see figure 7)
F_{Rg} loadbearing capacity of circlip when in contact with radiused or chamfered edge of component (see figure 8)
R_{eL} yield point
g width of chamfer at component
h distance between plates in the determination of radial flatness error (dish)
m groove width
n edge margin
n_{abl} speed at which circlip is released from its slot (see clause 8)
r groove bottom radius or radius on test jaw
s circlip thickness
t groove depth at nominal size of d_1 and d_2

Continued on pages 2 to 10

3 Dimensions, designation and design criteria

Circlips are not expected to conform to the designs illustrated here; compliance is only required in the case of the dimensions specified.

Unstressed

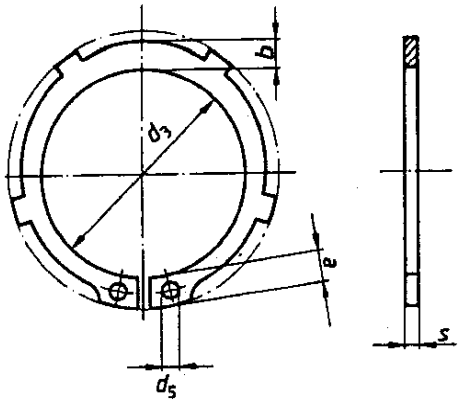

Figure 1

Expanded

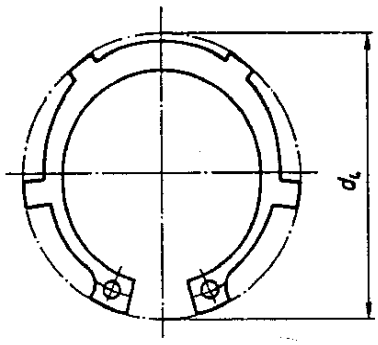

Figure 2

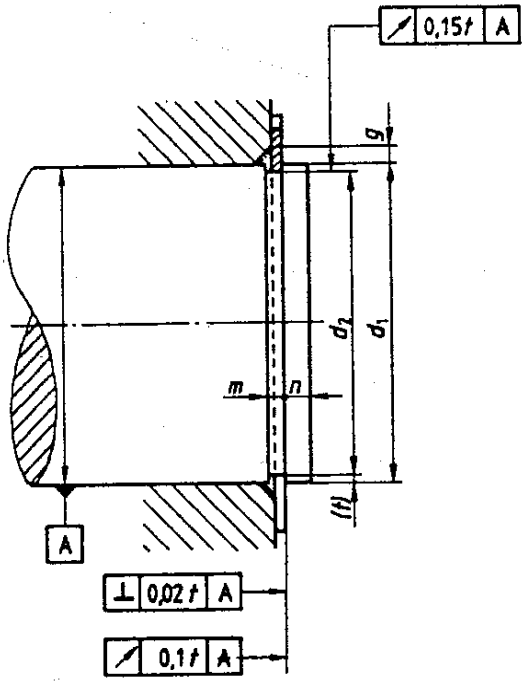

Figure 3

The surface roughness of the bottom and the loaded flank of the groove shall be specified as required.

Designation of a circlip with lugs, with a shaft diameter (nominal size), d_1, of 40 mm and a thickness, s, of 1,75 mm:

Circlip DIN 983 – 40 × 1,75

Table 1

Shaft diameter, d_1 Nominal size	Circlip							Groove					Design criteria						
	s	Lim. dev. *)	d_3	Lim. dev. *)	a max.	b ≈	d_5 min.	Mass of 1000 units, in kg ≈	d_2 1)	Lim. dev. *)	m 2) H13	t	n min.	d_4	F_N kN	F_R kN	g	F_{Rg} kN	n_{abl} min^{-1}	Nominal size of pliers as in DIN 5254
16	1		14,7		3,5	2,3	1,7	0,82	15,2		1,1	0,4	1,2	23,4	3,26	7,00	1	2,30	45 400	
17	1		15,7	+0,10 −0,36	3,6	2,3	1,7	0,93	16,2	0 −0,11 (h11)	1,1	0,4	1,2	24,6	3,46	8,00	1	2,40	40 900	10
18	1,2		16,5		3,7	2,4	2	1,24	17		1,3	0,5	1,5	25,8	4,58	17,0	1,5	3,75	37 800	
19	1,2		17,5		3,7	2,5	2	1,35	18		1,3	0,5	1,5	26,8	4,84	17,0	1,5	3,80	33 400	
20	1,2		18,5	+0,13 −0,42	3,8	2,6	2	1,45	19	0 −0,13 (h11)	1,3	0,5	1,5	28	5,06	17,1	1,5	3,85	30 400	
22	1,2		20,5		4	2,8	2	1,77	21		1,3	0,5	1,5	30,4	5,65	16,9	1,5	3,80	25 700	
23	1,2		21,5		4,1	2,9	2	1,84	22		1,3	0,5	1,5	31,6	5,90	16,6	1,5	3,80	23 800	
24	1,2		22,2		4,2	3	2	1,98	22,9		1,3	0,55	1,7	32,8	6,75	16,1	1,5	3,65	25 100	
25	1,2		23,2		4,3	3	2	2,12	23,9	0 −0,21 (h12)	1,3	0,55	1,7	34	7,05	16,2	1,5	3,70	24 200	
26	1,2		24,2	+0,21 −0,42	4,4	3,1	2	2,18	24,9		1,3	0,55	1,7	35,2	7,34	16,1	1,5	3,70	22 400	19
28	1,5	0 −0,06	25,9		4,5	3,2	2	3,15	26,6		1,6	0,7	2,1	37,5	10,00	32,1	1,5	7,50	20 200	
30	1,5		27,9		4,7	3,5	2	3,65	28,6		1,6	0,7	2,1	39,9	10,73	32,1	1,5	7,65	17 900	
32	1,5		29,6		5	3,6	2,5	4,00	30,3		1,6	0,85	2,6	42,5	13,85	31,2	2	5,55	15 500	
35	1,5		32,2	+0,25 −0,5	5,2	3,9	2,5	4,38	33		1,6	1	3	45,9	17,80	30,8	2	5,55	14 800	
38	1,75		35,2		5,5	4,2	2,5	6,50	36		1,85	1	3	49,6	19,30	49,5	2	9,10	12 900	
40	1,75		36,5		7,2	4,4	2,5	7,00	37,5		1,85	1,25	3,8	55,1	25,30	51,0	2	9,50	13 500	
42	1,75		38,5		7,2	4,5	2,5	7,50	39,5	0 −0,25 (h12)	1,85	1,25	3,8	57,1	26,70	50,0	2	9,45	12 600	
45	1,75		41,5	+0,39 −0,9	7,2	4,7	2,5	8,50	42,5		1,85	1,25	3,8	60,1	28,60	49,0	2	9,35	11 000	
47	1,75		43,5		7,2	4,9	2,5	8,70	44,5		1,85	1,25	3,8	62,1	30,00	49,5	2	9,55	10 000	
48	1,75		44,5		7,2	5	2,5	8,90	45,5		1,85	1,25	3,8	63,1	30,70	49,4	2	9,55	9 050	
50	2		45,8		8,2	5,1	2,5	11,5	47		2,15	1,5	4,5	67,2	38,00	73,3	2	14,4	10 000	
55	2		50,8		8,2	5,4	2,5	13,0	52		2,15	1,5	4,5	72,2	42,00	71,4	2,5	11,4	8 460	
57	2		52,8		8,2	5,5	2,5	14,0	54		2,15	1,5	4,5	74,2	43,70	70,9	2,5	11,4	8 000	
58	2		53,8		8,2	5,6	2,5	14,3	55		2,15	1,5	4,5	75,2	44,30	71,1	2,5	11,5	7 750	40
60	2		55,8		8,2	5,8	2,5	14,8	57		2,15	1,5	4,5	77,2	46,00	69,2	2,5	11,3	7 200	
62	2	0 −0,07	57,8		8,2	6	2,5	15,9	59		2,15	1,5	4,5	79,2	47,50	69,3	2,5	11,45	6 800	
65	2,5		60,8	+0,46 −1,1	10,2	6,3	3	21,7	62	0 −0,30 (h12)	2,65	1,5	4,5	86,4	49,80	135,6	2,5	22,7	6 300	
67	2,5		62,5		10,2	6,4	3	22,6	64		2,65	1,5	4,5	88,4	51,30	136,1	2,5	23,0	6 800	
68	2,5		63,5		10,2	6,5	3	23,5	65		2,65	1,5	4,5	89,4	52,20	135,9	2,5	23,1	6 600	
70	2,5		65,5		10,2	6,6	3	25,1	67		2,65	1,5	4,5	91,4	53,80	134,2	2,5	23,0	6 200	
75	2,5		70,5		10,2	7	3	28,2	72		2,65	1,5	4,5	96,4	57,60	130,0	2,5	22,8	5 500	
80	2,5		74,5		10,2	7,4	3	30,8	76,5		2,65	1,75	5,3	101,4	71,60	128,4	3	19,5	5 800	
85	3		79,5		10,2	7,8	3,5	39,5	81,5		3,15	1,75	5,3	106,4	76,20	215,4	3	33,4	5 200	
90	3	0 −0,08	84,5		10,2	8,2	3,5	47,7	86,5	0 −0,35 (h12)	3,15	1,75	5,3	111,4	80,80	217,2	3	34,4	4 750	
95	3		89,5		10,2	8,6	3,5	53,0	91,5		3,15	1,75	5,3	116,4	85,50	212,2	3,5	29,25	4 250	85
100	3		94,5	+0,54 −1,3	10,2	9	3,5	56,6	96,5		3,15	1,75	5,3	121,4	90,00	206,4	3,5	29,0	4 000	
110	4		103		12,2	9,6	3,5	84,0	106	0 −0,54 (h13)	4,15	2	6	135,6	113,0	457,0	3,5	66,9	4 150	
120	4	0 −0,1	113		14,2	10,2	3,5	89,7	116		4,15	2	6	149,8	123,5	424,8	3,5	64,5	3 500	
130	4		123	+0,63 −1,5	14,2	10,7	4	105	126	0 −0,63 (h13)	4,15	2	6	159,8	134,0	395,5	4	55,2	3 050	125
140	4		133		14,2	11,2	4	115	136		4,15	2	6	169,8	144,5	376,5	4	54,4	2 640	

1) See subclause 10.1. *) Lim. dev. = Limit deviations.
2) See subclause 10.2.

4 Material

Circlips shall be in C 67, C 75 or Ck 75 spring steel complying with DIN 17 222 (at the manufacturer's discretion), with a hardness as specified in table 2.

Table 2

Nominal size of circlip		Hardness
Over	Up to	
–	48	470 to 580 HV (corresponds to 47 to 54 HRC)
48	–	435 to 530 HV (corresponds to 44 to 51 HRC)
Hardness values converted in accordance with DIN 50 150.		

Other materials shall be subject to agreement.

5 Finish

Circlips shall be free from burrs.

Circlips are generally provided with one of the standard finishes specified in table 3 (at the manufacturer's discretion), no special reference being needed in the designation in this case.

Table 3: Types of finish

No.	Type of finish	Requirement
1	Phosphated and oiled in accordance with DIN 50 942; denoted by Znphr . . . f	There shall be no indication of corrosion after 8 hours of exposure to a DIN 50 021 – SS (neutral salt spray) test.
2	(Thermally or chemically) blackened and oiled	
3	Burnished and oiled in accordance with DIN 50 938, process group A; denoted by brAf	Degree of protection as in subclause 5.2 of DIN 50 938, December 1973 edition.

If, as a deviation from table 3, a particular corrosion protection is required, this is to be indicated in the designation, the symbols associated with electroplating being those specified in DIN 267 Part 9, e.g.:

Circlip DIN 983 – 40 × 1,75 – A3K

It is not possible to maintain closely toleranced coating thicknesses where circlips are subjected to bulk plating in a drum or bell.

Reference is made to DIN 267 Part 9 with regard to the risk of hydrogen-induced, delayed embrittlement in electroplated circlips. In the case of such circlips, the upper deviation for thickness s may be exceeded by an amount equal to the coating thickness. This shall be taken into consideration when designing the groove.

6 Testing

6.1 Material

Vickers hardness testing shall be as specified in DIN 50 133 Part 1.

Rockwell hardness testing shall be as specified in DIN 50 103 Part 1.

In case of doubt, the results of Vickers hardness testing shall be relevant.

6.2 Ductility

The ductility of circlips shall be determined as illustrated in figure 4.

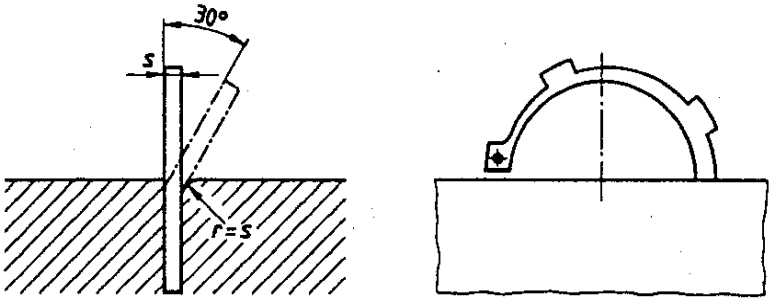

Figure 4: Bend test

The circlip shall be positioned so that it is gripped at the beam section between two jaws, the edge of one of which has been rounded so that the edge radius equals the circlip thickness. The circlip shall be bent through 30° over the radiused jaw by light hammer blows or by means of a lever, following which there shall be no visible sign of fracture or cracking in the circlip. The circlip shall then be further bent until fracture occurs. The fracture shall reveal a uniform structure.

6.3 Deviations of form

6.3.1 Radial flatness error (dish)

The circlip shall be placed between two parallel plates, which shall then be loaded as shown in figure 5. The difference $h - s$, with force F applied, shall not exceed the maxiumum values specified in table 4.

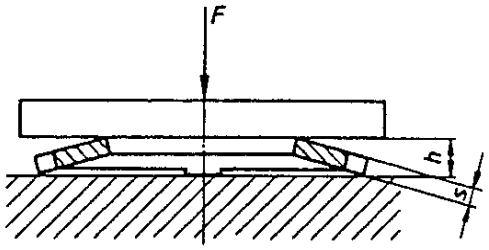

Figure 5: Determination of radial flatness error (dish)

Table 4

Nominal size of circlip		Force, F, in N	$h - s$
Over	Up to	± 5 %	max.
–	22	30	$b \times 0{,}03$
22	38	40	
38	80	60	
80	–	80	$b \times 0{,}02$

6.3.2 Spiral flatness error (helical pitch)

Two parallel vertical plates shall be arranged at a distance c as specified in table 5 and the circlip dropped between these plates, through which it shall pass (cf. figure 6).

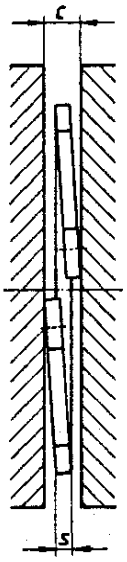

Figure 6: Determination of spiral flatness error

Table 5

Nominal size of circlip		c
Over	Up to	
–	100	$1{,}5 \times s$
100	–	$1{,}8 \times s$

6.4 Permanent set and grip

The circlip shall be placed five times on a cone with a diameter equal to 1,01 d_1, as illustrated in figure 15, and shall then be able to grip a shaft with a diameter equal to the minimum groove diameter.

6.5 Acceptance inspection

The principles of testing and acceptance as specified in ISO 3269 shall apply for acceptance inspection.

Table 6 lists the characteristics (attributes) to be inspected, table 7 specifying the acceptable quality limit.

Table 6

Characteristics
Circlip thickness, s
Internal diameter of circlip, d_3
Radial flatness error (dish)
Spiral flatness error (helical pitch)
Permanent set

Table 7

Acceptance quality level, AQL[1])	
For inspection by attributes	For inspection by defective items
1	1,5
1) See DIN 40 080.	

An agreement shall be reached at the time of ordering if other sampling plans are to be applied.

ISO 3269, clause 5, shall apply with regard to hardness testing (which is destructive).

7 Loadbearing capacity

The loadbearing capacities of the groove, F_N, and of the circlip, F_R, shall be calculated separately, the strength of a circlip assembly being a function of the lower value of the two.

Safety factors allowing for creep under static loading or for fatigue failure under oscillating stress are not included in the values given in clause 3 for the loadbearing capacities (F_N, F_R, F_{Rs}), but these do include a safety factor of at least two, allowing for fracture under static stress.

7.1 Loadbearing capacity of groove, F_N

The loadbearing capacity of the groove, F_N, specified in clause 3 is based on a yield point of the material in the zone of the groove, R_{eL}, equal to 200 N/mm² and on the nominal groove depth, t, and edge margin, n, specified.

The loadbearing capacity, F'_N, for differing groove depths, t' (resulting from differing shaft diameters, d_1, and/or differing groove diameters, d_2), and yield points R'_{eL} (formerly, σ'_s), is in direct proportion to the groove depth and the yield point. It is given by:

$$F'_N = F_N \cdot \frac{t'}{t} \cdot \frac{R'_{eL}}{200}$$

7.2 Loadbearing capacity of circlip, F_R

The loadbearing capacity of the circlip, F_R, as specified in clause 3 shall apply where a circlip is seated against a sharp-edged component (see figure 7).

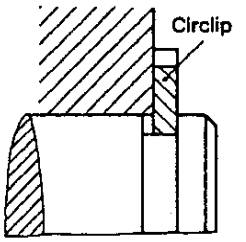

Figure 7: Seating of circlip against square-edged component

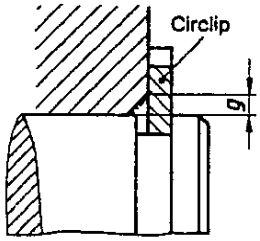

Figure 8: Seating of circlip against chamfered (rounded) edge of component

The F_{Rg} values shall apply where the circlip is seated against a component with chamfered edge (see figure 8).

Both the F_R and F_{Rg} values shall apply to circlip materials with a modulus of elasticity (Young's modulus) of 210 000 N/mm². If circlips are made from a different material with a different modulus of elasticity, E', conversion is based on the fact that the loadbearing capacity of a circlip is in direct proportion to its modulus of elasticity. This is expressed by:

$$F'_R = F_R \cdot \frac{E'}{210\,000}$$

$$F'_{Rg} = F_{Rg} \cdot \frac{E'}{210\,000}$$

If the width of the actual chamfer, g', differs from the values given in clause 3, conversion is based on the fact that the loadbearing capacity of the circlip is in indirect proportion to the chamfer width. This is expressed by:

$$F'_{Rg} = F_{Rg} \cdot \frac{g}{g'}$$

NOTE: If F'_{Rg} exceeds F_R for small values of g', F_R shall apply. If the gap resulting from the chamfer is too large for the loads that are to be applied to be sustained, a DIN 988 supporting ring shall be inserted to give a square edge (see figure 9).

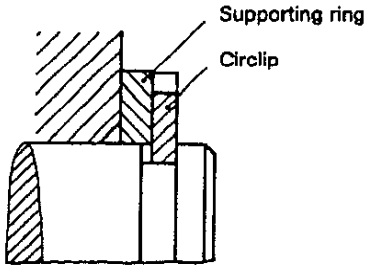

Figure 9: Improved contact of circlip by means of an inserted supporting ring

8 Release speed

The use of circlips is limited by any speed which neutralizes the prestress by means of centrifugal force, and at which the ring begins to release from its seat.

Table 1 gives the speed, n_{abl}, at which a ring begins to loosen from its seat. It is only after a further increase in speed of 50 % that the ring will come off. The values apply to circlips made of the spring steels specified in clause 4.

9 Concealed installation

Given a constant depth of lug, a, circlips are suitable for concealed installation, as illustrated in figure 10, this meaning that their fit is not a function of speed.

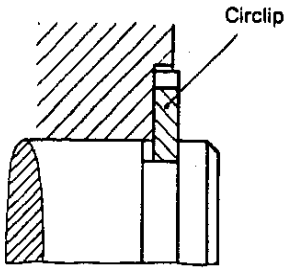

Figure 10: Concealed installation

10 Groove design

10.1 Groove diameter

The groove diameter, d_2, given in clause 3 has been specified so as to ensure that circlips have a firm grip on that diameter.

NOTE: The use of smaller groove diameters is permitted if the assembly does not require prestressing of the circlip. The minimum of d_2 shall be equal to the maximum of d_3.

10.2 Groove width

Groove width, m, as specified in table 1 is normally subject to tolerance zone H13, where loading is one-sided, the groove may be widened and/or chamfered on the other side. As the groove width has no influence on the loadbearing capacity of the assembly, groove forms and widths to works specifications are permitted. If the circlip is intended to transmit a load alternately to both groove flanks, m shall approach, as far as possible, the circlip thickness, s (e.g. by introducing closer tolerances) (see figures 11 to 14 for groove forms).

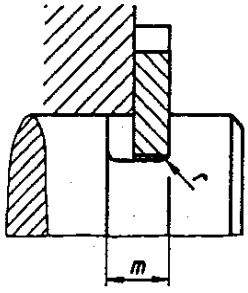

Figure 11

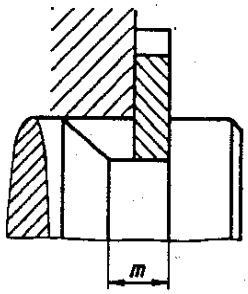

Figure 12

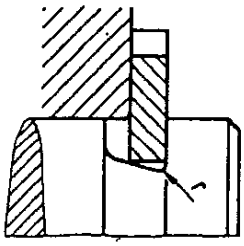

Figure 13

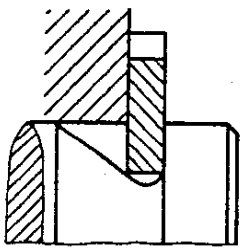

Figure 14

10.3 Groove form

The normal form of the groove shall be that shown in figure 11, the radius, *r*, on the loaded side not exceeding 0,1 *s*. Other common groove forms are illustrated in figures 12 to 14. A coefficient allowing for the notch effect shall be used in the case of square-edged grooves as shown in figure 12.

11 Fitting of circlips

DIN 5254 pliers shall preferably be used for the fitting of circlips, great care being taken not to overload them, i.e. they shall not be compressed more than is necessary for fitting on the shaft. Adjustable pliers with a facility for limiting the expansion shall be used where necessary, the most secure protection against overstressing, however, being fitting by means of a cone (see figure 15).

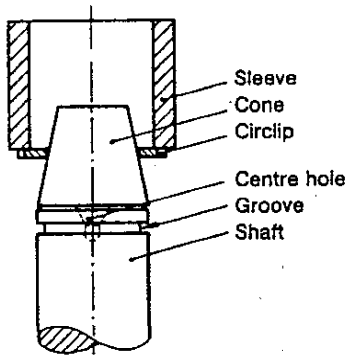

Figure 15: Fitting of circlip using cone

Standards referred to

DIN 267 Part 9	Fasteners; technical delivery conditions, electroplated components
DIN 988	Shim rings and supporting rings
DIN 5254	Pliers for circlips on shafts
DIN 17 222	Cold rolled spring steel; technical delivery conditions
DIN 40 080	Procedures and tables for sampling in testing by attributes
DIN 50 021	Corrosion testing; spray testing with various sodium chloride solutions
DIN 50 103 Part 1	Rockwell hardness testing of metallic materials; C, A, B and F scales
DIN 50 133 Part 1	Testing of metallic materials; Vickers hardness testing, with test loads from 49 to 980 N
DIN 50 150	Testing of steel and steel castings; conversion tables for Vickers hardness, Brinell hardness, Rockwell hardness and tensile strength
DIN 50 938	Burnishing of ferrous materials; principles, symbols and methods of test
DIN 50 942	Phosphating of metals; principles, symbols and methods of test
ISO 3269 : 1988	Fasteners; acceptance inspection

Other relevant standards

DIN 471	Normal type and heavy type circlips (retaining rings) for shafts
DIN 472	Normal type and heavy type circlips (retaining rings) for bores
DIN 894	Retaining rings with lugs for use in bores (external circlips)
DIN 5256	Pliers for external circlips
DIN 6799	Lock washers for shafts

Previous editions

DIN 471 and 472 Supplement 1: 01.45, 03.54x; DIN 983: 03.65; DIN 995: 01.70.

Amendments

The following amendments have been made to DIN 983, March 1965 edition, and DIN 995, January 1970 edition.

a) The standards have been combined to form one standard.

b) The content has been revised and harmonized with DIN 471.

Explanatory notes

This standard supersedes the March 1965 edition and parts of DIN 995, January 1970 edition, where these refer to circlips with lugs for use on shafts. By summarizing the data in one standard and including technical delivery conditions and guidelines regarding the fitting of circlips, a complete and comprehensive standard has been prepared, which can be used without reference to other standards.

Re clause 3

The form and position of the groove have been toleranced at the request of users, the specifications covering general purpose applications of circlips. Different works specifications may, however, be made. This applies in particular with regard to the surface finish of the groove.

Although the possibility of reducing the variety of circlips was discussed on several occasions, a satisfactory solution could not be found since almost all sizes are used to varying extents in consequence of the widely varying applications already referred to above. A reduction of the variety on the basis of selected rolling bearing diameters also proved impossible.

Re clause 4

The material specifications have been modified, three materials complying with DIN 17 222 now having been designated as standard. Other materials may be used subject to agreement.

Re clause 5

The information regarding surface finish has been supplemented and brought into line with current practice. As electroplated circlips are particularly susceptible to hydrogen embrittlement, express reference has been made to DIN 267 Part 9 for its description of the processes involved.

In order to prevent any future hydrogen-induced embrittlement in the case of electroplated circlips, the material, the electroplating process and the heat treatment before and after electroplating shall be selected so as to ensure that only a little hydrogen is absorbed in the pickling and electroplating processes and that this hydrogen is largely expelled again.

If embrittlement is to be prevented with a specified level of certainty, it is recommended that an appropriate number of samples be taken and the specimens subjected to fatigue testing for 48 hours at ambient temperature. For the purposes of this test, the circlips shall be compressed to d_1.

Re clause 6

Clause 6 which specifies methods of test permitting an assessment of the mechanical properties and the performance of circlips, has been included for the first time. The specifications given in this clause are the result of the experience gained both by manufacturers and users and assume the normal use of circlips. This also applies to acceptance inspection as specified in subclause 6.5, which is based on ISO 3269. Other acceptance conditions may, however, be the subject of agreement.

Re clause 11

The method recommended particularly is suitable for use in mass production.