UDC 621.887.6 : 621.824 : 001.4 : 003.62 : 620.1 September 1981

Circlips
(retaining rings)
for shafts
Normal type and heavy type

DIN 471

Sicherungsringe (Halteringe) für Wellen; Regelausführung und schwere Ausführung

Supersedes
DIN 471 Part 1/03.65 and
DIN 471 Part 2/03.65 and
partially supersedes
DIN 995/01.70

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

Dimensions in mm

Contents

1 Concept

Circlips within the meaning of this standard are retaining rings for holding structural components (e.g. rolling bearings) on shafts. They are given an eccentric shape, are fitted with spring retention in grooves and are suitable for the transmission of axial forces (see in this respect clause 7).

2 Dimension letters, symbols

a	radial width of the lug
b	beam (radial width of circlip opposite the aperture)
c	distance between measuring plates for testing spiral flatness
d_1	shaft diameter
d_2	groove diameter
d_3	internal diameter of circlip not under tension
d_4	maximum symmetrical diameter of bore during fitting
d_5	diameter of the lug holes
E	modulus of elasticity
F_N	load-bearing capacity of groove at a yield point of the grooved material of 200 N/mm² (see subclause 7.1)
F_R	load-bearing capacity of circlip with sharp-edged abutment of the pressing part (see subclause 7.2)
F_{Rg}	load-bearing capacity of circlip for abutment with edge chamfering distance g (see subclause 7.2)
R_{eL}	yield point
g	edge chamfering distance of the abutment surface to the circlip
h	distance between the plates when testing conical deformation
m	groove width
n	edge margin
n_{abl}	detachment speed of the circlip (see clause 8)
r	curvature in the groove base or test jaws
s	thickness of the circlip
t	groove depth with nominal sizes of d_1 and d_2

Continued on pages 2 to 12

3 Dimensions, designation, design data

The circlips do not need to conform to the illustration; only the dimensions specified must be adhered to.

unloaded

shape of ring at manufacturer's discretion

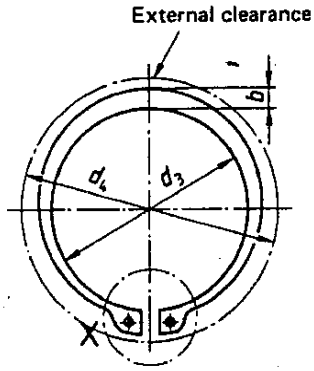


Figure 1.

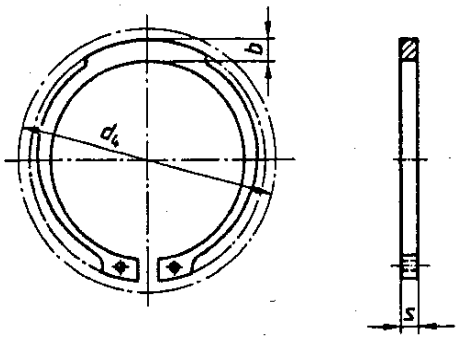
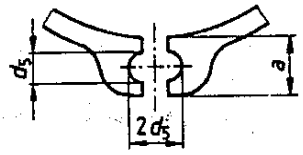


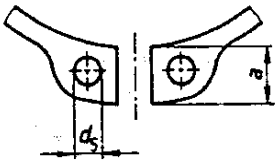
Figure 2.

Detail of X

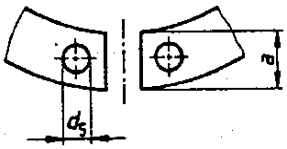
$d_1 \leq 9$ mm



$d_1 > 9 \leq 300$ mm



$d_1 \geq 170$ mm
at manufacturer's discretion



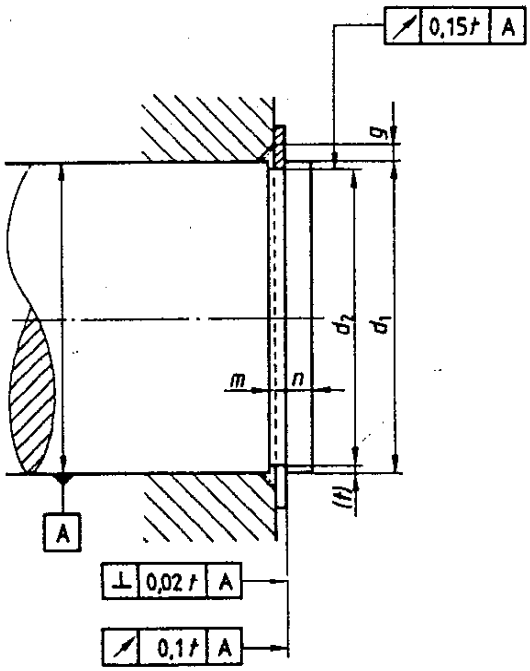


Figure 3.

Values for peak-to-valley height for groove base and loaded edge must be specified in each case.

Designation of a circlip for shaft diameter (nominal dimension) d_1 = 40 mm and circlip thickness s = 1,75 mm:

Circlip DIN 471 – 40 x 1,75

01-10-29; 1:37PM; # 40/108

Table 1. **Normal type**

Shaft diameter d_1 Nominal dimension	Clip							Groove					Supplementary data [4]						
	s	per. dev.	d_3	per. dev.	a max.	b [1] ≈	d_5 min.	Weight of 1000 pieces in kg ≈	d_2 [2]	per. dev.	m [3] H13	t	n min.	d_4	F_N kN	F_R kN	g	F_{Rg} kN	n_{abl} min^{-1}	Nominal size of pliers according to DIN 5254
3	0,4		2,7		1,9	0,8	1	0,017	2,8	0 −0,04 (h10)	0,5	0,1	0,3	7	0,15	0,47	0,5	0,27	360000	
4	0,4		3,7	+0,04 −0,15	2,2	0,9	1	0,022	3,8		0,5	0,1	0,3	8,6	0,20	0,50	0,5	0,30	211000	
5	0,6	0 −0,05	4,7		2,5	1,1	1	0,066	4,8	0 −0,048 (h10)	0,7	0,1	0,3	10,3	0,26	1,00	0,5	0,80	154000	
6	0,7		5,6		2,7	1,3	1,2	0,084	5,7		0,8	0,15	0,5	11,7	0,46	1,45	0,5	0,90	114000	3
7	0,8		6,5		3,1	1,4	1,2	0,121	6,7		0,9	0,15	0,5	13,5	0,54	2,60	0,5	1,40	121000	
8	0,8		7,4	+0,06 −0,18	3,2	1,5	1,2	0,158	7,6	0 −0,06 (h10)	0,9	0,2	0,6	14,7	0,81	3,00	0,5	2,00	96000	
9	1		8,4		3,3	1,7	1,2	0,300	8,6		1,1	0,2	0,6	16	0,92	3,50	0,5	2,40	85000	
10	1		9,3		3,3	1,8	1,5	0,340	9,6		1,1	0,2	0,6	17	1,01	4,00	1	2,40	84000	
11	1		10,2		3,3	1,8	1,5	0,410	10,5		1,1	0,25	0,8	18	1,40	4,50	1	2,40	70000	
12	1		11		3,3	1,8	1,7	0,500	11,5		1,1	0,25	0,8	19	1,53	5,00	1	2,40	75000	
13	1		11,9		3,4	2	1,7	0,530	12,4		1,1	0,3	0,9	20,2	2,00	5,80	1	2,40	66000	
14	1		12,9	+0,10 −0,36	3,5	2,1	1,7	0,640	13,4		1,1	0,3	0,9	21,4	2,15	6,35	1	2,40	58000	10
15	1		13,8		3,6	2,2	1,7	0,670	14,3	0 −0,11 (h11)	1,1	0,35	1,1	22,6	2,66	6,90	1	2,40	50000	
16	1		14,7		3,7	2,2	1,7	0,700	15,2		1,1	0,4	1,2	23,8	3,26	7,40	1	2,40	45000	
17	1		15,7		3,8	2,3	1,7	0,820	16,2		1,1	0,4	1,2	25	3,46	8,00	1	2,40	41000	
18	1,2		16,5		3,9	2,4	2	1,11	17		1,3	0,5	1,5	26,2	4,58	17,0	1,5	3,75	39000	
19	1,2		17,5		3,9	2,5	2	1,22	18		1,3	0,5	1,5	27,2	4,84	17,0	1,5	3,80	35000	
20	1,2		18,5		4	2,6	2	1,30	19		1,3	0,5	1,5	28,4	5,06	17,1	1,5	3,85	32000	
21	1,2		19,5	+0,13 −0,42	4,1	2,7	2	1,42	20	0 −0,13 (h11)	1,3	0,5	1,5	29,6	5,36	16,8	1,5	3,75	29000	
22	1,2		20,5		4,2	2,8	2	1,50	21		1,3	0,5	1,5	30,8	5,65	16,9	1,5	3,80	27000	
24	1,2	0 −0,06	22,2		4,4	3	2	1,77	22,9		1,3	0,55	1,7	33,2	6,75	16,1	1,5	3,65	27000	
25	1,2		23,2		4,4	3	2	1,90	23,9		1,3	0,55	1,7	34,2	7,05	16,2	1,5	3,70	25000	
26	1,2		24,2		4,5	3,1	2	1,96	24,9	0 −0,21 (h12)	1,3	0,55	1,7	35,5	7,34	16,1	1,5	3,70	24000	
28	1,5		25,9	+0,21 −0,42	4,7	3,2	2	2,92	26,6		1,6	0,7	2,1	37,9	10,00	32,1	1,5	7,50	21200	19
29	1,5		26,9		4,8	3,4	2	3,20	27,6		1,6	0,7	2,1	39,1	10,37	31,8	1,5	7,45	20000	
30	1,5		27,9		5	3,5	2	3,31	28,6		1,6	0,7	2,1	40,5	10,73	32,1	1,5	7,65	18900	
32	1,5		29,6		5,2	3,6	2,5	3,54	30,3		1,6	0,85	2,6	43	13,85	31,2	2	5,55	16900	
34	1,5		31,5		5,4	3,8	2,5	3,80	32,3		1,6	0,85	2,6	45,4	14,72	31,3	2	5,60	16100	
35	1,5		32,2	+0,25 −0,5	5,6	3,9	2,5	4,00	33		1,6	1	3	46,8	17,80	30,8	2	5,55	15500	
36	1,75		33,2		5,6	4	2,5	5,00	34		1,85	1	3	47,8	18,33	49,4	2	9,00	14500	
38	1,75		35,2		5,8	4,2	2,5	5,62	36		1,85	1	3	50,2	19,30	49,5	2	9,10	13600	
40	1,75		36,5		6	4,4	2,5	6,03	37,5	0 −0,25 (h12)	1,85	1,25	3,8	52,6	25,30	51,0	2	9,50	14300	
42	1,75		38,5		6,5	4,5	2,5	6,50	39,5		1,85	1,25	3,8	55,7	26,70	50,0	2	9,45	13000	
45	1,75		41,5	+0,39 −0,9	6,7	4,7	2,5	7,50	42,5		1,85	1,25	3,8	59,1	28,60	49,0	2	9,35	11400	
48	1,75		44,5		6,9	5	2,5	7,90	45,5		1,85	1,25	3,8	62,5	30,70	49,4	2	9,55	10300	
50	2		45,8		6,9	5,1	2,5	10,2	47		2,15	1,5	4,5	64,5	38,00	73,3	2	14,4	10500	
52	2		47,8		7	5,2	2,5	11,1	49		2,15	1,5	4,5	66,7	39,70	73,1	2,5	11,5	9850	
55	2		50,8		7,2	5,4	2,5	11,4	52		2,15	1,5	4,5	70,2	42,00	71,4	2,5	11,4	8960	
56	2		51,8		7,3	5,5	2,5	11,8	53		2,15	1,5	4,5	71,6	42,80	70,8	2,5	11,35	8670	40
58	2		53,8		7,3	5,6	2,5	12,6	55		2,15	1,5	4,5	73,6	44,30	71,1	2,5	11,5	8200	
60	2	0 −0,07	55,8		7,4	5,8	2,5	12,9	57		2,15	1,5	4,5	75,6	46,00	69,2	2,5	11,3	7620	
62	2		57,8	+0,46 −1,1	7,5	6	2,5	14,3	59	0 −0,30 (h12)	2,15	1,5	4,5	77,8	47,50	69,3	2,5	11,45	7240	
63	2		58,8		7,6	6,2	2,5	15,9	60		2,15	1,5	4,5	79	48,30	70,2	2,5	11,6	7050	
65	2,5		60,8		7,8	6,3	3	18,2	62		2,65	1,5	4,5	81,4	49,80	135,6	2,5	22,7	6640	
68	2,5		63,5		8	6,5	3	21,8	65		2,65	1,5	4,5	84,8	52,20	135,9	2,5	23,1	6910	
70	2,5		65,5		8,1	6,6	3	22,0	67		2,65	1,5	4,5	87	53,80	134,2	2,5	23,0	6530	

[1] Dimension b shall not exceed dimension a max.
[2] See subclause 9.1
[3] See subclause 9.2
[4] The supplementary data apply only to circlips in spring steel in accordance with DIN 17 222

Table 1. (continued)

Shaft diameter d_1 Nominal dimension	Clip							Groove					Supplementary data [4]						Nominal size of pliers according to DIN 5254
	s	per. dev.	d_3	per. dev.	a max.	b [1] ≈	d_5 min.	Weight of 1000 pieces in kg ≈	d_2 [2]	per. dev.	m [3] H13	t	n min.	d_4	F_N kN	F_R kN	g	F_{Rs} kN	n_{abl} min^{-1}	
72	2,5	0 −0,07	67,5	+0,46 −1,1	8,2	6,8	3	22,5	69	0 −0,3 (h12)	2,65	1,5	4,5	89,2	55,30	131,8	2,5	22,8	6190	40
75	2,5		70,5		8,4	7	3	24,6	72		2,65	1,5	4,5	92,7	57,60	130,0	2,5	22,8	5740	
78	2,5		73,5		8,6	7,3	3	26,2	75		2,65	1,5	4,5	96,1	60,00	131,3	3	19,75	5450	
80	2,5		74,5		8,6	7,4	3	27,3	76,5		2,65	1,75	5,3	98,1	71,60	128,4	3	19,5	6100	
82	2,5		76,5		8,7	7,6	3	31,2	78,5		2,65	1,75	5,3	100,3	73,50	128,0	3	19,6	5860	
85	3	0 −0,08	79,5		8,7	7,8	3,5	36,4	81,5	0 −0,35 (h12)	3,15	1,75	5,3	103,3	76,20	215,4	3	33,4	5710	85
88	3		82,5		8,8	8	3,5	41,2	84,5		3,15	1,75	5,3	106,5	79,00	221,8	3	34,85	5200	
90	3		84,5		8,8	8,2	3,5	44,5	86,5		3,15	1,75	5,3	108,5	80,80	217,2	3	34,4	4980	
95	3		89,5		9,4	8,6	3,5	49,0	91,5		3,15	1,75	5,3	114,8	85,50	212,2	3,5	29,25	4550	
100	3		94,5		9,6	9	3,5	53,7	96,5		3,15	1,75	5,3	120,2	90,00	206,4	3,5	29,0	4180	
105	4	0 −0,1	98	+0,54 −1,3	9,9	9,3	3,5	80,0	101	0 −0,54 (h13)	4,15	2	6	125,8	107,6	471,8	3,5	67,7	4740	125
110	4		103		10,1	9,6	3,5	82,0	106		4,15	2	6	131,2	113,0	457,0	3,5	66,9	4340	
115	4		108		10,6	9,8	3,5	84,0	111		4,15	2	6	137,3	118,2	438,6	3,5	65,5	3970	
120	4		113		11	10,2	3,5	86,0	116		4,15	2	6	143,1	123,5	424,6	3,5	64,5	3685	
125	4		118		11,4	10,4	4	90,0	121	0 −0,63 (h13)	4,15	2	6	149	128,7	411,5	4	56,5	3420	125
130	4		123	+0,63 −1,5	11,6	10,7	4	100	126		4,15	2	6	154,4	134,0	395,5	4	55,2	3180	
135	4		128		11,8	11	4	104	131		4,15	2	6	159,8	139,2	389,5	4	55,4	2950	
140	4		133		12	11,2	4	110	136		4,15	2	6	165,2	144,5	376,5	4	54,4	2760	
145	4		138		12,2	11,5	4	115	141		4,15	2	6	170,6	149,6	367,0	4	53,8	2600	
150	4		142		13	11,8	4	120	145		4,15	2,5	7,5	177,3	193,0	357,5	4	53,4	2480	
155	4		146		13	12	4	135	150		4,15	2,5	7,5	182,3	199,6	352,9	4	52,6	2710	
160	4		151		13,3	12,2	4	150	155		4,15	2,5	7,5	188	206,1	349,2	4	52,2	2540	
165	4		155,5		13,5	12,5	4	160	160		4,15	2,5	7,5	193,4	212,5	345,3	5	41,4	2520	
170	4		160,5		13,5	12,9	4	170	165		4,15	2,5	7,5	198,4	219,1	349,2	5	41,9	2440	
175	4		165,5		13,5	12,9	4	180	170		4,15	2,5	7,5	203,4	225,5	340,1	5	40,7	2300	
180	4		170,5		14,2	13,5	4	190	175		4,15	2,5	7,5	210	232,2	345,3	5	41,4	2180	
185	4		175,5		14,2	13,5	4	200	180		4,15	2,5	7,5	215	238,6	336,7	5	40,4	2070	
190	4		180,5	+0,72 −1,7	14,2	14	4	210	185	0 −0,72 (h13)	4,15	2,5	7,5	220	245,1	333,8	5	40,0	1970	
195	4		185,5		14,2	14	4	220	190		4,15	2,5	7,5	225	251,8	325,4	5	39,0	1835	
200	4		190,5		14,2	14	4	230	195		4,15	2,5	7,5	230	258,3	319,2	5	38,3	1770	
210	5	0 −0,12	198		14,2	14	4	248	204		5,15	3	9	240	325,1	598,2	6	59,9	1835	
220	5		208		14,2	14	4	265	214		5,15	3	9	250	340,8	572,4	6	57,3	1820	
230	5		218		14,2	14	4	290	224		5,15	3	9	260	356,6	548,9	6	55,0	1445	
240	5		228		14,2	14	4	310	234		5,15	3	9	270	372,6	530,3	6	53,0	1305	
250	5		238		14,2	14	4	335	244		5,15	3	9	280	388,3	504,3	6	50,5	1180	
260	5		245		16,2	16	5	355	252	0 −0,81 (h13)	5,15	4	12	294	535,8	540,6	6	54,6	1320	
270	5		255	+0,81 −2	16,2	16	5	375	262		5,15	4	12	304	556,6	525,3	6	52,5	1215	
280	5		265		16,2	16	5	398	272		5,15	4	12	314	576,6	508,2	6	50,9	1100	
290	5		275		16,2	16	5	418	282		5,15	4	12	324	599,1	490,8	6	49,2	1005	
300	5		285		16,2	16	5	440	292		5,15	4	12	334	619,1	475,0	6	47,5	930	

For [1], [2], [3] and [4] see page 3

Table 2. **Heavy type**

Shaft diameter d_1 Nominal dimension	Clip							Groove					Supplementary data [4]						Nominal size of pliers according to DIN 5254
	s	per. dev.	d_3	per. dev.	a max.	b [1] ≈	d_5 min.	Weight of 1000 pieces in kg ≈	d_2 [2]	per. dev.	m [3] H13	t	n min.	d_4	F_N kN	F_R kN	g	F_{Rg} kN	n_{abl} min^{-1}	
15	1,5	0 −0,06	13,8	+0,10 −0,36	4,8	2,4	2	1,10	14,3	0 −0,11 (h11)	1,6	0,35	1,1	25,1	2,66	15,5	1	6,40	57000	10
16	1,5		14,7		5	2,5	2	1,19	15,2		1,6	0,4	1,2	26,5	3,26	16,6	1	6,35	44000	
17	1,5		15,7		5	2,6	2	1,39	16,2		1,6	0,4	1,2	27,5	3,46	18,0	1	6,70	46000	
18	1,5		16,5		5,1	2,7	2	1,56	17		1,6	0,5	1,5	28,7	4,58	26,6	1,5	5,85	42750	
20	1,75		18,5	+0,13 −0,42	5,5	3	2	2,19	19	0 −0,13 (h11)	1,85	0,5	1,5	31,6	5,06	36,3	1,5	8,20	36000	19
22	1,75		20,5		6	3,1	2	2,42	21		1,85	0,5	1,5	34,6	5,65	36,0	1,5	8,10	29000	
24	1,75		22,2		6,3	3,2	2	2,76	22,9		1,85	0,55	1,7	37,3	6,75	34,2	1,5	7,60	29200	
25	2	0 −0,07	23,2	+0,21 −0,42	6,4	3,4	2	3,59	23,9	0 −0,21 (h12)	2,15	0,55	1,7	38,5	7,05	45,0	1,5	10,3	25000	
28	2		25,9		6,5	3,5	2	4,25	26,6		2,15	0,7	2,1	41,7	10,0	57,0	1,5	13,4	22200	
30	2		27,9		6,5	4,1	2	5,35	28,6		2,15	0,7	2,1	43,7	10,7	57,0	1,5	13,6	21100	
32	2		29,6		6,5	4,1	2,5	5,85	30,3	0 −0,25 (h12)	2,15	0,85	2,6	45,7	13,8	55,5	2	10,0	18400	40
34	2,5		31,5	+0,25 −0,5	6,6	4,2	2,5	7,05	32,3		2,65	0,85	2,6	47,9	14,7	87,0	2	15,6	17800	
35	2,5		32,2		6,7	4,2	2,5	7,20	33		2,65	1	3	49,1	17,8	86,0	2	15,4	16500	
38	2,5		35,2		6,8	4,3	2,5	8,30	36		2,65	1	3	52,3	19,3	101	2	18,6	14500	
40	2,5		36,5	+0,39 −0,9	7	4,4	2,5	8,60	37,5		2,65	1,25	3,8	54,7	25,3	104	2	19,3	14300	
42	2,5		38,5		7,2	4,5	2,5	9,30	39,5		2,65	1,25	3,8	57,2	26,7	102	2	19,2	13000	
45	2,5		41,5		7,5	4,7	2,5	10,7	42,5		2,65	1,25	3,8	60,8	28,6	100	2	19,1	11400	
48	2,5		44,5		7,8	5	2,5	11,3	45,5		2,65	1,25	3,8	64,4	30,7	101	2	19,5	10300	
50	3	0 −0,08	45,8		8	5,1	2,5	15,3	47		3,15	1,5	4,5	66,8	38,0	165	2	32,4	10500	
52	3		47,8		8,2	5,2	2,5	16,6	49		3,15	1,5	4,5	69,3	39,7	165	2,5	26,0	9850	
55	3		50,8	+0,46 −1,1	8,5	5,4	2,5	17,1	52	0 −0,30 (h12)	3,15	1,5	4,5	72,9	42,0	161	2,5	25,6	8960	40
58	3		53,8		8,8	5,6	2,5	18,9	55		3,15	1,5	4,5	76,5	44,3	160	2,5	26,0	8200	
60	3		55,8		9	5,8	2,5	19,4	57		3,15	1,5	4,5	78,9	46,0	156	2,5	25,4	7620	
65	4	0 −0,1	60,8		9,3	6,3	3	29,1	62		4,15	1,5	4,5	84,6	49,8	346	2,5	58,0	6640	
70	4		65,5		9,5	6,6	3	35,3	67		4,15	1,5	4,5	90	53,8	343	2,5	59,0	6530	
75	4		70,5		9,7	7	3	39,3	72		4,15	1,5	4,5	95,4	57,6	333	2,5	58,0	5740	
80	4		74,5		9,8	7,4	3	43,7	76,5		4,15	1,75	5,3	100,6	71,6	328	3	50,0	6100	
85	4		79,5	+0,54 −1,3	10	7,8	3,5	48,5	81,5	0 −0,35 (h12)	4,15	1,75	5,3	106	76,2	383	3	59,4	5710	85
90	4		84,5		10,2	8,2	3,5	59,4	86,5		4,15	1,75	5,3	111,5	80,8	386	3	61,0	4980	
100	4		94,5		10,5	9	3,5	71,6	96,5		4,15	1,75	5,3	122,1	90,0	368	3,5	51,6	4180	

For [1], [2], [3] and [4] see page 3

Note: d_4 calculated from: $d_4 = d_1 + 2{,}1\,a$

4 Material

C 67, C 75 or Ck 75 spring steel in accordance with DIN 17 222 (at manufacturer's discretion)
Table 3 applies in respect of the hardness:

Table 3.

Nominal diameter of circlip over	to	Hardness
–	48	470 to 580 Vickers hardness (corresponding to 47 to 54 Rockwell C hardness)
48	200	435 to 530 Vickers hardness (corresponding to 44 to 51 Rockwell C hardness)
200	300	390 to 470 Vickers hardness (corresponding to 40 to 47 Rockwell C hardness)
Hardness values converted in accordance with DIN 50 150		

Other materials on agreement

5 Finish

Circlips must be without burr.
Circlips are normally supplied corrosion-proof in accordance with table 4 (at manufacturer's discretion). No special details concerning this condition on delivery must be stated in the designation of a circlip.

Table 4. **Anti-corrosion treatment of circlips**

Serial No.	Type of anti-corrosion treatment	Corrosion resistance
1	Phosphatized and oiled according to DIN 50 942 Symbol: Znph r ... f	No sign of corrosion permissible after 8 hours of exposure to salt spray according to DIN 50 021 – SS
2	Blackened and oiled (thermally or chemically)	
3	Burnished and oiled according to DIN 50 938 Process class A Symbol: br A f	Protection value according to DIN 50 938 December 1973 edition, subclause 5.2

If a particular anti-corrosion treatment is required which is different from table 4, the designation of the circlip must be supplemented accordingly.
For platings, the symbols according to DIN 267 Part 9 apply, e.g.:

Circlip DIN 471 – 40 x 1,75 – A3K

In the case of mass plating of circlips in a drum or bell, it is not possible to maintain closely toleranced plating thicknesses.
Attention is drawn to DIN 267 Part 9 regarding the danger of hydrogen-induced delayed brittle fractures in the case of circlips with electroplated surface protection.
The upper limit of the circlip thickness s may be exceeded according to the film thickness of the plating required in the case of circlips with electroplated surface protection. This must be taken into account when designing the groove.

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6 Testing

6.1 Testing the material

Vickers hardness test in accordance with DIN 50 133 Part 1

Rockwell hardness test in accordance with DIN 50 103 Part 1

In cases of doubt, the Vickers hardness test applies.

6.2 Bend and fracture test

The testing of the circlip for ductility must be carried out in accordance with figure 4.

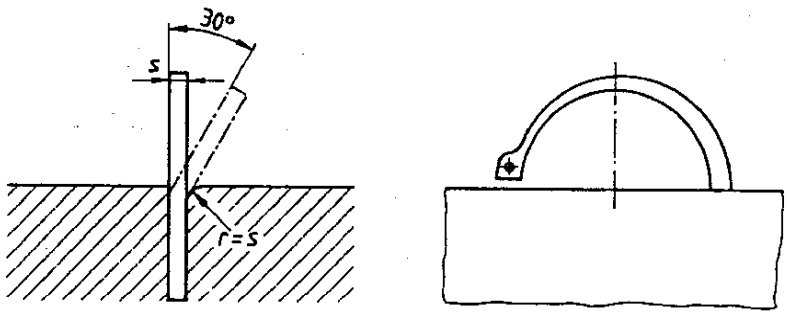

Figure 4. Bend test

One half of the circlip is clamped between two jaws, of which one has a radius equal to the thickness of the circlip. The circlip is bent through 30° by repeated light hammer blows or with a lever, following which there must be no fractures or cracks in the circlip. The circlip is then further bent until fracture occurs. The fracture surface must reveal a fine-grained structure.

6.3 Testing the deformation

6.3.1 Testing the conical deformation

The circlip is placed between two parallel plates and loaded in accordance with figure 5. The distance $h - s$ measured under force F must not exceed the maximum value stated in table 5.

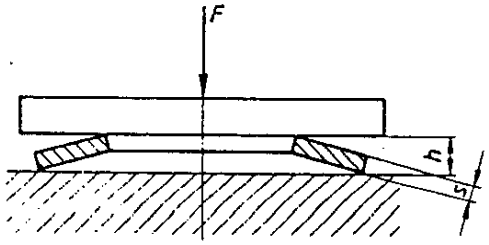

Figure 5. Testing the conical deformation

Table 5.

Nominal diameter of circlip		Force F in N ± 5 %		$h - s$
over	to	Normal type	Heavy type	max.
–	22	30	60	b X 0,03
22	38	40	80	
38	82	60	120	
82	150	80	160	b X 0,02
150	300	150	300	

6.3.2 Testing the spiral flatness

The circlip must fall through two parallel, perpendicular plates with a clearance c in accordance with table 6.

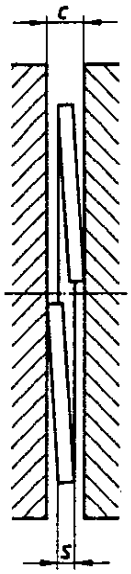

Figure 6. Testing the spiral flatness

Table 6.

Nominal diameter of circlip		c
over	to	
–	100	1,5 X s
100	–	1,8 X s

6.4 Testing the function (permanent set and grip test)

The circlip is passed five times over a cone with a diameter of 1,01 d_1 in accordance with figure 14 and must then be fitted onto a bolt of minimum groove diameter d_2 where it must remain under its own weight.

6.5 Acceptance testing

For the acceptance testing the principles for testing and acceptance in accordance with DIN 267 Part 5 apply.
Table 7 applies to the features, while table 8 applies for the acceptable quality level.

Table 7.

Features
Circlip thickness s
Circlip internal diameter d_3
Conical deformation
Spiral flatness
Function (set and grip)

Table 8.

Acceptable quality level AQL [1]	
for testing of features	for testing for faulty parts
1	1,5
[1] See DIN 40 080	

If other plans for sample testing are to be applied, this must be agreed at the time of ordering.

For hardness testing DIN 267 Part 5, April 1968 edition, clause 5, applies.

In case of circlips, the hardness test is regarded as a destructive test.

7 Load-bearing capacity

A circlip connection requires separate calculations for the load-bearing capacity of the groove F_N and for the load-bearing capacity of the circlip F_R. In each case the weaker part is that which applies. The load-bearing capacities (F_N, F_R, F_{Rs}) listed in clause 3 contain no safety neither against yielding under static stress nor against fatigue fracture under fluctuating stress. There is at least twice the level of safety against fracture under static stress.

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7.1 Load-bearing capacity of groove F_N

The load-bearing capacity of the groove F_N in clause 3 applies for a yield point of the material in the region of the shaft groove of $R_{eL} = 200$ N/mm² as well as for the given nominal groove depths t and edge margins n.

The load-bearing capacity F'_N for deviating groove depths t' (resulting from deviating shaft diameters d_1 and/or deviating groove diameters d_2) and yield points R'_{eL} (previously σ'_s) is directly proportional to the groove depth and the yield point:

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

7.2 Load-bearing capacity of circlip F_R

The load-bearing capacity of the circlip F_R in accordance with clause 3 applies to a sharp-edged abutment of the pressing machine part (see figure 7).

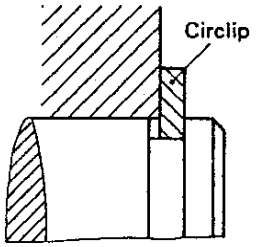

Figure 7. Sharp-edged abutment

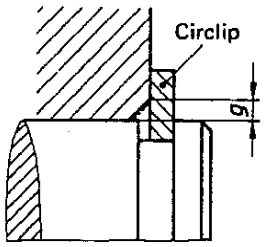

Figure 8. Abutment with edge chamfering distance (chamfering or rounding)

The values F_{Rg} apply to an abutment with an edge chamfering distance g (see figure 8).

The two values F_R and F_{Rg} apply to circlip materials with a modulus of elasticity (E-modulus) of 210 000 N/mm². If circlips of a different material with a different E-modulus E' are used, then, for conversion, the load-bearing capacity of the circlip is directly proportional to the modulus of elasticity:

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

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

If the existing edge chamfering distance g' deviates from the values in clause 3, then, for conversion, the load-bearing capacity of the circlip is indirectly proportional to the edge chamfering distance:

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

Note: If F'_{Rg} with small values of g' is greater than F_R, then F_R applies.

If the existing forces, because of too great an edge chamfering distance, cannot be accommodated, then a sharp-edged abutment must be created by means of a supporting ring in accordance wiht DIN 988 (see figure 9).

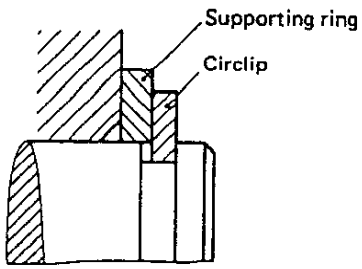

Figure 9. Sharp-edged abutment at the circlip using a supporting ring

8 Detachment speed

The application of circlips is limited by those speeds at which the pretension is relieved by centrifugal force and at which the circlip starts to lift from its seating in the groove base.

In table 1 and table 2, detachment speeds n_{abl} are given at which the circlips start to become detached from their seating in the groove (groove diameter = nominal diameter). Actual release of the circlip can be expected only after a further increase of the speeds by 50 %. The values apply to circlips made of spring steels as specified in clause 4.

9 Shape of groove

9.1 Groove diameter d_2

The groove diameters d_2 specified in clause 3 are selected so that the circlips are seated in the groove with pretension.
Note: Smaller groove diameters are possible if pretension can be dispensed with. The lower limit is: d_2 min. = d_3 max.

9.2 Groove width m

As a rule, for the groove widths specified in table 1 and table 2, the tolerance zone H13 applies. With unilateral power transmission, the grooves can be widened and/or chamfered towards the unloaded side. The groove width has no influence on the load-bearing capacity of the circlip connection. Intra-plant specified groove shapes and groove widths are therefore possible.
If the circlip is to be subjected to alternate power transmission on both groove edges, the groove width m must as far as possible, e.g. also by reducing the tolerance, be matched to the circlip thickness s. (For groove shapes, see figure 10 to figure 13).

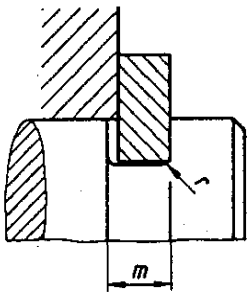

Figure 10.

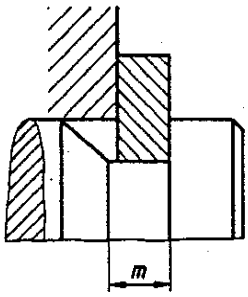

Figure 11.

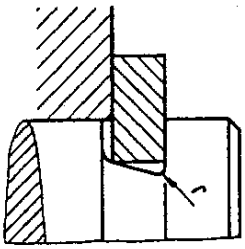

Figure 12.

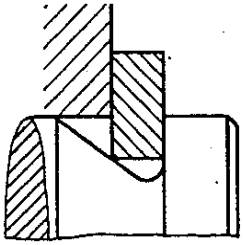

Figure 13.

9.3 Shape of groove base

A square shape is the normal type of groove base (see figure 10). The radius r on the load side must not exceed 0,1 s. Other successful shapes of groove are shown in figure 11 to figure 13. In the case of a sharp-edged square groove, the notch sensitivity of the material used produces a corresponding fatigue notch factor.

10 Fitting the circlip

Pliers in accordance with DIN 5254 shall be preferred for fitting the circlips.
When fitting, make absolutely sure that the circlips are not overspread, i.e. are not opened further than is necessary for fitting over the shaft. If necessary, pliers with opening restriction (set screw) shall be used. The safest protection against overspreading is fitting with the aid of cones (see figure 14).

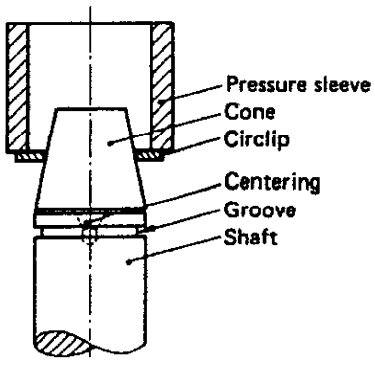

Figure 14. Fitting with cones

Standards referred to

DIN 267 Part 5	Bolts, screws, nuts and similar threaded and formed parts; technical conditions of delivery; testing and acceptance
DIN 267 Part 9	Mechanical fasteners; technical conditions of delivery; components with electroplated coatings
DIN 988	Shim rings and supporting rings
DIN 5254	Pliers for circlips for shafts
DIN 17 222	Cold rolled steel strips for springs; technical conditions of delivery
DIN 40 080	Procedures and tables for sampling test using qualitative features (sampling by attributes)
DIN 50 021	Corrosion tests; spray tests with different sodium chloride solutions
DIN 50 103 Part 1	Testing of metallic materials; Rockwell hardness testing, C, A, B, F methods
DIN 50 133 Part 1	Testing of metallic materials; Vickers hardness testing, test load range: 49 N to 980 N (5 kp to 100 kp)
DIN 50 150	Testing of steel and cast steel; conversion table for Vickers hardness, Brinell hardness, Rockwell hardness and tensile strength
DIN 50 938	Burnishing of iron material; principles of methods, symbols, testing
DIN 50 942	Phosphatizing of metals; procedural principles, symbols and test methods

Further standards

DIN 472 Circlips (retaining rings) for bores; normal type and heavy type
DIN 983 Circlips with lugs (retaining rings) for shafts
DIN 984 Circlips with lugs (retaining rings) for bores
DIN 5256 Pliers for circlips for bores
DIN 6799 Lock washers for shafts

Earlier editions

DIN 471: 12.41, 11.42, 01.52, 01.54; DIN 471 and 472 Supplement 1: 01.45, 03.54x; DIN 471 Part 1: 03.65; DIN 471 Part 2: 03.65; DIN 995: 01.70

Amendments

The following amendments have been made as compared with DIN 471 Part 1, March 1965 edition, DIN 471 Part 2, March 1965 edition and DIN 995, January 1970 edition:

a) standards combined

b) contents revised and extended (see Explanations).

Explanations

The present revised edition of DIN 471 supersedes DIN 471 Part 1 and Part 2 and parts of DIN 995 where these concern circlips for shafts. This inclusion of several standards within one standard and supplemented by technical delivery conditions and guidelines for fitting has produced a whole and complete standard which can be applied without the simultaneous application of additional standards. The following explanations are given with respect to this Standard.

Re Title

The term "(retaining rings)" has been added to the title of the standard. The old designation "circlips" has been retained, although these components are used only for the axial retention of components on shafts and have no locking action. The organizational problems associated with a general change in designation desirable for the sake of clarity were, because of the wide distribution of these standards, also rated as more important than the danger of misunderstood information on the part of the standards user due to an inappropriate title.

Re Clause 1 Concept

This clause was included in order to prevent possible errors in the application and function of the parts resulting from the designation.

Re Clause 2 Dimension letters, symbols

Clause 2 lists and describes the dimension letters and symbols used in the standard.

Re Clause 3 Dimensions, designation, design data

This clause contains the dimensions of the circlips of normal type and heavy type. Required design data have been added. The dimensions of the circlips or their tolerances have been corrected slightly in a few cases without any danger thereby of replacement difficulties.

Two types of circlip shape have been shown. The second type of circlip shape included as an additional option has been used for some years. In certain fields it has manufacturing advantages. The application and function of the circlips do not differ from the type previously represented in this standard (lefthand illustration).

Toleranced dimensions for the shape and position of the shaft groove have been included at the request of the users. These specifications apply to the general application of circlips. Other internal specifications may be used for individual cases. In the main, this applies also to the groove surfaces for which no generally valid regulations were able to be given in this standard.

The possibility of reducing the number of types of circlips, also possibly by means of main and subsidiary series for the shaft diameters, has been thoroughly examined. But no technically feasible solution was able to be found, since practically all sizes with varying datum points are in use as a result of the already mentioned wide range of application. It was also not possible to offer a selection according to rolling bearing diameters.

Re Clause 4 Material

Details of the material have been modified. Three materials have been selected as the most usual from DIN 17 222. Other materials must be agreed by the parties concerned.

Re Clause 5 Finish

Details of the finish have been extended and adapted to present conditions. With electroplated circlips, the danger of hydrogen embrittlement is relatively great and requires special attention within the meaning of DIN 267 Part 9. Particular reference has therefore been made to DIN 267 Part 9. According to this standard, the situation is approximately as follows:

In order to avoid hydrogen-induced delayed brittle fractures in the electroplated surface protection of circlips, the galvanic treatment and heat treatment before and after electroplating must be selected so that only a small amount of hydrogen is taken up in the pickling and galvanic treatment and this hydrogen is furthermore driven off again to a large extent.

Normally, delayed brittle fractures can be avoided by these measures. If brittle fractures must be avoided with specific, statistical certainty, the taking of appropriate quantities of random samples is recommended followed by fatigue testing of these samples over 48 hours at room temperature; the circlips must thereby be loaded up to the shaft diameter d_1.

Re Clause 6 Testing

Clause 6 covering the testing of circlips is new to the standard. It specifies tests which are required for the assessment of the mechanical and functional properties of circlips. The contents of this clause results from the experience of manufacturers and users and correspond to the general applications for circlips.

This also applies to the details of acceptance testing given in subclause 6.5. These details are based on DIN 267 Part 5. Special agreements are not thereby excluded.

Re Clause 7 Load-bearing capacity

Clause 7 contains details of the calculation of the load-bearing capacities of circlips and indicates how the extended data given in tables 1 and 2 have arisen. These data refer only to normal applications but clause 7 gives the priciples for calculating the load-bearing capacities also for other applications.

Re Clause 8 Detachment speed

Clause 8 is supplementary to clause 7 and explains the detachment speeds in tables 1 and 2.

Re Clause 9 Shape of groove

Various possibilities are presented in clause 9 for the shape of the grooves for circlips and these are also applicable from an economic standpoint. Decisions on appropriate shapes must be made on an individual basis.

Re Clause 10 Fitting the circlip

Clause 10 recommends the use of cones for fitting circlips. This type of fitting is of particular advantage in bulk manufacturing.