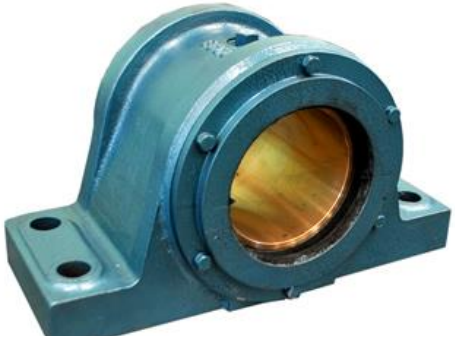
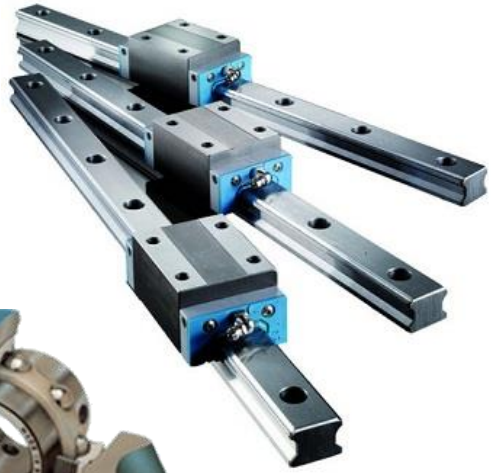
DESENHO TÉCNICO MECÂNICO I (SEM0564)

AULA 10 - ELEMENTOS DE MÁQUINA

(APOIO, ELÁSTICO E VEDAÇÃO)

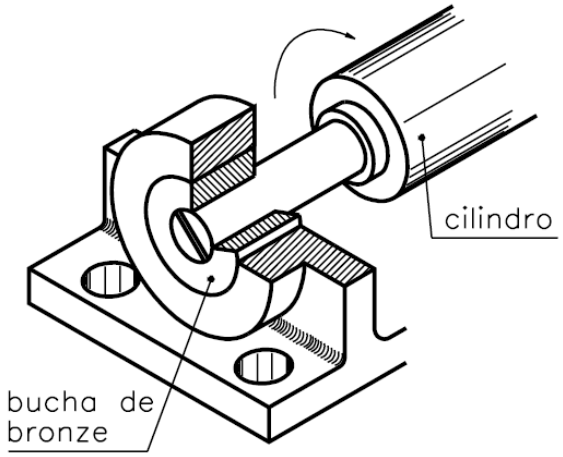




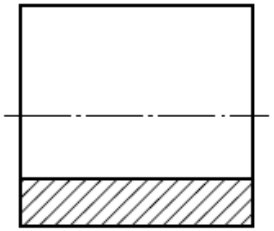
Notas de Aulas v.2016

ELEMENTOS DE APOIO

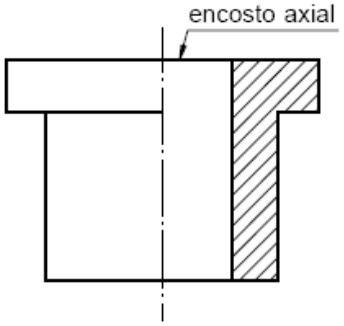
BUCHAS



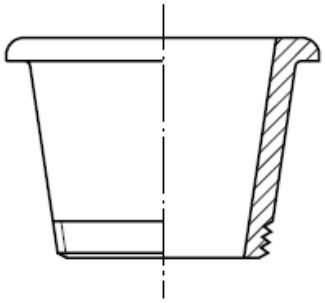
Radial

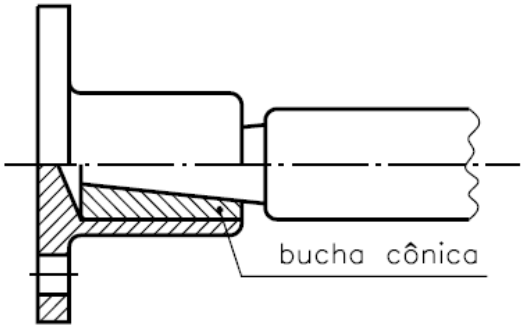


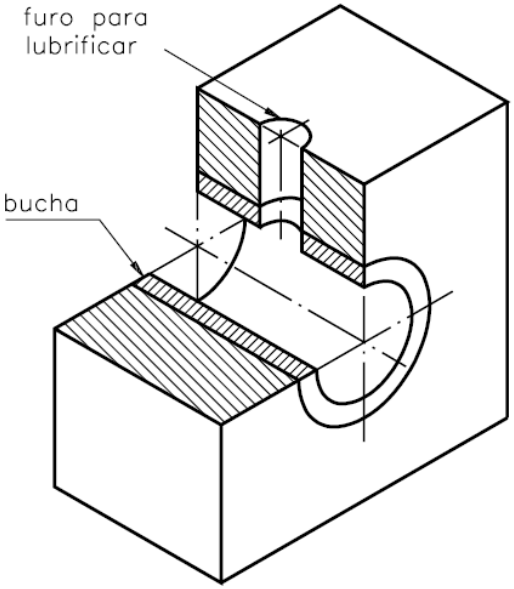
Axial

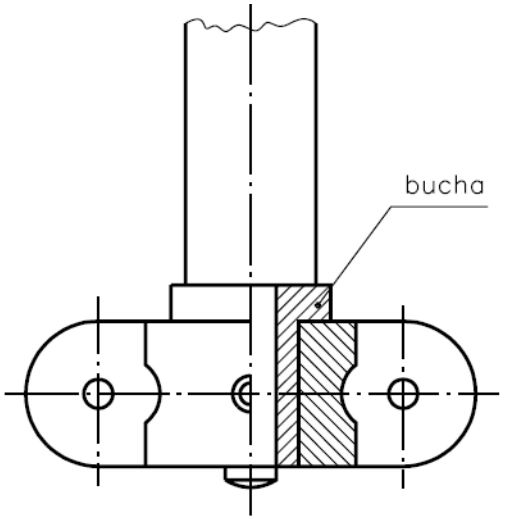


Cônica



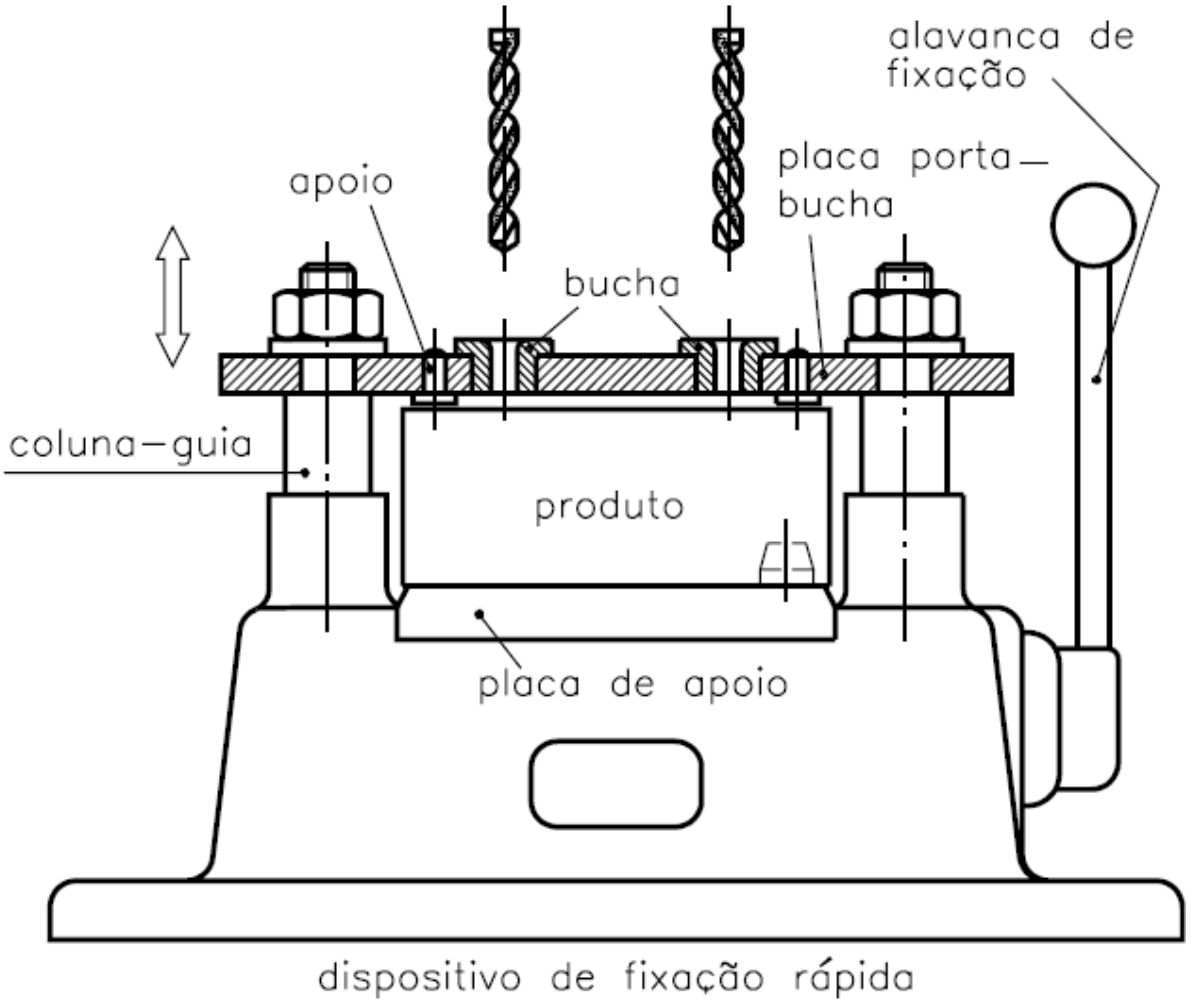






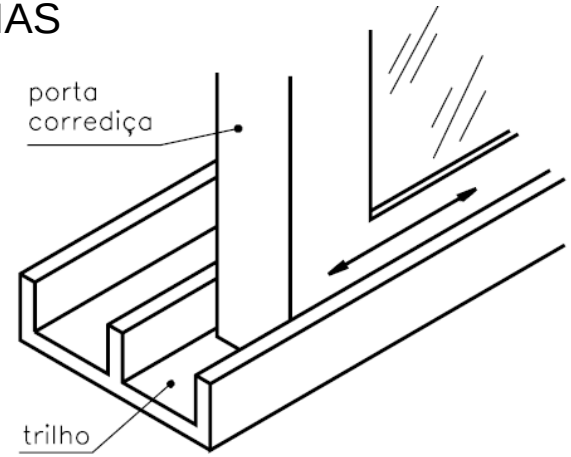
ELEMENTOS DE APOIO

BUCHAS

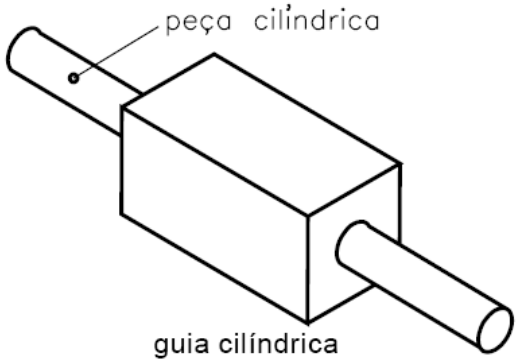


ELEMENTOS DE APOIO

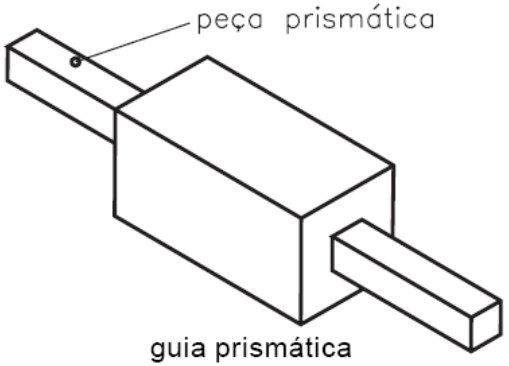
GUIAS



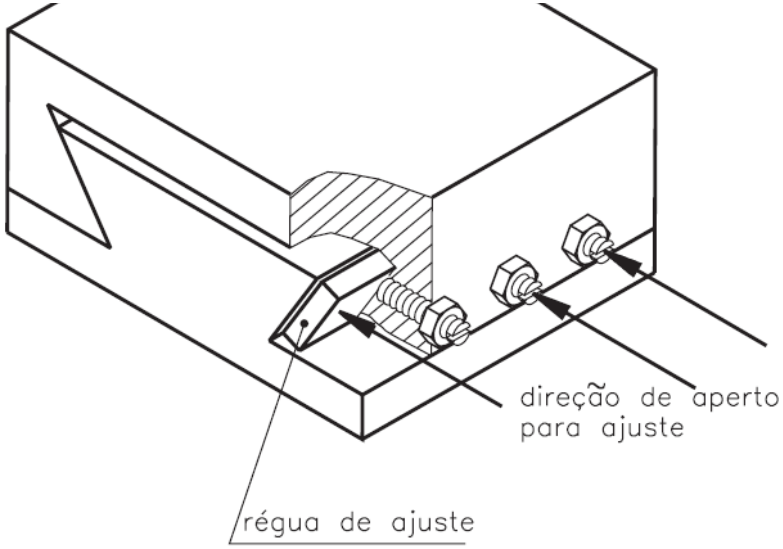
Guias de Deslizamento

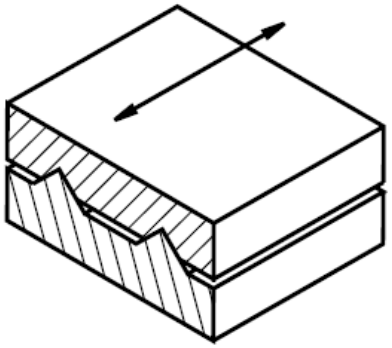


guia cilíndrica

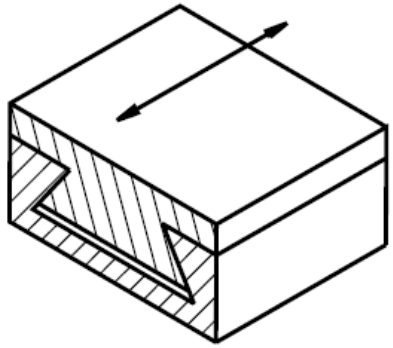


guia prismática





guia prismática aberta

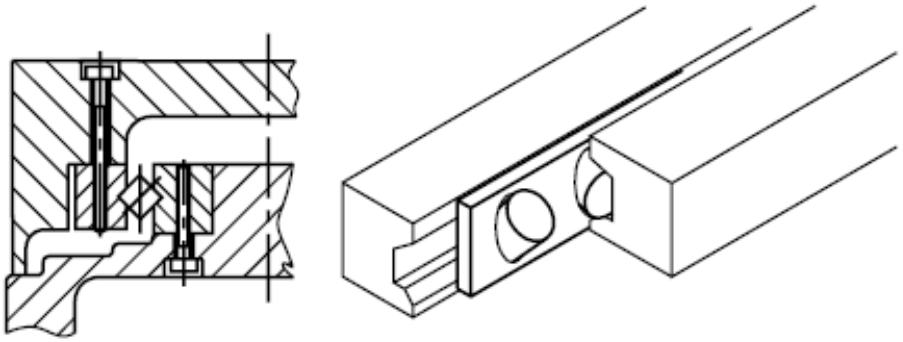


guia fechada – tipo rabo de andorinha

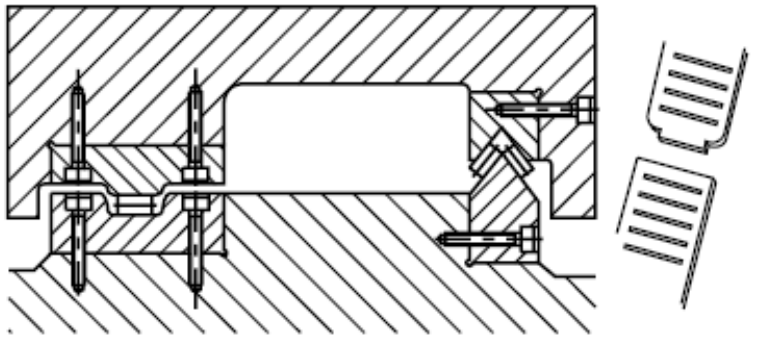
ELEMENTOS DE APOIO

GUIAS

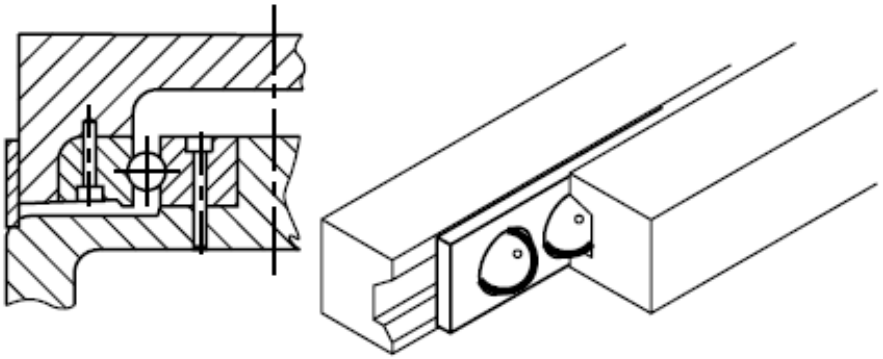
Guias de Rolamento



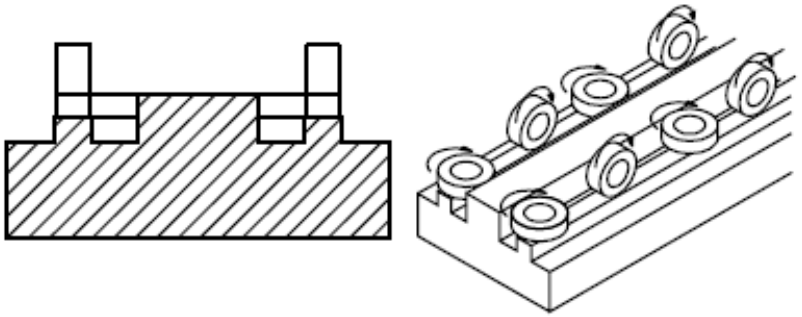
vias em V com guias de rolo



vias deslizantes com armadura de agulhas



vias em V com guia de esfera

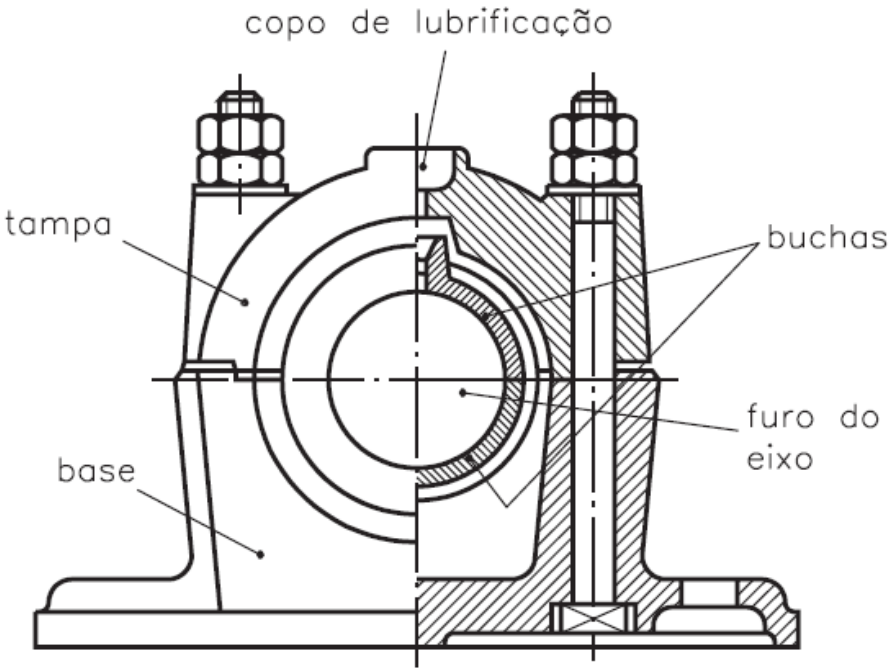


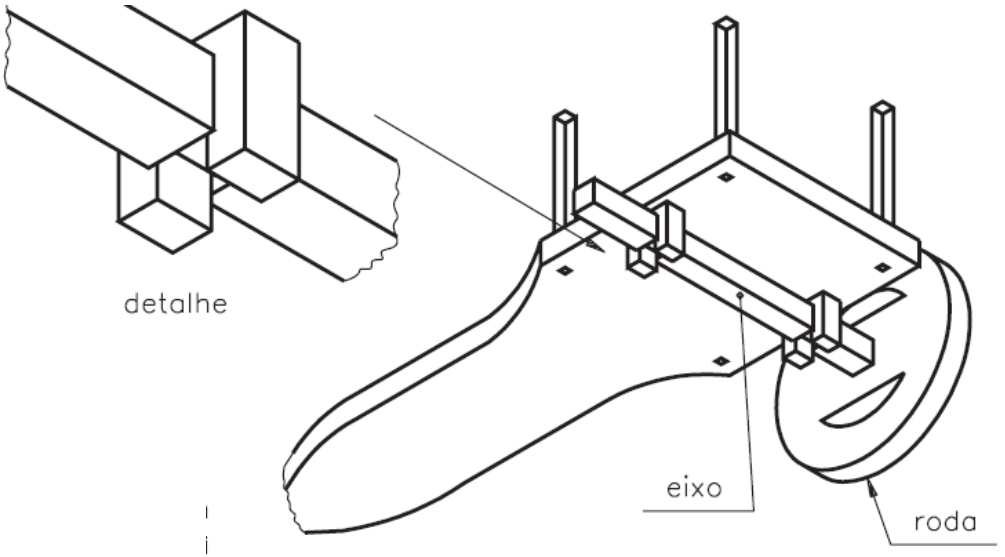
vias deslizantes com mancais de rolamentos

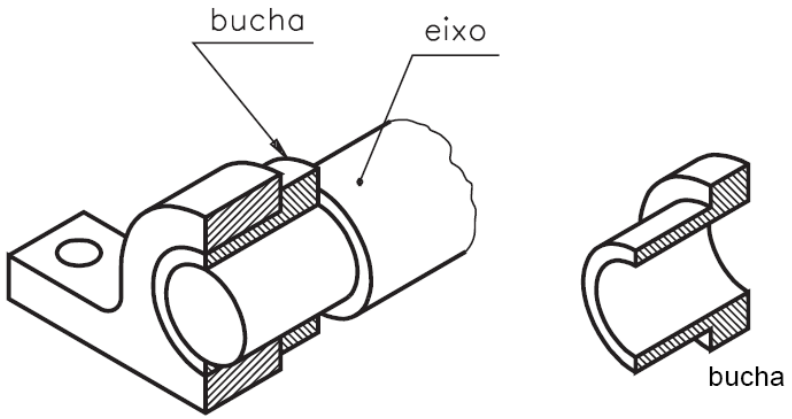
ELEMENTOS DE APOIO

MANCAIS

Mancais de Deslizamento



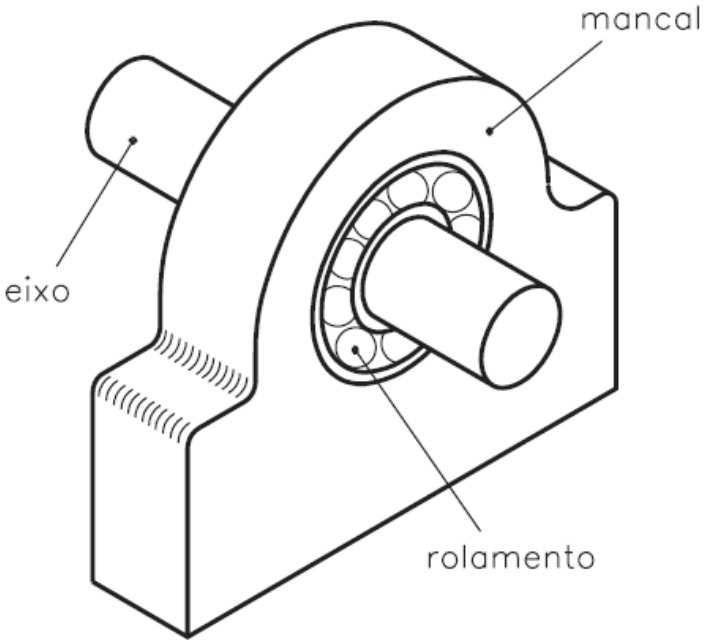




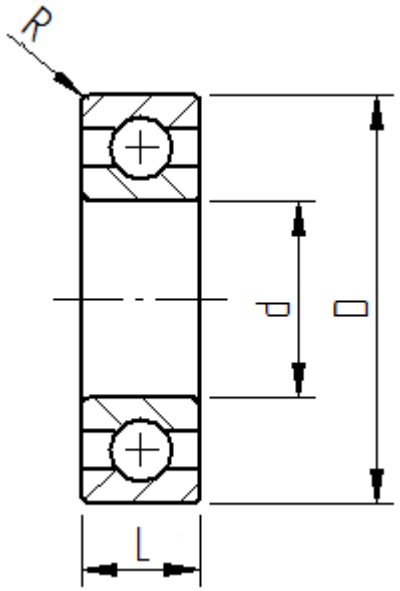
ELEMENTOS DE APOIO

MANCAIS

Mancais de Rolamento



Rolamentos



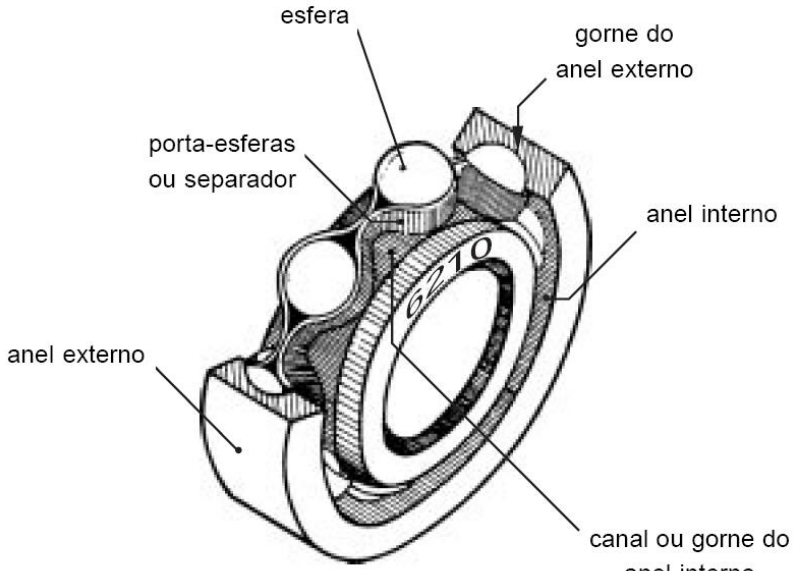
Características dos rolamentos:

D: diâmetro externo;

d: diâmetro interno;

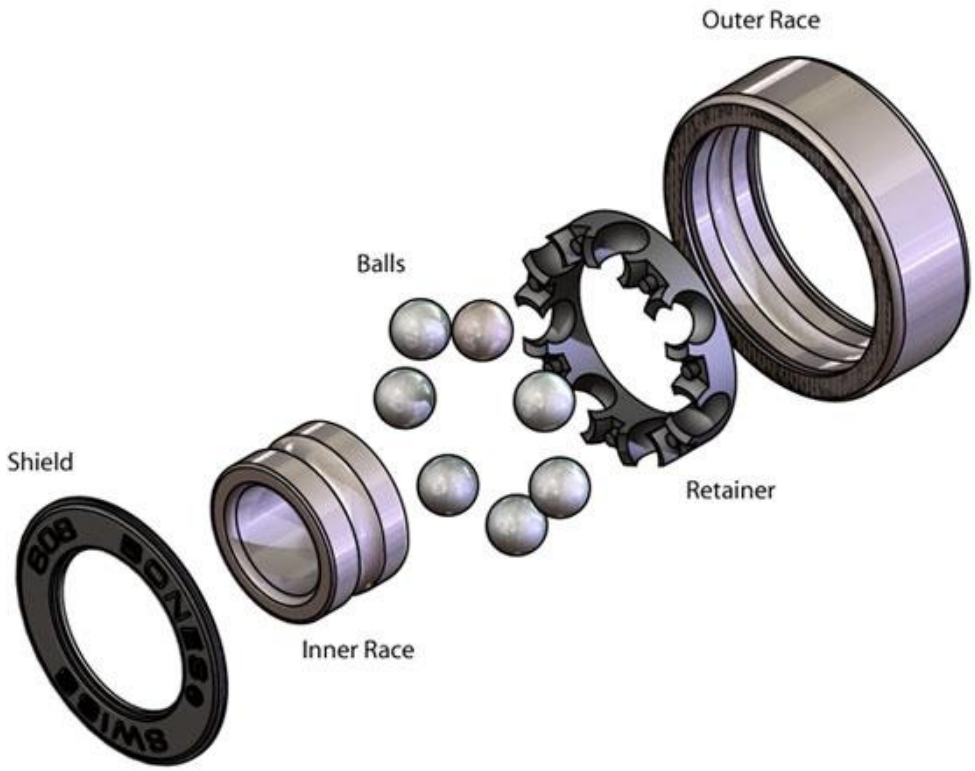
R: raio de arredondamento;

L: largura.



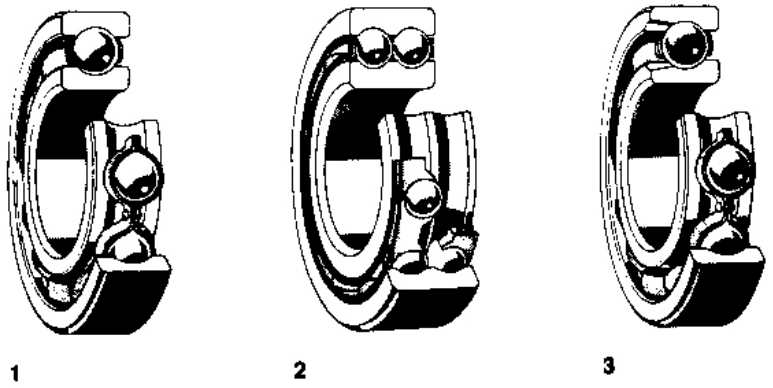
ELEMENTOS DE APOIO

MANCAIS

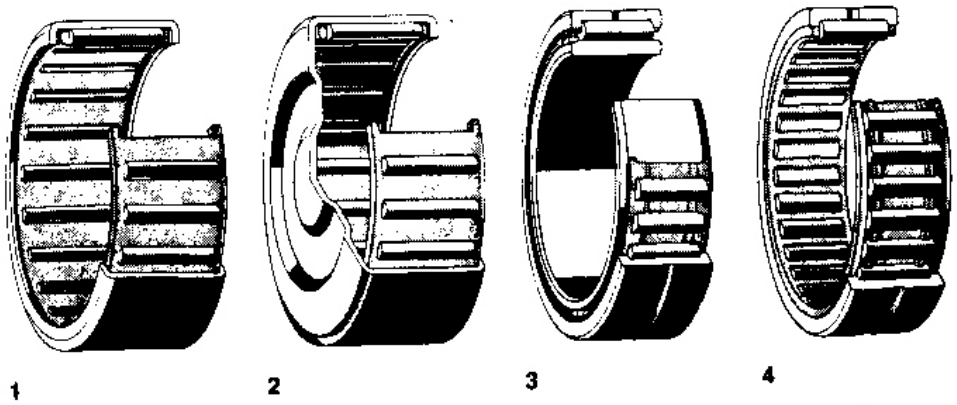


Tipos de elementos rolantes

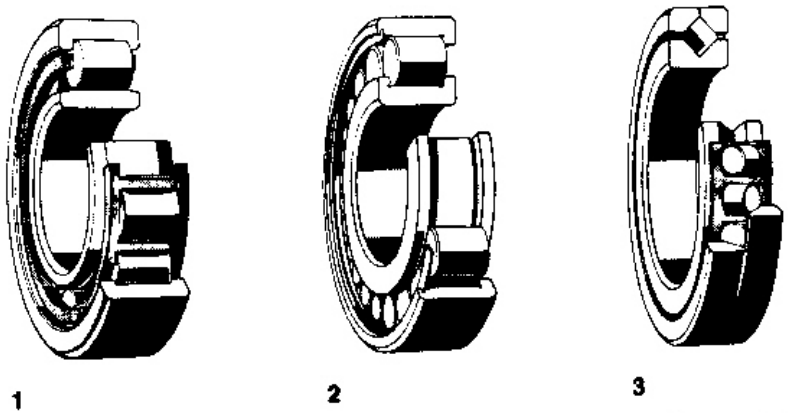
Rolamentos de esferas



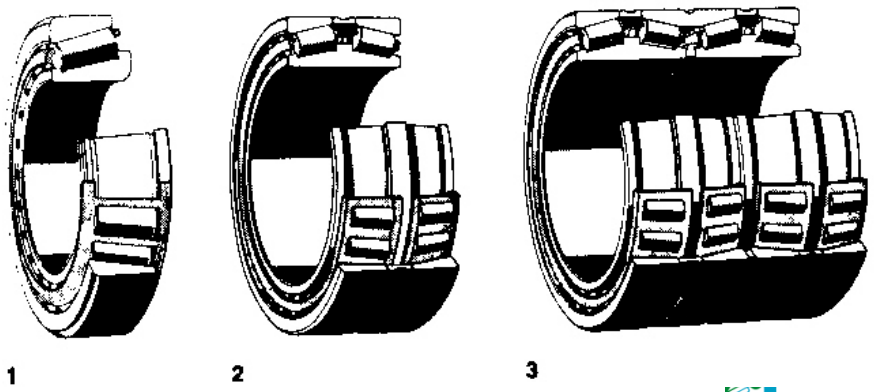
Rolamentos de agulhas



Rolamentos cilíndricos



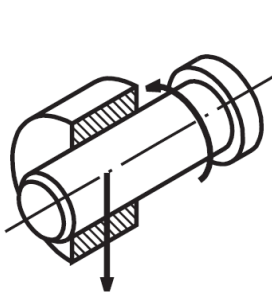
Rolamentos de rolos cônicos



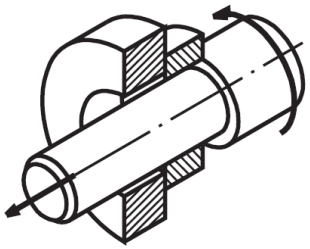
ELEMENTOS DE APOIO

MANCAIS

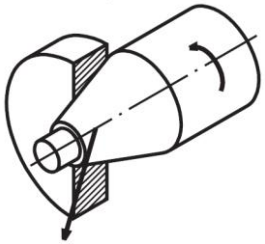
Classificação quanto à carga



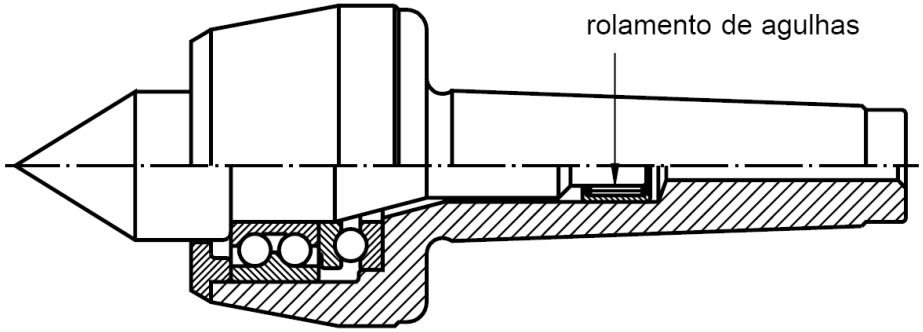
Radial

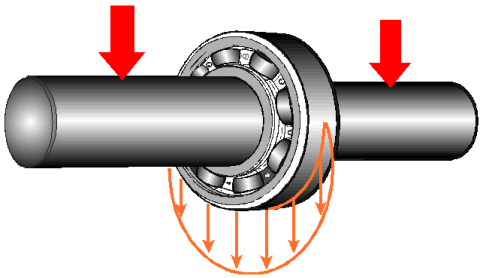


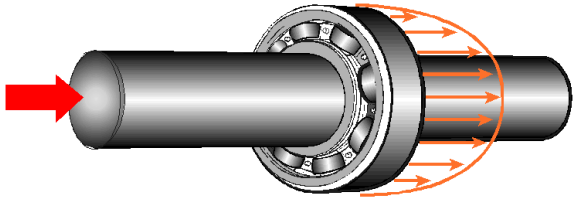
Axial

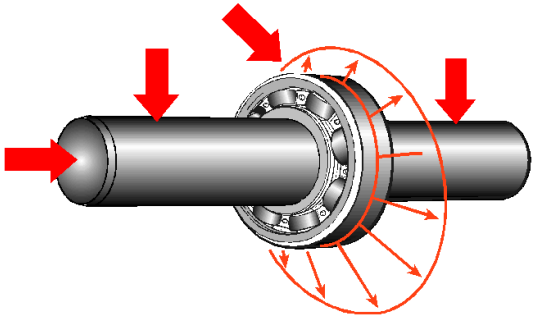


Mista



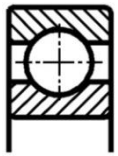
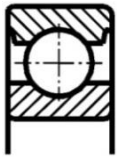
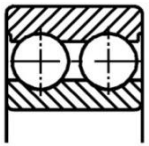
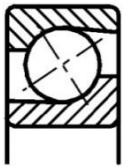
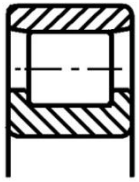
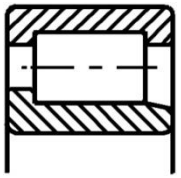
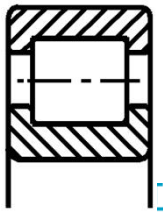




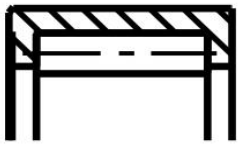
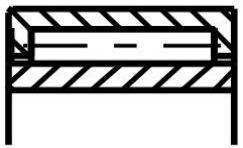
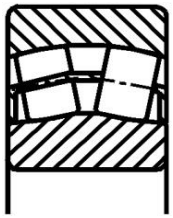
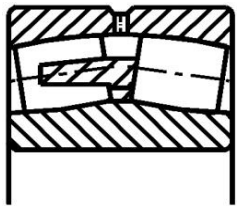
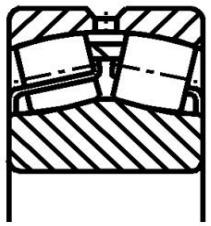


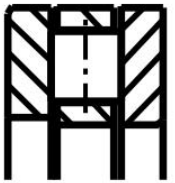
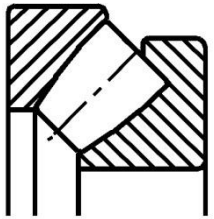
Fonte da imagem: FREITAS, M. Rolamentos. Escola de Engenharia de São Carlos, 2004.

Formas construtivas

Tipo	Forma Construtiva	Representação Esquemática
Rolamentos Rígidos de esferas	Básico: uma carreira de esferas sem ranhuras para placas de proteção ou de vedação	
	Uma carreira de esferas com ranhuras para placa de proteção ou de vedação	
	Uma carreira com ranhura para anel de retenção	
	Duas carreiras de esferas	
Rolamentos autocompen-sadores de esferas	Duas carreiras de esferas com uma pista esférica comum no anel externo	
Rolamentos esferas de contato angular	Pistas do anel interno e do anel externo deslocadas entre si na direção do eixo do rolamento	
Rolamento de rolos cilíndricos	Tipo NU: possui dois flanges integrados no anel externo e anel interno sem flanges	
	Tipo N: possui dois flanges integrados no anel interno e anel externo sem flanges	
	Tipo NJ:possui dois flanges integrados no anel externo e um no anel interno e pode ser usado para fixação axial do eixo somente em um sentido	
	Tipo NUP: possui dois flanges integrados no anel externo e o anel interno possui um flange integrado e um anel flange solto, permitindo que fixe o eixo em ambos os sentidos	

Fonte: Catálogo Geral SKF

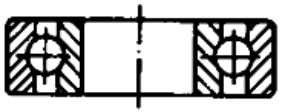
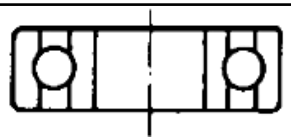
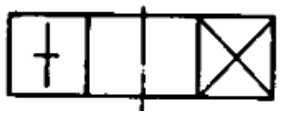
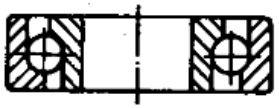
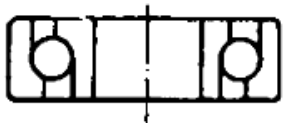
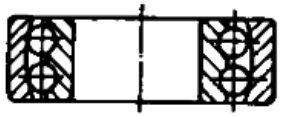
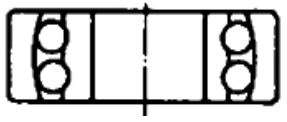
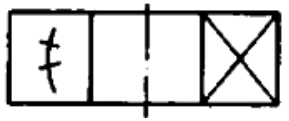
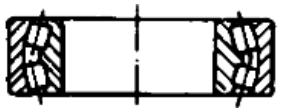
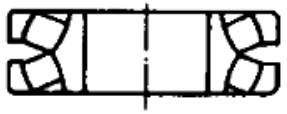
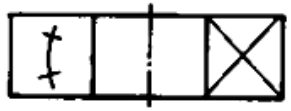
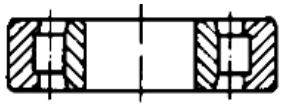
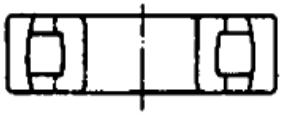
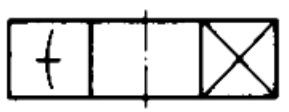
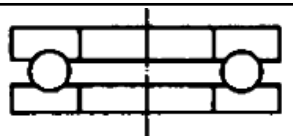
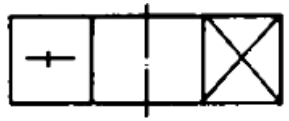
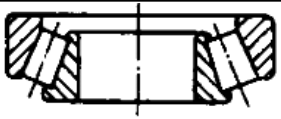
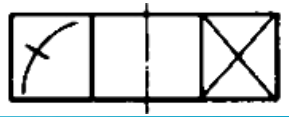
Tipo	Forma Construtiva	Representação Esquemática
Rolamentos de agulhas	Rolamento sem anel interno, usado quando é possível temperar e retificar um eixo para formar uma pista de rolamento	
	Rolamentos com anel interno, usados quando é impossível ou antieconômico temperar e retificar o eixo	
Rolamentos autocompen-sadores de rolos	Construção CC, C e EC: rolos simétricos, uma anel interno sem flange e uma gaiola prensada de aço para casa carreira de rolos.	
	Construção CAC, ECAC, CA e ECA: para rolos grandes. Rolos simétricos e o anel interno possui flanges de retenção	
	Construção E: rolos simétricos um anel interno sem flanges, um anel de guia sinterizado, posicionado na direção do anel externo e centrado nas gaiolas, com uma gaiola prensada de aço para cada carreira de rolos	

Rolamento de rolos cônicos	Uma carreira. Suportam cargas axiais atuando em apenas um sentido	
	Duas carreiras. Suportam cargas axiais nos dois sentidos	
Rolamentos axiais de esferas	De escora simples: Adequados para suportar cargas axiais em um sentido e fixar o eixo neste sentido	
Rolamentos axiais de rolos cilíndricos	Adequados para arranjos que devem suportar cargas axiais pesadas. De escora simples: Suportam apenas cargas axiais em um sentido	
Rolamentos autocompen-sadores de rolos	São capazes de suportar cargas radiais atuando juntamente com cargas axiais. E é auto-alinhante, o que o torna insensível a desalinhamentos do eixo em relação à caixa proveniente de deflexões do eixo	

Fonte: Catálogo Geral SKF

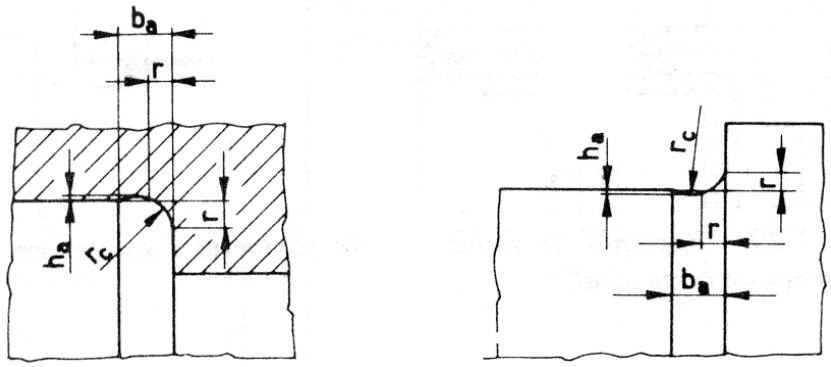
ELEMENTOS DE APOIO

MANCAIS

Rolamento	Representação	
	Simplificada	Simbólica
		
		
		
		
		
		
		

ELEMENTOS DE APOIO

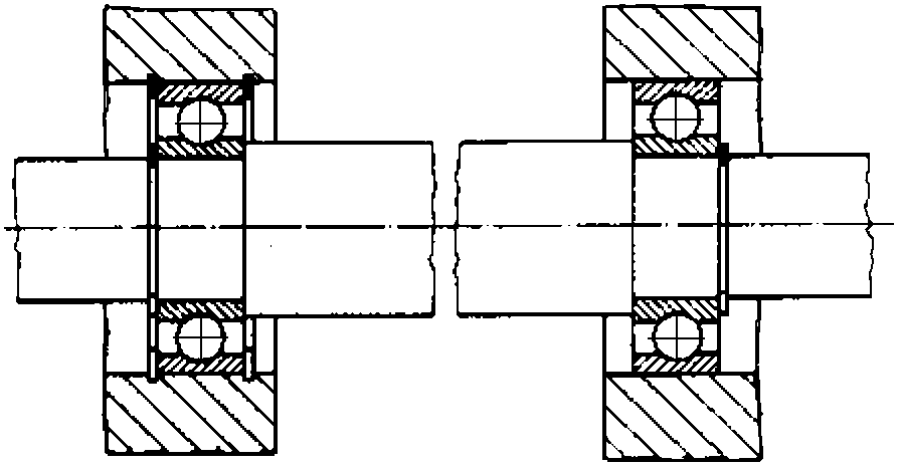
MANCAIS

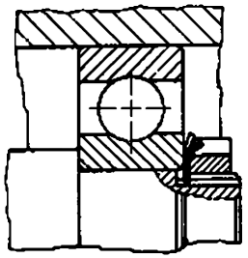


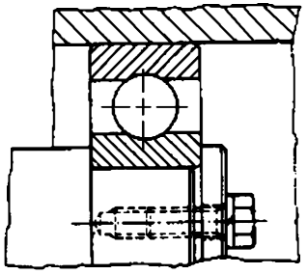
Cotagem do rebaixo para saída do rebolo (no furo e no eixo)
Publicação: RIV - SKF

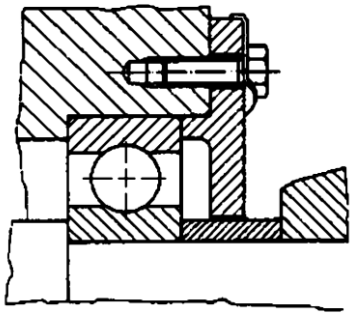
Suporte do rolamento	Dimensões		
r e r_1	**b_a**	**h_a**	**r_c**
1,5	2	0,2	1,3
2	2,4	0,3	1,5
2,5	3,2	0,4	2
3	4	0,5	2,5
3,5	4	0,5	2,5
4	4,7	0,5	3
5	5,9	0,5	4
6	7,4	0,6	5
8	8,6	0,6	6
10	10	0,6	7

Noções de montagem





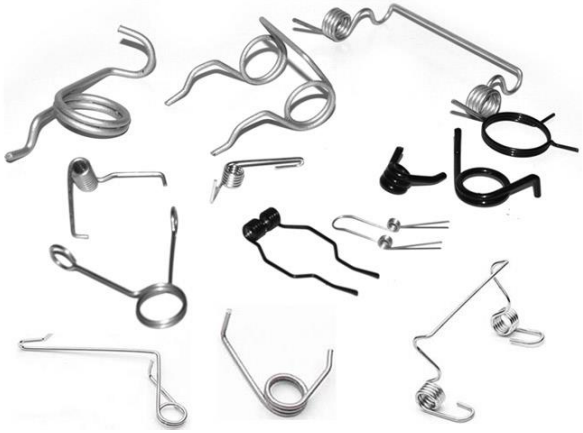




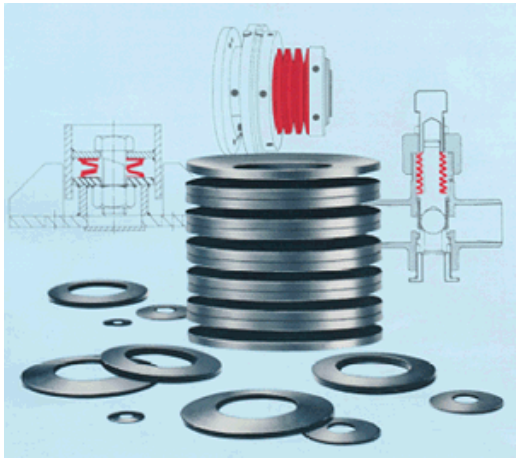
Um rolamento fixo axialmente, o outro livre

ELEMENTOS ELÁSTICOS

Tipos de Molas - NBR 11145



Molas de Torção



Molas prato

Feixe de Molas

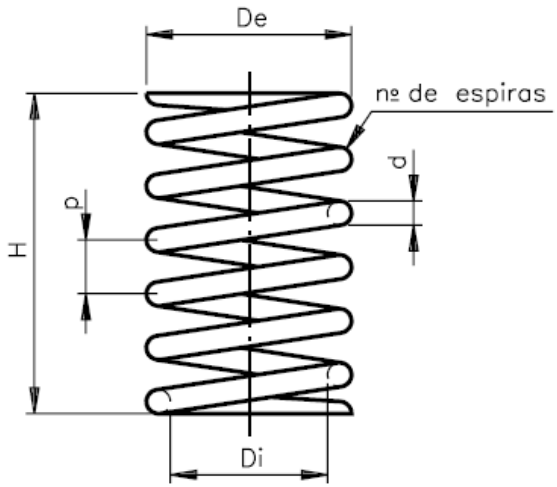
Molas Espiral

Molas de Compressão

Molas de Tração

ELEMENTOS ELÁSTICOS

MOLAS



De: diâmetro externo;

Di: diâmetro interno;

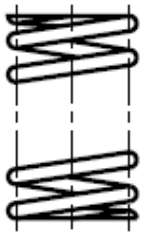
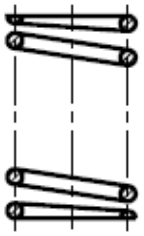
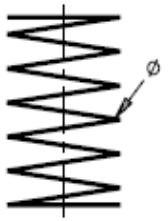
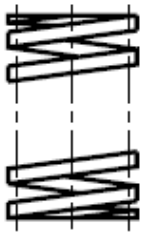
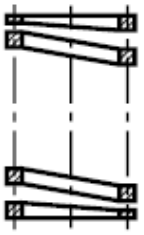
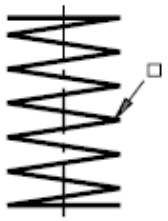
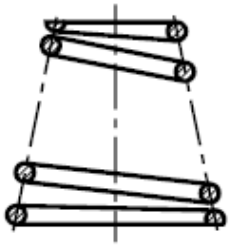
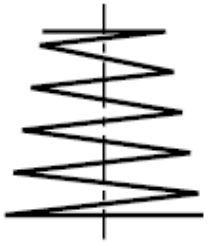
H: comprimento da mola;

d: diâmetro da seção do arame;

p: passo da mola;

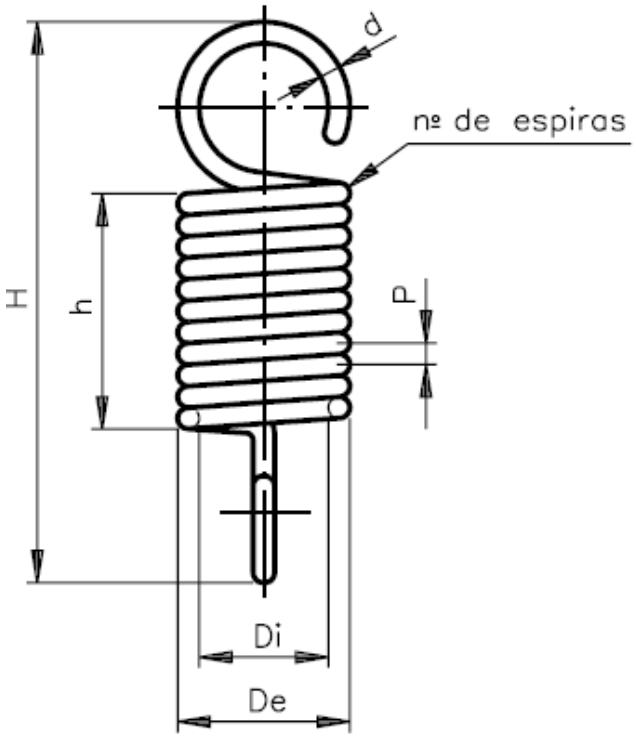
nº: número de espiras da mola.

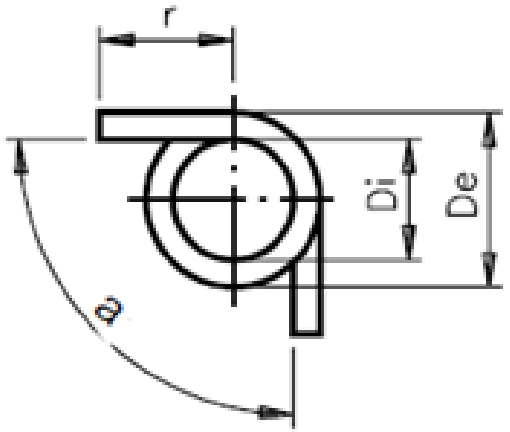
Representações convencionais de molas

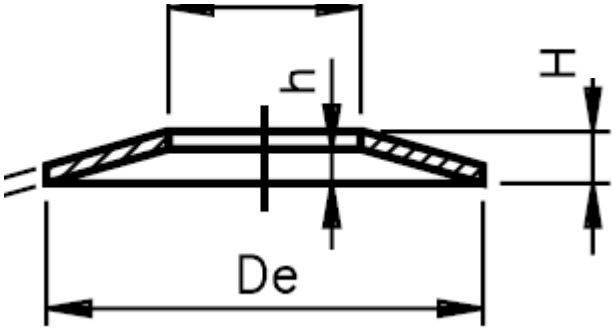
Tipo	Normal	Em corte	Simplificada
Compressão: Helicoidal cilíndrica de seção circular			
Compressão: Helicoidal cilíndrica de seção retangular			
Compressão: Helicoidal cônica de seção circular			

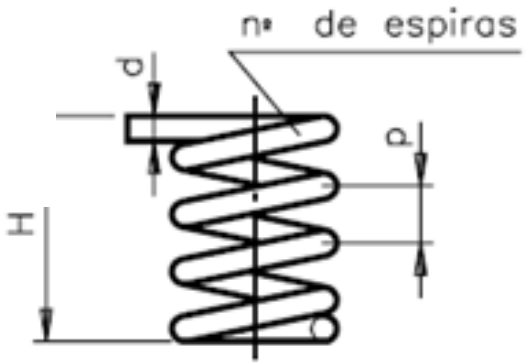
ELEMENTOS ELÁSTICOS

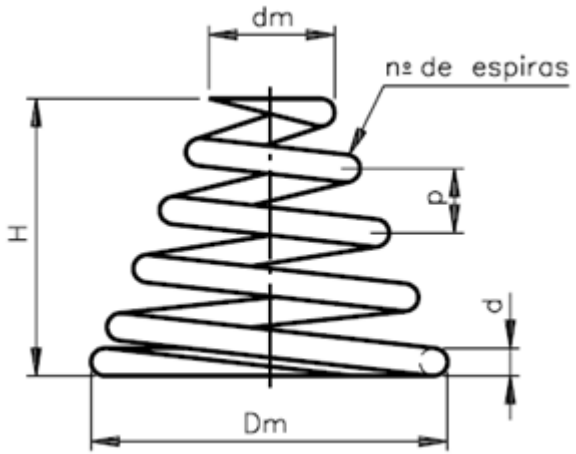
MOLAS

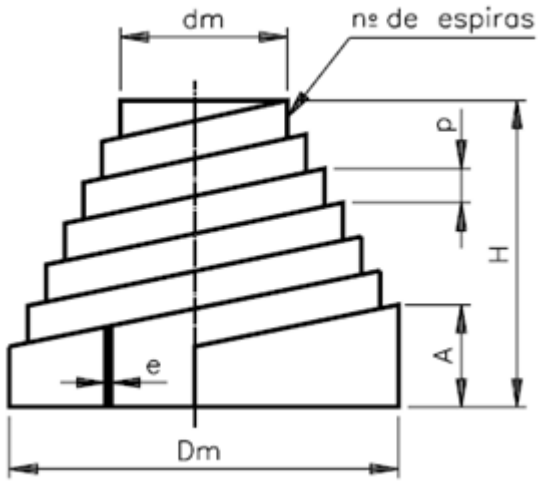












ELEMENTOS ELÁSTICOS

MOLAS

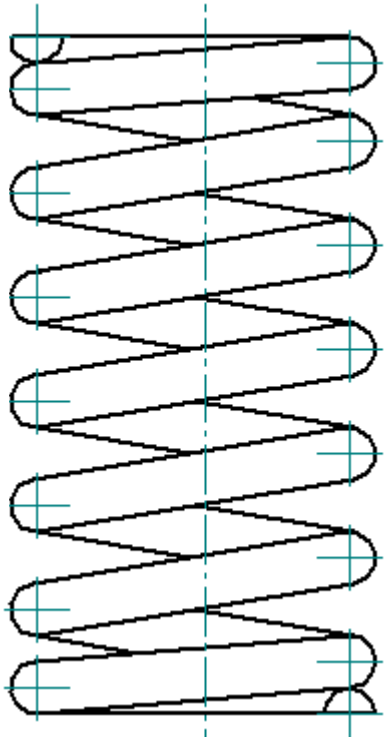
Comp. total livre = n_a . p + 2d

n_t = número total de espiras

n_a = número de espiras ativas

p = passo

d = diâmetro do arame

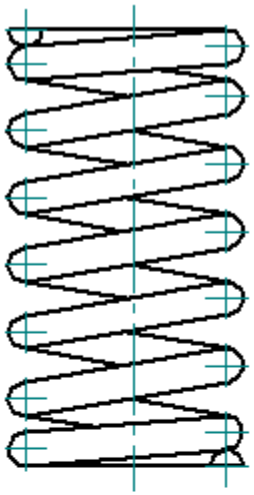


O número calculado de espiras ativas é arredondado para o ¼ mais próximo.

Número de Espiras Ativas

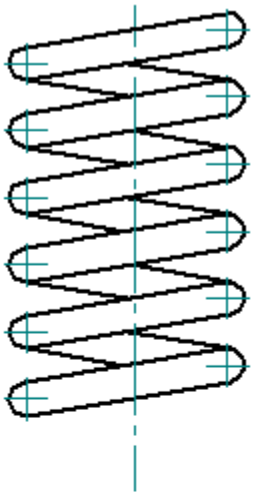
Extremidades esquadrejaas e esmerilhadas

nt = na + 2



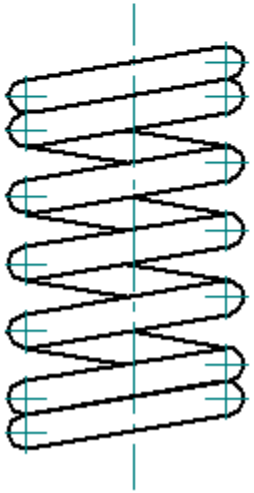
Extremidade simples

nt = na



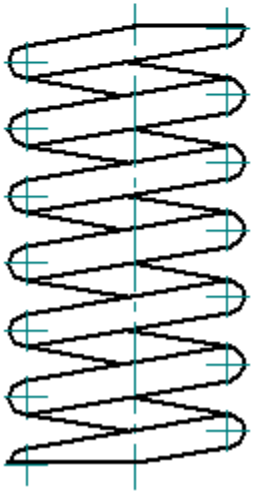
Extremidades esquadrejadas

nt = na + 2



Extremidades simples e esmerilhadas

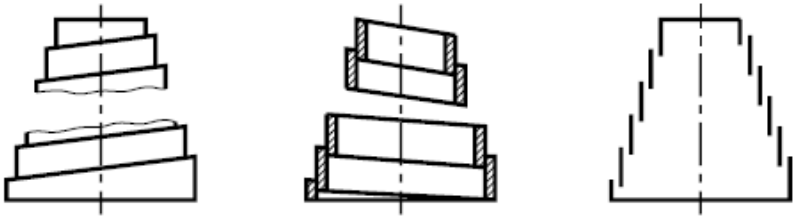
nt = na + 1



ELEMENTOS ELÁSTICOS

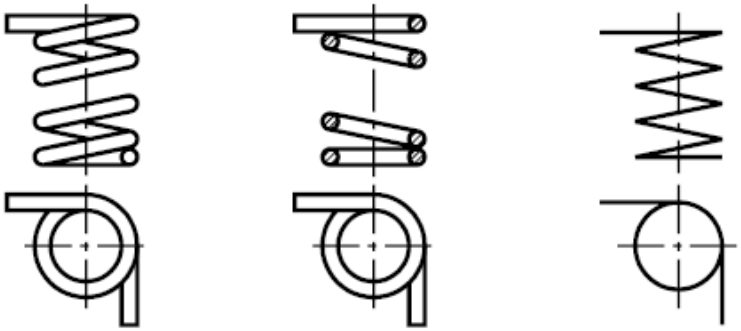
MOLAS

Compressão:
Helicoidal cônica
de seção retangular



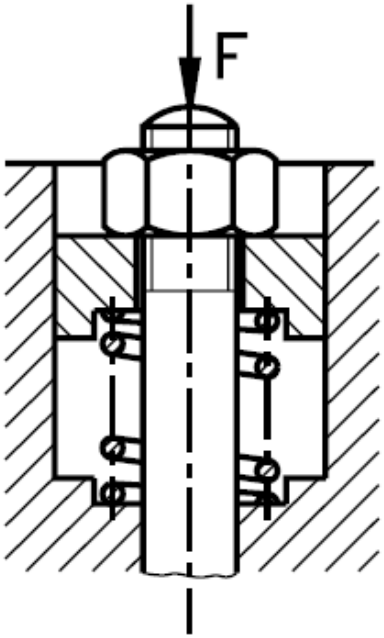
Tração:
Helicoidal cilíndrica
de seção circular

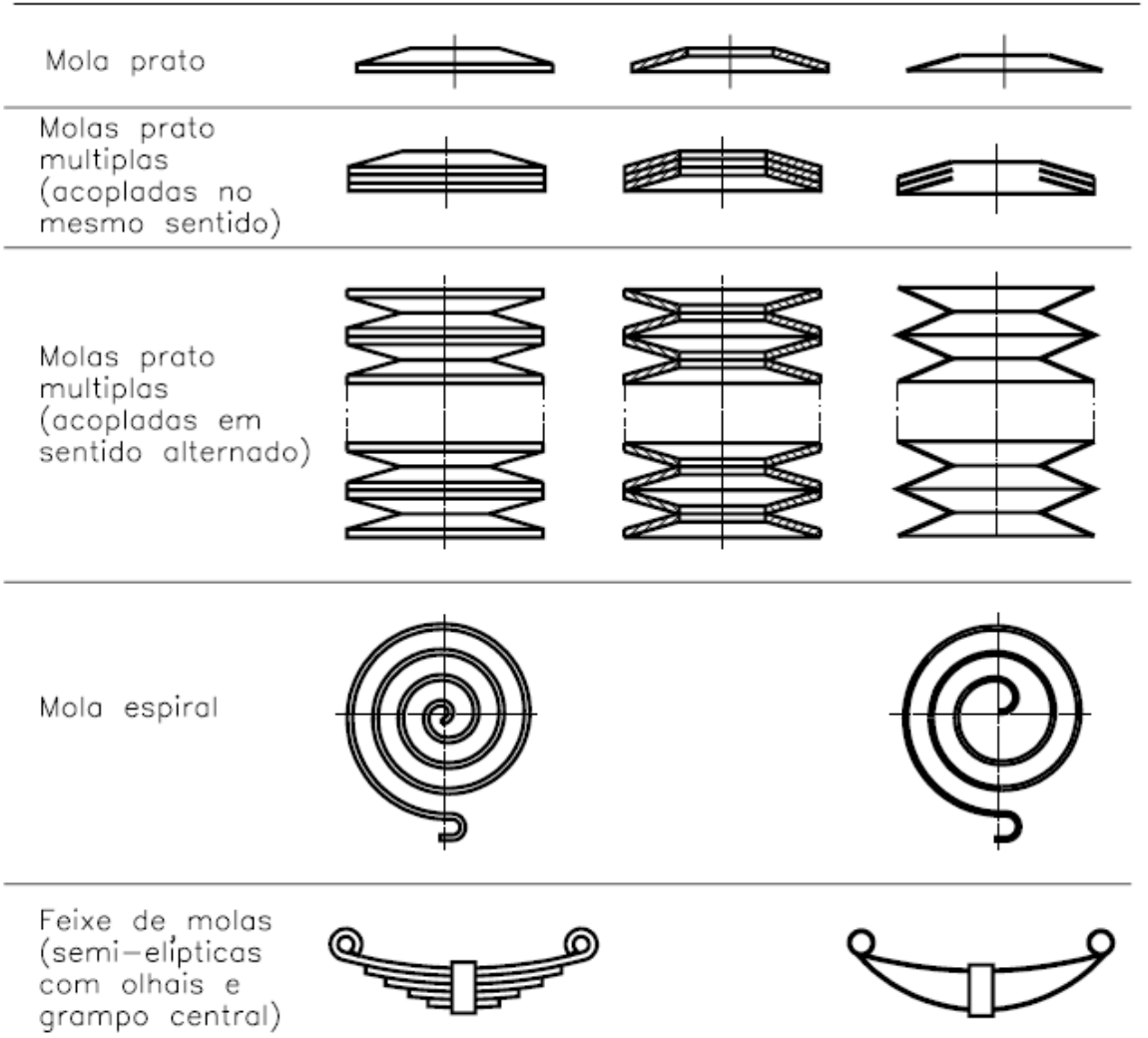
Torção:
Helicoidal cilíndrica
de seção circular
(enrolada à direita)



ELEMENTOS ELÁSTICOS

MOLAS

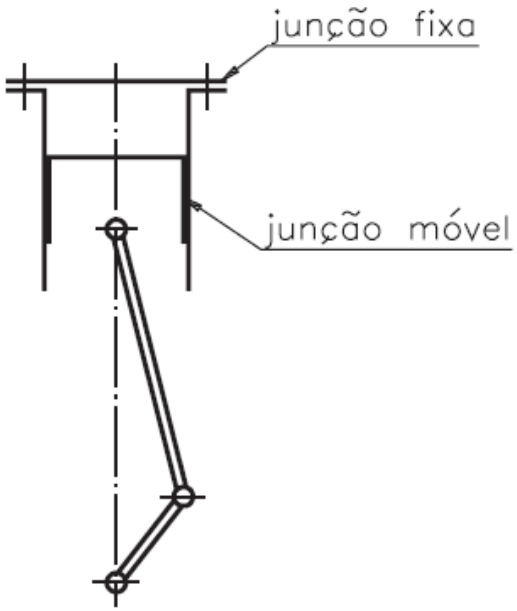




ELEMENTOS DE VEDAÇÃO

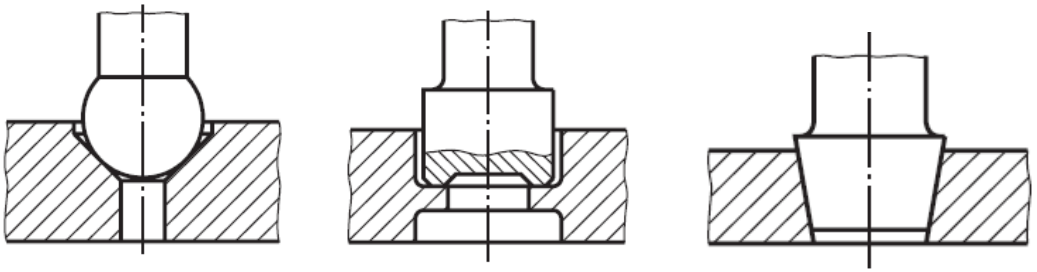
JUNTAS

Exemplo de Aplicação



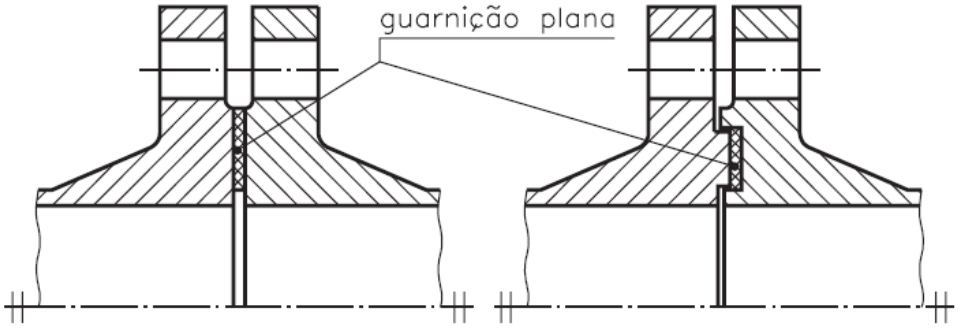
junções fixa e móvel no acoplamento cilindro - pistão

Vedações diretas em junções fixas



Ogiva | Faca | Cônica

Vedações em junções fixas com elementos intermediários

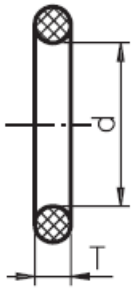


Guarnições

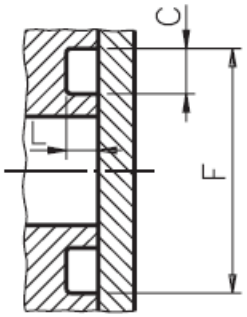
ELEMENTOS DE VEDAÇÃO

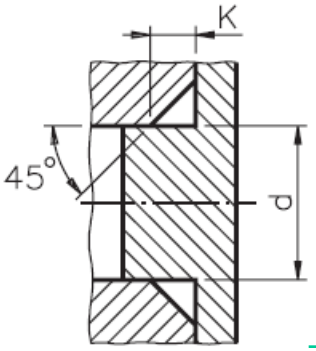
JUNTAS

Vedações em junções fixas ou móveis com elementos intermediários

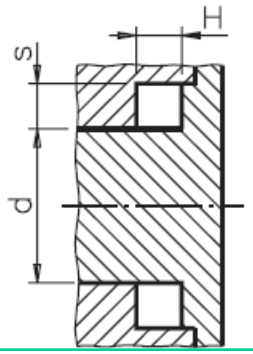


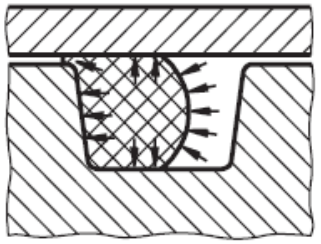
Anel O Ring





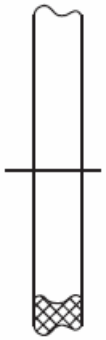
Cavidades



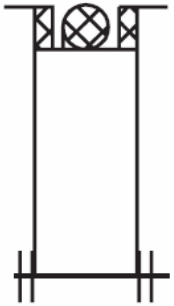


COTAS E TOLERÂNCIAS PARA SEDES DE ANÉIS O'RINGS

	T				
	Anel O Ring em trabalho				
Cotas	1,78	2,62	3,53	5,34	7
L	1,4	2,2	2,9	4,5	6
K	2,4	3,5	4,7	7	9,5
H	1,4	2,2	3,1	4,7	6
S	1,78	2,62	3,53	5,34	7
C	2,5	3,5	4,5	7	9,5



Anel H Ring

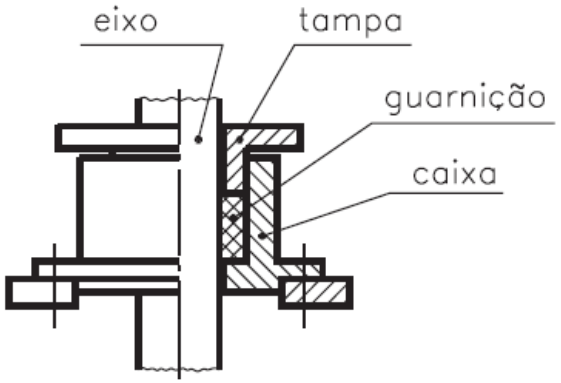


Anel de sustentação BK

ELEMENTOS DE VEDAÇÃO

JUNTAS

Vedações em junções fixas ou móveis com elementos intermediários

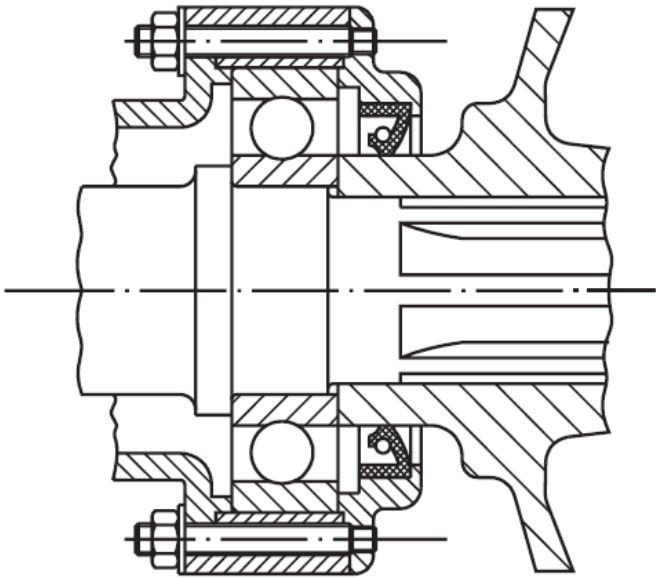


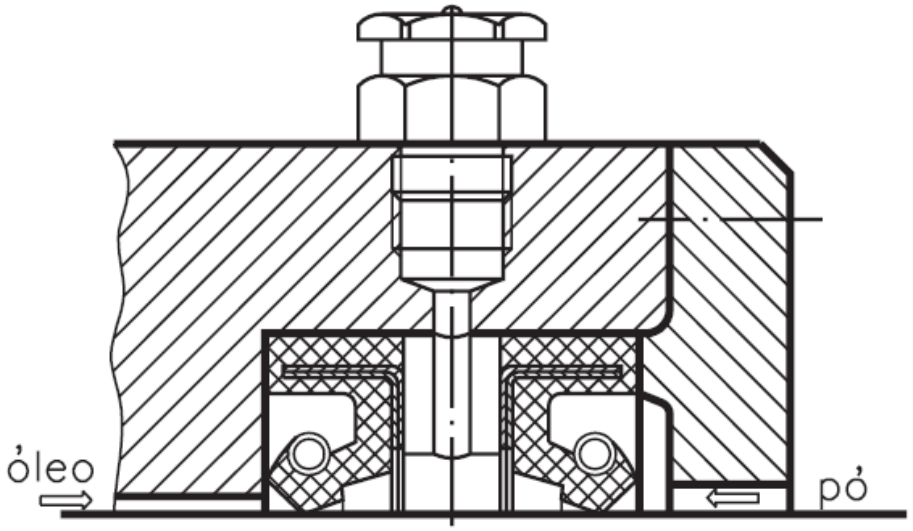
Gaxetas

Anel de vedação

ELEMENTOS DE VEDAÇÃO

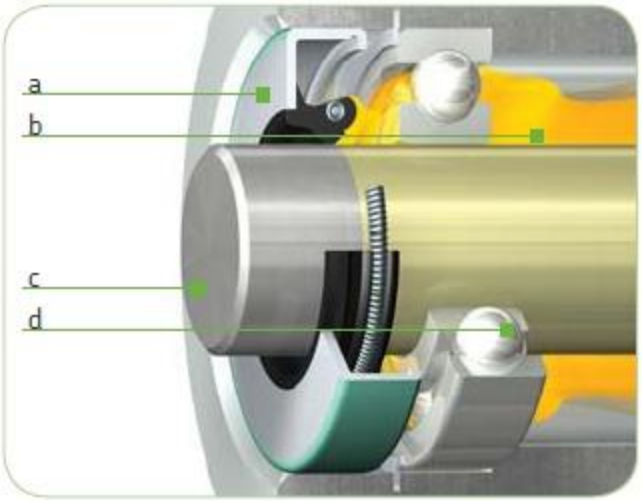
ANÉIS DE VEDAÇÃO



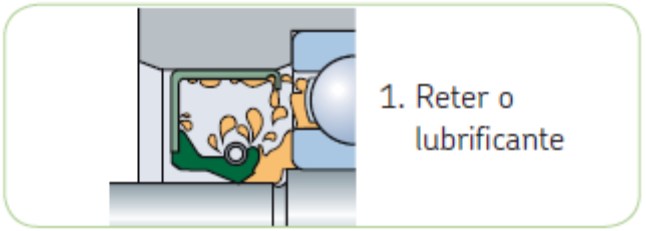


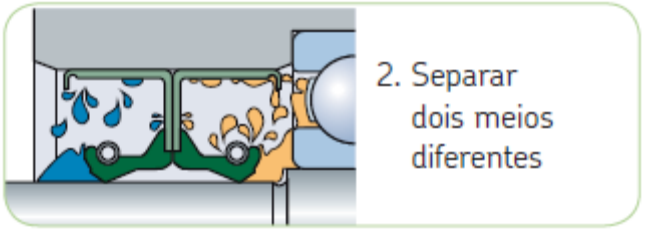
ELEMENTOS DE VEDAÇÃO

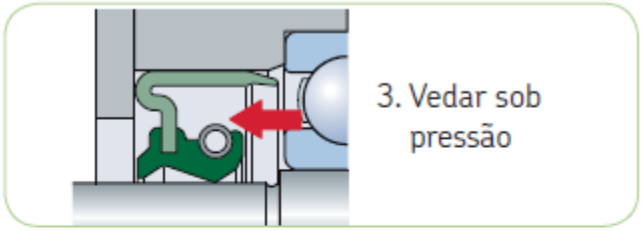
ANÉIS DE VEDAÇÃO

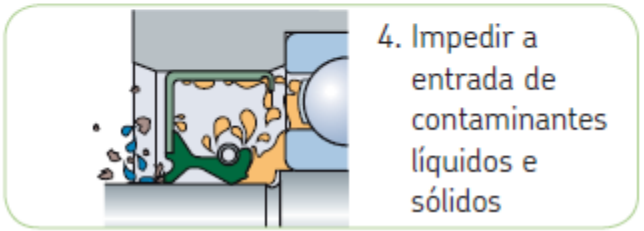


a. Retentor Radial
b. Lubrificante
c:. Eixo
d. Rolamento

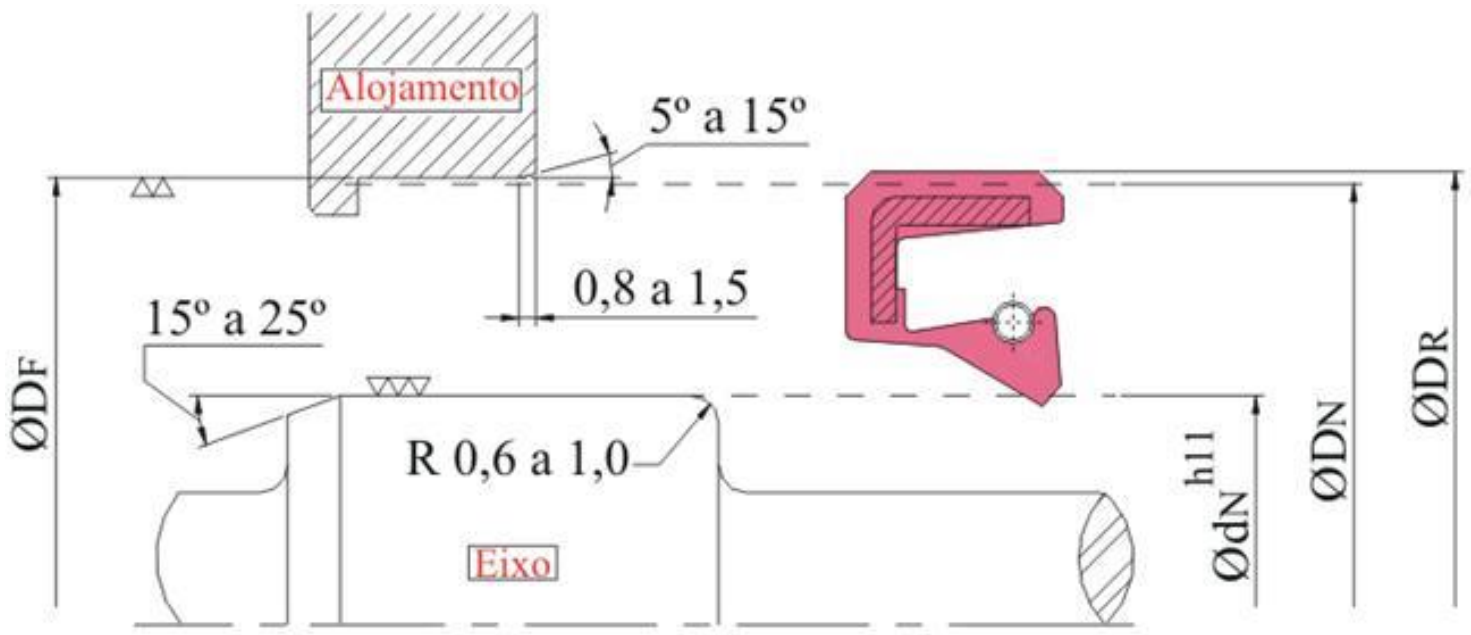




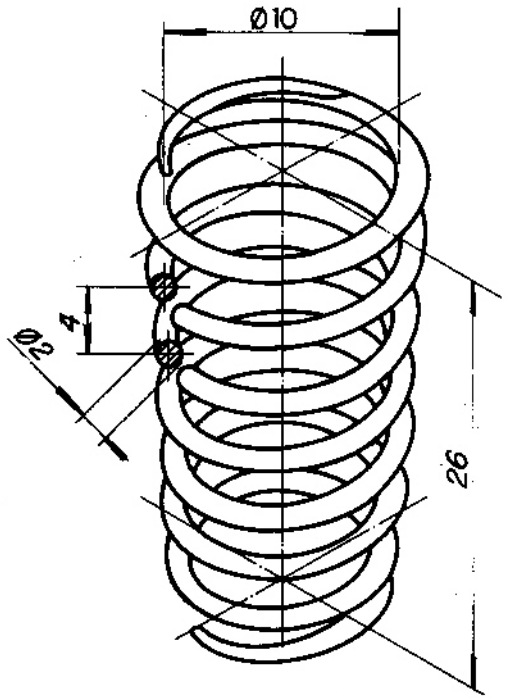




Dimensões do Alojamento – Ajuste interferente



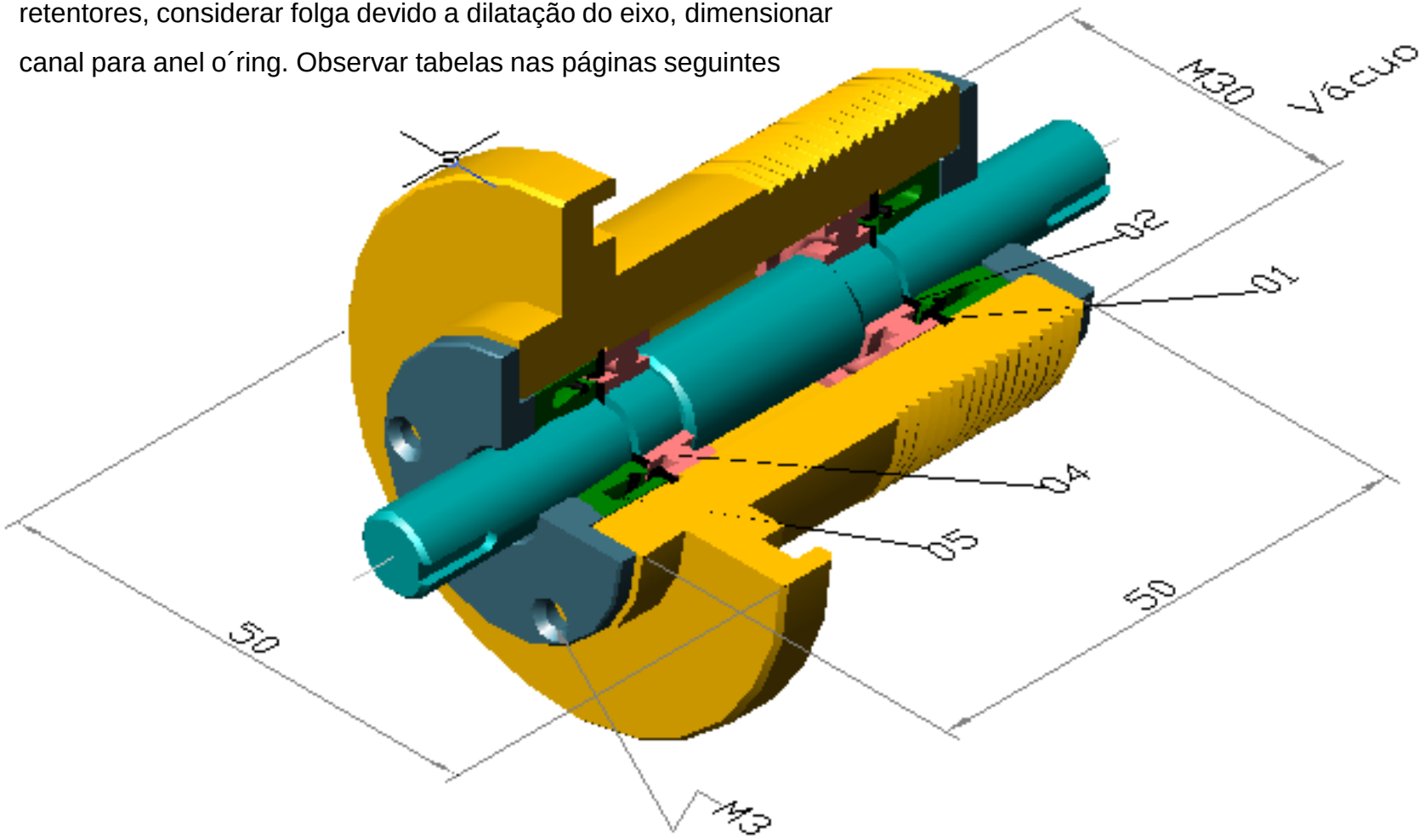
Exercício 1 – Desenhar a mola em vista única na escala apropriada.



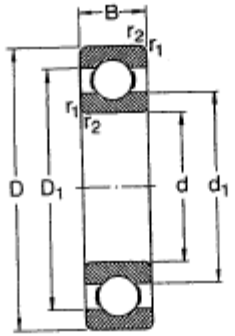
Exercício 2 – Fazer desenho de conjunto em corte, selecionar rolamentos, anéis elásticos para furos e para eixos, posicionar os retentores, considerar folga devido a dilatação do eixo, dimensionar canal para anel o´ring. Observar tabelas nas páginas seguintes

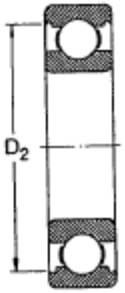
Nome:_____

Nº Turma

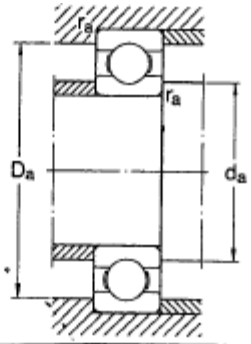


Anel externo sem ranhuras de placas



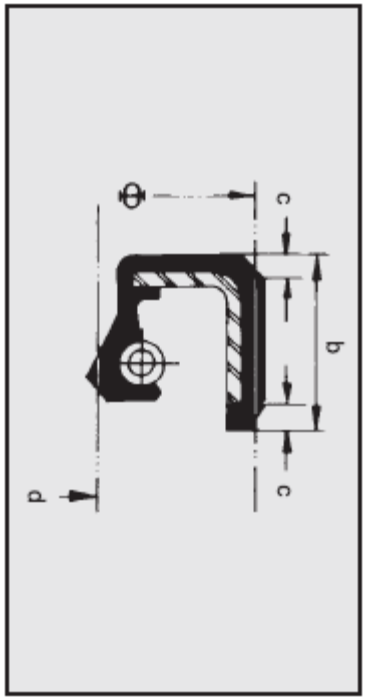


Anel externo com ranhuras de placas



Dimensões principais			Capacidades de carga		Carga limite de fadiga	Velocidades de referência		Massa	Designação	Outras dimensões					Dimensões de encostos		
			dinâm.	estât.		Lubrificação											
d	D	B	C	C_0	P_u	graxa	óleo			d	d_1 ≈	D_1 ≈	D_2 ≈	$r_{1,2}$ mín	d_a mín	D_a máx	r_a máx
mm			N		N	r/min		kg	–	mm					mm		
2,5	8	2,8	319	106	4	67 000	80 000	0,0007	**60/2.5**	**2,5**	4,6	6,4	–	0,15	3,7	6,8	0,1
3	10	4	488	146	6	60 000	70 000	0,0015	**623**	**3**	5,2	7,5	8,2	0,15	4,2	8,8	0,1
4	9	2,5	540	180	7	63 000	75 000	0,0007	**618/4**	**4**	5,2	7,5	–	0,1	5,2	7,8	0,1
	12	4	806	280	12	53 000	63 000	0,0022	**604**		6,4	9,6	–	0,2	5,6	10,4	0,2
	13	5	975	305	14	48 000	56 000	0,0031	**624**		6,7	10,3	11,2	0,2	5,6	11,4	0,2
	16	5	1 110	380	16	43 000	50 000	0,0054	**634**		8,4	12	13,3	0,3	6	14	0,3
5	11	3	637	255	11	53 000	63 000	0,0012	**618/5**	**5**	6,8	9,3	–	0,15	6,2	9,8	0,1
	16	5	1 110	380	16	43 000	50 000	0,0050	**625**		8,4	12	13,3	0,3	7	14	0,3
	19	6	1 720	620	26	36 000	43 000	0,0090	**635**		10,7	15,3	16,5	0,3	7	17	0,3
6	13	3,5	884	345	15	48 000	56 000	0,0020	**618/6**	**6**	7,9	11,2	–	0,15	7,2	11,8	0,1
	19	6	1 720	620	26	36 000	43 000	0,0084	**626**		10,7	15,3	16,5	0,3	8	17	0,3
7	14	3,5	956	400	17	45 000	53 000	0,0022	**618/7**	**7**	8,9	12,2	–	0,15	8,2	12,8	0,1
	19	6	1 720	620	26	38 000	45 000	0,0075	**607**		10,7	15,3	16,5	0,3	9	17	0,3
	22	7	3 250	1 370	57	32 000	38 000	0,013	**627**		11,8	17,6	19	0,3	9	20	0,3
8	16	4	1 330	570	24	40 000	48 000	0,0030	**618/8**	**8**	10,1	14	–	0,2	9,6	14,4	0,2
	22	7	3 250	1 370	57	36 000	43 000	0,012	**608**		11,8	17,6	19	0,3	10	20	0,3
9	17	4	1 430	640	27	38 000	45 000	0,0034	**618/9**	**9**	11,1	15	–	0,2	10,6	15,4	0,2
	24	7	3 710	1 660	71	32 000	38 000	0,014	**609**		14,2	19,8	21,2	0,3	11	22	0,3
	26	8	4 620	1 960	83	28 000	34 000	0,020	**629**		14,4	21,4	22,6	0,3	11	24	0,3
10	19	5	1 380	585	25	36 000	43 000	0,0055	**61800**	**10**	12,6	16,4	–	0,3	12	17	0,3
	22	6	1 950	750	32	34 000	40 000	0,010	**61900**		13	18,1	–	0,3	12	20	0,3
	26	8	4 620	1 960	83	30 000	36 000	0,019	**6000**		14,4	21,4	22,6	0,3	12	24	0,3
	28	8	4 620	1 960	83	28 000	34 000	0,022	**16100**		16,7	23,4	24,8	0,3	12	26	0,3
	30	9	5 070	2 360	100	24 000	30 000	0,032	**6200**		16,7	23,4	24,8	0,6	14	26	0,6
	35	11	8 060	3 400	143	20 000	26 000	0,053	**6300**		17,5	27,1	28,7	0,6	14	31	0,6
12	21	5	1 430	670	28	32 000	38 000	0,0063	**61801**	**12**	15	18,2	–	0,3	14	19	0,3
	24	6	2 250	980	43	30 000	36 000	0,011	**61901**		15,5	20,6	–	0,3	14	22	0,3
	28	8	5 070	2 360	100	26 000	32 000	0,022	**6001**		16,7	23,4	24,8	0,3	14	26	0,3
	30	8	5 070	2 360	100	26 000	32 000	0,023	**16101**		16,7	23,4	24,8	0,3	14	28	0,3
	32	10	6 890	3 100	132	22 000	28 000	0,037	**6201**		18,2	25,9	27,4	0,6	16	28	0,6
	37	12	9 750	4 150	176	19 000	24 000	0,060	**6301**		19,5	29,7	31,5	1	17	32	1

Exercício 2 – Tabela de retentores tipo básico Sabó



Diameter of d axle d	Φ	b	c min.
6	16	7	0.3
	22		
7	22	7	0.3
8	22	7	0.3
	24		
9	22	7	0.3
	24		
	26		
10	22	7	0.3
	24		
	26		
11	22	7	0.3
	26		
12	22	7	0.3
	24		
	28		
	30		
14	24	7	0.3
	28		
	30		
	35		
15	26	7	0.3
	30		
	32		
	35		
16	28	7	0.3
	30		
	32		
	35		
17	28	7	0.3
	30		
	32		
	35		
	40		
18	30	7	0.3
	32		
	35		
	40		
20	30	7	0.3
	32		
	35		
	40		
	47		
22	32	7	0.3
	35		
	40		
	47		

REFERÊNCIAS

Gordo, N.; Ferreira, J. **Elementos de Máquina**, Escola SENAI-SP.