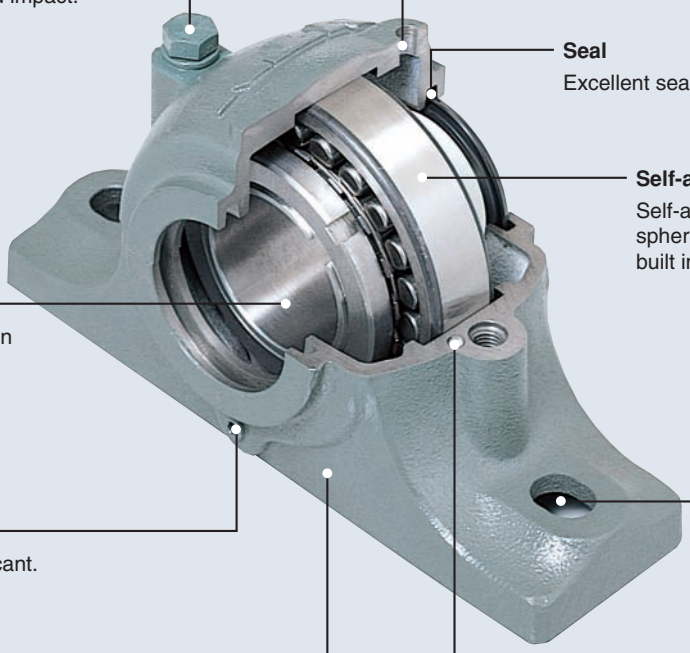
CONTENTS

1. Structure



Tightening bolt
The bolt protects the plummer block against loosening due to vibration and impact.

Oil fill plug
For relubrication.

Seal
Excellent sealing performance.

Self-aligning rolling bearing
Self-aligning ball bearings or spherical roller bearings is built into plummer block.

Adapter
Simplifies installation of the bearing.

Oil drain plug
For draining old lubricant.

Mounting bolt holes
Allow easy positioning and installation.

Plummer block unit
Designed for greater mechanical strength, and manufactured under strict quality control program. To suit the intended application, it can be made of either spheroidal graphite cast iron (ductile cast iron) or cast steel.

Knock ball
The upper and lower housings can be assembled together at higher accuracy thanks to ball-knock system using steel balls. Also, the upper cover can be installed or removed easily.

◀Products painted in user-specified colors

2. Nominal number of plummer block and bearing

2.1 Nominal number of plummer block

Nominal number of plummer block represents its model and structure, consisting of basic number and auxiliary symbol.

Table 2.1 How to indicate the basic number and auxiliary symbol

Basic number

I) Plummer block model symbol
- SN (S) : Two-split standard model
- SNZ : Two-split standard model, different bore type
- SD : Two-split heavy load type, equipped with double seal
- SV : Integrated type

I) Dimension series symbol of plummer block
- 5, 6, 30, 31, 33, and 34 : Tapered bore bearing applicable model
- 2, 3, 35, and 36 : Cylindrical bore bearing applicable model

III) Bore number
- Bore number of bearing to use: 05… 22…

SD 5 34 B4 M3 D3 N L5

Auxiliary symbol

IV) Bottom shape dimension and mounting bolt bore dimension
- F : Flat bottom with no bolt bore
- B1…Bn : (1) Shape and dimension different from standard
  (2) Flat bottom with mounting bolt bore

V) Shaft end model
- M3 : Fit into the seal of bore on one side
- M1 : With casted bore on one side
- M2 : With iron plate attached to the end face of bore on one side

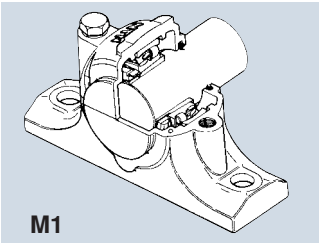
VI) Bore
- Dn : Shape and dimension different from standard

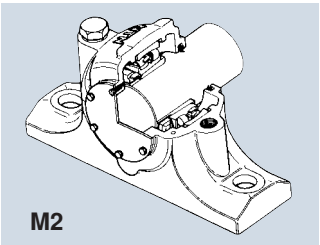
VII) Material of housing
- N : Made of cast steel
- N1 : Made of nodular graphite cast iron (ductile cast iron)
- N3 : Made by forging (S35C)

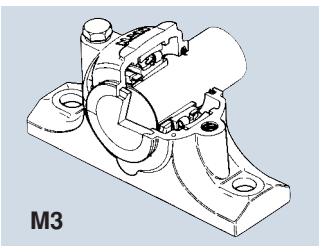
VIII) Lubrication
- L5 : Equipped with standard oil fill plug and oil drain plug
- L1 : Equipped with standard grease nipple and oil drain plug

Information

When using a plummer block for shaft end, it is typical to use that with its bore un-penetrated on shaft end side (external side), and there are three models available shown below:


M1


M2


M3

When placing an order

Nominal number of plummer block does not contain those of applicable parts.

Therefore, when respective part is necessary, place an order by respective nominal number.

[Example]

SN506	**1206SK**	**H206X**	**SR62X7**	**ZF6**
Plummer block	Roller bearing	Adapter	Positioning ring (only on fixed side)	Rubber seal

2.2 Nominal number of rolling bearing

Rolling bearing part numbers indicate bearing type, dimensions, tolerances, internal construction, and other related specifications. Bearing numbers are comprised of a "basic number" followed by "supplementary codes." The makeup and order of bearing numbers is shown in **Tables 2.2-2.4**.

The basic number indicates general information about a bering, such as its fundamental type, boundary dimensions, series number, bore diameter code and contact angle. The supplementary codes derive from prefixes and suffixes which indicate a bearing's tolerances, internal clearances, and related specifications.

Table 2.2 Bearing number arrangement

Bearing number arrangement			
Prefix supplementaly code	Special applivation code Material / heat treatment code		
Basic number	Bearing series	Type code	
		Dimensions series code	Width / height series code
			Diameter series code
	Single bore number		
Suffix supplementaly code	Innternal modification		
	Cage code		
	Bearing ring shape code		
	Innternal clearance code		

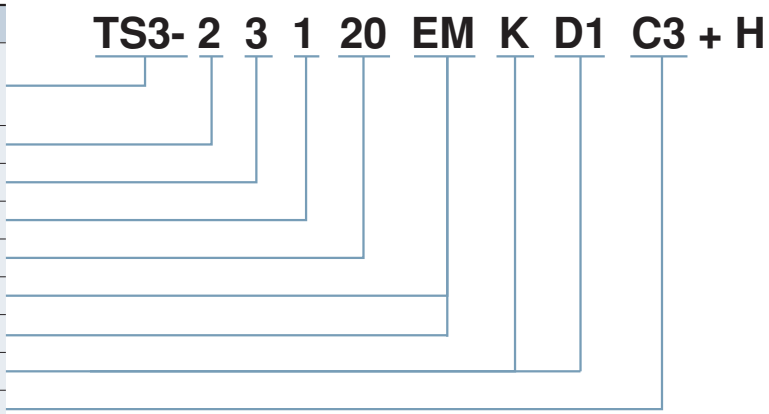


Table 2.3 Bearing series number

Bearing series code	Type code	Dimension series code		Bearing type
		❶ Width / height series	Dimension series	
12	1	(0)	2	Self-aligning ball bearings
13	1	(0)	3	
22	2	(2)	2	
23	2	(2)	3	
239	2	3	9	Sherical roller bearings
230		3	0	
240		4	0	
231		3	1	
241		4	1	
222		2	2	
232		3	2	
213		0	3	
223		2	3	

❶ Codes in ( ) are not shown in nominal numbers.

Table 2.4 Suffix supplementary code

Code		Contents
Cage code	EA	Window-type pressed steel cage
	EM	One-piece machined high-tension brass cage
	L1	High-strength brass machined cage
	F1	Carbon steel machined cage
Bearing ring shape code	K	Standard taper single bore 1/12 taper hole
	K30	Standard taper single bore 1/30 taper hole
	D1	With oil hole / groove
Innternal clearance code	C2	Smaller than normal clearance
	C3	Larger than normal clearance
	C4	Larger than C3 clearance
	C5	Larger than C4 clearance

3. Plummer Block and Rolling Bearing Tolerances

3.1 Plummer block tolerances

The tolerances of **NTN** split plummer blocks meet JIS B 1551, and those of unit type plummer blocks with Japan Bearing Industrial Association standard BAS 188. The tolerances of both types are given in the tables below.

Table 3.1 Tolerances of plummer blocks

Unit: mm

Split type				Unit type					
Plummer block series	Housing bore diameter Δ_{Ds}	Housing width Δ_{gs}	Center height Δ_{Hs}	Plummer block series	Housing bore diameter Δ_{Ds}	Center height Δ_{Hs}	Body width I_1	Cover dimensions I_2	Cover spigot width I_3
SN5, SN5F SN (S)6, SN (S)6F SN2, SNZ2, SN30 SN (S)3, SNZ (SZ)3, SN31 SBG5	H8	H13	h13	SV5 SV6 SV2 SV3 SV30 SV35 VA5	H7	h11	+0.2 0	±1	0 −0.2
SD30, SD31 SD33 SD34, SD35 SD36 SD2, SD3 SD5, SD6 SD31TS, SD32TS	H8	±0.2	h13						

Table 3.2 Tolerances of length of cast iron components

Unit: mm

Casting size				
120 or less	120 to 250	250 to 400	400 to 800	800 to 1600
±1.5	±2.0	±3.0	±4.0	±6.0

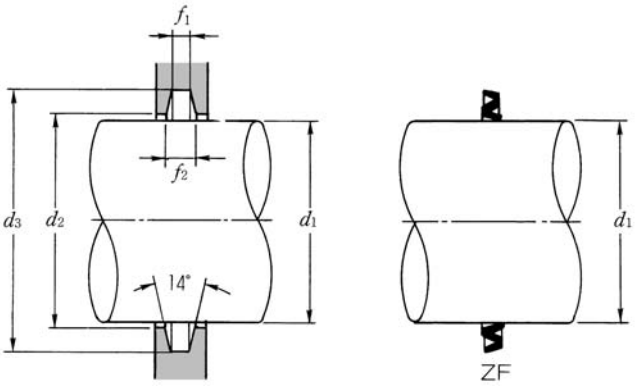


Table 3.3 Bore dimensions and tolerances

Unit: mm

Shaft diameter d_1	d_2		d_3		f_1		f_2	Angular tolerance	Rubber seal part number (reference)
	Dimension	Tolerance	Dimension	Tolerance	Dimension	Tolerance	Dimension		
20	21.5	+0.210 0	31	+0.250 0	3	+0.140 0	4.2	±1°	ZF 5
25	26.5		38		4	+0.180 0	5.4		ZF 6
30	31.5	+0.250 0	43		4		5.4		ZF 7
35	36.5		48		4		5.4		ZF 8
40	41.5		53	+0.300 0	4		5.4		ZF 9
45	46.5		58		4		5.4		ZF10
50	51.5	+0.300 0	67		5		6.9		ZF11
55	56.5		82		5		6.9		ZF12
60	62		77		5		6.8		ZF13
65	67		82	+0.350 0	5		6.8		ZF15
70	72		89		6		8.1		ZF16
75	77		94		6		8.1		ZF17
80	82	+0.350 0	99		6		8.1		ZF18
85	87		104		6		8.1		ZF19
90	92		111		7	+0.220 0	9.3		ZF20
100	102		125	+0.400 0	8		10.8		ZF22
110	113		135		8		10.7		ZF24
115	118		140		8		10.7		ZF26
125	128	+0.400 0	154		9		12.2		ZF28
135	138		164		9		12.2		ZF30
140	143		173		10		13.7		ZF32
150	153		183	+0.460 0	10		13.7		ZF34
160	163		193		10		13.7		ZF36
170	173		203		10		13.7		ZF38
180	183	+0.460 0	213		10		13.7		ZF40
200	203		240		11	+0.27 0 0	15.5		ZF44
220	223		260	+0.520 0	11		15.5		ZF48
240	243		286		12		17.3		ZF52
260	263	+0.520 0	306		12		17.3		ZF56
280	283		332		13		19		ZF60
300	303		352	+0.570 0	13		19		ZF64
320	323		372		13		19		ZF68
340	343	+0.570 0	390		14		19.8		GS72
360	363		412		13		19		GS76
380	383		432		13		19		GS80
400	403		452	+0.630 0	14		20		GS84
410	413	+0.630 0	460		14		19.8		GS88
430	433		480		14		19.8		GS92
450	453		505	+0.700 0	14		20.3		GS96

Table 3.4 (1) Dimensions and tolerances of locating rings

Unit: mm

Part number	Outside dia. h12	Inside dia.	Width 0 −0.2	Material
SR 52× 5	52	44	5	
SR 52× 6	52	44	6	
SR 52× 7	52	44	7	
SR 52× 9	52	44	9	
SR 62× 6	62	54	6	
SR 62× 6.5	62	54	6.5	
SR 62× 7	62	54	7	
SR 62× 8.5	62	54	8.5	
SR 62×10	62	54	10	
SR 72× 6	72	64	6	
SR 72× 7	72	64	7	
SR 72× 8	72	64	8	
SR 72× 9	72	64	9	
SR 72×10	72	64	10	
SR 80× 6	80	70	6	
SR 80× 7	80	70	7	
SR 80× 7.5	80	70	7.5	
SR 80× 8	80	70	8	
SR 80× 9.5	80	70	9.5	
SR 80×10	80	70	10	
SR 85× 6	85	75	6	Die-cast zinc alloy, class 2, ZDC2
SR 85× 8	85	75	8	
SR 85×10	85	75	10	
SR 90× 6	90	80	6	
SR 90× 6.5	90	80	6.5	
SR 90× 8	90	80	8	
SR 90× 9.5	90	80	9.5	
SR 90×10	90	80	10	
SR100× 6	100	89	6	
SR100× 8	100	89	8	
SR100× 8.5	100	89	8.5	
SR100×10	100	89	10	
SR100×10.5	100	89	10.5	
SR110× 6	110	99	6	
SR110× 8	110	99	8	
SR110× 9	110	99	9	
SR110× 9.5	110	99	9.5	
SR110×10	110	99	10	
SR110×11.5	110	99	11.5	
SR110×12	110	99	12	
SR120× 6	120	108	6	
SR120× 9	120	108	9	

Unit: mm

Part number	Outside dia. h12	Inside dia.	Width 0 −0.2	Material
SR120×10	120	108	10	
SR120×12	120	108	12	
SR120×13	120	108	13	
SR125× 9.5	125	113	9.5	
SR125×10	125	113	10	
SR125×13	125	113	13	
SR130× 4	130	118	4	
SR130× 8	130	118	8	
SR130× 9.5	130	118	9.5	
SR130×10	130	118	10	
SR130×12.5	130	118	12.5	
SR140× 8	140	125	8	
SR140× 8.5	140	125	8.5	
SR140×10	140	125	10	
SR140×11.5	140	125	11.5	
SR140×12.5	140	125	12.5	
SR140×15	140	125	15	
SR150× 5	150	135	5	
SR150× 9	150	135	9	
SR150×10	150	135	10	
SR150×10.5	150	135	10.5	Die-cast zinc alloy, class 2, ZDC2
SR150×14	150	135	14	
SR150×13	150	135	13	
SR160× 7	160	144	7	
SR160× 9.6	160	144	9.6	
SR160×10	160	144	10	
SR160×11	160	144	11	
SR160×11.2	160	144	11.2	
SR160×12.5	160	144	12.5	
SR160×14	160	144	14	
SR160×15	160	144	15	
SR160×16	160	144	16	
SR160×16.2	160	144	16.2	
SR170× 4	170	154	4	
SR170× 9.5	170	154	9.5	
SR170×10	170	154	10	
SR170×10.5	170	154	10.5	
SR170×11.5	170	154	11.5	
SR170×14.5	170	154	14.5	
SR170×15	170	154	15	
SR180× 9.5	180	163	9.5	
SR180× 9.7	180	163	9.7	

Table 3.4 (2) Dimensions and tolerances of locating rings

Unit: mm

Part number	Outside dia. h12	Inside dia.	Width 0 −0.2	Material
SR180×10	180	163	10	Die-cast zinc alloy, class 2, ZDC2
SR180×12	180	163	12	
SR180×12.1	180	163	12.1	
SR180×14.5	180	163	14.5	
SR180×18	180	163	18	
SR180×18.1	180	163	18.1	
SR190× 6	190	173	6	
SR190× 9.5	190	173	9.5	
SR190×13.5	190	173	13.5	
SR190×15.3	190	173	15.3	
SR200× 9.5	200	180	9.5	
SR200×10	200	180	10	
SR200×12.2	200	180	12.2	
SR200×13.5	200	180	13.5	
SR200×14.5	200	180	14.5	
SR200×15	200	180	15	
SR200×15.8	200	180	15.8	
SR200×18.5	200	180	18.5	
SR200×21	200	180	21	
SR200×22	200	180	22	
SR210×9.5	210	190	9.5	
SR210×10	210	190	10	
SR215× 6	215	195	6	
SR215× 9	215	195	9	
SR215× 9.5	215	195	9.5	
SR215×10	215	195	10	
SR215×12	215	195	12	
SR215×14	215	195	14	
SR215×17.5	215	195	17.5	
SR215×17.8	215	195	17.8	
SR225× 9.5	225	205	9.5	
SR225×10	225	205	10	
SR230× 6	230	210	6	
SR230×10	230	210	10	
SR230×11	230	210	11	
SR230×13	230	210	13	
SR240× 9.5	240	218	9.5	
SR240×10	240	218	10	
SR240×16	240	218	16	
SR240×19.8	240	218	19.8	
SR240×23	240	218	23	
SR250× 5	250	230	5	

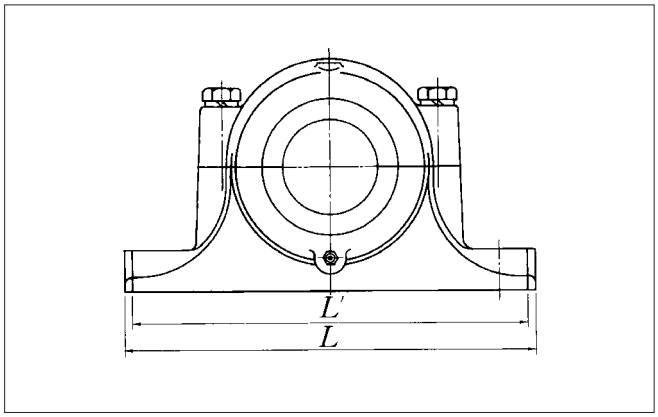
Unit: mm

Part number	Outside dia. h12	Inside dia.	Width 0 −0.2	Material
SR250× 6	250	230	6	Gray cast iron, class 3, FC200
SR250× 9.5	250	230	9.5	
SR250×10	250	230	10	
SR250×13	250	230	13	
SR250×15	250	230	15	
SR260× 9.5	260	238	9.5	
SR260×10	260	238	10	
SR260×17	260	238	17	
SR270× 7	270	248	7	
SR270× 9.5	270	248	9.5	
SR270×10	270	248	10	
SR270×15	270	248	15	
SR270×16.5	270	248	16.5	
SR280× 9.5	280	255	9.5	
SR280×10	280	255	10	
SR280×15	280	255	15	
SR290× 9	290	268	9	
SR290×10	290	268	10	
SR290×16.5	290	268	16.5	
SR290×17	290	268	17	
SR300× 9.5	300	275	9.5	
SR300×10	300	275	10	
SR300×11	300	275	11	
SR310×10	310	290	10	
SR310×12	310	290	12	
SR310×18	310	290	18	
SR320× 9.5	320	290	9.5	
SR320×10	320	290	10	
SR320×14	320	290	14	
SR320×18	320	290	18	
SR340× 9.5	340	310	9.5	
SR340×10	340	310	10	
SR340×16	340	310	16	
SR340×19	340	310	19	
SR360×10	360	330	10	
SR380×10	380	350	10	
SR400×10	400	370	10	
SR500×15.5	500	470	15.5	
SR540×18.5	540	510	18.5	
SR580×21.5	580	550	21.5	

3.2 Machining tolerances of mounting bolt seat faces

When subjected to a greater lateral load, a plummer block cannot be reliably secured with the tightening force of mounting bolts alone. To overcome this problem the end faces of the mounting bolt seat are secured with stoppers to lock the plummer block. With the plummer block used in this type of application, the end faces in contact with the stoppers are machined.

When a plummer block mounting seat end faces have been machined, the bottom length L of the bearing housing is smaller by the dimension in **Table 3.5**.



L: Basic casting dimension (as cast dimension)
L': Dimension after machining of the end faces of bearing base

Table 3.5 Machining allowance

Unit: mm

Plummer block part number	Machining allowance L-L'	Surface roughness
SN506～SN519 SN206～SN219 SNZ206～SNZ219 SN606～SN616 SN306～SN316 SNZ306～SNZ316 SV505～SV519 SV205～SV219 SV605～SV616 SV305～SV316	3	12.5Ra
SN520～ SN220～ SNZ220～ SN617～ SN317～ SNZ317～ Model SN30, model SN31 Model SN..F, model SD SV520～ SV220～ SV617～ SV317～	5	

Table 3.6 Tolerances of dimension L after machining of mounting bolt seat end faces

Unit: mm

Dimension after machining L'	30～120	120～315	315～1 000	1 000～2 000
Tolerance	±0.8	±1.2	±2.0	±3.0

3.3 Rolling bearing accuracies

The tolerances of self-aligning ball bearings and spherical roller bearings used in conjunction with **NTN** plummer blocks conform to JIS B 1514 (Tolerances for rolling bearings).

Table 3.7 Bearing tolerances

(1) Tolerances of inner rings (JIS class 0)

Unit: μm

Nominal bore diameter d (mm) over	incl.	Dimensional tolerance of mean bore diameter within plane Δ_{dmp} high	low	Bore diameter variation V_{dp} diameter series 0, 1 max	diameter series 2, 3, 4 max	Mean bore diameter variation V_{dmp} max	Inner ring radial runout K_{ia} max	Inner ring width deviation Δ_{Bs} high	low	Inner ring width variation V_{Bs} max
18	30	0	−10	10	8	8	13	0	−120	20
30	50	0	−12	12	9	9	15	0	−120	20
50	80	0	−15	19	11	11	20	0	−150	25
80	120	0	−20	25	15	15	25	0	−200	25
120	150	0	−25	31	19	19	30	0	−250	30
150	180	0	−25	31	19	19	30	0	−250	30
180	250	0	−30	38	23	23	40	0	−300	30
250	315	0	−35	44	26	26	50	0	−350	35
315	400	0	−40	50	30	30	60	0	−400	40
400	500	0	−45	56	34	34	65	0	−450	50

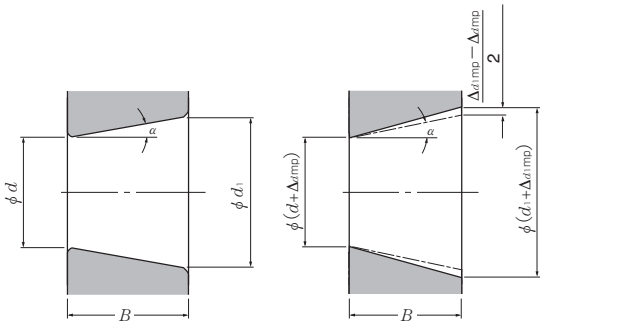
(2) Tolerances of outer rings (JIS class 0)

Unit: μm

Nominal outside diameter D (mm) over	incl.	Dimensional tolerance of mean outside diameter within plane Δ_{Dmp} high	low	Outside diameter variation V_{Dp} diameter series 0, 1 max	diameter series 2, 3, 4 max	Mean outside diameter variation V_{Dmp} max	Outer ring radial runout K_{ea} max	Outer ring width deviation Δ_{Cs} high	low	Outer ring width variation V_{Cs} max
30	50	0	−11	11	8	8	20			
50	80	0	−13	13	10	10	25			
80	120	0	−15	19	11	11	35			
120	150	0	−18	23	14	14	40			
150	180	0	−25	31	19	19	45			
180	250	0	−30	38	23	23	50			
250	315	0	−35	44	26	26	60			
315	400	0	−40	50	30	30	70			
400	500	0	−45	56	34	34	80			
500	630	0	−50	63	38	38	100			
630	800	0	−75	94	55	55	120			

Depends on tolerance of Δ_{Bs} relative to d of the same bearing.

Depends on tolerance of V_{Bs} relative to d of the same bearing.



Theoretical tapered bore

Tapered bore having dimensional difference of the average bore diameter within the flat surface

(3) Tolerance of and tolerance values for tapered ❶ bore of radial bearings (JIS class 0)

Unit: μm

Nominal bore diameter d (mm) over	incl.	Δ_{dmp} high	Δ_{dmp} low	$\Delta_{d1mp} - \Delta_{dmp}$ high	$\Delta_{d1mp} - \Delta_{dmp}$ low	V_{dp} ❶ max
18	30	+33	0	+21	0	13
30	50	+39	0	+25	0	16
50	80	+46	0	+30	0	19
80	120	+54	0	+35	0	22
120	180	+63	0	+40	0	40
180	250	+72	0	+46	0	46
250	315	+81	0	+52	0	52
345	400	+89	0	+57	0	57
400	500	+97	0	+63	0	63

❶ Applicable to all radial planes of inner ring tapered bore.

Note 1: Applicable to 1/12 tapered bore

2: Quantifiers

d_1 : Standard diameter at theoretical large end of tapered bore

$$d_1 = d + \frac{1}{12} B$$

Δ_{dmp} : Dimensional difference of the average bore diameter within the flat surface at the theoretical small end of the tapered bore.

Δ_{d1mp} : Dimensional difference of the average bore diameter within the flat surface at the theoretical large end of the tapered bore.

V_{dp} : Unevenness of the bore diameter with the flat surfacee

B : Nominal width of inner ring

α : Half of the tapered bore's nominal taper angle

α = 2°23'9.4"
= 2.38594°
= 0.041643 rad

3.4 Rolling bearing internal clearance

The radial clearance values of the self-aligning ball bearings used in the **NTN** plummer blocks are summarized in **Table 3.8 (1) and (2)**, and those of the spherical roller bearings in **Table 3.9 (1) and (2)**.

Table 3.8 Radial internal clearance of self-aligning ball bearings

(1) Data for cylindrical bore bearings

Unit: μm

Nominal bore diameter d (mm)		Clearance									
		C2		CN (normal)		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
24	30	5	16	11	24	19	35	29	46	40	58
30	40	6	18	13	29	23	40	34	53	46	66
40	50	6	19	14	31	25	44	37	57	50	71
50	65	7	21	16	36	30	50	45	69	62	88
65	80	8	24	18	40	35	60	54	83	76	108
80	100	9	27	22	48	42	70	64	96	89	124
100	120	10	31	25	56	50	83	75	114	105	145

(2) Data for tapered bore bearings

Unit: μm

Nominal bore diameter d (mm)		Clearance									
		C2		CN (normal)		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
24	30	9	20	15	28	23	39	33	50	44	62
30	40	12	24	19	35	29	46	40	59	52	72
40	50	14	27	22	39	33	52	45	65	58	79
50	65	18	32	27	47	41	61	56	80	73	99
65	80	23	39	35	57	50	75	69	98	91	123
80	100	29	47	42	68	62	90	84	116	109	144
100	120	35	56	50	81	75	108	100	139	130	170

Table 3.9 Radial internal clearance of spherical roller bearings

(1) Data for cylindrical bore bearings

Unit: μm

Nominal bore diameter d (mm)		Clearance									
		C2		CN (normal)		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
30	40	15	30	30	45	45	60	60	80	80	100
40	50	20	35	35	55	55	75	75	100	100	125
50	65	20	40	40	65	65	90	90	120	120	150
65	80	30	50	50	80	80	110	110	145	145	180
80	100	35	60	60	100	100	135	135	180	180	255
100	120	40	75	75	120	120	160	160	210	210	260
120	140	50	95	95	145	145	190	190	240	240	300
140	160	60	110	110	170	170	220	220	280	280	350
160	180	65	120	120	180	180	240	240	310	310	390
180	200	70	130	130	200	200	260	260	340	340	430
200	225	80	140	140	220	220	290	290	380	380	470
225	250	90	150	150	240	240	320	320	420	420	520
250	280	100	170	170	260	260	350	350	460	460	570
280	315	110	190	190	280	280	370	370	500	500	630
315	355	120	200	200	310	310	410	410	550	550	690
355	400	130	220	220	340	340	450	450	600	600	750
400	450	140	240	240	370	370	500	500	660	660	820
450	500	140	260	260	410	410	550	550	720	720	900

(2) Data for tapered bore bearing

Unit: μm

Nominal bore diameter d (mm)		Clearance									
		C2		CN (normal)		C3		C4		C5	
over	incl.	min	max	min	max	min	max	min	max	min	max
30	40	25	35	35	50	50	65	65	85	85	105
40	50	30	45	45	60	60	80	80	100	100	130
50	65	40	55	55	75	75	95	95	120	120	160
65	80	50	70	70	95	95	120	120	150	150	200
80	100	55	80	80	110	110	140	140	180	180	230
100	120	65	100	100	135	135	170	170	220	220	280
120	140	80	120	120	160	160	200	200	260	260	330
140	160	90	130	130	180	180	230	230	300	300	380
160	180	100	140	140	200	200	260	260	340	340	430
180	200	110	160	160	220	220	290	290	370	370	470
200	225	120	180	180	250	250	320	320	410	410	520
225	250	140	200	200	270	270	350	350	450	450	570
250	280	150	220	220	300	300	390	390	490	490	620
280	315	170	240	240	330	330	430	430	540	540	680
315	355	190	270	270	360	360	470	470	590	590	740
355	400	210	300	300	400	400	520	520	650	650	820
400	450	230	330	330	440	440	570	570	720	720	910
450	500	260	370	370	490	490	630	630	790	790	1 000

4. Plummer Block and Bearing Materials

4.1 Plummer block materials

The housings of **NTN** plummer blocks are made of class 3 gray cast iron (FC200). **Table 4.1** summarizes the mechanical properties of this material.

Cast iron materials boasts the greatest vibration dampening capability among various metal materials.

They also perform well in a wider operating temperature range of –20 to 300˚C.

For application involving shock load and vibration, class 2 spheroidal graphite cast iron (FCD450) or class 3 carbon cast steel (SC450) is used.

Table 4.1 Mechanical properties

(1) Mechanical properties of gray cast iron

Type	Symbol	Typical wall thickness of cast iron product mm	Cast diameter of samples mm	Tensile strength MPa (kgf/mm²)	Transverse test		Brinell hardness HB
					Maximum load N (kgf)	Flexure mm	
Gray cast iron, class 3	FC200	4 to 8	13	235 {24} over	1 960 {200} over	2.0 over	255 incl.
		over 8, incl. 15	20	216 {22} over	4 410 {450} over	3.0 over	235 incl.
		over 15, incl. 30	30	196 {20} over	8 820 {900} over	4.5 over	223 incl.
		over 30, incl. 50	45	167 {17} over	19 600 {2 000} over	6.5 over	217 incl.

(2) Mechanical properties of spheroidal graphite cast iron

Type	Symbol	Tensile test			Impact test
		Proof stress MPa (kgf/mm²)	Tensile strength MPa (kgf/mm²)	Elongation %	Charpy absorption energy N・m {kgf・m}
Class 2 spheroidal graphite cast iron	FCD450	226 {23} over	450 {46} over	10 over	—

(3) Mechanical properties of carbon cast steel

Type	Symbol	Yield point MPa (kgf/mm²)	Tensile test		
			Tensile strength MPa (kgf/mm²)	Elongation %	Reduction in area %
Carbon cast steel	SC450	226 {23} over	451 {46} over	19 over	30 over

Table 4.2 Plummer block accessories materials

Accessory	Material used	Symbol	Applicable JIS standard
Tightening bolt and nut	Class 2 rolled steel for general structure	SS400	G3101
Spring washer	Hard drawn steel wire	SWRH62B	G3506
Grease nipple (on housing)	Copper and copper alloy rod and bar	C3604B	H3250
Plug for relubrication or draining	Class 2 rolled steel for general structure	SS400	G3101
Stabilizing ring, general purpose	Class 3 gray cast iron and class 2 zinc die-casting	FC200, ZDC2	G5501, H5301
(normal width)	Class 2 rolled steel for general structure	SS400	G3101

4.2 Bearing materials

Raceway and rolling element materials

When the contact surfaces of a bearing raceway and rolling elements are repeatedly subjected to heavy stress, they still must maintain high precision and running accuracy. To accomplish this, the raceway and rolling elements must be made of a material that has high hardness, is resistant to rolling fatigue, is wear resistant, and has good dimensional stability.

By using pure materials, low in these non-metallic impurities, the rolling fatigue life of the bearing is lengthened. For all **NTN** bearings, pure material is prepared which has low oxygen content and low non-metallic impurities, by vacuum degassing process and secondary refining process.

Table 4.3 Adapter materials

	Part description	Material used	Symbol	Applicable JIS standard	Remarks
Sleeve, adapter	Bearing bore #14 or smaller	Carbon steel for machine structural purposes	STKM13A	G3445	Can be SS400 (G3101), S20C to S35C (G4051), STPG370 (G3454) or STKM13A (G3445).
	Bearing bore #15 or greater	Carbon steel for machine structural purposes	S25C	G4051	
Nut	#05～#07	Carbon steel for machine structural purposes	S20C	G4051	Can be SS400 (G3101), or S20C to S35C (G4051).
	#08～#32	Rolled steel for general structure	SS400	G3101	
	#34～	Carbon steel for machine structural purposes	S25C	G4051	
Lock-washer	Thickness: less than 3 mm	Cold rolled steel plate and strip	SPCC-SD	G3141	
	Thickness: 3 mm or greater	Rolled steel for general structure	SS400	G3101	Can be SPHD (G3131).
Lock plate		Rolled steel for general structure	SS400	G3101	Can be S20C to S35C (G4051).

Cage materials

Bearing cage materials must be strong enough to withstand the vibration and shock load occurring on running bearings, develop limited friction with rolling elements and bearing ring, be light, and resist the heat occurring on running bearings.

The cages for small- and medium-sized bearings are pressed cages prepared through pressing process with cold or hot rolled steel plate, while the cages for large-sized bearings are machined cages made of cast high tensile brass or carbon steel for machine structural purposes.

5. Strength of Plummer Blocks, and Combination with Bearings

5.1 Strength of plummer blocks

The disruptive strength of plummer block varies depending on its type, nature and direction of a load working on it, as well as the flatness of a surface to which it is installed. The typical trend of static disruptive strength of SN5 and SN6 (S6) series of cast iron plummer blocks is plotted in **Figs. 5.1 and 5.2** respectively.

When selecting a plummer block, the safety factors in **Table 5.1** must be considered. Also, a higher grade of flatness is required of a surface for mounting a plummer block.

Table 5.1 Safety factors of cast iron plummer blocks

Nature of load	Light	Repeated	Alternating	Shock
Safety factor	4	6	10	15

To counter a horizontal or axial load, the face of the bed must be secured with a stopper.

For applications where extreme shock load is present or a fractured plummer block can lead to severe accident, NTN offers special plummer blocks made of spherical graphite cast iron or cast steel. For further information, contact NTN Engineering.

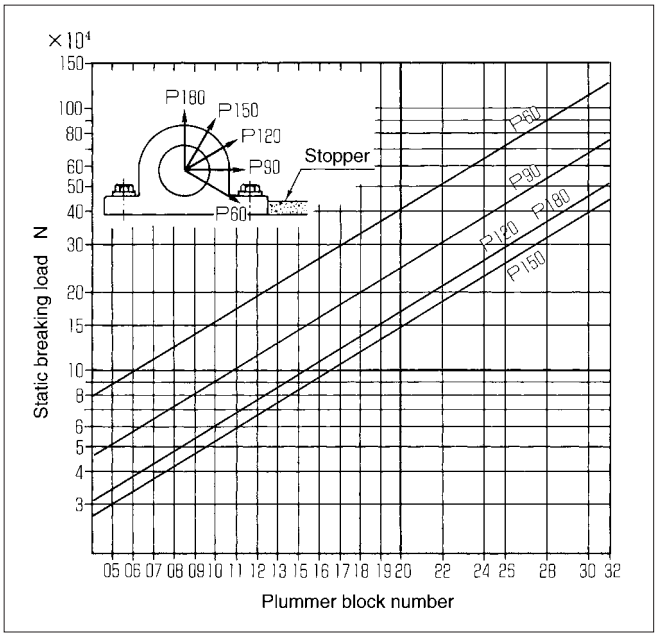


Fig. 5.1 Static disruptive strength of SN5 series

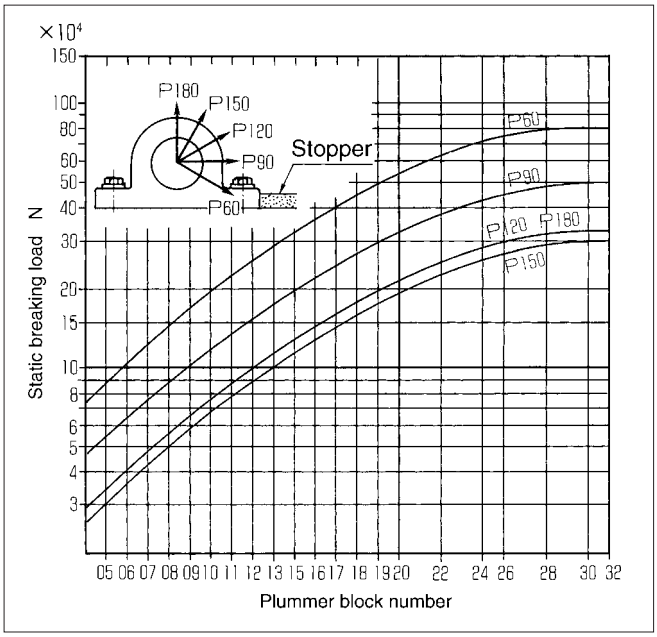


Fig. 5.2 Static disruptive strength of SN6 (S6) series

5.2 Combinations of plummer blocks and bearings

The typical plummer block-bearing combinations are listed in **Tables 5.2 (1) and (2).**

Table 5.2 (1) Plummer blocks and applicable bearings

Plummer block series \ Bearing series	12	22	13	23	230	231	222	232	213	223
SN5 SN5··F	06SK～22SK	06SK～22SK					08EAKD1＊～ 32EAKD1＊	18EMKD1＊ 20EMKD1＊～ 32EMKD1＊		
SN(S)6 SN(S)6··F			06SK～22SK	06SK～22SK					08CK～10CK 11K～22K	08EAKD1＊～ 28EAKD1＊ 30EMKD1＊～ 32EMKD1＊
SN2 SN2··F	06S～22S	06S～22S					08EAD1＊～ 32EAD1＊	18EMD1＊ 20EMD1＊～ 32EMD1＊		
SN (S) 3 SN (S) 3··F			06SK～22SK	06SK～22SK					08C～10C 11～22	08EAD1＊～ 28EAD1＊ 30EMD1＊～ 32EMD1＊
SNZ2 SNZ2··F	06SK～22S	06S～22S					08EAD1＊～ 32EAD1＊	18EMD1＊ 20EMD1＊～ 32EMD1＊		08EAD1＊～ 28EAD1＊ 30EMD1＊～ 32EMD1＊
SNZ (SZ) 3 SNZ (SZ) 3··F			06SK～22SK	06SK～22SK					08C～10C 11～22	
SN30					24EAKD1＊～ 38EAKD1＊					
SN31						22EAKD1＊～ 36EMKD1＊ 38EMKD1＊				
SD5 SD5··G							34EMD1＊～ 64EMD1＊			
SD6 SD6··G										34EMKD1＊～ 56EMKD1＊
SD2 SD2··G							34EMD1＊～ 64EMD1＊			
SD3 SD3··G										34EMD1＊～ 56EMD1＊
SD2··D SD2··DG							34EMD1＊～ 64EMD1＊			
SD3··D SD3··DG										34EMD1＊～ 56EMD1＊
SD30 SD30··G					34EAKD1＊～ 38EAKD1＊ 40EMKD1＊～ 76EMKD1＊ 80BK～96BK					
SD31 SD31··G						34EAKD1＊～ 36EAKD1＊ 38EMKD1＊～ 68EMKD1＊ 72BK～84BK				

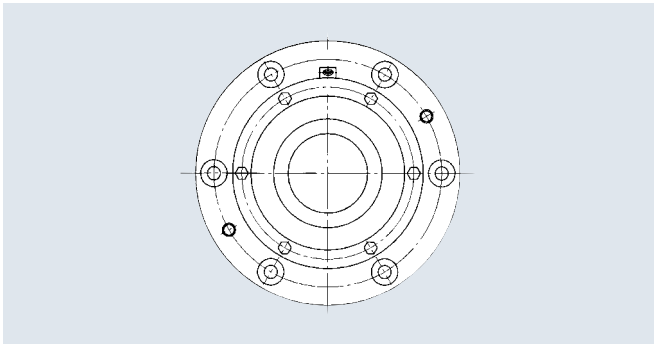
1) Bearing part numbers with ＊ are **ULTAGE series** and have outer ring oil holes and groove as standard.
2) “K” indicates bearings have tapered bore with a taper ratio of 1:12.

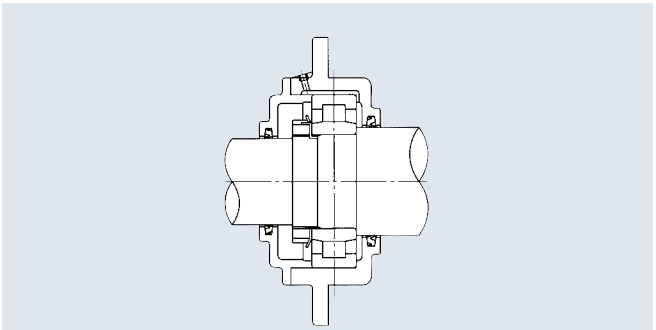
Table 5.2 (2) Plummer blocks and applicable bearings

Plummer block series \ Bearing series	12	22	13	23	230	231	222	232	213	223
SV5	05SK～22SK	05SK～22SK					08EAKD1＊～32EAKD1＊ 34EMKD1＊～64EMKD1＊	18EMKD1＊ 20EMKD1＊～64EMKD1		
SV6			05SK～22SK	05SK～22SK					08CK～10CK 11K～22K	08EAKD1＊～28EAKD1＊ 30EMKD1＊～56EMKD1＊
SV2	05S～22S	05S～22S					08EKD1＊～32EKD1＊ 34EMD1＊～64EKD1＊	18EMD1＊ 20EMD1＊～64EMD1		
SV3			05S～22S	05S～22S					08C～10C 11～22	08EAD1＊～28EAD1＊ 30EMD1＊～56EMD1＊

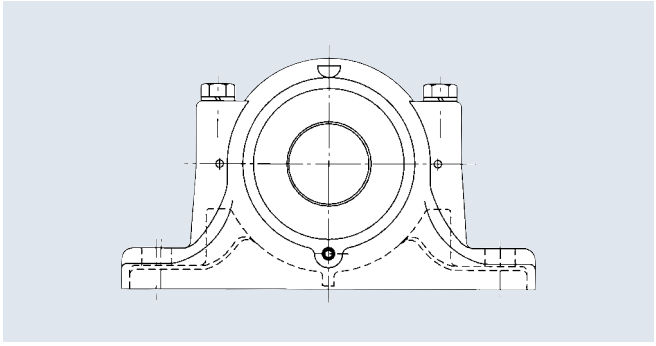
1) Bearing part numbers with ＊ are **ULTAGE series** and have outer ring oil holes and groove as standard.
2) “K” indicates bearings have tapered bore with a taper ratio of 1:12.

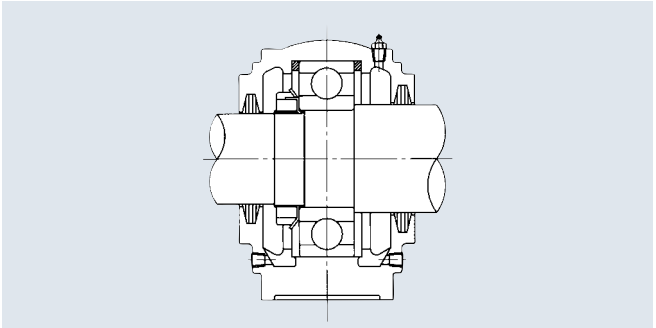
Example of application with cylindrical roller bearing





Example of application with deep groove ball bearing





6. Allowable Speed

Greater bearing speed leads to higher bearing temperature owing to friction heat occurring within the bearing. When the bearing is heated beyond a specific limit, a bearing failure such as seizure occurs, and the bearing cannot maintain stable operation any more. The limiting bearing speed where a bearing can operate without developing heat beyond a particular limitation is called allowable speed (min^{-1}). This varies depending on the type and size of bearing, type of cage, as well as loading, lubricating and cooling conditions.

The bearing tables in this brochure summarize the typical allowable bearing speeds either with grease or oil lubrication. However, these values assume that:

- An **NTN** standard design bearing having correct internal clearance is correctly installed.
- The bearing is lubricated with quality lubricant, and the lubricant is replenished or replaced at correct intervals.
- The bearing is operated under normal loading conditions ($P \leq 0.09C_r$, $F_a/F_r \leq 0.3$), and at a normal operating temperature.

Note, however, that rolling elements may fail to rotate smoothly under a load of $P \leq 0.04C_{0r}$. For advice against this problem, contact **NTN** Engineering. Also, note that the allowable speed of deep groove ball bearing having a contact seal (type LLU) or low-torque seal (type LLH) is governed by the peripheral speed of the seal. The allowable speed of a bearing that is used under severe operating conditions can be determined by multiplying the allowable speed of that bearing in a bearing table by an adjustment factor in **Fig. 6.1**.

The allowable speed of a plummer block with a bearing varies depending on the seal type used. For example, in the case of a plummer block having a contact seal, its allowable speed is restricted by the allowable peripheral speed of the seal. **Fig. 6.2** provides a guideline for selecting allowable peripheral speeds of various seals.

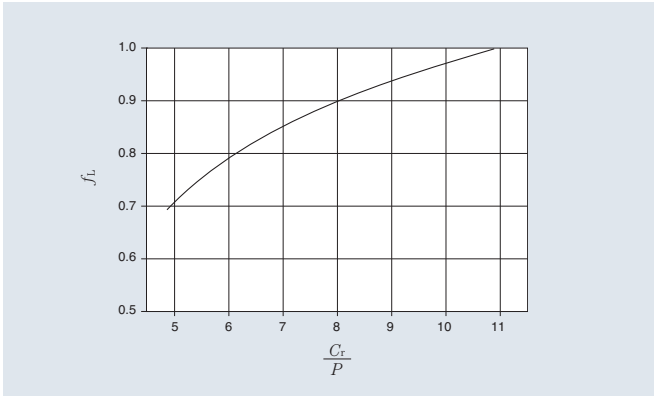


Fig. 6.1 Values of adjustment factor f_L dependent on bearing load

C_r : Basic dynamic load rating N
P : Dynamic equivalent load N

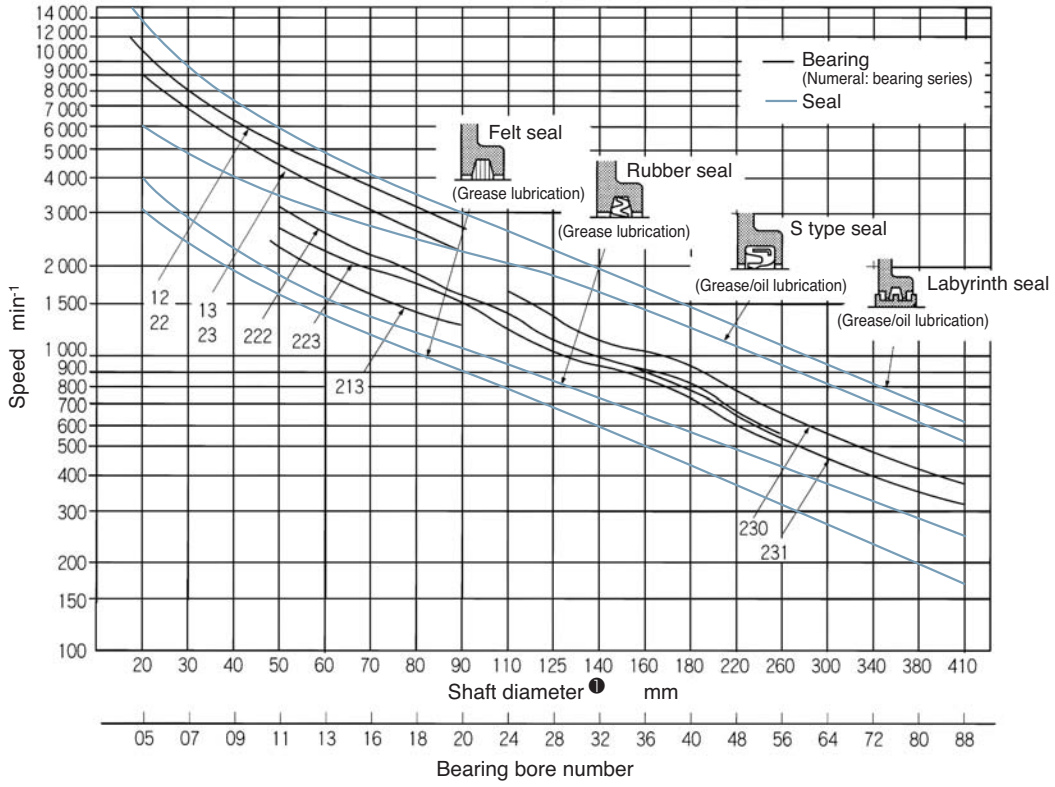


Fig. 6.2 Allowable speed of bearing vs. allowable peripheral speed of seal n_o

❶ Determine the allowable speed of the seal of a cylindrical bore bearing by referring to the shaft diameter at the contact surface of the seal. In the plotting above, the allowable speeds of the seal are indicated as shaft speeds (min^{-1}).

7. Bearing Seals

The purposes of bearing seals are to prevent lubricant from leaking out and to protect the bearing against ingress of dust and moisture.

An appropriate bearing seal is selected considering the lubricant type (grease or oil) and the peripheral speed of the seal.

The seal type of **NTN** plummer blocks can be either contact or non-contact type. The contact type is available as felt seals and rubber seals, while the non-contact type as labyrinth seals. Also, special combination seals are available for applications under severe operating conditions involving, for example, heavy air-borne dust.

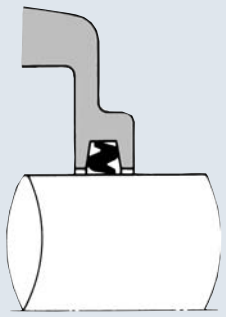


Fig. 7.1 Rubber seal

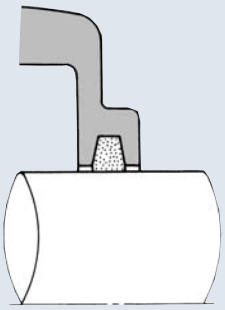


Fig. 7.2 Felt seal

7.1 Contact seals

(1) Rubber seal (Fig. 7.1)

Rubber seals are typically used for grease lubrication, and their allowable peripheral speed, as a guideline, ranges from 5 to 6 m/s.

Usually, the material of rubber seals are nitrile rubber. However, to cope with demanding ambient temperatures, the materials in **Table 7.1** are also available.

(2) Felt seal (Fig. 7.2)

Felt seals are compatible with rubber seals, but must be used for grease lubrication only.

Felt seals are not suitable for dusty or moist environments. Their allowable peripheral speed, as a guideline, is 4m/s. A felt seal can be cut into two pieces that are respectively fitted into the seal grooves on the upper and lower plummer block housings. This feature greatly simplifies the assembly procedure for plummer blocks.

Table 7.1 Types and features of rubber seal materials

Seal material	Wear resistance	Oil resistance	Acid resistance	Alkali resistance	Water resistance	Recommended operating temperature range °C	Features
Nitrile rubber (NBR)	◎	◎	○	○	○	− 25 100	Nitrile rubber (NBR) resists virtually all oil types and also features good wear resistance. Thus, this material is most commonly used as an oil seal material. It can be used in ordinary machinery operating under virtually any normal operating conditions.
Acrylic rubber (ACM)	◎	◎	△	×	△	− 15 130	Boasts excellent heat resistance and oil resistance, but is rather vulnerable to alkali or water. Thus, the scope of its applications is limited.
Silicone rubber (VMQ)	○	○	△	×	○	− 50 220	Boasts excellent heat resistance and cold resistance. However, it cannot be used together with extreme pressure grease or spindle oil.
Fluororubber (FKM)	◎	◎	◎	△	○	− 10 220	Inert to virtually all oil or chemical types. Its properties are well balanced. Therefore, it features wider operating conditions range. To sum up, this is a superior oil seal material.

◎: Excellent, ○: Good, △: Fair, ×: Poor (must not be used)

(3) S grease seal (Fig. 7.3)

The S grease seal (synthetic rubber seal with spring) excels in sealing performance and is well suited for grease or oil lubrication. Custom specification variants can be used in a plummer block.

Its recommended peripheral speed falls within a range of 10 to 12 m/s. The surface roughness and hardness of the shaft in contact with this sealing material necessitates special attention.

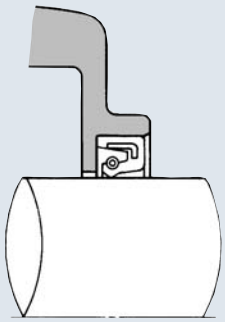


Fig. 7.3 S grease seal

6.2 Non-contact seals

(1) Labyrinth seal (Fig. 7.4)

The labyrinth seal used in the bore of plummer blocks -- SD31···TS and SD32···TS series-- comprise a labyrinth ring that is fitted into the bore of the plummer block. A labyrinth seal is used in clearance fit to a shaft (h9) together with an O-ring so that it can be readily installed and can follow expansion/compression of the shaft.

This seal type excels in sealing performance, and can be used for grease or oil lubrication.

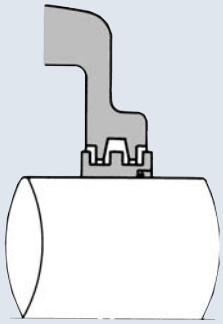


Fig. 7.4 Labyrinth seal

(2) Special labyrinth seal (Fig. 7.5)

The special labyrinth seals such as those in **Fig. 7.5** are very useful for applications where heavy soil and dust are present.

The plummer blocks used in conjunction with this seal type are manufactured per custom specifications. For further information, contact **NTN** Engineering.

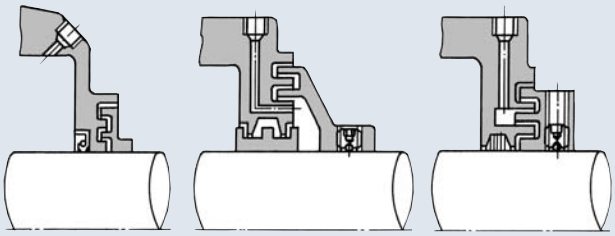


Fig. 7.5 Special labyrinth seal

Shaft design specification for the area in contact with the seal

The quality of a shaft section in contact with the seal lip greatly affects the sealing performance of the seal. Therefore, strictly adhere to the design standard for shafts in **Table 7.2.**

Table 7.2 Shaft design standard

Criterion	Design standard	Remarks
Hardness	HRC30～40	
Surface roughness	0.8Ra or smaller	The finish surface should be finish-ground without infeed.
Chamfering at end face	The end face to which a seal is fitted must be tapered and the sharp corner must be rounded.	

7.3 Combination seals

The combination seals used for the SBG series are unique seals that comprise both of an oil seal and labyrinth seal and are installed in the bore of a plummer block. They are used in environments where heavy dust and contaminants are present.

For better sealing effect, the labyrinth seal is often filled with grease.

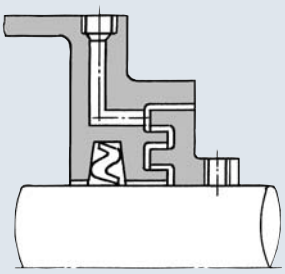


Fig. 7.6 Combination seal

With a continuous or intermittent lubrication scheme, lubricant can tend to leak. Use a seal that positively offers reliable sealing.

8. Shaft Design

8.1 Bearing-to-shaft fit

The tolerance requirements of the shaft outside diameter differs between a bearing with an adapter and a cylindrical bore bearing each mounted to a plummer block. **Tables 8.1(a) and (b)** summarizes the recommended bearing-to-shaft fits.

A bearing with an adapter is installed to a shaft by means of an adapter. A cylindrical bore bearing is usually positioned in interference fit by a shaft shoulder and secured with a nut and washer. For this application, the shaft is provided with threading and washer groove as illustrated in **Fig. 8.1**.

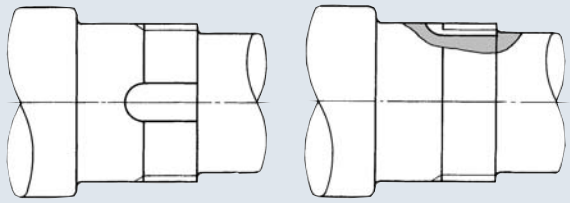


Fig. 8.1

Table 8.1(a) Recommended bearing-to-shaft fit

Bearing bore type	Load condition	Shaft diameter (mm)		Shaft type and tolerance class	Remarks
		Self-aligning ball bearing	Self-aligning roller bearing		
Tapered bore (complete with adapter assembly)	All type of loads	All shaft diameters		h9/IT5	The tolerance class for transmission shafts may be h10/IT7. "IT5" or IT7" means that the shaft form tolerance (circularity, cylidricity, etc.) must satisfy tolerance class IT5 or IT7.
Cylindrical bore	Light load and fluctuating load	over 18, incl. 100 over 100, incl. 200	— —	j6 k6	Light load essentially m<eans a load as small as 6 to 7% the basic dynamic load rating. P_r❶ ≤0.07C_r
	Normal load	over 18, incl. 100 over 100, incl. 200 — — —	— over 40, incl. 65 over 65, incl. 100 over 100, incl. 140 over 140, incl. 280	k5 m5 m6 n6 p6	Normal load is a load that satisfies 0.06C_r<P_r≤0.12C_r.
	Heavy load and shock load	— — —	over 50, incl. 100 over 100, incl. 140 over 140	n6 p6 r6	Heavy load is a load that satisfies P_r>0.12C_r. For this type of application, use a bearing whose clearance is greater than normal clearance.

❶ P_r : equivalent radial load

Note : 1. The above table applies to solid steel shafts.

2. Please refer to **Table 8.1(b)** for **ULTAGE series** of spherical roller bearings.

Table 8.1(b) Recommended spherical roller bearings-to-shaft fit (For ULTAGE series)

Bearing bore type	Load condition	Shaft diameter (mm)	Shaft tolerance class	Remarks
		Spherical roller bearings [type EA・EM]		
Tapered bore (complete with adapter assembly)	All type of loads	All shaft diameters	h9/IT5	The tolerance class for transmission shafts may be h10/IT7. "IT5" or IT7" means that the shaft form tolerance (circularity, cylidricity, etc.) must satisfy tolerance class IT5 or IT7.
Cylindrical bore	Light load or Normal load or Varying load	over 18, incl. 25 over 25, incl. 40 over 40, incl. 60 over 60, incl. 100 over 100, incl. 200 over 200, incl. 500	k5 m5 n5 n6 p6 r6	Light load is a load that satisfies P_r❶ ≤0.005C_r Normal load is a load that satisfies 0.05C_r<P_r≤0.10C_r
	Heavy load or Impact load	over 50, incl. 70 over 70, incl. 140 over 140, incl. 200❷	n6 p6 r6	Heavy load is a load that satisfies P_r>0.10C_r. For this type of application, use a bearing whose clearance is greater than normal clearance.

❶ P_r : equivalent radial load

❷ When using shaft diameter over 200mm with heavy load or impact load, please contact **NTN** Engineering.

Note : The above table applies to solid steel shafts.

"**ULTAGE**" (a name created from the combination of "**Ultimate**," signifying refinement, and "**stage**," signifying **NTN**'s intention that this series of products be employed in divers eapplications) is the general name for **NTN**'s new generation of bearings that are noted for industly-leading performance.

8.2 Mounting dimensions

To be able to correctly seat a cylindrical bore bearing to the shaft shoulder, the height and fillet radius r_{as} of the shoulder must be greater than the chamfering $r_{s\,min}$ of the bearing as specified in **Table 8.2**.

If the bearing is used on the shaft end, the configuration must be designed such that the shaft end does not interfere with the face of bearing bore. For reference, **Table 8.3** provides the wall thickness values at the bearing bore.

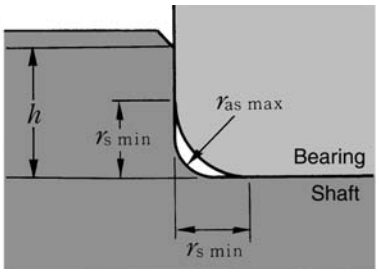


Table 8.2 Fillet radius and shoulder height of shaft

Unit: mm

Chamfer dimension r_s min mm	Shoulder height h ❶ (min)	Fillet radius r_{as} max
1	2.75	1
1,1	3.5	1
1,5	4.25	1.5
2	5	2
2.1	6	2
2.5	6	2
3	7	2.5
4	9	3
5	11	4
6	14	5
7.5	18	6
9.5	22	8

❶ The shoulder height must be greater than that specified when the shaft is subjected to a greater axial load.

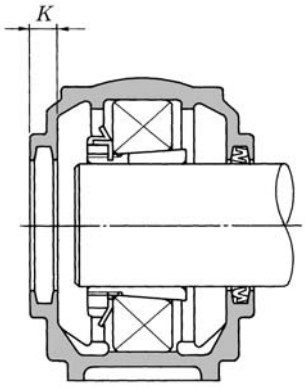


Table 8.3 Wall thickness at the bearing bore

(1)

Unit: mm

Bearing number	K	Bearing number	K	Bearing number	K
SN 506	11	SN 606	11	SN 206	11
507	11	607	11	(SNZ) 207	11
508	11	608	11	208	13
509	11	609	11	209	13
SN 510	11	SN 610	11	SN 210	13
511	14	611	14	(SNZ) 211	14
512	14	612	14	212	16
513	14	613	14	213	16
515	14	615	14	214	16
SN 516	16	SN 616	16	SN 215	16
517	16	617	16	(SNZ) 216	17
518	16	618	16	217	17
519	16	619	16	218	18
520	18	620	18	219	18
SN 522	20	SN 622	20	SN 220	20
524	20	624	20	(SNZ) 222	22
526	20	626	20	224	22
528	23	628	23	226	22
530	23	630	23	228	23
SN 532	25	SN 632	25	SN 230	23
				(SNZ) 232	25

Note: The dimensions for model SN3 are the same as those of model SN2.

(2)

Unit: mm

Bearing number	K	Bearing number	K	Bearing number	K
SD 534	44	SD3340	44	SN3024	20
536	44	3344	48	3026	20
538	48	3348	48	3028	22
540	48	3352	54	3030	22
544	54	3356	54	3032	22
SD 548	52	SD3360	58	SN3034	24
552	58	3364	58	3036	24
556	58	3368	60	3038	24
560	60	3372	60		
564	60	3376	60		
SD 634	48	SD3440	48	SN3122	20
636	48	3444	48	3124	20
638	54	3448	54	3126	20
640	54	3452	52	3128	22
644	58	3456	58	3130	22
SD 648	58	SD3460	58	SN3132	24
652	60	3464	60	3134	24
656	60	3468	60	3136	24
				3138	24

Note: For SD31TS and SD32TS, K=37 mm.
The dimensions for SD30 and SD31 are the same as those of SD33 and SD34.

9. Lubrication

9.1 Grease lubrication

Usually, plummer blocks are lubricated with grease. Grease lubrication leads to good sealing performance and simpler seal design.

(1) Characteristics of grease

Grease is prepared by mixing base oil such as mineral oil or synthetic oil with thickener. The characteristics of grease vary depending on types and combination of various additives.

Depending on the intended application, a grease of appropriate consistency number is used as summarized in **Table 9.1**.

Table 9.1 Grease consistency

NLGI consistency No.	JIS (ASTM) 60 times blend consistency	Applications
0	355～385	For centralized greasing use
1	310～340	For centralized greasing use
2	265～295	For general use and sealed bearing use
3	220～250	For general use and high temperature use
4	175～205	For special use

(2) Grease volume

When grease is packed into a bearing, the inside of the bearing is first filled with grease. During this course, the grease must be also filled into the inside guide way of the bearing cage.

As a guideline, the recommended volume of grease filled in plummer blocks is given below.

General application
……About 1/3 to 1/2 the empty space

Relatively high speed application
……About 1/2 the empty space

Low speed application
……More than 1/2 the empty space

The volume of grease should be carefully selected as it can lead to overheating of the bearing, outward leakage from the seal, or ingress of dust.

The recommended volume of grease commonly filled in the applicable bearings are summarized in **Table 9.2**.

Table 9.2 (1) Volume of grease filled into models SN5 and SN6

Bearing number	Grease volume (g)	Bearing number	Grease volume (g)
SN506	20～ 30	SN606	27～ 41
SN507	30～ 45	SN607	35～ 52
SN508	37～ 55	SN608	50～ 75
SN509	37～ 55	SN609	75～ 110
SN510	47～ 70	SN610	100～ 150
SN511	55～ 80	SN611	110～ 160
SN512	80～ 120	SN612	130～ 190
SN513	100～ 150	SN613	160～ 240
SN515	130～ 190	SN615	230～ 350
SN516	140～ 210	SN616	250～ 380
SN517	170～ 260	SN617	320～ 480
SN518	260～ 390	S618	370～ 550
SN519	250～ 370	S619	470～ 700
SN520	330～ 500	S620	500～ 750
SN522	470～ 700	S622	700～1 000
SN524	550～ 850	S624	950～1 400
SN526	650～ 950	S626	1 100～1 600
SN528	800～1 200	S628	1 300～2 000
SN530	1 100～1 600	S630	1 600～2 400
SN532	1 300～2 000	S632	1 800～2 700

Table 9.2 (2) Volume of grease filled into model SD

Bearing number	Grease volume (g)	Bearing number	Grease volume (g)
SD3340	1 400～ 2 100	SD534	1 500～ 2 300
SD3344	1 700～ 2 600	SD536	1 800～ 2 700
SD3348	2 000～ 3 000	SD538	1 900～ 2 900
SD3352	2 700～ 4 000	SD540	2 300～ 3 400
SD3356	3 400～ 5 100	SD544	3 000～ 4 500
SD3360	3 500～ 5 700	SD548	3 700～ 5 600
SD3364	4 300～ 6 400	SD552	4 800～ 7 200
SD3368	5 600～ 8 400	SD556	6 000～ 9 000
SD3372	6 300～ 9 400	SD560	6 700～10 000
SD3376	6 600～ 9 900	SD564	9 300～14 000
SD3440	1 500～ 2 200	SD634	1 900～ 2 900
SD3444	2 300～ 3 400	SD636	2 500～ 3 700
SD3448	2 300～ 3 500	SD638	2 700～ 4 000
SD3452	2 700～ 4 000	SD640	3 300～ 5 000
SD3456	3 200～ 4 800	SD644	3 800～ 5 700
SD3460	4 400～ 6 600	SD648	5 400～ 8 100
SD3464	5 100～ 7 700	SD652	6 500～ 9 800
SD3468	6 700～1 0000	SD656	8 700～13 000

Table 9.2 (3) Volume of grease filled into models SN30 and SN31

Bearing number	Grease volume (g)	Bearing number	Grease volume (g)
SN3024	260～ 390	SN3122	260～ 380
SN3026	370～ 550	SN3124	350～ 550
SN3028	420～ 650	SN3126	400～ 600
SN3030	490～ 750	SN3128	470～ 700
SN3032	650～1 000	SN3130	700～1 000
SN3034	800～1 200	SN3132	850～1 300
SN3036	1 000～1 500	SN3134	950～1 400
SN3038	1 000～1 500	SN3136	1 100～1 700
		SN3138	1 300～2 000

10. Handling the Plummer Blocks and Bearings

Rolling bearings are precision components. To maintain their accuracies, they must be handled very carefully. In particular, they must be kept clean, not be subjected to strong impact, and be protected against possible rusting.

Plummer blocks also need similar handling practices.

10.1 Inspection before installation

Before installing a bearing and a plummer block, the following points must be thoroughly checked and inspected.

(1) Prepare installation tools, measuring instruments, oil stone, lubricant and factory cloth. Before the installation work, remove dust and impurities from these tools. **(Fig. 10.1)**

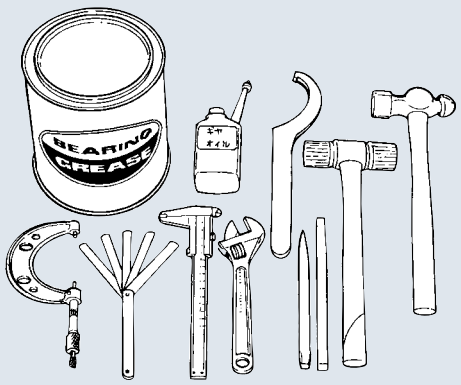


Fig. 10.1

(2) Make sure that the shaft is free from bends or other damages and that it has been dimensioned and formed as specified. **(Fig. 10.2)**

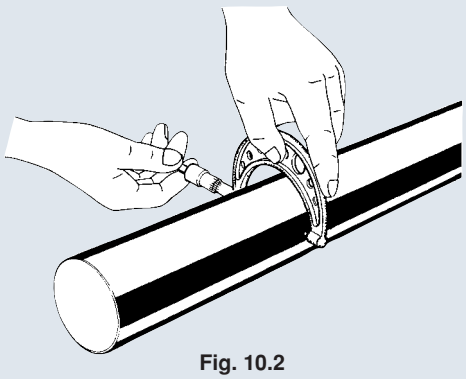


Fig. 10.2

(3) Remove dent marks (even though very small) from the mating faces with an oil stone or fine emery paper. Check that the contact face to the seal has specified surface roughness (0.8Ra). Wipe dust away from the shaft with clean factory cloth.

(4) Remove possible dust and metal chips from the inside of plummer block. **(Fig. 10.3)**

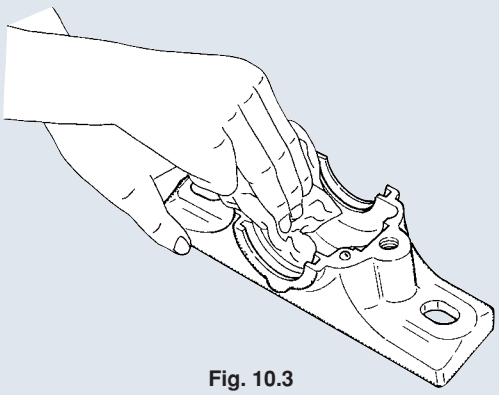


Fig. 10.3

(5) Check the flatness of the mounting face of the plummer block. (When placed on a frame, the plummer block must be stably seated.)

9.2 Preparation for installing the bearing

(1) Unpack the bearing just before the installation work.

(2) If the bearing is to be grease-lubricated, the rust-proof coating on it may remain unremoved. If it is to be oil-lubricated, remove the coating with benzene or kerosene.

(3) For a bearing with an adapter, check its radial clearance before the installation work. To do so, place it on a flat work bench, and fit a thickness gage between the uppermost roller and the raceway surface on the outer ring to measure the clearance **(Fig. 10.4)**. Do not force the thickness gage in or turn the bearing. Otherwise, the resultant clearance measurement will be greater than the actual clearance.

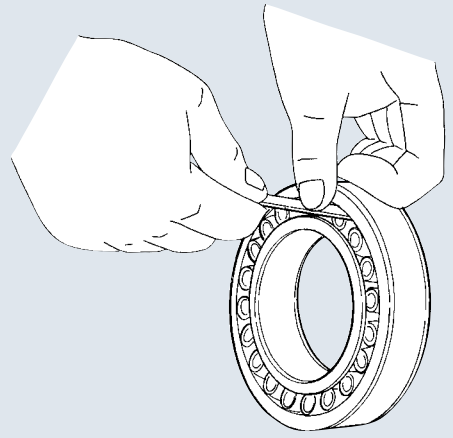


Fig. 10.4

10.3 Installation of the bearing and associated components

Once careful checking is complete, install the bearing and associated components. For the positional relationship, see **Fig. 10.5.**

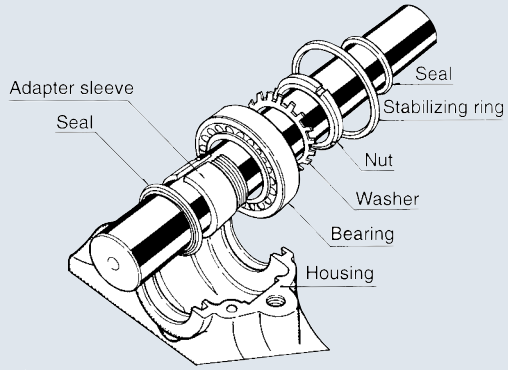


Fig. 10.5

When a bearing is installed onto a shaft or into a housing, do not directly hit its end face with a hammer or drift as shown in **Fig. 10.6**. Otherwise, its design performance can be lost. Always evenly exert force around the entire bearing ring face. Also, do not apply force to one bearing ring (for example, outer ring) as in **Fig. 10.7** to convey the force via the rolling elements to the other bearing ring (inner ring) to install the latter. Otherwise, a dent mark or other damage can occur on either or both rings.

When installing a cylindrical bore bearing, whose interference is relatively small, its whole inner ring can be uniformly press-fitted at an ordinary temperature as illustrated in **Fig. 10.8.** Usually, the inner ring is press-fitted by tapping the sleeve with a hammer. However, when many bearings must be installed at a time, a mechanical or hydraulic press will be helpful.

When installing a non-separable bearing to the shaft and housing at a time, apply a press-fitting force to both the inner and outer rings by using a pressure distribution pad as in **Fig. 10.9.**

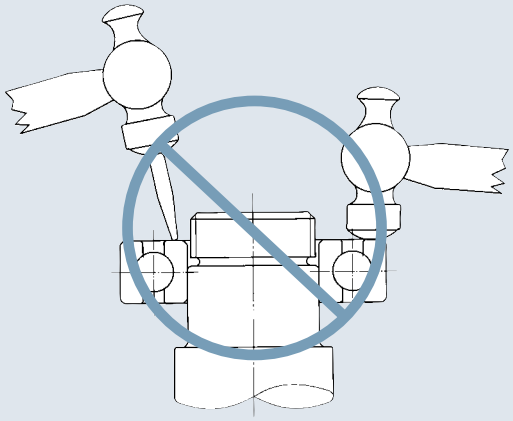


Fig. 10.6

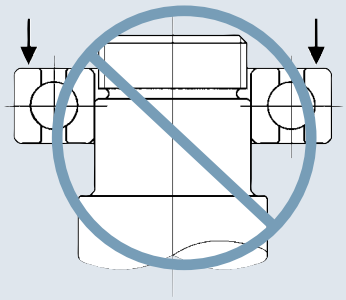


Fig. 10.7

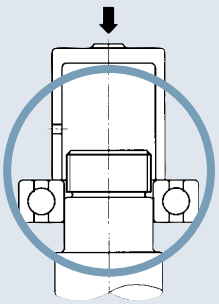


Fig. 10.8 Press-fitting the inner ring

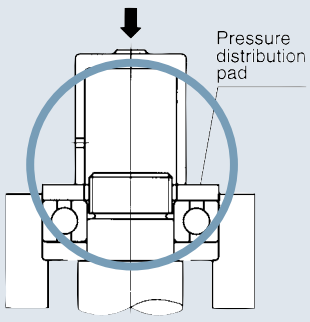


Fig. 10.9 Simultaneous press-fitting of the inner and outer rings

10.3.1 Bearing with an adapter

(1) Thinly apply highly viscous mineral oil to the taper, threading and the chamfered face of the nut (see **Fig. 10.10)** before press-fitting. In particular, apply molybdenum bisulfide paste to these areas on a large bearing. This prevents scuffing, and allows easy bearing removal. Before the installation work, remove oil from the shaft and the bore face of sleeve with a clean factory cloth.

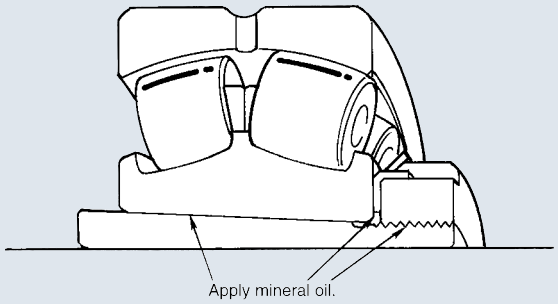


Fig. 10.10

(2) Mount the adapter to a correct position considering the dimension B_1, B_2 or B_3 in the bearing table. When fitting the adapter sleeve onto the shaft, open the slit with a flat-blade screwdriver for easy fitting. (See **Fig. 10.11.)**

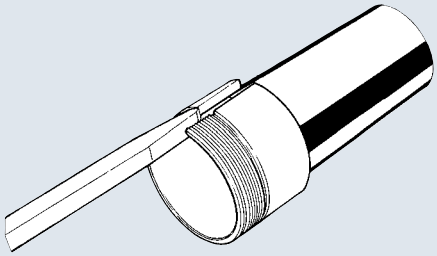


Fig. 10.11

(3) Fit the bearing over the adapter sleeve on the shaft as tight as possible, so that the bearing inner ring is fully seated onto the taper on adapter sleeve.

(4) Lightly tighten the nut until the sleeve is seated on the shaft.

(5) When fully tightening a self-aligning ball bearing, make sure that its radial clearance becomes approximately 1/2 that before fitting. For a spherical roller bearing, tighten the nut while measuring its radial clearance with a thickness gage so that the reduction of radial internal clearance value in **Table 10.1** is reached. Make sure that an installed self-aligning ball bearing can turn smoothly by hand (see **Figs. 10.12 and 10.13)**.

(6) To tighten the nut, use a spanner wrench illustrated in **Fig. 10.14.**When tightening the nut with a hammer and a drift, be sure that the chip from the drift does not enter the bearing.

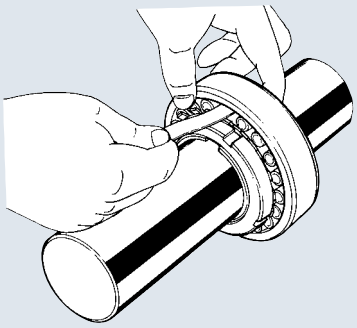


Fig. 10.12

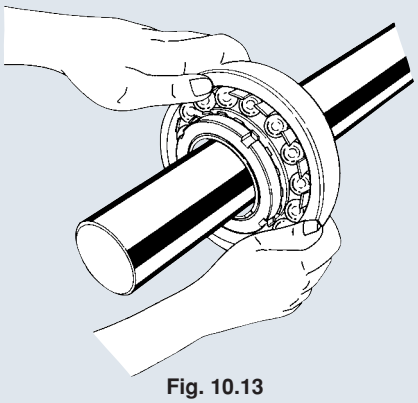


Fig. 10.13

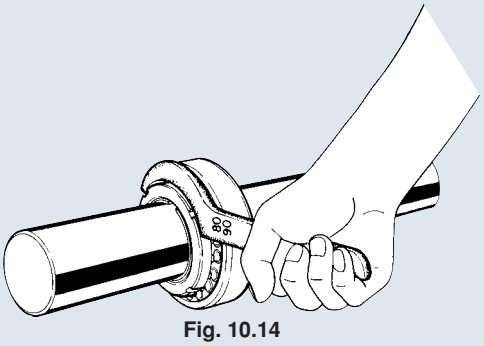


Fig. 10.14

(7) If it is difficult to tighten a large bearing by manual force, use a hydraulic nut or ram for easier assembly. **(**See **Fig. 10.15.)**

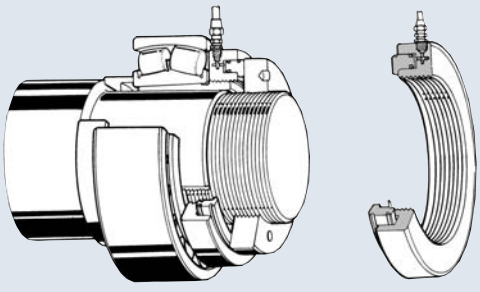


Fig. 10.15

(8) Make sure the bearing clearance is as specified, then bend one tab on the washer that corresponds with the cutout on the circumference of the nut to maintain the adjustment **(Fig. 10.16)**. Do not loosen the nut to allow the cutout to match the tab.
(9) When a large bearing is installed to a shaft, its outer ring will be deformed by its own weight into an elliptical form. The clearance measurement at the lowest point on a deformed bearing will be greater than a true clearance. Remember that a radial clearance value measurement at this point will result in excessively large tightening allowance.

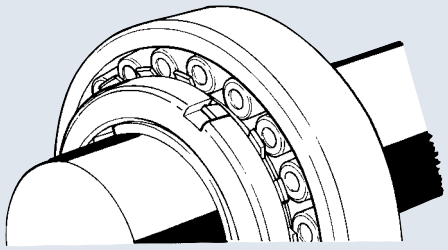


Fig. 10.16

Table 10.1 (a) Installation of tapered bore spherical roller bearings (installation of ULTAGE type)

Units: mm

Nominal bearing bore diameter d		Reduction of radial internal clearance		Axial displacement drive up				Minimum allowable residual clearance		
				Taper, 1:12		Taper, 1:30				
over	incl.	min	max	min	max	min	max	CN	C3	C4
24	30	0.01	0.015	0.15	0.2	—	—	0.015	0.025	0.04
30	40	0.015	0.02	0.25	0.3	—	—	0.015	0.03	0.045
40	50	0.02	0.025	0.35	0.4	—	—	0.02	0.035	0.055
55	65	0.025	0.03	0.4	0.45	—	—	0.025	0.045	0.065
65	80	0.035	0.04	0.5	0.6	—	—	0.03	0.055	0.08
80	100	0.04	0.05	0.6	0.7	—	—	0.03	0.06	0.09
100	120	0.055	0.065	0.8	0.9	1.8	2.3	0.035	0.07	0.105
120	140	0.065	0.075	0.9	1	1.95	2.7	0.045	0.085	0.125
140	160	0.075	0.09	1	1.2	2.35	3.1	0.04	0.09	0.14
160	180	0.08	0.1	1.1	1.4	2.8	3.55	0.04	0.1	0.16
180	200	0.09	0.11	1.2	1.5	3.2	3.95	0.05	0.11	0.18
200	225	0.11	0.13	1.5	1.8	3.85	4.6	0.05	0.12	0.19
225	250	0.12	0.14	1.6	1.9	4.2	4.95	0.06	0.13	0.21
250	280	0.13	0.16	1.6	2.1	4.25	5.4	0.06	0.14	0.23
280	315	0.15	0.18	1.9	2.4	4.45	5.7	0.06	0.15	0.25
315	355	0.16	0.19	2.1	2.5	5.1	6.1	0.08	0.17	0.28
355	400	0.18	0.22	2.3	3.0	5.75	7.5	0.08	0.18	0.3
400	450	0.21	0.25	3.0	3.6	—	—	0.08	0.19	0.32

Table 10.1 (b) Installation of tapered bore spherical roller bearings (non ULTAGE type)

Units: mm

Nominal bearing bore diameter d		Reduction of radial internal clearance		Axial displacement drive up				Minimum allowable residual clearance		
				Taper, 1:12		Taper, 1:30				
over	incl.	min	max	min	max	min	max	CN	C3	C4
30	40	0.02	0.025	0.35	0.4	—	—	0.015	0.025	0.04
40	50	0.025	0.03	0.4	0.45	—	—	0.02	0.03	0.05
50	65	0.03	0.035	0.45	0.6	—	—	0.025	0.035	0.055
65	80	0.04	0.045	0.6	0.7	—	—	0.025	0.04	0.07
80	100	0.045	0.055	0.7	0.8	1.75	2.25	0.035	0.05	0.08
100	120	0.05	0.06	0.75	0.9	1.9	2.25	0.05	0.065	0.1
120	140	0.065	0.075	1.1	1.2	2.75	3	0.055	0.08	0.11
140	160	0.075	0.09	1.2	1.4	3	3.75	0.055	0.09	0.13
160	180	0.08	0.1	1.3	1.6	3.25	4	0.06	0.1	0.15
180	200	0.09	0.11	1.4	1.7	3.5	4.25	0.07	0.1	0.16
200	225	0.1	0.12	1.6	1.9	4	4.75	0.08	0.12	0.18
225	250	0.11	0.13	1.7	2	4.25	5	0.09	0.13	0.2
250	280	0.12	0.15	1.9	2.4	4.75	6	0.1	0.14	0.22
280	315	0.13	0.16	2	2.5	5	6.25	0.11	0.15	0.24
315	355	0.15	0.18	2.4	2.8	6	7	0.12	0.17	0.26
355	400	0.17	0.21	2.6	3.3	6.5	8.25	0.13	0.19	0.29
400	450	0.2	0.24	3.1	3.7	7.75	9.25	0.13	0.2	0.31
450	500	0.21	0.26	3.3	4	8.25	10	0.16	0.23	0.35

(10) The adapter used on a large bearing whose bore number is 44 or greater is a lock plate type **(Fig. 10.17).** For this arrangement, first tighten the nut, then fit the lock plate into the cutout on the nut. In this case too, do not loosen the nut to allow the cutout to match the lock plate. Once the lock plate is seated in the cutout, secure the adjustment with a spring washer and a hexagonal nut.

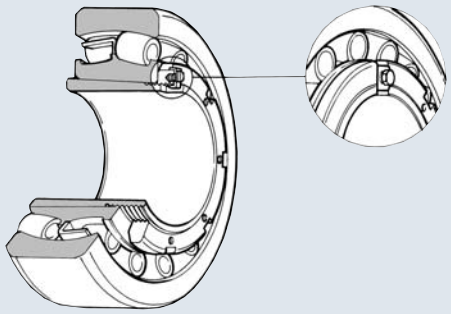


Fig. 10.17

10.3.2 Cylindrical bore bearing

(1) Press-fitting

a. It is recommended that a small bearing of smaller tightening allowance be press-fitted by forcing a press-fitting jig onto the end face of inner ring. (See **Fig. 10.18.)**

b. For easy fitting, apply mineral oil or molybdenum bisulfide lubricant to fitting surfaces on the shaft and bearing. During the press-fitting work, make sure that the bearing inner ring is not tilted.

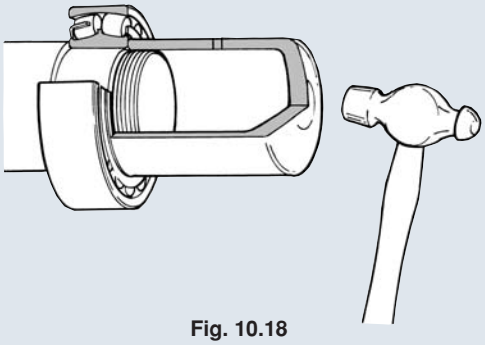


Fig. 10.18

(2) Shrink-fitting

a. To install a medium or large bearing, a shrink-fitting technique can be conveniently employed. The heating temperature for shrink-fitting can be selected from **Fig. 10.19** based on the bearing dimensions and tightening allowance requirements. Remember the temperature of the bearing must not exceed 120˚C.

b. Usually, the bearing is heated in oil **(Fig. 10.20).** However, it may be heated in a heater.

c. The oil used as a heating medium is clean machine oil #1 or transformer oil #1. The heating oil bath must be amply sized and contain sufficient amount of oil. Be careful not to allow the bearing to directly contact the vessel.

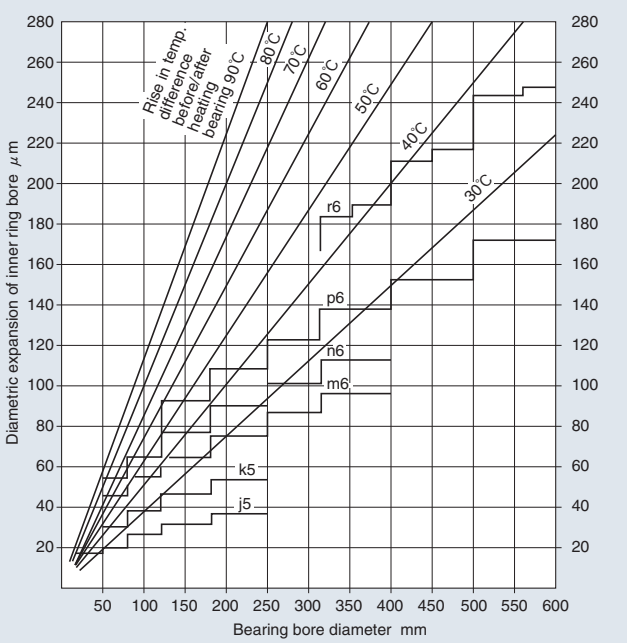


Fig. 10.19

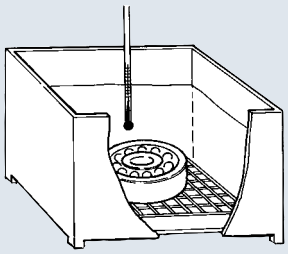


Fig. 10.20

d. After fitting the bearing onto a shaft, allow it to cool off. Note that the bearing will also shrink in the axial direction. To avoid gap occurrence between the bearing face and the shaft shoulder, force the bearing against the shaft shoulder until the bearing and shaft have fully cooled down. Alternatively, tap the bearing several times in the axial direction through a jig to bring the bearing in close contact with the shaft before the bearing and shaft have fully cooled down.

e. Make sure the bearing is fully seated on the shaft shoulder. Then, insert the washer and nut over the shaft, and secure the bearing by tightening the nut. Once the nut has been fully tightened, bend a tab on the washer and fit it into the cutout on the nut. If a tab cannot be readily fitted into the cutout, further turn the nut until the tab meets the cutout.

10.4 Assembling the plummer blocks

When installing two or more plummer blocks on a shaft, use one block to locate the outer ring of a bearing in the axial direction, and arrange the other block (s) so that the outer ring (s) of bearing (s) in the latter block (s) can move freely in the axial direction. (See **Fig. 10.21.**)

Once the bearing has been installed to the shaft and the associated components have been inserted over the shaft, assemble the plummer blocks according to the following procedure.

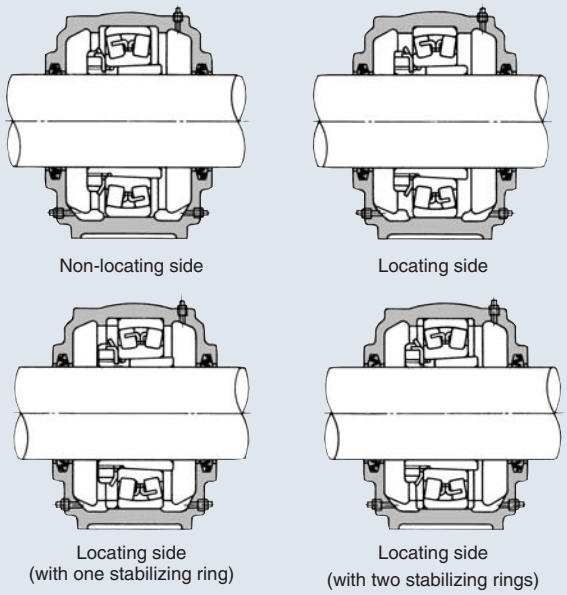


Fig. 10.21

(1) Temporarily install the lower plummer block housing to the frame. (See **Fig. 10.22.**)

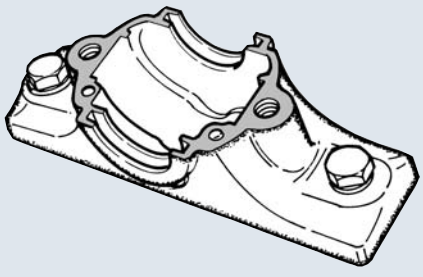


Fig. 10.22

(2) Fit the locating bearing into the lower plummer block housing, together with the seal and stabilizing ring. (See **Fig. 10.23.**)

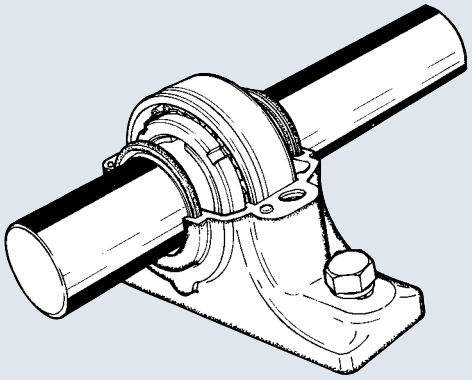


Fig. 10.23

(3) Adjust the position of the plummer block of the non-locating bearing to center the bearing to the bearing seating.
If the plummer block is to be used in a high temperature environment, carefully position the bearing considering the thermal expansion of the shaft.

(4) Once the bearing is correctly located, check the squareness of the plummer block relative to the shaft (make sure the face of bearing inner ring is parallel with that of the outer ring). Only then, fully tighten the nut. Remember a larger mounting error can cause the seal to fail or the shaft to interfere with the bearing bore, leading to non-smooth running **(Fig. 10.24)**. If such a problem occurs, correct the mounting seat, and then, install the lower plummer block housing.

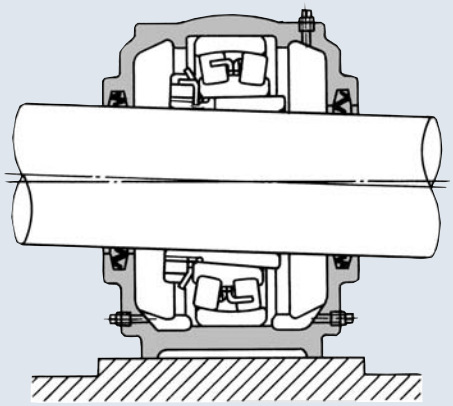


Fig. 10.24

(5) If the bearing is lubricated with grease, fill the bearing interior with grease, and apply grease to the mating surfaces of the upper and lower plummer block housings. Also, amply apply grease to the sliding surface of the seal. In the case of a self-aligning roller bearing, incline the outer ring to allow a sufficient volume of grease to be packed into the gaps between the rollers and the cage. (For the volume of grease, refer to Section 11.)

(6) In the case of oil-lubricated bearings, fill the oil up to the center of the lowest rolling element. (See **Fig. 10.25.**)

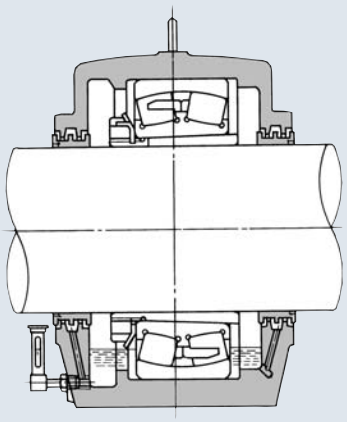


Fig. 10.25

(7) After filling with lubricant, check the mating surfaces between the upper and lower plummer block housings are stably in contact with each other. Remember to apply grease to the mating surfaces on the plummer block housings to ensure reliable sealing and rust-proofing. Then, fully tighten the tightening bolt. (See **Fig. 10.26.**)

Note that either the upper or lower housing of a particular plummer block is incompatible with the lower or upper housing of another plummer block. Do not confuse the like housings.

Knock pin seats **(Fig. 10.27)** are provided at the corners of the bed so locking knock pins can be driven into these seats. Use these seats when intending to install a plummer block with utmost precision.

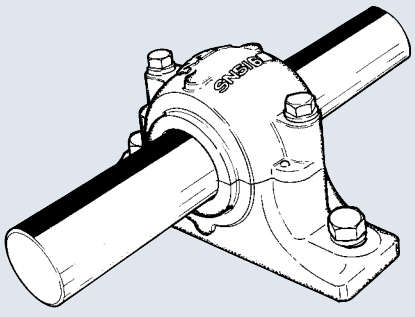


Fig. 10.26

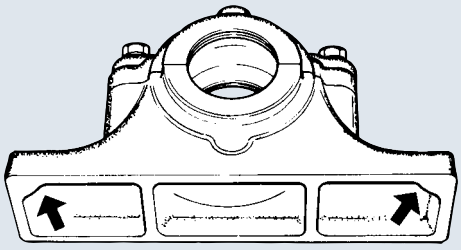


Fig. 10.27

9.5 Running inspection

Once the bearing arrangement has been assembled, make sure the assembly work has been correctly achieved by following the procedure below.

(1) First, turn the bearing by hand to check that the bearing and seal are free from any irregularities.
   a. Non-smooth touch: Trapped dust or scratch
   b. Irregular torque: Abnormal interference
   c. Excessively large running torque:
      Too small bearing clearance, poor flatness of mounting seat

(2) Next, run the bearing by power. Begin with no load and at lower speed.
   a. Abnormal noise:
      Dust, dent mark, or poor lubrication
   b. Vibration:
      Greater misalignment, or excessively large residual clearance

(3) Run the bearing under normal operating conditions to check for temperature rise on the bearing. The possible causes to abnormal temperature rise with bearings are as follows:
   a. Allowable speed has been exceeded.
   b. Overloading
   c. Too small residual clearance
   d. Negative clearance owing to excessive expansion or compression with the shaft
   e. Warped plummer block owing to poor flatness with the mounting seat
   f. Poor lubrication (excessive or insufficient lubricant, inappropriate lubrication method of lubricant)
   g. Too great tightening allowance for the contact seal, or interference with rotating components such as those around the labyrinth seal

If any irregularity is found as a result of running inspection, determine and remove the cause. Then, reperform the running inspection to make sure the bearing runs normally.

10.6 Maintenance and inspection

To be able to use a bearing to its design life and avoid any accident, check the following points at regular intervals.

(1) Running sound on bearing
(2) Temperature on bearing or plummer block
(3) Vibration on shaft
(4) Leaking grease or worn oil seal
(5) Loose tightening and mounting bolts
(6) Trouble-free operation of the lubrication system, and loosening or leakage with piping

If the bearing arrangement must be inspected while it is at a standstill, check it for the following points:

(1) Check appearance the of bearing for any irregularity.
(2) Fouling of grease, or contaminants (dust or steel dust) in grease
(3) Loose adapter sleeve
(4) Worn or damaged seal

10.7 Bearing disassembly

10.7.1 Bearing with adapter

Straighten the bent tab on the washer, and loosen the nut by two to three turns. Place a drift to a face of the nut. Lightly tap the drift to turn the sleeve **(Fig. 10.28).** Once the sleeve is shifted in the axial direction, the bearing can be easily removed.

Note, however, when the nut has been excessively loosened and only a few ridges remain engaged, and if the nut is further tapped, the threading on the sleeve or nut may be stripped.

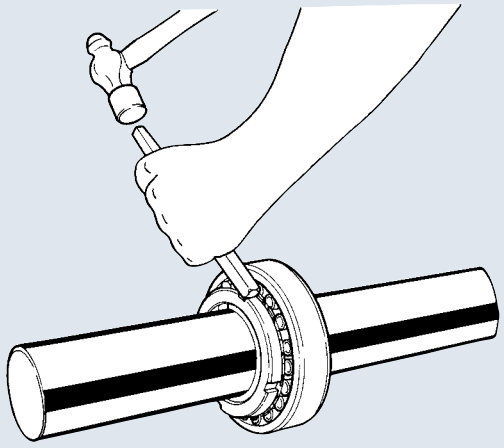


Fig. 10.28

10.7.2 Cylindrical bore bearing

Usually, a cylindrical bore bearing is interference-fitted. Thus, the bearing is simply drawn out by placing a jig to the face of the inner ring and exerting a force as illustrated in **Fig. 10.29** with a hand press. However, be careful not to apply a force to the outer ring. A puller such as that shown in **Fig. 10.30** is often used. When using this tool, make sure that the jig is fully engaged with the face of the inner ring.

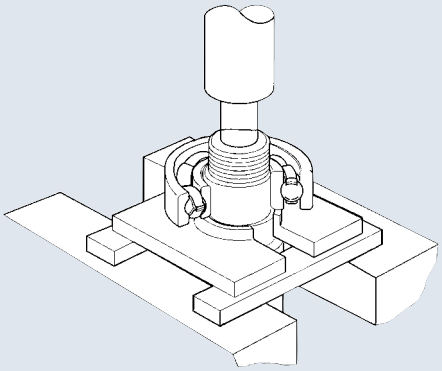


Fig. 10.29

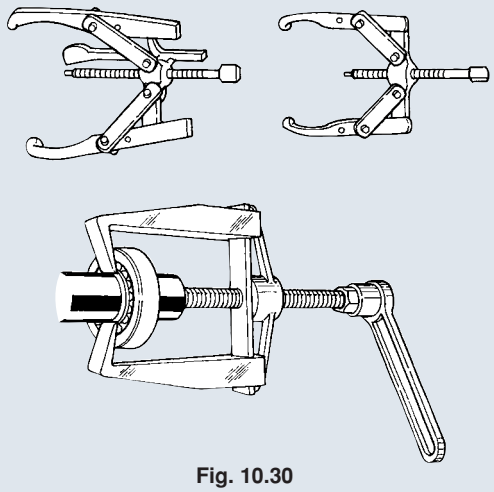


Fig. 10.30

10.8 Cleaning the bearing

Clean the removed bearing with diesel oil or kerosene. Use two vessels: one for rough cleaning and the other for finish cleaning. Prepare a cleaning station that has a metal screen as illustrated in **Fig. 10.31** so that the bearing does not directly contact the fouling on the bottom of vessel. In rough cleaning, virtually all oil and foreign matters should be removed from the bearing which should be immediately transferred to the finish vessel. The finish vessel must be provided with a filter unit to maintain the cleaning agent clean.

Once cleaned, the bearing must be immediately rust-proofed.

The bearings (which have been carefully removed) must be checked whether they can be reused. The judging criterion for reuse should be determined considering the following criteria through a trial-and-error basis.

(1) Scheduled operating duration to next regular inspection
(2) Importance of the machine that uses the bearing in question
(3) Operating conditions such as loading and bearing speed
(4) Severity of damage on the rolling contact surface
(5) Tendency of increasing bearing clearance and wear on the cage
(6) Loss in accuracy, etc.

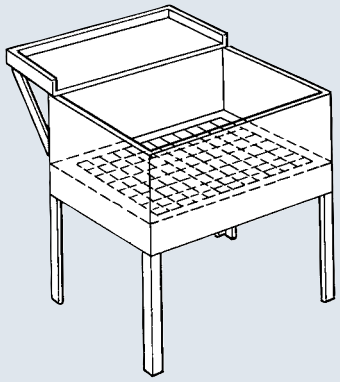


Fig. 10.31

10.9 Storing the bearing

When storing a bearing, pay particular attention to rust prevention. Note that the rust-proofing grease in the bearing will run away at a temperature of 50 to 60˚C. Therefore, store a bearing in a dry, cool location at a height at least 30 cm above the floor. Remember that wooden crate attracts moisture. Thus, immediately unpack the delivered bearings, and store them on shelves.