

# **MECH 325 Rolling Element Bearings - Part 2**



# Objectives

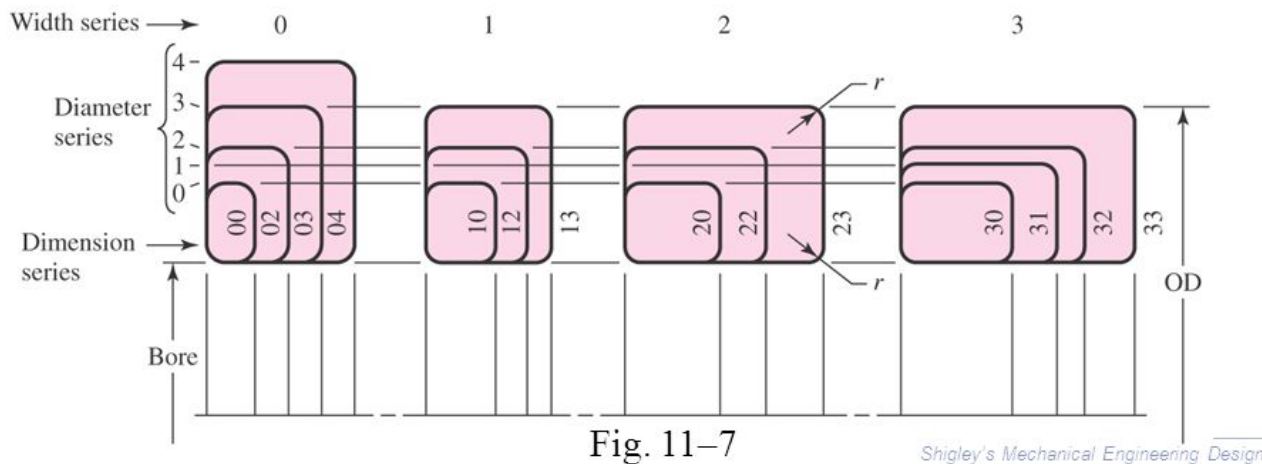
By the end of this section, you should be able to:

- Describe the necessary process for applying a bearing on a shaft and housing.
- Describe the selection procedure for tapered roller bearings
- Identify suitable mounting arrangements for rolling element bearings

# Bearing Sizing

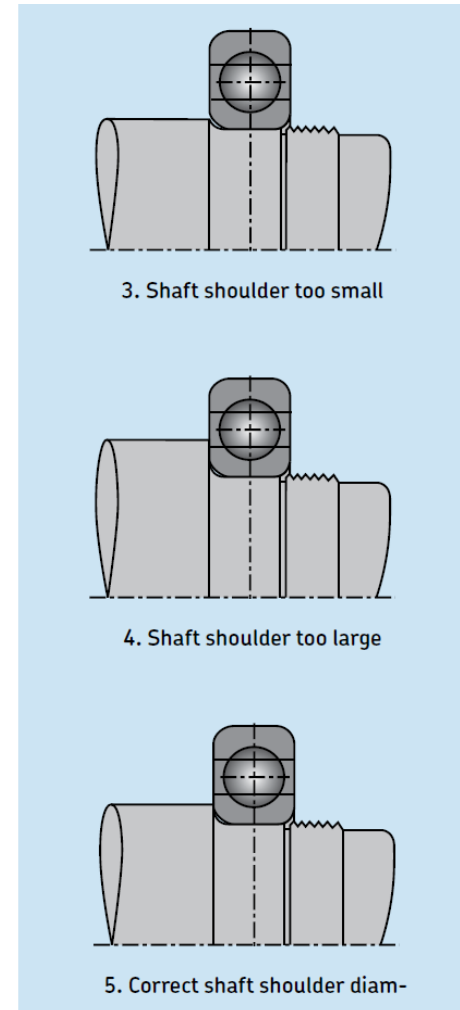
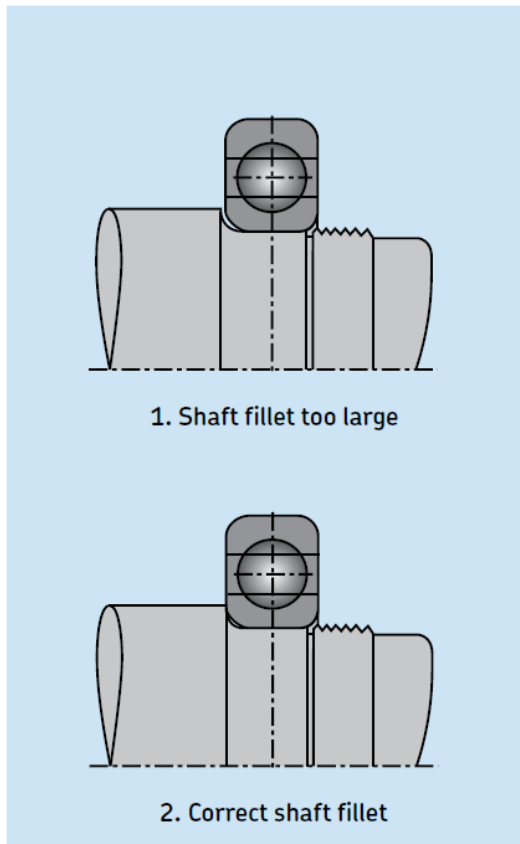
## Dimension-Series Code

- ABMA standardized *dimension-series code* represents the relative size of the boundary dimensions of the bearing cross section for metric bearings.
- Two digit series number
- First digit designates the width series
- Second digit designates the diameter series
- Specific dimensions are tabulated in catalogs under a specific series



# Bearing Mounting

Shafting must be designed to allow for proper seating for the bearing including proper fillet and shoulder sizing.



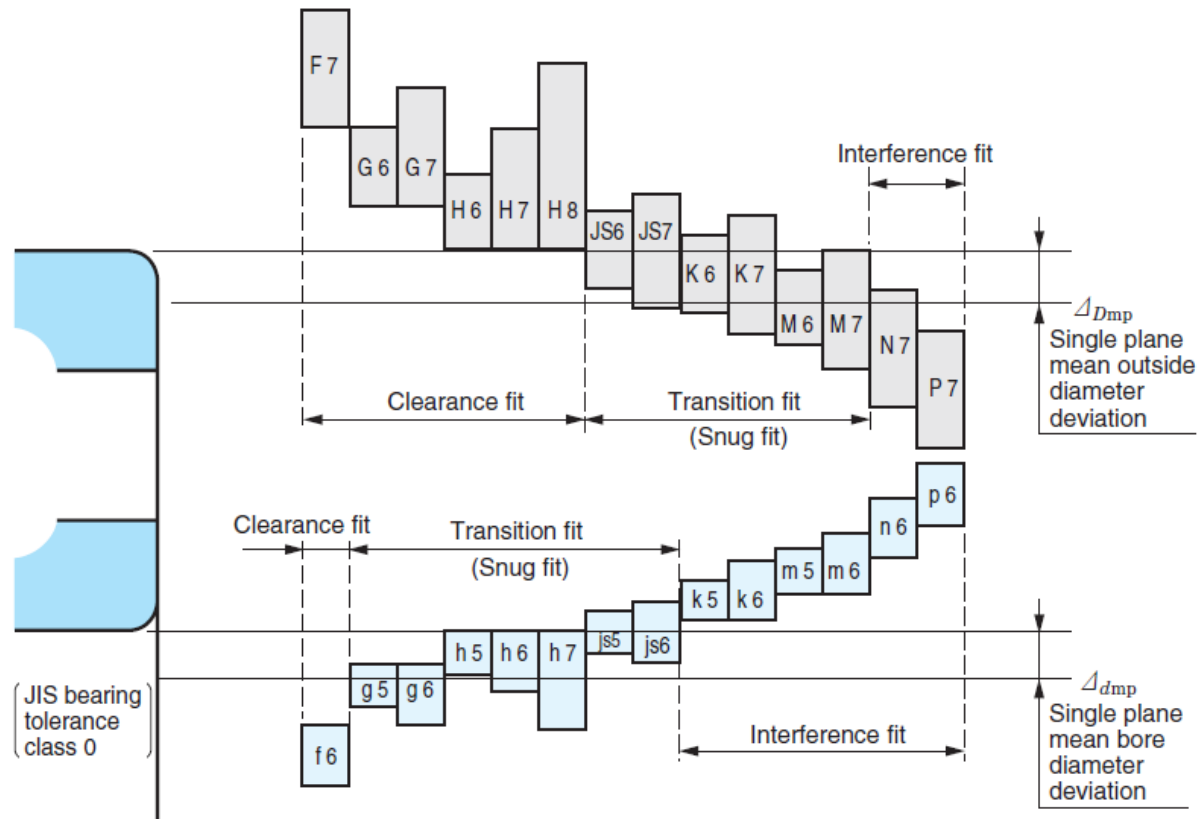
# Bearing Mounting

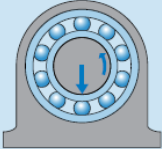
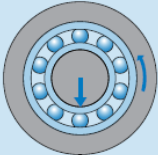
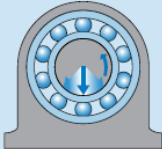
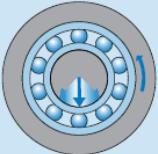
**Table 11-2**

Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder		Load Ratings, kN			
				Diameter, mm		Deep Groove		Angular Contact	
				$d_s$	$d_H$	$C_{10}$	$C_0$	$C_{10}$	$C_0$
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65
30	62	16	1.0	35	55	19.5	10.0	20.3	11.0
35	72	17	1.0	41	65	25.5	13.7	27.0	15.0
40	80	18	1.0	46	72	30.7	16.6	31.9	18.6
45	85	19	1.0	52	77	33.2	18.6	35.8	21.2
50	90	20	1.0	56	82	35.1	19.6	37.7	22.8
55	100	21	1.5	63	90	43.6	25.0	46.2	28.5
60	110	22	1.5	70	99	47.5	28.0	55.9	35.5
65	120	23	1.5	74	109	55.9	34.0	63.7	41.5
70	125	24	1.5	79	114	61.8	37.5	68.9	45.5
75	130	25	1.5	86	119	66.3	40.5	71.5	49.0
80	140	26	2.0	93	127	70.2	45.0	80.6	55.0
85	150	28	2.0	99	136	83.2	53.0	90.4	63.0
90	160	30	2.0	104	146	95.6	62.0	106	73.5
95	170	32	2.0	110	156	108	69.5	121	85.0

# Fitting a Bearing



Conditions of rotation and loading				
Operating conditions	Schematic illustration	Load condition	Example	Recommended fits
Rotating inner ring  Stationary outer ring  Constant load direction		Rotating load on inner ring  Stationary load on outer ring	Belt-driven shafts	Interference fit for inner ring  Loose fit for outer ring
Stationary inner ring  Rotating outer ring  Constant load direction		Stationary load on inner ring  Rotating load on outer ring	Conveyor idlers  Car wheel hub bearings	Loose fit for inner ring  Interference fit for outer ring
Rotating inner ring  Stationary outer ring  Load rotates with inner ring		Stationary load on inner ring  Rotating load on outer ring	Vibratory applications  Vibrating screens or motors	Interference fit for outer ring  Loose fit for inner ring
Stationary inner ring  Rotating outer ring  Load rotates with outer ring		Rotating load on inner ring  Stationary load on outer ring	Gyratory crusher  (Merry-go-round drives)	Interference fit for inner ring  Loose fit for outer ring

# Fitting a Bearing

## SKF bearing fitting tool kit TMFT 36

### Prevent 16 % of premature bearing failures

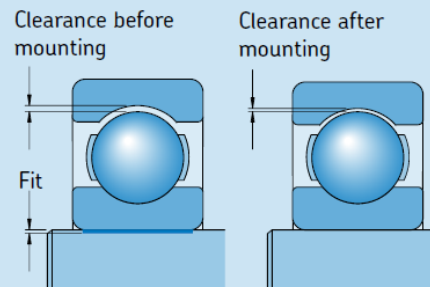
Poor fitting, usually using brute force, accounts for 16 % of premature bearing failures. The SKF® bearing fitting tool kit TMFT 36 is designed for quick and precise mounting of bearings, while minimising the risk of bearing damage. The right combination of impact ring and sleeve allows effective transmission of mounting force to the bearing rings with the interference fit, minimising the risk of damaging the bearings' housings or rolling elements. The kit contains 36 impact rings, 3 impact sleeves and a dead-blow hammer packed in a lightweight carrying case. In addition to mounting bearings, the TMFT 36 is also suitable for mounting other components, such as bushings, webs and pulleys.

- 36 impact rings in different sizes facilitate the mounting of more than 400 different bearings
- Facilitates correct mounting on shaft, housing and blind applications
- The diameter of the impact ring perfectly fits the inner and outer diameter of the bearing
- Small diameter of the impact ring and overlap of the sleeve allows effective transmission and distribution of mounting force
- Impact rings and sleeves are made of high-impact resistant material for longevity
- Close connection between impact ring and sleeve provides stability and durability
- The impact rings are suitable for use under a press
- Impact rings are marked for clear visual identification of the ring's size and size selection
- Even surface of the impact sleeve's body provides excellent grip
- The right double-side flange of the dead-blow hammer helps to prevent damaging the components
- The rubber handgrip of the dead-blow hammer provides excellent grip

Technical data	
Designation	TMFT 36
Description	Fitting tool kit
Impact rings	Blue diameter: 30 - 50 mm (0.39 - 2.0 in) Silver diameter: 26 - 32 mm (1.02 - 1.26 in)
Sleeves	Blue diameter: 26.5, 27.5, 32 mm (1.07, 1.1, 1.26 in) Silver diameter: 25, 30 and 36 mm (1.0, 1.1, 1.41 in)
Hammer	TMFT 36 is weight 1 kg (2.2 lb)
Dimensions of the case	525 x 420 x 130 mm (20.7 x 16.5 x 5.1 in)
Number of rings	36
Number of sleeves	3
Weight	1 kg (2.2 lb)
Not including carrying case	4 kg (8.8 lb)

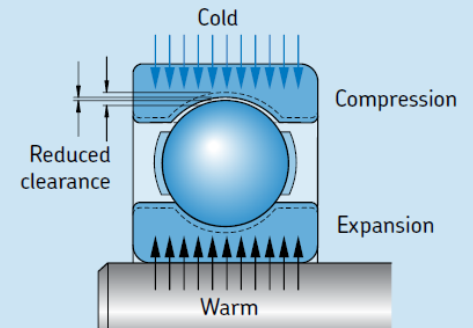


Figure 2



SKF

Figure 3





## Shaft fit tolerances for solid steel shafts

Classification for metric radial ball and roller bearings with cylindrical bore, Classes ABEC-1, RBEC-1  
(except inch dimensioned taper roller bearings)

Conditions	Examples	Shaft diameter, mm				Tolerance <sup>11)</sup>
		Ball bearings <sup>1)</sup>	Cylindrical roller bearings	Taper roller bearings	CARB and spherical roller bearings	
Rotating inner ring load or direction of load indeterminate						
Light and variable loads (P ≤ 0.05 C)	Conveyors, lightly loaded gearbox bearings	≤ 17	–	–	–	js5 (h5) <sup>2)</sup>
		18 to 100	≤ 25	≤ 25	–	j6 (js5) <sup>2)</sup>
		101 to 140	26 to 60	26 to 60	–	k6
		–	61 to 140	61 to 140	–	m6
Normal to heavy loads (P > 0.05 C)	Bearing applications generally, electric motors, turbines, pumps, gearing, wood working machines, windmills	≤ 10	–	–	–	js5
		11 to 17	–	–	–	j5 (js5) <sup>2)</sup>
		18 to 100	–	–	< 25	k5 <sup>3)</sup>
		–	≤ 30	≤ 40	–	k6
		101 to 140	31 to 50	–	25 to 40	m5
		141 to 200	–	41 to 65	–	m6
		–	51 to 65	–	41 to 60	n5 <sup>4)</sup>
		201 to 500	66 to 100	66 to 200	61 to 100	n6 <sup>4)</sup>
		–	101 to 280	201 to 360	101 to 200	p6 <sup>4)</sup>
		> 500	–	–	–	p7 <sup>4)</sup>
Heavy to very heavy loads and shock loads with difficult working conditions (P > 0.1 C)	Axle boxes for heavy railway vehicles, traction motors, rolling mills	–	51 to 65	–	51 to 70	n5 <sup>4)</sup>
		–	66 to 85	51 to 110	–	n6 <sup>4)</sup>
		–	86 to 140	111 to 200	71 to 140	p6 <sup>4)</sup>
		–	141 to 300	201 to 500	141 to 280	r6 <sup>4)</sup>
		–	301 to 500	–	281 to 400	s6min ± IT6/2 <sup>4)</sup> 6)
		–	> 500	> 500	> 400	s7min ± IT7/2 <sup>4)</sup> 6)
High demands on running accuracy with light loads (P ≤ 0.05 C)	Machine tools	8 to 240	–	–	–	js4
		–	25 to 40	25 to 40	–	js4 (j5) <sup>7)</sup>
		–	41 to 140	41 to 140	–	k4 (k5) <sup>7)</sup>
		–	141 to 200	141 to 200	–	m5
		–	201 to 500	201 to 500	–	n5

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## Shaft fit tolerances for solid steel shafts

Classification for metric radial ball and roller bearings with cylindrical bore, Classes ABEC-1, RBEC-1  
(except inch dimensioned taper roller bearings)

Conditions	Examples	Shaft diameter, mm				Tolerance <sup>11)</sup>
		Ball bearings <sup>1)</sup>	Cylindrical roller bearings	Taper roller bearings	CARB and spherical roller bearings	
Rotating inner ring load or direction of load indeterminate						
Light and variable loads (P ≤ 0.05 C)	Conveyors, lightly loaded gearbox bearings	≤ 17	–	–	–	js5 (h5) <sup>2)</sup>
		18 to 100	≤ 25	≤ 25	–	j6 (js5) <sup>2)</sup>
		101 to 140	26 to 60	26 to 60	–	k6
		–	61 to 140	61 to 140	–	m6
Normal to heavy loads (P > 0.05 C)	Bearing applications generally, electric motors, turbines, pumps, gearing, wood working machines, windmills	≤ 10	–	–	–	js5
		11 to 17	–	–	–	j5 (js5) <sup>2)</sup>
		18 to 100	–	–	< 25	k5 <sup>3)</sup>
		–	≤ 30	≤ 40	–	k6
		101 to 140	31 to 50	–	25 to 40	m5
		141 to 200	–	41 to 65	–	m6
		–	51 to 65	–	41 to 60	n5 <sup>4)</sup>
		201 to 500	66 to 100	66 to 200	61 to 100	n6 <sup>4)</sup>
		–	101 to 280	201 to 360	101 to 200	p6 <sup>4)</sup>
		> 500	–	–	–	p7 <sup>4)</sup>
Heavy to very heavy loads and shock loads with difficult working conditions (P > 0.1 C)	Axle boxes for heavy railway vehicles, traction motors, rolling mills	–	51 to 65	–	51 to 70	n5 <sup>4)</sup>
		–	66 to 85	51 to 110	–	n6 <sup>4)</sup>
		–	86 to 140	111 to 200	71 to 140	p6 <sup>4)</sup>
		–	141 to 300	201 to 500	141 to 280	r6 <sup>4)</sup>
		–	301 to 500	–	281 to 400	s6min ± IT6/2 <sup>4)</sup> 6)
		–	> 500	> 500	> 400	s7min ± IT7/2 <sup>4)</sup> 6)
High demands on running accuracy with light loads (P ≤ 0.05 C)	Machine tools	8 to 240	–	–	–	js4
		–	25 to 40	25 to 40	–	js4 (j5) <sup>7)</sup>
		–	41 to 140	41 to 140	–	k4 (k5) <sup>7)</sup>
		–	141 to 200	141 to 200	–	m5
		–	201 to 500	201 to 500	–	n5

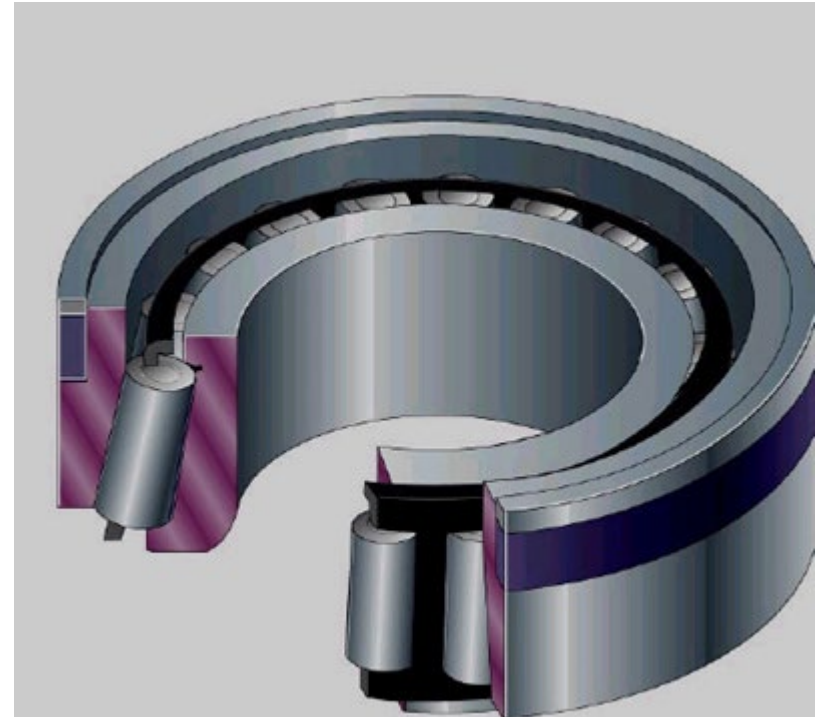
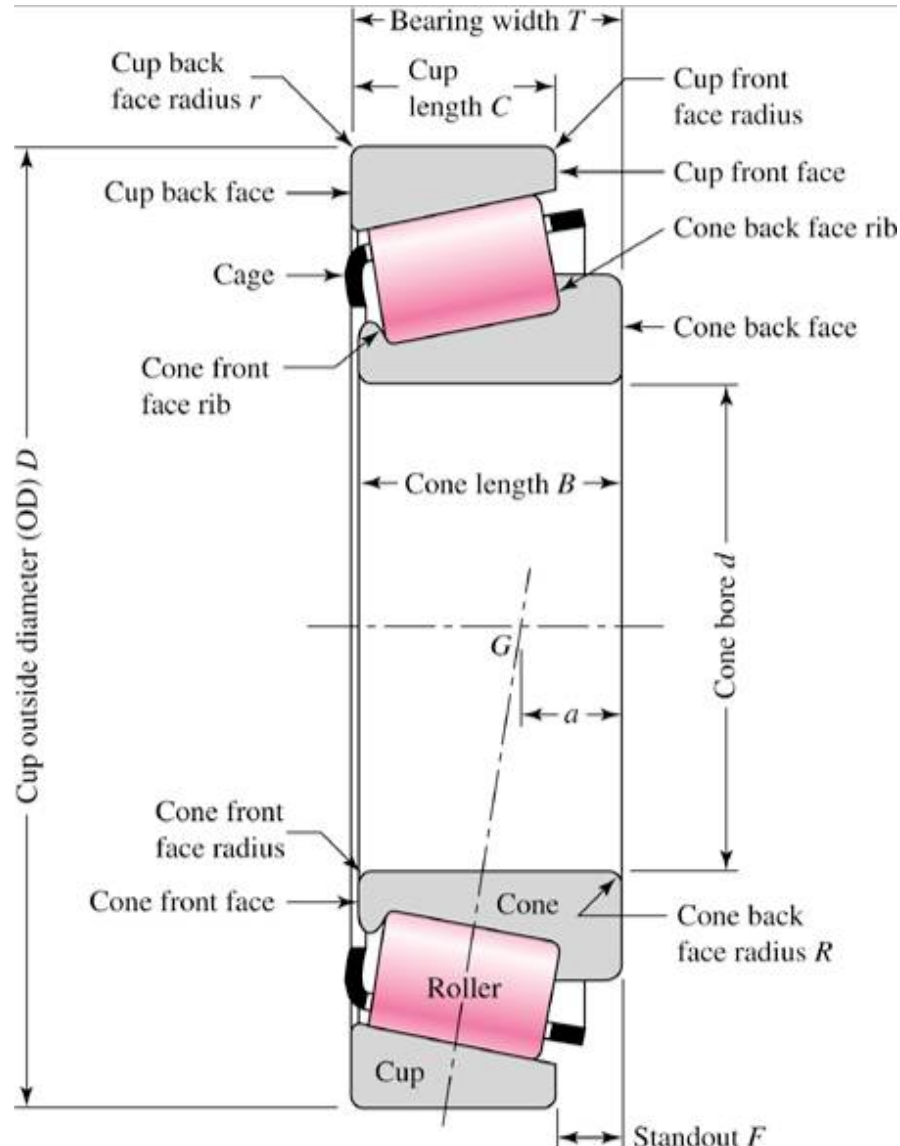
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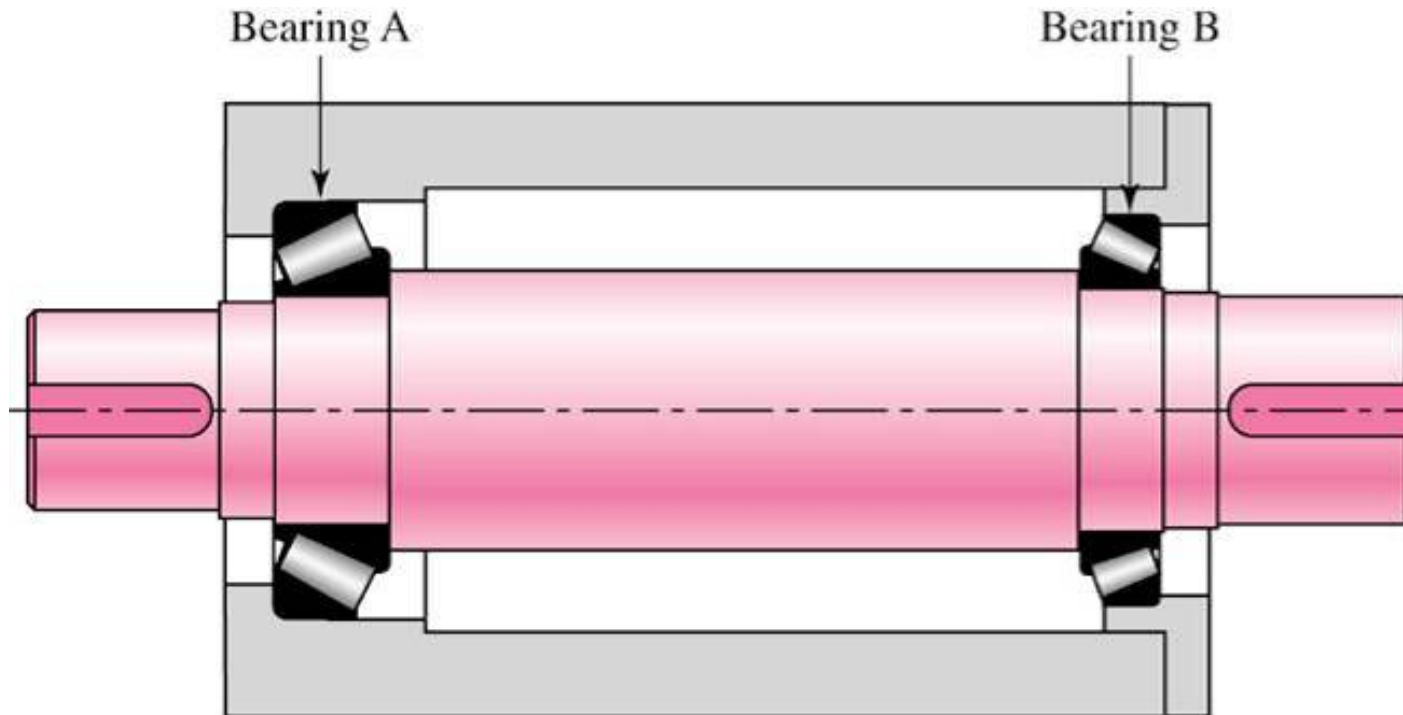
Shaft bearing-seat diameters (values in inches)														
Bearing bore diameter			k6			m5			m6			n5		
			Shaft dia.		Resultant fit <sup>1)</sup> in 0.0001"	Shaft dia.		Resultant fit <sup>1)</sup> in 0.0001"	Shaft dia.		Resultant fit <sup>1)</sup> in 0.0001"	Shaft dia.		Resultant fit <sup>1)</sup> in 0.0001"
mm	max.	min.	max.	min.		max.	min.		max.	min.		max.	min.	
4	0.1575	0.1572	0.1579	0.1575	0 T 7 T	0.1579	0.1577	2 T 7 T	0.1580	0.1577	2 T 8 T	0.1580	0.1578	3 T 8 T
5	0.1969	0.1966	0.1973	0.1969		0.1973	0.1971		0.1974	0.1971		0.1974	0.1972	
6	0.2362	0.2359	0.2366	0.2362		0.2366	0.2364		0.2367	0.2364		0.2367	0.2365	
7	0.2756	0.2753	0.2760	0.2756	0 T 7 T	0.2761	0.2758	2 T 8 T	0.2762	0.2758	2 T 9 T	0.2762	0.2760	4 T 9 T
8	0.3150	0.3147	0.3154	0.3150		0.3155	0.3152		0.3156	0.3152		0.3156	0.3154	
9	0.3543	0.3540	0.3547	0.3543		0.3548	0.3545		0.3549	0.3545		0.3549	0.3547	
10	0.3937	0.3934	0.3941	0.3937		0.3942	0.3939		0.3943	0.3939		0.3943	0.3941	
12	0.4724	0.4721	0.4729	0.4724	0 T 8 T	0.4730	0.4727	3 T 9 T	0.4731	0.4727	3 T 10 T	0.4732	0.4729	5 T 11 T
15	0.5906	0.5903	0.5911	0.5906		0.5912	0.5909		0.5913	0.5909		0.5914	0.5911	
17	0.6693	0.6690	0.6698	0.6693		0.6699	0.6696		0.6700	0.6696		0.6701	0.6698	
20	0.7874	0.7870	0.7880	0.7875	1 T 10 T	0.7881	0.7877	3 T 11 T	0.7882	0.7877	3 T 12 T	0.7883	0.7880	6 T 13 T
25	0.9843	0.9839	0.9849	0.9844		0.9850	0.9846		0.9851	0.9846		0.9852	0.9849	
30	1.1811	1.1807	1.1817	1.1812		1.1818	1.1814		1.1819	1.1814		1.1820	1.1817	
35	1.3780	1.3775	1.3787	1.3781	1 T 12 T	1.3788	1.3784	4 T 13 T	1.3790	1.3784	4 T 15 T	1.3791	1.3787	7 T 16 T
40	1.5748	1.5743	1.5755	1.5749		1.5756	1.5752		1.5758	1.5752		1.5759	1.5755	
45	1.7717	1.7712	1.7724	1.7718		1.7725	1.7721		1.7727	1.7721		1.7728	1.7724	
50	1.9685	1.9680	1.9692	1.9686		1.9693	1.9689		1.9695	1.9689		1.9696	1.9692	
55	2.1654	2.1648	2.1662	2.1655	1 T 14 T	2.1663	2.1658	4 T 15 T	2.1666	2.1658	4 T 18 T	2.1667	2.1662	8 T 19 T
60	2.3622	2.3616	2.3630	2.3623		2.3631	2.3626		2.3634	2.3626		2.3635	2.3630	
65	2.5591	2.5585	2.5599	2.5592		2.5600	2.5595		2.5603	2.5595		2.5604	2.5599	
70	2.7559	2.7553	2.7567	2.7560		2.7568	2.7563		2.7571	2.7563		2.7572	2.7567	
75	2.9528	2.9522	2.9536	2.9529		2.9537	2.9532		2.9540	2.9532		2.9541	2.9536	
80	3.1496	3.1490	3.1504	3.1497		3.1505	3.1500		3.1508	3.1500		3.1509	3.1504	

Housing bearing-seat diameters (values in inches)														
Bearing outside diameter			F7			G7			H6			H7		
			Housing bore		Resultant fit <sup>1)</sup> in 0.0001"	Housing bore		Resultant fit <sup>1)</sup> in 0.0001"	Housing bore		Resultant fit <sup>1)</sup> in 0.0001"	Housing bore		Resultant fit <sup>1)</sup> in 0.0001"
mm	max.	min.	min.	max.		min.	max.		min.	max.		min.	max.	
16	0.6299	0.6296	0.6305	0.6312	16 L 6 L	0.6301	0.6308	12 L 2 L	0.6299	0.6303	7 L 0 L	0.6299	0.6306	10 L 0 L
19	0.7480	0.7476	0.7488	0.7496	20 L 8 L	0.7483	0.7491	15 L 3 L	0.7480	0.7485	9 L 0 L	0.7480	0.7488	12 L 0 L
22	0.8661	0.8657	0.8669	0.8677		0.8664	0.8672		0.8661	0.8666		0.8661	0.8669	
24	0.9449	0.9445	0.9457	0.9465		0.9452	0.9460		0.9449	0.9454		0.9449	0.9457	
26	1.0236	1.0232	1.0244	1.0252		1.0239	1.0247		1.0236	1.0241		1.0236	1.0244	
28	1.1024	1.1020	1.1032	1.1040		1.1027	1.1035		1.1024	1.1029		1.1024	1.1032	
30	1.1811	1.1807	1.1819	1.1827		1.1814	1.1822		1.1811	1.1816		1.1811	1.1819	
32	1.2598	1.2594	1.2608	1.2618	24 L 10 L	1.2602	1.2611	17 L 4 L	1.2598	1.2604	10 L 0 L	1.2598	1.2608	14 L 0 L
35	1.3780	1.3776	1.3790	1.4000		1.3784	1.3793		1.3780	1.3786		1.3780	1.3790	
37	1.4567	1.4563	1.4577	1.4587		1.4571	1.4580		1.4567	1.4573		1.4567	1.4577	
40	1.5748	1.5744	1.5758	1.5768		1.5752	1.5761		1.5748	1.5754		1.5748	1.5758	
42	1.6535	1.6531	1.6545	1.6555		1.6539	1.6548		1.6535	1.6541		1.6535	1.6545	
47	1.8504	1.8500	1.8514	1.8524		1.8508	1.8517		1.8504	1.8510		1.8504	1.8514	
52	2.0472	2.0467	2.0484	2.0496	29 L 12 L	2.0476	2.0488	21 L 4 L	2.0472	2.0479	12 L 0 L	2.0472	2.0484	17 L 0 L
55	2.1654	2.1649	2.1666	2.1678		2.1658	2.1670		2.1654	2.1661		2.1654	2.1666	
62	2.4409	2.4404	2.4421	2.4433		2.4413	2.4425		2.4409	2.4416		2.4409	2.4421	
68	2.6772	2.6767	2.6784	2.6796		2.6776	2.6788		2.6772	2.6779		2.6772	2.6784	
72	2.8346	2.8341	2.8358	2.8370		2.8350	2.8362		2.8346	2.8353		2.8346	2.8358	
75	2.9527	2.9522	2.9539	2.9551		2.9532	2.9543		2.9527	2.9534		2.9527	2.9539	
80	3.1496	3.1491	3.1508	3.1520		3.1500	3.1512		3.1496	3.1503		3.1496	3.1508	

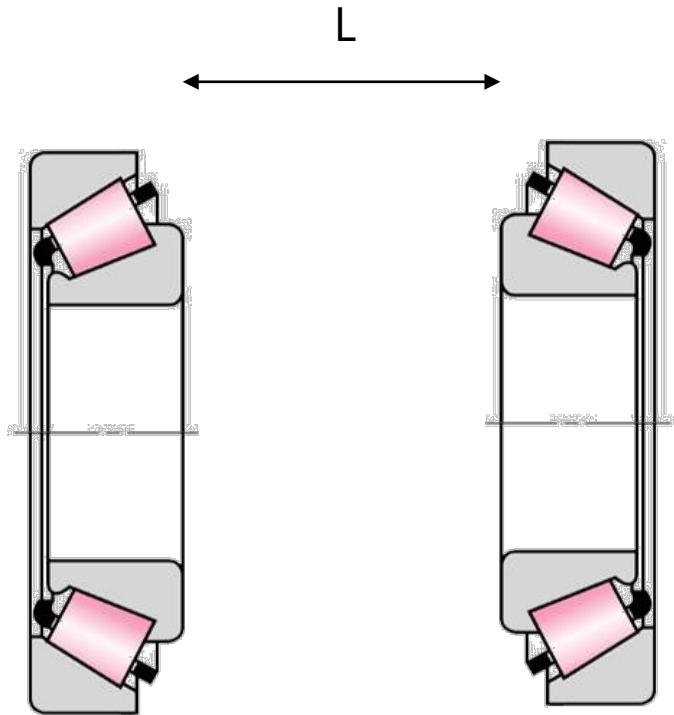
# Tapered Roller Bearings



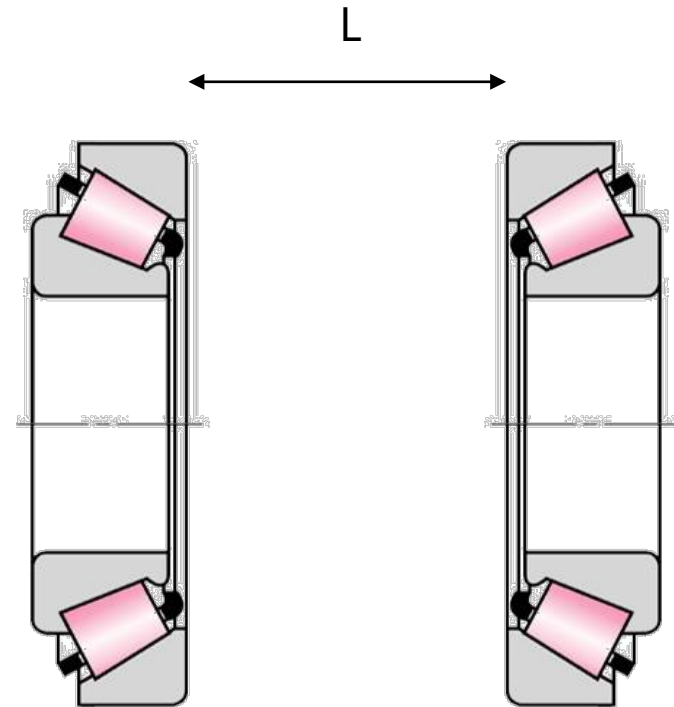
# Tapered Roller Bearings: Mount in Pairs



# Direct versus Indirect Mounting

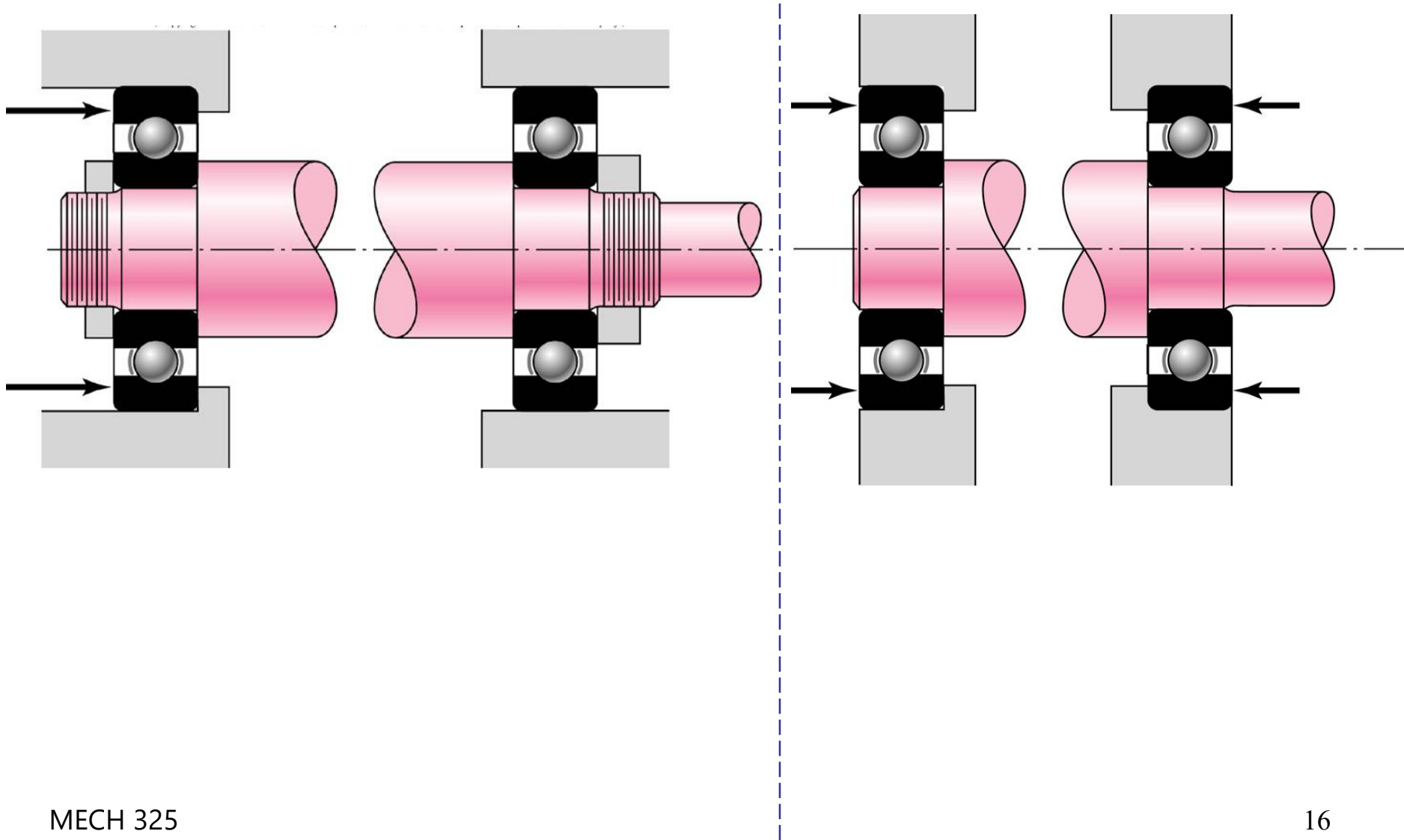


Direct Mounting



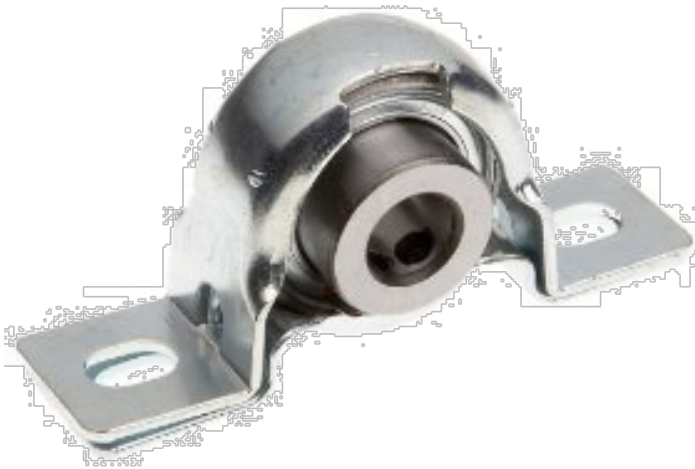
Indirect Mounting

# Mounting Bearings

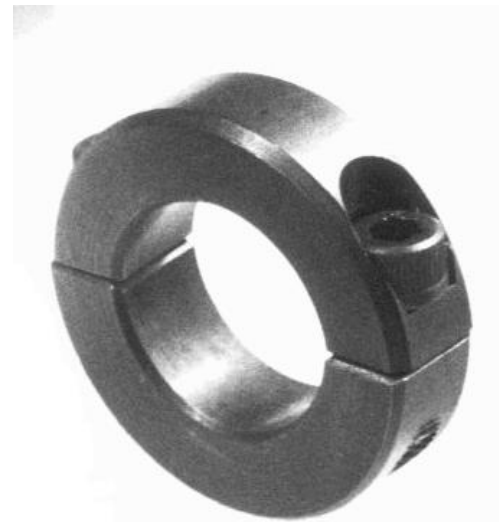




# Bearing Mounting Units

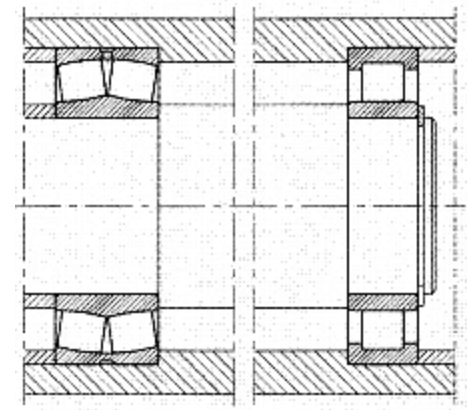
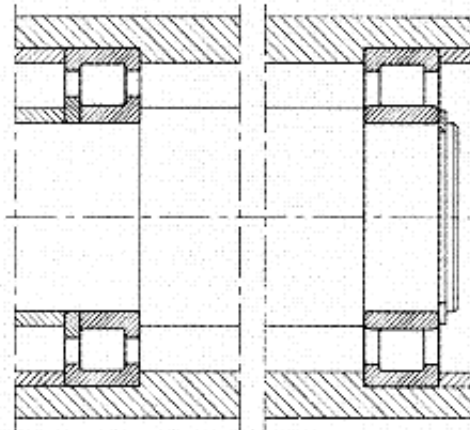
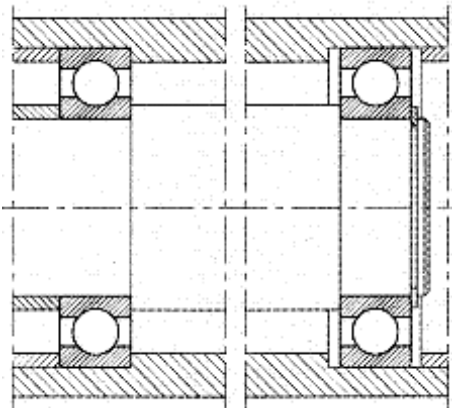
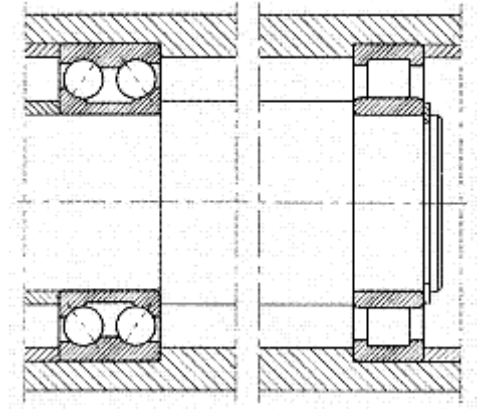


# Restraining Bearings



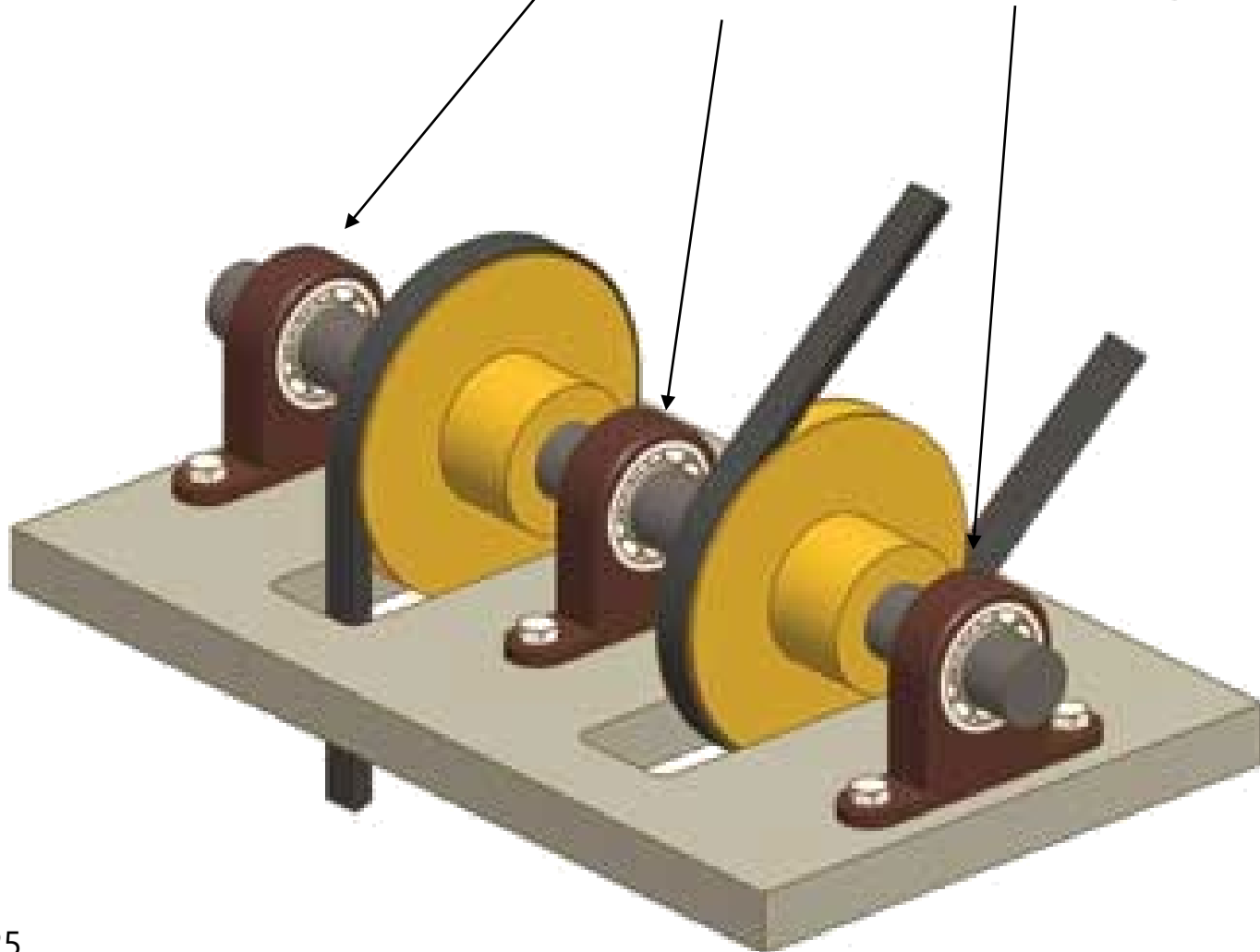
# Bearing Arrangement

Comment on the bearing arrangements shown (will they work? what are the limitations?)

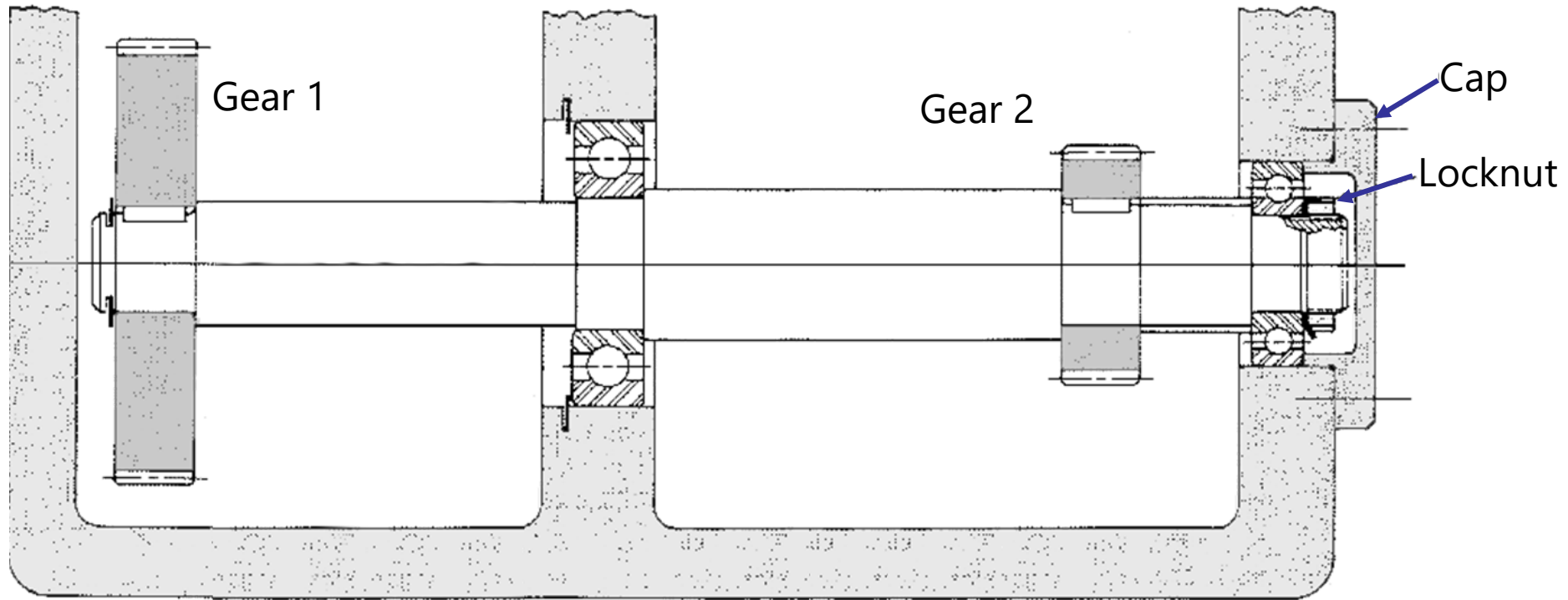


# Two-Pulley Shaft

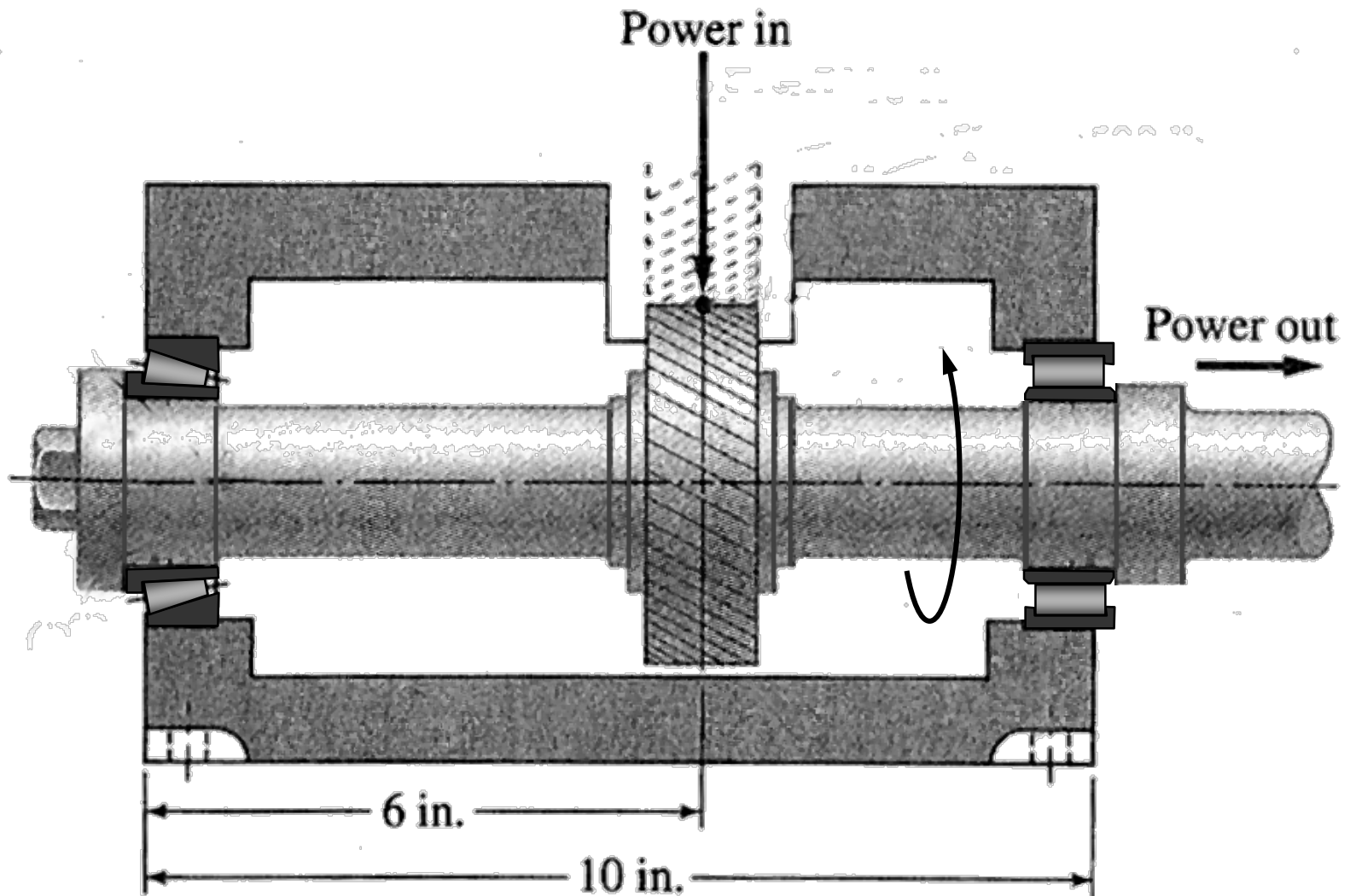
Spherical ball bearings



# Geartrain 1



# Geartrain 2





# Geartrain 3

