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

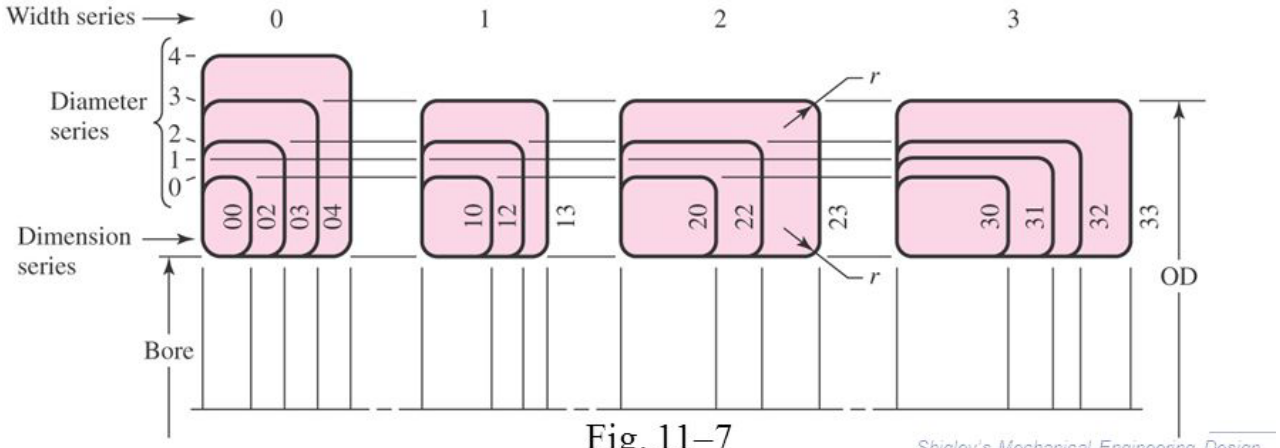
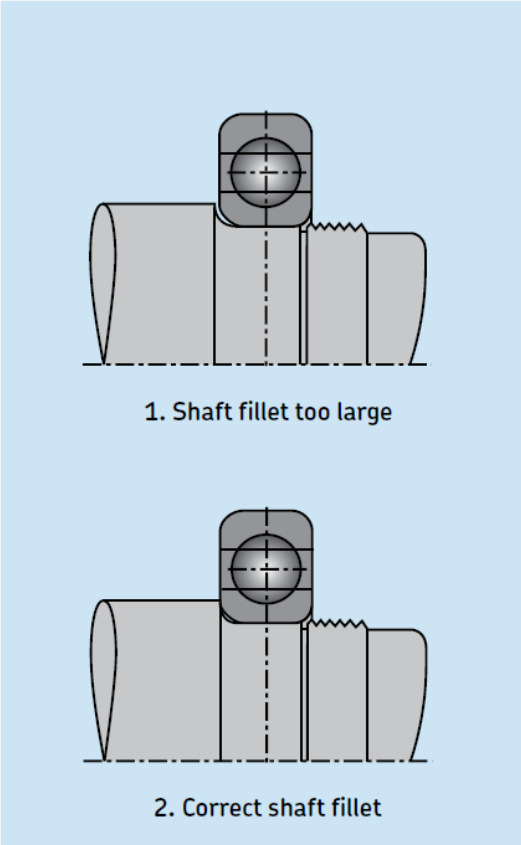


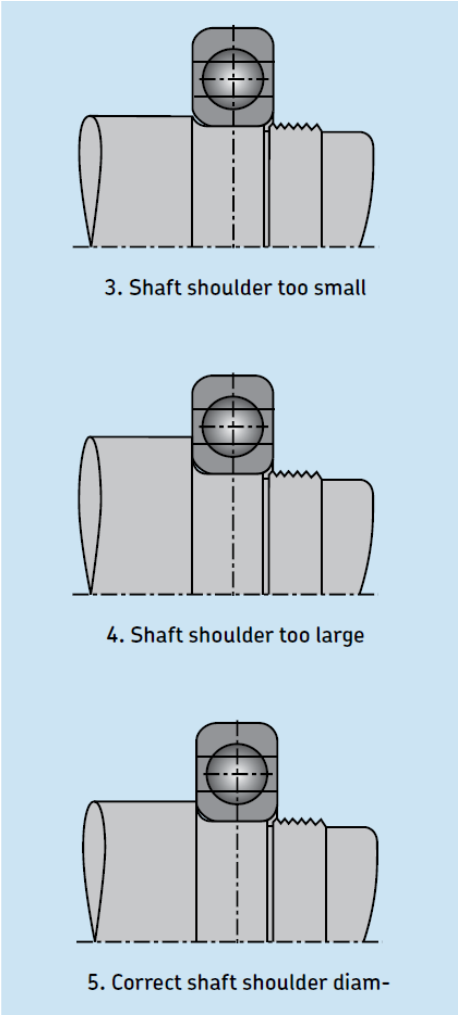
Fig. 11–7

Shigley's Mechanical Engineering Design

Bearing Mounting

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





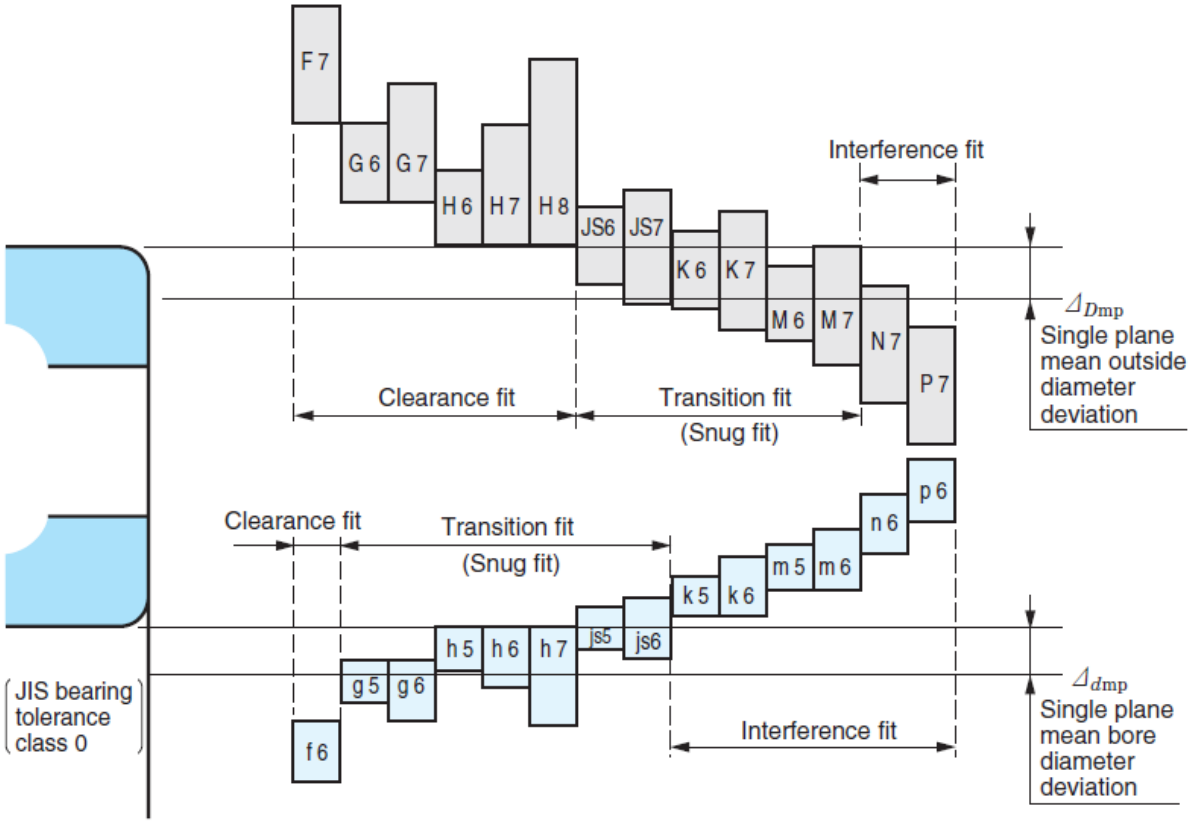
Bearing Mounting

Table 11–2

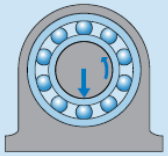
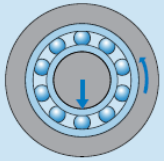
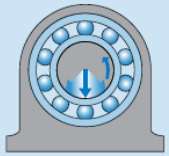
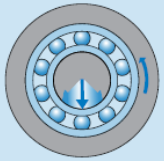
Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm		Load Ratings, kN			
						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

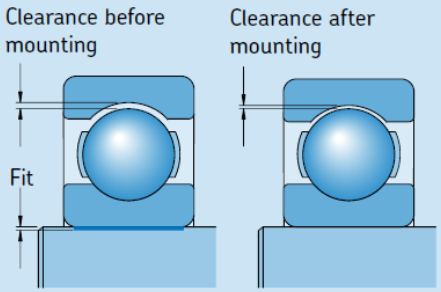


Conditions of rotation and loading

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

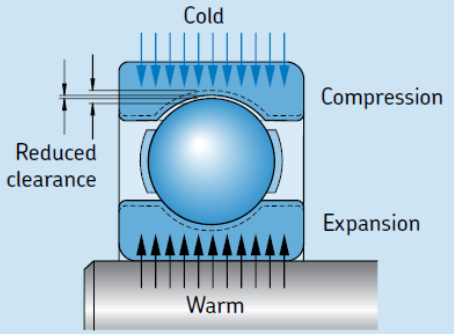
Fitting a Bearing

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 [11]
		Ball bearings[1]	Cylindrical roller bearings	Taper roller bearings	CARB and spherical roller bearings	
Rotating inner ring load or direction of load indeterminate						
Light and variable loads ($P \leq 0.05\ C$)	Conveyors, lightly loaded gearbox bearings	≤ 17	–	–	–	js5 (h5)[2]
		18 to 100	≤ 25	≤ 25	–	j6 (js5)[2]
		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)[2]
		18 to 100	–	–	< 25	k5[3]
		-	≤ 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[4]
		201 to 500	66 to 100	66 to 200	61 to 100	n6[4]
		–	101 to 280	201 to 360	101 to 200	p6[4]
		> 500	–	–	–	p7[4]
			281 to 500	361 to 500	201 to 500	r6[4]
			> 500	> 500	> 500	r7[4]
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[4]
		–	66 to 85	51 to 110	–	n6[4]
		–	86 to 140	111 to 200	71 to 140	p6[4]
		–	141 to 300	201 to 500	141 to 280	r6[4]
			301 to 500	–	281 to 400	s6min ± IT6/2[4,6]
		–	> 500	> 500	> 400	s7min ± IT7/2[4,6]
High demands on running accuracy with light loads ($P \leq 0.05\ C$)	Machine tools	8 to 240	–	–	–	js4
			25 to 40	25 to 40	–	js4 (j5)[7]
		–	41 to 140	41 to 140	–	k4 (k5)[7]
			141 to 200	141 to 200	–	m5
			201 to 500	201 to 500	–	n5

Shaft fit tolerances for solid steel shafts

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Conditions	Examples	Shaft diameter, mm				Tolerance [11]
		Ball bearings[1]	Cylindrical roller bearings	Taper roller bearings	CARB and spherical roller bearings	
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Light and variable loads (P ≤ 0.05 C)	Conveyors, lightly loaded gearbox bearings	≤ 17	–	–	–	js5 (h5)[2]
		18 to 100	≤ 25	≤ 25	–	j6 (js5)[2]
		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)[2]
		18 to 100	–	–	< 25	k5[3]
		-	≤ 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[4]
		201 to 500	66 to 100	66 to 200	61 to 100	n6[4]
		–	101 to 280	201 to 360	101 to 200	p6[4]
		> 500	–	–	–	p7[4]
			281 to 500	361 to 500	201 to 500	r6[4]
			> 500	> 500	> 500	r7[4]
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[4]
		–	66 to 85	51 to 110	–	n6[4]
		–	86 to 140	111 to 200	71 to 140	p6[4]
		–	141 to 300	201 to 500	141 to 280	r6[4]
			301 to 500	–	281 to 400	s6min ± IT6/2[4,6]
		–	> 500	> 500	> 400	s7min ± IT7/2[4,6]
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)[7]
		–	41 to 140	41 to 140	–	k4 (k5)[7]
			141 to 200	141 to 200	–	m5
			201 to 500	201 to 500	–	n5

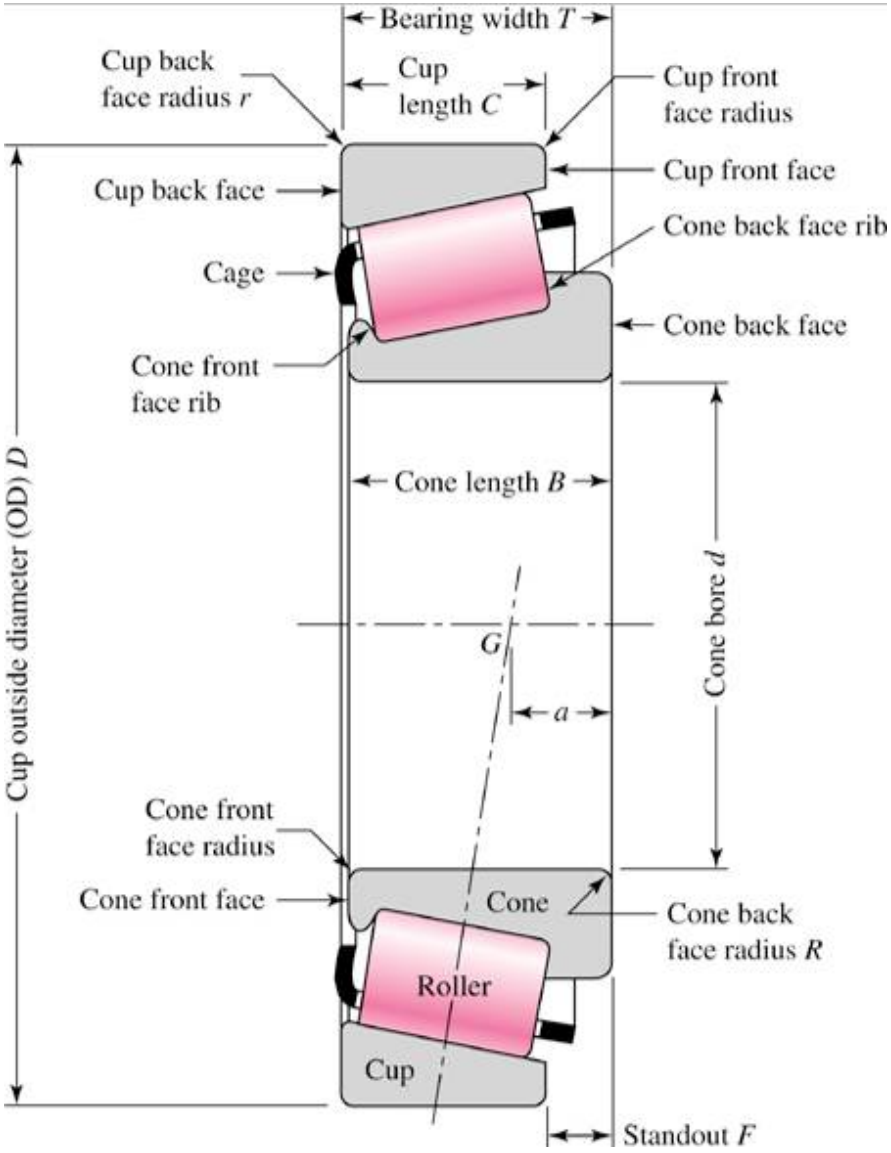
Shaft bearing-seat diameters (values in inches)

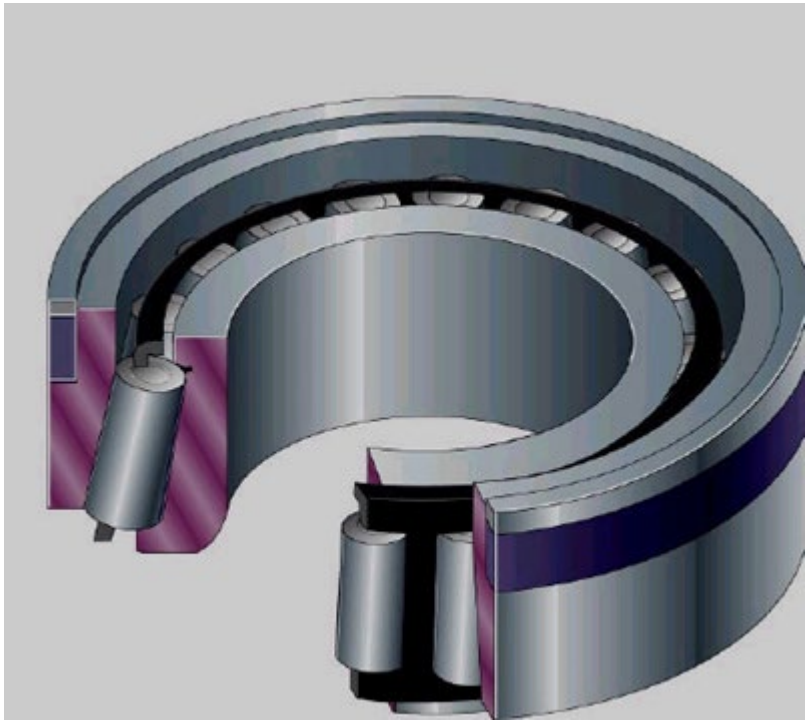
Bearing bore diameter			k6			m5			m6			n5		
	inches		Shaft dia.		Resultant fit [1] in	Shaft dia.		Resultant fit [1] in	Shaft dia.		Resultant fit [1] in	Shaft dia.		Resultant fit [1] in
mm	max.	min.	max.	min.	0.0001"	max.	min.	0.0001"	max.	min.	0.0001"	max.	min.	0.0001"
4	0.1575	0.1572	0.1579	0.1575	0 T	0.1579	0.1577	2 T	0.1580	0.1577	2 T	0.1580	0.1578	3 T
5	0.1969	0.1966	0.1973	0.1969	7 T	0.1973	0.1971	7 T	0.1974	0.1971	8 T	0.1974	0.1972	8 T
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	0.2761	0.2758	2 T	0.2762	0.2758	2 T	0.2762	0.2760	4 T
8	0.3150	0.3147	0.3154	0.3150	7 T	0.3155	0.3152	8 T	0.3156	0.3152	9 T	0.3156	0.3154	9 T
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	0.4730	0.4727	3 T	0.4731	0.4727	3 T	0.4732	0.4729	5 T
15	0.5906	0.5903	0.5911	0.5906	8 T	0.5912	0.5909	9 T	0.5913	0.5909	10 T	0.5914	0.5911	11 T
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	0.7881	0.7877	3 T	0.7882	0.7877	3 T	0.7883	0.7880	6 T
25	0.9843	0.9839	0.9849	0.9844	10 T	0.9850	0.9846	11 T	0.9851	0.9846	12 T	0.9852	0.9849	13 T
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	1.3788	1.3784	4 T	1.3790	1.3784	4 T	1.3791	1.3787	7 T
40	1.5748	1.5743	1.5755	1.5749	12 T	1.5756	1.5752	13 T	1.5758	1.5752	15 T	1.5759	1.5755	16 T
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	2.1663	2.1658	4 T	2.1666	2.1658	4 T	2.1667	2.1662	8 T
60	2.3622	2.3616	2.3630	2.3623	14 T	2.3631	2.3626	15 T	2.3634	2.3626	18 T	2.3635	2.3630	19 T
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)

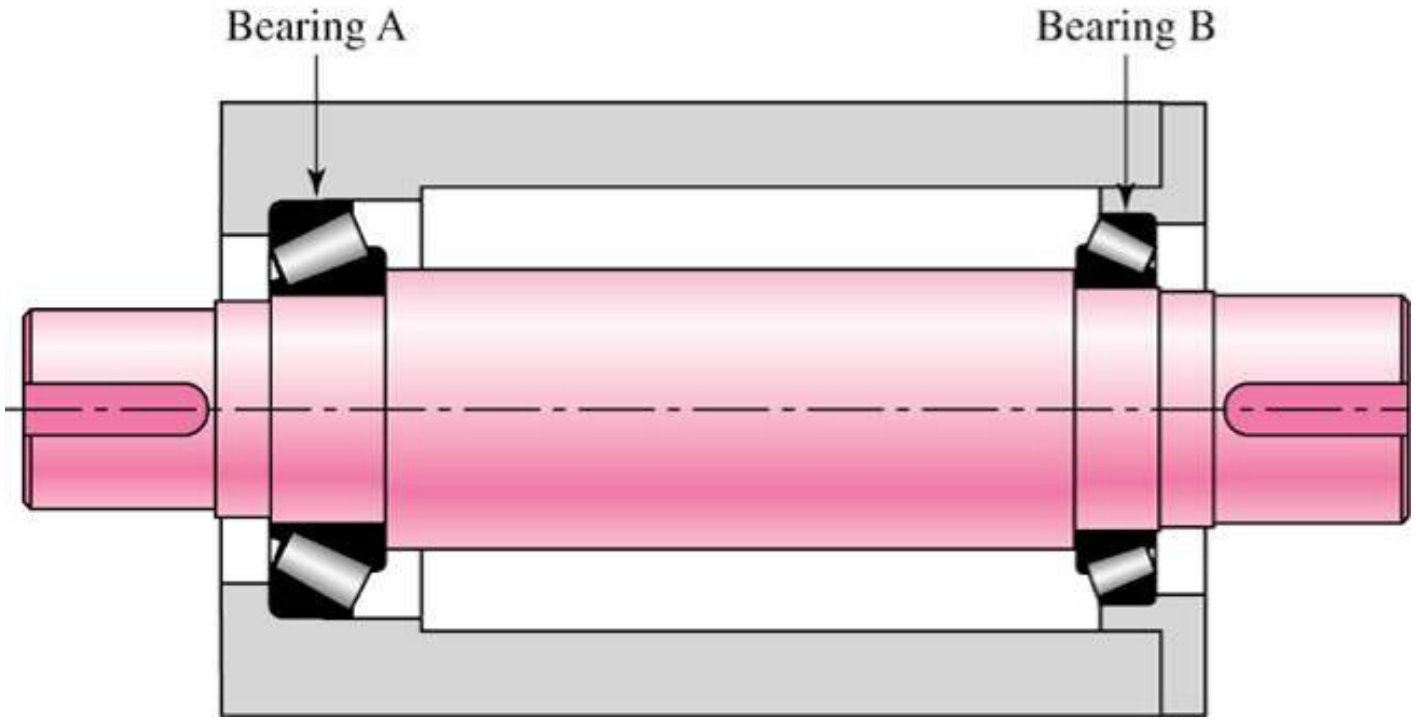
Bearing outside diameter			F7			G7			H6			H7		
	inches		Housing bore		Resultant fit [1] in	Housing bore		Resultant fit [1] in	Housing bore		Resultant fit [1] in	Housing bore		Resultant fit [1] in
mm	max.	min.	min.	max.	0.0001"	min.	max.	0.0001"	min.	max.	0.0001"	min.	max.	0.0001"
16	0.6299	0.6296	0.6305	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		0.7483	0.7491		0.7480	0.7485		0.7480	0.7488	
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	20 L	0.9452	0.9460	15 L	0.9449	0.9454	9 L	0.9449	0.9457	12 L
26	1.0236	1.0232	1.0244	1.0252	8 L	1.0239	1.0247	3 L	1.0236	1.0241	0 L	1.0236	1.0244	0 L
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		1.2602	1.2611		1.2598	1.2604		1.2598	1.2608	
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	24 L	1.4571	1.4580	17 L	1.4567	1.4573	10 L	1.4567	1.4577	14 L
40	1.5748	1.5744	1.5758	1.5768	10 L	1.5752	1.5761	4 L	1.5748	1.5754	0 L	1.5748	1.5758	0 L
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		2.0476	2.0488		2.0472	2.0479		2.0472	2.0484	
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	29 L	2.4413	2.4425	21 L	2.4409	2.4416	12 L	2.4409	2.4421	17 L
68	2.6772	2.6767	2.6784	2.6796	12 L	2.6776	2.6788	4 L	2.6772	2.6779	0 L	2.6772	2.6784	0 L
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

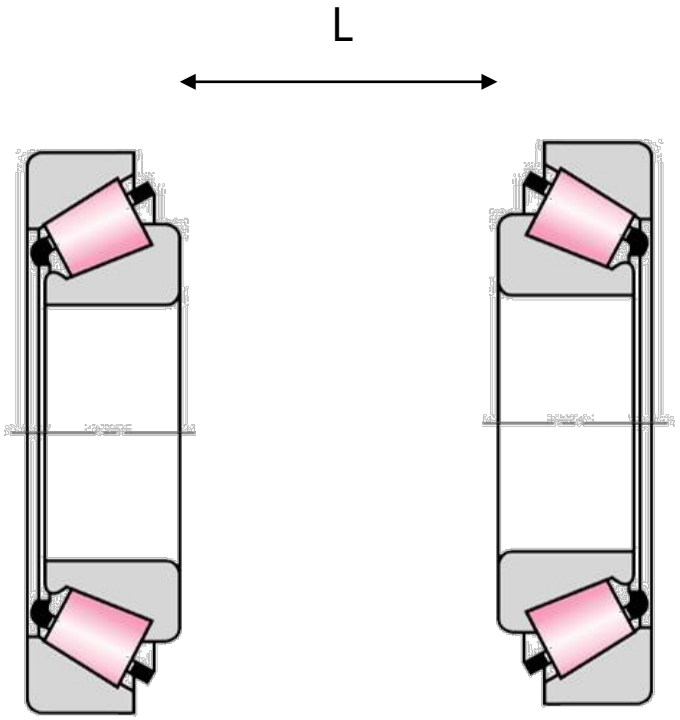




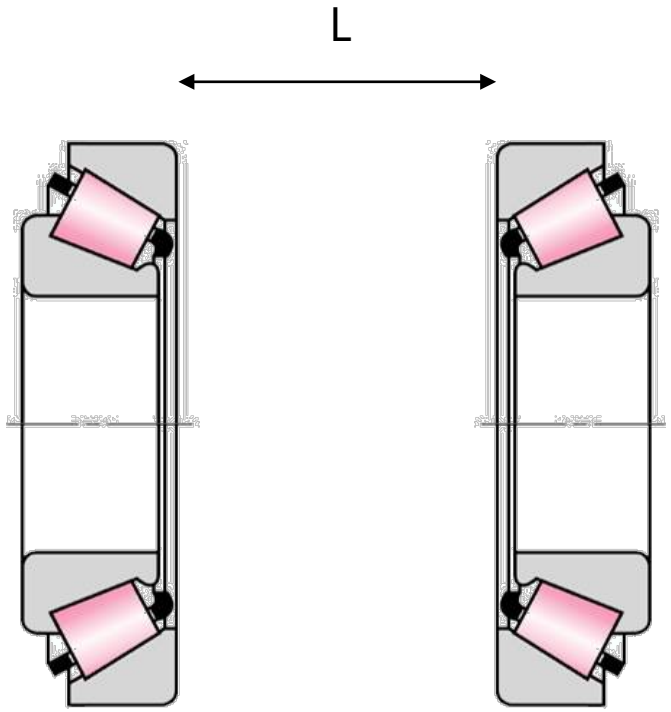
Tapered Roller Bearings: Mount in Pairs



Direct versus Indirect Mounting

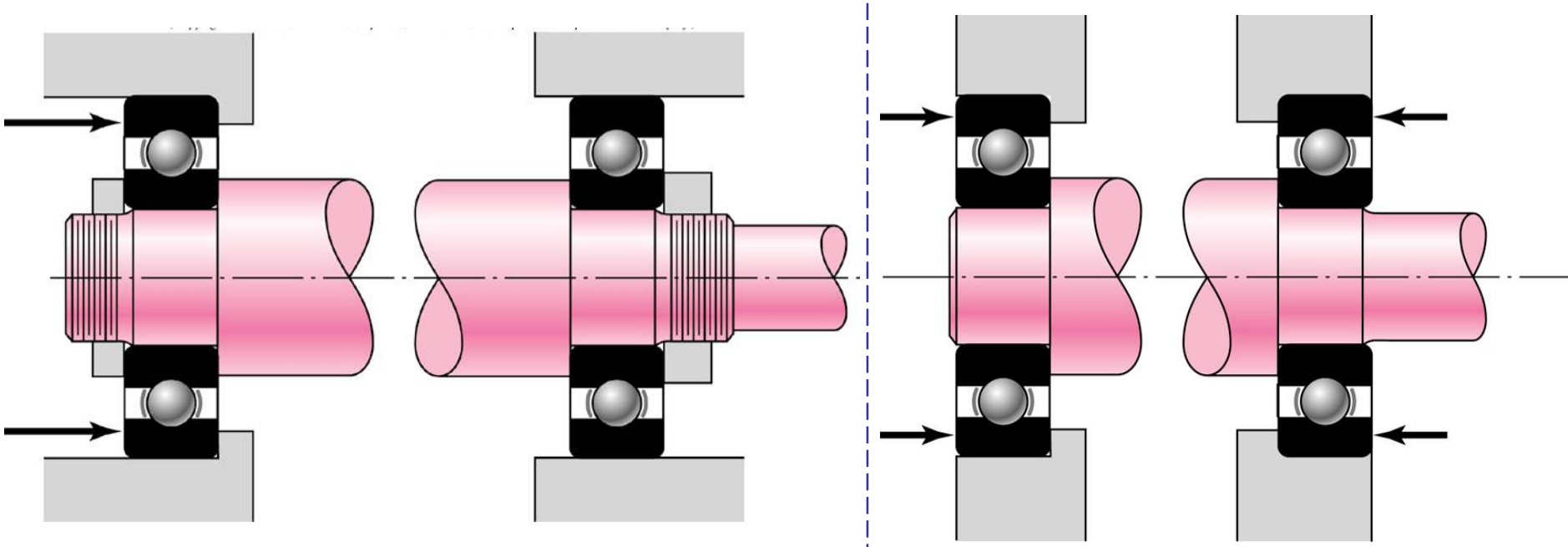


Direct Mounting



Indirect Mounting

Mounting Bearings

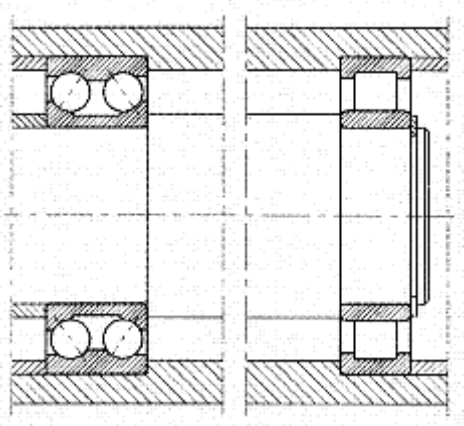


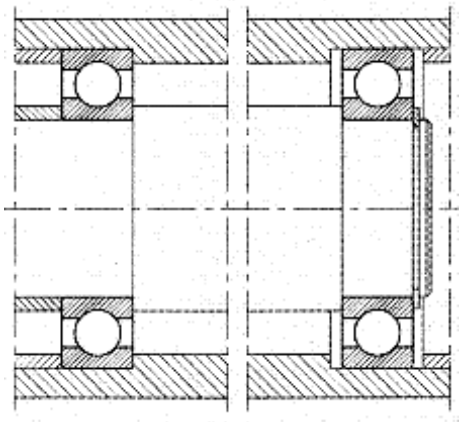
Bearing Mounting Units

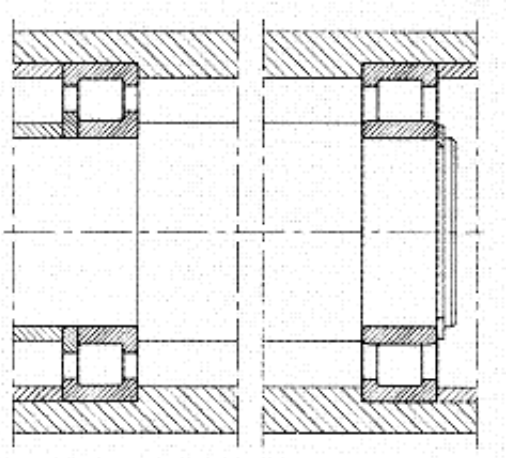
Restraining Bearings

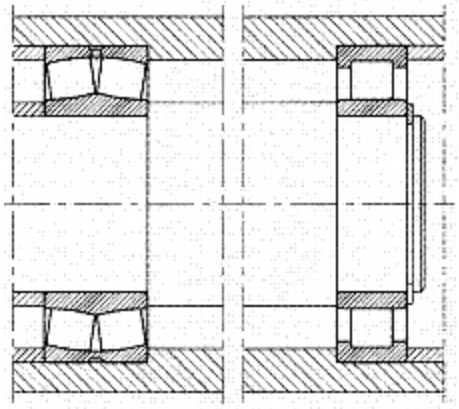
Bearing Arrangement

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

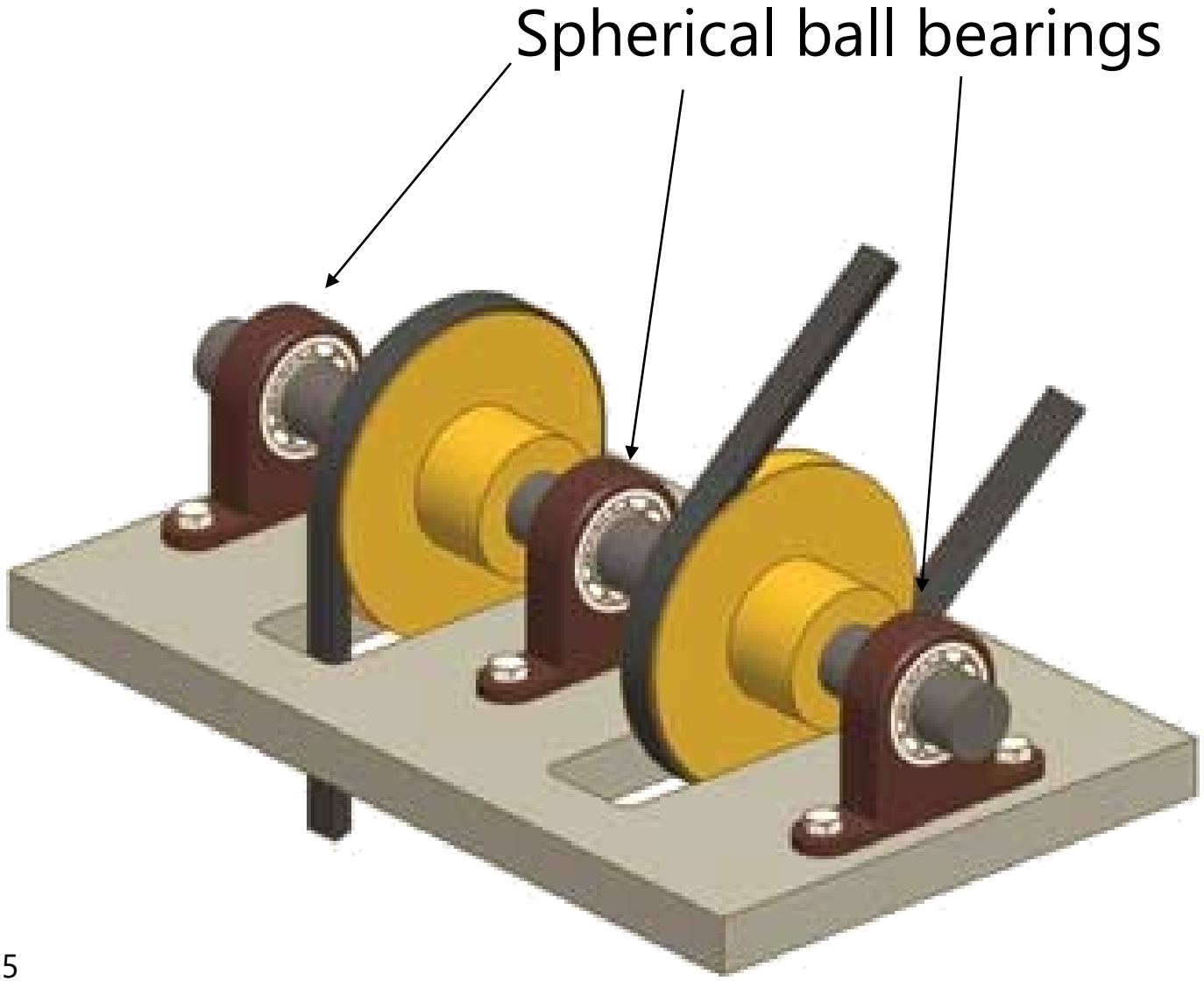




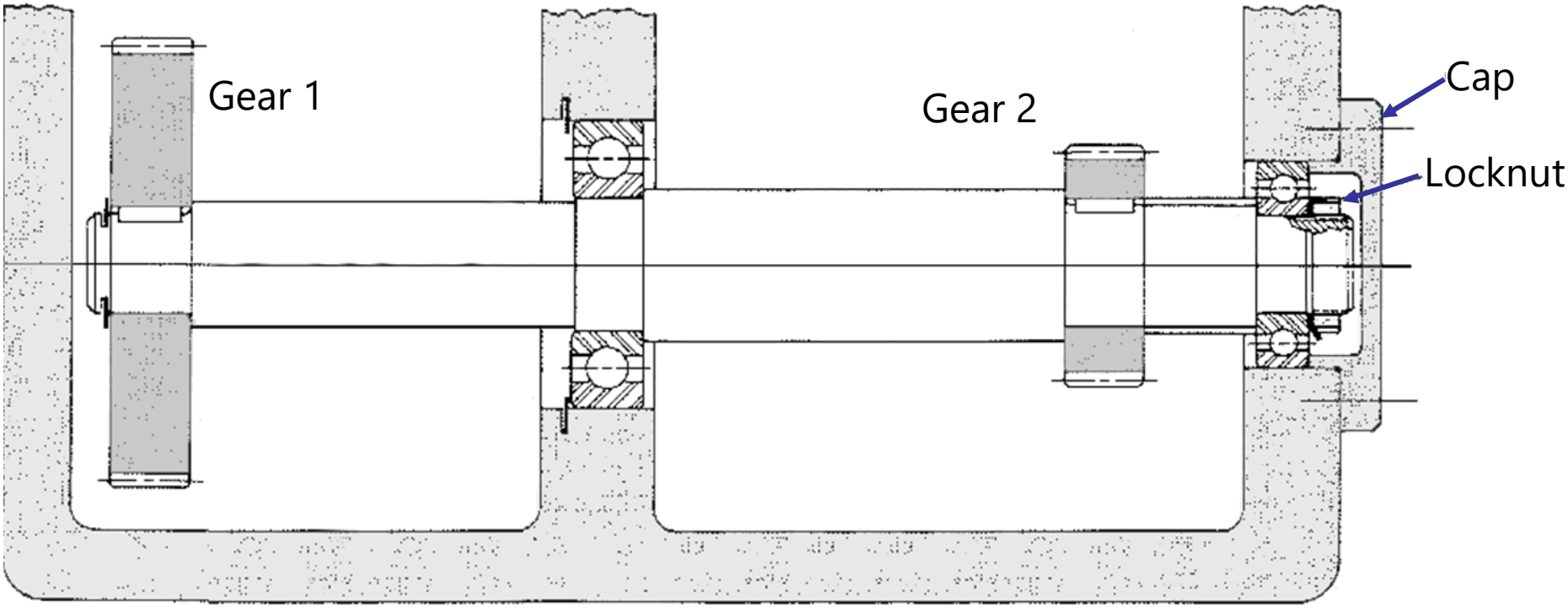




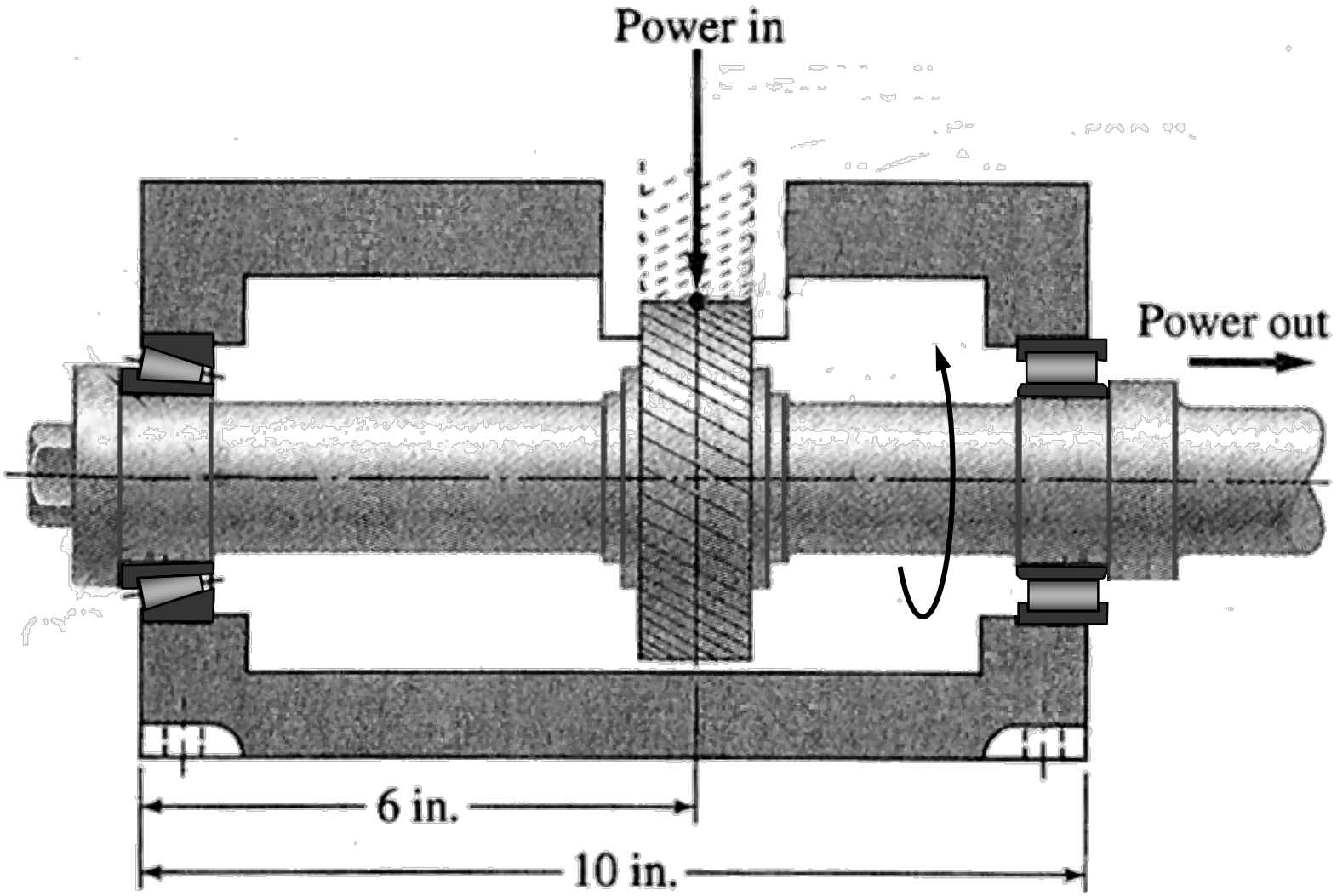
Two-Pulley Shaft



Geartrain 1



Geartrain 2



Geartrain 3