Spherical Rod Ends
—SAE J1120 SEP79

SAE Standard
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Report of the Ball Joint Committee, approved July 1975, last revised September 1979.

1. General Specifications

1.1 Scope—This SAE Standard covers the general and dimensional data for industrial quality spherical rod ends commonly used on control linkages in automotive, marine, construction, and industrial equipment applications.

The rod ends described are available from several manufacturers within the range of the interchangeable specifications. The sliding contact spherical self-aligning bearing members (ball and socket) are available in a variety of materials in types shown. The load capacities and wear capabilities vary considerably with the design and fabrication. It is suggested that the manufacturers be consulted for recommendations for the type and design appropriate to particular applications.

1.2 Sizes—Spherical rod end sizes are normally specified by a number indicating the ball bore size in sixteenths of an inch (size 5 = $^5/_{16}$ bore). The housing threads (external or internal) used for mounting, as well as the stud thread if required, are equal in size to the nominal ball bore. Sizes larger than those listed are available in both standard and special configurations.

1.3 Threads—Unified Standard fine thread series (UNF) Class 2A external threads and Class 2B internal threads shall apply to plain finish (unplated) parts. For externally threaded components with additive finish, the maximum diameters of Class 2A may be exceeded by the amount of the allowance; that is, the basic diameters (Class 2A maximum diameters plus the allowance) apply to an externally threaded part after plating. For internally threaded components with additive finish, the Class 2B diameters apply after ϕ plating. See SAE J475 (ANSI B1.1 - 1974).

Housing threads left or right hand may be specified as required. Standard studs are threaded right hand.

External and internal threads must be chamfered to insure a clean start according to good industrial practice. Roll formed internal and external threads are preferred.

1.4 Material—Spherical rod end housing members are normally made from low carbon steel turned, forged, headed, or press stamped blanks.

Race and ball materials vary according to manufacturers preference for bearing materials.

For special applications spherical rod ends can be produced from alloy steel, corrosion resistant steel, brass, bronze or other materials. The charted combinations illustrate the preferred materials in each category available as standard.

Spherical rod ends are available with ball and race material options listed below:

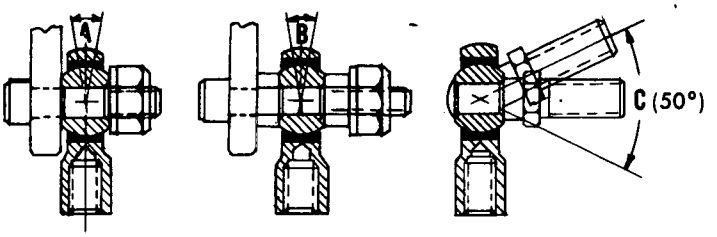
ϕ MATERIAL OPTIONS

Rod End	Housing	Race	Ball
Type A (Fig. 2)	Mild Steel, Alloy Steel, Stainless Steel, Hardened Steel, Aluminum Bronze, Brass	Sintered Phosphor Bronze	Hardened Sintered Nickel Steel, Oil Impregnated Case Hardened Steel, Tin Nickel Plated
		Wrought Bronze, Brass	Hardened Sintered Steel
		Mild Steel, Cad Plated	Hardened 52100 Steel, Chrome Plated Hardened Sintered Steel
		Hardened Steel	Hardened Sintered Nickel Steel, Oil Impregnated Sintered Bronze, Oil Impregnated Hardened 52100
Type B (Fig. 3)		Nylon Reinforced, Delrin, TFE Lined	Case Hardened Steel, Cad or Tin Nickel Plated Hardened Sintered Nickel Steel, Oil Impregnated Hardened 52100
Type C (Fig. 4)		None	Hardened 52100 Hardened Sintered Iron, Oil Impregnated Case Hardened Steel, Tin Nickel Plated
Type D (Fig. 5)		None	Mild Steel—Case Hardened, Cad Plated

Studs (Fig. 6) which may be secured in the bore of any of the ball variations are normally made from turned low carbon steel or headed blanks. Studs with greater strength to resist bending are also available as standard, employing high tensile bar stock or heat treatment during fabrication.

Ball studs which combine ball and stud as a single part are mild steel case hardened.

The ϕ symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.



Rod End Size	Min A	Min B
3	10°	34°
4	14°	34°
5	12°	28°
6	10°	30°
7	14°	32°
8	10°	32°
10	14°	30°
12	14°	25°

FIG. 1—A—HOUSING STRIKES YOKE OR LEVER
B—WASHER OR SHOULDERED SHAFT WITH DIA "O" STRIKES RACE ID
C—STUD STRIKES RACE ID

1.5 Angle of Misalignment—If a spherical rod end is mounted between the legs of a fork or clevis, the total misalignment angle will be limited by the diameter of the housing head as it contacts the legs. This angle varies from 18 deg to 34 deg in race type spherical rod ends and from 12 deg to 30 deg in raceless construction. Specific information for a given size and type should be requested from the manufacturer if this is a critical element of the application. See illustration, Fig. 1A.

If a spherical rod end is mounted on a shouldered shaft or with washers having a diameter equal to ball dimension "O" the shaft cone angle will vary from 25 deg to 34 deg. See illustration, Fig. 1B.

The use of a stud for mounting increases the limit of total misalignment to a minimum of 50 deg. See illustration, Fig. 1C.

1.6 Finishes—Unless otherwise specified, low carbon steel housings, races and studs shall be furnished with cadmium or zinc protective finish and shall meet the requirements of 32 h Salt Spray (Fog) Testing in accordance with ASTM B-117. At manufacturers option, a subsequent chromate treatment may be used. Black oxide treatment for studs may also be employed.

Hardened steel races shall be black oxide treated and oiled. Non sintered balls and ball studs shall be plated according to manufacturer's preference for corrosion protection appropriate to their use as bearing elements.

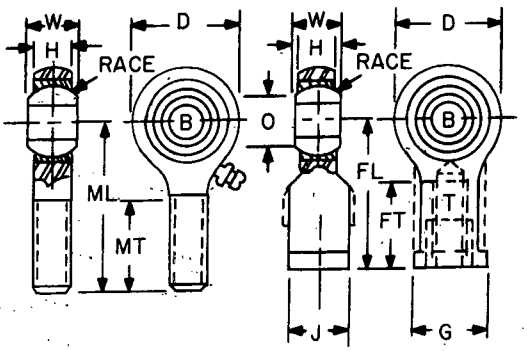


FIG. 2—TYPE A METALLIC RACE

1.7 Lubrication—Unless otherwise specified by the user spherical rod ends shall be supplied with ball sockets suitably lubricated in accordance with manufacturer's practice, including vacuum impregnation of self lubricating sintered bearing elements.

Grease fittings for supplemental lubrication are provided upon request for most types. Standard location is shown. Special locations at 12 o'clock and 3 o'clock positions are also available.

1.8 Workmanship—Industrial quality spherical rod ends must be free from burrs, loose scale, sharp edges, and any other defects.

1.9 Ball Bore Chamfer—Ball bores are chamfered at both faces to break the edge 0.005 in (0.13 mm) or up to a maximum of 0.03 in (0.8 mm) according to manufacturer's preference and method of fabrication. The user is cautioned against seating bolt heads against the ball face during mounting because bolt fillets under the head may distort or crack the ball. This is especially true of hex bolts and screws meeting ANSI B18.2.1-1972 specifications. The use of a washer or other suitable alternate is recommended.

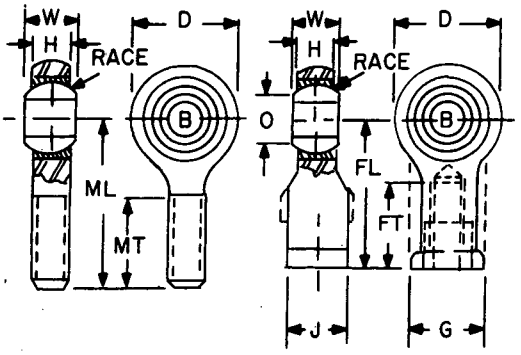


FIG. 3—TYPE B
MOLDED RACE

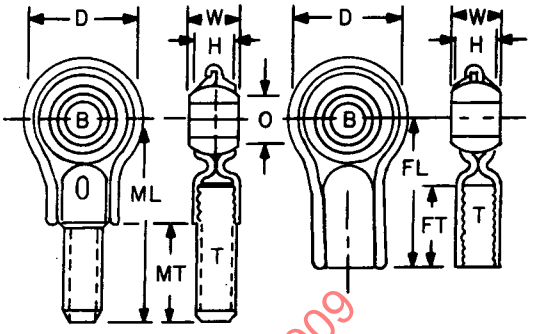
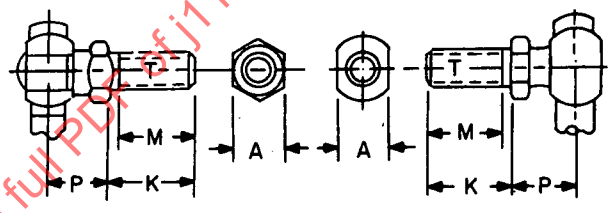


FIG. 5—TYPE D
RACELESS, STAMPED HOUSING



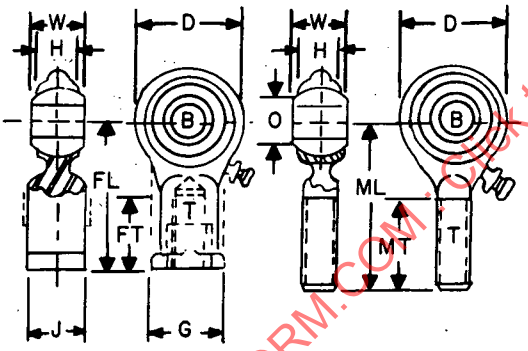


FIG. 4—TYPE C
RACELESS

Rod End Size	A		K		M		P		T
	±0.010	0.25	±0.03	±0.8	±0.03	±0.8	±0.04	±1.0	Nominal Thread Size
	in	mm	in	mm	in	mm	in	mm	
3	0.312	7.92	0.50	12.7	0.44	11.2	0.48	12.2	10–32
4	0.375	9.52	0.56	14.2	0.50	12.7	0.48	12.2	1/4–28
5	0.437	11.10	0.69	17.5	0.59	15.0	0.54	13.7	5/16–24
6	0.500	12.70	0.89	22.6	0.81	20.6	0.65	16.5	3/8–24
7	0.625	15.88	1.09	27.7	0.97	24.6	0.84	21.3	7/16–20
8	0.625	15.88	1.12	28.4	1.00	25.4	0.88	22.4	1/2–20
10	0.750	19.05	1.50	38.1	1.38	35.1	1.00	25.4	5/8–18
12	1.000	25.40	1.81	46.0	1.63	41.4	1.19	30.2	3/4–16

FIG. 6—STUD ASSEMBLED TO BALLS HAVING ANY STANDARD MATERIAL OPTIONS. ONE PIECE BALL STUD, LOW CARBON STEEL, CASE HARDENED

φ TABLE 1—DIMENSIONS FOR TYPE A ROD ENDS (FIG. 2)

Rod End Size	B		D		G		H		J		T	W		FL		FT		ML		MT		Ball Dia Ref		O	
	+0.0025 −0.0005	+0.064 −0.013	Max		Ref		Ref		±0.015	±0.38	Nominal Thread Size	±0.005	±0.13	+0.06 −0.03	+1.5 −0.8	±0.06	±1.5	+0.06 −0.03	+1.5 −0.8	±0.06	±1.5	Ref		Ref	
	in	mm	in	mm	in	mm	in	mm	in	mm		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
3	0.1900	4.826	0.76	19.3	0.41	10.4	0.25	6.4	0.312	7.92	10–32	0.312	7.92	1.06	26.9	0.56	14.2	1.25	31.8	0.75	19.0	0.44	11.2	0.31	7.9
4	0.2500	6.350	0.89	22.6	0.47	11.9	0.28	7.1	0.375	9.52	1/4–28	0.375	9.52	1.31	33.3	0.75	19.0	1.56	39.6	1.00	25.4	0.51	13.0	0.35	8.9
5	0.3125	7.938	1.01	25.7	0.50	12.7	0.34	8.6	0.438	11.12	5/16–24	0.438	11.12	1.38	35.1	0.75	19.0	1.88	47.8	1.25	31.8	0.62	15.7	0.45	11.4
6	0.3750	9.525	1.11	28.2	0.69	17.5	0.41	10.4	0.562	14.27	3/8–24	0.500	12.70	1.62	41.1	0.94	23.9	1.94	49.3	1.25	31.8	0.72	18.3	0.52	13.2
7	0.4375	11.112	1.20	30.5	0.75	19.0	0.44	11.2	0.625	15.88	7/16–20	0.562	14.27	1.81	46.0	1.06	26.9	2.12	53.8	1.38	35.1	0.81	20.6	0.59	15.0
8	0.5000	12.700	1.39	35.3	0.88	22.4	0.50	12.7	0.750	19.05	1/2–20	0.625	15.88	2.12	53.8	1.19	30.2	2.44	62.0	1.50	38.1	0.94	23.9	0.70	17.8
10	0.6250	15.875	1.57	39.9	1.00	25.4	0.56	14.2	0.875	22.22	5/8–18	0.750	19.05	2.50	63.5	1.50	38.1	2.62	66.5	1.62	41.1	1.12	28.4	0.81	20.6
12	0.7500	19.050	1.82	46.2	1.12	28.4	0.69	17.5	1.000	25.40	3/4–16	0.875	22.22	2.88	73.2	1.75	44.4	2.88	73.2	1.75	44.4	1.32	33.5	1.02	25.9