Designation: B 612 – 00

Standard Specification for Iron Bronze Sintered Bearings (Oil-Impregnated)[1]

This standard is issued under the fixed designation B 612; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers iron-copper-tin-graphite sintered metal powder oil-impregnated bearings of one composition commonly known as diluted bronze.

1.2 The following safety hazards caveat pertains only to the test method described in this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil-Impregnated Bearings[2]

E 9 Test Methods of Compression Testing of Metallic Materials at Room Temperature[3]

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Dimensions and

3.1.2 Certification (12.1).

4. Materials and Manufacture

4.1 Bearings shall be made by briquetting and sintering metal powders with an addition of graphite so as to produce finished parts conforming to the requirements of this specification.

5. Chemical Composition

5.1 The material shall conform to the requirements as to chemical composition prescribed in Table 1.

TABLE 1 Chemical Requirements

Element	Composition, %
Iron	54.2–62.0
Copper	34.0–38.0
Tin	3.5–4.5
Total carbon	0.5–1.3
Combined carbon[A]	0.5 max
Total other elements	2.0 max

[A] On basis of iron.

6. Physical Properties

6.1 *Density*—The density of bearings supplied fully impregnated with lubricant shall be 6.0 to 6.4 g/cm^3.

6.2 *Oil Content*—Oil content of bearings shall not be less than 17 % when determined in accordance with Test Method B 328.

6.3 *Radial Crushing Strength*—Radial crushing strength determined as prescribed in 9.2 shall be not less than nor greater than the calculated value limits using the minimum and maximum K values given below and using the following equation:

$$P = KLT^2/(D - T) \quad (1)$$

where:

P = radial crushing strength (Note), lbs (or N);
D = outside diameter of bearing, in. (or mm);
T = wall thickness of bearing, in. (or mm);
L = length thickness of bearing, in. (or mm); and
K = strength constant with K_{min} = 22 000 psi (152 MPa) and K_{max} = 50 000 psi (345 MPa).

NOTE 1—Strengths above the maximum value indicate high combined carbon, which has a deleterious effect on bearing performance.

7. Workmanship, Finish, and Appearance

7.1 Bearings shall be uniform in composition. When cut or fractured, the exposed surface shall be of uniform appearance. The parts shall be free of defects which would affect their serviceability. Upon metallographic examination, the microstructure of the material shall be iron dispersed through a matrix of substantially alpha bronze and containing no free tin visible at 300×. To check for uniform permeability, the part shall be observed either while it is being heated or while the inside of the bearing is being subjected to air pressure. Oil shall exude uniformly from all critical surfaces.

[1] This specification is under the jurisdiction of ASTM Committee B-9 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.04 on Bearings.

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[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

8. Sampling

8.1 *Lot*—Unless otherwise specified, a lot shall consist of parts of the same form and dimensions made from powders of the same composition, formed and sintered under the same conditions, and submitted for inspection at one time.

8.2 *Sample for Chemical Analysis*—At least one sample for chemical analysis shall be taken from each lot. A sample shall consist of not less than 2 oz (56 g) of chips obtained by milling or drilling from at least two pieces with clean dry tools without lubrication. To obtain oil-free chips, the parts selected for test shall be extracted in accordance with Test Method B 328, if necessary.

8.3 *Mechanical Tests*—The manufacturer and purchaser shall agree on a representative number of test pieces.

9. Test Methods

9.1 *Density*—Test Method B 328.

9.2 *Radial Crushing Strength*—Compress the test specimens between two flat surfaces at a "no load" speed no greater than 0.2 in./min (5.0 mm/min), the direction of the load being normal to the longitudinal axis of the specimen. The point at which the load drops as a result of the first crack shall be considered the crushing strength. Apply this test to plain cylindrical bearings. Test flanged bearings by cutting off the flange and compressing the two sections separately. Each section shall meet the minimum strength requirements prescribed in 6.3.

10. Inspection

10.1 Unless otherwise specified, inspection of parts supplied on contract shall be made by the purchaser at the destination.

11. Rejection

11.1 Unless otherwise specified, rejection based on tests made in accordance with this specification shall be reported to the manufacturer within 30 days from receipt of the material by the purchaser.

12. Certification

12.1 A certification based on the manufacturer's quality control that the material conforms to the requirements of this specification shall be the basis of shipment of the material. A certificate covering the conformance of the material to this specification shall be furnished by the manufacturer upon request of the purchaser.

13. Keywords

13.1 density; *K* strength constant; oil content; oil-impregnated bearings; porosity

APPENDIX

(Nonmandatory Information)

X1. EXPLANATORY INFORMATION

X1.1 Design Information

X1.1.1 In calculating permissible loads, the operating conditions, housing conditions, and construction should be considered. The maximum static bearing load should not exceed 8500 psi (60 MPa) of projected bearing area (length times inside diameter of bearing) for this material. This figure is 75 % of the value for the compression deformation limit (yield strength, permanent set of 0.001 in. (0.025 mm) for specimens 1⅛ in. (28.6 mm) in diameter and 1 in. (25.4 mm) in length) as determined in accordance with Test Methods E 9.

X1.2 Permissible Loads

X1.2.1 Permissible loads for various operating conditions are given in Table X1.1.

TABLE X1.1 Permissible Loads

Shaft Velocity, ft/min (m/min)	Permissible Loads, psi (MPa)
Slow and intermittent	4000 (28)
25 (7.6)	2000 (14)
50 to 100 (15.2 to 30.4), incl	400 (2.8)
Over 100 to 150 (30.4 to 45.7), incl	300 (2.1)
Over 150 to 200 (45.7 to 61), incl	200 (1.4)
Over 200 (61)	[A]

[A] For shaft velocities over 200 ft/min (61 m/min), the permissible loads may be calculated as follows:

$$P = 40\,000/V$$

where:
P = safe load, psi of projected area and
V = shaft velocity, ft/min.

In SI units:

$$P = 85/V$$

where:
P = is in MPa and
V = is in m/min and should not exceed 400 ft/min (122 m/min).

X1.3 Dimensional Tolerances

X1.3.1 Commercial dimensional tolerances are given in Table X1.2.

X1.4 Press Fits

X1.4.1 Plain cylindrical journal bearings are commonly installed by press fitting the bearing into a housing with an insertion arbor. For housings rigid enough to withstand the press fit without appreciable distortion and for bearings with wall thickness approximately one eighth of the bearing outside diameter, the press fits shown in Table X1.3 are recommended.

X1.5 Running Clearance

X1.5.1 Proper running clearance for sintered bearings depends to a great extent on the particular application. Therefore, only minimum recommended clearances are listed in Table

TABLE X1.2 Commercial Dimensional Tolerances

NOTE 1—This table is intended for bearings with a 4 to 1 maximum length to inside diameter ratio and a 24 to 1 maximum length to wall thickness ratio. Bearings having greater ratios than these are not covered by the table.

Inside Diameter and Outside Diameter		Total Diameter Tolerance[A]			
		Inside Diameter		Outside Diameter	
in.	mm	in.	mm	in.	mm
Up to 1.510	up to 38.36	0.001	0.025	0.001	0.025
1.511 to 2.510	38.37 to 63.76	0.0015	0.04	0.0015	0.04
2.511 to 3.010	63.77 to 76.46	0.002	0.05	0.002	0.05
3.011 to 4.010	76.47 to 101.86	0.003	0.08	0.003	0.08
4.011 to 5.010	101.87 to 127.26	0.004	0.10	0.004	0.10
5.011 to 6.010	127.27 to 152.65	0.005	0.13	0.005	0.13

Length		Total Length Tolerance[B]	
in.	mm	in.	mm
Up to 1.495	up to 37.97	0.010	0.25
1.496 to 2.990	37.98 to 75.96	0.015	0.38
2.991 to 4.985	75.97 to 126.61	0.020	0.51

Outside Diameter		Wall Thickness, max		Concentricity Tolerance[C]	
in.	mm	in.	mm	in.	mm
Up to 1.010	up to 25.66	up to 0.255	6.48	0.003	0.08
1.011 to 1.510	25.67 to 38.36	up to 0.355	9.02	0.003	0.08
1.511 to 2.010	38.37 to 51.06	up to 0.505	12.83	0.004	0.10
2.011 to 3.010	51.07 to 76.46	up to 0.760	19.30	0.005	0.13
3.011 to 4.010	76.47 to 101.86	up to 1.010	25.65	0.005	0.13
4.011 to 5.010	101.87 to 127.26	up to 1.510	38.35	0.006	0.15
5.011 to 6.010	127.27 to 152.65	up to 2.010	51.05	0.007	0.18

[A] Total tolerance on the inside diameter and outside diameter is a minus tolerance only.
[B] Total tolerance is split into plus and minus.
[C] Total indicator reading.

TABLE X1.3 Recommended Press Fits

Outside Diameter of Bearing		Press Fit			
		min		max	
in.	mm	in.	mm	in.	mm
Up to 0.760	up to 19.31	0.001	0.025	0.003	0.08
0.761 to 1.510	19.32 to 38.36	0.0015	0.04	0.004	0.10
1.511 to 2.510	38.37 to 63.76	0.002	0.05	0.005	0.13
2.511 to 3.010	63.77 to 76.45	0.002	0.05	0.006	0.15
Over 3.010	over 76.45	0.002	0.05	0.007	0.18

X1.4. The maximum running clearances will automatically be held within good design practice for average conditions if dimensions shown in the standard size list in Table X1.5 are used. It is assumed that ground steel shafting will be used and that all bearings will be oil impregnated.

X1.6 Standard Sleeve Bearing Sizes

X1.6.1 The standard size list shown in Table X1.5 is adaptable to the basic shaft and basic hole systems through control of the insertion arbor diameter. It is based on dimensional tolerances shown in Table X1.2 and on tables of recommended press fits, Table X1.3, and running clearances, Table X1.4.

X1.7 Flange and Thrust-Bearing Specifications

X1.7.1 Diameter and thickness specifications for flange and thrust washers are shown in Table X1.6.

X1.8 Impregnating Oil

X1.8.1 It was found that a circulating-type oil containing rust and oxidation inhibitors is the most desirable type of oil to be used. The viscosity should be specified by the user in accordance with the application.

TABLE X1.4 Running Clearances

Shaft Size		Clearance, min	
in.	mm	in.	mm
0.000 to 0.760	0.00 to 19.31	0.0005	0.01
0.761 to 1.510	19.32 to 38.36	0.001	0.025
1.511 to 2.510	38.37 to 63.76	0.0015	0.04
Over 2.510	over 63.76	0.002	0.05

TABLE X1.5 Standard Sleeve Bearing Size Specifications

Inside Diameter			Wall Thickness, in.	Outside Diameter			Length	
Fractional, in.	Decimal			Fractional, in.	Decimal			
	in.	mm			in.	mm	in.	mm
1/8	0.127	3.23	1/32	3/16	0.1905	4.83	0.250	6.35
1/8	0.127	3.23	1/16	1/4	0.253	6.43	0.250	6.35
5/32	0.158	4.01	3/64	1/4	0.253	6.43	0.312	7.92
3/16	0.1895	4.80	1/32	1/4	0.253	6.43	0.375	9.525
3/16	0.1895	4.80	1/16	5/16	0.3155	8.01	0.375	9.525
1/4	0.252	6.40	1/16	3/8	0.378	9.60	0.500	12.70
1/4	0.252	6.40	3/32	7/16	0.4405	11.19	0.500	12.70
5/16	0.3145	7.99	1/16	7/16	0.4405	11.19	0.562	14.275
5/16	0.3145	7.99	3/32	1/2	0.503	12.78	0.562	14.275
3/8	0.377	9.58	1/16	1/2	0.503	12.78	0.625	15.875
3/8	0.377	9.58	3/32	9/16	0.5655	14.36	0.625	15.875
1/2	0.502	12.75	1/16	5/8	0.628	15.95	0.750	19.05
1/2	0.502	12.75	1/8	3/4	0.753	19.13	0.750	19.05
5/8	0.627	15.925	1/16	3/4	0.753	19.13	0.750	19.05
5/8	0.627	15.925	1/8	7/8	0.879	22.33	0.937	23.80
3/4	0.752	19.10	1/16	7/8	0.879	22.33	1.125	28.575
3/4	0.752	19.10	1/8	1	1.004	25.50	1.125	28.575
1	1.003	25.48	1/8	1 1/4	1.254	31.85	1.500	38.10
1	1.003	25.48	3/16	1 3/8	1.379	35.03	1.500	38.10
1 1/4	1.2535	31.84	1/8	1 1/2	1.504	38.20	1.500	38.10
1 1/4	1.2535	31.84	3/16	1 5/8	1.630	41.40	1.875	47.625
1 1/2	1.504	38.20	1/8	1 3/4	1.755	44.58	1.500	38.10
1 1/2	1.504	38.20	3/16	1 7/8	1.880	47.75	2.250	57.15
2	2.004	50.90	1/4	2 1/2	2.505	63.63	2.000	50.80
2 1/2	2.505	63.63	1/4	3	3.006	76.35	2.500	63.50
3	3.006	76.35	1/4	3 1/2	3.507	89.08	3.000	76.20

TABLE X1.6 Flange and Thrust Bearings Diameter and Thickness Tolerances[A]

Flange Bearings, Flange Diameter Tolerances					
Diameter Range		Standard		Special	
in.	mm	in.	mm	in.	mm
0 to 1 1/2	0 to 38	±0.005	±0.13	±0.0025	±0.06
Over 1 1/2 to 3	39 to 76	±0.010	±0.25	±0.005	±0.13
Over 3 to 6	77 to 152	±0.025	±0.64	±0.010	±0.25
Flange Bearings, Flange Thickness Tolerances					
Diameter Range		Standard		Special	
in.	mm	in.	mm	in.	mm
0 to 1 1/2	0 to 38	±0.005	±0.13	±0.0025	±0.06
Over 1 1/2 to 3	39 to 76	±0.010	±0.25	±0.007	±0.18
Over 3 to 6	77 to 152	±0.015	±0.38	±0.010	±0.25
Thrust Bearings (1/4-in. (6.35-mm) Thickness, max), Thickness Tolerances for All Diameters[A,B]					
Standard				Special	
in.		mm		in.	mm
±0.005		±0.13		±0.0025	±0.06
Parallelism on Faces, max					
Diameter Range		Standard		Special	
in.	mm	in.	mm	in.	mm
0 to 1 1/2	0 to 38	0.003	0.08	0.002	0.05
Over 1 1/2 to 3	39 to 76	0.004	0.10	0.003	0.08
Over 3 to 6	77 to 152	0.005	0.13	0.004	0.10

[A] Standard and special tolerances are specified for diameters, thickness and parallelism. Special tolerances should not be specified unless required since they require additional or secondary operations and, therefore, are costlier.

[B] Outside diameter tolerances are the same as for flange bearings.