



Designation: **A534—09 A534 – 14**

## Standard Specification for Carburizing Steels for Anti-Friction Bearings<sup>1</sup>

This standard is issued under the fixed designation A534; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

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

### 1. Scope\*

- 1.1 This specification covers the requirements for carburizing bearing-quality steel to be used in the manufacture of anti-friction bearings.
- 1.2 Supplementary requirements of an optional nature are provided and when desired shall be so stated in the order.
- 1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

[A29/A29M](#) Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought

[A255](#) Test Methods for Determining Hardenability of Steel

[A304](#) Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements

~~A510~~[A510/A510M](#) Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel

[A519](#) Specification for Seamless Carbon and Alloy Steel Mechanical Tubing

[A751](#) Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

[A752](#) Specification for General Requirements for Wire Rods and Coarse Round Wire, Alloy Steel (Withdrawn 2011)<sup>3</sup>

[E45](#) Test Methods for Determining the Inclusion Content of Steel

[E112](#) Test Methods for Determining Average Grain Size

[E381](#) Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

[E1019](#) Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques

[E1077](#) Test Methods for Estimating the Depth of Decarburization of Steel Specimens

#### 2.2 ISO Standard:<sup>4</sup>

[ISO 683 Part 17](#): Ball and Roller Bearing Steels

### 3. Ordering Information

- 3.1 Orders for material under this specification should include the following information:
  - 3.1.1 Quantity,
  - 3.1.2 Alloy grade identification,
  - 3.1.3 Specification designation and year of issue,
  - 3.1.4 Dimensions, shape, and
  - 3.1.5 Supplementary requirements.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.28 on Bearing Steels.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale CP 56, CH-1211, CH-1211 Geneva 20, Switzerland, <http://www.iso.ch>.

\*A Summary of Changes section appears at the end of this standard

#### 4. Materials and Manufacture

4.1 The steel shall be made by a process that is capable of providing a high quality product meeting the requirements of this specification.

#### 5. Chemical Composition and Analysis

5.1 Typical examples of chemical compositions are shown in **Table 1**. Other compositions may be specified.

5.2 An analysis of each heat of steel shall be made by the steel manufacturer in accordance with Test Methods, Practices, and Terminology **A751**. The chemical composition thus determined shall conform to the requirements specified in **Table 1** for the ordered grade, or to other requirements agreed upon between manufacturer and purchaser.

5.3 Product analysis may be made by the purchaser in accordance with Test Methods, Practices, and Terminology **A751**. Permissible variations in product analysis shall be in accordance with Specification **A29/A29M**, Practices, and Terminology.

#### 6. Dimensions, Mass, and Permissible Variations

6.1 The size and shape of the material shall be agreed upon between manufacturer and purchaser.

6.2 Dimensional tolerances shall conform to the requirements specified in Specifications **A29/A29M**, **A510/A510M**, **A519**, or **A752** as appropriate for the material or as agreed between manufacturer and purchaser.

6.3 The dimensional tolerances for the forgings shall conform to the requirements of the engineering drawing.

#### 7. Quality Assurance

7.1 The supplier shall be held responsible for the quality of the material furnished and shall make the necessary tests to ensure this quality. The supplier shall be required to report on the results of the micro-inclusion rating tests detailed below. Quality tests shown in **7.2** through **7.3** are based upon procedures established in Test Methods **E45**.

7.2 *Sampling*—Samples taken in accordance with the following paragraphs shall be obtained from 4 by 4-in. (102 by 102-mm) rolled billets or forged sections. Tests may be made on smaller or larger sections by agreement with the purchaser. A minimum 3 to 1 reduction of rolled billets or forged sections is required for strand cast products.

7.2.1 For top poured products, a minimum of six samples representing the top and bottom of the first, middle, and last usable ingots shall be examined.

7.2.2 For bottom poured products, a minimum of six samples shall be examined and they shall represent the top and bottom of three ingots. One ingot shall be taken at random from the first usable plate poured, one ingot, at random, from the usable plate poured nearest to the middle of the heat and one ingot, at random, from the last usable plate poured. When two usable plates

**TABLE 1 Chemical Composition<sup>A,B</sup>**

Number <sup>C</sup>	Name	C	Mn	P (max)	S (max)	Si	Cr	Ni	Mo	Cu (max)	O (max) <sup>D</sup>	Al (max)
...	4118H	0.17 - 0.23	0.60 - 1.00	0.025	0.015	0.15 - 0.35	0.30 - 0.70	...	0.08 - 0.15	0.30	0.0020	0.050
...	4320H	0.17 - 0.23	0.40 - 0.70	0.025	0.015	0.15 - 0.35	0.35 - 0.65	1.55 - 2.00	0.20 - 0.30	0.30	0.0020	0.050
...	4620H	0.17 - 0.23	0.35 - 0.75	0.025	0.015	0.15 - 0.35	...	1.55 - 2.00	0.20 - 0.30	0.30	0.0020	0.050
...	4720H	0.17 - 0.23	0.45 - 0.75	0.025	0.015	0.15 - 0.35	0.30 - 0.60	0.85 - 1.25	0.15 - 0.25	0.30	0.0020	0.050
...	4817H	0.14 - 0.20	0.30 - 0.70	0.025	0.015	0.15 - 0.35	...	3.20 - 3.80	0.20 - 0.30	0.30	0.0020	0.050
...	4820H	0.17 - 0.23	0.40 - 0.80	0.025	0.015	0.15 - 0.35	...	3.20 - 3.80	0.20 - 0.30	0.30	0.0020	0.050
...	5120H	0.17 - 0.23	0.60 - 1.00	0.025	0.015	0.15 - 0.35	0.60 - 1.00	...	...	0.30	0.0020	0.050
...	8617H	0.14 - 0.20	0.60 - 0.95	0.025	0.015	0.15 - 0.35	0.35 - 0.65	0.35 - 0.75	0.15 - 0.25	0.30	0.0020	0.050
...	8620H	0.17 - 0.23	0.60 - 0.95	0.025	0.015	0.15 - 0.35	0.35 - 0.65	0.35 - 0.75	0.15 - 0.25	0.30	0.0020	0.050
...	9310H	0.07 - 0.13	0.40 - 0.70	0.025	0.015	0.15 - 0.35	1.00 - 1.45	2.95 - 3.55	0.08 - 0.15	0.30	0.0020	0.050
B20	20Cr3	0.17 - 0.23	0.60 - 1.00	0.025	0.015	0.40 max	0.60 - 1.00	...	...	0.30	0.0020	0.050
B21	20Cr4	0.17 - 0.23	0.60 - 0.90	0.025	0.015	0.40 max	0.90 - 1.20	...	...	0.30	0.0020	0.050
B22	20MnCr4-2	0.17 - 0.23	0.65 - 1.10	0.025	0.015	0.40 max	0.40 - 0.75	...	...	0.30	0.0020	0.050
B23	17MnCr5	0.14 - 0.19	1.00 - 1.30	0.025	0.015	0.40 max	0.80 - 1.10	...	...	0.30	0.0020	0.050
B24	19MnCr5	0.17 - 0.22	1.10 - 1.40	0.025	0.015	0.40 max	1.00 - 1.30	...	...	0.30	0.0020	0.050
B25	15CrMo4	0.12 - 0.18	0.60 - 0.90	0.025	0.015	0.40 max	0.90 - 1.20	...	0.15 - 0.25	0.30	0.0020	0.050
B26	20CrMo4	0.17 - 0.23	0.60 - 0.90	0.025	0.015	0.40 max	0.90 - 1.20	...	0.15 - 0.25	0.30	0.0020	0.050
B27	20MnCrMo4-2	0.17 - 0.23	0.65 - 1.10	0.025	0.015	0.40 max	0.40 - 0.75	...	0.10 - 0.20	0.30	0.0020	0.050
B28	20NiCrMo2	0.17 - 0.23	0.60 - 0.95	0.025	0.015	0.40 max	0.35 - 0.65	0.40 - 0.70	0.15 - 0.25	0.30	0.0020	0.050
B29	20NiCrMo7	0.17 - 0.23	0.40 - 0.70	0.025	0.015	0.40 max	0.35 - 0.65	1.60 - 2.00	0.20 - 0.30	0.30	0.0020	0.050
B30	18CrNiMo7-6	0.15 - 0.21	0.50 - 0.90	0.025	0.015	0.40 max	1.50 - 1.80	1.40 - 1.70	0.25 - 0.35	0.30	0.0020	0.050
B31	18NiCrMo14-6	0.15 - 0.20	0.40 - 0.70	0.025	0.015	0.40 max	1.30 - 1.60	3.25 - 3.75	0.15 - 0.25	0.30	0.0020	0.050
B32	16NiCrMo16-5	0.14 - 0.18	0.25 - 0.55	0.025	0.015	0.40 max	1.00 - 1.40	3.80 - 4.30	0.20 - 0.30	0.30	0.0020	0.050

<sup>A</sup> Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser.

<sup>B</sup> Intentional additions of calcium or calcium alloys for deoxidation or inclusion shape control are not permitted unless specifically approved by the purchaser.

<sup>C</sup> Steels B20 through B32 meet the requirements of ISO 683, Part 17, Second Edition, Table 3.

<sup>D</sup> Oxygen content applies to product analysis and shall be determined in accordance with Test Methods **E1019**.

constitute a heat, two of the sample ingots shall be selected from the second usable plate poured. Where a single usable plate constitutes a heat, any three random ingots may be selected. Other methods of sampling shall be as agreed upon by manufacturer and purchaser.

7.2.3 For strand cast products, a minimum of six samples representing the first, middle, and last usable portion of the heat cast shall be examined. At least one sample shall be taken from each strand.

7.3 *Inclusion Rating*—The polished face of the specimens shall be  $\frac{3}{8}$  by  $\frac{3}{4}$  in. (9.5 by 19.1 mm) and shall be taken from an area halfway between the center and outside of the billet or forged sections. The polished face shall be longitudinal to the direction of rolling. The scale used for rating the specimens shall be the Jernkontoret chart described in Test Methods E45, Method A, Plate F-F.I-A. Fields with sizes or numbers of all types of inclusions intermediate between configurations shown on the chart shall be classified as the lesser of the rating number. The worst field of each inclusion type from each specimen shall be recorded as the rating for the specimen. Two thirds of all specimens and at least one from each ingot tested, or from the first, middle, and last

**TABLE 3 Decarburization and Surface Imperfections for Coils and Bars for Balls and Rollers**

Size, in. (mm)	Decarburization or Surface Imperfections per side, max, in. (mm)	
	Hot-Rolled or Hot-Rolled Annealed	Cold-Finished
through 0.250 (6.35)	0.005 (0.13)	0.003 (0.08)
over 0.250 (6.35) to 0.500 (12.7), incl	0.006 (0.15)	0.004 (0.10)
over 0.500 (12.7) to 0.750 (19.1), incl	0.008 (0.20)	0.006 (0.15)
over 0.750 (19.1) to 1.000 (25.4), incl	0.010 (0.25)	0.008 (0.20)

**TABLE 4 Decarburization and Surface Imperfections for Bars and Tubes**

Size, in. (mm)	Decarburization and Surface Imperfections per side, max, in. (mm)				
	Hot-Rolled		Annealed		Cold-Finished
	Bars	Tubes	Bars	Tubes	Tubes
through 1.000 (25.4)	0.012 (0.31)	0.015 (0.38)	0.012 (0.31)	0.012 (0.31)	0.010 (0.21)
over 1.000 (25.4) to 2.000 (50.8), incl	0.017 (0.43)	0.022 (0.56)	0.020 (0.51)	0.015 (0.38)	0.014 (0.36)
over 2.000 (50.8) to 3.000 (76.2), incl	0.025 (0.64)	0.030 (0.76)	0.030 (0.76)	0.025 (0.64)	0.019 (0.48)
over 3.000 (76.2) to 4.000 (101.6), incl	0.035 (0.89)	0.045 (1.14)	0.035 (0.89)	...	0.024 (0.61)
over 4.000 (101.6) to 5.000 (127.0), incl	0.055 (1.40)	0.065 (1.65)	0.040 (1.02)	...	0.028 (0.71)

portion of the strands tested, as well as the average of all specimens, shall not exceed the rating specified in Table 2.

**8. Grain Size**

8.1 The grain size shall be six or finer as defined in Test Methods E112 (see Plate 4, austenitic grain size in steels). Material not meeting this requirement may be normalized at 1700°F (927°C) or above and retested.

**9. Hardenability**

9.1 Each heat shall be tested for hardenability in accordance with Test Methods A255. The “J” values for hardenability shall conform to limits specified in Specification A304 or as agreed upon by manufacturer and purchaser.

**TABLE 2 Inclusion Rating**

Rating Units	
Thin Series	Heavy Series
A — 2½	A — 1½
B — 2	B — 1
C — ½	C — ½
D — 1	D — 1

**TABLE 2 Inclusion Rating**

Rating Units	
Thin Series	Heavy Series
A 2.5	A 1.5
B 2.0	B 1.0
C 0.5	C 0.5
D 1.0	D 1.0