Designation: B 938 – 04

Standard Specification for Copper-Beryllium Alloy Forgings and Extrusions (UNS Nos. C17500 and C17510)[1]

This standard is issued under the fixed designation B 938; 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.

1. Scope

1.1 This specification establishes the requirements for copper-cobalt-beryllium alloy (UNS No. C17500) and copper-nickel-beryllium alloy (UNS No. C17510) forgings and extrusions.

1.2 The intent is to provide a system of interchangeable alloys.

1.3 *Units*—Values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.4 The following safety hazard caveat pertains only to the test method(s) 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:* [2]

B 194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar

B 249/B 249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings

B 601 Classification for Temper Designations for Copper and Copper Alloys-Wrought and Cast

B 846 Terminology for Copper and Copper Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

E 1004 Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method

3. General Requirements

3.1 The following sections of Specification B 249/B 249M constitute a part of this specification.

3.1.1 Terminology,
3.1.2 Materials and Manufacture,
3.1.3 Sampling,
3.1.4 Number of Tests and Retests,
3.1.5 Sample Preparation,
3.1.6 Test Methods,
3.1.7 Significance of Numerical Limits,
3.1.8 Inspection,
3.1.9 Rejection and Rehearing,
3.1.10 Certification
3.1.11 Mill Test Report,
3.1.12 Packaging, Marking, Shipping, and Preservation.

3.2 An identical section in this specification supplements the referenced section.

4. Terminology

4.1 For definitions of terms related to copper and copper alloys, refer to Terminology B 846.

4.2 *Definitions of Terms Specific to This Standard:*

4.2.1 *extrusion, n*—a uniform metal shape, long in relation to its cross-sectional dimensions, produced by forcing a suitably preheated billet or preform through an orifice (die) of the desired cross section. Extrusions generally are furnished in straight lengths.

4.2.2 *forging, n*—a metal part worked to a predetermined shape by one or more such processes as hammering, upsetting, pressing, rolling, and so forth.

5. Ordering Information

5.1 Include the following information when placing orders for product under this specification, as applicable:

5.1.1 ASTM designation and year of issue,
5.1.2 *Quantity*—total weight or total length or number of pieces of each size,
5.1.3 Copper Alloy UNS No. (Section 1).
5.1.4 Temper (Section 8) or condition (Section 12),
5.1.5 Drawing showing the shape, dimensions, and tolerances, if required,

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.02 on Rod, Bar, Wire, Shapes, and Forgings.

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

5.1.6 If an extrusion, the length (or mass) required and straightness as required,

5.2 The following options are available and should be specified at the time of placing of the order, when required:

5.2.1 Tension tests (Section 11)

5.2.2 Special tests such as electrical conductivity,

5.2.3 Finish (Section 15), and

5.2.4 When product is ordered for agencies of the U.S. government.

6. Materials and Manufacture

6.1 *Materials*:

6.1.1 The material of manufacture shall be cast or wrought billet of Copper Alloy UNS No. C17500 or C17510 of such purity and soundness as to be suitable for processing in to the products prescribed herein.

6.1.2 The product heat number shall appear on the certification or test report.

6.2 *Manufacture*:

6.2.1 The product shall be manufactured by hot working and heat treating as may be necessary to meet the properties specified herein.

6.2.2 The product shall be hot worked to the finished size, and subsequently annealed when required, to meet the temper properties specified.

7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements in Table 1 for the copper alloy UNS No. specified in the ordering information.

7.1.1 Results of analysis on a product (check) sample shall conform to the composition requirements within the permitted analytical variance specified in Table 1.

7.2 These composition limits do not preclude the presence of other elements. By agreement between the manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

7.3 Copper is listed as "Remainder," copper is the difference between the sum of results of all elements determined and 100 %. When all elements in Table 1 are determined, the sum of results shall be 99.5 % min.

8. Temper

8.1 The standard temper designations available under this specification and as prescribed in Classification B 601 are solution heat-treated TB00 (A) and precipitation treated TF00 (AT).

TABLE 1 Chemical Composition

Element	Concentration, %	
	Copper Alloy UNS No. C17500	Copper Alloy UNS No. C17510
Beryllium	0.4-0.7	0.2-0.6
Cobalt	2.4-2.7	0.3 max
Nickel	. . .	1.4-2.2
Iron, max	0.10	0.10
Aluminum, max	0.20	0.20
Silicon, max	0.20	0.20
Copper	Remainder	Remainder

NOTE 1—Although not produced under this specification, non-standard tempers are available by special order and the properties of such product are subject to negotiation between the manufacturer and the purchaser.

9. Physical Property Requirements

9.1 *Electrical Conductivity*—Product furnished to this specification shall conform to the electrical conductivity requirement given in Table 2 for the applicable temper when tested in accordance with Practice E 1004.

10. Mechanical Property Requirements

10.1 *Hardness*:

10.1.1 The product furnished under this specification shall conform to the hardness requirement prescribed in Table 2 for the solution heat-treated condition and Table 3 after precipitation heat treatment, unless tensile properties are required by the purchase order. Rockwell hardness shall be determined in accordance with Test Methods E 18.

10.1.2 The approximate Rockwell hardness values given in Table 2 and Table 3 are for general information and assistance in testing, and shall not be used as a basis for product rejection.

10.2 *Tensile*:

10.2.1 When specified in the contract or purchase order, the tensile properties of the product furnished under this specification shall conform to the tensile requirements prescribed in Table 2, when tested in accordance with Test Methods E 8.

10.2.2 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

NOTE 2—The Rockwell hardness test offers a quick and convenient method of checking for general conformity to the specification requirements for temper and tensile strength.

11. Precipitation Heat Treatment

11.1 When material is purchased in the TB00 (A) temper, the precipitation heat treatment is performed by the purchaser.

11.2 Conformance to the TF00 (AT) specification limits shown in shown in Table 2, for products supplied in the TB00 (A) temper, shall be determined by testing test specimens heat-treated at a uniform temperature of 850 to 900°F for the times shown in Table 3.

11.3 End products may be heat-treated at other times and temperatures for specific applications. These special combinations of properties such as increased ductility, dimensional accuracy, and endurance strength may be obtained by special precipitation-hardening heat treatments. The mechanical requirements of Table 2 do not apply to such special heat treatment. Specific test requirements as needed shall be agreed upon between the manufacturer or the supplier and the purchaser of the end product.

11.4 TF00 (AT) temper as standard mill-hardened products has been precipitation heat-treated and tested by the manufacturer. An appropriate time and temperature has been used to produce properties within the specification limits shown in Table 2. Table 3 does not apply. Further thermal treatment of these tempers is not normally required.

11.5 Material may be supplied with nonstandard properties. Table 2 values would not apply. Specific test requirements as needed shall be agreed upon between the manufacturer or supplier and the purchaser of these end products.

TABLE 2 Tensile Strength and Rockwell Hardness Requirements[A]

Temper Designation		As Supplied		
Standard	Former	Tensile Strength ksi[B](MPa[C])	Rockwell Hardness, B Scale	Electrical Conductivity IACS min, %
TB00	Solution heat-treated (A)	35-55 (240-380)	50 max After Precipitation Heat Treatment	20
TF00	Precipitation hardened (AT)	100-130 (690-895)[D]	92-100	45

[A] These values apply to mill products. See Section 10 for exceptions in end products.
[B] ksi = 1000 psi.
[C] See Appendix.
[D] The upper limits in the tensile strength column are for design guidance only.

TABLE 3 Precipitation Heat-Treatment Time for Acceptance Tests

Temper Designation		Copper Alloy UNS No. C17500 at 900°F (482°C), h	Copper Alloy UNS No. C17510 at 850°F (454°C)[A] to 900°F (482°C)[A], h
Standard	Former		
TB00	Solution heat-treated (A)	3	3

[A] Specific temperature used must conform with supplier's certification.

12. Purchases for the U.S. Government

12.1 When specified in the contract or purchase order, product purchased for agencies of the U.S. government shall conform to the special government regulations specified in the Supplemental Requirements section of Specification B 249/B 249M.

13. Dimensions, Mass, and Permissible Variation

13.1 The dimensions and tolerances for product described by this specification shall be those shown on the drawing that forms a part of each order, or as agreed upon between the manufacturer and the purchaser.

14. Workmanship, Finish, and Appearance

14.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

15. Test Methods

15.1 *Chemical Analyses*:

15.1.1 The chemical composition shall, in cases of disagreement, be determined in accordance with the applicable method in Annex A1 of Specification B 194.

15.1.2 Test method(s) to be followed for the determination of element(s) resulting from contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and purchaser.

16. Test Report

16.1 When specified in the contract or purchase order, the manufacturer or supplier shall furnish to the purchaser a manufacturer's test report showing the results of the required tests.

17. Keywords

17.1 copper beryllium; extrusions; forgings; UNS No. C17500; UNS No. C17510

APPENDIX

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the Newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa the metric equivalents are expressed as megapascal (Mpa), which is the same as MN/m^2 and N/mm^2.