Designation: A877/A877M – 16

Standard Specification for Steel Wire, Chromium-Silicon Alloys, Chrome-Silicon-Vanadium Alloy Valve Spring Quality[1]

This standard is issued under the fixed designation A877/A877M; 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 covers the highest quality of round and shaped chromium-silicon and chromium-silicon-vanadium alloys of steel valve spring wire, uniform in quality and temper, intended for the manufacture of valve springs and other springs requiring high-fatigue properties when used at moderately elevated temperatures. It is similar to the grade VD (referenced in EN 10270-2) intended for high fatigue levels. This wire shall be either in the annealed and cold-drawn or quenched and tempered condition as specified by purchaser.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E8 Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E45 Test Methods for Determining the Inclusion Content of Steel

2.2 *European Standard:*

EN 10270-2 Steel Wire for Mechanical Springs Part 2: Oil-Hardened and Tempered Spring Steel Wire of Unalloyed and Alloyed Steels.[3]

3. Ordering Information

3.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material under this specification. Such requirements are permitted to include, but are not limited to the following:

3.1.1 Quantity (mass),

3.1.2 Name of material (chromium-silicon alloy steel valve spring quality wire),

3.1.3 Dimensions (Table 1 and Section 8),

3.1.4 Condition (Section 6),

3.1.5 Packaging (Section 14),

3.1.6 Heat analysis report, if requested (5.2),

3.1.7 Certification or test report, or both, if specified (Section 13), and

3.1.8 ASTM designation and year of issue.

NOTE 1—A typical ordering description is as follows: 20 000-kg quenched and tempered chromium-silicon alloy steel valve spring quality wire, size 6.00 mm in 150-kg coils to A877/A877M dated ___, or for inch-pound units, 40 000-lb quenched and tempered chromium-silicon alloy steel valve spring quality wire, size 0.250 in. in 350-lb coils to A877/A877M dated ___.

4. Materials and Manufacture

4.1 The steel shall be made by a steel making process combined with secondary ladle refining that is capable of satisfying the inclusion content requirements of this specification.

4.2 The steel shall be continuously cast into blooms and rolled into billets.

4.3 Billet conditioning shall precede wire rod manufacture. The resulting wire rods shall be of sufficient surface quality that when combined with a surface removal operation performed prior to or during the wire manufacturing operation the resulting wire shall satisfy the surface condition and decarburization requirements of this specification.

4.4 The finished wire shall be free from detrimental pipe and undue segregation.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.03 on Steel Rod and Wire.

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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.

[3] Available from European Committee for Standardization, Rue de Stassart 36, B-1050 Brussels, Belgium.

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

TABLE 1 Permissible Variations in Wire Diameter[A]

SI Units		
Diameter, mm	Permissible Variations, ±mm	Permissible Out-of Round, mm
0.5 to 2.0, incl	0.02	0.02
Over 2.0 to 4.0, incl	0.03	0.03
Over 4.0 to 9.5, incl	0.04	0.04
Inch-Pound Units		
Diameter, in.	Permissible Variations, ± in.	Permissible Out-of Round, in.
0.020 to 0.075, incl	0.0008	0.0008
Over 0.075 to 0.148, incl	0.001	0.001
Over 0.148 to 0.375, incl	0.0015	0.0015

[A] For purposes of determining conformance with this specification, all specified limits are absolute as defined in recommended Practice E29.

5. Chemical Composition

5.1 The steel shall conform to the requirements for chemical composition specified in Table 2.

5.2 *Heat Analysis*—Each heat of steel shall be analyzed by the manufacturer to determine the percentage of elements prescribed in Table 2. This analysis shall be made from a test specimen preferably taken during the pouring of the heat. When requested, this shall be reported to the purchaser and shall conform to the requirements of Table 2.

5.3 *Product Analysis*—An analysis may be made by the purchaser from finished wire representing each heat of steel. The average of all the separate determinations made shall be within the limits specified in the analysis column. Individual determinations may vary to the extent shown in the product analysis tolerance column, except that the several determinations of a single element in any one heat shall not vary both above and below the specified range.

5.4 For referee purposes, Test Methods, Practices, and Terminology A751 shall be used.

6. Mechanical Properties

6.1 *Annealed and Cold Drawn*—When purchased in the annealed and cold-drawn condition, the wire shall have been given a sufficient amount of cold working to meet the purchaser's coiling requirements and shall be in a suitable condition to respond properly to heat treatment. In special cases the hardness, if desired, shall be stated in the purchase order.

6.2 *Quenched and Tempered*—When purchased in the quenched and tempered condition, the tensile strength and reduction of area (% R.A.) shall conform to the requirements prescribed in Table 3, Table 4, or Table 5. Percent reduction of the area (% R.A.) is not applicable to wire diameters under 2.0 mm [0.080 in.].

6.2.1 *Tensile Strength of Shaped and Flat Rolled Wire*—Tensile strength of shaped and flat rolled wires shall conform to these tables based on the conversion to equivalent round dimensions. Percent reduction of area is not applicable to flat rolled wires.

NOTE 2—Equivalent round definition: The cross sectional area of shaped wires converted to the round wire diameter.

6.2.2 *Tensile Strength Variation*—In addition, the maximum tensile variation in a coil shall be 70 MPa [10.15 ksi].

6.2.3 *Number of Tests*—One test specimen shall be taken from each end of every coil in a lot. Each heat in a given lot shall be tested.

NOTE 3—Any specimen breaking in the tensile grips shall be discarded and a new specimen tested if the specified mechanical properties are not achieved. If breakage in the tensile grips prevents conformance to percent reduction in area requirements, conformance to the wrap test (see 6.3) shall suffice.

6.2.4 *Location of Tests*—Test specimens shall be taken from both ends of the coil.

6.2.5 *Test Method*—The tension test shall be made in accordance with Test Methods and Definitions A370. For shaped wires, cross sectional area shall be calculated by either using the procedure in Test Methods E8 (Subsection 7.2.2) for uniform but nonsymmetrical cross-sections, or by measuring width and thickness and multiplying by a shape factor. Reduction of area for shaped wires shall be calculated by using this shape factor. Measure the maximum and minimum dimension on the necked down section and multiply by the shape factor to estimate the cross sectional area for use in the standard reduction of area calculation.

6.2.5.1 Upon agreement between purchaser and supplier, the shape factor for the design provided by the wire mill shall be permissible to be adopted for use. In other situations if the shape factor is not available from the wire mill, the shape factor shall be calculated by measuring the cross sectional area in accordance with Test Methods E8 and dividing by the width and thickness.

6.3 *Wrap Test:*

6.3.1 *Grade A*—Round quenched and tempered or cold drawn wire 4.00 mm [0.157 in.] or smaller in diameter shall wrap on itself as an arbor without breakage. Larger diameter wire up to and including 8.00 mm [0.315 in.] in diameter shall wrap without breakage on a mandrel twice the wire diameter. The wrap test is not applicable to wire over 8.00 mm [0.315 in.] in diameter or to shaped and flat rolled wires.

6.3.2 *Grades B, C, or D*—Round of quenched and tempered wire 4.00 mm [0.1575 in.] or smaller in diameter shall wrap on a mandrel twice the diameter without breakage. Larger diameter wire up to and including 8.00 mm [0.315 in.] shall wrap without breakage on a mandrel three times the wire diameter. The wrap test is not applicable to wire over 8.00 mm [0.315 in.] in diameter or to shaped and flat rolled wires.

6.3.3 *Number of Tests*—One test specimen shall be taken for each five coils, or fraction thereof, in a lot. Each heat in a given lot shall be tested.

6.3.4 *Location of Tests*—Test specimens shall be taken from either end of the coil.

6.3.5 *Test Method*—The wrap test shall be made in accordance with Test Methods and Definitions A370.

6.4 *Special Surface Inspection*—The entire length of every coil shall be inspected for surface imperfections with a rotating and stationary probe eddy current defect analyzer, or equivalent system. Imperfections deeper than 0.04 mm [0.0016 in.] shall be properly marked so the purchaser has the ability to identify and discard that length of wire; other depths may be agreed upon. Number of allowable marks per coil, shall be