



Designation: B9 – 76 (Reapproved 2017)

## Standard Specification for Bronze Trolley Wire<sup>1</sup>

This standard is issued under the fixed designation B9; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers round, grooved, and figure-9 deep-section grooved bronze trolley wire.

1.2 The bronze trolley wire may be made in any of the three distinct alloys indicated in accordance with their increasing conductivities: Alloy 40, Alloy 55, Alloy 80.

1.3 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units given in this standard may be approximate.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Ordering Information

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

- 2.1.1 Quantity of each size, section, and class,
- 2.1.2 Wire size: diameter in in. (see 5.1 and Table 1) or area in circular mils (see 8.1 and Fig. 1 and Fig. 2),
- 2.1.3 Shape of section (see 1.1),
- 2.1.4 Alloy (see 1.2),
- 2.1.5 Package size (see 17.3),
- 2.1.6 Lagging, if required (see 17.1),
- 2.1.7 Relation between vertical axis of grooved wire and axis of reel (see 17.1),
- 2.1.8 Size of arbor hole if other than 4-in. (102 mm) square (see 17.2),
- 2.1.9 Special package marking, if required (see 17.4), and
- 2.1.10 Place of inspection (Section 15).

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.04 on Conductors of Copper and Copper Alloys.

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### 3. Material

3.1 The material shall be bronze of such nature and composition (Explanatory Note 1) as to secure, by proper treatment, the qualities prescribed in this specification for the finished wire.

#### ROUND WIRE

### 4. Tensile Properties

4.1 Round wire shall conform to the requirements as to tensile properties prescribed in Table 1.

4.2 Tests on a specimen of round wire containing a joint shall show at least 95 % of the tensile strength specified in Table 1. Elongation tests shall not be made on specimens containing joints.

4.3 Tension tests shall be made on representative samples. The elongation shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between gage marks placed originally 10 in. (254 mm) apart upon the test specimen (Explanatory Note 2). The fracture shall be between the gage marks and not closer than 1 in. (25.4 mm) to either gage mark.

### 5. Dimensions and Permissible Variations

5.1 The size of round trolley wire shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.1 mil (0.0001 in.) (0.0025 mm).

5.2 Wire shall be truly cylindrical in form. The diameter shall not vary more than  $\pm 1$  % from that specified.

### 6. Twist Test

6.1 For the purpose of determining and developing defects which may be prejudicial to the life of trolley wire, owing to its peculiar service as compared to that of wire for other purposes, round wire shall be subjected to the twist test described in 6.2. Round wire shall not be considered satisfactory if it does not withstand, without breaking, at least the number of twists prescribed in Table 2.

6.2 Three twist tests shall be made on specimens 10 in. (254 mm) in length between the holders of the testing machine. The twisting machine shall be so constructed that there is a linear motion of the tail stock with respect to the head. The twist shall

**TABLE 1 Tensile Requirements for Round Trolley Wire**

Diameter		Area		Tensile Strength, min				Elongation in 10 in. (254 mm), min, %
in.	mm	cmil	mm <sup>2</sup>	Alloys 40 and 55		Alloy 80		
				psi	MPa	psi	MPa	
0.5477	13.911	300 000	152.0	64 800	447	61 500	424	4.50
0.4600	11.648	211 600	107.0	69 000	476	65 000	448	3.75
0.4096	10.404	167 800	85.0	71 000	490	67 000	462	3.25
0.3648	9.266	133 100	67.4	73 000	503	69 000	476	2.75
0.3249	8.252	105 600	53.5	76 000	524	72 000	496	2.40

be applied not faster than 10 turns/min. All three specimens shall be twisted to destruction and shall not reveal under test any seams, pits, slivers, or surface imperfections of sufficient magnitude to indicate inherent defects or imperfections in the wire. At the time of fracture the wire shall twist with reasonable uniformity.

### GROOVED AND FIGURE-9 WIRE

#### 7. Tensile Properties

7.1 Grooved and figure-9 wire shall conform to the applicable requirements as to tensile properties prescribed in [Table 3](#).

7.2 Tests on a specimen of grooved or figure-9 wire containing a joint shall show at least 95 % of the tensile strength specified in [Table 3](#). Elongation tests shall not be made on specimens containing joints.

7.3 The tension and elongation tests for grooved or figure-9 wire shall be made in the same manner as those on round wire as described in [4.3](#).

#### 8. Dimensions and Permissible Variations

8.1 The size of the trolley wire shall be expressed as the nominal area of cross section in circular mils.

8.2 The standard sizes of grooved trolley wire shall be as specified in [Fig. 1](#).

8.3 The standard size of figure-9 wire shall be as specified in [Fig. 2](#).

8.4 The weight in pounds per mile of grooved and figure-9 trolley wire calculated from the weight of a specimen not less than 18 in. (460 mm) in length shall not vary more than  $\pm 4$  % from that specified in [Fig. 1](#) for grooved wire, and [Fig. 2](#) for figure-9 wire.

8.5 Conformance of the trolley wire to the specified dimensions shall be determined by taking the measurements shown in [Fig. 1](#) and [Fig. 2](#) under the heading, “Dimensions for Inspection, in.” The shape of the groove shall be checked with the appropriate “go” and “no-go” slip gages described in [Fig. 3](#). The gages shall be applied to the ends of the samples taken from each reel. Samples shall be clean and the ends free from burrs. The groove shall be considered as conforming to this specification if the “go” gage can be pushed on the straightened wire by hand and the “no-go” gage cannot be pushed on the wire.

#### 9. Sections

9.1 Standard sections of grooved trolley wire shall be known as the “American Standard Grooved Trolley Wire Sections” (the Standard Design of the American Transit Engineering Association) shown in [Fig. 1](#).

9.2 The standard section of figure-9 wire shall be as shown in [Fig. 2](#).

#### 10. Twist Test

10.1 For the purpose of determining and developing defects that may be prejudicial to the life of trolley wire, owing to its peculiar service as compared to that of wire for other purposes, grooved wire shall be subjected to the twist test described in [6.2](#). Grooved wire that does not withstand at least three twists without breaking shall not be considered satisfactory. The twist test shall be omitted for figure-9 wire.

### ROUND, GROOVED, AND FIGURE-9 WIRE

#### 11. Resistivity

11.1 Electrical resistivity shall be determined on representative samples by resistance measurements (Explanatory [Note 3](#)). At a temperature of 20°C the resistivity shall not exceed the values prescribed in [Table 4](#).

11.2 Lower resistivities in wires conforming to the physical qualifications may be obtained by the use of special alloys.

#### 12. Density

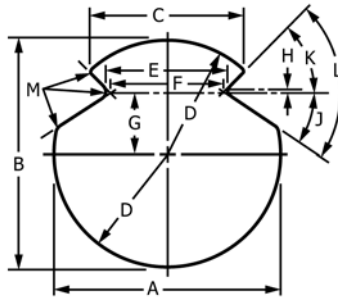
12.1 For the purpose of calculating mass, cross-sections, and so forth, the density of the bronze (Explanatory [Note 4](#)) shall be taken as 8.89 g/cm<sup>3</sup> (0.32117 lb/in.<sup>3</sup>) at 20°C (Explanatory [Note 5](#)).

#### 13. Joints

13.1 No joints shall be made in the completed wire. Joints in the wire and rods made prior to final drawings shall be in accordance with the best commercial practice, and shall be capable of meeting the tensile strength requirements in [4.2](#) or [7.2](#).

#### 14. Workmanship, Finish, and Appearance

14.1 The wire shall be of uniform size, shape, and quality throughout, and shall be free from all scale, flaws, splits, and scratches not consistent with the best commercial practice.



Nominal Size:					
cmil	133 100	167 800	211 600	300 000	350 000
(mm <sup>2</sup> )	(67.4)	(85.0)	(107.00)	(152.0)	(177.3)
Area (Explanatory Note 6):					
cmil	137 900	167 300	212 000	299 800	351 200
in <sup>2</sup>	0.1083	0.1314	0.1665	0.2355	0.2258
(mm <sup>2</sup> )	(69.9)	(84.7)	(107.4)	(151.9)	(177.9)
Weight (Explanatory Note 6):					
lb/mile	2205	2674	3389	4792	5612
(kg/km)	(621)	(756)	(955)	(1350)	(1581)
	Dimensions for Inspection, in.				
A	0.388 <sup>+0.006</sup> <sub>-0.012</sub>	0.429 <sup>+0.006</sup> <sub>-0.012</sub>	0.482 <sup>+0.006</sup> <sub>-0.012</sub>	0.574 <sup>+0.010</sup> <sub>-0.020</sub>	0.620 <sup>+0.010</sup> <sub>-0.020</sub>
B	0.392 ± 0.007	0.430 ± 0.008	0.482 ± 0.009	0.574 ± 0.011	0.620 ± 0.012
C	0.318 ± 0.007	0.340 ± 0.007	0.376 ± 0.007	0.376 ± 0.007	0.376 ± 0.007
	Dimensions for Inspection, mm				
A	9.86 <sup>+0.1524</sup> <sub>-0.3048</sub>	10.6 <sup>+0.1524</sup> <sub>-0.3048</sub>	12.2 <sup>+0.1524</sup> <sub>-0.3048</sub>	14.6 <sup>+0.254</sup> <sub>-0.508</sub>	15.7 <sup>+0.254</sup> <sub>-0.508</sub>
B	9.96 ± 0.1778	10.9 ± 0.2032	12.2 ± 0.2286	14.6 ± 0.2794	15.7 ± 0.3048
C	8.08 ± 0.1778	8.64 ± 0.1778	9.55 ± 0.1778	9.55 ± 0.1778	9.55 ± 0.1778
	Dimensions for Reference, in.				
D—radius	0.196	0.215	0.241	0.287	0.310
E	0.217 <sup>+0.005</sup> <sub>-0.010</sub>	0.237 <sup>+0.005</sup> <sub>-0.010</sub>	0.267 ± 0.010	0.267 ± 0.010	0.267 ± 0.010
F	0.200	0.220	0.250	0.250	0.250
G	0.031	0.047	0.063	0.127	0.156
H	0.005	0.005	0.005	0.005	0.005
J	27 ± 2°	27 ± 2°	27 ± 2°	27 ± 2°	27 ± 2°
K	51 ± 2°	51 ± 2°	51 ± 2°	51 ± 2°	51 ± 2°
L	78°	78°	78°	78°	78°
M—radius	0.015 <sup>+0.010</sup> <sub>-0.005</sub>	0.015 <sup>+0.010</sup> <sub>-0.005</sub>	0.015 <sup>+0.010</sup> <sub>-0.005</sub>	0.015 <sup>+0.010</sup> <sub>-0.005</sub>	0.015 <sup>+0.010</sup> <sub>-0.005</sub>
	Dimensions for Reference, mm				
D—radius	4.98	5.46	6.12	7.29	7.84
E	5.51 <sup>+0.127</sup> <sub>-0.254</sub>	6.02 <sup>+0.127</sup> <sub>-0.254</sub>	6.78 ± 0.254	6.78 ± 0.254	6.78 ± 0.254
F	5.08	5.59	6.35	6.35	6.35
G	0.7874	1.194	1.60	3.23	3.96
H	0.127	0.127	0.127	0.127	0.127
M—radius	0.381 <sup>+0.254</sup> <sub>-0.127</sub>	0.381 <sup>+0.254</sup> <sub>-0.127</sub>	0.381 <sup>+0.254</sup> <sub>-0.127</sub>	0.381 <sup>+0.254</sup> <sub>-0.127</sub>	0.381 <sup>+0.254</sup> <sub>-0.127</sub>

NOTE 1—Dimensions H is defined by two center lines of which the upper is the center line of the radius of the groove and the lower is the center line of the groove.

FIG. 1 Standard Sections Grooved Trolley Wire