U. S. Gov't
Master
Specification
No. 297

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
George K. Burgess, Director

CIRCULAR OF THE BUREAU OF STANDARDS, No. 208

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UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR WIRE ROPE

FEDERAL SPECIFICATIONS BOARD SPECIFICATION No. 297

This specification was officially promulgated by the Federal Specifications Board on June 1, 1925, for the use of the Departments and Independent Establishments of the Government in the purchase of wire rope.

CONTENTS

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I. TYPES

The wire ropes covered by this specification are of the following types:

A, 1 by 7 seizing strand.
B, 1 by 19 seizing strand.
C, 5 by 19 marline covered, extra strong cast steel.
D, 5 by 19 marline covered, high-grade plow steel.
E, 6 by 7 extra strong cast steel.
F, 6 by 12 cast steel.
G, 6 by 12 high-grade plow steel.
H, 6 by 12 phosphor bronze.
J, 6 by 19 cast steel.
K, 6 by 19 extra strong cast steel.
L, 6 by 19 plow steel.
M, 6 by 19 high-grade plow steel.

N, 6 by 19 phosphor bronze.
P, 6 by 24 cast steel.
Q, 6 by 24 high-grade plow steel.
R, 6 by 37 extra strong cast steel.
S, 6 by 37 high-grade plow steel.
T, 8 by 19 cast steel.
U, 8 by 19 extra strong cast steel.

II. MATERIAL AND WORKMANSHIP

1. GENERAL

The rope shall be made from the best quality of the specified grade of material, shall be of good workmanship, and shall be free from defects which might affect its appearance or serviceability.

2. WIRE

The wire shall be one of the following materials, designated commercially as:

(*a*) Phosphor Bronze.—Wires taken from the finished rope shall have a tensile strength of not less than 90,000 lbs./in.^{2}

(*b*) Cast Steel.—Wires taken from the finished rope shall have a tensile strength of not less than 170,000 lbs./in.^{2}

(*c*) Extra Strong Cast Steel.—Wires taken from the finished rope shall have a tensile strength of not less than 170,000 lbs./in.^{2} if galvanized, or 190,000 lbs./in.^{2} if uncoated.

(*d*) Plow Steel.—Wires taken from the finished rope shall have a tensile strength of not less than 190,000 lbs./in.^{2} if galvanized, or 210,000 lbs./in.^{2} if uncoated.

(*e*) High-Grade Plow Steel.—Wires taken from the finished rope shall have a tensile strength of not less than 210,000 lbs./in.^{2} if galvanized, or 230,000 lbs./in.^{2} if uncoated.

3. TENSILE TEST OF WIRES

The tensile test of the wires in a wire rope may be required at the option of the purchaser. If required, it shall be so stated in the order.

4. TORSIONAL TEST OF WIRES

The wire for bronze and uncoated steel wire rope shall not break when one end is held and the other end rotated the number of complete revolutions (of 360°) given in Table 1.

Table 1.—*Minimum number of revolutions for uncoated steel and phosphor bronze wire*

[Wires are uncoated, if they are not galvanized (zinc coated). They may be coated with other material, if desired by the maker, provided the diameter of the wire be not increased more than 0.001 inch and provided the coating material be not detrimental. Distance between jaws of testing machine, 8 inches]

Material	Number of revolutions	
Phosphor bronze	2.0	Divided by the diameter in inches of the wire.
Cast steel	2.6	
Extra strong cast steel	2.4	
Plow steel	2.2	
High-grade plow steel	2.0	

5. WRAPPING TEST FOR WIRES

When wrapped in a close helix, for six complete turns about a mandrel, and then unwrapped, the wire for galvanized steel wire rope shall not break. The diameter of the mandrel shall be twice the diameter of the wire.

6. GALVANIZING

Galvanized wires shall be uniformly and continuously coated with zinc, which adheres firmly to the wire. The zinc shall be applied in a molten condition by what is designated commercially as "hot-process galvanizing." Using the Preece test, the wire shall not show the appearance of bright, adherent copper, indicating exposed iron, for the number of immersions shown in Table 2.

This test for the thickness of the zinc coating may be required at the option of the purchaser. If required, it shall be so stated in the order.

TABLE 2.—*Minimum number of immersions, Preece test for galvanized steel wire*

[For one immersion the specimen is dipped into the solution for one minute and then removed. For one-half immersion it is dipped for one-half minute and then removed]

Diameter of wire in inches	Number of immersions
0.028 to 0.047	1
0.048 to 0.054	2
0.055 to 0.063	2½
0.064 to 0.079	3
0.080 to 0.092	3½
0.093 and larger	4

7. STRAND FABRICATION

Strands for wire rope having 19 wires may be fabricated either in one or in two operations. Small filler wires are sometimes used in addition to the 19 large wires.

(*a*) ONE OPERATION.—This is the process of fabricating the strand in which all the wires meet at a point and the strand is formed by laying all of the wires in a helix around the central wire at the same time. All the wires around the central wire have, therefore, the same lay, and each wire is in contact with the same wires for its entire length.

(*b*) TWO OPERATIONS.—This is the process of fabricating the strand in which the inside wires meet at a point and are laid in a helix around the central wires, after which the outside wires are laid in a helix having a different pitch around the inside wires. An outside wire, therefore, is not in contact with the same wires for its entire length.

(*c*) TEST.—To determine whether a strand has been fabricated in one or in two operations, remove a strand from the rope and unlay one outside wire, holding the remaining outside wires in their proper

positions. If the outside wire which is unlaid were in contact continuously with the same inside wires, the strand was fabricated in one operation; if it were in contact with different wires, the strand was fabricated in two operations.

(*d*) THREE OPERATIONS.—Wire ropes having three layers of wires and a central wire in each strand may be fabricated by using one operation to form the first layer about the central wire, a second operation to add the second layer, and a third operation to add the third layer of wires, which completes the strand. The test for the number of operations is similar to that for one and two operations in a rope having two layers of wire and a central wire.

8. FIBER CORES

Fiber cores for wire rope shall be of the required material, either cotton or one of the hard fibers, as specified in the detailed requirements. The hard fibers are manila (abaca), java (African, Mexican, or Yucatan), and sisal. Jute fiber shall not be used. A mixture of two or more kinds of hard fiber may be used. Fiber cores shall be of the best quality of fiber, thoroughly cleaned and free from waste, evenly twisted, of uniform ply, and of good workmanship.

9. LUBRICATION

Each fiber core of wire rope shall be thoroughly impregnated with a suitable lubricant during the process of manufacture of the rope.

10. MARLINE

Marline covering for wire rope shall be good quality, hard American or Russian hemp. The marline shall be saturated with pine tar.

III. GENERAL REQUIREMENTS

1. DIAMETER OF ROPE

The diameter of a seizing strand or of a wire rope is the diameter of the circumscribed circle. The amount which the actual diameter of a rope differs from the nominal diameter shall not be greater than the values in Table 3.

TABLE 3.—*Diameter tolerances for wire rope*

Nominal diameter of rope in inches	Undersize	Oversize
	Inch	*Inch*
0 to ¾	0	1/32
13/16 to 1⅛	0	1/16
1 3/16 to 1½	0	1/16
1 5/16 to 2¼	0	3/32
2 5/16 and larger	0	⅛

2. LAY

The lay of wire rope is the distance parallel to the axis of the rope in which a strand makes one complete turn about the axis of the rope. The lay of the strand, similarly, is the distance in which a wire makes one complete turn about the axis of the strand.

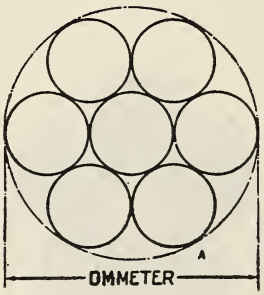
Wire rope shall be regular lay; that is, the strands shall form a helix about the axis of the rope similar to the threads of a right-hand screw and the wires form a left-hand helix about the axis of the strand. The lay of the wires in the strand should make them approximately parallel to the axis of the rope where they would come into contact with a cylindrical surface which inclosed the rope.

Seizing strand shall be standard lay; that is, the wires shall form a helix about the axis of the strand similar to the threads of a left-hand screw.

IV. DETAIL REQUIREMENTS

1. TYPE A, 1 BY 7 SEIZING STRAND

Seizing strand of type A shall be made as described and illustrated here and have the properties given in Table 4.



Construction.—One diameter of wire, one operation. One strand of 7 wires, total 7 wires. No core.

Material.—Wires: Iron or low carbon steel, annealed and galvanized.

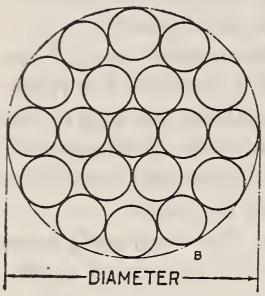
Diameter.—The actual diameter of seizing strand, type A, shall not be smaller than the nominal diameter nor larger than the nominal diameter plus $\frac{1}{64}$ inch.

Lay.—Seizing strand, type A, shall be standard lay, and the lay shall not be more than 12 times the nominal diameter.

TABLE 4.—*Properties of seizing strand, type A*

Nominal diameter	Approximate diameter of wire	Approximate weight per foot	Approximate weight per fathom (6 feet)	Weight of reel	Length of strand on reel		Minimum breaking strength
Inch	*Inch*	*Pounds*	*Pounds*	*Pounds*	*Feet*	*Fathoms*	*Pounds*
$\frac{1}{16}$	0.022	0.010	0.06	50	5,000	834	130
$\frac{3}{32}$	.032	.020	.12	50	2,500	416	280
$\frac{1}{8}$	.042	.033	.20	50	1,500	250	490
$\frac{4}{32}$	.052	.050	.30	50	1,000	166	750

2. TYPE B, 1 BY 19 SEIZING STRAND



Seizing strand of type B shall be made as described and illustrated here and have the properties given in Table 5.

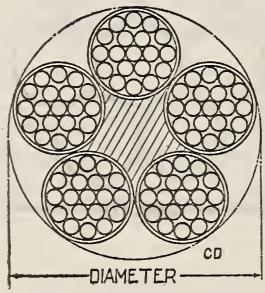
Construction.—One diameter of wire, one operation. One strand of 19 wires, total 19 wires. No core.

Material.—Wires: Iron or low carbon steel, annealed and galvanized.

Diameter.—The actual diameter of seizing strand, type B, shall not be smaller than the nominal diameter nor larger than the nominal diameter plus $\frac{1}{64}$ inch.

Lay.—Seizing strand, type B, shall be standard lay, and the lay shall not be more than 12 times the nominal diameter.

3. TYPE C, 5 BY 19 MARLINE COVERED EXTRA STRONG CAST STEEL



Wire rope of type C shall be made as described and illustrated here and shall have the properties given in Table 6.

Construction.—Either (*a*), (*b*), (*c*), or (*d*) of IV, 9. Five strands of 19 wires each, total 95 wires. Each strand shall be served with marline wound tightly on the strand, so that it is firm, durable, uniformly smooth, and free from knots and imperfections. One main core.

Material.—Wires: Extra strong cast steel, uncoated. Main core, hard fiber.

Diameter.—The actual diameter of wire rope, type C, shall not be more than $\frac{1}{16}$ inch larger or smaller than the nominal diameter.

Lay.—Wire rope, type C, shall be regular lay, and the lay shall not be greater than $6\frac{3}{4}$ times the nominal diameter.

TABLE 5.—*Properties of seizing strand, type B*

Nominal diameter	Approximate diameter of wire	Approximate weight per foot	Approximate weight per fathom (6 feet)	Weight of reel	Length of strand on reel		Minimum breaking strength
Inch	*Inch*	*Pound*	*Pound*	*Pounds*	*Feet*	*Fathoms*	*Pounds*
$\frac{1}{8}$	0.042	0.083	0.50	100	1,200	200	1,100
$\frac{1}{4}$	.052	.133	.80	100	750	125	1,900

TABLE 6.—*Properties of wire rope, type C*

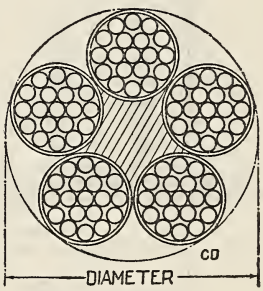
Diameter before serving	Approximate diameter after serving	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
1/4	1/2	0.21	1.26	3,600	890	1.0
3/8	11/16	.36	2.16	8,000	1,910	1.5
1/2	27/32	.54	3.24	14,400	3,200	2.0
9/16	29/32	.65	3.90	18,000	4,000	2.2
5/8	1	.80	4.80	22,400	5,000	2.5
3/4	1 1/16	1.05	6.30	32,000	7,100	3.0
7/8	1 1/4	1.35	8.10	44,600	9,900	3.5
1	1 3/8	1.70	10.2	57,000	12,700	4.0
1 1/8	1 1/2	2.07	12.4	72,000	16,000	4.5
1 1/4	1 5/8	2.52	15.1	90,000	20,000	5.0
1 3/8	1 3/4	3.06	18.4	107,000	23,800	5.5
1 1/2	1 7/8	3.64	21.8	128,000	28,400	6.0
1 5/8	2	4.26	25.6	149,000	33,100	6.5
1 3/4	2 1/8	4.90	29.4	174,000	38,700	7.0

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

4. TYPE D, 5 BY 19 MARLINE COVERED HIGH-GRADE PLOW STEEL

Wire rope of type D shall be made as described and illustrated here and shall have the properties given in Table 7.

Construction.—Either (*a*), (*b*), (*c*), or (*d*) of IV, 9. Five strands of 19 wires each, total, 95 wires. Each strand shall be served with marline wound tightly on the strand, so that it is firm, durable, uniformly smooth, and free from knots and imperfections. One main core.



Material.—Wires: High-grade plow steel, uncoated. Main core, hard fiber.

Diameter.—The actual diameter of wire rope, type D, shall not be more than 1/16 inch larger or smaller than the nominal diameter.

Lay.—Wire rope, type D, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter.

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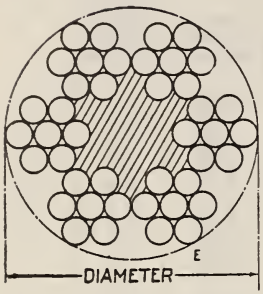
5. TYPE E, 6 BY 7 EXTRA STRONG CAST STEEL



Wire rope of type E shall be made as described and illustrated here and shall have the properties given in Table 8.

Construction.—One diameter of wire, one operation. Six strands of 7 wires each, total 42 wires. One main core.

Material.—Wires: Extra strong cast steel, galvanized. Main core, hard fiber.

Diameter.—The difference between the nominal diameter of wire rope, type E, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type E, shall be regular lay, and the lay shall not be greater than 8 times the nominal diameter.

TABLE 7.—*Properties of wire rope, type D*

Diameter before serving	Approximate diameter after serving	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
¼	½	0.21	1.26	4,800	1,160	1.0
5/16	11/16	.36	2.16	10,500	2,330	1.5
⅜	13/16	.54	3.24	18,400	4,020	2.0
7/16	15/16	.65	3.90	23,200	4,980	2.2
½	1	.80	4.80	28,800	6,330	2.5
¾	1⅛	1.05	6.30	40,000	8,890	3.0
⅞	1¼	1.35	8.10	53,000	11,800	3.5
1	1⅜	1.70	10.2	70,000	15,600	4.0
1⅛	1½	2.07	12.4	90,000	20,000	4.5
1¼	1⅝	2.52	15.1	110,000	24,400	5.0
1⅜	1¾	3.06	18.4	134,000	29,800	5.5
1½	1⅞	3.64	21.8	159,000	35,300	6.0
1⅝	2	4.26	25.6	187,000	41,600	6.5
1¾	2⅛	4.90	29.4	218,000	48,400	7.0

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

TABLE 8.—*Properties of wire rope, type E*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Galvanized		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
3/16	⅞	0.125	0.75	4,600	1,060	2.0
¼	1	.150	.90	5,800	1,420	2.2
5/16	1⅛	.220	1.32	8,000	1,890	2.8
⅜	1¼	.300	1.80	11,000	2,440	3.2
½	1½	.390	2.34	14,400	3,220	3.8
9/16	1¾	.500	3.00	18,200	4,000	4.0
⅝	2	.62	3.72	22,500	5,000	4.5
11/16	2⅛	.75	4.50	27,000	5,900	5.0
¾	2¼	.89	5.34	32,000	7,100	5.5
⅞	2¾	1.20	7.20	43,000	9,560	6.5
1	3	1.58	9.48	56,500	12,600	7.2
1⅛	3½	2.03	12.20	71,000	15,800	8.2
1¼	4	2.52	15.20	88,000	19,500	9.0
1⅜	4¼	3.05	18.30	107,000	23,800	10.0
1½	4¾	3.65	21.90	126,000	28,000	11.0

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

6. TYPE F, 6 BY 12 CAST STEEL

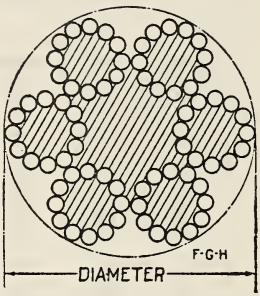
Wire rope of type F shall be made as described and illustrated here and shall have the properties given in Table 9.

Construction.—One diameter of wire, one operation. Six strands of 12 wires each, total 72 wires. Six strand cores and 1 main core, total 7 cores.

Material.—Wires: Cast steel, galvanized. Cores (see Table 9).

Diameter.—The difference between the nominal diameter of wire rope, type F, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type F, shall be regular lay, and the lay shall not be greater than 7¼ times the nominal diameter.



7. TYPE G, 6 BY 12 HIGH-GRADE PLOW STEEL

Wire rope of type G shall be made as described and illustrated here and shall have the properties given in Table 10.

Construction.—One diameter of wire, one operation. Six strands of 12 wires each, total 72 wires. Six strand cores and 1 main core, total 7 cores.

Material.—Wires: High-grade plow steel, galvanized. Cores (see Table 10).

Diameter.—The difference between the nominal diameter of wire rope, type G, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type G, shall be regular lay, and the lay shall not be greater than 7¼ times the nominal diameter.

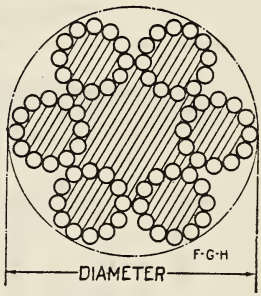


TABLE 9.—*Properties of wire rope, type F*

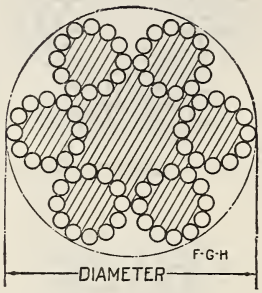
Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Galvanized		Core	
				Minimum breaking strength	Maximum safe working load	Strand	Main
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*		
1/4	3/4	0.07	0.42	2,000	470	Cotton	Hard fiber.
5/16	1	.10	.60	3,600	790	do	Do.
3/8	1 1/8	.14	.84	5,200	1,140	do	Do.
7/16	1 1/4	.20	1.20	7,000	1,560	do	Do.
1/2	1 1/2	.26	1.56	9,300	2,070	do	Do.
9/16	1 3/4	.33	1.98	11,700	2,600	do	Do.
5/8	2	.42	2.52	14,400	3,200	Hard fiber	Do.
3/4	2 1/4	.59	3.54	20,700	4,600	do	Do.
13/16	2 1/2	.68	4.08	24,300	5,400	do	Do.
7/8	2 3/4	.80	4.80	27,900	6,200	do	Do.
1	3	1.05	6.30	36,000	8,000	do	Do.
1 1/16	3 1/4	1.18	7.08	40,500	9,000	do	Do.
1 1/8	3 1/2	1.33	7.98	46,000	10,200	do	Do.
1 3/16	3 3/4	1.47	8.82	50,400	11,200	do	Do.
1 1/4	4	1.63	9.78	56,000	12,400	do	Do.
1 3/8	4 1/4	2.00	12.00	68,000	15,100	do	Do.
1 7/16	4 1/2	2.16	13.00	74,000	16,400	do	Do.
1 1/2	4 3/4	2.36	14.20	81,000	18,000	do	Do.
1 5/8	5	2.76	16.60	94,000	20,900	do	Do.
1 11/16	5 1/4	2.94	17.60	102,000	22,700	do	Do.
1 3/4	5 1/2	3.23	19.40	109,000	24,200	do	Do.
1 13/16	5 3/4	3.42	20.50	117,000	26,000	do	Do.
1 15/16	6	3.89	23.30	133,000	29,500	do	Do.
2	6 1/4	4.20	25.20	142,000	31,500	do	Do.
2 1/16	6 1/2	4.43	26.60	151,000	33,500	do	Do.

TABLE 10.—*Properties of wire rope, type G*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Galvanized		Core	
				Minimum breaking strength	Maximum safe working load	Strand	Main
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*		
1/4	3/4	0.07	0.42	2,400	534	Cotton	Hard fiber.
5/16	1	.10	.60	4,600	1,022	do	Do.
3/8	1 1/8	.14	.84	6,600	1,470	do	Do.
7/16	1 1/4	.20	1.20	9,000	2,000	do	Do.
1/2	1 1/2	.26	1.56	11,800	2,620	do	Do.
9/16	1 3/4	.33	1.98	15,000	3,330	do	Do.
5/8	2	.42	2.52	18,500	4,110	Hard fiber	Do.
3/4	2 1/4	.59	3.54	26,400	5,870	do	Do.
13/16	2 1/2	.68	4.08	31,100	6,910	do	Do.
7/8	2 3/4	.80	4.80	35,300	7,840	do	Do.
1	3	1.05	6.30	46,000	10,200	do	Do.
1 1/16	3 1/4	1.18	7.08	51,000	11,300	do	Do.
1 1/8	3 1/2	1.33	7.98	58,000	12,900	do	Do.
1 3/16	3 3/4	1.47	8.82	64,500	14,300	do	Do.
1 1/4	4	1.63	9.78	71,500	15,900	do	Do.
1 3/8	4 1/4	2.00	12.00	85,000	18,900	do	Do.
1 7/16	4 1/2	2.16	13.00	93,200	20,700	do	Do.
1 1/2	4 3/4	2.36	14.20	101,000	22,400	do	Do.
1 5/8	5	2.76	16.60	118,000	26,200	do	Do.
1 11/16	5 1/4	2.94	17.60	127,000	28,200	do	Do.
1 3/4	5 1/2	3.23	19.40	136,000	30,200	do	Do.
1 13/16	5 3/4	3.42	20.50	146,000	32,400	do	Do.
1 15/16	6	3.83	23.30	167,000	37,100	do	Do.
2	6 1/4	4.20	25.20	178,000	39,600	do	Do.
2 1/16	6 1/2	4.43	26.60	189,000	42,000	do	Do.

8. TYPE H, 6 BY 12 PHOSPHOR BRONZE

Wire rope of type H shall be made as described and illustrated here, and shall have the properties given in Table 11.



Construction.—One diameter of wire, one operation. Six strands of 12 wires each, total 72 wires. Six strand cores and 1 main core, total 7 cores.

Material.—Wires: Phosphorbronze. Cores (see Table 11).

Diameter.—The difference between the nominal diameter of wire rope, type H, and the actual diameter shall not be greater than the tolerances given in Table 3.

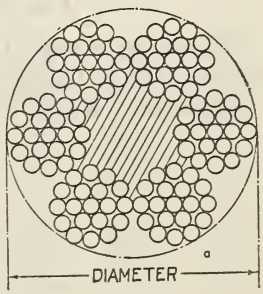
Lay.—Wire rope, type H, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter.

TABLE 11.—*Properties of wire rope, type H*

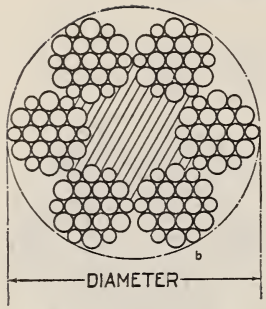
Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Minimum breaking strength	Maximum safe working load	Core	
						Strand	Main
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*		
¼	¾	0.075	0.45	1,400	310	Cotton	Hard fiber.
5/16	1	.115	.69	2,100	460	do	Do.
⅜	1⅛	.168	1.01	3,000	670	do	Do.
7/16	1¼	.227	1.36	4,000	890	do	Do.
½	1½	.295	1.77	5,200	1,160	do	Do.
9/16	1¾	.370	2.22	6,500	1,450	do	Do.
5/8	2	.460	2.76	8,100	1,800	Hard fiber	Do.
¾	2¼	.660	3.96	11,600	2,580	do	Do.
13/16	2½	.766	4.60	13,500	3,000	do	Do.
⅞	2¾	.895	5.37	15,700	3,490	do	Do.

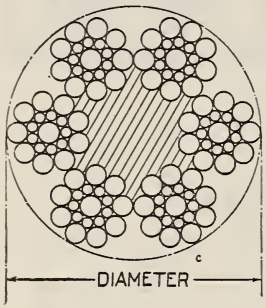
9. TYPES J, K, L, M, AND N, 6 BY 19 GENERAL

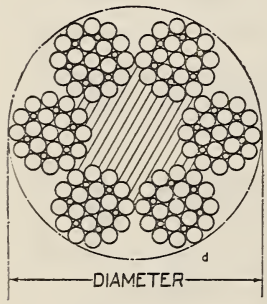
The four constructions described and illustrated here, may be used at the option of the seller or manufacturer for wire rope of types J, K, L, M, and N. If Seale construction is desired by the purchaser, this requirement shall be so stated in the order.



Construction.—(*a*) One diameter of wire two operations.—Six strands of 19 wires each, total 114 wires. All the wires in each strand shall be laid left-hand. All the outside wires of each strand shall be of the same diameter. One main core.







(*b*) Three diameters of wire (Warrington), one operation.—Six strands of 19 wires each, total 114 wires. The outside wires of each strand shall be of large and small diameter wires, laid alternately. One main core.

(*c*) Three diameters of wire (Seale) one operation.—Six strands of 19 wires each total 114 wires. All the outside wires of each strand shall be of the same diameter. All the inside wires in each strand, except the central wire, shall be of the same diameter. One main core.

(*d*) Three diameters of wire and filler wires, one operation.—Six strands of 25 wires each, total 150 wires. All the outside wires of each strand shall be of the same diameter. All the inside wires of each strand except the small filler wires and the central wire, shall be of the same diameter. All the small filler wires shall be the same diameter. One main core.

(*e*) *Diameter.*—The difference between the nominal diameter of wire rope, types J, K, L, M, and N and the actual diameter shall not be greater than the tolerances given in Table 3.

(*f*) *Lay.*—Wire rope, types J, K, L, M, and N, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter, if the wires are uncoated steel or phosphor bronze, nor more than 7¼ times the diameter, if the wires are galvanized steel.

10. TYPE J, 6 BY 19 CAST STEEL

Wire rope of type J shall be made as described here and in IV, 9, and shall have the properties given in Table 12.

Material.—Wires: Cast steel, uncoated. Main core, hard fiber.

TABLE 12.—*Properties of wire rope, type J*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
1/4	3/4	0.10	0.60	3,800	880	1.0
5/16	1	.15	.90	6,000	1,240	1.2
3/8	1 1/8	.22	1.32	8,400	1,920	1.5
7/16	1 1/4	.30	1.80	11,600	2,600	1.8
1/2	1 1/2	.39	2.34	15,000	3,360	2.0
9/16	1 3/4	.50	3.00	19,000	4,000	2.2
5/8	2	.62	3.72	23,000	5,000	2.5
3/4	2 1/4	.89	5.34	31,600	7,000	3.0
7/8	2 3/4	1.20	7.20	41,400	9,200	3.5
1	3	1.58	9.48	54,000	12,000	4.0
1 1/8	3 1/2	2.00	12.00	67,000	14,900	4.5
1 1/4	4	2.45	14.70	82,500	18,300	5.0
1 3/8	4 1/4	3.00	18.00	98,000	21,800	5.5
1 1/2	4 3/4	3.55	21.30	115,000	25,500	6.0
1 5/8	5	4.15	24.90	133,000	29,500	6.5
1 3/4	5 1/2	4.85	29.10	153,000	34,000	7.0
1 7/8	5 3/4	5.55	33.30	175,000	38,900	7.5
2	6 1/4	6.30	37.80	200,000	44,400	8.0
2 1/4	7 1/8	8.00	48.00	253,000	56,200	9.0
2 1/2	7 7/8	9.85	59.10	313,000	69,600	10.0
2 3/4	8 5/8	11.95	71.70	379,000	84,200	11.0

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

11. TYPE K, 6 BY 19 EXTRA STRONG CAST STEEL

Wire rope of type K shall be made as described here and in IV, 9, and shall have the properties given in Table 13.

Material.—Wires: Extra strong cast steel, either uncoated or galvanized. Main core, hard fiber.

TABLE 13.—*Properties of wire rope, type K*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Galvanized		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
1/4	3/4	0.10	0.60	4,200	930	3,780	840	1.0
5/16	1	.15	.90	6,500	1,440	5,840	1,300	1.2
3/8	1 1/8	.22	1.32	9,200	2,040	8,270	1,840	1.5
7/16	1 1/4	.30	1.80	12,600	2,800	11,300	2,510	1.8
1/2	1 1/2	.39	2.34	16,400	3,640	14,800	3,290	2.0
9/16	1 3/4	.50	3.00	20,600	4,580	18,500	4,110	2.2
5/8	2	.62	3.72	25,600	5,680	23,000	5,110	2.5
3/4	2 1/4	.89	5.34	36,400	8,080	32,700	7,260	3.0
7/8	2 3/4	1.20	7.20	48,000	10,700	43,200	9,600	3.5
1	3	1.58	9.48	62,000	13,800	55,800	12,400	4.0
1 1/8	3 1/2	2.00	12.00	77,000	17,100	69,200	15,400	4.5
1 1/4	4	2.45	14.7	95,000	21,100	85,400	19,000	5.0
1 3/8	4 1/4	3.00	18.0	113,000	25,100	102,000	22,600	5.5
1 1/2	4 3/4	3.55	21.3	133,000	29,500	120,000	26,600	6.0
1 5/8	5	4.15	24.9	154,000	34,200	138,000	30,600	6.5
1 3/4	5 1/2	4.85	29.1	178,000	39,600	160,000	35,600	7.0
1 7/8	5 3/4	5.55	33.3	202,000	44,900	182,000	40,400	7.5
2	6 1/4	6.30	37.8	231,000	51,300	208,000	46,200	8.0
2 1/4	7 1/8	8.00	48.0	292,000	64,800	262,000	58,200	9.0
2 1/2	7 7/8	9.85	59.1	362,000	80,400	326,000	72,400	10.0
2 3/4	8 5/8	11.95	71.7	437,000	97,100	393,000	87,200	11.0

[1] If the diameter of the drum or sheaves is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

12. TYPE L, 6 BY 19 PLOW STEEL

Wire rope of type L shall be made as described here and in IV, 9, and shall have the properties given in Table 14.

Material.—Wires: Plow steel either uncoated or galvanized. Main core, hard fiber.

TABLE 14.—*Properties of wire rope, type L*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Galvanized		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
1/4	3/4	0.10	0.60	4,500	1,000	4,050	900	1.0
5/16	1	.15	.90	7,000	1,560	6,300	1,400	1.2
3/8	1 1/8	.22	1.32	10,100	2,240	9,100	2,020	1.5
7/16	1 1/4	.30	1.80	13,800	3,070	12,400	2,750	1.8
1/2	1 1/2	.39	2.34	17,900	3,980	16,100	3,580	2.0
9/16	1 3/4	.50	3.00	22,600	5,020	20,400	4,540	2.2
5/8	2	.62	3.72	27,900	6,200	25,100	5,580	2.5
3/4	2 1/4	.89	5.34	40,000	8,890	36,000	8,000	3.0
7/8	2 3/4	1.20	7.20	53,000	11,800	47,700	10,600	3.5
1	3	1.58	9.48	69,000	15,400	62,100	13,800	4.0
1 1/8	3 1/2	2.00	12.00	86,000	19,100	77,400	17,200	4.5
1 1/4	4	2.45	14.70	106,000	23,600	95,400	21,200	5.0
1 3/8	4 1/4	3.00	18.00	128,000	28,400	115,000	25,600	5.5
1 1/2	4 3/4	3.55	21.30	150,000	33,300	135,000	30,000	6.0
1 5/8	5	4.15	24.90	173,000	38,400	156,000	34,600	6.5
1 3/4	5 1/2	4.85	29.10	202,000	44,900	182,000	40,400	7.0
1 7/8	5 3/4	5.55	33.30	231,000	51,400	208,000	46,200	7.5
2	6 1/4	6.30	37.80	263,000	58,400	237,000	52,600	8.0
2 1/4	7 1/8	8.00	48.00	333,000	74,000	300,000	66,600	9.0
2 1/2	7 7/8	9.85	59.10	412,000	91,600	371,000	82,400	10.0
2 3/4	8 5/8	11.95	71.70	496,000	110,000	446,000	99,100	11.0

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

13. TYPE M, 6 BY 19 HIGH-GRADE PLOW STEEL

Wire rope of type M shall be made as described here and in IV, 9, and shall have the properties given in Table 15.

Material.—Wires: High-grade plow steel, either uncoated or galvanized. Main core, hard fiber.

TABLE 15.—*Properties of wire rope, type M*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Galvanized		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
1/4	3/4	0.10	0.60	5,200	1,160	4,680	1,040	1.0
5/16	1	.15	.90	7,800	1,730	7,020	1,560	1.2
3/8	1 1/8	.22	1.32	11,400	2,530	10,300	2,290	1.5
7/16	1 1/4	.30	1.80	15,600	3,460	14,000	3,110	1.8
1/2	1 1/2	.39	2.34	20,200	4,490	18,200	4,040	2.0
9/16	1 3/4	.50	3.00	25,600	5,690	23,000	5,110	2.2
5/8	2	.62	3.72	31,800	7,060	28,600	6,360	2.5
3/4	2 1/4	.89	5.34	46,000	10,200	41,400	9,200	3.0
7/8	2 3/4	1.20	7.20	62,000	13,800	55,800	12,400	3.5
1	3	1.58	9.48	80,000	17,800	72,000	16,000	4.0
1 1/8	3 1/2	2.00	12.00	100,000	22,200	90,000	20,000	4.5
1 1/4	4	2.45	14.70	123,000	27,300	111,000	24,700	5.0
1 3/8	4 1/4	3.00	18.00	148,000	32,900	133,000	29,500	5.5
1 1/2	4 3/4	3.55	21.30	175,000	38,900	158,000	35,100	6.0
1 5/8	5	4.15	24.90	203,000	45,100	183,000	40,600	6.5
1 3/4	5 1/2	4.85	29.10	237,000	52,700	213,000	47,400	7.0
1 7/8	5 3/4	5.55	33.30	269,000	59,800	242,000	53,800	7.5
2	6 1/4	6.30	37.80	302,000	67,100	272,000	60,400	8.0
2 1/4	7 1/8	8.00	48.00	383,000	85,100	345,000	76,600	9.0
2 1/2	7 7/8	9.85	59.10	472,000	105,000	425,000	94,400	10.0
2 3/4	8 5/8	11.95	71.70	570,000	127,000	513,000	114,000	11.0

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

14. TYPE N, 6 BY 19 PHOSPHOR BRONZE

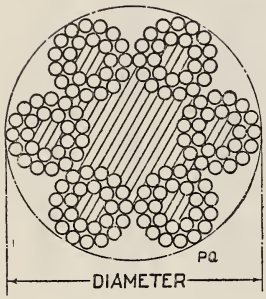
Wire rope of type N shall be made as described here and illustrated in IV, 9, and shall have the properties given in Table 16.

Material.—Wires: Phosphor bronze. Main core, hard fiber.

TABLE 16.—*Properties of wire rope, type N*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Minimum breaking strength	Maximum safe working load
Inch	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1/4	3/4	0.110	0.660	1,900	422
5/16	1	.160	.960	3,000	666
3/8	1 1/8	.230	1.380	4,400	978
7/16	1 1/4	.320	1.920	5,900	1,310
1/2	1 1/2	.410	2.460	7,700	1,710
9/16	1 3/4	.520	3.120	9,800	2,180
5/8	2	.640	3.840	12,100	2,690
3/4	2 1/4	.920	5.520	17,100	3,800
13/16	2 1/2	1.080	6.480	20,200	4,480
7/8	2 3/4	1.260	7.560	23,400	5,200

15. TYPE P, 6 BY 24 CAST STEEL



Wire rope of type P shall be made as described and illustrated here and shall have the properties given in Table 17.

Construction.—Either one diameter of wire, two operations (9 inside, 15 outside wires), or three diameters of wire, one operation (8 inside, 16 outside wires). Six strands of 24 wires each, either 9 inside and 15 outside wires as shown, or 8 inside and 16 outside wires, total 144 wires. Six strand cores and 1 main core, total 7 cores.

Material.—Wires: Cast steel, galvanized. Cores (see Table 17).

Diameter.—The difference between the nominal diameter of wire rope, type P, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type P, shall be regular lay, and the lay shall not be greater than 7¼ times the nominal diameter.

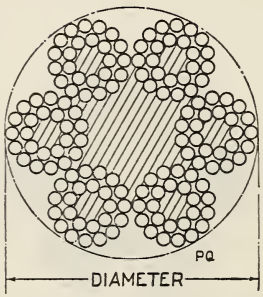
TABLE 17.—*Properties of wire rope, type P*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Galvanized		Core	
				Minimum breaking strength	Maximum safe working load	Strand	Main
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*		
¾	2¼	0.78	4.68	26,000	5,780	Cotton	Hard fiber.
13/16	2½	.90	5.40	31,000	6,880	do	Do.
⅞	2¾	1.05	6.30	36,000	8,000	do	Do.
1	3	1.38	8.28	48,000	10,700	Hard fiber	Do.
1 1/16	3¼	1.56	9.36	54,000	12,000	do	Do.
1⅛	3½	1.75	10.50	60,000	13,300	do	Do.
1 3/16	3¾	1.96	11.80	67,000	14,900	do	Do.
1¼	4	2.17	13.00	74,000	16,400	do	Do.
1⅜	4¼	2.65	15.90	90,000	20,000	do	Do.
1 7/16	4½	2.90	17.40	99,000	22,000	do	Do.
1½	4¾	3.15	18.90	108,000	24,000	do	Do.
1⅝	5	3.68	22.10	126,000	28,000	do	Do.
1 11/16	5¼	3.97	23.80	136,000	30,200	do	Do.
1¾	5½	4.27	25.60	146,000	32,400	do	Do.
1 13/16	5¾	4.57	27.40	157,000	34,900	do	Do.
1 15/16	6	5.22	31.30	178,000	39,600	do	Do.
2	6¼	5.55	33.30	190,000	42,200	do	Do.
2 1/16	6½	5.77	34.60	202,000	44,900	do	Do.

16. TYPE Q, 6 BY 24 HIGH-GRADE PLOW STEEL

Wire rope of type Q shall be made as described and illustrated here and shall have the properties given in Table 18.

Construction.—Either one diameter of wire, two operations (9 inside, 15 outside wires), or three diameters of wire, one operation (8 inside, 16 outside wires). Six strands of 24 wires each, either 9 inside wires and 15 outside wires, as shown, or 8 inside and 16 outside wires, total 144 wires. Six strand cores and 1 main core, total 7 cores.



Material.—Wires:-High-grade plow steel, galvanized. Cores (see Table 18).

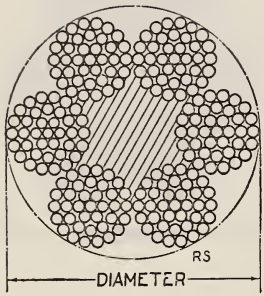
Diameter.—The difference between the nominal diameter of wire rope, type Q, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type Q, shall be regular lay, and the lay shall not be greater than 7 1/4 times the nominal diameter.

TABLE 18.—*Properties of wire rope, type Q*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Galvanized		Core	
				Minimum breaking strength	Maximum safe working load	Strand	Main
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*		
3/4	2 1/4	0.78	4.68	34,000	7,550	Cotton	Hard fiber.
13/16	2 1/2	.90	5.40	39,000	8,660	do	Do.
7/8	2 3/4	1.05	6.30	45,000	10,000	do	Do.
1	3	1.38	8.28	59,000	13,100	Hard fiber	Do.
1 1/16	3 1/4	1.56	9.36	67,000	14,900	do	Do.
1 1/8	3 1/2	1.75	10.50	75,000	16,700	do	Do.
1 3/16	3 3/4	1.96	11.80	84,000	18,700	do	Do.
1 1/4	4	2.17	13.00	93,000	20,700	do	Do.
1 3/8	4 1/4	2.65	15.90	113,000	25,100	do	Do.
1 7/16	4 1/2	2.90	17.40	124,000	27,500	do	Do.
1 1/2	4 3/4	3.15	18.90	135,000	30,000	do	Do.
1 5/8	5	3.68	22.10	158,000	35,100	do	Do.
1 11/16	5 1/4	3.97	23.80	170,000	37,800	do	Do.
1 3/4	5 1/2	4.27	25.60	183,000	40,600	do	Do.
1 13/16	5 3/4	4.57	27.40	196,000	43,600	do	Do.
1 15/16	6	5.22	31.30	224,000	49,800	do	Do.
2	6 1/4	5.55	33.30	238,000	52,900	do	Do.
2 1/16	6 1/2	5.77	34.60	248,000	55,100	do	Do.

17. TYPE R, 6 BY 37 EXTRA STRONG CAST STEEL



Wire rope of type R shall be made as described and illustrated here and shall have the properties given in Table 19.

Construction.—Either one diameter of wire, three operations, or four or five diameters of wire, two operations. Six strands. Each strand shall have not less than 37 nor more than 43 wires. The number of outside wires of each strand shall be not less than 18 nor more than 20. Total 222 to 258 wires. One main core.

Material.—Wires: Extra strong cast steel, either uncoated or galvanized. Main core. hard fiber.

Diameter.—The difference between the nominal diameter of wire rope, type R, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type R, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter, if the wire is uncoated, nor greater than 7¼ times the nominal diameter, if the wire is galvanized.

TABLE 19.—*Properties of wire rope, type R*

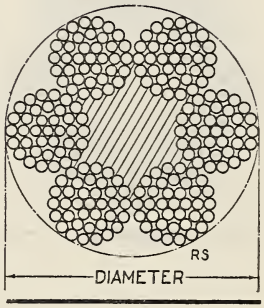
Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Galvanized		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
3/8	1 1/8	0.22	1.32	8,600	1,910	7,740	1,720	0.9
7/16	1 1/4	.30	1.80	11,600	2,580	10,400	2,310	1.1
1/2	1 1/2	.39	2.34	15,200	3,370	13,700	3,040	1.2
9/16	1 3/4	.50	3.00	19,000	4,220	17,100	3,800	1.4
5/8	2	.62	3.72	23,700	5,270	21,300	4,740	1.5
3/4	2 1/4	.89	5.34	34,000	7,560	30,600	6,800	1.9
7/8	2 3/4	1.20	7.20	47,000	10,400	42,300	9,400	2.1
1	3	1.58	9.48	60,000	13,300	54,000	12,000	2.5
1 1/8	3 1/2	2.00	12.00	74,000	16,500	66,600	14,800	2.7
1 1/4	4	2.45	14.70	90,000	20,000	81,000	18,000	3.1
1 3/8	4 1/4	2.95	17.70	108,000	24,000	97,200	21,600	3.3
1 1/2	4 3/4	3.55	21.30	128,000	28,400	115,000	25,500	3.7
1 5/8	5	4.15	24.90	149,000	33,100	134,000	29,800	3.9
1 3/4	5 1/2	4.85	29.10	170,000	37,800	153,000	34,000	4.3
1 7/8	5 3/4	5.50	33.00	192,000	42,700	173,000	38,500	4.5
2	6 1/4	6.30	37.80	217,000	48,200	195,000	43,300	4.8
2 1/4	7 1/8	7.95	47.70	274,000	60,900	246,000	54,600	5.4
2 1/2	7 7/8	9.85	59.10	339,000	75,400	305,000	67,800	6.0
2 3/4	8 5/8	11.90	71.40	410,000	91,100	369,000	82,000	6.5

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15, and 17.)

18. TYPE S, 6 BY 37 HIGH-GRADE PLOW STEEL

Wire rope of type S shall be made as described and illustrated here and shall have the properties given in Table 20.

Construction.—Either one diameter of wire, three operations, or four or five diameters of wire, two operations. Six strands. Each strand shall have not less than 37 nor more than 43 wires. The number of outside wires of each strand shall be not less than 18 nor more than 20. Total, 222 to 258 wires. One main core.



Material.—Wires: High-grade plow steel, either uncoated or galvanized. Main core, hard fiber.

Diameter.—The difference between the nominal diameter of wire rope, type S, and the actual diameter shall not be greater than the tolerances given in Table 3.

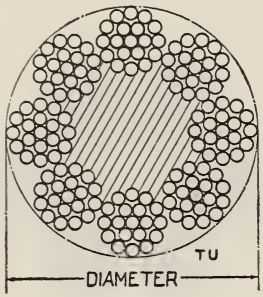
Lay.—Wire rope, type S, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter, if the wire is uncoated, nor greater than 7¼ times the diameter, if the wire is galvanized.

TABLE 20.—*Properties of wire rope, type S*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Galvanized		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
3/8	1 1/8	0.22	1.32	10,200	2,270	9,160	2,040	0.9
7/16	1 1/4	.30	1.80	13.800	3,070	12,400	2,750	1.1
1/2	1 1/2	.39	2.34	18,000	4,000	16,200	3,600	1.2
9/16	1 3/4	.50	3.00	22,500	5,000	20,200	4,490	1.4
5/8	2	.62	3.72	28,400	6,310	25,500	5,660	1.5
3/4	2 1/4	.89	5.34	41,000	9,110	36,800	8,180	1.9
7/8	2 3/4	1.20	7.20	54,000	12,000	48,600	10,800	2.1
1	3	1.58	9.48	70,000	15,600	62,900	14,000	2.5
1 1/8	3 1/2	2.00	12.00	87,000	19,300	78,200	17,400	2.7
1 1/4	4	2.45	14.70	107,000	23,800	96,100	21,400	3.1
1 3/8	4 1/4	2.95	17.70	129,000	28,700	116,000	25,800	3.3
1 1/2	4 3/4	3.55	21.30	153,000	34,000	138,000	30,600	3.7
1 5/8	5	4.15	24.90	176,000	39,100	158,000	35,100	3.9
1 3/4	5 1/2	4.85	29.10	202,000	44,900	182,000	40,400	4.3
1 7/8	5 3/4	5.50	33.00	232,000	51,600	209,000	46,400	4.5
2	6 1/4	6.30	37.80	264,000	58,600	237,000	52,600	4.8
2 1/4	7 1/8	7.95	47.70	334,000	74,200	300,000	66,600	5.4
2 1/2	7 7/8	9.85	59.10	413,000	91,800	372,000	82,600	6.1
2 3/4	8 5/8	11.90	71.40	500,000	111,000	449,000	99,800	6.5

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

19. TYPE T, 8 BY 19 CAST STEEL



Wire rope of type T shall be made as described and illustrated here and shall have the properties given in Table 21.

Construction.—One diameter of wire, two operations. Eight strands of 19 wires each, total 152 wires. Strands for wire rope of type T may be of the Warrington, Seale, or of three diameters of wire and filler wire construction as shown for types J, K, L, M, and N. One main core.

Material.—Wires: Cast steel, uncoated. Main core, hard fiber.

Diameter.—The difference between the nominal diameter of wire rope, type T, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type T, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter.

TABLE 21.—*Properties of wire rope, type T*

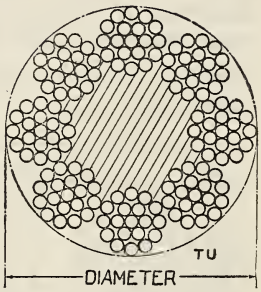
Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
¼	¾	0.09	0.54	3,200	710	0.6
5/16	1	.14	.84	5,000	1,110	.8
⅜	1⅛	.20	1.20	7,000	1,560	.9
7/16	1¼	.27	1.62	9,600	2,140	1.1
½	1½	.35	2.10	12,400	2,750	1.3
9/16	1¾	.45	2.70	15,700	3,490	1.4
⅝	2	.55	3.30	19,500	4,340	1.6
¾	2¼	.80	4.80	27,800	6,180	1.9
⅞	2¾	1.08	6.48	39,000	8,670	2.2
1	3	1.42	8.52	49,000	10,900	2.5
1⅛	3½	1.80	10.80	61,000	13,600	2.8
1¼	4	2.20	13.20	75,000	16,700	3.1
1⅜	4¼	2.67	16.00	90,000	20,000	3.5
1½	4¾	3.19	19.10	107,000	23,800	3.7

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17.)

20. TYPE U, 8 BY 19 EXTRA STRONG CAST STEEL

Wire rope of type U shall be made as described and illustrated here and shall have the properties given in Table 22.

Construction.—One diameter of wire, two operations. Eight strands of 19 wires each, total 152 wires. Strands for wire rope of this type may be of the Warrington, Seale, or of three diameters of wire and filler wire construction, as shown for types J, K, L, M, and N. One main core.



Material.—Wires: Extra strong cast steel, uncoated. Main core, hard fiber.

Diameter.—The difference between the nominal diameter of wire rope, type U, and the actual diameter shall not be greater than the tolerances given in Table 3.

Lay.—Wire rope, type U, shall be regular lay, and the lay shall not be greater than 6¾ times the nominal diameter.

TABLE 22.—*Properties of wire rope, type U*

Nominal diameter	Approximate circumference	Approximate weight per foot	Approximate weight per fathom (6 feet)	Uncoated		Recommended minimum diameter of sheave or drum
				Minimum breaking strength	Maximum safe working load [1]	
Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Feet*
¼	¾	0.09	0.54	3,600	800	0.6
5/16	1	.14	.84	5,600	1,240	.8
⅜	1⅛	.20	1.20	8,000	1,780	.9
7/16	1¼	.27	1.62	10,900	2,420	1.1
½	1½	.35	2.10	14,200	3,150	1.3
9/16	1¾	.45	2.70	17,800	3,960	1.4
⅝	2	.55	3.30	22,200	4,940	1.6
¾	2¼	.80	4.80	31,600	7,020	1.9
⅞	2¾	1.08	6.48	42,000	9,340	2.2
1	3	1.42	8.52	55,000	12,200	2.5
1⅛	3½	1.80	10.80	68,000	15,100	2.8
1¼	4	2.20	13.20	84,000	18,700	3.1
1⅜	4¼	2.67	16.02	101,000	22,400	3.5
1½	4¾	3.19	19.14	119,000	26,400	3.7

[1] If the diameter of the drum or sheave is less than the recommended diameter, lower safe working loads should be used. (See VII, 15 and 17).

V. INSPECTION AND TESTS

1. DIAMETER OF ROPE (REQUIRED)

The diameter of a wire rope shall be measured at three places at least 5 feet apart, with a suitable device, such as a machinist's caliper square (see figs. 1 and 2.) The average of these diameters is the diameter of the rope. For measuring the diameter of five-strand wire rope the jaws of the caliper square shall have a thickness sufficient to allow the diameter of the circumscribed circle to be measured.

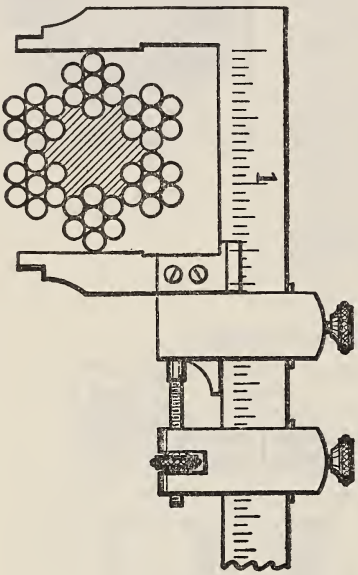


FIG. 1.—*Correct way to measure the diameter of wire rope.*
Use a machinist's caliper square.

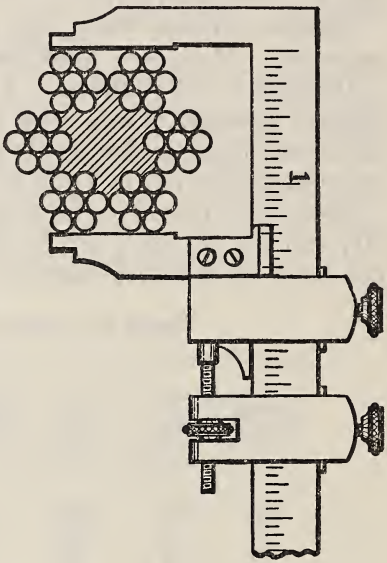


FIG. 2.—*Incorrect way to measure the diameter of wire rope.*

2. LAY (REQUIRED)

The lay of wire rope shall be obtained by measuring, parallel to the axis of the rope, the distance in which a strand makes five or more complete turns around the rope. This distance divided by the number of turns is the lay of the rope. When measuring the lay, there shall be no axial load on the rope, and the measured distance shall not be within 10 feet of the end of the rope.

3. TENSILE TEST OF ROPE (REQUIRED)

One tensile test specimen shall be cut from each continuous length of wire rope. The distance between the sockets or grips shall be at least 5 feet for ropes having a diameter larger than 2¼ inches.

For ropes of smaller diameter the distance shall be at least 25 times the nominal diameter of the rope. The ends of the specimen may be secured in taper sockets by using molten zinc or held in any other suitable device.

4. TENSILE TEST OF WIRES (OPTIONAL WITH PURCHASER)

For tensile tests of the wires a section shall be cut from each length of rope. From each section at least six tensile tests shall be made, one or more wires being selected from each strand. Specimens for obtaining the tensile strength of the wires shall be not less than 15 inches long, and the distance between the grips of the testing machine shall be not less than 10 inches. The speed of the movable head of the testing machine, under no load, shall not exceed 1 inch per minute.

5. TORSIONAL TEST OF WIRES (REQUIRED FOR UNCOATED STEEL AND FOR PHOSPHOR BRONZE)

Specimens for torsional tests of the wires, taken either before or after the rope is fabricated, shall be straight and at least 10 inches long. Not less than one specimen of each size of wire from each strand of the rope shall be selected, but the total number of specimens shall not exceed 25 per cent of the total number of wires in the rope. The distance between the clamps in which the wire is held shall, before the test, be 8 inches. One clamp shall be movable, parallel to the axis of the wire, and keep the specimen straight and under tension during the test. The wire shall be twisted by rotating one of the clamps at a uniform rate, not exceeding 60 revolutions per minute. If the temperature of the wire increases perceptibly, the speed shall be decreased. If the first torsional specimen fails, two more specimens shall be tested from the same wire, both of which shall comply with the torsional requirements for wire.

6. WRAPPING TEST OF WIRES (REQUIRED FOR GALVANIZED WIRES)

The specimens for wrapping test of wires, taken either before or after the rope is fabricated, shall be straight and of any convenient length.

Not less than one specimen of each size of wire from each strand of the rope shall be selected, and the total number of specimens shall not exceed 25 per cent of the total number of wires in the rope.

One end of the specimen shall be secured in any convenient way and the wire wrapped by the free end around the mandrel, so that the coils of the helix are practically in contact. After the six turns have been wrapped around the mandrel the specimen shall be unwrapped.

7. TEST OF GALVANIZING (OPTIONAL WITH PURCHASER)

(*a*) SPECIMENS.—Specimens, at least 6 inches long, for testing the thickness of the zinc coating shall be cut from the wire before the rope is made. Not less than three specimens shall be cut from each size of wire to be used in the rope.

(*b*) CLEANING.—The specimens shall be cleaned before testing, using cotton waste with carbon tetrachloride, benzine, or turpentine. A brush shall not be used. The specimens shall then be rinsed thoroughly in clear water and wiped dry, using clean cotton waste.

(*c*) PREECE METHOD.—Each specimen shall be immersed in a standard solution of copper sulphate for one minute, immediately washed thoroughly in water, and wiped dry. This process shall be repeated. If, after the last immersion and washing there is a bright metallic copper deposit on the specimen indicating that the zinc has been removed, the wire represented by the specimen shall be rejected. The temperature of the solution shall be between 60 and 65° F. during the test.

No wire shall be rejected because a copper deposit appeared within 1 inch of the end of a test specimen representing that coil of wire.

(*d*) COPPER SOLUTION.—1. *Preparation.*—The standard solution of copper sulphate shall be made by dissolving 36 parts, by weight, of commercial copper sulphate crystals in 100 parts, by weight, of cold water. To neutralize any free acid chemically pure cupric oxide (CuO) shall be added in excess, which will be indicated by the oxide appearing on the bottom of the container. The neutralized solution shall be filtered through filter paper before using. It shall have a specific gravity of 1.186 at 65° F. at the beginning of each test. If the specific gravity is too high, clean water should be added; if too low, a filtered solution of a higher specific gravity should be added.

2. *Use.*—The copper solution shall be contained in a glass vessel at least 2 inches inside diameter and filled to a depth of at least 4 inches before immersing the specimens. Not more than seven specimens shall be immersed simultaneously, and they shall be separated to allow the solution to act on all the immersed surface of the wires.

(*e*) COLOR SAMPLES.—Each day that tests of the galvanizing are made standard color samples of the bright metallic copper deposit shall be made, with which the test specimens shall be compared. These color samples cut from the wire to be tested shall be immersed in concentrated hydrochloric acid until all zinc is removed. The sample shall be immediately washed and wiped dry and immersed in the standard copper solution for one minute, removed, washed and wiped dry.

VI. PACKING AND MARKING

Wire rope should be marked with the name of the material, the size, the length, the name of the contractor, and the purchaser's order number. The end of the rope shall be suitably seized to prevent untwisting.

VII. ADDITIONAL INFORMATION

1. ORDERS

Orders for wire rope shall give the type, material, diameter (inches), length (feet), and whether uncoated or galvanized.

2. SEALE CONSTRUCTION

If Seale construction (IV, 9, (*c*)), Type J, K, L, M, or N is desired, it shall be so stated in the order.

3. OPTIONAL TESTS

Unless the order states that tests to determine the tensile strength of the wires (II, 2, and V, 4) or the thickness of the zinc coating (II, 6, and V, 7) are required, these tests will not be made. As, for small orders, the cost of making these tests is prohibitive, they are made only when required by the purchaser.

4. PROPERTIES OF WIRE ROPE

The strength and other properties of wire rope given in Tables 4 to 22 agree with those given in Bureau of Standards Technologic Paper No. 121, Strength and Other Properties of Wire Rope, and in the catalogues of wire rope manufacturers. As the breaking strengths for uncoated steel and phosphor bronze rope given by the manufacturers are average values, 10 per cent was subtracted to obtain minimum values for these specifications. Ten per cent was subtracted from the minimum values for uncoated rope to obtain minimum values for galvanized rope. Values obtained in this way have been used satisfactorily by the Navy Department for many years.

5. FIBER CORES

Cotton may be spun into cores of small diameter more satisfactorily than other fibers. It is therefore required for the cores of small wire ropes. For wire rope of large diameter, hard fibers (manila, java, African, Mexican or Yucatan, or sisal) shall be used. Jute shall not be used for the cores of any wire rope. Compared with the hard fibers, jute has less cellulose for its volume and is therefore weaker mechanically; it is more hydroscopic and, therefore, deteriorates more rapidly. In the event of war, jute would probably be unobtainable.

6. TEST FOR GALVANIZING

If an accurate determination of the thickness of the galvanizing is desired, the antimony chloride method of stripping the zinc and obtaining the loss in weight of the specimen should be used. This requires too much time and is too expensive for routine testing. The Preece method is therefore required in these specifications. This method is in general use, commercially, for testing galvanized wire for acceptance under purchase specifications.

The use of a "squeezer," which exerts a great compressive force on the outside wires, is necessary to form a satisfactory wire rope. The friction in passing through the squeezer reduces the thickness of the galvanizing on the outside wires where they come into contact with the squeezer. The test for thickness of the galvanizing shall, therefore, be made on samples cut from the wire before the rope is fabricated.

7. HANDLING

Wire rope should be handled in such a way that it is neither twisted nor untwisted. Great care should be used to avoid "kinks" in the rope. These are loops in the rope which have been "pulled through" by tension on the rope until the diameter of the loop is only a few inches. The wires at a kink are permanently bent and injured. Wire rope that has been kinked will not give satisfactory service.

The catalogues of some wire rope manufacturers give illustrations of correct and incorrect methods of handling wire rope, which are of great value to the users.

8. UNREELING

If the wire rope is on a reel, a shaft should be placed through the hole in the center of the reel and supported horizontally, so that the reel turns freely. The rope should then be pulled off in a straight line. It is advisable to use a board against the flange of the reel as a brake, otherwise, if the reel turns too rapidly, a loop of the rope will fall over the flange. If this happens, the rope will probably be kinked or otherwise injured.

If the method described above can be used, the reel should not be mounted on a turntable so that the axis of the reel is vertical as the rope is likely to drop over the bottom flange of the reel and be injured if it is pulled around the axle. Injury can be avoided if when a loop drops off the flange it is replaced on the reel and unreeled in the proper way. Under no circumstances should the loop be thrown over the upper flange of the reel and pulled out, as the rope will kink. If the side of the reel rests on the ground and the loops of rope are thrown over the upper flange and the rope pulled straight, the rope will either be twisted or untwisted, even if it is not kinked, and the

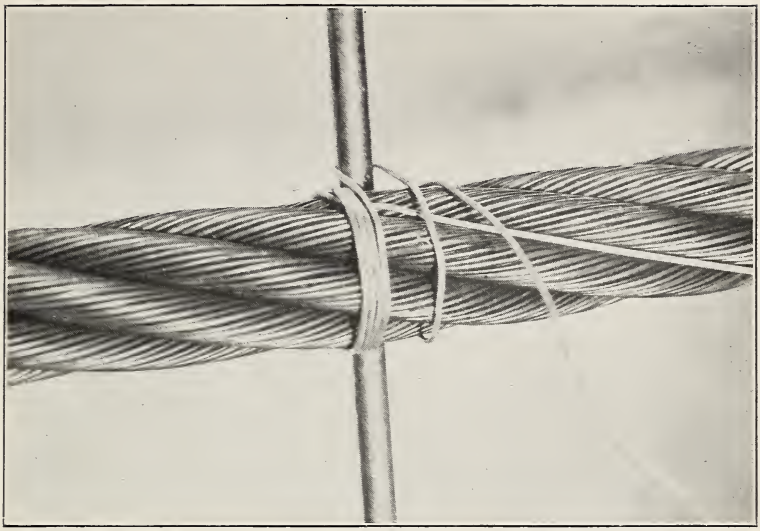


FIG. 3.—*Putting a seizing on a wire rope by method A*

Lay the seizing wire in the groove between two strands and wrap the other end of the wire back over this portion. Use a seizing iron as shown to keep the necessary tension on the wire

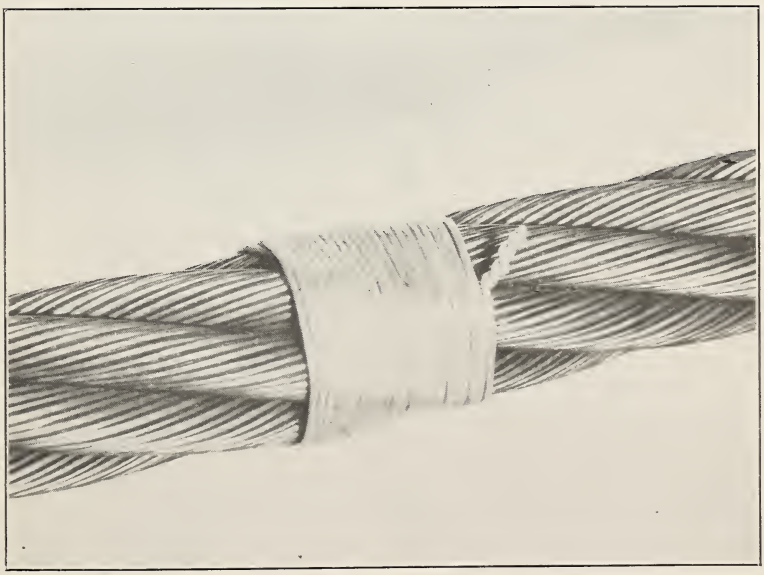


FIG. 4.—*A wire rope seizing correctly made by method A*

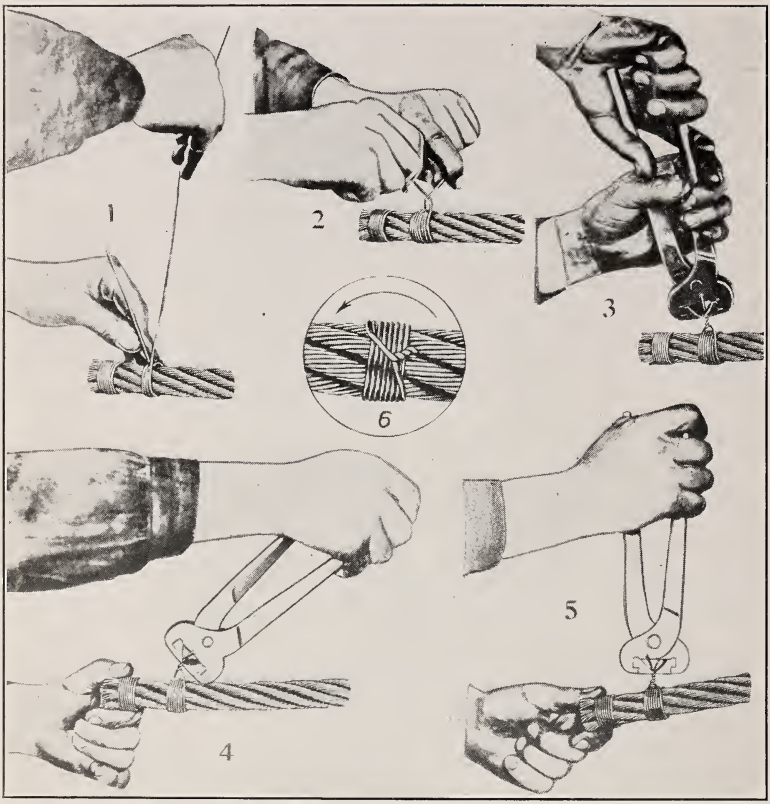


FIG. 5.—*Putting a seizing on a wire rope by method B*

(1) Wind the seizing wire on the rope by hand, keeping the coils together and considerable tension on the wire. (2) Twist the ends of the wire together *counterclockwise* by hand so that the twisted portion of the wires is near the middle of the seizing. (3) Using "Carew" cutters, tighten the twist just enough to take up the slack. Do not try to tighten the seizing by *twisting*. (4) Tighten the seizing by prying the twist away from the axis of the rope with the cutters. (5) Tighten the twist again as in (3). Repeat (4) and (5) as often as is necessary to make the seizing tight. Cut off the ends of the wires and pound the twist flat against the rope. (6) The appearance of the finished seizing

length of service will be shortened. The large manufacturers of passenger elevators publish instructions for unreeling wire rope, with photographs showing clearly the right and the wrong way to handle wire rope.

9. UNCOILING

If wire rope is in a coil, the outer end of the rope should be released and the coil rolled along the ground in a straight line, unwinding the rope as it proceeds. Under no circumstances should the coil be laid flat on the ground and the loops thrown off the coil and pulled out, as the rope will be kinked and injured as described in the preceding paragraph on unreeling.

10. SEIZING

The end of a wire rope should have at least three seizings to prevent unlaying, which, if it occurs, would make the rope useless. The seizings may be replaced by fittings if they prevent unlaying of the rope. Annealed iron wire should be wound tightly in a close helix around the rope.

A seizing may be made in either of two ways:

Method A.—For this seizing the ends of the wire are brought out at the same end of the seizing. This is done by laying the wire in the groove between two strands and wrapping the other end of the wire back over this portion. A seizing iron (round bar, ½ to ⅝ inch in diameter by 18 inches long) should be used, especially if the rope is over 1 inch in diameter. To keep the necessary tension in the wire, the free end should be given one complete turn about the rope, as shown in Figure 3. The ends of the wire should be twisted tightly together. A seizing made correctly by this method is shown in Figure 4. The length of each seizing should be at least equal to the diameter of the rope.

Method B.—This method is shown in Figure 5.

1. Wind the seizing wire on the rope by hand, keeping the coils together and considerable tension on the wire.
2. Twist the ends of the wire together counterclockwise by hand, so that the twisted portion of the wires is near the middle of the seizing.
3. Using "Carew" cutters, tighten the twist just enough to take up the slack. Do not try to tighten the seizing by twisting.
4. Tighten the seizing by prying the twist away from the axis of the rope with the cutters.
5. Tighten the twist again as in 3. Repeat 4 and 5 as often as is necessary to make the seizing tight. Cut off the ends of the wires and pound the twist flat against the rope.
6. The appearance of the finished seizing is shown in Figure 5.

Any annealed low carbon steel wire may be used for seizings. It should be about the size given in Table 23.

TABLE 23.—*Seizing wire*

Wire rope, diameter in inches	Seizing wire, diameter
	Inches
¼ to ⅞	0.054
1 to 1⅝	.105
1¾ to 3¼	.135

11. CUTTING

Before cutting a wire rope, seizings should be placed on each side of the place where the rope is to be cut to prevent unlaying of the strands. There should be three seizings on each side, applied as described in the preceding paragraph on seizing.

12. CLIPS

A wire rope may be attached to its load by passing the end around a thimble attached to the load and bending the end back so that it is parallel to the long end of the rope. Clips can then be used to fasten the ropes together.

A wire rope clip consists of a forged steel "roddle" or base having diagonal grooves which fit the strands of the rope. The ends of a steel U bolt pass through the roddle and the ropes are fastened by tightening the nuts on each end of the U bolt. A clip of this kind is shown in Figure 6 and also in Figure 8.

A wire rope clamp consists of two similar pieces, each having two straight parellel grooves which fit the rope. A number of straight bolts (two to four) pass through the pieces and the ropes are fastened by tightening the nut on each bolt. A clamp is shown in Figure 7.

It is much safer to use clips than to use clamps for fastening wire rope. Clamps should never be used except for cases where the stress in the rope is low.

Although fastening with clips requires little skill and can be readily inspected, the rope is apt to slip, the clips frequently crush and bruise the rope, and the strength of the fastening is usually less than 80 per cent of the strength of the rope.

The distance between clips should not be less than six times the diameter of the rope. The roddle should be in contact with the long end and the U bolt in contact with the short end of the loop in the rope. The correct way to attach clips is shown in Figure 8. Two incorrect ways which are frequently used are also shown. The number of clips and the length of the wrench for tightening the bolts are given in Table 24.

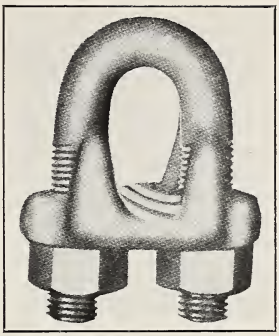
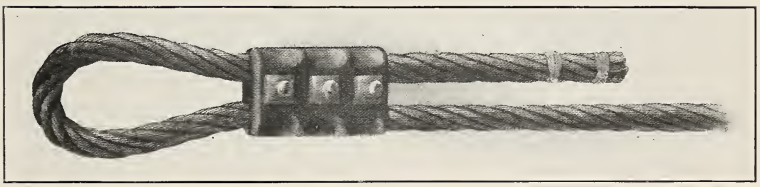


FIG. 6.—*A clip for fastening wire ropes*

Note the forged steel "roddle" having diagonal grooves which fit the strands of the rope



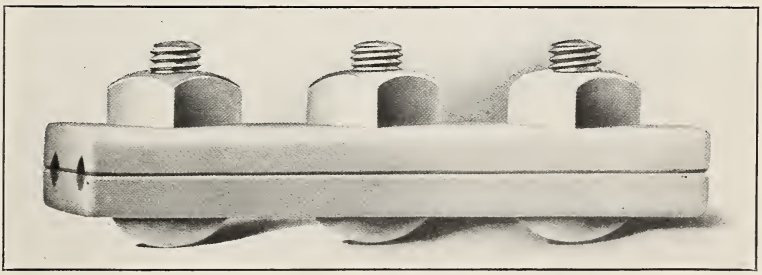


FIG. 7.—*Above: A wire rope fastening made with a clamp. Below: A clamp for fastening wire ropes*

Clamps should never be used except for cases where the stress in the rope is low

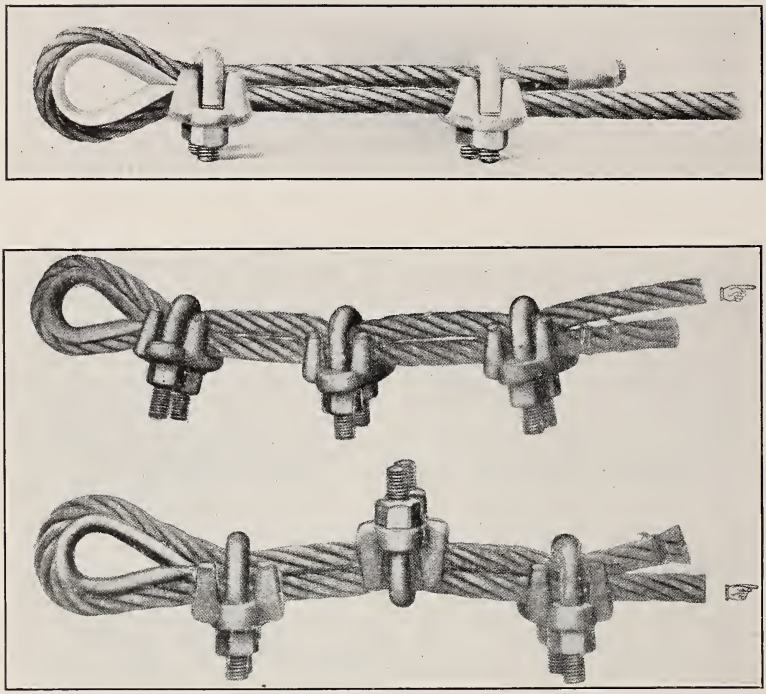


FIG. 8.—*Above: Correct way to fasten wire rope with clips. Below: Two wrong ways to use clips for fastening wire rope*

The roddle should be in contact with the long end of the wire rope and the U-bolt in contact with the short end of the loop in the rope

TABLE 24.—*Number of clips required to make a fastening having 80 per cent of the strength of 6 by 19 plow steel wire rope*

Diameter of rope	Number of clips	Efficiency of fastening	Efficiency of each clip	Length of wrench
		Per cent	*Per cent*	*Inches*
¾	5	77.39	15.5	18
⅞	5	79.13	15.8	18
1	5	77.89	15.6	24
1⅛	5	80.00	16.0	24
1¼	6	82.15	13.7	24

For wire rope smaller than ¾ inch diameter, at least four clips should be used. For wire ropes larger than 1¼ inches, it is preferable to socket the rope and avoid the use of clips. The clips should be inspected daily and the bolts tightened, if they become loose, as the rope stretches.

Much of this information about clips was found on page 8 of Technical Paper 237 of the Bureau of Mines, Safe Practice in Using Wire Ropes in Mines, by Kudlich and Hood. This publication contains much information of value to users of wire rope.

13. SOCKETING

Commercial sockets made from forged steel may be attached to the rope as follows: (*a*) The rope should be securely seized before cutting and at least two addtional seizings placed at a distance from the end equal to the length of the basket of the socket. For large ropes the seizing should be several inches long and securely wrapped with a seizing iron. This is very important, as it prevents the rope untwisting and insures equal tension in the strands when the load is applied (see VII, 10).

(*b*) The end seizing on the rope should be taken off, leaving the addtional seizing at a distance from the end equal to the length of the socket basket. The hemp center should be cut back to this seizing, and the wires should all be untwisted and broomed out, although they need not necessarily be straightened.

(*c*) The wires, for the distance that they are to be inserted in the socket, should be carefully cleaned with benzine, naphtha, or gasoline, and then the wires dipped for a distance not greater then three-quarters of the cleaned length of the wire in commercial muriatic acid for from 30 seconds to 1 minute or until the acid has thoroughly cleaned each wire. Care should be taken that the acid does not come into contract with any other portion of the rope. If it does, the wires will become brittle.

(*d*) The wires should be dipped in boiling water containing a small amount of soda to neutralize the acid.

(*e*) The wires should be inserted into the basket of the socket. Care should be taken that the socket is in line with the axis of the rope.

(*f*) The base of the socket should be sealed with putty, clay, or any similar substance. Pour molten zinc into the basket until it is full.

(*g*) The zinc must not be too hot or it will anneal the wires, particularly for small ropes. The temperature should not be above 830° F. When the zinc has solidified sufficiently, the socket may be plunged into cold water. If socketing is properly done, the strands will break near the middle of the specimen, not at the end of the basket.

(*h*) Do not use babbitt metal or lead for socketing wire rope. If they are used, the strength of the fastening will be much less than the strength of the rope.

(*i*) The catalogues of some of the manufacturers of wire rope and of passenger elevators give detailed instructions for socketing wire rope similar to those given here. Many illustrations show clearly the appearance of the rope end as the work proceeds and the methods used in attaching the socket.

14. SPLICING

The splicing of wire rope requires considerable skill. If lives would be endangered or property damaged by the failure of a rope at the splice, inexperienced persons should not attempt to splice wire rope.

The instructions for splicing rope are too long to be given here. They will be found in the catalogues of some of the wire-rope manufacturers. The sequence of the operations is carefully described and many clear illustrations show the progress of the work in the hands of experienced workmen. These illustrations give, in fact, most of the information which a person would receive by watching the making of a splice by skilled hands.

15. SHEAVES AND DRUMS

The sheaves and drums for wire rope should be as large as possible, and the less flexible the rope the larger should be the sheave. The length of service decreases as the diameter of the sheaves is made smaller. The results of tests which show that wire rope is stronger the larger the sheave are given in Bureau of Standards Technologic Paper No. 229 "Some Tests of Wire Rope on Sheaves." The space where the rope is to be used, usually, limits the size of the drums and sheaves. For wire rope of 6 by 7 construction good practice requires that the sheave diameter shall be not less than 85 times the diameter of the rope. For 6 by 19 construction good practice requires 1 foot diameter of the sheave for each ¼-inch diameter of the rope. In other words, the sheave should be not less than 50 times the diameter of the rope. Under no circumstances should the diameter of the sheave be less than 20 times the diameter of 6 by 19 rope.

For wire rope of 6 by 37 or 8 by 19 construction good practice requires that the diameter of the sheave shall not be less than 30 times the diameter of the rope. Under no circumstances should the diameter of the sheave be less than 15 times the diameter of 6 by 37 or 8 by 19 rope.

Whenever possible, the drums or sheaves for wire rope of any construction should be so arranged that the rope is not bent in service first in one direction then in the reverse direction. If reverse bending can not be avoided, the sheave about which the reverse bending occurs should be larger than the other sheaves. This will increase the length of service of the rope.

16. LUBRICATION

Wear of a running wire rope occurs where the outside wires come into contact with the sheaves and drums, especially if slipping takes place, and, also, where the wires are in contact. During the fabrication of a wire rope the fiber core is saturated with lubricating compound, which in service is gradually supplied to the wires and reduces the wear on them. As the core will not carry enough lubricant for the life of the rope, it is necessary to occasionally apply a lubricant to the outside of the rope, which will be absorbed by the core. A mixture of a heavy-bodied lubricant and a good grade of graphite is as satisfactory as any of the proprietary lubricants and is cheaper. A viscous preparation which remains on the outside of the rope does not lubricate the inner wires of the rope.

For elevator cables any lubricant containing an opaque substance is undesirable, as it interferes with the proper inspection of the rope by making it difficult to detect broken wires. Graphite and similar lubricants may cause excessive sliding of cables on traction-drive elevators and should not be used on this type of equipment. Boiled linseed oil, applied hot, will saturate the hemp center and will when dry give a transparent covering which will not interfere with the thorough inspection of the rope. If an uncoated wire rope is to be used where it is likely to corrode, the lubricant should have a very heavy body and be applied to the rope so hot that it will penetrate to the core.

17. SAFE OR WORKING LOADS

The safe or working load is obtained by dividing the minimum breaking strength of the wire rope by the factor of safety. The safe load given in the tables is computed, using a factor of safety of 4.5. For many purposes this factor is too low, and, therefore, the safe loads are much too high. For example, a factor of safety of from 8 to 12 should be used in computing the safe dead-weight load on wire ropes for passenger elevators because the acceleration is very high. The wire rope for elevator installations should comply with the requirements of the Safety Code for Elevators and Escalators,

published by the American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York, N. Y. For mines, the wire ropes should comply with the recommendations of the Bureau of Mines, in Technical Paper No. 237, Safe Practice in Using Wire Rope in Mines, and in Bulletin No. 75, Rules and Regulations for Metal Mines.

18. DETERIORATION

Wear, overload, and bending around sheaves which are too small in diameter are the principal reasons for the rapid deterioration of wire rope. If the wear is rapid, the outside wires will show flattened surfaces in a short time. If many of the outside wires, although little worn, are broken and stick out all along the rope, it has probably been overloaded or used on too small a sheave.

No definite rules can be given which will enable an inexperienced person to decide when a worn rope should be replaced by a new one. However, the following suggestions will, it is believed, be of assistance.

The service for which the rope is used and the damage which might result, if the rope broke, are of great importance. Consider the three conditions which follow:

(*a*) If little or no damage would result by the rope breaking, a wire rope might, theoretically, be used until it fails. Practically, however, this is undesirable under any circumstances.

(*b*) If material is hoisted, the rope should be renewed before there is a reasonable probability that it will fail.

(*c*) If persons are hoisted, as in a passenger elevator, every reasonable precaution should be taken that will prevent failure of the rope in service.

A rule which has been used is to replace a rope if it shows more than six broken wires per foot or has three or more adjacent broken wires in the same strand.

For conditions (*a*) and (*b*), the rope may be used, if there were no broken wires, until the thickness of the outside wires was about one-third of the original diameter. If many of the wires are broken, even if the rope is not worn, it should be replaced by a new one. Wire ropes should, under any circumstances, be replaced if there are as many as 10 broken wires in any 1 foot of the rope.

For conditions (*c*), particularly on elevators, the ropes are renewed, if a few wires are broken in the entire length of the rope or if the outside wires are worn to a thickness of one-half of their original diameter.

Users of wire rope should have tensile tests made of rope when it is removed from service. If the maximum safe working load, computed as described in VII, 17, is less than the maximum load to which the rope may be subjected, it has been in service so long as to be dangerous. The information gained in this way, may, in future, be used in judging when wire ropes should be replaced.

19. USES, GENERAL

(*a*) MATERIAL.—The strength of wire rope increases with the strength of the material from which it is made. The strength increases in the following order—phosphor bronze, cast steel, extra strong cast steel, plow steel, high-grade plow steel. The weight and the diameter of a wire rope for a particular purpose can be reduced by using a stronger material, as, for example, by using a plow steel instead of an extra strong cast-steel rope. Or, by using a stronger material the strength and, therefore, the safe working load can be increased for a given weight and diameter.

(*b*) GALVANIZED WIRE ROPE.—Galvanized wire rope should be used, if the rope is likely to corrode because of the presence of moisture, as for the standing rigging of a ship. Because the zinc coating is rapidly removed by wear, it should not, in general, be used for hoisting. It may, however, be used for the running rigging and for wheel (steering) ropes on ships, as these ropes do not wear rapidly.

(*c*) UNCOATED WIRE ROPE.—Uncoated wire rope should be used where it is protected from moisture, as in a building, and for more or less continuous hoisting. It may be used instead of galvanized wire rope where it is exposed to moisture, as for derrick guys, if a protective coating is applied to the rope at regular intervals.

(*d*) PHOSPHOR BRONZE WIRE ROPE.—Phosphor bronze wire rope has lower strength than steel wire rope; therefore, the working loads should be lower. The sheaves should also be larger than those for steel rope. It is nonmagnetic, and it can be used for conditions under which galvanized steel rope does not give satisfaction. Because of these properites it is used on small vessels.

20. USES FOR TYPES C AND D, MARLINE-COVERED WIRE ROPE

Marline covered wire rope is stronger and more durable than manila rope. The marline covering prevents wearing of the wires and supplies lubricant to them. As the marline wears to a smooth surface, the rope is easily handled or laid in a flat coil. Compared with uncovered wire rope, the marline-covered rope is more easily handled, has greater friction, which is an advantage, if it is used on a smooth drum, and is more durable, particularly if it is exposed to gases, grit, or moisture.

21. USES FOR TYPE E, 6 BY 7

Rope of 6 by 7 construction is the stiffest of the steel wire ropes included in this specification. When galvanized, it is suitable for standing guys and vang pendants but not for hoisting. When uncoated, it is used for well drilling and for haulage and gravity systems, particularly coal-haulage systems operating grip cars, and for use where the wear is great and a flexible rope is not required.

If a rope larger than 1½-inch diameter is required for any of these uses, a 6 by 19 construction should be used.

22. USES FOR TYPES F, G, AND H, 6 BY 12

(*a*) Phosphor Bronze.—Phosphor bronze rope of 6 by 12 construction is used for life lines, clearing lines, wheel ropes, or for rigging.

(*b*) Galvanized Steel.—Galvanized steel wire rope 6 by 12 construction is more flexible than either 6 by 19 or 6 by 37, but is not as strong. It is used for small guys, life lines, ridge ropes, boat ladders, jacob ladders, boom pendants, mooring lines, and for running rigging for which great flexibility is required.

23. USES FOR TYPES J, K, L, M, AND N, 6 BY 19

(*a*) Phosphor Bronze.—Phosphor bronze wire rope of 6 by 19 construction is used for the same purposes as 6 by 12 phosphor bronze rope and also, to a certain extent, for governor cables for elevators.

(*b*) Galvanized Steel.—Galvanized steel wire rope of 6 by 19 construction is used for guys, ladders, railings, ridge ropes, boat slings, engine controls, standing rigging, topping lifts for booms, wireless halyards and guys, wheel ropes (7/16-inch diameter and under), and for running rigging (5/8-inch diameter and under).

(*c*) Uncoated Steel.—Uncoated steel wire rope of 6 by 19 construction is the stiffest and strongest rope which is suitable for hoisting purposes. It has a great variety of uses, on cranes, elevators, derricks, conveyors, dredges, cableways, coal hoists, hay presses, inclined planes, skip hoists, balanced unloaders, and for mining and logging operations.

(*d*) Cast Steel.—Uncoated cast-steel wire rope of 6 by 19 construction has lower strength than extra strong cast-steel or plow-steel wire rope. It should only be used for moderate duty, such as for elevators requiring low working loads in the wire ropes; for cableways having a short span; for hoisting ropes for shallow mines, if they are operated at slow speed and the drums and sheaves are large; and for haulage ropes, if the operating conditions are favorable.

(*e*) Extra Strong Cast Steel.—Extra strong cast-steel wire rope can be used for the same purposes as cast-steel wire rope but where somewhat greater strength is required.

(*f*) Plow Steel.—Plow steel wire rope of 6 by 19 construction is very tough and resists abrasion. It is more generally used for hoisting than 6 by 19 ropes of other grades of steel.

(*g*) High-Grade Plow Steel.—Uncoated high-grade plow steel rope of 6 by 19 construction is used for the same purposes as uncoated plow steel rope. It should be used where the rope is subjected to fatigue and severe shock or abrasion. It is used for severe service in mines, logging lines, scraper dredges, wrecking, ballast and unloader ropes, and for heavy cranes and excavating machinery.

24. USES FOR TYPES P AND Q, 6 BY 24

(*a*) GALVANIZED STEEL.—Galvanized steel wire rope of 6 by 24 construction is stronger than 6 by 12 and almost as flexible. It is used for hawsers, mooring lines, and stream lines, and, in the larger sizes where great flexibility is necessary and a rope of 6 by 12 construction having the same diameter would not have the necessary strength.

25. USES FOR TYPES R AND S, 6 BY 37

(*a*) GALVANIZED STEEL.—Galvanized steel wire rope 6 by 37 construction is used for bridles, relieving tackle, towing hawsers, dip ropes, flexible pendants, slings for general hoisting, hawsers for which great strength is required, heavy running rigging, wheel ropes (over seven-sixteenths inch in diameter), steering gear transmission rope, tiller rope, and for boat and crane falls both afloat and ashore.

(*b*) UNCOATED STEEL.—Uncoated steel wire rope of 6 by 37 construction is very flexible and is suitable for cranes and similar machinery having sheaves smaller than the diameters recommended for 6 by 19 construction. It is very efficient because over 50 per cent of the wires (therefore 50 per cent of the strength) are in the inner layers of the strand, protected from abrasion. The wires are smaller than those in the 6 by 19 construction and will not stand as much wear. It may be used for heavy hoisting, especially if the conditions are unusually severe. Hoisting ropes larger than 1¾ inches diameter and the falls for large clam-shell buckets are usually of this construction.

26. USES FOR TYPES T AND U, 8 BY 19

(*a*) UNCOATED STEEL.—Uncoated steel wire rope of 8 by 19 construction is used for back drum counterweights on drum-type machines for elevators and for similar use in buildings. It should be used to replace iron rope of the same diameter. The diameter of the sheave recommended for iron ropes is greater than for steel ropes of the same diameter, so that no change in the sheave is necessary in replacing iron with steel rope.

VIII. GENERAL SPECIFICATIONS

No details.

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