PART II

DATA FOR THE WROUGHT CORROSION-RESISTING AND HEAT-RESISTING CHROMIUM-NICKEL STEELS

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TABLE XI.—CHEMICAL COMPOSITIONS OF WROUGHT CORROSION-RESISTING CHROMIUM-NICKEL STEELS.

A.S.T.M. Designation	A.S.T.M. Grade	A.I.S.I. Type Number	Carbon, per cent	Manganese, max., per cent	Phosphorus,[a] max., per cent	Sulfur,[a] per cent	Silicon, max., per cent	Chromium, per cent	Nickel, per cent	Molybdenum, per cent
A 167 - 42	1	301	0.08 to 0.20	2.00	0.035[a]	0.030 max.[a]	0.75	16.00 to 18.00	6.00 to 8.00	....
A 177 - 39										
A 167 - 42	2	302	0.08 to 0.20	2.00	0.035[a]	0.030 max.[a]	0.75	17.00 to 19.00	8.00 to 10.00	....
		303	0.20 max.	2.00	0.035[a,b]	0.070 min.[a,c]	....	17.00 to 19.00	8.00 to 10.00	0.60 max.
A 167 - 42	3	304	0.08 max.	2.00	0.035[a]	0.030 max.[a]	0.75	18.00 to 20.00	8.00 to 10.00	....
A 240 - 42	S	d	0.07 max.[e]	2.50	0.035[a]	0.030 max.[a]	0.75	18.00 min.	8.00 min.	....
A 167 - 42	4	f								
	5[g]		0.10 max.	1.50[h]	0.035[a]	0.030 max.[a]	0.75	18.00 min.[h]	8.00 min.[h]	....
A 240 - 42	T[i]	j	0.07 max.[k]	2.50	0.035	0.030 max.[a]	0.75	17.00 min.	9.00 min.	....
A 167 - 42	6[l]	347	0.10 max.	1.50[m]	0.035[a]	0.030 max.[a]	0.75	18.00 min.[m]	8.00 min.[m]	....
A 240 - 42	C[n]	o	0.07 max.[p]	2.50	0.035[a]	0.030 max.[a]	0.75	17.00 min.	9.50 min.	....
	7	q								
	8	309	0.20 max.	2.00	0.035[a]	0.030 max.[a]	3.50	22.00 to 24.00	12.00 to 15.00	....
A 167 - 42	9	r								
	10	310	0.25 max.	2.00	0.035[a]	0.030 max.[a]	2.00	24.00 to 26.00	19.00 to 22.00	....
	11	316	0.08 max.[s]	2.00	0.035[a]	0.030 max.[a]	0.75	16.00 min.[t]	10.00 min.[t]	2.00 to 3.00
A 240 - 42	M	t	0.07 max.[u]	2.50	0.035[a]	0.030 max.[a]	0.75	17.00 min.	10.00 min.	2.00 min.
A 167 - 42	12	v								

[a] Emergency Alternate Provisions EA - A 167 and EA - A 240 provide for a phosphorus and a sulfur content of 0.040 max., per cent, respectively, in A.S.T.M. Specifications A 167 - 42 and A 240 - 42.

[b] This steel may contain up to 0.17 per cent phosphorus with 0.10 max., per cent sulfur, or 0.07 min., per cent selenium.

[c] Or selenium 0.07 min., per cent.

[d] A.I.S.I. type 304 is similar to A.S.T.M. grade S.

[e] Emergency Alternate Provisions EA - A 240 provide for a carbon content of 0.08 max., per cent, which requirement is the same as in A.I.S.I. type 304.

[f] A.I.S.I. type 308 is similar to A.S.T.M. grade 4.

[g] Grade 5 has a minimum titanium content of four times the carbon content.

[h] Emergency Alternate Provisions EA - A 167 provide for a manganese content of 2.00 max., per cent, chromium from 17.00 to 19.00 per cent, and nickel from 8.00 to 12.00 per cent, which requirements are the same as in A.I.S.I. type 321.

[i] Grade T has a titanium content of not less than five times the carbon content and not more than 0.60 per cent; Emergency Alternate Provisions EA - A 240 provide for changing the titanium content to be "not less than four times the carbon content and not more than 0.60 per cent," which requirement as to the titanium: carbon ratio is the same as in A.I.S.I. type 321.

[j] A.I.S.I. type 321 is similar to A.S.T.M. grade T.

[k] Emergency Alternate Provisions EA - A 240 provide for a carbon content of 0.10 max., per cent, which requirement is the same as in A.I.S.I. type 321.

[l] Grade 6 has a minimum columbium content of ten times the carbon content; Emergency Alternate Provisions EA - A 167 provide for changing the columbium content to be "eight times the carbon content," which requirement is the same as in A.I.S.I. type 347.

[m] Emergency Alternate Provisions EA - A 167 provide for a manganese content of 2.00 max., per cent, chromium from 17.00 to 19.00 per cent, and nickel from 8.00 to 12.00 per cent, which requirements are the same as in A.I.S.I. type 347.

[n] Grade C has a columbium content of not less than ten times the carbon content and not more than 1 per cent; Emergency Alternate Provisions EA - A 240 provide for changing the columbium content to be "not less than eight times the carbon content and not more than 1 per cent," which requirement as to the columbium: carbon ratio is the same as in A.I.S.I. type 347.

[o] A.I.S.I. type 347 is similar to A.S.T.M. grade C.

[p] Emergency Alternate Provisions EA - A 240 provide for a carbon content of 0.10 max., per cent, which requirement is the same as in A.I.S.I. type 347.

[q] A.I.S.I. type 302B is similar to A.S.T.M. grade 7.

[r] A.I.S.I. type 309S is similar to A.S.T.M. grade 9.

[s] Emergency Alternate Provisions EA - A 167 provide for a carbon content of 0.10 max., per cent, chromium from 16.00 to 18.00 per cent, and nickel from 10.00 to 14.00 per cent, which requirements are the same as in A.I.S.I. type 316.

[t] A.I.S.I. type 316 is similar to A.S.T.M. grade M.

[u] Emergency Alternate Provisions EA - A 240 provide for a carbon content of 0.08 max., per cent.

[v] A.I.S.I. type 317 is similar to A.S.T.M. grade 12.

TABLE XII.—PHYSICAL PROPERTIES AND WORKING CHARACTERISTICS OF WROUGHT CORROSION-RESISTING CHROMIUM-NICKEL STEELS IN THE ANNEALED CONDITION.

A.S.T.M. Designation	A 167 - 42 A 177 - 39	A 167 - 42	....	A 167 A 240	A 167 - 42	A 167 - 42	A 167 A 240	A 167 A 240	A 167 A 240
A.S.T.M. Grade	1	2	....	3 S	8	10	11 M	5 T	6 C
A.I.S.I. Type No.	301	302	303	304 304	309	310	316 316	321 321	347 347
Modulus of elasticity in tension, psi	28 000 000[a]	28 000 000	28 000 000	28 000 000	29 000 000	30 000 000	28 000 000	28 000 000	28 000 000
Modulus of elasticity in torsion, psi	12 500 000[b]	12 500 000[b]	....	12 500 000	....	....	....	....	....
Density, lb. per cu. in.	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Density, g. per cu. cm.	7.9	7.9	7.9	7.9	7.9	7.9	8.0	7.9	8.0
Specific electrical resistance at room temperature, microhms per cm. per sq. cm.	72	72	72	72	78	80	76	72	73
Magnetic permeability, Annealed	....	1.003	1.003	1.02	1.003	1.003	1.003	1.02	1.02
Magnetic permeability, 10 per cent cold-worked	....	1.10	....	1.10	....	....	....	....	....
Magnetic permeability, Severely cold-worked	....	10.0	....	7.0	....	....	10.0	....	....
Specific heat, Btu. per lb. per deg. Fahr. (32 to 212 F.)	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Thermal conductivity, Btu. per hr. per sq. ft. per ft. per deg. Fahr., 212 F	....	9.4	9.4	9.4	....	7.5	9.0	9.3	9.3
Thermal conductivity, 392 F	....	10.2	....	10.3	....	8.2	....	10.2	10.2
Thermal conductivity, 572 F	....	10.9	....	11.0	....	8.8	....	11.1	11.1
Thermal conductivity, 752 F	....	11.6	....	11.8	....	9.5	....	11.9	11.9
Thermal conductivity, 932 F	....	12.4	12.4	12.5	....	10.0	12.1	12.8	12.8
Mean coefficient of thermal expansion per deg. Fahr., 32 to 212 F	0.0000094	0.0000096	....	0.0000096	0.0000083	0.0000080	0.0000089	0.0000093	0.0000093
Mean coefficient of thermal expansion per deg. Fahr., 32 to 572 F	....	0.0000099	....	0.0000099	....	....	....	....	....
Mean coefficient of thermal expansion per deg. Fahr., 32 to 932 F	0.0000101	0.0000102	....	0.0000102	0.0000096	0.0000092	0.0000097	0.0000103	0.0000103
Mean coefficient of thermal expansion per deg. Fahr., 32 to 1112 F	....	0.0000104	....	0.0000104	....	....	....	....	....
Mean coefficient of thermal expansion per deg. Fahr., 32 to 1832 F	....	0.0000112	....	0.0000112	0.0000115	0.0000106	....	....	....
Maximum temperature without excessive scaling, deg. Fahr.	....	1650	1600	1650	2000	2000	1650	1650	1650
Melting point range, deg. Fahr.	2550 to 2590	2550 to 2590	2550 to 2590	2550 to 2650	2550 to 2650	2550 to 2650	2500 to 2550	2550 to 2600	2550 to 2600
Forging practice, Initial temperature, deg. Fahr.	2150 to 2250	2000 to 2200	2100 to 2200	2000 to 2200	2000 to 2150	2000 to 2150	2100 to 2200	2100 to 2200	2100 to 2200
Forging practice, Final temperature, deg. Fahr.	1700 to 1750	1700 to 1750	1700 to 1750	1650 to 1700	1800 to 1850	1800 to 1850	1700 to 1750	1650 to 1700	1700 to 1750
Annealing temperatures, deg. Fahr., Low anneal	....	....	....	....	....	....	....	1550 to 1650	1550 to 1650
Annealing temperatures, deg. Fahr., Full anneal	1950 to 2050	1950 to 2050	1950 to 2050	1950 to 2050	2000 to 2100	2000 to 2100	1950 to 2050	1950 to 2050	1950 to 2050
Hardening temperature	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]
Maximum cold reduction of wire before anneal, per cent	80	80	50	80	80	80	80	80	80
Riveting and hot forming temperatures, deg. Fahr.	....	1900 to 2100	....	1900 to 2100	1900 to 2100	1900 to 2100	1900 to 2100	1900 to 2100	1900 to 2100

[a] Type 301 is used in the cold-worked condition for light-weight high-strength structures. As cold-worked the modulus in tension is lowered. By stress-relief heat treatment this value may be raised to 27,500,000 psi.

[b] As cold-worked, this value decreases.

[c] Nonhardening for all grades and types.

TABLE XIII.—MECHANICAL PROPERTIES OF 17 PER CENT CHROMIUM, 7 PER CENT NICKEL STEEL.

CHEMICAL COMPOSITION, PER CENT

Carbon	0.08 to 0.20	Silicon	0.75 max.
Manganese	2.00 max.	Chromium	16 to 18
Phosphorus	0.035 max.	Nickel	6 to 8
Sulfur	0.03 max.		

A.S.T.M. Designation	{A 167 - 42 {A 177 - 39
A.S.T.M. Grade	1
A.I.S.I. Type No.	301
Structure	Austenitic

MECHANICAL PROPERTIES

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point, psi.	Proportional Limit,[a] psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb. Charpy	Impact Resistance, ft-lb. Izod	Hardness Number Brinell (3000-kg. load, 10-mm. ball)	Hardness Number Rockwell	Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility Erichsen Value, mm.	Ductility Olsen Value, in.
Sheet:														
Cold-rolled, ¼ Hard	125 000 min.	75 000 min.	...	...	25 min.	...	...	...	...	C25	...	...	...	...
Cold-rolled, ½ Hard	150 000 min.	110 000 min.	...	35 000 min.	15 to 18[b]	...	...	...	...	C32	...	...	...	...
Cold-rolled, ¾ Hard	175 000 min.	135 000 min.	...	45 000 min.	10 to 12[b]	...	...	...	...	C37	...	...	...	...
Cold-rolled, Hard	185 000 min.	140 000 min.	...	55 000 min.	8 to 9[b]	...	...	...	...	C41	80 000	...	...	...
Annealed	75 000 min.	30 000 min.	...	14 000 min.	40 min.	...	...	...	...	B80	35 000	...	10 to 14	...
Strip:														
Cold-rolled, ¼ Hard	150 000 min.	110 000 min.	...	35 000 min.	15 to 18[b]	...	...	...	...	C32	...	...	...	...
Cold-rolled, ½ Hard	175 000 min.	135 000 min.	...	45 000 min.	10 to 12[b]	...	...	...	...	C37	...	...	...	...
Cold-rolled, Hard	185 000 min.	140 000 min.	...	55 000 min.	8 to 9[b]	...	...	...	...	C41	80 000	...	...	...
Annealed	75 000 min.	30 000 min.	...	14 000 min.	40 min.	...	...	...	...	B80	35 000	...	10 to 14	...
Wire:														
Cold-drawn, 20 per cent.	170 000	120 000	...	60 000	20	...	...	...	...	C33	...	...	...	...
Cold-drawn, 40 per cent.	220 000	180 000	...	100 000	8	...	...	...	...	C42	...	...	...	...
Cold-drawn, 60 per cent.	270 000	240 000	...	145 000	5	...	...	...	...	C47	...	...	...	...
Annealed	120 000	35 000	...	20 000	44	...	...	...	...	B85	...	180	...	...
Plate:														
Annealed	100 000	...	45 000	...	50	70	...	...	163	...	39 000	...	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bars:														
Cold-drawn, 30 per cent.	183 000	159 000	...	...	16	49	...	...	...	C36	78 000	180	...	...
Annealed	100 000	32 000	45 000	...	55	66	...	...	...	B80	39 000	...	...	...

[a] Proportional limit values at offset of 0.01 per cent.
[b] Elongation values vary with thickness being higher with greater thickness.

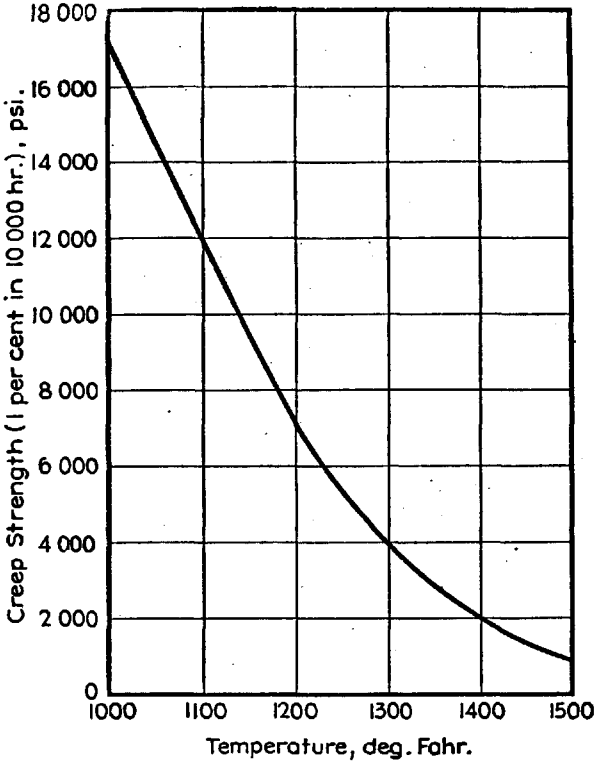


FIG. 12.—Creep Strength at Various Temperatures of 18 per cent Chromium, 8 per cent Nickel Steel (A.S.T.M. Designation: A 167 – 42, Grade 2; A.I.S.I. Type No. 302).

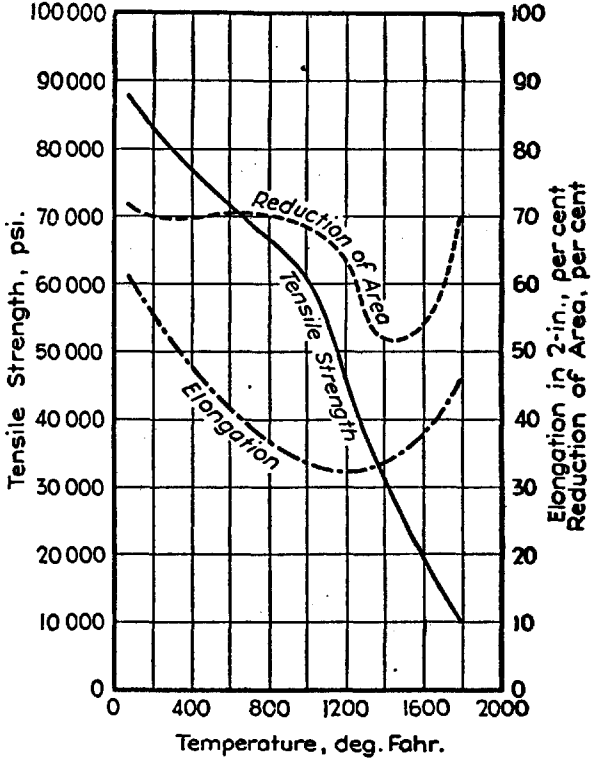


FIG. 13.—Short-Time High-Temperature Tensile Properties of 18 per cent Chromium, 8 per cent Nickel Steel (A.S.T.M. Designation: A 167 – 42, Grade 2; A.I.S.I. Type No. 302).

TABLE XIV.—MECHANICAL PROPERTIES OF 18 PER CENT CHROMIUM, 8 PER CENT NICKEL STEEL.

Chemical Composition, per cent			
Carbon	0.08 to 0.20	Silicon	0.75 max.
Manganese	2.00 max.	Chromium	17 to 19
Phosphorus	0.035 max.	Nickel	8 to 10
Sulfur	0.03 max.		

A.S.T.M. Designation	A 167 - 42
A.S.T.M. Grade	2
A.I.S.I. Type No.	302
Structure	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit,[b] psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled, quarter hard	125 000 min.	75 000 min.	...	35 000 min.	20 min.	...	...	...	...	C25	...	...	...	...
Annealed	75 000 min.	30 000 min.	...	14 000 min.	40 min.	...	...	...	...	B80	...	180	10 to 14	0.4 to 0.5
Strip:														
Cold-rolled, quarter hard	125 000 min.	75 000 min.	...	35 000 min.	20 min.	...	...	...	...	C25	...	...	...	...
Annealed	75 000 min.	30 000 min.	...	14 000 min.	40 min.	...	...	...	...	B80	...	180	10 to 14	0.4 to 0.5
Wire:														
Cold-drawn 20 per cent	140 000	105 000	...	40 000	25	...	...	...	...	C32	...	...	...	...
Cold-drawn 40 per cent	195 000	165 000	...	60 000	10	...	...	...	...	C40	...	...	...	...
Cold-drawn 60 per cent	250 000	225 000	...	100 000	5	...	...	...	...	C45	...	...	...	...
Annealed	105 000	30 000	...	20 000	55	...	...	...	...	B80	...	180	...	...
Plate:														
Annealed	85 000	...	41 000	...	50	73	...	...	150	...	...	180	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bars:														
Cold-drawn, 25 per cent	155 000	...	135 000	...	20	58	...	50	320	...	83 000	180	...	...
Annealed	85 000	30 000	40 000	...	60	65	80	90	160	B80	34 000	180	...	...

[a] *Yield point* as determined with dividers must not be confused with a defined *yield strength*, such as, at 0.2 per cent offset.
[b] Proportional limit values at offset of 0.01 per cent.

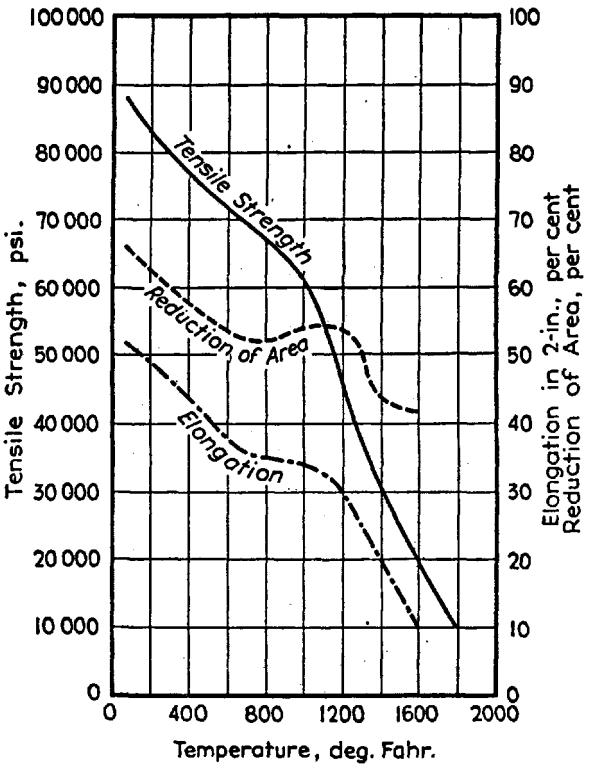


FIG. 14.—Short-Time High-Temperature Tensile Properties of 18 per cent Chromium, 8 per cent Nickel Steel (Free Machining) (A.I.S.I. Type No. 303).

TABLE XV.—MECHANICAL PROPERTIES OF 18 PER CENT CHROMIUM, 8 PER CENT NICKEL STEEL (FREE MACHINING).

Chemical Composition, per cent				A.S.T.M. Designation	
Carbon	0.20 max.	Chromium	17 to 19	A.S.T.M. Grade	
Manganese	2.00 max.	Nickel	8 to 10	A.I.S.I. Type No.	303
Phosphorus	0.035 max.[a]	Molybdenum	0.60 max.	Structure	Austenitic
Sulfur or Selenium	0.07 min.				

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point, psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Strip:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Wire:														
Cold-drawn {20 per cent	135 000	110 000	...	40 000	22	...	...	...	...	C30	...	...	...	...
Cold-drawn {40 per cent	180 000	170 000	...	75 000	10	...	...	...	...	C38	...	...	...	...
Annealed	105 000	35 000	...	20 000	52	...	...	...	...	B86	...	180	...	...
Plate:														
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bars:														
Cold-drawn	115 000	...	80 000	...	35	50	...	80	220	...	48 000	180	...	...
Annealed	85 000	...	35 000	...	55	60	...	80	160	...	35 000	180	...	...

[a] This steel may contain up to 0.17 per cent phosphorus with 0.10 max. per cent sulfur or 0.07 min. per cent selenium.

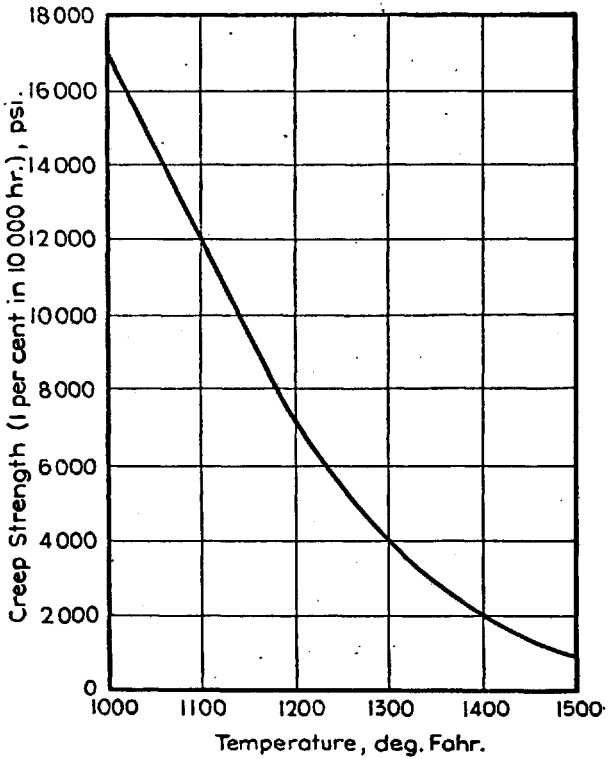


FIG. 15.—Creep Strength at Various Temperatures of Low-Carbon, 18 per cent Chromium, 8 per cent Nickel Steel (A.S.T.M. Designations: A 167 – 42, Grade 3, and A 240 – 42, Grade S; A.I.S.I. Type No. 304).

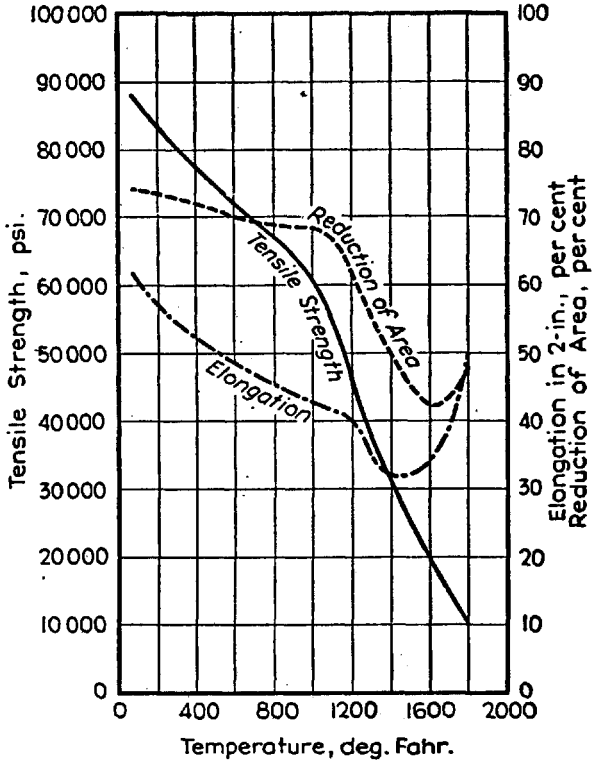


FIG. 16.—Short-Time High-Temperature Tensile Properties of Low-Carbon, 18 per cent Chromium, 8 per cent Nickel Steel (A.S.T.M. Designations: A 167 – 42, Grade 3, and A 240 – 42, Grade S; A.I.S.I. Type No. 304).

TABLE XVI.—MECHANICAL PROPERTIES OF LOW-CARBON, 18 PER CENT CHROMIUM, 8 PER CENT NICKEL STEEL.

Chemical Composition, per cent			
Carbon	0.08 max.	Silicon	0.75 max.
Manganese	2.00 max.	Chromium	18 to 20
Phosphorus	0.035 max.	Nickel	8 to 10
Sulfur	0.03 max.		

A.S.T.M. Designation	A 167 - 42	A 240 - 42
A.S.T.M. Grade	3	S
A.I.S.I. Type No.	304	304 is similar to grade S
Structure	Austenitic	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	85 000[b]	...	35 000	...	60	...	...	...	...	B80	35 000	180	10 to 14	0.4 to 0.5
Strip:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	90 000[b]	...	40 000	...	50	...	...	...	...	B80	...	180	10 to 14	0.4 to 0.5
Wire:														
Cold-drawn (20 per cent	140 000	105 000	...	40 000	25	...	...	...	...	C32	...	...	...	...
Cold-drawn (40 per cent	195 000	165 000	...	60 000	10	...	...	...	...	C40	...	...	...	...
Cold-drawn (60 per cent	250 000	225 000	...	100 000	5	...	...	...	...	C45	...	...	...	...
Annealed	105 000	30 000	...	20 000	55	...	...	...	...	B80	...	180	...	...
Plate:														
Annealed	85 000	...	35 000	...	60	65	...	100	150	B80	35 000	180	...	...
Tubing:														
Cold-drawn (Half hard	150 000	...	110 000	...	10	...	...	...	280	C30	...	...	...	...
Cold-drawn (Full hard	185 000	...	140 000	...	5	...	...	...	325	C35	...	...	...	...
Annealed	85 000	...	35 000	...	60	65	80	100	150	B80	35 000	180	...	...
Bars:														
Cold-drawn, 25 per cent	150 000	...	120 000	...	20	...	...	48	320	...	...	180	...	...
Annealed	85 000	30 000	40 000	...	60	70	...	90	160	B80	34 000	180	...	...

[a] *Yield point* as determined with dividers must not be confused with defined *yield strength*, such as, at 0.2 per cent offset.
[b] This is a representative and not a minimum value. Therefore, it must not be compared with the minimum values shown for grades 1 and 2 of A.S.T.M. Standard A 167 - 42 (see Tables XIII and XIV).

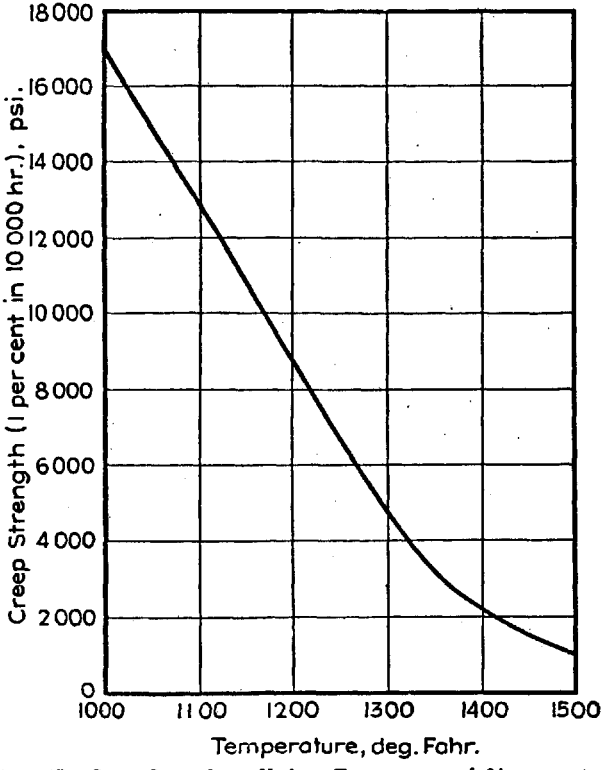


FIG. 17.—Creep Strength at Various Temperatures of 24 per cent Chromium, 12 per cent Nickel Steel (A.S.T.M. Designation: A 167 – 42, Grade 8; A.I.S.I. Type No. 309).

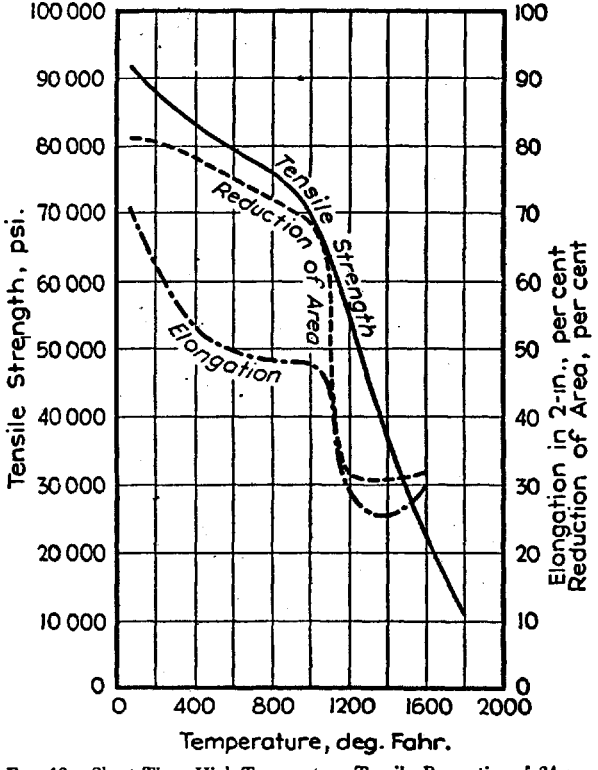


FIG. 18.—Short-Time High-Temperature Tensile Properties of 24 per cent Chromium, 12 per cent Nickel Steel (A.S.T.M. Designation: A 167 – 42, Grade 8; A.I.S.I. Type No. 309).

TABLE XVII.—MECHANICAL PROPERTIES OF 24 PER CENT CHROMIUM, 12 PER CENT NICKEL STEEL.

Chemical Composition, per cent			
Carbon	0.20 max.	Silicon	3.50 max.
Manganese	2.00 max.	Chromium	22 to 24
Phosphorus	0.035 max.	Nickel	12 to 15
Sulfur	0.03 max.		

A.S.T.M. Designation	A 167 - 42
A.S.T.M. Grade	8
A.I.S.I. Type No.	309
Structure	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	90 000[b]	...	45 000	...	47	...	...	...	...	B85	...	180	...	...
Strip:														
Cold-rolled (30 per cent)	116 000[b]	...	...	...	15	...	...	...	...	...	...	...	...	...
Cold-rolled (60 per cent)	166 000[b]	...	...	...	3	...	...	...	...	...	...	...	...	...
Annealed	90 000[b]	...	50 000	...	47	...	...	...	...	B85	...	180	7 to 8	...
Wire:														
Cold-drawn (20 per cent)	130 000	...	115 000	50 000	12	...	...	...	...	C25	...	...	...	...
Cold-drawn (40 per cent)	160 000	...	150 000	75 000	8	...	...	...	...	C33	...	...	...	...
Cold-drawn (60 per cent)	190 000	...	175 000	100 000	5	...	...	...	...	C37	...	...	...	...
Annealed	100 000	30 000	50 000	25 000	42	...	...	...	...	B86	...	180	...	...
Plate:														
Annealed	100 000	...	50 000	...	55	60	...	...	...	...	...	...	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bars:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	100 000	...	50 000	...	54	60	...	100	170	...	...	180	...	...

[a] *Yield point* as determined with dividers must not be confused with a defined *yield strength*, such as, at 0.2 per cent offset.

[b] This is a representative and not a minimum value. Therefore, it must not be compared with the minimum values shown for grades 1 and 2 of A.S.T.M. Standard A 167 - 42 see Tables XIII and XIV).

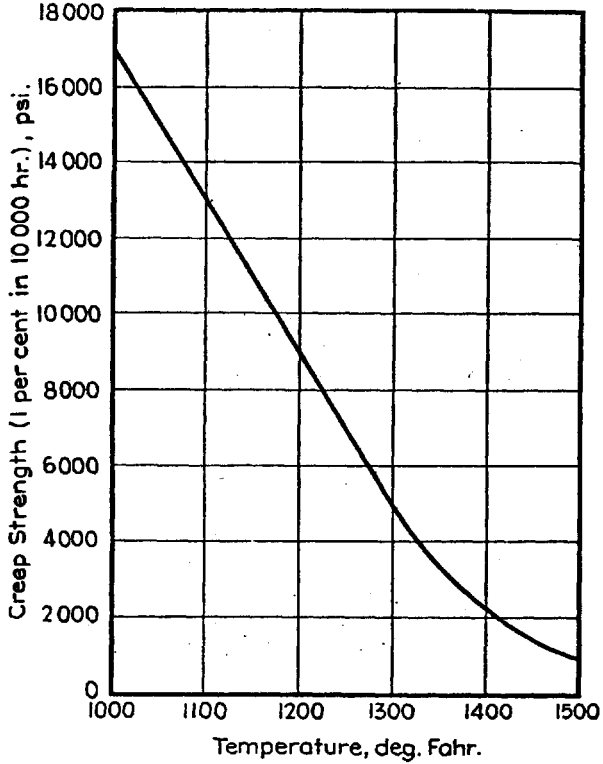


FIG. 19.—Creep Strength at Various Temperatures of 25 per cent Chromium, 20 per cent Nickel Steel (A.S.T.M. Designation: A 167 – 42, Grade 10; A.I.S.I. Type No. 310).

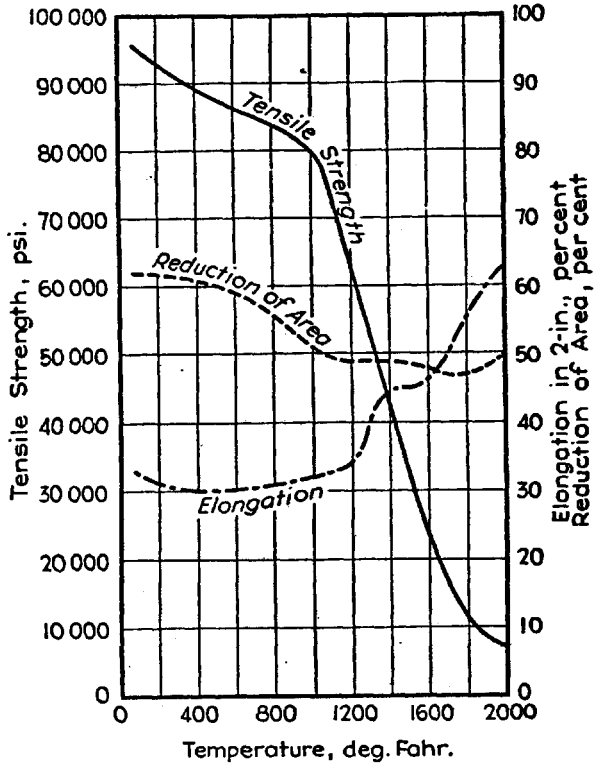


FIG. 20.—Short-Time High-Temperature Tensile Properties of 25 per cent Chromium, 20 per cent Nickel Steel (A.S.T.M. Designation: A 167 – 42, Grade 10; A.I.S.I. Type No. 310).

TABLE XVIII.—MECHANICAL PROPERTIES OF 25 PER CENT CHROMIUM, 20 PER CENT NICKEL STEEL.

Chemical Composition, per cent			
Carbon	0.25 max.	Silicon	2.00 max.
Manganese	2.00 max.	Chromium	24 to 26
Phosphorus	0.035 max.	Nickel	19 to 22
Sulfur	0.03 max.		

A.S.T.M. Designation	A 167 - 42
A.S.T.M. Grade	10
A.I.S.I. Type No.	310
Structure	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	95 000[b]	...	50 000	...	40	...	...	...	...	B85	...	180	...	...
Strip:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Wire:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	100 000	...	50 000	...	40	...	...	...	B85	...	...	180	...	...
Plate:														
Annealed	100 000	...	50 000	...	40	55	...	...	...	B85	...	180	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	100 000	...	50 000	...	40	55	...	60	...	B85	...	...	...	...
Bars:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	100 000	...	50 000	...	40	55	...	60	170	B85	...	180	...	...

[a] *Yield point* as determined with dividers must not be confused with a defined *yield strength*, such as, at 0.2 per cent offset.
[b] This is a representative and not a minimum value. Therefore, it must not be compared with the minimum values shown for grades 1 and 2 of A.S.T.M. Standard A 167 - 42 (see Tables XIII and XIV).

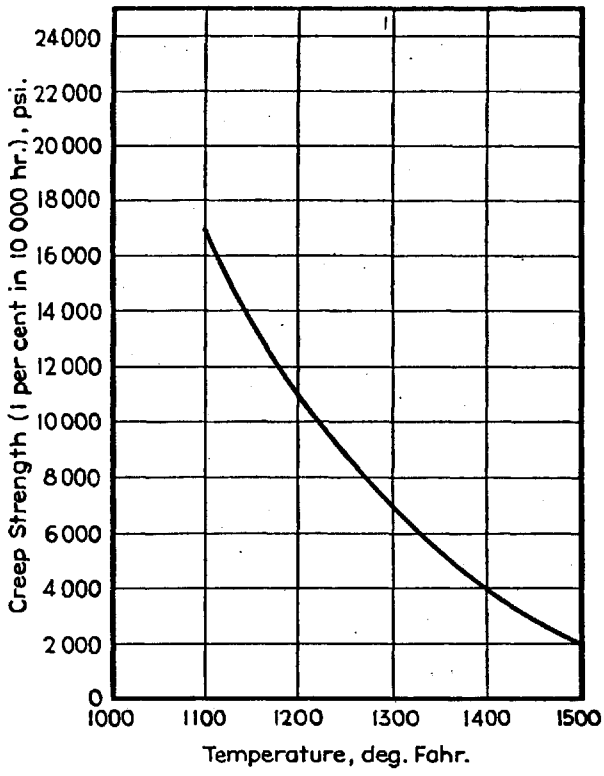


FIG. 21.—Creep Strength at Various Temperatures of 18 per cent Chromium, 12 per cent Nickel, 2 to 3 per cent Molybdenum Steel (A.S.T.M. Designations: A 167 – 42, Grade 11, and A 240 – 42, Grade M; A.I.S.I. Type No. 316).

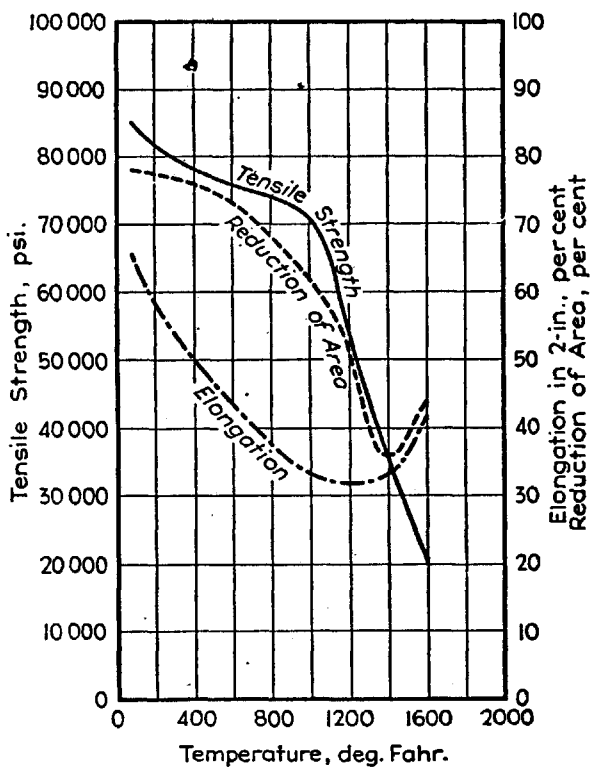


FIG. 22.—Short-Time High-Temperature Tensile Properties of 18 per cent Chromium, 12 per cent Nickel, 2 to 3 per cent Molybdenum Steel (A.S.T.M. Designations: A 167 – 42, Grade 11, and A 240 – 42, Grade M; A.I.S.I. Type No. 316).

TABLE XIX.—MECHANICAL PROPERTIES OF 18 PER CENT CHROMIUM, 12 PER CENT NICKEL, 2 TO 3 PER CENT MOLYBDENUM STEEL.

Chemical Composition, per cent			
Carbon	0.08 max.	Silicon	0.75 max.
Manganese	2.00 max.	Chromium	16 min.
Phosphorus	0.035 max.	Nickel	10 min.
Sulfur	0.03 max.	Molybdenum	2 to 3

A.S.T.M. Designation	A 167 - 42	A 240 - 42
A.S.T.M. Grade	11	M
A.I.S.I. Type No.	316	316 is similar to grade M
Structure	Austenitic	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	88 000[b]	...	40 000	...	52	...	...	...	...	B85	39 000	180	10 to 14	0.4 to 0.475
Strip:														
Cold-rolled, 30 per cent	145 000[b]	122 000	...	...	12	...	...	...	...	...	...	...	...	...
Cold-rolled, 40 per cent	159 000[b]	137 000	...	...	7	...	...	...	...	...	...	...	...	...
Annealed	90 000[b]	35 000	...	...	40	...	...	...	...	B85	...	180	10 to 14	0.4 to 0.5
Wire:														
Cold-drawn, 20 per cent	130 000	100 000	...	45 000	21	...	...	...	...	C25	...	...	...	...
Cold-drawn, 40 per cent	170 000	140 000	...	75 000	12	...	...	...	...	C33	...	...	...	...
Cold-drawn, 60 per cent	205 000	180 000	...	105 000	6	...	...	...	...	C38	...	...	...	...
Annealed	90 000	30 000	...	20 000	55	...	...	...	...	B85	...	180	...	...
Plate:														
Annealed	88 000	...	40 000	...	55	65	...	95	170	B85	39 000	180	...	...
Tubing:[c]														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	85 000	...	40 000	...	55	...	...	...	...	B85	...	...	...	...
Bars:														
Cold-drawn, 30 per cent	141 000	116 000	...	...	13	60	...	...	...	C29	...	...	...	...
Annealed	85 000	30 000	40 000	...	55	65	78	100	170	...	38 000	180	...	...

[a] *Yield point* as determined with dividers must not be confused with a defined *yield strength*, such as, at 0.2 per cent offset.

[b] This is a representative and not a minimum value. Therefore, it must not be compared with the minimum values shown for grades 1 and 2 of A.S.T.M. Standard A 167 - 42 (see Tables XIII and XIV).

[c] Some seamless tubing is made from a steel containing about 16 per cent chromium, 13 per cent nickel, and 3 per cent molybdenum.

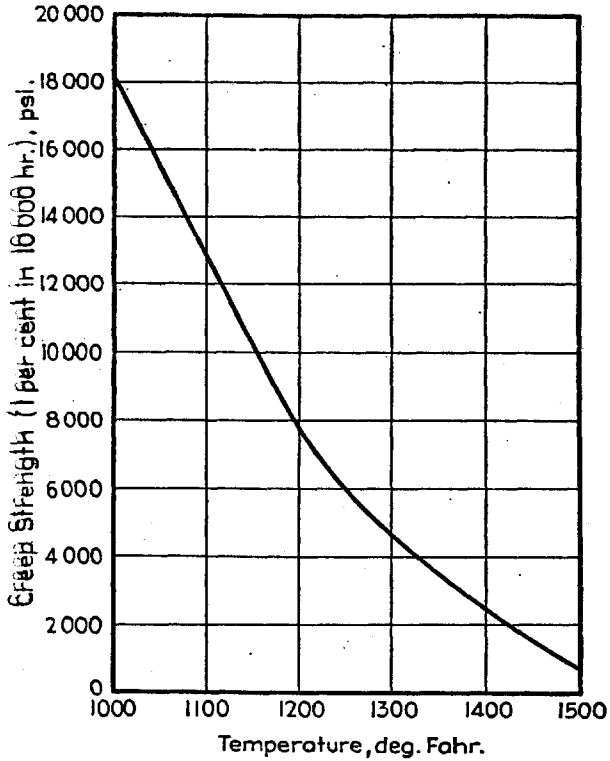


FIG. 23.—Creep Strength at Various Temperatures of 18 per cent Chromium, 8 per cent Nickel, Titanium Stabilized Steel (A.S.T.M. Designations: A 167 – 42, Grade 5, and A 240 – 42, Grade T; A.I.S.I. Type No. 321).

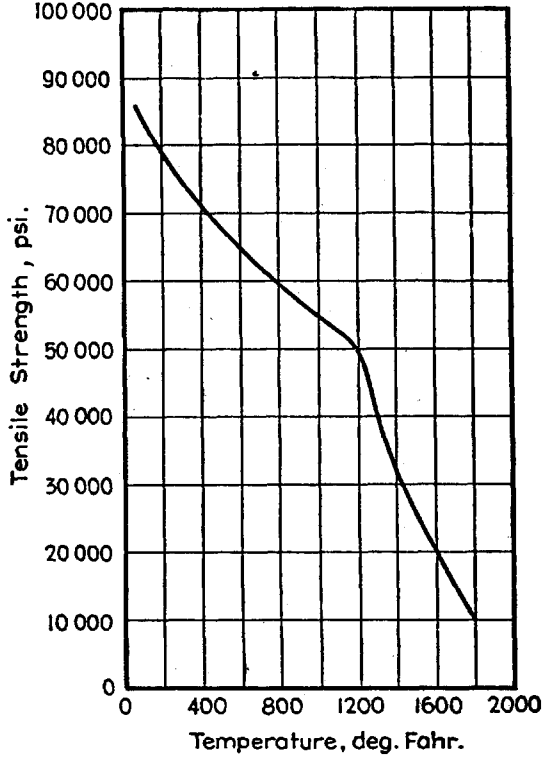


FIG. 24.—Short-Time High-Temperature Tensile Properties of 18 per cent Chromium, 8 per cent Nickel, Titanium Stabilized Steel (A.S.T.M. Designations: A 167 – 42, Grade 5, and A 240 – 42, Grade T; A.I.S.I. Type No. 321).

TABLE XX.—MECHANICAL PROPERTIES OF 18 PER CENT CHROMIUM, 8 PER CENT NICKEL, TITANIUM STABILIZED STEEL.

Chemical Composition, per cent			
Carbon	0.10 max.	Silicon	0.75 max.
Manganese	2.00 max.	Chromium	18.00 min.
Phosphorus	0.035 max.	Nickel	8 min.
Sulfur	0.03 max.	Titanium	4 × C min.

A.S.T.M. Designation	A 167 - 42	A 240 - 42
A.S.T.M. Grade	5	T
A.I.S.I. Type No.	321	321 is similar to grade T
Structure	Austenitic	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	85 000[b]	...	35 000	...	54	...	...	...	...	B80	...	180	12	0.400 to 0.475
Strip:														
Cold-rolled, 35 per cent	147 000[b]	136 000	...	...	7	...	...	...	...	...	...	...	...	...
Annealed	88 000[b]	...	39 000	...	56	...	...	...	...	B80	...	180	12	...
Wire:														
Cold-drawn 20 per cent	100 000	90 000	...	40 000	23	...	...	...	...	C20	...	...	...	...
Cold-drawn 40 per cent	145 000	130 000	...	70 000	10	...	...	...	...	C32	...	...	...	...
Cold-drawn 60 per cent	190 000	175 000	...	95 000	4	...	...	...	...	C37	...	...	...	...
Annealed	90 000	30 000	...	20 000	55	...	...	...	...	B85	...	180	...	...
Plate:														
Annealed	89 000	...	38 000	...	55	60	...	100	170	...	...	180	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bars:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	90 000	...	40 000	...	55	60	...	100	170	B85	...	180	...	...

[a] *Yield point* as determined with dividers must not be confused with a defined *yield strength*, such as, at 0.2 per cent offset.

[b] This is a representative and not a minimum value. Therefore, it must not be compared with the minimum values shown for grades 1 and 2 of A.S.T.M. Standard A 167 - 42 (see Tables XIII and XIV).

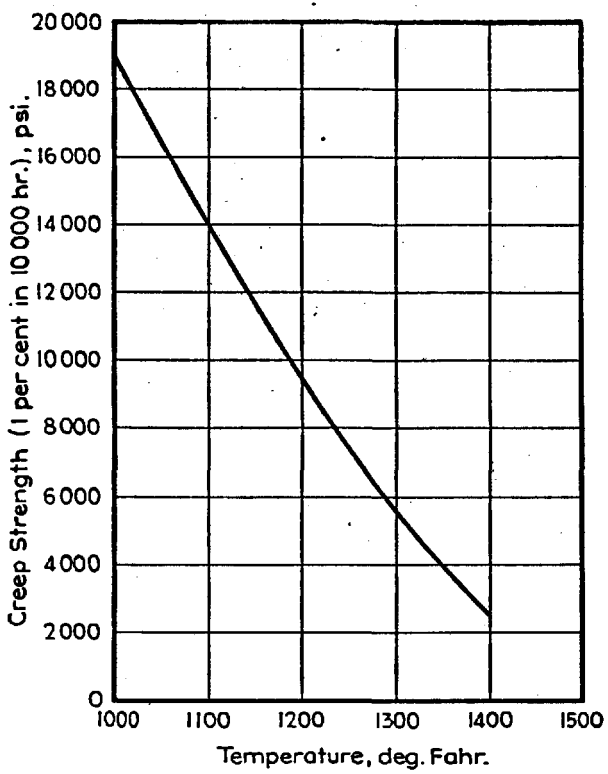


FIG. 25.—Creep Strength at Various Temperatures of 18 per cent Chromium, 8 per cent Nickel, Columbium Stabilized Steel (A.S.T.M. Designations. A 167 – 42, Grade 6, and A 240 – 42, Grade C; A.I.S.I. Type No. 347).

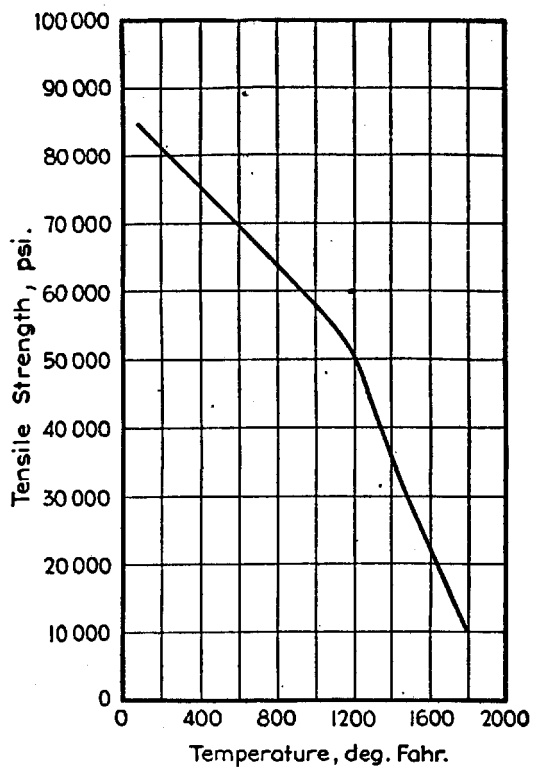


FIG. 26.—Short-Time High-Temperature Tensile Properties of 18 per cent Chromium, 8 per cent Nickel, Columbium Stabilized Steel (A.S.T.M. Designations: A 167 – 42, Grade 6, and A 240 – 42, Grade C; A.I.S.I. Type No. 347).

TABLE XXI.—MECHANICAL PROPERTIES OF 18 PER CENT CHROMIUM, 8 PER CENT NICKEL, COLUMBIUM STABILIZED STEEL.

Chemical Composition, per cent			
Carbon	0.10 max.	Silicon	0.75 max.
Manganese	2.00 max.	Chromium	18.00 min.
Phosphorus	0.035 max.	Nickel	8 min.
Sulfur	0.03 max.	Columbium	10 × C min.

A.S.T.M. Designation	A 167 - 42	A 240 - 42
A.S.T.M. Grade	6	C
A.I.S.I. Type No.	347	347 is similar to grade C
Structure	Austenitic	Austenitic

Mechanical Properties

Form and Treatment	Tensile Strength, psi.	Yield Strength (offset = 0.2 per cent), psi.	Yield Point,[a] psi.	Proportional Limit, psi.	Elongation in 2 in., per cent	Reduction of Area, per cent	Impact Resistance, ft-lb.		Hardness Number		Endurance Limit (Fatigue), psi.	Cold Bend, deg.	Ductility	
							Charpy	Izod	Brinell (3000-kg. load, 10-mm. ball)	Rockwell			Erichsen Value, mm.	Olsen Value, in.
Sheet:														
Cold-rolled	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	90 000[b]	...	40 000	...	50	...	...	...	...	B85	...	180	12	0.400 to 0.475
Strip:														
Cold-rolled, 20 per cent	132 000[b]	102 000	...	...	23	...	...	...	...	...	...	...	...	...
Cold-rolled, 30 per cent	152 000[b]	125 000	...	...	10	...	...	...	...	...	...	...	...	...
Annealed	90 000[b]	...	38 000	...	50	...	...	...	...	B85	...	180	12	...
Wire:														
Cold-drawn, 20 per cent	100 000	90 000	...	40 000	23	...	...	...	...	C20	...	...	...	...
Cold-drawn, 40 per cent	145 000	130 000	...	70 000	10	...	...	...	...	C32	...	...	...	...
Cold-drawn, 60 per cent	190 000	175 000	...	95 000	4	...	...	...	...	C37	...	...	...	...
Annealed	90 000	30 000	...	20 000	55	...	...	...	...	B85	...	180	...	...
Plate:														
Annealed	90 000	...	37 000	...	50	60	...	100	170	...	...	180	...	...
Tubing:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	90 000	...	40 000	...	50	60	...	100	170	...	...	...	...	...
Bars:														
Cold-drawn	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Annealed	90 000	...	40 000	...	50	60	...	100	170	...	...	180	...	...

[a] *Yield point* as determined with dividers must not be confused with a defined *yield strength*, such as, at 0.2 per cent offset.

[b] This is a representative and not a minimum value. Therefore, it must not be compared with the minimum values shown for grades 1 and 2 of A.S.T.M. Standard A 167 - 42 (see Tables XIII and XIV).