CHAPTER 4
COPPER AND ITS ALLOYS

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4.1 COPPER

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4.1.1 Composition of Commercial Copper

Specifications for copper, generally accepted by industry, are the ASTM standard specifications. These also cover silver-bearing copper. (See Table 1)

Low-resistance copper, used for electrical purposes, may be electrolytically or fire refined. It is required to have a content of copper plus silver not less than 99.90%. Maximum permissible resistivities in international ohms (meter, gram) are: copper wire bars, 0.15328; ingots and ingot bars, 0.15694.

	Mechanical Properties of Copper		
	Annealed	Cold Rolled or Drawn	Cast
Tensile strength			
psi	30,000–40,000	32,000–60,000	20,000–30,000
MPa	210–280	220–400	140–210
Elongation in 2 in.	25–40%	2–35%	25–45%
Reduction of area	40–60%	2–4%	—
Rockwell F hardness	65 max	54–100	—
Rockwell 30T hardness	31 max	18–70	—

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Physical Properties of Copper

Density	0.323 lb/in.^{3}		8.94 g/cm^3	
Melting point	1981°F		1083°C	
Coefficient of linear thermal expansion	0.0000094/°F	(68–212°F)	0.0000170/°C	(20–100°C)
	0.0000097/°F	(68–392°F)	0.0000174/°C	(20–200°C)
	0.0000099/°F	(68–572°F)	0.0000178/°C	(20–300°C)
Pattern shrinkage	¼ in./ft		2%	
Thermal conductivity	226 Btu/ft^2/ft/hr/°F at 68°F		398 W/m/°C at 27°C	
Electric resistivity	10.3 ohms (circular mil/ft) at 68°F		1.71 microhm/cm at 20°C	
Temperature coefficient of electric resistivity	0.023 ohms/°F at 68°F		0.0068/°C at 20°C	
Specific heat			0.386 J/g/°C at 20°C	
Magnetic property			Diamagnetic	
Optional property			Selectively reflecting	
Young's modulus	17,300,000 psi		119,300 MPa	

ASTM Specification B216-78, *Fire-Refined Copper for Wrought Products and Alloys*, calls for the following analysis: Cu + Ag, min 99.88%; As, max 0.012%; Sb, max 0.003%; Se + Te, max 0.025%; Ni, max 0.05%; Bi, max 0.003%; Pb, max 0.004%.

Oxygen-free high-conductivity copper is a highly ductile material, made under conditions that prevent the entrance of oxygen and the formation of copper oxide. It is utilized in deep-drawing, spinning, and edge-bending operations, and in welding, brazing, and other hot-working operations where embrittlement must be avoided. It has the same conductivity and tensile properties as tough pitch electrolytic copper.

Deoxidized copper containing silver has been utilized to increase softening resistance of copper. It does not affect oxygen level. A number of elements that reduce oxygen in copper, such as Zr, Cr, B, P, can also provide some softening resistance.

4.1.2 Hardening Copper

There are three methods for hardening copper: grain-size control, cold working, or alloying. When copper is hardened with tin, silicon, or aluminum, it generally is called bronze; when hardened with zinc, it is called brass.

4.1.3 Corrosion

Copper is resistant to the action of seawater and to atmospheric corrosion. It is not resistant to the common acids, and is unsatisfactory in service with ammonia and with most compounds of sulfur. Manufacturers should be consulted in regard to its use under corrosive conditions.

4.1.4 Fabrication

Copper may be hot forged, hot or cold rolled, hot extruded, hot pierced, and drawn, stamped, or spun cold. It can be silver-soldered, brazed, and welded. For brazing in reducing atmosphere or for welding by the oxyacetylene torch or electric arc, deoxidized copper will give more satisfactory joints than electrolytic or silver bearing copper. High-temperature exposure of copper containing oxygen, in reducing atmosphere, leads to decomposition of copper oxide and formation of steam with resulting embrittlement. Copper is annealed from 480 to 1400°F, depending on the properties desired. Ordinary commercial annealing is done in the neighborhood of 1100°F. Inert or reducing atmospheres give best surface quality; however, high temperature annealing of oxygen-containing coppers in reducing atmosphere can cause embrittlement. Copper may be electrodeposited from the alkaline cyanide solution, or from the acid sulfate solution.

4.2 SAND-CAST COPPER-BASE ALLOYS

Robert F. Schmidt

4.2.1 Introduction

The information required for selection of cast copper-base alloys for various types of applications can be found in Table 4.1. The principal data required by engineers and designers for castings made of copper-base alloys are given in Table 4.2. A cross-reference chart is shown in Table 4.3 for quick reference in locating the specifications applying to these alloys. Additional information in regard to

Table 4.1 Application for Copper-Base Alloys

Uses	Types of Alloys	Alloy Number
Andirons	Leaded yellow brass	C85200
Architectural trim	Leaded red brass	C83600
	Leaded yellow brass	C85400
	Leaded nickel silver	C97400
Ball bearing races	Manganese bronze	C86200
	Aluminum bronze	C95400
	Leaded yellow brass	C85200
Bearings, high speed, low load	High-leaded tin bronze	C93200
		C93800
		C93700
Bearings, low speed, heavy load	Tin bronze	C91300
		C91000
	Manganese bronze	C86300
	Aluminum bronze	C95400
Bearings, medium speed	High-leaded tin bronze	C93700
		C93800
Bells	Tin bronze	C91300
	Silicon bronze	C87200
Carburetors	Leaded red brass	C83600
	Leaded tin bronze	C92200
Cocks and faucets	Leaded semired brass	C84400
		C84800
	Leaded yellow brass	C85200
Corrosion resistance to acids	Aluminum bronze	C95400
	Leaded nickel bronze	C97600
alkalies	Silicon bronze	C87200
seawater	Nickel aluminum bronze	C95800
water	Leaded red brass	C83600
	Leaded semired brass	C84400
Electrical hardware	Leaded red brass	C83300
	Silicon bronze	C87200
	Aluminum bronze	C95400
Fittings	Leaded semired brass	C84400
Food-handling equipment	Leaded nickel bronze	C97600
		C97800
Gears	Tin bronze	C90700
		C91600
	Aluminum bronze	C95400
General hardware	Leaded red brass	C83600
Gun mounts	Manganese bronze	C86200
	Aluminum bronze	C95300
High-strength alloy	Manganese bronze	C86300
Impellers	Tin bronze	C90300
	Leaded red brass	C83600
	Aluminum bronze	C95400
	Silicon brass	C87200
Landing gear parts	Aluminum bronze	C95400
Lever arms	Manganese bronze	C86500
Marine castings and fittings	Manganese bronze	C86500
		C86200
	Aluminum bronze	C95800
Marine propellers	Aluminum bronze	C95800
	Manganese bronze	C86500
Musical instruments	Leaded nickel bronze	C97800
Ornamental bronze	Leaded yellow brass	C85200

Table 4.1 ***(Continued)***

Uses	Types of Alloys	Alloy Number
Pickling baskets	Aluminum bronze	C95300
Piston rings	Tin bronze	C90500 C91300
Plumbing fixtures	Leaded semired brass	C84400 C84800
Pump bodies	Tin bronze Leaded tin bronze Aluminum bronze	C90300 C93800 C95800
Steam fittings and valves	Leaded tin bronze	C92200 C92300
Valves, high pressure	Leaded tin bronze	C92200 C92600
Valves, low pressures	Leaded red brass Leaded semired brass	C83600 C84400
Valve seats for elevated temperature	Leaded nickel bronze	C97800
Valve stems	Silicon brass Silicon bronze	C87500 C87200
Wear parts	High-leaded tin bronze	C93700 C93800
Weldability	Tin bronze Manganese bronze Aluminum bronze Silicon bronze	C90700 C86500 All grades C87200
Welding jaws	Aluminum bronze	C95300
Wormwheels	Aluminum bronze	C95500

special alloys, such as high conductivity copper, chromium-copper, and beryllium copper, is covered in Section 4.2.5.

4.2.2 Selection of Alloy

Table 4.1 is an outline of the various types of allows generally used for the purposes shown. When specifying a specific alloy for a new application, the foundry or ingot maker should be consulted. This is particularly important where corrosion resistance is involved or specific mechanical properties are required. While all copper-base alloys have good general corrosion resistance, specific environments, especially chemical, can cause corrosive attack or stress corrosion cracking. An example of this is the stress corrosion cracking that occurs when a manganese bronze alloy (high-strength yellow brass) is placed under load in certain environments.

The typical and minimum properties shown in Table 4.2 for the various alloys are for room temperature. The effect of elevated temperature on mechanical properties should be considered for any given application. The ingot maker or foundry should be consulted for this information.

Since copper-base alloy castings are often used for pressure-tight value and pump parts, caution should be exercised in alloy selection. In general, when small-sized, thin-wall castings are used, such as valve bodies with up to 3-in. openings, with all sections up to 1 in., the leaded red brass and leaded tin bronze alloys should be specified. When heavy-wall valves and pump bodies over 1-in. thickness are used, the castings should be made of nickel aluminum bronze or 70/30 cupronickel. These alloy preferences are based on differences in solidification behavior.

4.2.3 Fabrication

All sand-cast copper-base alloys can be machined, although some are far more machinable than others. The alloys containing lead, such as the leaded red brasses, leaded tin bronzes, and high-leaded tin bronzes, are very easily machined. On the other hand, aluminum and manganese bronzes do not machine easily. However, use of carbide tooling, proper tool angles, and coolants permit successful machining. In regard to weldability, no leaded alloys should be welded. In general, the aluminum bronzes, silicon bronzes, and α-β manganese bronzes can be welded successfully. This also applies

Table 4.2 Sand-Cast Copper-Base Alloys

UNS Number	Ingot Number	Nominal Composition (% by Weight)						Mechanical Properties: Yield Strength[a] ksi (MPa)		Tensile Strength[a] ksi (MPa)		Elongation[a] (%)		Brinell Hardness (500 kg)	Impact Strength (Izod) (ft-lb)	Electrical Conductivity (%, IACS)	Pattern Skrinkage (in./ft)
		Cu	Sn	Pb	Zn		Others										
C83600	115	85	5	5	5			14 (97)	16 (110)	30 (207)	36 (248)	20	32	65	9	15	11/64
C83800	120	83	4	6	7			13 (90)	16 (110)	30 (207)	35 (241)	20	28	60	8	15.2	11/64
C84400	123	81	3	7	9			13 (90)	14 (97)	29 (200)	34 (234)	18	25	55	8	16.7	11/64
C84800	130	76	3	6	15			12 (83)	14 (97)	28 (193)	36 (248)	16	37	55	12[b]	16.6	11/64
C85200	400	72	1	3	24			12 (83)	13 (90)	35 (241)	38 (262)	25	40	46		18.6	3/16
C85400	403	67	1	3	29			11 (76)	12 (90)	30 (207)	34 (234)	20	37	53		19.6	3/16
C85700	405.2	61	1	1	37.3		0.3 Al	14 (97)	18 (124)	40 (276)	51 (352)	15	43	76		21.8	7/32
		Cu	Zn	Fe	Al	Mn	Others										
C86200	423	64	26	3	4	3		45 (310)	48 (330)	90 (621)	96 (662)	18	21	180[c]	12	7.4	1/4
C86300	424	62	26	3	6	3		60 (414)	68 (469)	110 (758)	119 (821)	12	18	225[c]	15	8.0	9/32
C86400	420	58	38	1	0.75	0.25	0.75 Pb	20 (138)	24 (165)	60 (414)	65 (448)	15	20	105[c]	30	19.3	1/4
C86500	421	58	39	1	1	1		25 (172)	28 (193)	65 (448)	71 (490)	20	30	130[c]	32[b]	20.6	1/4
C87200	500	92	4				4 Si	18 (124)	25 (172)	45 (310)	58 (400)	20	35	87	33	6.1	1/4
C87200	500	95					1 Mn, 4 Si	18 (124)	25 (172)	45 (310)	58 (400)	20	35	88	33	5.9	1/4
C87500	500	82	14		3		4 Si	24 (165)	30 (207)	60 (414)	65 (462)	16	21	115[c]	32[b]	6.1	15/64
		Cu	Sn	Pb	Zn		Others										
C90300	225	88	8	0	4			18 (124)	20 (138)	40 (276)	45 (310)	20	30	70	14[b]	12.4	3/6
C90500	210	88	10	0	2			18 (124)	22 (152)	40 (276)	46 (317)	20	30	75	10	10.9	3/16
C92200	245	86	6	1½	4½			16 (110)	20 (138)	34 (234)	40 (276)	24	30	64	19[b]	14.3	3/16
C92300	230	87	8	1	4			16 (110)	20 (138)	36 (248)	42 (290)	18	32	70	14	12.3	3/16
C92600	215	87	10	1	2			18 (124)	20 (138)	40 (276)	44 (303)	20	30	72	7	10.0	3/16
C93200	315	83	7	7	3			14 (97)	18 (124)	30 (207)	38 (262)	15	30	67	5	12.4	7/32
C93700	305	80	10	10				12 (83)	17 (117)	30 (207)	39 (269)	15	30	67	5	10.1	1/8
C93800	319	78	7	15				14 (97)	16 (110)	26 (179)	32 (221)	12	18	58	5	11.6	5/32

Table 4.2 (*Continued*)

UNS Number	Ingot Number	Nominal Composition (% by Weight)					Mechanical Properties: Yield Strength[a] ksi (MPa)		Tensile Strength[a] ksi (MPa)		Elongation[a] (%)		Brinell Hardness (500 kg)	Impact Strength (Izod) (ft-lb)	Electrical Conductivity (%, IACS)	Pattern Skrinkage (in./ft)
		Cu	Fe	Ni	Al	Others										
C95200	415	88	3		9		25 (172)	29 (200)	65 (448)	80 (552)	20	38	120[c]	35	12.2	7/32
C95300	415	89	1		10		25 (172)	27 (186)	65 (448)	75 (517)	20	25	140[c]	30	15.3	7/32
C95400	415	86	3½		10½		30 (207)	36 (248)	75 (517)	92 (634)	12	18	156[c]	15	13	9/32
C95410	415	84	4	2	10		30 (207)	36 (248)	75 (517)	96 (662)	12	15	176[c]	15	13	9/32
C95500	415	81	4	4	11		40 (276)	44 (303)	90 (621)	102 (703)	6	12	200[c]	13	8.8	3/16
C95800	415	81½	4	4½	9	1 Mn	35 (241)	37 (255)	85 (586)	96 (662)	15	25	160[c]	20	7.0	3/16
C96400		68	1	30		1 Nb	32 (221)	37 (255)	60 (414)	68 (469)	20	28	140[c]	78[b]	5.0	3/16
		Cu	Sn	Pb	Zn	Others										
C97300	410	57	2	9	20	12 Ni	15 (103)	17 (117)	30 (207)	36 (248)	8	25	60		5.9	1/8
C97400	411	60	3	5	16	16 Ni	16 (110)	17 (117)	30 (207)	38 (262)	8	20	70		5.5	1/8
C97600	412	64	4	4	8	20 Ni	17 (117)	25 (172)	40 (276)	47 (324)	22	22	85	11[e]	4.8	1/8
C97800	413	66	5	2	2	25 Ni	22 (151)	30 (207)	50 (345)	55 (379)	10	15	130[b]		4.5	3/16
		Cu	Sn	Pb	Zn	Others										
C81100	—	99.7	—	—	—	—		6 (41)		20 (138)		50	40		92	1/4
C81400	—	99	—	—	—	1 Cr		53 (365)[d]		36[d] (248)		11[d]	B69[e]		60	1/4
C82500	—	97½	—	—	—	2 Be, 0.5 Cr		80 (551)		45 (310)		20	B82.5[e]			
						0.25 Si		160[d,e]				14	C40[d,e]	84	20[d]	3/16
C83300	131	93	1	2	4			32 (220)		10 (69)		35	35		32	3/16
C83450	—	88	2½	2	6½	1 Ni	30 (207)	37 (255)	14 (97)	15 (103)	25	34	55		20	3/16
C90700	205	89	11	—	—	—	35 (241)	44 (303)	18 (124)	22 (152)	10	20	80		9.6	3/16
C91100	—	84	16	—	—	—		35 (241)		25 (172)		2	135[c]		8.5	3/16
C91300	194	81	19	—	—	—		35 (241)		30 (207)		0.5	170[c]		7.0	3/16
C91600	205A	88	10½	—	—	1½ Ni	35 (241)	44 (303)	17 (117)	22 (152)	10	16	85		10.0	3/16
C92900	206A	84	10	2½	0	3½ Ni	45 (310)	47 (324)	25 (172)	26 (179)	8	20	80	12	9.2	3/16
		Cu	Fe	Ni	Al	Others										
C99400	—	90.5	2	2.2	1.2	3 Zn, 1.2 Si	60 (414)	66 (445)	30 (207)	34 (234)	20	25	125[c]		16.6	3/16
C99500	—	88	4	4.5	1.2	1.2 Zn, 1.2 Si	70 (483)		40 (276)		12		145[c]		13.7	3/16
C99700	—	58	—	5	1	13 Mn, 23 Zn		55 (379)		25 (172)		25	110[c]		3.0	1/4
C99750	—	58	—	—	1	20 Mn, 20 Zn, 1 Pb		65 (448)		32 (220)		30	110[c]		2.0	1/4

[a] Left column is minumum; right column is typical; yield strength is 0.5% extension under load.
[b] Impact strength, Charpy (ft-lb).
[c] Brinell hardness (3000 kg).
[d] Heat treated.
[e] Rockwell.

Table 4.3 Copper-Base Alloy Casting Specifications

Alloy Number	Commercial Designation	American Society for Testing Materials: Specification Number	American Society for Testing Materials: Alloy Number	Federal: QQ-C-390A Alloy Designation	Federal: Former Specification	Military	Society of Automotive Engineers: Current	Society of Automotive Engineers: Former
C83600	85–5–5–5	B62,B584 B271,B505	C83600	836	QQ-L-225(2)	MIL-C-11866(25) MIL-C-15345(1) MIL-C-22087(2) MIL-C-22229(836)	836	40
C83800	83–4–6–7	B271,B584 B505	C83800	838	QQ-L-225(17			
C84400	81–3–7–9	B271,B584 B505	C84400	844	QQ-L-225(11)	MIL-B-11553(11) MIL-B-18343		
C84800	76–2½–6½–15	B271,B584 B505	C84800					
C85200	72–1–3–24	B271 B584	C85200	852	QQ-B-621(C)			
C85400	67–1–3–29	B271 B584	C85400	854	QQ-B-621(B)		854	41
C85700	61–1–1–37	B271 B584	C85700	857	QQ-B-621(A)	MIL-C-15345(3) MIL-C-11866(27)		
C86200	90,000 tensile manganese bronze	B271,B584 B505	C86200	862	QQ-B-726(B)	MIL-C-11866(20) MIL-C-22087(7) MIL-C-22229(862)	862	430A
C86300	110,000 tensile manganese bronze	B22,B505 B271,B584	C86300	863	QQ-B-726(C)	MIL-C-11866(21) MIL-C-15345(6) MIL-C-22087(9) MIL-C-22229(863)	863	430B
C86400	60,000 tensile manganese bronze	B271 B584	C86400	864	QQ-B-726(D) QQ-B-726(D)			
C86500	65,000 tensile manganese bronze	B271,B584 B505	C86500	865	QQ-B-726(A)	MIL-C-15345(4) MIL-C-22087(5) MIL-C-22229(865)	865	43

Table 4.3 ***(Continued)***

		American Society for Testing Materials		Federal			Society of Automotive Engineers	
Alloy Number	Commercial Designation	Specification Number	Alloy Number	QQ-C-390A Alloy Designation	Former Specification	Military	Current	Former
C87200	5% zinc max silicon bronze	B271 B584	C87200	872	QQ-593(B)	MIL-C-11866(19) MIL-C-22229(872)		
C87500	82–14–4 silicon brass	B271 B584	C87500		QQ-593(A)			
C90300	88–8–0–4	B271,B584 B505	C90300	903	QQ-L-225(5)	MIL-C-11866(26) MIL-C-15345(8) MIL-C-22087(3) MIL-C-22229(903)	903	620
C90500	88–10–0–2	B22,B505 B271,B584	C90500	905	QQ-L-225(16)		905	62
C92200	88–6–½–4½	B61,B505 B271,B584	C92200	922	QQ-L-225(1)	MIL-C-15345(9) MIL-B-16541	922	622
C92300	87–8–1–4	B271, B505,B584	C92300	923	QQ-L-225(6-6X)	MIL-C-15345(10)	923	621
C93200	83–7–7–3	B271,B584 B505	C93200	932	QQ-L-225(12)	MIL-B-11553(12) MIL-B-16261(6)	932	660
C93500	85–5–9–1	B271,B584 B505	C93500	935	QQ-L-225(14)		935	66
C93700	80–10–10	B22,B505 B271,B584	C93700	937		MIL-B-13506(792,797)	937	64
C93800	78–7–15	B66,B271, B144,B505, B584	C93800	938	QQ-L-225(7)		938	67
C95200	88–3–9 aluminum bronze	B148,B505 B271	C95200	952	QQ-B-671(1)	MIL-C-22087(6) MIL-C-22229(952)	952	68A

C95300	89–1–10 aluminum bronze	B148,B505 B271	C95300	953	QQ-B-671(2)	MIL-C-11866(22)	953	68B
C95400	85–4–11 aluminum bronze	B148,B505 B271	C95400	954	QQ-B-671(3)	MIL-C-11866(23) MIL-C-15345(13)		
C95500	81–4–11–4 aluminum bronze	B148,B505 B271	C95500	955	QQ-B-671(4)	MIL-C-11866(24) MIL-C-15345(14) MIL-C-22087(8) MIL-C-22229(955)		
C95800	81–4–9–5–1mN aluminum bronze	B148 b271	C95800	958		MIL-C-15345(38) MIL-B-21230(1) MIL-B-24480 MIL-B-22229(958)		
C96400	70–30 cupronickel	B369 B505	C96400	964		MIL-C-15345(24) MIL-C-20159(1)		
C97300	12% nickel nickel silver	B271 B584	C97300			MIL-C-15345(7)		
C94700	16% nickel nickel silver							
C97600	20% nickel nickel bronze	B271 B584	C97600					
C97800	25% nickel nickel bronze	B271 B584	C97800					

to tin bronzes and 70/30 cupronickel. These alloys not only can be joined to other materials by welding, but can also be repaired by welding if exhibiting casting defects such as shrinkage porosity. All copper-base alloys can be joined by brazing.

4.2.4 Mechanical and Physical Properties

The mechanical and physical properties of the most widely used copper-base casting alloys are given in Table 4.2. Alloy numbers used are the UNS numbers developed by the Copper Development Association (CDA) and now adopted by the American Society for Testing Materials (ASTM), Society for Automotive Engineers (SAE), and the U.S. Government. Also shown for reference purposes are the ingot numbers still used by the ingot makers. Much of the data shown in Table 4.2 were taken from *Standards Handbook*, Part 7, Alloy Data, published by CDA. Table 4.2 not only shows the typical properties that can be attained, but also the minimum values called for in the various specifications listed in Table 4.3. These properties, of course, can only be attained when care is taken toward proper melting, gating, feeding, and venting of casting molds.

The CDA *Standards Handbook*, Part 7, contains a very complete list of physical properties on not only the alloys shown in Table 4.2, but also other alloys less widely used.

4.2.5 Special Alloys

There are a number of alloys shown in Table 4.2 that are used for special purposes and amount to much less tonnage than the red brasses, leaded red brasses, tin bronzes, manganese bronzes, and aluminum bronzes. The following sections mention the more widely used of the special alloy families.

Gear Bronzes

High-tin alloys such as C90700 (89% copper, 11% tin), C91600 (88% copper, 10% tin, 2% nickel), and C92900 (84% copper, 10% tin, 2½% lead, 3½% nickel) are widely used for cast bronze gears. In addition to these tin bronze alloys, aluminum bronze, such as C95400 (86% copper, 4% iron, and 10% aluminum) is also used for gear applications.

Bridge Bearing Plates

These castings are made almost entirely to ASTM B22 specification and are generally made from copper-tin alloys like C91300 (81% copper, 19% tin) and C91100 (86% copper, 14% tin). Three other alloys, specified under ASTM B22 are C86300 high-tensile manganese bronze, C90500 tin bronze, and C93700 high-leaded tin bronze.

Piston Rings

Tin bronzes, such as C91300 and C91100, are commonly used for piston rings. These castings are usually made by the centrifugal castings process.

High Conductivity

When the electrical conductivity of pure copper is required, it can be melted and deoxidized and poured into casting molds. Care must be taken to avoid contamination by elements usually present in cast copper-base alloys, such as phosphorous, iron, zinc, tin, and nickel. Electrical conductivity values of 85% to 90% IACS can be attained with low level impurities present. This alloy is C81100.

Moderate Conductivity, High Strength. All of the alloys shown in Table 4.2 have electrical conductivity less than 25% IACS. However, there are additional copper-base alloys available with higher electrical conductivity. Beryllium copper and low-tin bronzes are examples of alloys in the 25-35% IACS range. C83300, which has 32% IACS, has a composition of 93% copper, 1% tin, 2% lead, and 4% zinc. A typical beryllium copper casting alloy with around 25% IACS is C82500, which has as-cast typical properties of 80,000 psi tensile strength and 20% elongation in 2 in., and after heat treatment has a tensile strength of 155,000 psi and elongation of 1% in 2 in. Hardness of this alloy is typically Rockwell C40 in the heat-treated condition and Rockwell B82 when as-cast. This alloy has a composition of 2% beryllium, 0.5% cobalt, 0.25% silicon, and 97.20% copper.

When some strength is required in addition to high electrical conductivity, the best casting alloy is chromium copper, alloy C81400. This alloy is made up of 0.9% chromium, 0.1% silicon, and 99% copper. It is heat treatable and maintains an electrical conductivity of 85% IACS, a tensile strength of 51,000 psi, a yield strength of 40,000 psi, and an elongation of 17%. The hardness value for this alloy is 105 under a 500-kg load.

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