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Standard Terminology for Copper and Copper Alloys¹

This standard is issued under the fixed designation B846; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 The terms defined in this terminology standard are applicable to copper and copper alloy products specifications, test methods, practices, and other documents within the jurisdiction of Committee B05 on Copper and Copper Alloys.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*²

- B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
- B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes
- B379 Specification for Phosphorized Coppers—Refinery Shapes
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E10 Test Method for Brinell Hardness of Metallic Materials
- E18 Test Methods for Rockwell Hardness of Metallic Materials
- E23 Test Methods for Notched Bar Impact Testing of Metallic Materials
- E112 Test Methods for Determining Average Grain Size

¹ This terminology is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.93 on Terminology.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Significance and Use

3.1 This terminology is not intended to apply to any standard, test method, practice, or other document not within the jurisdiction of Committee B05 on Copper and Copper Alloys.

4. Terminology

acid dip—see **dip solution**.

acid dipped-dry rolled finish—see **finish, acid dipped-dry rolled**.

Admiralty—an alloy containing nominally 71 % copper: 1 % tin and 28 % zinc, originally developed by the British Admiralty and generally available in tube, flat products, and wire. Its principal use is in heat exchanger and condenser tubes. An inhibitor may be added to increase the resistance to dezincification.

Admiralty, inhibited (arsenical, antimonial or phosphorized)—admiralty modified by the addition of small amounts of arsenic, antimony or phosphorus to inhibit dezincification. (Copper Alloy Nos. C44300, C44400, C44500)

air stain—see **stain, air**.

alpha—the name of a phase or of a certain range of copper alloys which contain one or more alloying elements dissolved in copper, the phase being a homogeneous solid solution.

alpha beta brass—a series of copper-zinc alloys containing approximately 55 to 63 % copper and the remainder mostly, if not all, zinc and composed of crystals or grains of both the alpha and the beta phases.

aluminum brass—a copper alloy containing nominally 77.5 % copper, 2 % aluminum and 20.5 % zinc with an arsenical inhibitor, available in tube form. Its principal use is in heat exchanger and condenser tubes. (Copper Alloy No. C68700)

aluminum bronze—copper alloys with aluminum as the principal alloying element, normally in the range of 3 to 11 % with or without the additions of other elements. (Copper Alloy Nos. C60800 – 64699 incl.)

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

anneal (annealing)—a thermal treatment to change the properties or grain structure of the product. When applied to a cold-worked product having a single phase: to produce softening by recrystallization or recrystallization and grain growth, with the accompanying changes in properties. When applied to a product having two or more phases: to produce softening by changes in the phase relationship that may include recrystallization and grain growth.

annealability of copper rod—the ease with which a material will soften after cold work and subsequent thermal treatments; this property is affected primarily by the purity of the metal since all other variables are kept constant.

annular ring—see **circular ring**.

antimicrobial copper alloy—a solid wrought or cast copper alloy that is listed under one of the following U.S. Environmental Protection Agency (EPA) registration numbers: 82012-1, 82012-2, 82012-3, 82012-4, 82012-5, or 82012-6, or is otherwise identified by a Unified Numbering System copper alloy code in an active EPA public health registration.

arbor—a cylindrical core around which metal is wound to obtain a desired inside diameter of the wound coil or roll.

arc welding—a group of welding processes wherein coalescence is produced by heating with an arc or arcs, with or without the application of pressure, and with or without the use of filler metal.

architectural bronze—an alloy containing nominally 57 % copper, 3 % lead, and 40 % zinc, generally available in extruded or drawn shapes and rod; used for architectural trim and for some mechanical applications. The alloy is not technically a bronze, but because of long usage, the term “Architectural Bronze” has been used. (Copper Alloy No. C38500)

area reduction—the decrease in cross-section of a product by rolling or drawing, which is a measure of the temper of the metal in the cold worked condition.

argentiferous copper—see **silver bearing copper**.

arsenical tough pitch copper—a modified tough pitch copper containing substantial amounts of arsenic regardless of origin or treatment.

as-welded condition—a condition created as a result of forming annealed sheet or plate into tubular form and welding without subsequent heat treatment or cold work.

average diameter—the average of the maximum and minimum measured diameters at any one cross-section. This

definition is the same for Average Outside Diameter or Average Inside Diameter, as long as the calculation is made with I.D. only or O.D. only measurements but not mixed (see Fig. 1).

average diameter (for round tubes only)—the average of the maximum and minimum outside diameters or the maximum and minimum inside diameters, whichever is applicable, as determined at any one cross section of the tube.

bar—a solid rectangular section, or one with two plane parallel surfaces and round or other simple regularly shaped edges, up to and including 12 in. (300 mm) in width and over 0.188 in. (5 mm) in thickness, furnished in straight lengths or in rolls and with finished edges, either rolled, drawn, or extruded.

bar, bus stock—high-conductivity copper bar stock of any dimension intended for use as an electrical conductor.

bar, cast—a flat casting for rolling into sheet and strip, or round casting for rolling and drawing into wire.

bar, cold-rolled—see **cold-rolled bar**.

bar, commutator segment stock—a bar for use in making commutators of electric motors and generators, the cross-section of the bar being a trapezoid or truncated sector or segment of a circle.

bar, drawn—see **drawn bar**.

bar, extruded—see **extruded bar**.

bar, hot-rolled—see **hot-rolled bar**.

barrel rolling—a method of polishing small parts in which the parts and a polishing medium are placed in a barrel, the polishing action resulting from the revolving of the barrel.

base metal—the sheet or plate from which the pipe is formed.

bend test—see **test, bend**.

beryllium copper—see **copper-beryllium alloy**.

billet—refinery shape used for piercing or extrusion into tubular products or for extrusion into rods, bars, and shapes. Circular in cross section, usually 3 to 16 in. (76 to 406 mm) in diameter, normally ranging in weight from 100 to 4200 lb (45 to 1905 kg).

bimetal tube—see **tube, bimetal**.

blank—a piece of flat product intended for subsequent fabrication by forming, bending, cupping, drawing, hot pressing, and so forth.

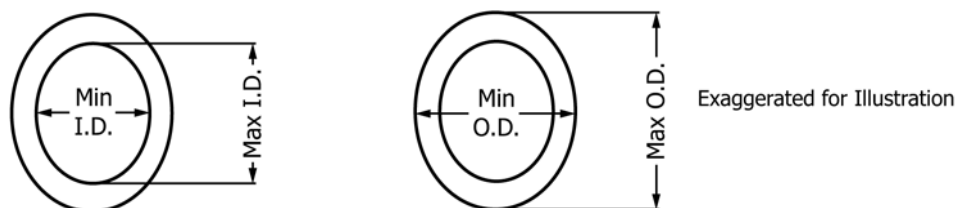


FIG. 1 Average Diameter

blanking—the process of cutting metal blanks by a die and punch set in a press, or by sawing or shearing.

Bourdon gauge tube—see **tube, Bourdon gauge**.

brass—any copper alloy with zinc as the principal alloying element, with or without small quantities of some other elements.

brazed tube—see **tube, brazed**.

brazing filler material—wire, rod, strip, or powder that is manufactured to special chemical composition for use in joining metals by brazing.

bridge plate—a low-friction plate of a copper alloy used to provide a bearing surface for the expansion end of trussed bridge structures.

bright annealed finish—see **finish, bright annealed**.

bright dip—see **dip, bright**.

bright dipped finish—see **finish, bright dipped**.

bright rolled finish—see **finish, dry rolled**.

Brinell hardness test—see **test, Brinell hardness**.

brush brass finish—see **finish, brush brass**.

buckle—alternate bulges and hollows recurring along the length of a flat product with the edges remaining relatively flat.

buckle (centre bulge or oil can)—alternate bulges and hollows recurring along the length of a strip with the edges remaining relatively flat.

buffed surface finish—see **finish, buffed surface**.

bulging—the expanding of a portion of the body of a drawn shell below the top or neck.

bull ring rod—copper rod manufactured to special surface requirements and furnished in coils for redrawing or re-rolling.

bull rod—see **redraw rod**.

bursting pressure—the internal pressure required to burst tubes or other hollow products.

bus bar—includes material of solid rectangular or square cross section or a solid section with two plane parallel surfaces and round or other simple regular-shaped edges.

bus conductor stock—a bar, rod, shape or tube of high conductivity copper used for the manufacture of bus conductor or bus bar.

bus stock bar—see **bar, bus stock**.

butt seam tube—see **tube, open seam**.

cake—refinery shape used for rolling into plate, sheet, strip, or shape. Rectangular in cross section and of various sizes, normally ranging in weight from 140 to 62 000 lb (63 to 28 123 kg).

camber—see **edgewise curvature**.

capable of—the test need not be performed by the producer of the material. However, if subsequent testing by the purchaser establishes that the material does not meet the specified requirements, the material shall be subject to rejection.

capacitor plate stock—strip manufactured to special flatness and thickness tolerances for use in electrical variable capacitors.

cartridge brass—a copper alloy containing nominally 70 % copper and 30 % zinc and generally available in flat products, rod, wire, and tube. (Copper Alloy No. C26000)

cast bar—see **bar, cast**.

cast shell process—a process for making seamless tube whereby the metal is cast in the form of a shell or tube and subsequently reduced to the finished size by a series of suitable alternate cold drawing and annealing operations.

casting—a general term for a metal object produced at or near-finished shape by pouring or otherwise introducing molten metal into a mold and allowing it to solidify.

casting, centrifugal—a casting produced in a cylindrical mold rotating on its axis with the major axis of the product coinciding with the axis of rotation. The axis of rotation may be horizontal, vertical, or any angle in between.

casting, centrifuged—a casting produced in a mold, a number of which may be mounted around a central sprue. The molds are rotated, in a vertical position, about a central axis concentric with the central sprue.

casting, continuous—a casting produced by the continuous pouring and solidification of molten metal through a water-cooled mold which determines the cross-sectional shape. The length of the product is not restricted by mold dimensions.

casting, permanent mold—a product produced in a reusable mold constructed of a durable material, usually iron or steel, with the molten metal being introduced by gravity, low-pressure, or vacuum.

casting, sand—a casting produced in a sand mold.

casting, semicentrifugal—a casting produced in a manner similar to the centrifugal casting except that a central core is used to allow the formation of other than a cylindrical inside surface. The axis of rotation is always vertical.

cathode—unmelted, electrodeposited, and somewhat rough flat plate normally used for melting. The customary size is about 3 ft (0.914 m) square, about ½ to ⅞ in. (12.7 to 22.2 mm) thick, weighing up to about 300 lb (136 kg) and may have hanging loops attached. Cathodes may also be cut to smaller dimensions.

cavitation corrosion—see **corrosion, cavitation**.

chemically refined copper—copper recovered from an aqueous solution by other than electrolytic means. Usually when this term is used alone it refers to chemically refined tough

- pitch copper. This designation applies to the following: (a) copper cast in refinery shapes suitable for hot or cold working, or both, and by extension, to fabricators products made therefrom, (b) ingots or ingot bars suitable for remelting.
- circle**—a completely round, commercially flat, solid blank made from a rolled product.
- circular ring**—a completely round, commercial flat blank lacking the central concentric area.
- cladding ratio**—ratio by percent thickness of the component layers, for example.
- clean annealed finish*—see **finish, clean annealed**.
- clock brass**—a term sometimes used to designate high-leaded brass. (Copper Alloy No. C34200)
- close nipple**—a nipple with no shoulder or unthreaded portion between two threads; the shortest possible pipe nipple with complete threads.
- coalesced copper**—a commercially pure oxygen-free copper formed in a protective atmosphere at elevated temperature but below its melting point by application of mechanical pressure to particles of electrolytic cathode copper. (Copper No. C10200)
- coil**—a length of the product wound into a series of connected turns. The unqualified term “coil” as applied to tube usually refers to a bunched coil.
- coil, bunched**—a coil in which the turns are bunched and held together such that the cross section of the bunched turns is approximately circular.
- coil, double layer flat**—a coil in which the product is spirally wound into two connected disc-like layers such that one layer is on top of the other. (Sometimes called “double layer pancake coil” or “double layer spirally wound coil.”)
- coil, helical*—See **coil, level or traverse wound**.
- coil, level or traverse wound**—a coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another. (Sometimes called a “helical coil.”)
- coil, level or traverse wound on a reel or spool**—a coil in which the turns are positioned into layers on a reel or spool parallel to the axis of the reel or spool such that successive turns in a given layer are next to one another.
- coil set**—*as applied to strip*, the natural curvature remaining in strip after it has been unwound from a coil.
- coil, single layer flat**—a coil in which the product is spirally wound into a single disc-like layer. (Sometimes called “pancake coil” or “single layer spirally wound coil.”)
- coil, stagger wound**—a coil in which the turns are positioned into layers approximately parallel to the axis of the coil, but not necessarily with the fixed regularity of a level or traverse wound coil.
- cold heading*—see **heading**.
- cold-rolled bar**—bar stock brought to final dimensions by cold rolling, regardless of prior operations.
- cold-rolled finish*—see **finish, cold-rolled**.
- cold-rolled rod**—rod stock brought to final dimensions by cold rolling, regardless of prior operations.
- cold-rolled shape**—shape stock brought to final dimensions by cold rolling, regardless of prior operations.
- cold-rolled wire**—wire stock brought to final dimensions by cold rolling, regardless of prior operations.
- cold rolling*—see **rolling**.
- cold shortness**—the characteristic of metals that are brittle at temperatures below the recommended hot working temperature range.
- cold shut**—(1) a discontinuity that appears on the surface of cast metal as a result of two streams of liquid metal meeting and failing to unite. (2) on a forging, a portion of the surface that is separated by oxide from the main body of the metal.
- cold side**—*as applied to forging*, the temperature range below the optimum hot working temperature.
- cold work**—controlled mechanical operations for changing the form or cross section of a product and for producing a strain-hardened product at temperatures below the recrystallization temperature.
- collapsing pressure**—the external hydrostatic or pneumatic pressure required to collapse a tube or other hollow article.
- collett brass*—see **high-leaded brass**.
- commercial bronze**—a copper alloy containing nominally 90 % copper and 10 % zinc, generally available in flat products, wire, rod, and tube. The alloy is not technically a bronze, but because of long usage the term “commercial bronze” has been used. (Copper Alloy No. C22000)
- commercially pure copper**—metal for which the specified minimum copper content is not less than 99.88 %, silver being counted as copper.
- commutator segment stock bar*—see **bar, commutator segment stock**.
- condenser tube plate**—plate manufactured to special thickness tolerances and furnished in various contours as tube sheets or head plates for condensers and heat exchangers.
- copper alloy**—metal for which the specified minimum copper content is less than 99.3 % and not less than 40 % and having no other element specified in excess of the copper content: exception to this definition occurs in the case of copper-nickel-zinc alloys where zinc slightly exceeds the copper content in certain alloys which are commonly designated as copper alloys.
- Copper Alloy UNS No.**—In the Unified Numbering System, wrought copper alloys are designated as C16000 to C79999 and cast copper alloys are designated as C81300 to C99999.

copper-beryllium alloy—heat-treatable copper alloys containing varying amounts of beryllium and sometimes small amounts of cobalt, nickel, and chromium. It is capable of being formed readily when in the soft condition and heat treated to hardnesses approaching those of steel. (Copper Alloy Nos. C17000 – C17530 incl.)

copper drainage tube—see **tube, copper drainage (DWV)**.

copper-iron alloy—copper alloys with iron as the principal alloying element with or without the addition of other elements. (Copper Alloy Nos. C19200 – C19810 incl.)

copper-nickel alloy—copper alloys composed of copper and nickel with nickel content up to 40 % and with small additions of elements such as iron and manganese. (Copper Alloy Nos. C70000 – C72950 incl.)

copper service tube—see **tube, copper service**.

Copper UNS No.—In the Unified Numbering System, wrought coppers are designated as C10000 to C15999 and cast coppers are designated as C80000 to C81199.

core brass—see **radiator core brass**.

cored forgings—forgings produced between closed dies, including cores.

corner radius on square or rectangular wire—any configuration on the corner between a chamfer and a full radius. The measurement of a corner radius is the distance from the blend point on one surface to the extension of the other surface.

corrosion, cavitation—the damage caused to a material by a moving liquid and associated with the formation and collapse of cavities in the liquid at the solid-liquid interface.

corrosion, impingement attack—a type of localized corrosion caused by the striking of a liquid over a period of time containing entrained gases, on a metal surface.

corrosion, stress—spontaneous failure of metals by cracking under combined action of corrosion and residual or applied stress.

cracking, intercrystalline—see **intercrystalline cracking**.

cracking, intergranular—see **intercrystalline cracking**.

creep test—see **test, creep**.

crimped copper—copper in sheets or strips having relatively small transverse corrugations applied subsequent to normal finishing operations to provide for expansion, to increase rigidity, or for ornamental purposes.

cross rolling—rolling at a 90° angle to the long dimension of the metal; usually done to increase width.

cup test—see **test, cup**.

deep drawing brass—see **cartridge brass** or **yellow brass**.

dents—depressions in the copper foil which do not significantly change the thickness of the copper foil.

deoxidized copper, high-residual phosphorus—copper deoxidized with phosphorus residual in amounts 0.015 to 0.040 %. The copper is not susceptible to hydrogen embrittlement, as determined in Specification B379. The copper is of relatively low-electrical conductivity due to the amount of phosphorus present.

NOTE 1—International Standards Organization specifications permit up to 0.050 % phosphorus.

deoxidized copper, low-residual phosphorus—copper deoxidized with phosphorus residual in amounts 0.004 to 0.012 %. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification B379. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

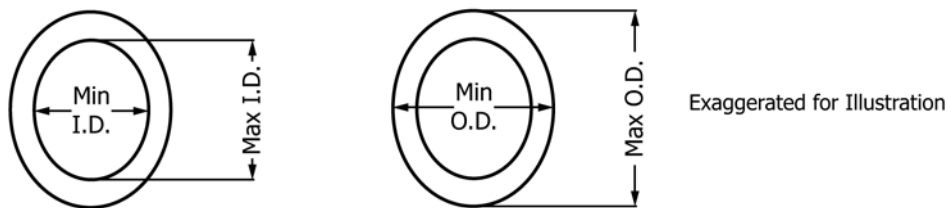
dewetting—a condition that results when molten solder has coated a surface and then receded leaving irregular-shaped mounds of solder separated by areas covered with a thin film but base metal is not exposed.

diameter at any point—inside or outside diameter can be measured at any point around the circumference of the tube. The individual readings may deviate from the nominal due to the tube being larger or smaller than nominal, or out of roundness, or a combination of the two (see Fig. 2).

die forgings—forgings produced between closed dies.

die scalping—drawing through a sharp-edged die to remove the surface layer.

die scratch—a longitudinal scratch on the surface of any drawn product resulting from the use of a roughened die or from the drag of a foreign particle between the die and the product.



Deviation of Actual Diameter at any Point = Max. Diameter – Nominal Diameter
Or, alternately = Nominal Diameter – Min. Diameter

FIG. 2 Diameter at any Point

die shaving—see **die scalping**.

dip, bright—a dip solution used to give a bright surface to copper alloys.

dip, matte—a dip solution used to obtain a matte or dull finish on copper alloys.

dip solution—any chemical solution used to produce a specific color or finish on copper or copper alloys.

disc—a round, commercially flat solid blank made from a flat rolled product.

disc straightening—see **straightening, ring or disc type**.

dish (cross or transverse bow)—the departure from flatness across the full width of the strip in the form of a single arc, excluding burrs.

disk—see **circle**.

distribution tube (Type D)—a seamless or welded copper tube known as copper distribution tube (Type D).

drainage tube—see **tube, copper drainage (DWV)**.

drawing brass—see **cartridge brass** or **yellow brass**.

drawn bar—bar stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn finish—see **finish, drawn**.

drawn flat product—see **flat product, drawn**.

drawn rod—rod stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn shape—shape stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn stress relieved (DSR)—a thermal treatment of a cold-drawn tubular product to improve ductility without significantly affecting its tensile strength or microstructure.

drawn tube—tube stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn wire—wire stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drifting—the piercing of a hole and turning up a collar or flange, on sheet, strip, or articles made therefrom.

driving-band blank—see **rotating-band blank**.

dry rolled finish—see **finish, dry rolled**.

duplex tube—see **tube, bimetal**.

DWV tube—see **tube, copper drainage (DWV)**.

earing—a wavy projection in a regular geometric pattern on the rim of drawn cups formed in the course of deep drawing, as a result of directional properties or anisotropy of the sheet.

eccentricity—the difference between the maximum wall thickness and the minimum wall thickness determined at any one cross-section (see Fig. 3).

edge contours—see **finished edges**.

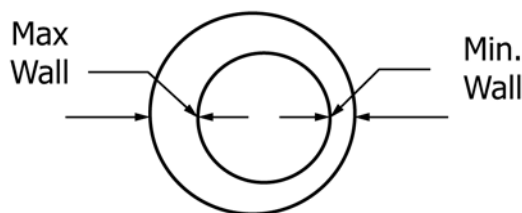
edgewise curvature—the lateral departure of the edge from a straight line, which may be unidirectional or reversing.

electrolytic copper—copper of any origin, refined by electrolytic deposition including electrowinning. Usually when this term is used alone it refers to electrolytic tough pitch copper. This designation applies to the following: (a) cathodes that are the direct product of the refining operation, (b) electrodeposited copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom, (c) electrodeposited copper cast into ingots or ingot bars suitable for remelting.

electrolytic tough pitch copper—a commercially pure high conductivity copper of any origin which has been produced by electrolytic deposition, then melted, oxidized, and brought to tough pitch or controlled low oxygen content, and finally cast into cakes, billets, wire bars, etc., suitable for hot or cold working, or both. (Copper No. C11000)

embossed tube—see **tube, embossed**.

embrittlement—the reduction of the normal ductility in a metal due to a physical or chemical change. As it relates to these test methods, embrittlement is the loss of ductility



Exaggerated for Illustration

$$\text{Eccentricity} = \text{Max. Wall} - \text{Min. Wall}$$

$$\text{Percent Eccentricity} = (\text{Max. Wall} - \text{Min. Wall}) / \text{Average Wall} \times 100$$

NOTE 1—There are no tolerances established for Eccentricity in ASTM Tube and Pipe documents. This parameter is controlled through Wall Thickness at any Point Tolerances.

FIG. 3 Eccentricity

caused by the reaction of cuprous oxide in the copper product when exposed at elevated temperatures to a reducing atmosphere.

endurance test—see **test, endurance**.

engraver's brass—see **extra-high-leaded brass**.

etching brass—a term used to indicate quality of material rather than chemical composition. The term signifies a flat product having unusual freedom from surface defects; very flat and usually of quarter-hard or half-hard temper.

expansion test—see **test, expansion (pin)**.

extra-high-leaded brass—a copper alloy containing nominally 61.5 % copper, 2.5 % lead, and 36 % zinc, generally available in flat rolled products, and used for engraving and other operations requiring considerable cutting. (Copper Alloy No. C35600)

extruded bar—bar stock brought to final dimensions by extrusion.

extruded finish—see **finish, extruded**.

extruded rod—rod stock brought to final dimensions by extrusion.

extruded shape—shape stock brought to final dimensions by extrusion.

extruded tube—tube stock brought to final dimensions by extrusion.

extrusion—a uniform metal shape, long in relation to its cross-sectional dimensions, produced by forcing a suitably preheated billet or preform through an orifice (die) of the desired cross section. Extrusions generally are furnished in straight lengths.

extrusion, hot—the process of shaping metal into a chosen continuous form by forcing it from a closed container through a die of appropriate shape.

extrusion pipe—a defect that occurs during extrusion and is located internally at the back end of the extruded piece. This defect is removed by cropping off the back end.

eyelet brass—see **cartridge brass**.

finish, acid dipped-dry rolled—the surface obtained by cold dry rolling on polished rolls of material previously dipped, giving a burnished appearance and retaining the color obtained by dipping.

finish, bright annealed—the surface obtained by annealing under conditions of controlled atmosphere to prevent oxidation and to retain the original luster of the product.

finish, bright-dipped—a bright surface having the true color of the metal obtained by immersion in a bright dipping solution.

finish, bright-rolled—see **finish, dry rolled**.

finish, brush brass—a frosted surface obtained on brass by brushing with a wheel that may or may not be treated with brush rouge and rotating at high speeds.

finish, buffed surface—the surface obtained by buffing with rouge or similar fine abrasive, resulting in a high gloss or polish. This may be applied in one operation or two, commonly known as cutting and coloring operations.

finish, clean annealed—a surface characterized by a light iridescent film generally obtained on copper alloys which have been annealed in a controlled atmosphere.

finish, cold-rolled—the surface obtained by cold rolling of strip with a lubricant, giving a relatively smooth appearance. In the case of sheet or strip, cold rolling may be done without any lubricant, the finish then being similar to that described under dry rolled finish.

finish, drawn—the surface obtained on tube, wire, and drawn rod, bar, and strip by drawing through a die resulting in a relatively smooth and bright appearance with some residual lubricant on the surface.

finish, dry rolled—(a) the surface obtained by cold rolling on polished rolls without the use of any coolant or metal lubricant; (b) the surface obtained by the rolling or tumbling of brass articles in a barrel with either dry sawdust, leather, or scrap cork.

finish, extruded—the surface obtained on tube, wire, and rod, bar, and strip by hot extrusion through a die, resulting in an oxidized and dull appearance.

finish, hot rolled—the surface obtained by rolling metal while hot resulting in a dark, oxidized, and relatively rough surface.

finish, kerosine rolled—the surface obtained by cold rolling with kerosine as a lubricant, giving a semi-burnished appearance. A similar finish can be obtained by cold rolling with soap or soluble oil.

finish, plain pickled—the surface obtained by immersion in a sulfuric acid solution. This effectively removes most heavy scale and oxides on yellow brasses, but less effectively on other alloys and will not remove any thin surface films of deposited copper. The color, is, therefore, usually duller than that of bright dipped.

finish, planish—a bright smooth surface usually obtained by rubbing metals together.

finish, scratch brushed—the surface obtained by mechanically brushing the surface with wire bristle brushes or by buffing with greaseless compound.

finished edges—smooth edges produced on flat wire, strip, or bar by drawing or rolling with or without previous slitting. The edge contours most commonly used are square corners, rounded corners, rounded edges, and full rounded edges.

finned tube—see **tube, finned**.

fire cracking—see **heat cracking**.

fire-refined copper—copper of any origin or type finished by furnace refining without having been processed at any stage by electrolytic or chemical refining. Usually when the term fire-refined copper is used alone it refers to fire-refined tough pitch copper. This designation applies to the following: (a) copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom, (b) ingots or ingot bars suitable for remelting.

flash—as in welding, the metal that protrudes at the weld of the tube, internally, externally, or both, as a result of the pressure applied when a forge-type seam is produced; the two types of flash are internal flash and external flash.

flatness—the degree to which a surface of a flat product approaches a plane.

flat product—a rectangular or square solid section of relatively great length in proportion to thickness. Included in the designation “flat product” depending on the width and thickness, are plate, sheet, strip, and bar. Also included is the product known as “flat wire.”

flat product, drawn—a flat product brought to final dimensions by drawing through a die, and furnished in flat straight lengths, on spools, or in rolls. The corners or edges may be square or of other contours.

flat product, rolled—a flat product brought to final thickness by rolling, and furnished in flat straight lengths, on spools, or in rolls. Longitudinal edges may be those resulting from final rolling to thickness or the product may be brought to final width by shearing, slitting, sawing, machining or rolling. The corners or edges may be square or of other contours.

flat straight lengths—see **straightening and flattening (patent levelling) applicable to flat straight lengths**.

flattening—the mill operation performed on rolled flat products to reduce departure from flatness, such as curl and dish. See **straightening and flattening**.

flattening test—see **test, flattening**.

flat wire—a product up to and including 0.188 in. (4.78 mm) in thickness and up to and including 1¼ in. (31.8 mm) in width.

fluted outside and plain inside tube—see **tube, fluted outside and plain inside**.

fluted tube—see **tube, fluted**.

foil—a term often applied to thin sheet or strip usually 0.005 in. (0.13 mm) or less in thickness.

forging—see **hot press forging**.

forging brass—a copper alloy containing nominally 59 % copper, 2 % lead, and 39 % zinc, generally available in rod, bar, tube and shapes and recommended for fabrication by hot forging and hot pressing. It has excellent machinability, approaching that of free-cutting brass. (Copper Alloy No. C37700)

forging, hammer—see **hammer forging**.

forging range—temperature range within which the slug or blank cut from wrought material should be heated and maintained to give optimum forging conditions.

formed shape—shape made from a flat product and brought to final dimensions by bending laterally by means of rolls or brakes. If the longitudinal gap is less than 25 % of the outside diameter or greatest overall dimensions, the product is classified as an open seam tube.

fourdrinier wire—wire used in making the fourdrinier screens used in the manufacture of paper.

free-cutting—the property of a material that enables it to be cut with high-speed machining equipment yielding a short, brittle chip.

free-cutting brass—a wrought copper alloy composed of copper, zinc, and lead having chemical composition within the defined limits of Copper Alloy UNS No. C36000.

free-cutting copper—a wrought copper enriched with tellurium and phosphorus, sulfur and phosphorus, or lead, having chemical composition within the defined limits of either Copper UNS Nos. C14500, C14510, C14520, C14700, or C18700.

free-cutting muntz metal—a wrought copper alloy composed of copper, zinc, and lead having chemical composition within the defined limits of Copper Alloy UNS No. C37000.

free-cutting phosphor bronze—a copper alloy containing nominally 88 % copper, 4 % tin, 4 % zinc, and 4 % lead, generally available in rod and flat products. (Copper Alloy No. C54400)

free-machining—the quality of an alloy which enables it to be cut in automatic machines at relatively high speeds yielding a short brittle chip.

free-turning—see **free-cutting**.

full rounded edges—see **finished edges**.

gauge number—a number in a specific series used to designate a dimension. There are several series of such gauge numbers, of which the most familiar are the American Wire Gauge or Brown & Sharpe and Birmingham or Stubs.

gilding metal—a copper alloy containing nominally 95 % copper, and 5 % zinc. This alloy is generally available in flat products, rod, and wire. (Copper Alloy No. C21000)

grain size—the average diameter or grains, usually determined microscopically, on an etched plane surface of the metal. See Test Methods **E112**.

hammer forging—a forging process in which the piece is deformed by repeated blows.

hand forgings—forgings produced between open dies.

hand straightening—see **straightening, hand**.

hardness number—the number used to designate the hardness of metal. The number is related to the scale of values of a particular hardness test, as for example Rockwell B80 or Brinell 150.

hardware bronze—see **leaded commercial bronze** or **leaded red brass**.

heading—the operation of either cold or hot forming the head of bolts, rivets, screws, and similar products by upsetting the end of a rod or a wire blank.

heat—a lot of cast product that shares, and can be identified by, a common chemical analysis result.

heat cracking—spontaneous failure of some metals by cracking under combined action of elevated temperature and stress (residual or applied). Fire cracking is a form of heat cracking resulting from residual stress and externally applied heat.

herringbone—a series of long continuous waves running at various angles to the rolling direction.

high brass—see **yellow brass**.

high-conductivity copper—copper that in the annealed condition has a minimum electrical conductivity of 100 % IACS.

high-leaded brass—copper alloys containing nominally for **C34200**, 63.5 % copper, 2 % lead, and 34.5 % zinc; and for **C35300**, 62 % copper, 2 % lead, and 36 % zinc, generally available in flat products and rod. (Copper Alloy No. C34200, C35300)

high-leaded brass tube—a copper alloy containing nominally 66 % copper, 1.6 % lead, and 32.4 % zinc. (Copper Alloy No. C33200)

Hooker Process—see **impact extrusion**.

hot extrusion—see **extrusion, hot**.

hot forging—see **hot press forging**.

hot press forging—a method of forming parts by pressing a heated slug or blank cut from wrought material in a closed impression die.

hot-rolled bar—bar stock brought to final dimensions by hot rolling.

hot rolled finish—see **finish, hot rolled**.

hot-rolled plate—plate stock brought to final dimensions by hot rolling.

hot-rolled rod—rod stock brought to final dimensions by hot rolling.

hot-rolled shape—shape stock brought to final dimensions by hot rolling.

hot-rolled sheet—sheet stock brought to final dimensions by hot rolling.

hot-rolled wire—wire stock brought to final dimensions by hot rolling.

hot rolling—see **rolling**.

hot working—controlled mechanical operations for shaping a product at temperatures above the recrystallization temperature.

hydrostatic test—see **test, hydrostatic**.

impact extrusion—the formation of a tubular closure by the rapid application of force through a punch on a metal blank, the metal flowing up around the punch to form the tubular section. Also known as **Hooker Process**.

impact test—see **test, impact**.

impingement attack corrosion—see **corrosion, impingement attack**.

inclined roll straightening—see **straightening, inclined roll**.

inclusions—foreign particles which may or may not be enclosed in the copper foil.

ingot and ingot bar—refinery shapes used for remelting (not fabrication). Ingots normally range in weight from 20 to 35 lb (9 to 16 kg) and ingot bars from 50 to 70 lb (23 to 32 kg). Both are usually notched to facilitate breaking into smaller pieces.

ingot bar—a small rectangular copper casting weighing about 50 to 70 lb for remelting.

intercrystalline—a term used to indicate a path along the grain boundaries and between the crystals or grains rather than through the grains of a metal.

intercrystalline cracking—fracture of a metal along the grain boundaries of the metal.

intergranular—see **intercrystalline**.

jewelry bronze—a copper alloy containing nominally 87.5 % copper and 12.5 % zinc having a rich golden color. (Copper Alloy No. C22600)

kerosine rolled finish—see **finish, kerosine rolled**.

lake copper—a commercially pure copper from the Lake Superior district generally fire refined and containing variable, but controlled, amounts of silver and arsenic. (Copper Nos. C12500, C12900)

leaded brasses—copper alloys, of copper and zinc, to which lead has been added to improve machinability.

leaded commercial bronze—a copper alloy containing nominally 89 % copper, 1.75 % lead, and 9.25 % zinc, generally available in rod, shapes, and bar, and used extensively for hardware. (Copper Alloy No. C31400)

leaded muntz metal—a copper alloy containing nominally 60 % copper, 0.6 % lead, and 39.4 % zinc, generally used for condenser tube plates. (Copper Alloy No. C36500)

leaded naval brass—a copper alloy containing nominally 60 % copper, 0.75 % tin, 1.75 % lead, and 37.5 % zinc, generally available in rod, shapes, and bar. (Copper Alloy No. C48500)

leaded red brass—a copper alloy containing nominally 85 % copper, 2 % lead, and 13 % zinc, generally available in rod and drawn bar. (Copper Alloy No. C32000)

lengths—straight pieces of the product.

lengths, ends—straight pieces, shorter than the nominal length, left over after cutting the product into mill lengths, stock lengths, or specific lengths. They are subject to minimum length and maximum weight requirements.

lengths, multiple—straight lengths of integral multiples of a base length, with suitable allowance for cutting, if and when specified.

lengths, random—run of mill lengths without any indicated preferred length.

lengths, specific—straight lengths that are uniform in length, as specified, and subject to established length tolerances.

lengths, specific with ends—specific lengths, including ends.

lengths, standard—uniform lengths recommended in a Simplified Practice Recommendation or established as a Commercial Standard.

lengths, stock with ends—stock lengths, including ends.

lip tube—see **tube, lip**.

lock seam tube—see **tube, lock seam**.

longitudinal corrugation—a condition similar to dish except that the sense of curvature changes sign at least once across the width of the strip.

longitudinal curl—a unidirectional departure from longitudinal flatness.

lot—a collection of like product (that is, same alloy, temper, and dimensions) produced under uniform conditions from which a sample is to be drawn for inspection or testing, or both.

low brass—a copper alloy containing nominally 80 % copper and 20 % zinc, generally available in flat products, rod, and wire. (Copper Alloy No. C24000)

low-leaded brass—a copper alloy containing nominally 63.5 % copper, 0.5 % lead, and 36 % zinc, generally available in flat products. (Copper Alloy No. C33500)

low-leaded brass tube—a copper alloy tube product containing nominally 66 % copper, 0.5 % lead, and 33.5 % zinc. (Copper Alloy No. 33000)

malleability—the property of a metal that permits deformation by rolling, heading, hammering, or extension by pressure without fracturing.

manganese bronze—a copper alloy containing nominally 58.5 % copper, 1 % tin, 1.4 % iron, 0.1 % manganese, and 39 % zinc, generally available in rod, flat products, shapes, and wire. (Copper Alloy No. 67500)

Mannesmann Process—the process of piercing heated solid billets to form seamless tubes. Also known as **piercing**.

matrix brass—see **medium lead**ed brass.

matte dip—see **dip, matte**.

medium leaded brass—a copper alloy containing nominally 63.5 % copper, 1 % lead, and 35.5 % zinc, generally available in flat products, rod, shapes, and wire. (Copper Alloy No. C34000)

mischmetal—an alloying additive, which includes a mixture of rare earth elements (atomic numbers 57 through 71) in metallic form, used during casting to improve processing characteristics or to affect material properties or microstructure.

modified copper—metal for which the specified minimum copper content is less than 99.88 % and not less than 99.3 %, silver being counted as copper.

Muntz metal—a copper alloy containing nominally 60 % copper and 40 % zinc, generally available in flat products, rod, wire, and tube. (Copper Alloy No. C28000)

naval brass—a copper alloy containing nominally 60 % copper, 0.75 % tin, and 39.25 % zinc, generally available in rod, bar, wire, shapes, tube, and flat products. (Copper Alloy No. C46400)

nickel silver—copper alloys containing nickel and zinc. (Copper Alloy Nos. C73500 to C79860 incl. and C97300 to C97800 incl.)

nodules—small irregularly shaped imperfections in the electrolytic copper foil which do not cause the foil to fail the thickness tolerance.

nonrefractory—a term applied to those copper alloys which, because of a lack of hardness or abrasiveness, present relatively little difficulty in maintaining standard dimensional tolerances.

oil burner tube—see **tube, oil burner**.

oil stain—see **stain, oil**.

open seam tube—see **tube, open seam** and **formed shape**.

order strengthening—a thermal treatment of a cold-worked product at a temperature below its recrystallization temperature causing ordering to occur to obtain an increase in yield strength.

overhauling—the process of cutting away the surface layer from bars or plates after breakdown rolling, the objective being to remove the minor surface casting defects and oxide.

oxygen free copper—a high conductivity copper that has been produced in such manner as to contain no oxide or residual

deoxidants. It has very high resistance to hydrogen embrittlement. (Copper Nos. C10100, C10200, C10300)

oxygen-free copper, extra-low phosphorus—oxygen-free copper containing 0.001 to 0.005 % phosphorus. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification **B379**. The copper in the annealed condition has a minimum conductivity of 98.16 % IACS.

oxygen-free copper, low phosphorus—oxygen-free copper containing 0.005 to 0.12 % phosphorus. The copper is not susceptible to hydrogen embrittlement, as determined in Specification **B379**. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

- (a) deoxidized, phosphorus-arsenical copper
- (b) arsenical, tough-pitch copper
- (c) silver-bearing copper
- (d) sulfur-bearing copper
- (e) deoxidized phosphorus-tellurium copper
- (f) zirconium-bearing copper
- (g) tellurium-bearing copper

NOTE 2—Coppers listed contain the designated element or elements in amounts as agreed upon between the manufacturer or supplier and the purchaser.

oxygen-free electronic copper—high-purity, high-conductivity oxygen-free copper normally intended for electronic applications. The copper has high resistance to hydrogen embrittlement, as determined in Specification **B170**. The copper in the annealed condition has a minimum electrical conductivity of 101 % IACS.

oxygen-free, silver bearing copper—a commercially pure high conductivity copper containing the designated element (silver) in amounts as agreed upon between the supplier and the consumer for the purpose of raising the softening temperature. (Copper Nos. C10400, C10500, C10700)

patent levelling—see **straightening and flattening (patent levelling) applicable to flat straight lengths**.

phosphor bronze—a copper alloy with tin as the principal alloying element, deoxidized with phosphorus, available in flat products, rod, tube, wire, and shapes. (Copper Alloy Nos. C50000 – C52999 incl.)

phosphorus deoxidized arsenical copper—a modified deoxidized copper containing the designated element (arsenic) mainly for the purpose of increasing corrosion resistance. (Copper No. C14200)

phosphorus deoxidized copper, high-residual phosphorus—a commercially pure copper that has been deoxidized with phosphorus, leaving a relatively high residual phosphorus content. It is not susceptible to hydrogen embrittlement but is of relatively low electrical conductivity due to the amount of phosphorus present. (Copper No. C12200)

phosphorus deoxidized copper, low-residual phosphorus—a commercially pure copper that has been deoxidized with phosphorus in such a manner as to leave a

very low residual phosphorus content. It is not readily susceptible to hydrogen embrittlement, and has an electrical conductivity slightly lower than that of high conductivity copper. (Copper No. C12000)

phosphorus deoxidized copper, silver-bearing—a commercially pure deoxidized copper containing the designated element (silver) in amounts as agreed upon between the supplier and the consumer. (Copper Nos. C12100, C12300)

phosphorus deoxidized copper, tellurium-bearing—a modified deoxidized copper containing the designated element (tellurium) to improve machinability. The electrical conductivity is somewhat lower than that of electrolytic tough pitch copper. (Copper No. C14500)

pickle stain—see **stain, pickle**.

piercing—(a) the process, also known as the “Mannesmann Process” by which seamless tubes are made from solid billets. A heated billet is rapidly rotated and driven ahead by drive rolls, the action of which is to form an opening in its center. The forward movement imparted by the rolls carries the shell over a freely rotating mandrel which shapes the inner surface of the tube, (b) punching holes in sheet or strip, or walls of shells.

pinholes—small holes occurring as imperfections which penetrate entirely through the copper foil.

pin test—see **test, expansion (pin)**.

pipe nipple—a short length of pipe with male threads at both ends.

pipe, seamless—seamless tube conforming to the particular dimensions commercially known as “standard pipe sizes.”

pipe, threadless—a seamless copper tube of standard pipe outside diameters conforming to particular dimensions commercially known as threadless pipe (TP).

pits—small holes having jagged edges, occurring as imperfections which do not penetrate entirely through the copper foil.

plain pickled finish—see **finish, plain pickled**.

planish finish—see **finish, planish**.

plate—as in *inch-pound specifications*, a wrought flat product over 0.188 in. thick and over 12 in. wide, in straight lengths or coils (rolls).

plate—as in *SI specifications*, a wrought flat product over 5 mm thick and over 300 mm wide, in straight lengths or coils (rolls).

plate, hot-rolled—see **hot-rolled plate**.

plater’s bar—a rectangular section, specially surfaced, for use as a base to which precious metal is to be applied before rerolling, for the jewelry and similar trades.

plater’s core—a round section, especially surfaced, for use as a base to which precious metal is to be applied before rerolling, for the jewelry and similar trades.

plug scratch—a longitudinal scratch on the inside surface of a tube resulting from the use of a roughened plug or the draft of a foreign particle between the plug and tube wall.

pointing—(a) the reduction of the diameter of ends of tubes, rod, or wire in order that they may be started through the drawing die, (b) the cutting of a taper point on wire to be made into wood screws and similar products.

pneumatic test—see **test, pneumatic**.

portion size—the number of lengths of pipe to be used for a specific test.

precipitation heat treatment—a thermal treatment of a solution heat-treated product to produce property changes such as hardening, strengthening, and conductivity increase by precipitation of constituents from the supersaturated solid solution. This treatment has also been called “age hardened” and “precipitation hardened.”

press straightening—see **straightening, press**.

print roll—a tube manufactured with special perfection of surface and straightness, for use in printing paper, linoleum, textiles, and similar products.

projectile-band blank—see **rotating-band blank**.

quench hardening—a treatment for copper-aluminum alloy products consisting of heating above the betaizing temperature followed by quenching to produce a hard martensitic structure.

radiator core brass—a term used to indicate strip brass or suitable characteristics for forming radiator cores.

ready-to-finish—a general mill term applied to size and condition of a product prior to the final drawing or rolling operation.

red brass—a copper alloy containing nominally 85 % copper and 15 % zinc, generally available in flat products, rod, wire, and tube. (Copper Alloy Nos. C23000 and C83600)

redraw rod—rod stock within a limited range of sizes for further drawing or rolling.

redraw tube—tube stock within a limited range of sizes for further drawing or rolling.

redraw wire—wire stock within a limited range of sizes for further drawing or rolling.

red stain—see **stain, red**.

reeded outside and plain inside tube—see **tube, reeded outside and plain inside**.

reeded tube—see **tube, reeded**.

reel—a device on which wire, flat wire, and narrow strip are wound to facilitate handling and shipping. See also **spool**.

reroll wire—see **redraw wire**.

residual stress—stresses that remain within a body as the result of plastic deformation or casting.

resquared metal—alternately called **square-sheared metal**.

A product furnished in a flat straight length, brought to final width and length by press shearing of both edges and ends. The edges are straighter than those of slit metal, with the ends at right angles to the edges.

rich low brass—see **red brass**.

ring straightening—see **straightening, ring or disc-type**.

Rockwell hardness test—see **test, Rockwell hardness**.

rod—a round, regular hexagonal or regular octagonal solid section furnished in straight lengths. A regular hexagonal or a regular octagonal rod is a solid section having equal sides and equal angles.

rod, brazing—see **brazing filler material**.

rod, cold-rolled—see **cold-rolled rod**.

rod, drawn—see **drawn rod**.

rod, extruded—see **extruded rod**.

rod, for staybolts—a round solid section furnished in straight lengths.

rod, hot-rolled—see **hot-rolled rod**.

rod, piston finish—a round rod having a special surface produced by turning or grinding to close tolerances for diameter and straightness.

rod, shafting—a round rod specially manufactured to the close straightness tolerances required for use in shafting.

rod, welding—see **welding rod**.

roll—a length of flat rolled product wound into a cylindrical spiral. See also **stagger wound roll**.

rolled edges—see **finished edges**.

rolled flat product—see **flat product, rolled**.

roll flattening—see **straightening and flattening**.

rolling—the process of passing metal between rolls under pressure to reduce its cross-section. (a) cold rolling is carried out below the softening temperature of the metal and, with copper alloys, usually at room temperature, (b) hot rolling is carried out above the softening temperature and, with copper alloys, usually at temperatures from about 1200 to 1700 °F (650 to 927 °C).

roll straightening—see **straightening, roll**.

roped tube—see **tube, roped**.

rope-fluted tube—see **tube, rope-fluted**.

rope-reeded tube—see **tube, rope-reeded**.

rotating-band blank—an unfinished tubular blank for making rotating bands for use on artillery projectiles.

rotating head straightening—see **straightening, rotating head**.

rounded corners—see **finished edges**.

rounded edges—see **finished edges**.

roundness—The deviation from roundness is defined as the difference between major and minor diameters at any one cross-section (see Fig. 4).

sample—the final form of a material submitted for chemical analysis (drillings, millings, and so forth) or a prepared test specimen to be used for mechanical testing.

satín finish—see **finish, scratch brushed**.

sawed bar—a bar brought to finished width by sawing.

sawed edges—the edges resulting when a product is brought to final width and length by sawing. The edges are parallel and at right angles to the rolled surface.

scalping—the process of removing by means of rotating cutters or cutter heads the surface layer from bars or rods to eliminate minor surface defects and oxide. See also **overhauling**, **die scalping**, or *die shaving*.

scarfing—the removing of flash or bead by a cutting operation.

scratch brushed finish—see **finish, scratch brushed**.

season cracking—see **corrosion, stress**.

70–30 brass—see **cartridge brass**.

shape—a solid section other than rectangular, square, or standard rod and wire sections, furnished in straight lengths.

shape, cold-rolled—see **cold-rolled shape**.

shape, drawn—see **drawn shape**.

shape, extruded—see **extruded shape**.

shape, hot-rolled—see **hot-rolled shape**.

shaving—see **die scalping**.

sheared edges—the edges resulting from press shearing to final width and length. These edges are straighter than slit edges.

sheet—as in *inch-pound specifications*, a rolled flat product up to and including 0.188 in. thick and over 24 in. wide, in straight lengths or coils (rolls).

sheet—as in *SI specifications*, a rolled flat product up to and including 5 mm thick and over 600 mm wide, in straight lengths or coils (rolls).

sheet, hot-rolled—see **hot-rolled sheet**.

short plumbing (hospital) threads—a special modified form of the tapered pipe thread basically achieved by elimination of the imperfect threads. This thread is normally used only on chromium-plated nipples to ensure that a minimum of thread shall remain exposed after the nipple is threaded into a fitting.

silicon bronze—any copper alloy with silicon as the main alloying element, with or without additions of such elements as zinc, manganese, aluminum, iron, or nickel. (Copper Alloy Nos. C64500 – C66100 incl.)

silver-bearing copper—any copper containing substantial amounts of silver, regardless of origin or treatment. (Copper Nos. C10400, C10500, C10700, C11300, C11400, C11500, C11600, C12100, C12300)

silver-bearing phosphorus deoxidized copper—see **phosphorus deoxidized copper, silver bearing**.

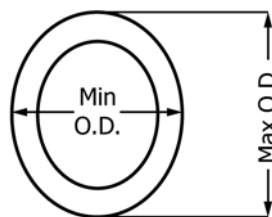
silver bearing tough pitch copper—a commercially pure high conductivity tough pitch copper containing silver for the purpose of raising the softening temperature. (Copper Nos. C11300, C11400, C11500, C11600)

slab—a casting in the form of a rectangular bar used for rolling into strip.

slit edges—the edges resulting from cutting to width by rotary slitter knives.

solderability—the capability of a metal to be wetted by solder.

soldering—joining metals by fusion of alloys that have relatively low melting points—most commonly, lead-base or tin-base alloys, which are the soft solders. Hard solders are



Exaggerated for Illustration

Deviation from Roundness
(that is, Out-of-Roundness) = Max. O.D. – Min. O.D.
Percent Out-of-Roundness = (Max. O.D. – Min. O.D.) / Average O.D. × 100

NOTE 1—Roundness Tolerances apply to Hard Drawn (H-80) and Drawn General Purpose (H-58).

FIG. 4 Roundness

alloys that have silver, copper, or nickel bases. Use of these alloys with melting points higher than 800 °F (427 °C) is properly called “brazing.”

solution heat treatment—a thermal treatment of a product to put alloying elements into solution in the base metal by heating into the temperature range of solid solubility, followed by cooling at a sufficient rate to retain them in a supersaturated solid solution.

spelter—mill term for cast zinc. Spelter usually is produced in the form of flat slabs for remelting.

spill—a defect which originates during casting and after rolling or drawing appears as a discontinuity either on the surface or as a faint streak which on distortion becomes open or blistered.

spinodal heat treatment—a thermal treatment of a solution-heat-treated product to produce property changes such as hardening, strengthening, and conductivity increase by spinodal decomposition of a solid solution. This treatment has also been called “age hardened,” “spinodal hardened,” or “spinodally decomposed.”

spool—a small reel.

springing—redistribution of residual stress by mechanical means, as for instance, passing rods through certain types of straightening machines.

square corners—see **finished edges**.

square-sheared metal—see **resquared metal**.

stagger-wound roll—a multiple layer roll, wound as in spooling, but with strands not necessarily of fixed regularity.

stain, air—superficial, uniform light-to-dark brown discoloration or dulling of the initial luster of a copper-base material due to atmospheric attack.

stain, oil—localized brown or black discoloration on the surface of a copper-base material caused by incomplete removal or burning of lubricants.

stain, pickle—a stain on a copper-base material resulting from insufficient pickling or inadequate rinsing.

stain, red—pink or reddish surface discoloration of a copper-base material usually resulting from volatilization of zinc during annealing or by a copper deposition during pickling.

stain, water—localized light-to-dark and often iridescent residue with a sharply outlined darker border on a copper-base material left from evaporation of water acquired from mill processing, transit, or storage.

standard—uniform lengths recommended in a simplified practice recommendation or established as a commercial standard.

straightening—any process applied to tube, rod, bar or wire that eliminates any general or local curvature resulting from mill processing.

straightening and flattening—any process applied to flat rolled products to eliminate any general or local curvature, either with respect to flatness or edgewise curvature.

straightening and flattening, (patent levelling) applicable to flat straight lengths—a process that simultaneously flattens and straightens a flat rolled product by longitudinally stretching it beyond its elastic limit. This process practically removes buckles, ripples, wavy edges, twist, and edgewise curvature; is partially effective in removal of crown, dish, and burr. It is particularly effective on all annealed tempers and on rolled tempers up to half hard.

straightening and flattening, roll flattening—the process of flattening a flat rolled product by a machine with a number of small diameter cylindrical rolls so positioned as to repeatedly flex the product and thus remove certain irregularities in shape. Roll flattening practically eliminates longitudinal curl, burr, and dish. It reduced edgewise curvature of narrow strip. This operation reduced buckles, but is relatively ineffective in eliminating wavy edges, ripples, and twist. It is particularly effective on annealed tempers, but is progressively less effective with increase in degree of rolled temper.

straightening, hand—the process of straightening by bending or twisting by hand with the aid of adjustable supports and suitable hand tools usually applied to shapes and to large diameter tube.

straightening, inclined roll—the process of straightening round rod or tube by passing the product through a machine with rolls having special contours and whose axes are at a slight angle so as to give the product a helical forward motion with repeated flexing in all planes through the axis.

straightening, press—the process of straightening bar, shapes, and large size rod and tube by means of mechanically or hydraulically actuated presses.

straightening, ring or disc-type—the process of straightening rod by rotating while feeding lengthwise through a series of rotating rings or discs which flex the rod in all planes through the axis. The equipment usually includes a cut-to-length device for use on rod, which is straightened from coils.

straightening, roll—the process of straightening tube, rod, and bar by passing lengthwise through a machine with suitable rolls so as to repeatedly flex the product in two planes at right angles.

straightening, rotating head—the process of straightening rod initially produced in a coil, and which comprises the rotation of a series of shaped dies pressed against the rod so as to repeatedly flex the rod in all planes through the axis as it moved forward through the machine by means of feed rolls. This type of straightening machine usually has an automatic cut-to-length device.

strain hardening—the increase in strength and hardness and decrease in ductility due to permanent deformation of the structure by cold working.

stress corrosion—see **corrosion, stress**.

stress corrosion crack—spontaneous failure of metals by cracking under combined action of corrosion and stress, residual or applied.

stress relief—a treatment of a product to reduce residual stresses.

by *mechanical treatment*—without causing a significant change in size.

by *thermal treatment*—without causing recrystallization.

stretcher straightening—see **straightening and flattening**.

strip—as in *inch-pound specifications*, a rolled flat product, other than flat wire, up to and including 0.188 in. thick, in straight lengths, coils (rolls), or traverse wound on reels or spools having either slit, sheared or slit and rolled edges in widths up to 24 in. inclusive, or having finished drawn or rolled edges, in widths over 1¼ to 12 in. inclusive.

strip—as in *SI specifications*, a rolled flat product other than flat wire up to and including 5 mm thick in straight lengths, coils (rolls), or traverse wound on reels or spools having either slit or sheared edges in widths up to 600 mm inclusive, or having finished drawn or rolled edges, in widths over 30 to 300 mm inclusive.

tellurium-bearing phosphorus deoxidized copper—see **phosphorus deoxidized copper, tellurium bearing**.

temper—the metallurgical structure and properties of a product resulting from thermal or mechanical processing treatments.

temper annealing—a thermal treatment above the eutectoid temperature for copper-aluminum alloy products to minimize the presence of the stable eutectoid structure.

tempering—a thermal treatment of a quench-hardened product to improve ductility.

tension test—see **test, tension**.

test, bend—a test sometimes made to indicate ductility or bending quality by bending a suitable specimen about a predetermined radius through a predetermined angle.

test, Brinell hardness—a test made to determine hardness on relatively thick sections of metal by pressing a tungsten carbide ball of specified diameter into a test specimen under a specified load. This test is seldom used on copper and copper-base alloys. See Test Method **E10**.

test, creep—a test to determine the extension of metallic materials due to the combined effects of temperature, tensile stress and time. Inherently, it is a long term test not suitable for specification purposes.

test, cup—a test to indicate the ductility of sheet or strip wherein a cup is drawn from the metal until it fractures. Several modifications of the original Erichsen method are now in use.

test, endurance—a test to determine the endurance limit of a metal's resistance to fatigue by subjecting a specimen to repeated alternating or pulsating stresses.

test, expansion (pin)—a test used to determine the capacity of the tube for expansion and to reveal surface defects by pushing a tapered pin into the open end of a specimen. See Test Method **B153**.

test, flattening—a test made on annealed tube to indicate ductility and freedom from mechanical defects.

test, hydrostatic—a test to prove soundness and resistance to leakage of tube and pipe under internal water pressure.

test, impact—a test made to determine the resistance of metals to failure by sudden shock load. See Test Methods **E23**.

test, pneumatic—a test used to prove resistance to leakage of tube or pipe by the application of internal air pressure to the product while submerged in water.

test, Rockwell hardness—a test to measure hardness by determining the depth of penetration into a specimen of a penetrator under predetermined conditions of test. See Test Methods **E18**.

test, tension—a test to determine one or more of the following: tensile strength, yield strength, elongation, and contraction reduction of area. See Test Methods **E8/E8M**.

test, torsion—a test to determine the strength in torsion by measuring the torque required to twist a specimen of given length through a predetermined angle.

thermal treatment—a controlled heating; time at maximum temperature-cooling cycle as needed to satisfy the property and grain structure requirements of the temper.

threadless pipe (TP)—seamless tube conforming to the particular dimensions commercially known as “threadless pipe (TP).”

tin bronze—see **phosphor bronze**.

torsion test—see **test, torsion**.

tough pitch copper—copper of any origin cast in the form of refinery shapes, containing a controlled amount of oxygen in the form of cuprous oxide. By extension the term is also applicable to fabricators' products made therefrom.

treatment—a process that is applied to one or both sides of the copper foil to enhance the adhesion of the foil to the base substrate that shall not degrade the foil or the base substrate.

trim bronze—a term used to designate copper-zinc strip with a bright finish suitable for architectural trim. (Copper Alloy Nos. C22000 and C23000)

tube—a hollow product of round or any other cross-section, having a continuous periphery.

tube, air conditioning—a seamless copper tube conforming to a standard series of sizes, and to specified internal cleanliness requirements normally furnished in straight lengths, with the ends capped or sealed.

tube, automotive and general service—a seamless copper tube of small diameter conforming to a standard series of sizes commercially known as automotive and general service tube.

tube, bimetal—a finished tube consisting of two different metal tubes mechanically bonded together by drawing one inside the other.

tube, Bourdon gauge—seamless tube of uniform wall thickness and special (usually oval) cross-section, produced to special dimensional tolerances and special temper for use as a pressure actuated measuring device, as in a Bourdon gauge.

tube, brazed—tube made from sheet or strip by forming and brazing.

tube, capillary—a tube of small inside diameter with an inside surface of highest quality and conforming to close-diameter tolerances. It is subject to special tests to ensure precision and uniformity of bore and is specially cleaned and packed.

tube, condenser—see **tube, heat exchanger**.

tube, copper drainage (DWV)—seamless copper tube conforming to the particular dimensions commercially known as Copper Drainage Tube (DWV). It is intended for above ground use only, for drainage, waste, vent, and other nonpressure applications.

tube, copper service—annealed copper water tube for underground water services.

tube, copper water—a seamless copper tube conforming to the particular dimensions commercially known as copper water tube and designated as Types K, L, and M.

tube, drawn—see **drawn tube**.

tube, embossed—tube, the outside surface of which has been ornamented by means of rolling with a design in relief, regularly repeated in a longitudinal direction.

tube, extruded—see **extruded tube**.

tube, ferrule—a tube from which metal rings or collars (ferrules) are made for use in installing condenser tubes.

tube, finned—tube having a series of metallic ribs on the outside or inside surface, or both, either parallel to the longitudinal axis or circumferentially extended from the tube to increase the effective surface area for heat transfer applications. The fins may be mechanically applied, drawn or integrally extruded from the tube wall.

tube, fluted—tube of nominally uniform wall thickness, having regular longitudinal concave corrugations with sharp cusps between corrugations.

tube, fluted outside and plain inside—tube having fluted outside periphery and plain inside periphery.

tube, gas—tube specifically intended for use in above ground natural gas and liquified petroleum gas fuel distribution systems and conforming to the particular dimensions known as Type GAS.

tube, heat exchanger—a tube manufactured to special requirements as to dimensional tolerances, finish, and temper for use in condensers and other heat exchangers.

tube, heat exchanger with integral enhanced surface—an external or internal surface, or both, modified by a cold forming operation, to produce an enhanced surface for improved heat transfer. The enhancement may take the form of longitudinal or helical fins or ridges, or both, or modifications thereto.

tube, heat exchanger with integral fins—a tube having a series of metallic ribs on the outside or inside surface either parallel to the longitudinal axis or circumferentially extended from the tube to increase the effective surface area for heat transfer applications. The fins may be mechanically applied, drawn, or integrally extended from the tube wall.

tube, lip—tube of generally circular cross-section with nominally uniform wall thickness having one hollow or solid protuberance or lip parallel with the longitudinal axis, intended for use in heat exchangers, particularly in the dairy industry.

tube, lock seam—tube made from sheet or strip, with a longitudinal, mechanically locked seam.

tube, oil burner—small diameter seamless copper tube of soft temper in coils intended for use in oil burner installations.

tube, open seam—a shape, other than extruded shape, of generally tubular form of nominally uniform wall thickness but having a longitudinal unjoined seam or gap of width not greater than 25 % of the outside diameter or greatest overall dimension.

tube, redraw—see **redraw tube**.

tube, reeded—tube of nominally uniform wall thickness having regular longitudinal convex corrugations, either with rounded or sharp cusps between corrugations.

tube, reeded outside and plain inside—tube having reeded outside periphery and plain inside periphery.

tube, refrigeration service—a seamless copper tube conforming to a standard series of sizes, and to special internal cleanliness and dehydration requirements, normally furnished to soft temper coils and with ends capped or sealed.

tube, roped—tube of nominally uniform wall thickness, having the appearance of stranded rope.

tube, rope-fluted—tube of nominally uniform wall thickness, both fluted and roped.

tube, rope-reeded—tube of nominally uniform wall thickness, both reeded and roped.

tube, seamless—a tube produced with a continuous periphery in all stages of the operations.

tube, seamless water—a tube conforming to the particular dimensions of tube commercially known as copper water tube and designated as Types K, L, and M in inch-pound units and Types A, B, and C in SI units.

tube sheet—see **condenser tube plate**.

tube, twisted—tube of symmetrical cross-section other than round having nominally uniform wall thickness and which has been twisted.

tube, waveguide—a tube used as a transmission line to electronic equipment.

tube, welded—tube made by processing strip into a tubular shape and welding the edges to make a longitudinal seam.

tube, welded water—a tube conforming to the particular dimensions of tube commercially known as copper water tube and designated as Types WK, WL, and WM in inch-pound units, and Types WA, WB, and WC in SI units.

tumbling—see **barrel rolling**.

twist—a winding departure from flatness.

twisted tube—see **tube, twisted**.

unaided eye—visual inspection, without the use of special equipment or enhancement excepting the use of corrective lenses.

wall thickness at any point—wall thickness can be measured at any point around the circumference of the tube. The deviation of the wall thickness at any point from nominal may be due to the wall being either thicker or thinner than nominal, or to the tube being eccentric, or a combination of the two (see Fig. 5).

wall thickness: average—the average of the maximum and minimum wall thicknesses at any one cross-section (see Fig. 6).

water stain—see **stain, water**.

wavy edges—a wrinkled condition along the edges of the product, with a relatively flat center portion.

welded pipe—product made from sheet, strip, or plate with a seam made by welding.

welded tube—product made from sheet, strip, or plate with a seam made by welding.

welding rod—filler metal, in wire or rod form, used in gas welding and brazing processes, and arc-welding processes in which the electrode does not furnish the filler metal.

weld reinforcement—the portion of the welded joint which extends beyond the inner and outer surface of the base metal of the welded pipe.

wetting—the formation of a relatively uniform, smooth, unbroken, and adherent film of solder to a base material.

wind—see **twist**.

wire bar—refinery shape used for rolling into rod or flat product for subsequent processing into wire, strip, or shape. Approximately 3½ to 5 in. (89 to 127 mm) square in cross section, usually 54 in. (1.37 m) in length, and ranging in weight from 200 to 420 lb (91 to 191 kg). Usually tapered on both ends.

wire, cold-rolled—see **cold-rolled wire**.

wire, drawn—see **drawn wire**.

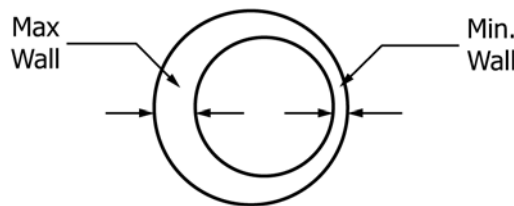
wire, hot-rolled—see **hot-rolled wire**.

wire, redraw—see **redraw wire**.

wire, reroll—see **redraw wire**.

wrinkle—see **wavy edges**.

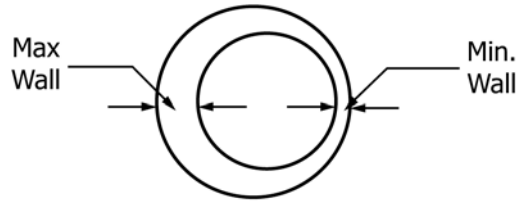
yellow brass—a copper alloy containing nominally 65 % copper and 35 % zinc, generally available in flat products, wire and rod. (Copper Alloy Nos. C26800 and C27000)



Exaggerated for Illustration

Deviation of Actual Wall at a Point = Max. Wall – Nominal Wall
Or alternately = Nominal Wall – Min. Wall

FIG. 5 Wall Thickness at any Point



$$\text{Average Wall} = (\text{Max. Wall} + \text{Min. Wall}) / 2$$

FIG. 6 Wall Thickness—Average

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B846 – 19) that may impact the use of this standard. (Approved Aug. 1, 2019.)

(1) Added the term “mischmetal.”

Committee B05 has identified the location of selected changes to this standard since the last issue (B846 – 11a) that may impact the use of this standard. (Approved Jan. 1, 2019.)

(1) Added the terms “antimicrobial copper alloy,” “coil set,” “cored forgings,” “die forgings,” and “hand forgings.”

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