



Designation: B846 – 06a

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.

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 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

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**.

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.

Current edition approved Nov. 15, 2006. Published December 2006. Originally approved in 1993. Last previous edition approved in 2006 as B846 – 06. DOI: 10.1520/B0846-06A.

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.

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.)

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.

annular ring—see **circular ring**.

- 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 (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.
- 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).
- 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**.
- 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, 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 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-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**.

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

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**.

cup test—see **test, cup**.

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.

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.

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.

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)**.

earring—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.

edge contours—see **finished edges**.

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 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.

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 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.