

Glossary

- a axis** In CNC, the rotational axis about the *X* axis.
- Abrasive** A substance such as finely divided aluminum oxide or silicon carbide used for grinding (abrading), smoothing, or polishing.
- Absolute dimensions** On drawings, a style in which all dimensions start at a zero or absolute point.
- Absolute positioning** A CNC programming mode called by the G90 code, in which all tool and workpiece positions are measured from a point of absolute zero.
- Acicular** Needlelike; resembling needles or straws dropped at random.
- Acute angle** An angle of less than 90 degrees.
- Alignment** The proper positioning or state of adjustment of parts in relation to one another, especially in line, as in axial alignment.
- Allotropic** Materials that can exist in several different crystalline forms are said to be allotropic.
- Alloy** A combination of two or more substances, specifically metals such as alloy steels or aluminum alloys.
- Aluminum oxide** Also alumina (Al_2O_3). Occurs in nature as corundum and is used extensively as an abrasive. Today, most aluminum oxide abrasives are manufactured.
- Ammonia** A pungent colorless gaseous alkaline compound of nitrogen and hydrogen (NH_3). It is soluble in water.
- Amorphous** Having no definite form or outline; materials such as glass that have no definite crystalline structure.
- Angular** Having one or more angles; measured by an angle; forming an angle.
- Angular measure** The means by which an arc of a circle is divided and measured. This can be in degrees (360 degrees in a full circle), minutes (60 minutes in one degree), and seconds (60 seconds in one minute), or in radians. See *Radian*.
- Angularity** The quality or characteristic of being angular.
- Anhydrous** Free from water.
- Annealing** A heat treatment in which metals are heated and then cooled slowly for the purpose of decreasing hardness. Annealing is used to improve machinability and to remove stress from weldments, forgings, and castings. It is also used to remove stresses resulting from cold work and to refine and make uniform the microscopic internal structures of metals.
- Anvil** The fixed measuring face of an outside micrometer.
- Arbor** A rotating shaft on which a cutting tool is fastened. Often used as a term for *mandrel*.
- Arc** Part of the circumference of a circle or a dimension defined by an angle.
- As rolled** When metals bars are hot-rolled and allowed to cool in air, they are said to be in the “as rolled” or natural condition.
- ATC** On CNC machining centers, the automatic tool changer.
- Austenite** A solid solution of iron and carbon or iron carbide in which gamma iron, characterized by a face-centered cubic crystal, is the solvent.
- Auxiliary view** On orthographic drawings, a view projected off the standard orthographic views to reveal the true shape and size of a part feature otherwise distorted in the standard views.
- Axial** (1) Having the characteristics of an axis (that is, centerline or center of rotation); situated around and in relation to an axis as in axial alignment. (2) In CNC, related to the fundamental programmable axes *X*, *Y*, *Z*, *a*, *b*, and *c*.
- Axial rake** An angular cutting surface rotated about the axial centerline of a cutting tool such as a drill or reamer.
- Axis** (1) Centerline or center of rotation of an object or part; the rotational axis of a machine spindle, which extends beyond the spindle and through the workpiece. Machining of the object imparts the machine axis to that area of metal cutting. (2) On CNC machine tools, the line along which a major machine tool component such as a mill table, saddle, lathe cross slide, or turret travels.
- b axis** In CNC, the rotational axis around the *Y* axis.
- Backlash** A condition created owing to clearance between a thread and nut. The amount of thread turn before a component begins to move.
- Beam** The scale on a vernier caliper or height gage graduated in true or full-sized units.
- Bellmouth** A condition in a machined hole in which the end is flared out in a bell shape to a dimension larger than the nominal size of the hole.
- Bezel** A rim that holds a transparent face of a dial indicator that can be rotated to bring the index mark to zero.
- Bimetallic** Made from two different metals.
- Blind hole** A hole that does not go completely through an object.
- Blotter** A paper disk placed between a grinding wheel and the retaining flange, often marked with wheel type and speed rating.
- Bolster plate** A structural part of a press designed to support or reinforce the platen (base surface) on which the workpiece is placed for press work.
- Bond** On a grinding wheel the material and its relative strength that holds the abrasive in place.
- Bore** (1) A machined hole. (2) The process of enlarging a drilled hole to a larger size.
- Boring** The process of removing metal from a hole by using a single-point tool. The workpiece can rotate with a stationary bar, or the bar can rotate on a stationary workpiece to bore a hole.
- Brinell hardness** The hardness of a metal or alloy, measured by hydraulically pressing a hard ball (usually 10 mm in diameter) with a standard load into the specimen. A value is derived by measuring the indentation with a special microscope.

- Brittleness** The property of a material that causes it to suddenly break at a given stress without bending or distortion of the edges of the broken surface. Glass, ceramics, and cast iron are examples of brittle materials.
- Broaching** The process of removing unwanted metal by pulling or pushing a tool on which cutting teeth project through or along the surface of a workpiece. The cutting teeth are progressively longer by a few thousandths of an inch to give each tooth a chip load. One of the most frequent uses of broaching is for producing internal shapes such as keyseats and splines.
- Buffing wheel** A disk made up of layers of cloth sewn together. Fine abrasive is applied to the periphery of the cloth wheel to provide a polishing surface as the wheel is rotated at a high speed.
- Burnish** To make shiny by rubbing. No surface material is removed by this finishing process. External and internal surfaces are often smoothed with high-pressure rolling. Hardened plugs are sometimes forced through bores to finish and size them by burnishing.
- Burr** (1) A small rotary file. (2) A thin edge of metal, usually sharp, left from a machining operation. See *Deburr*.
- Bushing** A hollow cylinder used as a spacer, reducer for a bore size, or bearing. Bushings can be made of metals or nonmetals such as plastics or formica.
- Button die** A thread-cutting die that is round and usually slightly adjustable. It is held in a diestock or holder by means of a cone-point setscrew that fits into a detent on the periphery of the die.
- c axis** In CNC, the rotational axis around the Z axis.
- CAD** Computer-aided design.
- Calibration** The comparison and adjustment of a measuring instrument such as a micrometer or dial indicator with a known measurement standard so that the tool will measure accurately.
- CAM** Computer-aided manufacturing.
- Cam** A rotating or sliding part with a projection or projecting geometry that imparts motion to another part as it slides or rotates past.
- Carburizing compound** A carbonaceous material that introduces carbon into a heated solid ferrous alloy by the process of diffusion.
- Cavity** (1) A machine feature, such as a hole, groove, or slot, enclosed on all sides in two dimensions. (2) The space in a casting mold where molten metal will flow to form a cast part.
- Celsius** A temperature scale used in the SI metric systems of measurement on which the freezing point of water is 0° and the boiling point is 100°. Formerly called *centigrade*.
- Cementite** Iron carbide, a compound of iron and carbon (Fe₃C) found in steel and cast iron.
- Centerline** A reference line on a drawing or part layout from which all dimensions are located.
- Chamfer** A bevel cut on a sharp edge of a part to improve resistance to damage and as a safety measure to prevent cuts.
- Chasing a thread** In machining terminology, making successive cuts in the same groove with a single-point tool. Also done when cleaning or repairing a damaged thread.
- Chatter** Vibration of workpiece, machine, tool, or a combination of all three due to looseness or weakness in one or more of these areas. Chatter may be found in either grinding or machine operations and is usually noted as vibratory sound and seen on the workpiece as wave marks.
- Checked** A term used mostly in grinding operations indicating a surface having many small cracks (checks). The terms *heat checked* or *crazed* are used in reference to friction clutch surfaces.
- Chip trap** A deformed end of a lathe cutting tool that prevents the chip from flowing across and away from the tool.
- Chips** The particles removed when materials are cut; also called *filings*.
- Circularity** The extent to which an object has the form of a circle; the measured accuracy or roundness of a circular or cylindrical object such as a shaft. A lack of circularity is referred to in shops as out of round, egg-shaped, or having a flat spot.
- Circumference** The periphery or outer edge of a circle. Its length is calculated by multiplying π (3.1416) times the diameter of the circle.
- Closed architecture** Proprietary control systems in which access to the machine control hardware and software is limited or “closed” to the end user. In a proprietary CNC, only the CNC builder provides replacement parts or modifies and reconfigures the components.
- Clutch** A component usually found in a mechanical drive that permits a driven component and driving component to be mechanically disconnected and reconnected at will.
- CNC** Computer numerical control. Control of machine tools and other manufacturing equipment using computer programs.
- Coarseness** (1) A measure of grit size in grinding. (2) Spacing of teeth on files and other cutting tools.
- Coincident** The alignment of two graduations on separate graduated scales with each other, such as the coincident line of vernier and true-scale graduations.
- Cold finish** The surface finish obtained on metal by any of several means of cold working, such as rolling or drawing.
- Cold working** Any process such as rolling, forging, or forming a cold metal in which the metal is stressed beyond its yield point. Grains are deformed and elongated in the process, causing the metal to have a higher hardness and lower ductility.
- Complementary angles** Two angles whose sum is 90 degrees. Often referred to in machine shop work, because most angular machining is done within one quadrant, or 90 degrees.
- Concave** An internal arc or curve; a dent.
- Concentricity** The extent to which an object has a common center or axis. Specifically, in machine work, the extent to which two or more surfaces of a shaft rotate in relation to each other; the amount of runout on a rotating member.
- Contour** Machining an uneven but continuous path on a workpiece in two or three dimensions.
- Convex** An external arc or curve; a bulge.
- Coolant** Any of several products using oil and water mixtures to cool and lubricate cutting tools and grinding wheels during machining operations.

- Coordinate dimensions** A method of specifying point locations in a two-dimensional plane system defined by two perpendicular axes.
- Cosine error** A condition in which the axis of a measuring instrument is out of line with the axis of the measurement to be taken, resulting in an error equal to the measuring instrument reading multiplied by the cosine of the misalignment angle.
- Crest of thread** Outer edge (point or flat) of a thread form.
- Critical temperatures** The upper and lower transformation points of iron that delineate the range in which ferrite changes to austenite as the temperature rises.
- Cutting fluid** Any of several materials used in cutting metals: cutting oils, synthetics, soluble or emulsified oils (water based), and sulfurized oils.
- Cyanogen (CN₂)** A colorless flammable poisonous gas with characteristic odor. It forms cyanic and hydrocyanic acids when in contact with water. Cyanogen compounds are often used for case hardening.
- DCN** Direct CNC networking. Allows data transmission to the CNC control at a greatly accelerated speed compared with DNC. DCN eliminates the DNC computer link and its limiting data transmission line, the RS-232 cable. The CNC control connected through a network to CAD/CAM computers can access 1,000,000 characters per second. Machining three-, four-, and five-axis contours may require data transmission at 1000 blocks per second to keep the machine from slowing down while it waits for more input.
- Deburr** To remove a sharp edge or corner caused by a machining process.
- Decarburization** The loss of surface carbon from ferrous metals when heated to high temperatures in an atmosphere containing oxygen.
- Decibel** A unit for expressing the relative intensity of sounds on a scale from zero (least perceptible sound) to about 130 (the average pain level).
- Degrees** (1) A circle is divided into 360 degrees, four 90-degree quadrants. Each degree is divided into 60 minutes and each minute into 60 seconds. Degrees are measured with protractors, optical comparators, and sine bars, to name a few methods. (2) Divisions of temperature scales.
- Dendrite** A formation that resembles a pine tree in the microstructure of solidifying metals. Each dendrite usually forms a single grain or crystal.
- Diagonal** A straight line from corner to corner on a square, rectangle, or any parallelogram.
- Diameter** Twice the radius; the length of any straight line going through the center of a figure or body, specifically a circle, in drafting the layout.
- Diametral pitch** The ratio of the number of teeth on gears to the number of inches of pitch diameter.
- Die** (1) Cutting tool for producing external threads. (2) A device mounted in a press for cutting and forming sheet metal.
- Die-cast metal** Metal alloys, often called *pot metals*, forced into a die in a molten state by hydraulic pressure. Thousands of identical parts can be produced from a single die or mold by this process of die casting.
- Dimension** A measurement in one direction; one of three coordinates—length, width, and depth. Thickness, radius, and diameter are given as dimensions on drawings.
- Discrimination** The degree to which a measuring instrument divides the units in which it measures. A .001-in. micrometer can discriminate to one thousandth of an inch. With a vernier, it can discriminate to one ten-thousandth of an inch (.0001 in.).
- Distortion** The alteration of the shape of an object that would normally affect its usefulness. Bending, twisting, and elongation are common forms of distortion in metals.
- Dovetail** An angular shape used on many types of interlocking slide components, especially on machine tools.
- Ductility** The property of a metal to be deformed permanently without rupture while under tension. A metal that can be drawn into a wire is ductile.
- EB machining** Electron beam machining. A process whereby a gas is passed through an electric arc, creating a plasma or high-temperature gas, which is then used as the cutting tool. EB processes are effective for welding materials.
- Ebonized** Certain cold-drawn or cold-rolled bars that have black-stained surfaces are said to be ebonized. This is not the same as the black, scaly surface of hot-rolled steel products.
- Eccentricity** A rotating member whose axis of rotation is different or offset from the primary axis of the part or mechanism. Thus, when one turned section of a shaft centers on a different axis than the shaft, it is said to be eccentric or to have “runout.” For example, the throws or cranks on an engine crankshaft are eccentric to the main bearing axis.
- ECM** Electrochemical machining or electrochemical deburring (ECDB), a process whereby a conducting fluid (electrolyte) is pumped between work and electrode to remove the workpiece material.
- Edgefinder** A tool fastened in a machine spindle that locates the position of the workpiece edge in relation to the spindle axis.
- EDM** Electrodischarge machining. With this process, a graphite or metal electrode is slowly fed into the workpiece, which is immersed in oil. A pulsed electrical charge causes sparks to jump to the workpiece, each tearing out a small particle. In this way, the electrode gradually erodes its way through the workpiece that can be a soft or an extremely hard material such as tungsten carbide.
- Elasticity** The property of a material to return to its original shape when stretched or compressed.
- Electrode** A tool or other device used to make an electrical contact such as the cutting tool in EDM machining equipment.
- ELG** Electrolytic grinding. A machining process in which an abrasive with a conducting bond is used to deplete the workpiece material.
- Emulsifying oils** An oil containing an emulsifying agent such as detergent so that it will mix with water. Oil emulsions are used extensively as coolants in machining operations.
- EOB** In CNC programming, the code denoting end of block or end of sequence.
- Expansion** The enlargement of an object, usually caused by an increase in temperature. Metals expand when heated and contract when cooled in varying amounts, depending on the coefficient of expansion of the particular metal.

- Expansion fit** The fitting of mating parts by heating one so as to expand its dimensions slightly. On cooling, the parts are locked together.
- Extruding** A form of metal working in which a metal bar, either cold or heated, is forced through a die that forms a special cross-sectional shape such as an angle or channel. Extrusions of soft metals such as aluminum and copper are common.
- F code word** In CNC programming, the code used to call a feed rate for milling or drilling.
- Face** (1) The side of a metal disk or end of a shaft when turning in the lathe. A facing operation is usually at 90 degrees to the spindle axis of the lathe. (2) The periphery or outer cylindrical surface of a straight grinding wheel.
- Fahrenheit** A temperature scale calibrated with the freezing point of water at 32° and the boiling point at 212°. The Fahrenheit scale is gradually being replaced with the Celsius scale used with the metric system of measurement.
- Ferrite** The microstructure of iron or steel that is mostly pure iron and appears light gray or white when etched and viewed with a microscope.
- Ferromagnetic** Metals or other substances that have unusually high magnetic permeability, a saturation point with some residual magnetism, and high hysteresis. Iron and nickel are both ferromagnetic.
- Ferrous** From the Latin word *ferrum*, meaning “iron.” An alloy containing a significant amount of iron.
- Fillet** (1) A concave junction of two surfaces. (2) An inside corner radius of a shoulder on a shaft. (3) An inside corner weld.
- Finishing (surface)** The control of roughness by turning, grinding, milling, lapping, superfinishing, or a combination of any of these processes. Surface texture is designated in terms of roughness profile in microinches, waviness, and lay (direction of roughness).
- Fixture** A device that holds workpieces and aligns them with the tool or machine axis with repeatable accuracy.
- Flammable** Any material that will readily burn or explode when brought into contact with a spark or flame.
- Flash** (1) Excess material extruded between die halves in die castings or forging dies. (2) The upset material formed when welding band saws.
- Floating** Free to move about over a given area, for example, a floating edge finder tip, floating die holder, or floating reamer holder.
- Flute** The groove in a drill, tap, reamer, or milling cutter.
- Forging** A method of metal working in which the metal is hammered into the desired shape or is forced into a mold by pressure or hammering, usually after being heated to a more plastic state. Hot forging requires less force to form a given point than does cold forging, which is usually done at room temperature.
- Formica** A trademark used to designate several plastic laminated products; especially, a laminate used to make gears.
- Forming** A method of working sheet metal into useful shapes by pressing or bending.
- Friable** Related to the brittleness of a grinding wheel abrasive.
- Friction** (1) Rubbing of one part against another. (2) Resistance to relative motion between two parts in contact, usually generating heat.
- G code word** In CNC programming, a preparatory function program code that calls a particular mode of operation such as rapid traverse, linear interpolation, or circular interpolation.
- Galling** Cold welding of two metal surfaces in intimate contact under pressure. Also called *seizing*, it is more severe and more likely to happen between two similar soft metals, especially when they are clean and dry.
- Gantry** A type of CNC machining center in which the spindle is supported on both sides of the table by vertical supports or gantries.
- Gib** A part of a slide mechanism used to adjust the clearance between two sliding parts.
- Glazing** (1) A work-hardened surface on metals resulting from using a dull tool or too rapid a cutting speed. (2) A dull grinding wheel whose surface grains have worn flat, causing the workpiece to be overheated and “burned” (discolored).
- Grade** (1) Hardness of a grinding wheel. (2) Level of precision of gage block sets.
- Graduations** Division marks on a rule, measuring instrument, or machine dial.
- Grain** (1) In metals, a single crystal consisting of parallel rows of atoms called a *space lattice*. (2) Abrasive particles in a grinding wheel.
- Grain boundary** The outer perimeter of a single grain where it contacts adjacent grains.
- Grain growth** Called *recrystallization*. Metal grains begin to re-form to larger and more regular size and shape at certain temperatures, depending to some extent on the amount of prior cold working.
- Graphite** Carbon used as the material for EDM electrodes.
- Grit** (1) Any small, hard particles such as sand or grinding compound. Dust from grinding operations settles on machine surfaces as grit, which can damage sliding surfaces. (2) Diamond dust, aluminum oxide, or silicon carbide particles used for grinding wheels.
- Ground and polished (G & P)** A finishing process for some steel alloy shafts during their manufacture. The rolled, drawn, or turned shafting is placed on a centerless grinder and precision ground, after which a polishing operation produces a fine finish.
- Gullet** The bottom of the space between teeth on saws and circular milling cutters.
- H code word** In CNC programming, the H code refers to tool offset file numbers.
- Hardenability** The property that determines the depth and distribution of hardness in a ferrous alloy induced by heating and quenching.
- Hardening** Metals are hardened by cold working or heat-treating. Hardening causes metals to have a higher resistance to penetration and abrasion.
- Harmonic chatter** A harmonic frequency is a multiple of the fundamental frequency of sound. Any machine part, such as a boring bar, has a fundamental frequency and will vibrate at that frequency and also at several harmonic or multiple frequencies. Thus, chatter or vibration of a tool may be noted at several different spindle speeds.

- Hazard** (1) A situation dangerous to any person in the vicinity. (2) A danger to property, such as a fire hazard.
- Heat treated** Metal whose structure has been altered or modified by the application of heat.
- Helical** The geometry of a helix where a point both rotates and moves parallel to the axis of a cylinder. Examples include threads, springs, and drill flutes.
- Helix** The path described by a point rotating about a cylinder while being moved along the cylinder. The distance of movement compared with each revolution is the lead of the helix.
- High-pressure lube** A petroleum-grease or oil-containing graphite or molybdenum disulfide that continues to lubricate even after the grease has been wiped off.
- Hog** To remove large amounts of material from a workpiece with deep heavy cuts.
- Horizontal** Parallel to the horizon or baseline; level.
- Hot rolled** Metal flattened and shaped by rolls while at a red heat.
- Hub** A larger diameter at the center of a wheel, gear, pulley, sprocket, or other shaft-driven member that provides a bore in its center to receive a shaft. The hub also provides extra strength to transfer power to or from the shaft by means of a key and keyseat.
- Hydrojet machining** A machining process in which high-pressure water containing an abrasive material is directed toward the workpiece.
- I code word** In CNC programming, the I and J words define arc centers.
- Increment** A single step of a number of steps; a succession of regular additions; a minute increase.
- Incremental positioning** In CNC, programming a mode called by the G91 preparatory function code, in which each positioning move is measured from the point where the tool is presently located.
- Inert gas** A gas, such as argon or helium, that will not readily combine with other elements.
- Infeed** The depth a tool is moved into the workpiece.
- Interface** (1) The point or area of contact between tool and workpiece. (2) The contact point or area of two mating parts in an assembly.
- Interference fit** Force fit of a shaft and bore, bearings, and housings or shafts. Negative clearance in which the fitted part is slightly larger than the bore.
- Internal stress** Also called *residual stress*. Stress in metals built in by heat treatment or by cold working.
- Interpolation** In CNC programming, a “best fit” tool path along an angular, circular, or helical programmed path.
- Intruding** A surface-hardening treatment for ferrous alloys obtained by heating an alloy in the presence of disassociated ammonia gas, which releases nitrogen to the steel. The formation of iron nitride causes the hardened surface.
- Involute** Geometry found in modern gears that permits mating gear teeth to engage each other with rolling rather than sliding friction.
- ipm rate** In machining, a feed rate measured in inches per minute.
- ipr rate** In machining, a feed rate specified in inches per revolution of the machine spindle.
- Iron carbide** Also called cementite (Fe_3O_4); a compound of iron and carbon, which is quite hard.
- J code word** In CNC programming, the I and J words specify arc center locations.
- Jig** A device that guides a cutting tool and aligns it to the workpiece.
- Journal** The part of a rotating shaft or axle that turns in a bearing.
- Just-in-time** Manufacturing system that produces a smaller number of parts at one time to reduce inventory for both the producer and the consumer.
- Kerf** The width of a cut produced by a saw.
- Key** A removable metal part that when assembled into keyseats provides a positive drive for transmitting torque between shaft and hub.
- Keyseat** An axially located rectangular groove in a shaft or hub.
- Keystock** Square or rectangular cold-rolled steel bars used for making and fitting keys in keyseats.
- Keyway** Same as keyseat (British terminology).
- Knurl** Diamond or straight impressions on a metal surface produced by rolling with pressure. The rolls used are called knurls.
- Laminated** Composed of multiple layers of the same or different materials.
- Laser** An intense source of coherent light energy often used as a cutting tool.
- Lattice** The regular rows of atoms in a metal crystal.
- Lead** The distance a thread or nut advances along a threaded rod in one revolution.
- Loading** A grinding wheel whose voids are being filled with metals, causing the cutting action of the wheel to be diminished.
- Lobe** The offset or projection on a cam that contacts the part to which motion is to be imparted.
- Longitudinal** Lengthwise, as the longitudinal axis of the spindle or machine.
- M code word** In CNC programming, M codes are miscellaneous function codes such as M06 for tool change or M03 for spindle stop.
- Machinability** The relative ease of machining, which is related to the hardness of the material to be cut.
- Magnetic** Having the property of magnetic attraction and permeability.
- Malleability** The ability of a metal to deform permanently without rupture when loaded in compression.
- Mandrel** A cylindrical bar on which the workpiece is affixed and subsequently machined between centers. Mandrels, often erroneously called *arbors*, are used in metal turning and cylindrical grinding operations.
- Mar** To scratch or otherwise damage a machined surface.
- Martensite** The hardest constituent of steel, formed by quenching carbon steel from the austenitized state to room temperature. The microstructure can be seen as acicular or needlelike.

- Mechanical properties (of metals)** Some mechanical properties of metals are tensile strength, ductility, malleability, elasticity, and plasticity. Mechanical properties can be measured by mechanical testing.
- Metal cementation** Introducing a metal or material into the surface of another by heat treatment. Carburizing is one example of metal cementation.
- Metal spinning** A process in which a thin disk of metal is rapidly turned in a lathe and forced over a wooden form or mandrel to form various conical or cylindrical shapes.
- Metallizing** Applying a coating of metal on a surface by spraying molten metal on it. Also called *spray weld* and *metal spray*.
- Metrology** The science of weights and measures or measurement.
- Microstructure** Structure visible only at high magnification.
- Modal commands** In CNC programming, modal commands once invoked remain in force until canceled or changed.
- Mode** A particular way in which something is done or a machine is operated, such as manual or automatic mode on machines.
- Mushroom head** (1) An oversized head on a fastener or tool that allows it to be easily pushed with the hand. (2) A deformed striking end of a chisel or punch that should be removed by grinding.
- Neutral** In machine work, neither positive nor negative rake is a neutral or zero rake; a neutral fit is neither a clearance nor an interference fit.
- Nitrogenous gas** Ammonia (NHA) used in nitriding.
- Nomenclature** Pertaining to the names of individual parts of machines or tools; a list of machine parts indicating their names.
- Nominal** Usually refers to a standard size or quantity as named in standard references.
- Nonferrous** Metals other than iron or iron alloys, for example, aluminum, copper, and nickel.
- Normalizing** A treatment consisting of heating to a temperature above the critical range of steel followed by cooling in air. Normalizing produces in steel a "normal structure" consisting of free ferrite and cementite or free pearlite and cementite, depending on the carbon content.
- Nose radius** The rounding of the point of a lathe cutting tool. A large radius produces a better finish and is stronger than a small one.
- Obtuse angle** An angle greater than 90 degrees but less than 180 degrees.
- Open architecture** A control system in which the PC platform allows a CNC machine manufacturer to use hardware and software from different vendors, various motors, and memory and storage upgrades. Users can run their own choice of programming systems, SPC software, and shop management software, all from a single PC.
- Origin** The intersection of the X, Y, and Z axes.
- Orthographic drawing** Projections of a single view of an object in which the view is projected along lines perpendicular to both the view and the drawing surface.
- Oxide scale** At a red heat, oxygen readily combines with iron to form a black oxide scale (Fe_2O_3), also called *mill scale*.
At lower temperatures, 400°F to 650°F (204°C to 343°C), various oxide scale colors (straw, yellow, gold, violet, blue, and gray) are produced, each color within a narrow temperature range. These colors are used by some heat treaters to determine temperatures for tempering.
- Oxidize** (1) To combine with oxygen. (2) To burn or corrode by oxidation.
- Oxyacetylene** Mixture of oxygen and acetylene gases to produce an extremely hot flame used for heating, welding, and flame cutting.
- Parallax error** An error in measurement caused by reading a measuring device, such as a rule, at an improper angle.
- Parallel** The condition in which lines or planes are equidistant from one another.
- Parting** Also called *cutting off*; a lathe operation in which a thin blade tool is fed into a turning workpiece to make a groove that is continued to the center to sever the material.
- Pearlite** Alternating layers of cementite and ferrite in carbon steel. Under a microscope, the microstructure of pearlite sometimes appears like mother-of-pearl, hence the name. It is found in carbon steels that have been slowly cooled.
- Pecking** A process used in drilling deep holes to remove chips before they can seize and jam the drill. The drill is fed into the hole a short distance to accumulate chips in the flutes and then drawn out of the hole, allowing the chips to fly off. This process is repeated until the correct depth of the hole is reached.
- Pedestal** A base or floor stand under a machine tool.
- Penetrant** A thin liquid that can enter small cracks and crevices. Penetrant oils are used to loosen rusted threads; dye penetrants are used to find hidden cracks.
- Periphery** The perimeter or external boundary of a surface or body.
- Perpendicular** At right angles to any geometry or part feature, that is, at a right angle to or forms a 90-degree angle with another part feature, line, or surface.
- Pin** Straight, tapered, or cotter pins are used as fasteners of machine parts or for light drives.
- Pinion** The smaller gear of a gear set, especially in bevel gears.
- Pinning** A condition in which chips of workpiece material jam in the teeth of a file.
- Pitch** (1) In saw teeth, the number per inch. (2) In threads, one divided by the number per inch. (3) The diameter or radius to the centerline of a feature or features located on the circumference of a circle, such as pitch circle or pitch diameter.
- Pitch diameter** For threads, the pitch diameter is an imaginary circle, which on a perfect thread occurs at the point where the widths of the thread and groove are equal. On gears, it is the diameter of the pitch circle.
- Plasma beam machining** A machining process in which a high-temperature gas (plasma) is used as the cutting tool. Plasma arcs are effective for cutting materials in sheet form.
- Point to point** In CNC machining, operations such as drilling and tapping that occur at single locations or points.
- Pot metals** Die-casting alloys, which can be zinc, lead, or aluminum based, among others.

- Potassium cyanide** A poisonous crystalline salt (KCN) used in electroplating and for case-hardening steel.
- Precipitation hardening** A process of hardening an alloy by heat treatment in which a constituent or phase precipitates from a solid solution at room temperature or at a slightly elevated temperature.
- Precision** A relative but higher level of accuracy within certain tolerance limits. Precision gage blocks are accurate within a few millionths of an inch, yet in some shops precision lathe work may be within a few thousandths of an inch tolerance.
- Pressure** Generally expressed in units as pounds per square inch (psi) and called *unit pressure*, whereas force is the total load.
- Profile** An outline view; also, a side or elevation view.
- Proportion** An equality of two ratios.
- Prototype** A full-scale original model on which something is patterned.
- Pulley** A flat-faced wheel used to transmit power by means of a flat belt. Grooved pulleys are called *sheaves*.
- Quadrant** The plane areas bounded by the perpendicular *X* and *Y* axes.
- Quench** A rapid cooling of heated metal for the purpose of imparting certain properties, especially hardness. Quenchants are water, oil, fused salts, air, and molten lead.
- Quench cracking** Cracking of heated metal during the quenching operation caused by internal stresses.
- Seize** A condition in which two metal parts are pressed together without the aid of lubrication, resulting in frictional forces that tear metal from each part and cause a mechanical welding (seizing) of the two.
- Semiprecision** Layout done to tolerances of $\pm\frac{1}{64}$ in.
- Serrated** Small grooves, often in a diamond pattern, used mostly for a gripping surface.
- Set** The width of a saw tooth. The set of saw teeth is wider than the blade width.
- Setup** The arrangement by which the machinist fastens the workpiece to a machine table or work-holding device and aligns the cutting tool for metal removal. A poor setup is one in which the workpiece could move from the pressure of the cutting tool, thus damaging the workpiece or tool, or when chatter results from lack of rigidity.
- sfpm** Surface feet per minute on a moving workpiece or tool.
- Shallow hardening** Some steels such as plain carbon steel (depending on their mass), when heated and quenched, harden to a depth of less than $\frac{1}{8}$ in. These are shallow-hardening steels.
- Shank** The part of a tool held in a work-holding device or in the hand.
- Shearing action** A concentration of forces in which the bending moment is virtually zero and the metal tends to tear or be cut along a transverse axis at the point of applied pressure.
- Sheaves** Grooved pulleys such as those used for V-belts or cables.
- Sherardized** Zinc-inoculated steel, a process in which the surface of steel is given a protective coating of zinc. It is not the same as galvanized or zinc-dipped steel. Zinc powder is packed around the steel while it is heated to a relatively low temperature in the sherardizing process.
- Shim** (1) A thin piece of material used to take up space between workpiece and work-holding device. (2) A piece used to fill space between machinery and foundations in assemblies.
- SI (Système International)** The international metric system of weights and measures.
- Silicon carbide** A manufactured abrasive. Silicon carbide wheels are used for grinding nonferrous metals, cast iron, and tungsten carbide, but are not normally used for grinding steel.
- Sine bar** A small precision bar with a given length (5 or 10 in.) that remains constant at any angle. It is used with precision gage blocks to set up or to determine angles within a few seconds of a degree.
- Sintering** Holding a compressed metal powder briquette at a temperature just below its melting point until it fuses into a solid mass of metal.
- Slot** Groove or depression as in a keyseat slot.
- Snagging** Rough grinding to remove unwanted metal from castings and other products.
- Soluble oils** Oils that have been emulsified and will combine with water.
- Solution heating treating** See *Precipitation hardening*.
- Solvent** A material, usually liquid, that dissolves another. The dissolved material is the solute.
- Spark testing** A means of determining the relative carbon content of plain carbon steels and identifying some other metals by observing the sparks given off while grinding the metals.
- SPC Statistical Process Control** The methods and tools used to determine the results of a manufacturing process by recording and graphing part dimensions and then generating various statistical information about the results.
- Specifications** Requirements and limits for a particular job.
- Speeds** Machine speeds are expressed in revolutions per minute; cutting speeds are expressed in surface feet per minute.
- Sphericity** (1) A condition of circularity in all possible axes. (2) The quality of being in the shape of a ball. (3) The extent to which a true sphere can be produced with a given process.
- Spheroidize anneal** A heat treatment for carbon steels that forms the cementite into spheres, making it softer and usually more machinable than by other forms of annealing.
- Spiral** A path of a point in a rotating plane that is continuously receding from the center is called a *flat spiral*. The term *spiral* is often used, though incorrectly, to describe a helix.
- Spline** A shaft on which teeth have been machined parallel to the shaft axis that will engage similar internal teeth in a mating part to prevent turning.
- Sprockets** Toothed wheels used with a chain for drive or conveyor systems.
- Squareness** The extent of accuracy that can be maintained when making a workpiece with a right angle.
- Statistics** Mathematical data generated by measuring a few samples of parts produced by a manufacturing process and then making inferences about the suitability of a larger production run. Statistics may also be used to generate graphs showing how close parts are being manufactured to design specifications.
- Stepped shaft** A shaft having more than one diameter.

- Stick-slip** A tendency of some machine parts that slide on ways to bind slightly when pressure to move them is applied, followed by a sudden release that often causes the movement to be greater than desired.
- Straightedge** A comparison measuring device used to determine flatness. A precision straightedge usually has an accuracy of about .0002 in. in a 24-in. length.
- Strength** The ability of a metal to resist external forces. This can be tensile, compressive, or shear strength.
- Stress** An external force applied to an object.
- Stress relief anneal** A heat treatment, usually under the critical range, for the purpose of relieving stresses caused by welding or cold working.
- Stroke** A single movement of many movements, as in a forward stroke with a hacksaw.
- Structure** The density of abrasive in a grinding wheel, open to dense.
- Surface plate** A cast iron or granite surface having a precision flatness for precision layout, measurement, and setup.
- Swarf** The chips produced by grinding operations.
- Symmetrical** Usually bilateral in machinery, in which two sides of an object are alike, but usually as a mirror image.
- Synthetic oils** Artificially produced oils given special properties such as resistance to high temperatures. Synthetic water-soluble oils or emulsions are replacing water-soluble petroleum oils for cutting fluids and coolants.
- T-nut** A threaded nut in a T shape designed to fit into the T-slot on a machine tool table.
- T-slot** The slot in a machine tool table shaped like a T and used to hold T-nuts and studs for various clamping setups or hold-down requirements.
- Tang** The part of a file on which a handle is affixed.
- Tap extractor** A tool sometimes effective in removing broken taps.
- Tapered thread** A thread made on a taper, such as a pipe thread.
- Tapping** A method of cutting internal threads by means of rotating a tap into a hole sufficiently under the nominal tap size to make a full thread.
- Telescoping gage** A transfer type of tool that assumes the size of the part to be measured by expanding or telescoping. It is then measured with a micrometer.
- Temper** (1) The cold-worked condition of some nonferrous metals. (2) Also called draw, a method of toughening hardened carbon steel by reheating it.
- Temperature** The level of heat energy in a material as measured by a thermometer or thermostat and recorded with any of several temperature scales: Celsius, Fahrenheit, or Kelvin.
- Template** A metal, cardboard, or wooden form used to transfer a shape or layout when it must be repeated many times.
- Tensile strength** The maximum unit load that can be applied to a material before ultimate failure occurs.
- Tension** A stretching or pulling force.
- Terminating threads** Methods of ending the thread, such as undercutting, drilled holes, or tool removal.
- Test bar** A precision ground bar that is placed between centers on a lathe to test for center alignment using a dial indicator.
- Thermal cracking** Checking or cracking caused by heat.
- Thread axis** The centerline of the cylinder on which the thread is made.
- Thread chaser** A tool used to restore damaged threads.
- Thread crest** The top of the thread.
- Thread die** A device used to cut external threads.
- Thread engagement** The distance a nut or mating part is turned onto the thread.
- Thread fit classes** Systems of thread fits for various thread forms range from interference fits to loose fits; extensive references on thread fits may be found in machinist's handbooks.
- Thread lead** The distance a nut travels in one revolution. The pitch and lead are the same on single-lead threads but not on multiple-lead threads.
- Thread pitch** The distance from a point on one thread to a corresponding point on the next thread.
- Thread relief** Usually, an internal groove that provides a terminating point for the threading tool.
- Tolerance** The allowance of acceptable error within which the mechanism will still fit together and be totally functional.
- Tool geometry** The proper shape of a cutting tool that makes it work effectively for a particular application.
- Tool offset** In CNC programming, the distance from the tool end to the workpiece.
- Tooling** Generally, any machine tool accessory separate from the machine itself. Tooling includes cutting tools, holders, work-holding accessories, jigs, and fixtures.
- Toolmaker** An experienced general machinist, often involved with high-precision work making other tools, dies, jigs, and fixtures used to support regular machining and manufacturing.
- Torque** A force that tends to produce rotation or torsion. Torque is measured by multiplying the applied force by the distance at which it is acting to the axis of the rotating part.
- Toxic fumes** Gases resulting from heating certain materials are toxic, sometimes causing illness (as metal fume fever from zinc fumes) or permanent damage (as from lead or mercury fumes).
- Transfer measurement** A step in measurement in which a transfer measuring tool such as a telescoping gage is set to the unknown dimension and subsequently measured with a direct measuring tool such as a micrometer.
- Transformation temperature** Same as critical temperature; the point at which ferrite begins to transform to austenite.
- Traverse** To move a machine table or part from one point to another.
- Truing** (1) In machine work, the use of a dial indicator to set up work accurately. (2) In grinding operations, to make a wheel concentric to the spindle with a diamond.
- Truncation** To remove the point of a triangle (as of a thread), cone, or pyramid.

Tungsten carbide An extremely hard compound formed with cobalt and tungsten carbide powders by briquetting and sintering into tool shapes.

Turning Operations in which the work is rotated against a single-point tool.

Turning center A CNC lathe.

Ultrasonic machining A machining process whereby high-intensity sound (above 20 kHz) is used to propel abrasive as a material removal tool.

Vernier A means of increasing the discrimination of a graduated measuring instrument by adding a shorter scale alongside the main scale so as to employ the mathematical principle of the vernier.

Vibration An oscillating movement caused by loose bearings or machine supports, off-center weighting on rotating elements, bent shafts, or nonrigid machining setups.

Vise A work-holding device. Some types are bench, drill press, and machine vises.

Wedge angle Angle of keenness; cutting edge.

Wheel dressing Sharpening the grinding surface of an abrasive wheel by means of a dressing tool such as a diamond or Desmond dresser.

Wrought Hot or cold worked; forged.

X axis On CNC machining centers the table axis; on CNC turning centers, the cross slide axis.

X–Y plane The plane formed by the X and Y axes.

X–Z plane The plane formed by the X and Z axes.

Y axis On a CNC machining center, the saddle axis.

Y–Z plane The plane formed by the Y and Z axes.

Z axis On CNC machine tools in general, the spindle axis.

Zero back rake Also neutral rake; neither positive nor negative; level.

Zero index Also zero point. The point at which micrometer dials on a machine are set to zero, and the cutting tool is located to a given reference, such as a workpiece edge.

