such as the hardness or toughness of metals being cut. On lathe cutting tools, the rake angles (top and side) are located on the top of the tool bit. The rake angle is **positive** if the face slopes downward from the point toward the shank and **negative** if the face slopes upward toward the shank.

Backing Off: A shop term meaning to put a relief or clearance land on a cutter back of the cutting edge or the primary relief land.

Backlash: Lost motion (play) in moving parts, such as thread in a nut or in the teeth of meshing gears.

Balance: (dynamic) A piece in static balance is in dynamic balance, if, upon rotating, there is no vibration nor "whip" action due to unequal distribution of its weight throughout its length.

Balance: (static) A grinding wheel is in static balance when, centered on a frictionless horizontal arbor, it remains at rest in any position.

Balancing: Testing for balance, adding or subtracting weight to put a piece into either static or dynamic balance.

Ball Bearing: An antifriction bearing having an inner race which fits on a shaft and an outer race which fits into a housing or support. Hardened steel balls are used between inner and outer races to reduce friction.

Bearing: Point of support. The part of a machine in which the spindle revolves.

Bed: One of the principal parts of a machine tool, having accurately machined ways or bearing surfaces for supporting and aligning other movable parts of the machine.

Bevel: The angle formed by a line or a surface that is not at right angles to another line or surface.

Blotter: A disc of compressible material, usually of blotting paper stock, used between a wheel and flanges when mounting.

Bond: The material in a grinding wheel which holds the abrasive grains together and supports them while they cut.

Bore: The inside diameter of a cylinder, or a hole for a shaft. Also, the operation of machining a circular hole in a metal workpiece.

Brass: An alloy of copper, tin, and lead.

Brazing: The joining of metals by the use of an alloy consisting of nonferrous metals having a melting point below that of the metals to be brazed. Brass and copper together with a suitable flux such as borax are often used.

Brinnell Hardness Tester: A machine used for testing hardness by indentation of metals, except very hard ones like tool steels.

Brittleness: In some respects the opposite of toughness. The characteristics that cause metal to break easily.

Broach: A long tool on which the cutting teeth increase slightly in size with each succeeding tooth, and which is pushed or pulled through a hole or across a surface to form the desired shape and size.

Bronze: An alloy of copper and tin.

Brown and Sharpe Taper: A commonly used standard taper for shanks or arbors of milling machine tools and cutters.

Burning (the work): A change in the work being ground caused by the heat of grinding, usually accompanied by a surface discoloration.

Burr: A turned over edge of metal resulting from punching a sheet and sometimes from grinding or cutting off operations.

Bushing: The material, usually lead, babbitt or aluminum, which sometimes serves as a lining for the hole in a grinding wheel.

Caliper: Instrument of measuring outside or inside diameters.

Cam: A plate or cylinder which transmits variable motion to a part of a machine by means of a follower.

Cap Screw: A finished screw, ¼ inch or larger, used for fastening two pieces together by passing the screw through a clearance hole in one part and screwing it into a tapped hole in the other. Heads may be hexagon, round, flat, fillister, or socket types.

Carbide Tools: Cutting tools with points of tungsten carbide, tantalum carbide, or other cemented carbide alloys. The carbide tips are brazed to steel shanks for strength and rigidity.

Carbon Steel: A board term applied to tool steels other than high-speed or alloy steels.

Carborundum: A very hard artificial abrasive produced in an electric furnace. It is a compound of silicon and carbide. Also, the trade name for this abrasive.

Cast Iron: Iron which is cast in molds, is granular in form, and contains a high percentage of carbon in the form of graphite. It cannot be rolled, forged, or tempered.

Casting: A part made by pouring molten iron into a mold. Sand is commonly used for making the mold.

Center: A fixed point about which the radius of a circle or an arc moves.

Center, Dead: A stationary center.

Center Hole Lapping: The cleaning or lapping of center holes with a bonded abrasive wheel cemented onto a steel spindle.

Centerless Grinding: Grinding the outside or inside diameter of a cylindrical piece which is supported on a work blade instead of being held between centers, and which is rotated by a so-called regulating wheel.

Center Line: A line used to indicate an axis of a symmetrical part. The center line consists of a series of long and short dashes.

Center Reamer: A countersink having a 60-degree included angle for sizing and smoothing center holes in workpieces to be turned or ground between centers.

Centers: Conical steel pins of a grinding machine upon which the work is centered and rotated during grinding.

Ceramic Tools: A newer cutting-tool material made of aluminum oxide or silicon carbide held together by binders or additives of other materials.

Chamfer: To bevel or remove the sharp edge of a machined part. May be internal or external and is expressed by the length and angle.

Chaser: A thread cutting tool that fits into a die head used on a turret lathe or screw machine. Usually a hardened steel plate with several teeth of the correct pitch cut into it. Three or four chasers are used in a die head.

Chatter Marks: Surface imperfections on the work being ground usually caused by vibrations between the wheel and the work.

Chip Breaker: A groove ground into the top of a lathe, shaper, or planer tool bit to keep the chips short.

Chuck: A device for holding grinding wheels of special shape or the work piece being ground.

Clearance: Often used synonomously with clearance angle. The distance by which one object clears or misses another.

Clearance Angle: An angle ground on a cutting tool to permit it to cut metal.

Climb Grinding: Work and grinding wheel traveling in the same direction at the point of contact.

Collet (Spring): Standard type of trisected hollow clamping or chucking device to hold work of a given diameter or form. Example: standard 5C lathe collets.

Collet (wheel): A type of arbor which holds the wheel and is attached to the end of a spindle shaft — usually by a taper lock.

Compound Slide: A principal part of a lathe, frequently called a compound rest, consisting of an upper and lower part dovetailed together. The lower part, or base, is graduated in degrees and can be swiveled to any angle for turning short tapers and angles. The upper slide carries the tool post and toolholder.

Concave Surface: A curved depression in the surface of an object.

Concentric: Having a common center.

Cone Wheel: A small wheel shaped like a bullet nose which is used for portable grinding.

Contour: The outline of an object.

Convex Surface: A rounded surface on an object.

Coolant: The liquid or solution used to cool the work and to prevent it from rusting.

Corner Wear: The tendency of a grinding wheel to wear on a corner so that it does not grind sharp corners without fillets.

Critical Speed: Every spindle with a wheel or point mounted on it has a certain critical speed at which vibration due to deflection or whip tends to become excessive.

Crossfeed: A transverse (across the axis) feed. In a grinder, the feed that operates at right angles to the axis of the work between centers or the main table.

Crush Truing (or Forming): The process of using steel rolls to true or form grinding wheels to a wide variety of shapes.

Cup Wheel: A grinding wheel shaped like a cup or bowl.

Cutters: The part of a grinding wheel dresser that comes in contact with the wheel and does the cutting.

Cutters (cutting tools): Usually of high-speed steel or carbide material.

Cutting Angle: The angle measured between the cutting face of a tool and the surface of the material on which the tool operates.

Cutting-Off Wheel: A thin wheel, usually made with an organic bond, for cutting off.

Cutting Rate: The amount of material removed by a grinding wheel per unit of time.

Cutting Surface: The surface or face of the wheel against which the material is ground.

Cylinder Wheel: A grinding wheel of similar characteristics to a straight wheel but with large hole size in proportion to its diameter and usually of several inches height.

Cylindrical Grinding: Grinding the outside surface or inside surface of a cylindrical (round) part mounted on centers, or held by a chuck or collet.

Deburring: Act of removing burrs from metal.

Diamond Tool: A diamond dresser.

Diamond Wheel: A grinding wheel in which the abrasive is natural or synthetic diamond.

Die: A tool used to cut external threads. Also, a tool used to impart a desired shape to a piece of metal.

Dish Wheel: A wheel shaped like a dish.

Dividing Head: An attachment for the milling machine for dividing or spacing holes, slots, gear teeth, and geometric shapes precisely. When geared to the table lead screw of a universal miller, helices (sometimes called **spirals**) can be cut. A grinder universal workhead which can be accurately indexed (rotated) by several methods is also termed "dividing head".

Dog (lathe or grinder): A device clamped onto work so that it can be machined between centers. A drive pin from the power head on the machine catches the dog during rotation, thus revolving the work.

Dog (trip): A projecting piece on the side of a machine tool worktable to trip the automatic feed mechanism for reverse travel.

Dovetail Slide: A slide bearing consisting of two parts held in alignment by angular sides called **dovetail angles** and widely used in machine-tool construction. A gib on one side permits adjustment for smoothness of operation and wear.

Dressers: Tools used for truing and opening a grinding wheel.

Dressing: Removing wheel material to improve or alter its cutting action, usually by means of a diamond tool or abrasive dresser.

Eccentric: Not on a common center. A device that converts rotary motion into a reciprocating (back and forth) motion.

Emery: A natural abrasive of the aluminum oxide type.

End Mill: A milling cutter having a straight or tapered shank mounted into a drive holder. The cutting portion has teeth on the end as well as on the circumference.

Expansion Reamer: A type of hand or machine reamer in which the diameter may be slightly increased. An expansion chucking reamer which has become worn may be enlarged and then re-ground to the original size.

Face: That part of the wheel which does the grinding. Also, end cutting edges of a face mill.

Faceplate: A circular plate that fits to the headstock spindle and drives or carries work to be machined.

Feed, Cross (Surface grinding): The distance of horizontal feed of the wheel across the table.

Feed, Down (Surface grinding): The rate at which the abrasive wheel is fed into the work.

Feed, Down (Tool Grinding): Refers to the vertical feed on a tool grinder column, which when lowered, lowers the entire grinding head.

Feed, Index (Cylindrical grinding): Measurement indicated by the cross index of the machine. On most machines this measurement refers to the diameter of the work; on a few to the radius.

Feed Lines: A pattern on the work produced by grinding. The finer the finish, the finer and more evident are these lines. Some type of feed lines indicate incorrect grinding condition.

Finish: The surface quality or appearance, such as that produced by grinding or other machining operation, often measured by a profilameter measuring surface roughness.

Finishing: The final cuts taken with a grinding wheel to obtain accuracy and the surface desired.

Fixture: A device for holding work in a machine tool.

Flanges: The circular metal plates on a grinding machine, wheelshaft, arbor or collet, used to drive the grinding wheel by friction clamping. (See wheel sleeves.)

Flaring Cup Wheel: A cup wheel with the rim extending from the back at an angle so that the diameter at the outer edge is greater than at the back.

Flute: A straight or helical groove of angular or radial form machined in a cutting tool to provide cutting edges and to permit chips to escape and cutting fluids to reach the cutting edges.

Fluted Chucking Reamer: A machine reamer which has straight or helical flutes to provide cutting edges the entire length of the flutes. Intended for removing a small amount of metal (0.005 to 0.015 inch) and for finishing a hole accurately and smoothly.

Fluting: Grinding the grooves of a twist drill, tap, or end mill.

Formed Cutters: Milling cutters for producing surfaces which have either a circular or irregular outline or shape. The operation is called **form milling,** and the cutters may be called **form** or **formed** cutters. The teeth of a formed cutter are relieved so that they can be ground without changing the outline or shape.

Forming Tool: A cutting tool used for forming regular or irregular shapes. The

cutting tool is ground to the shape desired and reproduces this shape on the work piece. Sometimes called a "slab forming tool" for use in lathes.

Gauge: A tool used for checking parts to determine whether they are made within specified limits.

Gauge Blocks: Precision gauge blocks are the accepted dimensional standards of industry. They are made with measuring surfaces which are plane, parallel, and a specified distance apart; then hardened, stabilized, and lapped to a very fine finish. Sets of gauge blocks make it possible to build up combinations that vary by only 25 millionths of an inch.

Gear Cutters: Accurately formed cutting tools of hardened steel having shaped teeth that cut the spaces between the teeth of a gear to the precise shape and size required.

Gib: A wedge-shaped strip that can be adjusted to maintain a proper fit of movable surface of a machine tool.

Glazing: The dulling of the cutting particles of a grinding wheel resulting in a decreased rate of cutting.

Grade: The strength of bonding of a grinding wheel, frequently referred to as its hardness.

Graduate: To divide into equal parts by engraving or cutting lines or graduations into the metal.

Grain (grit): Abrasive classified into predetermined sizes for use in polishing, in grinding wheels and in coated abrasive.

Grain Size: The size of the cutting particles of a grinding wheel or polishing abrasive.

Grain Spacing: The relative position of the cutting particles in a grinding wheel.

Gray Iron: The most popular type of cast-iron alloy used for machine castings. When broken, the cast iron appears dark and gray in color, thus its name. Relatively inexpensive, it has excellent melting, casting, and machining qualities.

Grinding: Removing material with a grinding wheel.

Grinding Action: Refers to the cutting ability of, and the finish produced by, a grinding wheel.

Grinding Wheel: A cutting tool of circular shape made of abrasive grains bonded together.

Hardening: A heat-treating process of heating and cooling steel to increase its hardness and tensile strength, to reduce its ductility, and to obtain fine-grained structure.

Heat Treatment: Heating and cooling a solid metal or alloy in such a way as to obtain the desired conditions or properties. There are many different methods of heat-treating metals and each has a specific purpose.

Helical Angle: The angle which any portion of a helix or screw makes with a line drawn at right angles to its axis.

Helix: The path a point generates as it moves at a fixed rate of advance on the surface of a cylinder, such as screw threads or the flutes on a twist drill.

Hob: A special type gear cutter designed to cut gear teeth on a continuous basis.

Honing: A process used to produce the final fine surface finish on a part after all other operations. Honing permits a closer fit on critical parts. Abrasive blocks are forced against the work surface under very light spring pressure in a rotary motion and at the same time moved back and forth. The area is flooded with cutting fluid.

I.D.: Abbreviation for inside diameter.

I.D. Grinding: Abbreviation for internal grinding.

Independent Chuck: A chuck in which each jaw can be moved independently of the other jaws.

Indexing: The term used to describe the correct spacing of holes, slots, etc., on the periphery of a cylindrical piece using a dividing or indexing head.

Indicator: A sensitive instrument capable of measuring slight variations when testing the trueness of work, machines or machine attachments.

Inserted Nut: Designating disc, segment, or cylinder wheels with nuts embedded in the back to facilitate mounting on the grinding machine.

Inserted Tooth Cutter: A milling cutter with teeth that can be replaced when they become damaged or worn rather than replacing the entire cutter.

Inspection: The process of measuring, testing, or gauging of workpieces to make certain each dimension is within the specified size shown on the blueprint.

Interlocking Cutters: Milling cutters consisting of two sections. Mating sections are similar to half-side or staggered-tooth cutters with uniform or alternate helical teeth so designed that the paths of teeth overlap when in proper assembly.

Internal Grinding: Grinding the inside surface (I.D., inside diameter) of the hole in a workpiece.

Jo-Block: Precisely made steel or carbide blocks introduced by the Johnson Co., and used by industry as a standard of measurement to millionths of an inch. They are made in a range of sizes and with a dimensional accuracy on the order of plus or minus 0.000002 (two millionths) inch, with a flatness and parallelism of plus or minus 0.000003 (three millionths) inch.

Key: A small piece of metal imbedded partially in the shaft and partially in the hub of a sleeve, gear, pulley, etc., to prevent its rotation on the shaft.

Keyseat: The slot or recessed groove, either in the shaft or gear, which is made to receive the key.

Keyway: The slot or recess in the shaft that holds the key.

Keyway Cutter: A milling cutter of specified size or type, or other cutting tool, used to cut keyseats and keyways in the shaft or hole of parts to be fitted with keys.

Land: The top surface, the tooth or flute of cutting tools, such as taps, reamers, and milling cutters. The land of a tap is the width of the threaded portion between the flutes.

Lapping: A finishing process typically employing loose abrasive grain, but now often including similar types of operation with bonded abrasive wheels or coated abrasives.

Lead Angle: The angle of the helix of a screw thread or worm thread. It is the measure of the inclination of a screw thread from a plane perpendicular to the axis of the screw.

Lead of Thread: On a single threaded screw, the distance the screw or nut advances in one complete revolution.

Left Hand Cutter: In lathe work, a cutting tool that cuts when fed from left to right or toward the tailstock. For milling cutters, when viewed from the spindle or shank end, the cutter would turn counterclockwise.

Left Hand Screw: One that screws into the mating part or advances when turned to the left or counterclockwise.

Lever: A simple machine for obtaining mechanical advantage. The lever consists of a rigid arm or bar pivoted or bearing on a point called the **fulcrum** and has a weight arm and a power arm.

Loading: Filling of the pores of the grinding wheel surface with the material being ground, usually resulting in a decrease in production and poor finish.

Lock Nut: A type of nut that is prevented from loosening under vibration. The locking action is accomplished by squeezing, gripping, or jamming against the bolt threads.

Machine Tool: The name given to that class of machines which, taken as a group, can reproduce themselves.

Mandrel: A hardened, tapered, or slightly tapered metal shaft, with the outside precisely concentric with the center holes, which is pressed into an accurate hole of a workpiece to support and revolve the part between centers.

Metal Slitting Saw: A thin milling cutter for slotting or cutting off stock in a milling machine.

Micro Inch: One millionth of an inch.

Micrometer: A precision, screw adjusted measuring instrument with which dimensions can be read in thousandths and ten-thousandths of an inch.

Micrometer Index Collar: A dial on the screw of a machine tool to indicate the movement of the screw or parts attached to the screw and usually graduated to read in thousandths of an inch.

Mill: To remove metal with a rotating cutter on a milling machine.

Millimeter: One thousandths of a meter. Equivalent to .03937 inches. One inch contains 25.4 millimeters.

Morse Taper: A standard taper of approximately ⅝ inch per foot. Used on lathe centers, drill shanks, etc.

Mounted Points and Wheels: Small bonded abrasive shapes and wheels that are mounted on steel spindles.

Mounting: Putting a grinding wheel on the arbor or spindle of the machine.

Nut: A metal fastener of square, hezagon, or other shape, having an internal thread which screws onto a bolt, stud, or arbor.

O.D.: An abbreviation for outside diameter.

O.D. Grinding: Abbreviation for cylindrical grinding.

Oilstone: A natural or manufactured abrasive stone impregnated with oil and used for sharpening keen edged tools.

Operating Speed: The speed of revolution of a grinding wheel expressed in either revolutions per minute or surface feet per minute.

Organic Bond: A bond made of organic materials such as the synthetic resins, rubber or shellac.

Parallel: Two lines in the same plane equidistant from each other and never meeting no matter how far extended.

Peripheral Speed: The speed at which any point or particle on the face of the wheel is traveling when the wheel is revolved, expressed in surface feet per minute (s.f.p.m.). Multiply the circumferance in feet by the wheel revolutions per minute.

Periphery: The line bounding a rounded surface — the circumference of a wheel or cutter.

Perpendicular: A line or surface which meets another line or surface at right angles (90 degrees).

Pinion: The smaller of two mating gears.

Plain Milling Cutter: A milling cutter that has cutting teeth on the circumference surface only.

Plug Gauge: A gauge on which the outside measuring surfaces are designed to test the special dimensions of holes. May be straight or tapered, plain or threaded, and of any cross-sectional shape.

Profilometer: An instrument for measuring the degree of surface roughness in micro inches, and often stated in R.M.S. — root mean square values.

Pulley: A wheel having a plain or V-groove rim over which a belt runs for the transmission of power from one shaft to another.

Rack: A flat strip with teeth designed to mesh with teeth on a gear. Used to change rotary motion to reciprocating motion.

Radial: Arranged outward from the center as the spokes of a wheel.

Radius: The distance from the center of a circle to the circumference which is equal to one-half the diameter.

Radius Cutter: A side or end milling cutter which has the edges of the teeth ground to a specified radius so it will reproduce the radius on the workpiece.

Rake Angle: For **milling cutters,** the angle between the cutting edge (face) and the work. With the cutting edge located along the radius line of the cutter, the tool has a zero rake. When the cutting edge (face) is ahead of the radius of the cutter, the rake is positive. If the cutting edge (face) is behind the radius of the cutter, the rake is negative. For **single point lathe tools,** the slope of the tool face toward the tool base from the cutting edge in the direction of the chip flow. It is the combination of the back-rake and side-rake angles which varies with the setting of the tool and the feed and depth of cut. For **twist drills,** the angle the flute or helix makes with the axis.

Reamer: A cutting tool used to produce a smooth, accurate hole by removing a small amount of metal from a drilled hole.

Recessed Wheels: Grinding Wheels made with a depression in one side or both sides to fit special types of flanges or sleeves provided with certain grinding machines.

Reinforced Wheel: A grinding wheel in which some type of mechanical addition has been added as an integral part of the wheel to increase its strength.

Relief: The offset surface immediately back of the cutting edge or face to provide clearance on a cutting tool to allow for the non-cutting portion of the cutter to clear the work. Some manuals call the first clearance land back of the cutting edge the relief, and the second land the clearance. The terms of 'relief' and 'clearance' are used synonomously in this manual, the latter being used for both primary and secondary lands, depending on the context.

Relieving: To remove some of the metal behind the cutting edge of a tool to provide clearance, as for taps and milling cutters. Also called **backing off.**

Resinoid Bond: A bonding material described commercially as synthetic resin.

Rest: That part of a grinding wheel stand which is used to support the work, dresser or truing tool when applied to the grinding wheel.

Right Angle: An angle of 90 degrees.

Right-Cut Tool: A single-point lathe tool which, when viewed from the point end of the tool with the face up, has the cutting edge on the right side. When used in the lathe, the cutting edge is on the left side and cuts when fed from right to left.

Right-Hand Cutter: A term used to describe both **rotation** and **helix** of milling cutters. A cutter that rotates clockwise when viewed from the spindle end is said to have right-hand motion. A cutter has a right-hand helix when the flutes slant downward to the right when viewed from the front, or twist clockwise when viewed from the end.

Right-Hand Thread: A screw thread which advances into the mating part when turned clockwise or to the right.

Rockwell Hardness Tester: A machine used for testing hardness by the indentation method.

Rose Reamer: A machine reamer designed so that all the cutting is done on the beveled ends of the teeth instead of on the sides.

Rough Grinding: The first grinding operation for reducing stock rapidly without regard to the finish the wheel leaves.

R.P.M. Revolutions per minute.

Rubber Bond: A bonding material, the sprincipal constituent of which is natural rubber or synthetic rubber.

Run-out: Peripheral or lateral (axial) distance variation from a fixed axis center or radial plane of a circular object.

Safety Flanges: Special type of flanges designed to hold together the broken parts of a wheel in case of breakage, thus protecting workmen.

Saucer Wheel: A shallow, saucer-like wheel.

Saw Gummer: A grinding wheel used for gumming or sharpening saws.

Scleroscope: An instrument for determining the relative hardness of materials by a drop and rebound method.

Scratches: Marks left on a ground surface caused by a dirty coolant or a grinding wheel unsuited for the operation.

Set Screw: Usually a hardened steel screw having either no head or a square head and with various designs of points or ends to lock or tighten adjustable machine parts in position on a shaft.

Set-up: The term used to describe the positioning of the workpiece, attachments and cutting tools on a machine tool.

S.F.P.M.: Surface feet per minute. See "Peripheral Speed." Multiply the circumference in feet by the wheel revolutions per minute.

Shank: The noncutting end of a tool which fits into the holding device for driving, as the taper shank on a drill.

Shellac Bond: A bonding material, the principal constituent of which is shellac.

Shell Reamer: A reamer which as a slightly tapered hole to fit on the end of an arbor or shank for holding and driving in a machine. One arbor can be used for several reamer sizes. Should the reamer become damaged, only the reamer end need be replaced.

Side-Clearance Angle: An obsolete term which refers to the amount of angle ground on the sides of a single-point cutting tool. It is replaced by the new term **side-relief angle.**

Side-Milling Cutters: Cutters which have cutting teeth on one or both sides as well as on the circumference.

Side-Relief Angle: On a single-point cutting tool, the angle between the portion of the flank immediately below the cutting edge and a line drawn through this cutting edge perpendicular to the base. Also, the angle of relief on the sides of milling cutters.

Silicone Carbide: An abrasive made from coke and silica sand (SiC).

Sine of an Angle: In a right triangle, the ratio of the side opposite to the side adjacent.

Sine Bar: A flat piece of metal accurately ground parallel and square to which is attached two hardened and ground steel plugs having the same diameter and usually spaced either 5 or 10 inches apart. The sine bar is used to measure angles accurately. Also, the sine bar represents the hypotenuse of a right triangle.

Single-Point Tools: Cutting tools for use in a lathe, planer, or shaper. Single-point tools have one face and one continuous cutting edge which produce the machined surface.

Slabbing Cutter: A wide plain milling cutter designed for heavy roughing cuts.

Sleeve: A round piece of metal having a straight or tapered hole which fits over or into another pieve to adapt parts to fit, as a taper sleeve for a lathe center.

Slitting Saw: A thin milling cutter of the plain type used for slotting or cutting off material in the milling machine.

Slotting Wheel: A thin grinding wheel, usually organic bonded, used for cutting slots or grooves in the work piece.

Spanner Wrench: A type of wrench having a hook or equipped with pins for tightening or loosening threaded circular collars which have either slots or holes to receive the hook or pins on the wrench.

Spindle (grinding): Often used synonomously with "quill", the term usually refers to a precision bearing mounted shaft inside a housing with end caps which hold or tighten and compress the bearings and shaft in a fixed position.

Spindle (workhead): Precision bearing mounted hollow steel sleeve with internal taper inside a housing, used to hold workholding arbors by means of an internal taperlock.

Spring Collets: A type of draw-in collet made of hardened steel and having three slots or saw cuts which permit the collet to be closed tightly upon the workpiece when drawn back against a tapered sleeve by the draw bar or tube.

Stagger-Tooth Cutters: Side-milling cutters in which the teeth have alternating helix and the "drag" ends are eliminated to provide more chip clearance.

Standard Tapers: Any of the numerous tapers specified in the American Standard system of tapers which include the self-holding tapers.

Steady Rest: A support attached to the ways of a lathe or grinding machine for turning long workpieces. The steady rest is used to prevent slender work from springing away from the cutting tool or wheel, or to permit machining operations to be performed on the end of the workpiece. Sometimes called a **center rest.**

Stops: Devices attached to the movable parts of a machine tool, such as a grinder table, to limit the amount of travel. When set and clamped in position, they assure the uniformity of each workpiece. Projections on the side of the worktable may also engage automatic power feed, and are known as a 'dog'.

Straight Wheel: A grinding wheel of any dimension which has straight sides, a straight face, and a straight or tapered arbor hole, and is not recessed, grooved, dovetailed, beveled or otherwise changed from a wheel with plain parallel sides.

Structure: A general term referring to the proportion and arrangement of abrasive and bond in an abrasive product.

Stub: That portion of a grinding wheel remaining after it has been worn down to the discarding diameter.

Surface Grinding: Abrasive machining which grinds flat surfaces on work pieces having sides parallel or at angles to each other.

Surface Roughness Scale: A series of small plates visualizing the degree of roughness for a particular surface. They establish a standard permitting a machinist or an inspector to compare specified finishes visually and by feel.

Table: That part of the grinding machine which directly or indirectly supports the work being ground.

Table Traverse: The length of reciprocating movement of the table of a grinding machine.

Tailstock: The part of a machine tool which holds one end of a work piece with

centers. A principal part of the engine lathe used for supporting the ends of work-pieces by means of a center point held in the spindle. May be moved along the ways and clamped in different positions and offset from the true axis of the lathe for turning tapers.

Tangent: A line that touches the circumference of a circle at one point only.

Tap: A hardened and tempered steel tool for cutting internal threads which has flutes lengthwise to provide cutting edges for the threads and a square at the end of the shank for turning the tap with a wrench.

Taper: A piece of work which increases or decreases uniformly in diameter or size and assumes a conical or wedge shape.

Tapered Wheel: A grinding wheel shaped similarly to a straight wheel but having a taper from the hub of the wheel to the face and thus being thicker at the hub than at the face.

Taper Per Foot: A means of specifying the amount or rate that a taper increases or decreases for each foot of length, usually stated in inches per foot.

Taper Reamer: A fluted reamer which has the cutting ends made to the standard taper it is designed to cut. The taper reamer is used either for roughing or finishing taper holes to size by hand or power according to the design of the reamer. Roughing reamers have notched teeth to relieve the load on the teeth.

Taper Taps: One of the three taps in a set of hand taps. The end threads are tapered or chamferred back for a length of 8 to 10 threads for easy starting.

T-Bolt: A threaded bolt having a square or rectangular end which fits into the T-slot of a machine table for clamping workpieces.

Teeth: Molded organic bonded abrasive segment for insertion in the periphery of a steel disc. Also, cutting segments or flutes of a milling cutter.

Temper: The heat treatment of a material to develop required qualities.

Tensile Strength: The strength of a material when tested in tension usually given in pounds per square inch.

Tolerance: The permissible deviation from a basic dimension.

Tool Bit: A piece of high-speed steel, usually square in shape and of suitable length, which may be ground to various shapes and forms for single-point cutting tools that are used in lathes, shapers, and planers for cutting metal.

Toolroom: Area or department where tools, jigs, fixtures and dies are manufactured.

Truing: A grinding wheel is trued in order to restore its cutting face to running truth so that it will produce perfectly round (or flat) and smooth work; or to alter the cutting face for grinding special contours.

Universal Chuck: A chuck on which all jaws move simultaneously at a uniform rate to center round or hexagonal stock automatically.

Universal Grinding Machine: A machine such as the K. O. Lee Universal Tool and Cutter Grinder on which cylindrical, internal and surface grinding can be done — usually used for tool room work. It consists of a swivel table, headstock, tailstock, and a wheelhead that can be rotated 360 degrees on its base and raised or lowered. It is also used for tool and cutter grinding with the addition of various fixtures.

Universal Vise: A work-holding device usually used on the milling machine which has either two or three swivel settings so that workpieces may be set at any desired angle, including compound angles. Also, called a **toolmaker's vise.** The K. O. Lee B989 fixture is an adaptation of this principle for tool grinding machines.

Vitrified Bond: A bonding material of which the chief constituent is clay.

Vitrified Wheel: A grinding wheel made with a vitrified ceramic bond.

V-Ways: The raised portion on machine tool beds that act as bearing surfaces and guide and align the movable portion of the machine that rides on them. They are shaped like an inverted V.

Washers: Circular metal rings or discs or various designs having a hole through the center and placed between a bolthead or a nut and the workpiece. A washer is used to lock a nut in place and to provide a seat that distributes the pressure over a greater area for holding parts together.

Ways: The flat or V-shaped bearing surfaces on a machine that aligns and guides the movable part of the machine that rides on them.

Wheel Dresser: A device to true the face of a grinding wheel.

Wheel Sleeves: A form of flange used on precision grinding machines where the wheel hole is larger than the machine arbor. Usually the sleeve is so designed that the wheel and sleeve are assembled as one unit.

Wheel Traverse: The rate of movement of the wheel across the work.

Woodruff Key: A flat, semicircular piece of metal used as a key in a special circular keyseat slot cut in a shaft to drive a gear, pulley, or other part.

Work: Term used to designate the material being machined.

Work Speed: In cylindrical, centerless and internal grinding, the rate at which the work revolves, measured in either r.p.m. or s.f.p.m.; in surface grinding, the rate of table traverse measured in feet per minute.

Worm: A threaded cylinder or shaft which meshes with and drives a worm gear, the thread being especially designed to mate with the teeth in the worm gear.

Worm Gears: Gears with teeth cut on an angle to be driven by a worm. The teeth are usually cut out with a hob to fit the worm.