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Glossary of Forging Terms



A	2
B	2
C	4
D	5
E	7
F	7

G	9
H	10
I	11
K	12
L	12
M	12

N	13
O	13
P	14
R	15
S	15
T	17

U	18
V	18
W	18

Glossary of Forging Terms

A

Air-lift hammer — A type of gravity-drop hammer in which the ram is raised for each stroke by an air cylinder. Because the length of stroke can be controlled, ram velocity and therefore the energy delivered to the workpiece can be varied. See also Drop Hammer and Gravity Hammer.

Aircraft quality — Denotes stock of sufficient quality to be forged into highly stressed parts for aircraft or other critical applications. Such materials are of extremely high quality, requiring closely controlled, restrictive practices in their manufacture in order that they may pass rigid requirements, such as magnetic particle inspection.

Alloy steel forging — One made from a steel containing additional alloying elements other than carbon (e.g., Ni, Cr, Mo) to enhance physical and mechanical properties and/or heat-treat response.

AMS — Aeronautical Materials Specification

As forged — The condition of a forging as it comes out of the finisher cavity without any subsequent operations.

ASTM (Specifications) — The American Society for Testing and Materials.

Auxiliary operations — Additional processing steps performed on forgings to obtain properties, such as surface conditions or shapes, not obtained in the regular processing operation.

Axial rolls — In ring rolling, vertically displaceable, tapered rolls, mounted in a horizontally displaceable frame opposite from but on the same centerline as the main roll and rolling mandrel. The axial rolls control the ring height during the rolling process.

Axisymmetric forging — A forging where metal flow, during deformation, is predominately in a direction away from a common axis in a radial direction.

B

Backward extrusion — Forcing metal to flow in a direction opposite to the motion of a punch or die.

Bar — A section hot rolled from a billet to a form, such as round, hexagonal, octagonal, square, or rectangular, with sharp or rounded corners or edges, with a cross-sectional area of less than 16 sq in. (A solid section that is long in relation to its cross-sectional dimensions, having a completely symmetrical cross section and whose width or greatest distance between parallel faces is 3/8 in. or more).

Bar end — See End Loss.

Barreling — Convexity of the surfaces of cylindrical or conical bodies, often produced unintentionally during upsetting or as a natural consequence during compression testing. See also Compression Test.

Batch/batch-type furnace — A furnace for heating materials where all loading and unloading is done through a single door or slot.

Bend or twist (defect) — Distortion similar to warpage, but resulting from different causes; generally caused in the forging or trimming operations. When the distortion is along the length of the part, it is called "bend"; when across the width, it is called "twist."

Bender — A die impression, tool, or mechanical device designed to bend forging stock to conform to the general configuration of die impressions subsequently to be used.

Bending — A preliminary forging operation to give the piece approximately the correct shape for subsequent forming.

Billet — A semifinished, cogged, hot-rolled, or continuous-cast metal product of uniform section, usually rectangular with radiused corners. Billets are relatively larger than bars. See Bloom.

Bite — Amount of the die in contact with the workpiece throughout one entire forging reduction, e.g., heavy bite is three-quarter to full width of the die.

Blank — Raw material or forging stock (also called a "slug" or "multiple") from which a forging is made.

Blast cleaning — A process for cleaning or finishing metal objects by use of an air jet or centrifugal wheel that propels abrasive particles (grit, sand, or shot) against the surfaces of the workpiece at high velocity.

Block — The forging operation in which metal is progressively formed to general desired shape and contour by means of an impression die (used when only one block operation is scheduled).

Block and finish — The forging operation in which the part to be forged is blocked and finished in one heat through the use of a die having both a block impression and a finish impression in the same die. This also covers the case where two tools mounted in the same machine are used, as in the case of aircraft pistons. Only one heat is involved for both operations.

Block, first and second — Blocking operation performed in a die having two blocking cavities in the same die; the part being forged is successively blocked in each impression all in one heat. As many as three blocker dies are sometimes needed for some forgings and up to three operations are sometimes required in each die.

Block, first, second, and finish — The forging operation in which the part to be forged is passed in progressive order through three tools mounted in one forging machine; only one heat is involved for all three operations.

Blocker impression — The forging die impression which gives the forging its general shape, but omits any details that might restrict the metal flow; corners are well rounded. The primary purpose of the blocker is to enable the forming of shapes too complex to be finished after the preliminary operations; it also reduces die wear in the finishing impression.

Blocker-type forging — A forging that approximates the general shape of the final part with relatively generous finish allowance and radii.

Such forgings are sometimes specified to reduce die costs where only a small number of forgings are desired and the cost of machining each part to its final shape is not exorbitant.

Bloom — A semifinished product of square, rectangular, or even round cross section, hot rolled, or forged. For steel, the width of a bloom is not more than twice the thickness, and the cross sectional area is usually not less than about 36 sq. in. No invariable rule prevails for distinguishing between blooms and billets; the terms are frequently used interchangeably.

Board hammer — A type of gravity drop hammer where wood boards attached to the ram are raised vertically by action of contrarotating rolls, then released. Energy for forging is obtained by the mass and velocity of the freely falling ram and the attached upper die. See also Drop Hammer.

Bolster plate — A plate to which dies can be fastened; the assembly is secured to the top surface of a press bed. In press forging, such a plate may also be attached to the ram.

Boss — A relatively short protrusion or projection on the surface of a forging, often cylindrical in shape.

Breakdown — (1) An initial rolling or drawing operation, or a series of such operations, for reducing an ingot or extruded shape to desired size before the finish reduction. (2) A preliminary press-forging operation.

Brinell hardness — The hardness of a metal or part, as represented by the number obtained from the ratio between the load applied on and the spherical area of the impression made by a steel ball forced into the surface of the material tested. The Brinell Hardness Number (BHN) is determined by measuring the diameter of the impression using a low power microscope, then matching this diameter with the load on a standard table.

Buckling — A bulge, bend, kink, or other wavy condition of the workpiece caused by compressive stresses. See also Compressive Stress.

Burning — Permanently damaging a metal or alloy by heating so as to cause either incipient melting or intergranular oxidation.

Burr — A thin ridge or roughness left on forgings by cutting operation such as slitting, shearing, trimming, blanking, or sawing.

Buster (rougher) — An impression employed in a die when considerable metal movement is required and which precedes a blocker cavity and a finisher cavity. Also known as breakdown/pancake, scalebreak, cheese.

Buster (preblocking impression) — A type of die impression sometimes used to combine preliminary forging operations such as edging and fullering with the blocking operation to eliminate blows.

C

Carbon steel — Steel containing carbon up to about 1.2%, and only residual amounts of other elements except for those added for composition control, with silicon usually limited to 0.60 % and manganese to 1.65%.

Cassette — Also known as sub-bolster, die assembly, trim and pierce assembly. An assembly of top and bottom dies and/or tools of each forming station assembled into one unit.

Cast (proof) — Any reproduction of a die cavity in any material, frequently lead, plaster or epoxy, used to confirm the exactness of the cavity. See Die Proof.

Cavity, die — The machined recess in a die that gives the forging its shape.

Chamfer — To break or remove sharp edges or corners of forging stock by means of straight angle tool or grinding wheel.

Charpy impact test — An impact test in which a specially V-notched specimen is broken by the impact of a falling pendulum. The energy absorbed in fracture is a measure of the impact strength or notch toughness of the sample.

Check — Crack in a die impression, generally due to forging pressure and/or excessive die temperature. Die blocks too hard for the depth of the die impression have a tendency to check or develop cracks in impression corners.

Chop — A die forging defect; metal sheared from a vertical surface and spread by the die over an adjoining horizontal surface.

Chucking lug — A lug or boss to the forging so

that "on center" machining and forming can be performed with one setting or chucking; this lug is machined or cut away on the finished item.

Cleaning — The process of removing scale, oxides, or lubricant—acquired during heating for forging or heat treating—from the surface of the forging. (See also Blasting, Pickling, Tumbling.)

Close-tolerance forging — One held to closer-than-conventional dimensional tolerances so that little or no machining is required after forging. See also Precision Forging.

Closed die forging — The shaping of hot metal completely within the walls or cavities of two dies that come together to enclose the workpiece on all sides. The impression for the forging can be entirely in either die or divided between the top and bottom dies. Impression-die forging, often used interchangeably with the term closed-die forging, refers to a closed-die operation in which the dies contain a provision for controlling the flow of excess material, or flash, that is generated. By contrast, in flashless forging, the material is deformed in a cavity that allows little or no escape of excess material. See Impression Die Forging.

Closing-in — The forging operation that locally reduces diameters in hollow forgings.

Closure, die — A term frequently used to mean variations in thickness of a forging.

Cogging — The reducing operation in which an ingot is worked into a billet by the use of a forging hammer or a forging press.

Coining — (1) A post-forging process—on hot or cold parts—used to attain closer tolerances or improved surfaces. (2) A closed-die squeezing operation in which all surfaces of a workpiece are confined or restrained, resulting in a well-defined imprint of the die on the work.

Coining dies — Dies in which the coining or sizing operation is performed.

Cold-coined forging — A forging that has been restruck cold in order to hold closer face distance tolerances, sharpen corners or outlines, reduce section thickness, flatten some particular surface, or, in non-heat-treatable alloys, increase hardness.

Cold forging — Various forging processes conducted at or near ambient temperatures to produce metal components to close tolerances

and net shape. These include bending, cold drawing, cold heading, coining, extrusion (forward or backward), punching, thread rolling and others.

Cold heading — Plastically deforming metal at ambient temperatures to increase the cross-sectional area of the stock (either solid bar or tubing) at one or more points along the longitudinal axis. See also Heading and Upsetting.

Cold lap — A flaw that results when a workpiece fails to fill the die cavity during the first forging. A seam is formed as subsequent dies force metal over this gap to leave a seam on the workpiece surface. See also Cold Shut.

Cold saw — Mechanical sawing machine used to produce cut pieces prior to the forging operation. Sawing is carried out on the material at ambient temperature.

Cold shut — Also known as lap or fold. A defect such as lap that forms whenever metal folds over itself during forging. This can occur where vertical and horizontal surfaces intersect.

Cold trimming — Removing flash or excess metal from the forging in a trimming press when the forging is at room temperature.

Cold working — Permanent plastic deformation of a metal at a temperature below its recrystallization point—low enough to produce strain hardening. Usually, but not necessarily, conducted at room temperature. Also referred to as cold forming or cold forging. Contrast with hot working.

Concavity — A concave condition applicable to the width of any flat surface.

Concentricity — Adherence of part features to a common center.

Controlled cooling — Cooling from an elevated temperature in a predetermined manner to avoid hardening, cracking, or excessive internal stresses, or to produce a desired microstructure.

Conventional forging — A forging characterized by design complexity and tolerances that fall within the broad range of general forging practice.

Counterblow forging — One made by equipment incorporating two opposed rams, which simultaneously strike repeated blows on the workpiece.

Counterblow forging equipment — A category of forging equipment in which two opposed rams are activated simultaneously, striking repeated blows on the workpiece at a midway point. Action is vertical or horizontal.

Cross forging — Preliminary working of forging stock in alternate planes, usually on flat dies, to develop mechanical properties, particularly in the center portions of heavy sections.

D

Decarburization — The removal of carbon from the surface of steel as a result of heating in a medium that reacts with the carbon. Decarburization is usually present to a slight extent in steel forgings. Excessive decarburization can result in defective products.

Die holder — Also known as bolster, insert holder, can. Used to locate, clamp and support dies, die assemblies or die inserts.

Die impression — The portion of the die surface that shapes the forging.

Die lubricant — A material sprayed, swabbed, or otherwise applied during forging to reduce friction and/or provide thermal insulation between the workpiece and the dies. Lubricants also facilitate release of the part from the dies and provide thermal insulation. See also Lubricant.

Die match — Also known as mismatch. The alignment of the upper (moving) and lower (stationary) impression in the die.

Die proof (cast) — A casting of the die impression made to confirm the exactness of the impression.

Die set — The assembly of the upper and lower die shoes (punch and die holders), usually including the guide pins, guide pin bushings, and heel blocks. This assembly takes many forms, shapes, and sizes and is frequently purchased as a commercially available unit. Also, two (or, for a mechanical upsetter, three) machined dies used together during the production of a die forging.

Die shift — The condition that occurs after the dies have been set up in a forging unit in which a portion of the impression of one die is not in perfect alignment with the corresponding portion of the other die. This results in a mismatch in the forging, a condition that must be held within the specified tolerance.

Die shoes — The upper and lower plates or castings that constitute a die set (punch and die holder). Also a plate or block upon which a die holder is mounted, functioning primarily as a base for the complete die assembly. This plate or block is bolted or clamped to the bolster plate or the face of the press ram.

Die sinking — The process of machining impressions in die blocks.

Die straighten — A straightening operation performed in either a hammer or a press using flat or cavity dies to remove undesired deformation and bring the forging within the straightness tolerance.

Dies (die blocks) — The metal blocks into which forging impressions are machined and from which forgings are produced.

Dies, forging — Forms for the making of forgings; generally consist of a top and bottom die. The simplest will form a completed forging in a single impression; the most complex, made up of several die inserts, may have a number of impressions for the progressive working of complicated shapes. Forging dies are usually in pairs, with part of the impression in one of the blocks and the balance of the impression in the other block.

Dies, gripper — Clamping or lateral dies used in a forging machine or mechanical upsetter.

Direct (forward) extrusion — See Extrusion.

Directional properties — Properties whose magnitude varies depending on the relation of the test axis to a specific direction within the metal or alloy.

Disc (disk) — "Pancake" shaped forging (flat with a round cross-section); e.g., a blank for gears, rings and flanged hubs. Abbreviation is "D."

Discontinuities — Includes cracks, laps, folds, cold shuts, and flow-through, as well as internal defects such as inclusion, segregation, and porosity; internal discontinuities can be detected and evaluated using ultrasonic testing equipment.

Double forging — A forging designed to be cut apart and used as two separate pieces.

Draft — The necessary taper on the side of a forging to allow removal from the dies; also applies to the die impression. Commonly expressed in degrees as the draft angle. As applied to open die

forging, draft is the amount of relative movement of the dies toward each other through the metal in one application of power.

Draft angle — The angle of taper, expressed in degrees (usually 5° to 7°), given to the sides of the forging and the side walls of the die impression.

Draftless forging — A forging with zero draft on vertical walls.

Drawing — (1) A forging operation in which the cross section of forging stock is reduced and the stock lengthened between flat or simple contour dies. See also Fullering. (2) in heat treating, the same as tempering.

Drawing out — The forging operation in which the length of a metal mass (stock) is increased at the expense of its cross section; no "upset" is involved. The operation covers converting ingot to pressed bar using "V," round, or flat dies.

Dressout — A condition where the dimensions of a part or forging are changed by local grinding or machining to remove one or more defects thereby causing a localized imperfection of a maximum depth. The depth is the dimension of the dressout.

Drifting — In forging, the operation of forming or enlarging a hole by use of a tapered punch.

Drop forging — A forging made in closed or impression dies under a drop or steam hammer.

Drop hammer — A term generally applied to forging hammers wherein energy for forging is provided by gravity, steam, or compressed air. See also Air-Lift Hammer, Board Hammer, Steam Hammer.

Ductility — The property of a metal that enables it to stretch before rupturing.

Dwell — Portion of a press cycle during which the movement of a member is zero or at least insignificant. Usually refers to the interval between the completion of the forging stroke and the retraction of the ram.

Dye-penetrant testing — Inspection procedures for detecting surface irregularities using penetrating liquids containing dyes or fluorescent substances.

E

Eccentric — The offset portion of the driveshaft that governs the stroke or distance the crosshead moves on a mechanical or manual shear.

Eccentric press — A mechanical press in which an eccentric, instead of a crankshaft, is used to move the ram.

Edger (edging impression) — The portion of the die impression that distributes metal, during forging, into areas where it is most needed to facilitate filling the cavities of subsequent impressions to be used in the forging sequence. See also Fuller.

Edging — The forging operation of working a bar between contoured dies while turning it 90° between blows to produce a varying rectangular cross section.

Efficiency (forging) — The amount of applied energy, in percentage, that is employed in deforming the workpiece to the total energy expended by the forging equipment.

Ejector — Also known as knockout. Heat treated steel rods located within the dies and operated by the press action to remove a completed forging after the forging cycle.

End loss (crop end) — Bar end left over after cutting bar lengths of stock into forging multiples. See also Multiple.

Etch test — The process of revealing the macrostructure of metals by preferential attack of a prepared surface by a suitable reagent.

Expanding — A hollow forging operation whereby the diameters are increased by reducing wall thickness with relatively little increase in length by working on a mandrel.

Extrusion — The process of forcing metal to flow through a die orifice in the same direction in which energy is being applied (forward extrusion); or in the reverse direction (backward extrusion), in which case the metal usually follows the contour of the punch or moving forming tool. The extrusion principle is used in many impression die forging applications.

Extrusion billet — A metal slug used as extrusion stock.

Extrusion defect — See Extrusion pipe.

Extrusion pipe — A central oxide-lined discontinuity that occasionally occurs in the last 10% to 20% of an extruded bar. It is caused by the oxidized outer surface of the billet flowing around the end of the billet and into the center of the bar during the final stages of extrusion. Also called coring.

F

Feather (Fin) — The thin projection formed on a forging by trimming or when the metal under pressure is forced into hairline cracks or die interfaces.

Fiber — A characteristic of wrought metal, including forgings, indicated by a fibrous or woody structure of a polished and etched section, and indicating directional properties. Fiber is chiefly due to the extension of the constituents of the metal synonymous with flow lines and grain flow in the direction of working.

Fillet — The concave intersection of two surfaces. In forging, the desired radius at the concave intersection of two surfaces is usually specified.

Fin — The thin projection formed on a forging by trimming or when metal is forced under pressure into hairline cracks or die interfaces.

Finish — (1) The forging operation in which the part is forged into its final shape in the finish die. If only one finish operation is scheduled to be performed in the finish die, this operation will be identified simply as finish; first, second, or third finish designations are so termed when one or more finish operations are to be performed in the same finish die. (2) The surface condition of a forging after machining. (3) The material machined off the surface of a forging to produce the finish machine component.

Finish all over (F.A.O.) — A designation that a forging must have sufficient size over the dimensions given on the drawing so that all surfaces may be machined in order to obtain the dimensions shown on the drawing. The amount of additional stock necessary for machining allowance depends on the size and shape of the part, and is agreed on by the vendor and the user.

Finish allowance — The amount of stock left on the surface of the forging to be removed by subsequent machining. Also called "machining allowance" or "forging envelope."

Finish forging — See Conventional Forging.

Finish trim — Flash removal from a forging; usually performed by trimming, but sometimes by band sawing or similar techniques.

Finisher (finish impression) — The die impression that imparts the final shape to a forged part.

Finishing dies — The die set used in the last forging step

Finishing temperature — The temperature at which hot mechanical working of a metal is completed or discontinued.

Flakes — Randomly oriented internal thermal cracks ("shatter cracks") in steels resulting from critical combinations of stress and hydrogen content. In a fracture surface, flakes appear as bright silvery areas; on an etched surface they appear as short discontinuous cracks.

Flame straightening — The correction of distortion in metal structures by localized heating with a gas flame.

Flange — A projecting rim or edge of a part; usually narrow and of approximately constant width for stiffening or fastening. See Rib.

Flash — Metal in excess of that required to fill completely the blocking or finishing forging impression of a set of dies. Flash extends out from the body of the forging as a thin plate at the line where the dies meet and is subsequently removed by trimming. Because it cools faster than the body of the component during forging, flash can serve to restrict metal flow at the line where dies meet, thus ensuring complete filling of the impression. See also Closed-Die Forging.

Flash extension — Portion of flash remaining after trimming. Flash extension is measured from the intersection of the draft and flash at the body of the forging to the trimmed edge of the stock.

Flash, internal — That portion of the flash located entirely within a forging or enclosed by two or more forgings within a cluster of forgings.

Flash land — Configuration in the blocking or finishing impression of forging dies designed to restrict or to encourage the growth of flash at the parting line, whichever may be required in a particular case to ensure complete filling of the impression.

Flash line — The line left on a forging after the flash has been trimmed off. See Parting Line.

Flashless forging — "True" closed die forging in which metal deformed in a die cavity permits virtually no excess metal to escape.

Flat die forging (open die forging) — Forging worked between flat or simple contour dies by repeated strokes and manipulation of the workpiece. Also known as "hand" or "smith" forging. See Open-Die Forging.

Flattener — Usually a flat surface cut to an exact depth below the parting line in each die to widen the material so as to more nearly cover the next impression.

Flattening — The forging operation of flattening the forging stock prior to further working.

Floating die — (1) A die mounted in a die holder or a punch mounted in its holder such that a slight amount of motion compensates for tolerance in the die parts, the work, or the press. (2) A die mounted on heavy springs to allow vertical motion in some trimming, shearing, and forming operations.

Flow lines — Patterns in a forging resulting from the elongation of nonhomogeneous constituents and the grain structure of the material in the direction of working during forging; usually revealed by macroetching. See also Grain Flow.

Flow stress — A measure of materials resistance to deformation and depends upon such things as temperature and strain rate.

Flow-through — A forging defect caused by metal flow past the base of a rib with consequent rupture of the grain structure.

Fluorescent magnetic particle inspection — Inspection with either dry magnetic particles or those in a liquid suspension, the particles being coated with a fluorescent substance to increase the visibility of the indications.

Fold — A forging defect caused by folding the metal back on its own surface during its flow in the die cavity. See Lap.

Force multiplier — A dimensionless factor that is used to describe the relative force requirement of a forging or a forging section.

Forgeability — The relative ability of material to deform without fracturing, rupturing, or developing flaws. Also describes the resistance to flow from deformation. See also Formability.

Forging — The process of working metal to a desired shape by impact or pressure in hammers, forging machines (upsetters), presses, rolls, and related forming equipment.

Forging billet — A wrought metal slug used as forging stock.

Forging dies — Forms for making forgings; they generally consist of a top and bottom die. The simplest will form a completed forging in a single impression; the most complex, consisting of several die inserts, may have a number of impressions for the progressive working of complicated shapes. Forging dies are usually in pairs, with part of the impression in one of the blocks and the rest of the impression in the other block.

Forging envelope — See Finish Allowance.

Forging machine (upsetter or header) — A type of forging equipment, related to the mechanical press, in which the main forming energy is applied horizontally to the workpiece, which is gripped and held by prior action of the grip dies.

Forging plane — The plane that includes the principal die face and is perpendicular to the direction of ram travel. When parting surfaces of the dies are flat, the forging plane coincides with the parting line.

Forging quality — Term describing stock of sufficiently superior quality to make it suitable for commercially satisfactory forgings.

Forging reduction — Ratio of the cross-sectional areas before and after forging; sometimes refers to percentage reduction in thickness.

Forging roll — Also known as reducer roll. A machine situated alongside the forging machine for pre-forming. The operation is carried out by passing the work-piece between contra-rotating shafts, which carry appropriately shaped dies.

Forging stock — A wrought rod, bar, or other section suitable for subsequent change in cross section by forging.

Forging stresses — Elastic residual stresses induced by forging or by cooling from the forging

temperature. They can be relieved by subsequent annealing or normalizing.

Form rolling — Hot rolling to produce bars having contoured cross sections; not to be confused with the roll forming of sheet metal or with roll forging.

Forward extrusion — Same as direct extrusion. See Extrusion.

Fracture toughness — The resistance of a given material to catastrophic failure in the presence of an existing sharp crack.

Frame — The main structure of a press.

Free-machining-steel forgings — Those made from steels with special alloying-element additions to facilitate machining.

Friction factor — A factor that, when multiplied by the flow stress, expresses the friction shear stress.

Fuller (fullering impression) — Portion of the die that is used in hammer forging primarily to reduce the cross section and lengthen a portion of the forging stock. The fullering impression is often used in conjunction with an edger (or edging impression).

Fullering — Reducing the cross section of a forging between ends of stock.

G

Gate (sprue) — A portion of the die that has been removed by machining and permits the bar or tongs to be closer to the impression without being smashed.

Gathering stock — Any operation whereby the cross-section of a portion of the forging stock is increased above its original size.

Gibs — Guides or shoes that ensure the proper parallelism, squareness, and sliding fit between press components such as the ram and the frame. They are usually adjustable to compensate for wear and to establish operating clearance.

Grain — An individual crystal in a polycrystalline metal or alloy.

Grain flow — Fiber-like lines appearing on polished and etched sections of forgings that are caused by orientation of the constituents of the metal in the direction of working during forging. Grain flow produced by proper die design can improve the mechanical properties of forgings.

Grain growth — An increase in the size of the grains of a metal with a proportional reduction of the number of grains.

Grain separation — In forging aluminum, rapid metal flow sometimes causes a separation or rupture of grain. Metal flow is affected by lubricant, die and metal temperature, part shape, alloy, and hammer operator technique; consequently, any one or combination of these factors can cause grain separation. The irregular crevices are seldom more than a few thousandths of an inch deep and can be removed by grinding or polishing.

Grain size — An expression that rates the number of grains per unit area of cross section as determined by metallographic examination.

Gravity hammer — A class of forging hammer wherein energy for forging is obtained by the mass and velocity of a freely falling ram and the attached upper die. Examples are board hammers and air-lift hammers.

Gripper dies — The lateral or clamping dies used in a mechanical upsetter or forging machine.

Grit blasting — See Blasting.

Guide — The parts of a drop hammer or press that guide the up-and-down motion of the ram in a true vertical direction.

Gutter — A shallow impression machined around the periphery of a forging die impression outside the flash land that acts as a reservoir for excess metal.

H

Hammer — A machine that applies a sharp blow to the work area through the fall of a ram onto an anvil. The ram can be driven by gravity or power. See also Gravity Hammer and Power-Driven Hammer.

Hammer forging — The mechanical forming of metal by means of a hammer. The action of the hammer is that of an instantaneous application of pressure in the form of a sudden blow.

Hand forging — (See also Open Die Forging) (1) A forging made by hand on an anvil or under a power hammer without dies containing an exact finishing impression of the part. Such forgings approximate each other in size and shape but do not have the commercial exactness of production die forgings.

Used where the quantity of forgings required does not warrant expenditure for special dies, or where the size or shape of the piece is such as to require means other than die forging. (2) A forging worked between flat or simply shaped dies by repeated strokes and manipulation of the piece. Also known as smith forging or flat die forging.

Hand straightening — A straightening operation performed on a surface plate to bring a forging within the straightness tolerance. Frequently, a bottom die from a set of finish dies is used instead of a surface plate. Hand tools used include mallets, sledges, blocks, jacks, and oil gear presses in addition to regular inspection tools.

Handling hole — Holes drilled in opposite ends of the die block to permit handling by the use of a crane or bar.

Handling marks — Nicks and gouges formed on forgings if improperly handled; most prevalent for forgings in the as-forged condition prior to heat treatment.

Header — See Forging machine.

Heading — The upsetting of wire, rod, or bar stock in dies to form parts that usually contain portions that are greater in cross-sectional area than the original wire, rod, or bar.

Heat — A term used to identify the material produced from a single melting operation. Different heats of the same material can vary in chemical composition within prescribed limits. Stock from a single heat will have a consistent analysis and more uniform properties. Also known in the U.K. as "Cast".

Heat (forging) — Amount of forging stock placed in a batch-type furnace at one time.

Heat analysis — See Ladle analysis.

Heat-resistant steel — Alloy steel designed for application at elevated temperatures.

Heat treatment — A sequence of controlled heating and cooling operations applied to a solid metal to impart desired properties.

Hogout — A product machined from bar or plate stock or from a hand forging, rather than from an impression die forging. The process is commonly known as "hogging out" material.

Hollow forging — (1) Processes for forging tubes or ring forgings. (2) Cylindrical open die forging, e.g., thick-walled tubes or rings.

Hot-die forging — A process in which dies are heated close to the forging temperature of the alloy being forged; used for difficult-to-forge alloys.

Hot forging — Same as hot working—plastically deforming an alloy at a temperature above its recrystallization point, i.e., high enough to avoid strain hardening.

Hot inspection — An in-process examination of forgings, using gauges, templates, or other nondestructive inspection methods to ensure quality.

Hot shortness — Lack of ductility when metal is hot.

Hot trimming — The removal of flash or excess metal from a hot part (such as a forging) in a trimming press.

Hot upset forging — A bulk forming process for enlarging and reshaping some of the cross-sectional area of a bar, tube, or other product form of uniform (usually round) section. It is accomplished by holding the heated forging stock between grooved dies and applying pressure to the end of the stock, in the direction of its axis, by the use of a heading tool, which spreads (upsets) the end by metal displacement. Also called hot heading or hot upsetting. See also Heading and Upsetting.

Hot working — The plastic deformation of metal at such a temperature and strain rate that recrystallization takes place simultaneously with the deformation, thus avoiding any strain hardening. Also referred to as hot forging and hot forming. Contrast with cold working.

Hub — A boss that is in the center of a forging and forms a part of the body of the forging.

Hydraulic hammer — A gravity-drop forging hammer that uses hydraulic pressure to lift the hammer between strokes.

Hydraulic press — A forging press with a hydraulically operated ram.

Impact extrusion — A reverse extrusion process in which metal is displaced backwards between a punch and a die to form a hollow part.

Impact test — Test to determine the energy absorbed in fracturing a notched test bar at high velocity. See also Charpy Test, Izod Test.

Impact velocity — The relative velocity of the forging dies just prior to impact.

Impression — A cavity, or series of cavities (multiple), machined into a forging die to produce a desired configuration in the workpiece during forging.

Impression die forging — A forging that is formed to the required shape and size by machined impressions in specially prepared dies that exert three-dimensional control on the workpiece.

Inclusions — Particles of nonmetallic compounds of metals and impurity elements that are present in ingots and are carried over in wrought products. The shape and distribution of inclusions are changed by plastic deformation and contribute to directionality in metals.

Indirect (backward) extrusion — See Extrusion.

Induction heating — Heating metals by means of an alternating magnetic field.

Ingot — A casting intended for subsequent rolling, forging, or extrusion.

Ingotism — A term used to describe the remnants of dendritic structure which may occasionally be found in forgings.

Insert — A piece of steel that is tightly fixed in a die. The insert may be used to fill a cavity, to replace a portion of the die with a grade of steel that is better suited for service at that point, or to function as a small die with the impression fastened to a master die.

Insert die — A relatively small die containing part or all of the impression of a forging, and which is fitted to the master die block by means of a key.

Isothermal forging — A hot-forging process in which a constant and uniform temperature is maintained in the workpiece during forging by heating the dies to the same temperature as the workpiece. Most commonly conducted at about 2000°F under a controlled atmosphere or

in a vacuum to prevent oxidation while forging superalloys.

Izod impact test — A pendulum-type impact test in which the specimen is supported at one end as a cantilever beam and the energy required to break off the free end by the impact of a falling pendulum is used as a measure of impact strength. See Charpy Impact Test.

K

Knockout — A mechanism for releasing workpieces from a die.

Knockout mark — A small protrusion, such as a button or ring of flash, resulting from the depression of a knockout pin from the forging pressure, or the entrance of metal between the knockout pin and the die.

Knockout pin — A power-operated plunger installed in a die to aid removal of the finished forging.

L

Ladle analysis — The results of the chemical analysis of a test sample taken during the pouring of a melt. Also called heat analysis.

Lap — A surface irregularity appearing as a fissure or opening, caused by the folding over of hot metal, fins or sharp corners and by subsequent rolling or forging (but not welding) of these into the surface.

Layout — (1) Transferring drawing or sketch dimensions to templates or dies for use in sinking dies. (2) A detailed inspection operation in which significant dimensions of a forging are checked against blueprint specifications.

Layout sample — A plaster, lead, or forged alloy sample taken from new dies to verify accuracy by layout and precise measurement. See also Cast.

Lead proof — A reproduction in lead, or a lead alloy, of the die impression, obtained by clamping the two dies together in alignment and pouring molten metal into the finish impression.

Liftout — The mechanism also known as knockout.

Lock — In forging, a condition in which the flash line is not entirely in one plane. Where two or more plane changes occur, it is called compound lock. Where a lock is placed in the die to compensate for die shift caused by a steep lock, it is called a counterlock.

Locked dies — Dies with mating faces that lie in more than one plane.

Lower punch — The lower part of a die, which forms the bottom of the die cavity and which may or may not move in relation to the die body; usually movable in a forging die.

Lubricant — A material applied to dies, molds, plungers, or workpieces that promotes the flow of metal, reduces friction and wear, and aids in the release of the finished part.

Lubricant residue — The carbonaceous residue resulting from lubricant burned on the surface of a hot forged part.

M

Machine forging (upsetter forging) — The process of forging in a forging machine (upsetter), in which the metal is moved into the die impression by pressure applied in a horizontal direction by the moving die in the ram.

Machining allowance — See Finish allowance.

Macroetch — A testing procedure for conditions such as porosity, inclusions, segregation, carburization, and flow lines from hot working. After applying a suitable etching solution to the polished metal surface, the structure revealed by the action of the reagent can be observed visually. See Etch test.

Macrostructure — The structure and condition of metals as revealed on a suitably prepared and etched sample, and visible without the use of a microscope or under low magnification (up to 10 diameters).

Magnetic-particle inspection (testing) — A nondestructive method of inspection/testing for determining the existence and extent of possible defects in ferro-magnetic materials. The metal is magnetized, then iron powder is applied. The powder adheres to lines of flux leakage, revealing surface and near-surface discontinuities.

Mandrel — A blunt-ended tool or rod used to retain or enlarge the cavity in a hollow metal product during forging.

Mandrel forging — The process of rolling and forging a hollow blank over a mandrel in order to produce a weldless, seamless ring or tube. See Saddle/Mandrel Forging.

Manipulator — A mechanical device for handling an ingot or a billet during forging.

Master — Wood, metal or plastic reproduction of a proposed forged shape, used to control cutters on tracer-controlled die sinking equipment.

Master block (or master holder) — A forging die block primarily used to hold insert dies.

Match — A condition in which a point in one die half is aligned properly with the corresponding point in the opposite die half within specified tolerance.

Matching draft — Increased draft used on the shallow side of a forging to match its surface at the parting line with a similar surface of less draft on the deeper side.

Mechanical press — A forging press with an inertia flywheel, a crank and clutch, or other mechanical device to operate the ram.

Mechanical upsetter — A three-element forging press, with two gripper dies and a forming tool, for flanging or forming relatively deep recesses.

Metal discontinuities — See Discontinuities.

Microalloyed-steel forging — One made from a microalloyed steel requiring only controlled cooling to reach optimum properties, in contrast to conventional quenched-and-tempered steels that require traditional heat treatments to achieve the same results.

Microstructure — The structure and internal condition of metals as revealed on a ground and polished (and sometimes etched) surface when observed at high magnification (over 10 diameters).

Mill scale — The heavy oxide layer that forms during heating and forging of steel.

Mismatch — The misalignment or error in register of a pair of forging dies; also applied to the condition of the resulting forging.

Mismatch allowance — An allowance for misalignment (or mismatch) included in forging tolerances.

Multiple — (1) Term used to describe a die impression designed to produce more than a single piece at a time. (2) A piece of stock for forging that is cut from bar or billet lengths to provide the exact amount of material needed for a single workpiece.

N

Natural draft — Taper on the sides of a forging, due to its shape or position in the die, that makes added draft unnecessary.

Near-net-shape forging — Forging components as close as possible to the required dimensions of the finished part.

Nesting — The positioning of multiple pieces in a forging die design.

Net-shape forging — (See also Precision forging) Forging components on one or more sides to net shape requiring no further machining on at least one side. e.g. net forged gear with machined back face.

No-draft forging — A forged shape with extremely close tolerances and little or no draft, requiring a minimum of machining to produce the final part. Mechanical properties can be enhanced by this closer control of grain flow and retention of surface material in the final component.

Nondestructive inspection — Any method of detection or measurement of the properties or performance capabilities of materials, parts, assemblies, or structures that does not impair the surface or internal integrity of the part.

Nonferrous — Metals or alloys that contain no appreciable quantity of iron; applied to such metals as aluminum, copper, magnesium, and their alloys.

Nonfill (underfill) — Forging condition that occurs when the finish die impression is not completely filled with metal. Some causes are: improper distribution of metal in preforming operations such as fullering, edging, and blocking; excessive removal of material by chipping defects prior to finish forging; improper lubrication of die impression; low forging pressure; rough or uneven die finish; inadequate hammer or press capacity.

Nonmetallic inclusions — See Inclusions.

O

Offset — (1) A condition created in a forging when the dies used in the forging operation do not align properly. (2) The alignment of the upper and lower dies in the hammer or press.

Open die forging — Forging produced by working between flat or simply contoured dies with unrestricted metal flow using repetitive strokes

and continuous manipulation of the workpiece; sometimes called hand forging.

Open dies — Dies with flat surfaces that are used for preforming stock or producing hand forgings.

Overheated metal — Metal with an undesirable coarse grain structure due to exposure to an excessively high temperature. Unlike a "burnt" structure, the metal is not permanently damaged but can be corrected by mechanical working.

Overetch — In the normal processing of aluminum forgings, a caustic etch operation is employed for the dual purpose of cleaning parts and emphasizing defects to facilitate visual inspection. Immersion of parts for too long or use of too concentrated a solution will produce a rough, slightly pitted surface.

P

Pancake forging — A rough forged shape, usually flat, that can be obtained quickly with minimal tooling. Considerable machining is usually required to attain the finish size.

Parting line — (1) The line along the surface of a forging where the dies meet, usually at the largest cross section of the part. Flash is formed at the parting line. (2) The plane that divides the two forging die halves.

Penetration rate — Depth rate of working.

Pickling — The process of removing oxide scale from forgings by treating in a heated acid bath.

Pick-up — Small particles of oxidized metal adhering to the surface of a mill product.

Pierce — In ring rolling, the process of providing a through hole in the center of an upset forging using a tapered or cylindrical punch. See Drifting.

Plan view area — The area of the plan view of a forging; sometimes used to indicate the relative size of a forging.

Planishing — A finishing operation for the purpose of removing the trim line of forgings or of obtaining closer tolerances. Usually done by rolling, pressing or hammering, hot or cold.

Plaster cast — See Lead Proof.

Platter — The entire mass of metal upon which the hammer performs work, including the flash, sprue, tonghold, and as many forgings as are made at one time.

Plug — (1) A protruding portion of a die impression for forming a corresponding recess in the forging. (2) A false bottom in a die.

Poisson's ratio — The ratio of strain in the longitudinal direction to that in the transverse direction. Typical values range from 0.28 to 0.33 for most forging alloys.

Powder forging — The plastic deformation of a powder metallurgy compact or preform into a fully dense finished shape by using compressive force; usually done hot and within closed dies.

Power-driven hammer — A forging hammer with a steam or air cylinder for raising the ram and augmenting its downward blow.

Power rolls — Power-driven rolls used in preforming bar or billet stock that have shaped contours and notches for introduction of the work.

Precision forging — (See also Net-shape forging) A forging produced to closer tolerances than normally considered standard by the industry.

Preform — (1) The forging operation in which stock is preformed or shaped to a predetermined size and contour prior to subsequent die forging operations. When a preform operation is required, it will precede a forging operation and will be performed in conjunction with the forging operation and in the same heat. (2) Ring blanks of a specific shape for profile (contour) ring rolling. (3) The initially pressed powder metallurgy compact to be subjected to repressing.

Preform impression — Any one or a combination of preliminary die impressions used in producing a preform. Also known as blocker, buster, scalebreak, and extrusion.

Preheating — (1) A preliminary heating of ingots, billets, or forgings to reduce the hazards of thermal shock upon subsequent heating to higher temperatures. (2) A high-temperature soaking treatment used to change the metallurgical structure in preparation for a subsequent operation, usually applied to the ingot.

Preparation charge — A one-time charge covering the cost of sinking dies and preparing required auxiliary tooling for producing forgings to a particular design. In usual practice, this charge conveys to the customer the exclusive right to purchase forgings produced on this tooling. The dies themselves are the property of the forger,

who also has the responsibility for maintaining and replacing the dies as required for satisfactory production of forgings.

Pre-pierce — (1) In ring rolling, a vertically mounted piercing (punching) tool used for preparation of ring blanks on the ring blank press. (2) A tapered tool of various diameters and lengths.

Press — A machine tool with a stationary bed and a slide or ram that has reciprocating motion at right angles to the bed surface; the ram is guided in the frame of the machine.

Press capacity — The rated force a press is designed to exert at a predetermined distance above the bottom of the stroke of the ram.

Press forging — The shaping of metal between dies on a mechanical or hydraulic press. The action is that of kneading the metal by relatively slow application of force as compared with the action of hammering.

Pressure profile — A tabulation of the change in pressures across a forging section, usually in graphical form.

Profile (contour) rolling — In ring rolling a process to produce seamless rolled rings with a predesigned shape either on the outside or the inside diameter, requiring less volume of material and less machining to produce finished parts.

Progressives — A collection of sample forgings taken following the first and subsequent blows of the forging sequence. Also known as a progression.

Prolongation — An extra portion of metal added in a mutually agreeable location of a forging to permit removal and subsequent testing without destroying the forging. Generally applies to open die and some large rolled rings.

Proof — Any reproduction of a die impression in any material. See also Lead Proof.

Punchout — Metal removed when punching a hole in a forging.

R

Ram — The main reciprocating member of a press, guided in the press frame, to which the punch or upper die is fastened.

Ram adjustment — The distance that a press ram position can be altered to change the shut height of the die space. The adjustment can be made by

hand or by power mechanism.

Rib — A relatively flat (but generally with draft) thin portion of a forging, generally perpendicular to the forging plane.

S

Sadden — To forge an ingot lightly in the initial forging operation in order to break up and refine coarse, as-cast structure at the surface.

SAE (specifications) — The Society of Automotive Engineers.

Shoe — A holder used as a support for the stationary portions of forging and trimming dies.

Shot blasting — A process of cleaning forgings by propelling metal shot at high velocity by air pressure or centrifugal force at the surface of the forgings. See also Blast cleaning.

Shrinkage — The contraction of metal during cooling after hot forging. Die impressions are made oversize according to precise shrinkage scales to allow the forgings to shrink to design dimensions and tolerances.

Shrink scale — A measuring scale or rule, used in die layout, on which graduations are expanded to compensate for thermal contraction (shrinkage) of the forging during cooling.

Shut height — For a press, the distance from the top of the bed to the bottom of the ram with the stroke down and adjustment up. In general, it is the maximum die height that can be accommodated for normal operation, taking the bolster plate into consideration.

Shuts (cold) — Faults produced in a forging by incorrect tool design or incorrect flow of steel that results in the formation of a crack in the forging surface.

Side thrust — Lateral force exerted between the dies by reaction of the forged piece on the die impressions.

Sinking — The operation of machining the impression of a desired forging into die blocks.

Sizing — Secondary forming or squeezing operations needed to square up, set down, flatten, or otherwise correct surfaces to produce specified dimensions and tolerances. Often accomplished with a coining press. See Coining.

Sliver — A slender fragment or splinter that is a part of the material, but that is incompletely attached. A torn fiber of metal forced into the surface of a forging.

Slot furnace — A common batch-type forge furnace where stock is charged and removed through a slot or opening.

Slug — (1) Forging stock for one workpiece cut to length. See also Blank. (2) Metal removed when punching a hole in a forging (also termed "punchout").

Smith — The blacksmith, forger, or pressman.

Smith forging — See Flat die forging, Hand forging.

Smith hammer — Any power hammer where impression dies are not used for the reproduction of commercially exact forgings.

Snag grinding (snagging) — The process of removing portions of forgings not desired in the finished product, by grinding.

Sow block — A block of heat-treated steel placed between a hammer anvil and a forging die to prevent undue wear to the anvil. Sow blocks are occasionally used to hold insert dies. Also called Anvil cap.

Splitter impression — (1) A die cavity used to divide laterally or split the material being worked so that it better covers the impression and reduces forging load; (2) A die cavity used to cut the material apart in the desired section by means of a shearing action.

Split die — A die made of parts that can be separated for ready removal of the workpiece. Also known as segment die.

Springback — (1) The elastic recovery of metal after stressing. (2) The extent to which metal tends to return to its original shape or contour after undergoing a forming operation. This is compensated for by overbending or by a secondary operation of restriking.

Stainless steels — Steels that are corrosion and heat resistant and contain a minimum of 10% to 12% chromium. Other alloying elements are often present.

Stamp (marking) — An operation performed to identify the particular forgings as specified or requested by the customer.

Station — A regular stopping place in the die during the forging sequence.

Steam hammer — A type of drop hammer where the ram is raised for each stroke by a double-action steam cylinder and the energy delivered to the workpiece is supplied by the velocity and weight of the ram and attached upper die driven downward by steam pressure. Energy delivered during each stroke may be varied.

Stock — The material to be forged regardless of form. Also, an individual piece of metal used to produce a single forging.

Stock marks — In cutting forging stock to specified length for a die-forged part, the ends of the bar always contain surface imperfections caused by the cutting tool; these are often retained on the surface of the finished part. If pronounced, such marks are removed by light grinding. On parts where repeated indications of stock marks are encountered, efforts are usually made to eliminate them by conditioning the stock ends prior to forging by polishing the cut ends and beveling the edge of the cut.

Straighten — Finishing operation for correcting misalignment in a forging or between different sections of a forging. Straightening may be done by hand, with simple tools, or in a die in forging equipment.

Straighten, coin — A combination coining and straightening operation performed in special cavity dies designed to impart a specific amount of working in specified areas of the forging to relieve stresses set up during heat treatment.

Straighten, die — A straightening operation performed in either a hammer or a press using flat or cavity dies to remove undesired deformation and bring the forging within straightness tolerance.

Straighten, hand — A straightening operation performed on a surface plate to bring a forging within straightness tolerance. Frequently, a bottom die from a set of finish dies is used instead of a surface plate; hand tools used include mallets, sledges, blocks, jacks, and oil gear presses, in addition to regular inspection tools.

Strain hardening — An increase in hardness and strength caused by plastic deformation at temperatures below the recrystallization range. Also known as work hardening.

Strain rate — The rate at which metal is deformed.

Strain-rate sensitive — Alloy that can be forged only at low rates of deformation.

Stripper — A lug or ring on the forging or an impression in the dies of a mechanical upsetter to ensure firm clamping of the workpiece in the gripper dies.

Stripper punch — A punch that serves as the top or bottom of the die cavity and later moves farther into the die to eject the part or compact. See also Ejector and Knockout.

Stroke (up or down) — The vertical movement of a ram during half of the cycle, from the full open to the full closed position or vice versa.

Structural integrity — Inherent microstructural soundness of forgings as a result of achieving 100% density, uniform metallurgical structure and grain size, as well as the absence of porosity, segregation, large inclusions, and other non-forged part defects.

Sub-sow block (die holder) — A block used as an adapter in order to permit the use of forging dies that otherwise would not have sufficient height to be used in the particular unit or to permit the use of dies in a unit where the shank sizes are different.

Suck-in — A defect caused by the "sucking in" of one face of a forging to fill a projection on the opposite side.

Superalloys — A term broadly applied to iron-base, nickel-base, and cobalt-base alloys, often quite complex, that exhibit high elevated-temperature mechanical properties and oxidation resistance.

Superplasticity — The ability of certain metals to develop extremely high tensile elongations at elevated temperatures and under controlled rates of deformation.

Swaging — (1) Reducing the diameter of or rounding out a section of a forging by a series of blows, tapering the forging lengthwise until the entire section attains the smaller dimension of the taper. (2) Tapering forging stock by forging, hammering, or squeezing.

T

Table mill — In ring rolling, a type of ring forging equipment employing multiple mandrels with a

common main roll. Usually used in high volume production of small-diameter rolled rings.

Target machining — Incorporating a "target" (benchmark or gage point) on a forging to facilitate machining; coined locating surfaces and drilled centers are commonly used.

Temperature (Forging) — The temperature of the forging stock just prior to forging.

Template (Templet) — A gage or pattern made in a die department, usually from sheet steel; used to check dimensions on forgings and as an aid in sinking die impressions in order to correct dimensions.

Thermal cracks — Ruptures in metal set up by stresses due to thermal differentials.

Thermal-mechanical treatment — See Thermomechanical working.

Thermomechanical working — A general term covering a variety of processes combining controlled thermal and deformation treatments to obtain synergistic effects, such as improvement in strength without loss of toughness.

Thermal stress — Stresses in metal resulting from non-uniform distribution of heat.

Tolerance — The permissible deviation from a specification for any design characteristic.

Tong hold — The portion of the forging billet, usually on one end, that is gripped by the operator's tongs. It is removed from the part at the end of the forging operation. Common to drop hammer and press-type forging.

Tongs — Metal holder used to handle hot or cold forgings.

Tool steel — A superior grade of steel made primarily for use in tools and dies.

Tooling marks — Indications imparted to the surface of the forged part from dies containing surface imperfections or dies on which some repair work has been done. These marks are usually slight rises or depressions in the metal.

Tooling pad — See Chucking lug.

Trepanning — Removal of a core of metal by a hollow tool. May be performed by a hollow punch at forging temperatures or by a hollow cutting tool by machining at ambient temperatures.

Trim — The removal of the excess metal or flash produced during the forging process. The operation takes place in tools produced to the peripheral shape of the component, the component being pushed through the female impression by the identically-shaped male punch. The operation may be carried out hot or at room temperature.

Trim and punch — (1) A shearing operation to remove both an inner and an outer section of metal from a blocked or finished forging. (2) A combination of two operations whereby flash and punchout are removed simultaneously. The operation is generally performed on a trim press using a combination trim and punch die.

Trimmer — The combination of trimmer punch, trimmer blades, and perhaps trimmer shoe used to remove flash from a forging.

Trimmer blade — The portion of the trimmers through which the forging is pushed to shear off the flash. The shearing edge may be in more than one plane in order to fit the parting line of the forging.

Trimmer die — The upper portion of the trimmer that comes in contact with the forging and pushes it through the trimmer blades; the lower end of the trimmer punch is generally shaped to fit the surface of the forging against which it pushes. Also termed Trimmer punch.

Trimming press — A power press suitable for trimming flash from forgings.

Tryout — Preparatory run to check or test equipment, lubricant, stock, tools, or methods prior to a production run. Production tryout is run with tools previously approved; new die tryout is run with new tools not previously approved.

Tumbling — (1) The process for removing scale from forgings in a rotating container by means of impact with each other and abrasive particles and small bits of metal. (2) A process for removing scale and roughness from forgings by impact with each other, together with abrasive material in a rotating container.

Turning — Removing metal from the outside of a part by means of a tool in a lathe or similar machine tool.

U

Ultrasonic testing — A method of nondestructive testing of solid metal for internal flaws utilizing high-frequency sound waves.

Undercuts — Sections of a forging which, if driven into the impression while the metal is hot, would lock themselves into a die impression and prevent removal of the forging without distortion.

Underfill — A portion of a forging that has insufficient metal to give it the true shape of the impression.

UNS — The Unified Numbering System. A system that provides a means of correlating many nationally used numbering systems currently administered by societies, trade associations, and individual users and producers of metals and alloys, thereby avoiding confusion caused by use of more than one identification number for the same material. It also avoids having the same number assigned to two or more entirely different materials.

Upset forging — (1) A forging made by upsetting an appropriate length of bar, billet or bloom. (2) Working metal to increase the cross-sectional area of a portion or all of the stock. (3) A forging formed by heading or gathering the material by pressure upon hot or cold metal between dies operated in a horizontal plane.

Upsetter (Forging machine) — A horizontal forging machine where the workpiece is gripped between two grooved dies and deformed by a punch that exerts force on the end of the stock.

V

Vent — A small hole in a punch or die for admitting air to avoid suction holding or for relieving pockets of trapped air that would prevent die closure or action.

Vent mark — A small protrusion resulting from the entrance of metal into die vent holes.

W

Warm forging — Deformation at elevated temperatures below the recrystallization temperature. The flow stress and rate of strain hardening are reduced with increasing temperature; thus, lower forces are required than in cold working. For steel, the temperatures range from about 1000° F to just below the normal hot

working range of 1900 to 2300° F. See also Cold Working and Hot Working.

Warpage — Term generally applied to distortion that results during quenching from heat-treating temperatures; hand straightening, press straightening, or cold restriking is employed, depending on the configuration of the part and the amount of warpage involved. The condition is governed by applicable straightness tolerances; beyond tolerances, warpage is defect and cause for rejection. The term is not to be confused with "bend" or "twist."

Ways — The fitted V-shaped grooves in the ram and columns of a hammer or press that guide the descent and ascent of the ram.

Web — A relatively flat, thin portion of a forging, generally parallel to the forging plane—that connects ribs and bosses. See also Rib.

Wrought steel — A descriptive term for any particle of steel that has been produced by hot mechanical working.