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IS 14758 (2000): Forging Machine Tools - Glossary of Terms  
[PGD 4: Metal Forming Machines]



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भारतीय मानक

गढ़ाई मशीन - पारिभाषिक शब्दावली

*Indian Standard*

**FORGING MACHINE TOOLS – GLOSSARY OF TERMS**

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110 002

## FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Metal-Forming Machines Sectional Committee had been approved by the Basic and Production Engineering Division Council.

This standard has been prepared to cater to the needs of forging machine tool industry for correct understanding of terms used in connection with forging machines, processors, relating tools and their components. It would also help in correct interpretation of common terms being used in this field.

## *Indian Standard*

# FORGING MACHINE TOOLS – GLOSSARY OF TERMS

### 1 SCOPE

This standard covers the terms and definitions relating to forging machine tools.

### 2 TERMINOLOGY

The glossary of terms relating to forging machine tools are as follows.

**2.1 Ageing** — A gradual change in properties of a metal that occur at ambient/low temperatures (Natural ageing) and more rapidly at higher temperatures (artificial ageing).

**2.2 Angularity** — The conformity or deviation of the specified angular dimensions in the cross-section of a shape or bar.

**2.3 Annealing, Full** — A heat treating operation wherein metal is heated to a temperature above its critical range, held at that temperature long enough to allow full recrystallization, then slowly cooled through the critical range. Annealing removes working strains, reduces hardness and increases ductility.

**2.4 Anvil** — Extremely large and heavy block of metal that supports the entire structure of conventional gravity or steam driven forging hammers. Also, the block of metal on which hand or (Smith) forgings are made.

**2.5 Anvil Block/Anvil Cap/Bolster** — A block of hardened, heat treated steel placed between the anvil of the hammer and the forging die to prevent undue wear to the anvil.

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

**2.7 Axis of Deformation** — Line along which the resulting deformation power acts.

**2.8 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 100 cm<sup>2</sup>. 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 0.95 cm or more.

**2.9 Bar End/End Loss** — Bar end left over after cutting bar lengths of stocks into forging multiples.

**2.10 Bar Hold** — The end of a bar of forging, so reduced as to accommodate tongs for manipulation during forging.

**2.11 Bar : To Forge from a Bar** — To produce a forging off a length of bar material greater in length than is required for that forging.

**2.12 Batch Type Furnace** — A furnace for heating of materials in which the loading and unloading is done through a single door or slot.

**2.13 Bed** — Stationary platen or a press to which the lower die assembly is attached.

**2.14 Belt Drop Hammer/Stamp** — A hammer using a belt as a means of lifting the tup.

**2.15 Belt** — The flexible connection used for lifting the tup of the hammer.

**2.16 Bend/Twist (A 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'. Low-draft and no-draft forgings are more susceptible to bending, as they must be removed from the dies by some form of mechanical ejection. Dull trimming tools and improper nesting would cause bending in the trimming operation. When bend or twist exceeds tolerances, it is considered a defect. Corrective action entails either hand straightening, machine straightening or cold restriking.

**2.17 Bend (An Operation)** — Operation to preform (bend) stock to approximate shape of die impression for subsequent forging; also includes final forming.

### 2.18 Bender

**2.18.1** Bends stock in the required directions for preliminary forging to approximate the ultimate shape; the die portion forming the longitudinal axis in one or more planes.

**2.18.2** 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.

### 2.19 Billet

**2.19.1** A semifinished section hot rolled from a metal ingot, with a rectangular cross-section usually ranging from 100 to 230 cm<sup>2</sup>, the width being less than twice the thickness. Where the cross-section exceeds

230 cm<sup>2</sup>, the term 'bloom' is properly but not universally used. Sizes smaller than 100 cm<sup>2</sup> are usually termed 'bars', a solid semifinished round or square product which has been hot worked by forging, rolling, or extrusion.

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

**2.20 Blank** — A piece of stock (also called a 'slug' or 'multiple') from which a forging is to be made.

**2.21 Blast Cleaning (Sand Blasting)** — A process for cleaning or finished metal objects by use of an air-jet or centrifugal wheel that propels abrasive particles (grit, sand or shot) against the surfaces of the work piece at high velocity.

**2.22 Blister** — A raised part on the surface of the metal caused by expansion of gas in a sub-surface zone during thermal treatment.

**2.23 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).

**2.24 Blocker** — 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 primary operations; it also reduces die wear in the finishing impression.

**2.25 Blow** — The impact or force delivered by one work stroke of the forging equipment.

**2.26 Blow 'Die to Die'** — Blow with upper and lower dies making contact.

**2.27 Board Drop Hammer/Stamp** — 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.

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

**2.29 Bottom Die** — That half of a die fixed to the anvil.

**2.30 Bow** — Longitudinal curvature.

**2.31 Breaker** — That part of the die used to distribute the metal in the proportion necessary to fill the die impression.

**2.32 Broken Surface** — Surface fracturing generally most pronounced at sharp corners.

**2.33 Burn (To Burn)** — Heating to such a high temperature that the properties of the material are permanently impaired by incipient fusion or oxide penetration.

**2.34 Buster/Pre-Blocking Impression** — A type of die impression some times used to combine preliminary forging operations such as edging and fullering with the blocking operation to eliminate blows.

**2.35 Carbonise** — Introducing carbon into the surface by heating to and holding at a suitable temperature usually above the transformation range in contact with a suitable source of carbon.

**2.36 Cavity/Die Cavity** — The machined recess in a die that gives the forging its shape.

**2.37 Chamfer** — Break or remove sharp edges or corners of forging stock by means of straight angle tool or grinding wheel.

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

**2.39 Chip Mill** — An intermediate inspection and repair operation in which surface defects in forgings are located and removed by means of chipping hammers, rotor mills, and similar tools (not to be confused with final inspection where similar operations are performed).

**2.40 Chipping** — A method for removing seams and other surface defects with a chisel or gouge so that the defects are not allowed in the finished product.

**2.41 Chisel** — Forging tool used to cut metal by notching. Cold chisels are used to notch cold metal so that it can be broken by a hammer blow; hot chisels are often used to make a complete cut in hot metal.

**2.42 Coating/Wear Resistance Coating** — Depositing a hard layer on the die surface in order to improve wear resistance.

**2.43 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.

**2.44 Clink** — A rupture caused by thermal stress or thermo cycling.

**2.45 Clip (To Clip)** — To remove flash or extraneous metal by a shearing action.

**2.46 Clipping Bed** — The lower member of the clipping tools used for removing the flash from the forgings.

**2.47 Clipping Punch** — The upper or moving member of the clipping tools used for removing the flash from drop forgings.

**2.48 Clipping Tool** — A tool used for removing flash by shearing it from the forging.

**2.49 Closed Die Forging/Impression Die Forging** — A forging that is formed to the required shape and size by machined impressions in specially prepared dies that exert 3-dimensional control on the work piece.

**2.50 Close Tolerance Forging/Net or Near Net Shape Forging** — A forging held to usually close dimensional tolerances. Often little or no machining is required after forging.

**2.51 Closure/Die Closure** — A term frequently used to mean variations in thickness of a forging.

**2.52 Coil (Induction)** — A coil carrying a current of known frequency to produce a uniform magnetic field within itself.

**2.53 Coining** — The process of applying necessary pressure to all or some portion of the surface of a forging to obtain closure tolerances or smoother surfaces or to eliminate draft. Coining can be done while forgings are hot or cold and is usually performed on surfaces parallel to the parting line of the forging.

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

**2.55 Coin Sizing** — A cold squeezing operation for refining face distance dimensions on forgings.

**2.56 Coin Straightening** — A combination coining and straightening operation performed in special cavity dies so designed as to also impart a specific amount of working in specified areas of the forging to relieve stresses developed during heat treatment.

**2.57 Cold Coin 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.

**2.58 Cold Shut** — A defect characterized by a fissure or lap on the surface of a forging that has been closed without fusion during the forging operation.

**2.59 Cold Working** — Permanent plastic deformation of metal at a temperature below its recrystallization point — blow enough to produce strain hardening.

**2.60 Commercial Tolerance Forging** — A forging held to dimensions closer than commercial tolerances.

**2.61 Contouring** — Milling a die impression in such a manner that the milling cutter flows the outer line.

**2.62 Contraction** — The reduction in dimensions occurring during the cooling of metals and other substances.

**2.63 Copy Milling** — A method of producing a shape on a milling machine by connecting the cutter with a copying stylus, which slides along the master.

**2.64 Core** — The softer interior portion of an alloy piece that has been surface hardened; or, that portion of a forging removed by trepanning or punching.

**2.65 Counter Blow Hammer** — A category of forging equipment wherein two opposed rafts are actuated simultaneously, striking repeated blow on the work piece at a mid way point. Action may be vertical, as in the case of counter blow forging hammers, or horizontal as with an impactor.

**2.66 Counter Lock** — A jog in mating surfaces of dies to prevent lateral die shift caused by side thrust during forging of irregularly shaped pieces.

**2.67 Crack** — Fissures resulting from stress conditions.

**2.68 Crank Press** — A press operating by a connecting rod which is driven by a crank on the main shaft.

**2.69 Crop (To Crop)** — To detach metal from a bar or billet by applying a shearing force normal to its length without loss of material.

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

**2.71 Cushion Faces** — The faces of the top and bottom dies which can make contact on striking.

**2.72 Cut-Off** — A pair of blades positioned in dies or equipment (or a section of the die milled to produce the same effect as inserted blades) used to separate the forging from the bar after forging operations are completed. (Used only when forgings are produced from relatively long bars instead of individual, precut multiples or blanks.)

**2.73 Cutters** — Cutters are used with power hammer, instead of chisels. They often have long, straight blades, but sometimes the blades are curved or in the shape of a 90° angle; blades are attached to handles of varying lengths.

**2.74 Cutting** — Cutting stock to specified length or weight on circular saws or band hacksaws or shear presses.

**2.75 Decarburisation** — The loss of carbon from the surface of steel by heating above lower critical temperature or by chemical action. Decarburisation is usually present to a slight extent in steel forgings. Excessive decarburisation can result in defective products.



**2.76 Deformation** — Permanent change in the shape of a material by application of force.

**2.77 Deformation Efficiency** — Ratio of assumed frictionless deformation work of actual work.

**2.78 Deformation Force** — The force necessary for the deformation of the work piece.

**2.79 Deformation Ratio** — Ratio of a dimension after deformation to the original one.

**2.80 Deformation Work** — Work necessary for deformation.

**2.81 Descaling** — The process of removing oxide scale from heated stock prior to any forging operation, using such means as extra blows, wire brushes, scraping devices, or water spray.

**2.82 Die/Die Block** — Steel block into which the impressions are cut corresponding to the shape of the forging to be produced.

**2.83 Die Crank** — Step in the parting line of a forging die.

**2.84 Die Layout** — The transfer of forging drawing or sketch dimensions to template or die surfaces for used in sinking dies.

**2.85 Die Life** — The productive life of a die impression, usually measured in terms of the number of forgings produced before the impression has worn beyond the permitted tolerances.

**2.86 Die Line** — A line or scratch resulting from the use of a roughened tool or the drag of a foreign particle between tool and product.

**2.87 Die Lock** — For locked dies, a dimension expressing extreme variation in parting line level measured in a direction parallel to ram stroke.

**2.88 Die Lubricant** — A compound sprayed, swabbed, or otherwise applied on die surfaces or forgings during forging to reduce friction between the forging and the dies. Lubricants would ease release of forgings from the dies and provide thermal insulation.

**2.89 Die Match** — The condition of dies, after having been set up in the forging equipment, where every point in one die half is within specified alignment with every point in the mating die half.

**2.90 Die Proof (Cast)** — A casting of the die impression made to confirm the exactness of the impression.

**2.91 Die Set** — Two (or, for a mechanical upsetter, three or more) machined dies to be used together during the production of a die forging.

**2.92 Die Shift** — The condition occurring after the dies have been set up in the forging unit, and 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 mismatch in the forging, a condition that must be held within specified tolerance.

**2.93 Die Sinking** — Machining the die impressions for producing forgings of required shapes and dimensions.

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

**2.95 Die Wear** — The loss of dimension or shape in a die as a result of movement of hot or cold metal relative to its surface.

**2.96 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.

**2.97 Disk** — Blanks for gears, rings, or hubs are examples of this type of forging; parts may or may not have holes.

**2.98 Double Acting Hammer** — A hammer, in which the tup is moved by compressed air, steam or a liquid acting through a cylinder and piston.

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

**2.100 Dovetail** — A slot shaped like the tail of a dove for holding and/or locating a male to a female part.

**2.101 Dowel** — A metal insert placed between mating surfaces of the die shank and die holder in the forging equipment to ensure length-wise die match.

**2.102 Draft** — The amount of taper on the sides of the forging necessary for removal of the work piece from the dies. Also the corresponding taper on the side walls of the die impression.

**2.103 Draft Angle** — The angle of taper, expressed in degrees, given to the sides of the forging and side walls of the die impression.

**2.104 Draftless Forging** — A forging with zero draft on vertical walls.

**2.105 Drawing Out** — To reduce thickness and increase the length.

**2.106 Drop Forging** — A forging produced by hammering metal in a drop hammer between dies containing impressions designed to produce the desired shape.

**2.107 Drop Hammer/Stamp** — A term generally applied to forging hammers wherein energy for forging is provided by gravity, steam, or compressed air.

**2.108 Edger (Edging Impression)/Fuller** — The portion of the die impression that distributes metal, during forging, in the areas where it is most needed to facilitate filling cavities of subsequent impressions to be used in the forging sequence.

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

**2.110 Ejector** — A device for pushing the finished work piece out of the die.

**2.111 Etch (To Etch)** — Treatment of prepared metal surfaces with acid or other reagents which by differential attack reveals the structure.

**2.112 Fettling** — Removing surface defects by manual or pneumatic chisel or by a grinding wheel.

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

**2.114 Fillet** — The concave inter-section of two surfaces. In forging, the required radius at the concave inter-section of two surfaces is usually specified.

**2.115 Fin** — The metal in excess of that required to fill the die impression and which forms a thin plate between the die faces.

**2.116 Finish Allowance** — Amount of stock left on the surface of the forging for machining.

**2.117 Finish Temperature** — The temperature at which hammering or pressing has been finished.

**2.118 Flash** — Necessary metal in excess of that required to completely fill the finishing impression of the 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. Cooling 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 finishing impression.

**2.119 Flash Land** — Configuration in the finishing impression of the dies designed either to restrict or encourage growth of flash at the parting line; whichever may be required in the particular instance in order to insure complete filling of the finishing impression.

**2.120 Flat Die Forging (Open Die Forging)/Smith Forging** — Forging worked between flats or simple

contour dies by repeated strokes and manipulation of the work piece.

**2.121 Flatter** — Forging tool used to make a smooth flat surface.

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

**2.123 Flop Forging** — A forging in which the top and bottom die impressions are identical, permitting the forging to be turned upside down during the forging operations.

**2.124 Flow Lines** — Patterns in a forging resulting from the elongation of non-homogeneous constituents and the grain structure of the material in the direction of working during forging; usually revealed by macroetching.

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

**2.126 Forgeability** — Term used to describe the relative ability of the material to deform without rupture. Also describes the resistance to flow from deformation.

**2.127 Forging Dies** — Steel block into which the impressions are cut corresponding to the shape of the forging to be produced.

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

**2.129 Forging Press** — A press, either hydraulically or mechanically operated for forging hot metals.

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

**2.131 Forging Roll** — Power-driven rolls with shaped contours and notches for introduction on the work, used in free forming operations.

**2.132 Forging Stock** — A wrought rod, bar or other section suitable for subsequent change in cross-section by forging.

**2.133 Forging Strains** — Strains that have been set up in the metal by the process of forging; they are usually relieved by subsequent annealing or normalizing.

**2.134 Former** — Part of a master used in machining impressions in dies.

**2.135 Forming** — A process whereby planes of different shape are changed without materially changing the cross-section.

**2.136 Forming Force** — The force acting between the tools which is necessary for the deformation of the work piece.

**2.137 Foundation** — The mass of structural materials on which forging equipment is placed to support the weight and to absorb residual energy of the forging operation.

**2.138 Furnace** — Equipment for heating of materials.

**2.139 Gate** — A portion of the die that has been removed by machining to permit a connection between multiple impressions or between an impression and the bar of stock.

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

**2.141 Gouge** — A gross type of scratch.

**2.142 Grain** — The characteristic crystalline structural unit of metals and alloys.

**2.143 Grain Flow** — Fibre-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 required mechanical properties of forgings.

**2.144 Grain Separation** — In forging aluminium, 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.

**2.145 Grain Size** — The average size of the crystals or grains in a metal as measured against an accepted standard.

**2.146 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.

**2.147 Gripper Dies** — The lateral or clamping dies used in a mechanical upsetter.

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

**2.149 Gutter** — A depression around the periphery of the die impression outside the flash pan that allows space for excess metal; surrounds the finishing impression and provides room for the excess metal used to ensure sound forging. A shallow impression outside the parting line.

**2.150 Hairline Cracks** — Very fine cracks caused by excessive stress, which usually can only be detected by etching or magnetic particle testing.

**2.151 Hammer Forging** — A forging that is made on the flat die on a hammer. A forged piece produced in a forging hammer, or the process of forming such a piece.

**2.152 Hammer Stroke** — The distance moved by the weight or tup of a hammer.

**2.153 Hand Forging** — 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 forging. 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. A forging worked between flat or simply shaped dies by repeated strokes and manipulation of the piece.

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

**2.155 Hard Chrome Plating** — Depositing a hard chrome layer in order to improve wear resistance.

**2.156 Hardening** — Increase in the hardness of steel by quenching from a temperature within or above the transformation range.

**2.157 Header Die** — A die in the ram of a horizontal forging machine/heading machine.

**2.158 Heading** — Increasing the sectional area of a length of material to form a head or boss.

**2.159 Heat Resistance** — Capable of being heated without loss of important mechanical and metallurgical properties.

**2.160 Heat Treatment** — A combination of heating, holding and cooling operations applied to a metal or alloy in the solid state to produce desired properties.

**2.161 Helve Hammer** — A power hammer in which power is delivered through a helve or handle; used in light work, tools making and supplementary operation.

**2.162 High Energy Rate Forging** — The process of producing forgings on equipment capable of extremely high ram velocities resulting from the sudden release of a compressed gas against a free piston.

- 2.163 Horizontal Forging Machine** — Press in which the forming movement is carried out horizontally. A prior gripping movement on the material to be worked is carried out at right angles to this.
- 2.164 Impact Velocity** — The speed of the moving die at the moment of impact with the work piece.
- 2.165 Impression** — A cavity machined into a forging die to produce a desired configuration in the work piece during forging.
- 2.166 Inclusion** — Impurities in metal, usually in the form of particles in mechanical mixture.
- 2.167 Induction Heating** — Heating materials by inducing eddy currents into them.
- 2.168 Insert** — A piece of steel that is removable from a die. The insert may be used to fill a cavity, or to replace a portion of the die with a grade of steel better suited for service at that point.
- 2.169 Interstate of the Forging** — Shape of the forging after a preforming operation.
- 2.170 Ironing**
- 2.170.1** A press operation used to obtain a more exact alignment of the various parts of the forging, or to obtain a better surface condition.
- 2.170.2** An operation to increase the length of the tube by reduction of wall thickness and outside diameter.
- 2.171 Isothermal Annealing** — A process of heating ferrous material above its critical temperature, then cooling to and holding at a fixed temperature until transformation to a desired microstructure.
- 2.172 Isothermal Forging** — Forging at a constant temperature.
- 2.173 Jet Lapping** — A method of finishing of the surface of the die impression by blasting it when abrasive particles suspended in a liquid.
- 2.174 Key** — A wedge used to secure dies into the forging equipment.
- 2.175 Kick Crack** — Step in a die outside the impression which balances the forces tending to strike the dies off-set during production.
- 2.176 Lock Out Mark** — A small protrusion, such as a button or ring of flash, resulting from the depression of a knock-out pin from the forging pressure, or the entrance of metal between the knock-out pin and the die.
- 2.177 Knock-Out Pin** — A power operated plunger installed in a die to aid removal of the finished forging.
- 2.178 Knuckle Joint Press** — Mechanical press in which power is transmitted from crankshaft to ram by a system of levers.
- 2.179 Lap** — A surface defect appearing as a seam, 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.
- 2.180 Liners** — Thin strips of metal inserted between the die and the unit into which the die is fastened.
- 2.181 Lock** — One or more changes in the plane of the mating faces of the dies. In a compound lock, two or more changes are in the mating faces. A counter lock is a lock placed in the dies to off-set a tendency for die shift. Caused by a necessary steep lock, a condition in which the parting line is not all in one plane.
- 2.182 Locked Dies** — Dies with mating faces that lie in more than one plane.
- 2.183 Logarithmic Deformation Ratio** — The logarithm of the ratio of a dimension before and after deformation.
- 2.184 Loose Material** — During forging operations, pieces of flash often break loose, necessitating cleaning of the dies between forging blows; this is usually accomplished by lubricating the die while air is blown on it. Insufficient cleaning results in pieces of flash becoming embedded in the surface of the forging. Such forgings are often salvaged by removing the loose pieces and hot preforming to fill out the depressions.
- 2.185 Machinability** — That property of a metal which governs the ease with which metal may be removed by chip formation.
- 2.186 Machining Rating** — Amount of energy a machine can apply to the work piece.
- 2.187 Macro Graph** — A photographic reproduction of any object that has been magnified not more than 10 diameters.
- 2.188 Macrostructure** — The structure and internal condition of metals as revealed on a polished and etched sample, examined either by naked eye or under low magnification (up to 10 diameters).
- 2.189 Magnaflux/Magnetic Particle Testing** — A non-destructive test method of inspecting areas on or near the surface of ferromagnetic materials. The metal is magnetized, then iron powder is applied. The powder adheres to lines of flux leakage, revealing surface and near surface discontinuities. Magnetic particle testing is used for both raw material acceptance testing and product inspection. Quality levels are usually agreed on in advance by the producer and the purchaser.
- 2.190 Magnaglo** — A type of magnetic particle testing where the magnetic powder is fluorescent and the inspection is performed under black light.

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

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

**2.193 Master Block** — A forging die block primarily used to hold insert dies.

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

**2.195 Matched 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.

**2.196 Matched Edges** — Two edges of the die face that are machined exactly at 90° to each other, and from which all dimensions are taken in laying out the die impression and aligning the dies in the forging equipment.

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

**2.198 Mechanical Properties** — Those properties of the material that reveal the elastic and inelastic reaction when force is applied. The properties that involve the relationship between stress and strain; for example, the modulus of elasticity, tensile strength, and fatigue limit. Mechanical properties are dependent on chemical composition, forging technique and heat treatment.

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

**2.200 Metal Flow** — Movement of the metal during deformation.

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

**2.202 Mismatch** — The misalignment or error in register of a pair of forging dies; also applied to the condition of the resulting forging. The acceptable amount of this displacement is governed by blue print or specification tolerances. Within tolerances, mismatch is a condition; in excess of tolerance, it is a serious defect. Defective forgings may be salvaged by hot reforging operations.

**2.203 Modulus of Elasticity** — The ratio, within the limits of elasticity, of the stress to the corresponding strain.

**2.204 Natural Draft** — Taper on the sides of the forging due to its shape or position in the die, that make added draft unnecessary.

**2.205 Necking** — Forming a groove in the bar to set off the amount of material required to make one forging.

**2.206 No Draft Forging** — A forging 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 closer control of grain flow and retention of surface material in the final component.

**2.207 Non-fill** — Occurs when the die impression is not completely filled with the metal. Some causes are: improper distribution of metals 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.

**2.208 Normalize** — A heat treatment in which ferrous alloys are heated to temperatures slightly above the critical range depending on the composition, holding at that temperature for the required time depending on the processing, and cooling to room temperature in air.

**2.209 Notch Sensitivity** — The reduction in the impact, endurance or static strength of the metal, caused by stress concentration as a result of scratches or other stress raisers on the surface.

**2.210 Off-Set** — A fault caused by the misalignment of the impressions in top and bottom dies.

**2.211 Oil Stain** — A stain produced by the incomplete burning of the lubricant on the surface of a product.

**2.212 Optical Pyrometer** — A optical viewing device used to measure elevated temperature.

**2.213 Orange Peel** — A surface roughening encountered in forming products from material that has a coarse grain size.

**2.214 Over Etch** — In the normal processing of aluminium forging 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 a concentrated solution to produce a rough, slightly pitted surface.

**2.215 Over Heating** — Can occur in preheat furnace prior to forging or in the heat treating operation. The condition results when metal temperature exceeds the critical temperature of the alloy involved and a change in phase occurs; this is also known as the

transformation temperature. Externally, over heated material would often form blisters or a web of fine cracks; internally, over heating causes precipitation of melted constituents around grain boundaries and the formation of rounded pools of melted constituents often called 'Rosettes'.

**2.216 Parting** — The line around the periphery of a forging at which the flash has been forced out of the impression.

**2.217 Parting Line** — The dividing plane between the two dies used in the forging metal. The line along the edge of a forging where the dies meet, or the line along the corresponding edge of the die impression.

**2.218 Peg** — A male extension of the tub or anvil fitted into a corresponding hole in the die block for accurate location in longitudinal direction.

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

**2.220 Pick Up** — Small particles of oxidized metal adhering to the surface of a product.

**2.221 Pierce** — To remove a core or slug of metal from a work piece.

**2.222 Piercing** — To produce a hole through the forging by punching out a thin web of metal.

**2.223 Pipe** — A cavity formed in metal (especially ingots) during the solidification process by the contraction of that part of the liquid metal which is last to solidify.

**2.224 Pit** — A sharp depression or hole in the surface of metal.

**2.225 Planishing** — A finishing operation to remove the trim line of a forging or to obtain closer tolerances. Usually done by hot or cold rolling, pressing or hammering.

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

**2.227 Plastic Deformation** — The ability of material to permanently distort without fracture under the action of an applied stress.

**2.228 Plating** — Forging in such a manner that there is a greater movement of metal transversely than in the longitudinal direction.

**2.229 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 a time.

**2.230 Plug** — A protruding portion of a die impression for forming a corresponding recess in the forging.

**2.231 Pneumatic Hammer** — Hammer whose top is driven by compressed air usually generated in the machine itself.

**2.232 Poisson's Ratio** — The ratio of lateral unit deformation to longitudinal unit deformation within the elastic limit during a uniaxial tension or compression test. Also called the factor of lateral contraction; a body that is stretched length-wise becomes thinner cross-wise. Poisson established by experiment that, within the elastic limit, the ratio of length of stretch or squeeze to the length by which a body of given material is decreased or increased in cross-wise thickness is a constant; for Aluminium, Poisson's Ratio is an average of approximately 0.33.

**2.233 Poppet Pin** — Screw for adjusting and setting bottom die on an anvil.

**2.234 Pre-Forming** — The forging operation in which stock is preformed or shaped to a predetermined size and contour prior to subsequent die forging operation; the operation may involve drawing, bending, flattening, edging, fullering, rolling, or upsetting. The preform operation is not considered to be a scheduled operation unless a separate heat is required; usually, when a preform operation is required to precede a forging operation and would be performed in conjunction with the forging operation and in the same heat.

**2.235 Proof** — Any reproduction of a die impression in any material, frequently a lead or plaster cast.

**2.236 Protective Atmosphere** — A mixture of gases controlled in their composition to prevent scaling or oxidation of metals.

**2.237 Punch Out** — A pierced hole in a forging.

**2.238 Punch Out Rigging** — The parts required to fasten the punch and plates to the press.

**2.239 Quench** — Rapid cooling of metal from above the critical range in some quenching medium, usually water or oil.

**2.240 Quench Bath/Bath** — A bath of fluid into which hot metal is placed for cooling purpose.

**2.241 Radius** — To remove sharp edges or corners of forging stock by means of a radius or form tool.

**2.242 Ram** — The moving or falling part of a drop hammer or press to which one of the die is attached; sometimes applied to the upper flat die of a steam hammer.

**2.243 Rate of Deformation** — Increment of deformation during unit of time.

**2.244 Reducer Roll** — The portion of a forging die where cross-sections are altered by pressing while the work piece is being rotated.

**2.245 Reducer Rolling** — A means of reducing and changing the section of a metal by using rolls.

**2.246 Reducing Atmosphere** — Combustion in a furnace where there is no oxygen to prevent oxidation; also termed wet fire.

**2.247 Reduction of Area** — The difference, in a tension specimen between the size of the original section area and that of the area at the point of rupture. It is generally stated as the percentage of decrease of cross-section area of a tension specimen after rupture.

**2.248 Re-heating** — A thermal operation designed solely to heat stock for hot working; in general, no metallurgical changes are intended.

**2.249 Reset** — Realign or adjust dies or tools during the production run; not to be confused with set-up, an operation performed prior to production run.

**2.250 Resink Designation** — Identification of a duplicate set of dies made to supplement or respace a die set.

**2.251 Restriking** — Returning to the die after forging a clipping is completed to correct the shape.

**2.252 Rib** — A forged wall or brace projecting generally in a direction parallel to the ram stroke.

**2.253 Roller** — That part of a die used to reduce a portion of the stock to the appropriate form of the forging.

**2.254 Roll Forging** — The process of shaping stock between power driven rolls bearing contoured dies. The work piece is introduced from the delivery side of the roll, and is reinserted for each succeeding pass. Usually used for preforming, roll forging is often employed to reduce thickness and increase length of stock.

**2.255 Rolling Edger** — A combined edger and roller, employed for the distribution of the metal in preparation for the finishing operation.

**2.256 Rotary Hearth Furnace** — A circular furnace constructed so that the hearth and the work pieces rotated around the axis of the furnace during heating.

**2.257 Rub Mark** — A minor form of scratching consisting of areas made up of large number of very fine scratches or abrasions.

**2.258 Ruptured Metal** — Forging stock, particularly on very thin sections, that has been hammered so severely as to cause broken fibres in the metal.

**2.259 Saw Trim** — The operation of removing flash from blocker or finished forgings by means of a band saw equipment.

**2.260 Scab** — A relatively thin film or tongue of metal imperfectly attached to the surface of the steel.

**2.261 Scale** — The oxide film that is formed on forgings, or other heated metal, by chemical action between the surface metal and oxygen in the air.

**2.262 Scale Loss** — The amount of metal lost in heating due to oxidation.

**2.263 Scale Pit** — A surface depression formed on a forging due to scale in the dies during the forging operation.

**2.264 Scalping** — Machining operation in which the outside surface of rolled, pressed, or cast stock is removed to eliminate surface defects.

**2.265 Specific Furnace Capacity** — Weight of material per unit area of furnace heated within one hour.

**2.266 Seam** — A longitudinal surface defect in the form of a seam that appears on a forging when opened by the forging action; a crack or inclusion on the surface of a forging. If very fine, termed a hair seam or hair crack.

**2.267 Segregation** — A non-uniform distribution, usually a concentration of certain constituents and/or impurities arising during freezing.

**2.268 Semi Finisher** — An impression in the forging die that only approximates the finishing dimensions of the forging. Semi finishers are often used to extend die life of the finishing impression, to ensure proper control of grain flow during forging, and to assist in obtaining desired tolerances.

**2.269 Set Hammer** — Forming tools used to make smooth, flat surfaces especially in small areas.

**2.270 Shank** — A portion of the die or tool by which it is held in position in the forging unit or press.

**2.271 Shear (A Defect)** — An indirect result of mismatch, a shearing action that occur: (i) by restriking mismatched forgings, or (ii) by restriking in misaligned dies. The first way is more common, as it is generally employed as a remedial action for mismatched parts. The severity of the shear depends on the amount of mismatch of the parts; the acceptance or rejection of parts so treated depends on the resulting effect on forging dimensions. Because forging dies may wander off-match restriking in misaligned dies can occur at die set-up or at any time using the operation.

**2.272 Shearing** — A process of mechanically cutting metal bars to the proper stock length necessary for forging the desired product.

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

**2.274 Shot Blasting** — A process of cleaning forgings by propelling metal shot at high velocity by air pressure or centrifugal force at the surface of a forging.

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

**2.276 Shrinkage** — The contraction of metal during cooling after forging. Die impressions are made over-size according to precise shrinkage scales to allow forgings to shrink to design dimensions and tolerances.

**2.277 Side Thrust** — Lateral force exerted between the die by reaction of the forged piece on the die impressions.

**2.278 Sinking** — The operation of machining the impression of the desired forging into the forging dies.

**2.279 Sizing** — The operation in a coining press performed in order to obtain closer tolerances on portions of a forging.

**2.280 Slab** — A slack shaped semi finished rolled metal ingot with a width not less than 25 cm and a cross-sectional area not less than 100 cm<sup>2</sup>.

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

**2.282 Slot Furnace** — A common batch type forged furnace where stock is charged and removed through a slot or opening.

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

**2.284 Snag Grinding** — The process of removing portions of forgings not desired in the finished product, by grinding.

**2.285 Snip Vents** — An operation to remove metal projections resulting from vents in the die cavity and where such an operation is an independently scheduled operation and not performed in conjunction with the forging operation.

**2.286 Soaking** — A heating process during which metal is held at an elevated temperature for the length of time sufficient for the attainment of uniform temperature throughout the material, or for homogenization of elements.

**2.287 Spall** — The cracking off or flaking of small particles of metal from the surface.

**2.288 Spring Power Hammer** — A hammer in which the energy is applied through a spring.

**2.289 Sprue** — A small impression at one end of the finisher for forming a small projection that can be used to handle forgings cut-off from the forging stock before completion of the forging operations; permits connection between multiple impressions or the forging bar and impression.

**2.290 Squeezing** — Forming under pressure in closed dies.

**2.291 Stains** — A product of caustic action on aluminium; sometimes results from inefficient etching operations, hindering the visual inspection of parts. The condition is easily remedied by repeating the etching operations, taking care that the method of stacking and agitation is sufficient to result in complete removal of the etching products.

**2.292 Stamp** — An operation performed to identify the particular forgings as specified or requested by the customer.

**2.293 Standard Tolerance** — An established tolerance for a certain class of product; this term is preferred to commercial or published tolerance.

**2.294 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 work piece 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.

**2.295 Stock** — A general term used refer to a supply of metal in any form or shape and also to an individual piece of metal used to produce a single forging.

**2.296 Stock Marks** — In cutting forging stock to a 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.

**2.297 Stocks** — Stocks are tong-like forging instruments that permits the operator to obtain a good hold on the hot metal and manipulate forgings at the hammer.

**2.298 Strain (Compression/Elongation)** — Deformation (shortening/elongation) produced by a stress and expressed as the change per unit of original dimension.

**2.299 Strain Rate** — Increment of deformation during unit of time.



**2.300 Stream Line** — Line, the tangents of which coincide with the velocity vectors of a flowing material.

**2.301 Stress** — Load, or force per unit area.

**2.302 Stress Relieving** — A process of producing residual stresses in a metal object by heating the object to a suitable temperature and holding for a sufficient time. This treatment may be applied to relieve stresses induced by quenching, normalizing, machining, cold working or welding.

**2.303 Striking Surface** — Those areas of the faces of a set of dies that are designed to meet when the upper die and lower die are brought together. Striking surface helps protect impressions from impact shock and aids in maintaining longer die life. Also termed 'beating area'.

**2.304 Strip** — To remove flash or extraneous metal by shearing action.

**2.305 Stripper** — A lug or ring on the forging or an impression in the dies for a mechanical upsetter to ensure clamping the piece firmly by a gripper die.

**2.306 Stroke** — The operating cycle of the ram of the press.

**2.307 Surface Peening** — Shot blasting to improve the fatigue life of the forgings.

**2.308 Swage** — Operation of reducing or changing the cross-section area by revolving the stock under fast impact of blows. Finishing tool with concave working surface; useful for rounding out work after its preliminary drawing to size.

**2.309 Swaging** — Reducing the size of the forging stock; to shape metal by causing it to flow in a swage by pressing, rolling, or hammering.

**2.310 Table of the Press** — Part of the press to which the lower die is fixed.

**2.311 Taper** — The angle of taper on the walls of the die impressions to permit removal of the forgings from the dies.

**2.312 Tempering** — Heating hardened, normalized or mechanically worked steel to some temperature below the transformation range and holding for a suitable time at that temperature followed by cooling.

**2.313 Template** — A gauge or pattern made in a die shop usually from sheet steel; used to check dimensions on forgings and as an aid in sinking die impressions in order to correct dimensions.

**2.314 Tensile Properties** — The property data obtained from tensile test on a specimen, including tensile strength, elongation, reduction of area, and yield strength.

**2.315 Toggle Press** — Mechanical press in which power is transmitted from crank shaft to ram by a system of levers.

**2.316 Tolerance** — Allowable deviation from a nominal or specified dimension; the permissible deviations from the exact dimensions given on the drawing or model or from a specification from any characteristic.

**2.317 Tong Hold** — The end of a bar of forging so reduced as to accommodate tongs for manipulation during forging.

**2.318 Tongs** — Device for holding and handling the work piece.

**2.319 Tooling Marks** — Dies containing surface imperfections and dies on which some repair work has been done which impart indications on the surface of the part; these tooling marks are usually slight projections or depressions in the metal. Light grinding or polishing is used to remove the marks if they seriously affect the appearance of the product.

**2.320 Top Die** — That half of the die carried up by a moving member of a hammer or press.

**2.321 Tote Box** — Metal container used to convey forgings to the various processing operations.

**2.322 Trim** — A shearing operation to remove flash along the outer parting line of a blocked or finished forging, performed on a trim press.

**2.323 Trim and Punch** — A shearing operation to remove both an inner and outer section of metal from a blocked or finished forging. A combination of two operations whereby flash and punch out are removed simultaneously. The operation generally performed on a trim press using a combination trim and punch die.

**2.324 Trimmer** — Dies used to remove the flash or excess stock from the forging.

**2.325 Trimmer Die** — The punch-press die used for trimming flash from a forging.

**2.326 Trimming** — The mechanical shearing of flash or excess material from a forging by use of a trimmer in a trim press. This can be done either hot or cold.

**2.327 Trimming Shoe** — The holder used to support the trimmer.

**2.328 Trip Hammer** — A small power hammer that delivers blows in rapid succession.

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

**2.330 Tumbling** — 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. A process for removing scale and roughness from forgings by impact with each other, together with abrasive material in a rotating container.

**2.331 Tup** — The stroking head of a hammer which carries the upper die and transmits its energy to the forging.

**2.332 Typing** — A small hardened block machined to the shape of a small portion of the impression and driven into this portion of the impression to determine the shape and dimensions accurately.

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

**2.334 Upend Forging** — A forging in which the metal is so placed in the die that the direction of the fibre structure is at right angles to the faces of the die.

**2.335 Upset Forging** — A forging obtained by upset of a suitable length of bar, billet or bloom; formed by heading or gathering the material by pressure upon hot or cold metal between dies operated in a horizontal plane.

**2.336 Upsetter** — A machine with horizontal action used for making upset forging.

**2.337 Upsetting** — Working metal in such a manner that the cross-sectional area of a portion or all of the stock is increased, and length is decreased.

**2.338 Upper Displacement** — Movement of the metal into the upper or moving half of the die set.

**2.339 Vent** — A small hole provided for escape of the air from a die cavity.

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

**2.341 Wad** — A thin web of metal which is punched out to produce a hole through the forging.

**2.342 Water Descaling** — A means of descaling hot metal by impinging water on to its surface at a high velocity.

**2.343 Water Stain** — A superficial etching of the surface from prolonged contact with moisture in a restricted air space such as between the layers of the product. The stain is generally white.

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

**2.345 Wear** — The loss of dimension or shape in the die as a result of the movement of hot or cold material relate to its surface.

**2.346 Wear Resistance** — Able to resist wear (usually by abrasion).

**2.347 Web** — A relatively flat, thin portion of a forging that affects an interconnection between ribs, and bosses. A panel or wall that is generally parallel to the forging plane.

**2.348 Wide Tolerance** — Any special tolerance that is wider than standard.

**2.349 Y (Double)** — A forging such as connecting rod that is widened at each end.

**2.350 Yield Point** — The load per unit for original cross-section at which a marked increase in the deformation of the specimen occurs without increase of load. It is usually calculated from the load determined by the drop of the beam of the testing machine or by use of divider. The stress in a material at which there occurs a marked increase in strain without an increase in the stress.

**2.351 Y Shape** — Forging shaped generally in a 'Y' such as connecting rods or banjo shaped parts. Piece where one end require spreading into a 'U', 'V', 'Disk', or similar shape, or a combination of one or more of these.

**2.352 Yield Strength** — Stress corresponding to some fixed permanent deformation, such as 0.1 or 0.2 percent off-set from the modulus shape.

**2.353 Zyglo** — A method for non-destructive surface inspection of primarily magnetic materials using fluorescent penetrants. Trade name of Magnaflux Corp.

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