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Glossary of Contemporary Engineering



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Edited by J. D. Beadle

MACMILLAN

Preface

Branches of engineering are growing further apart and, with constant innovation, development and diversification within each discipline, there is a strong demand for increased specialisation by the engineer. Along with this growth, the terminology employed in industry has become more sophisticated and at times confusing. However, these engineering disciplines are still linked in practice and those involved in industry are frequently called upon to understand the precise meaning of the terms used in a field other than their own.

This glossary is a collection of current terms presented as a straightforward alphabetical list. It covers a wide range of disciplines, including mechanical, production and electronic engineering, and is of value both to students and practising engineers. It includes numerous cross references and employs the SI system of units. With its wide coverage and ease of use it should help to bridge the interdisciplinary gap in a number of situations.

A

A: symbol for ampere; argon; also various physical quantities.

Abrasion: abrasive wear; removal of material from a surface by a cutting or scratching action; resultant effect depends on relative physical characteristics and velocity of the materials involved; qualitatively divided into gouging, grinding, scratching abrasion (qv).

Abrasion: (gears) a form of wear caused by abrasive particles between meshing gear teeth, especially when the normal lubricant film cannot prevent contact between tooth and abrasive; depending on size of particle, wear shows as a polished or scratched surface on the gear tooth.

Abrasive finishing: finishing (qv).

ABS: see acrylonitrile butadiene styrene.

Absolute maximum system: a system of electrical and thermal ratings for components under which the figure given for a particular parameter cannot be exceeded without the risk of permanent damage to the component.

Absorbent (electrochem): material to immobilise free electrolyte within a cell.

Absorption current: that fraction of current in a dielectric varying proportionally with the rate of accumulation of electric charge within the material.

Accelerated ageing test: subjects a product to intensified but controlled conditions of heat, pressure, radiation or other factors to produce, in a short time, the effects of long-time storage or use under normal conditions.

Accelerated test: a test applied to components in which the level of applied stress exceeds that stated in the reference conditions in order to shorten the time required to observe the stress response of the item.

Accelerating voltage: (electronics, oscilloscopes) the cathode-to-viewing-screen voltage applied to a cathode-ray tube for the purpose of accelerating the electron beam.

Accelerator: a catalyst, or a substance added to a catalyst, to accelerate a chemical action, thus reducing the time or temperature required for processing.

Acceptor level: the band of energy in an energy level diagram of a semiconductor crystal lattice to which have been added acceptor impurities.

Accumulator: (electrochem) common term for rechargeable lead-acid (secondary) cells; (data processing) a register in the arithmetic unit of a digital computer in which the results of arithmetic and logical operations are formed.

Acetal: thermoplastics material produced by polymerisation of formaldehyde and possessing high softening point and numerous good physical properties resulting in its use for bearing, gears, bushes, etc.

Acetal copolymers: thermoplastic materials produced by polymerisation of formaldehyde with other monomers, as opposed to polyacetal (qv).

Acid cleaning: a process in which a solution of a mineral acid, organic acid or acid salt in combination with a wetting agent and detergent is used to remove oxide, oil, grease and soil from metal surfaces.

Acid dew point: (combust) temperature of deposition of acid solutions, eg sulphur oxides in water, from flue gas; important factor in design of eg exhaust systems, chimneys, to avoid corrosion and production of smut.

Acid dip: a dip solution usually consisting of sulphuric acid, nitric acid, hydrochloric acid, and water, used to give a bright surface to brasses; also general term for cleaning, etching, brightening dips used for various metals and alloys (eg before electroplating).

Acid lead: copper-containing lead alloy used eg in plant involving sulphuric acid (ASTM B29-55/66).

Acid pickling: see pickling.

Acid process: steelmaking process in which the furnace is lined with a

siliceous refractory and using pig iron low in phosphorus.

Acid recovery plant: for recovery of sulphuric acid from acid sludge.

Acid refractory: refractory material used in furnaces with a high silicon content (over 90%).

Acid sludge (tar): material of high relative density (sp gr) formed during chemical refining of oils by sulphuric acid; can usually be separated by settling or centrifuging.

Acoustic surface wave devices: single crystal semiconductor devices in which amplification is achieved by passing a signal along the surface of a semiconductor chip as a mechanical wave which interacts with the electrical properties of the crystal, giving an increase of the power transfer.

Acrylic polymers: these are based on esters of acrylic acid and/or of its homologue, methacrylic acid.

Acrylic resins: thermoplastic material produced by polymerisation of an acrylic resin. Can be extremely clear, eg 'Perspex' (polymethylmethacrylate).

Acrylonitrile: acrylic monomer containing nitrogen used with styrene, styrene and butadiene, or butadiene to produce thermoplastics and rubbers.

Acrylonitrile butadiene styrene: thermoplastic material produced by copolymerisation of acrylonitrile, butadiene and styrene. Exceptionally high impact strength and good resistance to heat distortion and chemicals, suitable for electroplating.

Activator: alternative term for an 'accelerator' (qv).

Addendum: (mech) of a gearwheel, the distance between the pitch

circle (qv) and the outside diameter (od) of the wheel; *ie*, the dimension by which the od is greater than the pitch circle; see dedendum.

Additive: material used to modify properties of a product such as a fuel; *eg* to reduce smoke, improve ignition, depress pour point, reduce wear, corrosion, sludge; odour may be added to gases to make them detectable.

Additives (oil): substances added to petroleum fractions to modify their natural properties; *eg* tetraethyl lead to improve gasoline octane number (anti-knock additive); special materials for production of detergent oils.

Adhesive wear: (mech) damage caused when two surfaces loaded together are made to slide, thus breaking adhesive junctions ('welds') between the two surfaces (materials) and possibly leading to pick-up or scuffing (transfer of material from one surface to the other), creation of loose particles, and severe wear (gross surface damage).

Admiralty brass: brass of the composition: copper 70%, zinc 29% and tin 1%. The tin is added to increase strength and corrosion resistance.

Admiralty gunmetal: copper-tin alloy (*ie* bronze) with copper 88%, tin 10% and zinc 2%.

After running: running on.

Ag: symbol for silver.

Age-hardening: change in properties (*eg* increase in tensile strength and hardness) that occurs in certain metals at ambient temperature after heat treatment (as in Duralumin) or after cold working (as in mild steel). Also known as ageing.

Ageing: term generally used to indicate a change in properties of a material that occur with time, under normal, specially controlled or adverse conditions; *eg* deterioration of rubber or plastics caused by exposure to atmospheric air or ozone, or to heat or light; also changes in structure or properties of metals and alloys such as recrystallisation, age-hardening.

AGMA: American Gear Manufacturers Association; issue standards, specifications, general data.

Air cell (diesel): combustion chamber system in which fuel is injected into the main chamber (open to the cylinder, as in open chamber design) which is connected by narrow throat(s) to one or more air cells in which rapid secondary combustion takes place; uses high proportion of air charge; is suitable for automotive uses.

Air cored coils: (electronics) coils with no magnetic material used in their construction; include coils wound on non-magnetic formers as well as air-spaced coils.

Air-hardening steel: alloy steel that can be hardened by cooling in air instead of in water. Typical composition: carbon 0.3%, nickel 4.0% and chromium 1.5%.

Air injection: applied in a fuel system to force a fuel charge into a combustion, or pre-combustion, space; uses highly compressed air.

Air register: device that admits air to a fuel burner and controls flow pattern to promote good burning.

Air-set sand: a wet mix of sand, resin and catalyst which is self-curing at ambient temperature.

Air-slip forming: bubble assist vacuum forming (qv).

Al: symbol for aluminium.

Alkali Act: UK legislation of 1906 to register works (production plants of various classes), and to control waste emission from them; extended 1966.

Alkaline cleaning: the removal of soiling from a metal surface by one or more of the following mechanisms: emulsification, dispersion, film shrinkage and saponification.

Alkaline derusting: the use of aqueous caustic-based solutions, containing various chelating agents, to derust iron and steel, and employed where base metal attack or hydrogen embrittlement is unacceptable. Alkaline derusters are considerably less efficient than acid-based products.

Alkaline etching: used to reduce or eliminate surface scratches, die-lines and other imperfections of aluminium surfaces. Particularly important as a treatment before anodising, providing a finely etched surface on which to build up the anodised film.

Alkyd resins: saturated and unsaturated polyester resins used to produce polyurethanes and for laminating and casting. Thermosetting alkyd moulding material has various moulding advantages over amino and phenolics. See diallyl phthalate.

Allotropes: the two or more solid, liquid or gaseous forms in which an element may exist.

Alloy: a material with metallic properties, consisting of two or more elements of which at least one is a metal; the number of principal constituents is indicated by the terms binary (2, eg Sn-Pb), ternary (3), quaternary (4), etc alloy.

Alloy cast irons: wide range of highly alloyed irons employed for their special resistance to eg corrosion, high or low temperatures, wear;

types include austenitic, high chromium, high silicon, and nickel-containing.

Alloy diode: a diode manufactured from a semiconductor wafer to which contact leads are welded.

Alloy steel: steel containing, in addition to carbon and manganese, intentionally added alloying elements to impart particular properties.

Alloyed diodes: semiconductor junction diodes usually fabricated using aluminium as a p-type dopant on an n-type crystal.

Alloy-treated steels: steels which have had an alloying element added to purify them, but not to form part of the final composition.

Allyl resin: resin used to produce thermosetting moulding materials and laminates.

Alpha cut-off: (electronics, semiconductors) that frequency at the point at which the current gain of a transistor has fallen to 0.7 of its low frequency value.

Alpha decay: a radioactive decay mode most often found in elements with high atomic numbers; the alpha particle is emitted as a discrete energy not as continuous energy like the positive and negative beta particles.

Alpha iron: iron with a body-centred cube crystal system stable below 910 °C.

Alternate mode: (electronics, oscilloscopes) a means of displaying output signals of two or more channels by switching the channels, in sequence, after each sweep.

Alternative fuel engine: designed to operate (i) on oil fuel alone with compression ignition, or (ii) solely on gaseous fuel ignited by a spark; fuel conversion is possible while the engine is running.

Aluminising: cementation (qv) process for producing protective coatings by heat treatment which causes previously sprayed aluminium to be diffused into the product at about 850-900 °C. The results are not as good as those obtained by calorising (qv).

Aluminium: (Al) metallic element, atomic number 13, atomic weight 26.97, m.pt 658 °C; important structural/protective metal with wide range of alloys; used extensively in engineering, packaging, electrical (eg as conductor material in place of copper) industries.

Aluminium brass: copper-zinc-aluminium alloy (eg 77.5-20.5-2%).

Aluminium bronze: copper with aluminium as principal alloying element (eg 3-11%), with or without addition of other elements.

Amino resin: polymer produced from reaction of an aldehyde (eg formaldehyde H.CHO) with a compound containing more than one amino ($-NH_2$) group, eg urea, thiourea, guanidine, cyanamide, dicyanamide, melamine, benzoguanamine. Resins also termed aminoplasts; are strictly amide-, not amine-based.

Aminoplast: aminoplastic; see amino resin.

Aminoplastics: thermosets produced by condensation of formaldehyde with aminos, such as melamine and urea.

Amorphous: Material structure or microstructure that shows no regular pattern; non-crystalline.

Amorphous carbon: non-crystalline form of the element carbon, distinct from the crystalline allotropes graphite and diamond. Term is applied to all industrial carbons in which the carbon bonding agent has been converted to amorphous carbon, whether or not graphite

materials are included in the composition.

ampere (A): base SI unit of electric current; defined as constant current which, if maintained in two straight parallel conductors (of infinite length and negligible cross-section) placed 1 m apart in vacuum, would produce between the conductors a force of 2×10^{-7} newton per metre of length.

Amplification factor: (elec, thermionic valves) the ratio of the change in anode voltage to the change in control grid voltage producing that effect.

Amplitude modulation: (elec) imparting intelligence to a radio carrier wave by causing the amplitude of the wave to vary in sympathy with the amplitude of the modulating waveform.

Analogue computing: an electronic computing system in which the quantities to be computed are represented by the magnitude of generated voltages.

Andalusite: a silicate of aluminium used in ceramic refractories.

Anderson bridge: (electronics) a modified form of Maxwell bridge used for measuring inductance in terms of capacitance and resistance.

Angstrom (Å): An SI unit of length, used to define very short wavelengths; equal to 10^{-10} metres.

Angular misalignment: (of shafts) see misalignment.

Aniline point: lowest temperature at which equal volumes of petroleum fuel and aniline become just miscible; high an.pt indicates high paraffin content (good ignition quality), low an.pt=high aromatic.

Annealed temper: temper produced by annealing and usually defined by

a nominal grain size or grain size range.

Annealing: reheating a metal followed by slow cooling. The purpose may be to: (a) remove internal stress or induce softness; or (b) refine the crystalline structure in addition to (a).

Annular profile rolling: a recent development in transverse rolling used to produce solid components (eg half-shafts and electric motor shafts) with annular profiles that are formed by pulling a pre-heated bar between three driven conical rolls which are caused to move in and out hydraulically to reproduce the required contour.

Anode: in electroplating the anode is the positive electrode used in a plating bath; in corrosion processes it is usually the metal that has the greatest tendency to dissolve.

Anode brightening: electrobrightening (qv).

Anodic oxidation: anodising (qv).

Anodic treatment: anodising (qv).

Anodise: the process of forming a protective film over a material (usually metal) surface by electrolytic or chemical action.

Anodised gears: (mech) aluminium alloy gears treated (anodised) to produce a thin, hard, oxide film coating which protects the material from corrosive environments and improves appearance.

Anodising: a process whereby a hard non-corroding oxide film is deposited on aluminium or light alloys. The aluminium is made the anode in an electrolytic cell containing, for example, chromic or sulphuric acid.

Antidegradant: an ingredient added to a material (eg rubber, plastics) to restrict deterioration, eg from UV radiation, oxidation, heat, stress.

Anti-knock compound (additive): typically tetraethyl or tetramethyl lead, added to gasolines to improve octane number (knock rating).

Anti-knock value: resistance of a fuel to conditions that cause explosive combustion (knocking) of fuel-air mixture in a spark-ignition engine; related to octane number.

Antioxidant: compound which stabilises the composition to which it is added by preventing oxidation.

Antiozonant: additive incorporated in a material (eg plastics, rubber) to protect it from attack by ozone.

Anti-parallel: (electronics) two rectifier systems connected in parallel in such a way as to provide an arrangement capable of conduction in either direction.

Anti-rotating rope: constructed with two or more layers of strands laid in opposite directions so that the torque effect from each layer is balanced.

Antistatic agent: material which reduces the tendency of a composition to accumulate static electrical charges.

Anti-static rubber: material with resistivity of about 10^8 ohm/cm used eg in vehicle tyres to stop build-up of static charges; property derived from addition of carbon black as a filler during rubber compounding.

Anvil: steel block that supports lower die in hammer.

APL: The abbreviation generally recognised for Approved Parts and Materials List; this list is the result of discussions between purchaser and manufacturer on a particular project and relates to components and materials which are acceptable to both parties.

Applied stress: stress produced and maintained in a material during application of an external load.

'A' Process (alkaline process): core-making technique similar to the fluid sand process (qv), except that a fluidising agent is not used.

A.Q.L.: (electronics) a point on the operating characteristic of a sampling scheme which defines the quality level at which there is a reasonable probability (usually 0.95) that the lot will be passed as acceptable by the sampling scheme.

Aqua regia: a mixture of nitric and hydrochloric acids.

Aquadag: a trade name for a graphitised carbon conductive coating applied to the inner surface of cathode ray tubes and some other thermionic valves.

Arc (electric): discharge between two points across which a sufficiently high electric potential is applied; *eg* in arc welding, metal melting furnaces; an arc between an electrode and an object or surface, or between two electrodes.

Arc back: (electronics, valves) the passing of unwanted current (usually from anode/cathode) during a normally non-conducting period.

Arc welding: a process for the joining of metal parts by fusion in which the heat necessary for the fusion is produced by means of an electric arc struck between an electrode and the metal.

Architectural bronze: copper-zinc-lead alloy (*eg* 57-40-3%).

Armature: (elec machine) stationary or rotating part in which emf is produced (in the case of a generator) or the torque is produced (in the case of a motor); includes winding through which the main current of

the machine passes, and part of the magnetic circuit on which the winding is mounted.

Armature reaction: (elec) mmf produced by armature currents in the magnetic circuit of an electric machine.

Armature type relays: a term used to cover the broad spectrum of electromagnetic relays which have an armature hinged or pivoted to the fixed yoke of the relay; operating from either a.c. or d.c.

Aromatic: hydrocarbon with a 6-carbon ring in the molecular structure (*eg* benzene).

Aromatic acids: acids in which the carboxyl group is attached to an aryl radical.

Arrest point: critical point (qv).

As: symbol for arsenic (used *eg* as alloying element).

Ash: mineral content of solid and liquid fuels, usually left as residue after combustion; ash content is important in fuel oils for gas turbines.

ASME: American Society of Mechanical Engineers.

Assessed: (electronics reliability) a statistical adjective meaning that result determined as a limiting value of the confidence interval with a stated probability level based, usually, on the same data as the observed result on nominally identical items.

ASTM: American Society for Testing and Materials; issues standards, tests, and procedures; (*eg* ASTM D88-56, Saybolt viscosity).

Associated gas: natural gas dissolved in crude oil (solution gas) or in contact with underlying gas-saturated crude (gas-cap gas) in an underground petroleum reservoir.

at: technical atmosphere, non-SI metric unit of pressure or stress; $1 \text{ at} = 1 \text{ kgf/cm}^2 (=14.2233 \text{ lbf/in}^2)$; cf atm.

atm: standard atmosphere, non-SI unit of pressure or stress; $1 \text{ atm} = 101.325 \text{ kN/m}^2 (=14.6959 \text{ lbf/in}^2)$; cf at, bar.

Atmolysis: a method of separating the components of a mixture of two gases utilising their differing diffusion rates through a porous material.

Atomic distance: the distance between the centres of two atoms; usually expressed as an average distance.

Atomic mass: (nuclear physics) relative masses of atoms of different elements based on a unit of one-sixteenth of the atomic mass of the isotope of oxygen $O(16)$; cf atomic weight.

Atomic number: the number of protons contained in an atomic nucleus, therefore being a measure of the positive charge of the nucleus.

Atomic weight: (chem) relative weights of atoms of different elements, based on a scale related to a 'standard' atomic weight of oxygen of 16.000; cf atomic mass.

Atomiser: device for converting a liquid to small droplets (fine spray) eg for fuel combustion.

atto (a): prefix used to denote sub-multiple of SI units; value 10^{-18} .

Au: symbol for gold.

Audio frequency choke: (electronics) an iron-cored inductor designed to offer high resistance to audio frequency signals.

Ausforming: the warm working of austenite, in its thermodynamically unstable condition following austenitisation, between the tem-

peratures of austenitisation and martensite transformation. Gives considerable increase in the mechanical properties of steels over that obtained by conventional heat treatment after hot working.

Austenite: a generic term for all solid solutions based on γ -iron.

Austenitic cast irons: alloy irons with wide range of properties depending on composition, with graphite in flake or nodular form. Typical grades and properties include: high manganese (non-magnetic); copper-containing (corrosion-resistant, some non-magnetic); high nickel (20%-35%) copper-free (heat and corrosion resistant); 4% manganese chromium-free (good low-temperature impact properties).

Auto-ignition: spontaneous (auto-genous) ignition, particularly of air-fuel mixture in an internal-combustion engine.

Automatic triggering: (electronics, oscilloscopes) a mode of triggering in which one or more of the triggering circuit controls are preset to conditions suitable for automatically displaying repetitive wave-forms. The automatic mode may also provide a recurrent sweep in the absence of triggering signals.

Auto transformer: (electronics) a wound transformer in which part of the winding is common to both the primary and secondary windings.

Auto-transformer starting: (elec) reduced voltage starting of an induction motor which is more flexible than a straight star-delta starter (q.v.); by selecting a suitable transformer tapping, any desired reduction in starting current can be achieved.

Autoxidation: the relatively slow oxidation of certain substances when exposed to air.

Availability: (of plant/machinery) can be expressed as $= 100 \times (\text{plant running time})$ divided by the sum of (plant running time + breakdown time).

Avalanche breakdown: (electronics, semiconductors) the mechanism for current increase in a reverse biased junction where electrons gain sufficient energy between collisions to ionise atoms on collision and thus provide additional charge carriers.

Avcat: heavy kerosine fuel for aircraft based in marine carriers; distillation range 175°-290°C.

Avgas: fuel for aircraft piston engines; distillation range 30°-200°C.

Avtag: Wide-cut fuel for aviation gas turbines; distillation range 30°-200°C.

Avtur: kerosine fuel for aviation gas turbines; distillation range 150°-250°C.

Axial flow: (compressor / turbine) design in which working gases pass

through alternate series of rotor (rotating) and stator (fixed) blades which are mounted around a common axis; blades are aerodynamically shaped to convert pressures arising from gas flow into rotary motion of the rotor; several stages of stator/rotor may be used.

Axial lead diodes: plastics and epoxy axial lead semiconductor diodes, inexpensive and reliable and becoming increasingly used for domestic and industrial applications with ratings up to 3 amps.

Axial-piston motor: operates on the same principles as the axial-piston pump (qv); hydraulic and pneumatic versions are used.

Axial-piston pump: a reciprocating piston pump in which the axes of the cylinders are parallel or slightly inclined to the drive shaft; commonly swashplate and bent-axis (or tilted-body) types, according to method of reciprocating the pistons; typically used in hydrostatic transmission systems in conjunction with a motor; also pneumatic.

B

B: symbol for boron; also various physical quantities.

Ba: symbol for barium.

Babbitt: tin-base alloys, usually with antimony and copper as hardening agents (and other constituents for special purposes), used as mechanical bearing metals.

Back-emf: (elec) the induced voltage in a d.c. motor armature; its direction opposes the current flow in the motor conductors.

Back-pressure steam turbine: all the steam flow is taken from the turbine after the final expansion stage at a positive pressure for use in a subsequent heating or process operation.

Backward extrusion: to cause material to flow backwards over a punch to form a recess. (See forward extrusion.)

Bakelite: one of the earliest plastics. Thermosetting resins of the phenol-formaldehyde type with high electrical insulation properties. Used with 'fillers' as moulding materials and in laminates.

Balanced steel: steel not fully deoxidised, small amounts of deoxidising agent (eg aluminium) having been added to the ingot moulds after pouring, to reduce the oxygen content. The object being to minimise the formation of a hollow centre in the ingot, caused by contraction of the cooling metal.

Bandwidth: (electronics) a statement of the frequencies defining the upper and lower limits of a frequency spectrum where the amplitude response of an amplifier to a sinusoidal waveform becomes 0.707 (-3dB) of the amplitude of a reference frequency. When only one number appears, it is taken as the upper limit.

bar: non-SI, but commonly accepted, unit of pressure or stress; 1 bar = 10^5 N/m² = 1 hpa (hectopieze); cf atm, at.

Bar: wrought product of uniform section, usually circular or rectangular.

Barnett effect: of ferromagnetic materials, the magnetisation produced solely by rotation of the material in the absence of an external field.

Barrel: (petroleum), unit of volume measurement; 1 barrel (bbl) = 42 US gal = 35 Imp gal (approx) = 159 litres (approx); common US abbreviation is bbl.

Barrel plating: a method of plating small parts in which the parts are placed in a perforated barrel, which revolves partially submerged in a plating solution.

Barrel polishing: see barrelling.

Barrel tumbling: see barrelling.

Barrelling: tumbling of castings in foundry shaking barrels to remove sand; deburring of components; or the polishing of small parts in which

the parts and a polishing medium are placed in a barrel, which is revolved to provide polishing action.

Barrier layer: an extremely thin layer deposited on the surface of a semiconductor material before the addition of a counter-electrode; resistivity of the layer is much greater than that of the bulk material.

Base: (semiconductors) the region between the emitter and collector in a junction transistor.

Basic process: steelmaking process in which the furnace is lined with a basic refractory; the slag produced is rich in lime and phosphorus is removed during the process.

Basic refractory: heat - resisting material rich in metallic oxides, used to line furnaces.

Battery (electrochem): normally an arrangement of two or more cells, but term is widely used for single cell application.

BCC: body centred cubic structure.

bdc: bottom dead centre; *eg* crank-shaft position at bottom of reciprocating piston stroke; opposite to tdc (qv).

Be: symbol for beryllium (used *eg* as alloying element).

Beating: mechanical treatment of fibrous materials in order to give them the properties necessary to make paper and board.

Becquerel rays: rays which include all three radioactive rays, alpha, beta and gamma; emitted by uranium salts.

Belt: (mech) as used in a belt drive may be flat, V-shaped, hexagonal, toothed, or other variations of form; made of various natural or synthetic materials, often with cord or wire reinforcement.

Belt drive: (mech) power is transmitted by a continuous belt, usually via a system of pulleys (or drums for flat belts).

Belt drop hammer: forging drop hammer equipped with belt to lift tup.

Bend: involves a test that determines the relative ductility, soundness and toughness of metal. The test specimen is usually bent over a specified diameter.

Bender: portion of a die used to form metal so that its longitudinal axis lies in two or more planes.

Bent-axis motor: hydraulic motor in which pistons are reciprocated by tilting the axis of the cylinder body in relation to a plate or flange rigidly fixed to the drive shaft; also known as tilted-body motors.

Bent-axis pump: hydraulic pump operated on the same principle as the bent-axis motor (qv).

Bentone grease: lubricating grease with bentonite thickener.

Benzene: aromatic hydrocarbon with ring structure of six carbon atoms; b.pt 80°C; (cf benzine).

Benzine: obsolescent term for gasoline (petrol).

Benzole: commercial aromatic fraction from coal tar, mainly benzene and other aromatics.

Beryllium copper: copper alloy containing varying amounts of beryllium and sometimes small amounts of cobalt, nickel, chromium.

Betatron: a circular electron accelerator employing magnetic induction as the accelerating medium.

Bevel gears: used to connect shafts with intersecting axes, theoretically at any angle (though there are usually practical machine design limitations); most industrial bevel

gears are designed for mounting at 90°; gear teeth may be straight or spiral.

BGMA: British Gear Manufacturers Association.

Bi: symbol for bismuth (used *eg* as alloying element).

Bichromate dipped finish: a semi-matt finish approaching the true colour of the metal, obtained by immersing in an aqueous solution of sodium bichromate and sulphuric acid to remove scale and oxide.

Bifilar winding: a method of producing non - inductive wound electronic components by winding half the turns back over themselves.

Big end: (mech) term for crankshaft end of connecting rod in reciprocating piston engine; *eg* big-end bearing.

Billet: semi-finished wrought product of uniform section, usually square with radiused corners; cross-sectional area normally not less than 25 cm² nor more than 160 cm².

BISRA: British Iron and Steel Research Association.

Black oxide coating: see oxide blacking.

Black smoke: (diesel engine) exhaust emission containing visible dark particles from incomplete combustion of fuel during (normal) running.

Blank: a portion or piece of material designed for mechanical working (*eg* forging). The blank is normally of a predetermined weight and form.

Blanking: in sheet metal forming the process of cutting the outside profile of a part by shearing between a punch and die.

Blister copper: relatively pure (99%+) metal produced from smelting (converting) of copper ore, the solidified

copper having a rough or blistered surface.

Block coefficient: (marine) the ratio between the actual underwater volume of a ship's hull and the volume of the circumscribing rectangular block.

Blocking voltage: (rectifier circuits) the forward or reverse voltage which the semiconductor can stand without breaking down.

Blow moulding: process used to make one-piece hollow plastics products, *eg* bottles. There are various techniques but they are normally based on the use of extrusion or modified injection moulding equipment.

Blowholes: rounded cavities in the surface of a casting mainly caused by low permeability, high volatile content or the presence of moisture in the moulding medium.

Blowing: method of producing shell moulds by blowing the sand into a gap between the pattern plate and a profiled plate.

Blue lead: a term used to distinguish metallic lead from other lead products such as white lead, red lead, *etc.*

BMC: bulk moulding compound; subdivision of DMC (qv).

bmep (brake mean effective pressure): constant pressure which would have to be applied throughout one stroke to a frictionless piston of same size/stroke as the actual piston of an engine, to obtain the same power as the latter gives per cycle; for diesel engines bmep is in the range 4-14 bars.

Board drop hammer: forging hammer in which a board connected to the tup is used to lift it by being gripped between rotating rollers.

Bobbing: finishing (qv).

Bolster: (forging) dovetailed block of steel which rests on base block of the hammer, into which bottom die is keyed.

Boltzmann's constant: a ratio giving the mean total energy of a molecule to its absolute temperature; symbol k .

Boost: increase in pressure, *eg* of intake air into a piston engine by means of a mechanically-driven compressor or exhaust-driven turbo-charger; boost system may be single- or multi-stage (normally up to two stages).

Boss: a protrusion on a component which adds strength and also may facilitate alignment during assembly.

Bottom force: see force.

Boundary lubrication: condition when two surfaces moving relative to one another are only partly separated by an oil film (or other lubricant).

Bound charge: the charge on a conductor which does not leak away when the conductor is earthed.

Bound joints: an electrical connection method in which the lead wire is laid parallel to the length of the terminal adjacent to the wide face and secured by several turns of wrapping wire.

Br: symbol for bromine.

Brake horsepower (bhp): measure of useful rate of working of an engine; $1 \text{ bhp} = 33\,000 \text{ ft-lb/min} = 1.01387 \text{ metric horsepower (ch, cv, PK, PS)} = 0.7457 \text{ brake kW}$.

Brake motor: typically a cage electric motor that incorporates a fail-safe brake (qv) and is used for cyclic stop-start applications, *eg* on machine tool drives.

Brake thermal efficiency: proportion of thermal energy in a fuel that is available for work outside an

engine; equals indicated thermal efficiency less heat losses due to friction between moving parts.

Brass: (metal) basically copper⁴zinc alloy, but covers range of materials which include other alloying elements, *eg* aluminium, nickel, tin, manganese, iron, lead.

Brayton (Joule) cycle: thermodynamic cycle on which the gas turbine principle is based; heat is supplied at essentially constant pressure; in practice, ideal thermodynamic processes are not realised because of component inefficiencies which reduce the work ratio (qv).

Breakdown maintenance: corrective action is taken only after plant has failed (wholly/partly); applicable particularly to readily-replaceable units, *eg* lamps.

Breakdown potential (V_b): of gases, a function of the product of the gas pressure (p) and the distance between electrodes (d); (Paschens Law); also dependent upon electrode geometry and material and temperature.

Breeder reactor: a reactor system in which more new fissile material (*eg* Pu) can be produced than that used originally to fuel the reactor.

Breeding fuels: fissile material produced by neutron bombardment of *eg* fertile U238 and thorium; plutonium (Pu) is a well-known example.

Breeze: small material sieved out of larger sizes of coke; used as a domestic fuel.

Bright drawn steels: steel bars, hot-rolled and descaled, reduced in diameter by drawing through a die aperture; thus producing a smoother and brighter surface on the bar which is also dimensionally accurate.

Brinell test: a method of testing the hardness of a material (usually steel) by forcing a hardened and tempered chromium-steel ball of a specified size into the material's surface under a controlled pressure.

Brittle point: (elastomer) highest temperature at which a rubber specimen fractures on sudden impact (BS903 ptA25; ASTM D746).

Brittleness temperature: see, brittle point.

Broaching: passing a tool known as a broach across part of the surface of a component to give it a desired form. The broach consists of a series of cutting teeth, the cutting edge of each tooth standing slightly proud of the preceding tooth.

Bronze: (metal) originally a copper-tin alloy, but now covers a range of materials with or without tin but including other alloying elements, eg aluminium, beryllium, manganese, zinc, lead, iron.

Brush: (elec) component in contact with a moving surface to provide (ideally) a continuous electrically conducting junction; spring-loaded brushes (eg carbon) may be in reaction, radial, trailing forms (qv).

Brushgear: (elec) system for maintaining electrical contact between relatively moving parts (eg a rotating commutator and stationary brushes); typically spring-loaded carbon brushes in suitable housing with necessary leads, or metal spring contact against a slipping.

Brushless motor: (elec) various forms of winding are used to produce miniature d.c. motors without a conventional commutator and brush-gear system, which can cause high friction losses in very small motors.

BS&W: bottom settlements and water (or basic sediment and water); ie solids and aqueous solutions in an oil which separate out on standing or are removed more rapidly by centrifuging.

BSI: British Standards Institution.

B-Stage: a plastic system where the resin and hardener have reacted to form a gel, but have not cross linked completely; a B-staged system can be made to liquefy by applying heat.

Bubble assist: refinement of the vacuum forming (qv) method of forming plastics sheet in which the sheet is prestretched by air pumped into the vacuum box prior to applying the vacuum.

Buckle: an expansion defect in the form of protruding metal on the surface of a casting.

Buffing: polishing (qv).

Bulk factor: the volumetric ratio of loose powder or granules to the resultant formed product.

Bund: wall of earth, concrete, etc, built to confine any spillage of (particularly) oil eg from storage tanks.

Buried layer mask: (electronics, semi-conductors) buried layer mask, buried layer deposition and diffusion, are all processes in integrated circuit manufacture concerned with the formation of layers of n- or p-type.

Burned air: (piston engine) air per engine cycle of which the oxygen is consumed in the process of combustion.

Burner feed (solid fuel): gravity; underfeed stoker, with rotating screw or reciprocating ram; coking stoker, with flat reciprocating ram; continuous moving chain-link or bar grate (front to back of furnace);