

GLOSSARY OF TERMS USED IN THE SPRING INDUSTRY

with appendix for items applicable to laminated springs

- Action (Total Deflection).** The total movement of a spring from free to solid length, or from free to maximum safe length in the case of an extension spring.
- Active Coils.** The coils of a spring which at any instant are contributing to the rate of the spring, otherwise known as working coils.
- Adjusting.** The adjustment of a spring so that it may conform to the drawing requirements, e.g. length at load, squareness of ends.
- Ageing.** See *Precipitation Hardening*.
- Air-Patenting.** See *Patenting*.
- Almen Strip.** A flat steel strip produced to standard requirements of composition, size and hardness which is used for the assessment of shot-peening intensity.
- Almen Test.** A test to determine the intensity of shot-peening. The test is carried out by peening one side of an Almen strip whilst it is kept flat in a fixture. On completion of peening, the strip is released, whereupon it takes up a curved form with the peened face on the convex side. A measure of the intensity of shot peening is the height of the arc in inches over a chord length of 1-25 in.
- Arbor.** The part of an automatic spring coiling machine against which a spring is cut off.
- Austempering.** The quenching of a steel from a temperature above the upper transformation point to some lower temperature above the upper limit of martensite formation, and holding at this temperature until the austenite is completely transformed to bainite.
- Austenite.** The solid solution of carbon and/or alloying elements in gamma iron.
- Austenitic Steel.** Steel which, owing to the presence of high percentages of certain alloying elements, such as nickel, consists essentially of austenite at atmospheric temperatures.
- Bainite.** The constituent produced when austenite transforms at a temperature below that at which pearlite is produced and above that at which martensite is formed. This constituent may be produced by austempering.
- Baking.** The process of heating components subsequent to pickling and/or electro-plating to remove hydrogen from the steel.
- Bar.** Straight lengths of metal whose dimensions have not been changed by cold work.
- Barrel Spring.** A helical spring (shaped like a barrel) in which the loci of the outside diameter of each coil forms two facing convex arcs. (See also *Spring*.)
- Barrelling.** 1. (Cylindrical grinding.) The grinding of the outside diameter of a spring to reduce it or to ensure an even surface. (Normally applicable to heavy springs — not to be confused with scouring, wet or dry barrelling.)
2. The process of abrasive cleaning carried out in a rotating barrel containing an abrasive mixture. This process removes burrs and/or polishes the surface of springs.
- Belleville Washer.** A spring in the form of a dished ring, the height of which is decreased on the application of a load. (See also *Spring*.)
- Bend Test.** A test performed by bending a test piece, usually at atmospheric temperature, over a specified radius by steadily applied pressure or blows. The test is a means of assessing the ductility of a material.
- Single Bend Test.** A test in which the test piece is bent once, the angle and radius of the bend being specified.
- Close Bend Test.** A single bend test in which the angle of bend is 180° and the test piece is folded flat on itself.
- Reverse Bend Test.** A test in which the test piece is subjected to a number of bends over a former of specified radius. One reverse bend consists of bending the test piece through an angle of 90° and then returning it to the original position. The test piece is then bent through 90° in the opposite direction and back to the original position which counts as the second bend. The test is then repeated in opposite directions through 90° and back to the original position until the fracture occurs. The test is commonly applied to wire, sheet or strip.
- Bevel Section Bar.** Bar whose cross-section is trapezoidal. (See also *Bar*.)
- Bevel Section Rod.** Rod whose cross-section is trapezoidal. (See also *Rod*.)
- Bevel Section Wire.** Wire whose cross-section is trapezoidal. (See also *Wire*.)
- Bimetal Spring.** A device produced from bimetal strip which deflects as a result of a change in temperature. (See also *Bimetal Strip*.)
- Bimetal Strip.** A strip which consists of two strips of metal which on rolling have welded together and whose coefficients of linear expansion are such that the composite strip bends a consistent but substantial amount for small changes in temperature.
- Blueing.** The process of heating bright steel in a suitable oxidising environment, to produce a blue colour.
- Bow.** 1. A condition where the centroids of the coils of a helical spring do not lie on a straight line.
2. The formed anchoring point of a helical spring or wire form.
- Bowing.** A process of forming a bend in a wire or strip.
- Bright Annealing.** The annealing of metal in a heating chamber with a controlled environment to prevent surface contamination.
- Bright Drawing.** A method of producing materials with a bright surface by means of suitable lubricants and drawing conditions.
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- Brinell Hardness.** A measure of hardness obtained by pressing a hard steel ball of known diameter under standard conditions into the surface of the material and measuring the diameter of the indentation produced.
- Brittle Fracture.** Fracture unaccompanied by visible plastic deformation.
- Brittleness.** A tendency to fracture without visible plastic deformation.
- Broken Back.** A term describing patches of transverse cracks in a length of wire.
- Browning.** The process of heating bright steel in a suitable oxidising environment, to produce a brown colour.
- Brush Spring.** A clock type spring having a relatively small number of coils not in contact with one another. (See also *Clock Spring*.)
- Buckling.** The unstable or lateral distortion of the major axis of a spring when compressed.
- Bundle.** Two or more coils or a number of lengths of wire securely bound together.
- Capacity.** The amount of energy which a spring is capable of storing, a measure of which is the area under its load/deflection curve.
- Cast (of steel), Heat, Melt.** Usually the product of a single furnace charge. Sometimes, however, the furnace contents are tapped into two or more ladles in which case the product of each ladle may be called a separate cast.
- Cast (of wire).** The behaviour of a single wap of wire when released from a bundle, e.g.
Bad Cast—Wire which when released from a coil does not conform to the desired shape.
Dead Cast—Wire which when released from a coil lies in circles approximating to the diameter of the original coil.
Straight Cast—Wire which when released from a coil will run out approximately straight.
- Chasing Up.** The regulating of the diameter of the coils of a spring by setting on a suitably sized mandrel.

Circlip. A discontinuous ring made from round or sectional material which snaps onto a shaft or into a hole also called Spring Ring, Locking Ring.

Clock Spring. A generic term describing all types of spring with spiral coils lying in the same plane made from flat section material. (See also *Spring*.)

Closed End. The name given to the end of an open coiled spring in which the helix angle of the end coil has been progressively reduced until the end coil touches the adjacent coil.

Coating. The process of covering the surface of a wire with a film to act as a vehicle for the drawing lubricant or covering the surface of wire or springs with a protective film, e.g. zinc, tin, etc.

Coiling. 1. The forming of wire, rod or bar into a helical spring.
2. The winding of wire or rod into coils or onto drums.

Coiling Fingers. (Coiling points.) Those parts of an automatic spring coiling machine which form the coil of a spring by impingement of the wire against them.

Coils. 1. The coils of a spring. (See also *Active Coils* and *Total Number of Coils*.)
2. Single lengths of wire (rod) formed into a series of nominally circular turns in approximately the same plane about the same axis.

Cold Drawing (Drawing). The process of reducing the cross-sectional area of a material by pulling it at ambient temperature through a die.

Compression Spring. A spring whose dimension, in the direction of the applied load, reduces under the action of that load.

Compression Test. A test carried out by pressing a spring to a specified length a specified number of times.

Coned Disc Spring. See *Belleville Washer*.

Coned (tapered) End Extension Spring. An extension spring whose end coils are progressively reduced in diameter. (See also *Extension Spring*.)

Cone Height. The total movement from unloaded height to flat position of a Belleville washer or diaphragm spring.

Conical Spring. A spring made from bar, rod or wire formed into a conical helix.

Coning. The operation of reducing the diameter of the ends of an extension or compression spring.

Controlled Atmosphere (Prepared Atmosphere). A gaseous atmosphere, whose composition is controlled to prevent contamination during heat treatment.

Copper Sulphate Test (Preece Test). A test applied to galvanised coatings on steel whereby the quality of the coating is assessed by dipping in copper sulphate solution under standardised conditions.

Corrosion Fatigue. The acceleration of fatigue failure by corrosive environment.

Cramp Test. A test carried out by compressing a spring to a specified length for a defined period.

Creep. The plastic deformation of a material which proceeds slowly and continuously when stresses below the yield

point are applied. This phenomenon is particularly pronounced at elevated temperatures.

Crinkle Washer. A spring washer with two or more axial waves.

Crystalline Fracture. A fracture in which the fractured surfaces show clearly the crystalline structure of the material. This type of fracture is indicative of a brittle material.

Cup and Cone Fracture. This describes the fractured surfaces of a ductile material subjected to tensile stresses. One surface is cup-like while the other has the form of a truncated cone which fits into the cup of the other surface.

Cupping Test. A test of ductility of sheet and strip obtained by measuring the depth of cup which can be formed in the material before rupture. The common form of test involves drawing the test piece in a circular die by means of a punch with a hemispherical end.

Cut-Off Tool. The cutting tool of an automatic spring coiling machine which in conjunction with the arbor cuts off the coiled spring.

Cut Wire Shot. Lengths of hardened steel wire (approximately equal to the wire diameter) with the edges rounded used in the process of shot-peening springs.

Damper Coils. The coil or coils of a variable pitch helical compression spring which close first on compression thus varying the rate and natural frequency of the spring.

Dead Coils. The coils of a spring which do not affect the rate of the spring. These are usually at the ends of the spring.

Deburring. The process of removing burrs from a spring.

Decarburization. The loss of carbon from the surface of a steel during heating.

Deep Etch Test. A test in which the surfaces of a sample of a material are etched to facilitate examination for surface defects.

Deflection. The relative displacement of the ends of a spring on the application of a load.

Diameter. Diameter is the chord of a circle which passes through the centre of that circle.

Bar Diameter. The diameter of the cross-section of a bar.

Inside Diameter of a Spring. The diameter of the cylindrical envelope formed by the inside surfaces of the coils of a spring.

Mean Diameter of a Spring. The diameter of a coil of a helical spring from the centre of area to the centre of area of the section of the material, measured at right angles to the axis of the spring*.

Outside Coil Diameter. The diameter of the cylindrical envelope formed by the outside surface of the coils of a spring.

Rod Diameter. The diameter of the cross-section of a round rod.

Wire Diameter. The diameter of the cross-section of a round wire.

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Diamond Pyramid Hardness Test. A test to measure the hardness of a material by pressing a square based diamond pyramid under standard conditions into the surface of the material. The hardness number is related to the diagonal of the impression.

Diaphragm Spring. A compression spring consisting of a dished ring (known as the Belleville portion) having radial fingerlike extensions. The action of an axial load causes the Belleville portion and the fingers to deflect.

Ductility. The property of a material which allows it to undergo plastic deformation.

Eddy Current Test. A test to determine the presence of surface defects in a material by comparing the pattern of induced magnetic currents across different planes in the material.

Effective Coils. See *Active Coils*.

Elastic Deformation. The deformation which takes place when a material is subjected to any stress up to its elastic limit. On removal of the force causing this deformation the material returns to its original size and shape.

Elastic Limit. The highest stress that can be applied to a material without producing permanent deformation.

Electro-galvanising. The process of depositing zinc by means of electrolysis.

Elongation. The increase in length of a tensile test piece when stressed. The elongation of the test piece up to fracture is usually expressed as a percentage of the original gauge length.

Endurance Limit. See *Fatigue Strength*.

End Quench Hardenability Test. A test carried out to determine the hardenability of a steel by heating a test piece to a temperature above the transformation range and then quenching it at one end. The hardness gradient along the length of the test piece is then determined. The most common form of this test is the Jominy test.

Etching (in preparation for microscopic examination). The treatment of prepared metal surfaces with acid or other reagents, which, by differential attack, reveal the material structure.

Extension Spring. A spring whose dimension, in the direction

of the applied load, increases under the action of that load. (See also *Spring*)

Eye (extension spring). See *Bow 2*.

Facing. The final smooth grinding of the end faces of a spring to obtain great accuracy in flatness and squareness.

Fatigue. The phenomenon that gives rise to a type of failure which takes place under conditions involving repeated or fluctuating stresses below the ultimate stress of the material.

Fatigue Fracture. A fracture, resulting from cyclic stress below the ultimate stress, whose surfaces exhibit evidence of progressive failure, typified by concentric bands around the origin of the failure.

Fatigue Limit. The value, which may be statistically determined, of the stress condition below which a material may endure an infinite number of stress cycles.

Fatigue Strength (Endurance Limit). A stress condition under which a test specimen will have a life of a given number of cycles.

Fatigue Test (Endurance Test). A test to determine the number of cycles of stress that will produce failure of a component or test piece.

Ferrite. The microscopic constituent alpha iron, or solid solution of which alpha iron is the solvent.

Ferritic Steel. A steel in which, at normal temperatures, the ferritic phase predominates. The term has also been extended to cover steels containing high percentages of alloying elements such as chromium, silicon, etc., which form little or no austenite when heated.

Finishing. 1. The application of protective or decorative coatings to springs.
2. See *Adjusting*.

Fitted Length. The length of a spring when assembled into the position, within a mechanism, from which it is required to function.

Flat Spring. A spring that is not in a coiled form which is produced from flat material. (See also *Spring*.)

Free Length. The length of a spring when it is not loaded. In the case of extension springs this includes the anchor

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- ends.
- Gap.** See *Space*.
- Gauge. 1.** The diameter or thickness of strip, rod or wire. **2.** A device against which a dimension or form can be compared.
- Gauging.** The comparison of a dimension by the use of gauges.
- Goodman Diagram.** A graphical presentation of fatigue data in which either stress range is plotted against mean stress or as in the modified Goodman diagram the maximum stress is plotted against initial stress for any given life.
- Grinding.** The removal of metal from the end faces of a spring by the use of abrasive wheels to obtain a flat surface which is square with the spring axis.
- Hair Spring.** A very light brush spring used mainly in watches, clock and instrument mechanisms. (See also *Spring* and *Brush Spring*.)
- Handing.** The direction in which the helix of a spring is formed, i.e. right or left hand.
- Hardened & Tempered Wire.** Plain carbon or alloy steel wire which has been hardened and tempered by a continuous process such that it needs no further hardening and tempering after forming.
- Hardenability.** The ability of a material to harden under standard conditions of heat treatment. This property is measured by an end quench hardenability test.
- Heat Resisting Steel.** An alloy steel usually containing substantial percentages of chromium, with or without nickel, and other alloying elements, which possesses good mechanical properties at high temperatures.
- Heat Stabilisation.** Heat stabilisation of which hot scragging is a particular case, is the process of removing primary creep and inducing beneficial stresses into a spring, such that when the spring is subjected to a stress and temperature, in magnitude no greater than those applied during the heat stabilisation process, it will exhibit improved stress temperature relaxation properties.
- Helical Spring.** A wire, rod or bar coiled into a helix. (See also *Spring*.)
- Hook.** See *Bow 2*.
- Hot Galvanising.** The process of coating materials or components with zinc by immersion in a bath of molten zinc.
- Hot Scragging.** The rapid loading of a spring during manufacture, at a temperature at which there shall be no substantial change in its mechanical properties. The object of this is to reduce relaxation of a spring under working conditions.
- Hourglass Spring.** A helical spring in which the loci of the outside diameter of each coil forms two facing concave arcs. (See also *Spring*.)
- Hydrogen Embrittlement.** Brittleness in a material caused by the absorption of hydrogen usually during pickling or electroplating.
- Hysteresis.** Hysteresis is the lagging of the effect behind the cause of the effect. A measure of hysteresis in a spring is represented by the area between the loading and unloading curves produced when the spring is stressed within the elastic range.
- Inclusions.** Particles of oxides, silicates, sulphides, refractory materials, slag, etc., entrapped in a metal.
- Index.** The index of a spring is the ratio of the mean coil diameter to the wire, bar or rod diameter for circular sections or radial width of cross-section for rectangular or trapezoidal sections.
- Initial Tension.** That part of the force, exerted when a close coiled spring is axially extended, not attributable to the product of the theoretical rate and the measured deflection.
- Internal Stress.** See *Residual Stress*.
- Isothermal Transformation.** A metallurgical process in which changes in the structure of a metal take place at constant temperature.
- Jigger. (Twirler.)** A bench or vice mounted hand operated coiling device.
- Jig Setting.** A process carried out after hardening and before tempering, at a temperature slightly below the tempering temperature, in a jig designed to hold the component to the desired form, thus correcting distortion produced during hardening.
- Jig Tempering.** A process of tempering a hardened component in a jig which constrains the component so that it assumes its required form.
- Keystone Bar.** See *Bevel Section Bar*.
- Keystone Rod.** See *Bevel Section Rod*.
- Keystone Wire.** See *Bevel Section Wire*.
- Laminated Spring.** A composite flat spring made up of a number of formed strips.
- Lead Patenting.** See *Patenting*.
- Leaf Spring.** A flat spring operating as a cantilever or beam supported at each end.
- Limit of Proportionality.** The stress (load divided by original area of cross-section of the test piece) at which the strain (elongation per unit of original gauge length) ceases to be directly proportional to the corresponding stress.
- Load Test.** A test on a spring to determine either the load at a given length or the length under a given load.
- Loop.** See *Bow 2*.
- Low Temperature Heat Treatment.** See *Stress Relieving*.
- Macro Etch Test.** The determination of the surface condition of material, by etching with a suitable reagent followed by examination using a low magnification optical system.
- Magnetic Crack Detection.** A method of examination for surface defects in which the part is suitably magnetized, and coloured magnetic powder, usually suspended in paraffin, is applied to the surface. Cracks or other surface defects which cause discontinuities in the magnetic flux are revealed by a concentration of particles on the surface of the component at the discontinuity.
- Mandrel. 1.** A bar around which wire is coiled to form a spring. **2.** See *Arbor*.
- Martempering.** The quenching of a suitable steel from a temperature above the transformation range to some temperature slightly above the upper limit of martensite formation, holding at that temperature long enough to permit equalization of temperature without transformation of the austenite, followed by cooling in air. This results in the formation of martensite which may be tempered, as desired.
- Martensite.** The hard constituent produced when a steel is rapidly cooled from the hardening temperature at a speed greater than its critical cooling rate.
- Micro-structure.** The structure of metals and alloys as revealed, after polishing and etching, by examination under a microscope.
- Modulus of Elasticity.** The modulus of elasticity of a material is the ratio within the elastic range of the stress in the material to the strain which it produces. The modulus of elasticity of a material under tensile or compressive stresses is known as Young's Modulus (E) and that under shear stress as the modulus of rigidity (G).
- Modulus of Rigidity.** See *Modulus of Elasticity*.
- Music Wire.** A high tensile patented, cold drawn, plain carbon steel wire suitable for highly stressed static applications.
- Natural Frequency.** The frequency at which a spring will freely vibrate once it has been excited.
- Normalising.** The process of heating a material to and holding at a temperature just above the transformation range followed by cooling in air. This process refines the grain size and removes residual stresses resulting in a material with uniform properties.
- Oil Tempered Wire.** A misnomer commonly used to describe hardened and tempered wire. (See also *Hardened and Tempered Wire*.)
- Open End.** The end of an open coiled helical spring in which the angle of the end coil has been progressively reduced.
- Outside Grinding.** The grinding of the outside of the end coil of a spring to ensure that the diameter is within the specified tolerance.
- Overall Length.** See *Free Length*.
- Parallelism.** The degree to which the two ground ends of a spring are parallel to each other.
- Patented Cold Drawn Wire.** Steel wire which has been cold drawn subsequent to patenting.
- Patenting.** The process of heating steel to above the transformation temperature (850—1 000°C dependent upon the carbon content of the steel and the required properties) followed by cooling at a controlled rate in either air, molten metal or molten salt, in order to produce a metallurgical structure which will facilitate a high degree of cold work.
- Patented Wire.** Steel wire which is in the patented condition.
- Pearlite.** The micro-constituent of steel which consists of lamellae of ferrite and cementite produced by the eutectoid transformation of austenite. It is an iron-carbon alloy containing approximately 0-82% carbon.

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Permanent Set. The permanent deformation of a body after the application and removal of a load.

Pitch. The pitch of a spring is the distance from any point in the section of one coil to the corresponding point in the next coil when measured parallel to the axis of the spring.

Plastic Deformation. The permanent deformation of a body produced when it is subjected to a stress greater than the limit of proportionality of the material. (See also *Permanent Set*.)

Power (Motor) Spring. A device in which a clock spring having a relatively large number of coils is constrained within a box of inside diameter smaller than the outside diameter of the spring. The power is delivered by successively winding a few coils from the arbor and transferring them to the inside of the box.

Precipitation Hardening. The process by which a material is hardened due to the precipitation of a constituent from a super-saturated solution. This phenomenon occurs in certain suitably quenched materials on ageing or tempering.

Prestressing. A process during which internal stresses are induced into a spring which have the effect of increasing the apparent elastic limit of the material. It is achieved by subjecting the spring to a stress greater than that to which it is subjected under working conditions and higher than the elastic limit of the material. The plastically deformed areas resulting from this stress cause an advantageous redistribution of the stresses within the spring. Since stress is a vector quantity, advantage from prestressing can only be obtained from springs which are loaded so that the algebraic sum of the prestress and the applied stress is less than the applied stress.

Pretempered Wire. See *Hardened and Tempered Wire*.

Proof Stress. That stress which when applied to a test piece produces a permanent elongation equal to specified percentage of the original gauge length of test piece.

Quenching. The process of cooling rapidly a material a certain percentage component by contact with liquids, gases or so produce desired properties.

Radiusing. The formation of a semi-circular shape on the cut off edges of a spring.

Rate. The rate of a spring is the load or force which must be applied to it in order to produce unit deflection.

Reeling. The process of straightening bars or lengths of wire by feeding them between two formed driven rollers in which they are rotated.

Residual Range. The residual range of a spring is the deflection available beyond the normal working position.

Residual Stress. The term used to describe the stresses set up within a metal as a result of non-uniform plastic deformation which may be caused by cold work, metallurgical transformations or steep temperature gradients during heat treatment.

Reverse Bend Test. See *Bend Test—Reverse Bend Test*.

Reverse Torsion Test. A test to assess the torsional ductility of wire and the influence of surface defects upon this property. The wire is twisted axially a specified number of twists in one direction and then a specified number of twists in the opposite direction. Wire having satisfactory torsional ductility will show no signs of fracture after the specified total number of twists.

Ring Spring. A compression spring consisting of a stack of solid or split rings. The tapered outside diameter of the inner rings are in contact with the tapered inside diameter of the outer rings. Under a compressive load there is relative movement between these surfaces which cause stack height to decrease.

Rockwell Hardness Test. A test to determine the hardness of a material by indicating on a dial the depth of the impression caused by a loaded indenter which may be either a diamond cone or a hardened steel ball.

Rod. Rod is defined as metal section which has not been cold worked and is supplied in coil.

Roller Straightener. This is a machine consisting of a series of offset rollers which locally plastically deform the material being straightened, such that on exit from the machine the wire, bar or rod is straight.

Scouring. See *Barrelling*.

Scragging. An expression applied loosely, and therefore sometimes confusingly, to cover both prestressing and the scrag test. See *Prestressing* and *Scrag Test*.

Scrag Test. An inspection applied to a finished compression spring wherein the spring is compressed to its solid length and then released, in order to determine whether it will return to its initial free length.

Screw Insert. A plug screwed into the ends of a helical extension spring as a means of attaching a spring to another component. The plug has an external thread, the diameter, pitch and form of which, match that of the spring.

Seam. A longitudinal surface defect in wire, rod or bar, originating from a defect in the material from which it was produced.

Set. See *Permanent Set*.

Setting. The adjustment of a helical spring to conform with drawing dimensions. This operation can be carried out at any stage of processing after coiling.

Setting Up. The assembly and adjustment of tools in a coiling or forming machine to obtain the required dimensions on the finished component.

Shot. Rounded particles of hard cast steel or cut wire used in the process of peening springs.

Shot Peening. A cold working process in which shot is impinged on to the surfaces of springs thereby inducing residual stresses in the outside fibres of the material. The effect of this is that the algebraic sum of the residual and applied stresses in the outside fibres of the material is lower than the applied stress, resulting in improved fatigue life of the component.

S/N Curve. A curve obtained from a series of fatigue tests, carried out on test pieces or components by plotting the number of cycles of stress to produce failure, against the maximum stress applied.

Solid Length. Solid length is the overall length of a helical spring when each and every coil is in contact with the next.

Solution Heat Treatment. A process in which an alloy is heated to a suitable temperature, is held at this temperature long enough to allow a certain constituent to enter into solid solution and is then cooled rapidly to hold the constituent in solution. The metal is left in a super-saturated, unstable state and may subsequently exhibit age hardening.

Space. The distance between one coil and the next coil in an open coiled helical spring measured normal to the wire.

Spinning. The process of straightening wire, rod or bar by feeding it through rotating rollers or dies. Unlike reeling the material being straightened does not rotate.

Spiral (Scroll) Spring. A clock type spring made from any shaped section material. (See also *Spring* and *Clock Spring*.)

Spring. A spring is an elastic body designed to deflect under the action of a load, thereby storing mechanical energy. When the load is removed the energy stored in the spring is released and the spring returns to its original unstrained condition.

Squareness. (More accurately, out of squareness.) This is the deviation from a right angle that the ground end of a helical spring in its free state makes with its longitudinal axis. The deviation is normally expressed in units of length over the free length of the spring.

Squaring. The operation of adjusting a spring to ensure it meets the specified squareness.

Stabilising. 1. See *Stress Relieving*.

2. The inhibition of weld decay in stainless steel by the addition of certain elements, e.g. titanium, niobium.

Stainless Steel. An alloy steel which contains substantial quantities of chromium, with or without the addition of nickel and other elements, which has a high resistance to many corrosive environments.

Stiffness. See *Rate*.

Strain. The deformation produced by stress and expressed as the change per unit of original dimension.

Stress. The load or force divided by the area over which it acts.

Stress Raiser. A feature of a component which causes a concentration of stress, e.g. an abrupt change in contour, scratch, pit or discontinuity in structure.

Stress Range. The difference between the stresses induced by the minimum and maximum applied loads in a component subjected to cyclic loading.

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Stress Relaxation. Permanent deformation of a spring when it is subjected to a stress. The degree of relaxation is dependent upon magnitude of stress, temperature and time. Relaxation increases with increasing stress, temperature and time.

Stress Relieving. A low temperature heat treatment carried out at temperatures where there is no apparent change in metallurgical structure of the material. The purpose of the treatment is to relieve stresses induced during manufacturing processes.

Stroke. (Range.) The distance between the minimum and maximum working positions of a spring.

Swift. A device on which coils of wire are placed so that they may be unwound by rotating them about their axis.

Swivel Hook. A bow (hook or eye) fitted to the end of an extension spring so that it is capable of rotating about the axis of the spring.

Tapered Spring. See *Conical Spring*.

Tapering. (Drawing Out.) The forming of the end of a bar (usually hot) into a taper prior to coiling to facilitate the production of a spring with a closed and square end with a minimum of grinding.

Tempering. The process of modifying the structure of a hardened material by heating to a suitable temperature for a specified time and in some cases followed by controlled cooling in order to obtain optimum mechanical properties.

Tensile Strength. See *Ultimate Tensile Stress*.

Tensile Test. A test in which the two ends of a standard test piece are pulled until fracture of the test piece occurs. From this test the following properties of the material may be obtained: Young's modulus, limit of proportionality, yield stress, proof stress, ultimate tensile stress, percentage elongation and percentage reduction of area.

Torsion Bar. A particular type of spring consisting essentially of a straight length of bar or wire designed to give an angular deflection about its longitudinal axis when subjected to an external load. (See also *Spring*.)

Torsion Spring. A helical coiled spring designed to give an angular deflection of its ends about its longitudinal axis when subjected to an applied load. (See also *Spring*.)

Torsion Test. 1. This test, also known as the twists to failure test is one in which the effect of defects upon the torsional properties of a wire are assessed by twisting a length of the wire about its own axis until fracture occurs. The assessment is made upon the number of twists before failure and the form of fracture.

2. A test in which the two ends of a standard test piece are twisted about the longitudinal axis of the test piece usually until fracture occurs. From this test the following properties of the material may be obtained:— Modulus of rigidity, limit of proportionality in shear, proof stress in shear, ultimate shear stress, angular deflection to fracture.

Total Number of Coils. The sum of the active and dead coils in a coil spring.

Ultimate Tensile Stress. The ultimate tensile stress of a material is the maximum load reached during a standard tensile test divided by the original cross-sectional area of the gauge length of the test piece.

Ultrasonic Test. A test to determine the presence of internal flaws in a material by the transmission of high frequency sound waves through the material section.

Vapour Blasting. A process by which the surface of a component is modified by the action of a stream of liquid carrying solid particles of abrasive energised by compressed air. The results of this process can be to remove scale, produce a clean matt surface finish and induce into the outer fibres of the material moderate compressive stresses.

Variable Pitch Spring. A helical spring in which the pitch of the active coils is not constant.

Vickers Hardness Test. See *Diamond Pyramid Hardness Test*.

Volute Spring. A spring produced from flat section material, helically coiled with its thickness as the radial dimension such that each coil nests within its adjacent larger coil. (See also *Spring*.)

Wap. A single turn of wire or rod in a coil.

Wave Washer. See *Crinkle Washer*.

Wire. Wire is metal section whose dimension has been changed by cold work. It can be obtained in coil or straight lengths and a number of metallurgical conditions.

Working Coils. See *Active Coils*.

Wrapping Test. This is a test in which the ductility of wire is assessed by wrapping it round a mandrel of specified size and determining whether or not the surface of the wire shows signs of fracture.

Young's Modulus. See *Modulus of Elasticity*.