Section 4 – WHICH FORMS OF BRASS?

EXTRUSIONS

Extruded rods, bars and profiles are one of the most readily available forms of the duplex brasses. They are made by forcing hot metal through a shaped die. Round or polygonal shaped sections are held in stock and specially shaped profiles can be produced to order. Material may be supplied either as extruded or may be further worked by cold drawing to improve properties, tolerances and surface finish. The material is sound and has a uniform, fine grain structure. The most readily available alloys are listed in ***Table 12***.

Hollow profiles are also available and may be the most cost-effective starting stock for the manufacture of many components.

HOT STAMPINGS

A hot stamping is manufactured by forming a hot, solid billet of material between two halves of a die. The die is so designed as to produce a component which is as close in size to the finished desired product as possible with a minimum of machining and surface finishing necessary. The metal structure is sound and uniformly fine grained. The duplex brasses are available in this form. Those listed in the Standards are shown in ***Table 13***, the most popular and readily available are covered in ***Table 7***.

Where needed, it is possible to use inserts in the dies to produce hollow recesses in hot stampings to reduce the need for subsequent drilling. The hot stamping process is ideal for medium to long runs of components such as bosses, elbows, tees, valves, other plumbing accessories and general engineering parts needing strength, machinability and corrosion resistance at a modest cost.

FORGINGS

Open forging is used to produce relatively short runs of large components. Preheated billets are repeatedly struck between head and anvil while the material is moved to obtain the required round, rectangular or complex shape. Formers and punches are used to help produce shapes near-net-size. Leaded alloys must be forged with more care than is needed for hot stamping. Single phase alloys can be forged relatively easily provided that impurity contents likely to produce hot shortness are kept low.

TABLE 12 – Brasses available as extruded rod and section

Compositional Designation and EN number	Nearest Equivalent Old British Standard Alloy	Typical Applications
CuZn39Pb3 CW614N	CZ121 Pb3	High speed free-machining brass.
CuZn36Pb2As CW602N	CZ132	Dezincification resistant brass. Good corrosion resistance.
CuZn37Pb2 CW606N	CZ131	This alloy is suitable for riveting and also has good machinability.
CuZn39Pb2 CW612N	CZ128	Machining and semi-riveting brass.
CuZn40Pb2 CW617N	CZ122	General purpose brass.
CuZn43Pb2 CW623N	CZ130	Suitable for complex sections.
CuZn43Pb2Al CW624N	CZ130	Complex section brass with aluminium.
CuZn36Sn1Pb CW712R	CZ112	Corrosion resistant naval brass.
CuZn40Mn1Pb1AlFeSn CW721R	CZ114	High tensile brass.

TABLE 13 – Brasses for hot stamping

Compositional Designation and EN number	Nearest Equivalent Old British Standard Alloy	Relevant Properties	Approximate Tensile Strength N/mm^2
CuZn40Pb2 CW617N	CZ122	This is the alloy most frequently used for hot stamping. Complex shapes can be formed and it has good machinability.	360
CuZn40 CW509L	CZ109	This lead-free alloy has superior cold ductility, as well as excellent hot working properties. It is not so easily machined.	340
CuZn39Pb3 CW614N	CZ121 Pb3	Has excellent machinability.	360
CuZn39Pb2 CW612N	CZ128	This alloy has better cold ductility than CuZn40Pb2.	350
CuZn36Pb2As CW602N	CZ132	Dezincification resistant brass. Used for plumbing fittings.	280
CuZn37Mn3 Al2PbSi CW713R	CZ135	High tensile brass. Silicon addition imparts excellent wear resistance.	510
CuZn40Mn1Pb1Al1FeSn CW721R	CZ114	High tensile brass with lead to improve machinability.	440
CuZn40Mn1Pb1FeSn CW722R	CZ115	High tensile brass with no aluminium. Can be soldered.	390
CuZn40Mn1Pb1 CW720R	CZ136	High tensile brass with excellent resistance to seizure. Also used for architectural fittings.	To be agreed between purchaser and supplier

Flanges, large bosses, bearing blocks and similar components are produced by this process, especially when the mechanical properties required are to be better and more uniform than available with castings.

WIRE

Wire is made by drawing cold from rod through a succession of dies that reduce the diameter to give a degree of work hardening not so easily achievable by any other process apart from strip rolling. This means that wire can be made with strength, hardness and springiness far higher than for most other materials. Depending on composition, tensile strengths in the range of 300–850N/mm^2, and hardness values up to 200HV can be produced. Due to the ductility of many brasses, reductions in sectional area of over 90% can be made between anneals.

Some of the brasses in wire form, covered in EN 12166, are shown in ***Table 14***.

The most usual shape of wire is round. In this form wire is available in sizes ranging from 0.10mm up to 8.00mm and beyond. There is little standardisation, however, since dimensional requirements are usually dictated by the individual customer's requirements. Improvements in die materials in recent years have meant that tolerances on size have been tightened to meet customer requirements and those listed in ***Table 15*** are now available as standard. Square, rectangular and custom shaped wires are also freely available in sizes from about 0.25mm to 8.0mm across flats. Wire is used for the manufacture of pins, springs, clips, zips, electrical applications and a wide variety of other uses including rail for model railways.

Irrespective of shape, wire is provided either as coils or on reels. Maximum package weights vary from about 1,000kg for larger sizes to 3kg for very fine wires.

SHEET AND STRIP

Brasses which are available in coil, flat lengths or circles, covered in EN 1652 are shown in ***Table 16***.

Strip widths up to 330mm are common with minimum thickness typically being 0.15mm. Specialist suppliers can provide strip with lengths joined by welding or brazing and layer wound on to wide steel drums containing up to 500kg of strip in one continuous length. Strip is used frequently as the feedstock for transfer presses and other continuously running machines to produce small parts punched, bent, formed and deep drawn to shape including locks, hinges, finger plates, reflectors, electrical components, terminals, contacts, springs, cartridge cases and good quality light bulb bases and holders.

Brass strip is widely produced from semi-continuous slabs or strip (***see Figure 7, page 39***). Slabs (150mm thick) are hot rolled, and strip (13 - 20mm) is cold rolled and annealed (625ºC) to break down the initial coarse as cast structure and soften the material to allow further cold rolling to produce strip in the desired temper.

Sheet is a product wider than 300mm and less than 10mm thick supplied flat. The alloys commonly available are as for strip but low-leaded Clock brasses and Aluminium brasses with extra corrosion resistance are also supplied.

The surface finish on sheet and strip is often an important consideration. For deep drawing operations it is useful to have some roughness in order to retain lubricant during deformation whereas for applications requiring subsequent polishing and plating at least one side should be 'plating quality'.

Besides surface finish, fitness for purpose is obtained by specifying hardness and/or grain size in order to be able to optimise the quality of edge shearing, bending, cupping or deep drawing without cracking or failure (***see Figure 12, page 42***).

TABLE 14 – Brass wire (EN 12166)

Compositional Designation and EN number	Nearest Equivalent Old British Standard Alloy	Typical Applications
CuZn10 CW501L	CZ101	Gilding Metal or Commercial Bronze. Zip fasteners and decorative items.
CuZn15 CW502L	CZ102	Jewellery Bronze - springs, contacts, wire shapes, jewellery.
CuZn30 CW505L	CZ106	Electrical applications include fluorescent tube studs, alkaline battery anodes, vacuum cleaner electrical systems. Decorative meshes and embossed shaped wire for use on dishes, salvers and trophies. Picture frame wire. Model making. Ferrules.
CuZn36 CW507L	CZ107	Widely used for cold headed fasteners, springs and screws with rolled threads. Picture frame wire. Knitted wire washers. Connector pins.
CuZn35Pb2 CW601N	CZ119 / CZ131	Screws and machined parts.
CuZn40Si	CZ6	Brazing wire - ideal for joining mild steel.
CuNi10Zn27	NS103	Nickel silver - white colour. Good corrosion resistance. Uses - toothbrush anchor wire, pins, jewellery, model making.

TABLE 15 – Standard tolerances on diameter of round wire

Specified Diameter		Tolerance (Class A)
Over (mm)	Up to & including (mm)	± (mm)
-	0.25	0.005
0.25	0.50	0.008
0.50	1.0	0.012
1.0	2.0	0.020
2.0	4.0	0.030
4.0	6.0	0.040
6.0	10.0	0.060
10.0	18.0	0.080

TABLE 16 – Brasses in sheet or strip (EN 1652)

Compositional Designation and EN number		Description	Nearest Equivalent Old British Standard Alloy
CW507L	CuZn36	Common Brass	CZ107
CW505L	CuZn30	70/30 Brass	CZ106
CW501L	CuZn10	90/10 Gilding Metal	CZ101
CW502L	CuZn15	85/15 Gilding Metal	CZ102
CW503L	CuZn20	80/20 Gilding Metal	CZ103
CW409J	CuNi18Zn20	Nickel Silver - polishes white	NS106

TUBE

Welded tube is manufactured from strip and has the benefit of this relatively cheaper cold working process but the disadvantage of needing high volume applications. Precision rolled strip can be made to thin gauge and subsequent roll-forming and welding operations automated. Welded tube is widely used for high volume decorative purposes where strength and proven integrity is less of an issue.

Seamless tubes (EN 12449, General Purpose Tubes) are normally made by drawing to size from hollow tube shells produced by extrusion. They are then cold drawn to size by a succession of passes with interstage anneals as required and supplied in either straight lengths or coil. Some of the tubes covered in EN 12449 are shown in ***Table 17***.

The advantages of using seamless tube in design is that the cold working results in a thin walled, close tolerance, high strength to weight product which may give weight advantages over corresponding cast and machined tubes.

Normally brass tubes are thought of as being circular, with tolerances on inside and outside diameters that make them easy to join with standard fittings. However, tubes can in fact be made by many different techniques to bespoke shapes and sizes. They can be square, circular or hexagonal. They can be made twisted or indented. They can be fluted, decoratively patterned or grooved. The inside shapes can be different from the outside and can have specified wall thicknesses, uniform or uneven. For example, a round hole inside a square tube is often needed to ensure correct flow of coolant. Another frequent need is for an oblong tube with the corners either square or typically, radiused to half the wall thickness. Often, one side must be significantly thicker than the other. In tubular heat exchangers, such as oil coolers, there are concentric tubes and the flow of coolant can be made turbulent by helical grooves or raised ridges.

Brass is frequently specified for the tubes of heat exchangers (EN 12451:– Aluminium, Admiralty, Arsenical) because it is relatively cheap, strong, corrosion resistant and easily soldered. Precision brass tube is used for the concentric thin walled tubes to make collapsible aerials and pointers.

PLATE

Plate is used to make the tubeplates of many heat exchangers, even when the tubes themselves may not be of brass. It is generally supplied 'as manufactured' in the hot rolled condition. If required it can be pickled clean before delivery or milled flat. It is usually supplied with sheared, sawn or machined edges. Thicknesses are generally greater than 10mm. Both single phase and duplex brasses in leaded and lead-free versions are available.

CASTINGS

Pouring of liquid metal into a shaped mould to solidify as a shape that needs minimal finishing is one of the oldest production methods. With modern technology the techniques available now produce products that are of good, reproducible quality and made to close tolerances on size and properties. Many techniques are available and described below. Further information is included in CDA TN42.

Sand and shell mould castings

Most castings are made by pouring metal into sand moulds. Depending on the casting required, the sand may be bonded with clay or silicates or various organic mixes. Shell moulding involves the use of a thermosetting resin bond. For hollow castings, cores are used. Moulding techniques range from simple hand moulding to fully mechanised repetition moulding for very long runs.

Permanent mould processes

For long production runs it is frequently economical to make permanent metallic moulds from which many castings can be made with good reproducibility. The rapid rate of cooling given by chill casting gives good properties. Metal may either be poured by gravity into simple open moulds or injected into a closed mould under pressure.

Low pressure die castings

Gravity diecasting is used to make taps and other plumbing fittings simply and cheaply. Fairly complex shapes can be made with a good surface finish. Because of solidification shrinkage and other considerations, not all brasses can be cast this way but the alloys available include conventional 60/40 leaded brasses and some high tensile brasses, sufficient for most applications.

High pressure die castings

For relatively long runs, this process gives excellent products with good properties, accurate reproduction and thin walls. If the mould costs can be amortised cost-effectively, it is an excellent process.

Investment casting

Investment casting by the 'lost wax' method has been used for centuries to make useful and decorative, high precision components in weights from grammes to tonnes.

TABLE 17 – Brass tubes – general purpose (EN 12449)

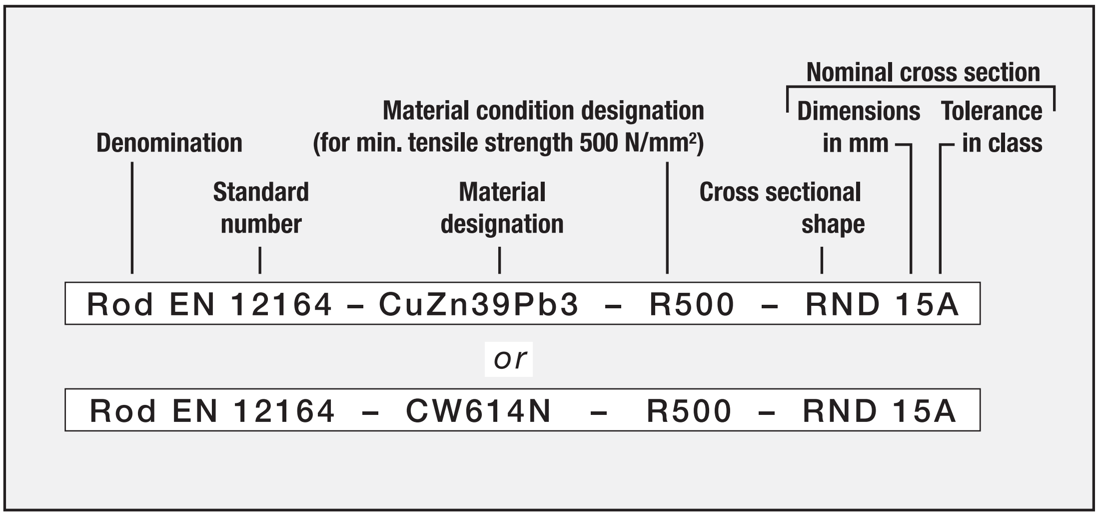
Compositional Designation and EN number	Nearest Equivalent Old British Standard Alloy	Comments
CuZn10 CW501L	CZ101	Widely used - driving bands for projectiles. Architectural applications - handrails. Communication systems - wave guides. Bellows for fluid and steam systems.
CuZn15 CW502L	CZ102	Used for condensers and cooling units, gauges and instrument tubes. Decorative uses. Musical instruments.
CuZn20 CW503L	CZ103	Architectural applications.
CuZn30 CW505L	CZ106	Easy to work - most ductile of all brasses (α structure).
CuZn37 CW508L	CZ108	Common brass. More difficult to work than CW505L ($\alpha + \beta$ structure).
CuZn35Pb1 CW600N	CZ118	Machinability good due to lead but limited cold working possible.
CuZn36Pb3 CW603N	CZ124	Machinability excellent due to increased lead but cold working should be avoided.
CuNi12Zn24 CW403J	NS104	Nickel Silver - white colour. Spring and decorative applications.
CuNi18Zn20 CW409J	NS106	Whitest of Nickel Silvers - good corrosion resistance - decorative applications.

ORDERING INFORMATION
European Standard Specifications

The EN Standards urge the use of a ‘Product Designation’ as a means of providing a description to ‘convey mutual comprehension at international level’. This designation will comprise, in sequence :

Denomination	e.g. rod, wire, strip, etc.
Standard number	(EN xxxxx)
Material designation	Alloy symbol or number, e.g. CuZn30 or CW505L
Material condition designation	Mechanical property requirements, e.g. R380 for minimum tensile strength of 380N/mm^2
Cross-sectional shape	e.g. RND - round or SQR - square
Nominal cross-sectional dimension	e.g. 15 for 15mm
Tolerance class	e.g. for wire: A, B, C, D or E
Corner type	Where appropriate, e.g. SH - sharp or RD - rounded

For example, free-machining brass rod can be ordered to the appropriate EN 12164 as:



The product designation provides a summary of primary ordering information when joined with quantity and length/pieceweight tolerance. Additional ordering information may include method of testing, packing details and type of quality assurance certification.

Table 18 shows a few of the titles of the EN standards for copper and copper alloys.

TABLE 18 – European standards for copper and copper alloys covering brasses		
Title	**EN Number**	**Superseded BS Number**
Plate, sheet, strip and circles for general purposes	1652	2870, 2875
Plate, sheet and circles for boilers, pressure vessels and hot water storage units	1653	2870, 2875
Strip for springs and connectors	1654	2870
Seamless round tubes for general purposes	12449	2871
Seamless round tubes for heat exchangers	12451	2871 Pt3
Rolled, finned seamless tubes for heat exchangers	12452	-
Rod for general purposes	12163	2874
Rod for free-machining purposes	12164	2874
Wrought and unwrought forging stock	12165	2872
Wire for general purposes	12166	2873
Profiles and rectangular bar for general purposes	12167	2874
Hollow rod for free-machining purposes	12168	-
Rod and wire for brazing and braze welding	1044	1845
Forgings	12420	2872
Plumbing fittings Parts 1-2	1254-1/2	864
Ingots and castings	1982	1400
Master alloys	1981	-
European numbering system	1412	-
Material condition or temper designation	1173	-
Scrap	12861	-

Tables 19 and 20, for wrought and cast material respectively, show the brasses and nickel silvers most common in Europe.

Quality assurance
EN ISO 9001:2000

This standard for quality assurance has replaced BS 5750 Pt 2 as the document covering the requirements for quality management systems for the production of the materials covered in this publication. Conformance is assured by assessment of quality management systems by accredited organisations. Products manufactured in accordance with this standard are assured of conforming to order requirements. Although manufactured in accordance with an approved quality management system by the manufacturer, it is the customer's duty to check that the order is sufficiently explicit to ensure that material is fit for the purpose intended.

Certification

Certificates of conformity can be a valuable assurance of the compliance of the goods supplied with written order requirements. If self-certified by the manufacturer, the customer should ensure that full responsibility is accepted. If the goods are manufactured in accordance with an approved scheme such as EN ISO 9001, customers can be more certain that manufacturers' quality-monitoring equipment has been calibrated according to National Standards.

Kitemark

A product guaranteed to conform to standard and produced under a quality control system approved under the BSI 'Kitemark' scheme can bear the appropriate marking.

CE Mark

Products that are subject to EEC directives covering safety may be required to carry a 'CE' mark of conformity to specification. Frequently this mark is applied by manufacturers after self-certification.

Weight calculation

(Courtesy Outokumpu Copper MKM Ltd)

Calculation of the weight of brasses, assuming a density of 8450 kg/m^3

To use D in inches, apply the formulae and multiply the answer by 645.2

Shape	kg/m	kg/ft
Round	D^2 x 0.00663	D^2 x 0.00203
Hexagon	D^2 x 0.00732	D^2 x 0.00223
Square	D^2 x 0.00845	D^2 x 0.00257
Rectangle	Width x Thickness x 0.00845	Width x Thickness x 0.00257

TABLE 19 – BS and European designations - summary of compositions for wrought products

Alloy Designation		Common British Description	Remarks	Availability						
EN Compositional Designation and Number	Nearest Old BS Equivalent			Tube	Rod	Profiles	Wire	Forgings	Plate & Sheet	Strip
BINARY COPPER-ZINC ALLOYS										
CuZn0.5 CW119C			Used for radiator fin strip and for building purposes.							x
CuZn5 CW500L	CZ125	Cap copper	Industrial use practically confined to caps for ammunition.	x	x				x	x
CuZn10 CW501L	CZ101	Gilding Metal	Good corrosion resistance. Used for architectural metalwork and costume jewellery. Can be brazed and enamelled.	x	x		x		x	x
CuZn15 CW502L	CZ102	Gilding Metal, Jewellery bronze	Used for condenser units, gauges, instrument tubes, springs, contacts and jewellery	x	x		x		x	x
CuZn20 CW503L	CZ103	Ductile brass	As above. This alloy has good deep drawing properties.	x	x		x		x	x
CuZn28 CW504L			Suitable for cold deformation.		x					
CuZn30 CW505L	CZ106	70/30 brass (Cartridge brass)	In sheet form known as deep drawing brass. As wire, suitable for severe cold deformation.	x	x		x		x	x
CuZn33 CW506L			A good cold working brass.		x				x	x
CuZn36 CW507L	CZ107		General purpose alloy suitable for simple forming.	x	x	x	x		x	x
CuZn37 CW508L	CZ108	Common brass	As above	x	x	x	x	x	x	x
CuZn40 CW509L	CZ109	60/40 brass	Good for hot working. Limited ductility at room temperature.	x	x	x		x	x	x
COPPER-ZINC-LEAD ALLOYS										
CuZn35Pb1 CW600N			Machinable and has good workability.	x	x	x	x		x	x
CuZn35Pb2 CW601N			Machinable and has good workability. Used for riveting.	x	x	x	x			
CuZn36Pb2As CW602N	CZ132	Dezincification-resistant brass	Good hot ductility. Heat treated to give dezincification resistance.	x	x	x		x		
CuZn36Pb3 CW603N	CZ124	Free-cutting brass	Excellent machinability but very limited cold workability.	x	x	x	x			
CuZn37Pb0.5 CW604N			Machinable and has some cold workability.	x					x	x
CuZn37Pb1 CW605N			Machinable and has good to very good cold workability.	x	x					
CuZn37Pb2 CW606N	CZ119/131	Free-cutting brass with improved ductility	Good machinability, some cold workability. Used for cold heading and riveting.		x	x	x		x	x
CuZn38Pb1 CW607N	CZ129		Machinable and has good to very good cold workability	x	x	x				
CuZn38Pb2 CW608N	CZ128	Free-cutting brass	Good machinability, sufficient ductility for some cold work.	x	x	x	x	x	x	x
CuZn39Pb0.5 CW610N	CZ137		Machinable and has some workability.		x	x	x	x	x	x
CuZn39Pb1 CW611N	CZ129	Free-cutting brass with improved ductility	Commonly used for hot stamping. Machinable and good workability.		x	x		x		
CuZn39Pb2 CW612N	CZ120/128	Free-cutting brass with improved ductility	Good machinability, some cold workability but lower than that of CZ131.		x	x	x	x	x	x
CuZn39Pb2Sn CW613N			Similar to CZ128 but with higher permitted impurity level. Unsuitable for machining at highest speeds.		x	x		x		
CuZn39Pb3 CW614N	CZ121Pb3	High speed machining brass	Excellent machinability, very limited cold workability. Also used for hot stamping.	x	x	x	x	x		
CuZn39Pb3Sn CW615N			Similar to CZ121Pb3 but with higher permitted impurity level. Unsuitable for machining at highest speeds.					x		
CuZn40Pb1Al CW616N			Forging brass. The aluminium gives an attractive colour and eases extraction from the dies.					x		
CuZn40Pb2 CW617N	CZ122	Free-cutting brass	Most popular alloy for hot stamping. Excellent machinability but very limited cold ductility compared with alloys also containing 2% Pb but with higher copper content	x	x	x	x	x		
CuZn40Pb2Al CW618N		Brass for architectural sections	Good bright yellow colour for architectural profiles. The higher the zinc content the more complex the profiles achievable.			x				

Alloy Designation			Common British Description	Remarks	Availability						
EN Compositional Designation and Number		Nearest Old BS Equivalent			Tube	Rod	Profiles	Wire	Forgings	Plate & Sheet	Strip
CuZn40Pb2Sn	CW619N			Similar to CZ122 but with higher permitted impurity level. Unsuitable for machining at highest speeds.		x	x		x		
CuZn41Pb1Al	CW620N			Production of complex profiles by hot extrusion.			x				
CuZn42PbAl	CW621N			As above			x				
CuZn43Pb1Al	CW622N			As above			x				
CuZn43Pb2	CW623N	CZ130		Production of complex profiles by hot extrusion. Aluminium free.			x				
CuZn43Pb2Al	CW624N	CZ130		Good bright yellow colour for architectural profiles. The higher the zinc content the more complex the profiles achievable.			x				
COMPLEX COPPER-ZINC ALLOYS											
CuZn13Al1Ni1Si1	CW700R	CZ127	Tungum	Hydraulic tubes.	x						
CuZn20Al2As	CW702R	CZ110	Aluminium brass	Excellent corrosion resistance in clean seawater and is a favoured alloy for condenser tubes.	x					x	x
CuZn23Al3Co	CW703R			Used for springs and connectors.							x
CuZn23Al6Mn4Fe3Pb	CW704R					x			x		
CuZn25Al5Fe2Mn2Pb	CW705R	CZ116	High tensile brass	High strength and good corrosion resistance.		x			x		
CuZn31Si1	CW708R			General purpose alloy produced as rod and tube.		x					
CuZn32Pb2AsFeSi	CW709R			Dezincification-resistant brass of Swedish origin.	x	x					
CuZn35Ni3Mn2AlPb	CW710R				x	x	x		x		
CuZn36Pb2Sn1	CW711R	CZ134	Leaded naval brass	Tin addition improves corrosion resistance, especially in sea water. Lead improves machinability.		x					
CuZn38Sn1Pb	CW712R	CZ112	Leaded naval brass	As above		x	x	x	x		
CuZn37Mn3Al2PbSi	CW713R	CZ135	High tensile brass with silicon	Silicon addition gives extra wear and galling resistance to suit applications such as gear box components.	x	x	x		x		
CuZn37Pb1Sn1	CW714R					x	x	x	x		
CuZn38AlFeNiPbSn	CW715R									x	
CuZn38Mn1Al	CW716R					x					
CuZn39Mn1AlPbSi	CW718R			Silicon and manganese additions give good wear resistance for gear box components and bearings.	x	x	x		x		
CuZn39Sn1	CW719R	CZ133	Naval brass	Tin addition improves corrosion resistance especially in sea water.		x	x		x	x	
CuZn40Mn1Pb1	CW720R	CZ136	Manganese brass	Excellent resistance to seizure. Used in contact with cast iron. Used for architectural profiles. Attractive chocolate brown oxide.		x	x	x	x		
CuZn40Mn1Pb1AlFeSn	CW721R	CZ114	High tensile brass	General purpose high strength alloy.		x	x		x		
CuZn40Mn1Pb1FeSn	CW722R	CZ115	High tensile brass	Aluminium free, used where components are to be joined by soldering or brazing.		x	x		x		
CuZn40Mn2Fe1	CW723R			General purpose high strength alloy.	x	x	x		x		
COPPER-NICKEL-ZINC ALLOYS											
CuNi7Zn39Pb3Mn2	CW400J						x	x	x		
CuNi10Zn27	CW401J	NS103	10% nickel silver					x		x	x
CuNi10Zn42Pb2	CW402J	NS101	Leaded 10% nickel brass				x	x	x		
CuNi12Zn24	CW403J	NS104	12% nickel silver	Good spring properties.	x	x	x	x		x	x
CuNi12Zn25Pb1	CW404J	NS111		Lead addition improves machinability.						x	x
CuNi12Zn29	CW405J			Contains no lead and is only available as strip.							x
CuNi12Zn30Pb1	CW406J			Used for extrusions.			x	x			
CuNi12Zn38Mn5Pb2	CW407J						x				
CuNi18Zn19Pb1	CW408J	NS113					x	x			
CuNi18Zn20	CW409J	NS106	18% nickel silver	The whitest of the nickel silvers with optimum corrosion resistance.	x	x	x	x		x	x
CuNi18Zn27	CW410J	NS107		Contains no lead and is only available as strip.						x	x

TABLE 19 – continued

TABLE 20 – EN and old BS designations for cast products		
Alloy designation		Remarks
EN Compositional Designation and Number	Nearest Old BS Equivalent	
CuZn33Pb2-C CC750S	SCB3	General purpose castings for less onerous duties, gas and water fittings. Good machinability.
CuZn33Pb2Si-C CC751S	DZR2	Die casting brass with dezincification resistance. Mainly for water fittings.
CuZn35Pb2Al-C CC752S	DZR1	Die casting brass with dezincification resistance. Mainly for water fittings.
CuZn37Pb2Ni1AlFe-C CC753S	–	Die casting brass, fine grained and freely machinable.
CuZn39Pb1Al-C CC754S	DCB3	Die casting brass. Used extensively for plumbing fittings.
CuZn39Pb2AlB-C CC755S	DCB3a (fine grained)	Die casting brass used where superior strength and thinner sections with finer finishes are required.
CuZn15As-C CC760S	Arsenical brass	Used for sand castings. Has good corrosion resistance, suitable for brazing.
CuZn16Si4-C CC761S	Silicon brass	General purpose castings, both sand and die. Used particularly for valves and water fittings. Low lead content.
CuZn25Al5Mn4Fe3-C CC762S	HTB3	Suitable for all casting methods. Good resistance to wear under high load at low speeds such as rolling mill slipper pads, screwdown nuts, etc. Unsuitable for marine conditions.
CuZn32Al2Mn2Fe1-C CC763S	HTB1(Pb)	Lead containing version of HTB1 used mainly where friction and wear occurs, e.g. valve spindles.
CuZn34Mn3Al2Fe1-C CC764S	–	General high tensile brass. Sand and die castings.
CuZn35Mn2Al1Fe1-C CC765S	HTB1	General engineering castings suitable for all casting methods. Good resistance to corrosion. Frequently used for marine components including propellers.
CuZn37Al1-C CC766S	–	General purpose die casting brass.
CuZn38Al-C CC767S	DCB1	General purpose high quality engineering die castings.

Case Histories

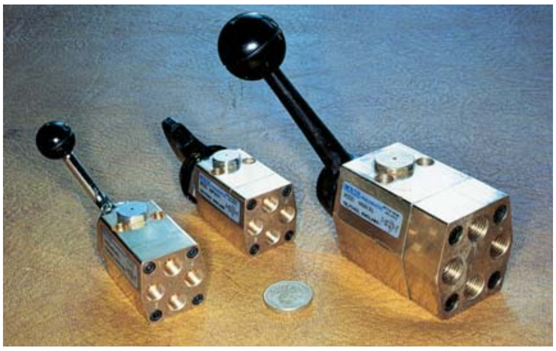
Handle for Rolls Royce car, hot forged from brass


(Rolls Royce)

Brass was found to be the material of choice, for longevity and reliability, for exterior door handles for the 'Silver Spirit'.

Handles made from a zinc based material had failed to meet the standards for which Rolls Royce is noted. A brass forged handle was designed and developed with the co-operation of a major hot brass stamper, whose involvement from an early stage resulted in substantial cost savings over the original concept. By switching to brass, a potential problem was removed without cost penalty, with retooling costs low and implementation of change achieved quickly.

A selection of Vickers' valves


(Vickers Systems Division Trinova Ltd)

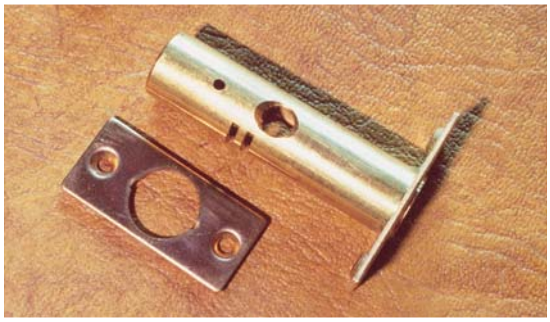
A cost comparison favours brass rather than aluminium for the manufacture of Vickers' 4-way semi-rotary slide valves.

These valves operate in harsh and rugged environments such as quarries and mines, and in railway wagons, military vehicles and brewery handling equipment. The valves need to be manufactured from a corrosion resistant, low friction, self-lubricating and easily machined material, the obvious choice of material being a free-machining brass in extruded rod form. Material choice depends not only on properties, but also on cost-effectiveness. A possible alternative choice might be extruded aluminium, which has a lower raw material cost.

A full cost analysis shows that the finished cost of the valve body in brass is 15% cheaper than the same component made in aluminium, due to:

- *lower production costs, since brass machines faster than aluminium*
- *higher resale value of brass swarf*
- *no finishing requirement, since aluminium has to be hard anodised to have the same wear properties as brass.*

Concealed security bolt


(J E Reynolds & Co Ltd)

Replacement of the steel tubular housing of this security bolt with brass has led to the production of a superior, all brass product, with no increase in cost.

The assembly consists of a round sliding bolt housed in a tube, the bolt being driven backwards and forwards with a splined key in the tube which mates with a rack on it. The assembly is fitted into the edges of doors and windows for additional security. The steel tube had to be machined, painted and then brazed to an end plate.

The following problems were encountered using steel: the tube and end plate had to go off site for brazing and the machining required a drilling operation where break-out of the drill left a flap on the bore.

These manufacturing problems using steel led to brass being considered as an alternative material. Even though brass tube is five times the price of steel the switch to brass proved to be cost-effective. The brass tube does not need painting, due to its good corrosion resistance, and can be secured to the end plate without the need for brazing, due to the high degree of formability of brass. The brass tube machines quicker and a clean break-through on drilling enables all burrs to be removed easily by the reaming operation required to finalise the size of the bore. The whole process is now carried out on site and production rates have increased by over 300%.

Tungum tube preferred to stainless steel


(Tungum Hydraulics Ltd)

The Tungum tube (top sample) is expected to serve for 20 years marine exposure on a Shell semi-submersible support vessel. The stainless steel section (lower sample), from a southern North Sea gas platform in the Lima field, shows both crevice corrosion and chloride pitting after barely 5 years in the same environment.

Failure of stainless steel instruments and hydraulic tubing in these aggressive environments has necessitated replacements after only five years on platforms with a life expectancy of 20 years. This has had serious cost implications, not only in replacement materials, but in the higher labour costs involved in working offshore. An alternative material was sought and Tungum, CW700R (CZ127), a high copper brass containing aluminium, nickel and silicon, was found to be the most cost-effective. Tungum has a high strength-to-weight ratio, good ductility, excellent corrosion resistance (especially to seawater in the 'splash zone'), excellent fatigue properties and is non-magnetic and non-sparking. In tube form it exhibits clean bore features making it ideal for hydraulic and pneumatic applications. Shell's Southern Business Unit in Lowestoft now specifies Tungum tubing on all new platforms and is replacing existing stainless steel during platform refits. Despite Tungum being initially more expensive to buy, lifetime costing shows it to be the most cost-effective material for tubing in the oil/gas/petrochemical industry.

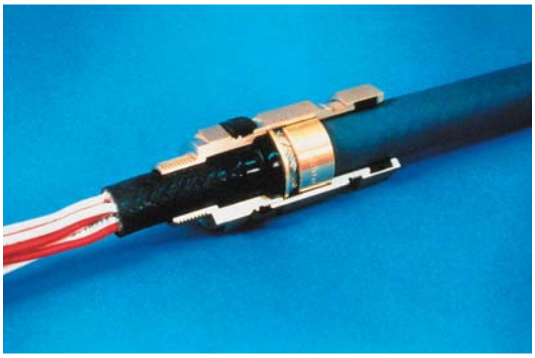
Automatic door closer

End and anchor plates made from brass last fifty times longer than steel and are cheaper to produce.

The 'Perkomatic' concealed door closer is secured to a door and door frame by end and anchor plates respectively. Twin chains connect the hydraulic cylinder mechanism in the door to the anchor in the frame, passing through the end plate and rubbing against it every time the door opens and closes. Brass stampings were chosen for the end and anchor plates as these were cheaper than forged steel plates, required no protective finish and also looked attractive. The self lubricating and low friction properties of brass give a life of 500,000 operations compared to 10,000 for steel.

(Samuel Heath & Sons plc)

Universal cable gland



(Hawke Cable Glands Ltd)

Brass cable glands are strong, high quality, high performance products made at low cost, with exceptional electrical, mechanical and corrosion resistant properties, ideally suited for a long life of use in all situations.

They are machined from extruded bar, with a cross-sectional profile designed to give optimum shape for minimum metal removal. Brass machines at exceptionally high rates, many times that of steel, giving short, economical cycle times. The swarf produced comes away in chip form rather than spiral, thus eliminating the need for chip breakers, and commands a high scrap value. The minimum cost of tooling required for machining brass makes it ideal for short runs or specials and modifications can be made at short notice. Brass cable glands are therefore cost-effective to manufacture.

Brass cable glands meet all the necessary safety regulations enabling them to be used with wire screened and armoured cable, they are much stronger than plastic, have better impact resistance and can be used at sub-zero temperatures. They have superb corrosion resistance, without the need for protective finishes, enabling them to be used in the offshore industry.

Control valves for pneumatically powered tools

The valve on the left incorporates more brass and yet is 17% cheaper to produce than the old design of valve on the right.

The control valve of a pneumatic tool consists of a valve body and a valve stem. Operation of a hand lever, attached to the valve body, pushes the valve stem down allowing compressed air to flow through the valve and operate the tool. The original design had a steel valve body into which a brass seat was inserted and machined, and a steel valve stem. Problems arose when the valve seat needed to be replaced during servicing. Machining the valve seat in situ, without factory tooling, was then necessary. This could be done incorrectly, causing loss of performance of the valve and damage to the company's reputation. The company's engineers came up with a new design which eliminated the need for machining in situ in the field, was totally interchangeable with existing models and was cost-effective. This design proposed a steel valve body with the seat machined in and a valve stem manufactured as a turned part from brass rod.

(Trelawny Products Ltd)

60mm bore bearing used in aircraft generators

(MPB Corporation)

Brass has the desirable properties that make it ideal for use as a rolling element cage material, such as good frictional properties against hardened steel components, reasonable strength, high toughness and excellent thermal conductivity. In addition, brass has good machining and joining characteristics that help to make it very cost-effective.

Bearings can range in size from the larger commercial bearings, such as heavy duty ones for use in rolling mills, to the high precision bearings custom produced for the aircraft industry. In both these types of application, the finished cost of bearing cages made from brass is significantly cheaper than if other materials were specified, due to the ease with which brass can be formed and machined.

Brass and stainless steel hose couplings

The brass fitting shown cost a quarter the price of an identical stainless steel one.

Brass is cheaper to buy than stainless steel but an even greater saving is made in the cost of machining. Free-machining brass is easier to machine than stainless steel (machinability rating of brass is 100% compared with 12% for 316 stainless steel), therefore production costs are much lower.

(Hydrapower Dynamics Ltd)