Alloys used in Centennial Medals

Medals are manufactured in a myriad of metallic alloys and other materials, and Centennial medals are certainly no exception. Webster defines alloy as “a mixture containing two or more metallic elements or metallic and nonmetallic elements usually fused together or dissolving into each other when molten. To avoid confusion, I will always use the word “alloy” when referring to the material from which a metallic medal is manufactured, and “metal” only when referring to the specific elements from which an alloy is made.

As if the similar sounds of the two words, medal and metal, were not confusing enough, several of the alloys employed in the manufacture of Centennial are difficult to identify, either qualitatively or quantitatively. The best example is white metal (wm). In many auction catalogs and dealer offerings, white metal is listed as "I don't know what metal this thing is made of, but it is white in color, and definitely not made of silver.” Nowhere is the recipe for white metal specifically defined, nor is there any requirement for medal manufacturers to adhere to or even publish the recipe they used. Pewter is a white metal, but not all white metal is pewter. Silver, aluminum, and lead (also referred to as type metal) appear white when new and untarnished or polished, but none of them is white metal. Fortunately, there are straightforward ways to identify silver, aluminum, and lead. The rest are white metal. To add to the confusion, another alloy, albata, is essentially indistinguishable from white metal. Any reference in other texts to albata have been translated to white metal here.

The predominantly copper alloys present a more difficult problem, specifically with those medals referred to as copper or bronze. Firstly, medals are seldom made of pure copper, because of its softness and corrodibility. Therefore, even so-called copper medals are alloyed with other metals, notably tin and zinc. Copper and tin usually yield bronze. Copper and zinc usually result in brass.. Secondly, some types of brass are referred to as bronze, and vice-versa. When copper is alloyed with zinc, the result varies with the percentage of zinc. It is called copper and is reddish in mint state until the zinc reaches about 15 percent (i.e., 85 percent copper). From 15 to 28 percent zinc, the alloy is called brass and has the typical brass yellow color. Above 28 percent zinc the color becomes grayer and whiter, looking like copper-nickel, and even nickel-silver, though there is neither nickel or silver in the alloy. Now, here’s where it gets really confusing. Bronze is normally about 88 percent copper and 12 percent tin. However, 90 percent copper alloyed with 10 percent zinc is called “commercial bronze,” but is actually a brass. And an alloy called “architectural bronze” is made up of 57 percent copper, 40 percent zinc, and 3 percent lead. Who knew?

When copper and bronze are new and unoxidized, they appear to be bright and somewhat reddish in color (like mint-state U. S. cents). New brass appears bright and yellowish. However, as all three of these alloys oxidize or “tone” (the polite word for tarnish), they darken and tend more and more to a common brown, or even black, until the three alloys can be visually indistinguishable. Of the three, brass retains its yellow color longer than copper or bronze do their reddish hues. Joe Levine, in my humble opinion the premier American medals dealer, once sent off a number of common (i.e., expendable) dark brown medals to a metallurgist, with instructions to determine their metallic content. After destructive testing (the only affordable way to do it back then), the metallurgist returned his verdict. They were all “sculptural bronze.” Since then, Joe prefers to use the term “bronze” for most brown medals, except sometimes in cases where a medal is still bright enough to distinguish brass from bronze. Even then, the differences in color are often subjective, blurred by minor alloy variations, and suffused by toning.

The bottom line is that a slavish adherence to certain alloys, especially pewter, copper, and brass, can result in the listing of more medal types than actually exist. Take, for example, the works of H. W. Holland and Eduard Frossard, who each published contemporary lists of Centennial medals in 1876 through 1877. They obviously did not consult each other in their use of the terms copper, brass, and bronze. Thus, if their lists are combined, the result is a larger number of “different” medals than can actually be found today. Since they had the good fortune to see just-struck medals, they probably named the alloys by their as-new colors, thus referring to bright red medals sometimes as bronze and sometimes as copper. Today that distinction has melded mostly into “brownish” medals. Unfortunately, the only inexpensive affordable ways to determine quantitatively the exact metallic content of a medal are destructive. I’d rather not know my medals’ exact content than destroy them to find out.

Taxonomists mockingly refer to their fellow biologists as either “splitters.” or “lumpers.” Splitters are always looking for new organisms to name (usually after themselves) as new species. Lumpers prefer to treat “new” organisms simply as varieties of existing species, if possible. When it comes to medals, I am definitely a lumper. Therefore, I consider all white(-ish) non-silver, non-aluminum, and non-lead medals to be made of white metal. Thus, white metal includes pewter, tin, and albata (a variety of German silver containing copper, zinc, and nickel), without distinction. Similarly, I list all brown(-ish) medals to be bronze, which includes copper and bronze medals, also without distinction. There are other, less common, alloys that I have lumped together. For example, some references list type metal instead of or in addition to lead, but I call them both lead. Gutta-percha is a form of latex made from the sap of a Southeast Asian tree, *Palaquium gutta*, similar to the hard rubber made by vulcanizing the

sap of a *Hevea brasiliensis* (rubber tree). Since I can't tell the difference without hiring an expert, I call both of them hard rubber.

In summary, I do not claim that there are no such things as gutta-percha or copper medals, but I'd rather list fewer alloys than lead my fellow collectors into chasing varieties of medals that might not even exist. I do invite those who feel otherwise to indulge in splitting their collections as they see fit. One criterion for such splitting could certainly be color. To that end, I have included shaded entries in the above table of alloys and other materials that I have lumped and you may prefer to split. Feel free to use the abbreviations as the subscript in your own list as you add "new" varieties to your collection.

Below are detailed definitions of the various alloys and other materials used in the manufacture of Centennial medals.

Albata

A white alloy of copper, nickel and zinc, essentially synonymous with white metal.

Black Walnut

The Philadelphia Centennial Exposition of 1876 used the centennial to celebrate and proclaim the industrial might of the United States. The biggest, the fastest, and the most powerful machines drew the largest crowds. One popular example of power was the use of heavy presses to stamp medals and slabs out of hard woods, such as black walnut and cherry. Even though this took great power, wood is still softer than metal, so larger and thicker wooden medals could be (and were) made. To facilitate the striking, the blank wood disks were steamed to soften them.

Black walnut was the species of wood used by the Philadelphia Ornamental Wood Company, which struck the majority of the Centennial woods.

Brass

Brass is an alloy of copper and zinc, ranging from 3% to 30% zinc. As a result, brass can vary in color all the way from the red of new copper to a bright yellow. The Bashlow restrikes of the Dickeson Continental Dollar (q.v.) include a brass version consisting of 85% copper and 15% zinc, which is so gold in color that the trade name of the alloy is Goldine. Brass medals ring when struck with a tone that varies with the amount of zinc used.

Bronze

Bronze is an alloy of copper and tin, consisting usually of 80% to 95% copper. The tin adds hardness to the alloy and makes it more resistant to corrosion and tarnishing as well. Bronze medals ring when struck, which is why bells are usually cast from bronze. (The Liberty Bell is 70% copper and 25% tin. The remaining 5% is made up of lead, zinc, iron, silver, antimony, arsenic, gold, and nickel.)

Cherry

Cherry wood was used to strike a version of the A-____ medal depicting Washington chopping down the cherry tree. It has the same design, but is smaller than A-____.

Composition

Composition is a general term, which includes various mixtures of materials, usually with a wood-pulp base, though early versions of composition included ingredients such as cloth fibers, plaster, glue, whiting, zinc oxide, sawdust, rubber particles, ground stone, shale dust, and tree sap.

Copper

Symbol: Cu, Atomic No. 29, Density 8.96 kg/liter, Melting Point 1083°C

Copper is a reddish-colored metal, which is too soft and too easily tarnished to be used much in circulating coinage, but it was frequently used for Centennial souvenir medals. When new (or when preserved in new condition), copper is easily distinguished from new bronze and new brass. Copper is definitely reddish; bronze is definitely brownish; and brass is usually yellowish. However, as the three compositions tone, they all move more to the brown, which can make fully toned chocolate-brown specimens difficult to distinguish. Copper medals ring when struck.

Enamel

Enamel is an opaque vitreous composition applied by heat fusion to the surface of metal, glass, or pottery. Enamel is used to apply colored elements to a medal.

Gelluloid

Frossard lists his medal no. 67 as being made of “Gelluloid.” This is either a typographical error in the published text, or Frossard misread the inscription of the medal, which actually reads “Celluloid.”.

Gilt

Gilt medals are usually made of gold-plated copper. Bronze can also be gilded, but it is more expensive and its lower conductivity does not lend itself as well as copper to the gilding process.

Gold:

Element: Au, Atomic No. 79, Density 19.32 kg/liter, Melting Point 1063°C

Gold is ideal for medals. Since it is chemically inert, it does not corrode. Since it is highly malleable, it is ideal for the die-striking process. Gold, however, is very soft and does not wear well; so it is usually alloyed with one or more base metals metal, such as copper, to make it more durable. The amount of base metal alloyed with gold can affect the final color of the resultant alloy, ranging from more yellow to more rose or greenish. Gold medals ring with a distinctive bell-like tone when balanced on the tip of a finger and struck with a metal object.

Graphite

Graphite is an allotrope (i.e., a structurally differentiated form or polymorph) of carbon. Since synthetic carbon was not invented until the mid-1890s, the Dixon Centennial medal (A-____) must have been made from the mined form of the mineral known as vein or lump graphite. Though graphite is brittle, it possesses a high compressibility (40-50%). Thus, it was possible to strike the medal from graphite, but it most likely required slow, rather than sudden, application of the pressure. It was probably more like squeezing than striking.

Gutta-percha

An inelastic form of natural latex produced from the sap of tropical trees of the genus *Palaquium*, particularly *Palaquium gutta*. The word 'gutta-percha' comes from the tree’s name in Malay, *getah perca*, which translates as "percha sap".

Hard Rubber

Hard rubber is produced by heating rubber in the presence of sulphur, a process called vulcanization, patented by Charles Goodyear in 1851. Goodyear’s patent ran out in 1872, and hard rubber became a very popular material for buttons and, less commonly, medals. Usually black in color.

Lead

Element: Pb, Atomic No. 82, Density 11.36 kg/liter, Melting Point 327°C

Lead is a very soft metal that can be polished to a silver color and quite easily struck. However, the surface quickly tarnishes to a bluish- to blackish-gray color. Its softness results in extremely poor wear resistance, so not many centennial medals were struck in lead, and those few are difficult to find in higher grades. Of significant interest to collectors, though, is the fact that lead was frequently used to test medal dies, and those lead trial strikes can be quite rare.

Milk Glass

Milk glass is an opaque or translucent milky white glass, blown or pressed into a wide variety of shapes. First made in Venice in the 16th century, colors include black, blue, brown, pink, yellow, and the white that led to its popular name.

Oreide (or Oroide)

An alloy of copper, tin, and zinc; also used to manufacture imitation gold jewelry.

Pewter

Pewter is an alloy of mostly tin, with copper (up to 1%) and sometimes lead (up to 4%).

Alloys used in Centennial Medals

Porcelain

Porcelain was named after the pig cowry (Cypraea porcellana), whose white and smooth surface it resembles. Porcelain is a fine translucent earthenware, first made in China and Japan. It is also called China.

Silver

Element: Ag, Atomic No. 47, Density 10.49 kg/liter, Melting Point 961°C

Silver is a white metal that is harder than gold, but still soft enough that it is frequently alloyed with copper to increase its durability. Unlike gold, silver tarnishes readily, especially in the presence of sulphur, which is a component of many papers and fabrics, as well a common air pollutant. Silver medals ring with their own distinctive bell-like tone when struck with a metal object.

Silver Plate

A base metal, usually copper or bronze, plated with silver.

Tin

Element: Sn, Atomic No. 50, Density 7.30 kg/liter, Melting Point 232°C

Tin is bright silver in color and very malleable, which makes it too soft for most coining and medallic applications. It is most often seen alloyed with copper to make bronze or with antimony to make white metal. It is likely that many, if not all, medals listed as tin are actually white metal. Tin does not ring when struck.

The metal occurs in three allotropes (two or more distinct physical forms of a chemical element in the same physical state):

- Gray tin, stable below 13.2°C (55.8°F).
- White tin, stable between 13.2°C and 161°C (321.8°F).
- Rhombic tin, stable above 161°C to the melting point of 232°C.

The gray to charcoal surface that many tin and white metal medals develop is not tarnish or corrosion but actually the gray allotrope of tin, commonly referred to as “tin pest.” Since it probably occurs as the result of low temperatures (below 55°F), it is wise to store such medals above 60°F.

Type Metal

An alloy of lead, antimony, and tin, used in the manufacture of moveable type for printing presses. The term is also used interchangeably with lead.

Vermeil

Legally, in the jewelry trade, vermeil is made from a base of sterling silver that is coated or plated on its surfaces with gold of at least 10K fineness and at least 2.5 microns thick (100/1,000,000 inch). In numismatics, the term vermeil is used for any gold-plated silver medal.

White Metal

White metal is a catch-all name for antimony mixed with tin, copper and/or lead to produce a white silvery alloy. When made with tin, as it most frequently is, white metal is susceptible to a form of discoloration known as “tin pest.” Tin pest is not, however, a form of tarnish or corrosion, since these involve a chemical interaction with other elements. Tin pest is actually the gray allotrope of tin, which is explained in greater detail under Tin. Medals made of white metal do not ring. “White metal” is often used as the catch-all term for silver-colored alloys such as albata, pewter, and type metal where the exact composition is not known.

Alloy	Abbrev.
Albata (see White Metal)	ab
Black Walnut	bw
Brass	bs
Bronze	bz
Cherry	ch
Composition	cm
Copper	co
Enamel	en
Gelluloid	ge
Gilt	gi
Gold	go
Graphite	gr
Gutta-percha	gp
Hard Rubber	hr
Lead (including Type Metal)	ld
Milk Glass	mg
Oreide	or
Pewter	pe
Porcelain	pn
Silver	si
Silver Plate	sp
Tin (see White Metal)	ti
Type Metal (see Lead)	tm
Vermeil	vm
White Metal (including albata)	wm

Alphabetical Order	
Alloy	Abbrev.
Aluminum	al
Black Walnut	bw
Brass	bs
Bronze	bz
Cherry	ch
Composition	cm
Copper	co
Copper-nickel	cn
Earthenware	ea
Enamel	en
Gelluloid	ge
Gilt	gi
Gold	go
Gutta Percha	gp
Hard Rubber	hr
Lead (including Type Metal)	ld
Nickel	ni
Oreide	or
Pewter	pe
Porcelain	pn
Silver	si
White Metal (including albata)	wm

To the left are all the materials listed for 1876 medals in this book, in alphabetical order.

The materials are listed to the right in the traditional order of seniority with gold and silver before the less noble metals, and metals (including metal alloys) listed before non-metallic substances. Wherever possible, medals of the same design but made from different materials will be listed in this order.

By Seniority	
Alloy	Abbrev.
Gold	go
Silver	si
Gilt	gi
Bronze	bz
Brass	bs
Copper	co
White Metal (including albata)	wm
Pewter	pe
Lead (including Type Metal)	ld
Nickel	ni
Aluminum	al
Copper-nickel	cn
Oreide	or
Gelluloid	ge
Black Walnut	bw
Cherry	ch
Composition	cm
Enamel	en
Hard Rubber	hr
Gutta Percha	gp
Porcelain	pn
Earthenware	ea