

Historical Fine Metal Soldering

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Barony of Stromgard



Timeline of Sources:

Pliny the Elder	Theophilus	Benvenuto Cellini
Natural History	On Divers Arts	Treatises of Ben. Cellini on Goldsmithing and Sculpture
Written 77-79 CE	Written~1120 CE	Published 1568 CE

What the Sources Say:

Natural History: “The [solder] is made with Cyprian copper verdigris and the urine of a boy who has not reached puberty with the addition of soda; this is ground with a pestle made of Cyprian copper in mortars of the same material, and the Latin name for the mixture is *santerna*. It is in this way used in soldering the gold called silvery-gold; a sign of its having been so treated is if the application of borax gives it brilliance. On the other hand coppery gold shrinks in size and becomes dull, and is difficult to solder; for this purpose a solder is made by adding some gold and one seventh as much silver to the materials above specified, and grinding them up together.” (b. XXXIII, ch. 29)

On Divers Arts: “Take some beechwood ashes and make a lye out of them. Strain it again through the same ashes so that it becomes thick. Put it again into a small pan and boil it down to a third; then put some soap in and a little fat from an old pig. When it is cold and has settled, strain it carefully through a cloth and put it into a copper vessel, which should be solid all over except for a small hole which should project on top and be round so that it can be stopped with the finger. After this take a flat thin piece of copper, wet it in water, and rub salt on both sides of it. Then put it in the fire and when it is red-hot quench it in fresh water in a clean basin, in which whatever is burnt off the copper should be kept. Again rub salt on the copper and do as before and keep on doing so until there is enough. Then pour off the water and dry out the powder in a copper pot and grind it in the same pot with an iron hammer, until it is very fine. Put it on the coals and again burn it and grind as before. Add soap and mix carefully; then put it on the live coals, burn it together, and grind again. After this, pour the lye out of the former vessel into the one which contains the powder, mix it and let it boil for a long time. When it is cold, pour it together with the powder back to where it was before, and also put in four small pieces of copper with which the powder should everywhere be mixed whenever you want to stir it. Gold and silver are soldered with this composition; but in soldering gold the powder should be stirred, as was said above, whereas in soldering silver it should not be stirred.” (pp.121-122)

“...Then melt a little gold and mix with it a third part of pure red copper. When this has been melted together and hammered out a little, file it all up and put the filings in a goose quill.” (p. 124) He then proceeds to explain how to use the filings and the copper salt solder solution together in firing a handle to a bowl of a chalice. A more structurally demanding join.

On soldering silver: “Weigh out two parts of pure silver and a third part of red copper; melt them together and file them fine into a clean pot and put the filings into a quill. Then take argol (the substance that accumulates on the insides of jars in which the best wine has lain for a long time) and wrap pieces of it in a cloth and put it into a fire to burn until smoke no longer comes from it. Take it away from the fire and let it cool. Blow away the ashes of the cloth and grind the stuff, now that it is burnt, in a copper pot with a pestle, mixing in water and salt so that it becomes as thick as lees.” This mixture is put onto the workpiece, and then the silver/copper alloy filings are added on top, it’s allowed to dry, and then more of this mixture is added on top prior to firing.

The Treatises of Benvenuto Cellini...: “Then, too, you must have your solder prepared and ready to hand, and the right solder to use (for filigree) is the ‘terzo’ solder, so called because you make it with two ounces of silver and one of copper. Now though many are accustomed to make solder with brass, be advised that it is much better to make it with copper, and less risky. Take heed that you file your solder very fine, then put to every three parts of solder one of well ground borax...” (pp. 10-11)

“And now for the soldering, if you’ve brought your work on so far. For this same hot soldering you take a little verdigris, the best you can get, from its original cake, nor must it ever have been used before, & it should be about the size of a young hazel nut without its rind, with it you put the sixth part of salts of ammonia and as much borax; when these three substances are well pounded together you dissolve them in a glass of clear water.” (p. 46)

“...by the making of a special solder, and in this wise: You take six carats of pure and fine gold and put with it one-and-a-half carats of fine silver and of fine copper, melting the gold first and then putting the others to it, and so you have your solder, and with it you may make good all your holes and rents. Note further that every fresh soldering you must introduce a fresh alloy of silver and copper so as to prevent the solder of the time before from running together...” (p. 47)

What the Science is:

Copper salt soldering: Alternately called colloidal soldering, eutectic soldering, or transient liquid phase bonding. The copper oxide or copper carbonate reduces in high heat to pure copper. The copper fuses with the gold at approximately 890°C, creating an in situ alloy. This alloy diffuses into the neighboring gold, acting like a tiny amount of alloy solder. It’s not as strong as an alloy solder joint. Techniques were employed to strengthen the bond by increasing the areas of contact between joined pieces.



8th-5th century BCE Etruscan fibula, Pinterest

Copper salt soldering has been used since at least just before 3000 BCE, according to Jack Ogden's *Jewelry Technology in the Ancient & Medieval World*. That's more than 3000 years before Pliny wrote *Natural History*. Granulation was often, but not always, accomplished with copper salt soldering, and that art flourished in the Bronze Age. Copper salt soldering is largely, though not infallibly, identifiable by the imperceptible joins and no excess solder. It requires microscopic inspection to truly identify it.

Alloy Soldering: Alloy soldering uses an alloy of either silver+copper (or silver+brass, though Cellini cautions against this for good reason), gold+copper, or gold+silver+copper. Other alloys exist in other manuscripts, but they all have one thing in common: the alloy melts at a lower temperature than the metal of the work piece. When it melts, it flows into the joints, sealing them. You don't need to use much of it, as your joints should be tight, and a little goes a long way. The melting point of the solder varies by the alloy. And I love that Cellini mentions using different alloys for subsequent soldering operations. The more silver/copper you add, the lower the melting point will get.



12th Century Byzantine ring, Pinterest

The reason you don't want to use brass for solder, even today, is because unless you've made the brass, you probably don't know the alloy of it. So you're making unpredictable solder. Even today, people will use brass in lieu of copper and zinc separately in their silver solder. (Modern silver solder is an alloy of silver+copper+zinc.) Brass contains zinc, ergo, it's a shortcut. However, weighing out the silver, copper, and zinc individually and alloying them together yourself is the more reliable method, if you're going to make modern solder.

Modern Soldering; a very, very brief overview: Some time in the intervening years between Cellini and the 20th century, the art of copper salt soldering was lost, at least in Europe (I can't speak to other parts of the world). In the 1930s, a goldsmith in London named H.A.P. Littledale rediscovered the art, and patented it. While it is not practiced widely today, it is used by some people. What's used far more commonly is alloy solder. Just like Cellini indicated using different alloys for subsequent firings, there are commercially available solders of different alloys with stepped melting points so that you can stage your soldering operations if you so desire. What's also true is that each time you fire, your solder gets a little harder because some of the alloying metals burn off. Particularly the zinc. So some very talented, or well trained, goldsmiths choose to use one solder for all their operations. Gold solder is alloyed with silver, copper, and zinc. Silver solder is alloyed with copper and zinc. For flux, some jewelers use a modern paste or liquid flux. Others use the same thing that Cellini was using: simple borax.

Glossary:

Annealing: to restructure the crystalline structure of a metal, which causes it to soften, by heating it to a given temperature and quenching it (heating temperature and quenching varies by metal).

Work-hardening: Metal gets stiffer or harder as you manipulate it or hit it with a hammer. You are disrupting its crystalline structure when you do that. Sometimes, like for an earring post, you want your metal hard. When you need to re-soften your metal, you anneal it.

Flux: A solution applied to your workpiece at and around the join(s) prior to soldering to protect the join from oxidation. Tartar of potash was commonly used as a flux before borax became popular.

Solder: A material applied to a metal joint, exposed to high heat, which then flows into the joint and acts as a metallic “glue”.

Pickle: A mildly acidic solution that a piece that has been exposed to high heat is submerged in to remove oxidation.

Reducing flame: A flame atmosphere that can extract oxygen from the metal oxides placed within it.

Verdigris: A bluish-greenish patina that forms on copper. Copper carbonate.

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