Shop Practice 5
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Quick review of Soldering, Brazing, Welding

This topic started while I was using resistance soldering for joining some parts that I did not want to disassemble. As I discussed the topic of brazing with members of my building circle I came to realize that there is a lot of confusion about what are the differences between these processes.
The most obvious differentiating parameter between the processes is that of temperature, so let's start at the coolest and go up from there. Typical soldering is a non fusion process, that is, the base metal, let's use copper pipe, is not melted. The solder alloy adheres to the base metal like a glue with the metals intertwining at the surfaces. If you have ever seen microscope pictures of the surface of, even shiny, metal you will see there is a lot to hold on to without fusing the surface. So the solder flows between the layers of metal and coats the surface. Surfaces have to be clean and a flux is used to keep the surfaces clean and to carry the dirt out of the joint. Fluxes vary for the purpose with very benine rosin fluxes to very aggressive acid fluxes. Copper and brass are easily soldered and steel, stainless, cast iron can be soldered with proper fluxes. There are Aluminum soldering procedures but I have no knowledge of them.
Filler materials (solders) come in all sorts of strength and temperature ranges up to 480 degrees fahrenheit. That is the general dividing temperature between Soldering and Brazing. Reading the specifications for filler material you may not find total agreement with that but we need a general number, exceptions to the rule exist as specialty materials have been developed and not every manufacturer subscribes to the international standards in descriptions. Overheating a solder joint usually causes failure because some materials will boil off and others will reach a temperature where alloying will occur. Plumbing solder is a good choice for general soldering of copper and brass and electronic solders are best for soldering wires. Electronic solders (higher in tin content) are lower in strength but well made joints in cooler areas can certainly be made with it. It is easy to reheat for disassembly. The lower strength of lead tin solders can cause cracking under mechanical stress but this can be avoided by proper design.

Sealing a riveted joint in a water tank is a perfect application for low temp solder. Joining steam lines is not, and I have seen joints blow loose.
At the upper end of soldering temperatures are “silver solders”. These are still lead tin alloys with the addition of mainly silver to raise the strength and melting point. Stay Bright is a commonly available product. These alloys with silver have great strength and the higher temperature makes them very useful for live steam projects. Remember 100 pound steam is 338 degrees fahrenheit.
We have the greatest confusion as we move from soldering to brazing, and vendors are not helping by calling “Silver Brazing” hard soldering or silver soldering. I am constantly annoyed by the live steam hobby's disregard for the difference and I would not trust a boiler silver soldered rather than brazed. In Brazing the surface of the base material becomes liquid in the presence of the brazing material. An alloy is created and the surfaces are fused. Good fit between parts is essential to making high strength silver brazed joints. It is not a material to fill gaps. Silver brazing is much stronger than soldering and can be trickier to accomplish since you're nearing the melting point of the base material and it is getting soft. This is important because if your part is under stress, clamps or misalignments, the part will become distorted. There are many specialized silver braze filler rods that liquify at different temperatures but for our use a general purpose rod is suitable. Also there are many fluxes and I have settled on a more aggressive “black” flux. The reason is sometimes I need it and I want to only have one on hand and I have a bad habit of not cleaning my joints thoroughly.
Silphos is similar to silver braze using phosphorus as a fluxing agent mixed into the filler rod. It is commonly used in copper to copper joining and is exceptional for poorly fitting parts. A great method of joining copper boiler parts it requires no flux and has exceptional flow characteristics. My only reservation is the surfaces around the joint are ugly and will never look like the clean silver brazed look we are used to. Silphos can be used to join brass as well if you apply a flux to the joint.
I should mention Bronze brazing in passing. This is a process of using a bronze filler rod with a specialized flux. The Coles vertical boilers were all steel and bronze brazed. Less expensive than silver brazing, it is a way of

brazing ferrous metals and was the most common method to rejoin broken cast iron parts before good welding methods were developed.
Welding is a fusion process and the base material is melted and fused with the adjoining material. Usually the materials being joined are the same like steel and steel but dissimilar metals can be welded together. The key is the molten pool of material. Filler rods are often the key as their trace elements promote the fusing of the base materials without embrittlement.The fusing of materials can be accomplished by several methods. Gas, electric, lasers, induction, and even electron beam welding. Usually we would see Gas, Stick,Tig or Mig welding. The most used welding system used today is the family of mig welding properly called GMAW welding. This is a system where a consumable electrode wire is fed continuously into the weld, supplying the electric current and filler material. It is fast and inexpensive so it is great for fabricating. The ease at which it is accomplished can also it's downfall as it allows untrained users to tag items together with no understanding of structural integrity. The derogatory moniker "squirt welding" is used by the welding profession.
For the welding projects I work on I have found Gas and Tig to be the most usable with a reliance on Stick welding for structural needs. I have several times thought of investing in a mig system but just cannot justify the expense to speed a few joints.
Tig welding is a lot like gas welding where the torch is just the heat source and has the advantage of shielding gas surrounding the weld area. I have used it with silver braze filler and silphos to make joints that would be near impossible, such as fixing boiler leaks with just a localized heat. Tig allows the welding of stainless and cast iron with the right filler material.

If you intend to solder, braze, or weld materials, get training so that your work will be without fault. Safety is a large part of all the joining methods since we depend on the products to perform as expected, and all the methods use high temperatures. Hopefully this brief explanation has cleared up some confusion and raised awareness of the differences in processes so you can more effectively plan your work.
In my own shop I always plan my welding and brazing for times when I will be able to stay in the shop area for at least an hour after shutting down.

This is a fire watch. I of course make sure the area I am working in is free of flammables and has more than adequate ventilation and wear my personal protection equipment.