Got it Together! By Henry Sibenaller

Editor's note: Henry wrote such a complete article on forge welding that I did not want to edit any part of his writing. Therefore, the second part of this article will be included in the next issue!

Introduction – Jerry Darnell, a full time blacksmith in Seagrove, North Carolina and proprietor of Mill Creek Forge and Blacksmith Shop was the instructor of my class this summer. Jerry specializes in 18th century hardware including lighting, fireplace equipment, and hardware, using typical blacksmithing methods of that era. He does however, employ a power hammer to take the place of the 18th century striker and an arc welder is used to help make tooling, even though he could make it using traditional methods. Jerry sells his reproductions to museums and customers at his shop.

The class at Touchstone was advertised to be for intermediate/ expert blacksmiths, so I wasn't so sure that I qualified, but as it turned out, with Jerry's help, I made it through the week and completed four projects and an auction item. Each of the projects was supposed to take one day to complete, but it took me two days to complete the chandelier, and one day each for a pendant light, 18 century pipe joint rush nips, and a primitive two light pendant. Jerry was willing to work until 10 PM each night so that we would be able to finish all of the planned projects before week's end.

One of the skills that an intermediate smith needs to complete the assignments, is the ability to forge weld more than a simple fagot weld (like that typically used on the pointy end of a fireplace poker). Before attending this class I was not having much success at forge welding, particularly in my propane fueled forges. During the class I learned enough to be able to successfully forge weld using Touchstone coal forges. So the rest of this article is dedicated to explaining what I learned about forge welding in Jerry's class, with the hope that it might help you become more successful at forge welding too.

Jerry says, "What does everyone want to learn when they come to a blacksmithing class? Forge Welding." What we learned is that it isn't all that easy to do, particularly in a gas fueled forge. There are a number of things that must come together at the correct time and in the proper way to successfully forge weld. You need to be able to raise the steel to a sufficiently high temperature, and keep it there long enough to do the welding; the mating metal surfaces need to be fluxed and properly shaped prior to welding; and you need to very quickly get the parts in position relative to each other and the anvil and then forge them together using a suitable technique. This is possible once you get the hang of it, and as Paul Harvey said, "And now here is the rest of the story."

Forging Temperature Info – A properly designed coal forge can achieve a temperature of 3000 °F. Testing of a very well designed recuperating propane forge, like the Sandia Forge, shows that 2600 °F is achievable when the loading door is fully closed, but that the temperature drops significantly when the door is partially opened, as is the case for typical forge welding other than making Damascus billets, etc. Other well designed gas forges with good insulation and sufficient burner and blower capacity are known to be used for forge welding, but forge welding in a coal forge is generally easier. We know it is possible to forge weld using a gas forge, so how is it done?

A partial answer is that the forge needs to be adjusted to have a reducing atmosphere in it. That is, one that is depleted of oxygen and still gets up to welding temperature. To achieve this condition the air flow needs to be cut back to produce a reducing condition inside the forge. Then if the fire is hot enough, forge welding may be possible. To successfully forge weld steel the metal temperature during forging needs to be at least between 2350 to 2400 °F. Structural steel starts to melt at about 2750 °F. As soon as you take the parts out of the forge the metal temperature starts to drop and if the parts are small or are relatively thin, they drop in temperature very quickly. So what is the secret to forge welding? The answer is to use a proper flux and to use good forging technique.

Flux Info – A proper flux is one that does several favorable things including:
Lowers the required metal forge welding temperature by about 200 °F
Melts the oxidized layer on the metal's surface and then it goes into solution in the melted flux
Keeps additional oxidation from forming by providing an air tight seal
Protects the surrounding metal from burning up during the forging process.

Certain fluxes, like Easy Weld, sold by Centar Forge, have small flakes of steel in them that help to "burn out" scale impurities as the parts are removed from the forge and, to some extent, also helps to prevent the parts from slipping out of position due to increased friction between the mating fluxed parts prior to and during the initial stages of forging (during the first one or two forging hammer blows). If a second weld is necessary after the parts are partially stuck together a flux without metal filings is generally recommended. A flux like Crescent, sold by Centar Forge was recommended for the follow-up weld.

If it is necessary to make a second try at finishing a weld it is sometimes referred to as being "an insurance weld." This is only possible if you can get the partially welded assembly into the forge and back out efficiently. This is generally not possible in a gas forge, with the exception of compact billets as in making Damascus or horse shoes. So if you are going to forge weld using your gas forge you will need to do a good job of it the first time, because you don't usually get a second chance. In our class we needed to weld a 12 inch diameter ring and that is impractical in a typical gas forge, but was relatively easy to do in the coal forge.

Typical components of good flux for coal forging generally include borax that melts at a relatively low temperature and does not readily burn up at high temperatures, and may also include some kind of tinning agent that acts like the acid used in soldering that cleans and facilitates wetting of the metal surfaces by the flux.

Forging Technique – When larger blocks of metal are placed in a gas forge (like a billet for a forge welded Damascus knife) the larger mass helps to maintain forging temperature and therefore it is easier to weld more massive components together. In general, speed is essential for successful forge welding to occur. As Jerry Darnell says, "You can't think about it, you just have to do it, using quick, accurate, properly placed, and rapid blows. Hit-it, Hit-it, Hit-it.

"Is that all you've got?" The blows are not particularly hard, but they need to be applied quickly with proper technique, without making the parts too thin. The proper technique to use is dependant on the type of weld being made and can't be discussed in detail in this article. You will need to read about the various weld designs elsewhere or ideally find an experienced teacher, like Jerry, who has forge welding skill, or possibly attend one of our PAABA Hammer-Ins where forge welding is being demonstrated.

In order to be quick you may need to practice getting the parts out of the fire smoothly and getting them in position, dropping the tongs from your hammer hand, pick up the forging hammer and start the welding blows in not more than two or three seconds. Having another person to help, or a fixture of some kind to hold one of the parts in position, may facilitate the process of producing a good weld, particularly if the parts to be welded are relatively heavy or difficult to hold in position. The hammer should not be too big because if it is you just can't apply rapid blows. Jerry recommends using a short handled hammer that weighs not more than 1.5 pounds, and probably a little less.

Applying Flux – The powder flux is applied to the heated metal surfaces using a fluxing spoon. Flux is applied when the metal is at a dull red heat that causes the flux to stick to the metal surfaces. The surfaces to be welded and the surrounding surfaces should be fluxed. The flux on the outside of the parts helps to prevent them from burning up while the parts are coming up to welding temperature.

As the flux is heated and approaches welding temperature it melts and coats the surfaces. It flows over the surface, generally bubbles for a short while, and then starts to shimmer as welding temperature is approached.

To be continued……………….. in the December Issue!