Ironflower Forge - U-Guard & Box Tangs

Steve Bloom

This project started as an idea (well- what doesn't?). The construction of a full tang knife involves making the tang perfectly match the inside surface of the scales so that there are no gaps and – especially from the owner's viewpoint – preventing/minimizing rust on the exposed steel in the grip. The solution is to create a hybrid of the full and hidden tang – what I'm calling the "box tang". To document the process for the curious and – ok—myself, let's start with a heat treated blade originally destined to be a full-tang knife

The first step is to cut steps in the tang where the guard and the box are to be located. Remember – this is a heat-treated blade (Damascus run through austempering and running about 58-60 Rockwell C). Saws and files just won't do. What will (and at an affordable price) is a 7" piece of 7/8" round stock with one end turned down to ¾" and the other faced, drill and tapped for a 3/8x16 bolt. A 3" cutoff wheel (Harbor Freight 25 for ~ $15) sandwiched between two fender washers makes a decent substitute for a slitting saw. In the image to the right, the unit is almost hidden behind the blade but you can see that the cutoff wheel profile is aligned to the marked line on the blade. Note that the blade is sandwiched between two pieces of scrap steel to minimize movement of the blade during cutting.

The blade was positioned at a slight angle (because I think it just looks cooler!) and the saw was moved to the left and positioned with the axis of rotation of the saw perpendicular to the tang's dorsal surface (ok – the spine...whatever). The mill was SLOWLY cranked to the left and to create an approximately 3/16" slot.

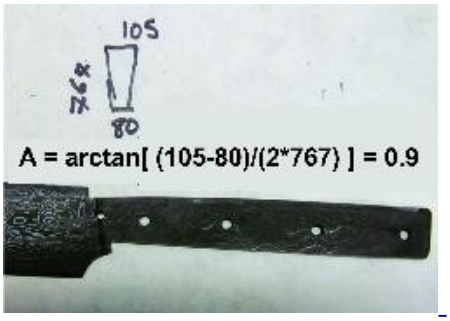
The saw was then repositioned to the right and the second cut was made. The mill table elevation was decreased by 0.25" because the guard material is that thick. The guard will be a "U" shaped block of nickel silver with the bottom of the "U" at the dorsal surface of the tang. The slots are absolutely parallel to one another and 0.25" apart. This same operation could have been done with a carbide slitting saw but at about 100 times the cost.

The tang was then marked with a line representing the amount of material to be removed. Obviously if I had started with this project in mind, I could have avoided these steps by doing this stuff before the heat treat. Maybe next time.

Once the material was removed (Cubitron belt on a 2x72 variable speed grinder), one step is still needed – the grinding of a radius in the junction of the slot edge to the tang. The tool of choice was an air die grinder with a 1/8" carbide burr.

The image to right shows the radii and the offset of the slots. The 3/32" hole in the midline of tang was intended for a rivet holding two bolster blocks to the blade. Guess what isn't really needed. Oh well…

The next step is to cut a "V" slot in a block of guard material. Using a dial caliper, the dimensions are shown at the right (units are in 1/1000"). There is about 0.025" difference between top to bottom over a 0.768" run. A bit of trig indicates that a 1.3^{o} angle is needed relative to the dead center of the tang.



A little bit of marking ink and a scribe allows transferring that data to the actual block (1" x ¼" nickel silver bar). There are a lot of ways to cut the slot but you'll notice it isn't very wide – and as the minimum dimension drops, the probability of breaking expensive micro-end mills goes up. So, I created a jig (Surprise!) that allows me to cut the slot with a slitting saw (and I could have used the saw described above just as well – but nickel silver is soft and I already had the slitting saw).

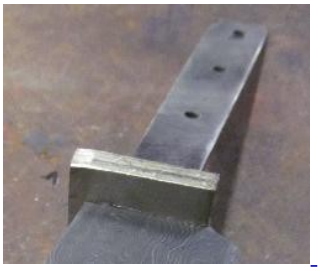
The first step is to clamp the guard block in the jig (far right of the image) such that the center line of the slot to be lines up with the center line of the jig. The jig is a piece of 2" x 2" x ¼" aluminum angle with two 0.5" holes just kissing one side. The clamp end is a couple of 10x32 button screws and a strap of scrap aluminum. The 0.5" round stock to the right is permanently fastened to the jig while the one to the left can be removed. With both in place, a digital protractor is plunked on the jig and the zero is set.

The removable peg is pulled and the jig is rotated downwards until the protractor reads the correct angle. Given the 5/16x18 bolt (peeping over the left of the protractor), there are 0.055" per rotation. The distance between the pivot point and the bolt center is 5.2", Using the same equation, arctan[0.055/5.2] gives 0.6^{O} per revolution, so a little over two turns ought to be close (for those without a cool digital protractor)

The table is cranked to the right by the depth of the slot (in this case, 0.767"). The saw is withdrawn and the jig is cranked up to the same angle on the other side of dead level. The table is then adjusted so the cut will form the other side of the slot taking into consideration the 0.080" thickness of the saw. Depending on whether the slot widens or narrows to the left, you'll have to do some thinking.

When done the slot should look like the one shown. In this example, the bottom of the "U" is to be positioned at the spine of the blade and there is a taper such that the dorsal edge is wider than the ventral edge. As long as there is a taper from the guard position to the end of the tang, getting it on will not be a problem.

The proof of why do all this is shown here – not a bad fit and no filing needed.



The guard needs to be polished on the blade side and the jeweler vise shown here (Harbor Freight) makes the work a whole lot easier.

The next step is to make sure the fit is within soldering limits. A vise grip is used to “close” the ‘U” and a piece of square tubing is used to tap the guard solidly onto the shoulder.

I use TIX solder and the MAPP gas torch shown here does the trick. Note the torch holder on the tank. I start from the tang side and will eventually have to flip the blade over. The holder means I don’t have to turn off the torch or have it go wandering during the flip operation.

Shown here is the left side of the blade. Not a bad fit and….

Here is the other side. Note that the guard is close to correct at the ventral side of the tang and I have a bit of nickel silver to remove at the dorsal side.

The next task is the fabrication of the wood scales. I like to start with a paper pattern and then match that to the various blocks of stabilized wood I have kicking around the shop. In this case, it is a piece of madolo a bit over 0.75" thick.

The idea is to split the block taking into account the offset due to the tang thickness (here 0.105"). Given a block of 0.758", the midpoint would be 0.379". Move that 0.105/2" to one side and the thickness of the two scales is known.

A line was drawn on the block at that offset and the block was cut on the band saw. Note that the spine of the block was left square to make the sawing easier. Eventually the "ski jump" curve shown here will be echoed on the spine side.

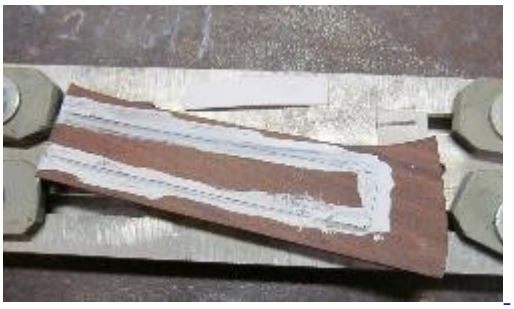
If the outer surfaces are clean and flat, all you have to do is flip-flop the blocks left to right and the smooth surfaces are now inside and the saw marks are outside.

An old carpenter's protractor is a cool item to measure the angle of the guard to the dorsal side of the tang.

Once the angle is set, the guide on the disk sander can be set to the same angle.

The blocks are bumped against the disk and the results are certainly acceptable. You could just eyeball the angle and keep altering the angle as you sand until it is right, but what's the fun in that?

The next step is to etch-a-sketch the recess into the thicker block. A bit of white-out makes seeing the scribed outline of the tang a whole lot easier. Incidentally, white-out is removed by acetone.



Since the scale is likely to damaged if just scrunched in the mill's vise, a milling table is handy. What you see here is a block of aluminum with four 1/4x10 carriage bolts in "T" slots. Note the popsicle sticks preventing damage to the scale when clamping. A chuck of angle iron and a few machinist clamps would also suffice. Given the tapers front to back and top to bottom and possible variance in the block thickness, you can calculate what shimming is needed. In this case the tail needs to come up 0.013" (a business card at 10 and a piece of typing paper at 3) and the ventral needs to come up 0.025" (2 cards & a bit of paper).

The next step is to fire up the mill – here with a 3/16” 2-flute end mill and running at high speed. Just trace out the recess and keep blowing off the chips to see what to cut next. Etch-a-Sketching is a very accurate description.

In a couple of minutes, here is the result – a clean recess and nary a chisel in sight,

The tang fits with no difference in wood-to-metal detected by running a finger tip over the interface at the guard. It literally snapped into the recess. The scale was deliberately oversized and the wood to be removed is delineated with a white pencil.

When that was done, the tang was glued into the recess using 5-minute epoxy and black colorant. Note the masking tape protecting the blade.

The 1/8” pin holes were drilled and the other scale fitted. When the fit of the guard to the scale was acceptable, the scale was clamped to the blade and the holes drilled through the second scale. Alignment pins will be used when the second scale is to be glued in place. Note that the second scale is also oversized.

When clamped and with the alignment pins in place, the rear surface was sanded smooth and perpendicular to the sides using the disk sander. The surface shown here will be the mating surface to the pommel.

The pommel needs to be mechanically locked to the handle – glue just can not be relied on by itself. One scheme is to set a couple of rivets of the same material as the pommel (in this case – nickel silver), spread them as shown and then recess them into the scales.

But for this blade, I elected to make a "T" block which fits into a milled recess and is riveted into place. Following the same procedure as outlined above for the tang….

Recesses were made in both scales. It's finally time to glue everything together. The pommel recesses were filled with epoxy and more epoxy was spread over all the mating surfaces. Using alignment pins makes the assembly fairly easy and the scales were clamped with several "C" clamps. The only major question left is how to press the pommel firmly against the mating surface since the pommel and the guard are not parallel to one another.

The solution is shown here. Use a small drill press vise (2.5") to hold the pommel perpendicular to the vise's jaws. The whole assembly is then place in a machinist vise and the pommel is pressed to the mating surface. Once the epoxy sets up inside the pommel recesses, there is no way anything can come loose without destroying the handle first.

The next step is to insert the 1/8" pins and jazz the handle up with mosaic pins. The tooling needed is shown here = a drill the size of the mosaic pin to be used (#2 at 0.221" – and I don't remember where I got 5.6mm tubing to make the pins), a depth indicator, a saw jig and the Allen wrench needed for the jig.

The jig for sawing the mosaic pins is shown here in more detail. It is composed of a wide and narrow block of aluminum with a "V" cut into the mating surfaces. Two #10x32 button screws connect the blocks and a band saw cut was made along the inner surface of the narrow block to beyond the "V". The amount of pin material needed is positioned to the right of the saw slit and the screws are tightened. The jig is then placed on the band saw and the cut made. This unit can be used for a variety of pin diameters and makes cutting the pin a dream.

The lengths of 1/8" pin stock are marked and are sheared using this repurposed fencing tool. The cup (thin walled steel pipe and a chair leg cap) on the far side is held to the tool with a hard disk magnet and catches the pins as they attempt to escape and vanish into the recesses of the shop floor. The lengths are deliberately over long to compensate for the deformation due to shearing. To prevent splintering of the scale as the pin is pressed through the handle, a slight conical point will be ground on one end of all the pins.

All the pins are gently started in their respective locations and then epoxy is smeared over the sides as well as into the cavities for the 1/8” pins on the opposite scale.

A scrap of wood (here a 6” piece of ¾” ply) is placed against one jaw of the machinist vise. The protruding pins are placed against the other jaw and the vise is closed. As it closes, the pins are pressed through the handle and into the scrap of wood. Without the scrap, the over-long pins would bend and crack the scales. The pins are pressed in such a way as to leave some pin material protruding from both sides. It is usually necessary to finish pressing the mosaic pins flush to the surfaces by positioning the handle diagonally in the vise jaws so only those pins are in contact with the jaws.

All that is left to do is grind off the protruding pins and finish the handle using a slack belt setting on the grinder. Belts of 80, 100 and 320 grit (Hermes J-Flex) are my choice for this. A quick buff with white rouge and a coat of hot beeswax finishes the work. Here’s the result – not half bad, IMHO.