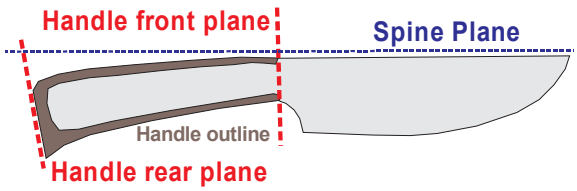
Simple Box Tang Blades – Construction Details

Dr. Steve Bloom, IronFlower Forge 2015

One of the standard blade types is the full-tang blade in which the tang extends throughout the handle and is exposed to the air (and user). The advantages of this type are strength and balance and the chief disadvantage is the possibility of rust due to hand contact with the exposed steel of the tang. Ease of construction is actually a toss-up depending on how persnickety you are about getting the scales to lie absolutely flat to the tang and whether there are pommels and/or bolsters involved.

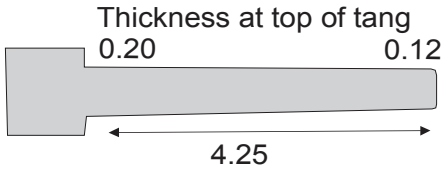
What I am describing here is a revision of the full tang blade – essentially a procedure to encase the tang within the handle while preserving as much of the metal of the tang as possible. In my opinion, the time involved in this procedure is – if anything- faster than carefully fitting scales to a hand forged tang.

A blade is forged with a full tang and is coarse ground. The spine plane and the planes defining the front and back of the handle are diagrammatically shown. The location of the pin holes is set by the length of the handle and the number of pins to be used (typically 5 in my usual blade). Cuts ~1/8" deep are made in the tang at the location of the front plane (using a slitting saw on the mill and/or by carefully scribing a line on the plane and using a band saw). From the cuts, ~1/8" of steel is removed from the periphery of the handle outline by grinding. The bottom of the shoulder cuts are rounded to prevent stress risers. Holes are drilled and the blade is heat treated, finish ground and etched (if needed).



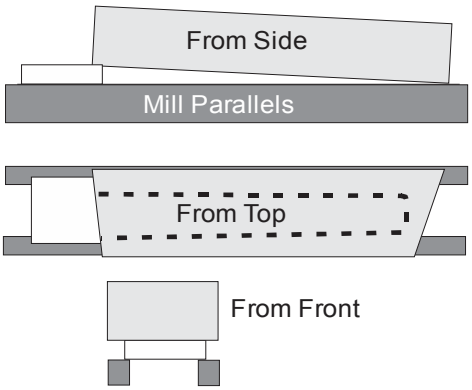
Since the goal is to create a cavity inside of the handle that very closely matches the tang, the process must accommodate any taper from front of tang to rear and any differences of thickness from top of tang to bottom. Sooo...

Box Tang Theory

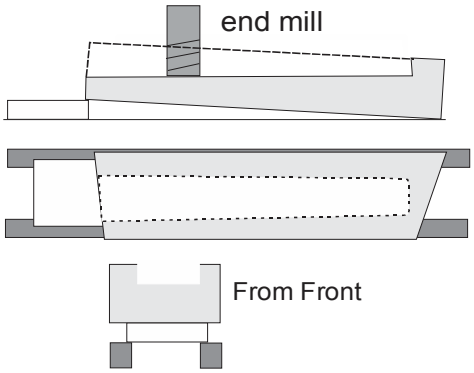


0.20 - 0.12 = 0.08 difference over 4.25
angle relative to center line =(0.08/2) / 4.25 = 0.0094
arctan(0.0094) = 0.54 degrees
to shim - need 0.009 =~1 business card thickness

1. shim wood with a card at front



2. mill recess for tang

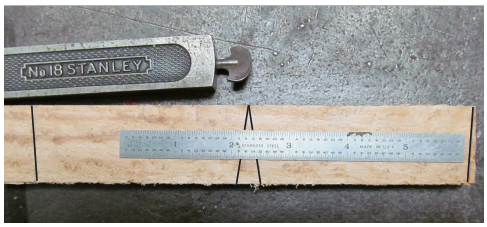


If there is an appreciable taper across the tang at the front (top of tang to bottom of tang), shim the top of the handle appropriately

I typically have sawed woods such as bocote, rosewood & ziricote into 1.5” x ~3/8” x 12” slabs and then stabilized those slabs. The selected slab is clamped on the mill (because I don't have a planer) and one of the surfaces is leveled. The milled surface will be the inner surfaces of the handle scales.

The angle of the front plane for the handle is transferred to an angle finder and that line is scribed onto the milled surface of the handle material on one end of the slab. The tang is positioned on the slab and the outline of the handle is sketched in. Typically, I allow 1/2” extension beyond the steel and like to use a more acute angle for the rear relative to the front of the handle.

That sketch sets the length of the handle, so measure that length from the end of the first scale so as to define the start of the second scale. With the angle finder, scribe the start plane in mirror image to the first line. The result will eventually be four lines that define the two scales and the grain patterns across the pommel will be quasi-mirror images. The lines shown here are overlaid on the actual locations on the wood (the pencil marks are really hard to see in the actual image)



Reset the angle finder for the rear angle and scribe it for the first slab. The flip the finder over and repeat for the second scale. There will now be 4 lines on the slab, 1st scale start, 1st scale end, 2nd scale end and 2nd scale start (with a triangle defined by the terminal acute angles. Saw on those lines and you have the two scales. They will need to be made absolutely the same length, so it's off to the mill.

While there are many ways to align the front and back ends of the scales to the mill plane, the use of a digital protractor makes this easy. The scales are aligned to one another and clamped together. The pair is lightly clamped in the mill vise. The protractor is zeroed on the vise and...

The protractor is placed on the end to be flattened. The blocks are gently tapped in the appropriate direction until the protractor indicates zero. The vise is closed fully and....

The surface is planed off by the mill. Note the dust collection system in the background – essentially a steel box with a slot and a connection to a shop vac.

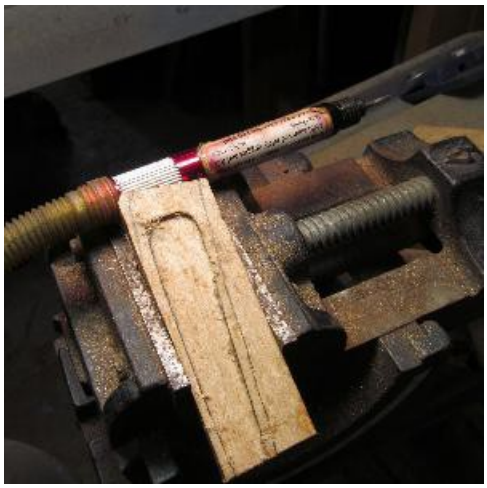
All of this produces two scales of exactly the same lengths and outlines with flat milled surfaces that eventually will be glued together. The recesses for the tang now need to be created. The tang is carefully placed on one scale with the front plane of the scale aligned to the shoulders of the tang. The tang is C-clamped to the scale and a white pencil and then a sharp black pencil are used to trace the outline of the tang. The thickness of the tang at the front and rear planes is measured with a dial caliper. The differences between front top and bottom (184 vs 150) define the shim needed across that plane (34/2=~20) and the difference between front and back at the spine (184 vs 95) defines the shim needed along the length of the tang (~50). Measurements are in thousands, that is 20 is really 0.020".

Shim stock can be used but so can old business cards (~0.010” thick). The appropriate number of thicknesses are positioned at the front spine and rear spine locations and the vise is closed. The end mill is positioned at the front spine location and the depth is set to ½ of the thickness of the tang at that location. Here that is 184, so 100 ought to do. Note that I round up a bit, usually 5 to 10 thousands. Afterall, the epoxy has to go somewhere.

If you don't have a mill, you can make one. Before I got the Bridgeport, I cobbled together an adequate unit from a Harbor Freight cross-vise, a 1/4” air die grinder, a scrap acme thread and miscellaneous steel lying around the shop. It's not as good as a full sized mill but it did work!

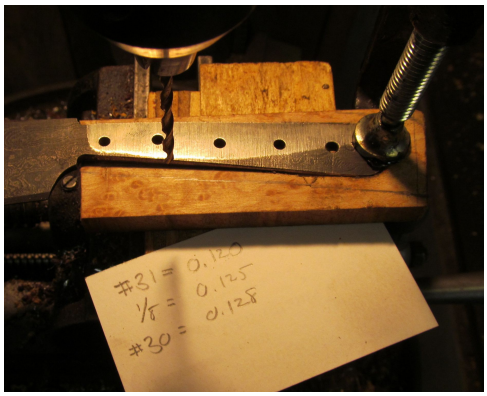
The shop vac and the mill are turned on and the recess is created. The best description of the process is “etch-a-sketch”. Plow out the center well away from the lines, then come back and carefully run the edge of the end mill up to the line.

The final adjustment is done with a 1/8” air die grinder and a small cutting bit. The tang is laid on the recess and the location where a bit more wood needs to be removed is determined. Do that and repeat until the tang snaps into the recess. Be sure to match the curve at the bottom of the shoulders.



If done correctly, the tang will snap into the recess.

The tang is clamped into the recess and the pin holes are drilled. I use 1/8" pins. The holes in the tang are drilled with a #30 bit (0.128") so that there is allowance for slop in the pin diameter. As a precaution, I drill the scale holes with a #31 bit (0.120"). After epoxying the scales together, I will ream out the holes with a 0.125" bit. This process reduces the possibility of a pin hole being "wallowed" out and provides a tighter fit of pin to scale.



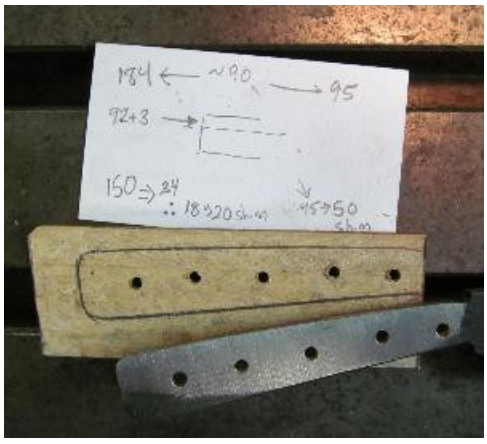
One of the realities of smithing (and knife making) is figuring out how to hold things. While C-clamps work, they are bulky. Old lab hose clamps actually work quite well. Alignment pins are very useful and are made from pin stock bent into 'L's and slightly ground to fit the #31 holes.

Once the first scale is drilled, the blade is removed and the scales are clamped together after being carefully aligned to one another. The holes in the first scale are then used as a guide to allow drilling the second scale. Note the wood platform under the scale. The drilling is occurring on a drill press with a cross-vise installed. Since the scales are reasonably flat and any taper in the tang is handled by the recess (and the shims), drilling as shown results in holes that are perpendicular to the central plane of the tang.

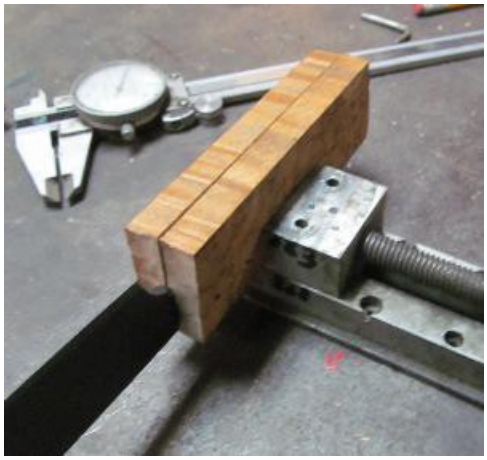
C-clamps and drill chucks often compete for the same physical location, so move the clamps and pins as needed.

You can now use the holes on the second scale and two or more pins to locate the tang for tracing of outline on to that scale. Like the first one, white pencil followed by black works well (especially on dark, highly figured woods).

It is then back to the mill and the second recess is made using the same measurements and processes as were used for the first one.



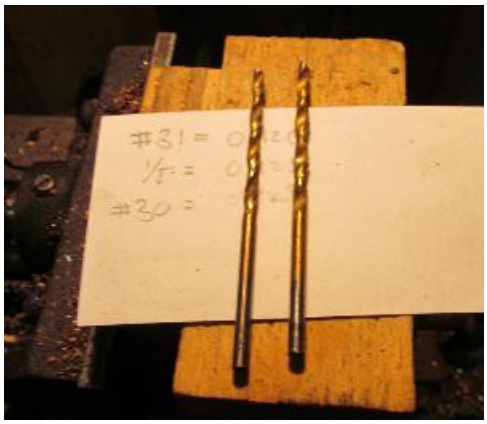
Finally clamp the two scales together around the tang and verify that there are no gaps. If there are, you will have to deepen the recesses until the gaps vanish.



It is now glue time. You will need gloves, masking tape, 5-minute epoxy, epoxy colorant, 2 alignment pins and three C-clamps. The colorant I use came from Brownell's but is no longer available. A quick web search turned up “Castin' Craft Opaque Pigment 1 Oz: Black” which might do or even laser toner could suffice (if you can control that stuff!).

I like to adjust the clamps and place them on the deck in the same order as they will be used. The pins are extended through the first scale and the tang sufficiently far so that they enter the second scale. I typically set the pins in #2 & #4 holes which leaves the middle and ends available to the clamps.

The blade is masked with the tape. The epoxy is mixed and is buttered into the recess with the pins and the mating surface is coated. The tang is pressed into place and the second scale is buttered like the first. It is placed over the pins and the clamps are applied. Epoxy will flow everywhere and will weep out the holes. I like to run a 3/32 pin through the holes to remove the excess glue and move & replace the clamps as needed to get to all holes. Excess glue is wiped off with acetone and paper towels – especially at the interface of the scales and the blade.



After the glue has set up, the holes are reamed with a 1/8” bit.

Pin material is marked for the length of the pins needed. It is always a good idea to over-estimate the length by ~1/4”.

The pin stock is sheared (here using a re-purposed fencing tool). The shear will crush the ends of the pins which is why a bit of extra length is needed. One end will be given a slight point on the knife grinder.

The pins are gently started in the holes. Note the tapered pin end. That end goes in first and will help align the pin without splintering the far side of the second scale.

Mix up a bit more epoxy and butter the pins. BTW, tongue depressors or Popsicle sticks are the butter-knife of choice in my shop.

Use a mechanist vise to drive pins. The rear jaw has a liner made of 3/4" plywood. As the pins emerge from the back of the 2nd scale, the liner will support the scale while the pins penetrate the plywood.

When done correctly, there will be pin stock visible on either side of the handle.

The rationale for the excess pin length is shown with a quick grind. The pins show a round and complete profile . Note that #3 does not have a pin yet.

A coarse grind on the handle is accomplished with a rubber platen & an 80 grit AO flex belt.

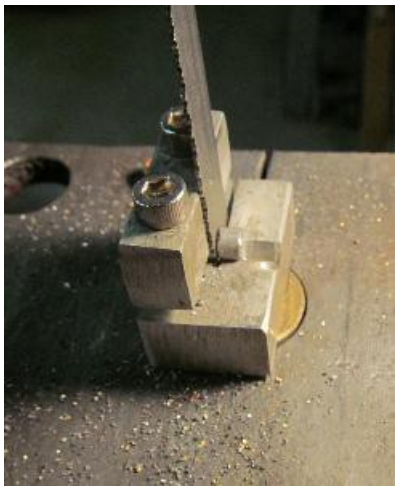
A close-to-finished profile is generated using a slack belt setting of the grinder.

It is now time to handle #3 pin hole by filling it with a mosaic pin. The tooling is a depth gauge, the pin stock, a drill of the right size (exactly matching the pin diameter) and a pin vise. Note the red paint on the drill bit. That marks it as something special so that it gets back to the pin drawer and not into the collection of miscellaneous bits hanging out near my drill press.

The 1/8” holes in the handle nicely identify exactly where the mosaic pin holes need to be made. The holes are carefully drilled to approximately 1/4” deep – NOT all the way through since there is a harden tang inside. The depth gauge is used to determine the deepest of the two holes and that measurement is transferred to the pin stock using a Magic Marker as shown. Note that the ends of the pin stock are slightly beveled (a quick pass on the grinder is all that is needed). Those bevels will make inserting the pins into the handle much easier.

The jig for sawing pins is a pin vise composed of 2 aluminum blocks with a matching 'V' groove. The upper block is ½ the width of the lower and the lower has a saw cut extending to just beyond the 'V' groove. The blocks are clamped together with 10-32 socket bolts. Note the wine cork on the Allen wrench. It makes is easier to use the wrench and much easier to find it when dropped on a shop floor.

The pin stock is clamped in the pin vise with the mark visible. The vise is then placed on the vertical band saw and the pin is sawed as shown. This procedure is *sooo* much better than using a hack saw or a jewelers saw.



The pin is gently inserted into the hole in the first scale. Note the wood block with a shallow hole. To insert the second pin, flip the handle over and allow the protruding pin to rest inside that hole. The insert the 2nd pin. Do not run them all the way in.

This is what the pins should look like. They are now ready for epoxy.

After buttering the pins, use the vise to drive pins home. Be careful to run them in without splitting the handle!

Use a rough grind to level the pins smooth to handle and then finish grinding the handle with 120, 320 and 600 grit belts.

The last step is to buff the handle with white rouge. Note the masking tape is still protecting the blade. Remove the tape. If the tape is stuck down from epoxy running under it (or over it), use a sharp small chisel to remove anything that needs to do. Don't scratch the blade!

In my shop, the dimensions of the blade (minimum and maximum blade thickness, minimum and maximum handle width and heights, and lengths of blade and handle) are recorded along with wood type, fittings, etc. A serial number is assigned and I sign the blade and engrave the number onto it.

The last step is to coat the knife with hot beeswax. A heat gun is used to melt the wax and to heat the knife just hot enough to allow the wax to flow. Excess wax is wiped off and the handle is given a final buff with a cotton buff (no polish).

The results are shown below. The balance point is at the front surface of the handle so that it feels like it floats on the fore finger.