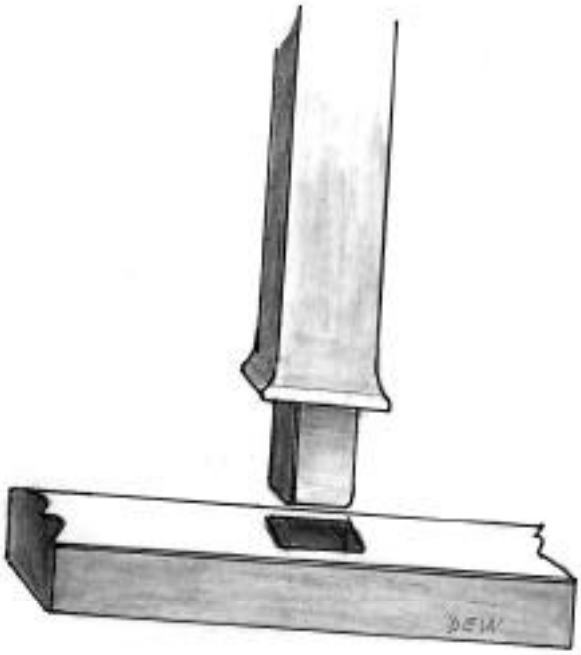
Mortise and Tenon Joinery

Text and Illustrations by Doug Wilson



#1. Example of technique

#2. A top and bottom side set

Lesson Number Nine–Mortise and tenon joinery

Definition:

Making a mechanical joint with two or more pieces

Intent:

The smith will learn to forge a tenon and assemble a mortise and tenon joint.

Tools

Side set – top and bottom (drawing #2) Note that the cutting edges aren't sharp. The cutting edges are slightly radiused.

Set hammer

Monkey tool or bolster plate with 1/4" x 3/4" hole (drawing #3)

(This is a tool block with a 1/4" x 3/4" hole in center.)

Materials:

1/2" x 1" x 18" mild steel bar.

Method:

Step One:

Upset end of bar and forge to 1 1/8" x 5/8", 3/4" from end. End tapers down to 3/8" x 3/4". (drawing #4) Mark bar on hot cut 3/4" from end.

Step Two:

Take a full yellow heat. Place the bar over the bottom side set. Hit a light blow. The bottom surface of the bar will be cut. Turn the bar up on its corner. Strike another light blow.

Turn bar onto uncut next surface. Strike again. This marks the second side of the bar. (drawing #5)

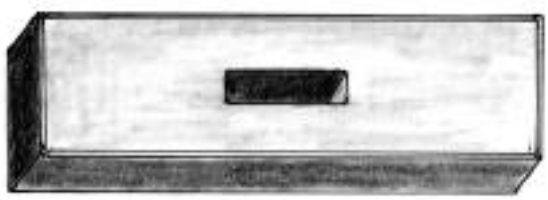
Repeat and cut the remaining two corners and sides with light blows.

Notes: The light blows on the corners help to insure proper tool alignment.

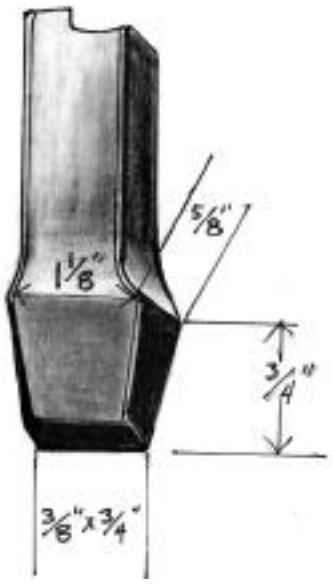
Misaligned cuts or double cuts cause hot shuts, then cracks. Proper tool alignment is critical here. Any mis-cuts should be filed out immediately.

Once marked, the bar can be supported on a stand or your hip. Use top tool to continue. (See previous lesson for bar support.)

Reheat bar if necessary. Continue cutting until the core of the bar is just a bit oversize, in this case about 5/16" x 13/16".



#3. A bolster plate



#4. Upsetting and forging dimensions

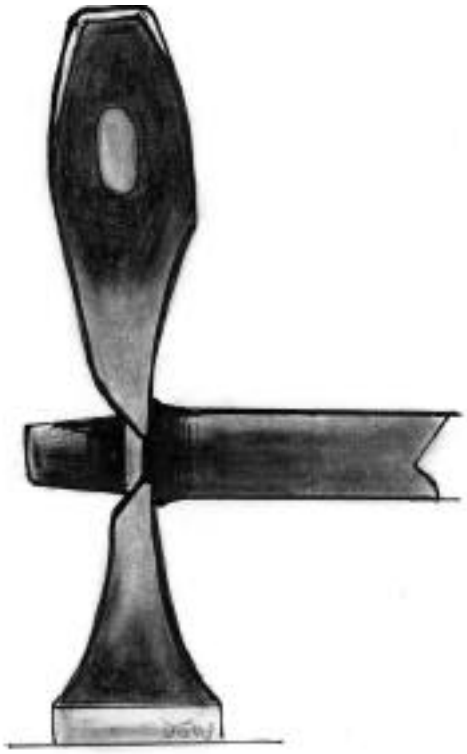
Notes: If the tenon is a bit too fat that's ok. Too thin won't do.

A striker's assistance helps with drawing down the tenon.

Step Three:

Reheat bar to full yellow. Place bar over sharp edge of anvil face. Place set hammer directly over it. (drawing #6)

Strike a heavy blow. Turn the bar 1/4 turn. Strike again. Turn again in the same rotation. Strike again. You are drawing out the tenon.



#5. Marking the second side of the bar

Continue until you have drawn down the tenon to 1/4" x 3/4"; length as far as it goes.

Finally, lightly forge down the corners.

Note: As you forge down the tenon, the set hammer and the anvil must be parallel. Check size of tenon by inserting end of tenon into bolster.

Step Four:

Upset square shoulders. Reheat to full yellow. Heat should extend about an inch up from tenon shoulder.

Note: Quench the tenon to prevent burning if necessary.

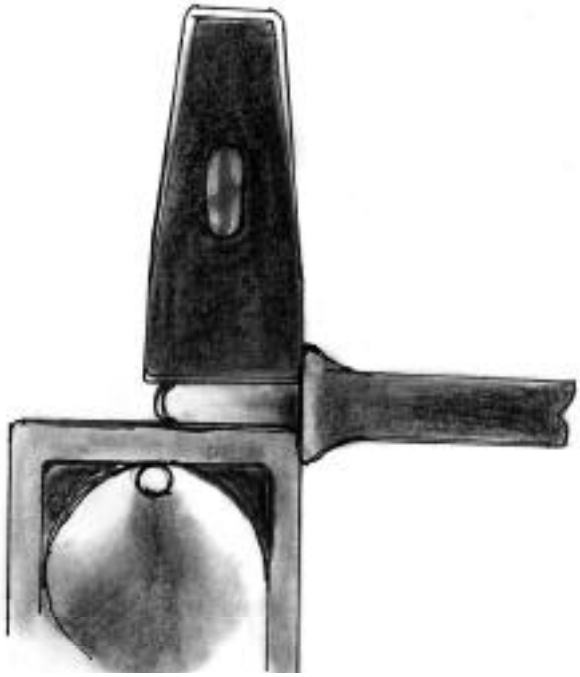
Pull the bar from the fire. Set bolster over the hardie hole. Insert tenon. Upset and square by hitting hard on top end of bar. (drawing #7)

Straighten bar as necessary. Square shoulders to bar with light hits on anvil face.

Note: Tenon should be centered on the bar. Centerlines of bar should be straight. Shoulders should be straight and square.

Step Five:

Cut tenon to length on cutoff hardy. In this case, length should be 1 1/4" from shoulder.



#6. Using the set hammer

Note: Beveled edges on the end of the tenon help prevent thin, sharp or cracked edges on the finished tenon head.

Step Six:

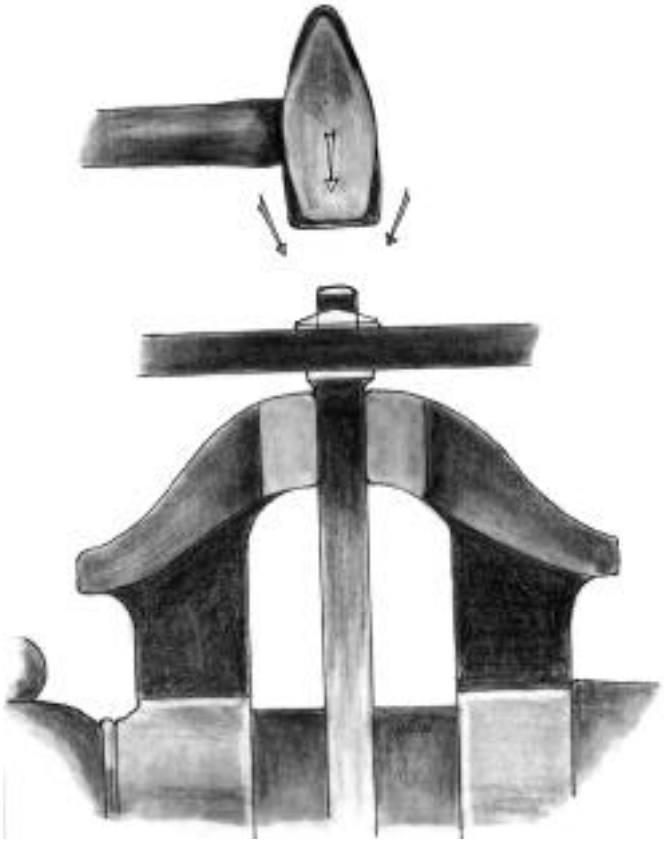
Finishing the joint. Heat tenon and about 1" above shoulder to full yellow.

Quickly set bar in vise. Set mortise onto it. Tap it down so it sits firmly on tenon shoulders. With rapid hammer blows, upset the tenon. (drawing #8) First hammer blows are straight down. Finish with angled blows.

#7. Using the bolster plate

Note: The entire tenon and a bit of the shoulder must be at a bright heat to insure a tight joint.

Forge the head of the tenon into a symmetrical shape with smooth edges. It should be centered on the face of the bar it has joined.



#8. Upsetting the tenon

Note: If you run out of heat, you can use a torch to reheat the tenon head. It is best to finish this operation in one heat. A second heat should only heat the tenon, not the bar with the mortise. (drawing #9)

Troubleshooting:

If the tenon has cracks at the shoulder, this was caused by (1) cutting too deep in step two, (2) misaligned or double cuts, or (3) forging tenon at black heat.

Note: File out hot shuts before and during forging of the tenon.

If the tenon head is not centered on the bar it joins, your upsetting blows may not have been straight down or the mortise was not centered in the bar the tenon joins.

Targets, Time:

Upsetting bar, one heat.

Cutting shoulder and drawing out tenon, two to three heats.

Trimming end of tenon, one heat.

Assembling pieces and heading tenon, one heat.

Targets, Dimensional:

Tenon head should be symmetrical, without sharp edges and centered on the bar it joins.

Tenon shoulder should be the same dimension or slightly smaller than the bar it passes through and joins.

#9. The lesson completed