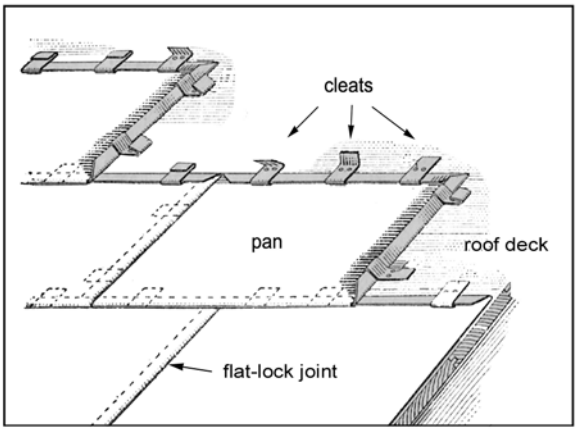
Flat-Lock

Soldered Copper Roofing

Barry Smith



For a roof pitch less than 3/12, a solid membrane roof of some sort is needed. One long-term solution is a flat-lock soldered copper roof. This can be done using just a few hand tools[1], but the time required can be greatly reduced with the proper sheet metal equipment.[2]

The basic component of this style roof is the roofing pan, which is a rectangle typically measuring 18" by 24," though I have seen old roofs with pans smaller or larger than this. The largest that I remember were 24" by 30." Multiple small pans are used, instead of fewer, larger ones, so that thermal expansion and contraction can be absorbed by each pan, instead of accumulating and concentrating in just a few areas, where it could tear the metal apart. If the roof area exceeds 30' in any direction, then an *expansion joint is needed*. I always have rolls of 18" 20 oz. cold rolled copper around for flashing purposes, so 18" x 24" stock is what I start with.

The pans will have ¾" folds around the perimeter, 2 turned up, and 2 turned down, as shown at right. Again, this could be less (½") or more (1"), but I find ¾" to be a nice width, in that there is some extra room for adjustment, when fitting them together without losing too much pan size. The corners have to be trimmed off first to allow the sides to be bent properly (Figure 2). At ¾", scribe two lines in one corner, and draw a 45 degree line so that the intersection made by the two ¾" lines is cut off, leaving a 3/16" wide corner. When the edges get folded, this will leave a 3/16" wide crack which is called a butt (I'll pretend I don't hear that giggling!) This can vary, but if too thin, the pans won't fit easily together, and if too wide, there will be a big hole that needs to be filled with solder.

So the pans are cut to size, and the corners are cut off. Now they can be "pre-tinned,"[3] which means applying a stripe of solder around the perimeter of the pans, on both sides. Because we are making ¾" seams, the stripe will be twice that, or 1 ½". Though pre-tinning is widely recommended, it isn't required. It does reduce the chances of having voids in the solder joints after the pans are assembled and soldered, but an experienced mechanic can apply all of the solder at one time, and be confident that the joints are good. Pre-tinning is a form of "idiot proofing," which, when you are a beginner, is a good thing!

Now, the edges can be folded (2 up, 2 down), at about a 130 degree angle. Your pans are ready for the roof.

The roof sheeting should be solid 1" boards, not plywood, and covered with 30 lb. felt. Install rosin paper, so that the copper doesn't come into contact with the felt. This will keep the felt from melting into the solder joints, and provides a slippery surface as the copper expands and contracts.

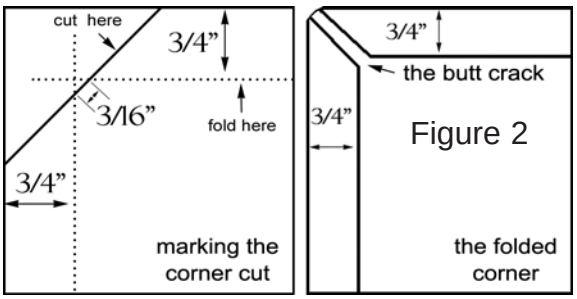


Figure 2

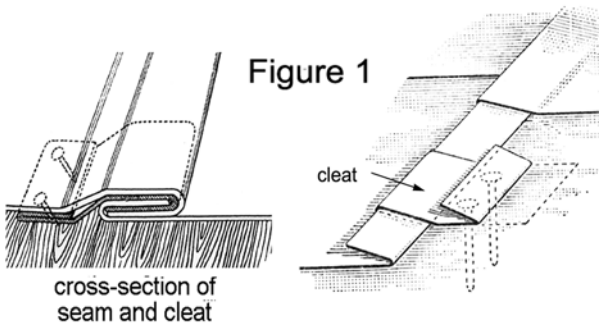
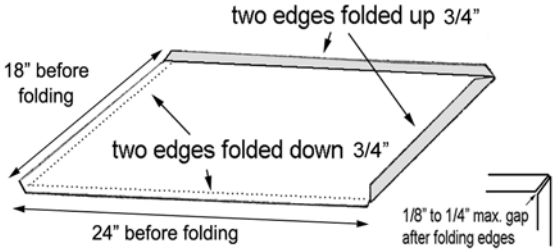


Figure 1



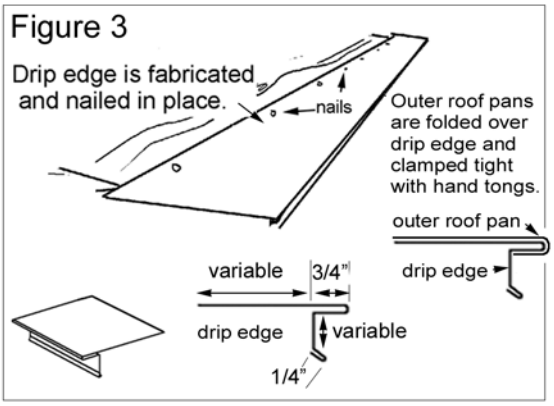


Figure 3

Photos this page and facing page by Joseph Jenkins

Install the drip edge (Figure 3). Snap a chalk line 22½" from the outside of the drip edge and begin installing the pans in the staggered pattern shown above using copper cleats measuring roughly 1 ½" by 3". Use the chalkline as a guide to keep everything straight, but don't worry if the pans aren't lining up perfectly. The cleats can be nailed with 1 or 2 nails (I've seen both recommended), and then folded over the nail. There can be two or three cleats on the long side.

The pans should ideally lay on the roof, so that water runs out of the joint, not into it. This isn't required however, since the joint will soon be filled with solder, and sometimes,

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certain details are more easily assembled and more easily soldered if the joint is "backwards."

Resist the temptation to assemble the pans as tightly as you can, because when the seams are pounded down flat, the pans will tighten against each other. Use a mallet to start the process of pounding down the seams and then a dead blow hammer to pound them *as flat as possible*. The flatter they are, the easier to solder. Don't assemble too far ahead before doing this. Most roofs are going to have more details than just edge pieces and standard pans. For some detailed explanations and drawings of some of the possible pieces that might need to be constructed (including the expansion joint mentioned above), you can look at the Copper Development Association's website. This is the address to the page on flat seam roofing — http://www.copper.org/applications/architecture/arch_dhb/roofing/flat_seam_roofing.html.

To prevent leaking, you should solder all of the seams that you assemble each day. It is not the purpose of this article to do a tutorial on soldering, but here are the basics. A heavy soldering iron should be used with a wedge shaped, or chisel tip. Stay Clean flux is the best that I have found for copper (thanks Chris Paulin!), although other suitable brands include Ruby Fluid and Johnson's Flux. The solder should be 50/50 tin/lead in either 1 lb. or ¼ lb. bars. Assuming the copper is relatively clean and bright, first brush or squirt on the liquid flux, hold the hot iron on top of and against the seam, then add additional solder when the metal gets hot enough to melt it, until the joint is filled. You might have to add additional flux. Move the iron slowly in the direction that you are soldering, not quickly back and forth.

I've seen that others recommend a practice called "stitching" that involves going back over the soldered joint and walking the point of the iron across the seam about every ¼" and adding more solder. It is usually explained that this will draw more solder into the joint. If this is drawing more solder into the joint, then you didn't do it correctly the first time. The only good reason to stitch a joint is for aesthetic reasons — if you like the look. Stitching adds a lot of time and doesn't improve the performance.

You should practice on some scrap pieces and cut them apart to see inside the joint. Do this until you have some confidence that everything is bonding well and there aren't any voids.

Do not use a torch, whenever there is flammable material underneath the metal being soldered! This can start a fire. The whole purpose of the iron, is to give you greater control of the heat being applied, so that just enough heat to melt and draw the solder is used, and no more.

When the soldering is completed, the copper will be a mess from the whole process. To clean it up: brush down the whole roof with flux; then brush and rinse this off with soda water (1 lb. of baking soda stirred into a 5 gallon bucket of water); now, rinse the whole thing off with water.

Remember, practice makes perfect!

[1]Tin snips, hand seamers, scribe, wooden mallet, dead-blow hammer, soldering iron; [2] Foot shear, brake, solder trough; [3] This can be done with a soldering iron, or with a solder trough. I have made a trough from scratch, using a stainless steel melting trough with some legs welded on and a propane burner underneath, protected by a windshield. While very effective (see photo at right), I'm told that it might be improved (and possibly safer) by fitting a regular furnace type burner to it. Since the design is still being worked out, I don't want to make any recommendations yet. Slateroofcentral.com has an electric one for sale (see below).

Barry Smith pre-tins copper pans in a pre-tinning trough.

TOOLS FOR FLAT-LOCK COPPER WORK

16 ounce copper — 18" or 24" rolls are already the correct width for cutting into 24"X18" pans.

Soldering devices — These should be "closed flame" soldering devices, such as the Swedish-made Sievert, the French-made Express, or the Johnson acetylene torch. Or use an electric soldering device such as the American Beauty 300 watt model. Or use hand irons and a Johnson bench furnace.

Solder — Use either 1/4 lb. 1/2 lb. or 1 lb 50:50 tin/lead bar solder.