Construction of an Experimental Tetrahedral Ambisonic Microphone

Dan T. Hemingson
The University of Texas at Austin
Austin, Texas 78712, USA
dhemingson@mail.utexas.edu

PLEASE READ ALL OF THESE INSTRUCTIONS BEFORE BEGINNING.

Building the tetrahedral frame:

Parts list:
5 lengths of #12 AWG solid copper wire ¾" long*
1 U-frame of #12 AWG solid copper wire*
1 3" long, 1/4" ID (internal diameter), 3/8" OD (outside diameter) all-thread pipe

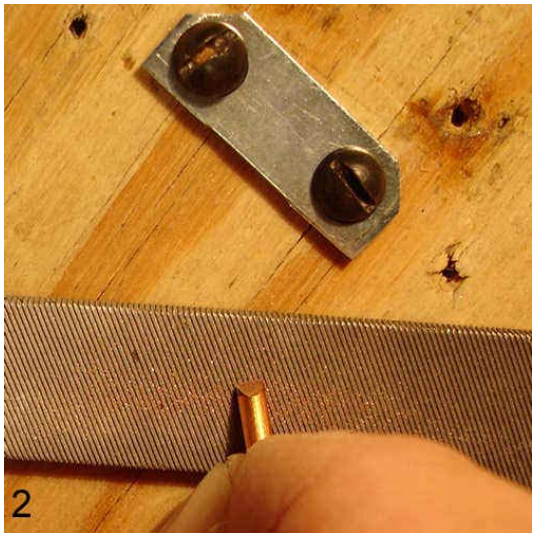
Tools and materials:
1 soldering iron, pencil-type, 60 watts or so
1 propane torch or 140-watt (or greater) soldering gun
1 screwdriver (type depending on wood screws you provide)
1 pair of needle-nose pliers (heavier rather than lighter)
2 pair of regular pliers
2 heavy rubber bands to clamp handles of pliers or several lighter rubber bands
1 small fine file
1 vise or clamp
Solder (not acid core)
6 wood screws
Small metal brackets (see things to note in step 01 below)
Piece of wood: 12x12-inch ½-inch plywood will work really well; almost anything from 12-inch long 1x4 or larger will work

*Note: The #12 AWG solid copper wire may be obtained as standard electrical wire with insulation, often known as #12 THHN, #12 THWN, or #12 TW. Total length required is less than one foot. The metric equivalent is 1/2.05 solid copper wire, also more available with insulation. Strip the insulation from the wire before cutting into appropriate lengths.

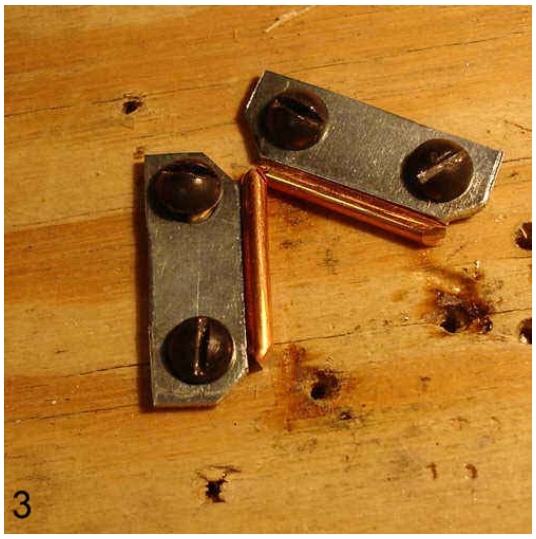
Process with pictures:
Note: Some things are better described in pictures. I tried to do that as much as possible; at times I used the timer on my camera to show things that required my two hands. There are times that the length of the timer was too short to get things in front of the lens, and I will describe those in text! The numbers of each step match up with the picture numbers. Picture numbers are 2-characters wide since most computer programs, even photo software, look at alpha-numeric increments rather than numeric ones.

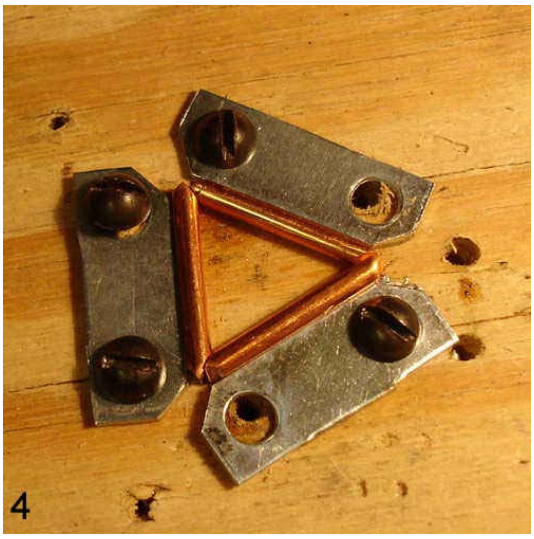
CAUTION! You will be dealing with HOT wires and MOLTEN solder. All of it can burn you if you do not let it cool before touching. This includes the tools that are often used both to hold parts in place and as heatsinks to keep other joints from melting.

01. Place two metal brackets at a 60-degree angle on the board. Things to note about the brackets: they are about 1” long and have 2 holes in each bracket; those holes are larger than needed for the screws, but this gives you room for adjustment. I used 1” hinges and cut off the part that I wanted to use. These are also used as heatsinks, so a heavier thickness has its benefits. Now would be a good time to file the inside corners off of your brackets like the one in Figure 02. Also, I drew lines on the board a few pictures in, but now would be a good time to draw 2 legs of the isosceles triangle on the board.

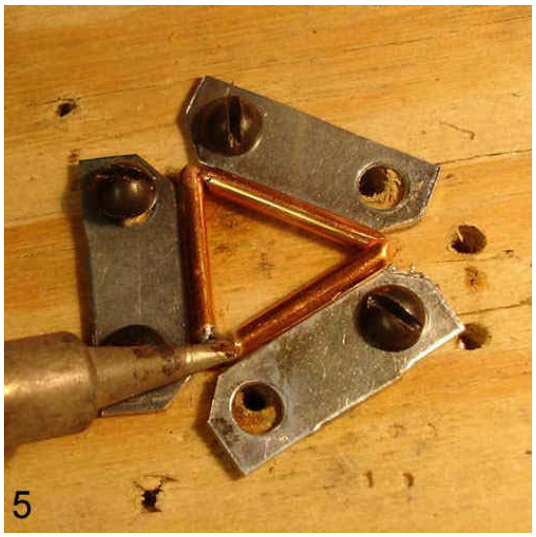


02. File the each end of 3 pieces of ¾-inch long wire to match the adjoining segments.



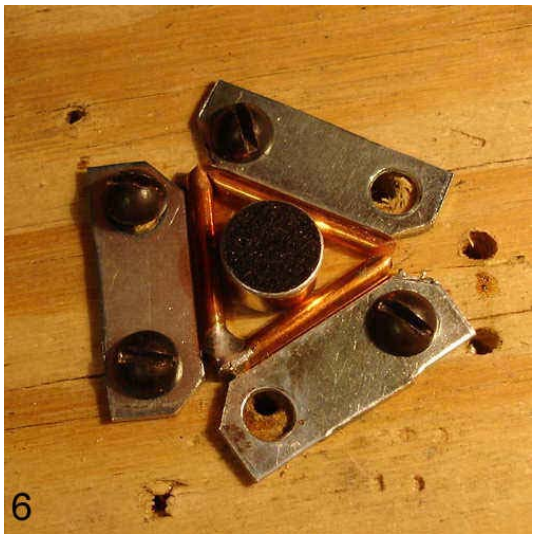


03-04. Add the other sides.

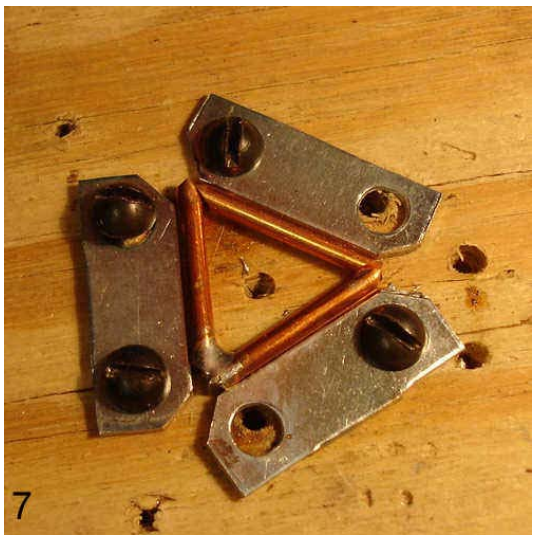


05. Solder <u>one</u> corner of the triangle. Let the wires cool.

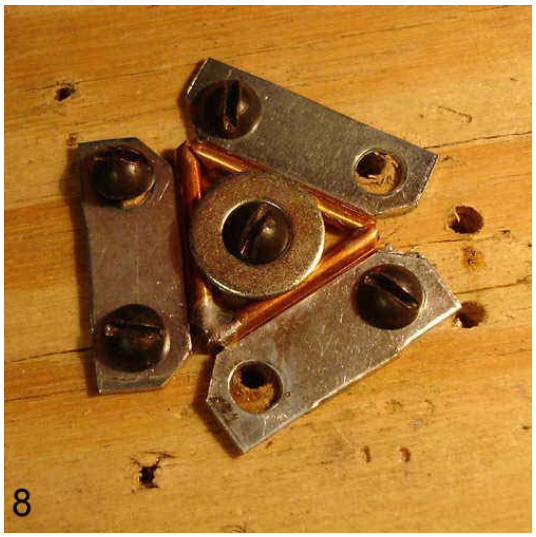
Note: An excess of solder in the interior corners may make it more difficult to wire the tetrahedral in the next chapter of construction. The capsule wires will be threaded between the edge of the capsules and the soldered corners of the triangles.



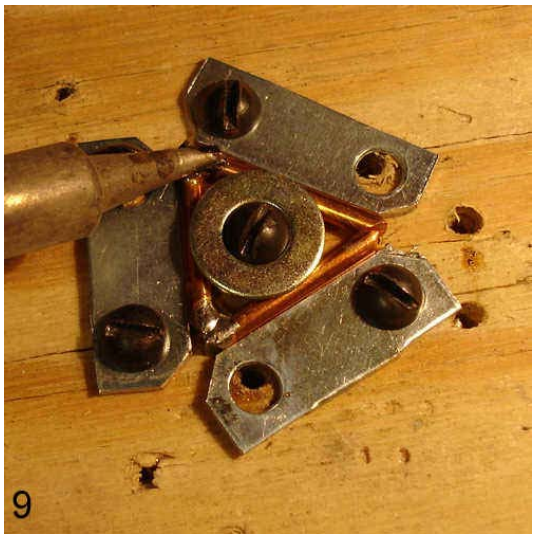
06. Place a microphone capsule in the triangle. It should rest about midway around the wire, not falling through and not resting on the top of the wires. Make adjustments now to your brackets and resolder/refile (Let it cool.) as necessary.

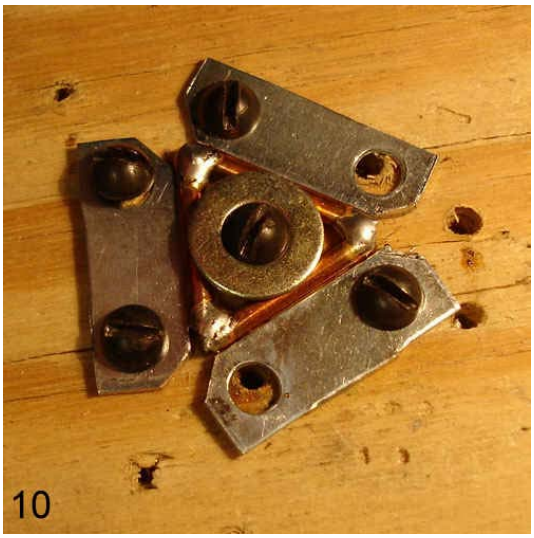


07. Store the capsule away from the work area or in a baggie to keep it clean. Draw the third line of the triangle on the board. Mark the center of the triangle and make a pilot hole for another wood screw for step 08.

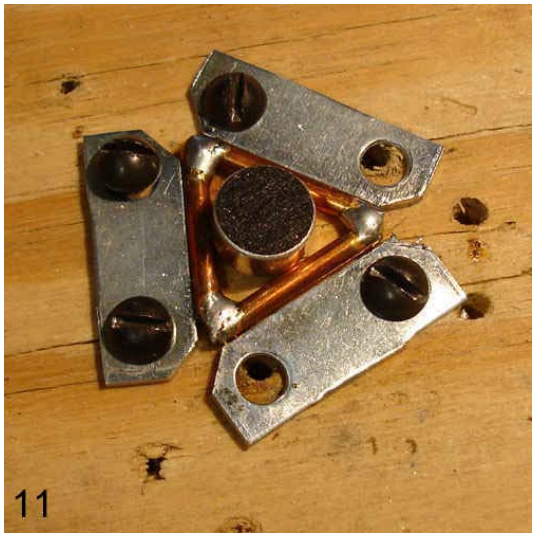


08. Clamp the triangle with a screw and washer.





09-10. Solder the remaining two corners. Let it cool.



11. Recheck the capsule placement.

Note again: An excess of solder in the interior corners may make it more difficult to wire the tetrahedral in the next chapter of construction. The capsule wires will be threaded between the edge of the capsules and the soldered corners of the triangles.

12. Turn the cool triangle over and re-clamp it.

13-16. Resolder the corners. Heat the joints enough for the solder to flow, and don't add too much solder. You may notice that other corners melt. Keep this timing in mind as later on we do this with free standing joints! Let the triangle cool.

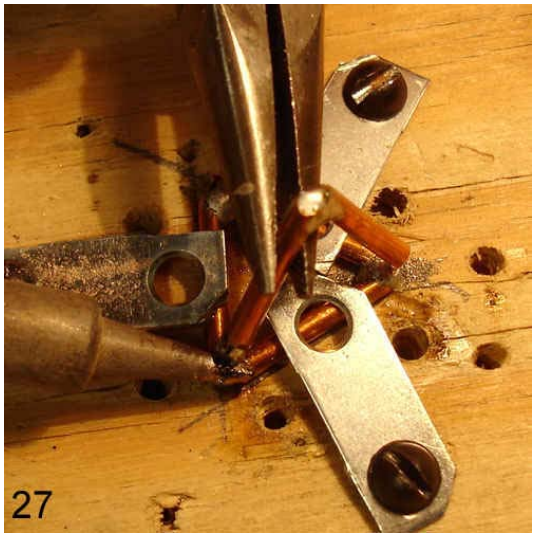
17-18. Remove the triangle and build a “uni-angle” and let it cool.

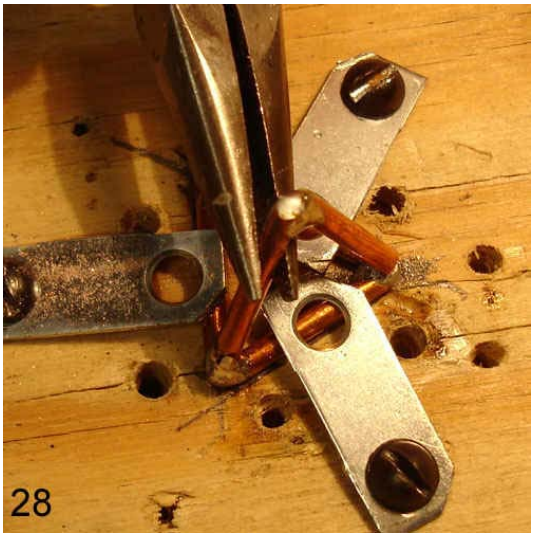
19-20. Turn it over and resolder. Let it cool and remove the uni-angle.

21-24. Reset the metal brackets to be clamps rather than guides for the triangle.

25. Tin (that is, put a thin coating of solder) on the end of *one* leg of the uni-angle.

26. File the excess solder from the top of one corner of the triangle so the uni-angle can rest flat on the corner.

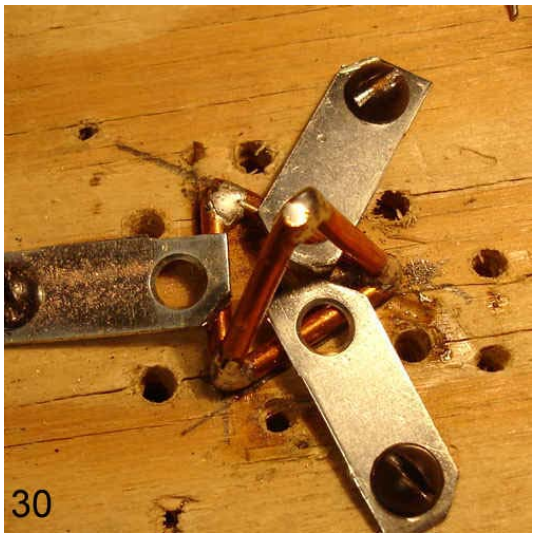




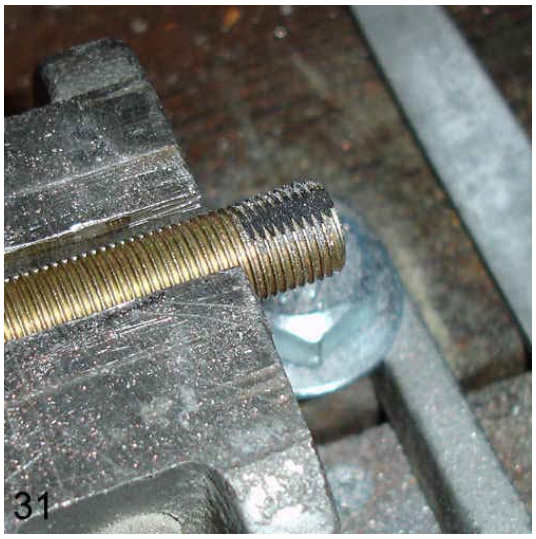
27-28. File a free end of the uni-angle so it will rest flat on the filed corner of the triangle while the uni-angle is tilted toward the middle of the triangle just outward from the center of the triangle (where the center clamp screw hole is located). All angles are 60-degrees!

The pliers are going to be a heatsink as well as a tool to hold the uni-angle. Do the next step as quickly as possible, yet get a good solder joint. You may need a third hand to help you do this. Again, all of the angles on a tetrahedral are 60-degrees.

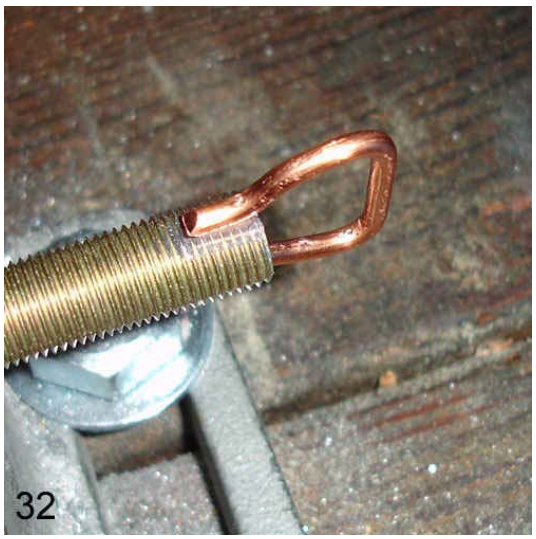
Clamp onto the pre-tinned leg of the uni-angle with the pliers. Start heating the unfiled triangle joint, resting the other end of the uni-angle on the corner you filed in step 26. Rest the tinned leg in the heated joint and (third hand) while heating the entire joint add just enough solder to make a nice joint. Keep a good grip on the pliers so it will be an efficient heatsink. Things may get warm if you take too much time. Keep the grip on the pliers until the solder has solidified and cooled somewhat, otherwise the heat could transfer to other joints and … Yes, I have had two tetrahedral frames fall apart.



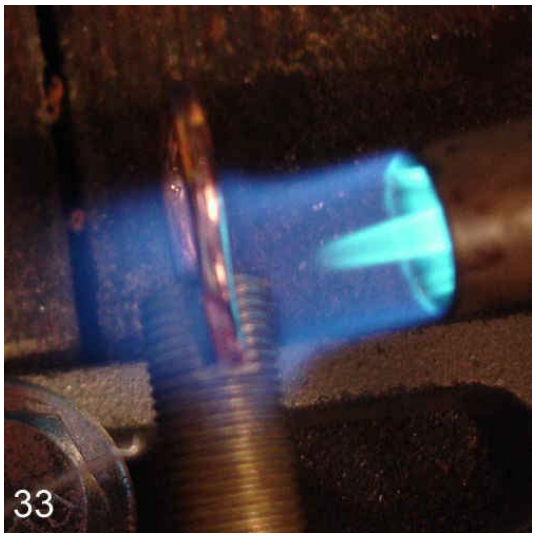
29-30. Let the pliers cool! Clamp the pliers onto the second leg of the uni-angle and solder it to its corner. After the joint has cooled, take a short break.

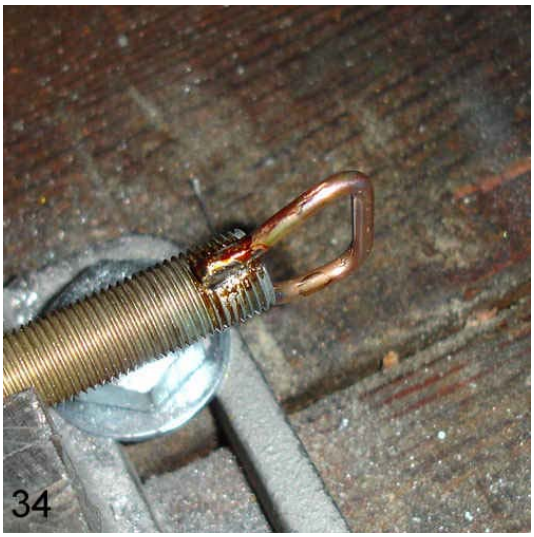


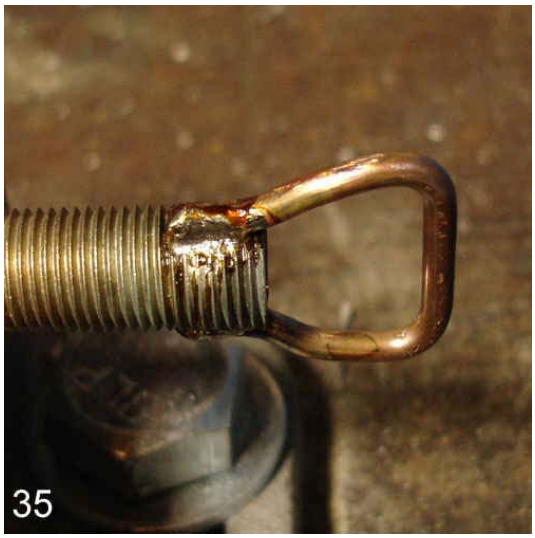
31. Clamp the all-thread pipe into a vise (not so hard that it damages the threads) and file about 3/8 of an inch of the threads to form a flat on each side of one end of the pipe. Do not file through the pipe. Move the pipe further from the jaws of the vise to prevent the vise from being too great a heatsink.



32. Place the U-frame on the flats (It should be tight enough to remain on the flats on its own.) and align the U-frame will be true to the pipe vertically and the "U" flat is perpendicular to the pipe. The horizontal flat alignment is critical to the alignment of the tetrahedral. Adjust any misalignments now. Do not move it during the soldering steps.







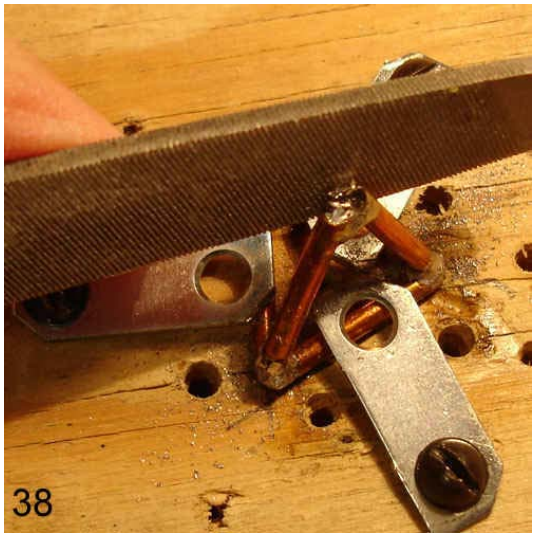
33-35. Using a *low* flame from a propane torch (best way) or a soldering iron (140-watts or more), heat the end of the pipe and the U-frame. Solder only the top side. Use enough solder to hold the wire in place. There should not be a blob of solder. The joint should get hot enough for some of the solder to flow into the threads of the pipe.

Let it completely cool before touching it. Confirm that the U-frame is in alignment with the pipe, especially what will be the 90-degree horizontal leg of the tetrahedral. (This part of the U-frame will be called the "horizontal leg" because it will be the bottom horizontal wire in the completed frame.)

Reclamp the pipe in the vise with the unsoldered side up and solder the second side. Let it cool before removing it from the vise.

Look at the structure you just made with the pipe vertical, U-frame on top. The frame should extend vertically from the pipe and the horizontal leg should be horizontal. Some minor vertical alignment is possible by bending the copper wire. If there are problems with either alignment, correct it now.

36-37. Tin *one* corner of the frame as shown.



38. File the inside edge of the frame so the solder joint is flat. Put minimal pressure on the solder joints connecting the uni-angle to the triangle.

39. Wrap rubber bands around the grips of two sets of regular pliers. They should be difficult to open. Clamp the jaws of one set to each leg of the uni-angle, setting the jaws with as much surface contact with the wire as possible. Support the handles of the pliers so there is the least amount of tension on the joints of the uni-angle and triangle.

Hold the pipe with a pot holder or insulated glove. The tinned corner should be down as it will be soldered to the remaining free corner of the triangle. Place the horizontal leg such that it becomes the final side of the tetrahedral.

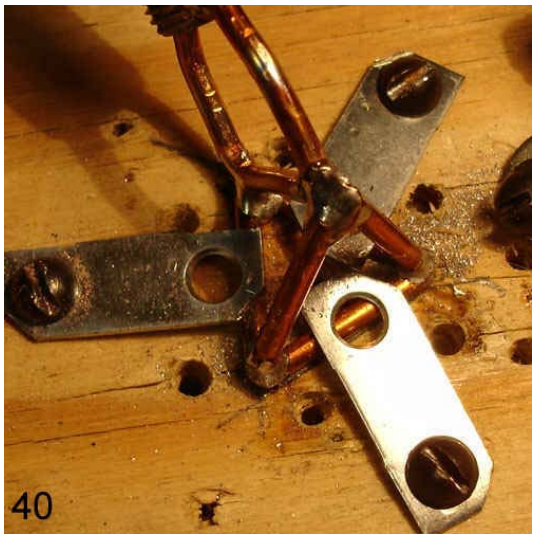
Heat the bottom corner with a soldering iron and add solder as needed while lightly pressing the top corner into the freshly filed corner of the uni-angle. Check that the isosceles triangles formed by this new leg are true.

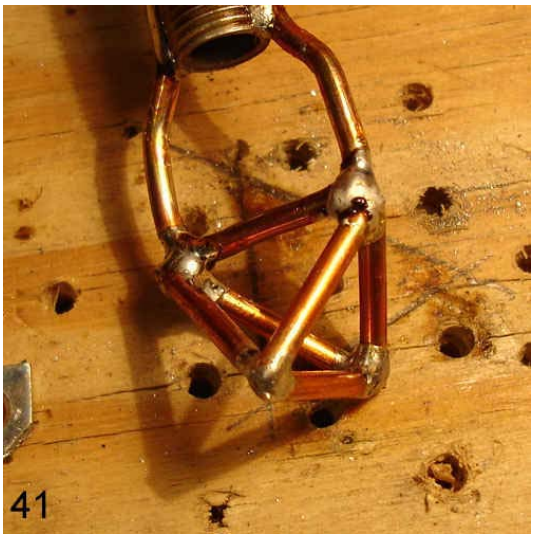
Hold the pipe in place until the joint has cooled. Let everything cool *before* soldering the final joint, including the heatsink pliers.

Holding the pipe in place and with the pliers still clamped in place, solder the final joint. Check the angles. Let everything cool before moving anything.

Test each face of the tetrahedral with a microphone capsule. If the capsule does not rest on the round of each of the wires, you can slightly bend one of the wires. Remember that bending one will affect another; probably bending inward is the best correction. Too much stress could fracture a solder joint.

Should you feel that a solder joint needs more work, clamp pliers on all 3 of the legs attached to the joint in question. If you do not use these heatsinks, the possibility of the frame completely collapsing is very, very high; and that may lead to excessive muttering and even drinking.





40-41. Remove the pliers and clamps and congratulate yourself on a job well-done. You have completed the most difficult part of building the microphone.

Whew!

The next step is to wire the tetrahedral.

Rev. 20120227 – correct wording at figure 26, minor editing elsewhere
Rev. 20121126 – notes added at parts list and figures 5 and 11