A True Plumber's Delight for 2 Meters–An All-Copper J-Pole

By Michael P. Hood, KD8JB
2323 Jefferson Drive SE
Grand Rapids, MI 49507-3148

KD8JB was not happy with how his old J-Pole held up in the weather, so he made a much more rugged one.

A number of years ago, I built a J-Pole antenna from some scrap aluminum tubing and a 5-foot stick of TV mast.[1] The antenna tuned easily, and operated well for a few years until nature did it in. After taking it down, I found a number of problems not contemplated in the original construction, such as dissimilar metals and other types of corrosion, and deterioration of parts of the coaxial feed line. These problems are identified and explained in the accompanying sidebar.

With the shortcomings of the original J-Pole in mind, I set about planning for another, similar antenna, using parts commonly available from a single source. If you spend much time in hardware stores and home improvement places, you get a feel for what's available at a moment's notice. In my case, rigid copper tubing, fittings, and assorted hardware, came to my attention as the material of choice. See **Fig 1**. The entire assembly can be soldered together when copper is used, thus ensuring electrical integrity, and making the whole antenna weatherproof in the bargain.

I'll bet you could solder one of these together faster than using the nuts and bolts I did in my previous design. This antenna can be easily used for ARES/RACES groups that spot antennas around for emergency use, since it requires little, if any, maintenance during its lifetime.

The J-Pole will take about an hour or so out of your day to build and tune, making a great antenna for a VHF base station.

No special hardware or machined parts are used in this antenna, nor are insulating materials needed, since the antenna is always at dc ground. Best of all, even if the parts aren't on sale, the antenna can be built for less than $15. If you only build one antenna, you'll have enough tubing left over to make most of a second antenna, or perhaps to finish that small plumbing project the XYL has been hounding you about.

Materials

Copper and brass is used exclusively in this antenna. These metals get along together, so dissimilar metal corrosion is eliminated. Both metals solder well, too. **Table 1** provides a detailed parts listing for the antenna.

Construction

Cut the copper tubing to the lengths indicated in Table 1. Item 9 is a 1 1/4-inch nipple cut from the 20 inch length of 1/2-inch tubing. This leaves 18 3/4 inches for the λ/4-matching stub. Item 10 is a 3 1/4-inch long nipple cut from the 60-inch length of 3/4-inch tubing. The 3/4-wave element should measure 56 3/4 inches long. Remove burrs from the ends of the tubing after cutting, and clean the mating surfaces with sandpaper, steel wool, or emery cloth.

After cleaning, apply a very thin coat of flux to the mating elements and assemble the tubing, elbow, tee, endcaps, and stubs. Solder the assembled parts with a propane torch and rosin-core solder. Wipe off excess solder with a damp cloth, being careful not to burn yourself. The copper tubing will hold heat for a long time after you've finished soldering. After soldering, set the assembly aside to cool.

Flatten one each of the 1/2-inch and 3/4-inch pipe clamps. Drill a hole in the flattened clamp as shown in **Fig 2**. Assemble the clamps and cut off the excess metal from the flattened clamp using the unmodified clamp as a template. Disassemble the clamps.

Assemble the 1/2-inch clamp around the 1/4-wave element and secure with two of the screws, washers, and nuts as shown in Fig 2. Do the same with the 3/4-inch clamp around the 3/4-wave element. Set the clamps initially to a spot 4 inches or so above the bottom of the "J" on their respective elements. Tighten the clamps only finger tight, since you'll have to move them when tuning.

Tuning

Tuning an antenna couldn't be simpler.[2] The toughest part might be determining what type feed line you are going to use. Anything from RG-58 to open-wire line is

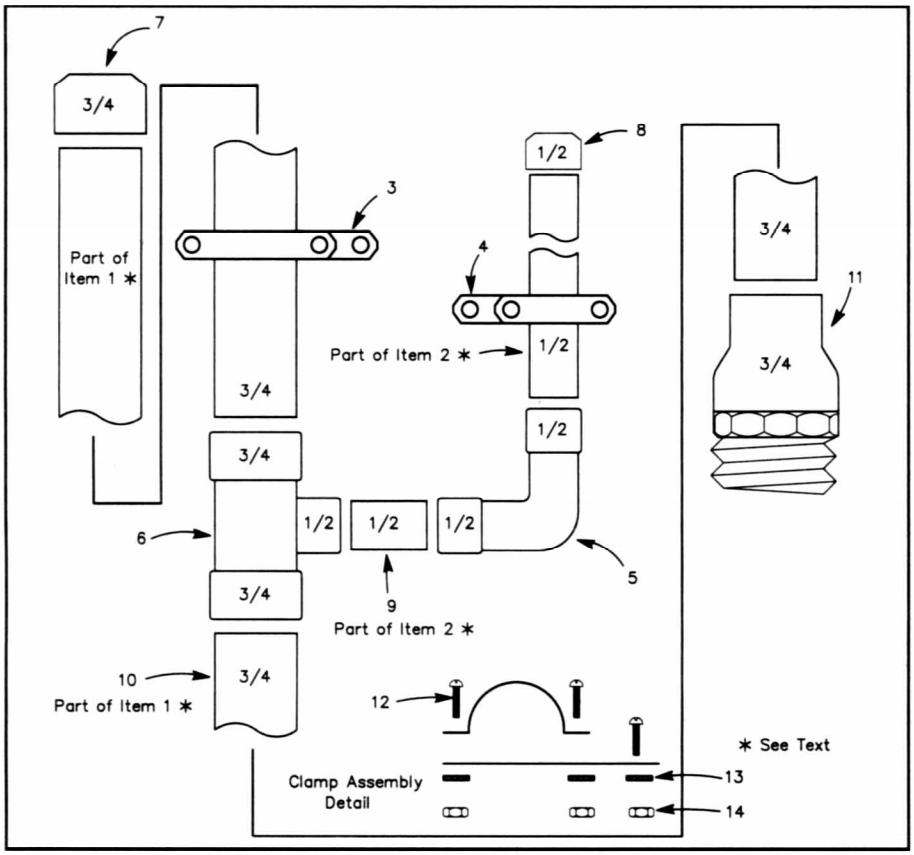

Fig 1—Exploded assembly diagram of all-copper J-Pole antenna. Item numbers refer to parts list in Table 1.

Table 1
Detailed Parts List (See Fig 1)

Item No.	*Qty*	*Part or Material Name*
1	1	3/4 inch × 10 foot length of rigid copper tubing (enough for 2 antennas, 60 inches per antenna)
2	1	1/2 inch × 10 foot length of rigid copper tubing (enough for 6 antennas, 20 inches per antenna)
3	2	3/4 inch copper pipe clamps
4	2	1/2 inch copper pipe clamps
5	1	1/2 inch copper elbow
6	1	3/4 × 1/2 inch copper tee
7	1	3/4 inch copper end cap
8	1	1/2 inch copper end cap
9	1	1/2 × 1 1/4 inch copper nipple (Make from item 2. See text)
10	1	3/4 × 3 1/4 inch copper nipple (Make from item 1. See text)
11	1	Your choice of coupling to mast fitting (3/4 × 1 inch NPT used at KD8JB)
12	6	8-32 × 1/2 inch brass machine screws (round, pan, or binder head)
13	6	no. 8 brass flat washers
14	6	8-32 brass hexnuts
15	A/R*	Rosin core solder
16	A/R*	Paste flux
17	A/R*	Fine sandpaper, steel wool, or emery cloth
18	A/R*	Solvent to clean away flux after soldering

*As required.

usable. The J-Pole can be fed directly from 50 Ω coax alone or with a 1/2-wave balun, or twin lead, or whatever. Before tuning, mount the antenna vertically, about 5 to 10 feet from the ground. A short TV mast on a tripod works well for this purpose.

When tuning VHF antennas, keep in mind that they are extremely sensitive to nearby objects—such as your body. Attach the feed line to the clamps on the antenna, and make sure all the nuts and screws are at least finger tight. If using coax, it really doesn't matter to which element (3/4-wave element or stub) you attach the coaxial center lead. I've done it both ways with no variation in operational effectiveness. Tune as follows:

1. Apply RF at the frequency you want the antenna to perform best.
2. Check the SWR.
3. Turn off the RF.
4. Move the clamps *equally* up from the original position 1/2 inch.
5. Reapply RF.
6. Check the SWR again, and turn off the RF.
   a. If the SWR went higher, move the clamps 1 inch downward, equally.
   b. If the SWR went lower, move the clamps 1/2 inch upward, equally.
7. Reapply RF.
8. Check the SWR once more, then turn off the RF. By this time you will be approaching minimum SWR (You may *never* get a 1:1 SWR. Don't sweat it, it's not important enough to worry about.)
9. Adjust the clamps a small amount in the direction of minimum SWR.
10. Repeat Steps 7 through 9 until minimum SWR is achieved.
11. Remove RF.

A point to remember about tuning the antenna is this: It will tune with any type of feed line, but the clamps will not be in the same place for all types of line. In other words, 50-Ω coaxial cable will tune further down the antenna than 600-Ω open-wire line. You have to think of this feedpoint as being similar to a delta match, which it is, except the elements run parallel and not away from each other.

Final Assembly

The final assembly of the antenna will determine its long-term survivability. Perform the following steps with care:

1. After adjusting the clamps for minimum SWR, mark the clamp positions with a pencil.
2. Remove the feed line and clamps.
3. Apply a very thin coating of flux to the inside of the clamp and the corresponding surface of the antenna element where the clamp attaches.
4. Install the clamps and tighten the clamp

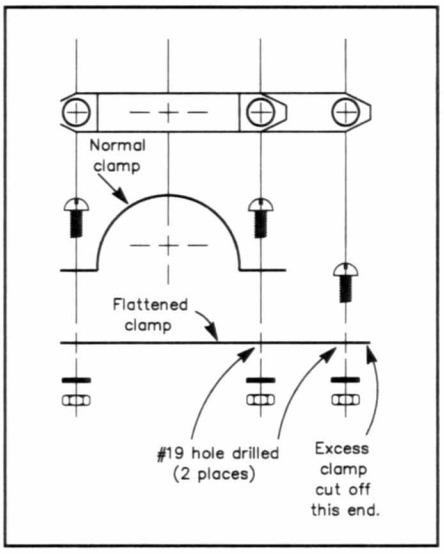

Fig 2—Detail of clamp assemblies. Both clamp assemblies are the same.

screws. Don't attach the feed line yet, and leave off the final washer and nut at the feedline attachment point.

5. Solder the clamps where they are attached to the antenna elements.
6. Apply a small amount of solder around the screw heads and nuts where they contact the clamps. Don't get solder on the screw threads!
7. Clean away excess flux with a non-corrosive solvent.

After final assembly and erecting/mounting the antenna in the desired location , attach the feed line you tuned the antenna for, and secure with the remaining washer and nut. It would be a good idea to weather-seal this joint with RTV. Otherwise, you may find yourself repairing the feed line after a couple years.

On-Air Performance

Years ago, prior to building the first J-Pole antenna for this station, I used a standard 1/4-wave ground plane vertical antenna. While there is no problem working the various repeaters around town with my 1/4 wave antenna, simplex operation left a lot to be desired, so I felt something with a little more gain was necessary. Hence the switch to the J-Pole. In on-air comparisons with the Ringo Ranger 2B, a popular antenna everywhere, a small difference in bandwidth was noted. This J-Pole's bandwidth, as built here, is slightly wider, probably from the greater element thickness, resulting in a lower Q. Actual performance differences between antennas of similar dimensions, such as those of the Ringo Ranger are negligible, although significantly better than the 1/4-wave ground-plane vertical.

Post Inspection/Evaluation of the Original J-Pole

1. ALUMINUM MOUNTING PLATE: The plate was rust-stained from contact with the non-stainless steel elements of the antenna. The alloy used for the plate was 2024 aluminum, which is quite hard and holds its finish well. However, the rust deposits affect the continuity between elements. This plate was reused after cleaning.
2. GALVANIZED PAINTED 3/4-WAVE SECTION: The painted portion of this element survived the ravages of weather very well. The small portion where the paint was removed to make contact with the aluminum plate was completely coated with rust, as were the U-bolts holding the element to the plate, and the screw (probably zinc plated) used to ensure contact between the section and the mounting plate's upper edge. The hole drilled for the stainless screw used to attach the coaxial cable shield was in as good a condition as when originally drilled owing to the liberal application of Silastic 732 RTV[4] after assembly. This section was reused as a 5-foot mast section. I would use 1 1/4-inch aluminum tubing if this antenna were rebuilt in this form.
3. NON-STAINLESS HARDWARE: All plated and unplated hardware exhibited varying degrees of oxidation (rust). Some of the galvanized hardware came through with only spot rust where the galvanized coating had either deteriorated or been scraped away. The cadmium-plated mast brackets bought at Radio Shack showed rust only where excess length on the U-bolts was removed and at the bends in the bracket plates. These brackets were reusable, but the nuts were replaced. The U-bolts holding the 3/4-wave section to the mounting plate were so badly rusted that when removal was attempted, the bolts broke off.
4. STAINLESS STEEL HARDWARE: As expected, all stainless steel came through in great shape. Even though mated with some non-stainless hardware like star washers or nuts with integral star washers, the stainless hardware was easy to disassemble. Never use other than stainless steel or brass hardware in antenna construction! It's well worth the extra cost.
5. COAXIAL CABLE: This antenna was fed with RG-8X (foam) made for LaCue Communications. Some cable was cut off for inspection when the antenna was taken down. (I do this whenever I take down an antenna to get a visual idea of how the coax is doing.) The cable was terminated at the antenna with crimp lugs, which I crimped and soldered. The shield remained in good condition throughout except for normal copper oxide near the lug. (I used RTV[4] to seal the spot where the center lead passed through the shield. The sealant worked well.) However, the foam dielectric between the shield and the terminal lug cracked in a number of places causing water to leak in and wick down the center conductor. Not good! Interestingly, the foam that had melted near the soldered terminal lug protected the center conductor well at that point.
   Lesson: When terminating coax in this fashion, the foam dielectric should be sleeved or taped to prevent cracking. In your haste to use a new antenna, always solder the lugs—never leave them just crimped. I should point out that I was responsible for the deterioration of the coaxial cable because of the way I used it. LaCue had nothing to do with what happened in this instance. I use LaCue's RG-8X cable for most of my feed lines, and when properly terminated, it works very well.

References

[1]M. P. Hood, "All-Metal 2-Meter J-Pole Antenna" (and References), *Ham Radio*, Jul 1984, pp 42-44.

[2]"A Combination 6 and 2 Meter J-Pole," *FM and Repeaters* (Newington: ARRL, 1972). (Out of print.)

[3]"Building and Using VHF Antennas," *VHF Handbook* (Newington: ARRL, 1972). (Out of print.)

[4]Silastic 732 RTV is made by the Dow Corning Company.