Home-Brew Quagis

A novice can build these 2m and 440-MHz antennas for under $15.

by Mike Snowden KE6HVH

I remember, as I was growing up, being awakened at zero dark hundred hours by the unbelievable roar (what I now know as intermod) of garbled voices coming from the speakers of my J. C. Penney stereo, which I had left on while I had fallen asleep. It was my father, now silent key K6YPB, attempting some DX work with his old Swan rig. Aside from the early morning cardiac test, I also remember that he always seemed to be building something. The name Heathkit was so common around the house, I often wondered where this mysterious sibling was hiding.

Now after some 37 years, I was bitten the ham radio bug. While my father would build rigs, I was just plopping down my plastic. It was not long till I began to get the urge to try some building of my own. I do not have the electronics background that my father had, and with Heathkit being out of the kit-building business (as of a few months ago, they still provide product support on some of the kits), there did not seem to be much left.

"Home-brew," as I began to learn, seemed to be a lost art form in my area. I joined a local ham club, but discovered that there were no club building events or projects. So I picked up a few books from the local ham store and began to read. My interest was soon drawn to the subject of antennas. There is an overabundance of information published on the subject and it seemed a good place to begin a foundation. Besides, these parts did not appear expensive, especially when mistakes, I mean, design changes, are made.

One of the books I found most helpful was the *ARRL Antenna Book*. It was stuffed full of designs and projects. Being a "newbie" I opted to start with VHF/UHF projects. This month's cover photograph depicts a few of my first efforts in antenna building. Even the tower was a "home-brew" project. The first two antennas were 2 meter and 440-MHz quagis. Then a 6-foot, 1.2-GHz dish, and then a second 6-foot dish tuned for 440 MHz. All designs and information were taken from the pages of the *ARRL Antenna Book*. Some design changes were made to reflect better SWR and gain. In the case of the quagis, all parts are available from most hardware or hobby stores. The 440-MHz quagi parts will cost between $12 and $15. The parts for the dish antennas might be a bit more difficult to find. I had the dishes left over from upgrading home satellite systems. They may be purchased new from most satellite dealers.

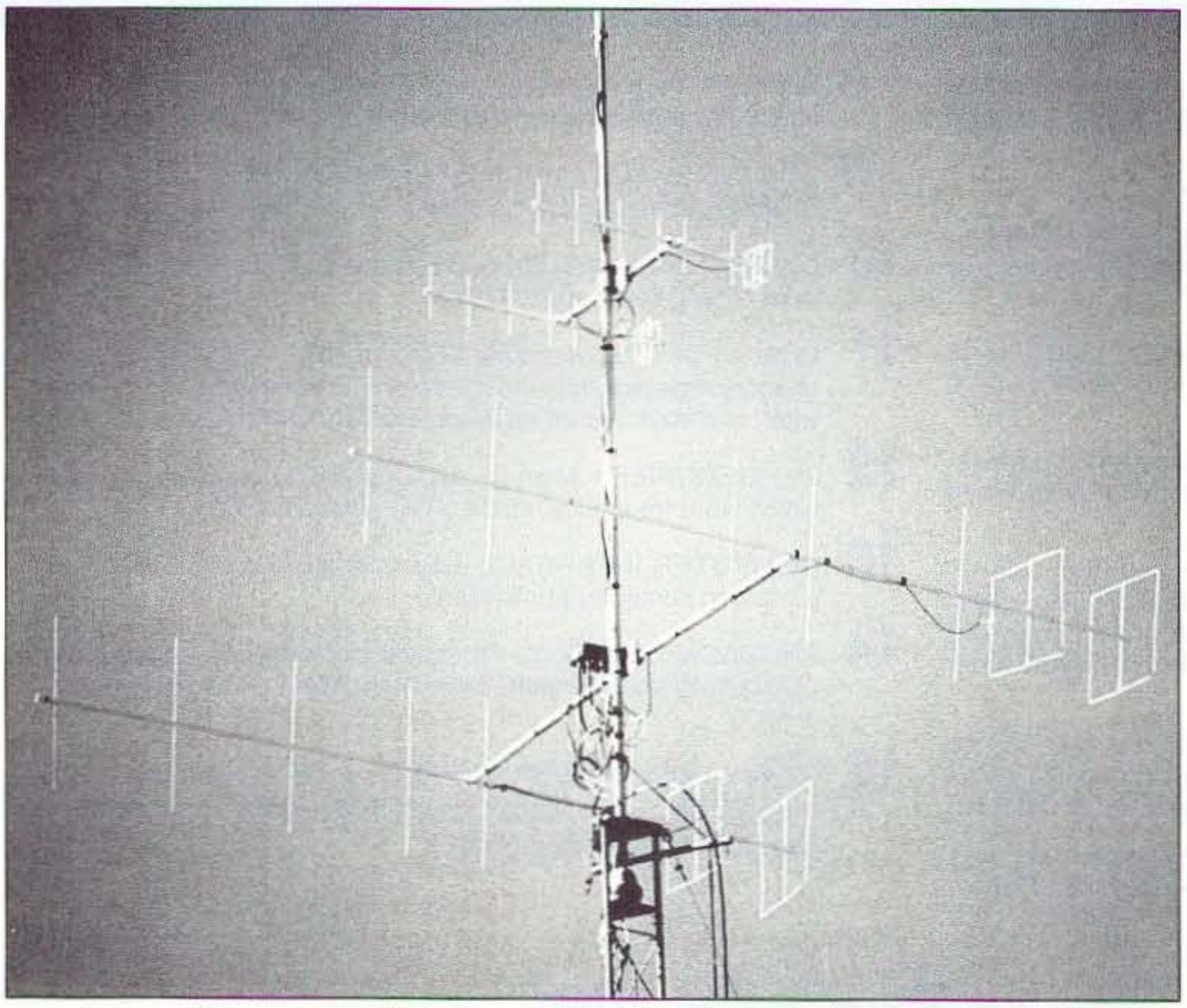

Photo A. KE6HVH's 2 meter and 440-MHz quagi antenna setup.

Just What *Is* a Quagi?

The quagi is a cross between a quad and a yagi antenna. The reflector and the driven element represent the quad and the director elements are that of the standard yagi. The book boasts a 13-dBi gain. In my experiments I found the quagis to be very directional with nulls developing 10 degrees off either side when vertically oriented. Cross polarization rejection is very good also, with significant drop off starting at 45 de-

grees when being rotated from vertical to horizontal. These experiments were conducted on a number of antennas built at a club building party, and the results were very consistent. In less than an afternoon, either, if not both, the 2 meter or the 440-MHz quagis can be built. The dish is a weekend project, as it requires much more effort to build. The tower is a major project requiring special skills and experience and should only be attempted by those who posses the welding and fabricating skills to complete a project of this nature safely.

For this article, we will concentrate on the building of the quagis and leave the dish antenna to a follow-up article. The following is a short list of parts and supplies that will be needed. With the exception of the boom for the 2 meter quagi, try not to vary from the described parts, as it can have an effect on the resonant frequency and SWR.

Construction

Construction of the two quagis is the same. Only the dimensions change. I will describe the building of the 2 meter quagis, but the techniques apply to both. We start by cutting the director elements. Do not use a wire cutter or other such cutting tool. Use a hobby razor saw or hacksaw. Cut the six director elements to length, starting at 35-5/16 inches and ending with 34-3/8 inches, in 3/16-inch steps. Be sure to identify each element with a marking pen to designate which element it is. For example, the first element may have one line and the sixth will have six lines. Next cut one piece of 3/8-inch wood dowel to 21 inches and another to 21-3/4 inches long. Notch a "U" shape groove in the end of each dowel, parallel to each other. The notch in the ends will hold the wire loops in place. Now cut the #6 bare solid copper wire to 85 inches long. Measure and make three marks on the wire at intervals of 20-1/4 inches. We are now going to form the reflector square loop. Grip the #6 wire with a pair of pliers so that the first mark is on the edge of the pliers' jaws. Starting with the shorter end of the wire, fold it up to a 90 degree angle, creating the first side of the loop. Now grip the wire at the second mark. While keeping the first leg of the loop pointing straight up, start to fold the wire upwards to form the second leg of the loop. Now do the same with the third mark. When done you should have a square loop with sides of approximately 20-1/4 inches (inside to inside). With a hammer, flatten the two meeting ends slightly, so that the flattened sides are parallel to each other. The flattened side will provide more surface area for a stronger solder joint. Solder the flattened joint together. This completes the reflector loop. Now cut the 10-gauge insulated copper wire to 82-1/4 inches. Strip about 3/4 of an inch of insulation from both ends. Solder the 10-32 solder lug onto one of the ends. Starting at the same end that the lug is on, measure and place a mark on the wire at 10-7/8 inches. Now, from the 10-7/8-inch mark, measure 20-9/16 inches and mark the wire. Measure and make two addition marks on the wire at 20-9/16-inch spacing. You should end up with 9-11/16 inches remaining. Using the same technique as used for the reflector, bend the 10-gauge wire into a square using the marks you put on the wire. Using the 4-40 nut and bolt, fasten a corner of the SO-239 connector to the soldering lug which you attached to the 10-gauge wire. Set both of the loops aside and now we will work on the boom.

Cut the boom material to 14 feet. Measure and place a mark one inch from one of the ends. Now drill a 1/8-inch hole through the boom, being sure that you are centered on the material and that you drill straight down. Now find a small piece of wood approximately 3/4-inch thick, 3 inches wide and 18 inches long. Using a 1-5/8 inch drywall screw, fasten the end of the boom with the 1/8-inch hole in it to the wood near the center. This will prevent the round boom from twisting as you drill the remaining holes. We are now ready to measure and mark the location of the holes for the director elements and the loop supports. Using a tape measure, starting from the end screwed to the wood, measure and place a mark at the "2-inch indication." Now pay close attention to this step so you do not end up with a boom that resembles

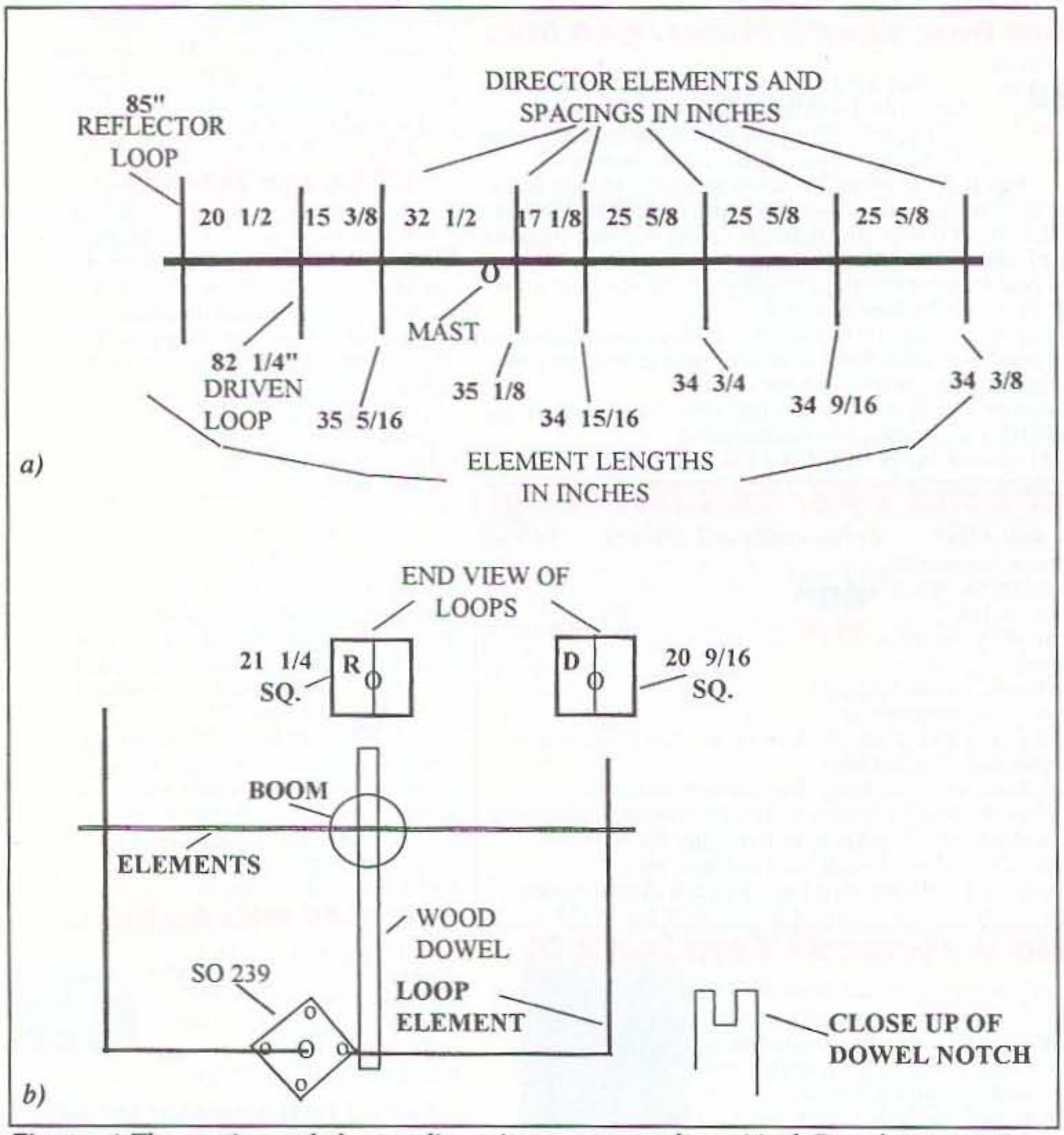

Figure. a) The spacing and element dimensions are somewhat critical. Pay close attention to your measurements. The elements are cut from 1/8" brass rod. Drill the holes in the boom parallel to each other. The elements are held in place with the silicone adhesive.
b) Orient loops with dowels vertical. Cut two wooden dowels 21-3/4" and 21" long. Notch the ends of the dowels in a "U" shape to support the top and bottom of the loops. Be careful not to distort the shape of the loop!. Attach coax to connector at a right angle and run coax back to mast.

Swiss cheese. *For all the following dimensions, you will be adding* ***two inches to all*** *the dimensions called for in the drawing.* Stretch your tape measure across the top of the boom. Take a piece of electrical tape and wrap it around the boom and measuring tape near the starting end to hold the tape measure in place. After taping, be sure the 2-inch mark on the tape measure matches the 2-inch mark you made on the boom. If all lines up we are ready to begin marking the locations of the elements. Referring to the drawing, the first spacing is 20-1/2 inches. Remembering to add the two inches to the 20-1/2 inches, place a mark on the boom at the 22-1/2-inch indicator. Continue this same technique for all remaining element spacing. Remember to add the two inches to the given dimension. When done, double-check your measurements. You are now ready to dig out the Binford super drill you ordered from Tool Time. Place the boom on a flat surface such as the floor of your garage. Use a small block of 3/4-inch thick wood under the boom as a spacer. Starting at the *opposite end*, where the drywall screw is holding the boom, position the wood spacer under the first mark on the boom, drill a 1/8-inch hole through the boom. Try to keep the drill centered on the boom and take care to drill your hole perpendicular to the boom. Repeat this same step for the next five marks. When done, you should have six holes in the boom. Measure the diameter of your boom, divide the diameter in half. Now working from the end of the boom which is screwed to the wood, use that half-diameter dimension and draw a line through the center of the boom parallel to the wood. This line will be the reference line when you rotate the boom to drill the last two holes. Remove the drywall screw and rotate the boom 90 degrees so that the reference line is straight up and down. Either drill a new 1/8-inch hole one inch from the end and refasten the boom to the wood or, while carefully holding the boom in place, drill the remaining two 1/8-inch holes at the locations you had marked. Again take care to keep the drill perpendicular to the boom. Now change to a 3/8-inch drill bit, and drill out the two holes you just drilled to the new 3/8-inch diameter. These two holes will be for the wood dowels. We are now ready to assemble the antenna. For the assembly, you might want to suspend the boom in the air by hanging it from the rafters in the garage or some similar method. Starting with the shortest director element (either the one marked as "six" or as "one," depending on the numbering system you used), insert it through the first 1/8-inch hole in the boom at the opposite end where the drywall screw was. Center the element on the boom by being sure you have equal amounts sticking out on both sides of the boom. Continue to insert the elements in ascending order. When you are done with the director elements, insert the wood dowels in the boom. The 21-3/4-inch dowel goes in the first hole (closest to where the drywall screw was) and the 21-inch dowel goes into the second hole. Be sure to orient the notch in the dowel so that it will support the loops properly. Next, after checking to be sure all the elements and the wood dowels centered in the boom, use a drop of "super glue" to hold them in place. Now install the reflector loop on the first wood dowel. Center the loop on the dowel and glue in place. Install the driven loop as shown in the cut away drawing, so that the SO-239 connector is to the left of the wood dowel, when looking at the antenna front the rear. Push the SO-239 connector against the dowel and glue in place. Center the opposite side of the loop on the dowel and glue in place. With the exception of soldering the free end of the driven loop to the center conductor of the SO-239, the construction is complete and we are ready to move on to tuning the antenna. The driven loop was cut to a center frequency of 145 MHz. Depending on your needs, you can raise the center frequency by trimming the free end of the loop. (I suggest that if you do trim the loop, do it in small steps of about 1/16 of inch at a time, soldering the end to the center conductor and checking the SWR each time.) Solder the free end of the loop to the center conductor of the SO-239.

"Note, if you use a radio to tune the antenna, use the lowest power setting possible to prevent causing interference to another operator."

Parts List
2 Meter Quagi

14' 1-1/8" i.d. Fiberglas tube or 1-1/4" pvc pipe
18' 1/8" dia solid brass rod or six 3' pieces
6' 3/8" dia wood dowel
8' #6 bare solid copper—bare wire
8 feet 10-gauge solid copper—insulated house wire
1 SO-239 chassis mount coax Connector
1 10-32 nut and bolt
1 10-32 solder lug
1 tube silicone sealer

Parts List
440 MHz Quagi

5' 1" dia PVC pipe
6' 1/8" dia solid brass rod
14-3/8" dia wood dowel
3' 10-gauge solid copper—insulated house wire
3' 12-gauge solid copper—insulated house wire
1 10-32 nut and bolt
1 10-32 solder lug
1 SO-239 chassis mount connector
1 tube silicone sealer

Tuning the Antenna

There are two simple methods to tune the antenna. The first is to use your radio tuned to your desired frequency, using a SWR meter to tune for the best SWR at that frequency. The second method is to use an antenna analyzer. I use the MFJ model 259 SWR Antenna Analyzer. If you have any desire at all to build and experiment with HF or VHF antennas, this is a must-have item. Simply hook up the analyzer up to the antenna, turn the "tuning" knob to the target frequency on the digital read out, and read the SWR and resistance. Trim the antenna if necessary, resolder and that's it. This analyzer is also great for finding the resonant frequency of those hamfest/swap meet specials.

Note, if you use a radio to tune the antenna, use the lowest power setting possible to prevent causing interference to another operator.

When you are done tuning the antenna, be sure the solder joint at the SO-239 connector is a strong one. Use generous amounts of the silicone sealer to glue all the elements and dowels in place where they intersect with the boom. Also, put some silicone sealant on the ends of the wood dowels where the loop go through the notch. Now seal the back side of the SO-239 connector with silicone. Give plenty of time for the silicone to dry, and that's it. Mount the antenna and enjoy. The antenna works extremely well in either polarization. I cut the top off a PVC "TEE," found the balance point of the antenna and used two hose clamps to clamp the two halves of the "TEE" around the boom. I also chose to use a short length of PVC connected to the "TEE" as the a mast. Using the PVC as a mast eliminates any changes to the performance of the antennas. 73