10 Meter X-Beam

Upgrade your antenna as well as your license.

by John E. Williams N5SJZ

After a year as no-code Techs, my wife Debby N5SKA and I decided it was time to upgrade to Tech-plus and work some DX. With help and encouragement from Joe Nunnamaker KD3VR, passing 5 wpm was much less of a chore than we had imagined. The big day was here and we had our 5 wpm Certificates of Successful Completion in hand; it was time to work the world.

I had previously purchased a small 10 meter rig and had put up a simple 10 meter horizontal dipole in anticipation of this day. Over the next few weeks, even though I made several contacts, I was not happy with the results. I felt it was time to upgrade my antenna. First I considered several commercial antennas. However, I had caught the bug for homebrewing with a 2 meter amplifier kit and had met Joe in the process, but that's another story. Since this was my first antenna project, I wanted it to be simple, high performance, and low cost. At first my criteria seemed mutually exclusive, but then I came upon an article in the *ARRL Handbook* by Brice Anderson W9PNE concerning X-Beam antennas. I spoke with Joe and told him my idea. He enthusiastically agreed to lend his expertise and help with the project.

Materials

I wanted to construct the antenna with materials I could locate at the local hardware store. So, with Joe and Debby, I paid a visit to the hardware store. For the X-beam arms, we considered aluminum and copper. We selected copper tubing for several reasons. First, copper is less than half the price of aluminum. Second, unlike aluminum, copper can be soldered-to directly. And finally, copper has a lower resistance to radiation, perhaps giving a slight performance edge. For the center support we chose a 1/2" thick, 2' x 2' square precut piece of plywood.

After purchasing the necessary materials on a Saturday, we planned to build and put the antenna on the air the next Saturday. All the materials for the antenna cost less than $40.

Construction

The first step is to prepare the copper tubing and plywood. Cut the four 8' pieces of the copper tubing to 6'11" with a pipe cutter, then use extra-fine steel wool to polish the copper tubing to remove oxidation and let the beauty of the copper show. To ensure that the antenna will continue to look good and resist the elements, apply several coats of a spray-on acrylic protectant to the copper tubing. Prepare the plywood with two or three coats of weatherproof paint, allowing two days of drying time between each coat. Next week, the plywood and the tubing will be ready to go.

The first step in actual construction is to draw an X on the center board where the copper tubing arms will go. After drawing the X, measure 2.25" from dead center on each line. This is where the end of each arm is placed on the board. Place the pipe brackets over one arm and use this arm as a guide for marking holes for the bracket bolts on each line. Next, drill the holes for the brackets and a 1.25" hole at dead center for the mast. If you are using a larger or smaller mast you should adjust the center hole size accordingly.

The next step is to drill a small hole on the

Photo A. The construction team with materials. Left to right: John Williams N5SJZ, Debby Williams N5SKA, Joe Nunnamaker KD3VR.

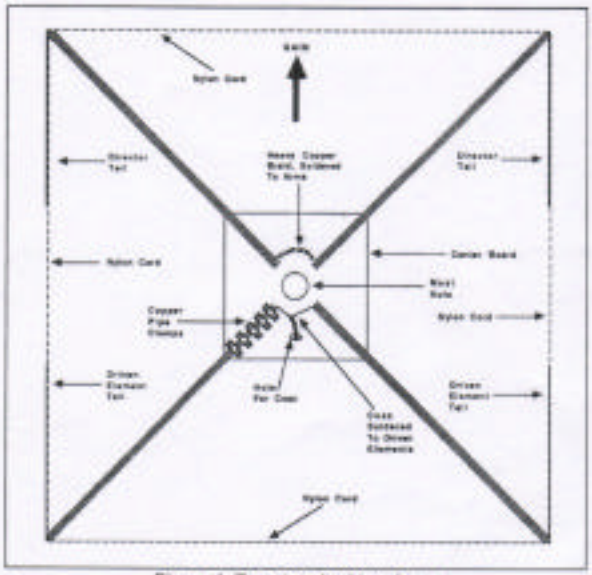

Figure 1. Top view, looking down.

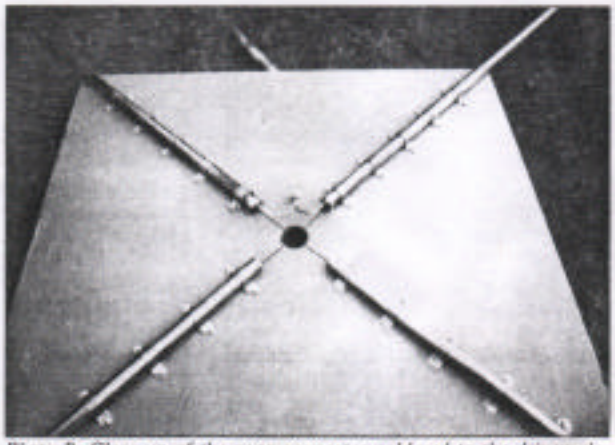

Photo B. Close-up of the coax connector soldered to the driven element arms.

Photo C. Using plastic wire ties to secure tails to nylon supporting cord.

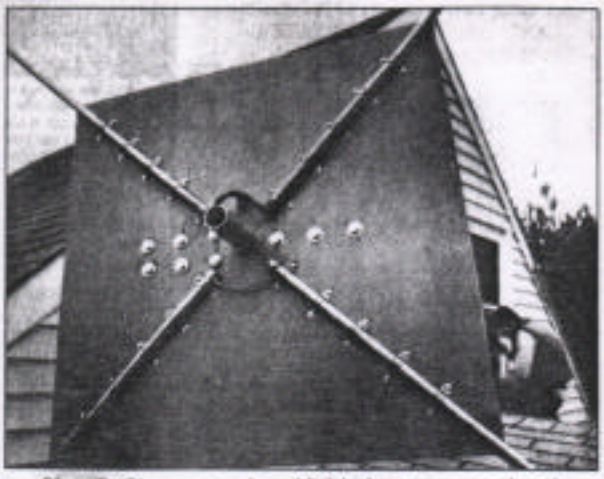

Photo D. Close-up top view of finished antenna center board.

center board between two arms. It makes no difference which two arms you choose at this point since they are all the same length. Route the pigtail coax connector (or plain coax) through the center board and solder the inner conductor to one arm and the outer braid to the other. These now become the driven arm elements. To ensure the best contact, clean the areas on the arms to be soldered with steel wool to remove the acrylic protectant previously applied. Since the weather was somewhat cold, we used a propane torch for soldering instead of a soldering iron. Since we were concerned that the paint would be blistered by the heat, we solved this potential problem by placing a double thickness of aluminum foil under the arms when soldering close to the center board. After soldering the coax connector, solder a heavy piece of copper braid to the other two arms. The arms connected with copper braid become the director arms.

Now that the driven element and director arms have been determined, it's time to solder the element tails to the ends of the arms. Since the element tails will not be under stress, we chose 16-gauge enamel-coated solid copper wire instead of Copperweld wire. Start with each driven element tail 36" long and each director tail 30" long. If you use aluminum tubing or smaller gauge wire you will need to start with each element tail 12" longer to ensure that the antenna can be tuned. If using coated wire, carefully scrape away about 1" of the enamel coating at the ends of the wire to be soldered. To ensure a durable connection, bend the ends of the wires in 1", then solder them parallel to the arms.

To provide support for the element tails, use nylon cord strung through the ends of the arms. To prepare the arms for the cord drill two 1/8" holes, located 1/2" from the ends of each arm, parallel with the center board. Pass one length of nylon cord through the holes, pull it tight and tie it securely. Place the element tails beside the nylon cord and use plastic wire ties to secure them to the cord. The cord not only supports the element tails, it also strengthens the entire antenna structure.

Mounting and Finishing

Now it's time to prepare the antenna for mounting. For good strength use three L-brackets to support the antenna. Place two brackets on one side of the center board and one opposing the other two. Start the L-brackets about 1" away from the edge of the center hole to allow for proper U-bolt placement. After marking and drilling holes, mount the L-brackets securely to the center board. After mounting the L-brackets, place the antenna mast through the center hole and secure the antenna to the mast with three U-bolts.

Now that the antenna is mounted, the next step is to form a current balun (RF choke). Form the balun by winding six turns of coax (directly below the center board) into a 6" i.d. loop. This keeps RF at the antenna and prevents stray RF from coming down the coax cable.

You are now down to the finishing touches to make the antenna last longer and perhaps perform better. Placing plastic wire ties around the coax directly above and below the coax feedhole in the center board will provide strain relief for the coax. Coax seal applied to exposed coax will keep water out and will prevent premature coax failure. Finally, to help ensure a longer life for the center board, apply touch-up paint to any small chips that resulted from drilling.

Photo E. Bottom view of center board. John making current balun (RF choke).

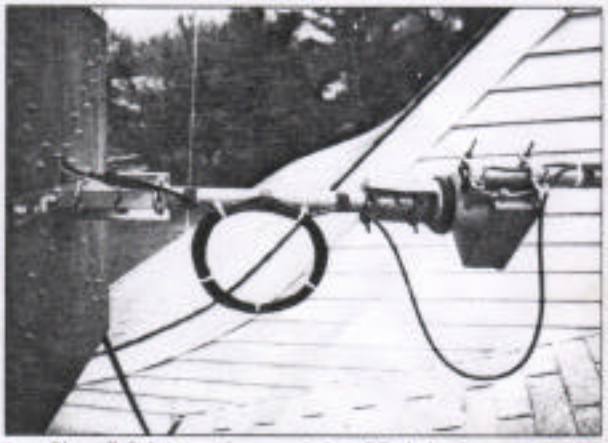

Photo F. Side view of current balun (RF choke) on antenna.

The final step before going on the air is tuning. First, remeasure each element tail. At this point the driven element tails are 36" and the director tails are 30". The driven element tails must be exactly 6" longer than the director element tails. If they are not the same, cut them to length. To tune the antenna, place it in its final position and measure the SWR. The antenna is tuned by taking the antenna down, cutting 1/4" off each tail, putting the antenna up, and remeasuring the SWR. It will most likely take several rounds of checking SWR, cutting the tails, and remeasuring SWR before the antenna is tuned. Our final measurement for each driven element tail was 34", while each director tail was 28". As shown in Table 1, the X-Beam antenna is usable from one end of 10 meters to the other! Since the tail lengths may vary according to the material used in the antenna construction, the antenna height, etc., it is much better to start with tails a bit too long and cut to size.

Performance

The X-Beam more than met my expectations. According to the *ARRL Handbook*, forward gain is about 5 to 6 dBd. Also, the angle of radiation seems very low. The first noticeable difference in performance was that we could hear many more DX stations than with the dipole.

Photo G. The finished antenna.

I have gotten reports of 2 to 3 S-unit differences from both stateside and DX stations, depending on where the beam is pointed. With only 25 watts, I have been able to work pile-ups to DX stations in Senegal, New Zealand, the Balearic Islands, Denmark and Japan, to mention a few. Now I have a fighting chance in pile-ups. Put one up and you will, too. 73

Parts List

4	Pieces 1/2" copper tubing, cut to 6'11" each
1	2-foot-square piece plywood
1 pint	Weatherproof paint for plywood
1 can	Spray acrylic protectant for tubing
15'	16-gauge copper wire
4"	Heavy copper braid
3	Heavy L-brackets
3	U-bolts
20	1/2" pipe clamps
40	Small bolts, 1/4" x 3/8"
9	Large bolts, 3/8" x 1"
	Nylon cord
	Plastic wire ties
	Coax-seal

SWR Measurements

Frequency	SWR
28.0	1.6
28.1	1.5
28.2	1.4
28.3	1.4
28.4	1.3
28.5	1.3
28.6	1.3
28.7	1.3
28.8	1.3
28.9	1.2
29.0	1.2
29.1	1.2
29.2	1.2
29.3	1.3
29.4	1.3
29.5	1.3
29.6	1.4