all-metal 2-meter J-pole antenna

5/8 wave vertical survives any weather

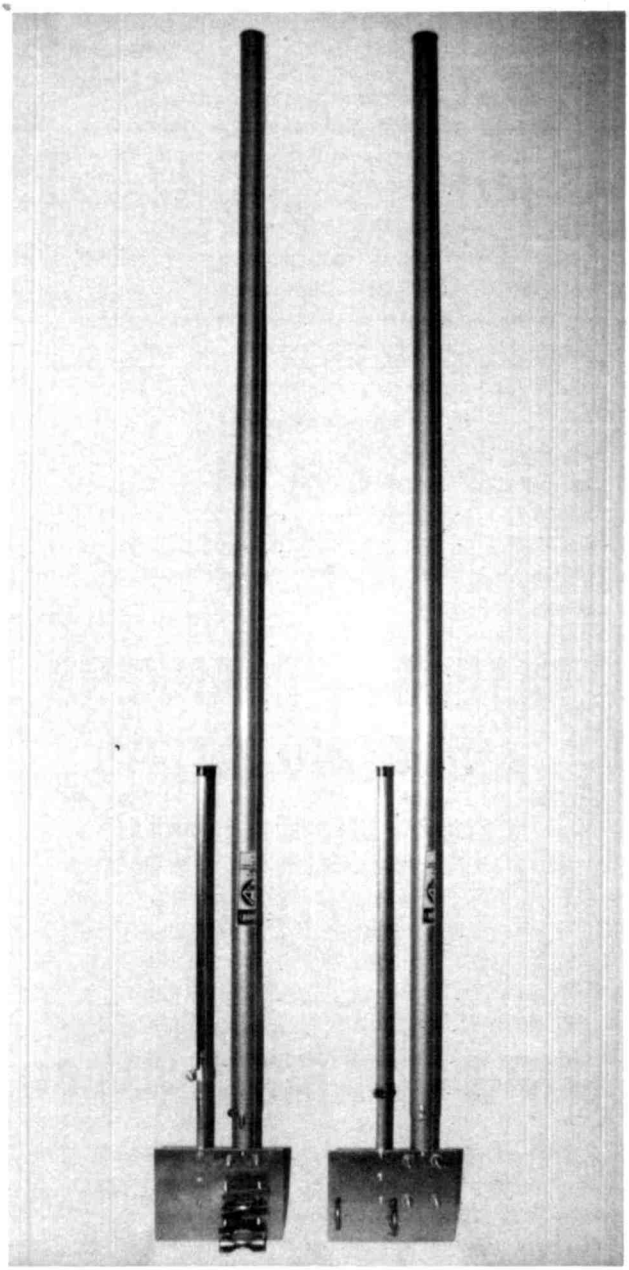

fig. 1. J-pole antenna: for upright mast mounting (left) and mounting to horizontal boom on tower (right).

While the J-pole antenna shown in fig. 1 is by no means a new design,[1] it doesn't seem to be used often. Basically it's a 5/8-wave radiator with a 1/4-wave matching section. The matching section is positioned 1-1/4 inch from and parallel to the 5/8-wave element.

I've built two of these antennas; one is for mounting to a conventional upright mast, as shown by the unit on the left in **fig. 1**; the other is for mounting to a horizontal boom on a tower. No significant problems were experienced in either installation.

The advantages of the J-pole design are its omnidirectional radiation pattern, characteristic of vertical antennas, and its small-diameter installation area. It lacks the radials common to ground plane antennas, and does not require driven elements to be cut in order to tune for best match.

Advantages less readily apparent, but equally important, are the elimination of the need to insulate the radiating element from the ground system, making possible an all-metal unit of rigid construction. With the whole antenna effectively grounded and installed atop a tower or mast which is grounded at the base, there is very little static noise buildup. The additional gain possible over the quarter wave ground plane because of the increased length is considered yet another advantage.

construction

A list of materials is provided in **table 1**; dimensional information is shown in **fig. 2**. The mounting plate is shown in **fig. 3**. The extra set of four holes in the plate allows the J-pole to be mounted in either of two different planes, depending on the location of the final installation.

The total length of the longest piece of tubing is 57 inches (144.8 cm) from the tip to the mounting plate. This piece can be made from a 5-foot (152-cm) section of lightweight (20 gauge) mast available from Radio Shack. There is no reason to spend more for the heavier gauge mast because it doesn't support anything other than its own weight. (If you really want to spend more money on this antenna, put the money to good use and buy better coax, or stainless steel assembly hardware, or both.)

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table 1. List of materials.

quantity	item
1	20-gauge galvanized steel TV mast, 5 ft. × 1-1/4 in. (152 × 3.18 cm)
1	length aluminum tubing, 22 × 1/2 × 0.035 inch (56 cm × 1.3 cm × 0.89 mm)
1	mounting plate, 6 × 4-1/2 × 1/8 inch (15.2 × 11.4 × 0.32 cm)
3	6-32 × 1 inch stainless steel panhead machine screws
3	No. 6 star lockwashers*
3	6-32 stainless steel hex nuts*
4	1-1/4 inch U-bolts
2	6-32 × 1/2-inch self-tapping sheet-metal screws**
1	1/2-inch diameter clamp (MS21919-DG5)
1	10-32 × 5/8-inch stainless steel panhead machine screw
2	No. 10 flat washers
2	No. 10 star lockwashers
2	10-32 stainless steel hex nuts
1	3/8 × 3 inch dowel
2	tubing caps for element ends (optional)

*Can be replaced by 6-32 nuts with star washers attached as part of the nut itself.

**One screw is not required if the through-bolt arrangement is used. In this case, a 10-32 × 1-1/2 inch cap screw, two star washers, two plain hexnuts, and one spring lockwasher will be required to replace the one 6-32 sheet-metal screw and its associated star washer. The choice is yours.

(Metric dimensions are approximate; build to fit. — Editor)

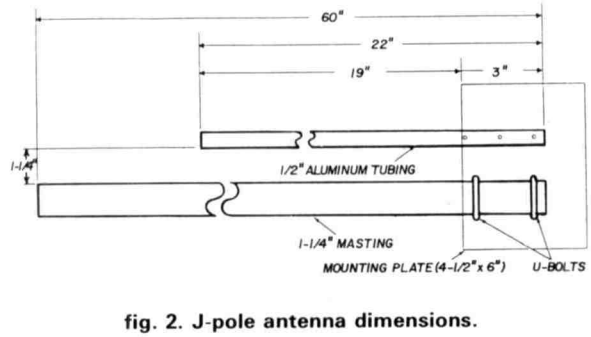

fig. 2. J-pole antenna dimensions.

The clamps holding the 5/8 wave section to the mounting plate are 1 to 1-1/4 inch (3.2 cm) U-bolts expanded slightly to pass comfortably around the compressed portion of the mast without distorting the tubing.

Electrical connection with the mounting plate is accomplished by filing or wirebrushing the paint from the bottom 3 inches (7.6 cm) of the mast where it comes in contact with the mounting plate. A second electrical connection is made by passing a self-tapping sheet-metal screw (6-32 or larger preferred) through the mounting plate and into the mast section as shown in **fig. 4**.

The quarter wave matching section is made from any gauge aluminum tubing of 1/2 inch (1.3 cm) O.D. In this case, 0.035 inch (0.89 mm) or so wall thickness was used; again, there's no need to buy heavier tubing because no weight is supported. A total of 19 inches (48.26 cm) must project above the mounting plate (see **fig. 2**), making the total length 22 inches (55.88 cm) for this portion of the assembly.

Electrical connection with the mounting plate is made by removing any oxidation from the tubing before bolting it to the mounting plate. Insert a piece of 3/8-inch (0.95 cm) wooden dowel into the end of the tubing until it's flush with the bottom edge; then bolt the matching section to the mounting plate with 6-32 × 1 inch machine screws, star lockwashers, and

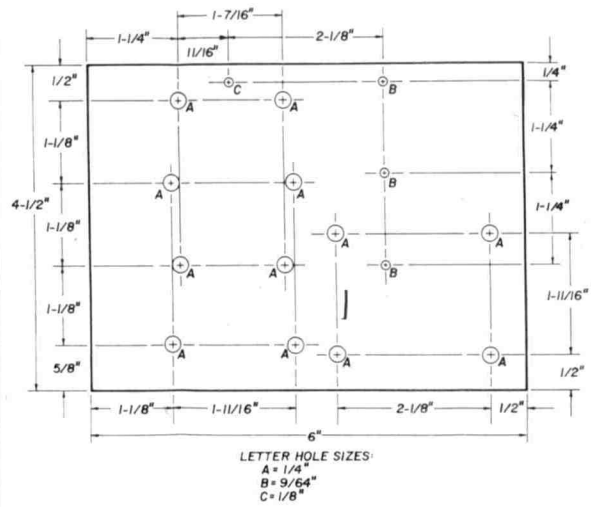

fig. 3. J-pole antenna mounting plate template.

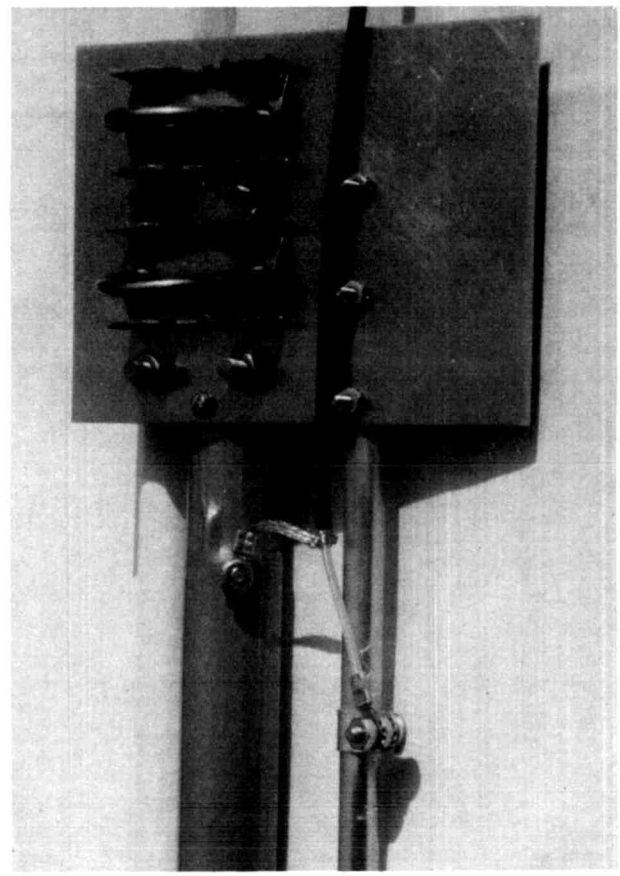

fig. 4. Assembly showing coaxial cable connections.

hexnuts (see **fig. 5**). Inserting the dowel permits the 6-32 hardware to be tightened without unduly distorting the tubing, which would allow hairline cracks to form and cause premature element failure.

The clamp used to attach the coax center conductor (**fig. 4**) is an aircraft-type Adel clamp with the rubber sleeve removed. This clamp was originally intended for 5/16-inch (0.79 cm) tubing, but with the rubber removed and the clamp installed as shown, a tight fit is maintained around the matching section. Any such device can be used as long as a good mechanical connection is maintained.

As shown in **fig. 4**, the shield of the cable is attached to the larger diameter element at a point 1-1/2 inches (3.8 cm) away from the mounting plate. Two different methods of attaching the shield to the 5/8-wave section were used; both are satisfactory, though I feel more confident about the No. 10 through-bolt in the 5/8ths section than I do about the No. 6 sheet-metal screw and lockwasher. This is a matter of personal preference. A No. 14 AWG terminal lug was used to terminate the shield as shown, but both lug ends were replaced with a solderable lug and then silver soldered on the completed installation.

If a certain amount of hardware "overkill" seems apparent in this project, it's because in the case of antennas, too much is usually better than too little, particularly where weather conditions are severe. It's a good idea to invest in stainless steel hardware and to protect the mounting plate assembly with a polyurethane coating or spray varnish, following the directions and precautions on the spray can. Do this *after* tuning the matching section.

tuning

To tune the matching section, start at a point about 2 inches (5 cm) from the mounting plate and apply RF at the frequency most likely to be used, for example, 146.52 MHz. Note the SWR at that frequency and adjust the clamp, sliding it as necessary to produce minimum SWR. The antennas in the photographs tuned at approximately 2-1/2 to 4 inches (6.4 to 10 cm) from the mounting plate. They did not tune to identical points on the respective matching sections. In both cases, the antennas tuned to an indicated SWR of 1.2:1 at 146.52 MHz. If you've worked with antennas before, you probably know that any SWR reading depends on so many factors that tuning for minimum SWR is, more often than not, sufficient for most purposes.

installation

Figure 6 shows the antenna mounted to a horizontal boom off the side of a mast. Convention dictates that the antenna point upward when installed, but there is no reason that it cannot be pointed downward. If high winds are a problem, or if the clamps used to attach the assembly to the boom are not of the gripper variety, pointing the antenna downward can help maintain its vertical position. As long as the antenna is mounted one or more wavelengths away from any large reflective or RF absorbent surface, fear of upside-down mounting is completely unfounded.

Conventional mounting to a vertical mast is accom-

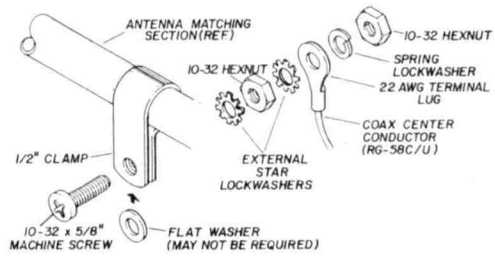

fig. 5. Half-inch clamp and hardware assembly sequence.

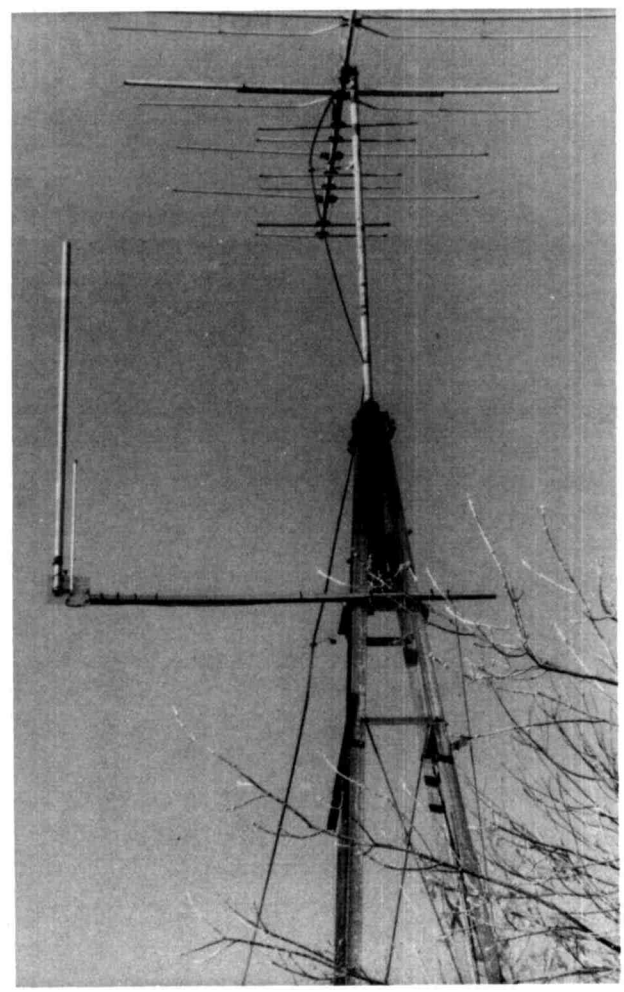

fig. 6. Horizontal mounting on a windmill tower.

plished by using the other set of mounting holes in the antenna mounting plate. No special problems were noted with this arrangement.

variations

As with any project, several additional ideas came to mind after the antennas were completed. For instance, the coaxial shield attachment to the 5/8th's element could certainly be made to be adjustable. Doing this might result in a better SWR reading, or perhaps allow the coax terminations to be physically matched more evenly at the antenna. If I were to build another, I would try this approach. Should you decide to make both connections adjustable, remember to remove the paint from the portion of the mast the clamp will rest against when tuned.

It may also be possible to make the 5/8th's element diameter smaller. The 1-1/4 inch tubing is convenient because it can be purchased at the proper length, but if you have stock left over from other antenna projects, it would be less expensive to use what you have. If you do, remember that antennas built from different stock may tune at positions other than those indicated in this article. I'd be delighted to hear from anyone who attempts this alternative approach.

reference

1. *FM and Repeaters for the Radio Amateur*, American Radio Relay League, Newington, Connecticut, 1978, page 70.

bibliography

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