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Direct-Mount "J" Antenna for 440 MHz HTs

If you're looking for better performance ...

The much-maligned rubber duck antenna is widely popular simply because it is a handy item and is adequate for working local area repeaters. In situations where you need more push in your signal, a "J" antenna is often the most practical solution.

This usually requires the presence of a tree or some portable structure to support it. On the 440 MHz band, a simple and very effective answer to the problem is a "J" antenna that can be mounted directly on an HT, thus making the system as portable as the HT itself.

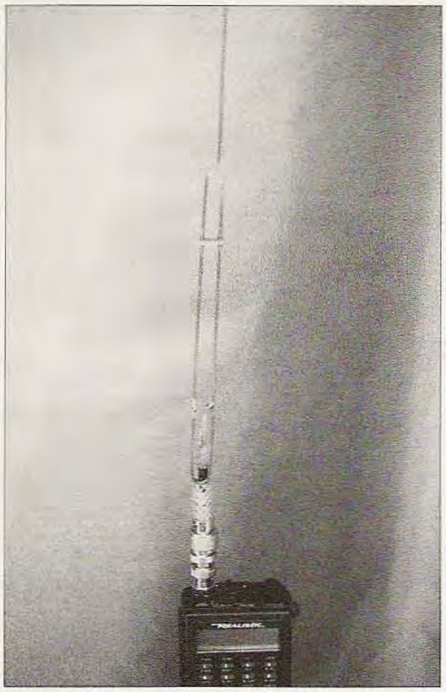

Photo A. *The construction of the matching section portion of the antenna.*

While not as small as a rubber duck, this antenna is not unduly cumbersome, and it gives substantial lift to the output of an HT. The overall length is about 24 inches. It weighs about 5 ounces. In fringe area operations, you can expect practical improvement over a rubber duck from poor or no copy at all to usable or maybe even solid copy.

An AEA model SWR-121V/U Antenna Analyst was used to arrive at the dimensions and for the SWR and return loss data shown in **Table 1**. Return loss is a relatively recent concept in evaluating loss in antenna systems and is defined in the *ARRL Handbook 2001* (page 19.4) as the reciprocal of the reflection coefficient in dB. Since reflected power is always less than forward power, return loss is a negative value. Hence, the larger the return loss figure, the smaller the power loss. It would seem more logical to define return loss as the ratio of reflected power to forward power, expressed in dB. The standard formulas for SWR and decibels seem to confirm this. It will be noted that the dimensions of a "J" antenna do not always coincide with textbook formulas. The "J" antenna is a derivative of the old "Zepp" antenna, which used an open-wire transmission line feeding the quarter-wave matching section. Everything was pretty much straightforward and copacetic — the balanced transmission line fed a quarter-wave matching section which was also balanced. The only departure from this consistency was in connecting the matching section to the antenna,

Freq.	SWR	Return MHz Loss, dB
439	1.5	−13.8
440	1.4	−15.1
441	1.3	−16.6
442	1.2	−20.0
443	1.1	−26.3
444	1.0	−50.0
445	1.0	−50.0
446	1.0	−50.0
447	1.0	−38.7
448	1.1	−26.3
449	1.1	−24.0
450	1.2	−18.2
451	1.3	−16.6
452	1.4	−15.1
453	1.5	−13.8

Table 1. *SWR and return loss data for the direct-mount "J" antenna.*

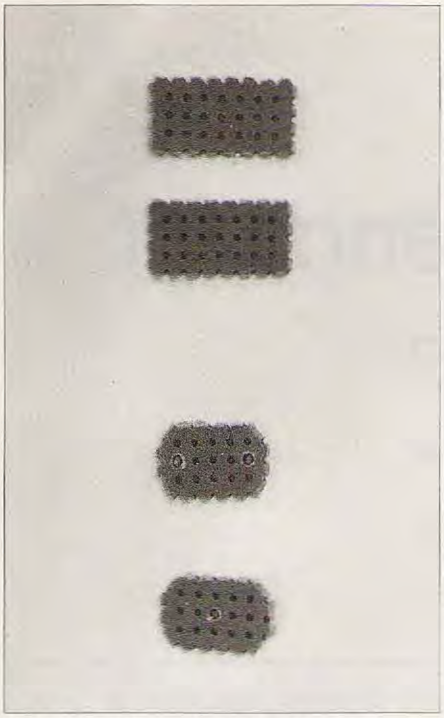

Photo B. The perfboard before and after snipping off the corners and ends so they will fit loosely inside the PVC pipe.

which was a half-wave wire connected to one side of the matching section. The other side of the matching section was left floating. Although no balanced-to-unbalanced transformer device was used, the antenna worked and served its intended purpose.

In "J" antennas, amateurs generally use coax, which is an unbalanced line, to feed the matching section which is a balanced quarter-wave line, and one side of this line is connected to an unbalanced load consisting of a single half-wave wire end fed. In some applications, such as this particular antenna, physical constraints do not permit using a balun to provide proper decoupling. The result is that common currents intermingle and neither the radiator nor the matching section, nor even the coax line, knows where the currents of one stop and the other begin. Consequently, the physical dimensions of the three elements of the system become interdependent. That being the case, varying combinations of dimensions will result in varying resonant frequencies with varying SWR bandwidths.

The antenna is made of no. 14 solid copper wire formed as shown in **Fig. 1**. The wire is enclosed in 1/2-inch thinwall PVC pipe with a weatherproof cap at the top and a PL-259 fitting at the bottom. The PL-259 plugs into an SO-239/BNC adapter (Radio Shack 278-120), which mounts directly onto a hand-held 440 MHz transceiver.

Spacers are used to keep the wire centered in the PVC; these are made by breaking off two 3/8" x 13/16" pieces of unclad perfboard. Each piece will have three holes by seven holes. The hole in the center will be enlarged on one piece for the radiating element. On the other piece, two holes, about 13/32" apart, one on each side and equidistant from the center hole, will be enlarged for the matching stub. Use a 1/16" drill to enlarge the holes in the spacers, pushing the drill back and forth a few times so that the #14 wire is a snug fit. Snip off the corners and then snip off the pointed ends of the spacers so they will fit very loosely inside the PVC pipe. No filing will be necessary unless you wish to smooth the rough edges.

Straighten a piece of #14 solid copper wire about 3 feet long, by hand, so that it is reasonably straight, and then clamp one end in a well anchored vise or some solid object. Then, with a hefty pair of pliers at the other end, give it a sharp tug, and that will finish the straightening. Make a U-bend about 7 inches or so from one end, by laying it across the shank of a 5/16" drill bit. Use a pair of diagonals to cut the radiator leg about 2 ft. from the U-bend. Use a file to round and smoothen the ends of the wire to facilitate installing spacers. Before you make the other centering bends, push the spacers for the matching stub and the radiator element onto the wire. On the matching section, place its spacer about 5-1/2" from the U-bend. On the radiator element, place its spacer about 19 inches from the U-bend. A snug fit is desirable so that the spacers will remain in a horizontal position on the wire and not flop around. After the spacers are in place, make the double bend in the radiator element for centering just above the matching section. Next, measure and cut the matching section and radiator lengths slightly longer than the dimensions shown in **Fig. 1**.

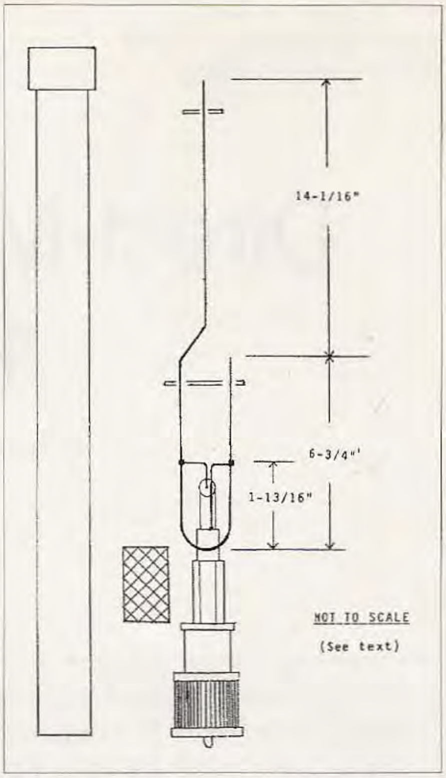

Fig. 1. Form the "J" of no. 14 solid copper

Fig. 3 shows the initial plot of an antenna with such random length elements, before doing any trimming. The radiator element was 14-5/8" and the matching section length was 7-1/8". The feed point was 1-13/16". This information is given just in case someone may have an interest in the low end of the band. You can trim the elements later, very carefully and in small increments, to arrive at the desired resonant frequency.

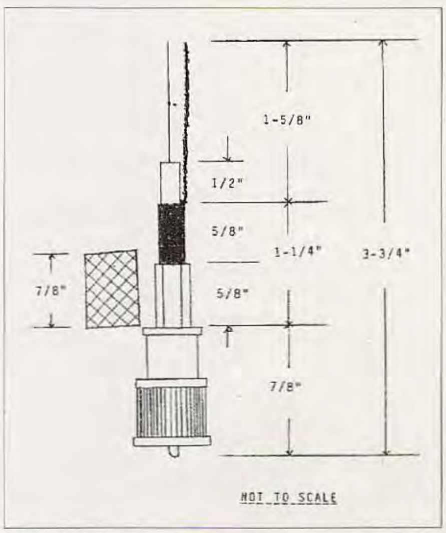

Fig. 2. Coax assembly measurements. Use a soldering iron to melt the insulating material. Do not pull. (Drawing not to scale.)

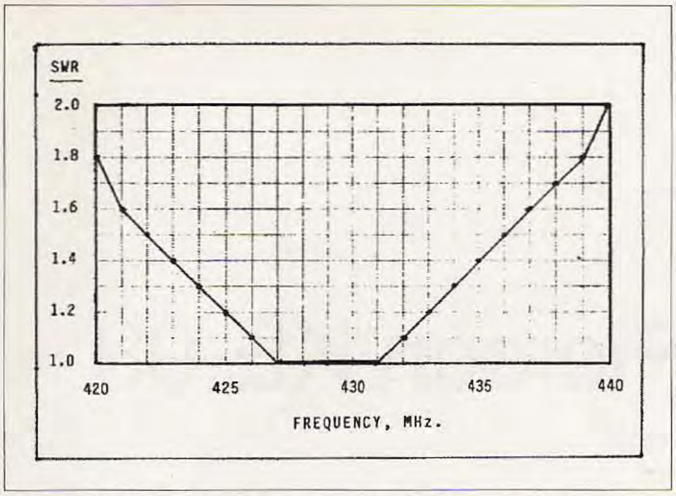

Fig. 3. Initial plot on an antenna, before trimming element lengths. See text.

The coax assembly consists of a short piece of RG-58 with a PL-259 connector attached (cut from one end of a Radio Shack #278-968), and a short piece of nylon-mesh-reinforced plastic tubing. This particular tubing is used for high-pressure lines and is sold at PVC supply stores. The inside diameter is about 1/4"; the outside diameter is a little over 7/16". In cutting and trimming the RG-58, be very careful with the knife and constantly watch for loose strands. Cut the coax at a point so that the overall length from the tip of the center pin to the cut is 3-3/4". This is the final dimension of the overall length of the PL-259/RG-58 coax assembly. Remove the black vinyl outer covering to a point 5/8" from the metal shank. Comb the braid out, straighten the strands, and twist them into a straight, round lead. Carefully remove the insulation on the center conductor to within 1/2" of the black vinyl. It is important that you use a soldering iron to melt the insulation material from the wire. If you try to strip and pull on the insulation this close to the PL-259 fitting, you run the very real risk of dislodging the center conductor from the pin on the PL-259. See **Fig. 2**. Slip the 7/8" piece of clear plastic tubing over the braid and the center conductor leads, and push it tight against the metal shoulder on the PL-259. You may have to stretch the hole in the tubing by using a tapered rod, tool, or ballpoint pen so that the tubing will fit tight against the PL-259. Lay the U-bend of the matching section on the black vinyl that covers the coax, and butt the U-bend of the matching section against the end of the plastic tubing.

Watch carefully for any loose strands, and check spacing so there won't be unwanted shorts. Orient the coax so that the center conductor is vertically above the braid where it exits the plastic tubing. Bend the bare ends of the center conductor and the braid lead to form right angles about 3/16" from their ends, so they will touch the matching section feedpoints at right angles at exactly 1-13/16" above the bottom of the U-bend. Just a spot-solder connection is advisable and adequate.

To ensure that the spacers will stay put in their respective positions on the #14 wire, use a toothpick and apply a small dab of clear silicone caulk onto the wire where it passes through the holes in the spacers.

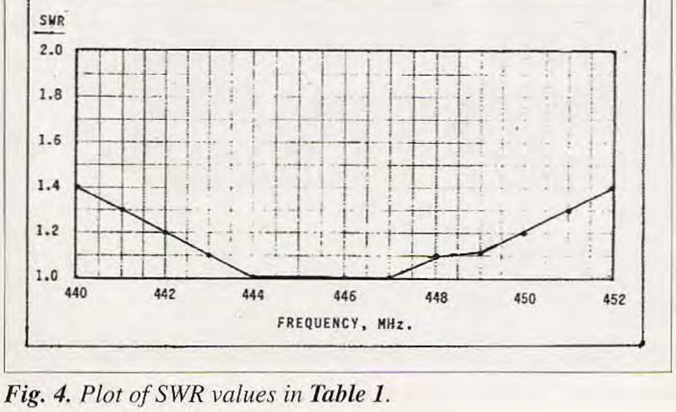

*Fig. 4. Plot of SWR values in **Table 1**.*

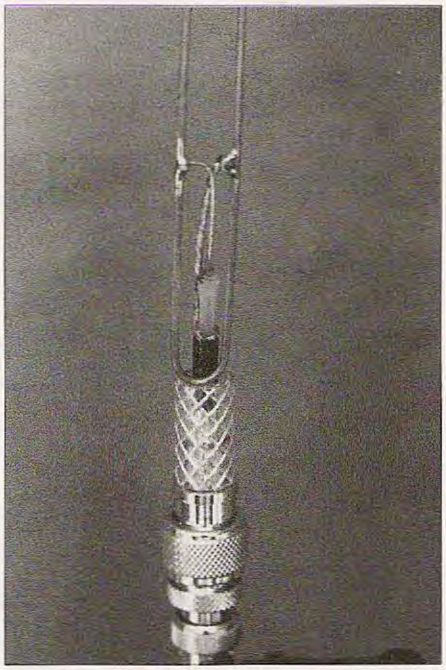

***Photo C.** The coax assembly, spot-soldered to the matching section.*

The PVC goes over the knurled retaining collar on the PL-259 connector. In **Fig. 1** the plastic tubing and the PVC pipe are shown alongside the antenna assembly for clarity. A Radio Shack #278-120 adapter finishes the construction. Depending upon the particular PVC pipe you use, it may or may not fit snugly onto the PL-259

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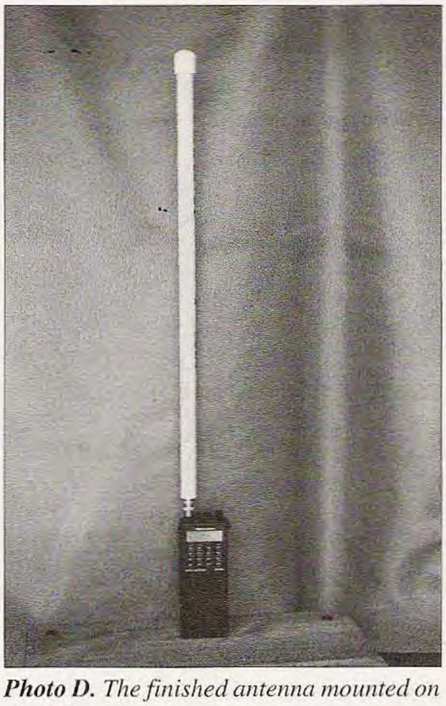

***Photo D.** The finished antenna mounted on the HT.*

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rotating collar, and you probably will need to cement the two together. E-6000 clear adhesive works fine. This antenna is not difficult to build, but it does require care and neatness in construction. To duplicate the antenna, just be sure you do in fact do a duplicate and don't deviate. For example, on the coax assembly, don't substitute a different kind or type of coax or alter the specified dimensions.

In doing your final trimming, you will find that the length of the matching section has a greater effect on the resonant frequency of the system than does the length of the radiating element. Plug a small UHF SWR meter (such as Radio Shack #940-0866) directly into the transceiver antenna socket. Plug the antenna PL-259 into the SWR meter without any intervening coax, and use the fewest adapters possible. Obviously, the antenna should be inside the PVC housing while making SWR meter readings.

I have built more than a dozen of these antennas, and an SWR of 1.2:1 or less across the voice-repeater band from 442 to 450 MHz is typical. Outside the band the SWR rises rather rapidly, reaching 1.5:1 at about 439 MHz and 453 MHz. 73