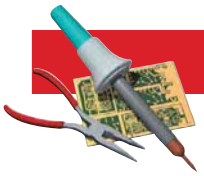

By Richard W. Stroud, W9SR

Copper Loops for 222 and 440 MHz

These small copper pipe antennas feature rugged construction, wide bandwidth and good performance.

These antennas can be built using standard copper water pipe and fittings available from your local hardware or home building supplier. The 222 MHz version is made from $^{3}/_{4}$ inch tubing, while the 440 MHz version is made of $^{1}/_{2}$ inch tubing. Figure 1 shows the completed antennas. Both use copper fittings that adapt the antenna to $^{1}/_{2}$ inch standard pipe threads for mounting. Copper is a good choice for VHF/UHF antennas because it is readily available, low in cost and easily worked, plus it has low losses at these frequencies.

Soldering is required during the assembly. The dimensions and tube cutting lengths are shown in Figures 2 (222 MHz) and 3 (440 MHz). All of the copper, brass and stainless hardware is available from hardware, plumbing or home building suppliers. The 8 gauge Teflon sleeving and wire is available from many surplus houses or from the author. Copper fittings from different manufacturers seat to slightly different depths so check the overall centerline dimensions carefully when laying out the antennas before soldering. The elbows that were used on the prototypes are metal stamped "EPC."

Fabrication

Soldering the components is not difficult. The ends of the tubing are first cleaned with steel wool and a thin layer of flux is added before assembly. It is an advantage to make a simple soldering fixture and it is advisable to wire the elements to this fixture (a piece of plywood) to keep the sides straight and square. Heavy aluminum foil between the plywood and the copper will prevent an accidental bonfire… be careful! When you use a propane torch, the tubing should be heated and bought up to temperature before solder is applied.

Use a standard rosin core solder. When properly heated, the solder will be "sucked" into the joint. Very little solder is needed and you will probably tend to use too much. If so, it will pool on the low side of the work and will need to be removed later if you are at all interested in appearance. Excess solder can be filed away after cooling. Any remaining flux should be removed and the copper can be polished for a nice appearance by using steel wool. (Use gloves when handling steel wool!) The finished antenna can be sprayed with Krylon 1301, a clear coat plastic, to preserve the finish. The antenna can be painted, if you desire, using an acrylic spray. Be sure to mask the front and back of the connector and exposed gamma tube end before painting.

The shape of the antenna is chosen so that the 50 Ω point on the tubing wall is roughly in line with the UG-58/U type N connector. The $^{1}/_{4}$ inch gamma tube is placed through a hole drilled through the inside wall of the main tubing and soldered per the assembly drawings (Figures 2 and 3). The length of the wire inside the gamma tube is critical. The 14 gauge wire used is stranded and vinyl insulated. The insertion length for each band is $2^{1}/_{8}$ inches. Different sizes and wire types may require slightly different lengths projecting into the tube. The tube, Teflon sleeving and wire form the capacitance required to tune out the inductive reactance of the matching system. This is about 4.8 pF at 222 MHz and 6.4 pF at 440 MHz. The $^{5}/_{32}$ inch OD 8 gauge sleeving fits snugly inside the gamma tube and the wire is a good fit inside the sleeving.

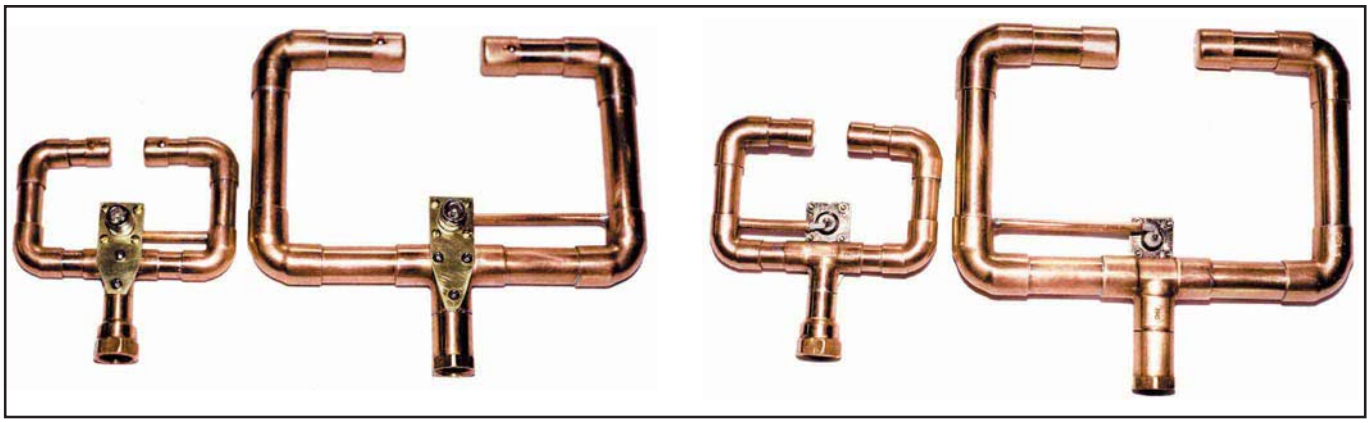

Figure 1—Front (left) and rear (right) views of the completed copper loops. The gamma tube penetrates the inner wall of the main element and is soldered parallel to the main lower tube. The connector mounting plate is anchored with self-tapping screws on the main and support tube centerline. The larger antenna is the 222 MHz version.

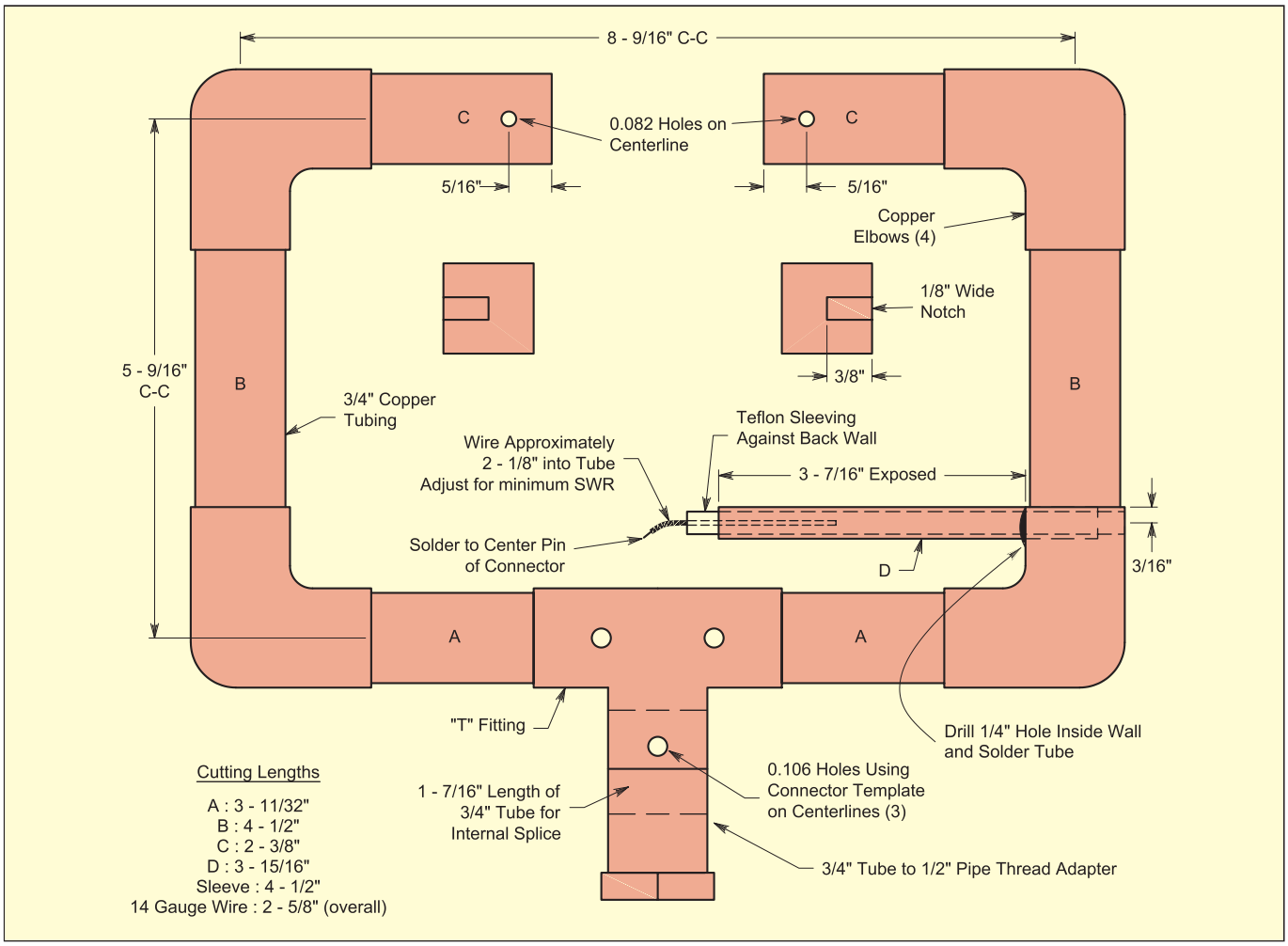

Figure 2—Assembly information for the 222 MHz loop antenna.

Connector Mounting Plates

The connector mounting plate outlines are shown in Figure 4. The plates are made of 0.062 inch brass stock and are attached to the copper antenna using #6 × 1/2 inch stainless self tapping screws at the point where it is internally reinforced. Three screws are used on the 222 MHz version and two are used on the 440 MHz version. Drill pilot holes into the adapter and the "T" (use a #36 drill) on the centerlines, using the completed mounting plate as a template. The connectors are type N, panel mount (UG-58/U), available from many surplus dealers or Digi-Key Corporation.[1] The connectors are attached using #4 screws, lock washers and nuts. All hardware should be brass or stainless steel to prevent corrosion and the connectors' rear terminations should be sealed against moisture penetration. The weight of the 222 MHz antenna is 1.6 pounds and the 440 MHz antenna weighs 1 pound.

Testing, Adjusting and Fine Tuning

All testing should be done with the antenna at least six feet above ground and away from any metal objects. Typical SWR at resonance is less than 1.2:1. This can be checked by using a VHF/UHF RF analyzer, a power meter such as a Bird model 43 or by measuring the return loss by use of a directional coupler, signal generator and RF voltmeter. In this case, the return loss at resonance should be at least 20 dB. The power-handling capability of the antenna is limited by the connector. This amounts to a few hundred watts at these frequencies.

The center frequency of the 222 MHz version can be set from about 216 to 230 MHz by adjustment of the end caps. The 440 MHz version can similarly be adjusted from 428 to 452.5 MHz. All adjustment should be with the two caps equidistant from the copper elbows. After you adjust the end caps to frequency, hold them in place using #4 by 1/2 inch stainless sheet metal screws. If you intend changing the antenna frequency often you might want to place slots in the caps, as shown, to make this adjustment easier.

The 2:1 SWR bandwidth on 222 MHz is 14 MHz and on 440 MHz is about 11 MHz. The wide bandwidth makes the antenna attractive for wideband applications such as amateur TV. The rugged construction also makes it ideal for remote beacon use.

Polarization and Pattern

Polarization can be chosen by arrangement of the elbows and pipe fittings. For horizontal polarization the antenna can be supported on a 1/2 inch threaded mast. For vertical polarization the antenna should be mounted with the open side in the vertical plane. In this case the support mast should be nonmetallic to avoid detuning the antenna. The cable should be routed back and away from the active part of the antenna.

As the patterns of the two are nearly identical, only those

[1]Notes appear on page 61.

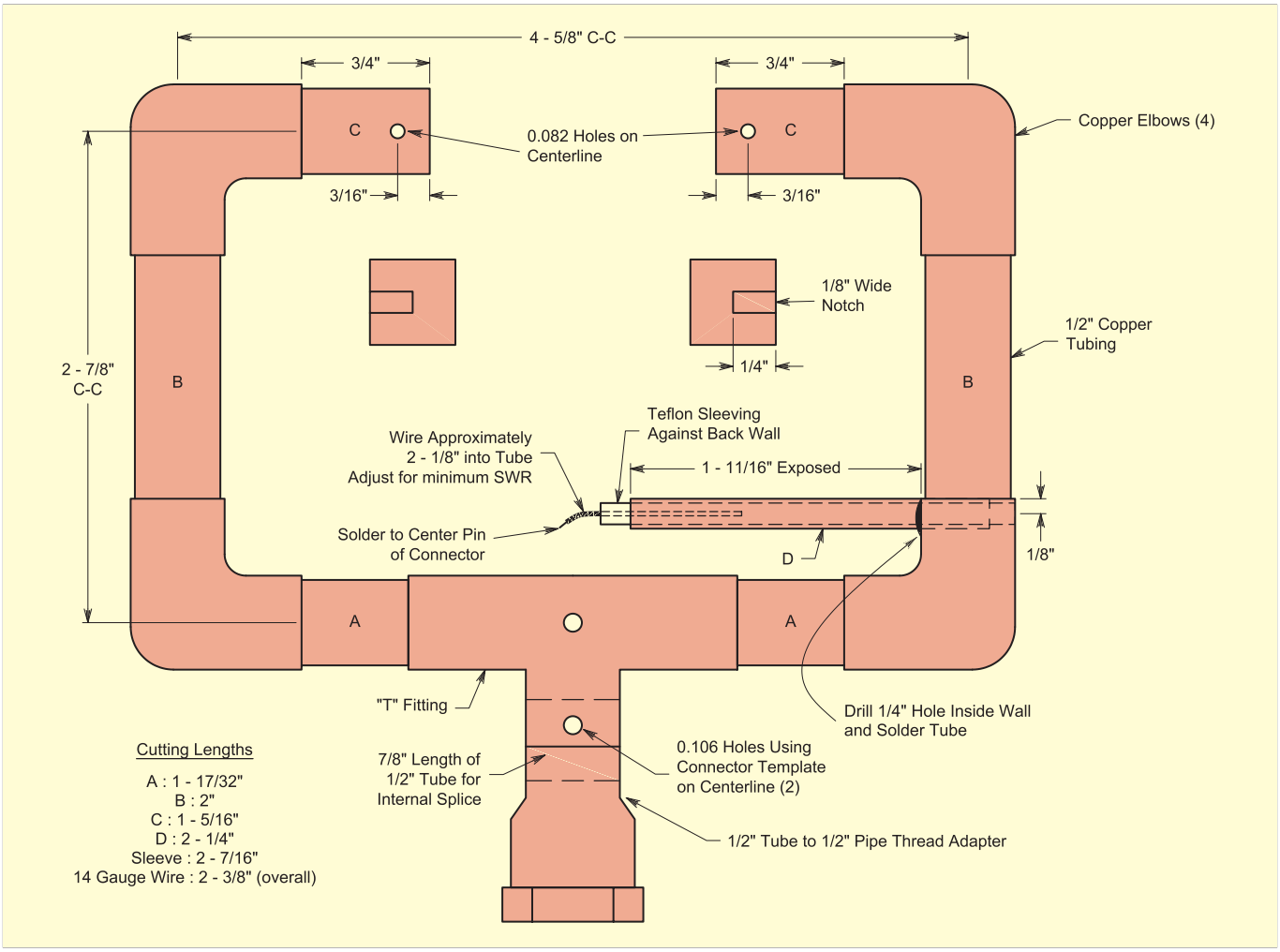

Figure 3—Constructional details for the 440 MHz antenna.

of the 440 MHz antenna are shown. The azimuth and elevation patterns for both horizontal and vertical polarization are shown in Figure 5.

How Do They Stack Up?

Once the loops are built you might want to consider stacking two or more for additional gain. Adding the second unit will increase the gain by about 2.7 dB. Recommended stacking methods are shown in Figure 6. Phasing of two antennas can easily be accomplished by using equal $^3/_4$ wavelength sections of 75 Ω coaxial cable (RG-59/U or RG-11/U). These are placed between each antenna and the feed point. The lengths are shown in Figure 6 and they include compensation for the velocity factor of the cables listed. The phasing network acts as a transformer, converting the individual branches to 100 Ω and, when fed in parallel, to 50 Ω to match the system feed line. A pair of stacked loops, vertically polarized, is shown in Figure 7.

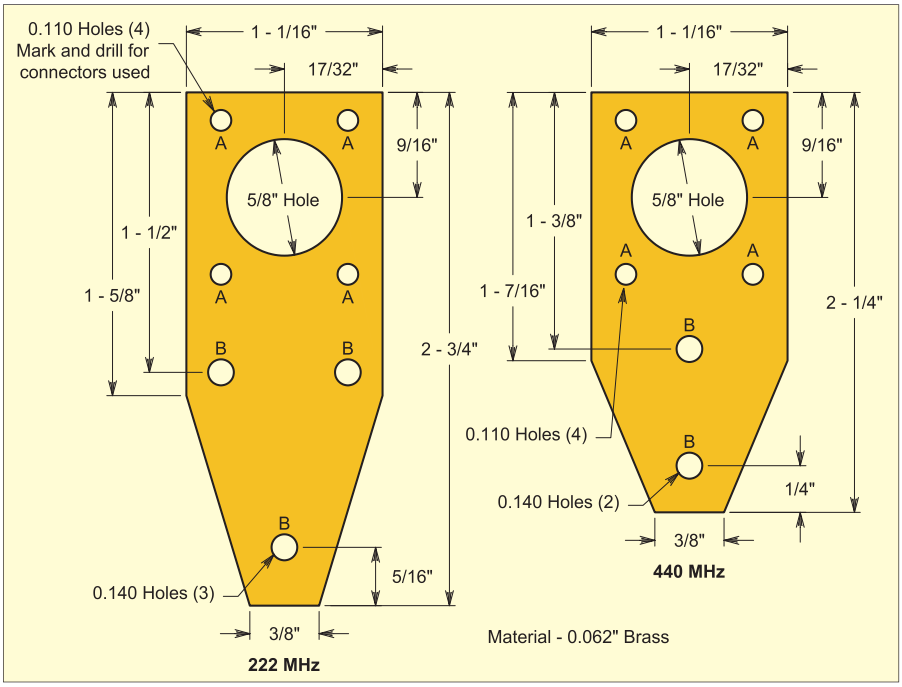

Figure 4—Constructional details for the feed connector mounting bracket.

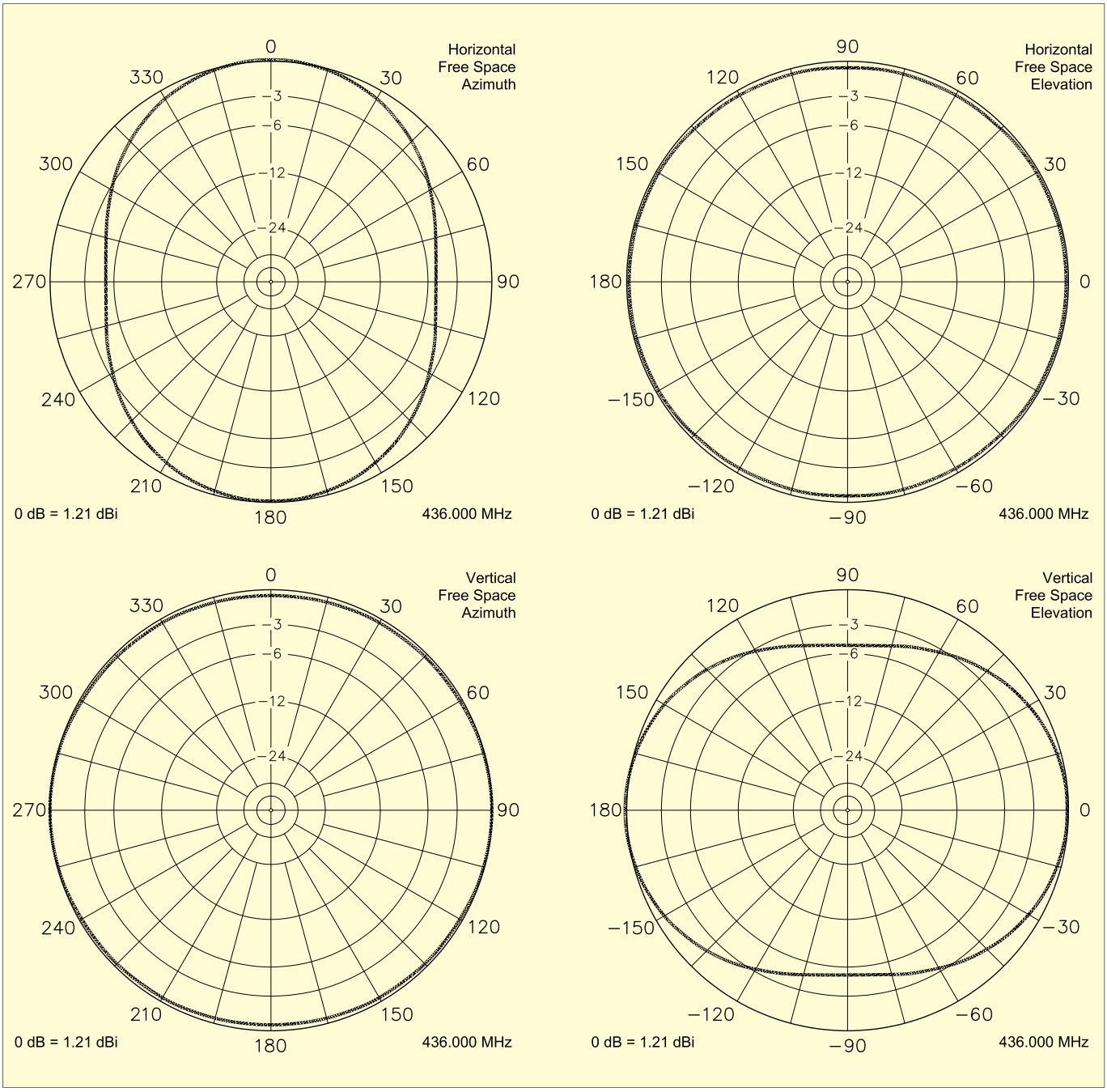

Figure 5—Azimuth and elevation patterns for both vertical and horizontal polarization modes for the 440 MHz antenna.

When two vertical units are stacked side by side, as in Figure 6C, the cable routing and metal support are not a factor. Further information on stacking, matching and phasing is available in *The ARRL Handbook*[2] and *The ARRL Antenna Book.*[3] Note that the gamma tubes are in the same direction on both antennas. If you are planning on stacking two antennas it is an advantage to build one of them with a feed point connector on the opposite side to that of its mate. This is so that phasing will be proper with the feed connectors both facing the midpoint of the array. Be sure to seal the back of the connectors, the mating cable connectors and the exposed end of the gamma tube against moisture entry. The type N cable connectors are waterproof if properly installed.

The Bottom Line

For an antenna that's not much larger than the palm of your hand, the 440 MHz antenna does a terrific job. With the antenna on a short test stand, I can work a 443 MHz repeater over 60 miles away and my experience with local (about 30 miles away) repeaters is very good. I can also hear the AO-27 satellite repeater. The 222 MHz antenna has also been tested locally and performs as expected. I want to thank Carl Luetzelschwab, K9LA, for running the antenna plots and Joe Stroud, K9MRI, for help with field testing.

Notes

[1]Digi-Key Corporation 701 Brooks Ave South, Thief River Falls, MN 56701-0677; **www.digi-key.com**.

[2]*The ARRL Handbook* is available from your local dealer or the ARRL Bookstore. Order no. 1964. Telephone toll-free in the US 888-277-5289, or 860-594-0355, fax 860-594-0303; **www.arrl.org/shop/**; **pubsales@arrl.org**.

[3]*The ARRL Antenna Book* is available from your local dealer or the ARRL Bookstore. Order no. 9043. Telephone toll-free in the US 888-277-5289, or 860-594-0355, fax 860-594-0303; **www.arrl.org/shop/**; **pubsales@arrl.org**.

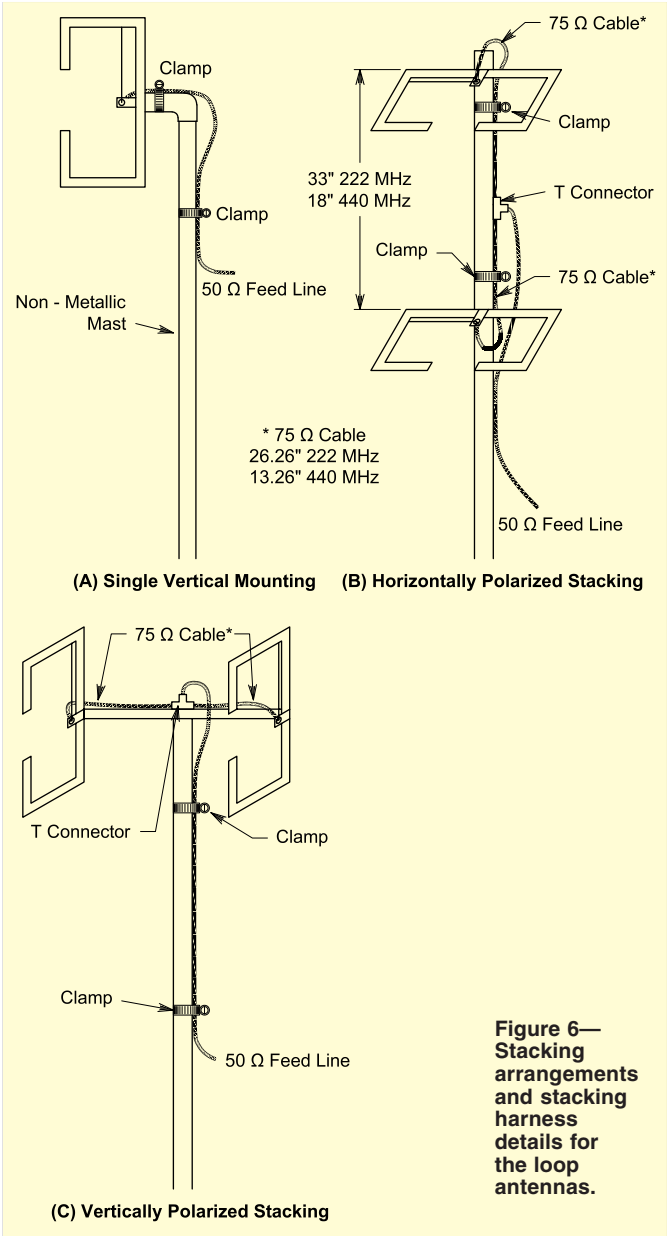

Figure 6—Stacking arrangements and stacking harness details for the loop antennas.

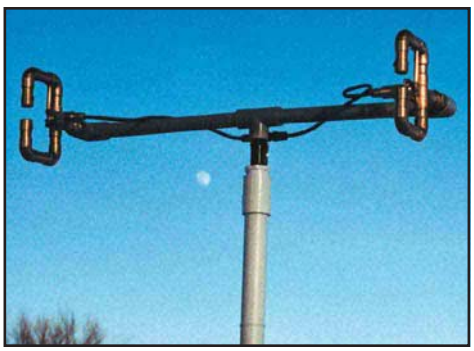

Figure 7—The complete loop antenna assembly shown in a stacked configuration for vertical-mode polarization.

Photos by the author.

Dick Stroud, W9SR, was first licensed in 1939 and received his Amateur Extra class license in 1952. Dick is an electrical engineer (retired) who spent over 30 years designing military electronics equipment. He obviously enjoys the art of homebrewing. You can contact him at PO Box 73, Liberty Center, IN 46766 or at **dikw9sr@citznet.com**.

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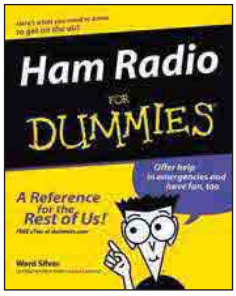

By Ward Silver, NØAX

Published by Wiley Publishing, Inc, April 2004. 384 pages with index. ISBN 0764559877. Available from ARRL, order no. 9392, $21.99 plus shipping. Order toll-free 1-888-277-5289 or order on-line at **www.arrl.org/shop/**.

Reviewed by Rick Tavan, N6XI

◊ Well, it's about time! For years I have been wondering when the popular "for Dummies" series of books for beginners in just about everything would embrace Amateur Radio. The wait is over and *Ham Radio for Dummies* by *QST* Contributing Editor Ward Silver, NØAX, is now available…and it was worth the wait. Although best known perhaps as Dr Beldar of contest forum fame or as the editor of the biweekly *Contest Rate Sheet*, Ward has shown that he also understands the bewilderment of the neophyte and how to cure it. The book is true to the series, a highly readable introduction to the what, how and why of Amateur Radio. Eschewing technical jargon and excessive detail but reserving ample space to touch on every major aspect, *Ham Radio for Dummies* is an effective introduction for anyone who is curious about us.

Ham Radio for Dummies is not a license manual. Although it overlaps some of the content of classics like *Now You're Talking!* and the *General Class License Manual*, it does not replace them. It contains thorough overviews of the licensing process, types of on-the-air activities, station construction and the like, but it does not attempt to include "all you need to know" in order to do anything. Instead, this book refers extensively to other publications and on-line resources that will take the interested reader from curiosity to accomplishment.

I particularly liked Ward's layered approach to instruction, introducing topics in overview chapters before going into more detail later on. He provides the reader with descriptions of a broad spectrum of activities, all equally worthy of the reader's time, attention and further investigation. If there is any license class bias at all it is the assumption that the reader will advance to whatever level is necessary to pursue his or her particular interests. The book is well organized and written, although the illustrations could have been of a higher quality and more complete.

We should all own a copy or two of this book, if not for our own "expert" selves then for the next friend who comes along with questions about Amateur Radio. Let's give away a lot of copies to prospective hams—I predict a high success rate! And keep a copy on the shelf for yourself. It includes excellent introductions to special topics such as digital modes, QRP, contesting, DXing, satellite and TV. The chapter on Specialties certainly got my juices flowing to add a few more of those skills to my repertoire. Also, the admonitions on station maintenance and record keeping remind us of overdue improvements to our own amateur practice.

We were all Dummies once with respect to ham radio and some of us have enjoyed the progression from Dummy to Expert to Elmer. *Ham Radio for Dummies* is poised to launch a new generation onto that exciting trajectory. Congratulations to NØAX and the Dummies crew for another winner.