The "Lowbander's" One-Antenna Farm

Not enough area for a full-size 160-meter antenna? You may have more room, electrically, than you realize — with plenty of space for 80- and 40-meter antennas, too.

By Lee Aurick,* W1SE, ex-K3AZ

An earlier article[1] described an antenna system for 80, 40, 20 and 15 meters that was simple and inexpensive, provided gain and was easy to construct. That antenna has been duplicated by hundreds of amateurs, with excellent results. A new transceiver that covered 160 meters provided the impetus to see if the principles could be applied to an antenna system for this band, as well as benefiting the 80- and 40-meter bands. Other antennas at my station presently provide coverage for 20, 15 and 10 meters, so this new approach had to deal only with our lower three bands.

This system offers a good antenna for each band without having a yard and house festooned with wire. Accomplishing this in suburbia without arousing the ire of the neighbors, not to mention that of your spouse, is an achievement. The antenna works well on three bands, so the design objectives were met.

The first effort was toward achieving the best 40-meter antenna design for property size, efficiency and economy. This was the band of greatest interest, even though it would place a performance limitation on the other two bands. The antenna would resonate close to desirable frequencies on these bands, but would not be "right on."

A system emerged that, according to the textbooks, offers some gain on each of the three bands. However, no claim about gain will be made here. The use of open-wire phasing sections brings the collinear elements too close together to provide much gain, and the phasing sections radiate on the two lower-frequency bands, thereby distorting the radiation pattern. In addition, the antenna is not mounted as high as it might be ideally. The complete antenna system is shown in Fig. 1, but it will perhaps be easier to understand how it functions if a band-by-band explanation is made.

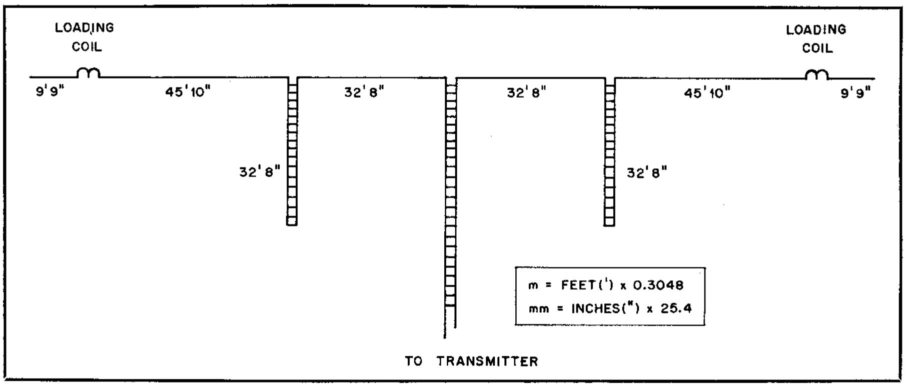

Fig. 1 — Diagram of the three-band antenna system. Forty-meter loading coils, used at W1SE to reduce the physical length of the antenna to 176.5 feet, are Van Gordon Engineering units. The phasing stubs and feeder are 450-ohm open-wire line.

40 Meters

The system functions at 7 MHz as three half waves in phase. Each horizontal section represents a half wavelength on 40 meters. Open-wire phasing sections reverse the phase of the voltage and current from what would be expected if they were not included. These phasing sections are 1/4 wavelength long on 40 meters (each section totals 1/2 wavelength of wire) so that each horizontal section has the same direction of current flow and voltage polarity as its neighbor (in-phase relationship). The phasing sections are constructed of 450-ohm open-wire line, as is the feeder.

80 Meters

On 80 meters the antenna *includes* the phasing sections. They add to the total length of wire, so you now have 5/8 wavelength each side of center. How many people do you know who have even *one* 5/8-wavelength antenna on 80 meters? This new antenna replaces a single 5/8 wavelength on 80 meters, and while it is impractical to compare antennas when used several weeks apart, the new antenna appears to work as well as the earlier one. Many 5-9 reports have been received from Eastern European stations while I was operating "barefoot," on sideband and cw.

160 Meters

Although this band doesn't offer the daily DX opportunities found on our other bands, it is difficult not to feel a little reverence when preparing to operate here. After all, "pioneers" operated on this band, and some of them are still around. It's a band that requires colossal antennas if they are to be full size. Even a quarter wavelength at 1.9 MHz is 123 feet (meters = feet × 0.3048). However, this antenna provides 307 feet of wire, center fed, just waiting to be loaded up! A 5/8-wavelength antenna won't beat four phased quarter-wavelength verticals, but if you can be satisfied with a respectable

[1]Notes appear on page 24.

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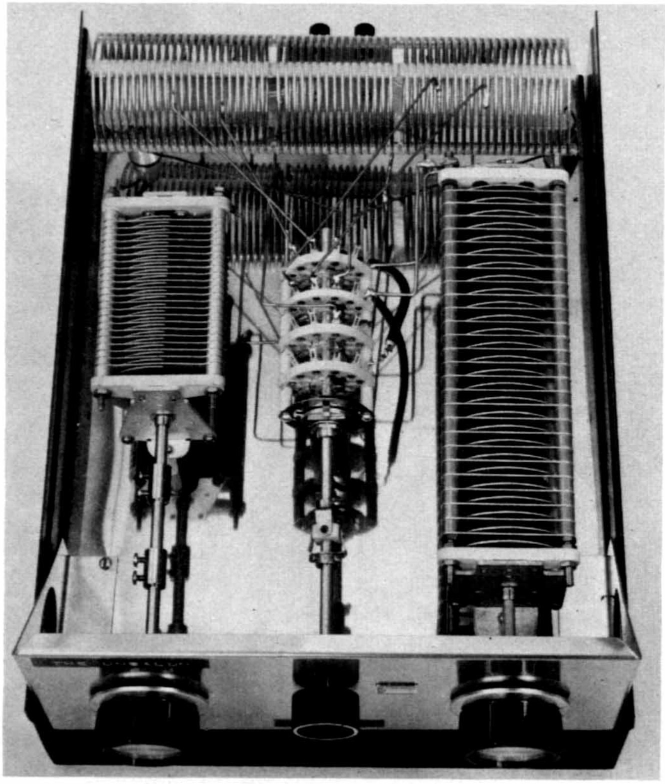

Fig. 2 — Photograph showing the interior construction of the link-coupled network used to match the antenna to 50-ohm coaxial cable.

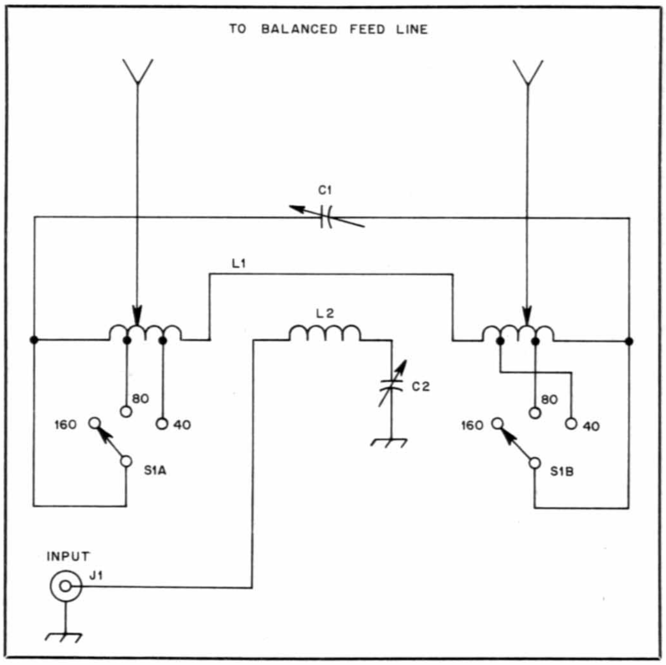

Fig. 3 — Schematic diagram of the link-coupled matcher. The arrows indicate taps that must be found experimentally, because each system will have different requirements.
C1 — 210 pF, with spacing greater than that of the final tank-circuit capacitor.
C2 — 350 pF, spacing not critical for low power.
L1, L2 — See text.
S1 — Two-pole, three-position ceramic rotary switch.

signal throughout the U.S., and occasional DX, this could be the system for you.

Feeding The Antenna

The use of open-wire line requires conversion from balanced line to unbalanced coaxial cable. Why not feed the antenna with coaxial cable? Well, coaxial cable is great — *if* the antenna you plan to feed *always* exhibits the same impedance at its feed point as the characteristic impedance of the line you are using — 50 ohms for example. If the antenna doesn't meet this criterion, you can expect something other than unity (1:1) SWR.

Coaxial cable doesn't handle high SWR very well; open-wire line does. Accept the fact that the SWR is going to be high with this antenna — perhaps 10:1 on 80 meters. No matter: The matching system described here will permit your rig to look at unity SWR, and everything will be fine. The feed-line radiation is cancelled as a result of the balanced feeders (equal but opposite voltages and currents), leaving you with just the normal I^2R (power) loss in the wire.

I decided to build a link-coupled matcher (1981 *Radio Amateur's Handbook*, p. 19-13), for the three bands covered by the antenna. Fig. 2 shows how I constructed the coupler. The layout is not critical. A large cabinet is required to house the big components needed to achieve resonance on 160 meters. Fig. 3 shows the schematic diagram of the circuit. L1 and L2 are made from one 10-inch (mm = inches × 25.4) length of B&W Air-Dux 2406T. Cut the coil wire 20 turns in from each end. Remove one turn from each side of the center portion. The two sections of L1 are then connected to form a single inductor of 40 turns, 3 inches in diameter. The center portion of the coil is used as L2. L1 is resonated by means of C1. Resonance on 160 meters occurs at nearly maximum capacitance, while resonance for the other bands occurs at approximately half capacitance. This can vary, depending on where the taps for each band are placed. In my unit the taps are at 14 and 18 turns from each end for 80 and 40 meters, respectively. The taps are selected by a ceramic-wafer switch that progressively shorts turns from the ends of the coils as you change to each higher-frequency band. Wafer-switch sections were originally provided for the 14-turn link, L2. However, it was unnecesary to tap this coil because a proper match was achieved on each band with the 500-pF capacitor I used for C2. Anything more than 350 pF is satisfactory. C2 may be of the broadcast-receiver type, unless high-power operation is contemplated. L1, L2 and C1 must be insulated from the chassis.

The antenna is tapped onto the coil at 10 turns from each end. This position of the taps permitted the antenna to be matched and loaded fully on each band. These points may be different in other installations and will depend largely upon the length of the feed line and, to some extent, on the antenna height.

Summary

At W1SE, there was insufficient room for the 196-foot length required for the three half waves in phase on 40 meters. Consequently, 40-meter loading coils were used in each of the outboard sections to reduce the size of the antenna to 176.5 feet. These loading coils have a small effect on 80/75 meters, and even less on 160 meters. The dimensions shown in Fig. 1 provide resonance at 7.15, 3.8 and 1.9 MHz. The coils used at W1SE are Van Gordon Engineering Coils, but any commercial 40-meter loading coils should work.[2]

The antenna system described provides good coverage of the top bands, and does it without making suburbia look like the Voice of America antenna site! Also, no balun is needed in this system. The link-coupled matcher permits conversion between the *bal*anced feeder and *un*balanced transceiver, and provides the impedance match that no practical balun could.

Notes

[1]L. Aurick, K3AZ, "The AZ Special," CQ, Sept. 1975, pp. 35-37.

[2][Editor's Note: These coils were measured in the ARRL lab and were found to have an inductance of 10.3 μH, and a Q of 170 at 7.1 MHz. One 10-inch piece of B&W Air Dux 1008T coil stock could be cut in half to make a pair of loading coils. Some method of strain relief would be required. A second alternative would be to "roll your own" using information found in *The Radio Amateur's Handbook*, page 2-11.]