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DOUG'S DESK

CONSTRUCTION PROJECTS, TECHNIQUES, AND THEORY

Small Antennas For 160 Meters

The 160 meter season is upon us, and my mailbag is overflowing with letters from amateurs who want to operate top band, but lack the space for a full-size antenna. Although this subject has been covered in the amateur literature many times in recent years, it is worth treating again for those who are new to 160 meters. This article describes various "widget" types of 1.8 MHz antennas that I have used successfully as an urban dweller in the Detroit and Hartford, Connecticut areas.

It is important to recognize that antennas of reduced size for any MF or HF band are not as effective as fully dimensioned radiators. They do, however, offer an acceptable alternative to having no antenna at all. In fact, some of the smaller antennas can provide surprising results, even for DX work.

It is not unusual to hear weak signals from nearby stations on 160 meters during the course of an evening's activity. The operators of these stations frequently join my 1919 kHz group and ask for signal reports. Many of them are making their first excursions into top band. Almost without exception, the weak signals come from operators who are feeding a 75 meter dipole with a Transmatch. Although the system presents an SWR of 1 via the tuner, the antenna efficiency is poor, especially with coax-fed short dipoles. Better results can be expected when using tuned feeders with a short dipole. Others with weak signals report using random-length end-fed wires close to the ground.

Best results with a 75 or 40 meter dipole on 160 meters can be expected when the coaxial or balanced-feeder transmission line is shorted at the station end and matched with a tuner. This provides the equivalent of a flat-top T, which operates as a 1/4-wave vertical. The legs of the dipole function as a capacitance hat. The higher the dipole and the more vertical the feed line, the better it will perform. A counterpoise or ground radial system is essential in order to make this style of antenna function efficiently.

Compressed Full-Wave Loop

It is well known that closed loops are less responsive to manmade noise than are the more common dipole and vertical antennas. Furthermore, loops don't require ground screens, such as radials. A small, loaded 160 meter loop is attractive for those who live on city lots. The performance tradeoff for smaller, loaded antennas is restricted bandwidth. Therefore, moving from one part of the 160 meter band to another requires readjustment of the antenna tuner or loading coils to ensure a low SWR.

Fig. 1 shows a mini loop that uses four loading coils. This technique was described by two authors.[1] I have chosen a wire length of 30 feet for each side of the square loop in order to make it small. The antenna may be erected vertically from a tower and a mast, or from a tall tree. It can be used as a horizontal loop if four supporting structures are available. The choice between vertical or horizontal deployment is not important, apart from the directivity that results from vertical erection. In either situation the radiation angle of the signal is high (a "cloud warmer"), which is especially desirable for communication out to a few hundreds of miles.

L1 through L4 have an inductance of 212 μH. They are inserted at the outer ends of the two horizontal sides of the loop, as shown. The center frequency for this antenna is 1.9 MHz. No. 12 wire is used for the radiator. Resonance is effected by trimming wire from the vertical sides of the loop. I recommend a dip meter, SWR meter, or an instrument such as the MFJ-259 SWR Analyzer for adjusting the loop. With the latter two instruments resonance will be indicated by the lowest value of reflected power, regardless of how high the SWR may be.

For 1.5 KW PEP the loading coils are close-wound with 132 turns of No. 12 enamel wire. The coil form OD is 2 3/8 inches, which is a standard PVC tubing size. The coil form length is 12 1/2 inches to accommodate the 11 3/8 inch winding. Smaller coil forms and wire of higher gauge may be used to decrease the weight and bulk of the inductors if the transmitter power does not exceed 200 watts. The ideal form factor for the coils is 1:1 to 2:1 to obtain the highest Q. However, form factors up to 5:1 will produce good results. For power outputs up to 200 watts you may use 175 close-wound turns of No. 18 enamel wire on a 1 1/2" × 9" low-loss form.

A balanced antenna tuner and 300 or 450 ohm balanced feeders work well with this and other loop antennas. A single-ended tuner can be used as a balanced tuner, as described by A. Roehm in *The ARRL Antenna Compendium*.[2]

A Short Dipole For 160 Meters

Fig. 2 provides details for using loading coils to convert a 75 meter dipole for operation on top band. L1 and L2 have an inductance of 106.5 μH for operation at 1.9 MHz. The dipole may be erected horizontally, or you may use it as an inverted V. For maximum amateur power the coils are close-wound with 72 turns of No. 12 enamel wire on forms that are 2 3/8" × 8".

Smaller coils for operation up to 200 watts can be wound on 1.5" × 4" forms. Use 82 close-wound turns of No. 20 enamel wire. All coils for the short antennas described in this article need to be protected from dirt and moisture by enclosing them in plastic soda bottles, or by coating them with two layers of polyurethane exterior lacquer, glyptol, or marine spar varnish.

This short dipole has a much narrower 2:1 SWR bandwidth than that of a full-size dipole. Therefore, as with the fig. 1 loop, it will be necessary to readjust the tuner when making large frequency changes. Balanced feeders are recommended for this antenna, but coaxial feed may be used.

Helically Wound Short Vertical

Helically wound antennas have been used since the early 1950s by a number of city-dweller amateurs. I prefer them over lumped-constant antennas that are base, center, or top-loaded because the voltage and current distribution across the radiator is more linear than with the latter types of radiators. How much this buys us in dB, if at all, is questionable. However, in my mind it is a more "sani-

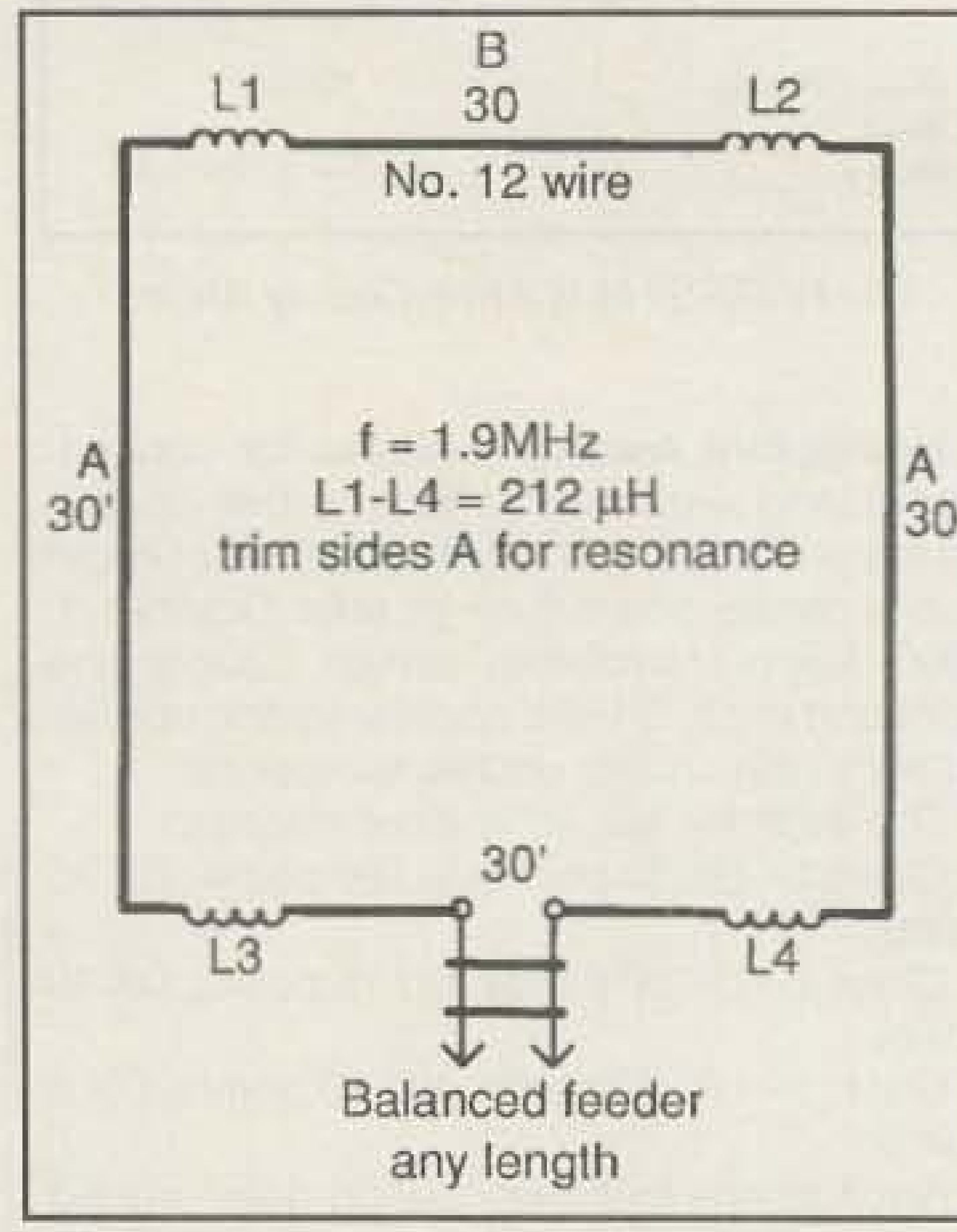

Fig. 1– Details for a compressed loop antenna. See text for information about the loading coils and antenna adjustment.

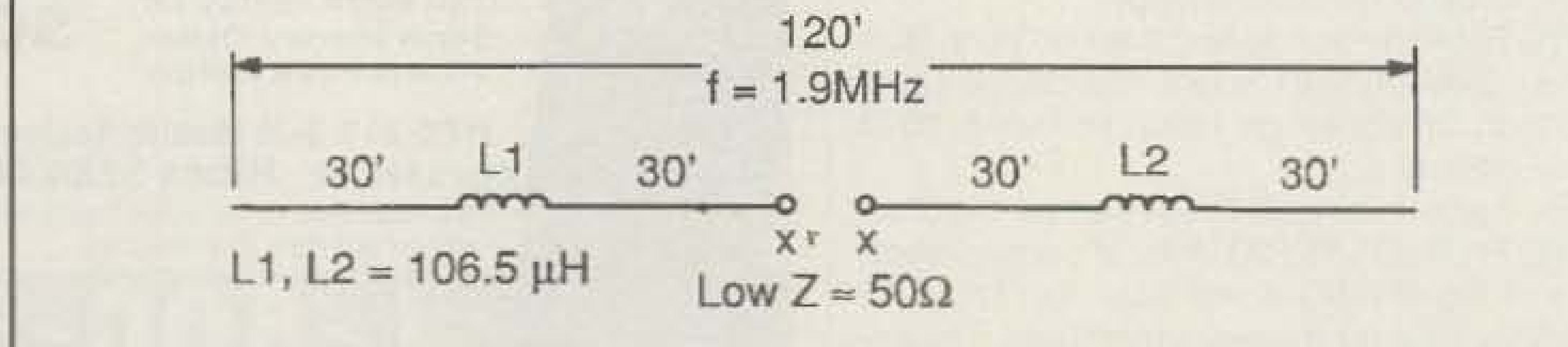

Fig. 2– Method for using a 75 meter dipole on 160 meters. Two center-loaded elements are used to provide resonance at 1.9 MHz. (Coil winding data provided in the text.)

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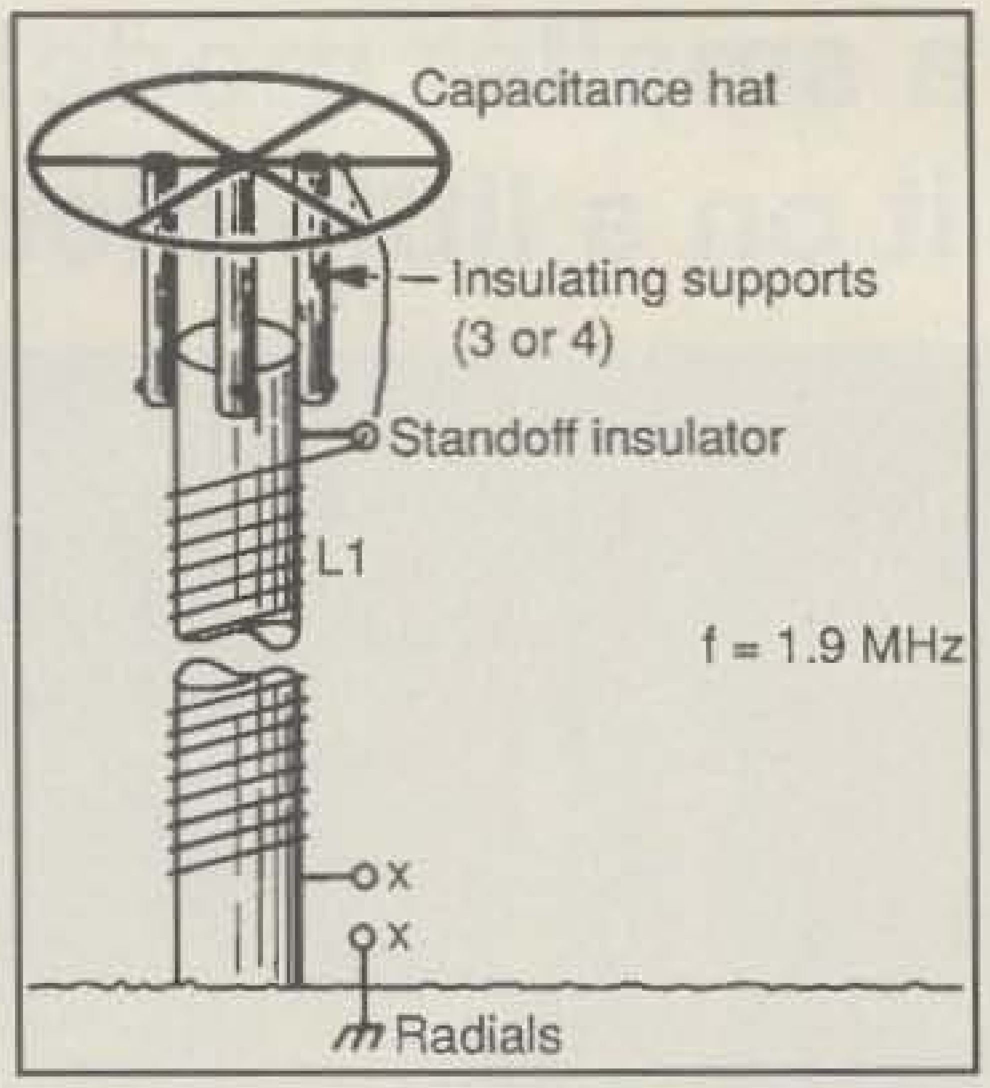

Fig. 3– Example of a short, helically wound 1/4-wave vertical for 1.9 MHz. L1 is wound on 26 feet of 2 3/8 inch OD guyed PVC pipe (see text for details).

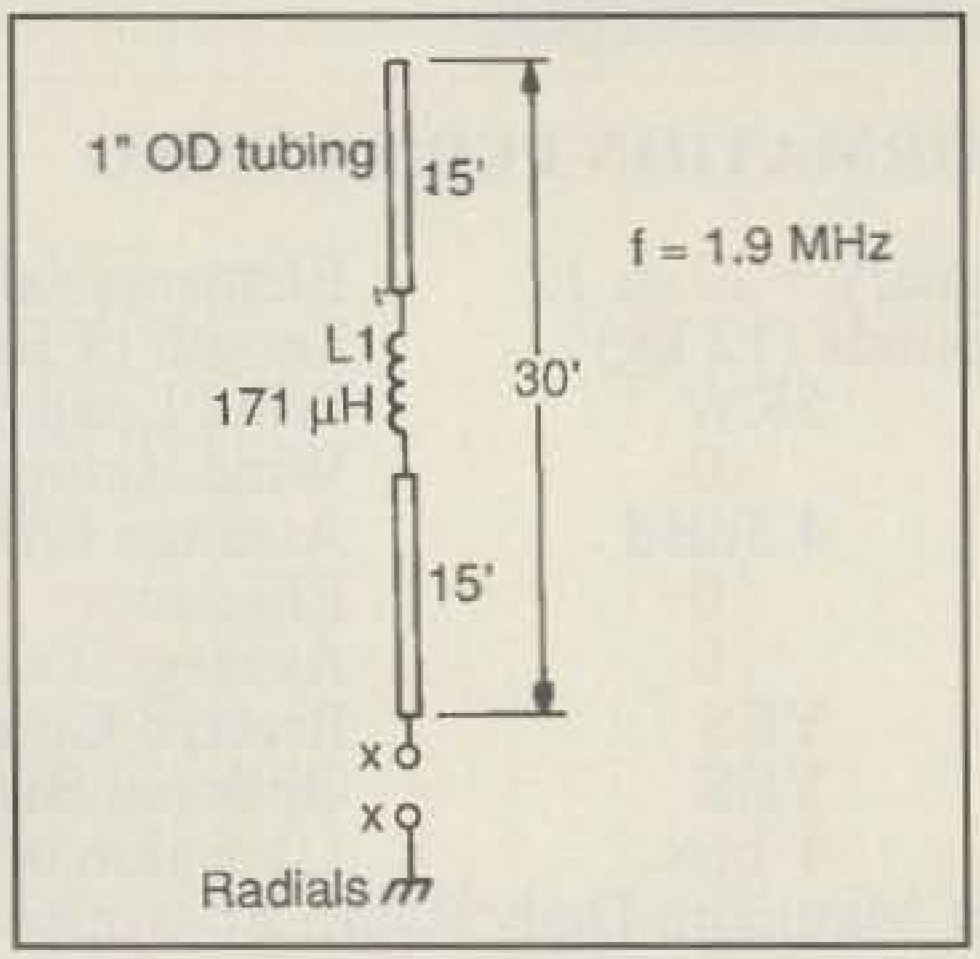

Fig. 4– Details for constructing a center-loaded 30 foot vertical for 1.9 MHz (see text). The elements are made from 1 inch OD aluminum tubing. For power less than 200 watts close-wind 123 turns of No. 20 enamel wire on a 1.5" × 6" coil form.

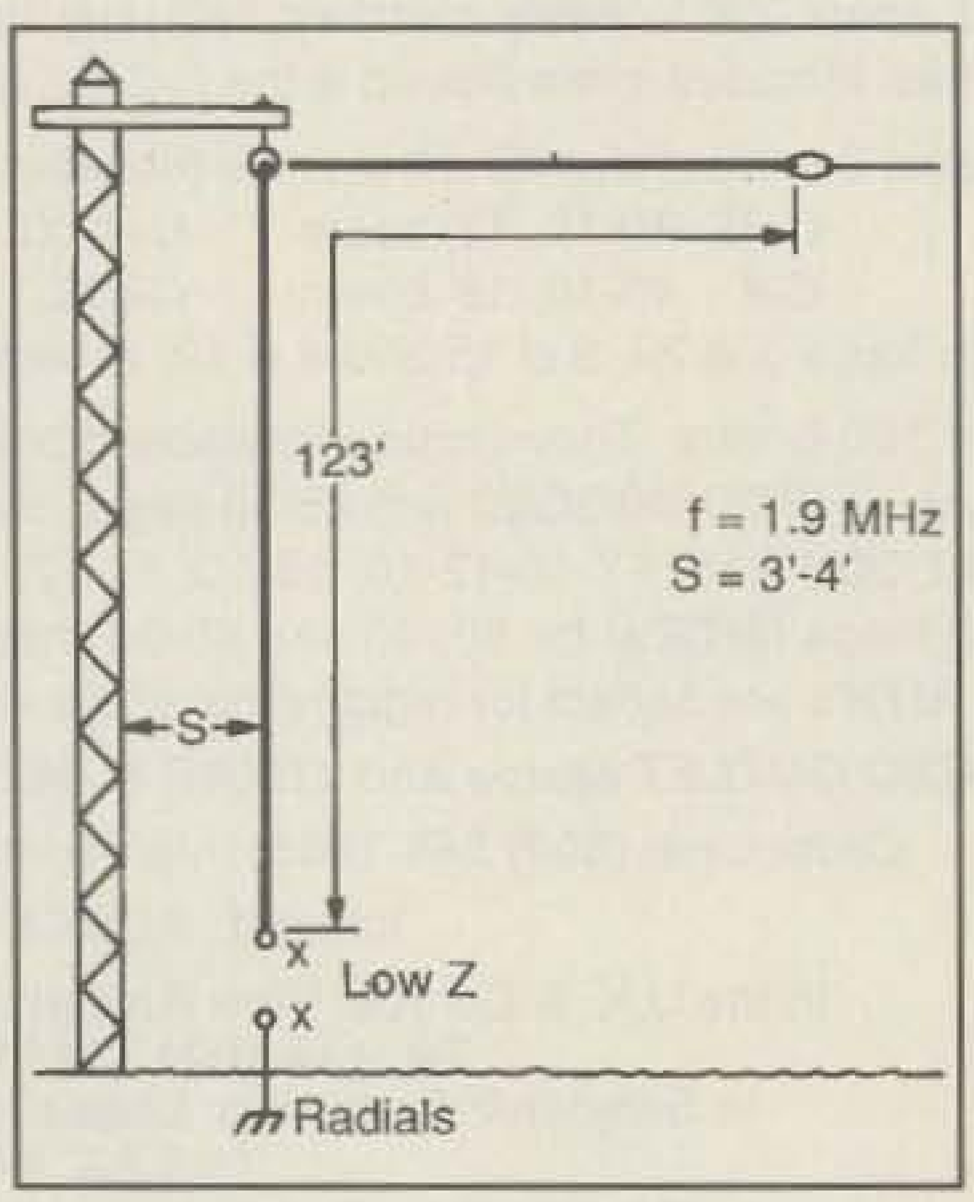

Fig. 5– Configuration for a classic 160 meter inverted-L antenna. The vertical portion of the wire should be as long as is practicable for best results.

tary" approach to design.

Fig. 3 shows how a helically wound vertical is configured. To achieve 1/4-wave resonance it is necessary to use approximately one-half wavelength of wire, spiral wound on a low-loss form. The fig. 3 ground-mounted radiator can be wound on 2 3/8 inch PVC tubing. Guying is required. Best performance will be had when using 16 or more buried or on-ground radials that are 30 feet or greater in length.

This antenna is 26 feet high. It may be wound with No. 12 or 14 bare or enamel wire. The spacing between turns is 3/4 inch. You will need to wrap 259 feet of wire on the coil form (410 turns). It is helpful to anchor the turns in place periodically during the winding process by means of tape. Once the winding is completed, it should be doped with exterior polyurethane lacquer or spar varnish (two coats) and allowed to dry before the tape is removed. This will keep the turns in place. The Q of this antenna is 5; the feed impedance is roughly 8 ohms.

An aluminum pie plate or similar metal disc is used at the top of the helical. It functions as a capacitance hat and prevents RF corona. A larger capacitance hat will reduce the number of turns needed to achieve resonance, and this will improve the antenna efficiency. A 3 foot diameter hat is not unreasonable. It can be fashioned like a wheel (with six spokes) from 3/8 or 1/2 inch OD aluminum or brass tubing. Mount the capacitance hat on three or four low-loss standoff insulators, such as Plexiglass or Delrin rods, that are screwed to the PVC tubing. Avoid allowing the high-impedance end of the helical winding or the hat to come in contact with the PVC tubing.

The L network in fig. 6A is suitable for matching 50 ohm coax to this antenna and to the low-Z radiators illustrated in figs. 3, 4, and 5. Fig. 6B shows how the L network can be reversed for use with end-fed antennas that present impedances greater than 50 ohms.

A 30 Foot Top-Band Vertical

A 30 foot, center-loaded 160 meter vertical is illustrated in fig. 4. The elements are made from 1 inch OD aluminum tubing. You will require a loading coil with an inductance of 106.5 µH for operation at 1.9 MHz. This is accomplished by winding 72 close-wound turns of No. 12 enamel wire on a 2 3/8 inch OD by 8 inch form, such as PVC tubing. Antenna efficiency will increase if you place a capacitance hat above the loading coil. This requires reducing the number of coil turns to obtain resonance at 1.9 MHz or some other top-band frequency of your choice. Prune the coil for minimum SWR when you adjust the system for resonance. The 2:1 SWR bandwidth of this antenna is approximately 25 kHz. The feed-point impedance is on the order of 15 ohms.

Use 16 or more on-ground or in-ground radial wires. Each wire should be 30 feet or greater in length. The radials for this and other 1/4 wave (or multiples thereof) antennas can be made from small-diameter bare or insulated wire. However, the smaller the wire the more rapidly it will deteriorate because of soil acidity. Wire as small as 20 gauge is satisfactory because only milliamperes of RF current flow in these conductors.

You should be aware that vertical antennas have a low radiation angle, even though they may be physically shortened. This means your signal will at times be weaker out to 300 miles

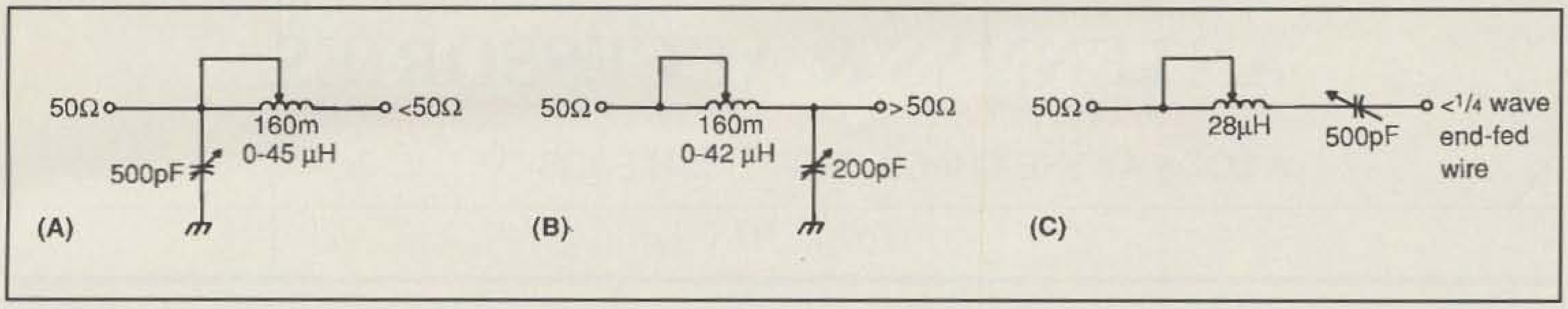

Fig. 6– Matching networks for the fig. 3, 4, and 5 antennas. Circuit A is for matching 50 ohms to a lower impedance. The circuit at B is for matching 50 ohms to a higher impedance. The series C and L combination at C is suitable for matching 50 ohms to quarter-wave antennas that are resonant higher than the desired operating frequency (see text).

than when using a horizontal antenna that is close to ground (less than ½ wavelength high).

The Popular Inverted L

There is probably no 160 meter antenna that is less complicated or costly to construct than the inverted L. This antenna consists of a ¼ wavelength of wire that is bent into a L shape, as seen in fig. 5. The objective is to make the vertical portion as long as practicable, since the inverted L is a vertical type of antenna. The horizontal portion of the wire acts as a capacitance hat to provide resonance. This horizontal section produces minimal radiation.

As with the antennas in figs. 3 and 4, this radiator requires a ground screen. Each of the radials (or a counterpoise wire) should be 130 feet in length. Try to deploy at least 16 radials (the more the better). If you lack the real estate for ¼-wave radials, use as many shorter ones as you can fit into the available space. I have employed mixed-length radial systems with some of the wires as short as 25 feet, while others were up to 130 feet long. Use whatever wire length you can manage for your property size, and then test the system for performance.

If your inverted L is supported by a tower or metal mast, try to space it away from the metallic support by a distance of three or four feet. Also, keep this and the other antennas described in this article well away from phone and power lines. This will reduce noise pickup and prevent nearby conductive objects from degrading the antenna performance.

Short Random-Length Wires

If antenna space is lacking for a full-size inverted L, you can erect a shorter length of wire and configure it as an inverted L, keeping the vertical portion as long as practicable. Reasonable performance may be expected if you provide radials or a counterpoise wire to work the antenna against. The wire must be resonated for ¼-wave operation by adding a center loading coil (as in fig. 2). As an alternative, the matching network in fig. 6C will enable you to obtain an SWR of 1 without a loading coil. In fact, the series coil and capacitor arrangement in fig. 6C may be used with the antennas in figs. 3 and 4 if you resonate them higher than the desired operating frequency. If the resonant frequency is lower than desired, use only the series variable capacitor to tune out the unwanted inductive reactance (XL).

Some Final Comments

If you are new to 160 meters, it is important to know that the frequencies between 1825 and 1830 kHz are reserved by gentlemen's agreement for use as a DX window. Foreign stations operate in that segment. You should answer them, or call CQ DX (if you must), above or below the window.

Most of the antennas treated here can be used for working DX if band conditions are good, and if you apply strategic operating techniques. It's unlikely that you will break pile-ups with these antennas, but don't be shocked if you do!

Footnotes

1. D. Sanders, CQ December 1981, p. 44. Also see Merschrod, KA2OIG, *The ARRL Antenna Compendium*, 2nd ed., p. 90.

2. A. Roehm, W2OBJ, *The ARRL Antenna Compendium*, 2nd ed., p. 90.

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