CONSTRUCTION PROJECTS, TECHNIQUES, AND THEORYs

Antenna Performance and 160 Meters

There is scarcely an evening when someone doesn't join one of my 160 meter QSOs to ask, "How's my signal? I'd appreciate a signal-strength reading." Some of the signals from these near and distant amateurs are alive and well, and they rise well above the ever-present atmospheric noise that is a part of the "top band" experience. On the other hand, many signals from those who request signal reports are barely readable or are lost in the noise. Almost without exception the very weak signals are from stations that are trying 160 meters for the first time. Most of the operators are attempting to communicate with 100 watt transmitters and grossly inferior antennas. When I ask for a description of the antenna, I am often told, "I'm trying to load up my 75 meter dipole with an antenna tuner." Others may say, "I strung up 100 feet of wire today and decided to try it." Generally speaking, these "make-do" antennas are very close to the ground—sometimes only 15 or 20 feet high, which further degrades the signal strength. This article provides some tips for getting started on 160 meters with a signal that can be heard throughout the USA when band conditions are favorable.

The Matter of Antenna Height

Antenna height versus operating frequency is a subject of importance that is often overlooked by amateurs. Predictable, classic antenna performance is based on a height above ground of 1/2 wavelength or greater. At lower heights dipoles and other horizontally polarized radiators show very little directivity and the radiation angle is high. It becomes pointless to orient a dipole for some favored direction when it is, say, 1/4 wavelength or less above ground. Typically, this type of antenna radiates a ball of energy of equal magnitude in all directions and at a high launch angle (not good for distant communications).

It is easy to be misled as we look skyward at a 160 meter dipole that is 35 feet above ground, because after all, that seems high in the air from our vantage point. The truth of the matter is that a 1.9 MHz dipole should be 273 feet high for a 1/2 wavelength spacing above ground! The 35 foot height on 1.9 MHz can be equated to a height of 2 feet above ground for a 10 meter dipole. Few amateurs would consider such an inefficient system for 10 meters. Therefore, it is essential that we erect our 75 and 160 meter antennas as high as practicable, recognizing that a height of 273 feet is beyond the means of most amateurs, myself included.

What Not to Use

Almost any resonant horizontal or vertical antenna for 160 meters will vastly outperform a dipole for some higher band that is being force-fed with an SWR disguiser (antenna tuner). The tuner allows the transmitter and receiver to interface with the desired 50 ohms (good), but that's where the free ride ends. A dreadful mismatch still exists at the dipole feedpoint, and maximum power transfer can only occur when unlike impedances are matched. The foregoing statements are based on the use of coaxial-cable feed lines. Tuned open-wire or ladder-line feeders and an antenna tuner will, on the other hand, permit reasonable 160 meter performance when using a 75 meter dipole, although much better results will be had if the dipole is resonant (longer) on 160 meters. Alternatively, it has been common practice for many years to short the center and outer conductors of the coax feeder at the transmitter and treat the feed line and 75 meter dipole as a flat-top T antenna. In effect, the coaxial feeder then becomes a single wire that exhibits vertical polarization. The dipole elements function as a top-hat loading device, but they do little radiating. The shortcoming associated with this method is that the overall 75 meter dipole system functions as a 1/4-wavelength radiator (when matched to the transmitter), and this requires a quality ground-radial system if there is to be reasonable efficiency. The same is true of a short random-length wire or even a 1/4-wavelength wire. A counterpoise or radial ground system is necessary in order to obtain good performance. Ground rods or household water pipes are not substitutes for an RF

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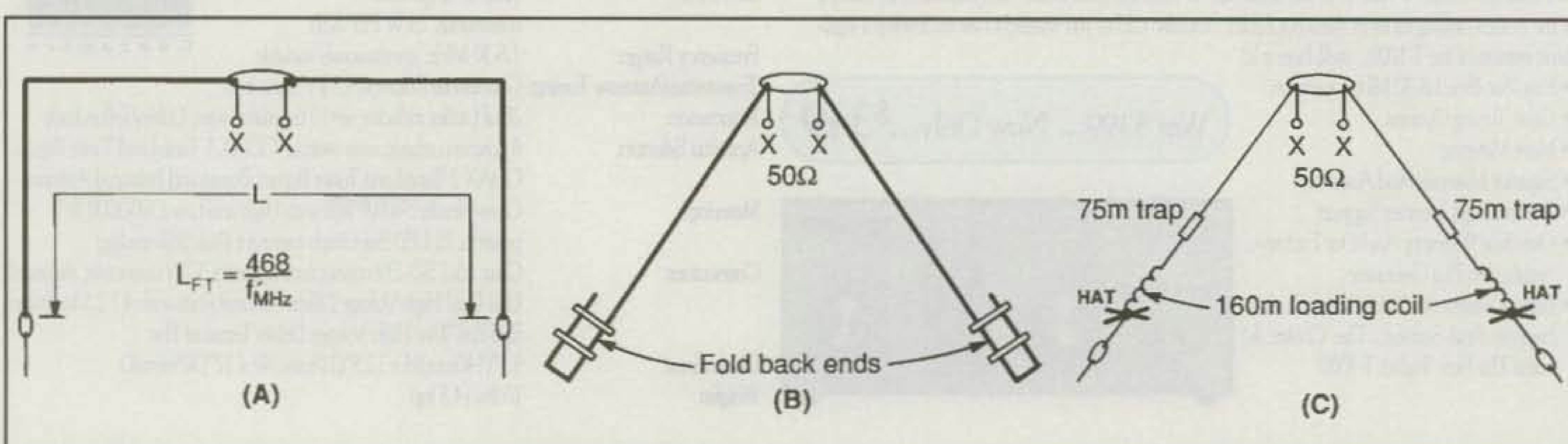

Fig. 1– Examples of shortened dipoles for 160 meter use. Antenna (A) is a horizontal dipole that has its voltage ends drooped toward ground. An inverted V may be erected in a similar manner. Example (B) shows how to fold back the voltage ends of a dipole to physically shorten the antenna. A two-band shortened dipole is illustrated at (C). A 75 meter dipole can be used also on 160 meters by adding two 75 meter traps and two 160 meter end-loading coils, as shown. This antenna can be fed with a single coaxial feed line, once adjusted for each of the bands.

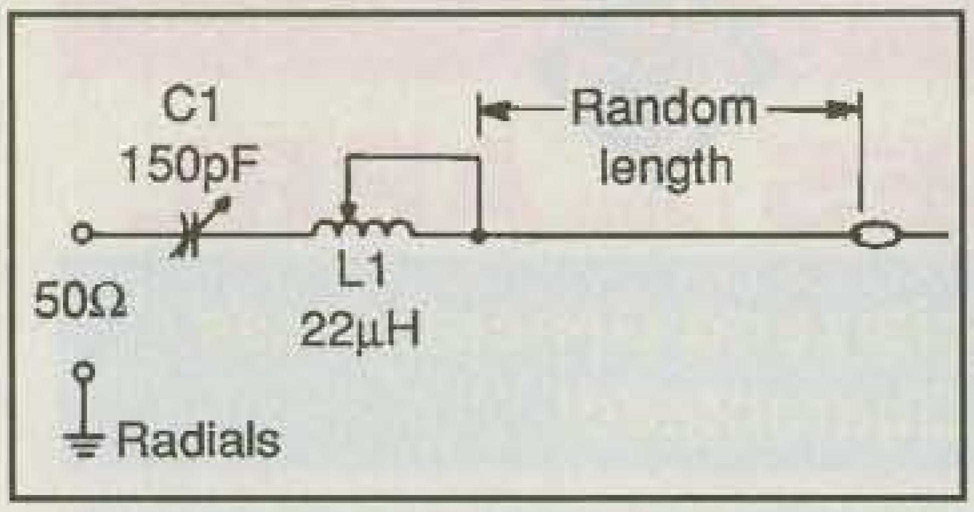

Fig. 2– A random length of wire may be matched to a 50 ohm transmitter by using series C and L as shown.

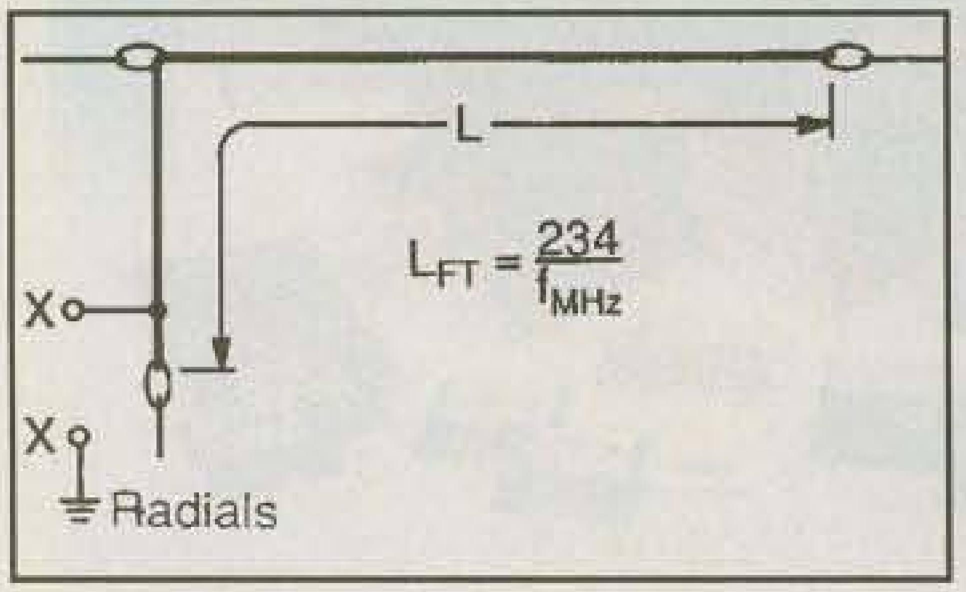

Fig. 3– The popular inverted-L antenna is depicted here. The greater the length of the vertical part of the wire the better the antenna performance. A ground radial system is required for this antenna and for the one in fig. 2. The horizontal part of this antenna acts as a top-loading device and does little radiating.

ground screen. All they can provide is a DC ground for ensuring operator safety.

The Problem of Limited Real Estate

Many of the weak 1.9 MHz signals I encounter come from stations where the operator laments about having too little yard space for a 160 meter dipole. They say that they can't even erect a 160 meter inverted V, which is an antenna that is used by many top-band operators. However, there are a number of ways to construct a shortened half-wave inverted V for 1.9 MHz. Fig. 1 illustrates some techniques that have provided good results for any band that requires a smaller-than-normal or "scrunched" dipole. If a horizontal dipole is erected, it is practical to droop the voltage ends toward ground (fig. 1[A]), thereby keeping the radiating current portion of the antenna higher above ground. The voltage ends of the dipole may be bent back on themselves (fig. 1[B]) by means of spreaders. Still another trick that works is to use a 75 meter dipole for 160 and 75 meters by installing a 75 meter trap at the ends of the 75 meter dipole, then adding a 160 meter loading coil and capacitance hat (fig. 1[C]) at each end of the dipole, beyond the 75 meter traps. Once adjusted for the chosen portions of the two bands, the antenna may be fed with coaxial cable and used without a tuner. Inexpensive traps made from RG-58 coaxial cable were described by R. Sommer, N4UU, in December 1984 *QST*. These traps are detailed also in *The ARRL Antenna Book*, 15th edition, 1988.

Short end-fed lengths of wire (the longer and higher the better) may be pressed into service on 160 meters by means of the matching network shown in fig. 2. C1 and L1 are adjusted until the fed end of the wire presents a 50 ohm load for the transmitter. Although a roller inductor of 22 μH or greater offers greater ease of adjustment, a tapped coil can be utilized in the network. It is important to mention that this system also functions as a 1/4-wavelength radiator, thereby requiring a ground screen for optimum performance. I have known a few amateurs who relied upon the cold-water pipes and their chain-link fences for ground screens when using 1/4-wave 160 meter antennas. Some of them reported good results, so the trick may be worth trying. The greater the number of large outdoor metallic objects that can be combined in a ground system the more effective the composite ground screen will be. Even a few on-ground or buried radials will make a big difference in the antenna performance.

The Old Standard Inverted L

An inexpensive but effective wire antenna for 160 meters is the long-established "inverted L." This antenna is shown in fig. 3. The radiator consists of 1/4 wavelength of wire (any gauge), insulated or bare, that is erected so that a large part of the wire is vertical—the more the better. The system functions as a top-loaded vertical, and the height above ground is not a significant consideration.

The matching network in fig. 2 may be used with this antenna. C1 can be motor driven remotely for maintaining a low SWR when QSYing within the band. Again, it is essential to operate this 1/4-wave antenna against a ground radial system or equivalent quality ground screen. A dozen or more radial wires can be buried in the lawn by using a lawn-edging tool to make slits in the turf, then tramping them closed after the wires are in place. The wires need not be 125 feet in length, although that size is the ideal. Wires as short as 40 or 50 feet will aid performance, since they are better than no wires at all. In a like manner, the often-recommended minimum of 125 buried radials is arbitrary. I have had excellent DX results with short top-band verticals on a small city lot when using only 15 or 20 radials of assorted lengths.

Inverted-L antennas yield a low angle of radiation if the vertical portion is fairly long. This makes them useful for stateside and DX operation. The trade-off is that they are more responsive to manmade noise than are horizontal antennas. This is true of all vertically polarized antennas. If you live in a noisy location, you may have difficulty sifting weak DX signals out of the QRN.

If the inverted L is made slightly shorter than 1/4 wavelength, it can be matched easily by placing a tapped coil at the feedpoint, as illustrated in fig. 4. The upper tap is adjusted (using a dip meter) to resonate the antenna. The lower tap is then chosen to provide a 50 ohm feed impedance for the RG-8 coax feeder. There is some interaction between the taps. Three or four experimental adjustments may be required before an acceptable SWR is obtained. Typically, a 50 kHz bandwidth (SWR below 2:1) is possible without readjusting the coil taps on 160 meters. The bandwidth will increase to approximately 100 kHz, given the same overall antenna Q, for a 75 or 80 meter system.

The DX Answer

Few of the antennas described in this article will cut the mustard for long-haul communications, although any dipole, shortended or not, has good DX capability if it is truly high in the air. The inverted L is the notable exception to the foregoing rule. I was able to confirm 72 countries with 100 watts of CW power in the winter of 1977 while living in Connecticut and using an inverted L for which the flat top was only 50 feet above ground. My ground system consisted of 24 buried radials. The longest one was 125 feet long and the shortest one was 40 feet in length.

Large, effective antennas such as full-size verticals with numerous buried radials, or full-size horizontal 160 meter loops at substantial height, are excellent for DXing on top band. W4ZCB in Hendersonville, North Carolina uses a 1/2-wavelength inverted L for 160 and 75 meters (60 feet high) and therefore he needs no ground screen. His signal into Michigan and points of greater distance is always loud. Of course, living atop a small mountain doesn't hurt Harold's signal a bit!

I have good results from Luther, Michigan while using my 160 meter inverted V at 70 feet above ground. The antenna is fed with 125 feet of 450 ohm ladder line. It performs admirably from 1.8 through 29 MHz. The antenna matcher or Transmatch "floats" at RF to permit using it as a balanced tuner, per the excellent article by A. Roehm, W2OBJ, that appears in the 2nd edition of *The ARRL Antenna Compendium*, page 172. This method eliminates the need for a balun transformer, which provides, at best, questionable performance in a multiband antenna system that employs tuned, balanced feeders. A balun in such a changeable environment scarcely knows whether to "wind its watch or burst into flame," depending upon the transmitter power level and the impedance reflected down the feed line at a given frequency.

A Few Words About Helicals

If you have no supports for an inverted-L antenna, it may be worth considering a helically wound short vertical (fig. 5) for that city lot. You can use 20 or 25 feet of PVC pipe for the coil form. Space wind 1/2 wavelength of wire on the PVC pipe to cover all of its length. Install a capacitance hat (the larger the better) at the top of the antenna. This will decrease the antenna Q and prevent it from becoming a Tesla coil when you speak into the microphone or key the transmitter (a ball of flame!), and it will increase the antenna bandwidth. The helically wound anten-

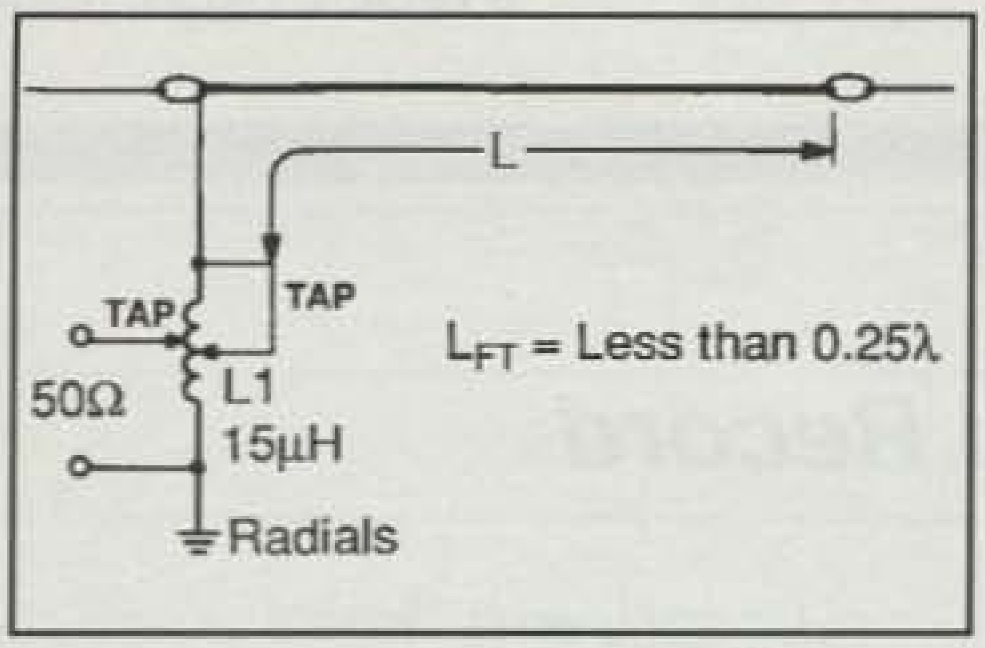

Fig. 4– Simple system for matching an inverted L or any ¼-wavelength antenna to a 50 ohm source. The antenna should be slightly less than ¼ wavelength overall to permit L1 to establish resonance. The upper tap is selected for antenna resonance while using a dip meter. The lower tap is chosen to provide a 50 ohm feed impedance.

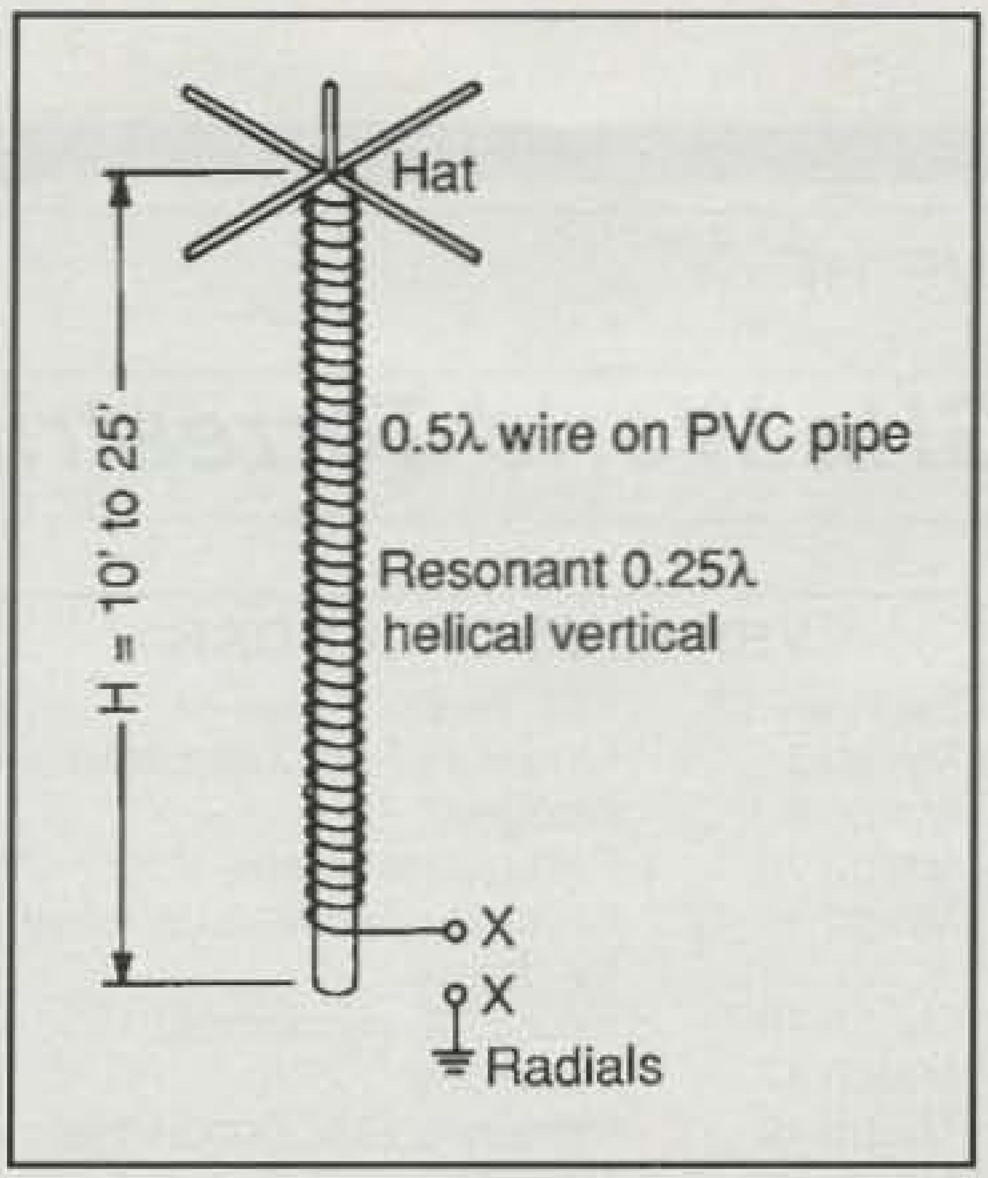

Fig. 5– A short helically wound vertical may be used effectively over a ground plane when space does not permit erecting larger antennas. The longer the helix he better the performance (see text).

na is tuned to reasonance by trimming turns at the bottom for the lowest SWR at the chosen part of the 160 meter band (it won't be 1:1). Tuning is done with the ground system in place. The simple matching networks described earlier in the article are suitable for this antenna.

In the early 1950s I used an antenna of this description and had excellent results with only 50 watts of AM transmitter power. I used a 16 foot wooden handrail I obtained from a lumber yard. It was treated with two coats of spar varnish (exterior polyurethane varnish may be used) and wound with 250 feet of No. 14 vinyl-covered house wiring. After I resonated the antenna I added two coats of spar varnish to help keep the spaced turns from moving and to protect the winding from the weather. The capacitance hat was fashioned from a 10 inch OD aluminum pie tin that was connected to the upper end of the helical winding. I had no difficulty maintaining regular contacts with stations as far away as 500 miles at night (sunspots were at an ebb), and worked a station in Death Valley, California from Michigan on two occasions.

Summary Remarks

If you want to enjoy success on 160 meters, you will need to use the best antenna system you can manage. This truism applies especially to top band, where noise levels are often high (atmospherics and manmade noise), and where some signals are somewhat puny because of poor antennas. Although I am by no means a power monger, it is beneficial to have a linear amplifier that operates on 160 meters for those times when noise levels or propagation make it almost impossible to be heard with a barefoot rig. My Ameritron AL-80A is called into service many times when conditions merit the use of additional power.

73, Doug, W1FB