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What's the Best Antenna for 160?

- - the inverted vee compromise

The downfall of potential 160 meter operators is most usually the antenna system. For some unexplainable reason, many persons who would operate the 1.8 MHz band apparently believe, perhaps due to the frequency, that any antenna made to load will produce satisfactory results. Satisfactory results are different to different folks, but if 160 is to be enjoyed to its potential, haphazard antennas are not the medium.

It is not the intent of this article to debate 1.8 MHz antenna type merits. That discussion has been underway for decades. Anyone who has operated 160 meters has his opinion, likely biased towards his particular use of the band.

There simply is no "best" antenna for all situations, but taking into consideration expense, ease of construction, and the ability to produce all-around performance, whether it be local or DX communication, the inverted vee dipole is probably the best compromise. Full-sized quarter wave verticals are popular with the DX crowd, but 160 meter pioneer W1BB leads them all with nearly 130 countries worked on an inverted vee.

In my general geographic location, three operators spent this past winter actively chasing DX and comparing results. Two stations were inverted vee equipped, the third had a full-sized quarter wave vertical. Letters from and on-air communication with DX stations throughout the world were interesting. The quarter wave vertical station ranked, on the average, slightly better for signal consistency compared to the inverted vees, but under certain conditions and over certain paths, the inverted vees took honors. An interesting comment came from a European, who said, "When the band is marginal, your quarter wave competitor may be copyable when you aren't, but when the band is open, your inverted vee is louder." Is this mixing and reinforcement of polarization? Possibly. You can find on 160 some unusual propagation and path quirks not found on any other amateur band. In the long run, the vagaries of propagation are the great equalizer so long as the antenna performs at the best possible efficiency.

If you have a tower topped with a high frequency tri or mono-band beam, can lay an adequate ground screen radial system (and I am not certain what is "adequate"), and wish low angle DX radiation, then by all means use the tower shunt fed as well-described in one or more previous articles.[1] A 3/8 wave inverted L type antenna is an excellent performer, provided it too is operated against a good radial system. The short, commercially available, base or center loaded 20 to 30 foot verticals are poor performers even used with a good radial system. Should you not want or be able to install a radial system, the inverted vee is likely the best all-around compromise 160 meter antenna, giving hours of enjoyable stateside contacts and doing a respectable DX job when the skip is long.

The inverted vee, however, is not to be constructed and installed in a haphazard manner. Set aside a Saturday afternoon and do it properly. To assist, here are a number of suggestions and tips that will ensure a well-performing installation.

1. Use number 14 or larger copperclad steel wire for the dipole.
2. The center insulator should be a 1:1 balun like the Palomar, which covers 160 meters, or the like. Be certain the balun selected does cover 160 meters. Many do not, have a low frequency cutoff around 3 MHz, and will not work at 1.8 MHz.
3. Cut the antenna length using the standard half wave dipole formula of 468/f(MHz) or 257 feet, 10 inches at 1.815 MHz.
4. Prepare the center balun/insulator and dipole wires according to the manufacturer's instructions.
5. On the dipole far ends, use 6 to 12 inch insulators similar to those made by Hy-Gain. Do NOT use "egg" type insulators.
6. Do not solder the dipole far ends after securing through the insulators. The antenna will have to be trimmed to resonance. The wires will be soldered after resonance determination.
7. Erect the center (apex) insulator/balun as high as possible. It should be a minimum of 95 feet high to obtain a between-leg apex angle of 90°. A 50 foot height will give an apex angle of 120° and is the *maximum* angle at which the inverted vee will exhibit low angle vertical radiation. A 90° to 100° angle is highly recommended, but with less than 90°, signal cancellation and severe loss of antenna efficiency will result. These figures place the antenna ends approximately 200 feet apart and at ground level. It is desirable to have the antenna ends elevated ten or more feet, if height capabilities per-

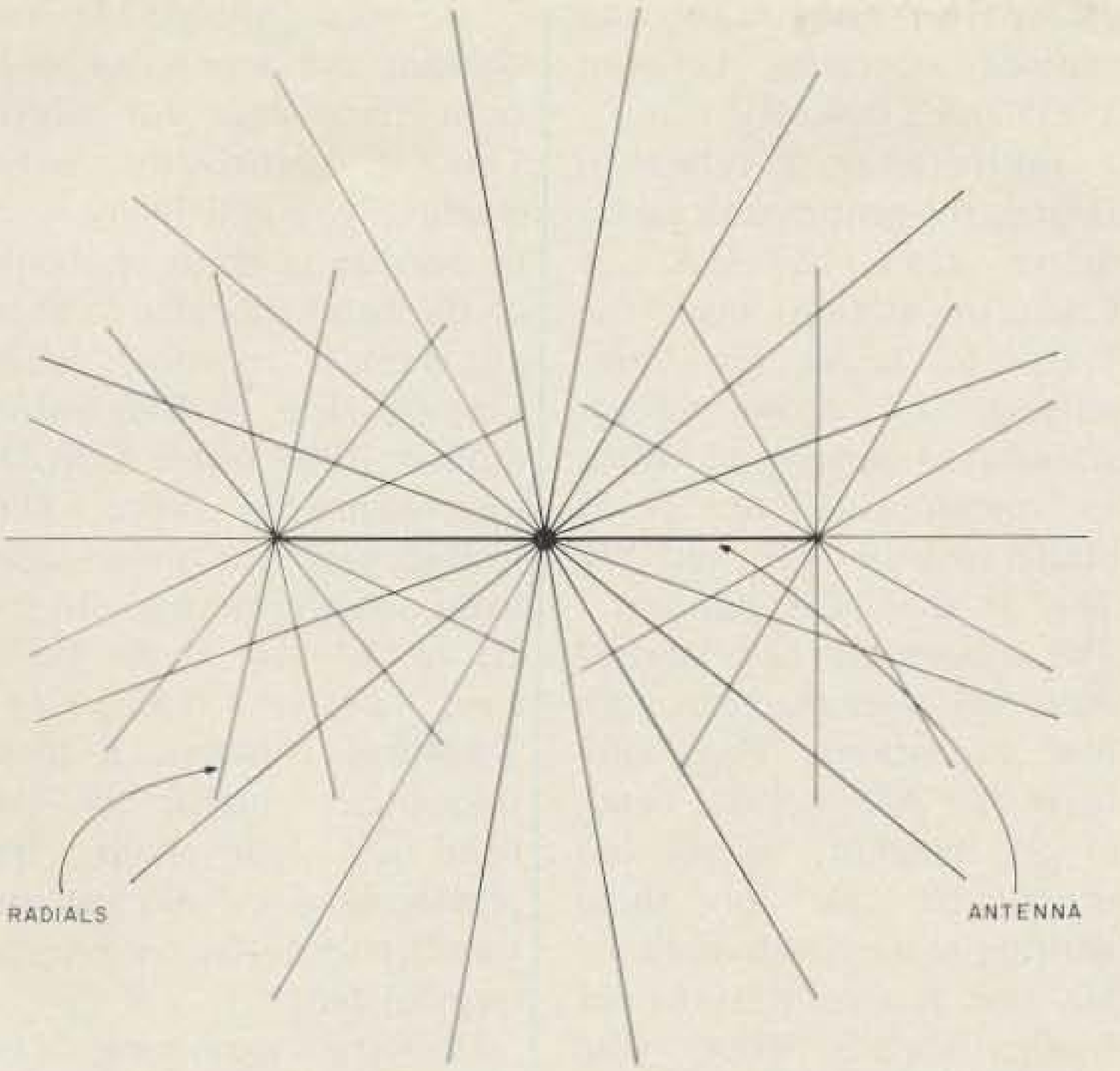

Fig. 1. Proposed ground screen radial system for 160 meter inverted vee (top view).

mit. It is also desirable to run the legs in a straight line, not folding them back upon themselves, but this may be necessary to fit the antenna into available space.

8. If the antenna center is to be supported by a metal mast or tower, it is recommended the center of the antenna be hung 3 or more feet off the support to minimize coupling. It is assumed any guy lines are broken with insulators into non-resonant lengths. Install the antenna as clearly as possible from guy lines.

9. The feed impedance of an inverted dipole is approximately 50 Ohms. The antenna may be fed with any popular 50 Ohm coaxial cable. At this frequency and amateur-allowed power levels of up to one kilowatt, there is nothing gained in using expensive RG-8 type cable. The much less expensive RG-58 type cable has very low loss and more than sufficient power handling capability at 1.8 MHz.

10. It is highly recommended that the feedline be made an *electrical* half wavelength or multiple thereof. A half wave length of foam dielectric coax, at 1.815 MHz, is 219 feet, 6 inches; solid dielectric coax has a length of 178 feet, 11 inches at the same frequency. These feedline lengths are calculated for 1.815 MHz. Should you elect operation in other available portions of the band, as shall be discussed briefly later, in addition to adjusting the dipole length, feedline length will need to be changed. Use these formulas for the calculation of an electrical half wavelength:

Foam

$$\frac{492}{f(MHz)} \times 0.81 = \text{length}$$

Solid

$$\frac{492}{f(MHz)} \times 0.66 = \text{length}$$

Any excess cable between the antenna and transmitter may be coiled, taped and placed out of the way.

11. Tuning the antenna may be accomplished through use of a reflectometer (swr bridge) or wattmeter having forward and reverse scales. Be certain the instrument is accurate at 160 meters. Many commonly available swr and wattmeters cut off around 3 MHz and are *entirely* inaccurate at 1.8 MHz. The least expensive swr meter having reasonable accuracy at 160 meters that I know of is the Swan SWR-3 at $10.95.

12. There are but two places to accurately measure swr: at the antenna feedpoint or along the feedline at the electrical half wave points. If you cut your feedline as described, you may do your measurements at the transmitter. Otherwise, if you want accuracy, measure at the antenna feedpoint. This may not be physically convenient, but a tuned antenna is our goal.

13. Initial swr measurements will most likely indicate the antenna is too long. This is expected due to a number of factors involving an inverted vee antenna. The antenna will need to be trimmed on *each* leg from 2 to 5 percent. Initial trimming may be up to 6 inches. Recheck the swr, trim again as necessary, but in smaller increments of 2 inches per leg.

14. Do not put absolute faith in an swr meter. If you have two, try both, being prepared to believe the one which shows the *highest swr*. Erratic readings, indication of reflected power varying under key-down conditions, may be diode saturation in the swr meter (use only as much transmitter power as needed for full scale forward reading), a faulty balun, or the like. If you are using an antenna tuner and it becomes warm or if you have difficulty loading the transmitter, suspect a problem in the antenna system that warrants immediate attention.

15. In practice you may not be able to obtain a 1:1 swr at the desired frequency. Trim for minimum swr, remembering that a 1.5:1 swr represents only 6.25% loss and a 2:1 but 11%. With the feedline cut as suggested, an swr of less than 1.5:1 is easily obtainable.

16. Inverted vee straight dipoles typically have a very narrow operating bandwidth rarely exceeding 25 kHz at the 2:1 swr points. Some additional bandwidth is possible using a folded dipole in the inverted vee configuration. Antenna and feedline lengths remain as previously described except the center balun/insulator will be a 4:1, such as a Palomar.

17. Observed radiation patterns of acute angle inverted vees suggest maximum radiation off the antenna *ends*, not broadside. Two inverted vees at right angles to one another are suggested for maximum coverage of all compass points. On certain paths, startling signal strength differences of 10 to 15 dB are not uncommon.

18. A remote-powered changeover relay may be used at the feedpoint for feedline switching between antennas. This saves the cost of one feedline but adds the cost of the relay and possibility of its failure some cold winter night. Separate feedlines are suggested.

19. Don't neglect waterproofing of connections. PL-259 connectors are not waterproof. Spray with several coats of a Krylon-type spray, wrap with good quality electrical tape and spray again.

Speculative Ground Screen Option

While I have not experimented with a ground screen radial system beneath an inverted vee, my speculation is that it may be worthwhile, particularly in locations having poor soil conductivity. Ground losses at 160 meters can cause severe absorbing of transmitted power. The suggestion would include bonding 20 to 40 radial wires to the tower base, the radial wires being .40 to .50 wavelengths long evenly spaced and fanned around the tower like spokes of a wheel. At the dipole ends and directly beneath them, a six foot or longer ground rod may be driven into the earth and bonded to it, another 20 to 40 radials each being .12 to .25 wavelengths long evenly spaced and fanned. Electrically it is not necessary to bury the radial wires.

Before undertaking the complete radial installation, try the first 4 radials directly

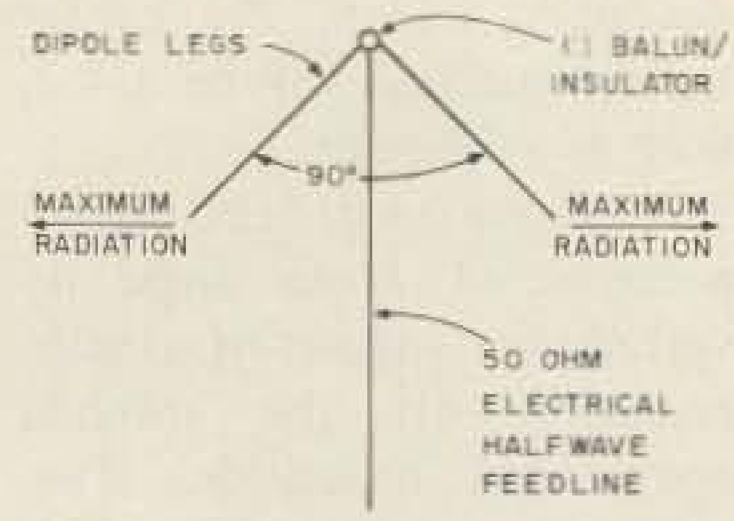

Fig. 2.

beneath the antenna center, spaced 90°. Place two radials directly beneath the antenna legs. I would anticipate a change in the antenna's resonant frequency which may be an indication the radial system would be worthwhile. Carefully controlled before and after signal strength measurements with the cooperation of a nearby colleague may provide meaningful information.

An inexpensive source of ground screen radial wire is the so-called electric fence wire available from Montgomery Wards, Sears Roebuck or most farm supply stores.

The Gentleman's Band

The 160 meter band is not an amateur band per se, but a shared band in which U.S. amateurs are permitted operation on a non-interference to LORAN navigational services basis. As protection to the LORAN service, the 160 meter band is segmented by frequency allocation and transmitter input power is related to geographic location. Traditionally popular segments of the band in the U.S. are 1.800 to 1.825 and 1.975 to 2.000 MHz. Over the years there has evolved a gentleman's agreement on usage. This agreement says that 1.800 to 1.810 is reserved for CW only, and 1.810 to 1.825 is for voice communication, although FCC regulation allows mixing of modes by not specifying CW and voice subbands. There is little U.S. CW activity elsewhere in the 160 meter band with the exception of Hawaiian stations operating between 1.995 and 2.000 MHz.

Furthermore, as relates to DXing, the gentleman's agreement says no U.S. or Canadian station may use 1.825 to 1.830 for transmitting, to allow foreign stations a segment in which to operate without being obliterated by VEs and Ws. This is the "DX Window." The agreement has worked quite well over the years with few exceptions. Five kilohertz of a 200 kilohertz band, or 2½ percent, is not too much to ask for those desiring to work international DX and as a courtesy to our foreign friends. Those who honor the agreement are commended, those who do not are respectively requested to be considerate.

If your 160 meter interest is DXing, your operation will likely be confined to 1.800 to 1.825, keeping in mind not to spill sidebands into the DX window by operating too close to 1.825 or 1.830.

If your interest is rag chewing and developing long-term friendships for which 160 is particularly noteworthy, you will likely wish to operate in those segments of the band allocated to your geographic location while keeping clear of frequencies around 1.900 where LORAN interference is fierce. This winter past saw much sideband activity moving into the 20 to 30 kHz above 1.830 and above 1.975 for QRM-free contacts. If these frequencies higher in the band are your choice, the previously given antenna and feedline formulas need to be recalculated.

Before operating 160 meters, be sure to check FCC regulations concerning power and frequency allocation for your area. The ARRL Operating Aid S-15A contains all necessary particulars. ■

Reference

[1] W5RTQ, "Shunt Feeding Towers . . .," *QST*, pg. 22, October, 1975.