The Vertical-V Antenna

"Rabbit ears for hf? Heresy!" you declare. Or is it? Let this article tempt you to find out what the "ears" can do for you!

By Dr. Lawrence B. Owen,* WB6HNQ

Most amateurs undoubtedly are familiar with the properties of inverted-V hf antennas. The inverted V is simple, is inexpensive to build, provides a good match to a 50-ohm coaxial line and produces a quasi-omnidirectional horizontally polarized radiation pattern when used at its fundamental frequency. It occurred to me recently that a vertical-V (an inverted V rotated 180 degrees in the vertical plane) might also have some interesting performance characteristics. In terms of appearance, the vertical-V is reminiscent of an indoor TV rabbit-ears antenna (Fig. 1).

A cursory literature review revealed that rigorous analysis of basic V-antenna performance had been completed by the late 1940s.[1,2] In fact, Wells[3] can probably be credited for the invention of the inverted V in 1944. Kraus, in the introductory chapter of *Antennas,*[4] points out in a generic sense that a cylindrical vertical-V can be expected to yield a broader usable bandwidth than the corresponding dipole. In considering the relative merits of vertical-V versus other common types of wire antennas, it seems clear that the vertical-V offers the potential for significantly improved performance. I am surprised, therefore, to find that in *QST*, at least, there has been no description of a practical vertical-V for amateur hf use.

The classical inverted V, while providing excellent performance, does suffer from several deficiencies. Ground effects undoubtedly degrade radiation efficiency and influence feed-point impedance. If the antenna is supported from a metallic structure, additional parasitic losses can occur. Since the antenna is center fed, unbalanced currents may be induced on the transmission line even if a balun transformer is used at the feed point. Finally, sloping the elements downward increases the likelihood of parasitic losses in nearby ground-mounted structures.

Vertical-Vs would be affected to a much lesser degree by the factors described above. In addition, vertical-Vs provide the additional advantages of increased effective antenna height, simpler construction (only one central support required when self-supporting aluminum elements are used) and a capability for rotating the antenna. My experiments indicated that a vertical-V exhibits a 6-dB

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[1]Notes appear on page 25.

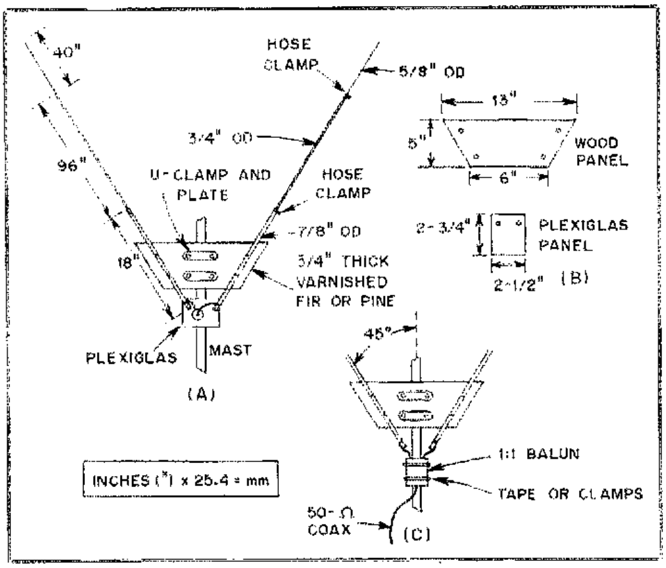

Fig. 1 — Construction details for the 15-meter vertical-V antenna. As indicated in section A, each element is bolted to the wood and Plexiglas panels. For the wooden panel use 1/4 × 2-1/4-inch bolts. For the Plexiglas panel use 1/4 × 1-1/2-inch bolts. Panel dimensions are shown at B. Part C shows the angle for the elements and the position for the balun. Both elements are individually adjusted to a length of 135.7 in (3.446 m) for resonance at 21.225 MHz.

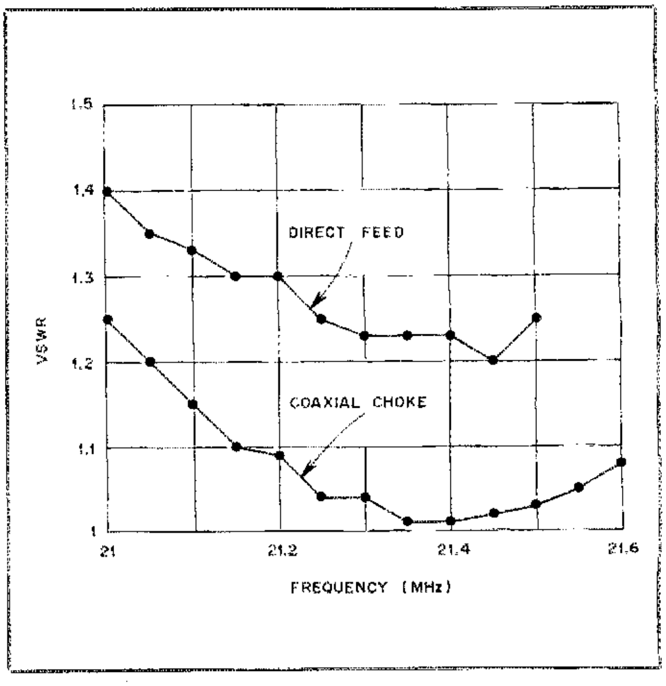

Fig. 2 — The VSWR performance of the 15-meter vertical-V antenna with and without the coaxial cable choke.

front-to-side ratio, suggesting that the ability to rotate the antenna might be advantageous under certain operating conditions.

Making a comparison of the mechanical properties of a vertical-V with those of an equivalent single-element delta loop or quad also proves to be instructive. A rather obvious point is that the vertical-V is lighter and offers lower wind loading than either a quad or delta loop cut for the same fundamental frequency. My experiments indicate that the length in feet of a resonant half-wave vertical-V constructed from aluminum tubing is approximated by 480/frequency (MHz). The length in meters is 146.3/frequency (MHz). A 1/4-wave vertical-V element is, therefore, about 28.5% and 4.5% shorter than single legs of corresponding equilateral delta loops and quads, respectively. You can conclude that the vertical-V offers the advantages of reduced construction cost, lower wind loading and weight. Besides being simpler to construct, it permits direct matching to a 50-ohm coaxial transmission line.

Construction

The basic design for a single-element 15-meter vertical-V is shown in Fig. 1A. Telescoping sections of aluminum tubing are used for the elements, which have outer diameters of 7/8 in. (22 mm), 3/4 in. (19 mm) and 5/8 in. (16 mm). One end of each of the two 7/8-in. and 3/4-in. element sections are slotted with a hacksaw to a depth of about 1 inch (25 mm). Since the elements must be insulated from each other and from the support bracket, the 7/8-in. dia element sections are mounted on a wood base. The wood (fir or pine) has several coats of varnish to ensure reasonable service life. The 3/4-in. OD elements are telescoped into the base section and secured with stainless steel hose clamps. The same procedure is used to secure the 5/8-in. OD sections to the 3/4-in. OD elements. A standard "coax" male connector is mounted in a piece of Plexiglas that is secured directly to the base-element sections.

The input impedance of the antenna is a function of the apex angle. My prototype employed an apex of 100°. As shown by the SWR curves in Fig. 2, excellent bandwidth and low SWR were attained. The data suggest, however, that an even better match to 50-ohm coaxial cable could be obtained by reducing the apex angle slightly to between 90° and 95°.

Initially, the antenna was fed directly by RG-8/U coaxial cable. With this arrangement the upper SWR curve shown in Fig. 2 was obtained. The SWR seemed too high and my Century 21 transceiver was bothered by severe distortion in the keying monitor. Rf feedback, traced to rf flowing along the shield of the transmission line, takes the blame for this condition. A coaxial choke installed at the antenna feed point solved the difficulty. This choke is constructed by simply forming a 5-in. (130-mm) dia coil consisting of four turns of transmission line that is taped to the mast.

Setting the resonant frequency of the antenna requires loosening the two base-element clamps and adjusting the telescoping elements as necessary for the lowest SWR. The initial 1/4-wave element length (11.3 feet or 3.45 meters for 21.225 MHz) was obtained from my empirically derived expression: length in feet for a quarter wavelength = 240/frequency in MHz. To determine the length in meters the equation is m = 73.2/frequency in MHz. The solder joints and the coaxial cable were subsequently sealed with a rubber repair compound obtained from a local hardware store. Any one of several commercial or homemade 1:1 baluns may be used to eliminate the need for separate Plexiglas coaxial connector mounts and coaxial chokes.

Performance of the 15-meter vertical-V was excellent during a six month period from October 1979 to March 1980 while I was using a Century 21 transceiver with 25 watts of rf output. All operations took place from a QTH located about 50 miles east of San Francisco. A total of 103 stations were worked. DX included contacts with Canada (6), Mexico (3), Hawaii (2), Japan (24), Australia (9) and New Zealand (1). The remaining 58 contacts included all contiguous U.S. call areas.

A second series of tests was carried out after the vertical-V elements had been shortened to 8.9 ft (2.7 m) for CB operation. CB tests, using a Radio Shack ssb rig, were conducted as a simple means of evaluating the major polarization mode of the antenna. Several local CB operators used quad antennas that featured instantaneous selection of either horizontal or vertical polarization. Tests indicated that the V was about 12 dB stronger when horizontal polarization was selected by the other operator. This suggests that a significant element of vertical polarization was produced by the V. Thus, the vertical-V offers a reasonably good compromise between quasi-omni-directional radiation and bipolarization performance.

There seems little doubt that the vertical-V is an excellent performer. Construction of single-element monoband versions for operation from 14 to 30 MHz (or higher) is certainly feasible. Multiband operation should be relatively easy to achieve by making use of various concepts developed over the years for conventional dipoles and verticals. A more intriguing thought, however, would involve appropriate modifications for producing a vertical-V beam antenna. As a starting point, I would suggest using conventional element spacing parameters developed for horizontal Yagi arrays. Input impedance, however, will probably be lower than for the equivalent Yagi. The advantages of increased effective height, shorter turning radius, reduction of adverse boom and tower interactions on beam performance, and the potential for increased bandwidth should be sufficient to justify further experimentation. QST

Notes

[1]Jasik, *Antenna Engineering Handbook*, McGraw-Hill, 1961.
[2]King, *The Theory of Linear Antennas*, Harvard University Press, 1956.
[3]Wells, *The Quadrant Aerial*, J. IEE (London), 1944, Part III, Vol. 91, p. 182.
[4]Kraus, *Antennas*, McGraw-Hill, 1950.

Strays

AMATEURS NEEDED TO ASSIST IN CONTAINING CALIFORNIA FIRES

☐ Amateurs in San Bernadino County have been asked to assist the California Department of Forestry during wildland fires. Two-meter communications will be provided for reconnaissance from the fire scene to central headquarters. Logistical support traffic will be passed from the fire camps to headquarters. Messages for the National Traffic System will be accepted for out-of-county and out-of-state firefighters. Interested volunteers please contact Thomas L. Markley, WA6IKH, 17400 Valley Blvd., No. 70, Fontana, CA 92335 or tel. 714-350-2194.

QST congratulates . . .

☐ Stuart Meyer, W2GHK, who was recently elected President of the Institute of Electrical and Electronic Engineers Vehicular Technology Society.

Some participants in the ARRL-sponsored IEEE SOUTHCON/81 professional program (Session 15) in Atlanta, Georgia, were, left to right, Dr. Ulrich Rhode, DJ2LR; Bill Allen; Marian Anderson, WB1FSB; Doug DeMaw, W1FB; and Tom Hayes. For further details see April 1981 *QST*, page 39. *(photo courtesy W1FB)*