Looking for an antenna to use on 160 meters? KD6GN came up with an approach that gave him full 160 meter coverage with low SWR and no need for an antenna tuner. Here's how he did it.

A 160 Meter Inverted-V Antenna

BY CARTER ROSE,* KD6GN

Last year I expanded my ham station by adding a transceiver that covered the 160 meter band as well as the frequencies up to 10 meters. It had lots of features I wanted, including a built-in antenna tuner. Unfortunately, the transceiver's tuner did not cover 160 meters, thus preventing me from operating on that band with my existing antenna system.

The desire to use the full-frequency capability of the transceiver triggered some trial-and-error experimental development on my part that ultimately resulted in an antenna with excellent capability on 160 without the need for an antenna tuner, and operation on all the other bands when the built-in tuner was employed. The steps I followed and the resultant design are described here.

Before presenting the details of my design, however, let me cover the "good" side and "bad" side of my approach:

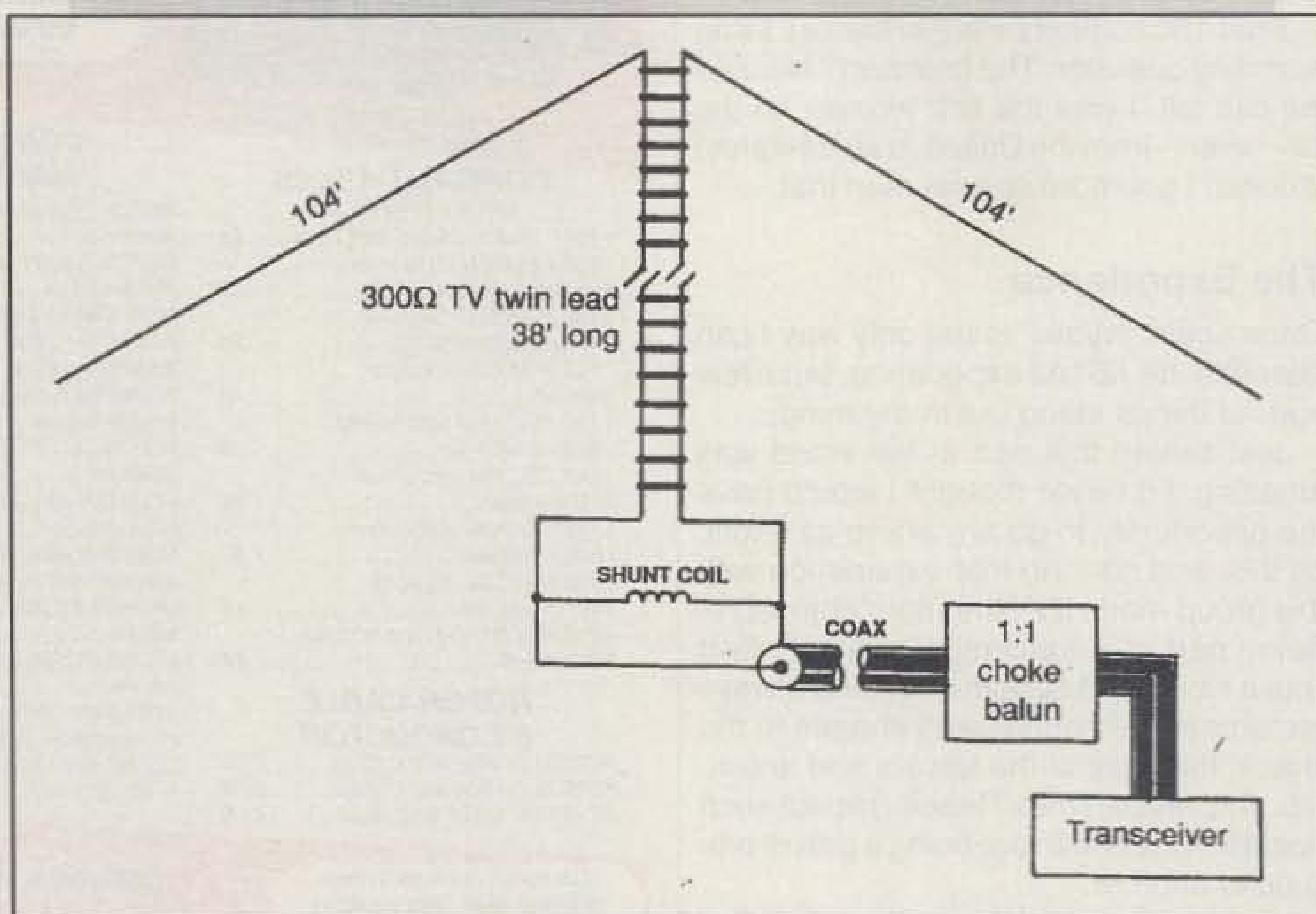

Fig. 1– The 160 meter inverted-V antenna.

Advantages

- Simple and easy to construct.
- Uses common readily available materials.
- Balanced system that does not require an RF ground.
- Omnidirectional radiation pattern on 160 meters.
- Provides 160 meter operational capabilities without the need for an antenna tuner. Simple radiating element length changes maintain an SWR of 1:1 over the full 160 meter band.
- Requires only one high support point
- Uses only one impedance matching element.
- With clear space around the central high point, the antenna easily converts to a high-gain V-beam on 20–10 meters.
- Antenna has been especially effective on 40 meters in the daytime, even under poor propagation conditions.

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Disadvantages

- Approximately 240 feet of space required between the end points of both legs.
- A 4:1 balun may be required to maintain a low SWR on 17, 15, and 12 meters.
- Difficult to maintain low SWR on 20–10 meters when TV twin line is wet.
- Design is based on a power limitation of 100 watts.

Design Evolution

A survey of my station site confirmed several facts. First, I had a single support point available 35 feet up (a 2×2 vertical pole adjacent to my chimney), and second, I had sufficient space around this support so that there was no limitation on the placement of the antenna end points.

Based on these facts, I decided to try an inverted-V with my 35 foot high point as an apex. With 160 meters as my major objective, I used two 120 foot wires as radiating elements. With the elements supported at the apex and slanting down in straight lines toward the ground, the end points of the V were about 120 feet each side of center and 8 to 10 feet above ground (see fig. 1).

I connected a 38 foot length of 300 ohm TV twin lead (left over from a recent TV antenna removal) between the radiating elements and the transceiver. A test of this first antenna system revealed that the antenna was resonant well below 1.8 MHz. Shortening each leg length to 104 feet changed the resonant frequency to 1.975 MHz, but the SWR could not be adjusted below 1.8 to 1.

My previous experience with conjugate admittance matching and calculations (see reference to M. W. Maxwell article in 1976 *QST*) led me to insert a shunt coil (about 5.5 microHenrys) across the input leads. This addition dropped the SWR to 1:1. During my tests I detected undesirable RF voltage on the transceiver chassis. I successfully eliminated this problem by inserting a 1:1 choke balun between the transceiver and the shunt coil. A method of easily changing the length of each antenna wire completed the fundamental design of this antenna.

Performance

I have used this antenna for over a year with extremely satisfactory results. The performance on 160 meters has exceeded my expectations, and the operation on the higher bands has also been excellent. The easiest way to show how the antenna performs is to present the radiation patterns modeled by Tom Lindstrom, W7VDQ, shown in figs. 2(A–B), as well as the SWR data shown in fig. 3.This data clearly shows the performance that results from the unique combination of the TV twin-line length and the 5.5 microHenry shunt coil.

On the 160 meter band this antenna achieves radiation performance equal to an isotropic antenna, only at elevation angles of 60 degrees or more. This characteristic is controlled by the height of the antenna; 35 foot elevation is quite low for 160 meters. With added height, the radiation performance will improve at lower angles of elevation. The lower the angle of elevation, the better the DX performance.

Now on to the actual construction, installation, and test.

Construction

The following steps are recommended:

1. Separate the 117 foot twin vinyl- covered wire by carefully slicing the insulation between the wires (If speaker wire or the equivalent is used, the wires can be carefully pulled apart.). Be careful not to break or cut the insulation on each wire, exposing the copper itself. Wind each length on corrugated cardboard panels for ease of handling. Remove about 1 inch of insulation from one end of each wire.

2. Form a center-loop insulator of about 3 inches in diameter from one of the black nylon ties. Fasten each length of wire to this insulating loop, leaving the stripped ends exposed.

Bill of Materials

117 feet of #18 twin vinyl-covered stranded wire. (I used speaker wire.) This wire is separated into two separate wires for use as the radiating elements.

38 to 40 feet of (good quality) 300 ohm TV twin line.

3 black nylon ties for use as the center and end insulators (ceramic insulators certainly are acceptable.).

Plastic cord to support the ends of the radiating elements and attach the TV twin line to the apex insulator.

2 one-foot long "bobbins" made of wood, metal, or plastic, each capable of holding approximately 12 feet of wire from the ends of the radiating elements. Wire is wound on each bobbin for the shortest antenna and unwound when increasing length for best SWR on 160 meters. See fig. 7 for a simple bobbin made from a wire coat hanger.

One 5.5 microhenry shunt coil. Made by winding 11 turns of #12 solid house wire on a $2^{1}/_{2}$ inch diameter plastic tube, or by winding a 9-turn, 2 inch long coil of #18 solid wire on a $^{3}/_{8} \times 3$ inch ferrite rod (from the AM broadcast band antenna of a transistor radio)—see fig. 4.

1:1 choke balun (see fig. 5).

4:1 choke (current) balun (if needed).

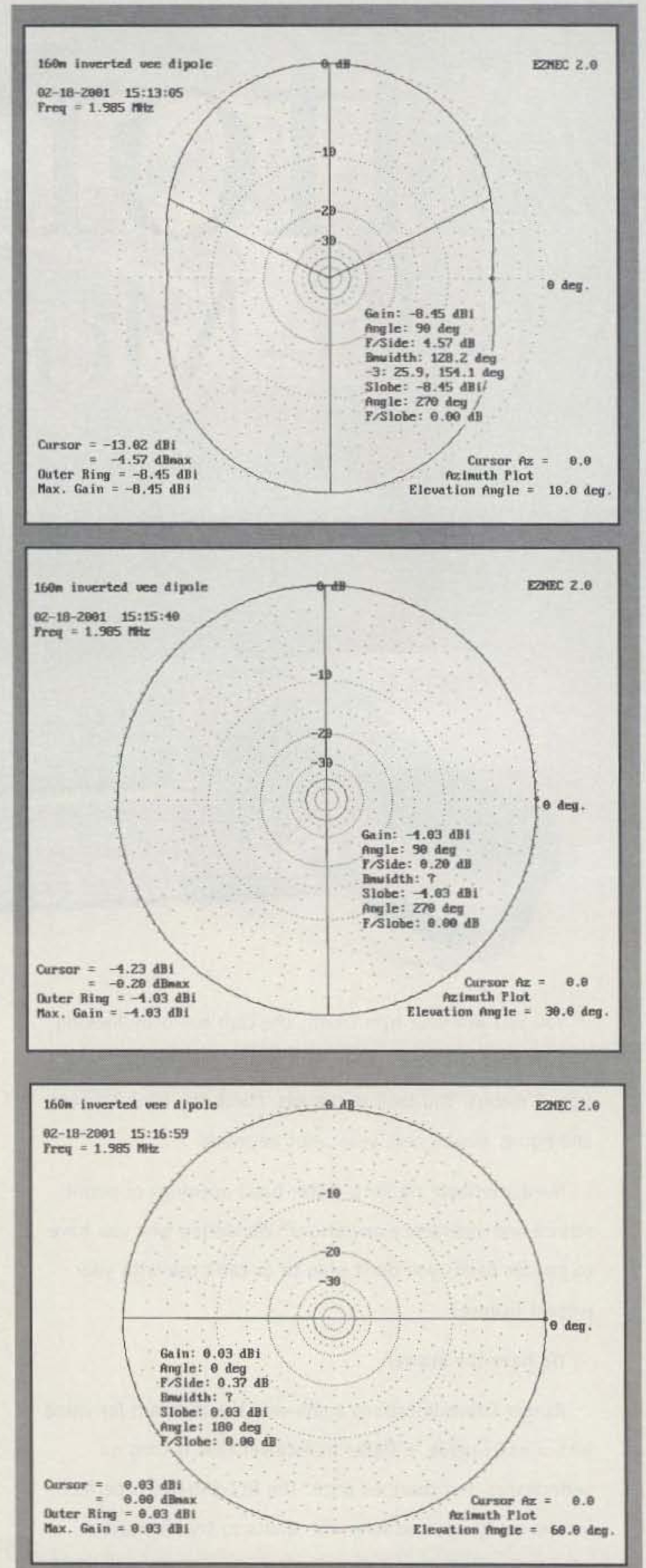

Fig. 2– (A) The 160 meter inverted-V antenna azimuth plot at 10 degree elevation angle; (B) azimuth plot at 30 degree elevation angle; (C) azimuth plot at 60 degree elevation angle.

Frequency (MHz)	Resistance	Reactance	VSWR
1.93	89.31	+35.85	2.17
1.94	76.97	+12.17	1.60
1.95	58.65	+1.24	1.17
1.96	43.68	−0.58	1.15
1.97	32.41	+1.45	1.54
1.98	24.88	+4.76	2.03

Fig. 3– VSWR calculations with 3.34 microHenry shunt coil installed as shown in fig. 1.

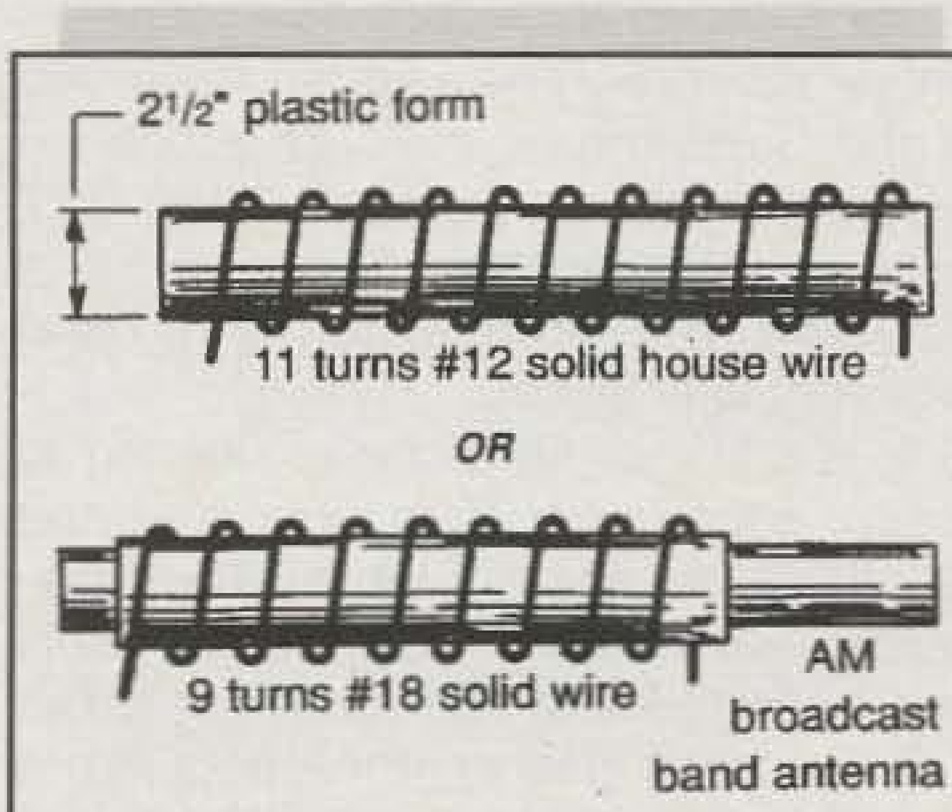

Fig. 4– Construction details of the shunt coil (two alternatives).

3. Strip the insulation from about 1 inch of the TV twin line and fasten the twin line to the same center-loop insulator. Solder the stripped ends of the radiating wires and transmission line together. Seal the connections with putty to provide protection from the elements.

4. Attach the center insulator to the apex support point and elevate it to 35 feet. Extend the radiating elements out in straight lines (see fig. 1) and wind about 6 turns (12 feet) of each end onto the "'bobbins." Secure the wound wire with the black nylon ties. Support these bobbins about 6 to 10 feet above the ground, but keep the wires extended in straight lines. I have used trees, vertical poles, and fence posts for such supports. The length of wire from each bobbin to the apex should now be 104 feet.

I currently am using a pulley at the top of the 35 foot pole to permit the antenna to be dropped quickly if necessary. This is a very important consideration in Tucson, where lightning is a serious hazard at any time of the year.

5. Connect the twin line, shunt coil, balun, and transceiver coax as shown in fig. 1.

That completes the assembly and installation process.

Testing and Use

The testing and operational requirements are quite simple:

1. Tune the transceiver to 1970 kHz and feed a little power to the antenna. The SWR should read 1:1. Tune to 1945 kHz and 1995 kHz; at each frequency the SWR should read about 1.5 to 1.

2. Lengthen each radiating element 6 feet by unwinding from each bobbin. Tune to 1880 kHz; SWR should be 1:1. Lengthen the radiating elements another 6 feet and tune the transceiver to 1820 kHz. Again SWR should read 1:1. The exact length of wire extension to achieve 1:1 SWR may vary for different locations. Experiment and record the exact lengths you should use.

3. While the transceiver, ungrounded, shows an SWR of 1.5:1, connect the transceiver chassis to ground while

feeding about 20 watts to the antenna. There should only be a small movement of the SWR meter, indicating that the antenna system is closely balanced, only a small common mode current is flowing to ground, and an RF ground has very little effect.

4. If a longer feed line is needed to reach your transceiver, increase the length of the coax going to the transceiver. Maintaining the 38 feet of TV twin line is important for 160 meter operation.

5. Because this antenna acts like a closely-spaced beam on 160 meters with a very high angle of radiation, it may be possible to improve performance by reducing the loss of the reflecting ground. This can be achieved by placing a wire directly under the antenna (see reference to *1993 Radio Amateur Antenna Handbook)*.

6. The shunt coil is required for 160 meters but can be left in the system, because it does not adversely affect the higher frequencies.

7. Use a 4:1 balun, if needed, on the 17, 15, and 12 meter bands. Install it between the choke balun and the TV twin line.

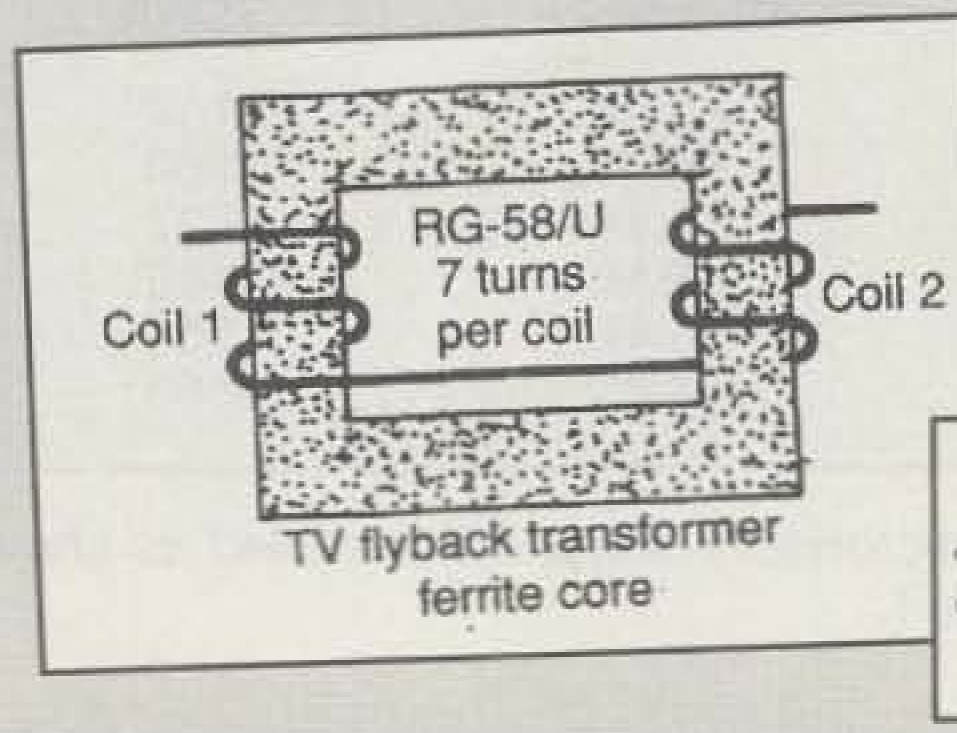

Fig. 5– The 1:1 choke balun.

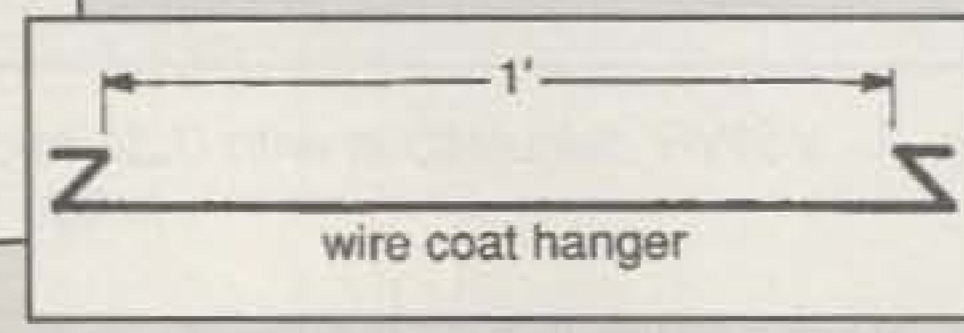

Fig. 6– Simple "bobbin" formed from a wire coat hanger.

Closing Comments

This antenna has been in use in two locations for over a year. I am very pleased with its performance and its durability. I've gotten lots of excellent signal reports from my many contacts.

Anyone interested in using it at higher power outputs must increase the wire sizes appropriately. I cannot see any restrictions in this regard.

I must point out that during the cut-and-try evolution of my antenna I became aware of the similarity of my antenna to the Varney G5RV multi-band dipole. Varney's antenna uses a total overall length of 102 feet for the radiation elements, whereas mine is approximately twice that size. Varney did indicate that the antenna could be used in the form of an inverted-V, but his fundamental approach was to maintain the radiating elements parallel to the ground.

The use of an admittance matching shunt coil with an electrical one-tenth-wavelength twin line feeding a low inverted-V is unique to my design. A 1:1 choke balun is necessary to maintain electrical balance and to minimize common mode currents on the coax shield.

To fully benefit from Varney's work and the similarities involved, it should be noted that he indicated that up to one sixth of the total antenna length can be dropped vertically, or bent at a convenient angle, to save on the space needed. I have not tried this approach on my antenna, but it may be of value to those who do not quite have enough room for the antenna described in this article.

For those of you who try my approach, I hope you have the same excellent results that I have had. Good luck and good DX!

Acknowledgements

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