INVERTED... Antenna

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The popular inverted-V dipole can be improved to provide some directivity by adding a little more wire and a couple of home-made phasing stubs

The inverted V, or sloping dipole antenna, which was described in Jim Fisk's article, "Antennas for the High-Frequency Amateur Bands" in the June, 1977 issue of *Ham Radio Horizons*, is one of the simplest arrangements you can use for working DX stations. Only a single support (tree or mast) is needed to hold the antenna above ground. The inverted V is really a dipole antenna with sloping elements, or legs. The angle between the legs isn't too critical; however, it should be somewhere between 90 and 120 degrees. If the angle is much less than 90 degrees, you can expect feed problems and high standing-wave ratio.

The inverted V has characteristics of both horizontal and vertically polarized antennas. The inverted V doesn't perform as a true vertical antenna; nevertheless it seems to have a low radiation angle in the vertical plane. Furthermore, an elaborate ground radial system, which is characteristic of vertical radiators, isn't necessary.

Energy radiated from a half-wave (dipole) antenna oriented horizontally looks like the pattern of **Fig. 1A**. The radio-frequency energy leaves the antenna in two broad lobes in opposite directions, **A** and **B**. If two dipoles arranged in a straight line are connected so that they operate in the *same phase*, the currents in each element will appear as shown in **Fig. 1B**. Such an

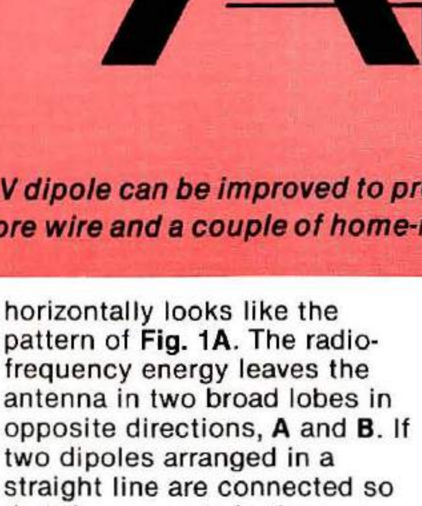

Fig. 1. Radiation pattern for a simple horizontal dipole antenna, **A**, and current distribution of two dipoles driven in phase, **B**.

arrangement is known as a *driven array*.

The radiation pattern of the antenna of **Fig. 1B** will be similar to that of **Fig. 1A**. However, because two half-wave elements are used, which are fed in phase, the radiation pattern will be intensified and will look somewhat like that shown in **Fig. 2A**. This radiation pattern is sharper and more directive, which is the same as saying that the antenna producing such a pattern has *gain* along the line of maximum energy propagation. Also, the antenna beamwidth is reduced. This is the same feature provided by expensive Yagi beams, which use aluminum tubing for elements and must be mounted on a tower or other high support for maximum effectiveness.

If all the elements in a driven array are in a straight line, the arrangement is called a *collinear array*. The current in each element must always be in the *same phase*. This phase relationship is maintained by connecting each element with sections of transmission line, called "stubs," of the correct length and impedance.

When two collinear half-wave antenna elements are connected directly, the effect is that of a full-wave antenna, **Fig. 2B**. The current in the first half-wavelength element is exactly 180 degrees out of phase with that in the second half-wavelength element.

When the elements are connected by a quarter-wavelength stub, as in **Fig. 1B**, the current travels down one side of the stub and up the other. The current travels a distance of one-half wavelength in the stub; thus the current travels through *one-half cycle* of change. When the current reaches the next element, it's in the desired phase. Since the current in one side of the stub is equal and opposite to the current on the other side, the fields produced by the stub cancel, and no radiation is produced from the stub. Thus, the two half-wave elements are said to be *driven in phase*.

Let's build one

Enough of the theoretical stuff. Here's how to put up an inverted V with collinear elements for increased directivity. A sketch of the modified inverted V is shown in **Fig. 3**. Dimensions are in terms of wavelengths for the radiating elements and the phasing stubs. Also shown are suggested angles for separating the antenna legs (angle α), the angle between the antenna legs and the phasing stubs (angle β), and the angle between the mast and antenna legs when the antenna is looked at from the side (angle γ). The reason for showing angle γ is that I've obtained better results with the inverted V when the plane of the element legs is sloped out of the plane of the supporting structure. See **Reference 1** for further details.

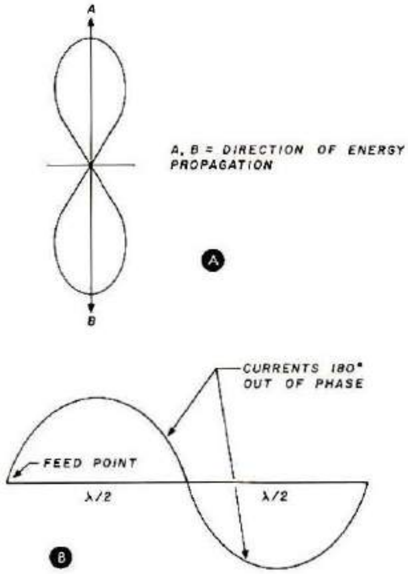

Fig. 2. Radiation pattern of an antenna with two half-wave elements driven in phase, **A**. The pattern is sharper than that of an ordinary dipole and gives increased signal strength in the directions shown. Sketch **B** shows the current distribution in two half-wavelength antenna elements connected directly together; that is, the system operates as a full-wavelength antenna.

Assuming you're now using the naked inverted V and want to add another half-wavelength section to each leg for improved performance, all you need is a little more wire for the additional elements and a couple pieces of coax cable for the phasing stubs. I've shown type RG-8/U coaxial cable for the stubs and transmission line in **Fig. 3**; however, if you're

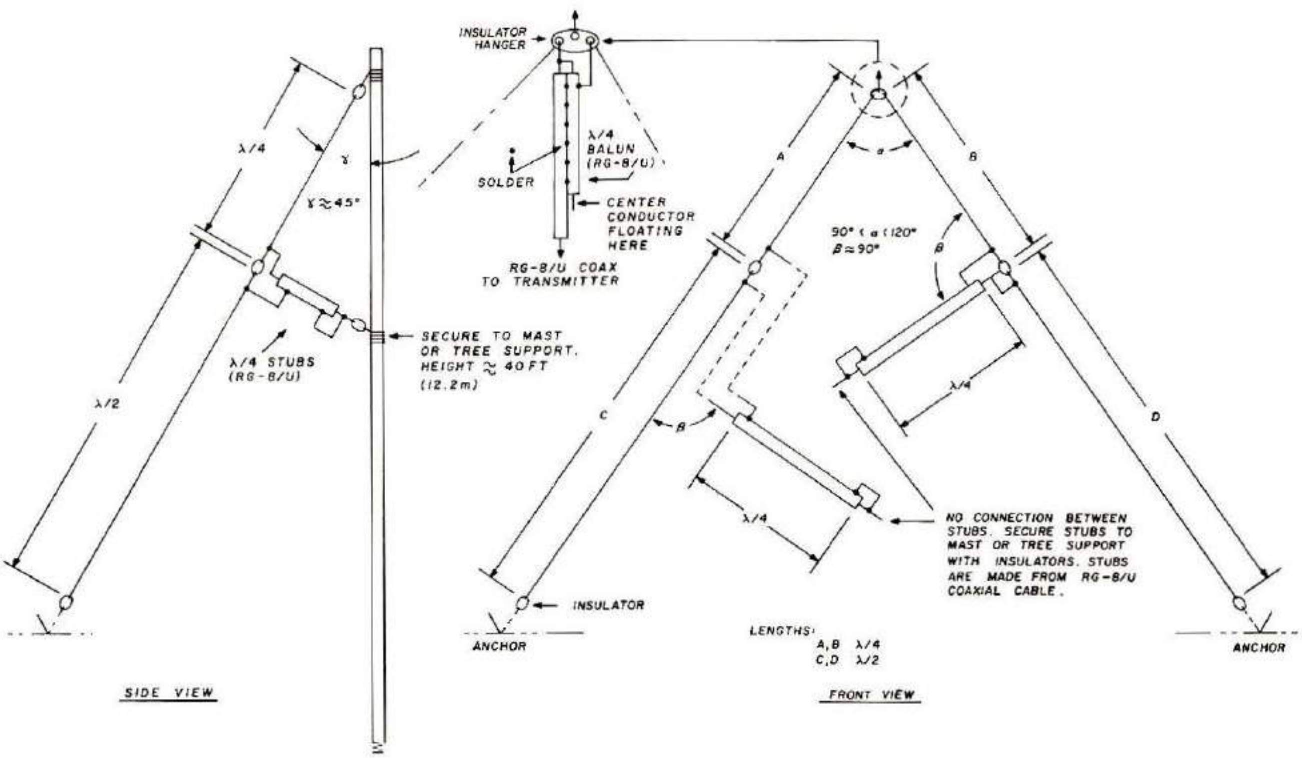

Fig. 3. The modified inverted-V antenna. Two half-wavelength elements are added, which are driven in phase. The angles shown are nominal. The coax cable is shown as RG-8/U, but RG-58/U will work for low-power transmitters. Good solder connections are important for trouble-free operation.

using low power (say, under 200 watts input), then type RG-58/U cable will be okay. The main thing to remember is that the added elements must be connected in the *proper phase*; adding the stubs will maintain this relationship.

Here's an example for a collinear inverted V antenna for 15 meters. Dimensions **A** and **B** (**Fig. 3**) are one-quarter wavelength, which means each of these legs will be 11 feet (3.4m) long. The two phasing stubs, also one-quarter wavelength, will also be the same electrical length. The added elements, **C** and **D**, are one-half wavelength long, which is 22 feet (6.7m). (All these dimensions are nominal for the 15-meter band).

So this means that each antenna leg will be of the order of 11 + 22 = 33 feet (10m) long. A 40-foot (12.2m) mast would be a good choice as a support. If the antenna apex angle is 90 degrees (angle α in **Fig. 3**), the insulators at the end of each leg will be about 16 feet (5m) above ground.

When you make the phasing stubs, remember that the coax center conductor is connected to the antenna elements and the coax-cable shield braid is connected with a *good* solder joint as shown. The solder joints should be wrapped with PVC tape then coated with silicone compound to avoid long-term corrosion problems.

The far end of the phasing stubs should be insulated from each other. A low-loss antenna insulator can be used here. The stubs should (ideally) drop at a 90-degree angle from the antenna elements, (angle β) although this doesn't seem to affect antenna performance. Secure the phasing stubs to the mast or other support through insulators. If the coax shields of the stubs are correctly soldered and coated with some kind of protective material, you won't have any problems with corrosion for a long time.

Ordinary "egg" insulators can be used for the setup shown if low power is used, or you can use pieces of thick plastic salvaged from discarded containers from household detergents. The choice is yours: you can be elegant and use expensive materials for insulators or use materials that would otherwise end up in the trash can. Either way, the antenna won't know the difference. You can save money by using your ingenuity.

Final remarks

During the next few years propagation conditions on the high-frequency amateur bands are expected to improve. The antenna described here won't provide a quantum jump in signal strength over your horizontal dipole or vertical antenna. Also it won't give results that a beam antenna will provide, but you'll find that the improvement obtained in received and transmitted signal strength will be well worth the construction effort.

Acknowledgement

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Reference

1. A. Wilson, W6NIF, "Dipole Sloping Inverted Vee," *ham radio*, February, 1969, page 48. **HRH**

"This is K9ARF apologizing to the FCC and all other listeners for the comment made when my desk drawer fell on my foot."

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