a sloping inverted-vee dipole

Here is an interesting antenna for small antenna farms that bears further investigation

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Most of us at one time or another have dreamed of the ultimate antenna. If your ambition, for example, is to accumulate new country DX contacts, then this ultimate antenna might be a family of rhombics covering 360 derees, or maybe a 100-foot telephone pole with full-sized Yagis for each band. The majority of us never realize the ultimate antenna, unfortunately. As a matter of fact, there are hams who, for various reasons, will never be able to own and operate **any** kind of antenna but a dipole or one of its relatives.

It is for these hams that this piece is written. I hope they may benefit by my experience with a restricted-space antenna that evolved over several months of testing to achieve the best possible compromise. In general, those who are restricted to low-gain antennas fall into one or more of the following groups:

a. Thin pocketbook city dwellers on small lots

b. Not-so-thin pocketbook city dwellers on small lots who have zoning restrictions, unreasonable neighbors, unco-operative spouses or all three.

c. Timid city dwellers who are reluctant to live under a potential catastrophe such as a ton of tubular steel crashing onto the house

Many of these hams, knowing it is futile to participate seriously in the big contests, nevertheless would like to have a chance at working some DX at least once in awhile. Being antenna dreamers, these people have read extensively and have learned the pros and cons of horizontally- and vertically-polarized low-gain antennas. They have resigned themselves to using one of the dipole family; what, then, is the best possible arrangement they can build that will provide at least a fair chance in the DX bands?

Let's assume a typical city dweller has room to erect an inconspicuous mast at least one-half wavelength high on 14 MHz, but doesn't have enough room laterally to erect a second mast one-half wavelength from the first. Full-sized horizontal dipoles are therefore out. He could put up a shortened (trap) dipole or one of the verticals, say a ground plane. Both have advantages and drawbacks, all of which are well known and will not be discussed here. Which is most effective, considering the restrictions involved?

Based on these restrictions the antenna to be described, while not in the competition class by any means, is a modified version of the dipole family that has given a good account of itself over a six-month period on 14 MHz. It is a variation of the well-known inverted vee. The conventional inverted vee has been covered fairly extensively in the literature[1,2,3,4]. Very little has been published, however, on any but the standard configuration.

the inverted vee

The standard inverted vee is a half-wavelength dipole with the elements in a vertical plane, oriented in an acute angle, α, and fed at the apex (**fig. 1**). The size of the apex angle apparently has little effect on the vertical radiation pattern but significantly changes the horizontal (earth plane) pattern such that the nulls off the ends normal to the wire axis tend to fill in as the apex angle decreases. (Reference 5 discusses this at length and provides typical patterns in both planes for several apex angles.) Thus as the antenna approaches a vertical configuration, its horizontal pattern approaches the omnidirectional pattern of the conventional vertical, which is to be expected. Reference 5 shows that the vertical pattern is virtually unaffected for antenna apex angles from 120 to 60 degrees. Reference 6 shows the vertical radiation pattern of any antenna should be lower than 30 degrees for effective DX work.

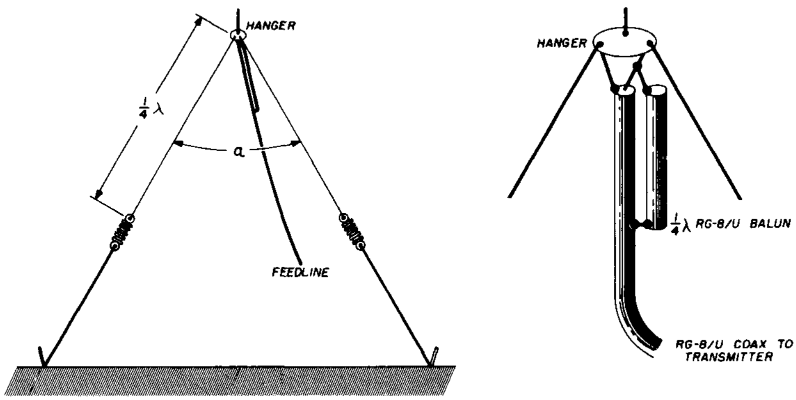

fig. 1. Basic inverted-vee antenna. Resonant frequency depends upon height above ground and angle. The length of the quarter-wave balun is equal to 246v/f, where v = 0.659 if balun is taped to feedline, and f is frequency in MHz. Center conductor of the "bazooka" section is floating.

The problem is to somehow get the vertical pattern down into the useful angles without sacrificing energy in high-angle lobes that penetrate the ionosphere. Increasing the antenna height above one-half wavelength does lower the vertical angle but introduces high-angle lobes that are useless for DX propagation. Also, recall that we are restricted to one-half wavelength in height on the 14 MHz band.

the sloping inverted vee

After using a conventional inverted vee at a height of one-half wavelength on 14 MHz for a month or so, I wanted to find out what would happen to antenna performance if the elements were rotated out of the x, y plane. The elements were kept broadside to the x, y plane but were elevated at a slope angle, θ (**fig. 2**).

At this point I must emphasize that no amount of wishful thinking will alter a basic physical fact; namely that the directional characteristics of a true vee antenna cannot be realized with anything less than one wavelength on the legs. A vee-shaped dipole is exactly that: its shape is that of a vee, but there its similarity to a vee antenna ends. The inverted vee dipole behaves like a dipole regardless of the apex angle, α, or the slope angle, θ. However, it appears that if the slope angle is between 40 and 70 degrees, the vertical radiation pattern angle of the lobe in the direction opposite to that in which the vee is rotated tends to decrease, so that more energy is radiated at angles below 30 degrees.

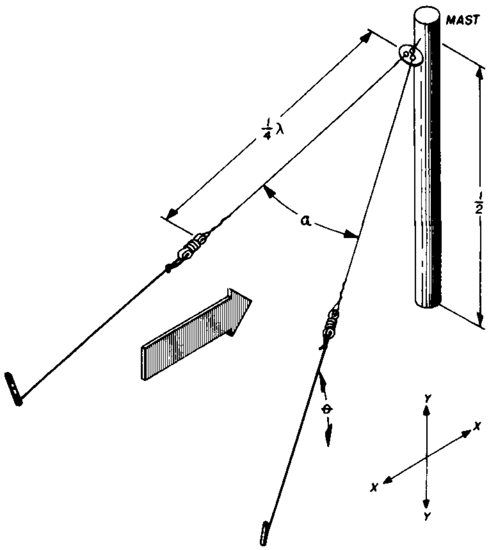

fig. 2. Geometry of the sloping inverted-vee antenna. The angle of the vertical lobe decrease in the direction of the arrow.

table 1. Characteristics of several simple antennas; all assumed one-half wavelength high and fed with the same current.

antenna	nominal radiation resistance (ohms)	vertical pattern useful lobe angles (degrees)	first reflection zone* (miles)
horizontal dipole	73	15 - 45	200 - 1100
ground plane	53**	10 - 55	100 - 1500
inverted-vee dipole	50	15 - 45	200 - 1100
sloping inverted-vee dipole	50	15 - 25 (estimated)	600 - 1500 (estimated)
yagi	8	15 - 45	200 - 100

*for F-layer heights between 125 and 250 miles
**with radials sloped approximately 50 degrees

tests

My sloping inverted vee dipole was oriented with the elements broadside to the long-path direction (about 230 degrees azimuth for my location). Over a six-month period, the antenna was used in tests with South African, Australian, Southeast Asian, and Asian stations on 14 MHz. Approximately 100 contacts were made. During these tests the sloping inverted vee antenna was compared with a shortened dipole and a quarter-wave ground plane. The driving points of all three antennas were within about 5 feet of being at the same height above ground. The inverted vee was rotated out of the x, y plane to slope angles as great as 70 degrees. This was accomplished by rigging a lightweight spreader between the antenna elements and raising them to various angles with a rope and pulley arrangement. An interesting effect was that the optimum slope angle seemed to depend on the time of day. During band openings on 14 MHz (1300-1400 GMT) best results were obtained with a slope angle of about 40 degrees. As the sun rose, reports improved with the slope angle approaching 70 degrees.

results

No quantitative measurements were made. Pattern and field strength measurements are difficult enough even under laboratory conditions; consequently any data taken with the limited facilities available would certainly be open to question. However, after testing the antenna under all band conditions, the following observations are offered:

a. The sloping inverted vee antenna apparently radiates better in the vertical plane at lower angles than a dipole or ground plane.

b. The first reflection zone of the sloping inverted vee appears to be at a greater distance than the comparison antennas.

c. As a receiving antenna, the sloping inverted vee is noisier than the dipole, but not as noisy as the ground plane.

d. Band openings occur earlier by about a half hour with the sloping inverted vee.

e. The sloping inverted vee requires less space than the dipole, but more than the ground plane.

Based on the data in reference 6 and the empirical results of the tests described above, the characteristics of the sloping inverted vee are summarized in **table 1**

conclusions

In conclusion I would like to point out that the sloping inverted vee is not in the same league as even a two-element Yagi, which has both directional and power gain. While the sloping inverted vee does seem to have more power at the lower angles than a conventional horizontal dipole, it simply cannot compete with a Yagi or any other directional array. The estimated first reflection zone for the sloping inverted vee is based on the curves of reference 6, which in turn are based on various vertical pattern lobe angles. Experience with this antenna seems to indicate performance close to the data shown in the table.

I hope that others will try this antenna with different slope angles. It will be very interesting to see how it performs at other locations and on different bands.

references

1. K. Glanzer, K7GCO, "The Inverted V-Shaped Dipole," *QST*, August, 1960.
2. D. Hardaker, W6PIZ, "All-Band Antenna," Technical Correspondence, *QST*, March, 1967.
3. B. Dzambik, WV6RLZ, "Multiband Antenna," Technical Correspondence, *QST*, November, 1961.
4. H. Green, "On the Delta Aerial," *IEEE Transactions on Antennas and Propagation*, January, 1963.
5. D. Covington, K4GSX, "Inverted-V Radiation Patterns," *QST*, May, 1965.
6. P. Lee, W3JHR, "Optimum Antenna Design for DX," *CQ*, November, 1962.

ham radio

vtvm modification

Most garden-variety vtvm's use a 1.5-volt flashlight cell for the ohmmeter supply. This works fine if you replace the flashlight cell every few months. However, the ohmmeter becomes very inaccurate on the low-ohms scale as the cell's internal resistance increases with age.

By adding a few parts and making a few circuit modifications, it is possible to do away with the flashlight cell altogether. The diagrams show the modifications I made to my Heathkit V-7A. This is typical of all inexpensive dc vtvm's, whether made by Heath, Allied, Eico or RCA.

As shown in **fig. 1,** the 6.3-volt filament voltage is rectified by a conventional bridge rectifier; the resulting dc is dropped by the 18-ohm resistor in conjunction with the regu-