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The Lazy U Dipole

VE7BS's Lazy Z takes on a new bent.

Several years ago I described a sort of "Lazy Z" antenna in use on 160 meters. Pat Hawker G3VA commented on it in *Radio Communications*, a reader tried it on 40 meters and reported promising results, and Bill Orr mentioned it in his column in *Ham Radio*. Somewhere along the line it had become the "VE7BS Antenna," but by this time I had come to the conclusion that the "Lazy U" (described below) worked rather better.

The VE7BS was basically a half-wave dipole bent in the right places (see Fig. 1). The arrows show the direction of current flow at a given moment, and you can see that the two end sections are in phase with each other. Most of the radiation is from the center section where the current is higher, so the contribution of the end sections is not that great, and they are too close to each other to give any broadside gain. But this configuration does make it possible to have the main radiating portion at a relatively steep angle while preserving the useful bandwidth of a full-length dipole.

A straight sloping half-wave dipole 240 feet long suspended from a 100-foot-high support thinks of itself as a horizontal dipole 50 feet high and fires mostly straight up on 160. A bit of geometry or a scale drawing shows why—even if the wire were tight and straight, it would be only 24 degrees from the horizontal.

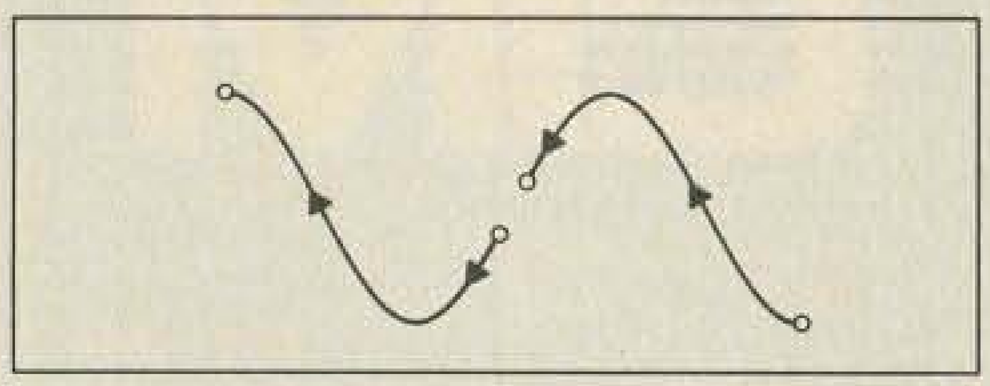

Fig. 1.

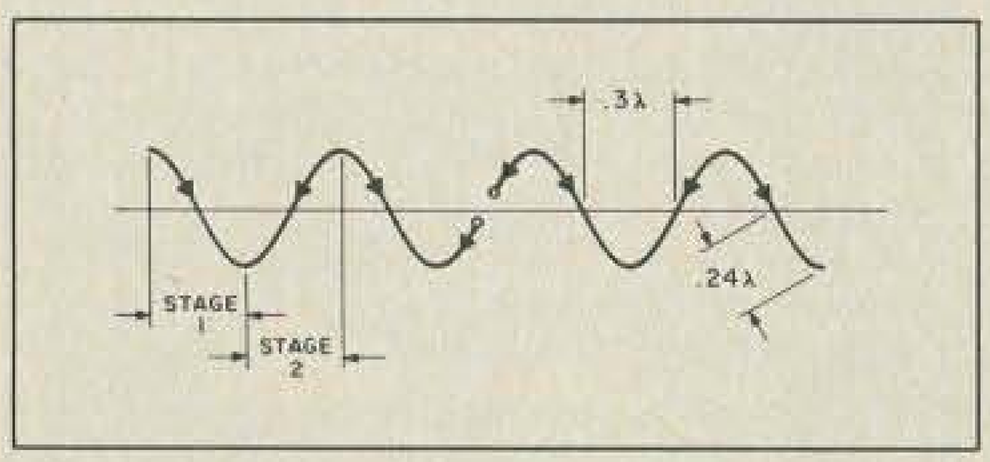

Fig. 2.

All this came to mind when W4KM brought to my attention an interesting item that appeared in *Radio* (published in the USSR), describing the "snake antenna" used by UY5AP for communication via satellites on 144 MHz (see Fig. 2). UY5AP's antenna is made with rigid coaxial cable, using the sheath as a fat conductor (3/8" or 1/2" copper pipe would be an ideal material to use for this kind of construction). It is described as a "seven-stage synphase" antenna, with a figure-8 pattern in the horizontal plane and a narrow lobe toward the horizon in the vertical plane. Bear in mind that this is on 144 MHz, so presumably the antenna is mounted several wavelengths above ground.

The dimensions given in *Radio* show that each stage is a half wave long, slightly shortened to allow for the diameter/length ratio, and the distance between each stage is a 5/16 wave.

In effect, then, we have seven close-spaced elements in phase as far as vertical polarization is concerned, but each stage is in antiphase to its neighbor as far as horizontal polarization is concerned. I came to this conclusion by playing with current-flow arrows, as illustrated in Fig. 3.

You can look upon it also as a pair of cross-polarized stacks with four elements co-polarized and three others in quadrature with them. Maybe, with four in one direction and three in the other, this could be said to be elliptical? (See Fig. 4.)

This is all very interesting for the 2-meter satellite enthusiast, but for me VHF is an abstraction. To erect such an antenna for an

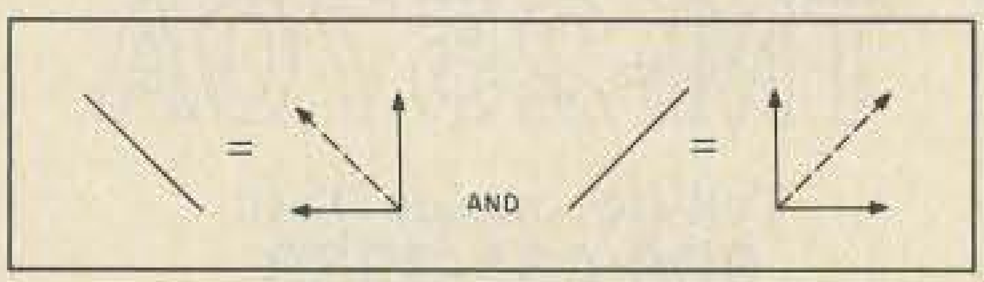

Fig. 3.

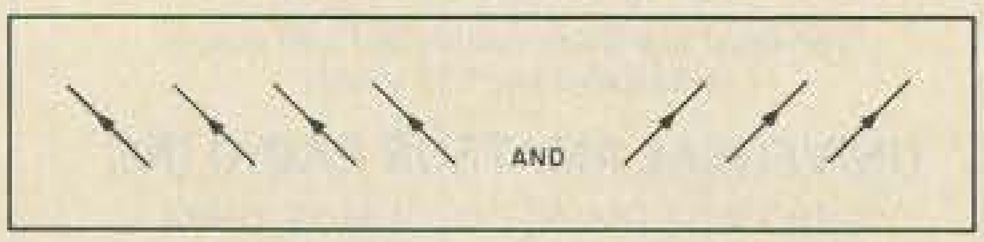

Fig. 4.

HF band requires a rather long line of trees, but it doesn't *have* to be seven stages long, does it! After all, not all yagis have 60-foot booms, but there are lots of yagis around.

How about three stages? With a basically vertically polarized array it can be close to the ground without suffering ill effects, and for 40 meters a three-stage "snake" would be about 150 feet long and could be hung on supports 50 feet high. It would need only two such supports, because one end of the snake is close to the ground (see Fig. 5).

There are definite advantages to having an antenna that has cross-polarized elements. All signals coming via the ionosphere rotate on the way, and the degree of rotation is unpredictable. It is because of this rotation that you can get good signals (most of the time) on your horizontal antenna although the other fellow is using a vertical. But some of the QSB you suffer comes from the rotation of the signal, and if your antenna can respond to any polarization, you suffer less. I don't recall seeing anything about this antenna arrangement in the literature, although it seems impossible that Kraus and Sterba and Franklin and company could have overlooked it in the heyday of linear arrays for HF in the thirties.

The seven-stage VHF snake has a feedpoint impedance of 300 Ohms, so it is fed

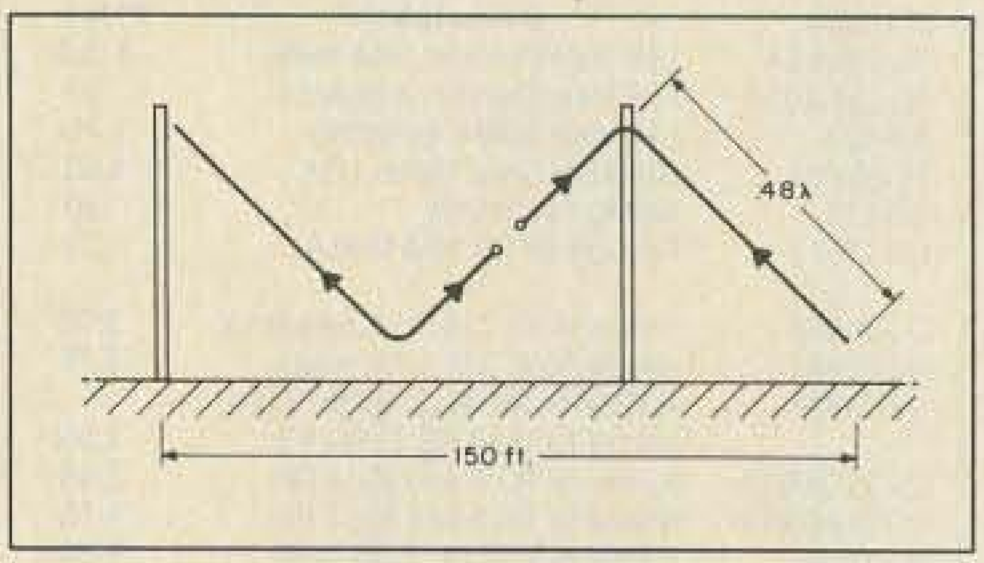

Fig. 5.

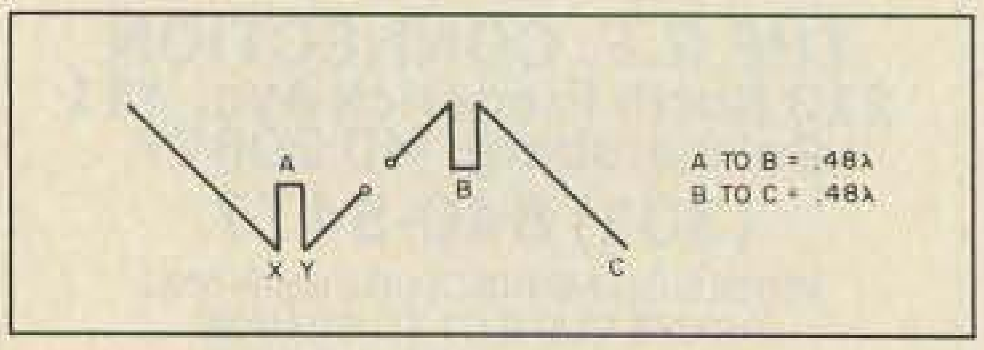

Fig. 6.

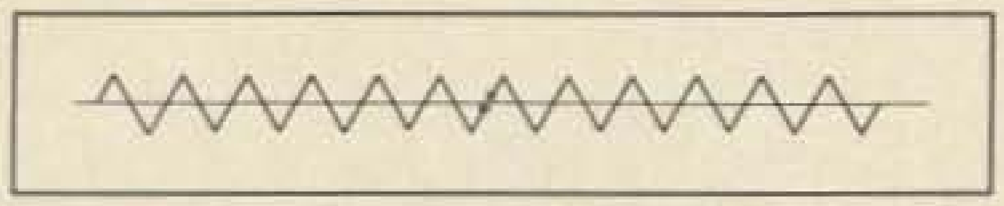

Fig. 7.

with 300-Ohm balanced feeder or with 75-Ohm coaxial cable through a 4:1 coaxial balun. In the three-stage HF version, the feedpoint impedance is between 100 and 125 Ohms. A quarter-wave section of 75-Ohm transmission line transforms nicely from 50-Ohm cable to the feedpoint impedance.

The wire is supported at the bends by insulators and a short piece of ABS tubing to keep the bend from being too sharp, so each "element" is 468/f long to allow for end effect. If available height or space is a bit short, there are some interesting possibilities in folding at the corners, as shown in Fig. 6. Points X and Y are at the same potential and sign, and so can be tied together without harming the resonance. But that's a complication.

A Japanese Snake

In 1984, a short item appeared in the IEEE literature[1] describing the results obtained from bending the wire of a dipole in zigzag fashion, but in this case at more frequent intervals than with the "synphase" just discussed. Starting with a length of wire a half wavelength long, it is bent as shown in Fig. 7 to make each zig or zag .0208 of a wavelength long (12 bends in each half of the dipole).

If the angle of each bend is made 130 degrees, the actual length of the antenna will be shortened by 10% and the antenna will be self-resonant with a feedpoint resistance of 65 Ohms and a negative reactance of about 50 Ohms. The patterns and the half-power bandwidth remain about the same as a straight half-wave dipole, and this stays true if the antenna is shortened further by decreasing the angle at each bend. What is more, the input resistance does not change radically.

For example, if you make the original wire .58 of a wavelength long and then compress it to .4 of a wavelength (20% shorter than a straight half wave), the input resistance is a little less than 50 Ohms, a direct match to RG-8 coax if you use a transmatch to compensate for any reactance that appears.

I suppose a stretched-out Slinky™ would work in a somewhat similar way, although the theory of the close-coiled Slinky is probably different. *[See "The Ramada Radiator" in this issue.—Ed.]* The possibilities of combining the shortening effect of the 24-bends-per-half-wave with the synphase effect of the one-bend-per-half-wave are endless. If you are interested, the basics of the shortening effect are covered in a 1982 IEEE publication[2].

The Lazy U

There are only two bends in the Lazy U variant of the half-wave dipole—see Fig. 8. You make the vertical portion as long as possible (some have been used on 160 meters with as little as 33 feet of vertical) and the top horizontal wire should be directly above (parallel to) the bottom wire. The bottom wire can

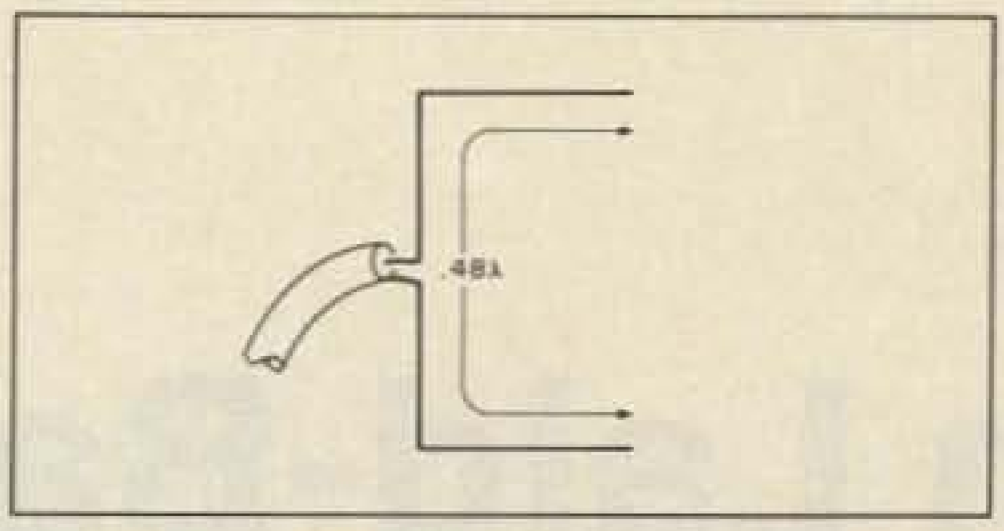

Fig. 8.

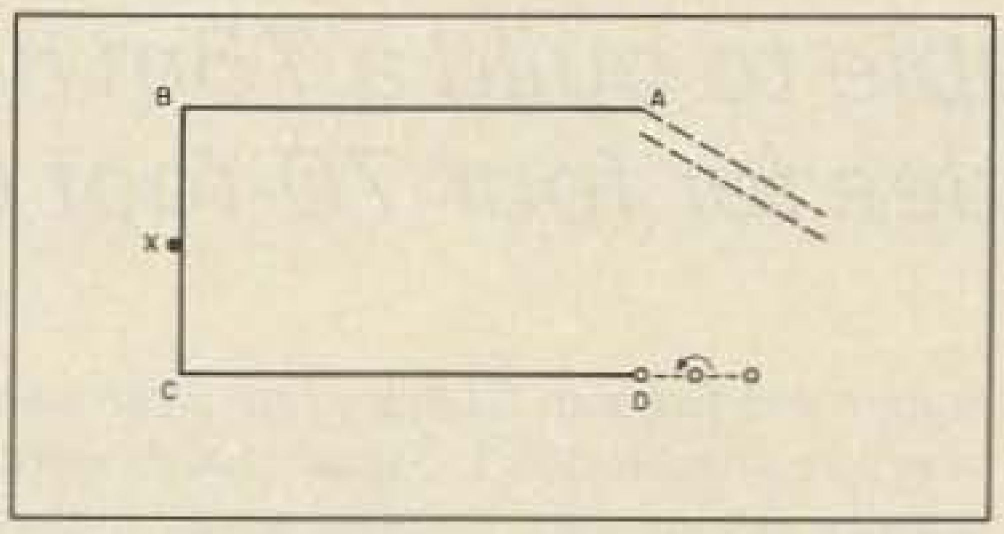

Fig. 9

be as close to the ground as practical convenience allows, but preferably at least six feet up; remember that there is a high rf potential at the end!

Radiation is effectively vertically polarized. Maximum current flows in the vertical portion, and experiments have shown that a displacement current flows between the upper wire and the lower (in effect, counterpoise) wire, creating a whole raft of phantom verticals.

It is much quieter than a vertical monopole on receive, and I have a special affection for it because it gave me my first African contact from VE7 on 160. (That particular antenna had about 90 feet of vertical, but one with 60 feet of vertical worked about the same.)

Bring the coax away horizontally for a few feet from either the side or the back of the U—a few turns of coax wound as a choke near the feedpoint will prevent antenna currents from running on the outside of the coax shield.

It is more or less a single-band antenna, but was derived from the multiband G8ON[3, 4]—see Fig. 9. A to D is a half wavelength; on harmonic frequencies, X to D is an odd number of quarter wavelengths. X is the center of a half-wave section, the point of maximum current. AB and CD are equal, and AB is parallel to CD. CD is, in effect, a counterpoise, at least six feet above the ground. The dotted portion is a single-wire feeder—it could be open-wire zepp.

To use it on higher frequencies, you put suitable lengths of wire as extensions at D to create a current maximum at X (make the point X an odd number of quarter waves from the *far end*—point D).

A General Reminder

When you make a bend in a resonant antenna, make it as gradually as possible. A sharp corner tends to look something like a termination to the rf current arriving at it. Although the general idea is that you want the current to jump off some time in the direction of the other station, you also want it to recognize what frequency the antenna is designed for!

Have fun bending! ■

References

1. H. Nakano et al, "Shortening Ratios of Modified Dipole Antennas," *IEEE Transactions on Antenna and Propagation*, Vol. AP-32, No. 4, April, 1984.

2. J. Rashed and C. T. Tai, "A New Class of Wire Antennas," *1982 IEEE Antennas and Propagation Society International Symposium Digest*, Vol. 2.

3. Pat Hawker G3VA, *Amateur Radio Techniques*.

4. VE7BS, "Wire Antennas," *The Canadian Amateur*, March and April, 1979.