Backward Inverted L Antenna

This low-band wire antenna is a good performer on both transmit and receive.

by Stan Gibilisco W1GV

In the March 1988 issue of *QST*, Doug DeMaw W1FB points out that closed loops have advantages for reception because they are less responsive to noise than open loops or dipoles. His design provides vertical polarization for low-angle radiation, another good feature for low-band DX operation. After experimenting with balloon-supported antennas and longwires at 1.8 and 3.5 MHz (see "Balloon Supported Antennas" in the September '88 issue of *73*), I wanted to try something that would last and have better noise immunity than previous antennas.

DeMaw's design has the high-current part of the antenna vertically polarized near the station (although some of the high-current portion is horizontal), and this apparently is the reason for the low angle of radiation and response. A quite popular antenna for 160 and 80 meters is the inverted L, also having this characteristic (see Figure 1a) when the length is ¼-wavelength. Ideally, the inverted L would be ½-wavelength with ¼-wave going up and ¼-wave going horizontally at a height of ¼-wavelength above ground (Figure 1b), but this is not always possible because of space limitations. I have neither the resources nor the kind of neighbors who would enjoy looking at a 125-foot vertical structure.

The typical inverted L would probably have poor noise characteristics because of its broad bandwidth, vertical polarization, and the fact that it is not a closed loop. The "balloon verticals" provided good evidence of the kind of noise reception that can occur at 1.8 MHz with large, vertically polarized antennas, and I was ready to try some other design, at least for receiving. Alas—a ⅝-wave balloon vertical puts out a whopping state-side signal at 1.8 MHz!

Terrain Considerations

The house here is on a hill and there is plenty of room for antennas out back, although the terrain slopes downward starting at about 200 feet from the back door. There are plenty of trees about 50 feet high, both on the hill and on the flat below the downslope. Getting an antenna up high above the ground is difficult near the house, but easy some distance away. Any vertical portion of an antenna would have to be located far away from the house. How would I get a high-current loop near the far end of the antenna? One answer was to ground the far end, rather than leaving it free, as is the usual practice.

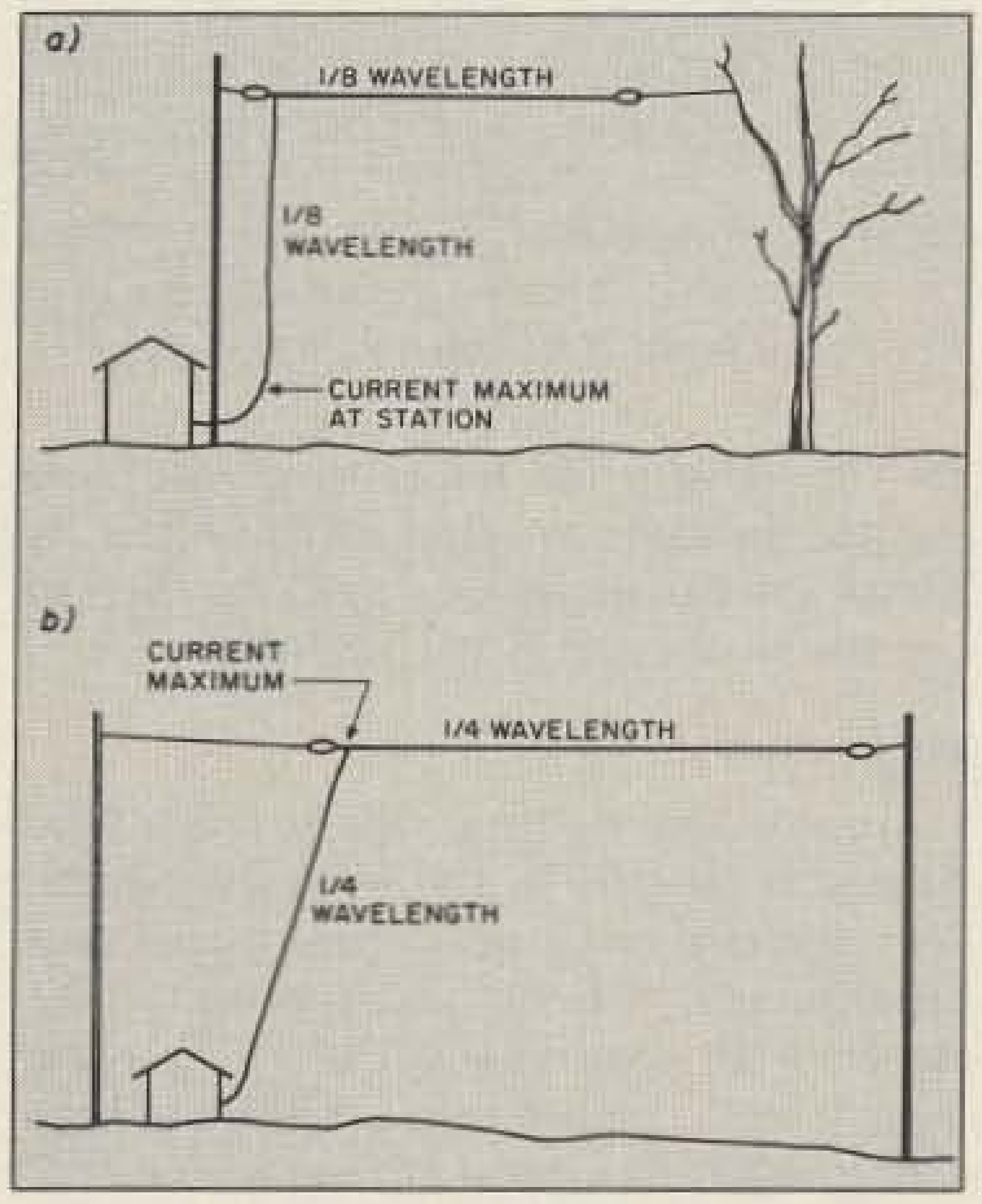

Figure 1. Inverted L antennas cut a) for quarter-wave; and at b), half-wave. The half-wave design has the current loop at a good elevation, and also has high feedpoint resistance, both desirable features for end-fed antennas.

There is nothing that says the far end of an antenna must be a free end. When this is the case, a voltage maximum and current minimum are found there. Grounding the end of the antenna causes this situation to be reversed. The ground should be a low-loss ground for RF. This means there should be numerous radials, not just a ground rod. This presented no problem at my location; there was tall grass and shrubbery all around in the vacant lots adjacent to the house, so no one would be likely to trip on radial wires laid at the surface.

I chose a tree about 100 feet to the north of the house for securing the far end of the antenna. This tree was just slightly below the level of the house and about 50 feet high. A support just 35 feet tall would result in a horizontal span of wire from the house to the top of the tree. This scheme is shown in Figure 2. The antenna is about 45 feet from the rig to the top of the support, 100 feet from the top of the support to the treetop, and 45 feet to the grounded far end, for a total of 190 feet. Since I have a wide-range antenna tuner, I was not especially concerned about the impedance at the feedpoint.

The antenna was easy to install, the support near the house being made from aluminum tubing and the rest of the antenna from A.W.G. No. 15 aluminum electric fence wire. The ground was made using a short iron stake (I've heard copper kills trees). This provided a mechanical anchor. The actual RF ground was made using the aluminum wire, which sells for $13.49 per quarter mile. I installed 12 radials, each 125 feet long, representing ¼-wavelength at 160 meters. I had to bend and cut some of the radials short because of the yard getting in the way (see Figure 3, top view of Inverted-L system). The radials were arranged at angles as nearly equal as possible.

A Little Theory

This antenna, about 195 feet long, is not resonant at any amateur frequency except perhaps 30 and 15 meters, and also somewhere in the 10 meter band. I was not concerned about resonance. However, since the far end of the antenna is at a current loop, it would be expected that if the antenna were operated at the frequency where it is ½-wavelength or any multiple thereof, the input impedance would be fairly low and purely resistive. For example, a 132-foot antenna would be resonant at 80 meters, and also at all of the harmonic bands.

Since the well-grounded (RF) far end is always a high-current point, there will always be good low-angle vertically polarized radiation and response, no matter what the frequency, as long as the vertical section is fairly long (say, 0.1-wavelength or more). This can be qualified if the frequency is so high that the vertical section measures more than about ⅝-wavelength; the radiation angle would be raised in this case. This might be of some concern at 28 MHz and perhaps at 21 MHz as well. I had the lower bands—160, 80 and 40 meters—in mind when I conceived this antenna.

Station Grounding

A good ground system at the station is an

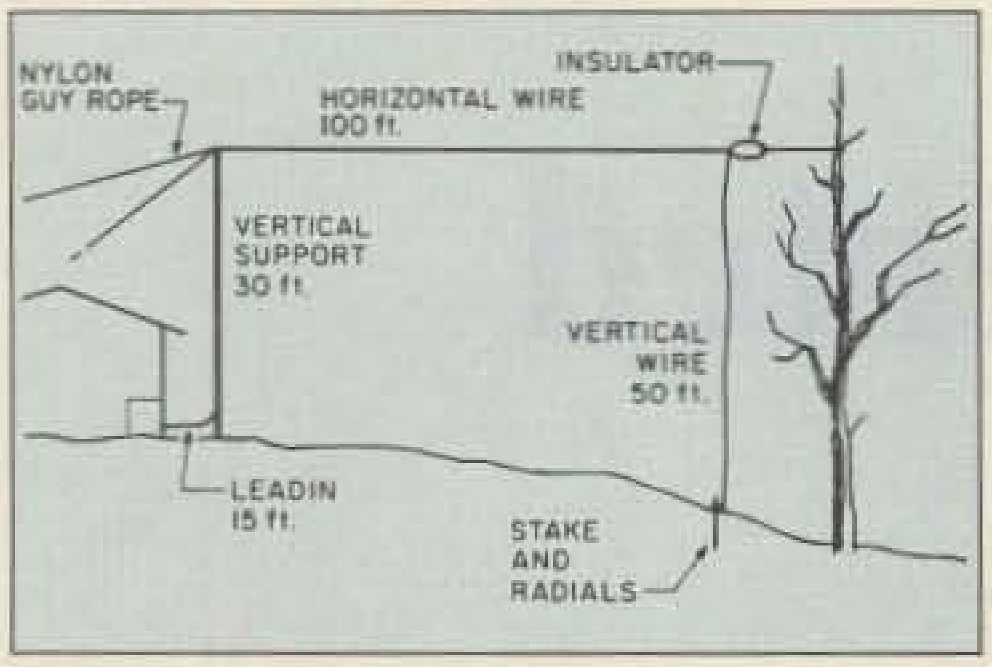

Figure 2. The "backward inverted L" or "inverted U." Note that the far end is grounded, ensuring a current maximum along a vertically polarized part of the antenna. (Radials not shown.)

advantage, even though the feedpoint may not occur at a current loop. The situation is essentially the same for this antenna as it would be for any end-fed, multiband antenna. I don't have a permanent radial system at the station, since burying a kilometer of wire is a true chore, and kids, lawn mowers, etc. tear up radials laying on the surface. (In the winter, if there is enough snow, you can lay them under the snow pack.)

Fortunately, there is a cold-water pipe running through the wall right behind the transmitter, and there is a removable piece of wall plaster that exposes the pipe for direct connection. This is pure coincidence, as I did not even realize this existed when I chose the transmitter location. Did Murphy miss one? Likely not—there was some evidence of RF in the shack at some frequencies even with this copper pipe tied directly to the radio with heavy braid, a sign that plumbers may have installed lengths of non-conducting PVC pipe. You cannot take a good RF ground for granted. Ideally there should be several ¼-wave (or longer) radials emanating from the station.

The horizontal span would provide high-angle radiation and response at all frequencies, making this antenna very similar to the inverted L, except that the main vertical portion would be at some distance from the shack rather than adjacent to the shack.

The antenna described here closely resembles DeMaw's loop, except that the low horizontal part is missing. The equivalent circuit is essentially the same, however, and I expected that the results would be similar to those described in DeMaw's article. I tuned the antenna using my transmatch and logged

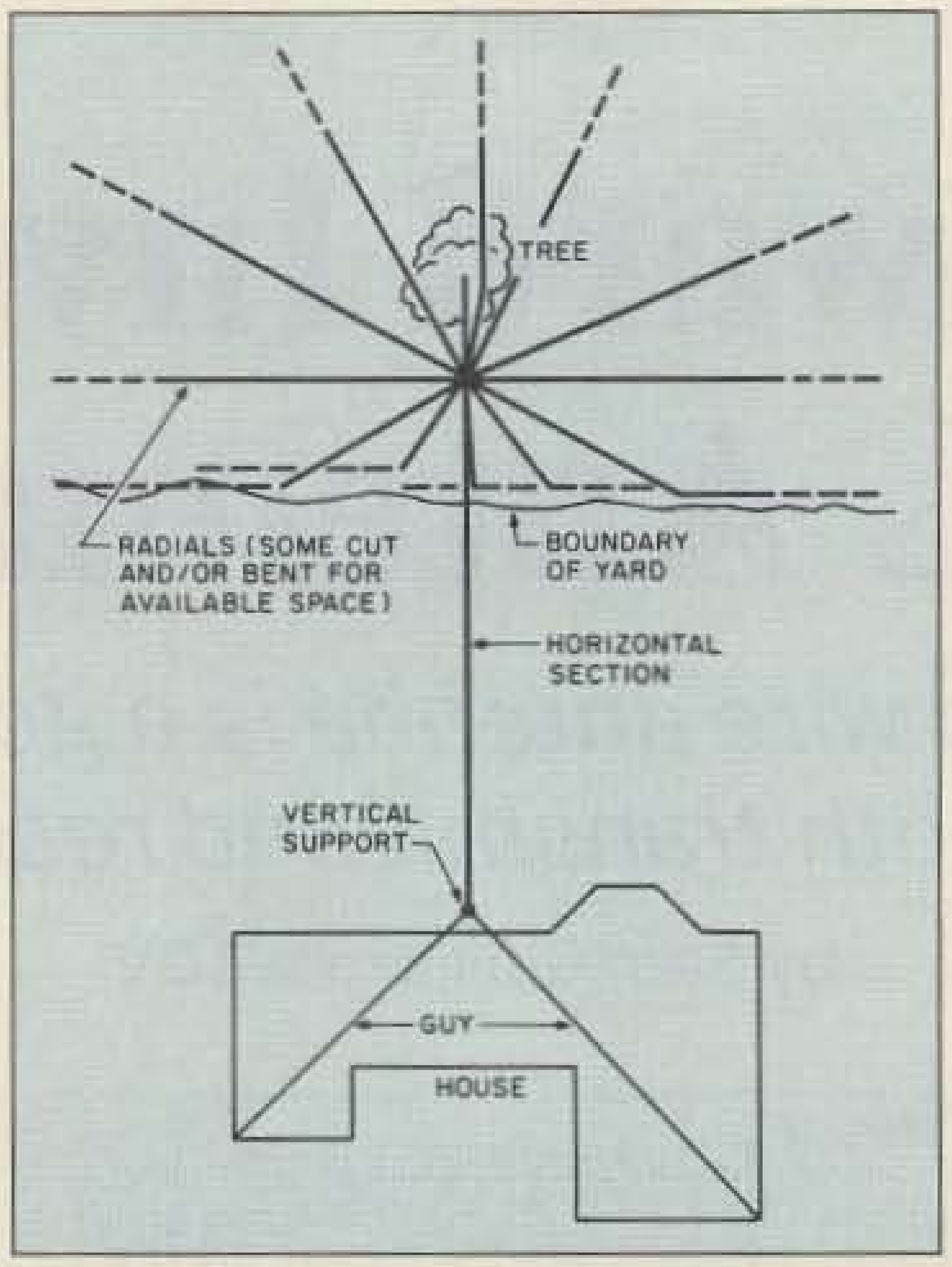

Figure 3. View of W1GV "backward inverted L" from above. Note how radials were bent and/or cut to fit within the available space.

all the settings for future reference, and awaited the early morning VKs and ZLs, as winter still had not given way to the QRN of warmer months at 1.8 and 3.5 MHz.

Performance

I received good signal reports on 160 and 80 meters using 75 to 100 watts CW output. This antenna could not compete with past experimental balloon verticals and "kite slopers" for transmitting, but the received noise level was much lower than it had been using the 880-foot longwire, and was certainly well below that received on the gigantic sky hooks.

Radiation Patterns

The inverted backward L wasn't rigorously tested for directionality. I received good reports from all over the continental US and Canada—there didn't seem to be any real "weak spots." I expect more thorough tests, however, to reveal that the backward inverted L radiates similar to a loop, since the actual antenna and its image form a loop with a circumference of about 390 feet, yielding almost a full wavelength circumference at 1.8 MHz. (See Figure 4.) This "loop's" plane is vertical, so the radiation patterns are expected to be hori-

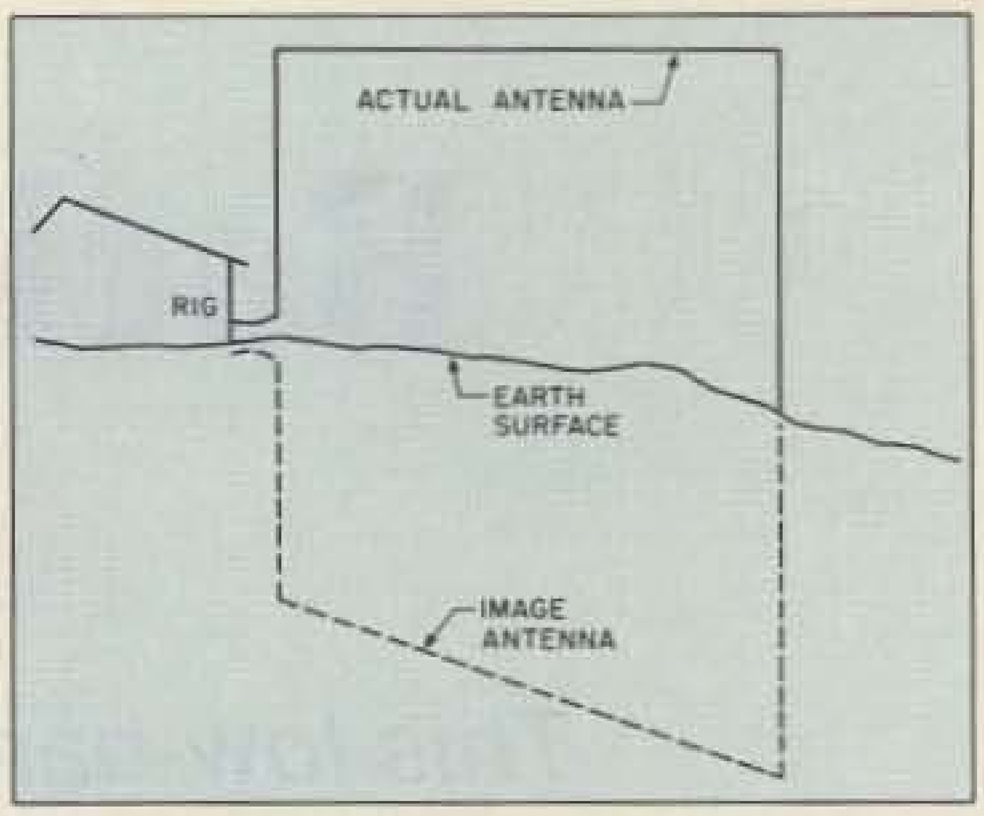

Figure 4. Diagram of actual antenna and image antenna, showing the equivalent vertical-plane loop that results from the combination.

zontal and normal to the plane of the loop.

I had no trouble hearing Europe in the evenings and Japan in the early mornings at 3.5 MHz, but have not yet heard those loud VKs and ZLs on 160. There doesn't seem to be much compliance with the idea that 1.825–1.830 MHz is DX only for transmitting.

Although I have heard that loops and their equivalents (such as this antenna) may be susceptible to intermodulation from broadcast stations in the standard AM band, I have had no trouble with this. I am lucky not to be near stations in the 900–1000 kHz range, where second harmonics might be heard.

Good TX/RX Compromise

Little, of course, can beat the transmit capabilities of the balloon vertical or kite sloper, but it certainly holds its own, and is much better on receive. An ideal fixed wire system would be the inverted backward L for transmit, and a system of beverage antennas for receive, if the beverages are properly installed and matched for impedance. (Beverages outperform the "L" on receive.) The "L" also has the advantage of being grounded all the time for DC, so that when the station end is disconnected, electrical charges are drawn away from the house. That's peace of mind when those big, black thunderstorms start rolling in from the Midwestern prairie.

If you've got the space, I recommend the backward inverted "L." It's one of the better single transmit/receive wire antennas going for the low bands! 73

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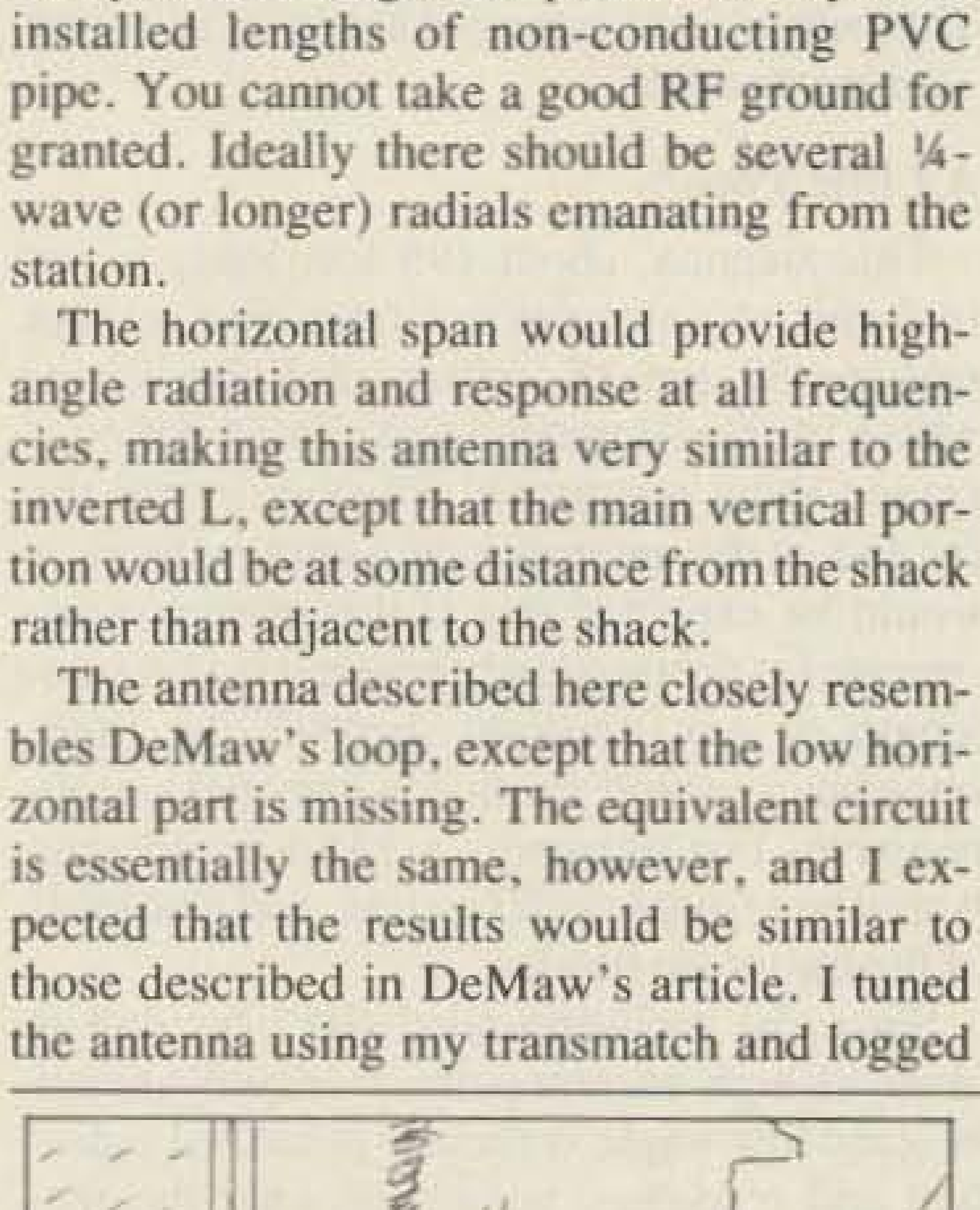

OL' RAY KEEPS TELLING ME IT WAS ACID RAIN, BUT I THINK HE WAS JUST RUNNING TOO MUCH POWER!