BY BILL ORR, W6SAI

THINGS TO LEARN, PROJECTS TO BUILD, AND GEAR TO USE

A Simple Multiband Antenna Array For 7, 10, 14, 18, and 21 MHz

As Bill mentioned several months ago, he will no longer be writing the "Radio Fundamentals" column for us each and every month. However, he does plan to continue to enlighten us now and then. This month Bill picks up his column with a novel antenna—the Lazy-V. —K2EEK

It's difficult to put out a loud signal from a city lot. It's equally difficult to work more than one band from a city lot. Yes, I know all about trap dipole antennas, G5RV antennas, and off-center-fed antennas. In fact, some of my past columns covered these antennas in detail. They all have their problems. The G5RV and OCF are long wires and require plenty of space. The trap dipole may prove to be fragile, and it is difficult to make waterproof traps. However, there's another approach to the problem: the Lazy-V antenna.

The Lazy-V is a novel antenna that may fit your situation to a "T." It takes up little room. No traps are required, and only one pole is required to support the antenna. Interested?

Well, the antenna is based on the idea of using a 40 meter ground-plane vertical (about 33 feet 6 inches high) as a support for higher band dipoles. The dipoles, in fact, act as guy wires for the vertical antenna. Nothing new about this idea.

In diddling around with the dipoles, however, various experimenters have found that they seem to perform much better if they are folded back into a "V," with the ends adjacent to the vertical support, and the far ends held away from the tower with a rope (fig. 1). By "much better," some operators say that the dipoles seem to radiate more low-angle DX energy when folded back upon themselves than when they form an in-line configuration—or so the conventional wisdom goes.

There's a lot of literature about using the Lazy-V dipole idea in directive arrays for 160, 80, and 40 meters (see the listing of further reading at the end of this article). In general, the scheme is to use four (or more) dipoles spaced around a supporting tower. One dipole is electrically loaded to present the proper reactance to act as a reflector for a second driven dipole. Four of these dipoles can be switched remotely from the shack, permitting the operator to quickly rotate the beam heading of this interesting array (fig. 2).

Judging from what the users of these two-element beam arrays achieve in DX contests, it's obvious that they pack a real wallop! If you are interested in such a one-band beam, search out the articles at the end of the article.

This is a one-band approach. However, how about using individual Lazy-V dipoles for different bands, supported from a 40 meter ground-plane antenna? That would provide multiband capability from a single supporting structure.

The Single Lazy-V Dipole Approach

Recently some operators have had luck with

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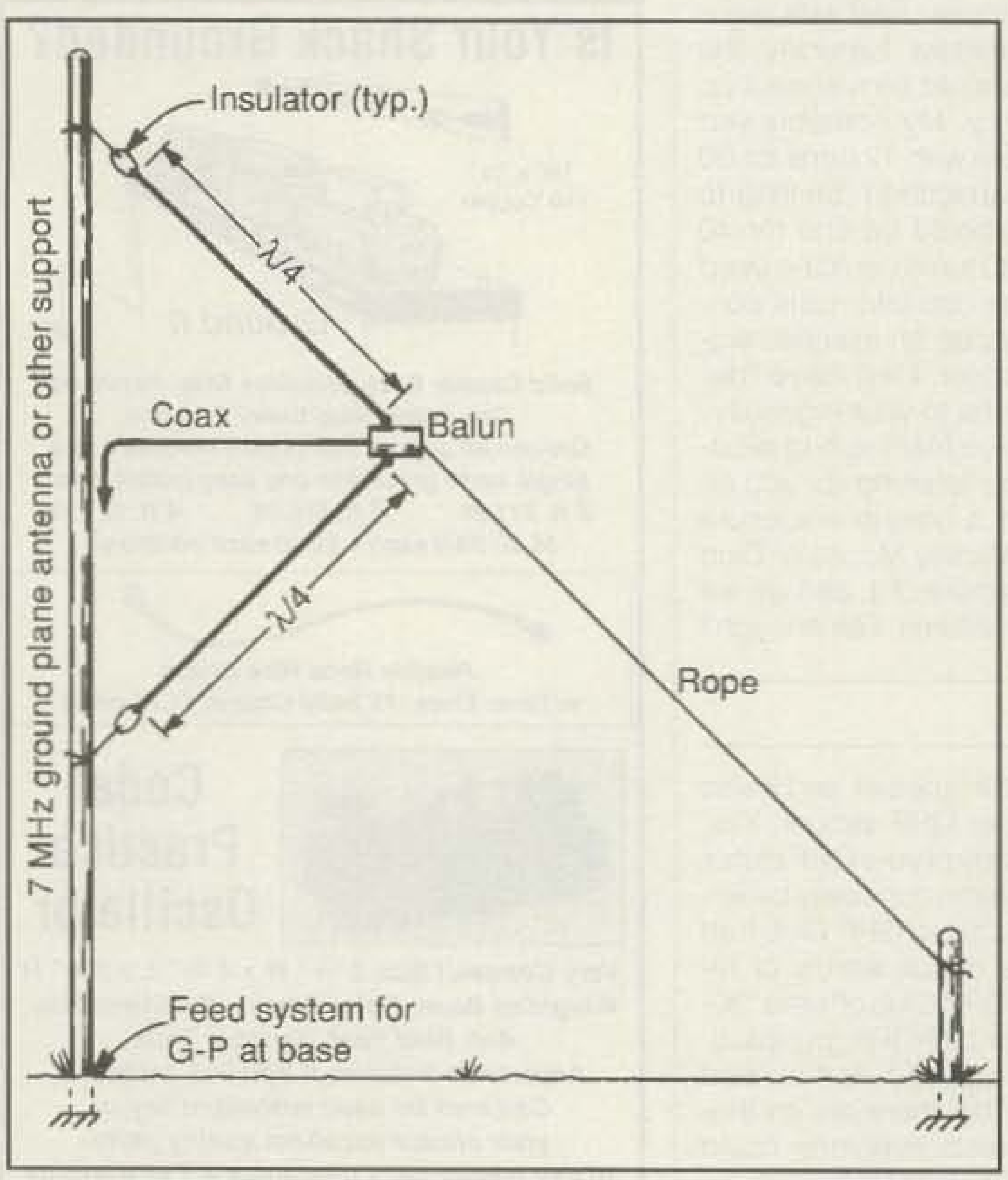

Fig. 1– Typical Lazy-V antenna can be supported by 7 MHz ground plane. Keep coax several inches clear of ground-plane antenna.

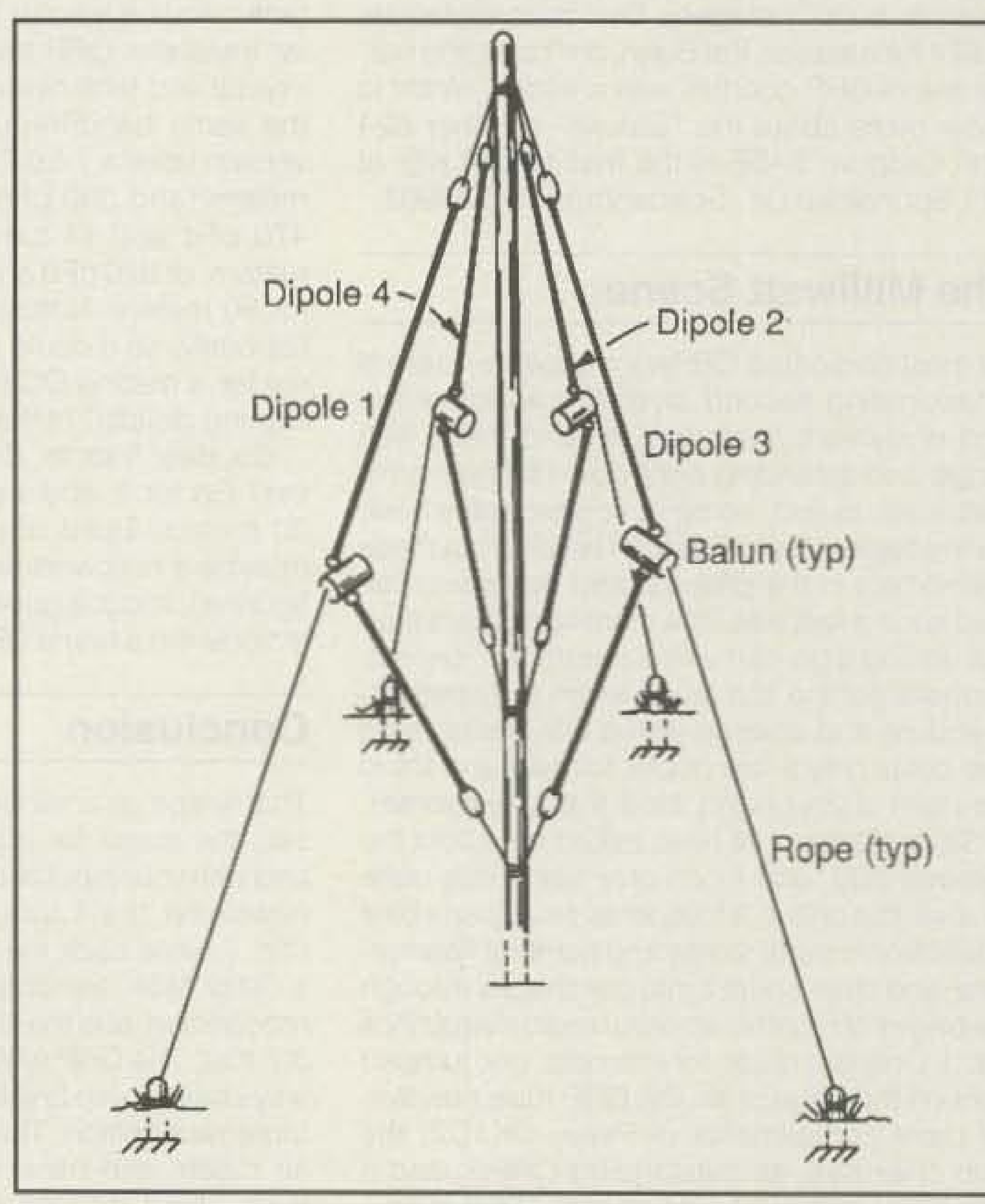

Fig. 2– Four dipoles 90 degrees apart mounted on mast form four-band switchable antenna system.

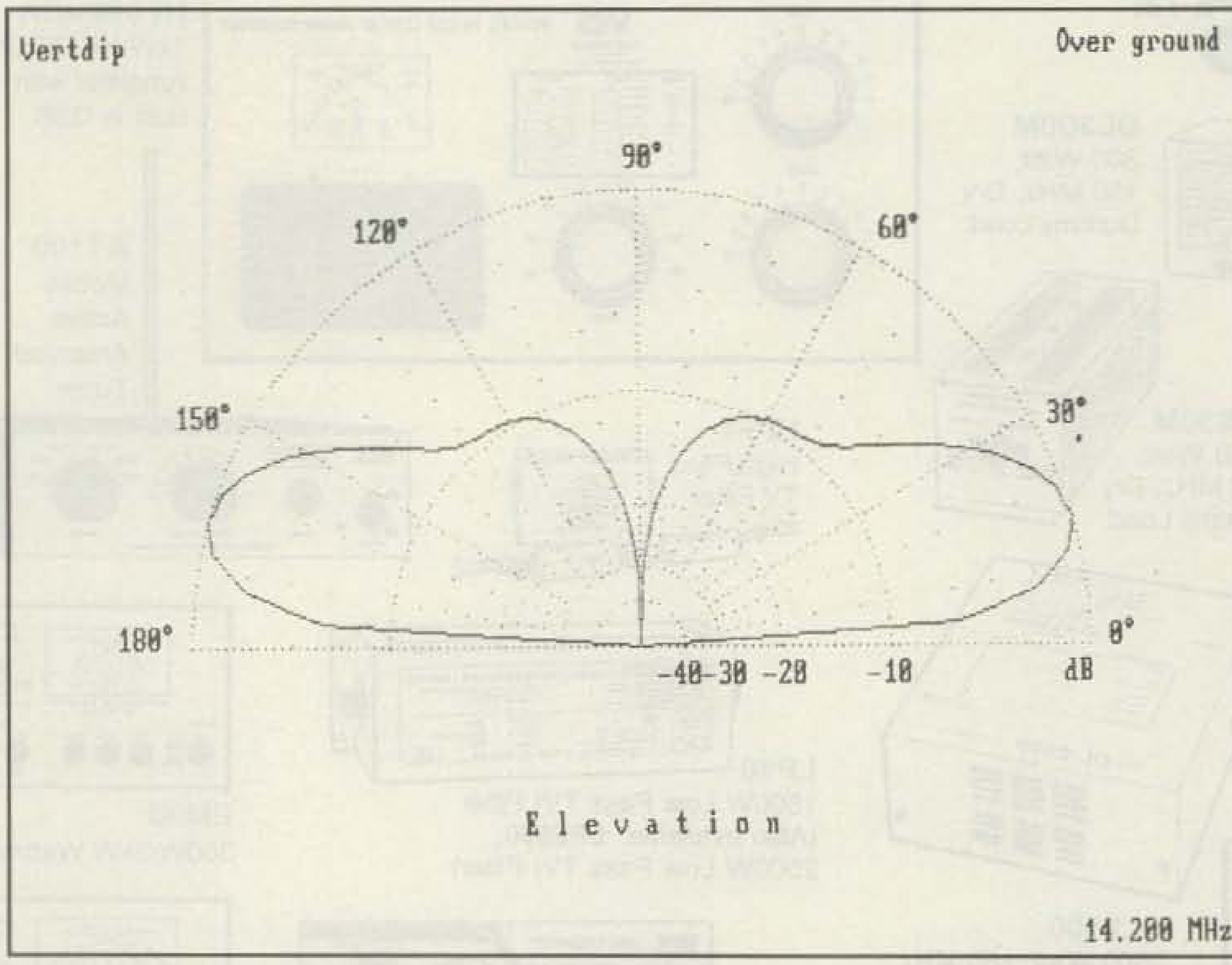

Fig. 3– Pattern of vertical dipole with base 7 feet above ground. Maximum takeoff angle is about 17 degrees.

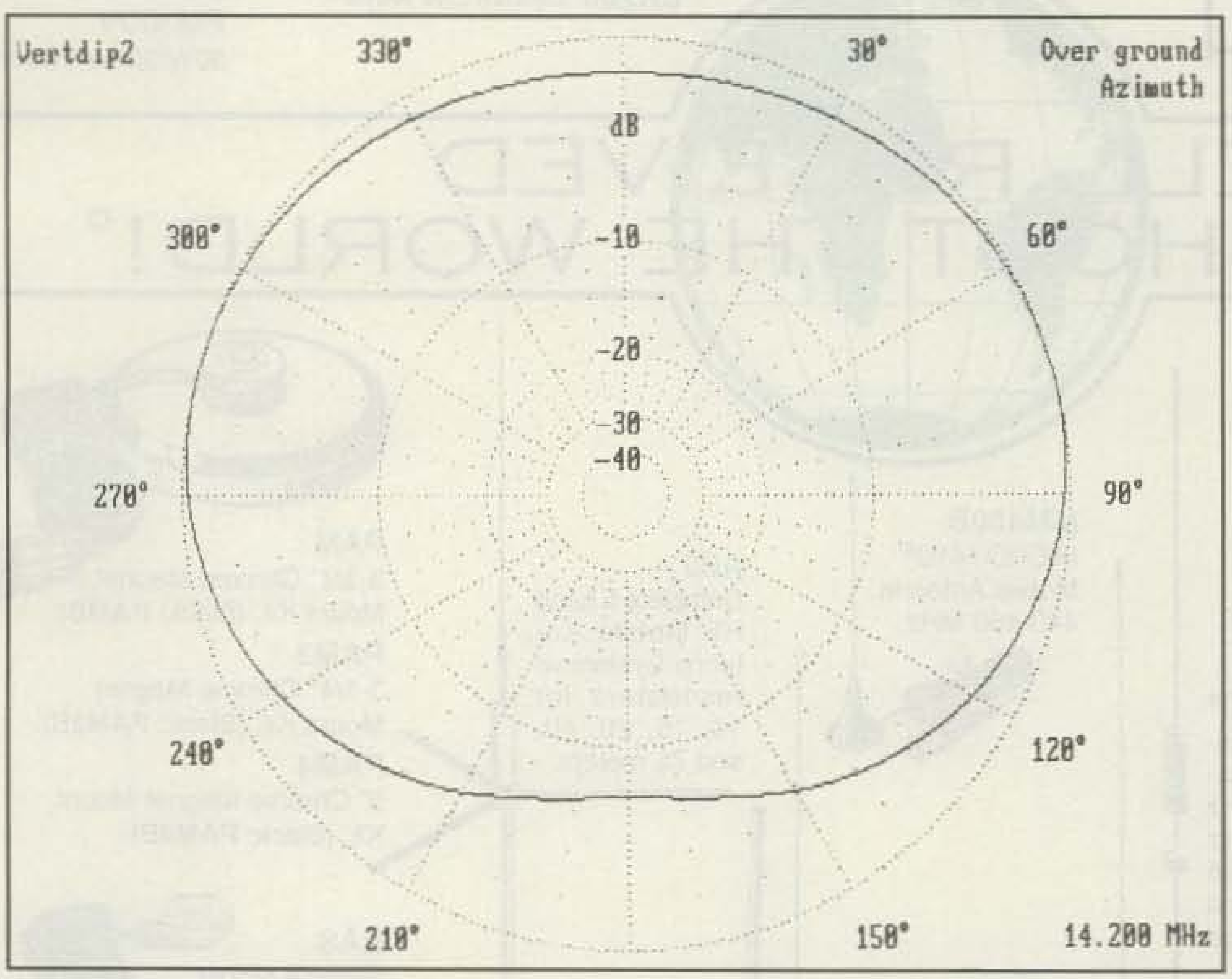

Fig. 4– Dipole tilted at 45 degrees exhibits slight front-to-back ratio. Pattern is "away" from support located at 180 degrees.

just a single "Lazy-V" dipole, extolling its low-angle gain and seeming DX improvement over a vertical or sloper antenna. If true, this would make this simple antenna a real winner.

It is instructive to look at a single dipole and see how it plays. A general determination of performance can be made with an antenna analysis program. I chose to do this task with the MN 4.5 program of K6STI. There are other programs that will do the job equally as well.

If the antenna does what some enthusiasts believe it does, the next step would be to try multiple dipoles, one each for a single band, and see how this layout functions as a multi-band antenna. This article describes just such a combination of antennas, suitable for 7, 10, 14, 18, and 21 MHz operation.

Eighty meter operation was not considered, as the resulting antenna would be too large, and 24 and 28 MHz were dropped because these bands are not worth very much at the bottom of the sunspot cycle. The five bands selected, however, are very much alive with plenty of DX, and this simple antenna may help you snag some of it!

Another investigation would be to analyze two dipoles in a beam configuration. This has been done by others (see further reading), and for me to do it again would be reinventing the wheel. Therefore, I dropped this idea.

A Vertical Test Dipole

What I want to know is the field pattern of the Lazy-V dipole and how it compares with a vertical dipole and a dipole inclined at a 45 degree angle. These three configurations can be compared quickly on the computer.

The first experiment was to evaluate the vertical dipole. My model was cut to a length of 33 feet 6 inches. I chose an element made of #18 wire, as I had plenty of that if I decided to build the antenna. The test frequency was 14.2 MHz and the base of the antenna was placed 7 feet above ground, making the top of the antenna/mast reach the 40 foot level. These figures were inputted to the computer program, and the analysis showed that the feed-point impedance at the center of the dipole was about 72 ohms and the main lobe of the antenna fell at an elevation angle of about 16 degrees (fig. 3). High-angle radiation is nicely suppressed, being reduced by 10 dB or more at angles above 60 degrees. In comparison, a quarter-wave ground plane has a takeoff angle of about 25 degrees.

The Tilted Dipole at 14 MHz

The next step was to tilt the dipole at an angle of 45 degrees. Feedpoint resistance increased to about 78 ohms, and a slight front-to-back ratio of about 5 dB was apparent (fig. 4).

The elevation pattern, alas, exhibited a lot of high-angle radiation (fig. 5). At 15 degrees the pattern was down 3 dB when compared with the vertical. Maximum radiation appeared at about 58 degrees. Great stuff if you want to talk to an amateur a few hundred miles away. Not so good for 20 meter DX! As far as I was concerned, this eliminated the tilted dipole as an effective 20 meter antenna.

The Lazy-V Dipole at 14 MHz

The next step was to configure the dipole in the Lazy-V design (fig. 1). A computer run showed that the azimuth pattern was practicaly omnidirectional; the null of the tilted dipole pattern had disappeared. The elevation plot looked something like that of the vertical dipole (fig. 6). Low-angle radiation peaked at about 16 degrees, but a high-angle lobe, absent in the vertical configuration, was apparent. By comparing the plots of the two antennas (figs. 3 and 6) it could be seen that the Lazy-V afforded no signal gain over the vertical, but instead produced some high-angle radiation that is relatively useless.

The next question to be considered is as follows: What is the effect on the Lazy-V antenna of the supporting mast? It was easy to eliminate or replace the vertical/mast support on

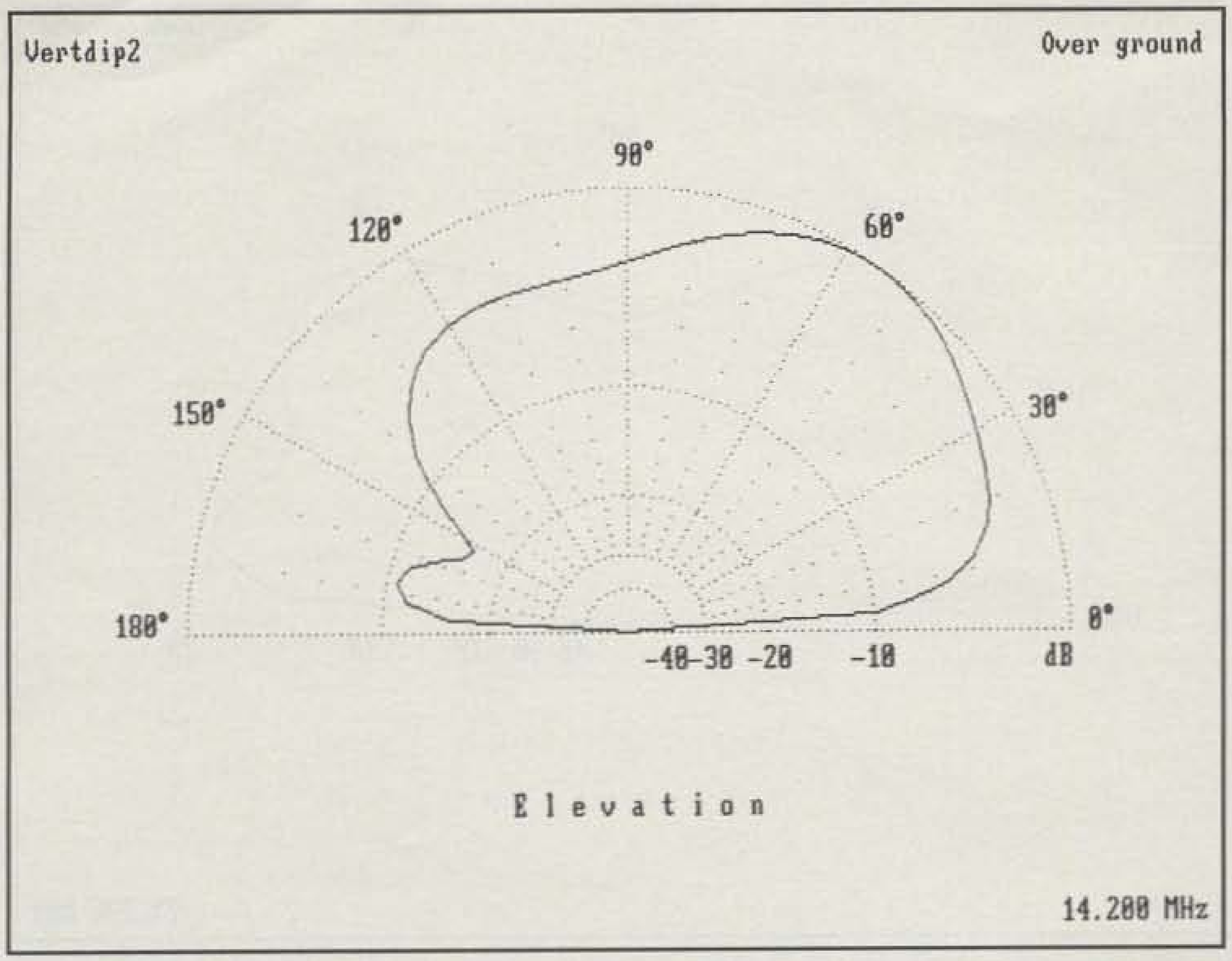

Fig. 5– Pattern of dipole tilted at 45 degrees exhibits unwanted high-angle lobe. Directivity is "away" from supporting tower.

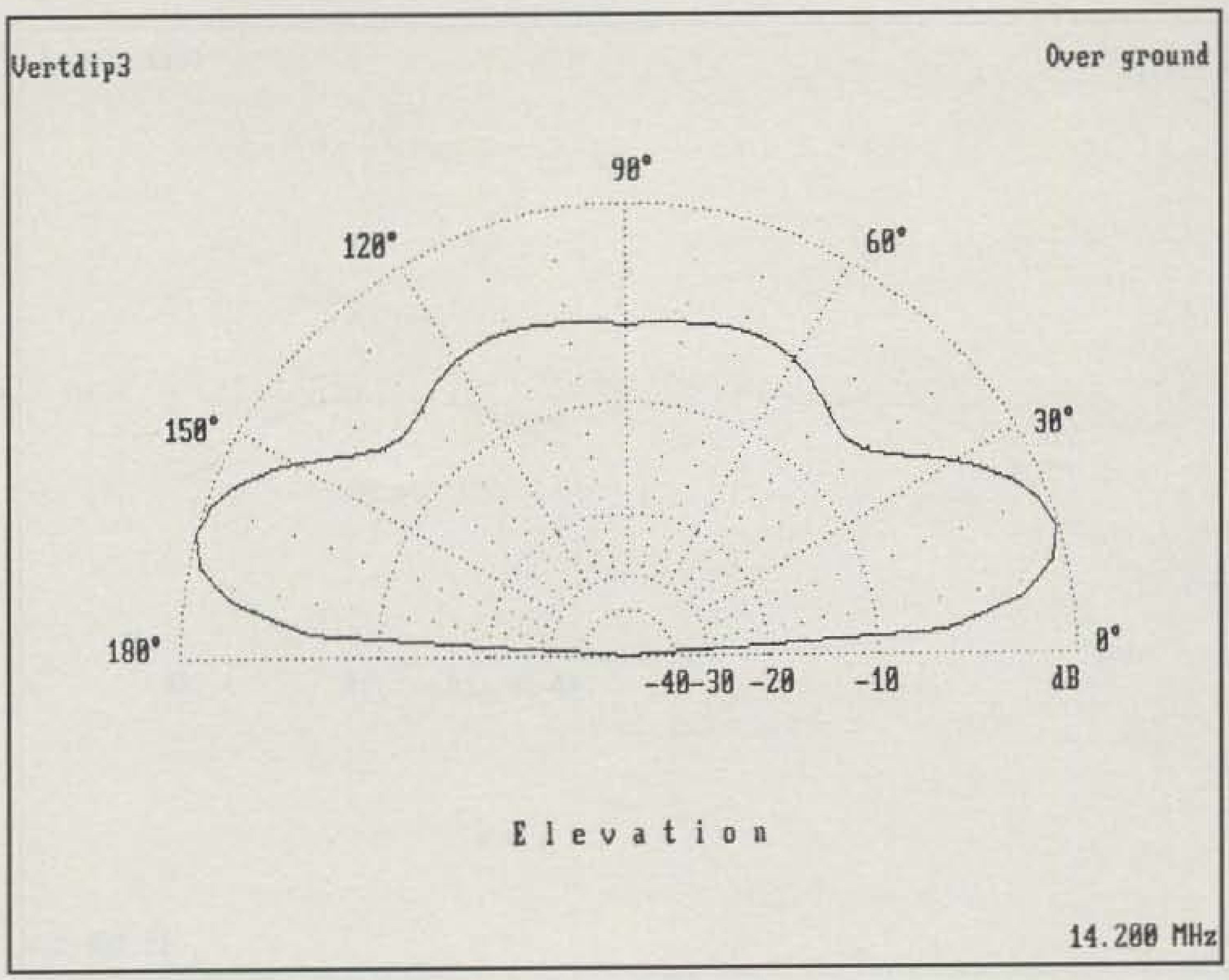

Fig. 6– Pattern of 20 meter Lazy-V dipole with top at 40 foot height. Maximum radiation lobe is about 15 degrees.

the computer program. A 3 inch diameter mast placed 2 feet away from the Lazy-V antenna had only a minor effect, with slight variations in the pattern, depending upon the distance of the mast from the Lazy-V antenna tips.

That's the summation of the 14 MHz runs. While the Lazy-V does show high-angle radiation, it still produces a low-angle lobe equivalent to that of the half-wave vertical antenna. Placing several Lazy-Vs around a ground-plane vertical provides a multiband antenna that doesn't take up much space.

The 21 MHz Lazy-V

The next step was to reconfigure the computer program for a 21 MHz Lazy-V, with the top wire tied off at the same level as that of the 14 MHz design.

Analysis showed the feedpoint impedance of the Lazy-V to be about 45 ohms. The elevation pattern had a split lobe, with maximum radiation at 13 and 47 degrees (fig. 7). The low-angle radiation is excellent, but the high-angle radiation merely warms the ionosphere.

Radiation Patterns At 10 and 18 MHz

So far, so good. The Lazy-V looked promising enough to check it out on the two remaining bands: 10 and 18 MHz.

At 10.1 MHz the feedpoint impedance of the Lazy-V is about 51 ohms. Good match! The azimuth pattern is omnidirectional, and the elevation pattern shows the main radiation lobe at an angle of about 26 degrees (fig 8). Very good!

The bottom insulator of the antenna is only about 4.5 feet clear of the ground in this particular setup. Care should be taken to isolate this point from inquisitive fingers, as it is "hot" when you are transmitting!

The last step was to try a computer run at 18 MHz. Feedpoint impedance runs about 38 ohms, and the radiation pattern is shown in fig. 9. The lowest lobe falls at 13 degrees elevation, and there is considerable radiation at higher angles, peaking at about 58 degrees. This is a usable pattern, in spite of the amount of high-angle radiation.

Try The Lazy-V Yourself!

If you want to try the Lazy-V yourself, the shack is a good place to start. And, I must admit the idea of placing four or more Lazy-V dipoles around a single mast is indeed tempting. Someday I must try this scheme in the backyard, but I don't expect some of the amazing results some of the backers of this antenna seem to be getting.

Building A Lazy-V Dipole Assembly

Here's the way I would go about building a multiband Lazy-V antenna system. For simplicity I would limit the design to five bands, covered by the vertical antenna/support, plus four Lazy-Vs which make up the guy wires. The basic vertical antenna is made up of three sections of 10 foot TV mast (Radio Shack 18-843) plus one 5 foot section (trimmed to length). A guy-ring and collar (15-835) are used as tie points at the top of the dipoles.

The vertical mast/antenna can be fed directly at the base, or the base can be grounded and the antenna shunt-fed with a gamma match. Five or six radials, about 20 to 30 feet long, are laid out across the grass of the yard. You can bend the radials to fit them within your property limitations.

The first step is to experiment with a single Lazy-V dipole. The apex of the dipole is pulled away from the tower by a rope and tied off at a convenient point. The bottom end of the dipole is led back and tied to the tower about 15 feet above ground. The aim is to make the included angle of the dipole at the apex about 90 degrees. A current balun is used at the feedpoint, and the coax line is brought back to

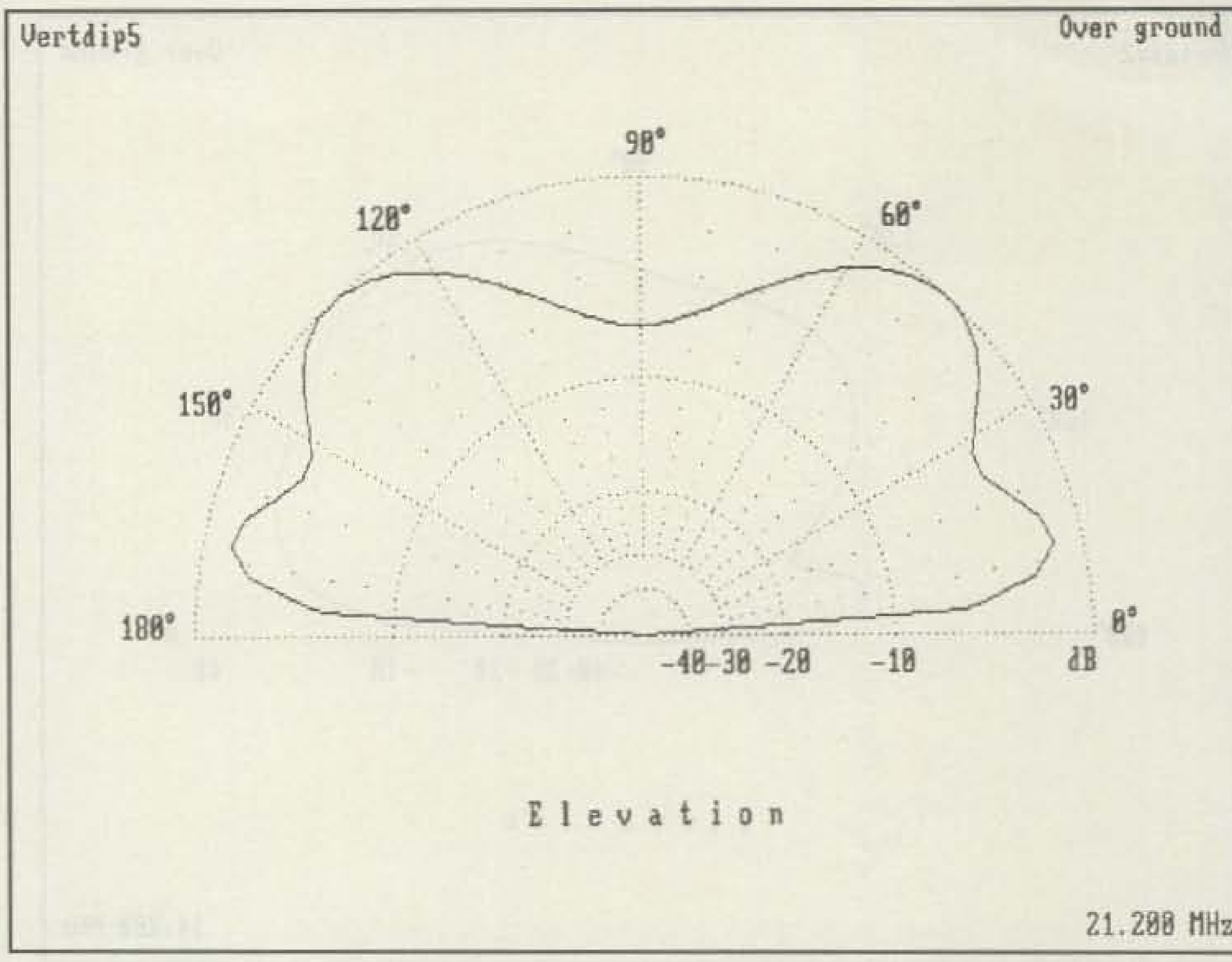

Fig. 7– Vertical plot of 21 MHz Lazy-V with top at about 40 feet. Lowest lobe is approximately 12 degrees.

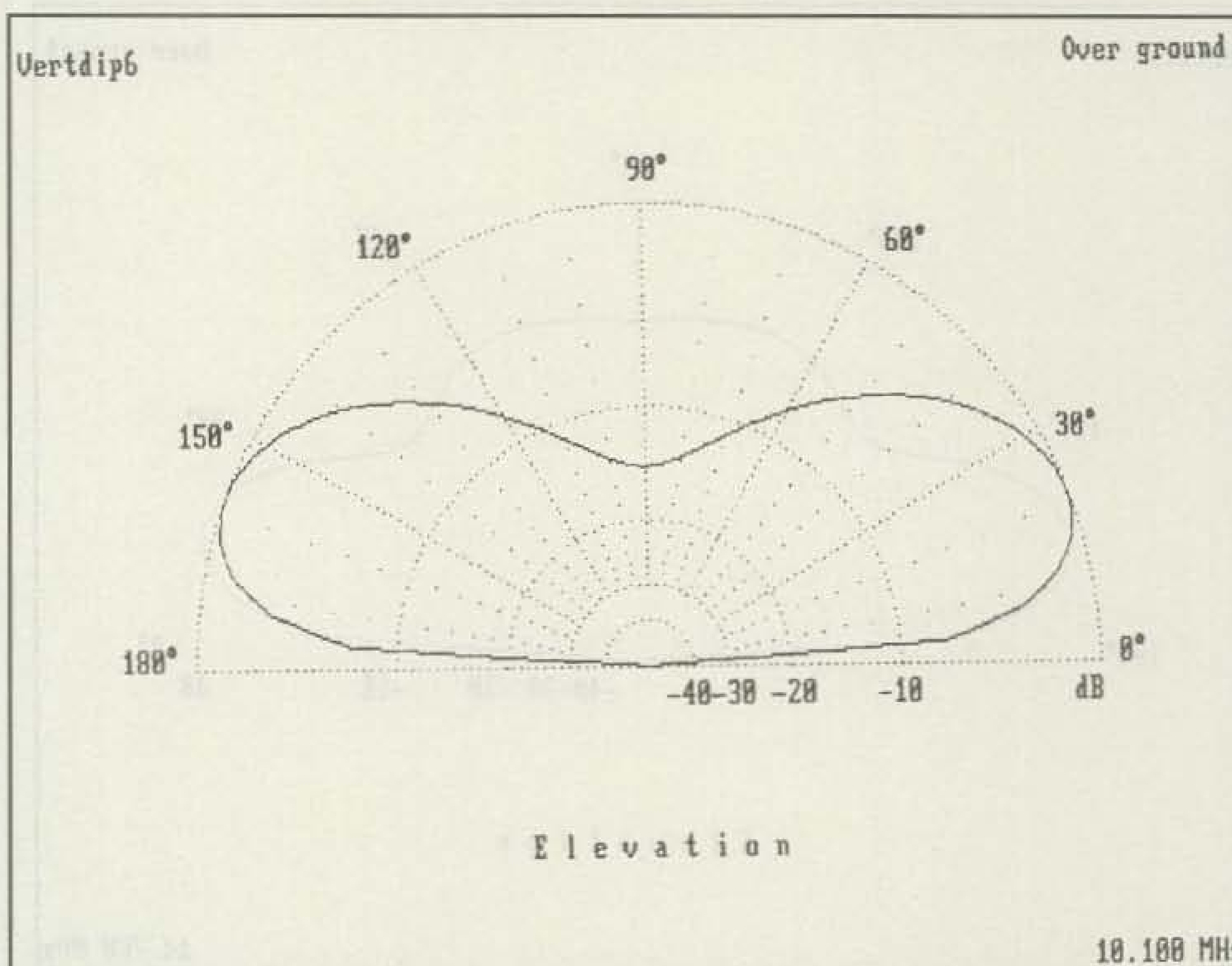

Fig. 8– The Lazy-V pattern at 10.1 MHz. Lobe is at 23 degrees.

the mast and runs down the side. I would keep the coax clear of the mast, as it might affect 7 MHz operation if it were taped to the mast. Just a suggestion.

At band center (14.2 MHz) the SWR on a 50 ohm line (RG-8X) should run about 1.8. Varying the distance of the dipole ends from the supporting vertical can change this figure for better or worse. As always, the dipole can be trimmed to place the point of lowest SWR at your favorite spot in the band.

Adding Extra Dipoles For Other Bands

Once you have gotten the "feel" of the 7/14 MHz combo, you are ready to add additional

Lazy-V dipoles to your antenna farm. Add them one at a time, and review the SWR on the other antennas after a new dipole is added. SInce each dipole is tuned to a different band, there should be little, if any, reaction between them. If, however, you notice a change in SWR when a dipole is added, it is possible to vary this figure by trimming the coax line of one of the antennas. They are closely coupled together, and an unused dipole, plus its coax line, may inadvertently detune or otherwise upset another dipole. It's not likely, but it could happen.

With the vertical, plus four Lazy-V dipoles, you can cover five bands. You'll need a multi-position coax switch at your operating position, plus an ATU unit. If your transceiver has a built-in ATU, that solves this little problem.

Contrary to some beliefs, this antenna system has unity gain, and like any vertical antenna it is sensitive to ground conductivity. Many handbooks have a table of ground conductivity in the United States. If you live in an area of good conductivity, you are in luck. Poor ground conductivity usually produces mediocre results with any vertical antenna.

For those interested in making two Lazy-Vs into a directive antenna, I refer you to the articles listed here.

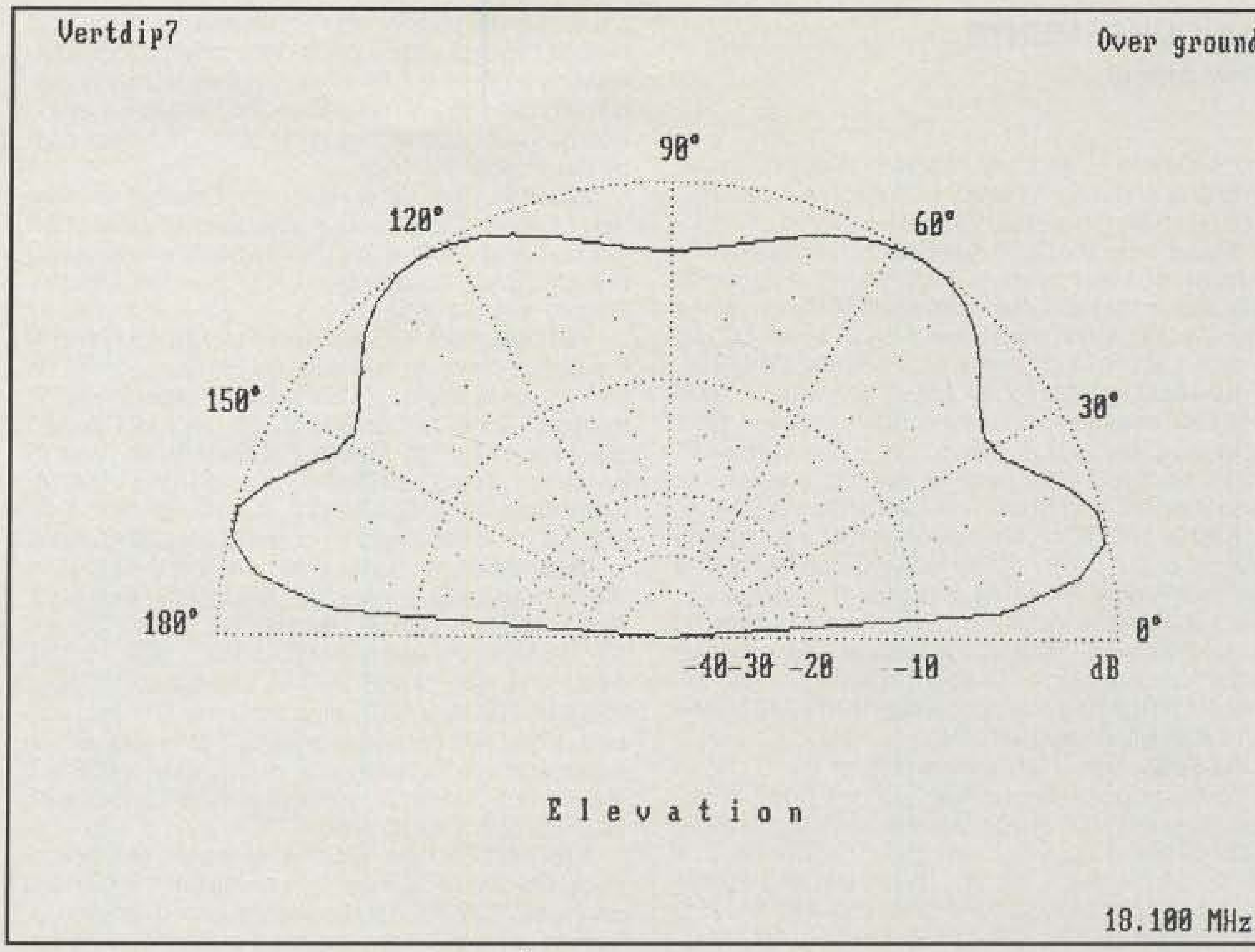

Fig. 9– The 18 MHz pattern of Lazy-V dipole with top about 40 feet above ground.

Further Reading

Here are some articles on using the Lazy-V dipole in antenna arrays.

Christman, Duffy, Breakall, "The 160 Sloper System at K3LR," *QST,* August 1994, pp. 36–38.

Pietrazewski, "7 MHz Sloper System," *The ARRL Antenna Book,* 1991, pp. 4–12 to 4–14.

Mitchell, "The K8UR Low-band Vertical Array," *CQ,* December 1989, pp. 42–46.

Leo, "The Lazy-V Array—An Antenna To Consider," *QST,* February 1995, p. 67.

Margelli, "Credit Where Credit is Due," *QST,* May 1995, p. 86.

Moxon, *HF Antennas For All Locations,* RSGB, 2nd edition, 1993, pp. 227–230.

Thank You

In the April column I announced that I would no longer write this column for *CQ* on a monthly basis but would from time to time contribute a column on some subject I thought was of general interest. This is the first.

I was pleased and thankful for the letters some of you sent me. I appreciate them more than you know. The past months have been difficult, as my XYL, Sunny, passed away, leaving a void in my life. Your letters helped fill that void. Thanks to Irving Morris, W2GMT; Ed Cartotto, W6ZZN; Rick Harmon, KK5BR; Jack Bennett, W8WEN; Rod Newkirk, W9BRD; Doug DeMaw, W1FB; Rick Littlefield, K1BQT; Terry Littlefield, KA1STC; George Goldstone, W8AP; Craig Clark, NX1G; Stu Cowan, W2LX; Vic Persson, SM5KP; George Papalias, W6GBA; Bill Hadgius, N5FIH; Bob Boehmig, W4SJS; Rod Holtz, K5BGB; Bradford Williams, KE7IP; Philip DeJarlais, WØJHS, Wm. J. Byron, W7DHD; Harold Ort, N2RLL; Paul Vaughn, WA4FST; John Clark, WF3Y; Ray Gregson, W6EMT; Al Bry, W2MEL; Don Lynch, W4ZYT; and John Monroe, W7KCN. Many thanks.

73, Bill, W6SAI