Radio FUNdamentals

BY BILL ORR, W6SAI

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

The V-beam

The V-beam is a simple and cheap wire antenna. Originally known as the "RCA Model D" antenna, it was featured in *Handbooks* as early as 1934 (fig. 1). It is still in the latest edition of the *ARRL Antenna Book*. That's pretty good life for an antenna design, don't you think?

Most amateur handbooks provide a nifty pattern for the V-beam—nice, bidirectional lobes, with greatly attenuated minor lobes (fig. 2). If the wires of the beam are long enough, and the included angle is correct, a sizeable gain can be achieved, up to 7.5 dBd for a beam with 5-wavelength long legs.

The recently available computerized antenna programs provide an interesting insight into the V-beam antenna. The gain figure can be verified and the field pattern plotted. The interesting result is that the V-beam has large minor lobes, much greater in amplitude than pictured in the amateur literature.

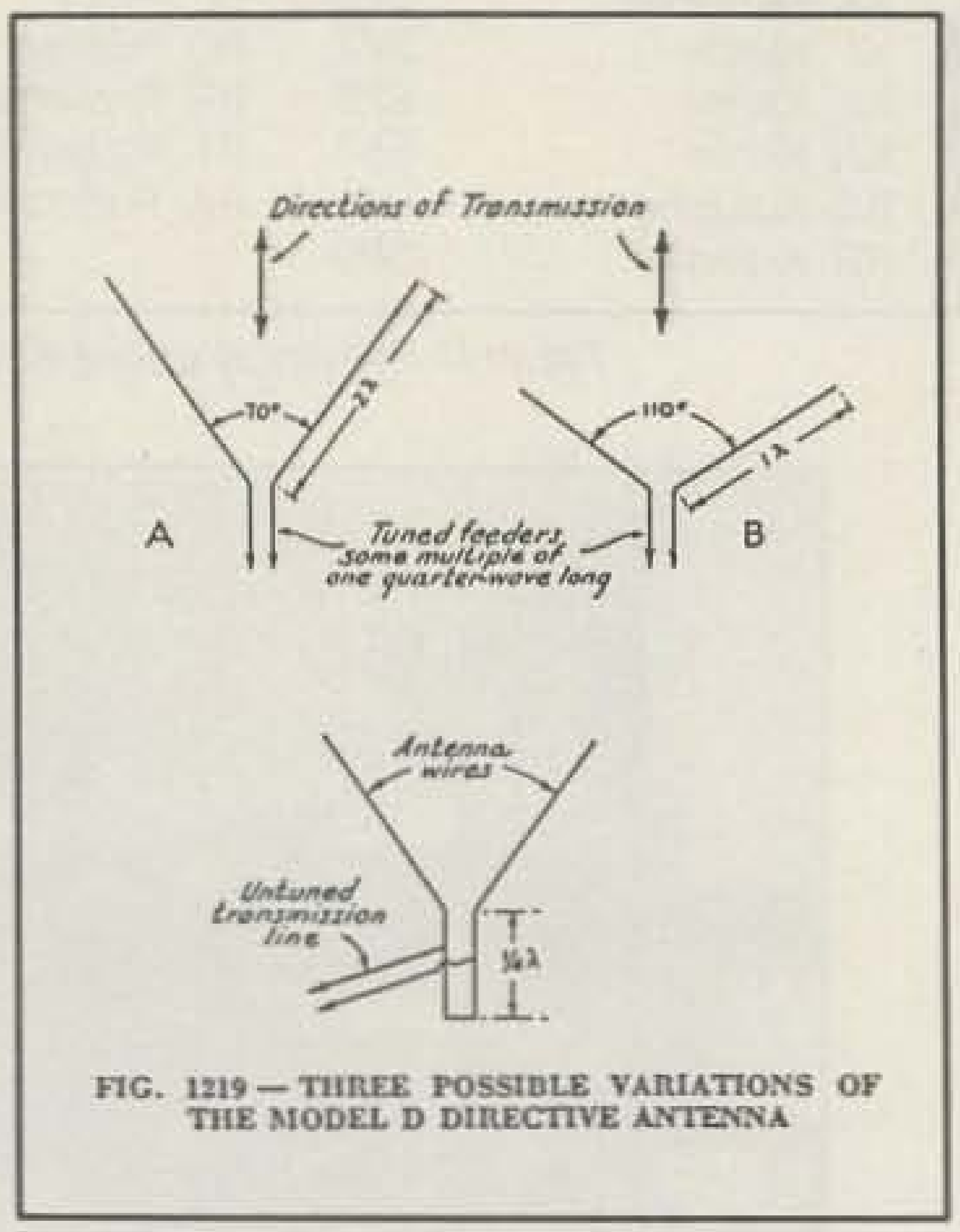

Fig. 1– The V-beam antenna, as shown in the 1934 issue of the Radio Amateur's Handbook. *Adapted from the RCA "Model D" beam antenna.*

V-beam Patterns

The azimuth pattern of a 5-wavelength V-beam is plotted in fig. 3 using the MN Antenna Analysis program of K6STI.[1] Look at the multitude of minor lobes! Four of them are only 6 to 8 dB below the main lobes, and others range in the −10 to −15 dB range. This means that for all practical purposes, the V-beam is an omnidirectional antenna with a field strength not much below a dipole in most directions off the main beam.

This point was brought to my attention by W2LX, who has a V-beam aimed at VK-ZL. It works very well in that direction, but Stu found that he could also work plenty of DX off the sides of the beam. Fig. 4 shows why this is so.

In real life, where wires sag and the interior angle of the V-beam is not accurate, the minor lobes are even larger than shown. Antenna gain is still present, but the pattern becomes more omnidirectional, with the minor lobes increasing in size. When erected over real earth with its losses and considering the signal reflection from various nearby objects, the minor lobes become even more blurred. The end result is gain along the main axis of the beam and near-dipole performance in all other directions.

Strung between trees, as W2LX has done, the V-beam is a utility antenna good for operation on several bands. Used with a balanced antenna tuner and an open-wire feedline, the old antenna still does a good job in today's DX world of competition.

The Amazing G5RV Multiband Antenna

You hear a lot of G5RV antennas on the air these days. They must work, or fellows wouldn't be using them! Like the V-antenna, the basic G5RV is a very simple sky wire (fig. 5). It has been around a long time, disguised in many forms. Bill Stewart, K6HV, helped me trace the history of this antenna, and it seems to have more lives than a cat!

The original antenna design was conceived by Art Collins, W9CXX, of Collins Radio Co., and the antenna was packaged as a kit. The matching section was composed of heavy copper tubing, resulting in a clumsy and difficult assembly.

The idea seemed to die for a while, then resurfaced after the 50s, when it was popularized by R. Varney, G5RV, who replaced the copper-tubing matching section with one made of a two-wire transmission line. He also eliminated the balanced feedline and substituted a 75 ohm coaxial line.

The G5RV design consists of a 102 foot flattop center-fed with a 34 foot open-wire matching section (fig. 6). Various articles on the G5RV[2] confirm the belief that for "all-band" operation, a balanced antenna tuner is helpful.

The ZS6BKV Version

A few years ago a computer analysis on the G5RV antenna was run by Brian Austin, ZS6BKW.[3] Brian confirmed that the original G5RV design provided a low value of SWR when fed by 75 ohm coax only on the 7, 14, and 24 MHz bands. When fed with 50 ohm coax, the SWR was poor on all bands.

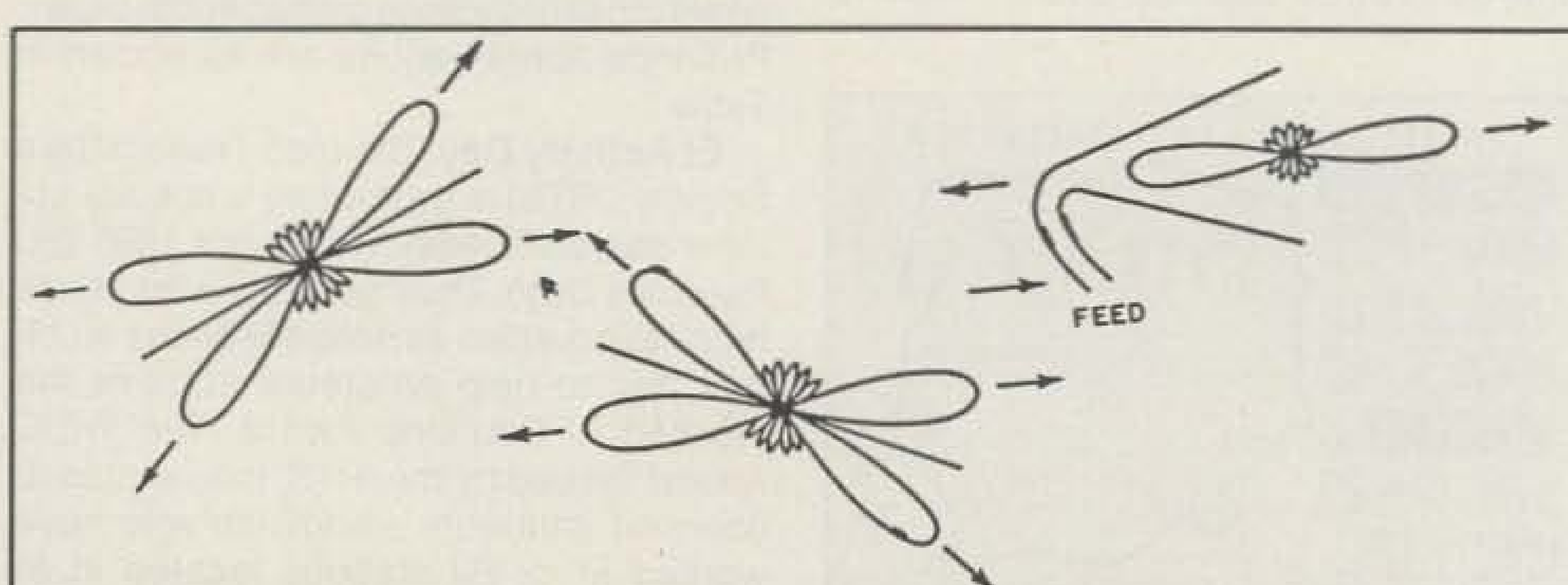

Fig. 2– Pattern of the V-beam antenna as given in the ARRL Antenna Book, *15th edition. These illustrations show how patterns of two long-wire antennas add up when placed at the proper included angle. Computer analysis of V-beam shows side lobes much greater than these here.*

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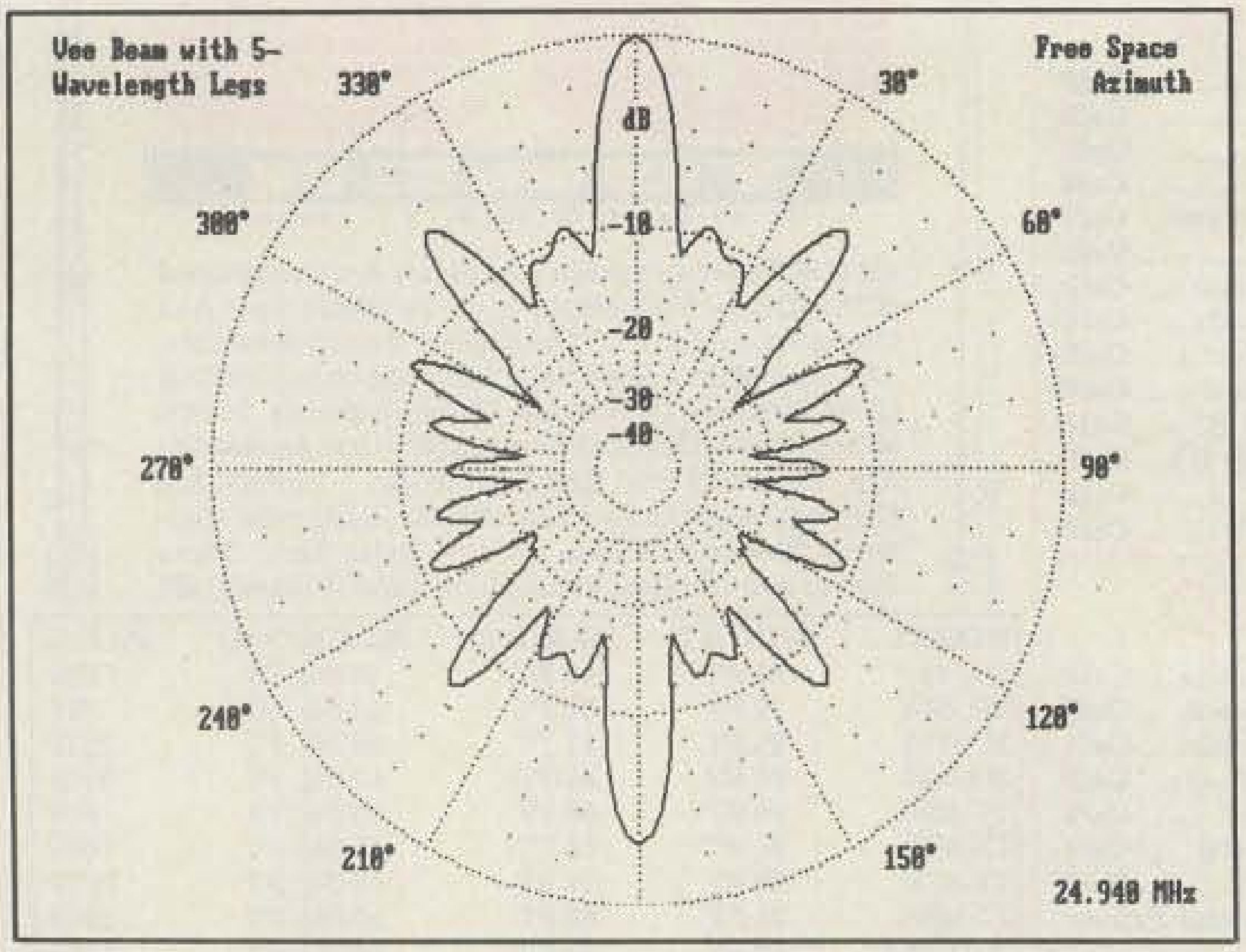


Fig. 3– K6STI analysis program shows side lobes of 5-wavelength V-beam. (See text for details.)

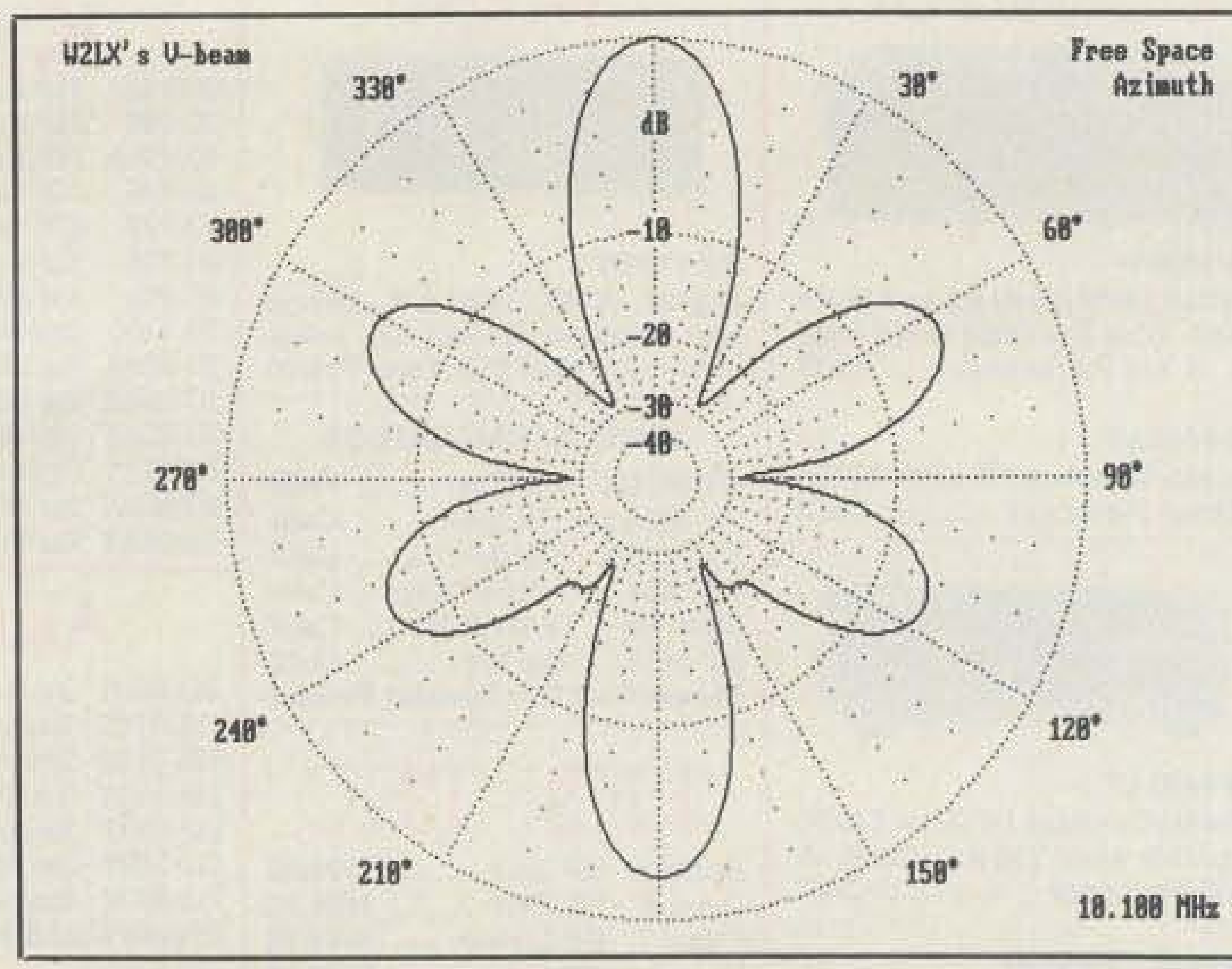


Fig. 4– Computer analysis of W2LX's short V-beam. Four minor lobes give good coverage at 60 and 120 degrees to main lobes.

These high values of SWR could be compensated for by the use of a balanced tuner at the station end of the coax line. However, ZS6BKW examined the computer program and came up with a new set of dimensions for the antenna which permitted 50 ohm feed, plus the use of 300 ohm ribbon line for the matching section.

The revised dimensions for the ZS6BKW antenna are given in fig. 7. The antenna provides a low value of SWR on the 7, 14, 18, and 24 MHz bands. On the 28 MHz band a low value of SWR is obtainable only over the range of 28.5 to 29 MHz.

This is quite an improvement over the original design, but an antenna tuner is required for 21 MHz operation, and would be helpful for full coverage of 28 MHz. Either antenna design will also work on 80 meters, with an appropriate antenna tuner.

Field Patterns of The G5RV Antenna

The field patterns of the original G5RV and the ZS6BKW version are substantially the same. On 80 meters the pattern is the familiar figure-8 of the conventional dipole. The pattern is the same on 40 meters, slightly narrower, and exhibiting a gain of about 0.5 dB at right angles to the antenna wire.

Computer plots of field pattern for the higher bands are shown in figs. 8 through 10. The 20 meter pattern has the main lobes at an angle of about 45 degrees to the wire. These lobes exhibit a gain of 1.02 dBd. The lobes at 90 degrees to the wire are down about 2 dB from the main lobes. In real life the deep nulls of the pattern will tend to be filled in to a great extent.

The 15 meter pattern shows the main lobes displaced about 65 degrees from the wire, with a large null at right angles to the wire. Four minor lobes exist, each down about 10 dB from the main lobes. It is not a very exciting pattern, as radiation in-line with the wire and at right angles to it is largely suppressed. Hopefully, the nulls will be filled in by virtue of the antenna environment.

The 10 meter pattern shows even more lobe splitting. Gain of the main lobes is about 2.45 dBd. Again, there are a lot of gaps in the plot.

Summing it up, the G5RV antenna operates like an ordinary random-length, center-fed wire with no special properties other than that it can be reasonably matched on most amateur bands with little effort.

The Balanced Antenna Tuner

I've mentioned the fact that the G5RV was originally designed to be used with a balanced transmission line. That's fine, but where does the prospective user obtain a balanced antenna tuner? All of today's tuners (sometimes called "Transmatches") have a balanced output derived from a balun (fig. 11). The balun is commonly a 4-to-1 design, providing a 200 ohm terminal point. This is okay if you have a 200 ohm transmission line with a low value of SWR on it. But this is not the case with the G5RV, the matching sec-

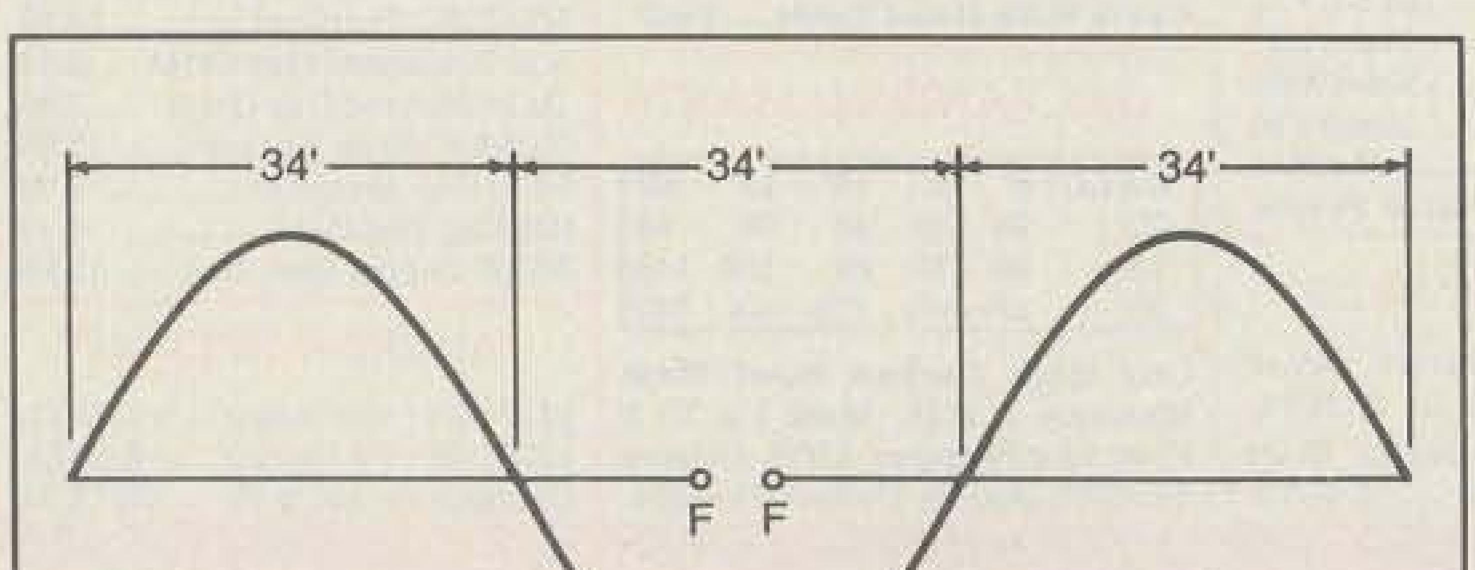


Fig. 5– Genesis of G5RV antenna is three half-waves at 14 MHz in phase, fed at the center segment. Current distribution is shown.

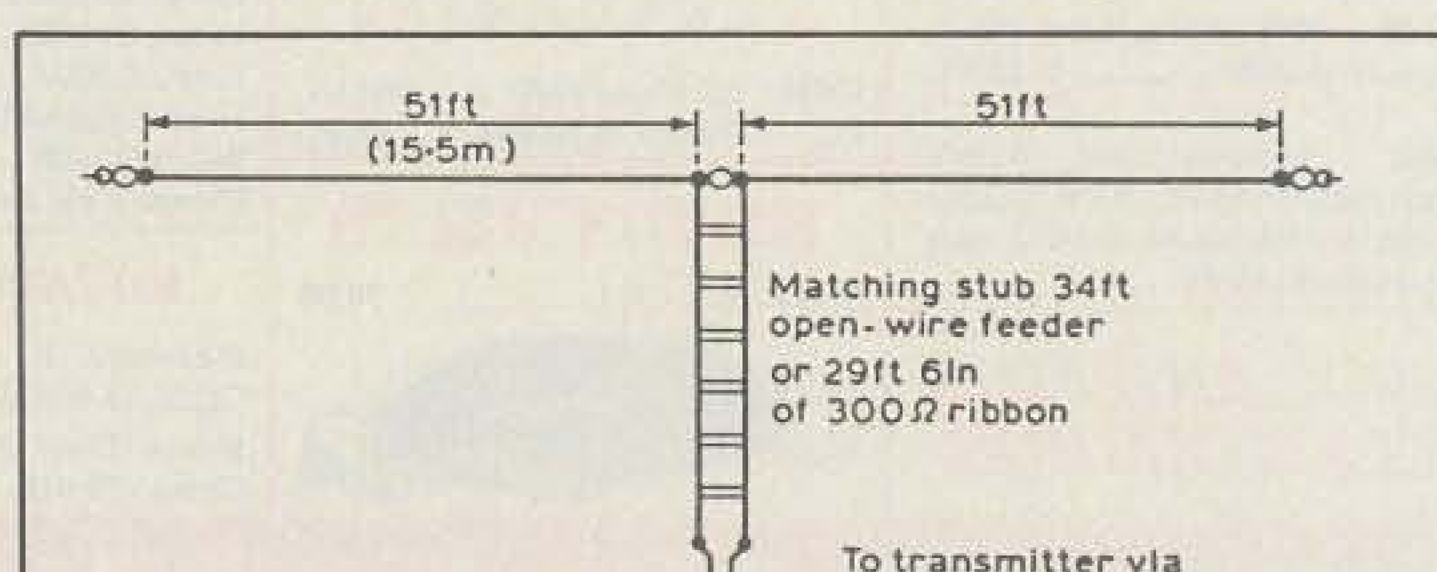


Fig. 6– Original G5RV antenna used open-wire stub and 75 ohm coax feed. Drawing from "hf antennas for all locations," by Moxon (RSGB).

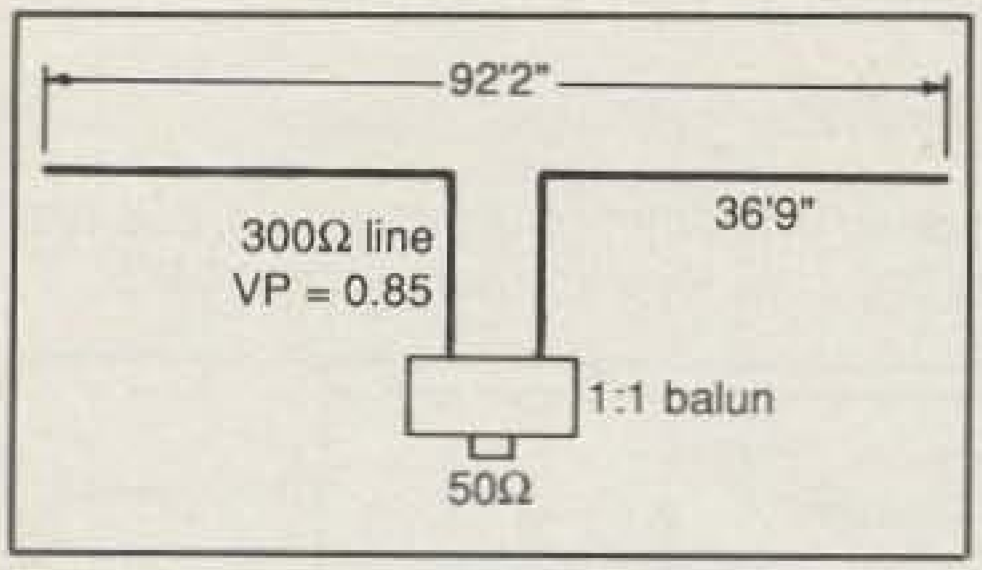


Fig. 7– ZS6BKV computer-derived G5RV antenna provides good match to 50 ohm line and uses 300 ohm ribbon line for matching section.

tion of which provides a widely varying reactive termination on most bands. The balun doesn't like this, and core saturation or flashover can take place under certain operating conditions.

The old Johnson "Matchbox," no longer in production (alas), is suitable for balanced, center-fed antenna systems. Information on building your own equivalent is in the *Radio Handbook* as well as the *ARRL Antenna Book*.

Parallel-Connected Dipoles

Parallel-connected dipoles are featured in most antenna handbooks, but very little practical information is given about them. It is said that the resonant length of a dipole in the presence of another is not the same as for the dipole by itself. A rather vague idea.

I've tried parallel connected dipoles and have had good luck with them, but noticed detuning at some times and not at others. I erected two dipoles connected at the feedpoint for 7 and 18 MHz. The angle between the two antennas was about 45 degrees. No problem! A textbook case. Both antennas acted as if the other was not there.

Later I cut the 18 MHz dipole to 14 MHz. I found the 14 MHz dipole severely detuned. It had to be lengthened to establish resonance. The conclusion I drew from this was that harmonically related dipoles exhibit detuning of the higher frequency dipole, but harmonically unrelated dipoles have little effect on each other. In either case, the dipoles had to run at a substantial angle from each other; 30 to 40 degrees of separation seemed to do the job.

The ON4UN Antenna Program

John, ON4UN, publishes his upgraded Yagi design program. The two-disk program is available in either monochrome or color. A plotting program is also available which will plot azimuth and elevation antenna patterns. In addition, it creates input files for the K6STI YO and MN programs. As such, the MN, YO, and ON4UN programs are ideal partners.

You can electrically design your Yagi with any of these programs. Element diameter, taper, spacing, and matching systems can be determined with a few keystrokes. Only one minor matter is left —building the antenna!

How should the antenna be built to withstand the vagaries of the weather? What is the wind load factor of the proposed antenna? If the rotary mast extends above the tower top, what is the stress on the mast? In short, how does the builder prevent the antenna from crashing down in high winds? (The VHF DX operator takes all this in stride. He says, "If my antenna doesn't come down in a high wind, it isn't big enough!")

But what about the rest of us? Consider the complex problems of element strength, sag, ice loading, mechanical balance, stress on the tower . . . wow! And what about stacking two antennas on one mast? Enough problems to cross the eyes of the best mechanical engineer.

Fortunately, these problems are met head-on in the ON4UN Mechanical Analysis Program, which is part of the overall Antenna program. The mathematical basis for the program is the article "Structural Evaluation of Yagi Elements," by Dick Weber (*Ham Radio* magazine, December 1989, pp. 29–46). The ON4UN program is available in the United States from the CQ Book Store, Main Street, Greenville, NH 03048.

The Dead-Band Quiz

In my December column I asked the readers to complete and identify the manuscript quotation, dated 1792: "I consul you by way of caution to forbear from crossing the moor in those dark hours when the powers of evil are exhalted."

I'm pleased to find that enthusiasts of the Sherlock Holmes stories are readers of this column, and some of them correctly identified the old manuscript read by Dr. James Mortimer that started the famous detective on one of his greatest cases.

The Sherlockian sleuth who provided the greatest insight into *The Hound of the Baskervilles* story is "Rick" Glisson, N4XMX. Rick also proposed that those amateurs interested in Mr. Holmes and his adventures set up a special net to meet from time to time on the "Speckled Band." Unfortunately, Rick does not give the frequencies of the Speckled Band, so the net has not yet been called to order.

Runner-up is Alex Funke, KC6IWR, who provides an interesting summary and insight into the quotation and also points out that Sherlock Holmes possibly may have been an early radio amateur, as he had extensive knowledge of the Morse code and other codes, and he refers to it during an episode in his life when he was a double

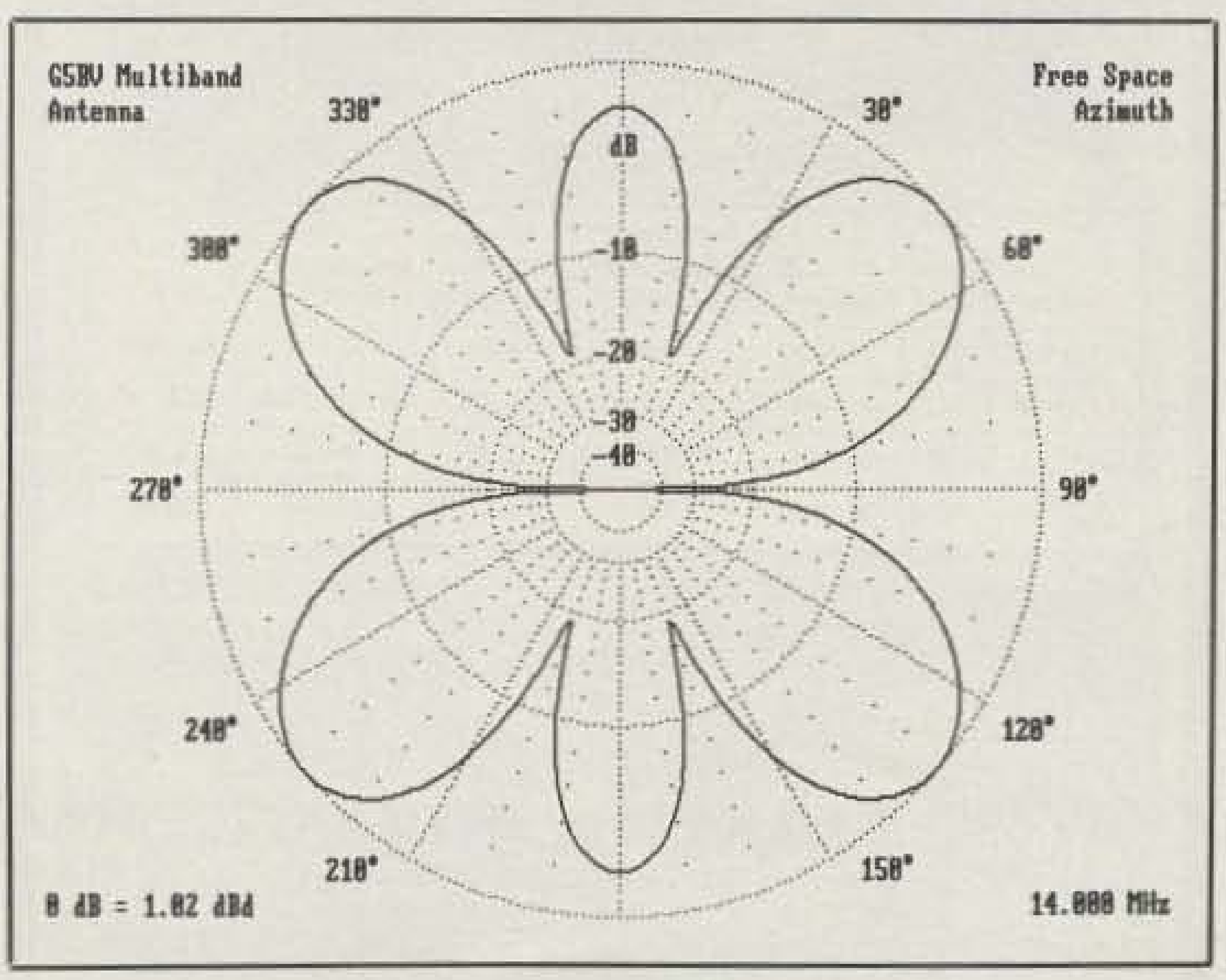


Fig. 8– Pattern of G5RV on 14 MHz.

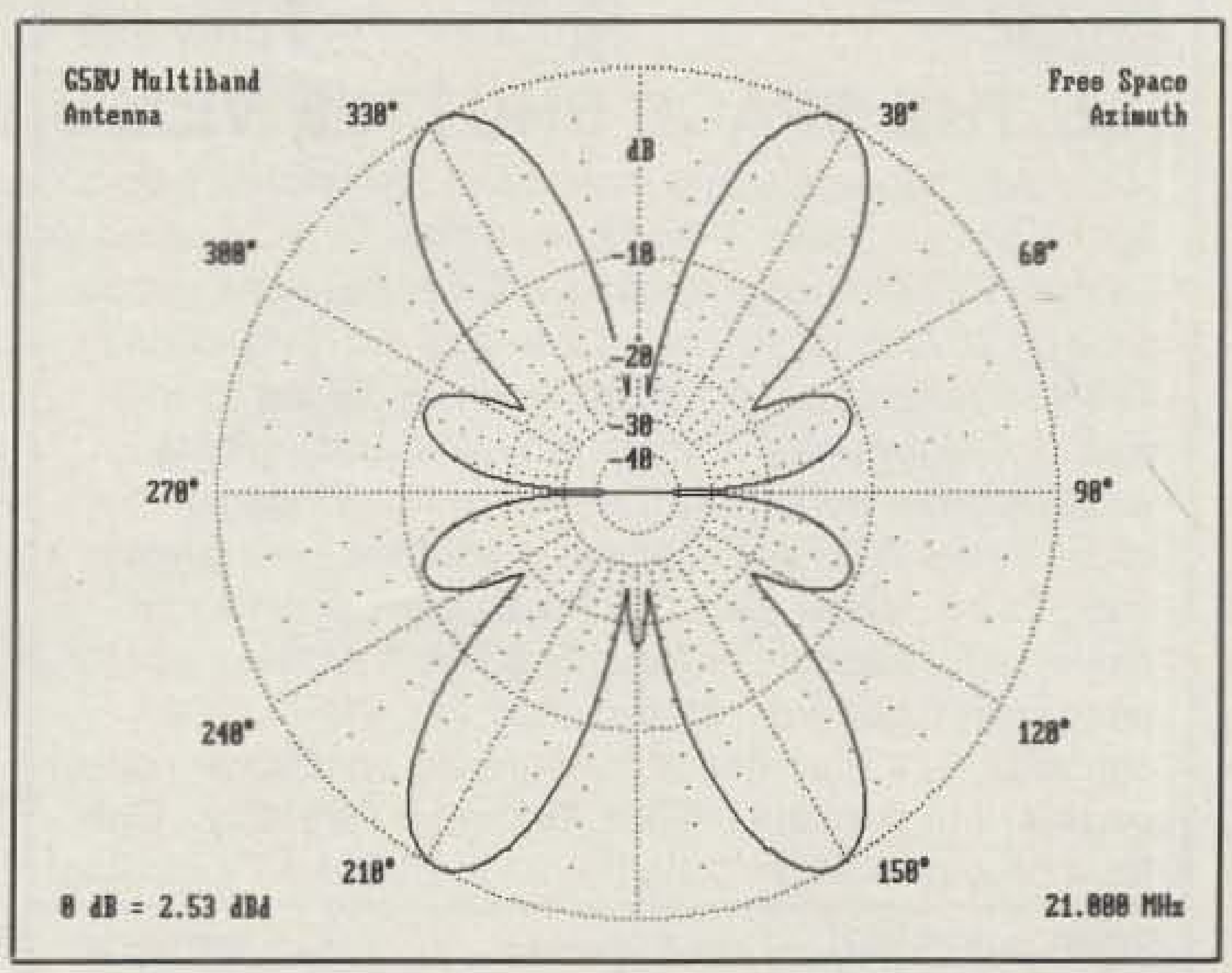


Fig. 9– Pattern of G5RV on 21 MHz.

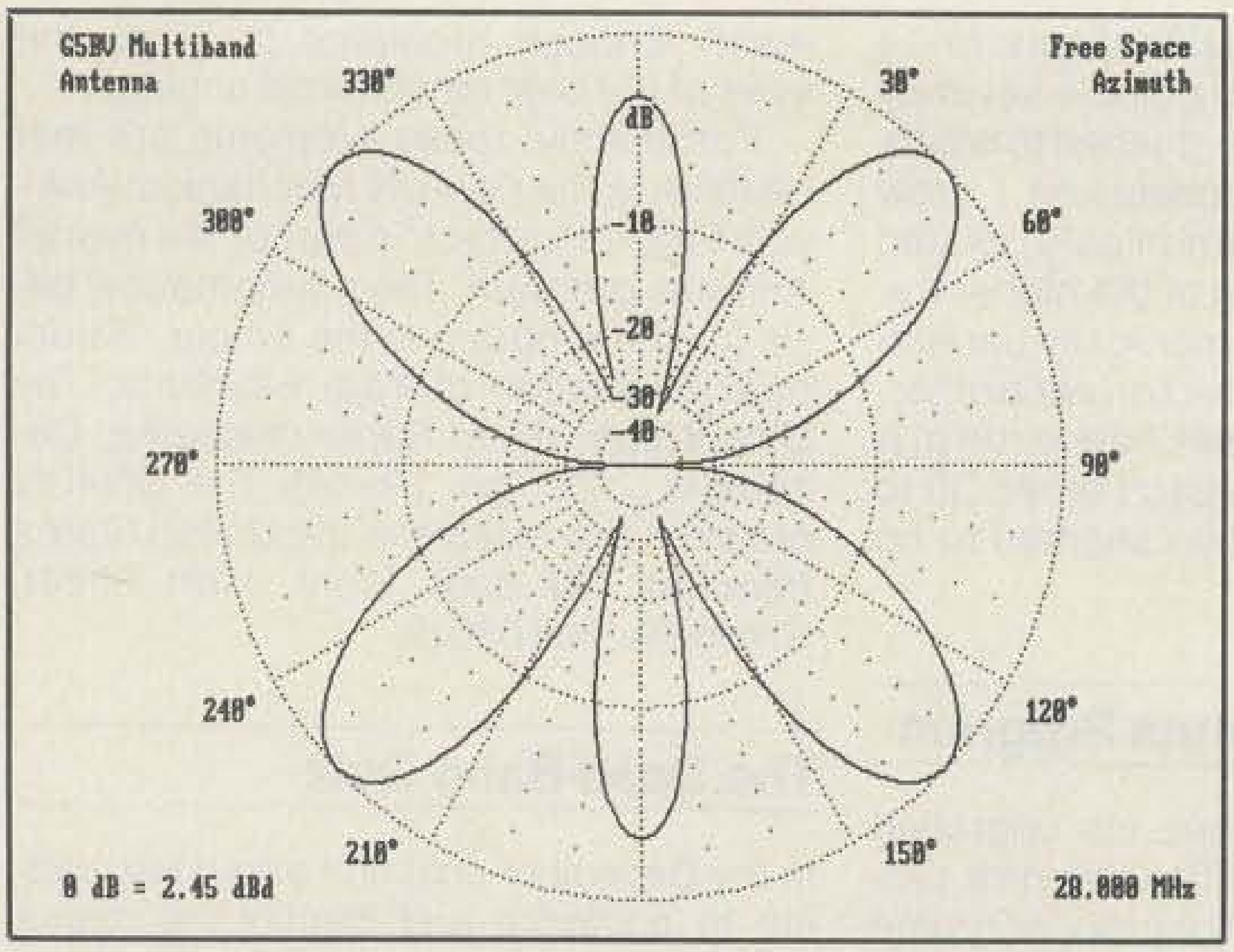
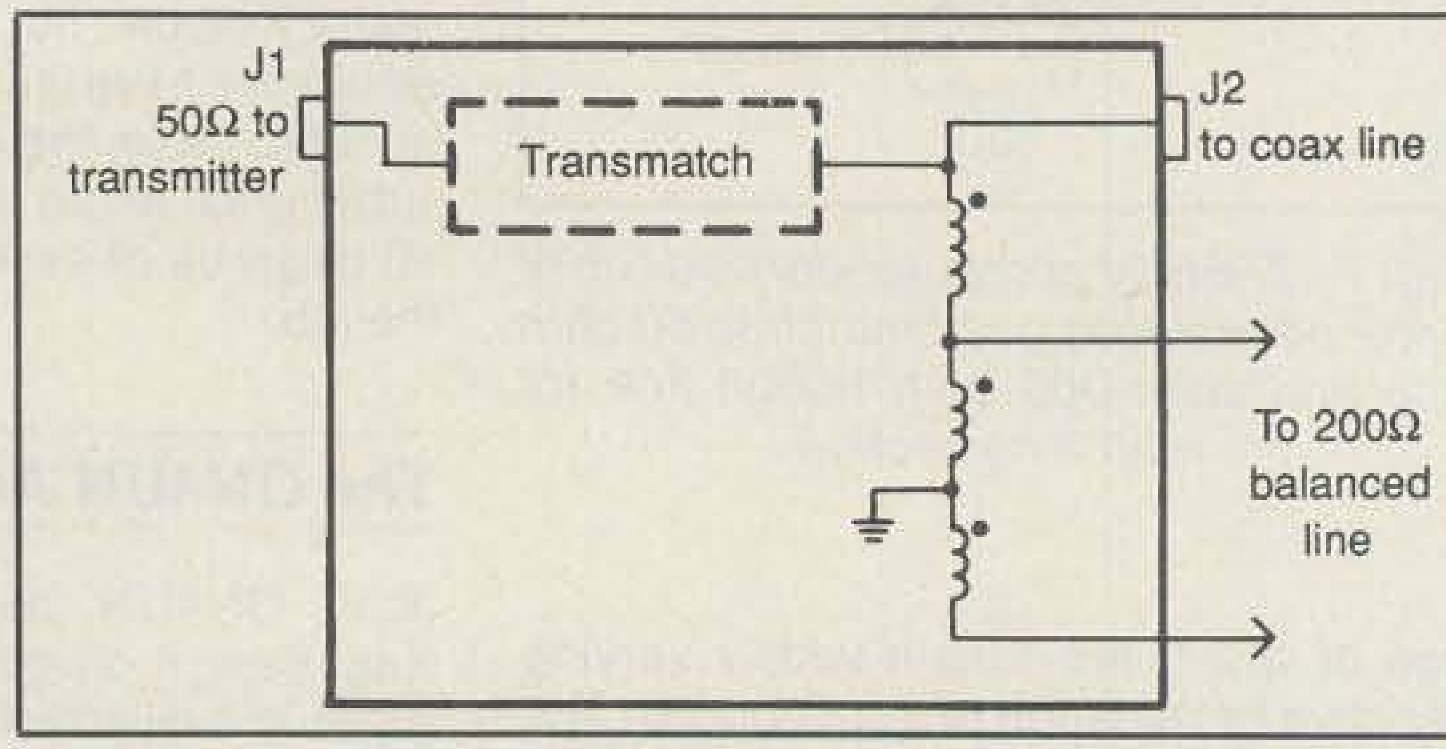


Fig. 10– Pattern of G5RV on 28 MHz.

Fig. 11– Ferrite balun used in many Transmatch tuners is not suitable for working into balanced line having high SWR.



agent: " . . . every last one of (the Naval signals), semaphore, lamp code, Marconi—a copy, mind you, not the original. That would have been too dangerous . . . ."

Rick and Alex, by virtue of their vast knowledge of the canon, receive autographed copies of the new edition of the *Beam Antenna Handbook*. Congratulations!

And thanks to the following who proved their accurate and extensive knowledge of *The Hound of the Baskervilles*: John Stroud, WA6WNN; Luther Phillips, KI4UZ; Brad Martin, N4YYP; Bob DiSilverio, KK6IJ; Marty Peritsky, K3PBU; and Robert Howe, W7EP.

And to the other readers of *CQ* who wrote to me, many thanks for your notes and good wishes: Jack, W2YYI; Wayne, AG4R; Fred, W5QJM; Bruce, W2AN/W2ICE; Dave, W6CUB; Shel, W6EL; Bob, W7GXX; Bill, W2YKG; and Hollis, WF6U. Thanks for your kind words. And to those who inquired about the whereabouts of my old friend Pendergast, he is now the Chief Engineer of that large Mexican communication company "Taco Bell."

Footnotes

1. MININEC (MN3.5), Brian Beezley, K6STI, 507½ Taylor, Vista, CA 92058.
2. Louis Varney, G5RV, "The G5RV Multiband Antenna," ARRL Antenna Compendium, Vol. 1., American Radio Relay League, Newington, CT 06111.
3. Brian Austin, "Computer-aided Design of a Multiband Dipole," Radio Communications, August 1985, Radio Society of Great Britain, Cranbourne Rd., Potters Bar, Herts., England EN6 3JE.

73, Bill, W6SAI