A Trigonal HF Beam

Not an April Fool article! A directional HF gain antenna that doesn't need a rotator.

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Rick, a local CBer, was interested in operation on the 10-meter band once he got his amateur license. He asked me whether it would be possible to retune his ground-plane vertical from 27 to 28 MHz, or use pieces of it to make a 10-meter beam. Pulling out my pocket calculator, I found that the radials of a 27-MHz ground plane were about 3 to 4% longer than a quarter wavelength at 28 MHz, so it seemed that two of his radials butted together would be just about the right length for the reflector of a 28-MHz beam. With a little further thought I realized that all we needed to make a 28-MHz beam was to hang a simple wire dipole between two of the radials. The two radials support the dipole act as a (bent) reflector, as shown in Figure 1. All Rick would need to do is extend the radials with short fiberglass rods (about 6 inches) so that the dipole could hang more-or-less horizontally. The ground plane itself could be left intact for CB use.

Bent Reflector

Rick was skeptical about the use of a bent reflector, so I suggested he read my article about the "Jungle Job."[1] I told Rick he'd need a rotator to turn the beam for 10-meter use. The next day, I realized that even that problem could be overcome, by using the three existing radials to support three separately fed wire dipoles. This scheme provides three independent 10-meter beams that can be selected to provide almost complete 360° coverage (Figure 2).

I found this arrangement quite attractive as, although it requires three separate feed lines, it doesn't require a rotator. All the same, I felt that further study was required, to ensure there were no harmful interactions. From initial tests with a 6-meter model I knew the design was viable. I optimized the dimensions with the aid of the MN 4.0[2] program, which indicated potential gain of nearly 9 dBi, with a 30-dB front-to-back ratio!

On 80 and 40 meters, many DX operators rely on a couple of suitably phased coax-fed quarter-wave verticals. If the feeder lengths are correctly chosen, this can provide both forward gain and useful front-to-back ratio. By switching in a delay line, you can also reverse the direction of fire.

There are three main disadvantages of such an installation:

- Feed lengths are fairly critical
- Lack of 360° coverage
- A large number of radials is required for good performance

Using Dipoles Instead

To overcome the need for radials and to provide coverage over a wider range of azimuths, a number of radio amateurs have experimented with beams using horizontal dipoles, rather than quarter-wave verticals. For example, given three suitable support points, such as a couple of trees and a house chimney, a center-fed wire dipole could be backed up by a pair of similar-length reflector elements (Figure 3A). This antenna would provide a forward gain similar to that of a couple of phased verticals, plus quite useful discrimination against unwanted signals arriving from the sides or the rear.

An even more interesting approach would be to use three driven dipoles in a very similar formation (Figure 3B). The dipoles not in use form the reflector for the dipole being fed. For the antenna shown in Figure 3B, you can see that by switching feed lines you can easily aim the signal in 120° steps. This method has the additional advantages of being faster and cheaper than a rotary Yagi on a tower. Antennas of this type are used to good effect by hams all over the world.

Just as with phased verticals, however, it is essential that all three feeders be cut to precise electrical lengths, to keep unused feeders from detuning their respective reflectors. I was tempted to experiment with the Figure 3B design, but I decided to first make a detailed computer analysis, to determine optimum phase delay and appropriate feeder lengths.

In the course of this study I found that, quite apart from feeder length problems, the system had many other somewhat unexpected shortcomings. For example, to make the reflectors fully effective, they really ought to be 3% to 5% longer than the driven element, and much more closely spaced than in Figure 3B. Even then, the feed lines would still need to be cut to very precise electrical lengths. After examining a number of alternatives, I finally settled for the rather curious three-wire reflector system shown in Figure 4. You easily can see the similarity to the antenna I worked up for Rick (Figure 2).

As far as I am aware, this "trigonal reflector" is entirely new. It is, in effect, three half-wave V-shaped reflectors coupled back-to-back. Each section embraces an arc of up to 120° in azimuth. For

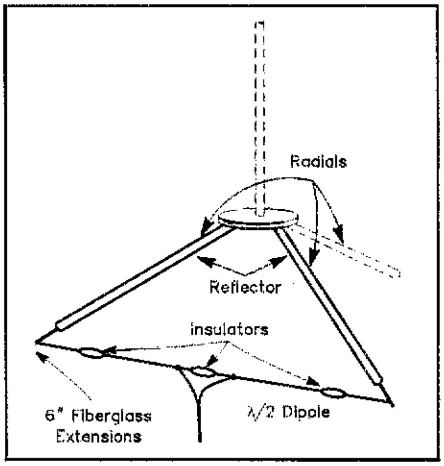

Figure 1—A 10-meter dipole suspended between radials on an 11-meter ground plane. The radials are just about the perfect length to act as a reflector for the dipole.

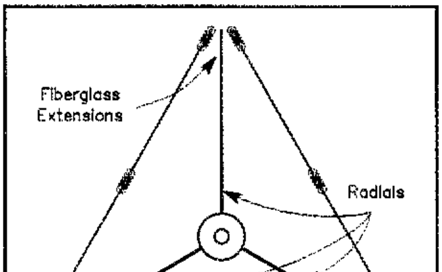

Figure 2—Bird's-eye view of the Figure 1 antenna, with three dipoles in place.

[1]Notes appear on page 34.

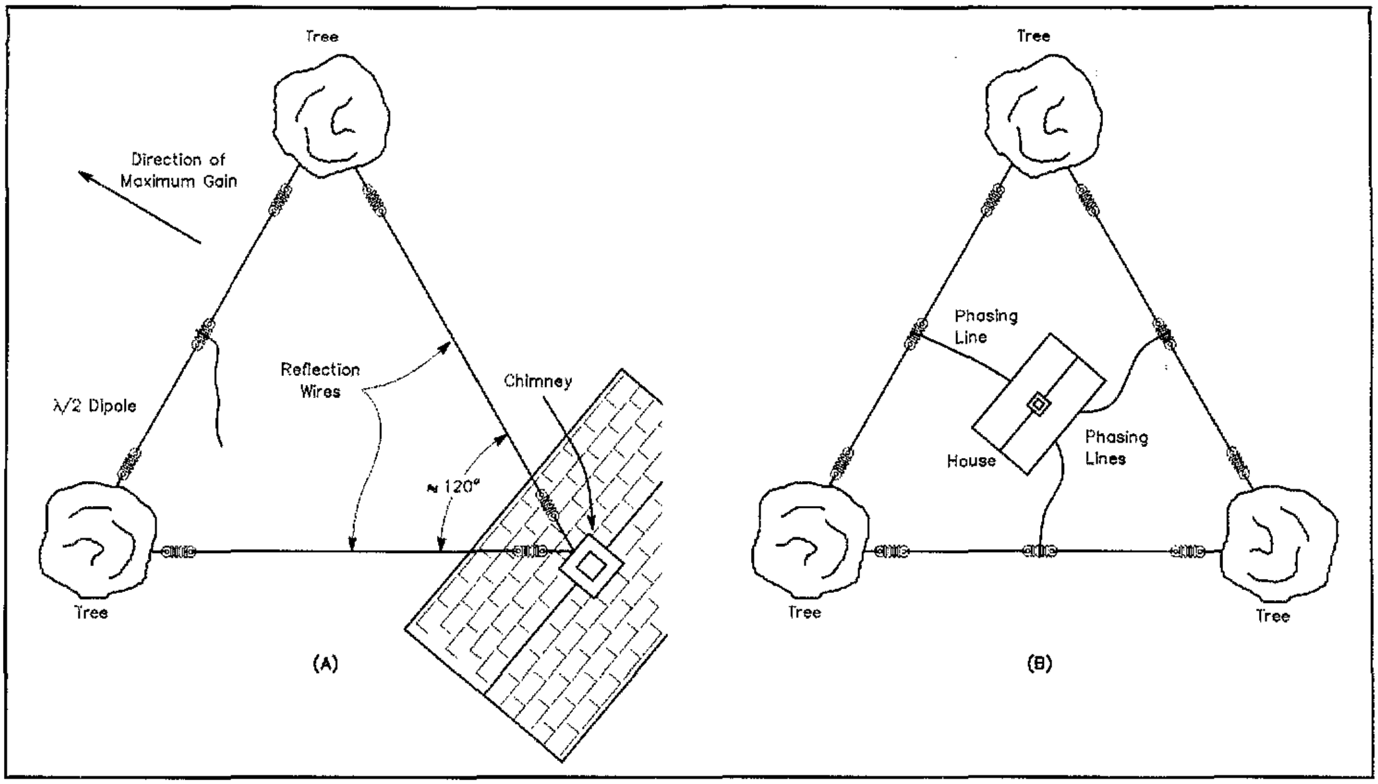

Figure 3—A large-scale arrangement good for a single arrangement is shown at A. B shows an array of phased dipoles suspended from trees. It helps to live in the woods. The disadvantage of the arrangement at B is the difficulty of properly phasing the dipoles.

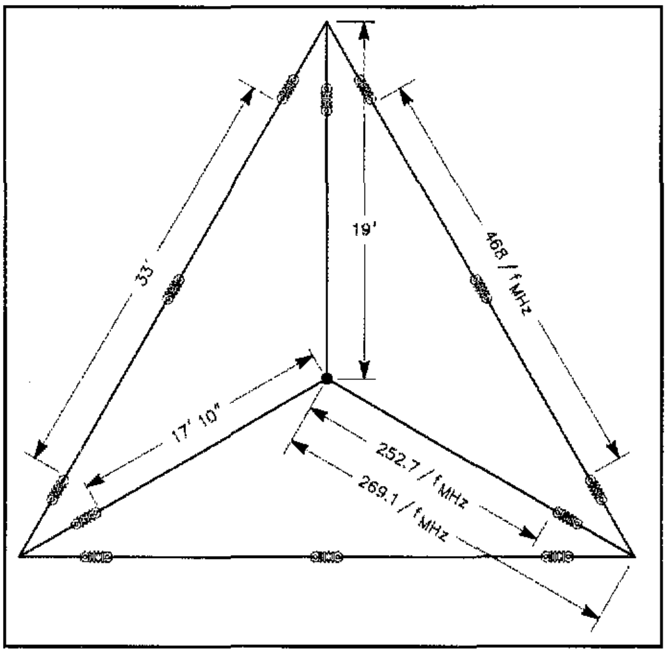

Figure 4—G4ZU's final design uses three dipoles and a trigonal reflector to switch the antenna pattern in three directions. The reflector can be made of wires or aluminum tubing. The dipoles are standard ½-λ designs. Each leg of the reflector is about 8% longer than ¼-λ. If you use a rigid reflector or three common supports for the dipoles and a wire reflector, you'll need to add some insulating material to the reflector tips to get the ends far enough apart so that the dipole fits. Generic dimensions are given in wavelengths so you can scale the design to any band. The specific dimensions shown are for 20 meters, and the performance of this antenna is shown in Figure 5.

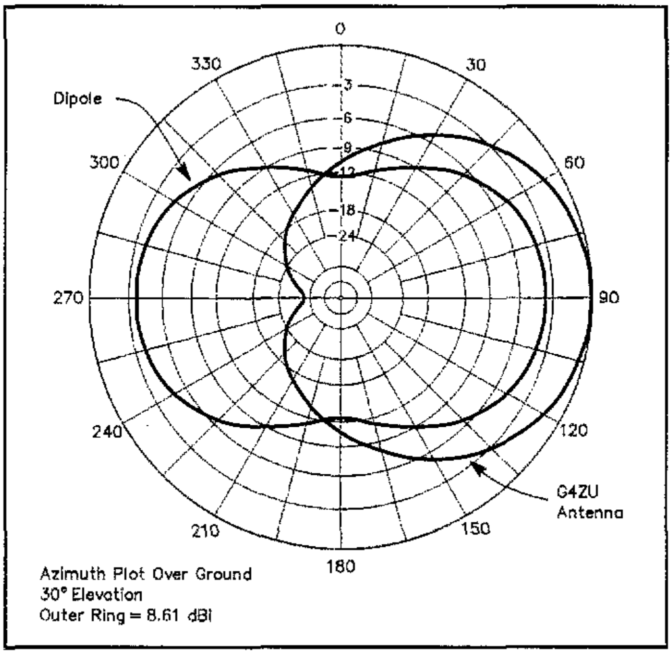

Figure 5—Azimuth plot generated by *ELNEC*, an antenna-modeling program, shows the pattern of the G4ZU Trigonal Beam antenna compared to a conventional dipole. This plot assumes the other dipoles are in place but aren't in use. This is a 20-meter version 25 feet above ground.

best results, each leg of this trigonal reflector must be cut to a length of 1/4 wavelength plus 3%. After they are soldered together at the center, the tips can be secured to appropriate support points.

Using the same support points, I then strung three half-wave center-fed wire dipoles around the trigonal reflector. With three feed lines, this arrangement gave me radiation over three independent arcs, each of 120°, any one of which could be selected at the flip of a switch. What's more, the feed lines can be of any random lengths, because the active segment is independent of and completely screened by its reflector from the two other segments that aren't in use. The suppression of radiation between adjacent segments was, in fact, found to be more than 30 dB.

If you'd prefer a more sophisticated look, a trigonal reflector could be fabricated from tapered aluminum tubing and mounted on a single mast.

Technical and Performance Notes

If you seek a very high front-to-back ratio, the spacing between the tips of each radiator and its reflector can be adjusted in accordance with the "critical coupling" techniques outlined in the article cited in Note 1. My first experimental model had a forward gain of nearly 9 dBi and a front-to-back ratio of more than 34 dB.[3] Its performance is better than some conventional 3-element Yagis. The lobe width of each section is broad enough to cover an entire continental area, so by switching from one bay to another, you have almost 360° coverage. Figure 5 is a polar plot of this antenna as modeled with the *ELNEC* program.

At a modest height of only 25 feet above ground, the measured feed impedance was 55 Ω, and the SWR was less than 1.2:1. Even more gain should be available if the antenna is 1/2 wavelength or more above ground. These measurements were made on the 20-meter band, although the trigonal beam should be even more attractive when constructed for use on 40 meters. On 40, only the lucky few can manage a Yagi and the necessary tower and rotator. A G4ZU Trigonal Reflector beam may be more manageable.

Notes

[1]G. A. Bird, "New Techniques for Rotary Beam Construction," Hall, ed., *The ARRL Antenna Compendium Volume 2* (Newington: ARRL, 1989, pp 58-60.

[2]*MN4.0 Antenna Analysis Software*, by K6STI, available from Brian Beezly, K6STI, 507 1/2 Taylor, Vista, CA 92084.

[3]ARRL Technical Advisor James W. ("Rus") Healey, NJ2L, used another antenna modeling program, *ELNEC*, to study the G4ZU antenna. He obtained similar gain-over-isotropic values, but lower F/B ratios (on the order of 22-25 dB), which are still quite respectable. *ELNEC* is available from Roy Lewallen, W7EL, 5470 SW 152 Ave, Beaverton, OR 97007.

Strays

QST de GALLERY

◊ Our thanks to Robert M. Gallery, of Gaithersburg, Maryland, for his recent donation of *QST*s from the 1920s and '30s. They are from the collection of his father, Robert A. Gallery, W3CTQ, who died in 1954. The senior Gallery had been commander of the carrier USS *Randolph* under Admiral Halsey. These issues will be used to replenish our stock of back issues for in-house use.

New Books

WHAT IS YOUR TNC DOING?

By Gloria Medcalf, KA5ZTX

ZM Expressions, 1544 N 1000 Rd, Lawrence, KS 66046-9610; tel 913-842-6808. 1993, 121 pp; B&W diagrams and tables; 6×9 inches. Retail $15 from dealers or directly from ZM Expressions.

Reviewed By Steve Ford, WB8IMY
Assistant Technical Editor

In the legion of beginner-level packet books, there's one subject that isn't always given the treatment it deserves: how a packet terminal node controller, or *TNC*, actually *works*. To many amateurs, TNCs are black-box devices. They understand that TNCs are the nerve centers of their packet stations, but that's about as far as it goes. They plug in their cables, load their software (or fire up their terminals) and they're on the air.

Understanding the inner workings of your TNC gives you a valuable edge in the packet radio world. You can use this knowledge to optimize your TNC and make it much more efficient on the air. You can interpret those odd messages you see from time to time and fix a potential problem.

Gloria Medcalf, KA5ZTX, gets you started at ground zero in *What is Your TNC Doing?* She explores this potentially deep subject in small, easy-to-understand steps. Gloria doesn't assume that you're a computer expert. In fact, she begins with the assumption that you're as new to your computer or data terminal as you are to your TNC. Chapter 1 (The Computer) begins with, "Voltages change and things happen. That's how a computer works." You can't get more elementary than that!

The learning curve ramps up quickly. Soon you're tackling the typical voltage/signal format in an RS-232 serial cable. That's the umbilical between your computer or terminal and the TNC. There are wiring diagrams for several types of serial cable connectors.

Once you're connected to your TNC, you have to talk to it. To this end, Gloria describes terminal software and typical communication settings (stop bits, parity and so on). This is a potential stumbling block for new packeteers and she does a fine job of leading readers through it.

Chapter 4 finally gets into the meat of the issue: the TNC itself. Without overwhelming you with technospeak, Gloria explains the operation of this complex device. The hookup diagrams alone are a major asset. The book illustrates typical speaker and microphone plug diagrams for several transceivers, including a number of hand-helds. Ample time is spent discussing TNC and radio settings. For example, transmit/receive switching time is explained in detail.

Chapter 6 is devoted to sample packet conversations. The emphasis is on what packet users may see on their screens during live, keyboard-to-keyboard chats. Although still aiming at the beginner, this section may be tough sledding for some. There's a lot of discussion about the frames exchanged during packet communication. The average user won't see most of these frames, but the discussion is worthwhile. At least the beginner will have a better sense of what's going on during a conversation, whether it's with a bulletin board or a live operator.

What is Your TNC Doing? ends with a convenient troubleshooting guide. This may be the most valuable chapter of the book for beginners. For example, some may wonder why their TNCs refuse to key their transceivers. How many will think to check the XMITOK command? As the guide points out, if XMITOK is off, the TNC won't switch to the transmit mode.

What is Your TNC Doing? lacks operational detail. For instance, there's no discussion of nodes and specialized networks such as DX *PacketClusters*. Packet bulletin boards aren't described at all. These are things beginners will face from the moment they activate their TNCs.

But *What is Your TNC Doing?* isn't an operational packet book. It concerns itself strictly with the nuts and bolts of TNCs and the packet protocol itself. For beginners who want to expand their understanding of how packet really works at the hardware and software level, *What is Your TNC Doing?* is an excellent choice.