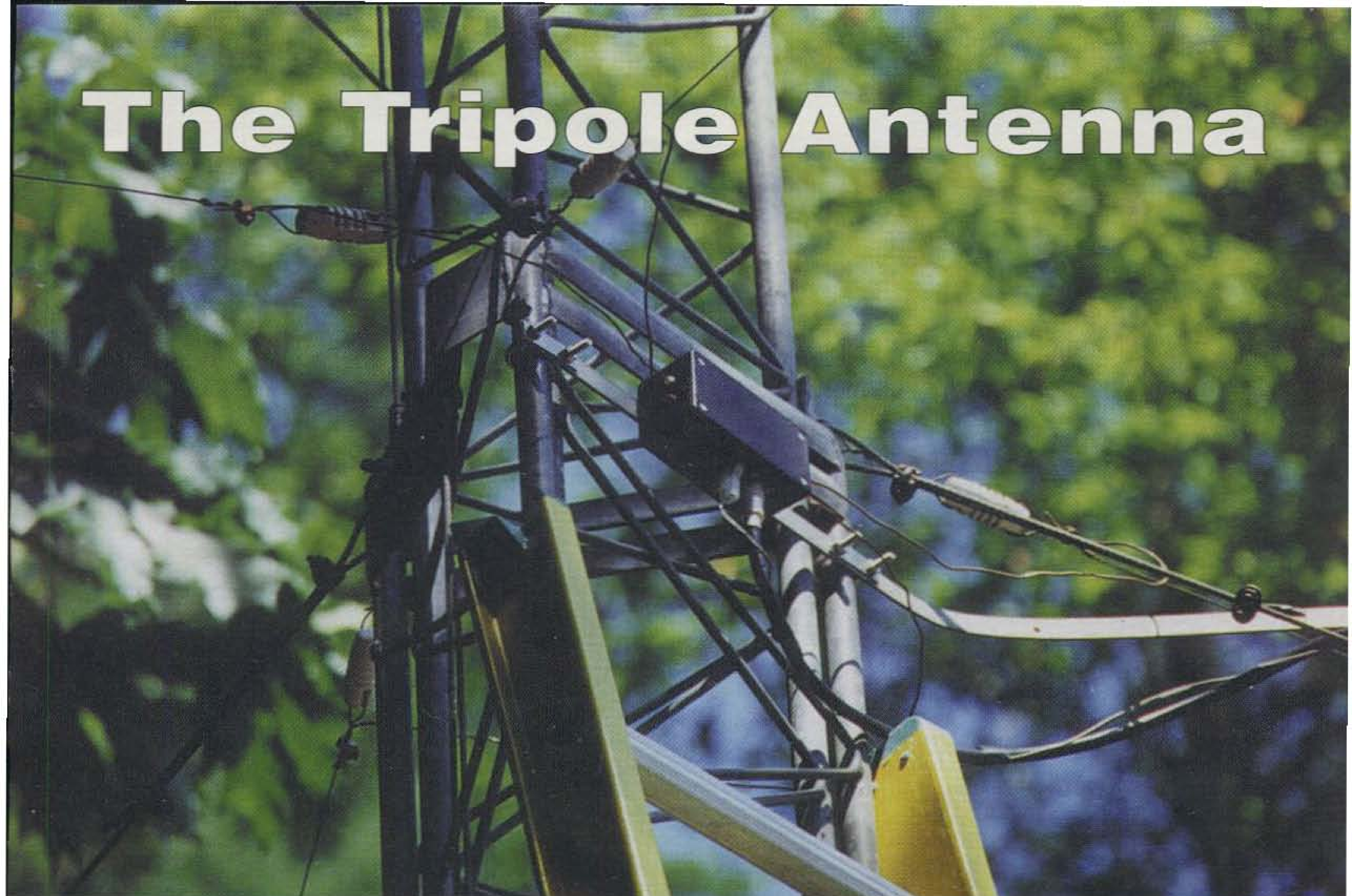
The Tripole Antenna



Close-up view of the 20 foot point on the author's tower where his four driven radials come together to form the tripole antenna. (Photo by Dick Miles, K7RNZ)

When is a vertical not a vertical? When it's also a pair of horizontal dipoles. Confused? Read on...

BY PHIL FERRELL,* K7PF

On a recent visit to my house, Dick Bingham, W7WKR, tossed a thumb at my tower. "Why don't you put a few radials on that and drive the radials?" he asked. I was getting ready to put up a 75 meter vertical, and his suggestion fell on attentive ears.

My tower is a 30-year-old Tri-Ex MW65 (four-section, tilt-over–crankup) which fully extends to 65 feet. The tower-top rotator holds a 10 foot section of 2.25 inch thick-wall T4 aluminum pipe. Various HF and VHF antennas have been up there over the years, but it currently hosts a pair of 13-element VHF Yagis. Attached at the top of the pipe is a Diamond X-510 dual-band vertical collinear, which is 17 feet long. The tip of that is 92 feet above ground. The tower is guyed at the 20 foot level, and one of the guy cables acts as a messenger, carrying all transmission lines and rotator control wires to the house. Neglecting the top loading due to the VHF Yagis, that leaves 72 feet above the elevated ground plane at 20 feet, a little more than a quarter wave on 80 meters.

With help from Jack West, W7LD, and Mike Michaeledes, W7ADR, four insulated 62 foot radials were placed at 90° intervals and attached to the tower at the 20 -foot level. The four radials were connected together using a ring made of #12 copper wire attached to each radial with a copper split-nut. The center conductor of the 50 ohm coaxial feedline was connected to the radial ring, and the coax shield was grounded to the tower. Details are shown in fig. 1.

At this point, I had an excellent vertical antenna with a VSWR of less than 2:1 over an incredible 400 kHz bandwidth (3.7 to 4.1 MHz). With the elevated ground radials in place, the resulting vertical antenna showed 32–34 ohms resistance and 0–20 ohms reactance over the 75 meter band. Keep in mind, though, that the radials were the driven elements of this "vertical"; that turned out to be a very important distinction.

I became very curious as to why I'd never heard of this crafty road to a nifty vertical. I queried vertical antenna expert Rudy Severns, N6LF[1], via e-mail,

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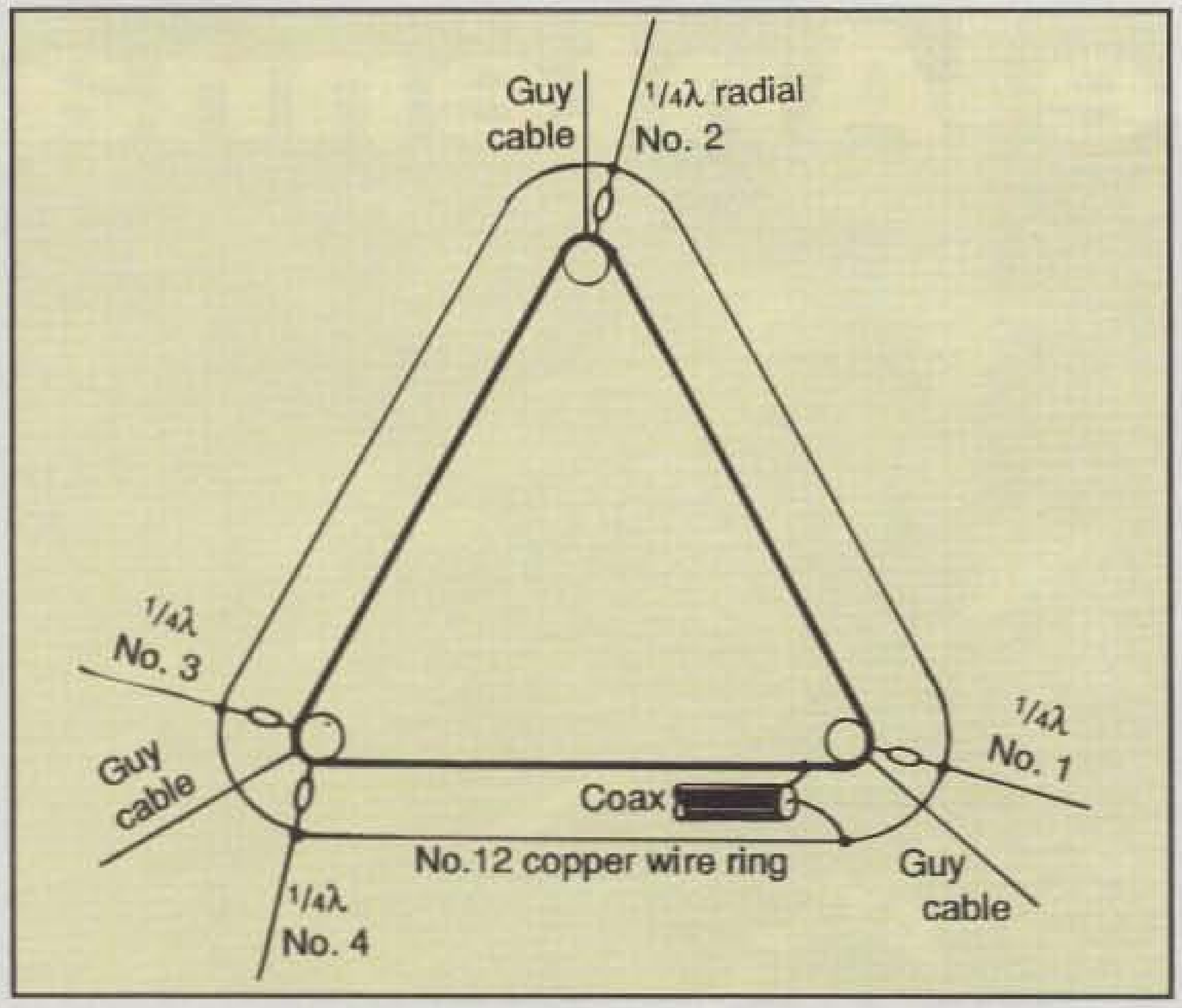

Fig. 1– Arrangement and connection of the four quarter-wave radials to create the elevated ground-plane vertical. Note that the center conductor of the coax goes to the copper ring connecting the radials, and that the shield is grounded to the tower.

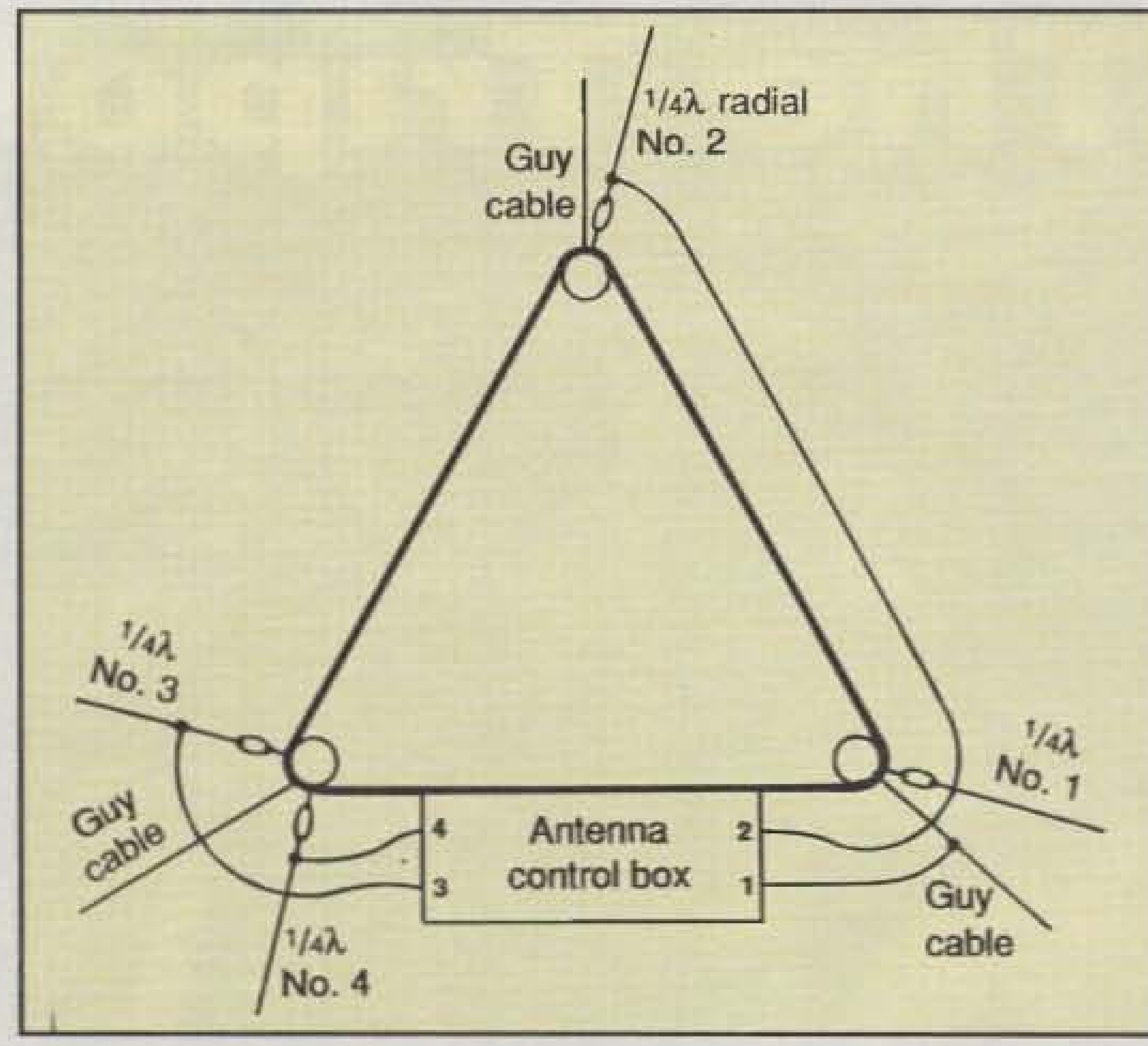

Fig. 2– Same arrangement of radials, but with the copper ring replaced by a switchbox and separate feedlines to each radial. This permits operation of any two sets of near-parallel radials as a half-wave dipole.

and he assured me that mine was a well-known configuration. He included a reference to a *QST* article[2], which describes my antenna as an "elevated ground-plane" vertical.

Radials or Dipoles?

I gradually noticed that local signals were weaker on the vertical than on a short horizontal wire. The new vertical gave superior performance for long-range, presumably low-angle, signals and on local vertically-polarized signals. Next I noticed the similarity between the four quarter-wave elevated radials and a pair of low horizontal dipoles at right angles. Thus arose the idea for the *tripole antenna*.

It got so that when I looked at my tower, I saw two half-wave dipoles instead of four ground radials. There had to be a way to have it all. A little back-of-the-envelope doodling gave the answer.

It takes three DPDT relays to reach all three antenna configurations (two horizontal dipoles and the elevated ground-plane vertical). One relay changes from the vertical antenna to an internal balanced feed, and the other relays route the balanced feed to one of the opposed pair of radials, which becomes a horizontal half-wave dipole (see fig. 2). The unused pair of radials remain connected together at the center, but are at right angles to the energized dipole so that little RF current is induced on the unused dipole.

Fig. 3 shows the wiring of the DPDT relay contacts. It also shows a simple antenna selector switch and how to connect the relay coils to achieve antenna switching. I used 12 volt relays with 160 ohm coils and contacts rated at 15 amps. I also used a separate control line for the relays. At the cost of a couple of RF chokes and coupling capacitors, you could use the RF transmission line to carry the control voltage. If you do that, be careful not to have a "sneak circuit" short out the 12 volt source. That's really embarrassing.

I epoxied the three relays into a 2" × 2" × 5" plastic project box. An SO-239 female coax connector and a two-pin Molex provide RF and control connections. I used four box-mounted pin jacks as connectors to the radials. They just exactly fit the #12 copper wire leading to each radial, attached there with a split-nut. Each piece of #12 wire was burnished at each end and coated with Dow-Corning silicon grease (DC4). If female pin jacks are unavailable, female banana jacks can be substituted, requiring a male banana connector on each of the #12 radial connector wires. The control wire and coaxial feedline connectors were likewise weather-protected with DC4. All internal RF wiring uses short pieces of #18 nylon (Formvar®) coated copper wire.

Just a word about the 1:1 balun: The major consideration is that the toroid core fits inside the box. I used two foot-long pieces of #18 Formvar®-covered copper wire close-spaced to approximate a 50 ohm parallel line. This short piece of transmission line was bifilar wound around a 1 inch diameter toroidal core (from WA7OK's well-supplied junk box). Nine turns covered the inside of the core. You could use either RG58 or RG174 rather than the #18 copper wire for a 50 ohm line on the toroid. RG174 would limit the transmitter power, and with RG58 the resulting balun might not fit in the control box.

As you may gather, the balun is not very critical. Once upon a time, you could go to the local ham store and have a choice from a wide variety of ferrite cores. At least *I* remember when you could do that. RadioShack does not stock ferrite cores. Pity. However, they do stock the following parts for this project: Project enclosure (plastic and metal lids), RS part #270-1803; 12 VDC plug-in relay (DPDT, 15A contacts), #275-218; 1N4001 diodes, #276-1101; 0.22 µF 50 V capacitors, #272-1070; female banana jacks, #910-4240.

Tripole on the Air

The tripole works amazingly well. I use a DPDT center-off switch as a "rotator." The center off position gives me the "elevated radial" vertical, and each "on"

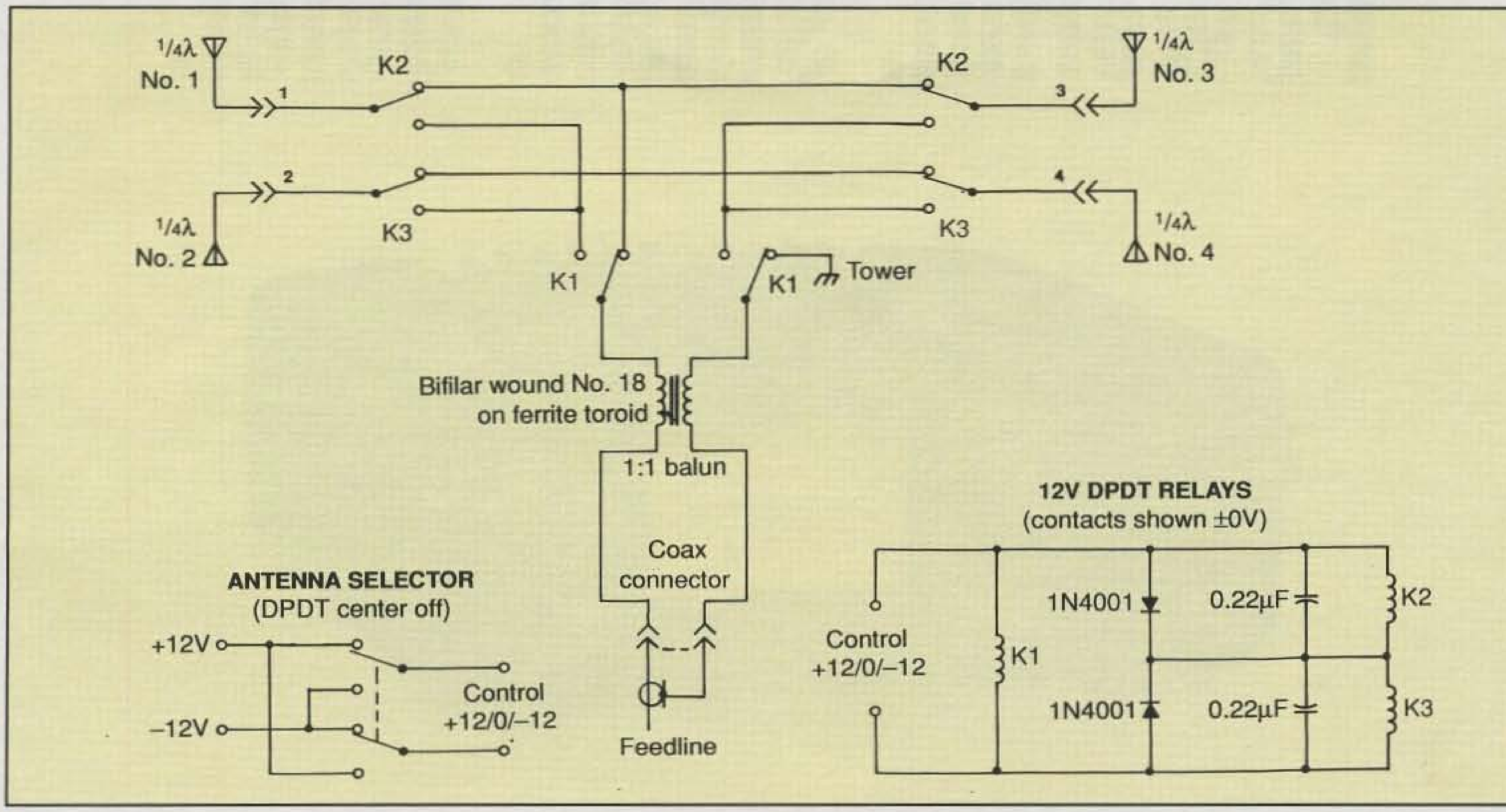

Fig. 3– Detail of the tower-mounted control-box circuitry. The 12 volt DC relay switches between either of two sets of radials and the elevated ground-plane vertical.

position of the switch activates one horizontal dipole.

Jack West, W7LD, lives about 13 airline miles from me. He has a large antenna collection, including a vertical dipole and a horizontal two half-waves in phase, both for 75 meters. Using either vertical-to-vertical or horizontal-to-horizontal polarization, we each are S9 to the other. Crossing our polarizations either way, we each drop to S5–S6. That squares with the real-world rule-of-thumb value of 20 dB cross polarization loss.

I regularly see a six S-unit difference between vertical and horizontal on some signals. That would have to include angle-of-arrival in addition to polarization differences. One of the horizontal dipoles seems to have a lower background noise level than does the other. Even if the S-meter shows a stronger signal on the "noisier" dipole, the "quieter" dipole can give a better signal-to-noise ratio (SNR). Received noise from the vertical seems to fall somewhere between that of the two horizontal dipoles.

A note on transmitting: You want to transmit on the antenna with the strongest received signal, but receive using the one with the best SNR. Thus you may find yourself doing a lot of antenna switching during a marginal contact. Switching between vertical and horizontal on transmit does measurably change the load seen by the transmitter, but no transmitter retuning is required in my case. Depending on tower height, top-hat capacity (guy wires or antennas), and available real estate for the radials, your tripole could be implemented on 160 or 40 meters instead of 75 meters. It adds an intriguing element to operating: What will happen when you switch antennas? Enjoy!

References

1. Severns, Rudy, N6LF "Verticals, Ground Systems and Some History," *QST*, July 2000, pp. 38–45.

2. Russell, Thomas, N4KG, "Simple, Effective, Elevated Ground-Plane Antennas," *QST*, June 1994, pp. 45–46.