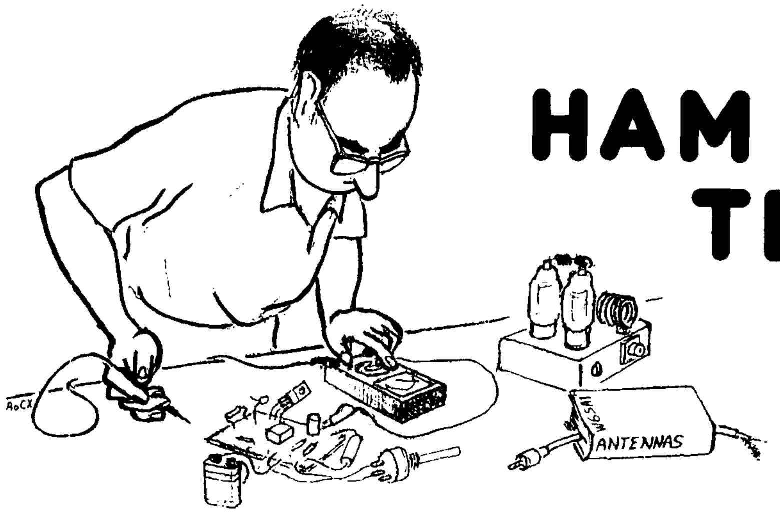


HAM RADIO TECHNIQUES

Bill Orr, W6SAI

Antenna projects for spring

It's a little too early for serious antenna work in most parts of the country. But spring will soon be here and it's time to start thinking about all those great DX antennas you're going to erect! Here are some interesting antenna projects you readers have sent to me.

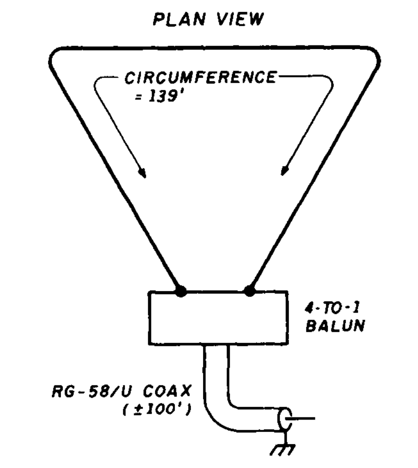
The AG9C horizontal loop antenna

I think the loop antenna has more interesting variations than any other! Bob Morrison, AG9C, has had excellent DX results with a full-wave horizontal delta loop that he uses on 40, 20, and 15 meters "as is," and with a tuner on 80, 30, and 10 meters (**fig. 1**). The only materials you need are about 139 feet of no. 14 copper-weld wire, a 4:1 balun, a few insulators, and a length of 50-ohm coax line.

Bob examined the antenna radiation pattern at 7, 10, 14, 21, and 28 MHz using the MININEC3 computer program with the Sommerfield-Norton option. He assumed a 20 foot height and poor ground ($k = 5$, and $\Gamma = 0.002$ siemens/meter). In general, Bob found that gain patterns are comparable to a dipole cut for each of these frequencies. One exception, he noted, is that the loop patterns are more omnidirectional than those of similar dipoles.

"The design is very forgiving," Bob comments. "Loop antenna patterns remain excellent when side lengths are unequal and/or the three corners have unequal heights."

FIGURE 1



Top view of the AG9C horizontal delta loop. Antenna works without tuner on 40, 20, and 15 meters. Tuner permits operation on 80, 30, and 10 meters.

Bob's observed SWR readings on the loop (taken through 100 feet of RG-58/U) are: 40 meters—1.55 at 7.0 MHz, 2.4 at 7.3 MHz; 20 meters—1.2 at 14.0 MHz, 1.7 at 14.35 MHz; 15 meters—1.38 at 21.0 MHz, 1.70 at 21.45 MHz; 10 meters—2.7 at 28.0 MHz, 3.7 at 28.5 MHz, 5.9 at 29.0 MHz, and 3.6 at 29.7 MHz.

You can move the minimum SWR point in the 10-meter band by changing the total length of the wire in the loop 6 inches at a time.

Bob says the loop can be used on 80 and 30 meters by adding an antenna tuner in the station. The input impedance of the loop on 80 meters is very high, as it is at a half-wave resonance. The mismatch at the balun causes high SWR and considerable power loss in the balun and coax line. Nevertheless, a tuner easily matches the feedline to the transmitter. Antenna radiated power is reduced, but adequate, over the CW portion of the 80-meter band.

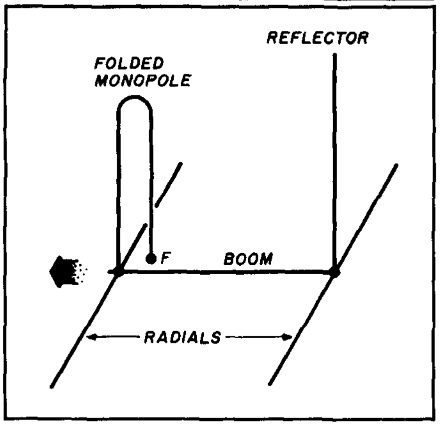
The two-radial ground plane revisited

In my October column I mentioned that two radials seem sufficient for an elevated ground-plane antenna. Along this line, Gunter Hoch, DL6WU, wrote to me about a two-element "ground-plane Yagi" he observed atop a nearby United States Army depot. The antenna is shown in **fig. 2**. It consisted of a quarter-wave folded radiator and a reflector mounted over a pair of radials. He estimated from the size that it was cut for a frequency near the 2-meter band.

This is an interesting concept. With a couple of remote-controlled relays at the antenna it would be possible to switch quickly from a vertically polarized ground-plane Yagi to a two-element, horizontally polarized conventional Yagi. The horizontal elements are cut to serve as a driven element and a reflector — just the ticket for a single antenna to work mobile stations (vertically polarized) and over-the-horizon DX (often horizontally polarized). I'll leave the details up to you!

DL6WU has submitted VHF Yagi data for inclusion in the *ARRL VHF Manual*.

FIGURE 2



Quarter-wave folded radiator is fed at F. Vertical elements are mounted above quarter-wave horizontal radials. (Courtesy DL6WU)

What is the correct radial length?

I mentioned some comments by Collin Stiteler, KE6VZ, about the correct length for ground-plane radials in my March column. Collin has raised another interesting question: "Many how-to-do-it articles on ground planes suggest that you make the radials something like 5 percent longer than the radiator. Why is this? Other articles call for radials equal in length to the radiator. If there are sufficient radials, they approximate a horizontal disc conductor. Should the radius of this disc be equal to, or 5 percent greater than the length of the radiator?"

Collin thinks that resonant radials should actually be a little shorter than the length of the radiator, not longer (as is occasionally stated), since the radials approach a "fat" conductor, or disc. The physical length of a "fat" conductor is less than that of a "thin" one for a given frequency, and Collin suggests that this rule should also apply to resonant radials.

This is an intriguing thought. I've always cut my radials to the same length as that of the radiator. Once I built a 21-MHz ground plane with radials 5 percent longer than the radiator. I couldn't notice any difference in operation or SWR measurements, as compared with an earlier, conventional ground plane. This leads me to think that radial length is unimportant (within 5 percent), at least in the HF region. Any comments on this question?

"Torching the Cat" and other exploits

I received a letter from "Doc" Sayre, N7AVK, who most assuredly deserves membership in the Antenna Experimenter's Club. Doc writes, "Fashioning a sky wire is truly exciting. I have loaded rain gutters on 160 meters (torching the cat in the process), fir trees on 15 meters (the nail gets hot and you shouldn't drive it in very deep for best results!), an all-band well casing about 160 feet deep, and an unusual buried run of two 4-0 insulated aluminum wires about 1/4 mile long that works amazingly well on 80 and 160 meters." He concludes, "If you're not thinking and improvising, then you're just taking up space!"

Good show, Doc!

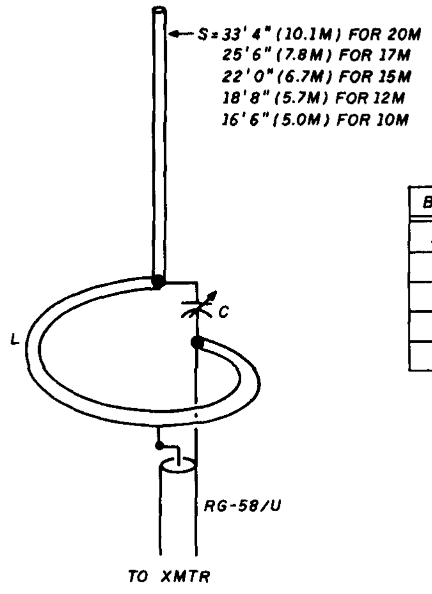
The gamma loop fed vertical antenna

In *The Radio Amateur Antenna Handbook*[1] I described an interesting DX antenna (shown in **fig. 3**). It consists of a half-wave vertical dipole fed at the bottom with a "ground independent" feed system.

The antenna shows about 1.8-dB gain over the classic ground-plane antenna and requires no radials. Feedline isolation is very good.

The feed system provides a match between the high-impedance end of the dipole and a low-impedance coax line. A parallel-tuned circuit will work. A low-loss design consists of a large, horizontally mounted single-turn coil in parallel with a high-voltage capacitor. The combination is resonant at the antenna's design frequency.

FIGURE 3



BAND	L (mH)	C (pF)
20	1.40	100
17	1.25	85
15	1.05	75
12	0.85	65
10	0.70	50

Vertical dipole fed with parallel tuned circuit at base. L-C circuit resonates at middle of band of choice. (Courtesy Radio Publications, Inc.)

John O'Brien, W2YYI, has solved the mechanics of making a waterproof tuned circuit and a high-voltage capacitor of inexpensive materials (see **fig. 4**). He makes the antenna and resonating coil out of soft, 1/2-inch, thin-wall copper tubing available from hardware and home improvement stores. The assembly is put together with a soldering torch.

In my original design, I achieved an impedance match by tapping the coax line on the single-turn inductor at the appropriate point. John, on the other hand, uses a gamma match system. I think his method is the better of the two. The gamma capacitor is made of a section of RG-8A/U coax cut to length and inserted in the copper tubing. The shield of the coax is attached to the shell (ground) of the coax receptacle. The center conductor is soldered to the gamma wire, which is tapped by a tubing clamp on the coil near the base of the antenna. The gamma wire is a length of PVC insulated house wire, or bare copper wire.

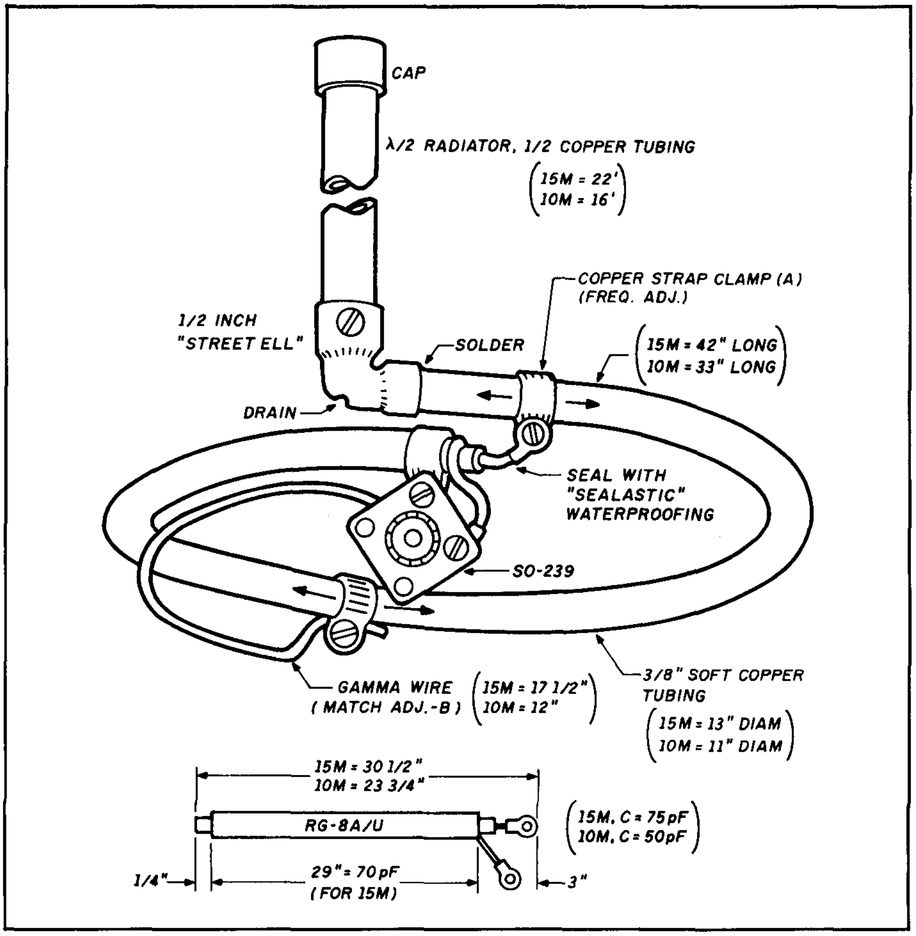
The antenna is adjusted for lowest SWR on the feedline by moving the two clamps along the coil. Clamp A is adjusted for frequency and clamp B is adjusted for the best impedance match. John notes that bending the gamma wire closer to, or further away from, the loop also affects the SWR.

Finally, John says you can make a "cheap and dirty" equivalent by substituting wire for the antenna and the loop, and making the capacitor out of a piece of double-sided pc board!

The W4TDI "Carolina Windom" array

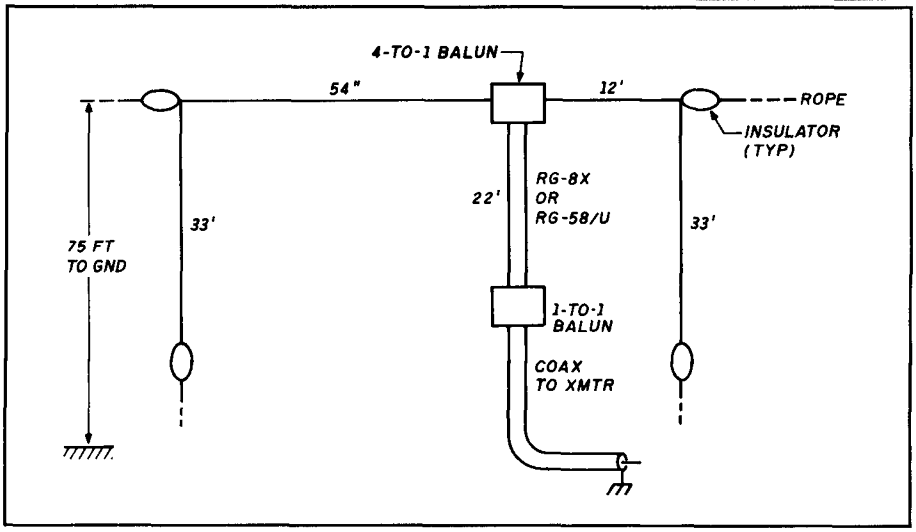
In the May 1988 column I discussed the Carolina Windom antenna, which seems to be enjoying some popularity. In brief, it's a multiband antenna fed with a stub and balun, which operates on more than one ham band. Ray Hoffman, W4TDI, making a virtue out of necessity, erected a version of the Carolina Windom between two trees only about 75 feet apart (see **fig. 5**). It was impossible to erect a 132-foot

FIGURE 4



Gamma loop-fed vertical for 10 or 15 meter bands. Capacitor is made of RG-8A/U coax and is slid inside copper tubing — Vaseline® helps!

FIGURE 5



The W4TDI version of the "Caroline Windom" antenna. Configuration works as broadside array on 20 meters with cloverleaf pattern. (See my column, May, 1988 for more data on "Carolina Windom" antenna.) A "Carolina Windom" kit maybe obtained from the Radio Works, Box 6159, Portsmouth, Virginia 23703, phone: 804-484-0140.

piece of wire on his property and keep it reasonably out of sight. He made his antenna 66 feet long and then dropped the two ends down vertically. The horizontal portion of the antenna is 75 feet above ground. He uses a feedline a half wavelength long on 75 meters, and the antenna works well on all bands between 80 and 10 meters without an auxiliary tuner.

W4TDI's antenna was, by chance, broadside to Europe. He found that, while working well on 75 meters in all directions, it did a great job into New York on 40-meter skeds with W2TBZ. But the big surprise was on 20 meters! Ray found he was getting exceptional signal reports on that band; Europeans said he had an "outstanding" signal. During the Russian DX contest he worked 26 stations in a row on the first call, in competition with the "big guns."

Ray felt these results were not in keeping with a conventional "all-band" antenna and he could only assume the excellent reports were caused by the antenna's unusual configuration. He generalized that the currents in the two vertical sections were in phase on 20 meters, resulting in two half-wave verticals in phase — separated by a full wavelength. This provides a cloverleaf pattern with two lobes perpendicular to the plane of the antenna and two lobes in the antenna plane. Gain is modest, perhaps 3 dB. But, because of antenna height, the angle of radiation is quite low.

Feeling he had stumbled onto something unusual, Ray built a 160-meter version of the antenna. It worked well on 160 meters, and results were very good on 75 meters. His most impressive results were achieved on 40 meters, and the antenna even worked on 20 meters — but not as well as the smaller version.

Ray is very enthusiastic about this simple antenna and is anxious to hear from anyone who tries it.

The Dead Band Quiz

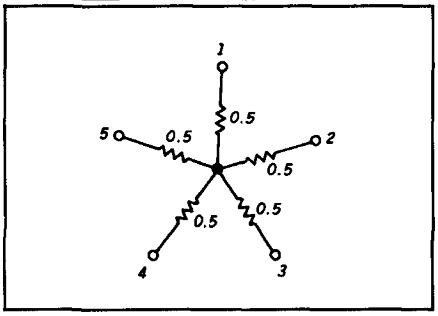
Answers are still trickling in for the locomotive/hornet quiz given in the October column. Judging from the number of replies (over 400 to date), you all appreciate a challenge.

The quiz on parsing the National Anthem was a dismal failure. Either you all got an "F" in English composition and were too bashful to enter, or weren't interested in this quiz! The sentence structure contains the subject "you", the verb "can see" and the object "what". Kudos to Tim Bratton, K5RA; Joe Vogt, W5JF; Jack Wells, KØYPE; John Peak, KE6HS; Eric Nichols, KL7AJ; Harry Johnson, NV7K. All of you go to the head of the class!

Last month's Dead Band Quiz

K4IHP's Black Box has five terminals. The resistance between any two terminals is 1 ohm. **Figure 6** shows the connections within the box. Okay?

FIGURE 6



Five 0.5-ohm resistors in star connection provide 1 ohm between any two terminals.

W3DZH's jar filled with transistors required a little brainstorming. If you have the March column in front of you, consider this:

A direct attack on the problem gets far too complex. It's actually easier to solve another problem instead, and then go back to the original.

Consider the leftover transistors: one if dividing by 2, two if dividing by 3, three if dividing by 4, four if dividing by 5, five if by 6 and six if by 7.

The key to the solution is to ask yourself the question, "What if there had been one more transistor in the jar?"

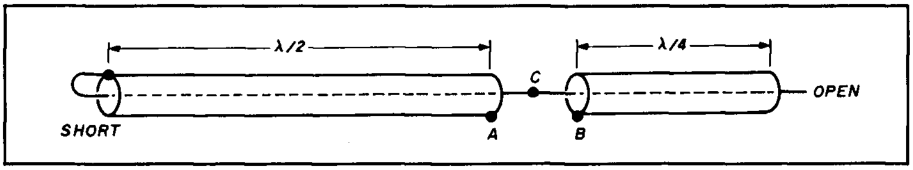
Aha! If this is so, then the number of transistors would have been evenly divisible by 2, 3, 4, 5, 6, and 7. That number is the least common multiple of those intergers, $2 \times 3 \times 4 \times 5 \times 6 \times 7$, which is 420. But of course, that's not the way it was — the smallest number of transistors Our Hero had was one less than that, or 419 devices! Q.E.D.

Thanks to Joe Caffrey, W3DZH, for that brainbuster.

A new Dead Band Quiz

Consider two pieces of RG-8/U coax cable connected as shown in **fig. 7**. One length is an electrical half-wave long, the other is an electrical quarter-wave long. Note that the inner conductors are connected at the joint A-B, but the outer shields are not. What is the impedance between points A and B (the two outer shields)? Send your QSL card with your answer to me at Box 7508, Menlo Park, California 94025. I'll give the solution in a future column. Good luck, and see you on the low end.

FIGURE 7



One length of coax an electrical half-wave length long is shorted at one end. A second piece a quarter-wavelength long is open-ended. The inner conductors are connected at C, but the outer shields are not. What is the impedance between the two outer shields (points A and B)?

References

1. William I. Orr, W6SAI, and Stuart D. Cowan, W2LX, *The Radio Amateur Antenna Handbook*, Radio Publications, Inc., Box 247, Lake Bluff, Illinois 60044. (Also available from *HAM RADIO* Bookstore for $11.95, plus $3.50 shipping and handling.)

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