a single-element DX antenna

Almost unknown, the half-wave vertical can out-perform the popular ground-plane and quarter-wave verticals

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I have spent many years in Asia. In the Asian context, DX usually means 20- to 100-watts input on CW. A rotary beam is almost a curiosity on the CW bands as the overwhelming majority of CW DX chasers here are using a single-element wire dipole or a simple ground-plane vertical. One element, properly erected and matched, however, can produce some astonishing results.

The quarter-wave vertical, or ground plane, is too well known to require an exhaustive description. It is traditionally accepted as a very simple, and yet effective, DX antenna. However, it does have some disadvantages that are worth considering. The greatest disadvantage is its characteristic inefficiency. It is fed at a low-impedance point with a relatively high rf current. For every ampere flowing in the vertical portion producing useful radiation, there is also an ampere flowing in the ground screen. This ground-current ampere produces no useful radiation, but does account for some very significant power losses.

Most amateurs using this antenna content themselves with a ground screen of four wires, little realizing how much of their rf power is simply warming the wires and contributing nothing to the outgoing signal. The same disadvantage applies to receiving as inefficiency in the ground system saps the incoming signal to the same degree. Yet another disadvantage is that the quarter-wave antenna just isn't very tall and doesn't have nearly the receiving capture area of a full dipole which is twice as long.

half-wave advantages

From my personal observation on the air, I've noted that the full half-wave vertical is unknown around the world. I have never yet contacted another station using one. This is indeed a mystery. The half-wave vertical has several distinct advantages which make it much more attractive than the quarter-wave. Because it is a full resonant half wave, and twice as tall, it is that much better for receiving. Its base impedance is much higher than the quarter wave, and this contributes to high efficiency. A simple example will clarify this point.

Feeding 100 watts of rf into a quarter-wave vertical with a nominal base impedance of 50 ohms would produce a current of 1.4 rf amperes. A full half-wave vertical made of typical tubing would have a nominal base impedance of 900 ohms.

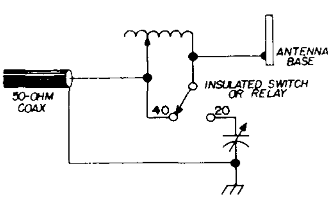

fig. 1. Switching method to use a 34-foot vertical as a half wave on 20 meters and a quarter wave on 40 meters.

Feeding 100 watts of rf into this impedance would produce a current of 0.33 rf amperes. Because the current flowing into the ground screen is the same as that which flows into the antenna, the quarter wave system would have 4.25 times more ground current than the half-wave system. The losses in the ground screen are the product of I^2R (where I is rf current and R is ground losses), and assuming the same ground screen for both antennas, the power

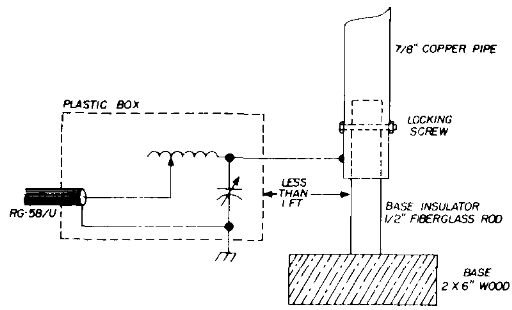

fig. 2. The antenna matching unit. The coil is 10 turns, no. 10 AWG wire, 1½-in. diameter and 1½-in. long. The capacitor is 100-pF maximum.

losses in the quarter-wave system would be eighteen times higher than in the half-wave system!

Another advantage to the half-wave system is that it has a theoretical gain of about 2 dB over the quarter wave, and concentrates that gain at a slightly lower angle above the horizon. With all these advantages to recommend the half-wave vertical, I can't help wondering why DXers around the world aren't using it. Is the 900-ohm base impedance the problem? It need not be. A simple coil and capacitor matching network takes care of that quite easily.

construction

Fig. 3 shows a half-wave vertical now in use at VQ9N. The material used is copper tubing, 7/8-inch outside diameter. It is a standard plumber's stock item on this island. Aluminum tubing is unavailable here. Note that the length is only 31 feet, rather than 34 feet, which would be a resonant half wave for 20-meter operation.

The reason for this shortage was purely economic. I bought one new 20-foot length. It was so expensive I didn't feel like buying another whole length to cut up. A scrap 11-foot length of 5/8-inch diameter was on hand, so I spliced the two to create a 31-foot vertical. The logic was that 0.45 wavelength is so close to full resonance, that it would give essentially the same performance. This logic has proven valid in practice. Also, the supporting insulators contribute some capacitive loading, which would tend to make the antenna a little taller electrically.

The most difficult part of the project was erecting the vertical. Copper is a very soft metal and cannot support its own weight in such a length, let alone the weight of guys and insulators. During my first three attempts at erecting it, my copper column suddenly became a folded dipole in the middle. This wasn't quite what I had in mind!

On the fourth attempt I enlisted a few extra helpers. Two pulled on the upper guys, one walked up under it and the fourth pushed at the top with a long wooden pushing prop. The fourth attempt was successful, though the copper column sustained some permanent standing waves along its length, created by the earlier collapses. A vertical made of 1-inch galvanized water pipe would be much easier to set up than the copper tubing I used.

The base matching coil is made of number 10 AWG copper wire (see **fig. 2**). It is wound on a form and then slipped off to make an airwound coil with a 1½-inch diameter. The original coil was made with 15 turns, close spaced. The finished coil should be spread just enough so that adjacent turns don't short together. The matching capacitor is an APC air padder, 100-pF maximum. This plate spacing is adequate for rf powers up to 200 watts, which would put about 600 peak volts across the capacitor.

tuning

The matching process is a simple matter of trial and error that can be accomplished in minutes. Insert a reflected power meter or swr bridge in the line at the transmitter end and apply enough power to give some meter deflection. Begin with the full coil in the circuit, and turn the capacitor through its range. If no dipping trend is noted on the meter, remove one coil turn and repeat the process.

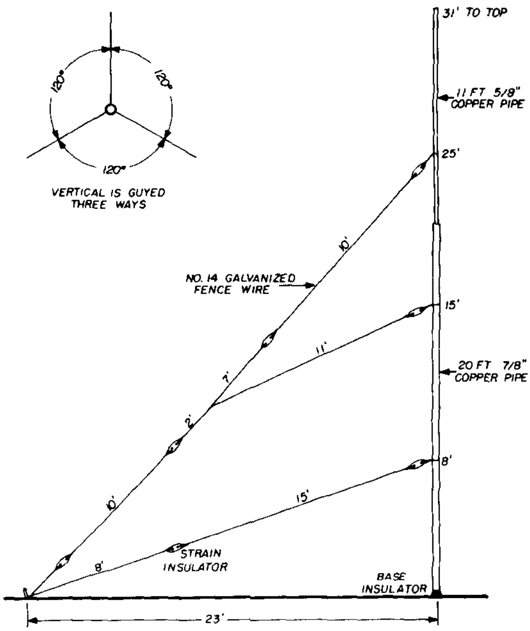

fig. 3. Overview of the 20-meter half-wave vertical. Although copper is used here, many different types of tubing could be used for the radiator.

Because the matching is quite critical, you won't see much of a meter null until you reach a point about two turns from the optimum one. Then the meter starts going down fast, and on the proper turn it can be nulled right down to zero with the capacitor. That's all there is to it.

I did my matching at 14.175 MHz, and got an swr of 1:1. The antenna response is so broad that at 14.000 and 14.350 MHz it rose to only 1.05! When the matching was finished, I had ten active turns in the circuit, which gave a coil length of 1½ inches. The unused turns were then snipped off and discarded. The capacitor was meshed to about 60-pF.

The proof of the pudding is in the signal reports. Corrugated metal roofs are almost the standard in Asia, but I went one better. My roof is corrugated aluminum, and almost level at that. A more ideal rf ground can hardly be imagined, although galvanized iron roofing does very well too. A number of tests were run on DX paths in excess of 4,000 miles to evaluate this half-wave vertical antenna in relation to other more familiar types.

I compared the half wave with the two-element quad at VQ9R and the standard quarter-wave vertical at VQ9DM (also using an almost-level aluminum roof for a ground plane). Allowing for the difficulty of taking accurate signal readings over a long path with fading, seasoned operators at the other end of the circuit gave the quad about a 6-dB advantage over the half-wave vertical.

Some of you may find it hard to believe that a single vertical element could deliver a signal only one S-unit below the popular two-element quad. Comparing the half-wave vertical to the quarter wave vertical, it was found that the half wave was considerably better. In the case at hand, the aluminum roofing rf ground plane was practically lossless for both vertical antennas.

Finally, the half-wave vertical was compared to a regular half-wave horizontal wire dipole at about the same elevation. The vertical beat the horizontal dipole by a considerable margin in any direction. So then, low-budget DXers of the world, take heart! Now's the time to pull down those wire dipoles and start standing half waves on end. At VQ9N, I run only 35 watts input on CW, and I work the world with this antenna. Where a level metal roof is not available, a ground plane of wires can come close to the same performance. An increase of signal performance over a wire dipole is very effective. Can any one imagine a simpler way to achieve so much DX gain for so little investment?

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