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The Multiband Vertical

—an aesthetically pleasing antenna with a punch

Space limitations often dictate the use of a vertical antenna on city lots. After a recent move, I found myself faced with this kind of situation. But not only was there insufficient space for any kind of horizontal antenna, there wasn't even room enough for a ground-radial system for my proposed vertical! Putting the thing on the roof was just out of the question. The landlord wouldn't allow any defacing of the physical plant.

In order to get on the air with any sort of efficient radiator, I would have to build it to meet the following set of requirements:

- It had to be put on the smallest possible amount of real estate, preferably only a few square feet.
- It could not have any ground-radial system (a condition essentially dictated by the above requirement).
- It had to be relatively unobtrusive—no complicated set of spears or prongs or guy wires—lest somebody complain and start imagining all sorts of horrible RFI.
- It had to be efficient, since my intent was to run QRP.
- It had to cover 20, 15, and 10 meters.

This may sound like a mutually exclusive set of parameters, but it's not!

The Vertical Dipole

The antenna described here is a multiband vertical dipole. It was developed as a modification of the familiar ground-plane antenna shown in (a), Fig. 1. A ground-plane antenna, elevated so the feedpoint is at least a quarter wavelength above the ground, requires only a few resonant (quarter-wave) radials in order to have excellent efficiency and low-angle radiation. But suppose that, instead of the radial wires shown at (a), a single length of tubing is used, as shown at (b)? A 20-meter antenna of this va-

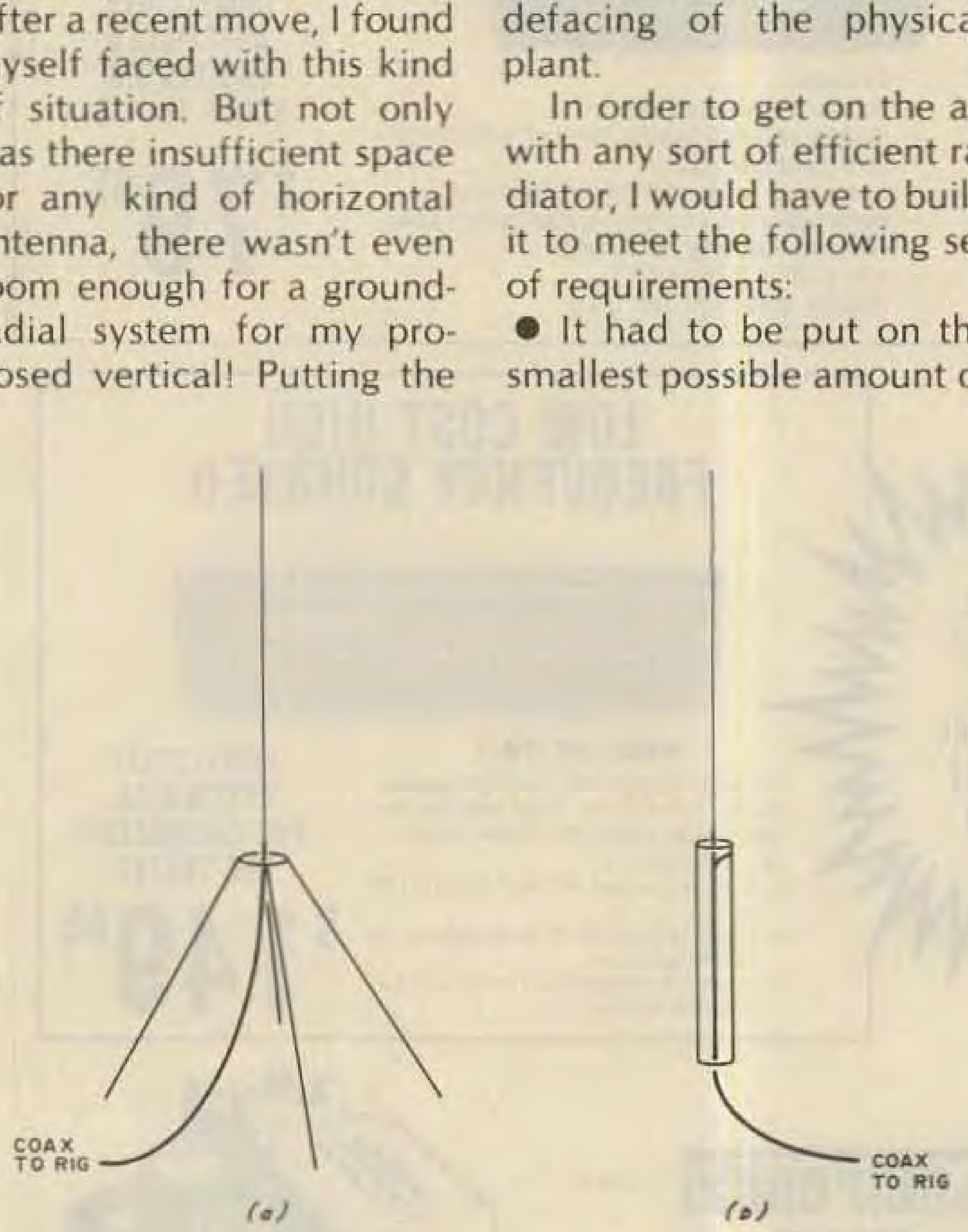

Fig. 1. (a) The conventional ground-plane antenna, with a quarter-wave vertical radiator and three quarter-wave radials. (b) A modification of the ground plane where the radials are replaced by a single quarter-wavelength section of tubing through which the feedline is run. The center conductor of the coaxial feedline should be connected to the top section in both cases.

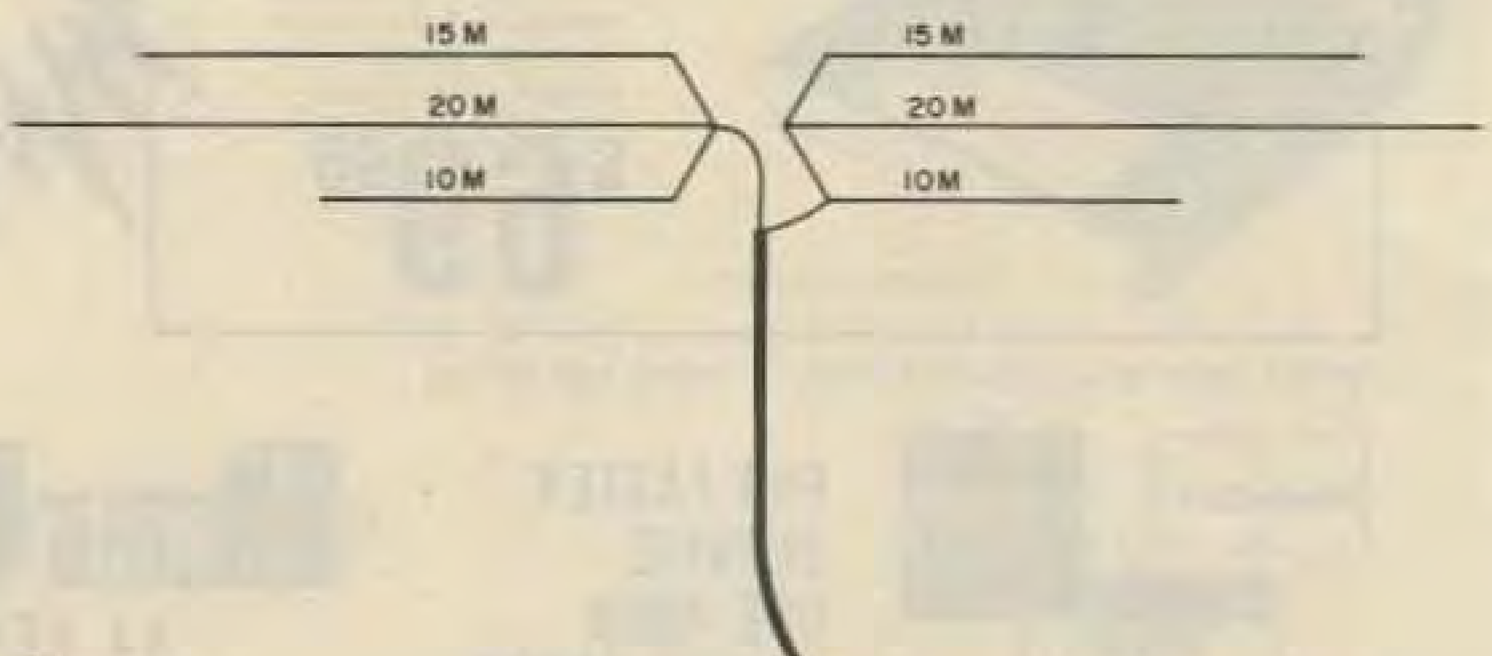

Fig. 2. Connecting three dipole antennas in parallel to get three-band operation. On a band where one of the dipoles is half-wave resonant, the other two are nonresonant and thus do not contribute to the system in any way.

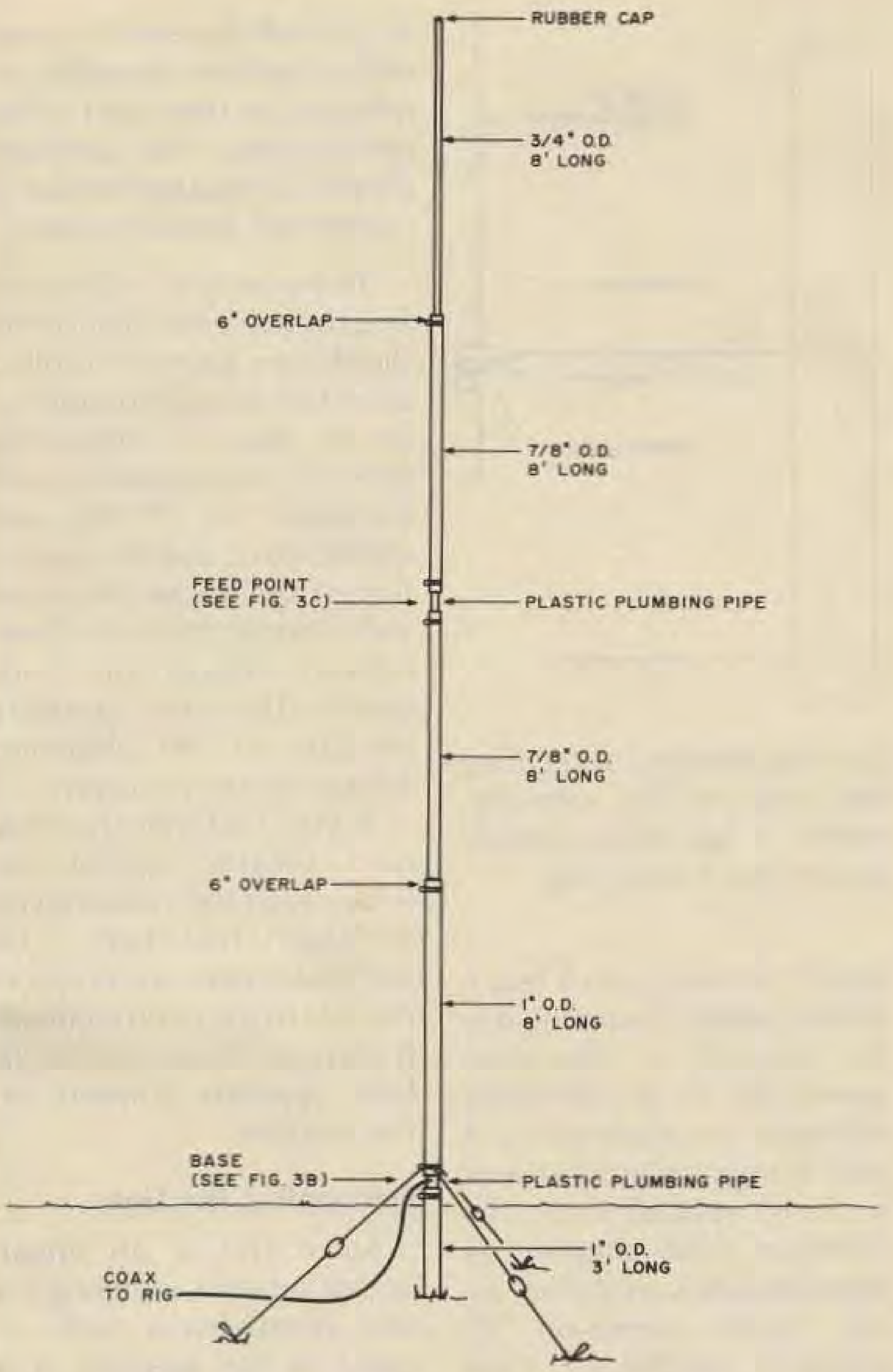

Fig. 3 (a). The overall construction of the 20-meter main support is shown. The tubing is slit and clamped together with hose clamps. Overall height, assuming the base is 2 feet above ground level, is just over 33 feet.

riety was constructed and tested at W1GV/4 and was found to perform exceptionally well.

How does an antenna such as that shown in (b), Fig. 1, work? Actually, it can be thought of as simply a ground-plane antenna in which the set of radials is brought straight down from the feedpoint. It may also be thought of as a vertical dipole in which the feedline is brought in from the underside, directly through the lower radiating section. However you want to visualize this antenna, though, it works—well!

Multiband Operation

One of my requirements for this antenna was that it have multiband capability. Because of the feed method, adding traps did not appear feasible. (It would not be a good idea to run the coax through the trap inductors.) One technique, commonly used with home-brew multiband dipole arrangements, came to mind: Simply place the dipoles for each band in parallel. Fig. 2 illustrates this scheme.

This kind of antenna will work very well on 20, 15, and 10 meters; on each band, the antenna cut to the proper length would accept and radiate electromagnetic energy, while the other two antennas would not, since they would be poorly matched. The result would be good low-angle radiation and true 1/2-wavelength resonance on all three bands.

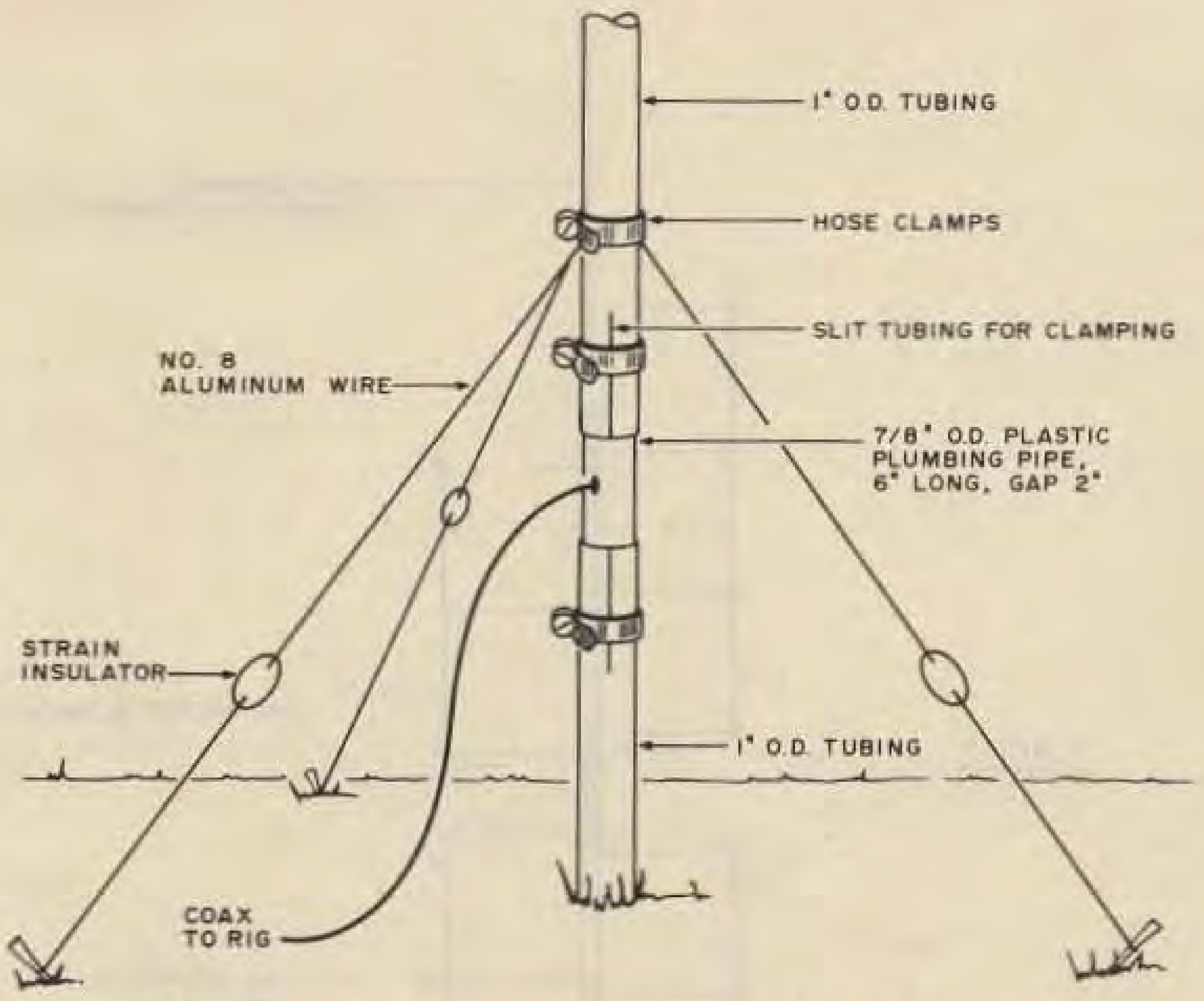

Fig. 3 (b). The base mount, showing the 20-meter pruning wires which act as reinforcement for the plastic pipe.

The only possible problem seemed to be how to physically construct the "multiple vertical dipole" antenna. This proved easy, requiring only a modification of the existing 20-meter vertical dipole.

Construction of the Main Support

Fig. 3(a) shows the construction of the 20-meter antenna which forms the main support for the structure. Aluminum tubing is used for the radiating elements, with 1-inch o.d. at the bottom tapering to 3/4-inch o.d. at the top. The 8-foot sections overlap 6 inches, so each side of the dipole is 15 feet 6 inches high. To obtain exact resonance, three short lengths of No. 8 soft aluminum ground wire are attached to the base, as shown. They should be trimmed so the swr is minimum at the desired frequency. A good starting length for the wires is 18 inches. Strain insulators should be used so the wires can provide extra support for the antenna base; otherwise, high winds might cause the antenna to blow down. (It's over 30 feet high!)

Fig. 3(b) is a close-up drawing of the base mount. A short piece of 7/8-inch o.d. plastic pipe is used to insulate the antenna base from the ground. The feedline, consisting of RG-58/U coaxial cable, is fed through a 5/16-inch hole in the side of the pipe, upward inside the lower part of the antenna, to the feedpoint.

Fig. 3(c) shows the construction of the center feedpoint. A short section of 3/4-inch o.d. plastic pipe is

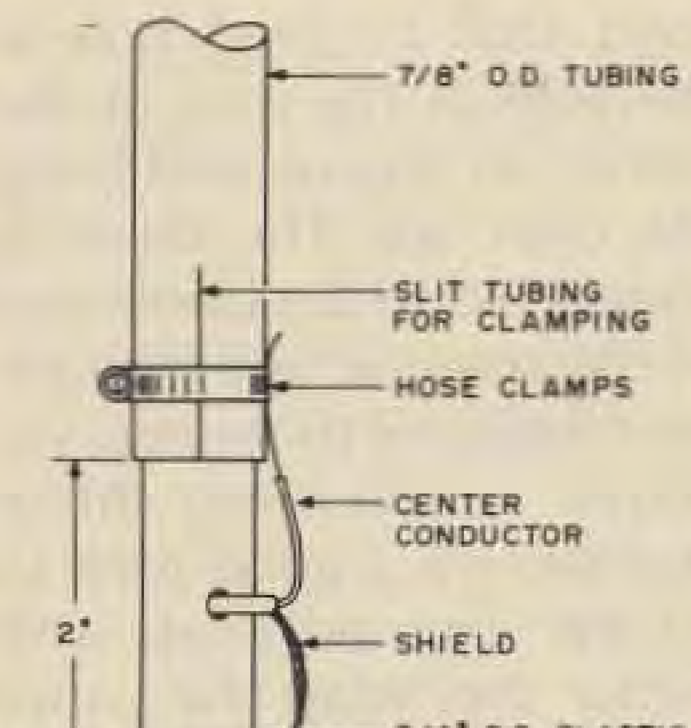

Fig. 3 (c). The feedpoint. To reduce the chances of corrosion, the entire feedpoint connection should be wrapped with electrical tape before the hose clamps are installed.

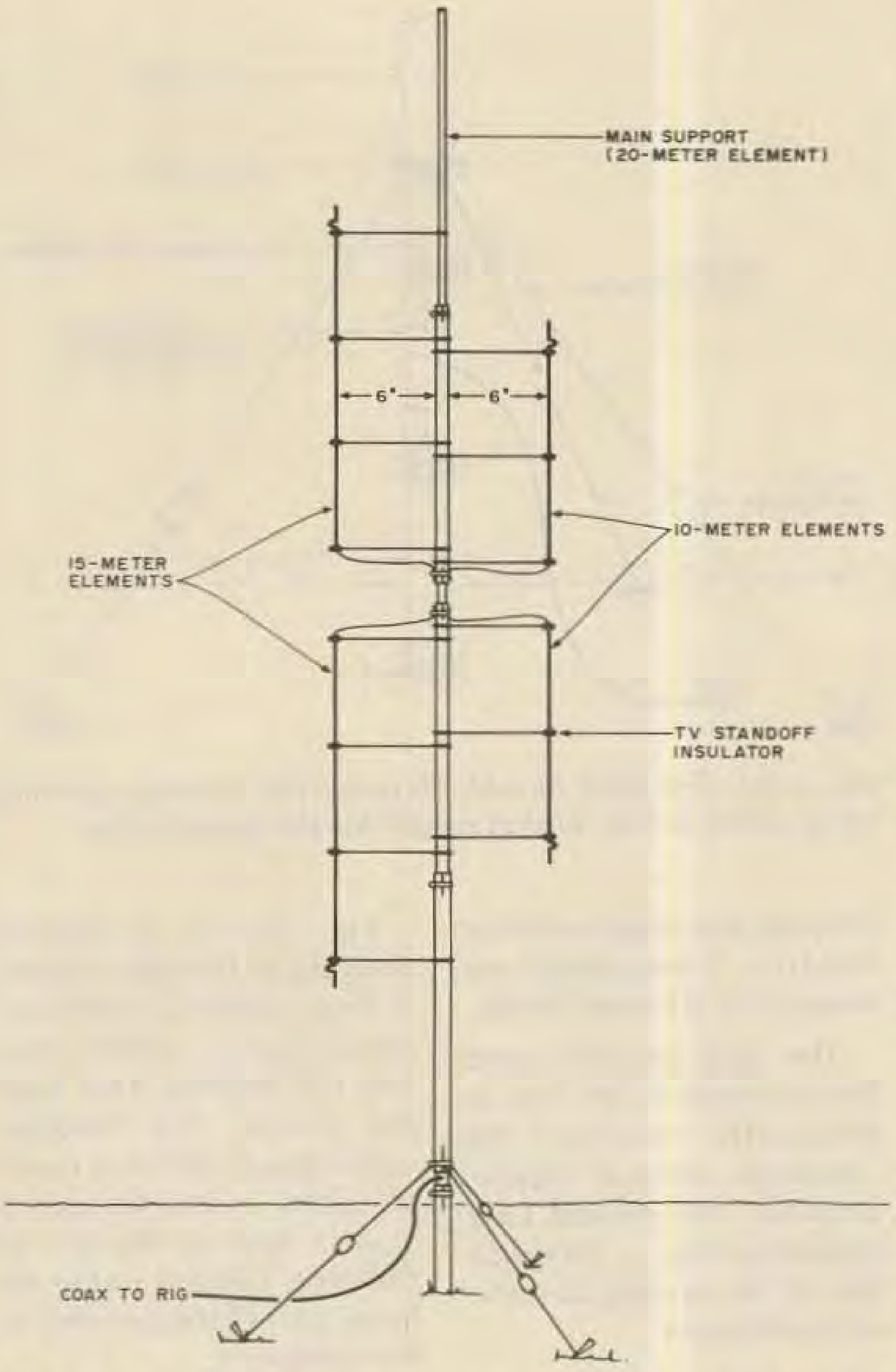

Fig. 4 (a). Overall picture of the completed vertical dipole. The 10- and 15-meter elements are spaced 6 inches from the main support.

used. Drill a $^{5}/_{16}$-inch hole in the side of the pipe at the center, as shown, and bring the coax out. The shield is connected to the lower part of the antenna, and the center conductor to the top, via those convenient hose clamps. It's a good idea to tin the exposed leads with solder and wrap the entire connection with electrical tape before clamping. Those hose clamps serve to hold the antenna together mechanically as well as electrically, so be sure to put them on tight. You might even want to put a separate pair of clamps on the tubing independent of the electrical connections to ensure rigidity of the structure.

Since this antenna is quite large, it is important that the base mount be properly assembled. The tubing at the bottom should be driven at least 12 inches into the ground. The set of resonator/guy wires should be tight, have a slant of at least 45 degrees to the vertical (less than 45 degrees to the horizontal), and their anchors should be *very* secure. Also, don't forget the little rubber cap at the top of the thing! Little details like this could be responsible for an early demise if neglected.

Adding 15 and 10 Meters

Fig. 4(a) shows the complete antenna, illustrating the installation of the 15- and 10-meter elements. The 15-meter elements should be precut to 11 feet 2 inches; the 10-meter elements

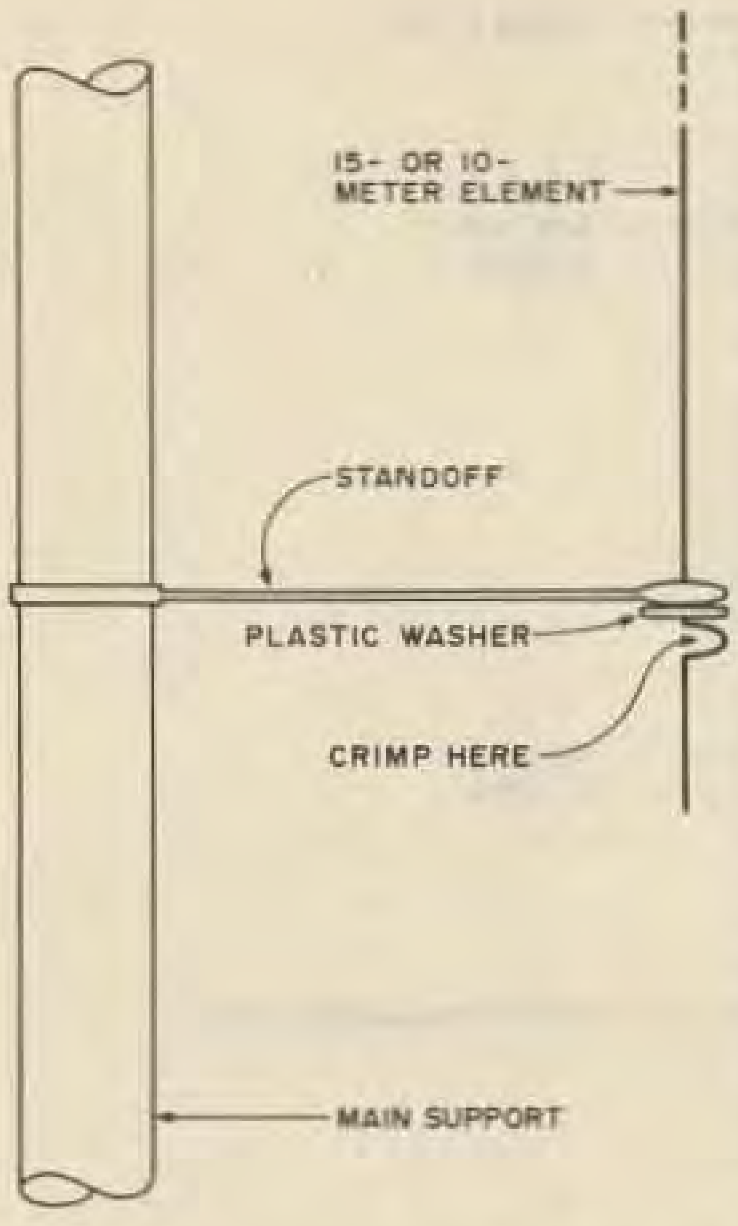

Fig. 4 (b). Method of securing the ends of the wire elements. A few inches should be left free for pruning.

should be precut to 8 feet 6 inches (some shortening will be needed to resonate them). The 15- and 10-meter elements are made of No. 8 soft aluminum ground wire and are spaced from the 20-meter main support on opposite sides, as shown, using 6-inch clamp-on TV standoff insulators. Care must be taken to see that the wires do not come into contact with the 20-meter element, except of course at the feedpoint. Electrical contact at any other point will disturb the resonance on 15 or 10 meters. The wires must be pulled tight, and they must not touch the metal rings on the standoff insulators.

The element ends are secured as shown in Fig. 4(b). Crimp the wire slightly, as shown, after sliding a plastic washer of at least 1½ inches diameter around it to prevent short-circuiting to the standoff ring. Leave about 10 or 12 inches of wire past the standoff for pruning purposes.

When trimming the elements, it will be necessary to raise and lower the antenna, since both the bottom and top elements must be cut to the same length. The final length will depend, to some extent, on how close the antenna is to trees and other obstructions. (The antenna should be located so that it cannot fall on utility lines!)

Theoretical element lengths (for each side of the dipole) are given in Table 1 as a function of frequency on 10 and 15 meters. At W1GV/4, the elements were trimmed for 21.100 and 28.500 MHz, and the lengths turned out to be about an inch shorter than the theoretical values on both bands. This was probably because of the abundant foliage on the property.

If you find that the resonant lengths appear nowhere near the values given in Table 1, first check to be sure that there are no short circuits to the main element. If there are none, you might have antenna currents on the feedline.

Decoupling the Line

Since this is an unbalanced antenna, meaning it is not symmetrical with respect to the feedline, it is possible that there may be rf currents on the shield of the coax. This is especially likely if the feedline happens to be a multiple of an electrical half wavelength on the operating frequency.

To decouple the line, the first thing to do is make certain that the length of the line is as far away from resonance as possible on all three bands simultaneously. Fig. 5 shows some of the best lengths, as well as those lengths that should be avoided. (Note that a feedline length of 66 feet is especially bad since it is resonant on all three bands!)

If this technique does not solve the problem, then you will have to install a choke in the line. To do this, simply wind the coax about 20 times around a piece of 2-inch o.d. plastic pipe, securing the coil in place with electrical tape. The choke should be placed at the point where the feedline enters the base of the antenna. After the choke has been wound, the remaining length of line to the rig should be nonresonant, as shown by Fig. 5.

A choke coil should be required only if high power is used, since the probability of getting rf in the shack increases with the power output of the transmitter.

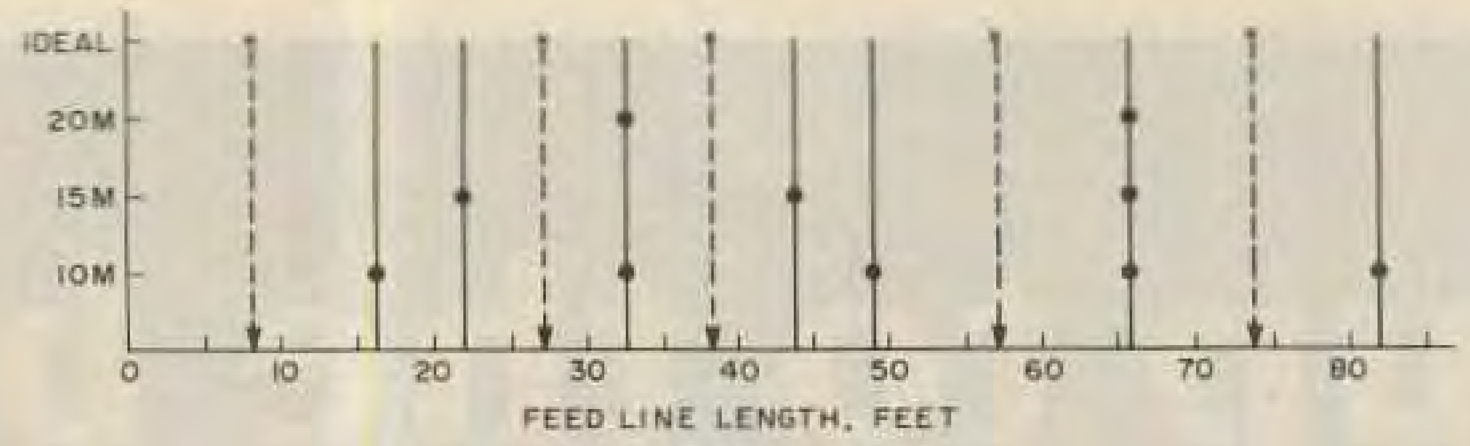

Fig. 5. Feedline resonant lengths are shown by dots and solid lines; these lengths should be avoided. Ideal lengths for a 20-, 15-, and 10-meter feedline are shown by an X with a dotted line. Resonant frequencies chosen for this chart are 14.175, 21.225, and 28.500 MHz, representing an approximate median for each band.

Performance

Using only 10 Watts output, many contacts have been made on all three bands. The low-angle radiation of this antenna appears to be exceptional, which is to be expected of a vertical dipole. The current loop is elevated about 17 feet above ground; this helps reduce absorption by nearby obstructions.

Particularly on 10 meters, where very little power is needed to produce DX, several European countries have been worked, often when competing against stations using yagis or quads and much more power.

The swr at resonance is better than 2 on all bands. It gets up to about 4 at the top end of 10 meters, since I adjusted it for 28.500 MHz. No matching network has been necessary to obtain proper transmitter tuning in normal operation.

Adding More Bands

It should not be difficult to add elements for the new bands at 18 and 24 MHz once they are opened for amateur use. These elements could simply be placed in parallel with the other three antennas.

There appears to be some possibility that, by adding enough elements of progressive lengths in parallel, it might be possible to build a broadband antenna capable of continuous coverage between two set frequencies. There are some structural problems involved with this, but I am presently working on the idea. If the results are good, I will present them in a future article. ■

Frequency (MHz)	Element Length
21.000	11′2″
21.100	11′1″
21.200	11′0″
21.300	11′0″
21.400	10′11″
28.000	8′4″
28.250	8′3″
28.500	8′2″
28.750	8′2″
29.000	8′1″
29.250	8′0″
29.500	7′11″

Table 1. Theoretical resonant lengths for each side of a dipole antenna as a function of frequency. These lengths are approximate because of possible capacitive loading effects from nearby objects. Lengths are to the nearest inch. These values are measured from the feedpoint connection along the wire to the end of the element.