Hams living on small lots where towers are not an option might be interested in K4PRL's creative approach to putting up several inverted-L wire antennas and feeding them with a single piece of coax.

Multiple Inverted "Ls" With A Common Feedpoint

BY W. L. STEED,* K4PRL

Want an antenna solution for all amateur HF bands that re-quires only one coaxial feedline? The following describes such an antenna assembly, consisting of three pairs of inverted "Ls" that cover all amateur HF bands, including the new 60-meter band. All the feedpoints of the inverted-Ls are paralleled into a single 50-ohm coaxial feedline and exhibit VSWRs well within the higher efficiency range of most antenna tuners. The entire assembly need not be duplicated, but can be scaled to cover only those bands of interest. While this article describes a specific assembly of inverted-Ls, the underlying message is that the feedpoints of an inverted-Ls that are resonant on different amateur HF bands can be paralleled into a common 50-ohm feedline while essentially preserving the VSWR of each inverted-L.

Each inverted-L operates at about one-quarter wavelength and/or odd multiples thereof. Odd multiples of one quarter wavelength are used at the higher frequencies so that sufficient wire length can be allocated to permit a significant length of each element to be made horizontal. Since the downhaul wire from the horizontal member to the feedpoint is part of the antenna, its length will determine the odd multiple of one-quarter wavelength to be selected. The odd multiple wavelengths used in this article are based on a downhaul wire length of only 14 feet.

Fig. 1 shows the general configuration of one pair of wire elements, A and B. My entire setup has two more similar pairs. Element A is like most inverted-Ls and is strung between supports such as a tree and a building. Element B is suspended beneath and insulated from element A. The far end of element B is designed to be about 2 feet below element A in order to minimize interaction between the elements. A 3/16-inch diameter braided polyester rope is used between the insulator at the far end of element B and the one at the far end of element A, connected so as to maintain the 2-foot separation of the elements. Rope rather than wire is used between these insulators to forgo wire acting as an unwanted parasitic element.

The 3-foot vertical section at the far end of each element provides some wire for pruning, as you tune each element.

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Photo A– Wide view of K4PRL's multiband inverted-L antenna array. The PVC separators "float" on the wires and are not connected to the base section. (Photos by the author)

The 5-ounce fishing sinker weights at the end of the tuning sections help to hold both the elements and ropes taut and to keep the tuning sections hanging vertical.

Element length is the sum total of the lengths of the vertical downhaul section, the horizontal section, and the tuning section of each element. The length of the tuning section is

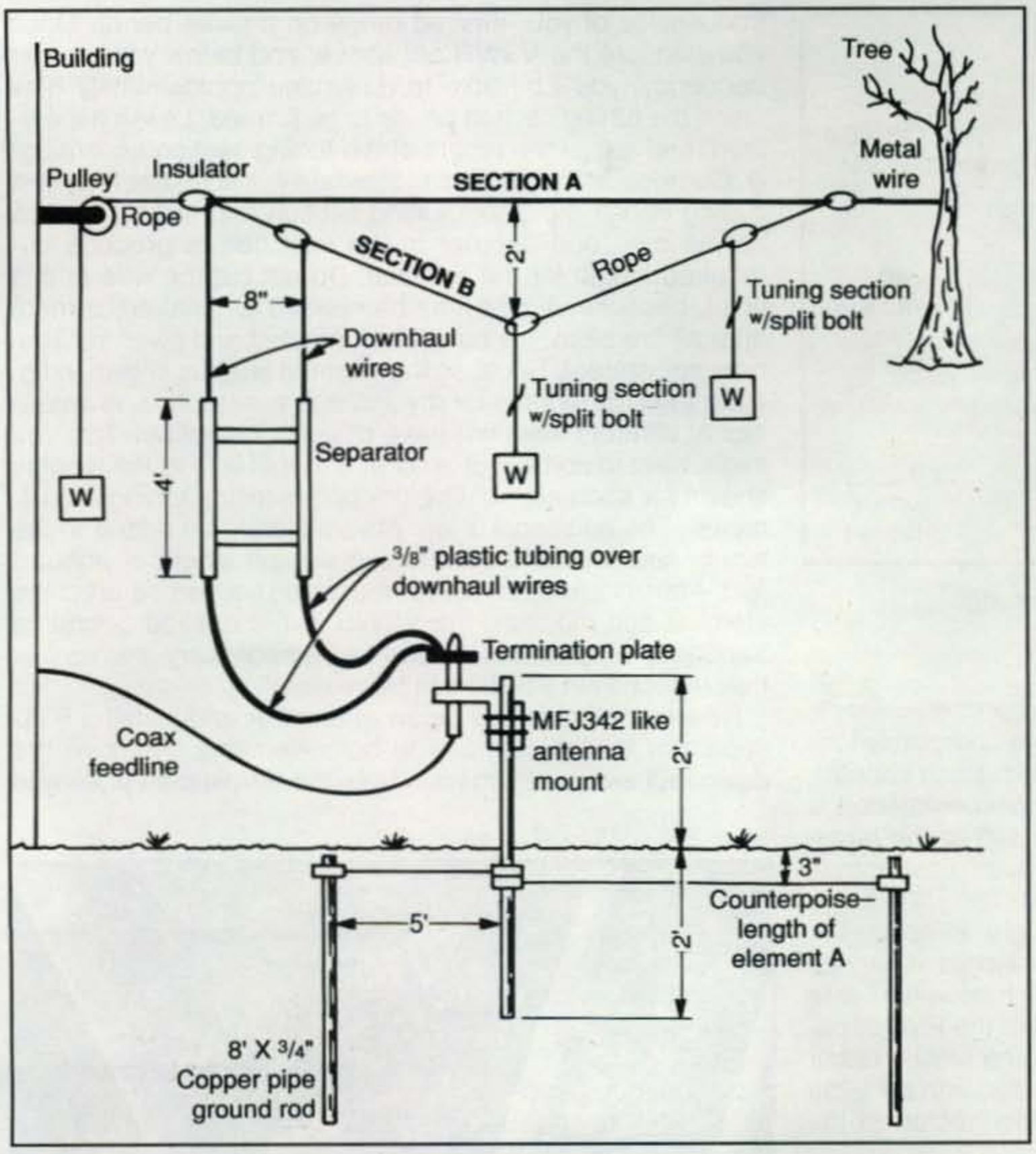

Fig. 1– The general configuration of one pair of wire elements, A and B.

to be pruned for minimum VSWR. The two antenna elements are separated by about 8 inches at the top of the downhauls. This separation is maintained by a 4-foot long ladder-like unit made of 3/4-inch PVC components that is positioned at the bottom end of the downhaul wires. These wires run through the PVC separator to the termination plate on the center conductor of the coaxial antenna mount such as the MFJ-342. The triangular termination plate is made of aluminum and is about 3" × 3" × 3" and at least 20 gauge. A 3/8-inch hole should be drilled in the center of the plate so that it can be secured to the antenna mount with a 3/8-inch bolt. Two holes should be drilled on each of three sides of the plate about 1/2 inch from the edges. The size of the holes should accommodate the lugs that are soldered to the ends of the six downhaul wires.

The antenna mount with the termina atop is supported about 2 feet above ground by a 3/4-inch copper pipe that in my case is driven into the ground only about 2 feet because of fear of hitting a sewer pipe. To provide a deep ground for this shallow copper pipe it is bonded to a 3/4-inch, 8-foot long copper pipe driven vertically into the ground 5 feet from the shallow pipe. The bonding is via a 5-foot long No. 6 copper wire using electricians' pipe clamps. A buried counterpoise made of No. 6 copper wire is run about 3 inches below ground surface beneath each pair of elements. See fig. 1 for details; in the figure, I have included two 8-foot ground rods.

The downhaul separators are made of 3/4-inch PVC water pipe, using "Ts" and straight sections in a configuration as shown in fig. 1. The distance between the centers of the 48-inch long barrels through which the downhauls are threaded is 8 inches.

Each counterpoise is connected to the copper pipe that supports the coaxial termination by use of electricians' grounding clamps. The clamps are secured to the pipes about 3 inches below the surface of the ground. Electricians' clamps are also used at the *far* end of each counterpoise to secure it to an 8-

Element		
Pair 1		
Length (feet)	127	26
Frequency (MHz)	1.85	10.125–29.4
Fraction of Wavelength	1/4	1/4–3/4
VSWR	1.8/1	1.7/1–1.4/1
Pair 2		
Length (feet)	62	40
Frequency (MHz)	3.9–28.4	18.15
Fraction of Wavelength	1/4–7/4	3/4
VSWR	1.7/1–2.6/1	2.2/1
Pair 3		
Length (feet)	51	35
Frequency (MHz)	5.32–14.2–24.93	7.2–21.3
Fraction of Wavelength	1/4–3/4–5/4	1/4–3/4
VSWR	3.7/1–2.2/1–2.3/1	2/1–2.8/1

Fig. 2– Characteristics of elements.

foot ground rod. A counterpoise for each pair of elements is a must if the antenna current path is to have acceptable loss and in-shack RF fields are to be minimized. Each counterpoise should be about as long as the longest element it is beneath. The downhaul wires are connected to the terminating plate via dip-loops to allow for non-destructive movement of the antenna assembly in the wind. The PVC separators float in the dip-loops, their weight keeping the downhauls separated and straight. A 3-foot length of 3/4-inch plastic tubing is put on the lower end of each downhaul wire from the termination block into the bottom of the PVC separators so that the separators can float on the plastic rather than the wire. The coaxial feedline is provided with a PL259 connector which mates directly with the connector on the MFJ-342 or similar antenna mount.

The three-pulley/counterweight system is used to allow non-destructive movement of the antenna pairs in the wind and facilitate lowering of the elements for tuning or general maintenance.

In my installation, the three pairs of elements are displaced from one another by about 15 degrees in the horizontal plane. The horizontal displacement between pairs of elements is thought not to be critical but should be greater than 10 degrees and less than 45 degrees.

Fig. 2 shows the characteristics of each element in each pair for my antenna assembly. The element length, center frequency and the fraction of a wavelength on which the element operates, and the associated VSWR are shown. Notice that the 51-foot element of pair 3 can be operated on three different frequencies of 5.32, 14.2, and 24.93 MHz, and the 35-foot element can operate on 7.2 and 21.3 MHz for a total of five bands, all with only two wire elements and with reasonable VSWRs.

Construction and Testing

The recommended construction ap-proach is to erect the longest element A of a pair first. Install the buried counterpoise beneath the element and terminate the downhaul wire on the termination plate. Connect a coaxial cable between the MFJ-342-like antenna mount and the VSWR measurement instrument. With the element fully erected, attach an SWR analyzer or a transmitter at very low power with an SWR meter in line, and measure the VSWR on and around your desired operating frequency (or the bottom, center, and top frequencies of your desired range on a given band). Once you measure the VSWR on, above, and below your center frequency, you'll be able to determine approximately how much the tuning section needs to be pruned. Lower the element and adjust the length of the tuning section accordingly. Electricians' split bolts can facilitate this adjustment by first cutting in half the 3-foot tuning section and sliding the two halves over one another in the split bolt to produce the required length for the first trial. Do not cut the wire at this point, because all of it may be needed for final adjustment after all the elements have been erected and given preliminary adjustment. Because the element lengths shown in fig. 2 are the final lengths for my antenna assembly, and antennas at different sites will have different characteristics, you might want to add about another 3 feet of wire to the lengths shown for each element before commencing tuning adjustments. The additional 3 feet of wire should be added to the tuning sections for a total tuning section length of about 6 feet. After initial adjustment to the tuning section, re-erect the element and measure the VSWR at the desired operating frequency. Repeat this procedure as necessary until no further reduction in VSWR can be realized.

Now erect element B below element A and install a PVC separator that is common to both elements. Remove the downhaul wire for element A from the termination plate and

Photo B– Close-up of base section showing antenna wires coming through each of the PVC separators and meeting in the middle, where they're connected to a single piece of coaxial feedline going back to the shack.

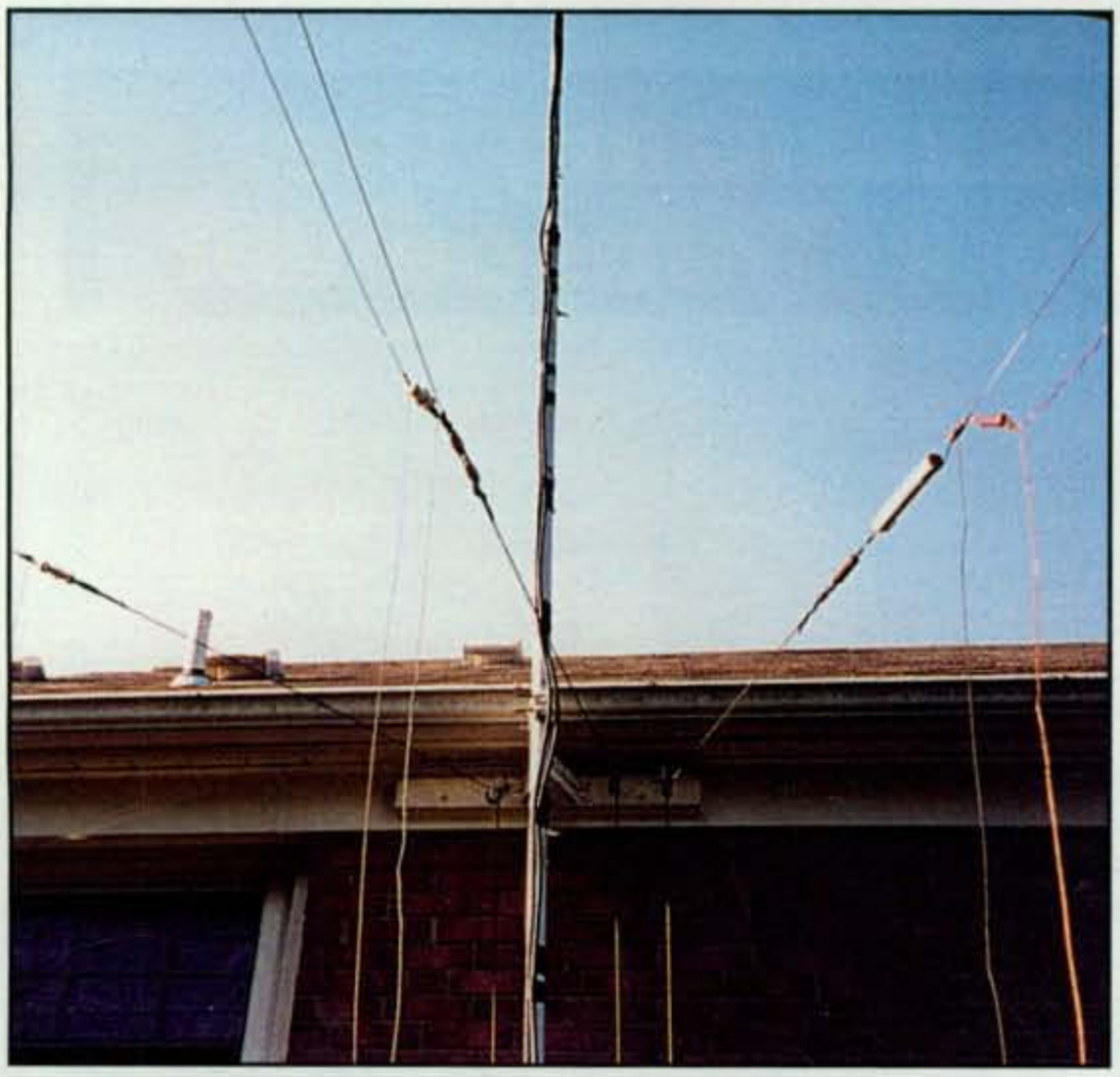

Photo C– Close-up of the connection points between the horizontal portions of the antennas and the 14-foot "downhaul" lines. Your measurements may vary, depending on how high you can mount the antennas, but the goal is to maximize the horizontal length over the vertical drop.

put a 3-foot length of 3/4-inch plastic tubing over the lower end of the downhaul. Put a like piece of the plastic tubing over the lower end of the downhaul for element B. Slide each of the downhaul wires, with the plastic tubing in place, through separate tubes of the PVC separator. Solder a lug on the ends of each downhaul wire and attach the lugs to separate holes in the termination plate. There must be sufficient downhaul wire length to permit the forming of dip-loops between the lower end of the PVC separator and the termination plate. The lower end of the plastic tubing should be against the termination plate, and the other end should be up in the PVC separator such that the separator floats in the dip-loop about a foot above the ground surface.

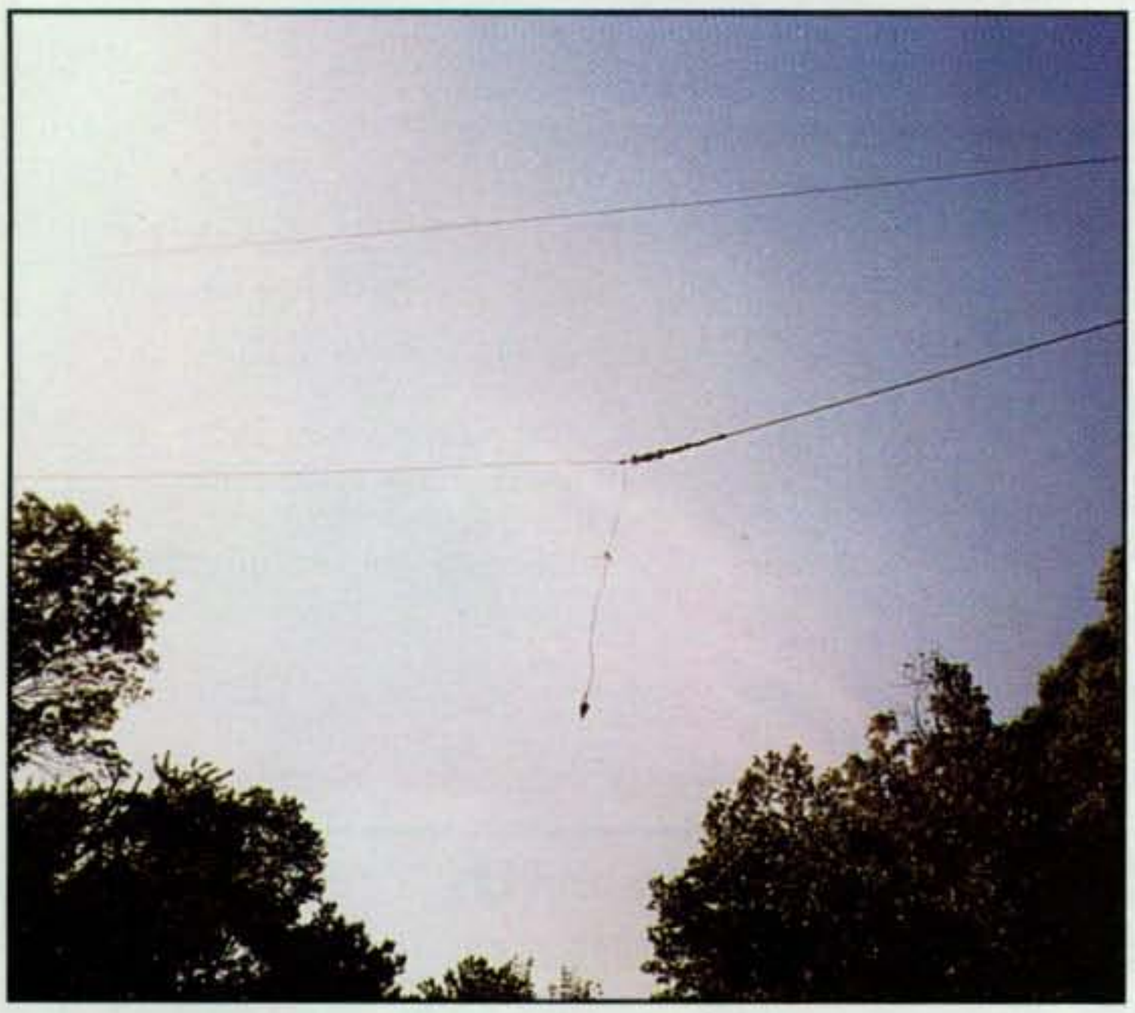

Photo D– Tuning stub of a B element, held in place by a fishing weight. Note the longer A element above.

With both A and B elements erected, check your VSWR on and around your desired operating frequency for element B to determine how much pruning is needed. Lower element B and make the appropriate adjustment to that tuning section. Re-erect element B and measure the VSWR again. Repeat this procedure until the VSWR cannot be reduced further. Now re-test element A and adjust its tuning section for minimum VSWR, since the addition of element B may have affected the resonant frequency of element A. Any increase in VSWR of an element due to the tuning of the other element can likely be corrected by retuning the adversely affected element.

Additional Element Pairs

Erect the other two pair of elements with a separation of 10 to 45 degrees in the horizontal plane between each pair of elements. Install a buried counterpoise beneath each pair of elements. Terminate the downhaul wires of each element on the termination plate. A PVC separator should be installed on each pair of downhauls. Make VSWR measurements and tuning adjustments as for the first pair of elements.

After all elements are erected and tested in sequence, repeat the tests to determine if the VSWR for any band has increased. Where such changes occur, re-adjust the tuning section for that band. Since there is only one tuning section for each element and some elements operate on more than one band, compromises have to be made so that all bands have acceptable but not necessarily minimum VSWRs.

Final Words

Should the far antenna support be marginally close, some relief can be had by making the tuning section longer than 3 to 6 feet with commensurate reduction in the length of the horizontal section.

The length of the line supporting the far end of each element A should be at least as long as the height above ground of the far support point so as to provide means to lower the element for tuning and maintenance. The far support lines should be metal if you have squirrels. A metal support line will have little impact on antenna operation in that the tuning will have been done with the metal line in place.

The radiation patterns of this antenna assembly have not been measured, but four years of on-the-air operation on all but the 30- and 60-meter bands have shown that it performs well both close-in and for DX.

No attempt has been made to reduce the VSWR of 3.7:1 at 5.32 MHz (60 meters). This VSWR is residual after adjustments have been made for the other bands and can probably be reduced at some sacrifice to the other bands that use the 51-foot element.

Plan your installation well, especially where you will put the downhaul terminations with respect to the pulley system. Start each run of wire at the termination plate and plan the locations of insulator support points out to the end of each element, keeping in mind that another element is to be suspended beneath each element A. Plan where to put grounds. Do not put up an inverted-L without a counterpoise. Keep in mind that antennas have to be able to move in the wind and survive in icy conditions or they will break.

I have explained one way to parallel inverted-L antennas. Each location is different, and you can probably do better by customizing your installation for your location. Have fun! ■