Minimizes weight,
wind resistance,
to realize gain
from height

a five-band dipole

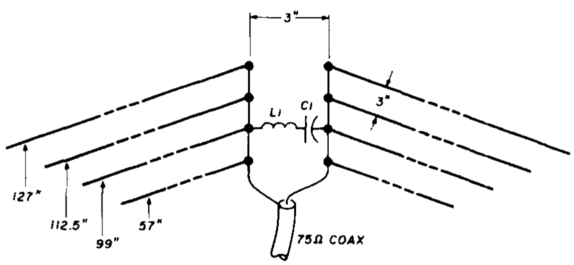

fig. 1. Electrical dimensions of the 5-band dipole. L1 and C1 are used only for 2-meter matching. C1 is 2.2 pF ceramic and L1 is 3 turns of No. 12 wire, 2-inch inner diameter, 1 inch long, air wound.

The advantage of antenna height is well known to DXers. Frequently a light-weight low-gain antenna at a respectable height will outperform a higher gain antenna of lower elevation. My new QTH was in a heavily wooded area and there was an 85-foot fir tree close to the shack. Comparisons of two antennas, one at treetop and one 40 feet lower, demonstrated the height advantage.

I gave much thought to the development of a design that would perform effectively at treetop level on five of my favorite bands: 15, 12, 10, 6, and 2 meters. A beam that would cover all of these bands was ruled out as too cumbersome and heavy to be carried to the top of an 85-foot tree. I feared the frequency separation of the 15, 12, and 10-meter bands would be inadequate for a conventional trap antenna to perform efficiently. Weatherproofing the traps would also be a problem. I resorted to a technique I had seldom used in the past — parallel dipoles. Results have been quite satisfactory; spaced only 3 inches apart, parallel dipoles on these bands seem to perform with almost no interaction.

Because the antenna is horizontal it was necessary to use a rotator. The pattern is bidirectional so only 180° of rotation is needed, and it is possible to get by with as little as 90°. The antenna is light in weight (26 pounds) and has low wind resistance; only a small rotator is needed.

A schematic of the five-band dipole is shown in **fig. 1**. The four dipoles are adjusted for half-wave resonance at frequencies of 21.25, 24.9, 28.6, and 50.3 MHz. The 10-meter dipole works as a 5/2 wavelength dipole on 2 meters where it has a theoretical gain of 3 dB over a half-wave dipole. A serious 2-meter operator would probably want to add elements for a four- or five-element Yagi to the same boom and feed it with a diplexer such as shown in **fig. 2**. Alternatively a small 2-meter Yagi could be added to the same mast. However, my own results with only 3 dB of gain have been quite satisfactory on 2 meters. Admittedly, my elevation (5300 feet ASL) has been a contributing factor.

A purist would want to feed this antenna with a 1:1 balun. Measurements with a current probe[1] have shown the rf current on the outside of the coax to be quite small compared with the dipole current, so no balun was used.

The 2-meter impedance of the 10-meter dipole turned out to be capacitive at my operating frequency near 144.2 MHz. It was necessary to cancel this reactance with a shunt inductance. In order not to upset the feed impedance of the lower frequency dipoles, the inductance was placed in series with a series-tuned circuit, resonant at 144.2 MHz. The series-tuned circuit inductance is in series with the matching inductance and the two inductances can be combined into a single larger inductance of about 0.8μH. The series

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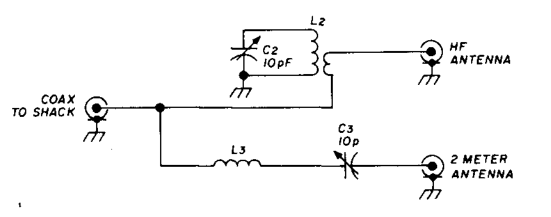


fig. 2. This 2-meter diplexer will permit use of the same coax feeder for a separate 2-meter antenna without compromising performance on either 144 MHz or the lower bands. Both L2 C2 and L3 C3 are carefully tuned to 144 MHz. The link on L2 is one turn. L2 and L3 can be 4 turns No. 18, 1/2-inch diameter, 3/8 inch long.

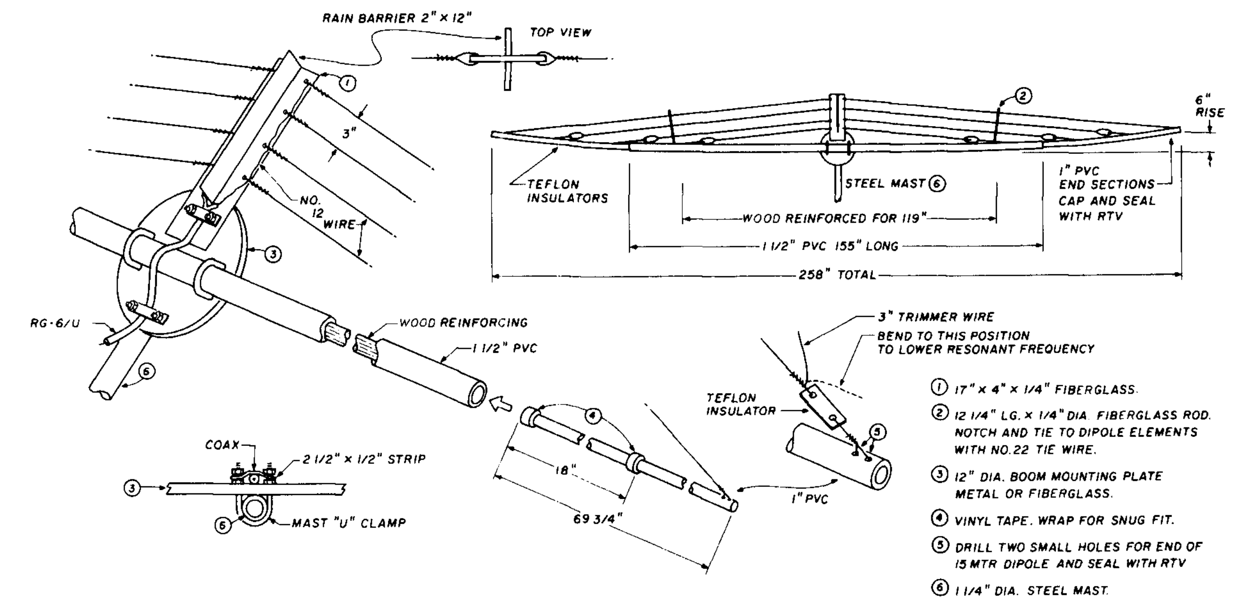


fig. 3. Construction details.

capacitance of 2.2 pF is too small to upset the resonant frequencies of the lower bands.

construction

As you can see in **fig. 3**, the antenna is made almost entirely of material that is frequently discarded at construction sites. By salvaging such material the total cost can be held to almost nothing. The dipoles are made of No. 12 (.081 inch diameter) solid copper wire stretched between ends of a slightly bowed nonmetalic boom. The center 155 inches of the boom is made of 1-1/2 inch PVC pipe commonly used in construction. PVC pipe of this diameter is not rigid enough for a boom length this size so I reinforced the center 119 inches with 1-1/2 inch wood dowel. To make the dowel, I planed off the corners of 1-1/2 inch square stock to form an octagonal cross section; and then planed the eight corners further to make a force fit into the PVC pipe. This is not easy without a power planer. You can use 1-3/8-inch diameter closet pole purchased from any lumber yard. Leave 18 inches empty on each end to receive 69-3/4 inch lengths of 1-inch PVC to make an overall length of 258 inches, or 0.46 wavelength at 21.15 MHz. The "1-inch" PVC has an outside diameter of about 1.32 inches, so wrap these lengths with vinyl tape as shown in **fig. 3** to build up the diameter and form a snug fit inside the 1-1/2 inch PVC pipe.

Teflon™ insulators are used at the far ends of the 6, 10, and 12-meter dipoles, but the 15-meter dipole ends are secured directly to the PVC boom in order to minimize the overall length. PVC has a bad reputation as an rf insulator[2], but at a power level of 65 watts I could detect no temperature rise in the PVC at the 15-meter dipole end points. If you comtemplate high power, I recommend checking for temperature rise before raising the antenna.

For the 12-inch diameter boom mounting plate I used high-strength plastic. Metal or fiber glass can also be used. If you use plywood, weatherproof it by painting with hot tar before assembling.

Seal all holes in the boom with RTV and cement end caps to the far ends of the 1-inch PVC sections. As an extra precaution against moisture accumulation, drill 1/4-inch drainage holes through the underside of both pipes 17 inches from each end of the 1-1/2 inch PVC.

pruning

Make final adjustments at least 10 feet above ground. You should get SWR curves similar to **fig. 4**. The final dipole lengths should be very close to those shown in **fig. 1**. **Figure 3** shows a trimmer adjustment scheme that will help avoid a lot of pruning.

If you check SWR between the ham bands you may find additional resonances where adjacent dipole reactances cancel. For instance, there is a resonance near 27 MHz where the capacitive reactance of the 12-meter dipole resonates with the inductive reactance of the 10-meter dipole. These "false" resonances can be distinguished from the main dipole resonance by their narrow bandwidth. At the frequency of a false resonance, a check with an rf current probe[1] will reveal current on two adjacent dipoles; at "true" resonance current will be strongly concentrated on only one dipole.

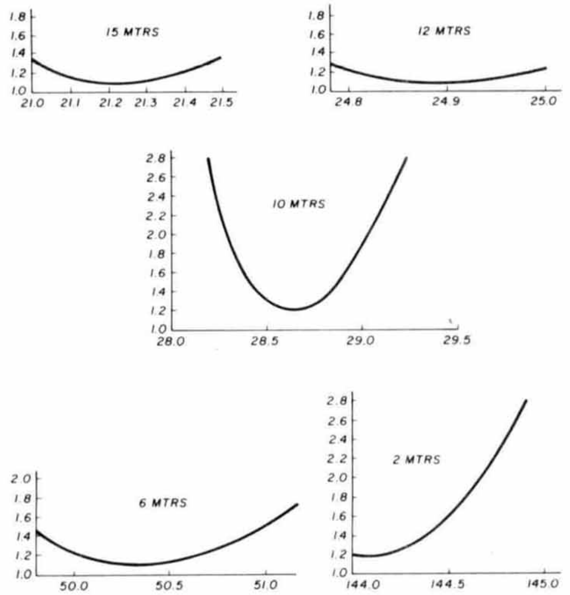


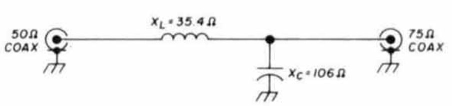
fig. 4. SWR curves measured on 75-ohm coax. The antenna was matched at the low end of 6 and 2 meters where all operating for this particular station is done.

The antenna impedance is close to 70 ohms — a good match to 75-ohm coax and not a bad one to 50-ohm coax. The latter will have a minimum SWR of 1.4 at resonance on each band. Perfectionists can obtain a better match to 50 ohms with a simple L section as shown in **fig. 5**. These L sections are extremely broad band, so no tuning is necessary once you have chosen the correct inductance and capacitance values.

In fact, the 12-meter L section is so broad it will provide a good match over the 15 and 10-meter bands as well. Determine inductance values with a grid-dip meter by shorting the input port, leaving the 75-ohm port open. Target resonant frequencies are given in the table on **fig. 5** along with the L and C values.

results

My antenna is fed through about 100 feet of low-loss 75-ohm 1/2 inch hard line. (I used a cable TV discard.) My results have been impressive on all bands. Sometimes I've worked stations that can't even be heard on a lower antenna. The broad azimuthal coverage provided by four main lobes on 2 meters is often a decided advantage over a beam in working multistation round tables.



BAND (METERS)	L	C	RESONANT FREQUENCY
10,12,15	0.21μH	56pF	46.4 MHz
6	0.112μH	30pF	86.6 MHz
2	0.039μH	10pF	255 MHz

fig. 5. This simple L-section will provide a broad-band match between 50 and 75 ohm coax. Target values for the inductive and capacitive reactances are 35.4 ohms and 106 ohms, respectively, but values are not critical. The bandwidth is so broad that the 15, 12, and 10 meter bands can be covered with one fixed L-section. If the 50-ohm port is shorted the inductance can be adjusted with a grid dip meter to the frequencies shown in the table.

In a pinch, the five-band dipole can even be used on 20 meters in conjunction with an antenna tuner in the shack. The SWR measured a surprisingly low 7:1 on 20, a figure that might be higher if a 1:1 balun had been used at the feedpoint. In any event, a 7:1 SWR will not increase coax losses prohibitively. For instance, if line loss is 1 dB with flat line it will increase only another 1.75 dB when the SWR is 7, or 2.75 dB total. Of course, an SWR of 7 will require an antenna tuner in the shack to bring the impedance back to 50 or 75 ohms resistive. Judging by on-the-air reports, performance on 20 is not bad at all. Maybe it should be called a six-band dipole.

references

1. F. Brown, W6HPH, "Better Results with Indoor Antennas," *QST*, October 1979, page 21, Figure 5.
2. "A Dielectric No-no," Hints and Kinks, *QST*, April 1977, page 56.

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