low swr dipole pairs for 1.8 through 30 MHz

A simple antenna system for the hf bands that offers low swr and broad bandwidth without a tuner

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After reading Bill Orr's article on multi-band dipoles for 10, 15 and 20 meters, I decided to try some of his ideas on the lower-frequency bands, together with a few innovations needed to solve the bandwidth problem.[1] If you calculate the percentage bandwidth of each amateur band from 160 through 10 meters, you come up with the figures in **table 1**.

Reference to the table tells us immediately that the only amateur bands requiring broadband treatment are 80 and possibly 10 meters, since conventional dipoles will readily meet the bandwidth and swr requirements for bandwidths of 5% or less.

The first dipole pair to be considered in an all-band installation is the 160- and 80-meter combination, since it is the biggest and is usually mounted near the top of the mast or tower. Both antennas may be mounted as inverted Vs as long as a minimum angle of thirty degrees is maintained between them. The thirty degree separation is necessary to keep antenna interaction to a minimum.

The 160-meter section is a simple wire dipole cut for 1850 kHz and then adjusted for minimum swr with the 80-meter dipole connected and mounted in place.

The 80-meter dipole is a standard broadband double bazooka.[2,3] This antenna has a fairly good broadband characteristic and works well with the 160-meter dipole as a two-band antenna system.

Construction details for my antenna are shown in **fig. 1** and **tables 2** and **3**. They depart somewhat from the original design, but mine are simpler and perform

table 1. Bandwidths of the hf amateur bands. Percentages were determined by dividing the bandwidth in MHz by the center frequency.

band	bandwidth (percent)
160	5.1
80	13.3
40	4.2
20	2.7
15	2.1
10	5.9

just as well. I used twinlead for the ends instead of ladder line because twinlead was more readily available.

The antenna is most easily set up by cutting the coaxial center section for 3750 kHz according to the formula in **table 3** and then adjusting the length of *the end sections for identical swr at each* band edge. This final adjustment must be made with the antenna connected to the 160-meter dipole. The result should be an swr curve similar to **fig. 2** for both dipoles. If the 2:1 swr on the band edges is objectionable, the curve may be modified by lengthening or shortening the twinlead ends slightly to favor that portion of the band used most frequently.

The double bazooka is a fine antenna for this application – but, as usual, there is a catch. It works well in conjunction with any dipole that is *lower* in frequency than the double bazooka. Thus, a 10-meter double bazooka will work well with a 20-meter dipole, just as an 80-meter double bazooka will work with a 160-meter dipole. However, any attempt to use the antenna with a *higher* frequency dipole will result in an absolutely unmanageable swr on the higher-frequency band. This peculiar behavior is caused by the center conductor of the *coaxial section acting as a pair* of short-circuited quarter-wave stubs on the second harmonic. Therefore, if 160-meter operation is not desired, the 80-meter double bazooka will have to be run on a transmission line separate from the other dipole pairs.

40 and 15 meters

Well accepted theory states that dipoles working from a common feedline or balun must be harmonically related to be effective, the implication being that the relationship usually involves the fundamental and the second harmonic. The question arose, when developing these dipole pairs, what to do about fifteen meters? The only amateur band to which

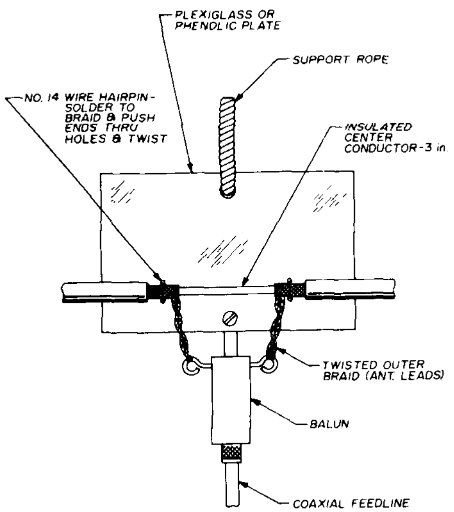
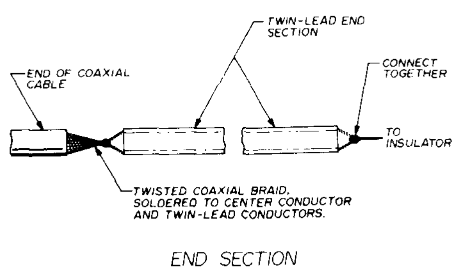


fig. 1. Construction details for the 80- and 10-meter broadband dipoles. Table 3 includes the necessary formulas and some typical dimensions. The end segments (D3) will vary somewhat from the calculated values and, like all dipoles, may need *pruning once the antenna* is in place.



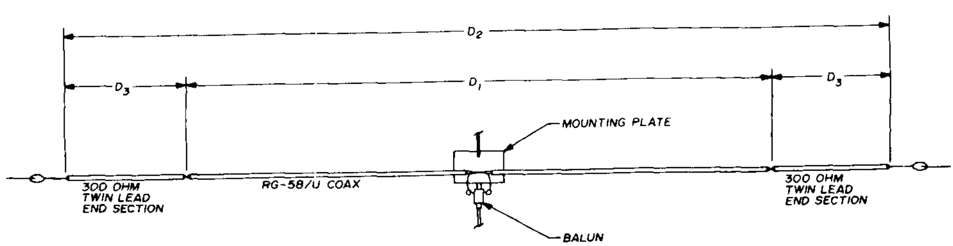


table 2. Wire dipole lengths.

band	overall length
160	243' 0"
40	64' 2"
20	33' 0"
15	22' 0"

it is harmonically related is forty, so I set up a 40-meter dipole with a low swr. When I tried operating on fifteen, the swr jumped to 3:1 and higher. This should really not be surprising since theory again tells us that the radiation resistance of an antenna increases as the number of half waves increases. The thought then occurred that the addition of a 15-meter dipole to the 40-meter dipole might solve the problem. This worked out very well indeed, as a reference to **fig. 3** will reveal.

The 40- and 15-meter combination, *unlike the previous dipole pair*, does not

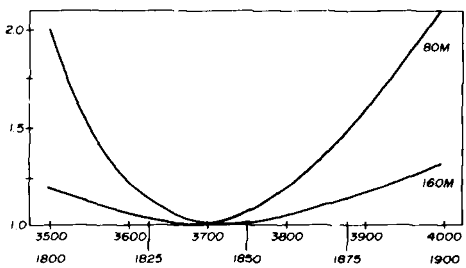


fig. 2. Swr curves for the 160- and 80-meter dipole pair. Dimensions of the final antenna lengths are given in tables 2 and 3.

require the application of broadband techniques. Conventional single-wire dipoles will do the job and, if carefully adjusted, will result in a swr of 1.5:1 or less on both bands. Incidentally, I did not attempt to center the swr curves as in the previous case. The 40-meter dipole is a little short and the 15-meter dipole a little too long, a situation readily corrected by the perfectionist.

To set up the pair, begin by adjusting the 40-meter dipole for equal swr at the band edges. This should be done with a pre-cut 15-meter dipole connected to the 40-meter dipole. Also, be sure to space the ends of the 15-meter dipole at least 8 feet from the 40-meter dipole, otherwise severe antenna interaction may result. This will show up as an excessive swr, usually on 15 meters. After obtaining a satisfactory swr curve on forty, proceed to adjust the 15-meter dipole. Usually very little adjustment of the 15-meter element will be required.

20 and 10 meters

The 10- and 20-meter dipole combination may be regarded as a scaled-down version of the 160- *and 80-meter dipole* pair, since both pairs use a simple wire dipole for the lower-frequency band and a broadband antenna for the higher-frequency band. The similarity ends there. You will find that the dipoles of this antenna pair are more interdependent and therefore more critical to adjust.

Begin by cutting both antennas to their calculated length. Connect both to a common balun, and make sure that the ends of the 10-meter dipole are at least 10 feet from the 20-meter dipole.

Adjust the 20-meter antenna for minimum swr. After obtaining a satisfactory swr similar to **fig. 4**, proceed to adjust the 10-meter dipole for minimum swr by adjusting the lengths of the twinlead ends. As a final touch, check both bands once again to see if any significant shift has occurred in either swr curve. By following this procedure you will experience little difficulty in setting up this last dipole pair.

The dipole pairs described in this article are the direct result of much experimentation done while developing a

table 3. Bazooka antenna dimensions. D1, D2 and D3 are shown in fig. 1. The formulas used to compute these lengths initially are D1=492/f(MHz) for foam coax and D1=325/f(MHz) for polyethylene coax. D2=460/f(MHz) and D3=(D2D1)/2.

band	D1	D2	D3	cable
80	105'	125'	10'	foam
10	11' 2"	15' 6"	26"	poly

simple, effective, all-band antenna system for Doc, WB6UWK. Doc is a blind amateur who likes to work all bands on all modes without the need for fooling

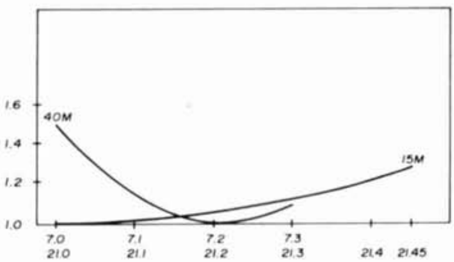


fig. 3. Swr curve for the 40- and 15- meter dipole pair.

with couplers or matching gimmicks of any kind. A coaxial switch makes antenna switching extremely simple.

The dipole pairs have been in service for about a year now and have given no trouble, even when running the legal

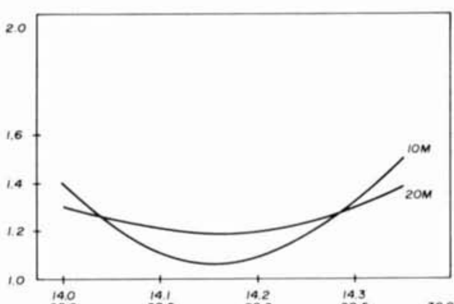


fig. 4. Swr curve for the 20- and 10- meter dipole pair.

power limit. No superlative DX claims are made for this system, but on each band it seems to perform as well as a simple dipole.

references

1. William I. Orr, W6SAI, "Multiband Dipoles for Portable Use," *ham radio*, May, 1970, page 12.
2. "The Radio Amateur's Handbook," 48th edition, ARRL, 1971, pages 368-369.
3. Charles C. Whysall, W8TV, "The Double Bazooka Antenna," *QST*, July, 1968, page 38.

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