A SIX ELEMENT WIRE YAGI FOR 20

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To many, there is something very strange and unYagi-like about a wire Yagi. These critics will point out that there aren't many wire Yagis in use or construction articles to be found. This is certainly true. They also argue that wire just won't work for Yagi construction. This argument isn't necessarily valid. To the contrary, it is quite possible to put up a wire beam that will give excellent results, yet cost less than 5% the expense of raising a comparable Yagi made of tubing.

In order to understand why this particular antenna works as it does, it is necessary to comprehend a few basic facts regarding the concepts of radiation resistance and bandwidth. It has been established that the feed-point impedance (also known as radiation resistance) of an infinitely-thin half-wave dipole located in free space is about 72 ohms. This value becomes lower when the length/diameter ratio of the conductor is made smaller (*i.e.* when the conductor gets thicker for a given length) and when one or more antennas are coupled to it, as when parasitic elements are placed parallel to a fed dipole to form a Yagi array.

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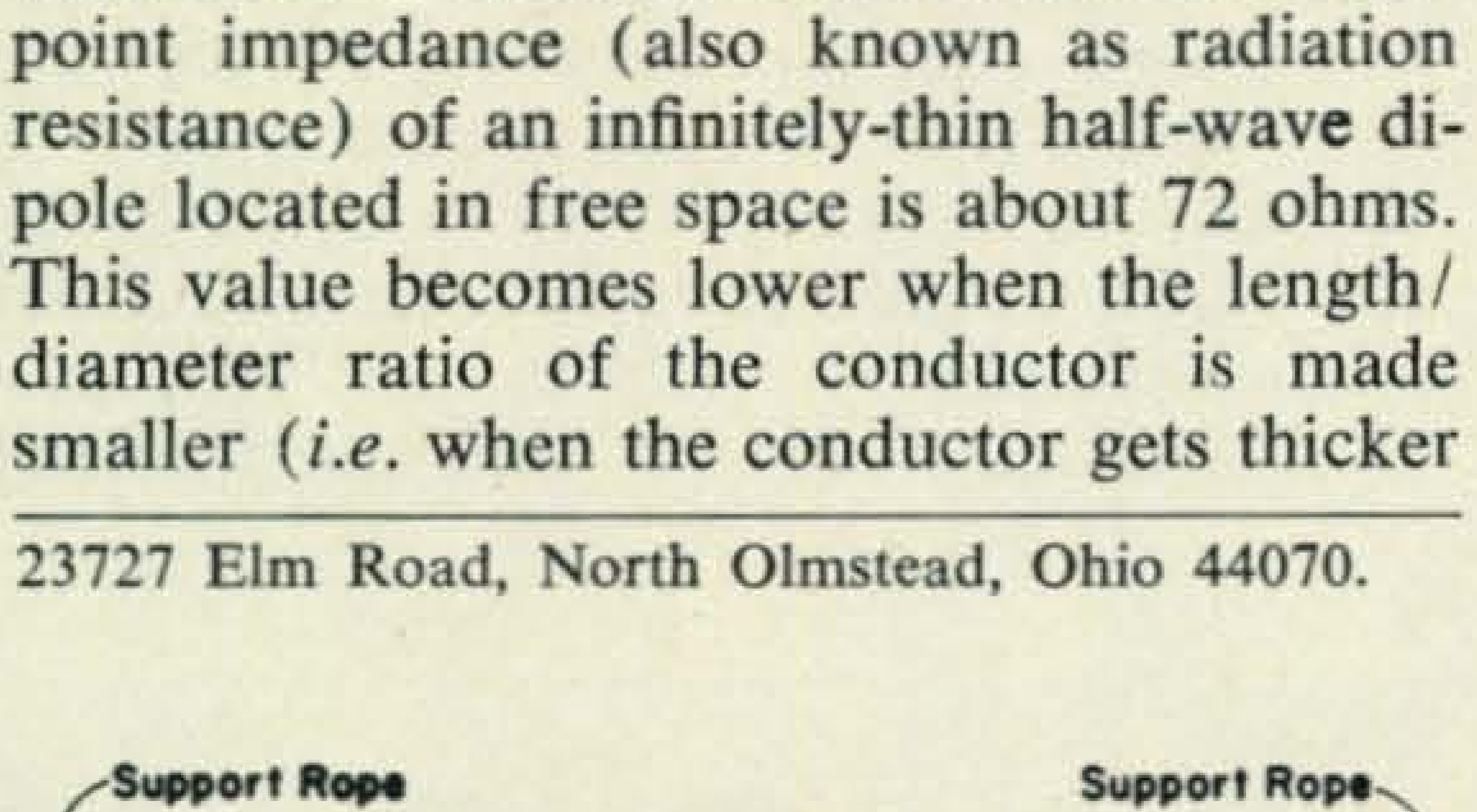

Fig. 1—Top view of a six element wire yagi for 20 meters. The element lengths in feet and inches are listed in Table I and the spacings in Table II.

Antenna Losses

Power lost due to radiation represents a power loss to the antenna just as does the actual I^2R loss due to the real resistance of the conductor. Obviously, energy radiated into space and absorbed by a DX station's receiving antenna is much more useful than energy which is only being used to heat up the transmitting antenna. From this it is possible to conclude that it is desirable to have a relatively high radiation resistance and a relatively low ohmic resistance. But it was just stated that antennas made of tubing have a lower radiation resistance than those made of wire. True, but the value of ohmic resistance is also less. However, wire will work fine as long as it doesn't have a terribly high resistance. Try to use #12 or thicker and steer clear of aluminum or iron wire. My beam was constructed of #10 insulated copper of the type used for house wiring.

Bandwidth

Perhaps the main argument in favor of "Tubing" Yagis is that the low-Q conductor will work over a wider bandwidth than the high-Q conductors inherent in wire beams. In a Yagi made of tubing, a small amount of gain is sacrificed for broadbanding. All this means is that a wire beam cut for the low end of the band will not work as well at the high end as will one constructed of tubing. It will perform satisfactorily at any point in the c.w. portion of twenty if cut for 14.050 mc, however. The same reasoning holds true for the phone part of the band.

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	Center Frequency In Kc.					
	14050	14100	14150	14200	14250	14300
Refl.	34′ 0″	33′ 10″	33′ 9″	33′ 7″	33′ 6″	33′ 4″
Driv. El.	32′ 8″	32′ 6″	32′ 5″	32′ 3″	32′ 2″	32′ 0″
Dir. #1	31′ 4″	31′ 2″	31′ 1″	30′ 11″	30′ 10″	30′ 8″
Dir. #2	30′ 8″	30′ 6″	30′ 5″	30′ 3″	30′ 2″	30′ 0″
Dir. #3	30′ 0″	29′ 10″	29′ 9″	29′ 7″	29′ 6″	29′ 4″
Dir. #4	30′ 0″	29′ 10″	29′ 9″	29′ 7″	29′ 6″	29′ 4″

Table I—Element lengths for the 20 meter six element wire yagi.

Keep in mind what was said about the decrease in radiation resistance of a dipole when elements are paralleled with it. This condition is worsened when closer spacing causes increased inter-element coupling. It is therefore evident that wide spacing is desirable. Wide spacing is employed in the design of the wire beam to be described. All elements are spaced 0.2 wavelengths apart with the exception of the spacing between driven element and the first director, which is 0.15 wavelength. This is depicted in fig. 1. As can be seen the array is over 60′ long. If room is not available for a 6 element array, one or more directors may readily be omitted. Even if all directors were to be left off, the remaining antenna would yield a worthwhile improvement over a dipole alone. It is also possible to add more directors if space is available.

For a 6 element beam, about 200′ of wire and two 100′ lengths of ⅜″ rope is required. Nylon rope is quite expensive, as well as being stretchy, so a cheaper grade of rope is recommended. The anatomy of the wire beam is quite simple. Attach the ends of the elements to two parallel ropes using small pieces of ⅛″ nylon rope as insulators. Don't use big ceramic insulators as they will weigh the antenna down considerably. The only insulator should be at the center of the fed dipole.

Feed Line

The antenna is fed with RG-8/u or RG-58/u. RG-17 or RG-19 is very nice if you have it, but would weigh the antenna down intolerably. There is a method to lick the coax drag problem, though. Install a wooden post beneath the antenna so that the top is a few feet away from the center of the driven element. Attach the coax to this and leave a little slack at the top. This will take most of the strain off the driven element. I found a dead tree in a nearby forest that fit the post requirement nicely.

Construction

The first step in construction is to cut the elements to the proper length. Attach a few feet of thin nylon line to the ends of each

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Distance in terms of:	Wave-length	Feet
Refl. to Driv. El.	0.20 λ	13′ 4″
Driv. El. to Dir. #1	0.15 λ	10′ 0″
Dir. #1 to Dir. #2	0.20 λ	13′ 4″
Dir. #2 to Dir. #3	0.20 λ	13′ 4″
Dir. #3 to Dir. #4	0.20 λ	13′ 4″

Table II—Element spacing for the 20 meter six element wire yagi.

at a faster rate than it can be used at the cadmium electrode. This can cause pressure buildup to the point where the seal is ruptured.

Charging

Knowing the milliampere-hour rating of a ni-cad battery is extremely important if its life is to be protected. If there are no clues provided on the battery case, the rating can usually be determined within a fair margin of error by estimating. A standard D-size 6 volt cell (the size of a conventional flashlight battery) will have a milliampere-hour rating of approximately 250. Using the 10% rule, it can be seen that the basic charge rate is 25 ma, and by application of the "plus 50%" time rule, the proper charge period is 15 hours.

Trickle-charging may be employed if the battery is used at low drain rates. A general rule for trickle-charging is to maintain the charge level at 10% of the standard charge rate, and keep the battery under this charge during all periods of nonuse. The trickle-charge current for the D-size battery is 2.5 ma.

A very simple battery charger can be built up readily with run-of-the-junkbox parts. If the battery is not to be in use during a charge, a half-wave rectifier will be adequate. The diagram in fig. 1 shows a simple rectifier circuit and lists the component values for various charging currents.

With the lower voltage ni-cads, a very simple and satisfactory charger can be made with an electric-train or road-race transformer, a potentiometer, and an inexpensive meter. The electric-toy transformer offers the advantage of a pre-rectified low voltage output. The hookup is shown in fig. 2. ■

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element and trim so that all elements plus nylon line add to the same length. Element lengths are given in Table I; spacings in Table 2.

The next step is to take the two lengths of ⅜" rope and measure off the points where the elements are to be attached. This is easily done by taking both lengths of rope laid side by side and tying one end of the pair to a tree. Measure off about 20′ and spot with a marker pen. This is where the reflector is attached. Measure off another 13′ 4″ and mark for the driven element, making sure that both ropes are marked in the same place. Measure off another 10′ 0″ and spot

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for the first director. All remaining spacing are 13′ 4″ so continue accordingly. Whe this has been done, attach the elements to th rope. Be sure to use good knots with the thi nylon line, as the wrong ones will just com apart.

Cut the center of the driven element an install the insulator and feedline. All tha remains is to raise the antenna, using the end of the side support ropes to tie onto nearb trees. If not enough trees are available, coun on using more wooden posts. Get the antenn as high as possible and watch for kinks in th elements. If necessary, use thin line (nc wire) to pull the side ropes out a bit to lesse element sag.

Results

Although my beam is only 25′ high, found that I could work stations never pos sible with the 3 element Yagi I had on a 50 tower. Obviously, since the antenna can't b rotated, (but then again, neither can a rhom bic) it is best to align the antenna in the mos interesting direction. Since I wanted an an tenna that could be used to provide reliabl communications to the Far East, I aligne my beam accordingly. The results surpasse my expectations. The first morning that th band was open to the Far East, I worked different JAs in one hour, all of which gav me 579 or better reports. That morning I als worked a KR8, a VK8, and a whole flock o UA∅s, receiving good reports from one an all. I was running 350 watts at the time. Th next morning was even better. Besides whole log page of JAs and UA∅-UA9s, worked a KX6, a UI8, and three UL7s. found that I could work stations slightly of the main lobe but had trouble working then off the sides and back of the beam. I even tually put up a ground plane to use when th band wasn't open to Asia.

In order to arrive at an approximate valu of forward gain, I installed a reference dipol aligned in the same direction as the beam and at the same height. The same feedlin length was also employed. Upon tuning in strong JA using the dipole, the signal in creased 2 S-units when the beam wa switched in. This would seem to indicate a 12 db gain over the dipole. Solid copy of certai stations was possible with the beam when th station could hardly be heard when either th dipole or the ground plane was switched in This to me is good performance from some thing so cheap and dirty. ■

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