antennas

BY KENT BRITAIN,* WA5VJB

More "Cheap Yagis"

These 450-MHz "Cheap Yagis" were the first ones published 11 years ago, but I've made a few tweaks along the way since then. They have proven great for portable operation, backpacking, and transmitter hunts, and are something inexpensive you can throw up in the attic for that weak repeater.

Theory

You don't see any gamma matches, shorting bars, trimmer caps, or any other adjustments on the driven element. We are using the structure of the Yagi itself for impedance matching.

It's a simple technique. A dipole has roughly 72 ohms impedance when it's in free space. As other elements, or even the ground, approach the dipole, its impedance is lowered. Put the other elements at just the right distance and you can get a direct match to 50 ohms. This works and is simple enough, but you can't get the elements close enough to couple much of the power into the Yagi structure.

You can also use a folded dipole as the driven element with its 300-ohm impedance in free space. Many antenna companies, such as Tonna (the F9FT), have used this technique. I've had one of Tonna's 21-element 432-MHz beams in the air for 25 years. However, that first director must be mounted very, very close to the driven element to pull it down to 50 ohms. That's okay for a machine shop, but the tolerances are very tight for a hand drill and a piece of wood.

As a result, I ended up with the folded-J driven element. This driven element has an approximately 150-ohm impedance in free space. With 150 ohms, the elements are spaced about right for a good-performing Yagi matched to 50-ohm coax (fig. 1). Later we can spread out the elements a bit and make 75-ohm ATV versions.

Now for our construction project.

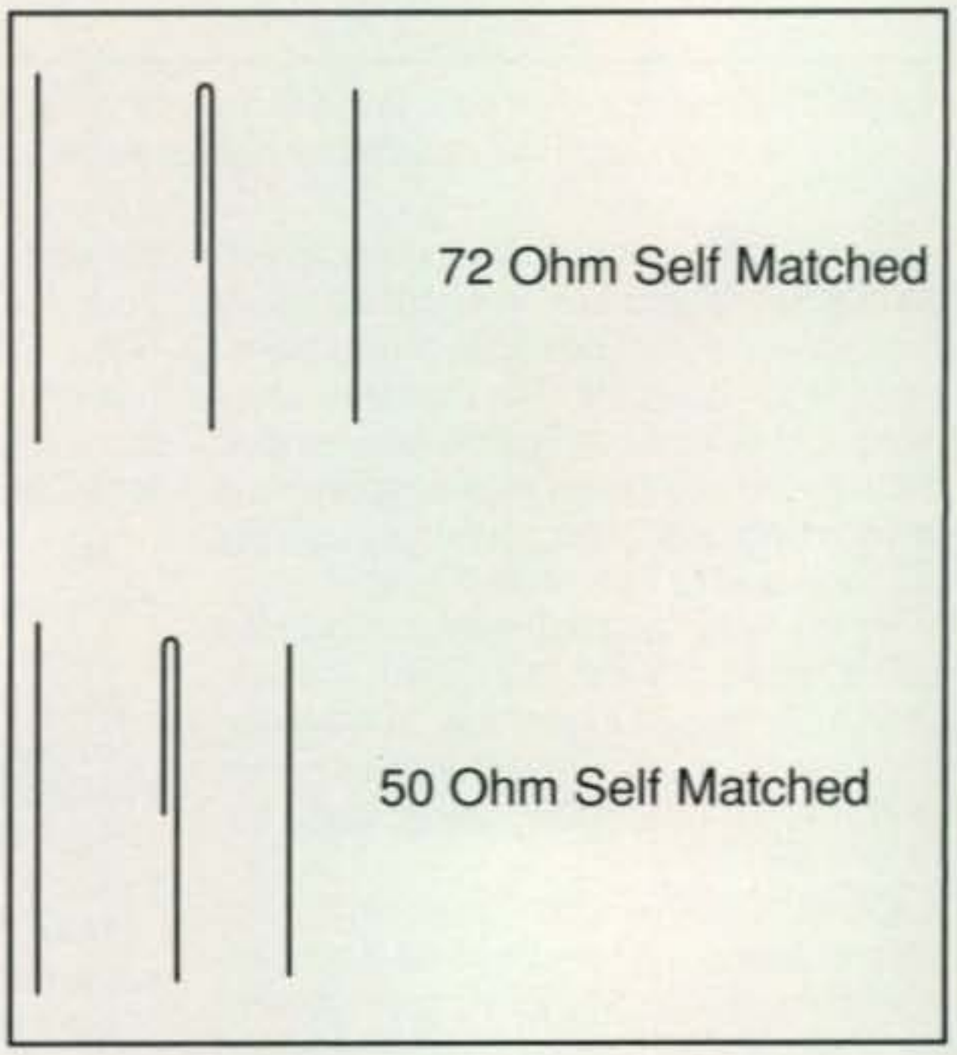

Fig. 1– 50-ohm and 75-ohm spacing.

Photo A– Driven element and coax.

Construction

Fig. 2 is the driven element, which is used in all four versions of the Cheap Yagi (3-, 4-, 6-, and 8-elements; see Table I, II, and III). If you want to tweak the SWR, then trim the free end of the J. If you trim off too much, you can solder back on almost any short piece of wire, although a short piece of 1/8-inch hobby brass tubing works best for me. Although harder to work with, 1/8-inch silicon bronze welding rod makes the strongest driven element, and it's still easy to solder.

The boom is made from wood. I like to use 1/2" × 3/4" for most projects, but 3/4-inch square or anything up to 1-inch square can be used. You really don't want to use a 2 × 4. There would be enough mass in the wood to detune the element. I learned this the hard way with a 1270-MHz version. For portable and temporary operation, almost any wood can be used. For longer life outside, fir, oak, or another hardwood works best, but I personally think it's overkill. A quick coat of spar varnish, wood sealer, or even house paint will greatly extend the life of the antenna.

One of my very first Cheap Yagis was a 900-MHz version that lasted about five years up on the tower. At about the same time, I built an array of 421-MHz Cheap Yagis for the local ATV repeater. These were mounted in the attic, and except for a coat of dust, they still look fine after 12 years. I know several have been built with plastic water

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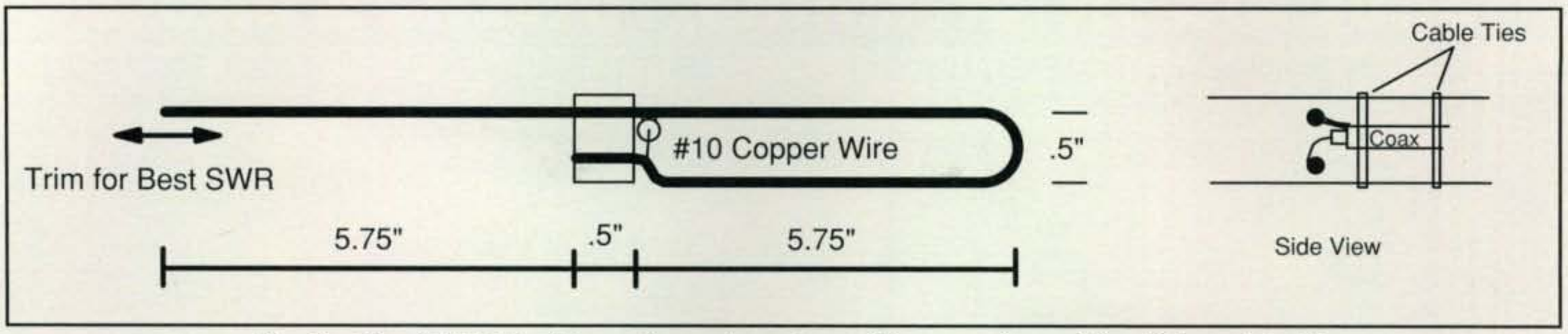

Fig. 2– The 445-MHz driven element used on all four versions of the "Cheap Yagi."

3-element Cheap Yagi*

	Length	Spacing	Diameter
Reflector	13.1	0	.125
Driven element	Fig. 2	2.6	—
Director	11.25	7.75	.125

**All dimensions are in inches.*

Table I– The 3-element Cheap Yagi. Gain is about 7.5 dBi with a front-to-back ratio of about 25 dB. If you want to use .25" (1/4") rod for the director and reflector, shorten the director from 11.25" to 11.0". Yes, we are changing only the director, even though a thicker rod is used for the director and the reflector.

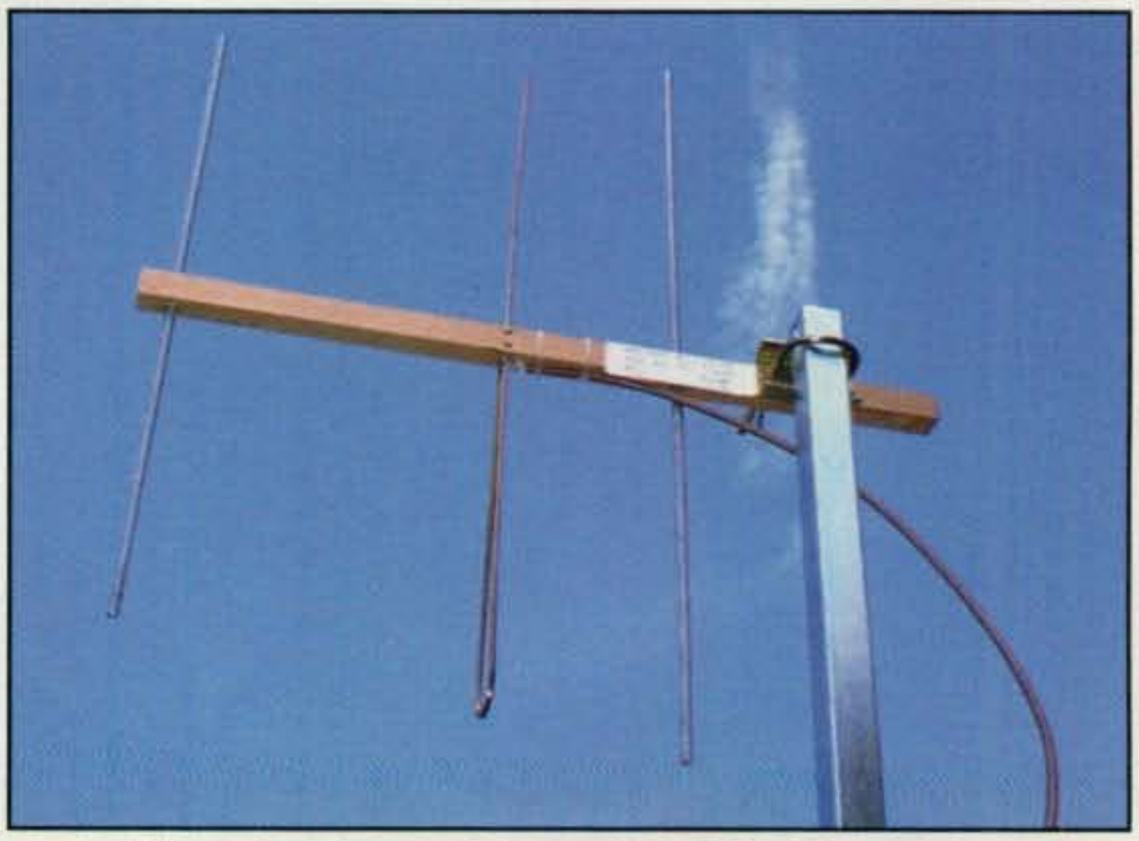

Photo B– The 3-element 445-MHz Cheap Yagi.

4-element Cheap Yagi*

	Length	Spacing	Diameter
Reflector	13.23	0	.125
Driven element	Fig. 3	2.75	—
Director 1 (D1)	12.0	6.0	.125
Director 2 (D2)	10.3	13.25	.125

**All dimensions are in inches.*

Table II– The 4-element Cheap Yagi. Gain is now about 8.5 dBi with the front-to-back ratio running between 25 and 35 dB. The antenna is usable from 430 to 450 MHz, although the pattern gets kind of rough below 435 MHz. Again, if you want to use .25" (1/4") rod for the directors and reflectors, shorten D1 from 10.0" to 11.75" and D2 from 10.3" to 10.0". The director length is not changed.

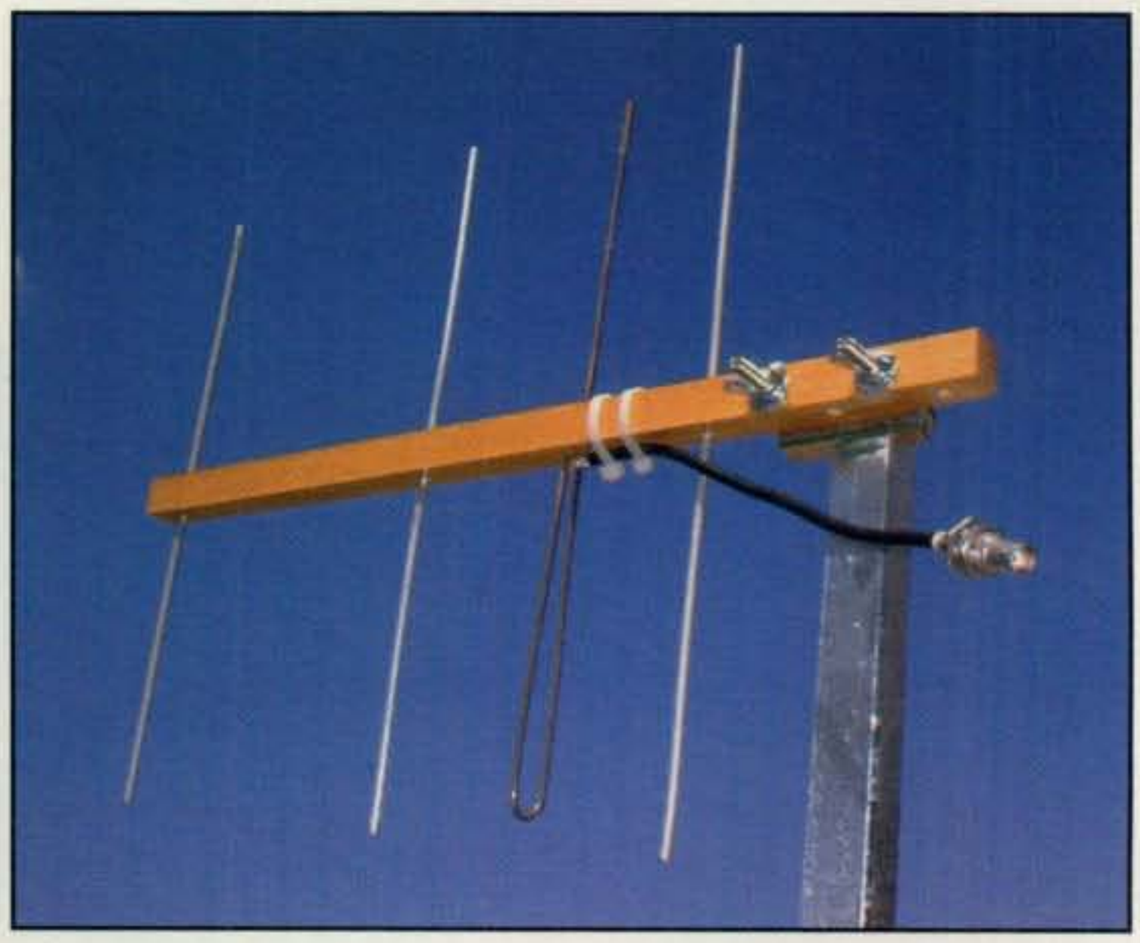

Photo C– The 4-element 445-MHz Cheap Yagi.

pipe. The only time I tried it, the plastic melted when I tried to solder on the coax, but plastic water pipe will work.

The elements can be made from #10 copper wire, silicon bronze welding rod, brass or copper 1/8-inch hobby tubing, or aluminum rod. However, by far the cheapest stuff to use is RadioShack 1/8-inch aluminum ground wire (catalog part #15-035). About $5.00 worth of this stuff is enough to build about ten of these antennas.

If you're using 1/8-inch diameter elements, just use a 1/8-inch drill bit to drill the mounting holes in the boom. This will give a good, snug fit. A dab of glue will hold the elements in. Super Glue® works well, RTV has been used, or my personal favorite is Liquid Nails®.

I have always soldered the coax to the driven element. The shield is soldered pretty close to the middle of the J element. The coax center conductor goes near the tip of the J driven element. I know some have built the antenna with an aluminum driven element and devised small clamps to hold on the coax. Long term, I think soldering is much more reliable than mechanical clips.

It was noted last time that I hadn't used UV-resistant cable ties to hold the coax to the boom. There is a lot of personal preference involved here. I've used cable ties, electrical tape, duct tape, solid-core wire, and garbage-bag ties to tie the coax to the boom. If you plan to mount these antennas out-

Photo D– The six-element version of the Cheap Yagi.

Photo E– Mounting holes.

side, I recommend sealing the coax braid to keep water from wicking back down the coax. Varnish, RTV, and Liquid Nails® all have been used with good results.

Mounting

While I have held these antennas up with duct tape and rope, a U-bolt is more practical. Spending a little more money and getting the wing nuts for the U-bolt is well worth it for when you're out portable. I also like to drill the boom to accept the U-bolt both ways so I can run it vertically or horizontally attached to almost any mast. Offset the holes a bit so you won't weaken the boom.

6-element Cheap Yagi*

	Reflector	DE	D1	D2	D3	D4	D5	D6
Length	13.0	Fig. 2	12.0	11.75	11.73	10.75	—	—
Position	0	2.5	5.5	11.0	18.0	23.5	—	—

8-element Cheap Yagi*

	Reflector	DE	D1	D2	D3	D4	D5	D6
Length	13.0	Fig. 2	12.0	11.5	11.5	11.5	11.5	10.5
Position	0	2.5	5.5	11.0	18.0	23.5	29.5	35.5

**All dimensions are in inches. All elements are 1/8" diameter.*

Table III– The 6- and 8-element versions. Gain for the 6-element version will be about 11 dBi with a pretty good 30-dB front-to-back ratio. With the 8-element Cheap Yagi, gain is near 12.5 dBi, with again a 30-dB front-to-back ratio. I could squeeze another 1/2 dB or so out of these designs, but the dimensions start getting very tight. Gain on a tight Yagi would disintegrate very quickly with a few bent elements, but an ugly Cheap Yagi just keeps on working.

On the Air

Just hook up the antenna to your radio and start talking. Built to the dimensions given, the SWR should be well under 2 to 1, and it usually will be better than 1.5 to 1. As I mentioned earlier, however, you can tweak the free end of the J for best SWR.

Wes, W7ZOI, likes to take these antennas backpacking. He takes advantage of the soft aluminum elements and just folds the antenna elements flush with the boom and packs them away. Later on a hilltop he just straightens out the elements. He says they are good for about a half-dozen expeditions, and then he just builds a new one.

I like to build each antenna before I publish the design, and not all of them work. I then started wondering, and just stood out in my garage and started counting antennas. I counted 119! The frightening part is that I know that was only the top layer! Oh well . . . I have at least another 37 in the air. Have fun experimenting and get some antennas up in the air!

Now what shall we cover next time? 222 MHz? ATV? AMSAT? Drop me an e-mail at <wa5vjb@cq-amateur-radio.com> and let me know.

73, Kent, WA5VJB

PS: For those of you who remember my column in the July issue, yes, I do know the difference between impedance and power. I'm afraid we were the victims of a glitch in the translation from one computer software version to another and the ohm symbol did not come through. From now on I'll be spelling out "ohm"! I also must say that the best comment was from the QRPer who didn't like to use 50-watt coax and wanted to know the best source for 1-watt coax.