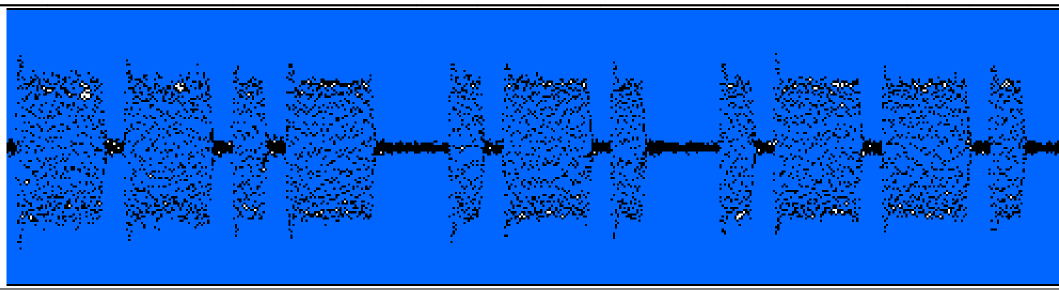
Antennas



The KJ5VW 20 Meter Mini Yagi

Gary R. Hanson, KJ5VW

Austin, Texas

Imitation, it is said, is the sincerest form of flattery so let me begin by pointing to the direct source of my inspiration for building this antenna. I first got the idea for a "mini" antenna from Frank, G3YCC's article in the QRPp quarterly, June, 1996. He described a "mini" dipole for 20 meters made from aluminum tubing with mid-element inductive loading coils. It was short, could be rotated, was easy to construct, and best of all -- it was inexpensive. I built it and it worked marvelously well. I received many fine signal reports, but that only started me thinking that if a dipole worked this well, wouldn't a two-element beam work even better? About the same time, I started surfing the Internet and began reading numerous posts from C. E. Cebik about wire beams on the QRP-L listserv and his web page. I learned enough about driven elements, directors and reflectors, boom length, gain and front/back ratios to start experimenting on my own.

Why not take the "mini-dipole" idea from Frank, add some of the ideas about wire beam ideas from W.L. Cebik and combine the two? I wanted to make a light, portable antenna that I could easily transport from my house, to a field operation, to the beach and maybe even lash to the top of my sailboat mast. And it had to fit in the trunk of my car! The latter criterion placed some pretty severe constraints on my plans. Did I mention it had to be inexpensive as well?

What I ended up with was a two-element mini-yagi that weighed less then 15 pounds, cost less than $30 dollars, could be disassembled into four-foot lengths, stored in the trunk of my car, and could be assembled in less than a half hour. Here's how I did it.

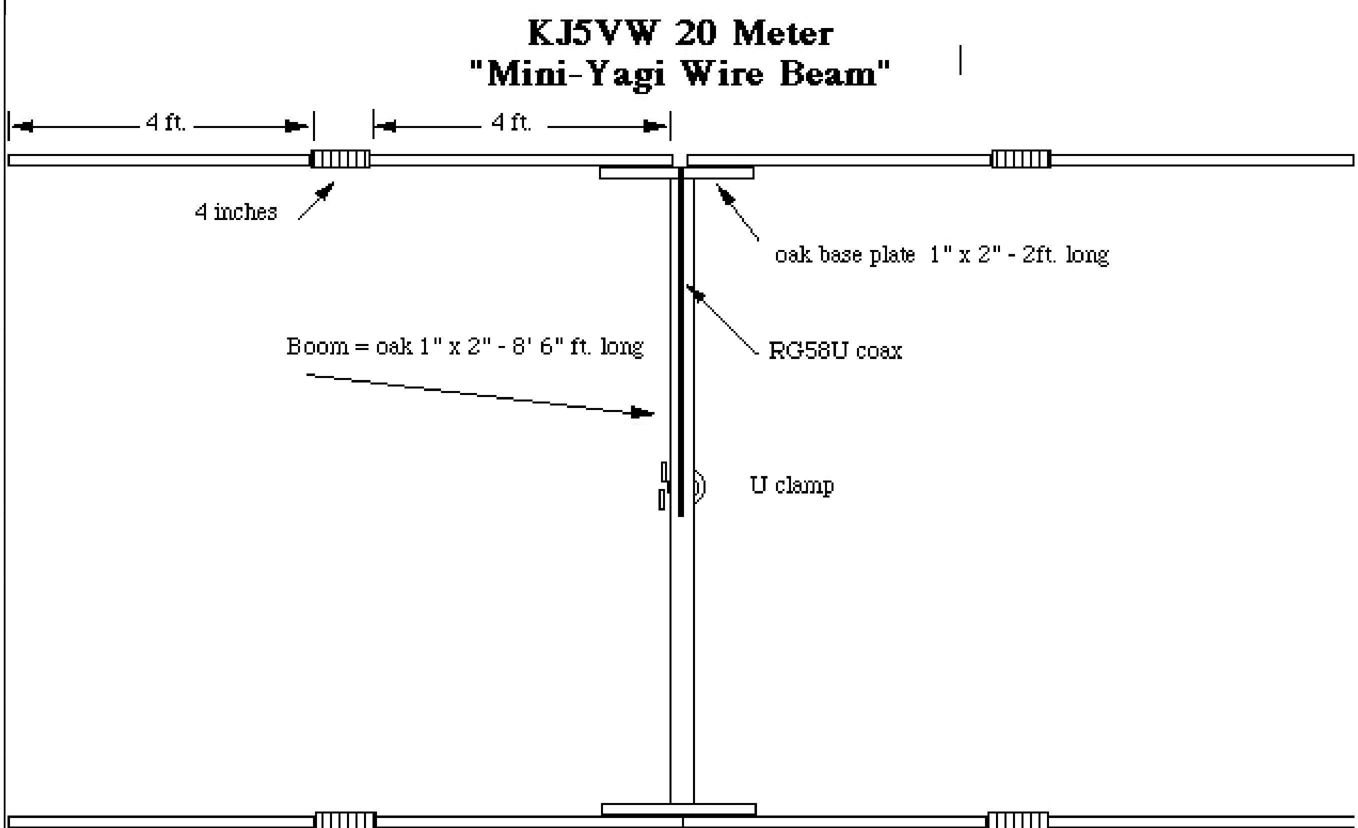
Construction Hints

Follow these simple steps:

1. Build the driven and reflector elements first
2. Wind the inductive loading coils
3. Mount the elements on a base plate
4. Attach the base plate to the boom
5. Attach wires to the elements
6. Attach feedline to driven element
7. Attach the boom to a support mast

Stage 1 Build the driven and reflector elements

1. Cut four pieces of 1/2 inch PVC pipe into 4" lengths
2. Make a pencil line 2" from the end of each four foot section of 5/8" dowel
3. Take a wood rasp and shave one end of each dowel section just enough so it provides some resistance when you tap a dowel into each end of the PVC pipe up to the pencil line.
4. Drill a hole through the PVC pipe and dowel about a 1/2" inch from the end of the PVC pipe.
5. Insert a 8-32 brass bolt through the hole, using a brass washer on the "top" side.
6. You should have four element sections, each eight feet long.



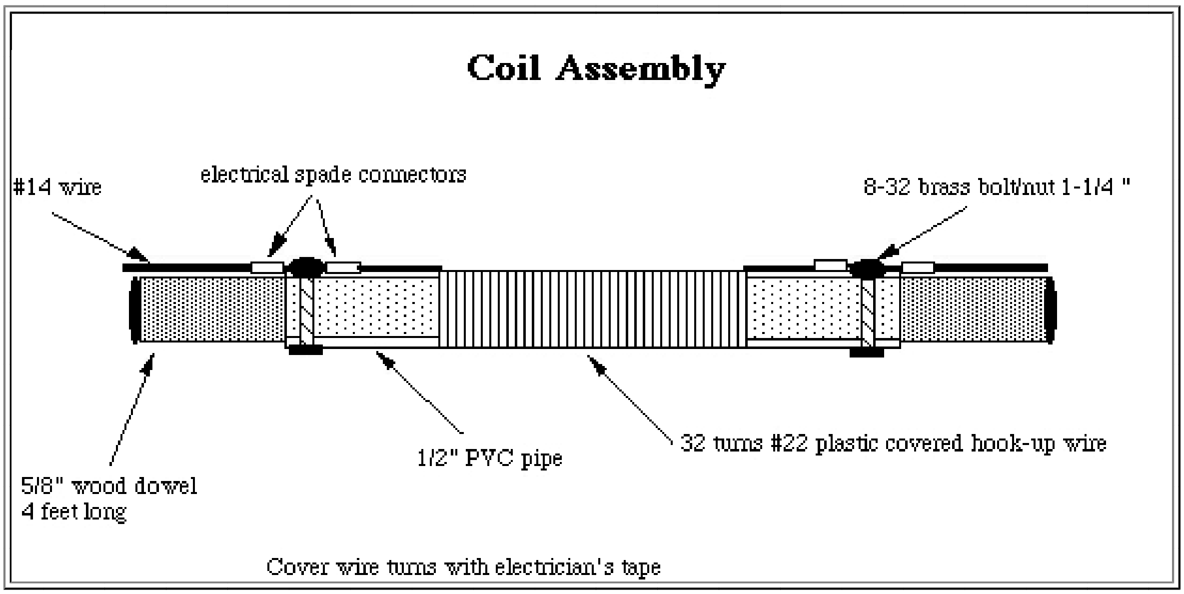
Materials List

8 - 5/8" wooden dowels	8 - 8-32 brass bolts and nuts 1-1/4 inches long
4 - 1/2" PVC pipe cut to 4 inches	8 - 8-32 brass bolts and nuts 1/1/2 inches long
2 - oak 1" x 2 " cut to 24 inches	12 - electrical spade connectors to fit 8-32 brass bolts
1 - oak 1 ! x 2" cut to 8 feet 6 inches	4 - metal "L" brackets to fit 1" x 2" boom

Stage 2 Wind the inductive coils

1. Cut a 7' 6" length of #22 plastic covered hook-up wire for each of the four coils.
2. Attach one end of the wire under the brass bolt and washer on the "left" side of the coil.
3. Wind the coil over the top of the PVC form in a clockwise fashion for 32 turns and then attach the free end under the brass bolt and washer on the "right" side of the coil.
4. I used electrical spade connectors crimped on the end of the wires to slip under the bolt head and washer.
5. Make four of these coils and wrap them with electrical tape to hold the windings in place.

Here's what the inductive coils should like when you have finished.



Stage 3 Attach the beam elements to a base plate

1. Cut two 1" x 2" pieces of oak to a length of 2 feet.
2. Mark a "center" line at the 12" inch mark and space the holes for your corner "L" brackets on the back side of the base plate so the boom will attach
3. Drill the holes for mounting your "L" brackets, but do not attach them.
4. Place one end of a element up to the center line and drill a mounting hole through the wood dowel so it either lines up with an existing hole for the "L" bracket or so that you create a new hole through the base plate and "L" corner bracket.
5. Drill a second hole through the dowel and base plate about an inch from the end of the base plate.
6. Attach two wood elements and the two "L" brackets to each base plate and secure with 8-32 brass nuts and bolts

Stage 4 Attach the base plates and elements to the boom

1. Cut a 1" x 2" piece of oak to a length of 8' 3-1/2"
2. Mark the mounting holes for the "L" brackets on the boom.
3. Drill the holes and attach the boom to each base plate using 8-32 brass nuts and bolts
4. Measure the center point of the boom length with a pencil line and drill holes for inserting a U-bolt clamp for mounting the boom to the mast.

Stage 5 Attach the wires to the elements

Driven Element

1. Measure two lengths of wire to run from the center of the element to the inductive coil, but allow about a 1" to an 1-1/2" gap at the center for attaching your transmission line (either a coaxial connector or ladder line). This length is not that critical as long as they are the same length on each side.
2. Attach electrical spade connectors to one end of the wire and place this end under one of the brass bolts and washer. Attach the other end to your feedline connector. I soldered mine directly to a PL259 socket mounted on a piece of plastic cut from a peanut butter jar cover. Do the same for the opposite side of the driven element.
3. Cut a second set of wires that run from the "outside" of the inductive coil out past the end of the wood dowel by about two inches.

After you mount your yagi at a given height you will come back and cut this "outer" wire on the driven element to resonate your antenna to the appropriate frequency. This driven element cut to these lengths should resonate below 14.000 Mhz and you can cut it a little shorter to bring it up to whatever frequency you desire. I got mine to resonate right about 14.070 Mhz. See the SWR chart below.

Reflector element

1. Follow the steps for the driven element but resonate the total length to a frequency about 5% below the driven element. That is, you want this reflector element to be longer. I ended up with my "outside" wire about 6 inches past the end of the wood dowel.
2. After you find the resonant point, replace the two center wires with one wire that runs from one inductive coil to the other with no break in it.

Stage 6 Attach the transmission line to the driven element

1. Since I was using RG-58U coaxial cable and I wanted to using this antenna without a tuner out in the field, I wanted to get the best match I could. I cut my feedline to a half wave length at 14.060 using my Autek RF-1 to establish the appropriate length. Just follow the manual. It's time consuming but relatively easy to do. You could use ladder line with a tuner and use this on antenna from 20 meters on up, but I haven't tried that yet.
2. Attach one end of your feedline to the coaxial connector and tape the transmission line to the boom.

Stage 7 Attach the boom to a mast

1. Buy a mast. I used a 13 foot section of 1-1/4 wooden closet pole for my mast.

2. I inserted the end of the mast into the U-bolt and tightened it to the boom.
3. Raise your yagi.

Stage 8 Resonate the driven and reflector elements to desired frequency

1. Check the resonate frequency of your yagi. It should be well below 14.000 Mhz.
2. Lower the yagi and trim off a short section of each end. I found that each inch of wire I trimmed off the end of each side would raise the resonant frequency about 100 Khz. The height of your yagi above ground and the surrounding objects may have a different influence.
3. Raise the yagi and check the resonant frequency.
4. Lower the yagi and trim.
5. Raise the yagi.
6. Lower the yagi
7. Raise the yagi

I think you get the picture. It is far easier to trim off very small sections of wire and stay below your desired frequency than cut off too much and get too far above it because then you have to completely replace the outside wires. Been there, done that.

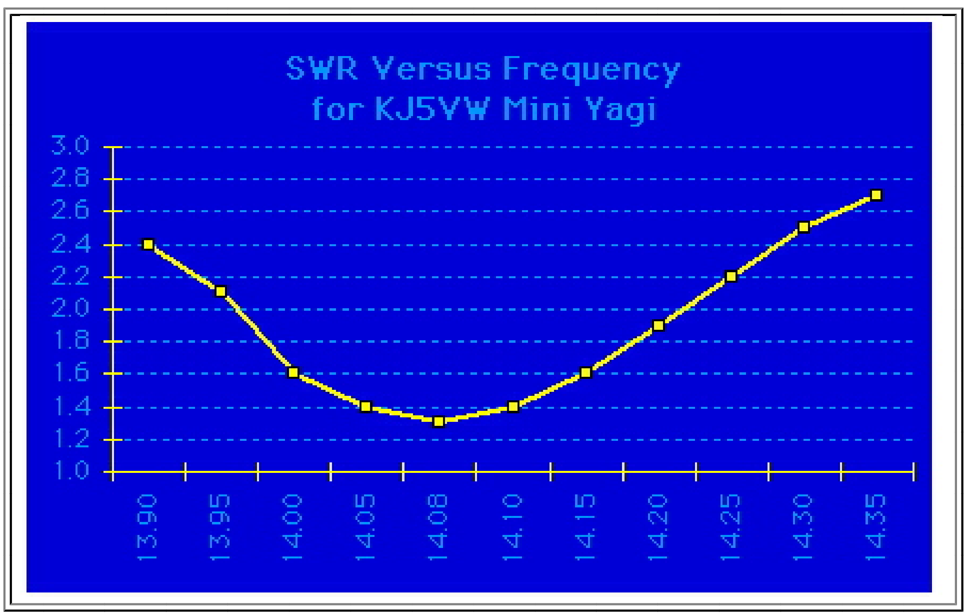
What does it look like?

Here it is mounted on my 2nd story deck:

and here is a bird's-eye view of it.

How well does it work?

Once I got the mini-yagi mounted on my back deck and got it to resonate near 14.060 I took a set of SWR readings across the entire 20 meter band from below 14.000 to 14.350. The chart below shows my readings when mounted approximately 32 feet above ground, but with part of the elements only two feet above the slanted part of my rooftop.



I was pleasantly surprised to see that the bandwidth between the SWR 2.0 points was more than 200 Khz. I had expected a much narrower bandwidth because of the wire elements and the inductive loading coils.

When I connected the mini-yagi to my Emtech NW20 transceiver the signals came roaring in. I heard WA9REQ calling CQ and gave him a shout. He came back on my first call and we exchanged 559 reports. I was very pleased. The yagi seemed to work. I signed with Dick and tuned around and heard KH6AFS in Hawaii calling CQ and even though the yagi was pointed north toward Illinois, I didn't take the time to run outside and rotate it by hand. I was astounded to get a 549 off the side of the mini-yagi and that was my first Hawaii contact. NOW, I was excited!

I was off the air for almost two weeks before I could get back to further testing of my new antenna, but I decided to try and work a station or two every day for about a month and keep track of my signal reports.

Signal Report Level	Number of Contacts	S/P/C
599	3	CA, WY
579	4	CA, IL, VE6,CO
569	1	VE4
559	8	IL,CA,PA,VK4,NY,IN
549	6	HI,VE7,TN,PA
339	1	CA

Here's a table of the signal reports and the SPC's worked during the last two weeks of July and the first two weeks of August, 1997. As you can see the majority of my signal reports were in the 549 and 559 category, but nearly one-fourth were a 569 or higher. Working a VK4 in Australia on 5 watts was icing on the cake. Now, no one can tell me this simple little antenna doesn't work. I'm convinced!

Delta Loop Antenna

Here is one of my favorite antennas. I cut my Delta Loop according to the ARRL formula:

Length = 1005 /7.040 = 142 ft. 9 inches.

I used vinyl covered #14 wire and configured it as an inverted delta loop and feed at the upper corner. When I first put it up, I connected a quarter-wave 75 ohm coaxialransmission line transformer to the upper corner. Then I connected 50 ohm coax from the transmission line transformer right into my rig.

The delta loop is up about 35 feet at the top of the loop and it slopes downward at about a 45 degree angle. One leg passes through several tree branches.

The table below shows the SWR by frequency. I used an Autek RF-1 connected at the end of my 50 ohm coax, not at the antenna feed point. As you can see, this antenna has it's lowest SWR around 7.200 ---NOT around 7.040.

As suggested on the QRP-L, it may be better to use 1030 or 1040, instead of 1005 in the formula to get your Delta Loop to resonate at the appropriate frequency.

Freq.	SWR
7.020	2.90

7.030	2.70
7.040	2.60
7.050	2.50
7.060	2.40
7.070	2.30
7.080	2.20
7.090	2.10
7.100	2.10
7.110	1.90
7.120	1.90
7.130	1.80
7.140	1.80
7.150	1.80
7.160	1.70
7.170	1.70
7.180	1.70
7.190	1.70
7.200	1.60
7.210	1.60
7.220	1.60
7.230	1.60
7.240	1.60
7.250	1.60
7.260	1.70
7.270	1.70
7.280	1.70
7.290	1.70
7.300	1.70
7.310	1.70
7.320	1.80
7.330	1.80
7.340	1.90
7.350	1.90