Tinkertoy Vertical

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Like many urban hams, I have a withering RF noise problem at my home station. So I like to take my rig to remote RF-quiet locations. Since this is my main operating mode, I want my portable antenna to be as near home-station efficiency as possible. I began with the Buddipole by Budd Drummond W3FF. I had some good experience with it, but felt the need for a lower radiation angle for better DX. Fortunately, the Buddipole system is like the Tinkertoy sets that many (older) hams remember. (Younger hams may think of Lego sets---almost the same thing in plastic.) Like these sets, it consists of modular pieces that can be assembled in myriad ways. This article describes a small modification of the standard Buddipole that turns it into a resonant, vertical, off-center-fed dipole with its characteristic omni-directional and low-angle radiation pattern. I hope that this idea will appeal to hams who already have a standard Buddipole and want to improve its DX performance.

The Design

The standard Buddipole set consists of two 22″ hollow tubes, two loading coils, and two 66″ whips, all horizontally mounted, as shown in Figure 1. The tubes screw into a central hub called the VersaTee.

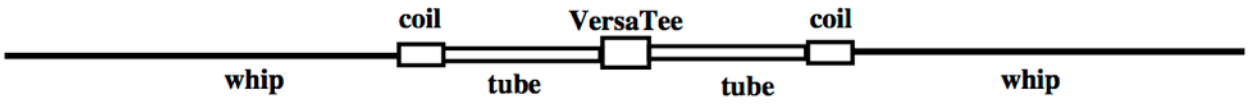

Figure 1. The standard horizontal Buddipole configuration.

The Tinkertoy Vertical shown in Figure 2 connects the horizontal whips directly to the VersaTee, and mounts the two hollow tubes and one of the loading coils vertically. The second loading coil is not used. A longer 112" whip, obtainable from Buddipole, is screwed vertically into the top of the upper tube. Note that no ground radials are used. The antenna is self-contained. Figure 3 is a picture of the antenna in operation.

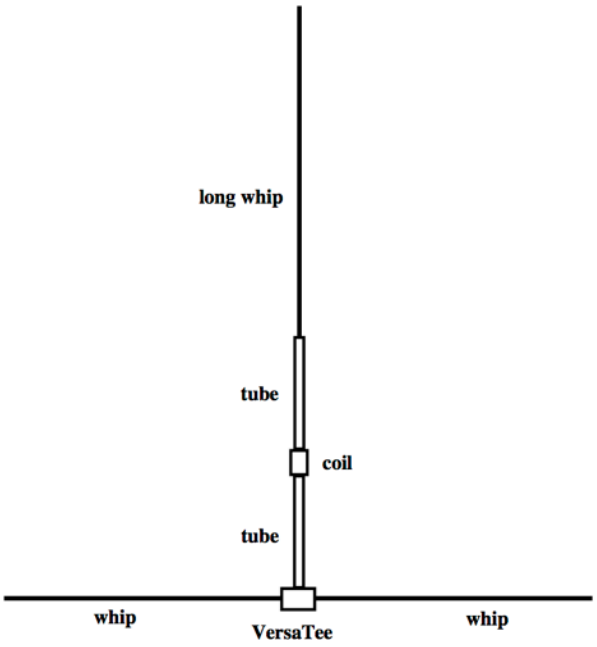

Figure 2. The Tinkertoy design. Only one loading coil is used and a longer 112″ whip is added at the top. The loading coil is placed between the two 22″ tubes.

Figure 3. The Tinkertoy Vertical in operation, supported by a tripod secured with tent pegs.

As seen in Figure 4, the coax connections are made using a small project box held to the back of the VersaTee with cable ties. The red wire exiting the right side of the project box goes to a 3/8″ terminal lug fastened under the right horizontal whip. A similar wire on the left connects to the left horizontal whip. These two wires are joined together inside the box and connected to the body of the coax jack. A red wire exiting the top of the project box connects the center pin of the coax jack inside the box to a 3/8″ terminal lug under the bottom vertical rod. The feed point of the antenna is thus between the bottom of the vertical element and the middle of the connected horizontal elements. The coax just below its connection to the antenna is threaded through 10 ferrite cylindrical cores for suppression of common-mode currents on the feed line.

As in the standard use of the Buddipole, the inductance of the loading coil is adjusted by shorting out some of its turns. The tap points on the coils are small metal clips with sockets for a mini banana plug. The initial placing of the clips can be tedious, but once they are set band change is simply a matter of moving the banana plug to a new tap point. The lengths of the whips are also adjustable, with the proviso that the two horizontal whips must be exactly the same length.

One nifty feature of the Buddipole is that the VersaTee has an optional attachment called the Center Tee Adapter that provides a socket for a standard painter's pole, the kind used by painters to run rollers over high ceilings. These poles can be bought cheaply at any hardware store. The Tinker-Toy Vertical sits atop an 8′ painter's pole which is supported either by guy ropes or by a tripod designed for mounting TV antennas on roofs. The tripod can be anchored to the ground using tent pegs driven through holes in the pads at the bottom of its legs. The result is a sturdy system that is easy to transport and assemble. The guyed version, with whips, tubes, modified Versa Tee, guy cord, coil, and soft case weighs only 2.75 pounds. And the painter's pole, collapsed to 4′, could be used as a walking stick by one of your party if you're hiking. A version of the antenna supported by guy ropes is shown in Figure 5.

Figure 4. Close up view of the coax connection. The small project box is held to the back of the VersaTee using cable ties.

Figure 5. An earlier version of the Tinkertoy Vertical with a 12′ painter's pole rather than the 8′ one. The elevation is greater, but the band-change is more difficult. The antenna is supported here by guy ropes rather than a tripod.

Tuning

The antenna is tuned by varying three settings: length of the vertical whip, lengths (equal) of the two horizontal whips, and number of un-shorted turns on the loading coil. Shortening the painter's pole will also have some effect, but I always operate with it at its maximum 8′ extension.

Table 1 shows typical adjustments for the various bands. The SWR measurements were done with a vector network analyzer[1] calibrated to measure SWR at the antenna end of the coax feed line. The tests were made in a flat field with my car about 25 feet from the base of the antenna. If the antenna is placed on ground that is level and unobstructed for at least 25 feet from its base, your results should be very close to those shown. Putting the antenna on sloping ground, the edge of a cliff for example, will produce slightly different tunings. Also, attempts to tune the antenna on a house roof near metal objects such as stove pipes, flashing, house wiring, etc., will yield strange tunings and, of course, unpredictable patterns of radiation.

The Buddipole coil taps are adjustable in increments of one-third turn. One-third turn is also the closest to zero possible, due to construction of the coil. Efficiency is estimated using NEC2 with a coil Q of 200, and an assumption of no antenna losses other than in the coil. Ground losses are also ignored.

I feed the antenna with 42 feet of the low loss LMR240 version of RG8X coax. At a 1:1 SWR, its measured loss is 0.39 db. With a 2.0 SWR, the loss rises to about 0.49 db. So 100 watts out of the radio produces at worst about 89 watts into the antenna. For an antenna efficiency of 95% and a 2.0 SWR, about 85 watts will be radiated, with 15 watts going to warm the coax and the coil.

Band Change

One feature of this antenna is the ease of changing bands. I twist the painter's pole to unlock it, then telescope it to its 4′ minimum. The horizontal whips are now at 4′ and the coil taps at about 7′ from the ground. I change the tap, adjust the horizontal whips, raise the pole back to 8′, twist to lock it and go back to operating. Note that the vertical whip has the same length (full extension) on 12 through 20 meters. Only 10 meters requires me also to tip the antenna over to adjust the vertical whip.

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[1] TenTec/TAPR VNA, designed by Tom McDermott N5EG, and the cocoaVNA control program from Willard Myers K1GQ.

Band	V whip	H whips	Coil turns	SWR max	SWR min	Efficiency
10	86″ 4 sec + 9″	50″ 4 sec + 5″	1/3	2.0	1.1	> 99%
12	112″ full 6 sec	56″ 5 sec	1/3	1.5	1.4	> 99%
15	112″ full 6 sec	56″ 5 sec	4	1.4	1.3	99%
17	112″ full 6 sec	54″ 4 sec + 9″	7 2/3	1.7	1.7	98%
20	112″ full 6 sec	66″ full 6 sec	15	1.9	1.6	92%

Table 1 - Tunings of the Tinkertoy Vertical mounted on an 8′ painter's pole in an open, flat field. Whip lengths are in inches. Lengths are also given as whip sections plus added inches. The coax loss at SWR = 2.0 is only 0.1 dB greater than the loss at SWR = 1.0. With a 100 watt transmitter, this produces a negligible two watt difference in radiated power.

But Is It a Vertical?

With the loading coil shorted and the whips fully extended, the antenna is resonant at about 23 MHz. This is about the resonance one would expect if the horizontal pieces were connected together, rotated ninety degrees, and attached to the bottom of the vertical piece, making one long vertical line. The Tinkertoy Vertical can be viewed as a resonant dipole with the lower part cut off, rotated ninety degrees, and placed symmetrically on the bottom of the vertical part, with the feed point at the junction. Ideally, the current in the antenna flows equally out the horizontal whips in phase but in exactly opposite directions. These equal but opposite horizontal currents produce radiations that nearly cancel each other. If the two horizontal whips were actually laid directly on top of one another, the cancellation would be perfect – no net current. The cancellation is not quite perfect only because the right horizontal whip and left horizontal whip are displaced from one another horizontally. The horizontal parts of the antenna do carry currents, and help to resonate the system. But they effectively do not radiate. Hams designing above-

ground radial systems might consider making their above-ground radials symmetric to avoid radiation from them.

The contribution from vertical and horizontal parts of the antenna can be seen if one looks at the vertically and horizontally polarized radiation produced. (The horizontally polarized radiation comes only from the horizontal whips, with the same for the vertical.) The cocoaNEC program by Kok Chen W7AY can display a NEC model of these radiations separately, as seen in Figure 6. The horizontal trace has the cloverleaf pattern characteristic of what is called quadrupole radiation. But notice that the maximum horizontal power is 30 db down from the vertical. When one plots the combined radiation, the horizontal part is completely swamped by the vertical and the azimuthal pattern is omni-directional. The combined elevation plot in Figure 7 is also identical to that of a purely vertical radiator. Note the low elevation angle of 18 degrees at maximum.

Results

My experience with this antenna has been that it is an efficient low-angle radiator. Operating from California with only 100 watts output, I have gotten consistent S7 to S9 reports from stations in Japan and the east coast of the US. Of course, your mileage may vary. I wish you good experimenting and good luck.

Bravo Antennas

After I had been using this antenna for several months, I was pleased to see a review in the March 2012 QST of a similar antenna, the Bravo 7k from Tom Schiller, N6BT. He places two loading coils right at the coax attachment point, one just above and one just below it, rather than the single loading coil about 22″ above the feed point in my design. This allows finer control over the SWR, but the results should be very similar. I got one of Tom's antennas, and have had good results with it also.

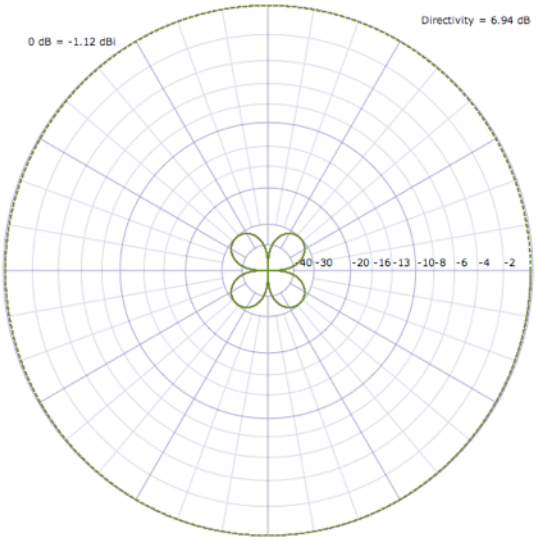

Figure 6. NEC plot showing the azimuthal pattern for the vertical and horizontal radiations separately. The small cloverleaf is the horizontal and the large circle is the vertical. Since the horizontal maximum is 30 dB down, the total azimuthal pattern (not shown) is omni-directional and indistinguishable from the vertical trace shown.

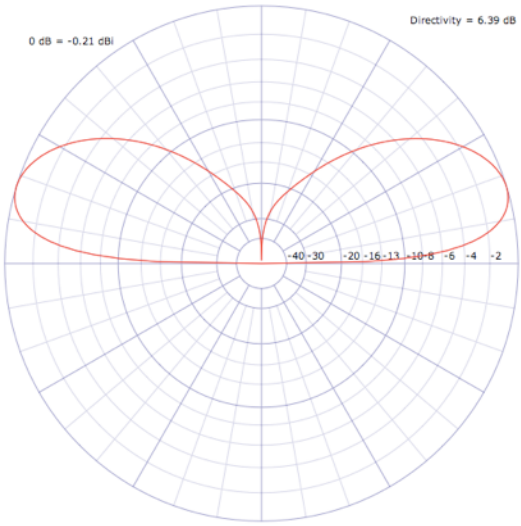

Figure 7. NEC plot of the elevation pattern of the total radiation. Since the horizontal radiation is negligible, the pattern is that of a vertical dipole, peaking at 18 degrees above the horizon.

Item	Price	Source	Comment
Buddipole	$199	http://buddipole.com	
Center Tee Adapter	$7	http://buddipole.com	
Long whip	$18	http://buddipole.com	
Tripod (optional)	$35	http://radioshack.com	RS #15-293
Project Box	$5	http://radioshack.com	RS #270-1803 5x2.5x2 inches
Type N Jack	$5	http://mouser.com	Mouser #523-82-97-RFX
Painter's Pole	$28	http://acehardware.com	4′ - 8′ Fiberglass Extension Pole Ace #1312602

Table 2. Bill of materials for the Tinkertoy Vertical. If the antenna is erected using guy ropes, the tripod will not be needed.