The J-Pole Antenna

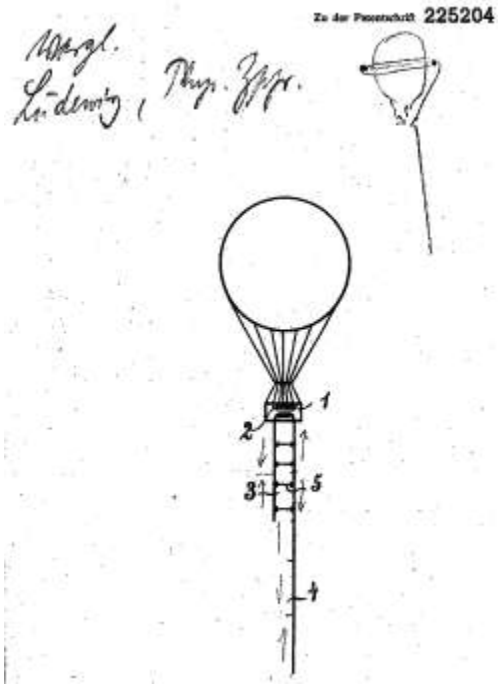
Gary Wescom - 2018

Much has been written about the J-Pole antenna. A simple Google search will net days worth of reading material on the subject. That would tend to indicate this paper should be unnecessary. It probably is if you were planning to do that Google search and study the results. Otherwise, this synthesis of J-Pole information may be of use.

History:

The J-Pole antenna is not a new conceptual design. It is an implementation of one of the oldest antenna designs: the Zepp antenna.

The Zepp antenna received its name from its use on Zeppelin Airships. This antenna was patented in 1909 by the German, Hans Beggerow. The sketch below shows its conceptual design from that patent document:



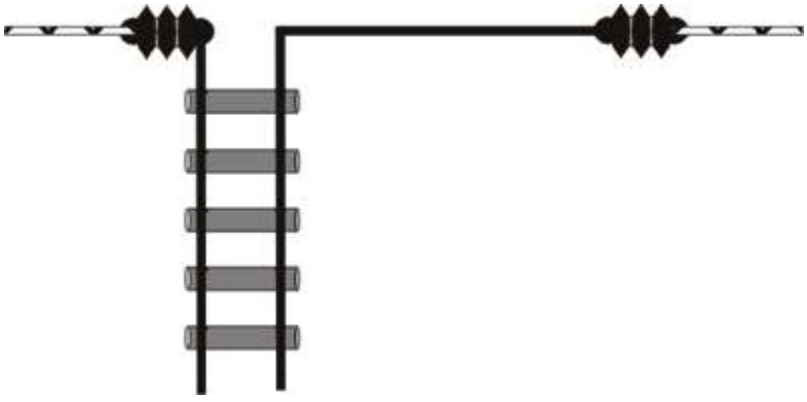
This is actually a clever design. Most radio operation at that time was on wavelengths 'above' 200 meters. In today's terminology we would describe that as frequencies below 1.5 MHz. Effective antennas at those frequencies are long. A quarter wavelength wire at 1.5 MHz is over 150 feet long and requires a similarly large electrical counterpoise (the equivalent of a ground). A half wavelength wire is twice that length but requires only minimal counterpoise.

The half wavelength wire introduced its own set of problems. Its high feed impedance eliminated the need for a large counterpoise but introduced a high RF voltage feed impedance. Even at moderate

transmitter power level, arcing to nearby objects and people was possible. Beggerow's ingenious solution to balloon and zeppelin antenna problems was a half wavelength wire radiating antenna fed with a quarter wavelength open wire feed line. The feed line performs the function of RF counterpoise for the half wavelength radiator.

An airship's Zepp antenna could be reeled out quickly for airborne communications and back in again when landing. The antenna proved to perform very well in spite of its simplicity.

While the days of the Zeppelin airships were short, the Zepp antenna has endured. The concept proved useful in ground installations. The configuration found at many ham stations in the first half of the twentieth century was like the airship Zepp but with the half wavelength wire strung horizontally.



Zepp Antenna as used by hams.

While the Zepp works quite well in it's simple one band mode, remember that the horizontal radiating part of the antenna is a half wavelength long providing a high impedance, low current feed point allowing the parallel wire ladder feed line to act as its counterpoise. At twice the frequency, the horizontal wire is two half wavelengths long also providing a high impedance feed point. This is true for all harmonics of the base design frequency.

The zepp antenna became a popular multiband antenna. Before the introduction of the 30, 17, and 12 meters WARC band, our bands were harmonically related. The 40, 20, 15, and 10 meter bands are even harmonics of 80 meters. An 80 meter Zepp antenna is thus a, at least theoretically, a multiband antenna. Early Amateur Radio antenna books provided tables of wire and feed line lengths for optimum operation with minimal radiation from the feed line wires.

The J-Pole:

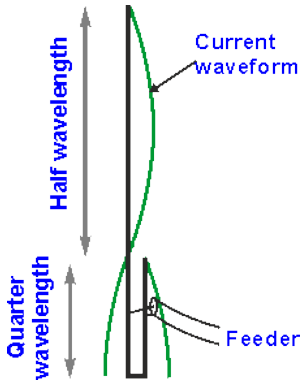
Eventually Amateur Radio technology progressed to a level where VHF and UHF operation was common. The Zepp antenna received a rebirth in the form of the J Antenna or J-Pole. It is simply an airship Zepp antenna standing upright.

Copper pipe J-Pole Antenna

The J-Pole antenna form of the Zepp antenna is one of the more popular homemade VHF/UHF vertical antennas. It has proven to be fairly insensitive to construction methods and materials.

Dozens of manufactured versions of the J-Pole are also available. Even some expensive commercial grade VHF and UHF vertical antennas use the Zepp concept by replacing the quarter wavelength stub with a metal tube that completely surrounds base of the half wavelength radiator.

The Technical View:



The Zepp and its J-Pole version are good antennas but with a minor problem to be aware of. As described above, the quarter wavelength transmission line section provides a counterpoise for the high impedance feed impedance of the half wavelength radiator. That, of course, means that the RF currents in the transmission line section conductors can never be equal. One end is connected to the half wavelength radiator and the other isn't.

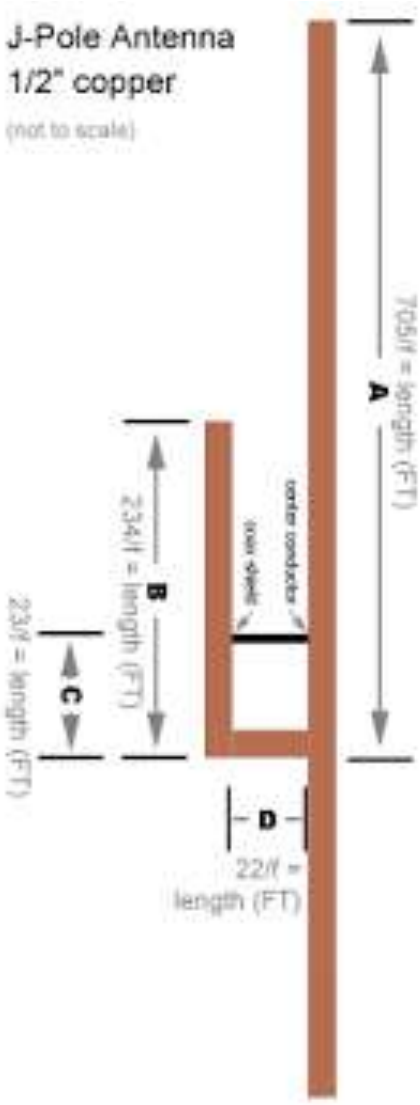
Fortunately, the current at bottom of the half wavelength radiator section is relatively low. That part of the antenna is an end fed half wavelength antenna. The feed impedance for that kind of antenna is between 1000 and 4000 ohms depending upon conductor diameter and materials. Current at that point is only a couple percent of that at the center of the half wavelength section.

Though small, the current imbalance between the conductors does affect the antenna's radiation pattern and sometimes causes RF coupling onto a feedline. There are various methods employed to minimize RF on the feedline…. Some even work.

One positive point about the J-Pole is that its main radiating portion is high up in the middle of the top half wavelength section. That means that mounting a two meter J-Pole at the top of a 10 foot pole will place the center of the radiating part of the antenna at about 13 feet.

As simple as it is, the J-Pole performs very well. It is usually built with rods or pipes thick enough to be essentially lossless. Its radiation pattern is simply that of a vertical half wave dipole though the unbalanced currents in the quarter wave stub produces a slight variation – usually less than 1 dB.

Building a J-Pole:



Dimensions for a J-Pole made from copper pipe.

The continued popularity of the J-Pole antenna is no doubt because of its simplicity. It is frequently built using 'Plumber's Delight' construction. That is, it built, as one solid piece of metal. The copper pipe J-

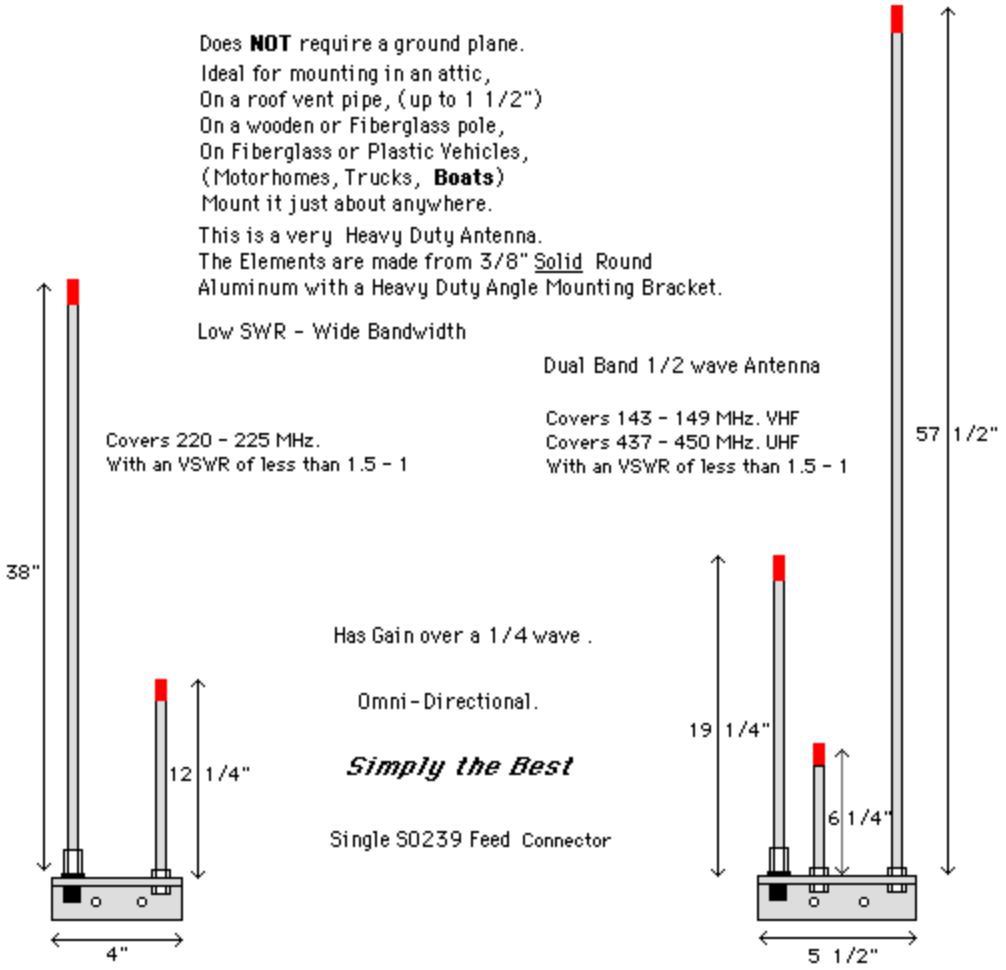
Pole above consists of some pipe, a copper T, a copper L, and a couple copper pipe caps. Standard plumbing flux, solder, a propane torch, and a hack saw are all that are needed to assemble it. While it is best to accurately build this antenna to the specified dimensions, the J-Pole is relatively insensitive to minor construction errors.

Direct feed of the J-Pole

A coaxial cable feed line may be directly connected to the pipe as shown above. The coax center conductor is connected to the shorter quarter wave vertical pipe and the shield connected to the longer vertical radiator tube at the same height as center conductor connection. This shield to the tall pipe and the center conductor to the shorter may seem a little strange at first. After all, this is connecting the center conductor to a part of the antenna that is not supposed to radiate RF. It turns out that really doesn't matter for J-Pole operation as an antenna which way the shield and center conductor are connected. However, it turns out that connecting the shield to the taller pipe results in less RF coupled onto outside of the coax cable feed line.

Direct feed with coax choke balun.

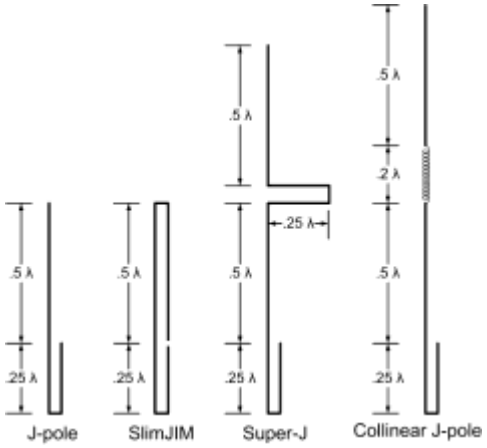
A wide variety of feed methods have been employed. While direct coax connection as in the above examples is common now for home made J-poles, Gamma Match, Half Wave Balun, and direct feed are used. Each has its own purpose but none have any noticeable performance advantage.



Of course, copper pipe is only one way a J-Pole may be constructed. Any metal that is a good electrical conductor will work. The design above is another popular design. The only non-hardware store part is the mobile antenna coax cable base connector. This part is inexpensive and available on Amazon, at some Radio Shack stores, and even some truck stops. The rest of the antenna is aluminum rods and angle stock plus some stainless steel nuts and lock washers. Of course, there are commercial manufacturers of this exact antenna. Typical prices run about $50.

The design on the right in the drawing above is interesting as it is actually two J-Pole antennas in one. It is both a two meter and 440 MHz antenna. These aluminum rod antennas have proven to perform well and to be very rugged. You can usually count on never having to replace one once it is up and solidly mounted.

J-Pole Variations



There have been quite a number of different antenna designs built upon the basic Zepp/J-Pole concept. Below are some examples. The Super-J and the Collinear J-Pole proved gain over a simpler J-Pole. A quick search on the Internet will turn up construction details all variations of the J-Pole.

Conclusion

The J-Pole antenna is a simple and reliable antenna for consideration for home construction. They may be constructed with inexpensive materials. Copper, aluminum, steel, brass, etc. may be used as long as they are conductive metal.

Dimensions are not critical. Just remember that lengths are shortened by about 5% from free space lengths. With standard dimensions, SWR is usually adjustable to a satisfactorily low value by moving the feed point connection up or down a little at a time.

The Zepp / J-Pole antenna has been around for over a century. It will likely be around for another.