McBride J-pole Ladder-Line Antenna

Materials and equipment:

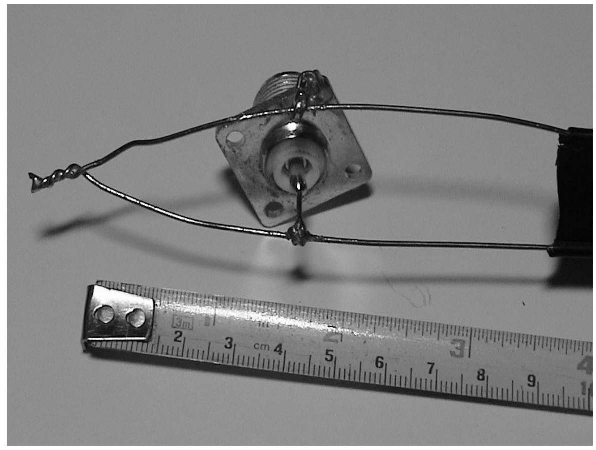

Photo #1

- 6′ Ladder-line, 450-ohm, 18 gauge, single strand wire
- Antenna analyzer (MFJ ® model 259 or 269)
- SO239 4-hole chassis mount connector
- Soldering tools, supplies
- Measuring tools, metric and standard
- Wire cutters, needle nose pliers,
- Coax (e.g. RG8X) with PL259 connectors

Below are the methods that I have come up with after making approximately 300 j-pole antennas. Due to the amount of detail given here, this document is quite long for such a relatively small project. There are a variety of methods to make this antenna, but the steps described here result in a predictable outcome and a finished product that is tuned very specifically to a chosen frequency and is also very durable under usual conditions of operation. These approximate steps can be used to make j-pole antennas for a variety of frequencies. The finished antenna weighs in at <u>less</u> than 3 oz. and can easily be rolled into a circle less than 8″ diameter.

Some measurements described here are in millimeters and others in inches. This is due to the ability, in my hands, to make some measurements more accurately with the smaller units available using the metric scale. One millimeter, for instance, is easier to duplicate than is the same portion of an inch.

For this project, when making measurements that include the shorted end of the antenna, begin the measurement by placing the measuring device on the inside edge of the shorted wires. (See Photo #1.) This photo also shows the finished connector in place at the correct location on the antenna.

To start with, choose a length of ladder-line that will allow a L″ cutout to be made near the middle portion of a "rung" of the ladder-line. (See Photo #2). If you wish to roll up the completed antenna, the cutout portion not within a "rung" tends to be unstable as well as unsightly.

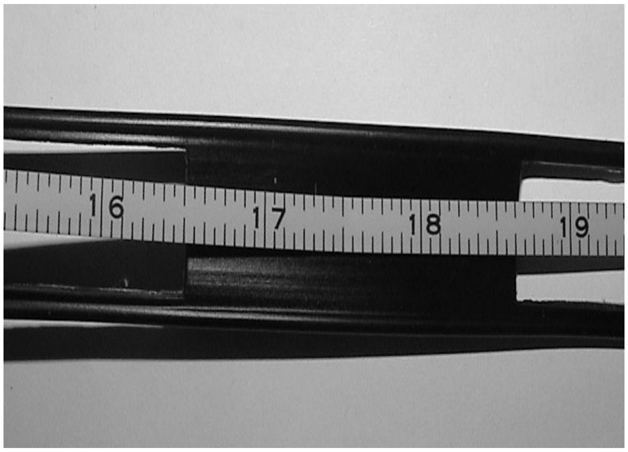

Photo #2

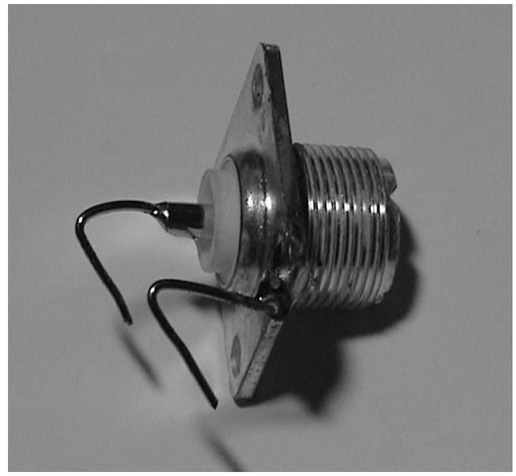

Photo #3

To cut the correct <u>total</u> length of ladder-line, place the 17 7/16" point of your tape measure (See Photo #2) over the middle portion of a "rung" at a point where you will able to cut out L" to create the "short arm" of the antenna. Leaving the 17 7/16" point of the tape measure where it is, continue measuring to the 60" point of your tape measure and cut the ladderline at the 60" mark. You should now have a length of ladder-line that is a little longer than 60". You are ready to strip the wires at the end to be shorted. The goal is to have the L" cut out ***begin*** at the point that is 17 7/16" from the shorted end of the antenna. Remove the insulation from approximately 3" of the ends of the ladder-line. Twist the ends of the wire together for a length of approximately 3/8" to ½". Solder the twisted wires solidly. Double check now to be certain that the 17 7/16" measurement from the shorted end is fairly close to the middle of the "rung" identified earlier. *Note: If the measurement is 17 8/16" or 17 6/16", the tuning may not get to be 1.0:1. This measurement is not "approximately 17 7/16"!*

Now prepare the SO-239 (4-hole chassis mount) connector. There are several ways to do this, but the method shown works well for me. A piece of the bare 18-gauge ladder-line wire works very well for this step. Using a length of wire longer than you will need, solder a piece of wire 1 ½" to 2" long onto the center post of the SO-239. Then using a piece of the same type of wire the same length, bend one end of the wire to wrap it around itself after going through one of the four holes in the edge of the SO-239 connector. Solder this end of the wire to make a solid connection with the SO-239. (See Photo #1.)

Cut the wires that you just soldered onto the SO-239 so that they are at a length easy to work with, yet long enough to be able to wrap around the bared wires near the shorted end of the antenna. (See Photo #3) *The ground side of the connector will be connected to the short arm and the center wire will be connected to the long arm of the j-pole*.

To make the tuning of the antennas more reproducible, it is better to have the finished length of the connecting wires from the SO239 to the antenna, a specific length. The center post wire should result in the "platform" or flat base of the SO239 being approximately ½" from the antenna wire. The ground wire from the SO239 seems to work best when ½" separates the "platform" of the SO239 and the wire of the antenna. (See Photo #1)

Before soldering the connector wires in place, be aware that the distance of the connector wires from the shorted end of the antenna is a critical measurement in this construction process. The finished position of connector wires should end up being soldered so that the closest point of the soldered connection is 40 mm from the shorted end of the antenna. For the first 30 to 40 antennas I made, I left the soldering of this point to be done while tuning each antenna. Later, when analyzing the measurements of each antenna very carefully, I found that the better antennas in my collection ALL had both connector wires located at a distance of 40 mm from the shorted end. So eventually, I began soldering the connector in place at this measured point before beginning the tuning process. (Interesting point: In making copper tubing j-poles, the same 40 mm distance works best for me in determining the location of the connector.)

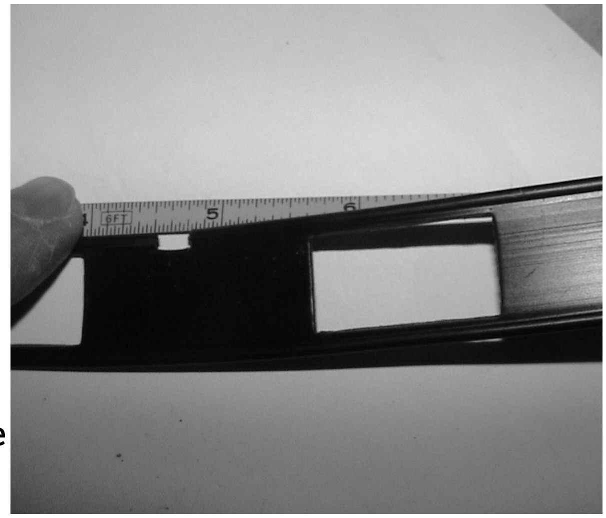

Photo #4

You can now make the L" length cutout in the ground wire side of the ladder-line. The closest end of the cutout to the shorted end of the antenna needs to be 17 7/16". (See Photo #4). This measurement is NOT an approximation – it is important that it be accurate. You will come to note that when fine tuning an antenna to a final SWR, extending the cutout portion toward the shorted end by 0.1 – 0.5 mm can change the SWR from 1.0:1 to 1.2:1, and vice versa. *Note: If the measurement is 17 8/16" or 17 6/16", the tuning may not get to be 1.0:1. This measurement is not "approximately 17 7/16"!*

An antenna analyzer, such as an MFJ ® Model 259 or 269 is required for the rest of the tuning process. The next steps are generally similar from one antenna to another, but the removed portions are different for each antenna. Some of the antennas end up with an overall length of 56" and others are 58", but most are within those measurements. If a person plans to make j-pole antennas and have them all be the same length without using an antenna analyzer, the SWR's will NOT be good in most of the antennas.

Connect the antenna analyzer to the antenna using at least 10' of coax. The longer the coax, up to about 20', the more predictable the tuning process is. Using less than 10' may result in the antenna *apparently* being well "tuned" but when placed a useful distance from your rig, you may find that the antenna's SWR's are significantly different.

Photo #5

Since the construction process is begun knowing that the overall length is likely to be too long, one would predict that the SWR is going to read "good" at a frequency lower than the 2-meter band range. You may see that the first SWR reading on the antenna being tuned reads an SWR of 1.1:1 at the frequency of 141.42. Then after approximately 1 ½ " is cut off and the best SWR shows in Photo #6 to be 1.0:1 at a frequency of 143.09. From this point in the tuning, smaller portions of the long arm are shown removed and are seen in the photos #6,#7 and #8.

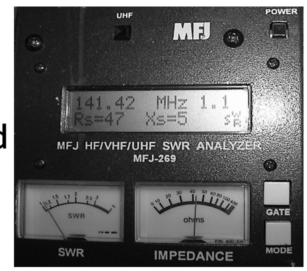

Photo #6

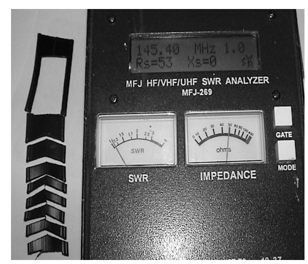

Photo #7

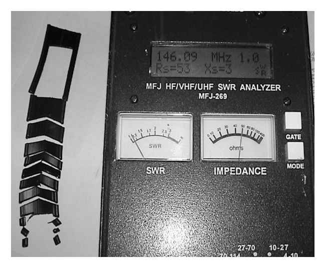

Illustration 1: Photo #8

The photos #7 and #8 show smaller amounts cut off and the SWR reading being good at frequencies closer and closer to 146 MHz. In Photo #8, the optimal SWR has been reached with the frequency being 146.09 MHz and the SWR 1.0:1. The 1.0:1 value was also read in this antenna from 145.75 to 146.20 MHz. Note that twelve cuts are represented by the pieces of antenna that are shown. The last three or four cuts have been very small segments, in the range of 1/8" each. This is done to avoid cutting off so much that one goes past the 146 MHz reading while missing the optimal 1.0:1 SWR at that frequency. At this point, one stops cutting. ***IF*** the SWR at 146.09 had turned out to be something like 1.2 or 1.1:1, a consideration could be given to filing off a very small length of the *short* arm, keeping in mind that ½ millimeter can make the difference in the SWR going to 1.2:1 or 1.3:1 at any given frequency. If not careful and cut off too much, you could end up with your antenna having an SWR of 1.0:1 at 147.0 or 148.0 MHz.

It goes without saying that you can always cut off more, but you cannot "cut off less" or put wire back on when you find that you cut off too much. The finished product looks pretty poor when you start soldering wires back on.

For non-ham radios operators, I have made several antennas with the SWR being 1.0:1 at frequencies of 152 MHz, 156 MHz, 462 MHz, etc, by shortening the long arm and by using a known j-pole formula to determine a starting point for the length of the short arm. ***(Radiator (A) = 705/f (MHz.)x12=inches, Stub (B) = 234/f (MHz.)x12=inches , Feed-point (C) = 23/f (MHz.)x12=inches and Spacing (D) 22/f (MHz.)x12=inches)***

I have found that most 2-meter j-poles can end up with an SWR of 1.5 or 1.6:1, or less, throughout the 2-meter ham band with the best SWR being 1.0:1 at 146 MHz. However, I also have found that most antennas transmit quite well as long as the SWR is 1.9:1, or less.

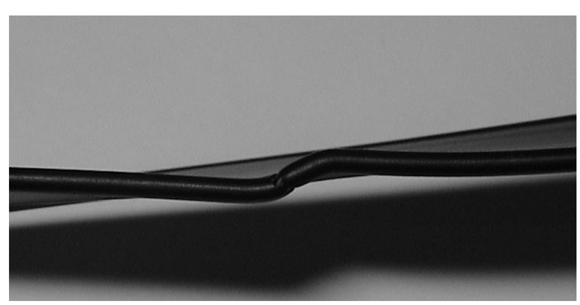

Photo #9

After the antenna is tuned to its very best SWR, I use 7" to 8" of black electrical tape to wrap tightly around the L" cutout area so that portion of the antenna is strengthened and water does not get in. I sometimes use a dab of hot glue to keep moisture from getting into the wires of the cut ends of the antenna.

I have had three users of my j-pole ladder-line antennas return them as they quit working well. On evaluation, it was easy to tell that the wire "up hill" from the short arm and "up hill" from the L" cut out section, had slipped "down stream" and was touching the wire in the short arm. This essentially voids the design feature of the j-pole. To try to reduce this occurrence, I began making a small crimp in the mid-portion of every other "rung" of the ladder-line to give some resistance to the straight 18-gauge wire and hopefully keep it from sliding "down stream". So far, this has not been a problem in those antennas with a crimp. (See Photo #9)

Generally, the antenna works best if the angle at the connector point is kept so that the coax connects to the SO239 at a 90 degree angle to the plane of the antenna. This may result in the need to tape or otherwise fix the coax connector so that tension does not later change this angle. I have placed my most used outside ladder-line antennas inside of a 3"diameter length of PVC pipe. I have used a variety of methods to keep the tension of the coax feeding the ladder-line antenna from pulling the SO239 downward and changing the angle with the antenna from the 90 degrees described above. PVC with a cap on the upper end and the bottom open, makes the very durable ladder-line into an even more durable antenna.

These steps are comparable when used to make a 70-centimeter version and I could send those steps to anyone interested. The 70-centimeter version is approximately 19" to 21" overall length. In formulas for j-pole antennas, the short arm is approximately 0.3 to 0.33 of the length of the long arm.

My Yaesu FT-100 transceiver has a SWR reading when transmitting. When using this specific antenna for 70-cm, the SWR seen by the radio on 444.350 MHz, is reported at less than 1.5:1 and the signal heard out of a local repeater from the 70-cm transmission is reported as excellent. The use of this antenna for "dual band" purposes is something that can be experimented with as far as I see.

With ladder-line antennas, I have not found any advantage to add any form of balun or separation device by rolling the coax around a can to form a roll of coax. However, there is no problem or detriment that I have found by doing so, either.

My preference for coax to feed the j-pole antennas is RG8X, or equivalent. Using Belden RG8X, and having my antenna up about 60' in a tree, I am able to transmit from the slight "hole" in which our house sits and reach repeaters that are 85 to 90 miles away.

There are certainly variations that can be made on the methods described. However, when one starts making changes, be prepared for other aspects of the fine-tuning to be affected negatively. I am certain that a number of folks could take my description and improve on it greatly, but so far, the described methods do produce a very functional and precise antenna for an "out-of-pocket" cost that is less than $3 in materials.

I also appreciate suggestions and improvements that I have not thought of that would make this antenna, and the construction process, better. I have also heard one person who has made more j-poles than I who has said that it is not worth the hassle to make a dual-band j-pole. Personally, I prefer to use one j-pole for 70-centimeters and another for 2-meters. However , I do have one copper tubing j-pole hanging in a tree that has a 2-m SWR of 1.4 or less for the frequency range of 138 to 162 MHz and the same antenna measures SWR's of 1.2 to 1.9 for the frequency range of 427 to 450 MHz.

There are certainly things about j-poles that I do not understand, but I do feel that, dollar for dollar, j-poles are among the best antennas that money can buy.

For more information contact:

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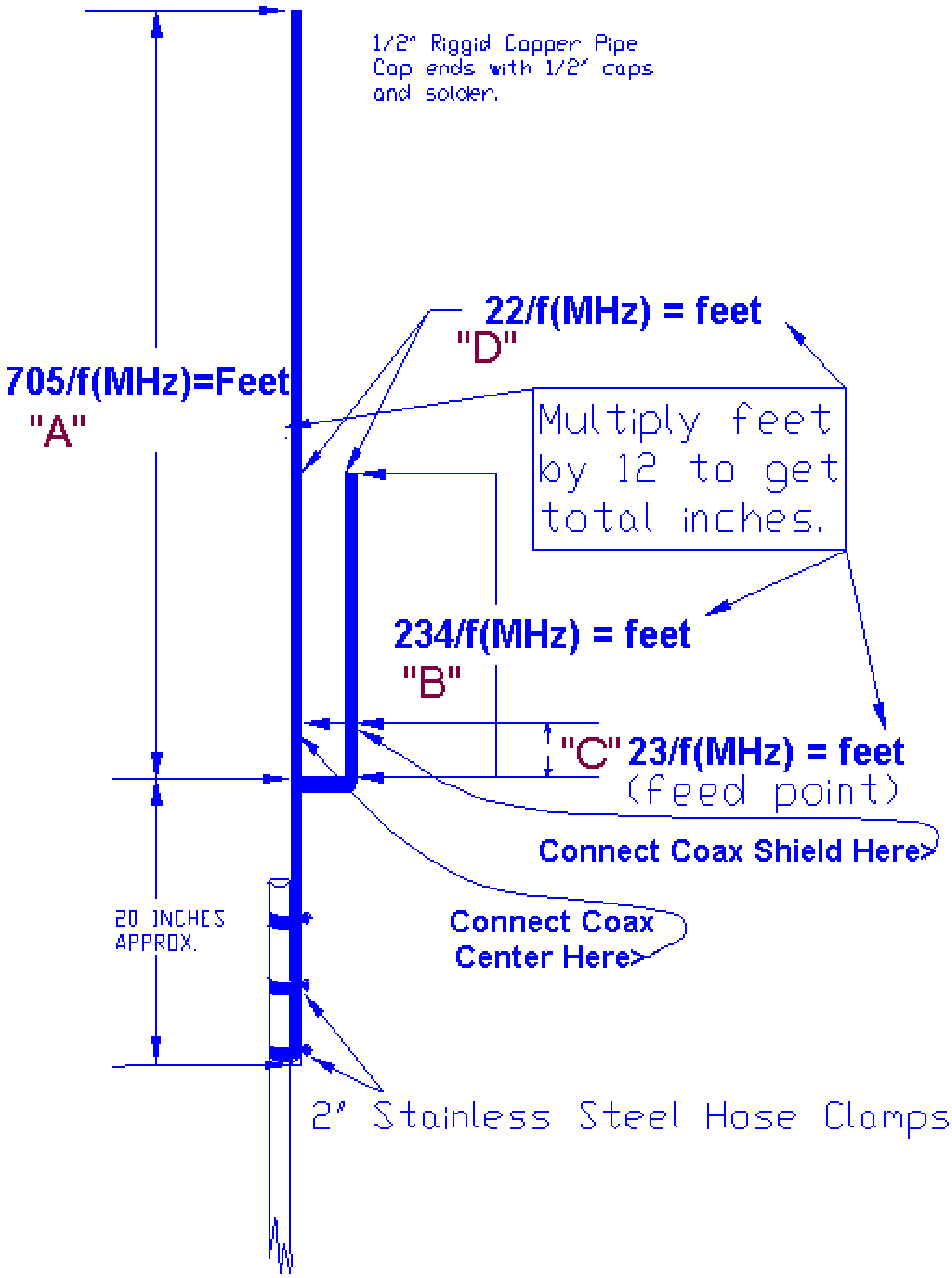

1/2" Riggid Copper Pipe
Cap ends with 1/2" caps
and solder.
22/f(MHz) = feet
"D"
705/f(MHz)=Feet
"A"
Multiply feet
by 12 to get
total inches.
234/f(MHz) = feet
"B"
"C" 23/f(MHz) = feet
(feed point)
Connect Coax Shield Here>
20 INCHES
APPROX.
Connect Coax
Center Here>
2" Stainless Steel Hose Clamps

McBRIDE J-POLE LADDER-LINE ANTENNA