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ANOTHER LOOK AT VERTICAL WATERPIPE ANTENNAS FOR TWO METER FM

There have been numerous articles written on this subject in the past; yet the fact that confusion abounds is confirmed by talking to groups who have tried to build these devices.

At the present time the Northern Berkshire Amateur Radio Club (K1FFK 146.31–91) (WA1KFZ 146.10–70) (K1FFK 52.76–52.66) has 6 of these in operation – three 20 footers, two 30 footers, and one 40 footer. These antennas have proven themselves perfect for amateur repeater use.

The ideas presented here were developed by K2CBA, K1DEU, and myself while constructing and checking out the club's antennas.

The antenna is a multiple of 1/2 wave elements with 1/4 wave sections on each end and a 1/4 wave conductor which acts as a stub to reduce feedline radiation. See Fig. 1.

Construction of the antenna proceeds as follows:

1. From the formula $\lambda/2 = 492/F(Hz)$ calculate the half wave length in air for 146.00. This comes out to 3.4 FT or 40.8 inches.

2. Select the coax you wish to use and obtain information on the velocity factor of the coax. Generally solid dielectric coax has a velocity factor of approximately .66 while foam dielectric velocity factor is approximately .8. I would recommend the solid because of its better heat resistant qualities and it makes a smaller antenna. For solid coax 1/2 wavelength is approximately 26.90 inches. In general, the velocity factor varies by as much as $\gamma 5\%$ from manufacturer to manufacturer. Measurements with a pulse generator and Tektroniks 585 confirmed that there was enough variation that some sort of procedure for taking this into account must be developed.

3. To proceed with the fabrication, two pieces of equipment are needed – a signal generator (low power transmitter) covering the range desired (140–150 MHz) and an SWR bridge. With these in hand, fabricate a 3 element section (three 1/2 wave elements including the 1/4 wave top element (13.5") and radiator 19.25" and the bottom 1/4 wave stub. With this completed, hang the antenna equidistant from the floor and ceiling and measure the resonant frequency. If this is not within $\gamma 1$ Hz of your desired frequency open the antenna and trim the 1/2 wave elements until you are within that

range. Do not worry about the actual VSWR; look only for the VSWR minimum.

4. Depending on whether you are slightly high or low compared to your design frequency, alter another pair of 1/2 wave elements cutting them 1/4–1/2" longer if you are too high and 1/4–1/2" shorter if you are too low. Solder these into the antenna and check again. Continue this operation adding pairs of elements and checking until you have reached the mechanical length you desire. The antenna can be any length you feel is mechanically supportable. If possible, try to stay a little on the high side of your design frequency.

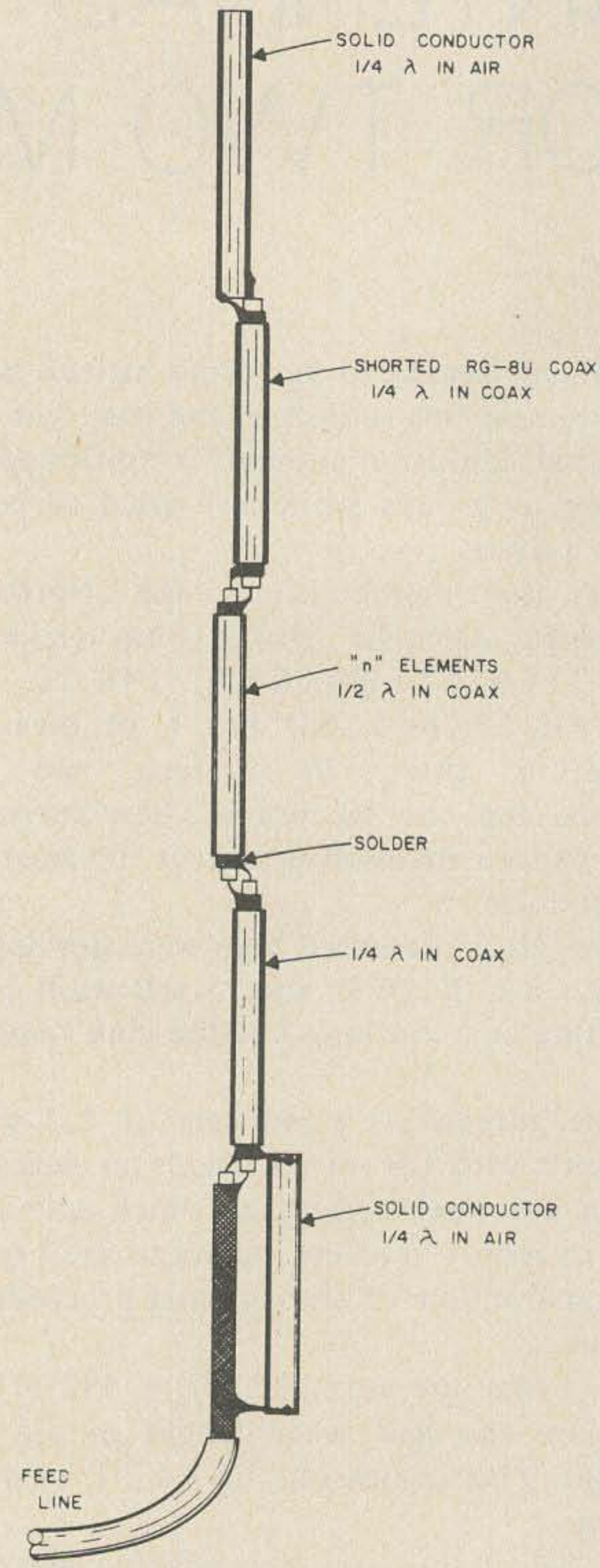


Fig. 1. Antenna construction.

5. When you have reached your desired length, stop adding sections and run a test by powering the antenna from a transmitter and running a wave meter (absorption) up and down it, each element should be radiating equally if you have no shorts or opens.

6. Now tape each junction completely with 3–4 layers of good electrical tape. This gives mechanical integrity and some sealing to the connection.

7. Again check for the minimum VSWR point. Hopefully you have come out a little (250–500 kHz) high of your design frequency. With the antenna draped in the air again, take some 1" wide strips of aluminum foil and hang over the taped electrical connections. Play with these strips, removing, adding, etc., until the minimum VSWR point is exactly on design frequency and the VSWR is also minimum. It is a two-man job at this point.

8. When you have the thing "right on," tape over the foil permanently holding it in place.

9. If you have built a 25–40 footer, your VSWR should come out to better than 1.1 to 1 and hopefully 1.0 to 1. If you have built an antenna less than 25 feet, your VSWR may be as great as 2.0 to 1. This is because the impedance of the bottom 1/4 wave element is not correct (I think). This can be compensated for by the addition of a matching stub (solid conductor) in parallel with the feed line quarter wave stub. Vary the point of soldering this to the feed line for minimum VSWR – using this technique, the VSWR can be brought under 1.2 to 1.

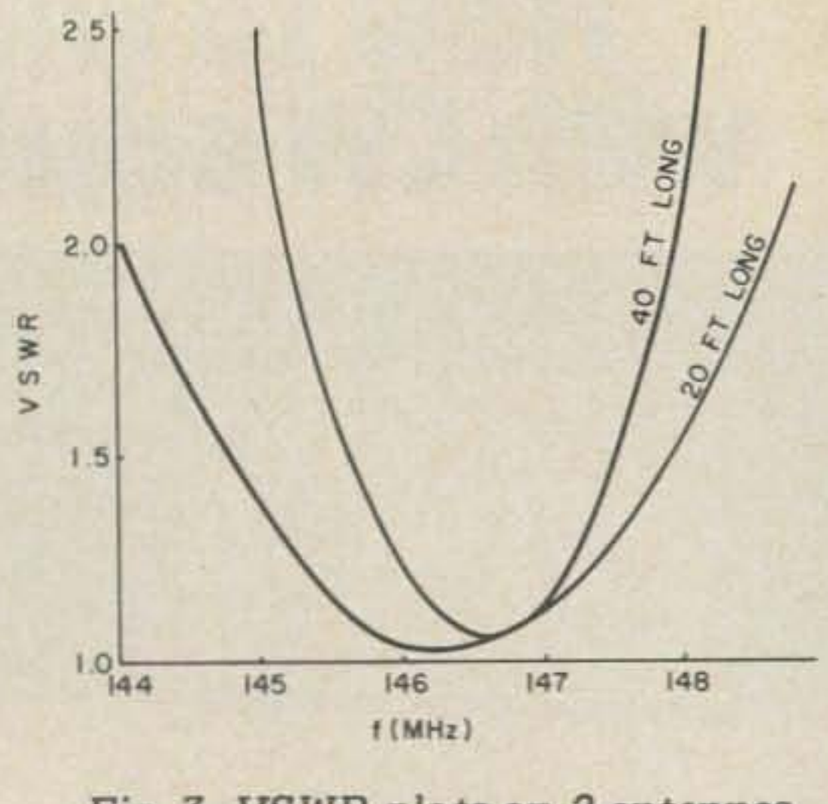
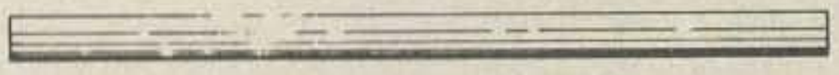


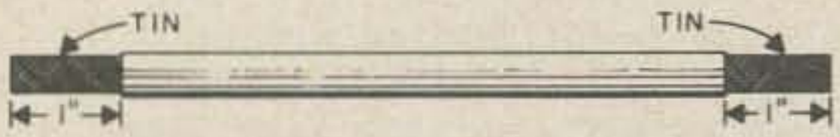
Fig. 3. VSWR plots on 2 antennas.

1) Cut to desired length + 2.0"

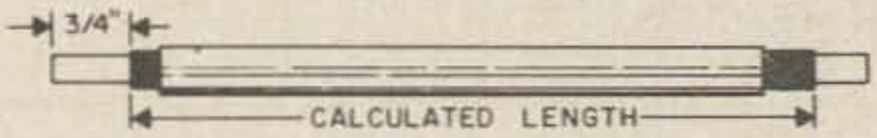


R6/8U Solid Dielectric

2) Cut insulation back 1" each end flux and tin each end.



3) Using tubing cutter, cut shield off 3/4" from first end, measure final dimension (from calculations) from shield on cut end to other end, mark, and cut shield with tubing cutter.



4) Using single edge razor trim insulation leaving 1/16–1/8" remaining.

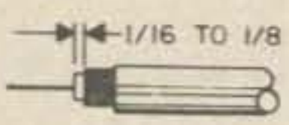


Fig. 2. Method of element preparation.

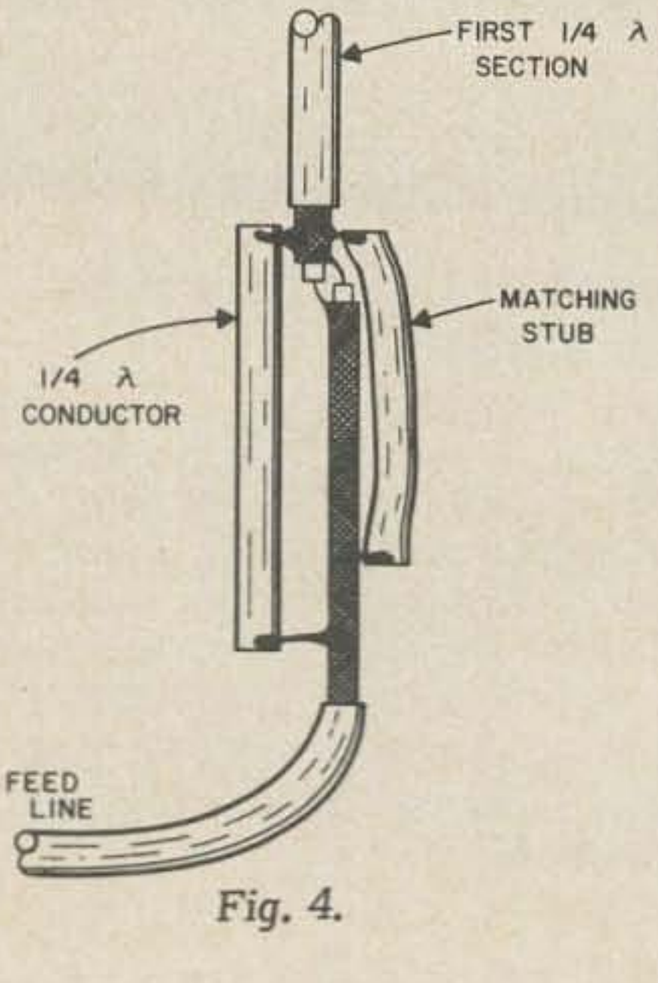


Fig. 4.

10. Now pick up some 1-¾ 2" OD PVC pipe and fittings and build a housing for your new creation. The 20 foot unit should show six dB gain while the 40 foot should have 9 dB gain omnidirectional, of course. The longer antenna will have a flatter pancake coverage pattern (vertical plane); and, of course, its VSWR plot will be sharper.

Good luck! Hope this has helped.

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