An Omni Directional Gain Antenna for UHF

US patent 8,947,313
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- Grant given in 2012 by AC Daughty for MESH networks- ATD alarms

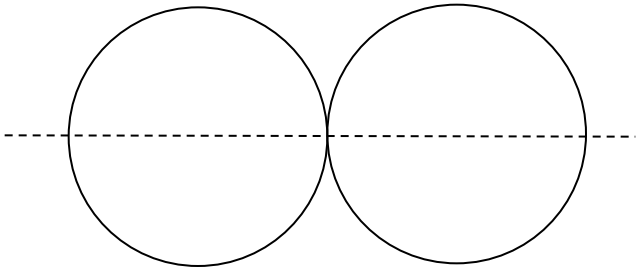
- Antenna needed to be low cost (under $40).

-It needed a gain of at least +5dB over a ¼ λ whip that was placed on top of the transceiver metal cabinet.

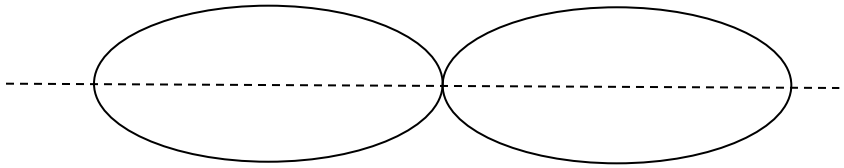
-The antenna had to withstand extreme outdoor weather conditions with winds over 100 mph and harsh winter conditions in New Jersey.

-Absolutely no radials (or other protruding elements) due to increase wind load and birds perching on them. With hundreds deployed in a meshed network, they had to be maintenance free.

Gain - you can't get something for nothing. Gain in an antenna DOES NOT create energy. It can only REDIRECTs it. Area inside the circles stays the same.



1 element vertical dipole pattern
0dB reference



2 element vertical dipole pattern
– 3dB gain

US009608336B1

(12) **United States Patent**
Fong

(10) **Patent No.: US 9,608,336 B1**
(45) **Date of Patent: Mar. 28, 2017**

(54) **RADIAL-FREE COLLINEAR OMNI-DIRECTIONAL TRIBAND HALF WAVELENGTH ANTENNA WITH VIRTUAL GROUND, SINGLE COAXIAL CABLE FEEDPOINT, AND WITH MINIMAL INTERACTION OF ADJUSTMENT BETWEEN BANDS**

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(72) Inventor: **Edison Fong**, Sunnyvale, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 47 days.

(21) Appl. No.: **14/834,435**

(22) Filed: **Aug. 25, 2015**

(51) **Int. Cl.**

H01Q 9/04	(2006.01)
H01Q 21/30	(2006.01)
H01Q 9/18	(2006.01)
H01Q 1/36	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 1/362*** (2013.01); ***H01Q 9/18*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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Primary Examiner — Trinh Dinh
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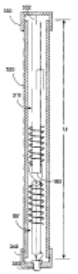
(57) **ABSTRACT**

An omni-directional triband antenna operates without ground radials with gain commensurate with a half wavelength vertical on each band. The triband antenna includes a dual-band twinlead J-pole providing half wavelength radiators for UHF and VHF, and an impedance transformer defining feedpoints to which a length Lc of coaxial cable is attached. The Lc lower end is the triband antenna connector port. Intermediate band radiators are first and second wire elements that collectively are a half-wavelength at the intermediate band. The first element is wound helically about the impedance transformer, with upper end floating and lower end connected to a first feedpoint. The second element is wound helically about the Lc upper portion of coaxial cable, with upper end connected to the remaining feedpoint, and lower end of the element floating. The helical windings radiate vertically and there is no cross-interference between antenna radiation in any of the three bands.

20 Claims, 12 Drawing Sheets



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(12) **United States Patent**
Fong

(10) **Patent No.: US 8,947,313 B2**
(45) **Date of Patent: Feb. 3, 2015**

(54) **RADIAL-FREE COLLINEAR OMNI-DIRECTIONAL ANTENNA WITH GAIN AND VIRTUAL GROUND**

(76) Inventor: **Edison Fong**, Sunnyvale, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1116 days.

(21) Appl. No.: **12/927,397**

(22) Filed: **Nov. 15, 2010**

(65) **Prior Publication Data**

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(51) **Int. Cl.**

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H01Q 9/42	(2006.01)
H01Q 9/30	(2006.01)

(52) **U.S. Cl.**
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USPC **343/825**

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/40; H01Q 9/30
USPC 343/790–792
See application file for complete search history.

(56) **References Cited**

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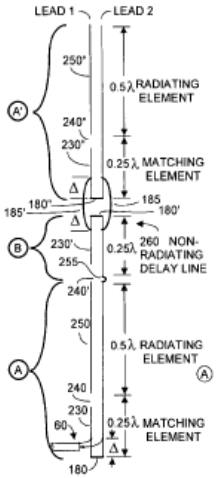
Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Michael A. Kaufman, Esq.

(57) **ABSTRACT**

An omni-directional antenna operable absent ground radials and providing at least 3 dB gain at a chosen wavelength relative to a dipole includes first and second like-oriented J-pole antennas and, coupled intermediate said J-pole antennas, a quarter-wavelength non-radiating delay line. Each J-pole antenna includes a half-wave radiating element, and a quarter-wavelength non-radiating section. The quarter-wavelength non-radiating delay line together with the quarter-wavelength non-radiation section of the second J-pole provide a half-wave non-radiating delay line. The result is that RF energy radiated by the first and second half-wave radiating elements are in proper phase, whereby gain is achieved. RF energy is coupled to the first J-pole antenna a distance Δ above the zero impedance end of that antenna.

10 Claims, 6 Drawing Sheets



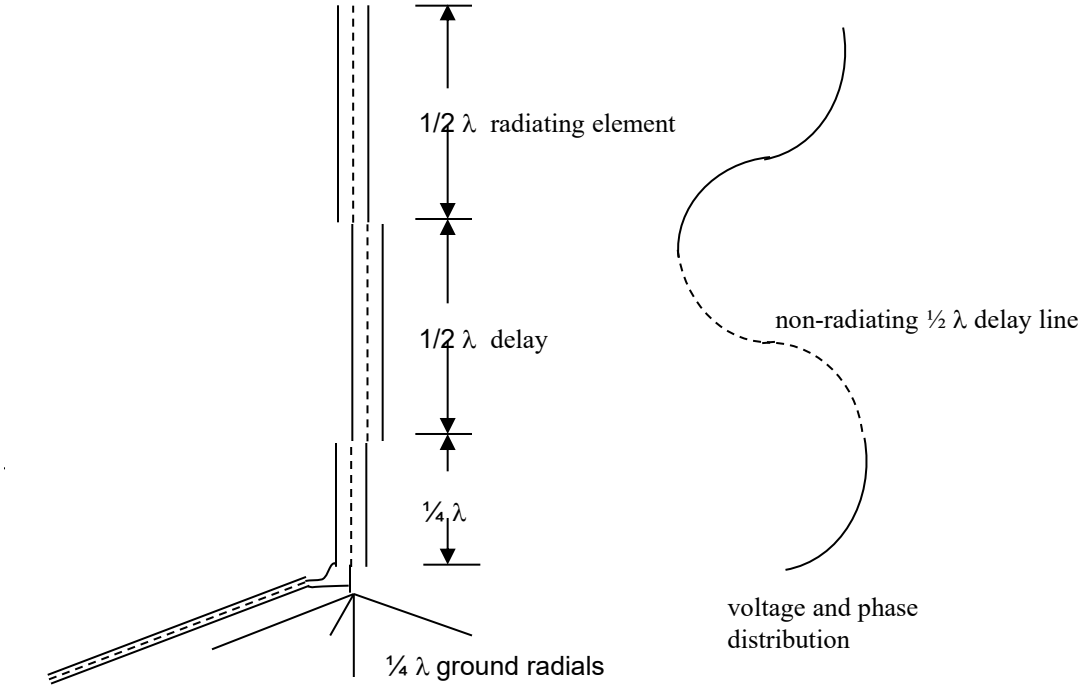


Figure 1 A two element collinear using a ground plane as the root antenna. The voltage and phase are shown on the right.

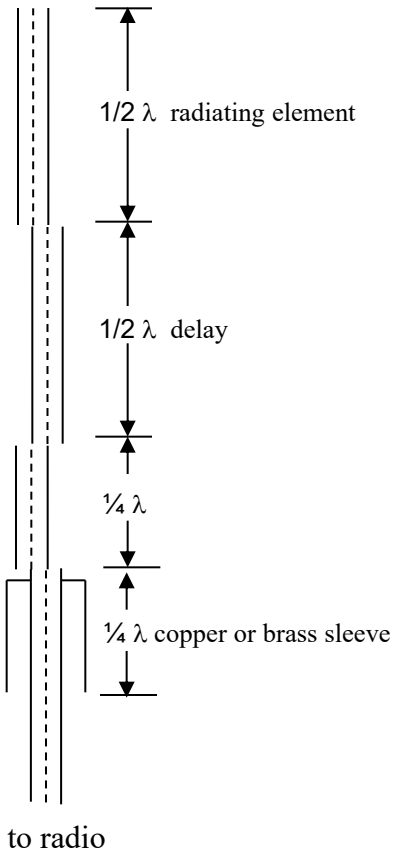


Figure 2 Many commercial antenna manufacturers use the ¼ λ sleeve in place of the radials for both durability and a slightly lower angle of radiation.

Figure 3 A very common configuration that claims gain at UHF. Measured results were minus 4-6 dB's.

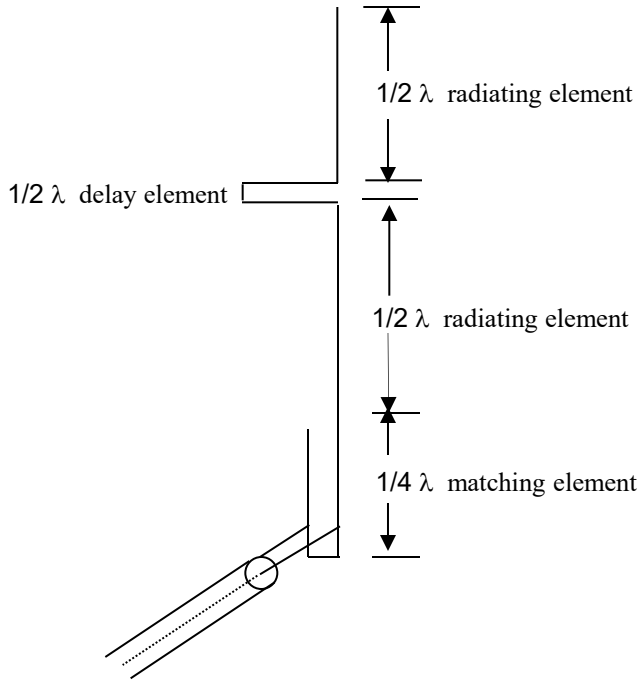


Figure 4 Known as the Super J, this configuration achieves a ½ λ delay by using two ¼ λ elements at 90°. It is a DC short so no lightning arrestor needed

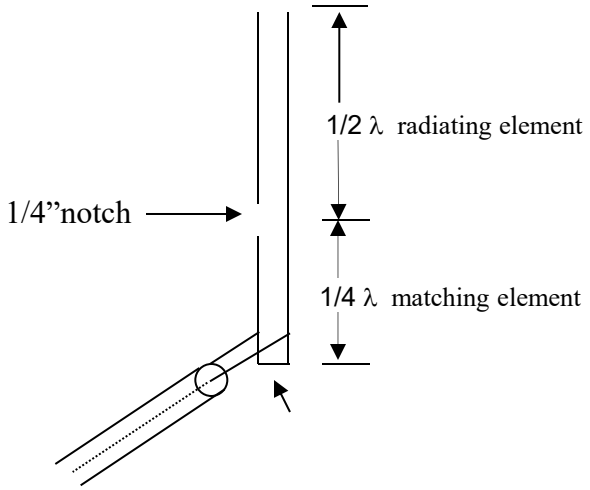


Figure 5 Typical dimensions for a J-pole at UHF constructed from 300 ohm twinlead. This is good starting point for the two element collinear.

Here is one of the main antenna towers in SF.

Notice there are NO radials on any of the antennas. Most use internal J-pole designs. A lightning arrestor is also not needed since by design, it is a DC short.

Figure 6a. This is a shorted ¼ λ loop made of RG174A with the outer insulation removed. This provides for a total delay of ½ λ. Using the principle of skin affect the wave travels down the inside shield and then returns via the center conductor. The outside conductor is shorted at multiple points thus behaving like one small loop. It showed promise, but its losses were too high.

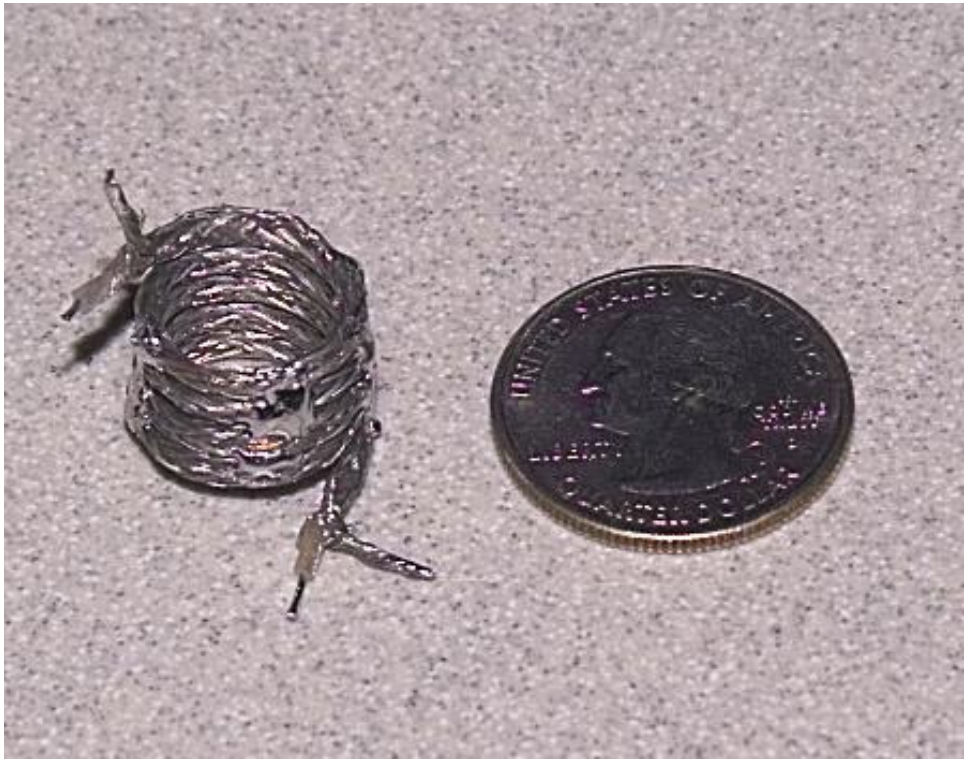


Figure 6b. This is a 1/2 λ loop made of RG174A with the outer insulation removed. This provides for a total delay of ½ λ. through the inside conductor. The outside conductor is shorted at multiple points thus behaving like one small loop. This configuration should minimize radiation at UHF but the insertion lost was too high.

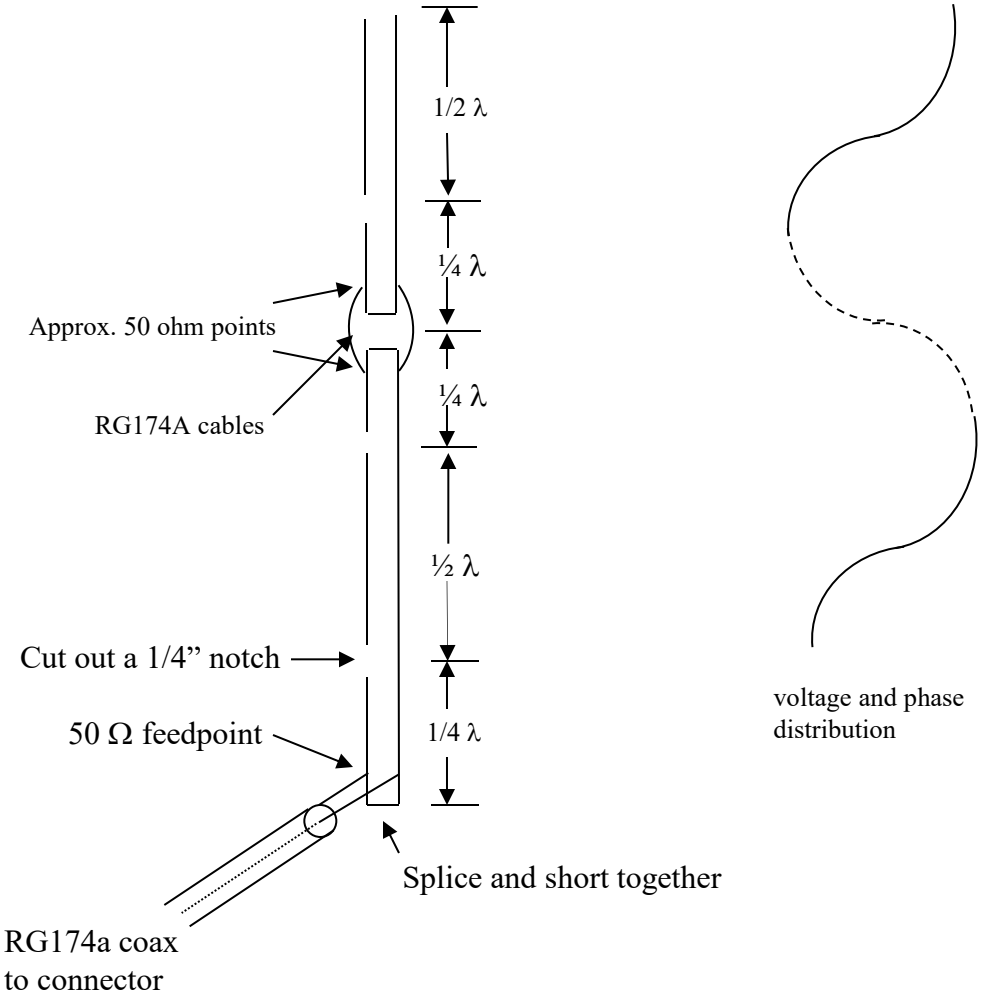
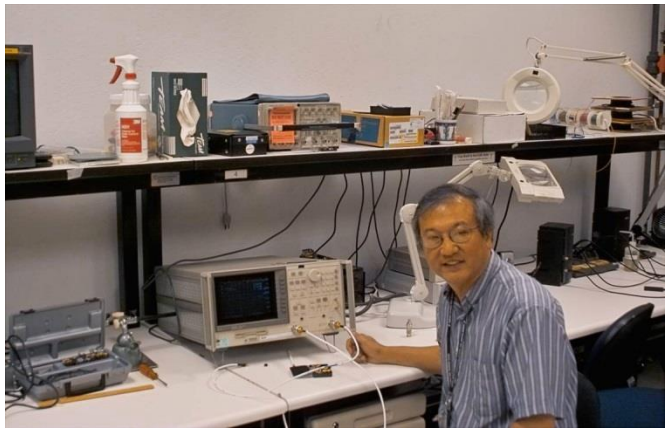


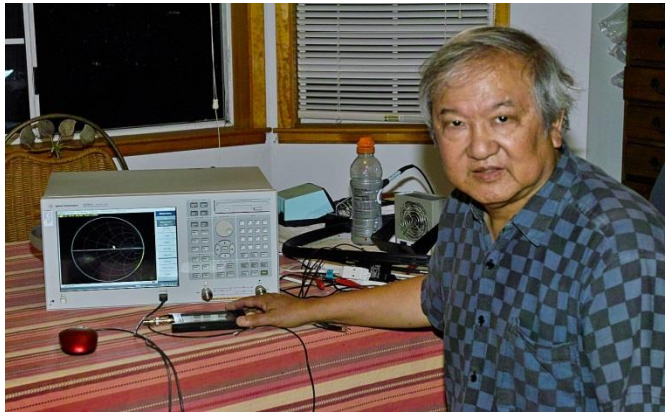
Figure 7 The two element UHF phase conlinear with the voltage and phase given on the right. Dimensions are given for insertion into ¾ inch 200 PSI pvc pipe.

groundplane	rubber duck	1 element collinear	2 element collinear	4 element collinear
0	-3dB	+1.5dB	+4.5dB	+6.5dB

Table I. Relative gain to a ground plane as measured with a repeater 30 miles away.



Our old HP 8753D network analyzer - 2008



Our new Keysight 5062A network analyzer 2021

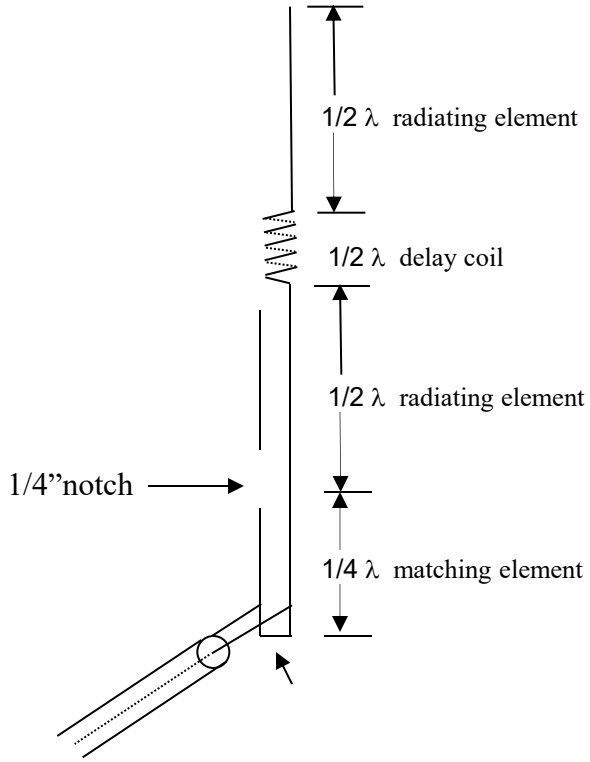
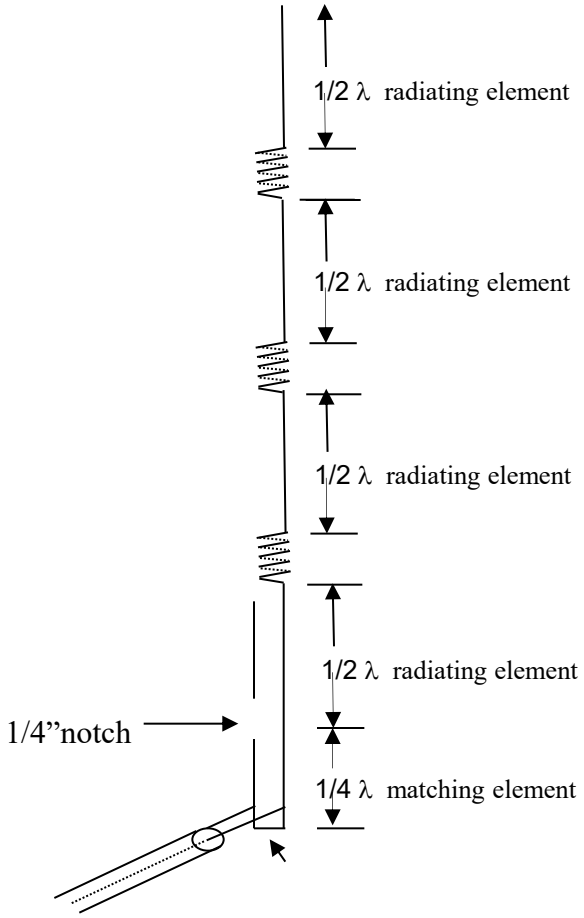


Figure 8 I found that this configuration gave the best bang for the buck over the years. Easy to construct and gave consistent results. Coil is very critical.



This is about the point of diminishing returns. 4 element collinear. About 6.5 dB over a groundplane or about 5dBd.

uSDX+ 80-10 all mode transceiver – Class S RF amplifier - $150

Inside view - very nicely layed out. No heat sinks.
Power output transistors are at top left. BS170 fets.

DBJ-1 dual band base antenna - available in HAM (144-148 MHz and 440-450 MHz) or Commercial (152-157 MHz and 460-470 MHz) $40 (retail $55)

DBJ-2 dual band roll up antenna - available in HAM (144-148 MHz and 440-450 MHz) or Commercial (152-157 MHz and 460-470 MHz) includes 6ft extension, BNC, SMA and SMA female adapter $40 (retail $60)

TBJ-1 triband base antenna 2mt/220 MHz/70 cm –- $65 - includes shipping with 6ft of pvc pipe. (retail $90)

UHF HAM (or GMRS) 5dB gain base antenna $46 (retails for $65)

6ft extensions cables (BNC male to BNC female $8

BNC – female to PL259 (adapter for roll up DBJ-2 to mobile or base) $2.50