Receive Antennas – A Review

by Rick W5RH

A practical look at the skyhooks that improve your station's ears.

February 12, 2026 BVARC

Disclaimer

- **Receive antennas come in many shapes, sizes, and philosophies**
- **The literature is deep — especially on the low bands**
- **This talk focuses on practical, field-tested, and ham-friendly solutions**
- **Goal: give you tools you can actually use to improve SNR**

- **Two publications stood out in my search**

  ARRL Antenna Book 25th edition –
  Chapter on Receive Antennas

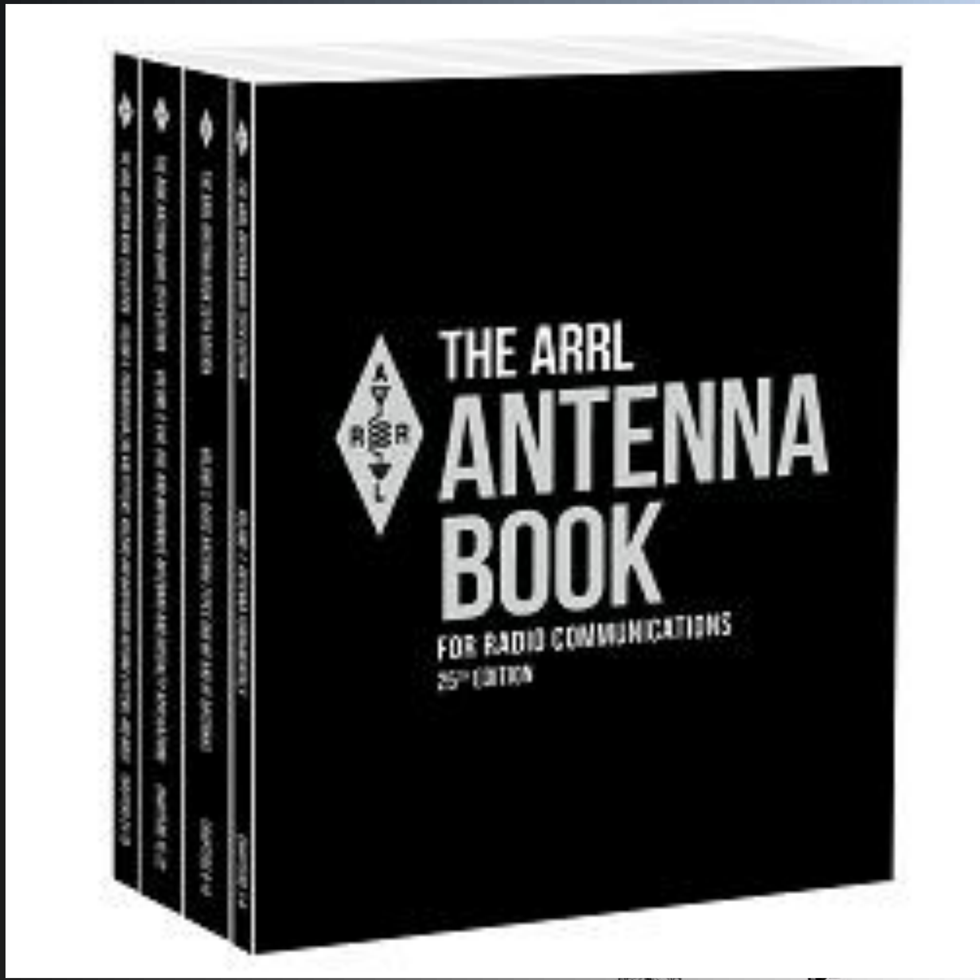
  ON4UN's Low Band DX'ing 4th Ed.
  100 page Receive Antenna chapter by Tom, W8JI

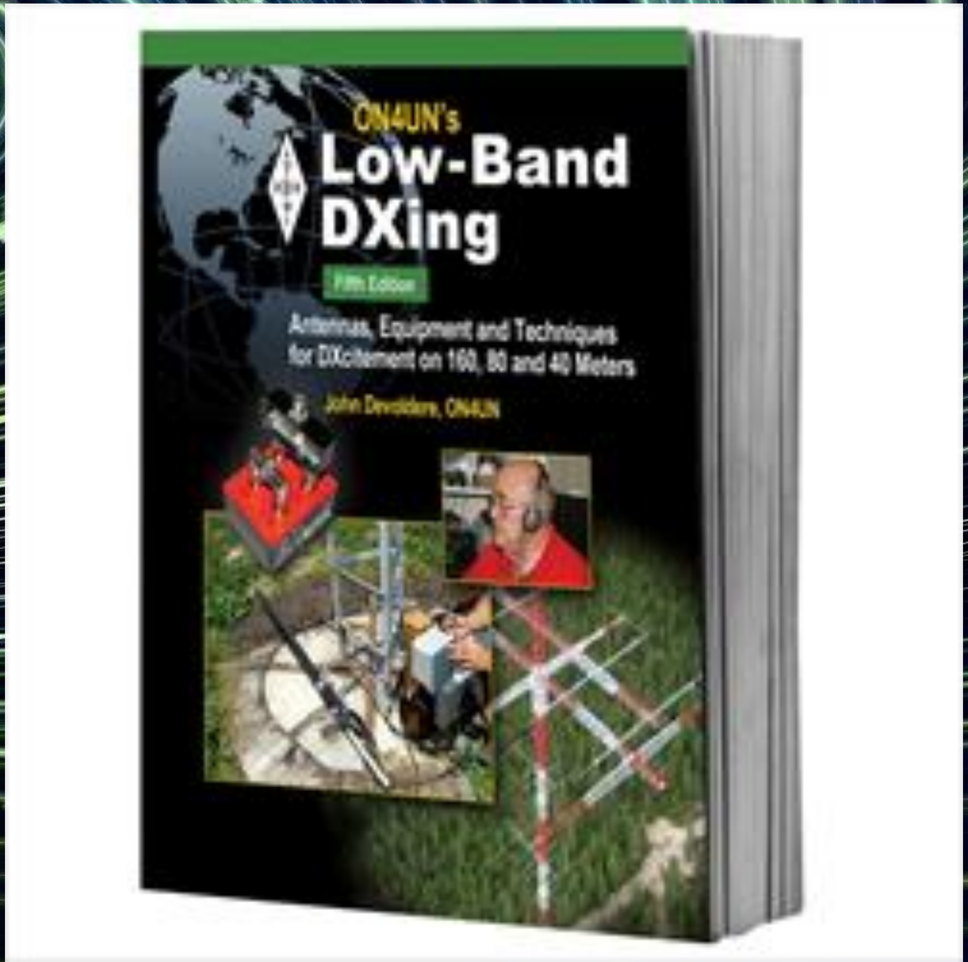
  These two works shaped much of today's receive-antenna thinking

ARRL Antenna Handbook 25th Edition

Chapter 7 – dedicated to Receive Antennas

First edition 1939





Low Band DX'ing provides an indepth information source for Low Band Ops.

4th edition has 100 pages on antennas, arrays, noise, etc.   Tom, W8JI

Note: 1987 First Edition had 18 pages at the back of the 133 page Antenna Chapter

Dedicated receive antennas can provide us with better ears.

But, do we need better ears? Yes!

- Phone 6DB above noise
- CW 0 dB at noise
- FT modes -24 dB in the noise

- **The problem isn’t weak signals — it’s noise**
- As N0AX says: “We’re really after a better SNR input to the receiver.”
- Best improvement: **reduce noise pickup at the antenna**, not in DSP

Xmit vs Receive Antennas

Transmit antenna —

radiate power efficiently

Receive antenna –-

deliver the best possible SNR

Sometimes conflicting goals

Hence, the value of separate antennas

Some times

Reciprocity

- Antennas are theoretically reciprocal
- But on low bands, **noise floor** and **omnidirectional noise** dominate
- A great transmit antenna may be a poor receive antenna
- Receive antennas are designed to reject noise, not radiate power

Why Receive Antennas Matter

•Receive antennas are optimized for **SNR**, not power handling

•Help dig weak signals out of noisy band conditions

•Especially valuable on 160, 80, and 40 meters

Why separate receive antennas for the lower bands?

They can provide an improved Signal to Noise ratio SNR

Optimize intelligibility

Typically a smaller footprint

Lower height needed

Reduced matching and radials

Where it all began

Low band radio was used for intercontinental message traffic.

For hams -- it all started on the low frequencies, as those were the frequencies allowed.

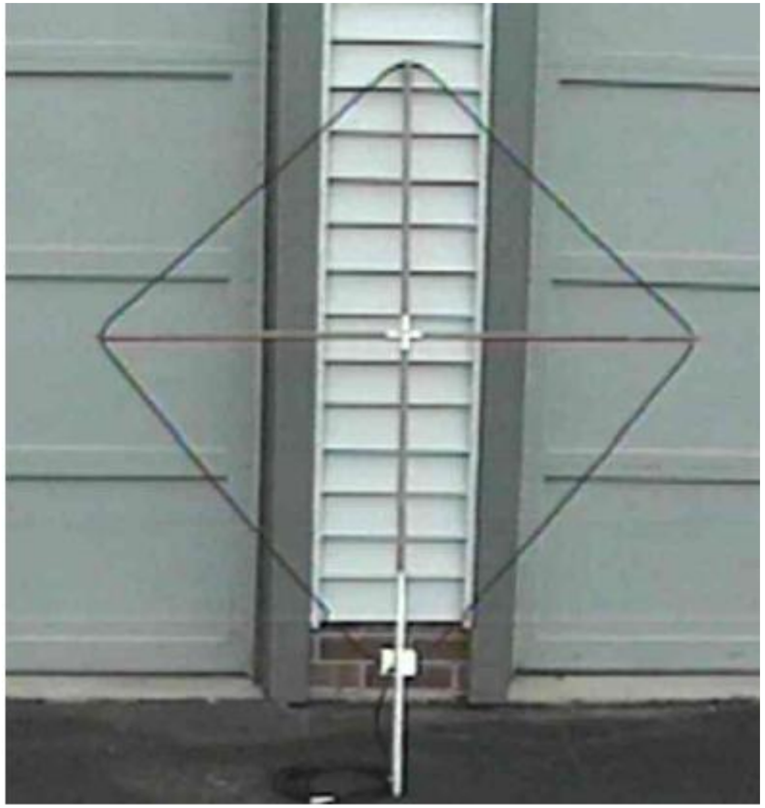
Beverage **found diversity reception** to be quite helpful to the commercial traffic stations. Hence the various patents.

Commercial Traffic and the “Wave” antenna

- Commercial “data” traffic was handled by RF telegraphy.
- River Head on the north shore of Long Island was a gateway. It required close to 100% station performance. Experiments showed multiple, long (2 miles long) wires coupled with diversity/voting type receivers improved copy

The ham receive antennas implemented have changed significantly since the early 20th century

- Early ham receive antennas were .1 wl loops for 160 mx
- Doug DeMaw, W1FB, took his many designs to QST and increased popularity



Doug DeMaw, W1FB, also recommended simple things to try for noise reduction

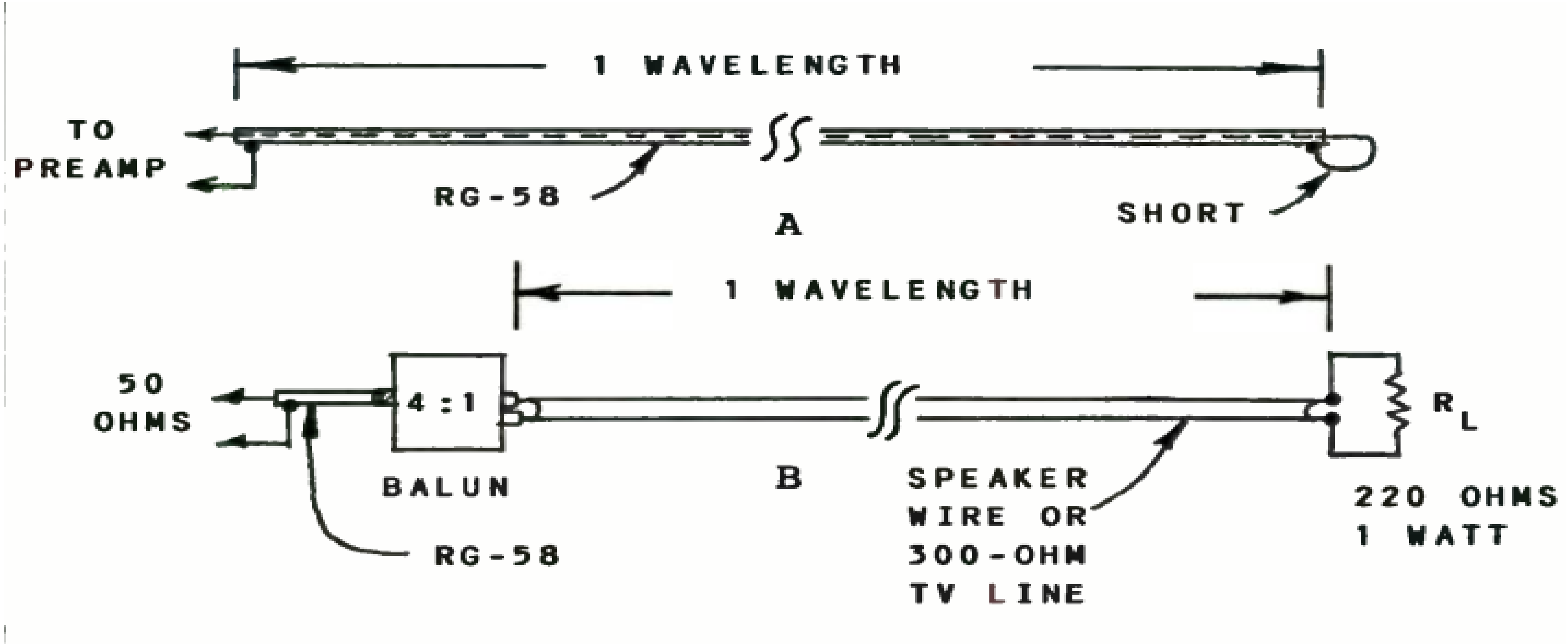
- Choose another antenna used for another band. Doesn't have to be resonant, but the poor matching could be advantageous. The separation might also provide diversity reception.

- A helically wound short dipole – again, non-resonant

- A "Snake"– a non-resonant, typically terminated, single wire spread out on the ground

- On Ground Antennas – QST April 1988

On Ground, Snake Antennas – W1FB Antenna Handbook



The recent path of receive antenna thinking

Outlined very well at Contest University over the past few years by Frank Donovan W3LPL.

Hence my plagiarizing his talk (giving citation/credit of course)

I encourage you to visit www.contestuniversity.com/files/

Using W3LPL's CTU presentation as a guide

Presents a wide range of antennas and analysis to help improve your receiving capability.

Most deal with low band 80 and 160 but the higher bands have an issue with noise/QRM and QRN, so receive antennas can also help there.

As the complexity of the receive antenna system increases, so it seems does the amount of landscape that is required.

Beverages are land hungry as are the ever expanding vertical arrays of 4 , 6, 8 elements.

-- to paraphrase Hillary Clinton “it takes a field” (that’s a joke son).

K9AY and his shared loop implementation allows a high level of performance in a smaller amount of space

Optimizing Low Band Receiving Antenna Performance

- Small antennas
- High performance antennas
- Diversity reception

Frank Donovan
W3LPL

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Why separate Receive Antennas?

- Lower Cost
- Smaller Size – less realestate for multiple antennas for diversity
- Reduced height requirement
- Reduced requirement for matching
- Reduced requirement for radial fields
- Ability to more easily phase multiple antennas for null steering

Measuring receive antenna performance

RDF -- Receiving Directivity Factor

- Receive antennas judged by **SNR**, not gain

- RDF compares desired direction vs. everything else

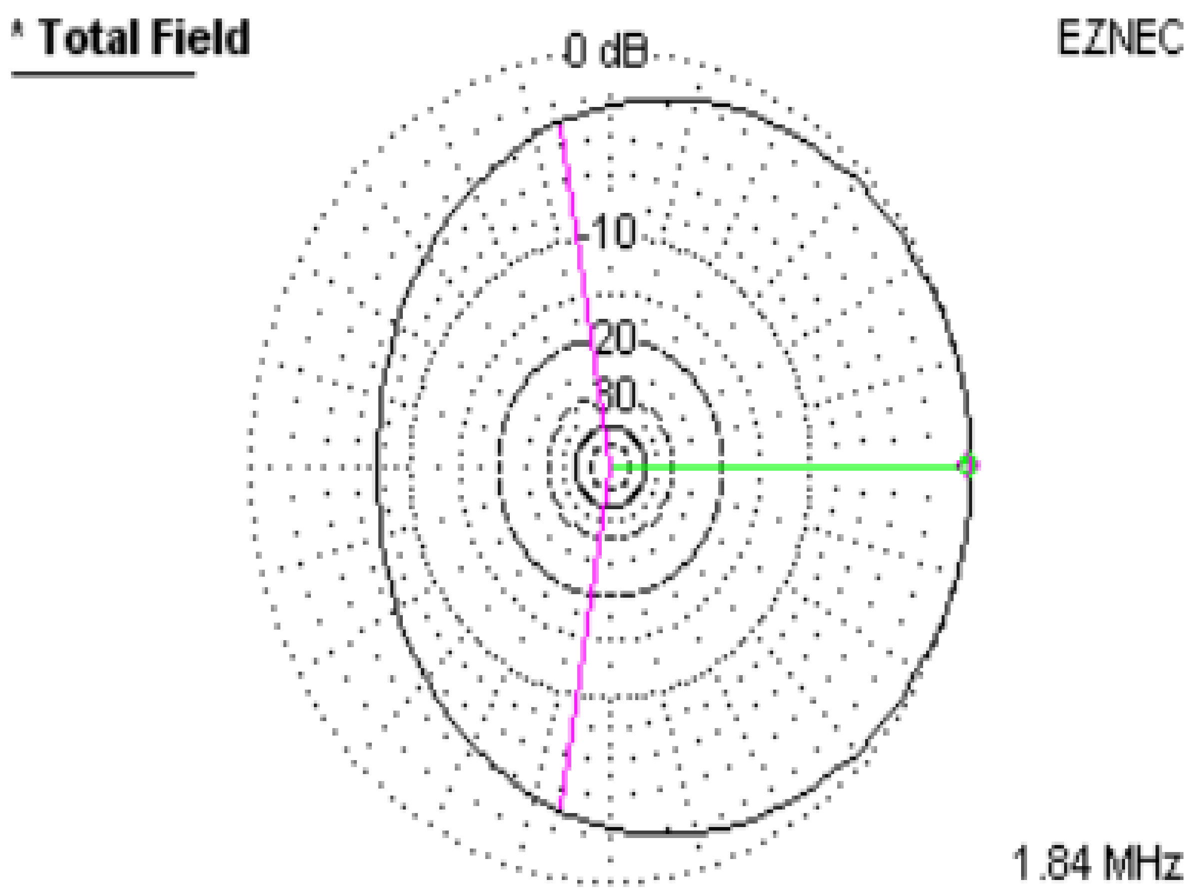
- Higher RDF = better noise rejection

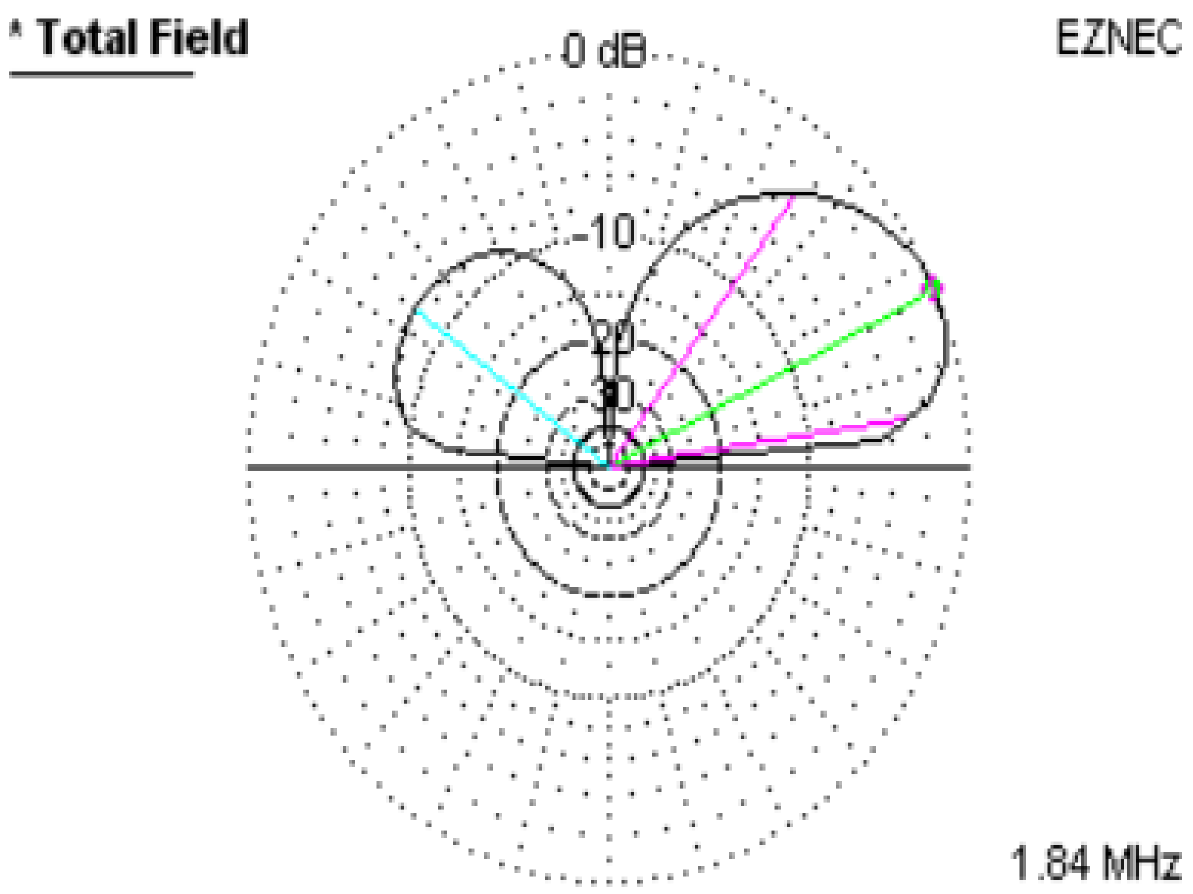
RDF – Receive Directivity Factor

- **Shows an antenna's ability to focus on a desired signal while suppressing noise and interference from other directions**

- **Expressed in decibels (dB).**

Using EZNEC Elevation and Azimuth plots



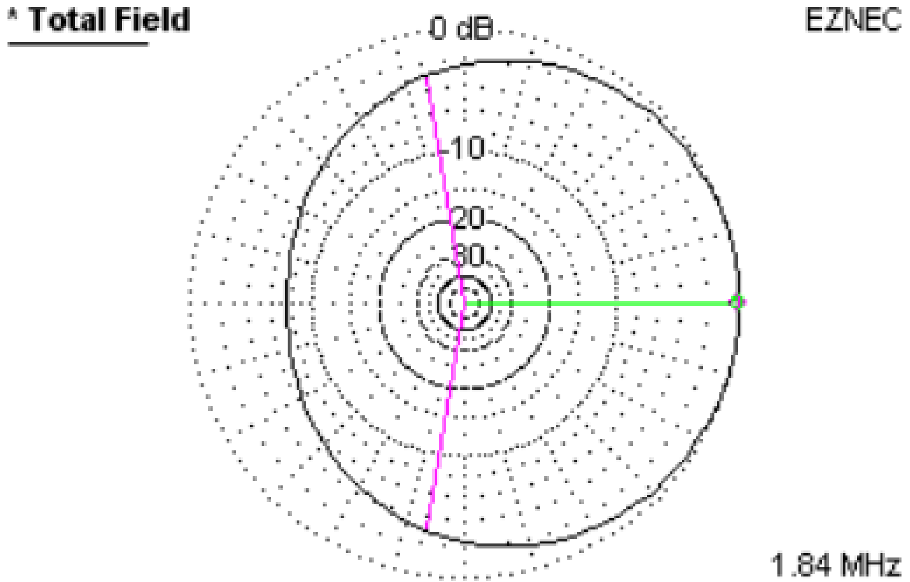


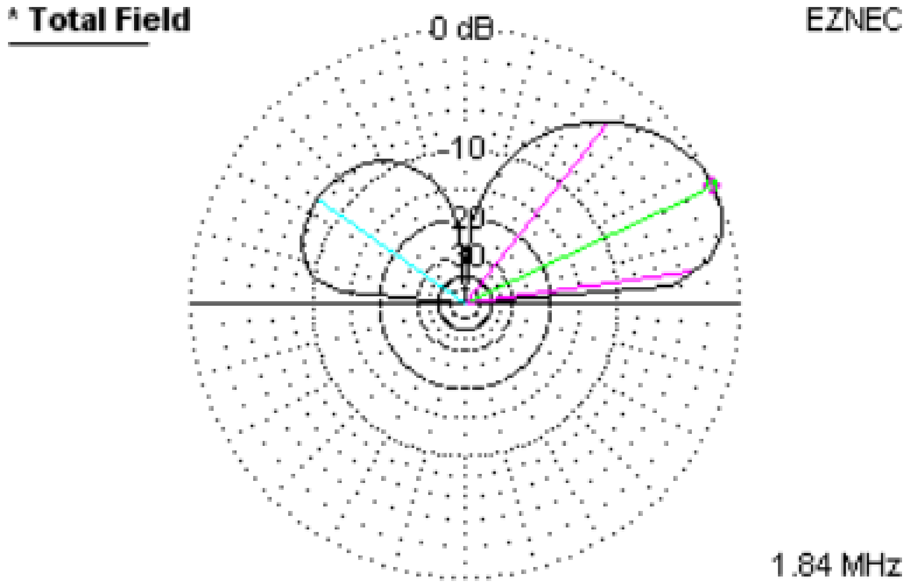
Receiving Directivity Factor (RDF) (W8JI Tom)

measure of receiving antenna performance

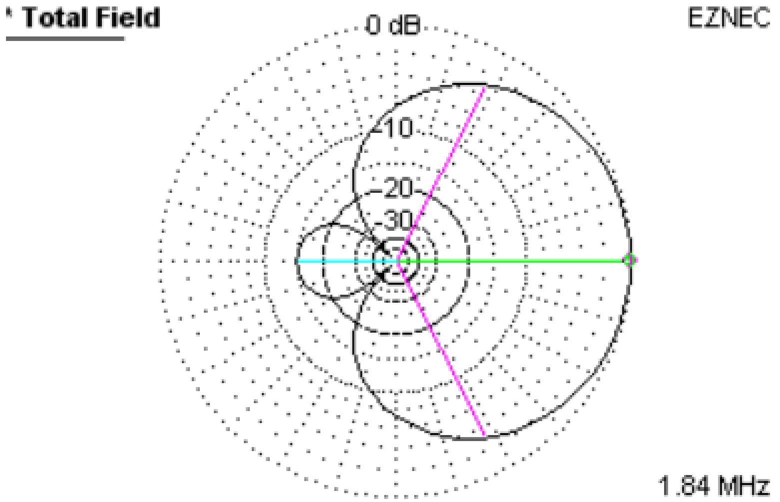
- **Compares forward gain at the desired azimuth and elevation angle to average gain over the entire hemisphere**
- **Assumes noise is equally distributed over the entire hemisphere**
- **Assumes that RFI is more then 1000 feet away, in the far field of the antenna**

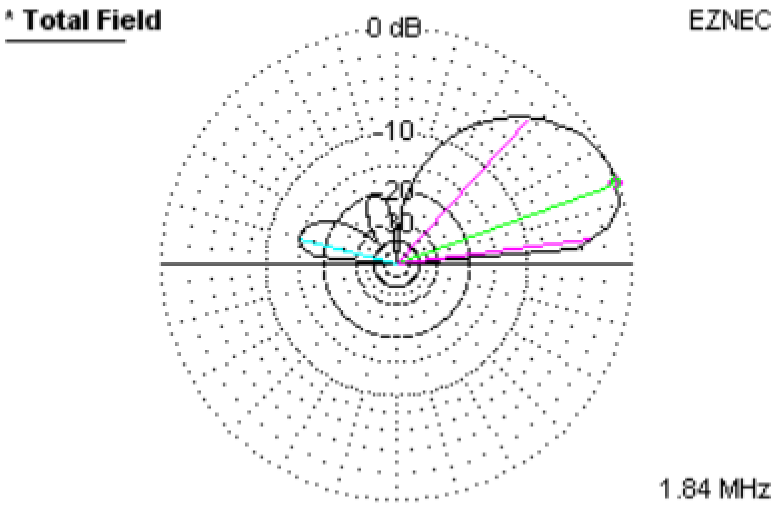
RDF 7.4


* Total Field
EZNEC
0 dB
-10
-20
-30
1.84 MHz


* Total Field
EZNEC
0 dB
-10
-20
-30
1.84 MHz

RDF 9.6


* Total Field
EZNEC
0 dB
-10
-20
-30
1.84 MHz


* Total Field
EZNEC
0 dB
-10
-20
-30
1.84 MHz

Small Receiving Antennas 4 to 11 dB RDF
Better RFI reduction

Typical RDF Values

- 4 dB — Small 8-ft magnetic loop
- 5 dB — Single short vertical
- 6 dB — 225-ft BOG
- 7 dB — 250-ft Beverage @ 7 ft
- 7 dB — Flags, pennants, EWEs
- 8 dB — K9AY / SAL
- 9 dB — Two phased short verticals
- 11 dB — Vertical Waller Flag

Small Loop Antennas

Pros:

- Excellent for nulling a single local noise source
- Great for RFI hunting
- Deep side nulls (figure-8 pattern)

Cons:

- Low output
- Not ideal for DX
- Requires careful choking and shielding

Small Loop Antennas 4dB RDF

Pros:

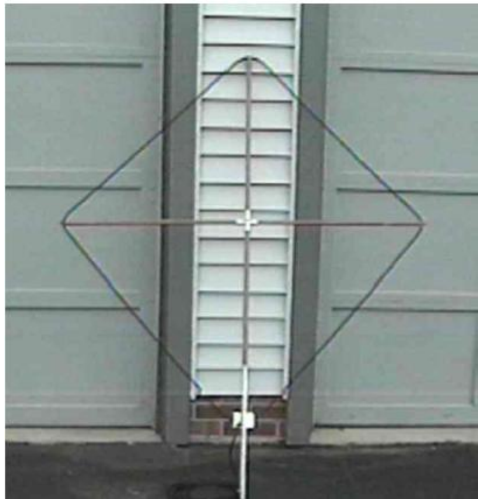
- Excellent for nulling a single, local noise
- Use for RFI source locating
- Figure 8 pattern
- Deep nulls off the sides

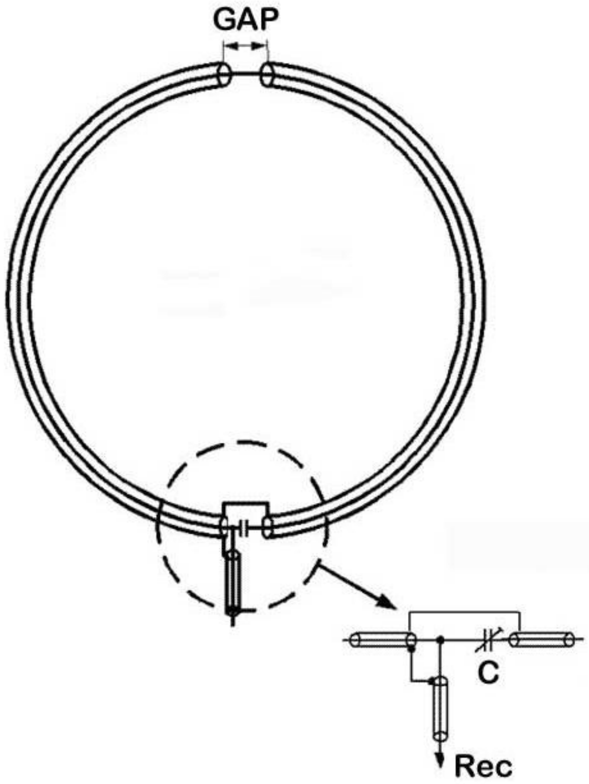
Cons:

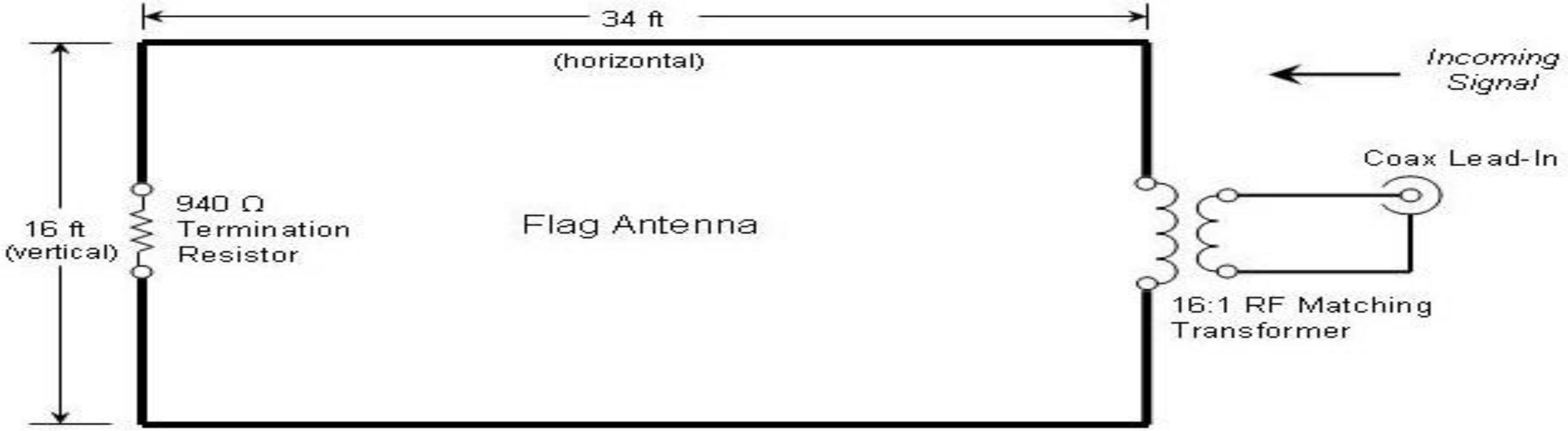
- Poor DX signal antenna
- Low amplitude output

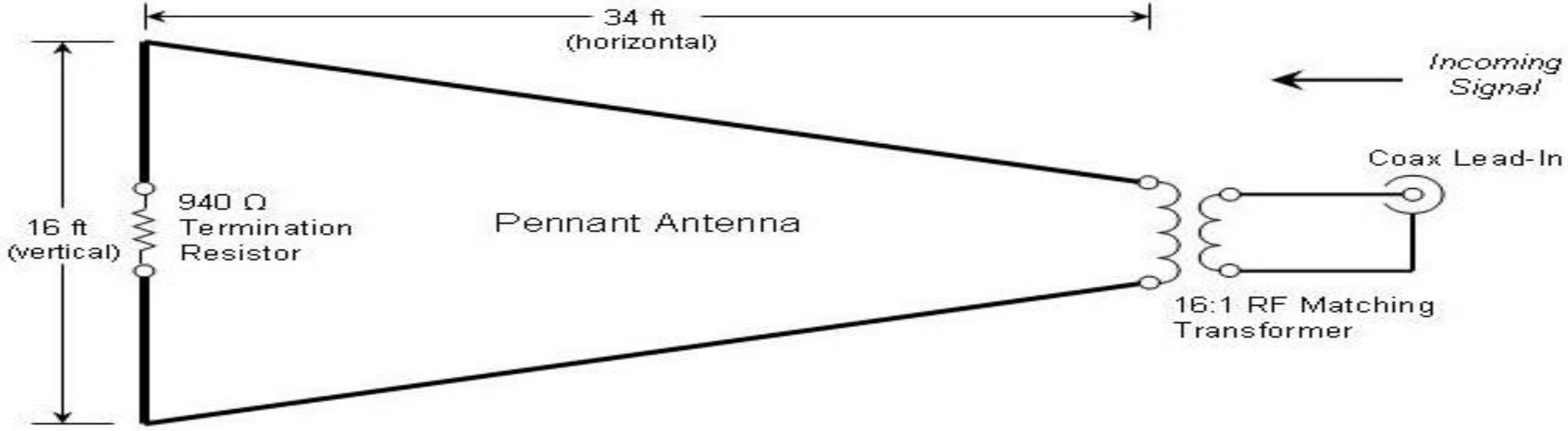
Configurations: < .1wl cir.

- Unshielded
- Shielded
- Mobius
- Active (pre-amp)

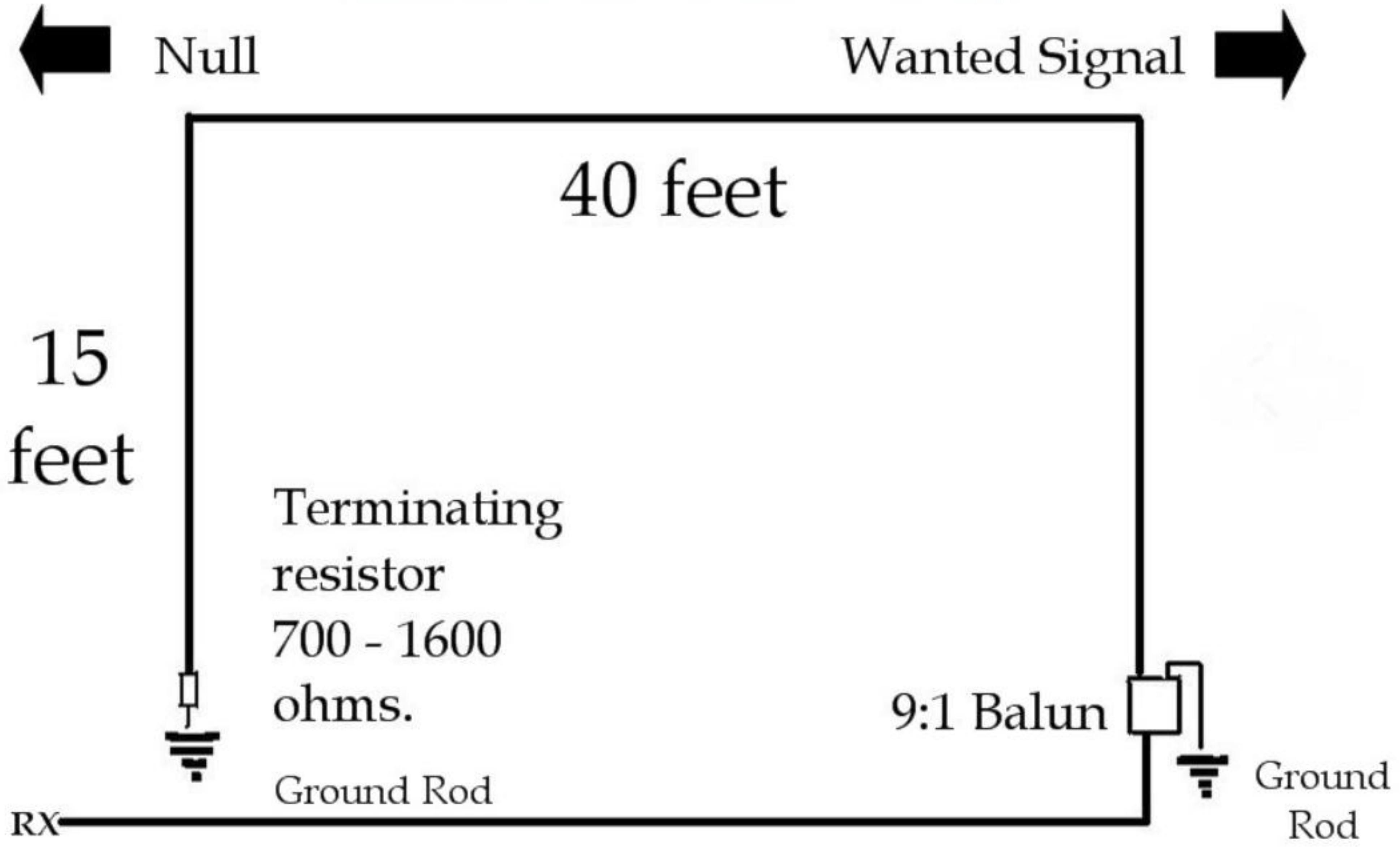





34 ft
(horizontal)
Incoming
Signal
Coax Lead-In
16 ft
(vertical)
940 Ω
Termination
Resistor
Flag Antenna
16:1 RF Matching
Transformer

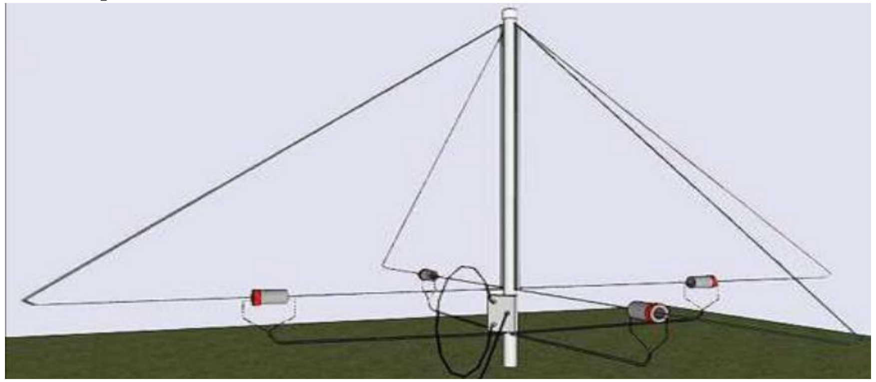

34 ft
(horizontal)
Incoming
Signal
Coax Lead-In
16 ft
(vertical)
940 Ω
Termination
Resistor
Pennant Antenna
16:1 RF Matching
Transformer

The EWE Antenna



Small Terminated Triangle Loops

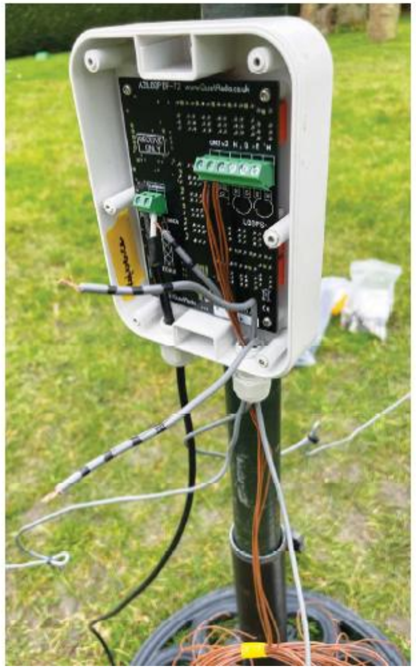
Low signal level out
Choking of all leads required



- **K9AY** – 4 directions – QST Sept. 1987

- **Shared Apex Loop Array** – 8 directions
  QST Oct. 2012

- **Aziloop** -- Dual mode K9AY & small loop
  Electronically rotated/switchable
  72 unidirectional headings
  @ DX Engineering /Quiet Radio UK



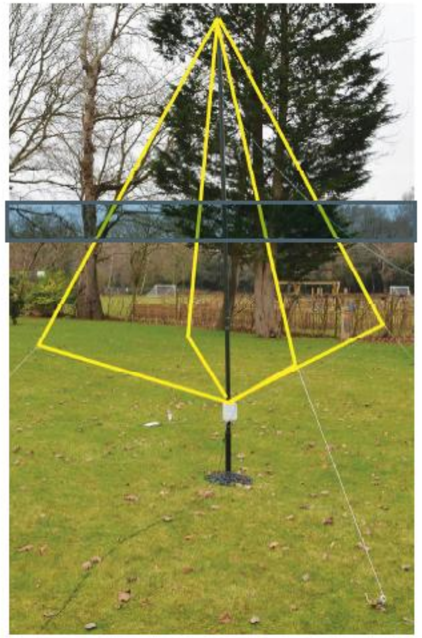


FIGURE 4: The completed assembly. The wires

Waller Flag Array – Vertical or Horizontal

11 dB RDF in only 30 feet of length

Two small terminated loops with end-fire phasing
For most locations: 14 feet tall and 30 feet long
For quiet locations: 20 feet tall and 50 feet long
At least 100 feet high for horizontal polarization
80º 3 dB beamwidth

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http://wwrof.org/wp-content/uploads/2016/03/WWROF-WEBNAIR-RX-Antennas-for-a-Small-Lot-.pdf

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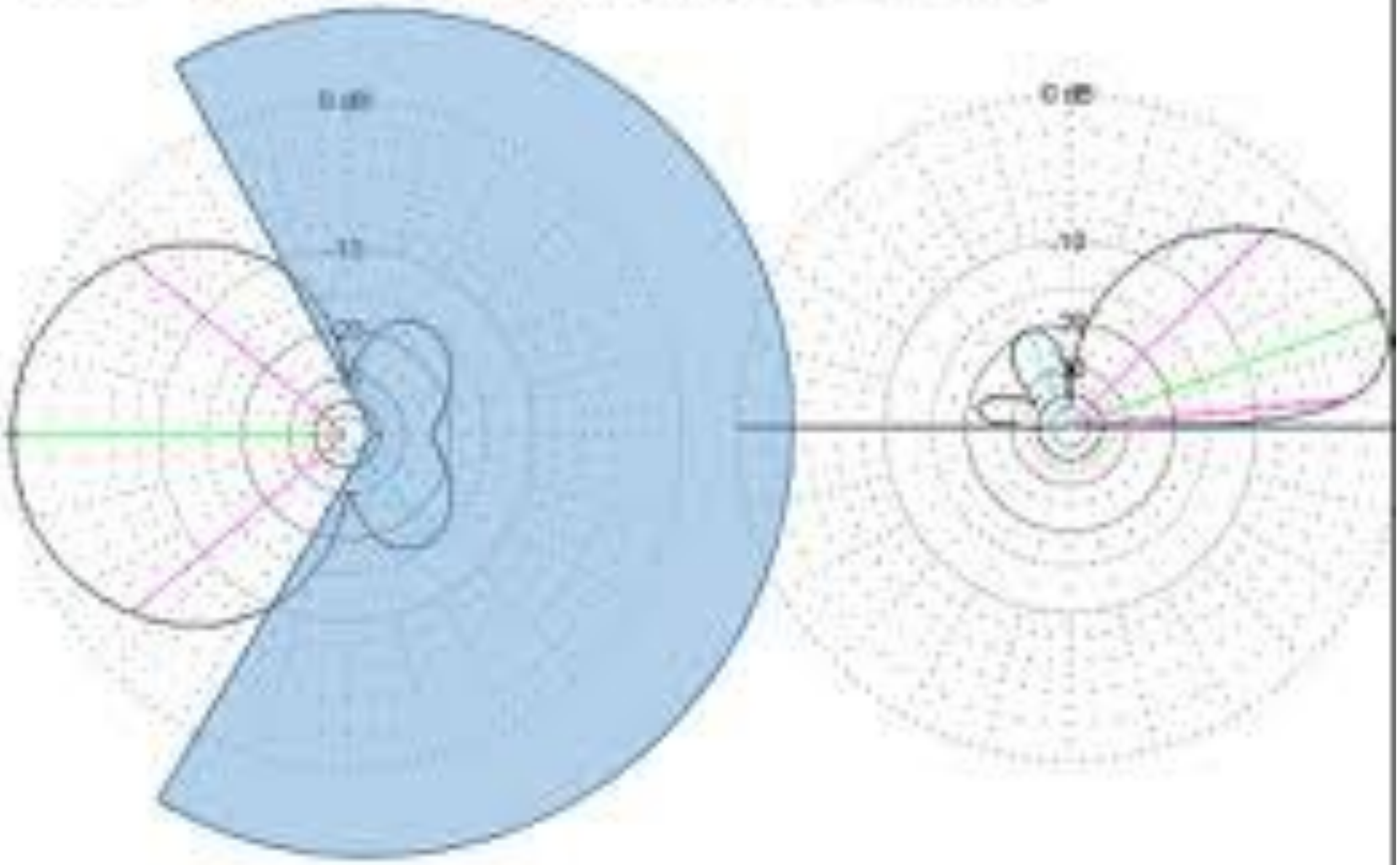
VWF Vertical Waller Flag 11.5 to 12 db RDF



High Performance Receiving Antennas
10 - 14 dB RDF

- 10 dB: 500 to 600 foot Beverage about 7 feet high
- 11 dB: Two or three close spaced 500 to 600 foot Beverages, staggered 125 feet
- 11 dB: Vertical Waller Flag array
- **12 dB: 4 square array of active or passive short verticals 80 x 80 ft**
- **12 dB: 3 element YCCC tri-band array of short active verticals 120 ft long**
- **12 dB: 5 element YCCC tri-band array of short active verticals 84 x 84 ft**
- **12 dB: 9-circle YCCC tri-band array of short active verticals 120 ft diameter**
- 12 dB: Horizontal Waller Flag: 2 phased horizontal loops *at least 100 ft high*
- 13 dB: BSEF array of 4 short verticals switchable in two directions 350 ft x 65 ft
- 13 dB: 8-circle array of short verticals with 106º phasing 200 ft diameter
- 13 dB: 8-circle BSEF array of short passive verticals 350 ft diameter + radials
- 14 dB: Four broadside/end-fire 800 foot Beverages 800 ft x 330 ft

Large antennas are less effective than small antennas at suppressing local RFI sources within a few thousand feet

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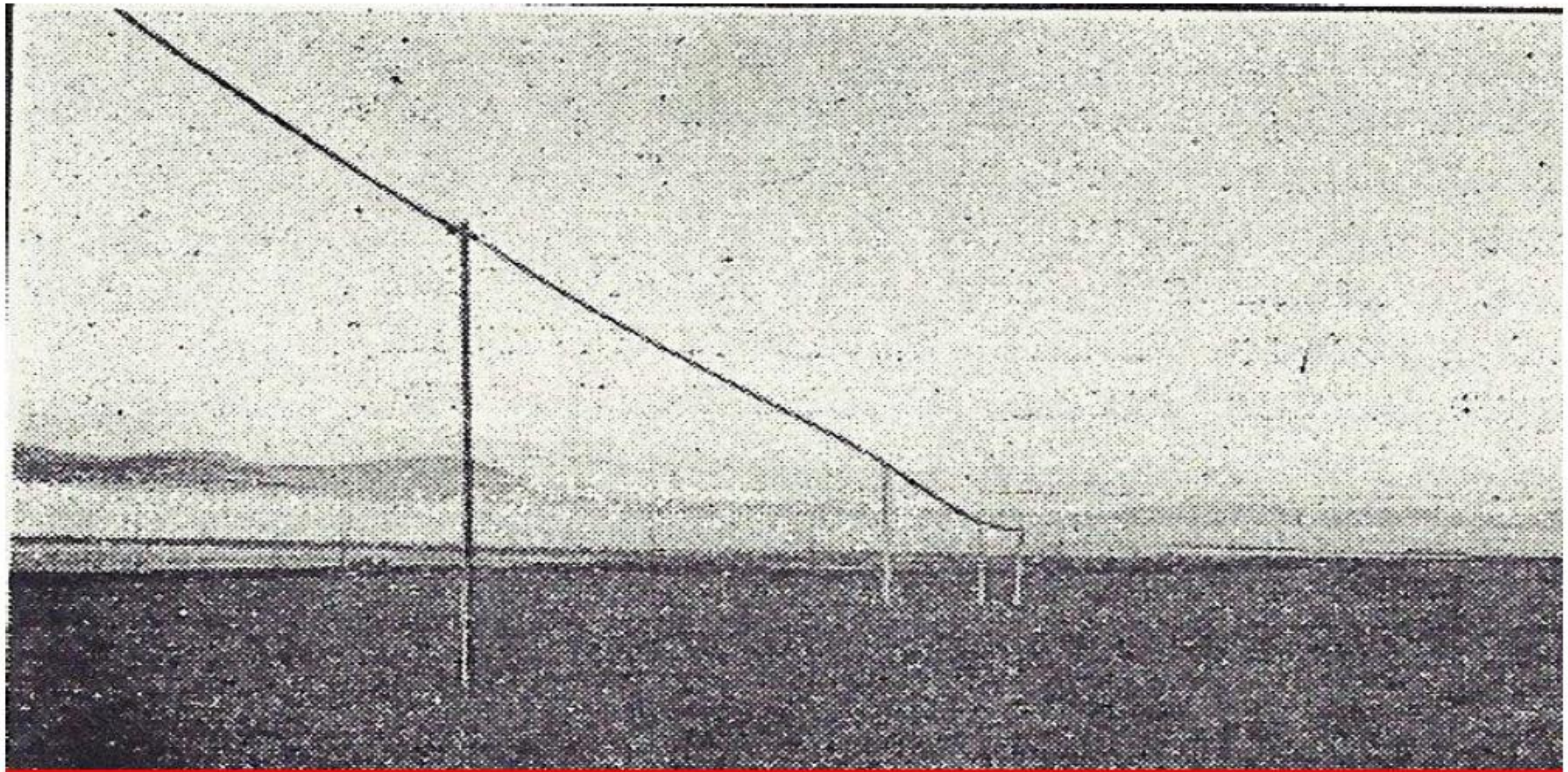
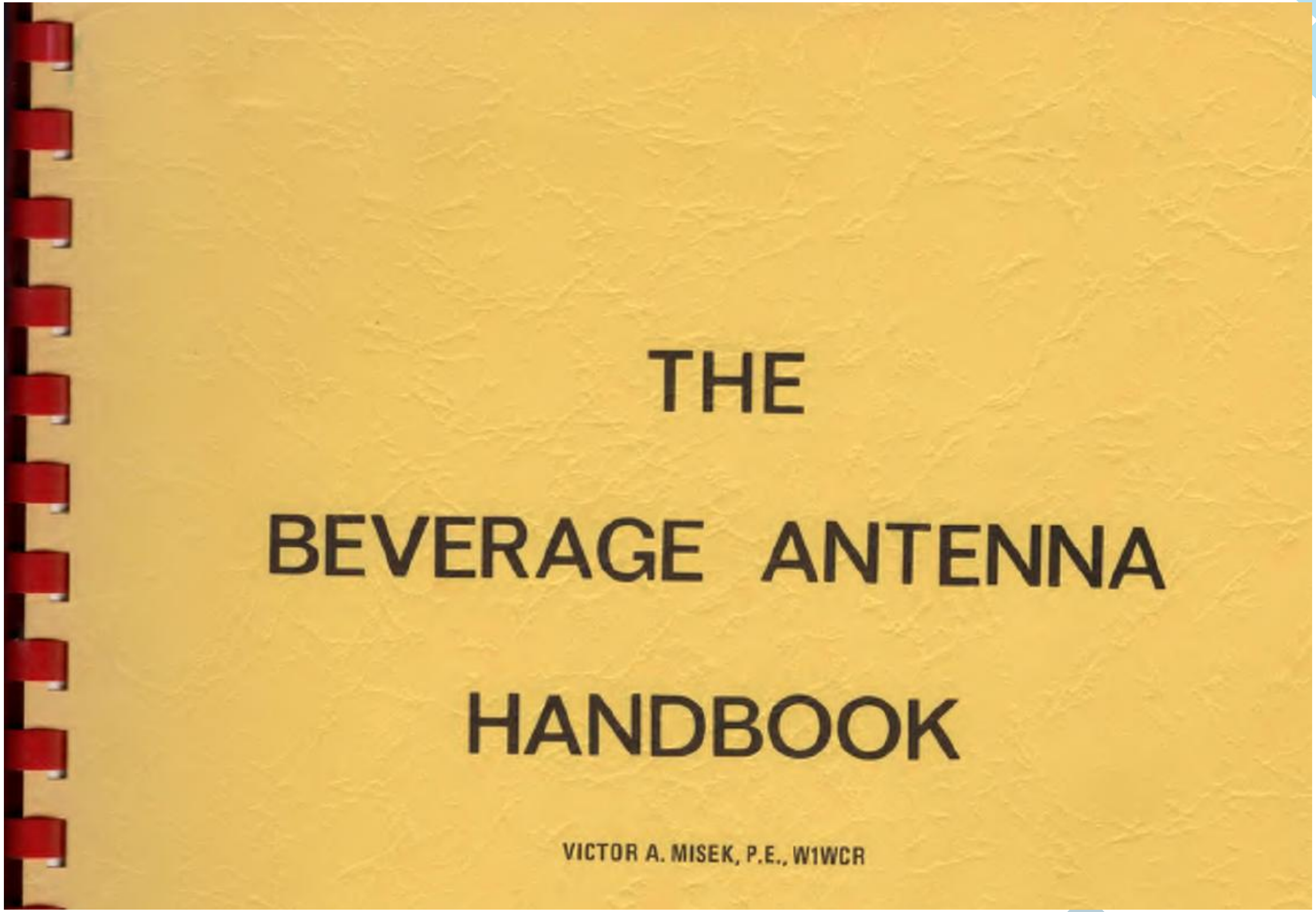
1300 Foot Beverage installed by Paul Godley 2ZE
on a beach in Androssan, Scotland
During the successful 1921 Trans-Atlantic Tests



Beverages were all but forgotten by hams for 45 years until K1PBW re-introduced them to 160 meter DXers in 1967

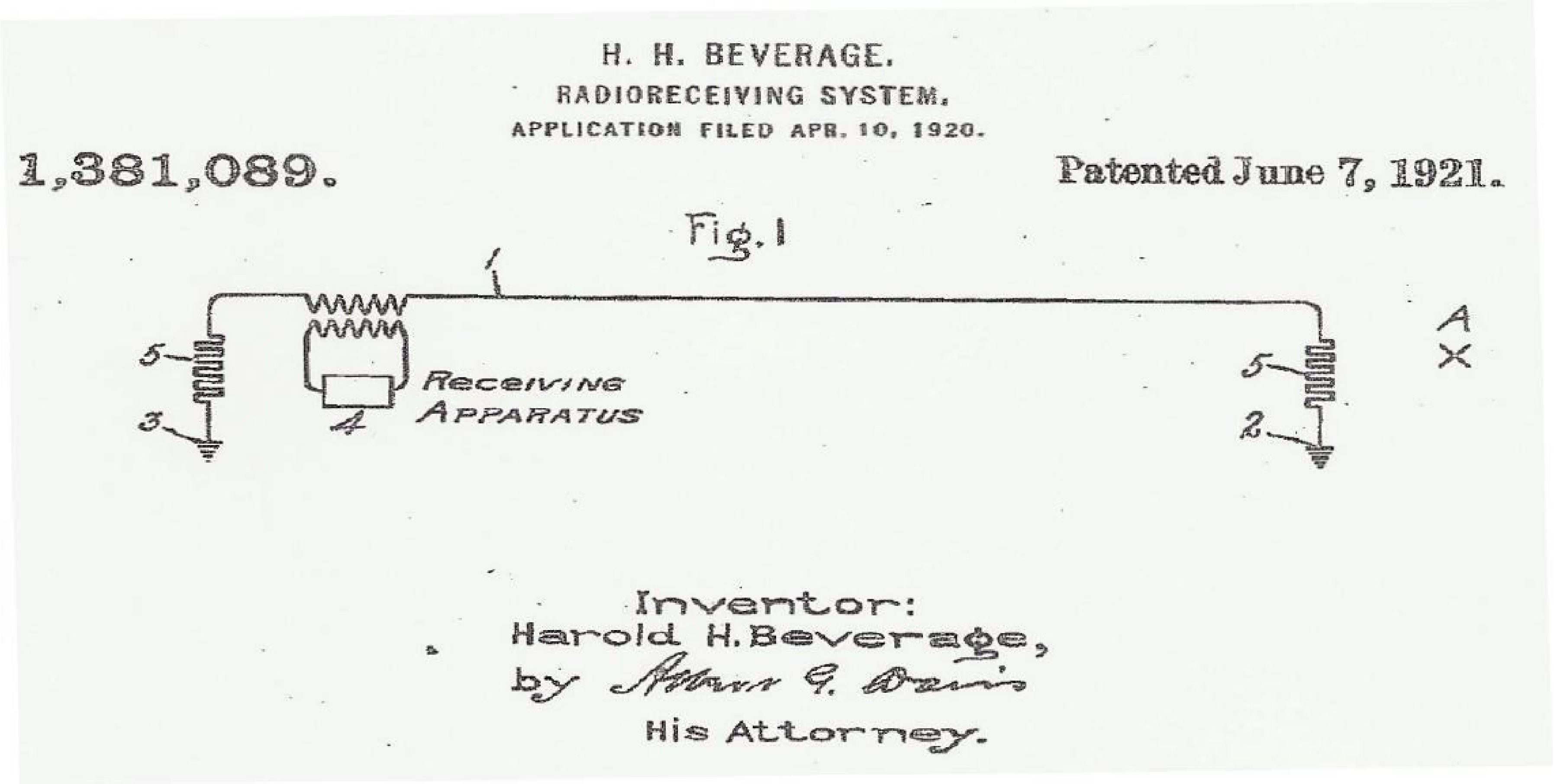


THE BEVERAGE ANTENNA HANDBOOK

VICTOR A. MISEK, P.E., W1WCR

Single Wire Beverage

The simplest and most reliable high performance receiving antenna



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http://www.w8ji.com/beverages.htm

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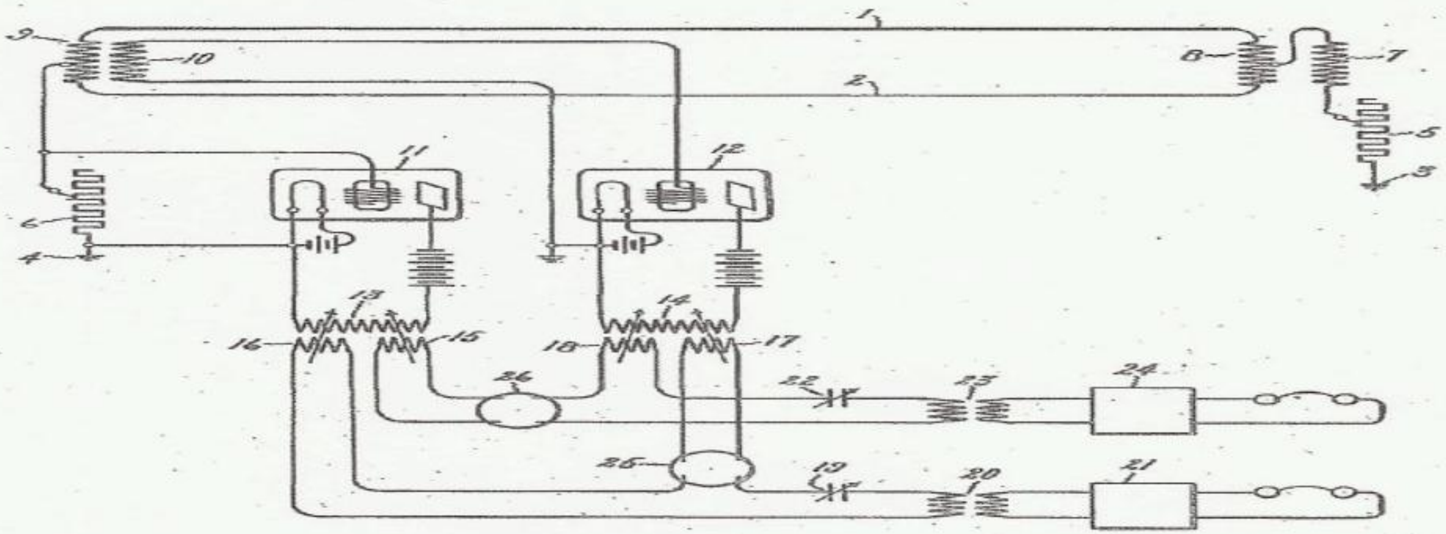
Two Wire Bi-directional Beverage - 1921

Switchable in two directions with one feed line
deep steerable rear null if both feed lines feed a variable phase controller

H. H. BEVERAGE.
RADIORECEIVING SYSTEM.
APPLICATION FILED MAY 3, 1921.

1,434,984. Patented Nov. 7, 1922.

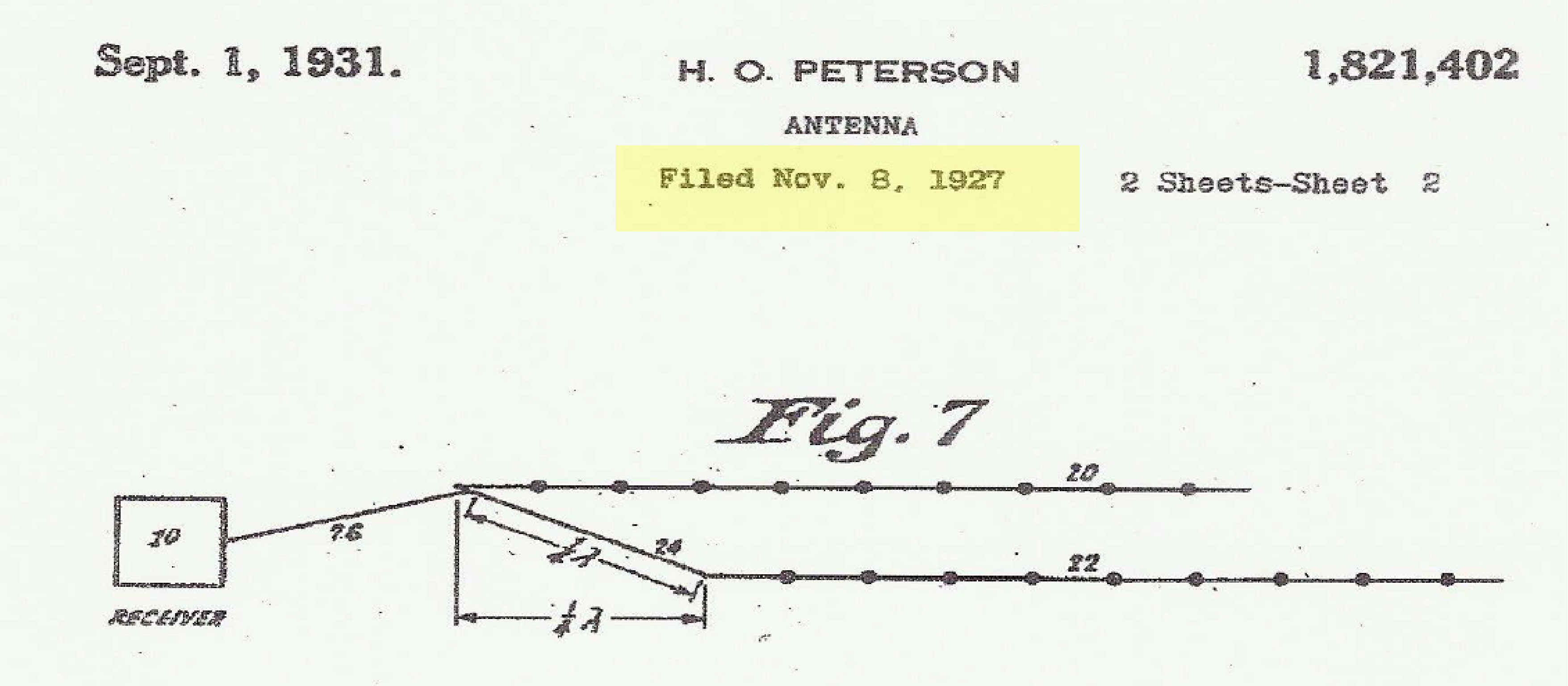


Inventor:
Harold H. Beverage,
by Albert G. Davis
His Attorney.

Staggered Beverage Array - 1927

11 dB RDF on one acre

two or three close spaced, 500 to 600 foot staggered Beverages
or two or three close spaced 225 foot BOGs -- 7 dB RDF
enhanced front-to-back ratio compared to a single Beverage or BOG
the deep rear null can be steered by a variable phase controller



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http://ncjweb.com/features/sepoct11feat.pdf

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Beverages and Beverage Arrays

6 - 14 dB RDF 45 - 120º 3 dB Beamwidth

- 250 to 400 foot Beverage 6 dB RDF 90 - 120º 3 dB beamwidth
  - approximately 7 feet high
  - single wire or two wire bi-directional
- 500 to 900 foot Beverage 8 - 10 dB RDF 50 - 70º 3 dB beamwidth
  - approximately 7 feet high
  - single wire or two wire bi-directional
- Staggered Beverage arrays 11 dB RDF 50 - 70º 3 dB beamwidth
  - two or three Beverages with 125 foot end-fire spacing
  - significantly improved front-to-back ratio especially with a variable phase controller
- Broadside Beverage arrays 12-14 dB RDF 45 - 60º 3 dB beamwidth
  - two Beverages with 350-400 foot broadside spacing, or
  - four Beverages with 125 foot end fire spacing and 350-400 foot broadside spacing

BOGs and BOG Arrays

6 to 8 dB RDF   60 - 90° 3 dB Beamwidth

- BOG   6 dB RDF   90° beamwidth
  - 225 foot wire laid just above ***but not on*** the surface of the ground
- Switchable bi-directional BOG   6 dB RDF   90° beamwidth
  - 225 foot coaxial cable laid just above ***but not on*** the surface of the ground
- Close spaced staggered BOGs   7 dB RDF   90° beamwidth
  - two or three close spaced BOGs with 125 foot end fire spacing
  - significantly improves front-to-back ratio especially if a variable phase controller is used
- Two wide spaced BOGs   8 dB RDF   60° beamwidth
  - 350-400 foot broadside spacing

BOGs are low sensitivity antennas requiring significant suppression of common mode signals from the coaxial cable feed line

Arrays of Short Verticals

9 - 14 dB RDF 50-135º 3 dB Beamwidth

- Active high impedance 20 foot verticals
  - capable of multi-band operation
  - requires a high input impedance amplifier *at the base of each vertical*

----- or ----

- Passive low impedance 25 foot verticals
  - mono-band antenna only
  - **easy to troubleshoot and repair** **low parts count** **very reliable**
  - eight 70 foot or sixteen 35 foot radials *at the base of each vertical*
    - stabilizes the feed point impedance during all weather conditions
    - decouples the coax shield
  - four 25 foot umbrella wires
    - reduces the required height to 25 feet
    - increases the array bandwidth
    - *if necessary*, 35 foot verticals with no umbrella wires can be substituted

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Any monoband array of phased short verticals can use either high or low impedance verticals

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Electrically Steerable 4-Square Vertical Array

12 dB RDF on less than ¼ acre

four *high impedance* 20 foot verticals
no radials or umbrella wires
80 x 80 foot square x 20 feet high
high input impedance amplifier at the base of each vertical
switchable in four directions
100° 3 dB beamwidth

Electrically Steerable 8-Circle Vertical Array

13.5 dB RDF on only ¾ acre

eight *high impedance* 20 foot verticals

no radials and no umbrella wires

requires a high input impedance amplifier at the base of each vertical

only 200 foot diameter array

switchable in eight directions with 106^o phasing

50^o 3 dB beamwidth, equivalent to a 5 element Yagi

www.hizantennas.com/8_element_arrays.htm

Electrically Steerable 8-Circle Vertical Array

13.5 dB RDF on four acres

eight *low impedance* 25 foot umbrella verticals
four 25 foot umbrella wires installed on each vertical
eight 70 foot or sixteen 35 foot radials installed under each vertical
350 foot diameter with 1/4 wavelength spacing plus space for radials
or only 200 foot diameter with a Hi-Z 106 degree phasing controller
switchable in eight directions
Very easy and inexpensive to build
50º 3 dB beamwidth, equivalent to a 5 element Yagi

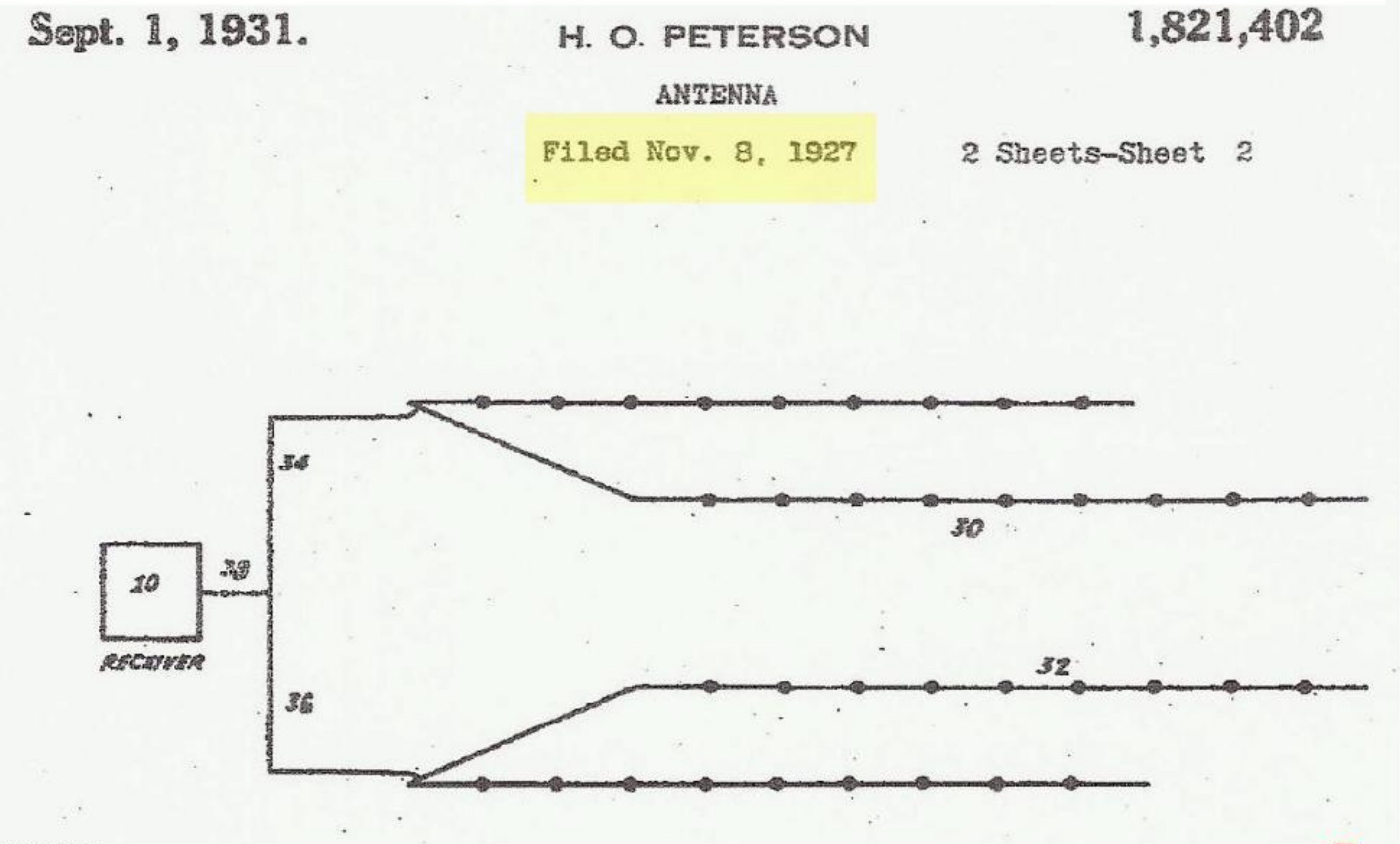
construction details: http://www.w5zn.org

Broadside Pair of Staggered Beverages - 1927

14 dB RDF on 8 Acres

800 to 900 foot Beverages, 330 foot broad side spacing

45º 3 dB beamwidth



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Ancillary device to lower noise/interference with 2 separate Antennas

- Adjustable antenna phasing provides null steering
- Can dramatically reduce local noise

Noise Reduction in our station assists in reducing the noise floor to improve SNR.

Essential Common-mode Chokes

Chuck Councilman -- W1HIS

YCCC.org download the articles

Succinct Articles -- out of many

Noise and Receive Antennas W2EEY 73 mag May 1972

find it at: Worldhistory.com/archive-all-amateur/73

Secrets of Successful Low Band Ops Pts 1 and 2 – Ham Radio mag 1986

find it at: archive.org/details/hamradioversion/HR_1986

Simple Low Band Receive Antennas– Ward Silver N0AX

find it at the DX Engineering.com blog Hard Core DX

Summary

- **Receive antennas have from very long Beverages to hula-hoop sized antennas.**
- **Along with that – receiver technology – continues to improve.**
- **But the ether hasn't changed — noise is still the enemy**
- **Our job: maximize SNR using smart antennas and noise control**

Bibliography and References

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- Low-Band Dxing – ON4UN – Chapter 7 -- Receiving Antennas
- Receiving Antennas for the Radio Amateur – Eric Nichols – KL7AJ
- Antennas Mastered – Peter Dodd – G3LDO RSGB Pub
- Receiving Antenna Handbook – Joe Carr – K4IPV – Chapter 11
- Contest University – May 16, 2024 – www.ctu.org Frank Donovon W3LPL
- The Internet and AI via ChatGPT and Microsoft Copilot
- Genius at River Head – HH Beverage Profile – Alberta I. Wallen

Bibliography and References

- **K9AY Terminated Loop QST Sept 1997   AYTechnologies.com Gary Breed K9AY**
- **Noise and Receive Antennas W2EEY 73 mag May 1972   find it at: Worldhistory.com/archive-all-amateur/73**
- **Secrets of Successful Low Band Ops Pts 1 and 2 – Ham Radio mag 1986   find it at: archive.org/details/hamradioversion/HR_1986**
- **Aziloop at Quietradio.uk   DF72 VLF and HF**
- **Coplanar Twin Loop – QST Sept 1988 Reduce skywave interference**
- **Simple Low Band Receive Antennas – Ward Silver N0AX Dxengineering.com Blog**
- **The Loop Antenna as a Probe – King and Whiteside – IEEE Ants and Prop April 1964   From AI and Web searches**
- **W1FB Antenna Handbook – Doug DeMaw W1FB**
- **Chuck Councilman W1HIS   @ YCCC.org Common Mode Choke Articles**

Receive Antennas – A Review by Rick W5RH

Thanks for listening, now go improve your station's ears.

February 12, 2026 BVARC

Smoking

Crow

Productions

---The End---

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Rick Hiller – W5RH