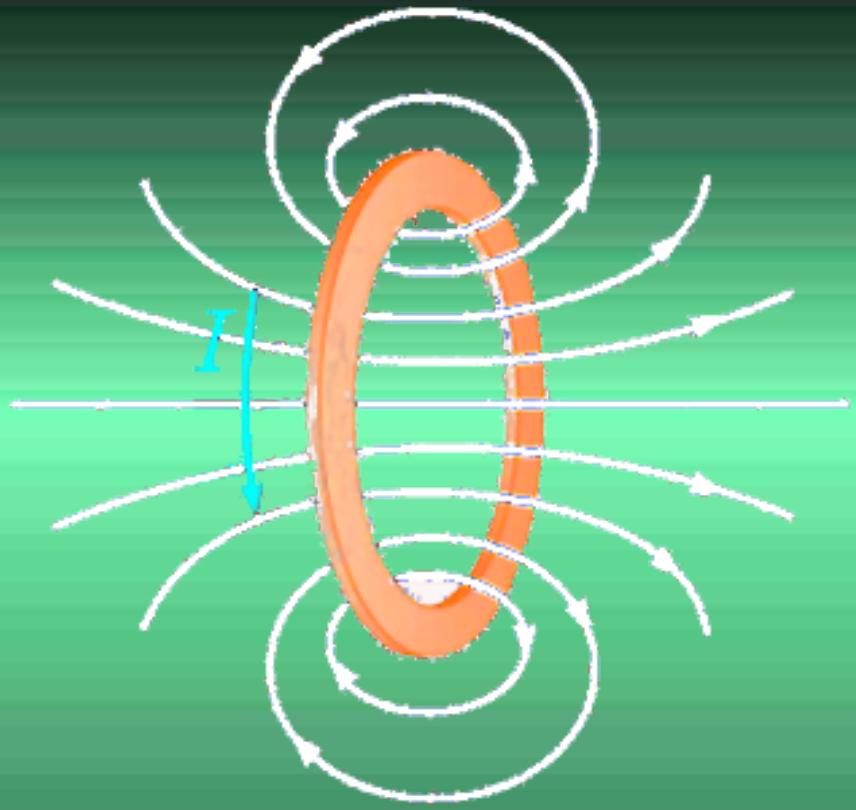
In Search of the "Optimized" Magnetic Loop



Magnetic Loop Antennas

Few Optimized Web Designs

Many Misleading Ads

Little Sound Principle How to Optimize

Optimize

SWR

Simple Dipole

One-Step Optimize:

L = f / 468

MORE for Magnetic Loops

1. Relative conductor diameter
2. Construction material
3. Loop shape
4. Self-resonance
5. Matching method
6. Tuning method
7. Receive only

This Presentation

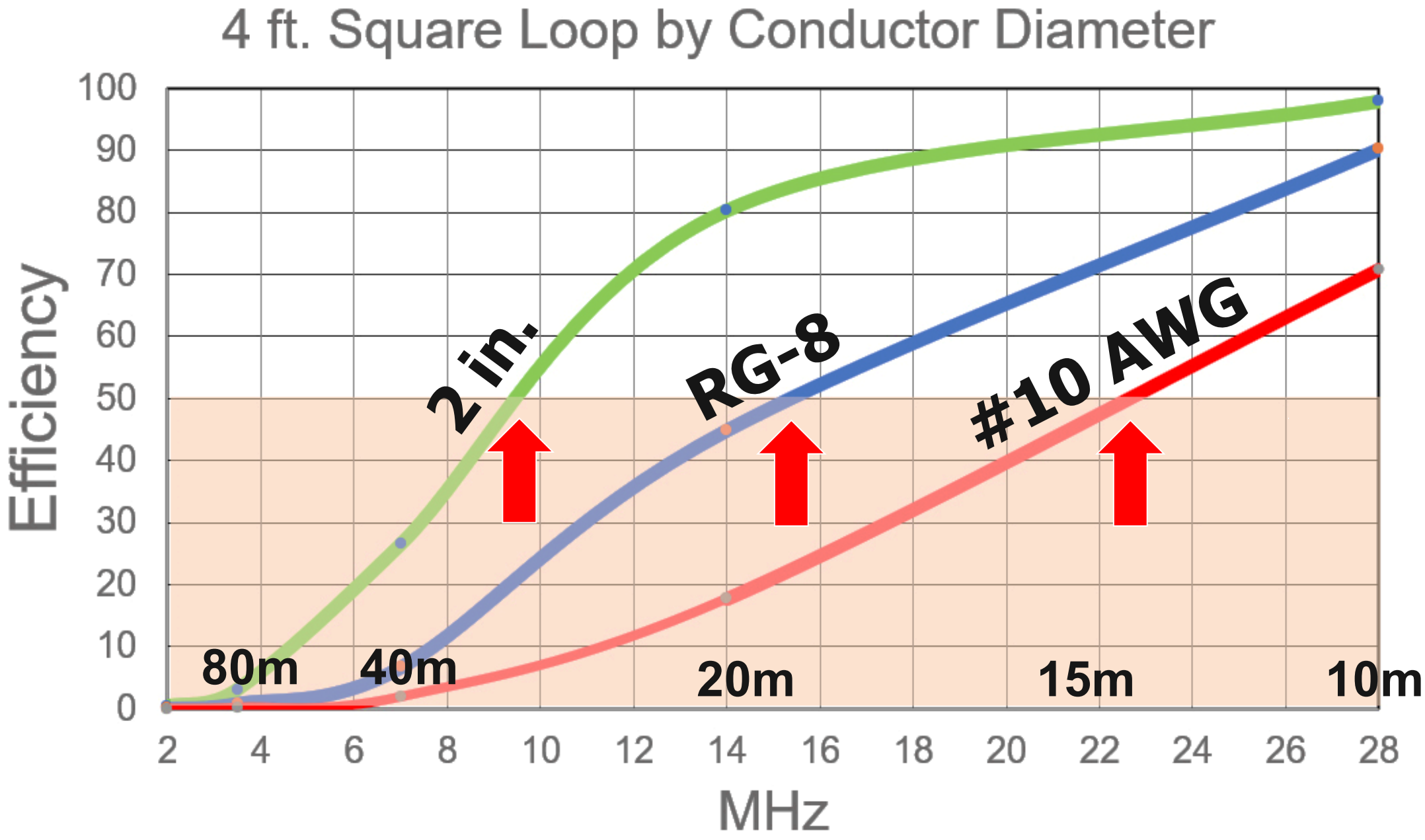
NOT – How they work
NOT – Their Pros/cons
NOT – How to build them

BUT – How to Optimize them
Factors → Max Performance

Factor 1

Relative Size of the Conductor

Efficiency / Lowest Frequency


4 ft. Square Loop by Conductor Diameter
Efficiency
100
90
80
70
60
50
40
30
20
10
0
2 in.
RG-8
#10 AWG
80m
40m
20m
15m
10m
2
4
6
8
10
12
14
16
18
20
22
24
26
28
MHz

TAKE AWAY:

EMBED

The next image deep in your mind

Relative Loop to Conductor Diameter Ratio

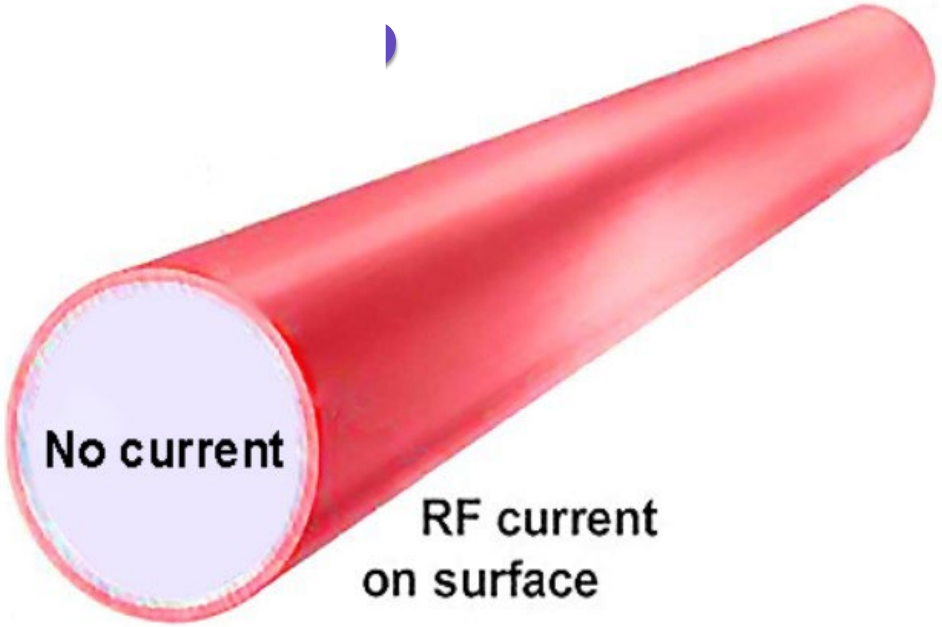
Ciro Mazzoni MIDI "Magnetic" Loop Antenna

Efficient down to 40-meters

Factor 2

Material

$ $ $ £ £ £ ¥ ¥ ¥ € € €



Aluminum Wire

Skin Effect AC/RF flows on the surface

Center of the conductor is not needed

3X Skin Depth

Band	Aluminun mils	Copper mils
80-m	5.1	4.2
40-m	3.6	3
20-m	2.7	2.1
10-m	1.8	1.5
2-m	0.9	0.6
440 MHz	0.6	0.3

mils = 1/1000 in.

Solid metal not required

Foil on PVC just as good

Buy tape of sufficient thickness

Optimized Materials

Aluminum AC Duct Tape

Aluminum is 40% less conductive than Copper

BUT, 2x thicker skin

Equal Loop Materials

You're shopping Santa Maria
OPEN until 10 pm
Delivering to 93455

Store Finder | Truck & Tool Rental | For the Pro | Gift Cards | Credit Services | Track Order | Help

1 1/2 copper pipe

My Account | Lists | Cart | 0 items

All Departments | Home Decor, Furniture & Kitchenware | DIY Projects & Ideas | Project Calculators | Installation & Services | Specials & Offers | Local Ad & Catalog

Home / Plumbing / Pipe & Fittings / Pipe / Copper Pipe

Internet #100354223 Model #1-1/2 L 10 Store SKU #741810

56

Cerro

1-1/2 in. x 10 ft. Copper Type L Hard Temper Straight Pipe

★★★★★ (3) Questions & Answers (3)

$128

Late 2022

3.8k

JM EAGLE

1-1/2 in. x 10 ft. 330-PSI Schedule 40 PVC DWV Plain End Pipe

★★★★★ (366) Questions & Answers (23)

$16.78

2 length for 4 ft. loop

Optimize the Cost

Factor 3

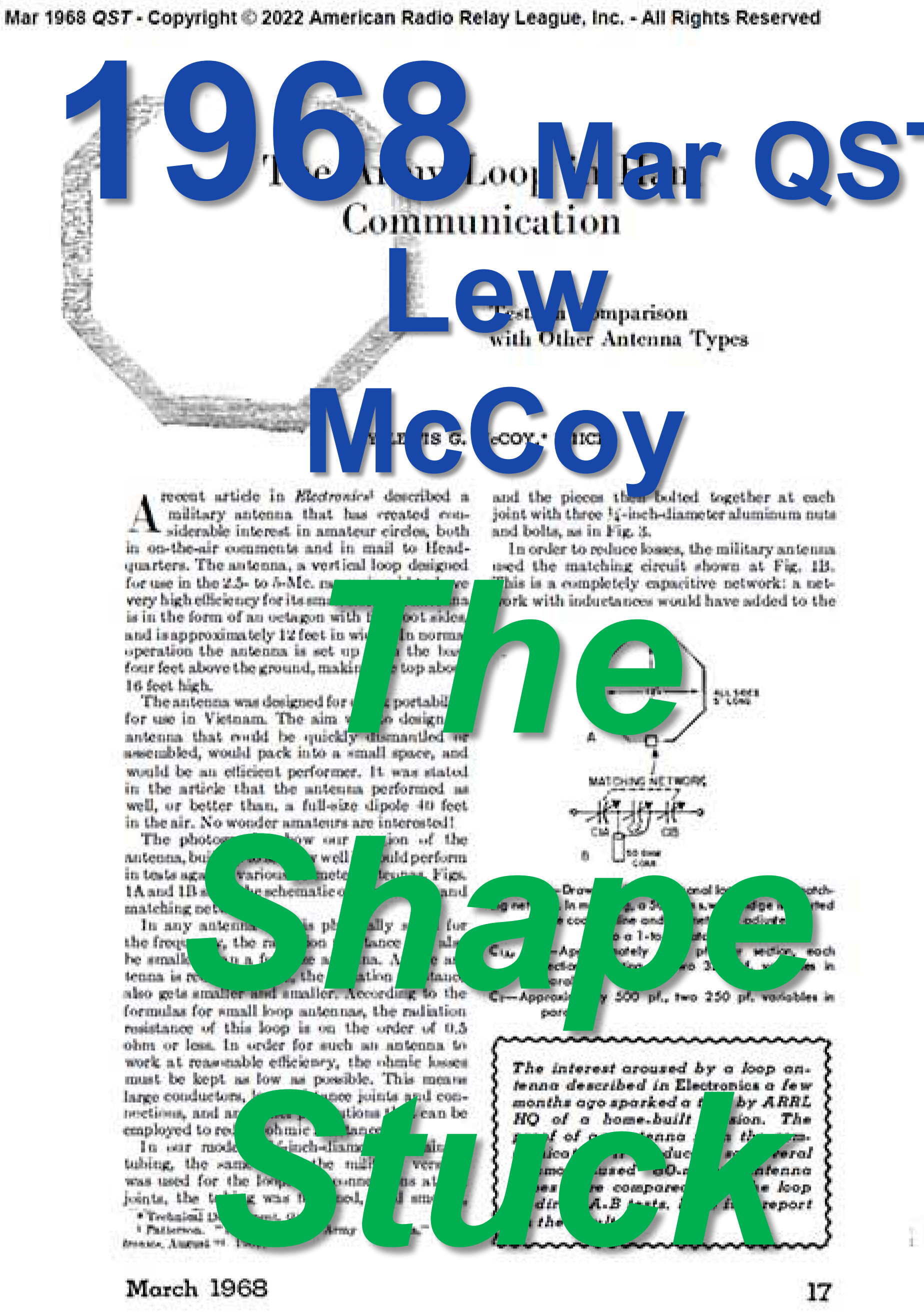
Loop Shape

Choice, Neighbors, HOA

1968 Mar QST

Lew McCoy

The Shape Stuck



The Army Loop in Ham Communication

Tests in Comparison with Other Antenna Types

A recent article in *Electronics*[1] described a military antenna that has created considerable interest in amateur circles, both in on-the-air comments and in mail to Headquarters. The antenna, a vertical loop designed for use in the 2.5- to 5-Mc. range [illegible] very high efficiency for its [illegible] is in the form of an octagon with [illegible] foot sides, and is approximately 12 feet in wi[illegible] In normal operation the antenna is set up [illegible] the base four feet above the ground, makin[illegible] top about 16 feet high.

The antenna was designed for [illegible] portabil[illegible] for use in Vietnam. The aim [illegible] design [illegible] antenna that could be quickly dismantled or assembled, would pack into a small space, and would be an efficient performer. It was stated in the article that the antenna performed as well, or better than, a full-size dipole 40 feet in the air. No wonder amateurs are interested!

The photo[illegible] show our [illegible] of the antenna, bui[illegible] well [illegible] would perform in tests ag[illegible] various [illegible] Figs. 1A and 1B [illegible] schematic [illegible] and matching net[illegible]

In any antenn[illegible] for the frequ[illegible] the ra[illegible] also gets smaller and smaller. According to the formulas for small loop antennas, the radiation resistance of this loop is on the order of 0.5 ohm or less. In order for such an antenna to work at reasonable efficiency, the ohmic losses must be kept as low as possible. This means large conductors, [illegible] joints and connections, and [illegible] can be employed to re[illegible] ohmic [illegible]

In our mode[illegible] tubing, the same [illegible] the mili[illegible] was used for the loop [illegible] joints, the t[illegible]

and the pieces then bolted together at each joint with three ¼-inch-diameter aluminum nuts and bolts, as in Fig. 3.

In order to reduce losses, the military antenna used the matching circuit shown at Fig. 1B. This is a completely capacitive network: a network with inductances would have added to the

MATCHING NETWORK

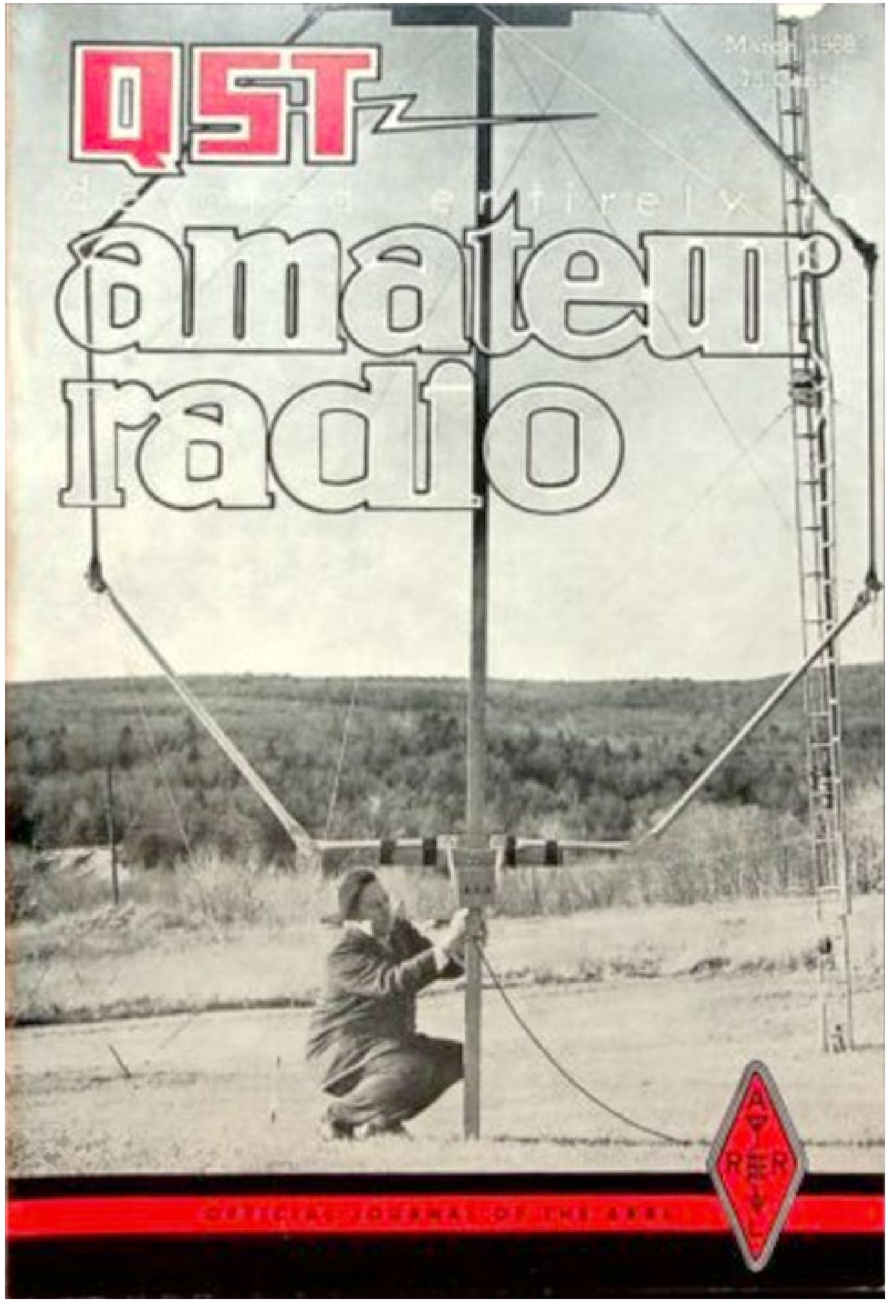
ALL SIDES 5' LONG

50 OHM COAX

C₁—Approximately 500 pf., two 250 pf. variables in par[illegible]

The interest aroused by a loop antenna described in Electronics a few months ago sparked a t[illegible] by ARRL HQ of a home-built [illegible]sion. The [illegible]

March 1968 17

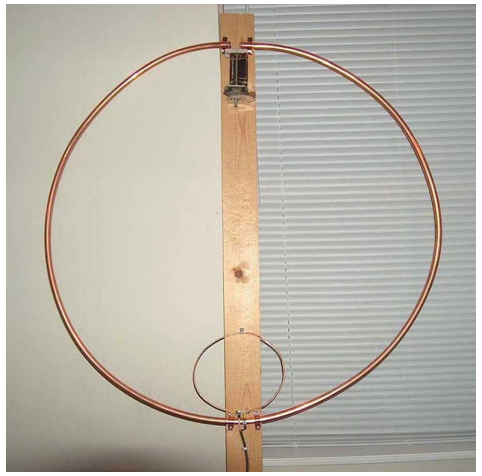


The Army Loop

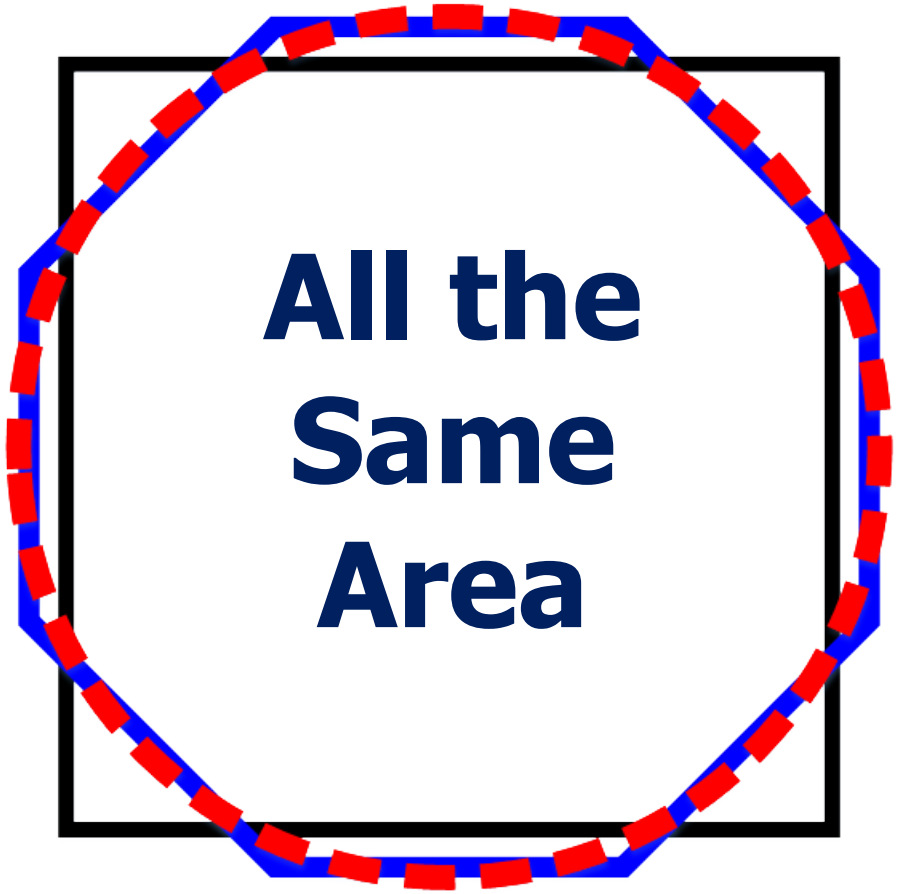
Kenneth H. Patterson, U.S. Army Limited War Laboratory, Maryland

Viet Nam

Michael Faraday – works by area not shape



Square
Easiest
Optimized
Shape



Least Noticeable Shape

SQUARE – Rose Trellis

Is it a Garden Decoration or a “Magnetic” Loop?

(Old trampoline frame)

Cute

Ineffecient Conductor Size

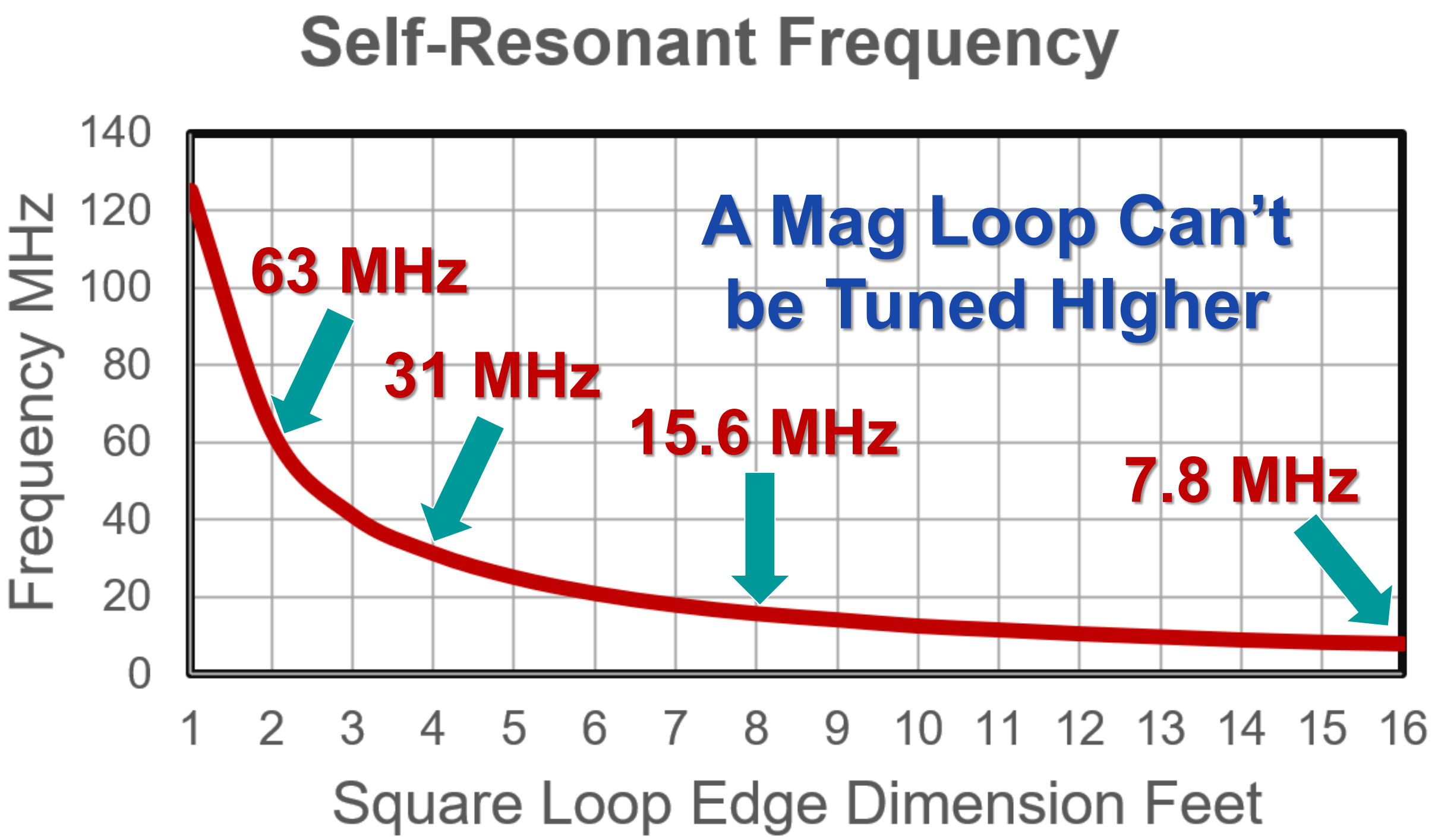
Good Tuning Capacitor

Factor 4

Self-Resonance

Sets the Maximum Frequency


Inductance
Self-
Resonance
Capacitance


Self-Resonant Frequency
Frequency MHz
140
120
100
80
60
40
20
0
63 MHz
31 MHz
15.6 MHz
7.8 MHz
A Mag Loop Can't be Tuned Hlgher
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Square Loop Edge Dimension Feet

Design TIP

Mono-band Loop

Make size just above band for min. tuning C, max. efficiency

6-meters, 2 ft. SRF 63 MHZ

Rob Jahnke K0XL

Ciro Mazzoni MIDI Magnetic Loop Antenna

Can’t work above 25 MHz

Ciro Mazzoni MIDI "Magnetic" Loop Antenna

Can't work 10-meters

TAKE AWAY:

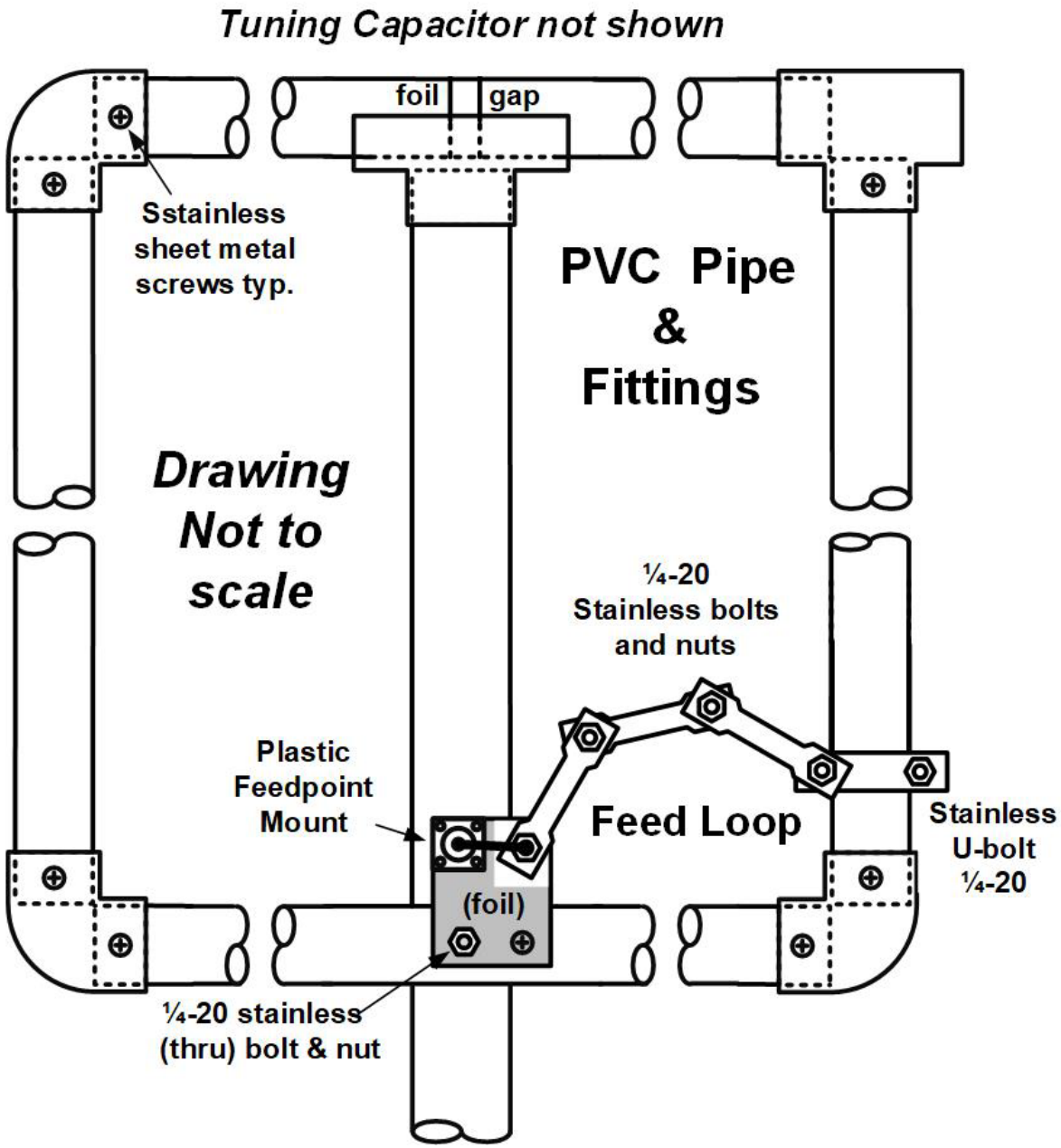
No one mag loop
can work
ALL HF bands

More than one

An Optimized Example

1½ PVC
(1.9 OD)

4-foot
square

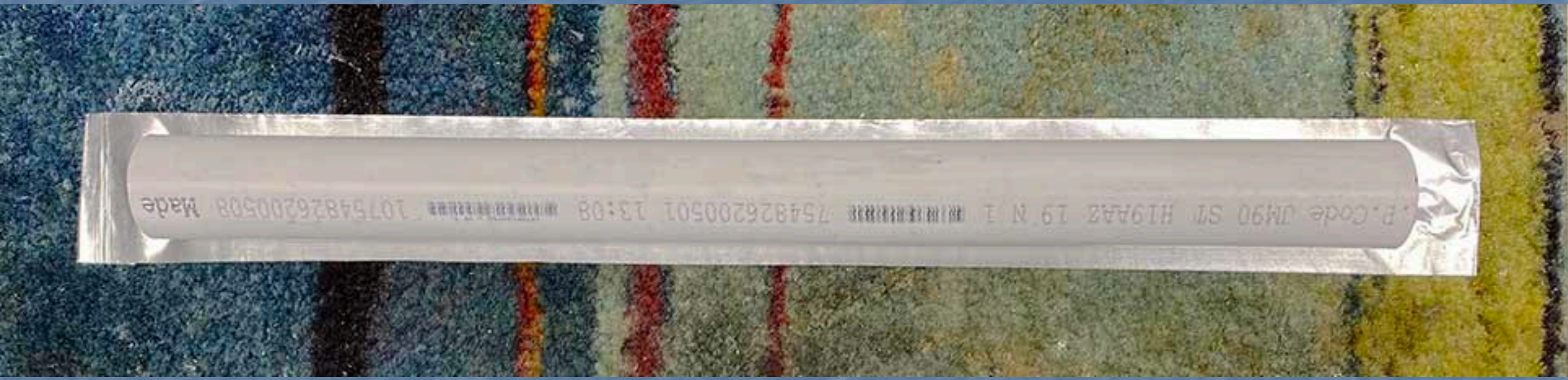


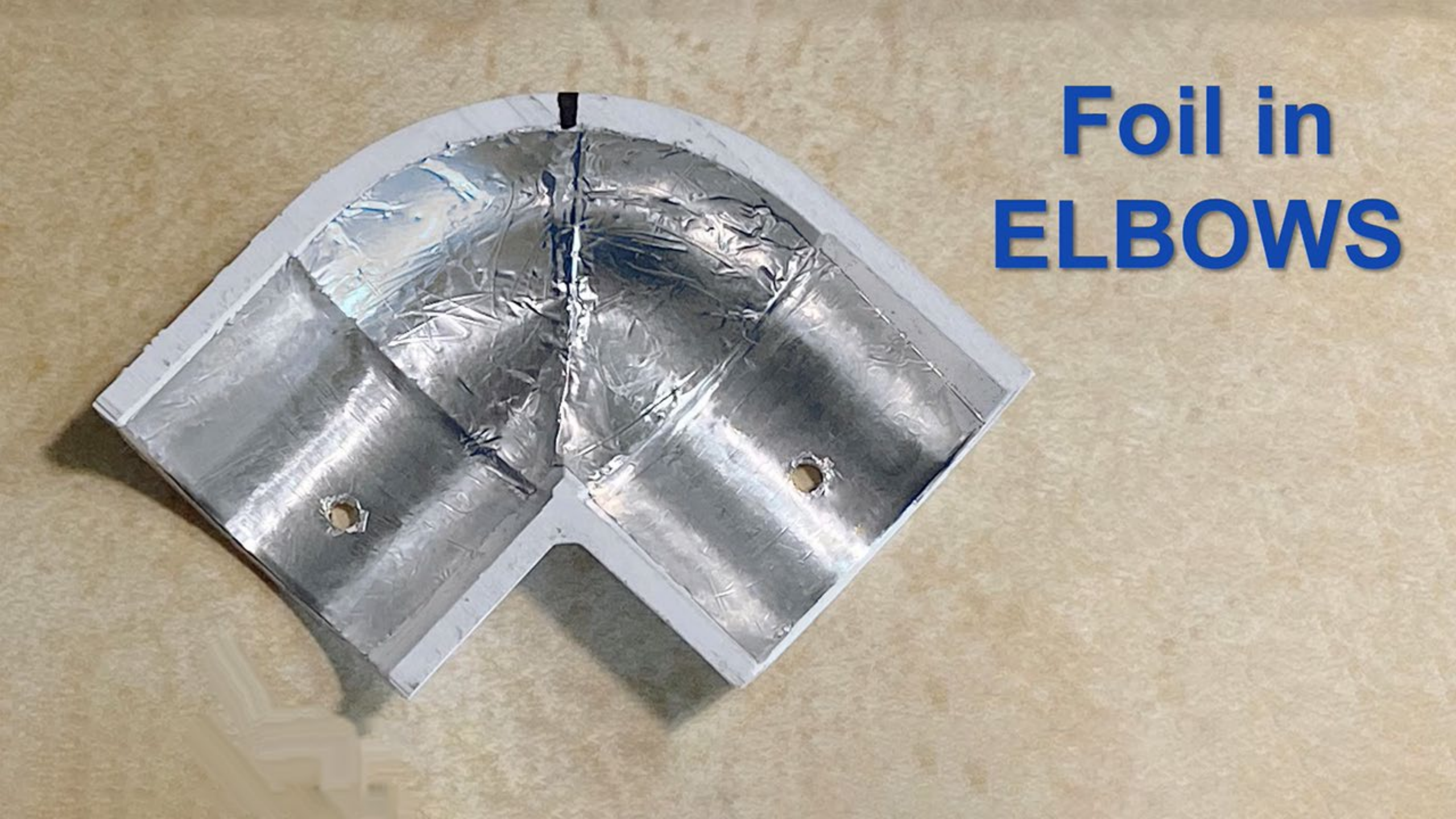
Vertically cut elbows/Tee, foil inside

2 in. mast and half Tee Saddle

w6nbc.com/slides

Applying Foil to PVC pipes




Foil in
ELBOWS

MG Chemicals Shielding Paints

Copper/Silver

Nickel

Soft Conductive Copper Nickel Plated Electricity Magnetic RF Shielding Fabric for Smart Meters 39"x43"

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$13.99

prime

FREE Returns

Size: **Width 43" inch / Length 39" inch**

Width 43" inch / Length 39" inch $13.99 prime	Width 43" inch / Length 78" inch $24.99 prime	Width 43" inch / Length 197" inch $62.99	
50 meters long $600.00	100 meters long $1,100.00		

Material	Nickel+copper+polyester
Color	Silver
Fabric Type	Polyester

HF Mountain Toppers, RV'ers, Portable

Radios
Portable Power
Computers
Antennas – A problem

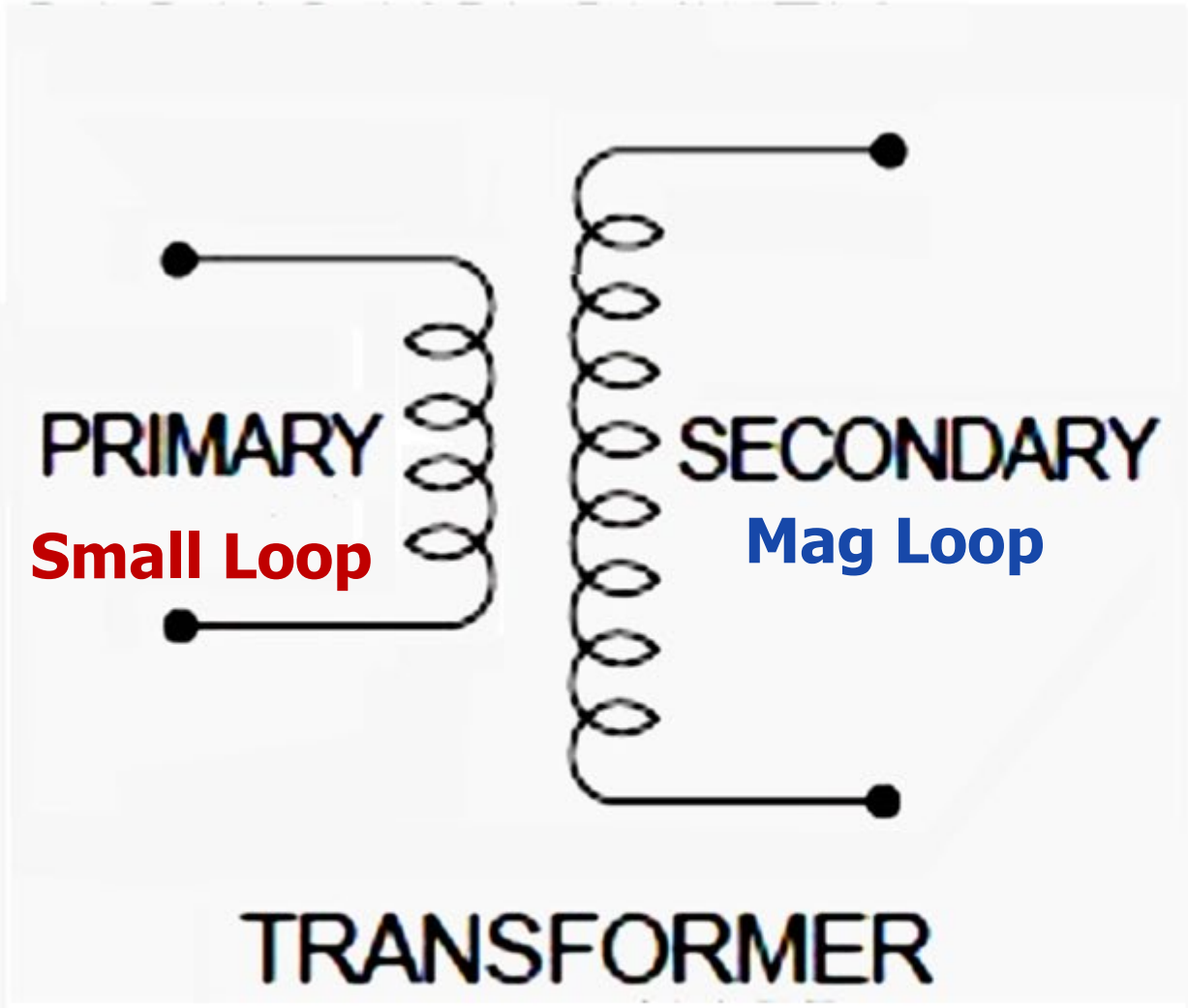
→ Small Whip? Wire over bush ?

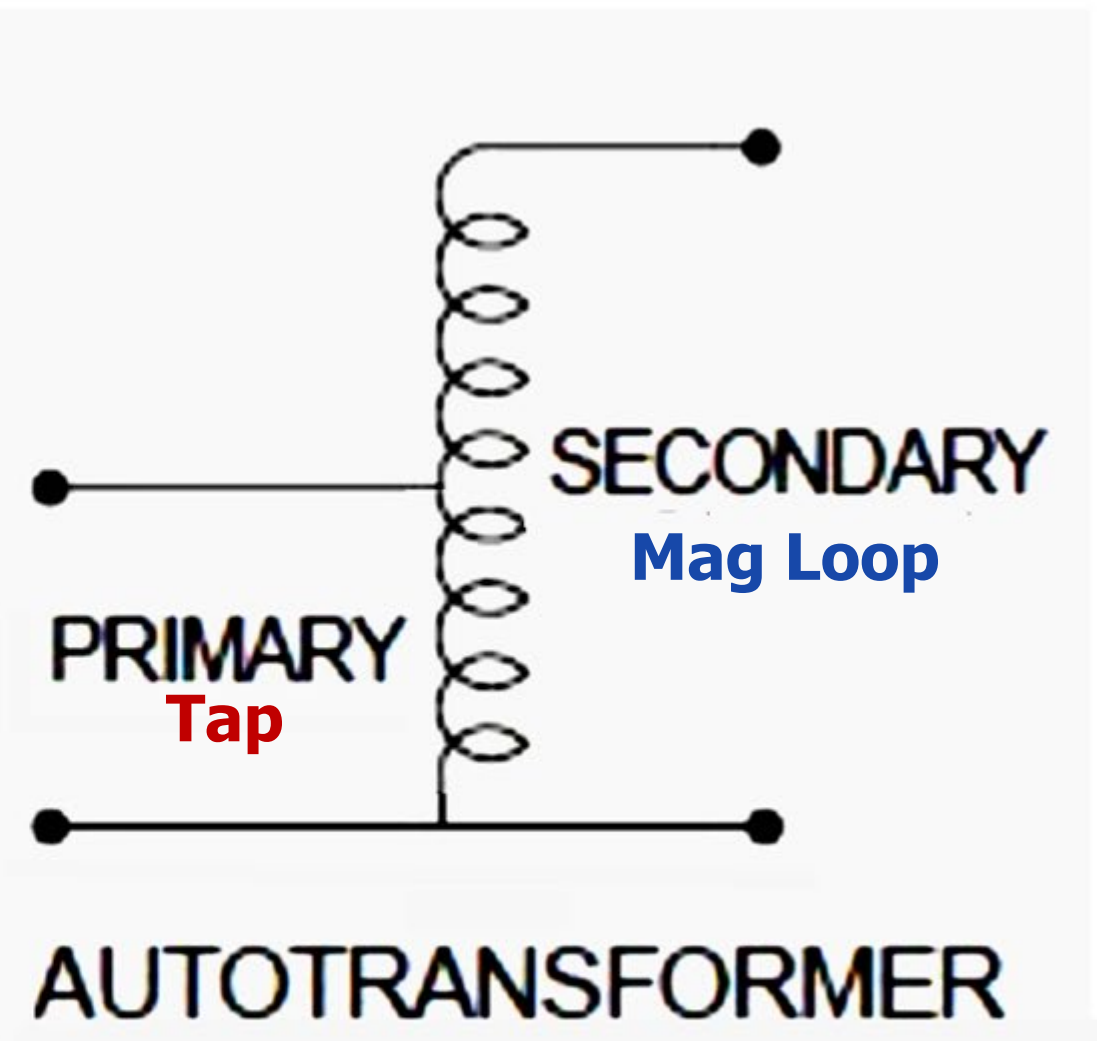
Inflated Portable Loop on Portable PVC Stand

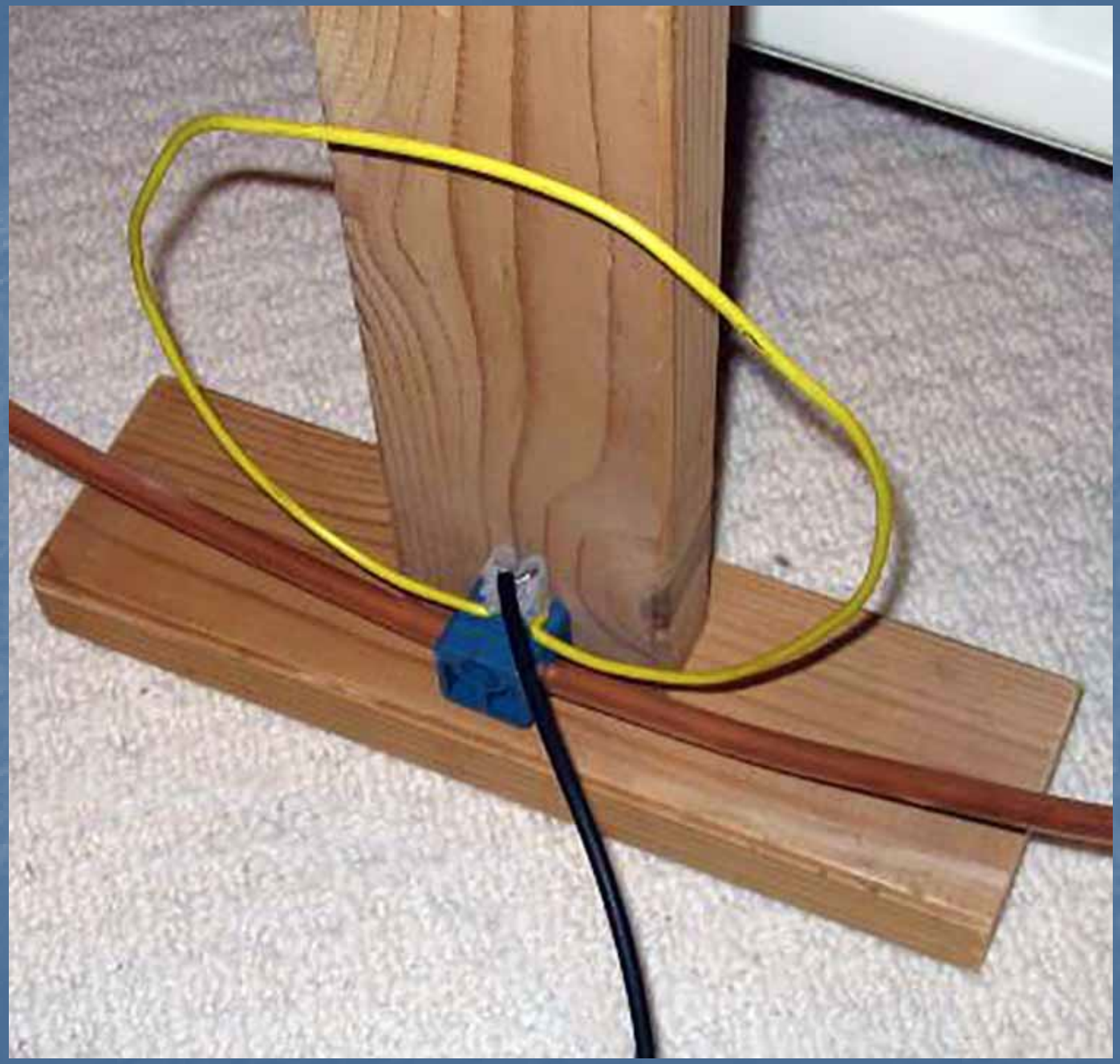
Factor 5

Matching

Ruggedness, Simplicity

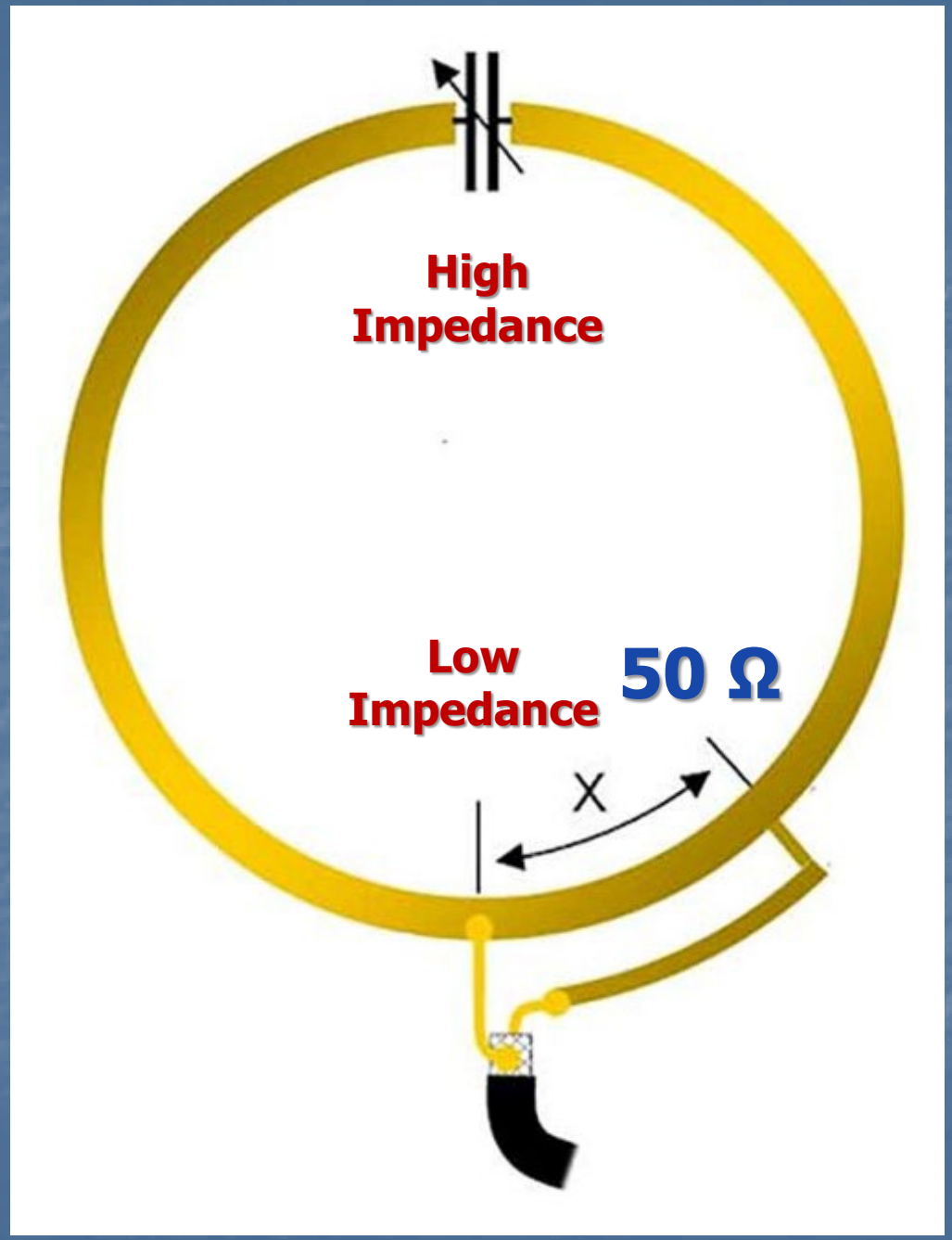

PRIMARY
Small Loop
SECONDARY
Mag Loop
TRANSFORMER


SECONDARY
Mag Loop
PRIMARY
Tap
AUTOTRANSFORMER



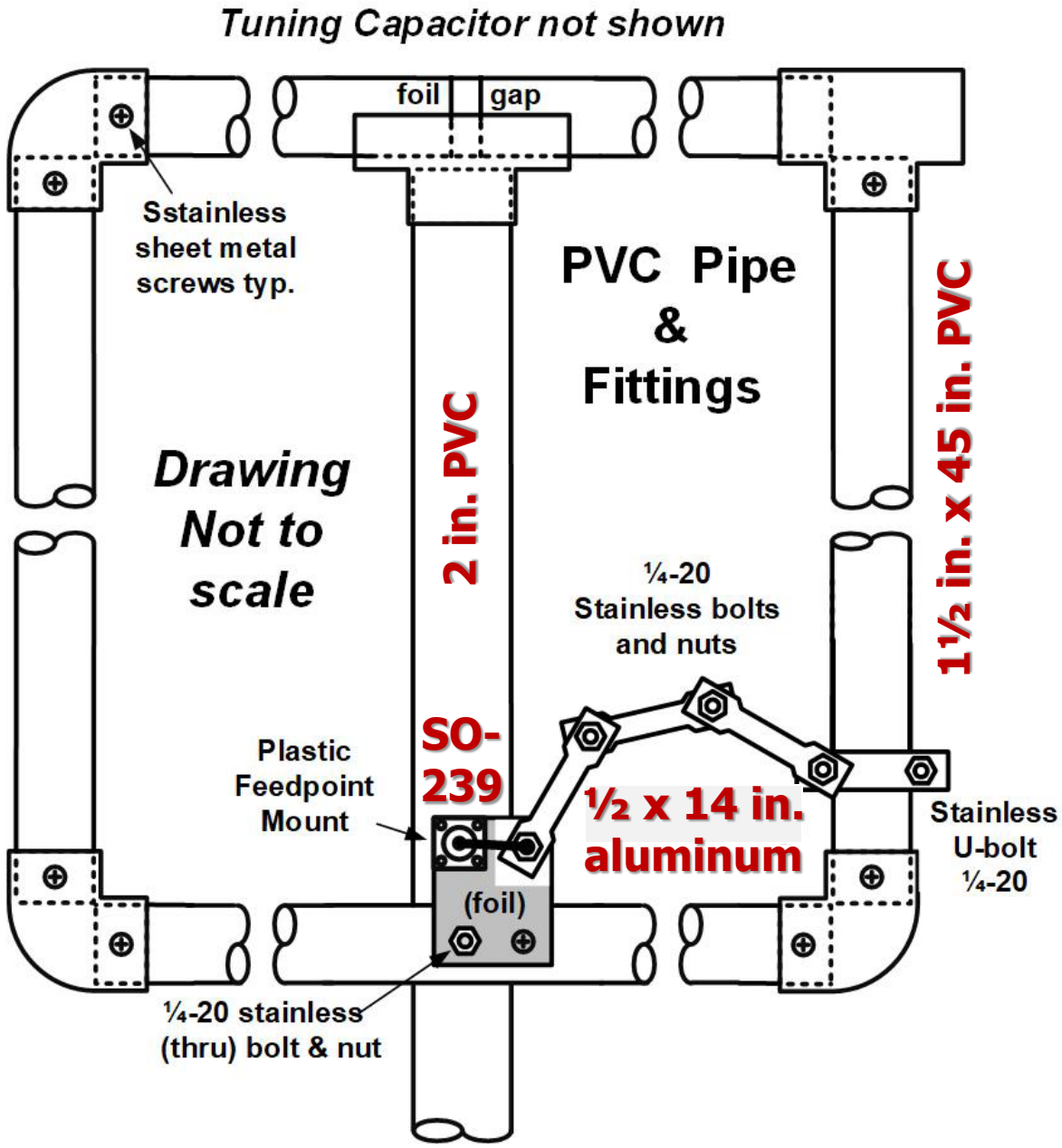
Small Separate Loop

Transformer



Tap Match

Auto Transformer



Aluminum tubing flattened and drilled 1/4-20 & U-bolt

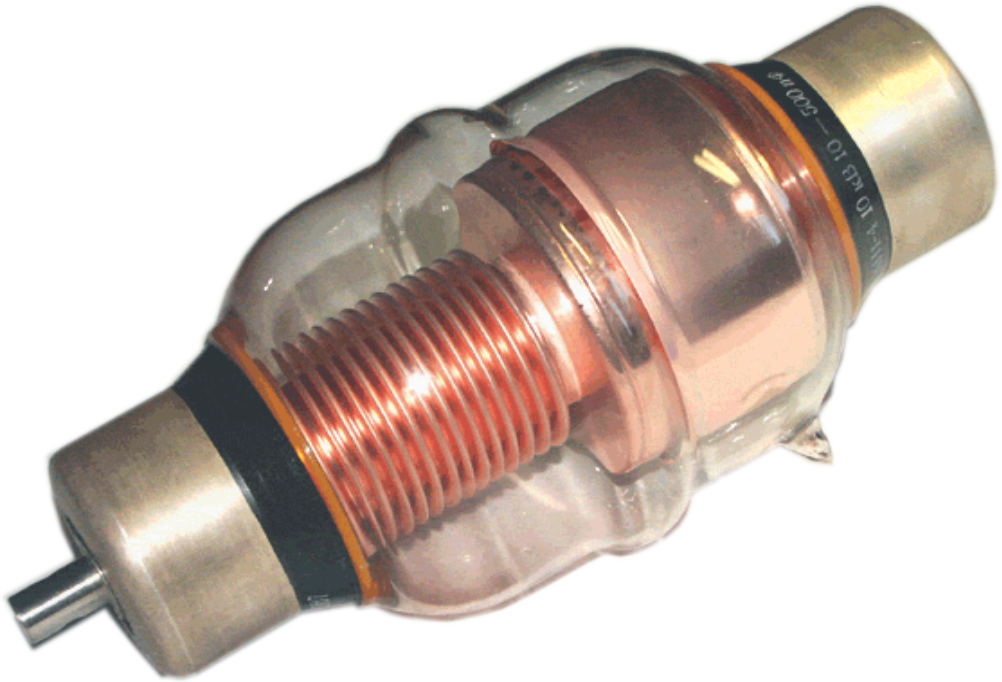
RF Auto-Transformer

Factor 6

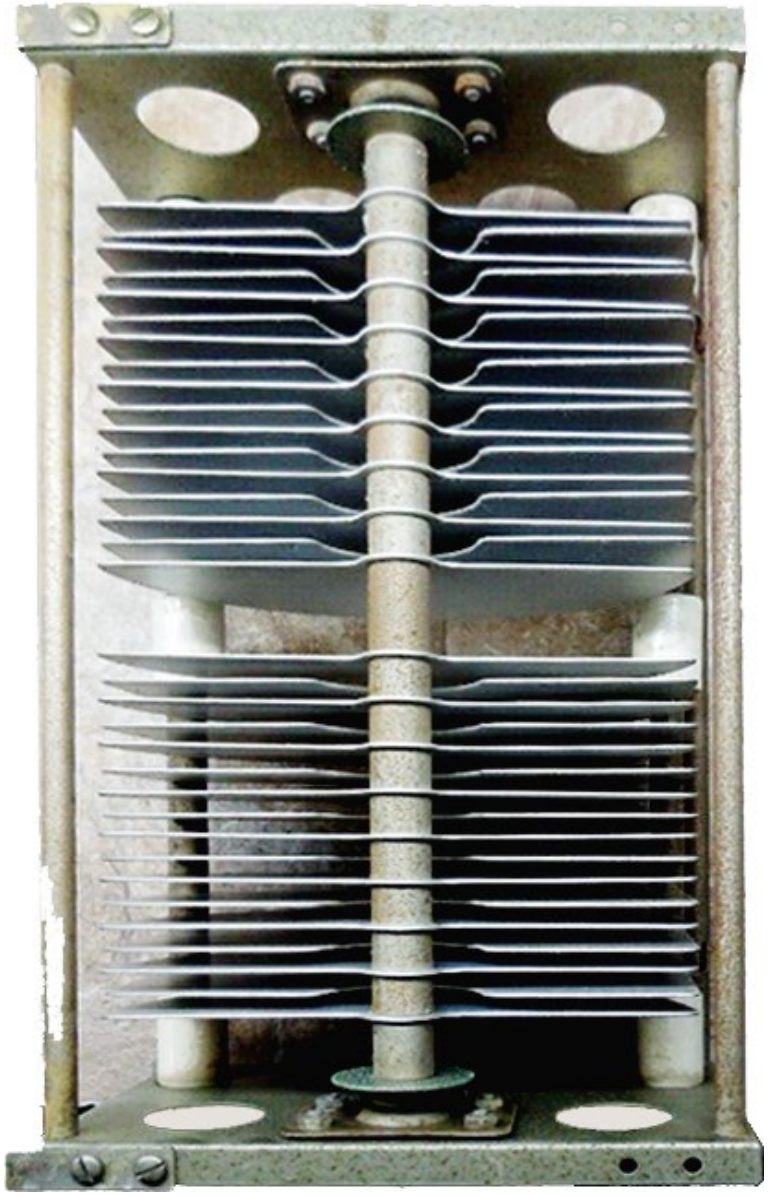
Tuning

Still Developing

Vacuum Variable



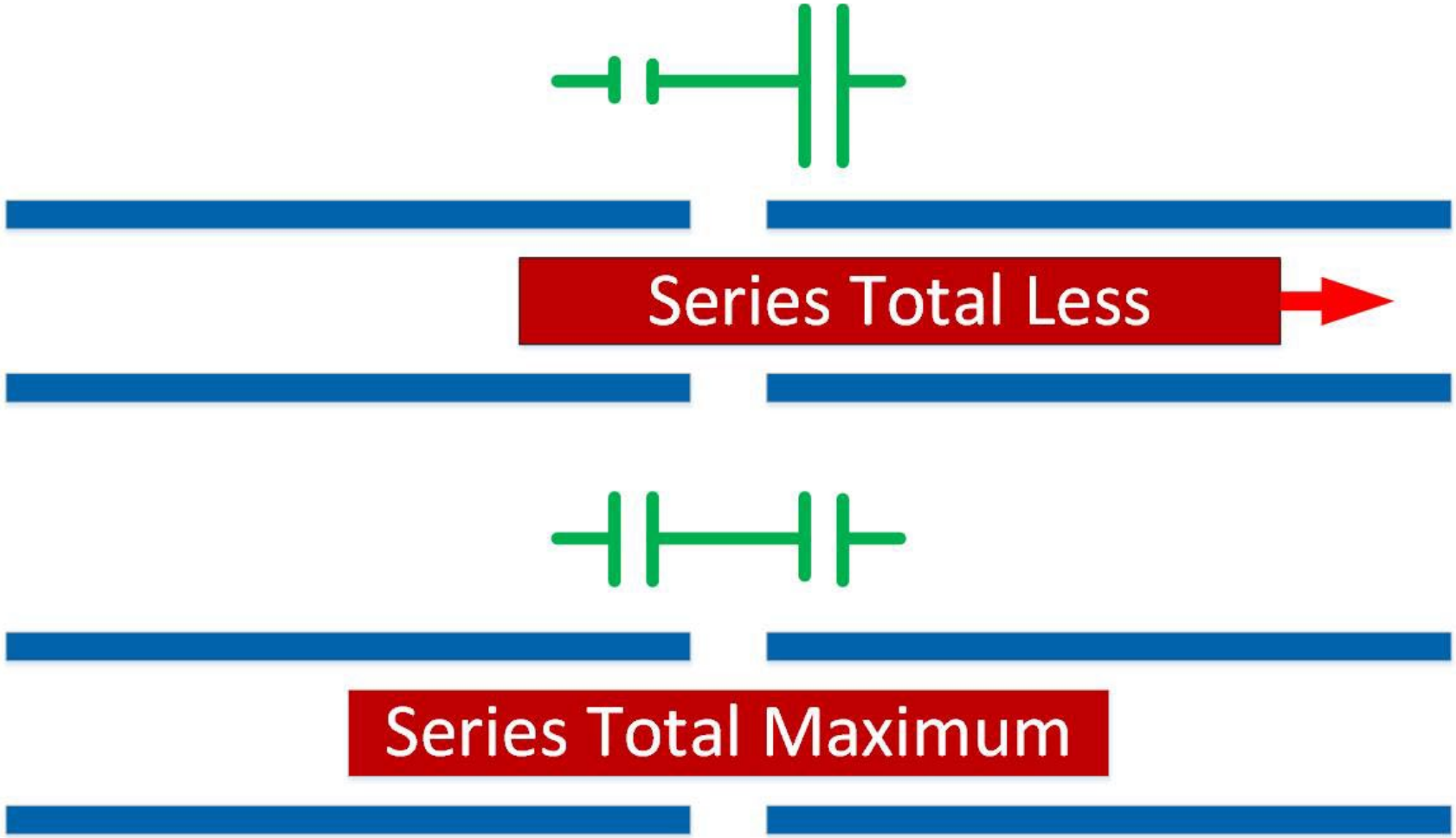
Rotary Variable



ORIGINAL COST OPTIMIZATION

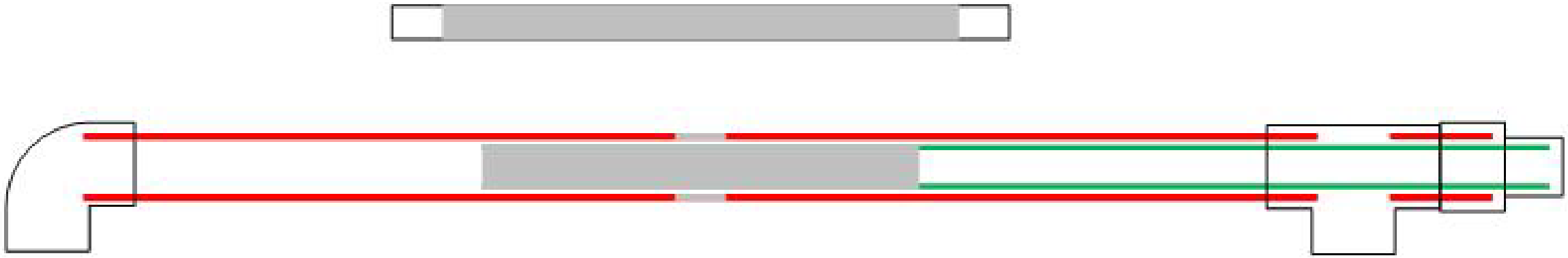
Internal Linear Capacitor

Internal Linear Capacitor



Dual Linear Capacitors

Band Tuning



Fine Tuning

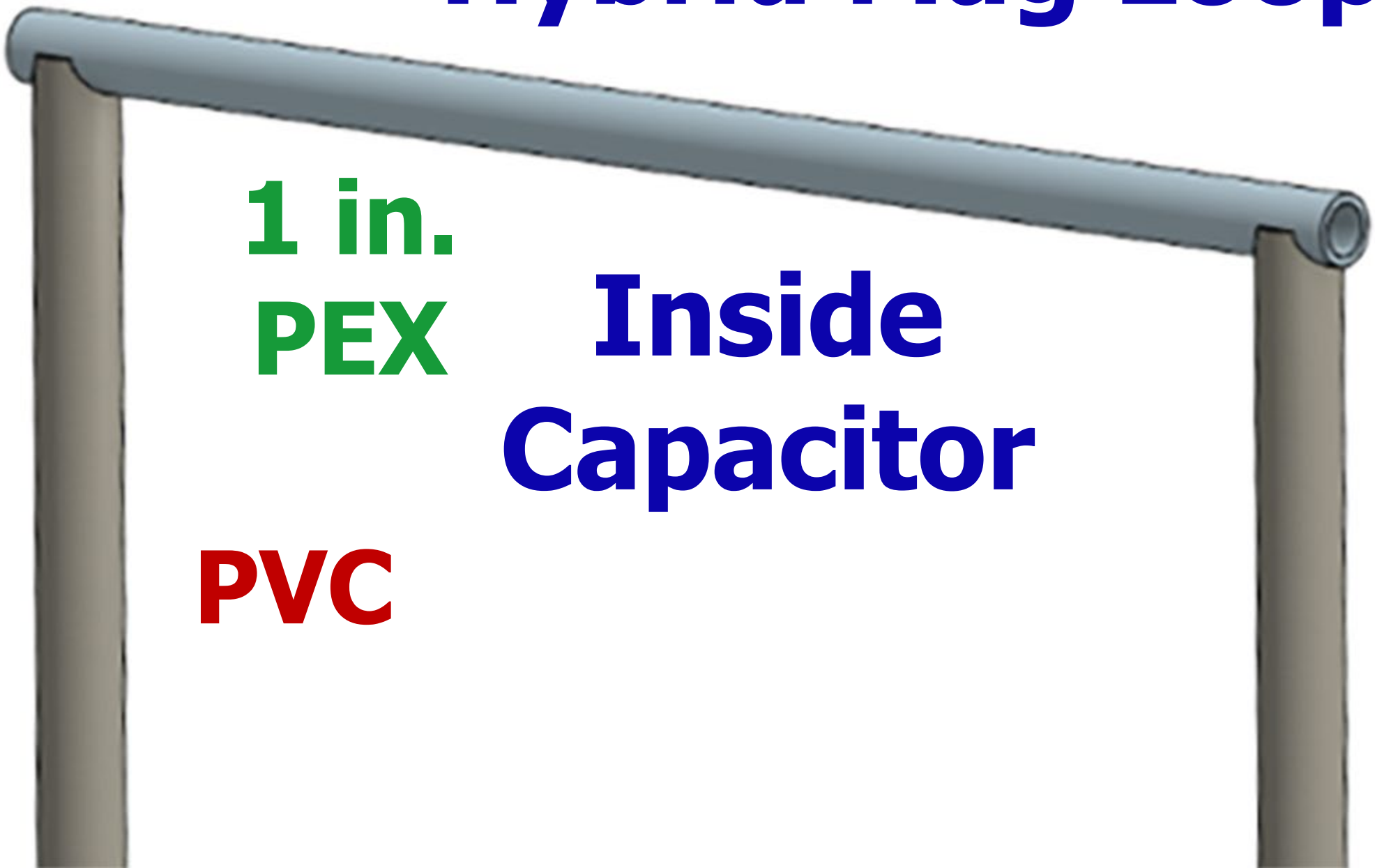
14 in. Band Tuning 2 in. PVC

12 in. Fine Tuning 1 in. PVC


C1

Viewer loop with stepper motor

Hybrid Mag Loop



LDPE Bottles from Amazon

Roll over image to zoom in

IMPRESA 3 Pack 16oz Plastic Bottle with 6 Caps in 2 Styles - BPA Free Latex-Free, Food-Grade, Great for Shampoo, Body Wash, Sauce and More

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Brand	IMPRESA
Material	Plastic
Color	Natural
Capacity	16 Ounces
Special Feature	Bpa Free

Factor 7

Receive-Only Loops

Best: not to Match to 50Ω

- Direct to high impedance RX
- Greater bandwidth
- Better signal to noise
- From an I.E.E.E. study

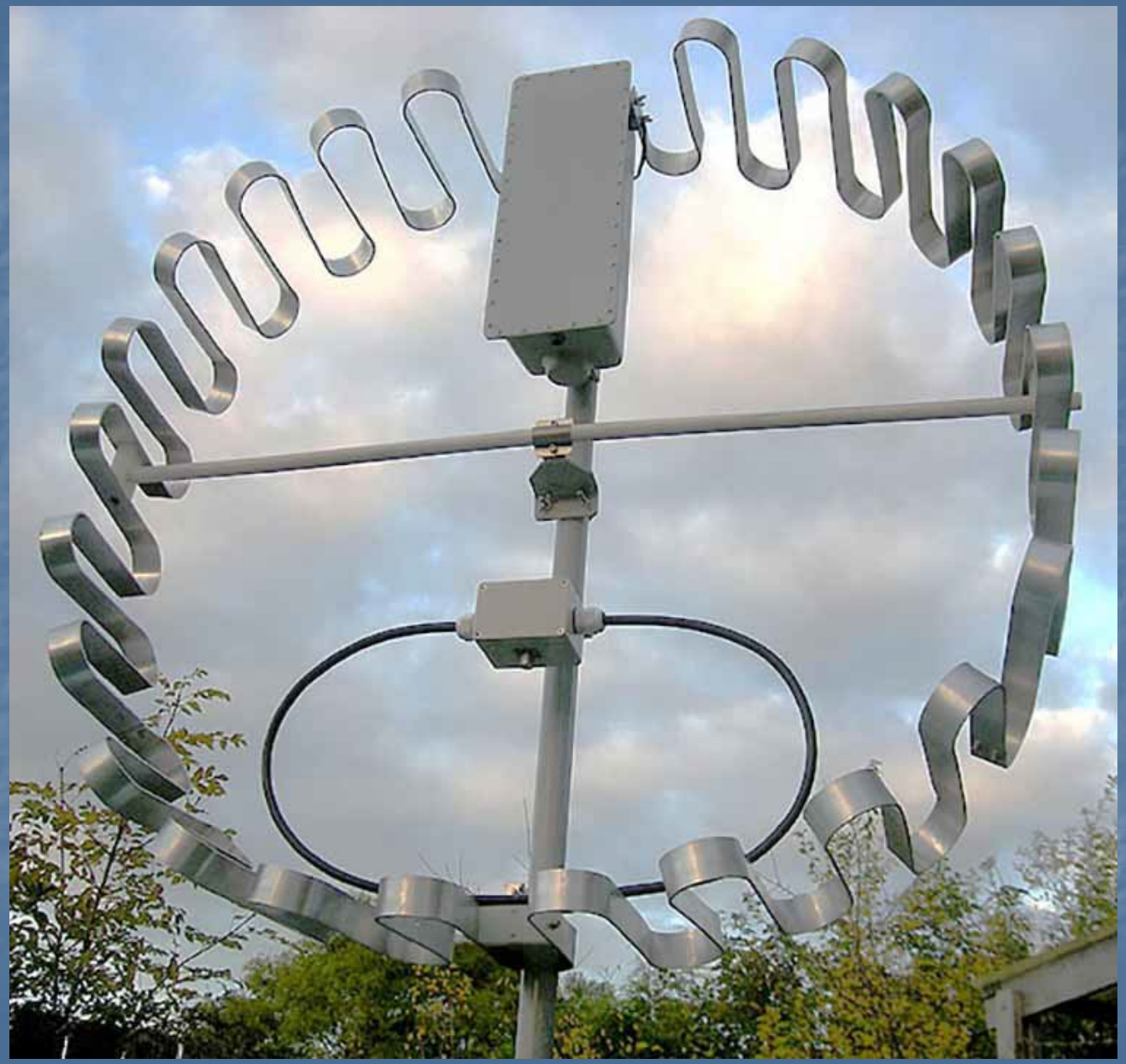
Some Take Aways

Multi-Turn Good Idea

Improves with size squared

Flat Conductor Bad Idea

Edge skin effect
All the current at edge



Convoluted Bad Idea

Small surface high conductor resistance

Edge skin Effect

Helical

Small surface area – high conductor resistance

Edge skin Effect

Horizontal Bad Idea

Poor Radiation Pattern

CLOSING THOUGHT

There's no such thing as a "MAG LOOP".

YES, The near field of a small loop is mainly magnetic and the near field of a small dipole is mainly electric, but both antennas respond to and make BOTH components of the E/M wave.

CLOSING THOUGHT

Both small loops and small dipoles are sensitive to both electric and magnetic fields.

CLOSING THOUGHT

There is little benefit to elevating a "magnetic" loop.

They work nearly as well ground mounted.

Magnetic Loops

1. Relative conductor diameter
2. Construction material
3. Loop shape
4. Self-resonance
5. Matching method
6. Tuning method
7. Receive only

If you build one

Send photos & ideas

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