# Restoring The (Very) Loose Coupler


## By Bart Lee, K6VK

A Fellow of the California Historical Radio Society

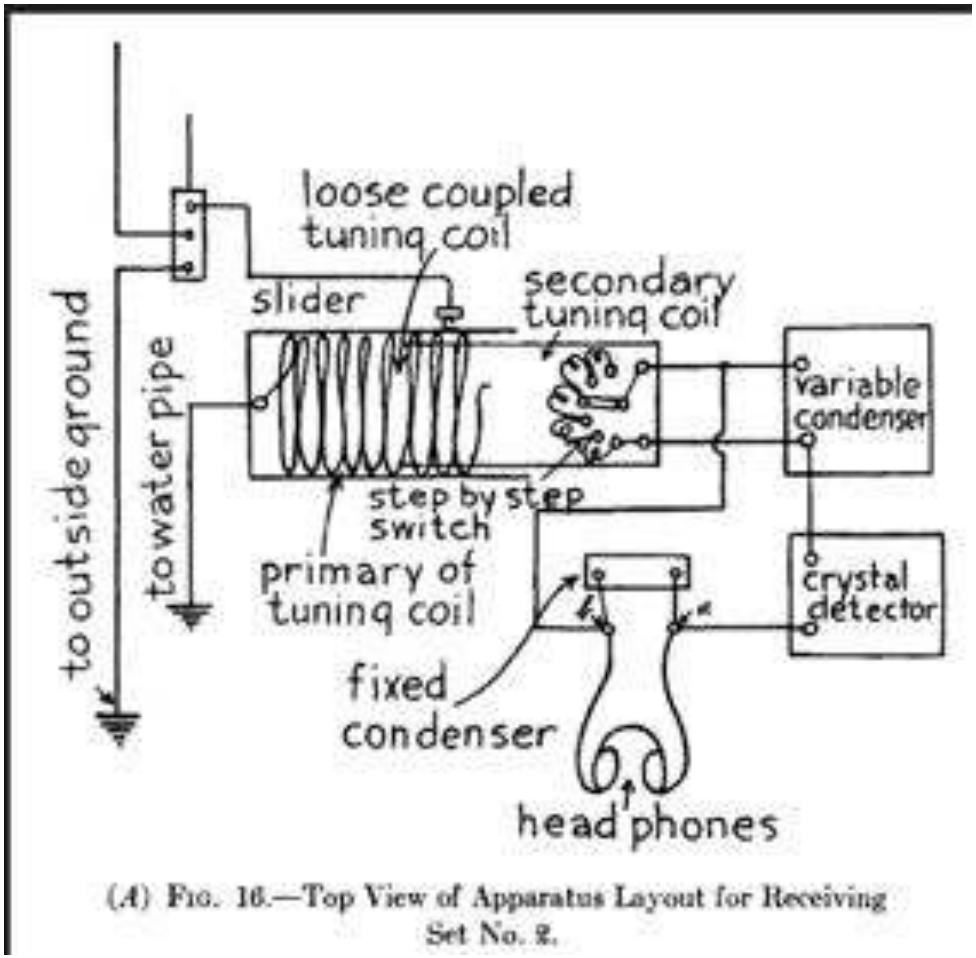

The antenna and ground connect to the big coil with the slider; the inner coil slides in and out with more or less of it switched in.

Acquired from CHRS @ KRE, for $50 in October, 2012

# The Rotary Switch for the Sliding Coil

The Switch Points are Brass Tacks, the Stops are Nails.

# The Schematic Diagram, *c*. 1910




(A) Fig. 16.—Top View of Apparatus Layout for Receiving Set No. 2.

A. Frederick Collins, The Radio Amateur's Handbook, 1922
http://www.gutenberg.org/files/6934/6934-h/6934-h.htm#chap04

# An Historical Footnote

- Karl Ferdinand Braun, later of Telefunken, about 1902 invented or discovered “Loose Coupling” of inductances in wireless telegraphy receivers:

- "In 1902 he carried out experiments which demonstrated that transferring energy from the receiving antenna to the detector through two loosely coupled coils resulted in both a sharper resonance effect as well as increased received signal strength.” So writes Brian Perrett, MW0GKX at http://highfields-arc.co.uk/biogs/kfbraun.htm

- The circuit found favor with amateurs especially after publication of Construction and Operation of a Two Circuit Radio Receiving Equipment with Crystal Detector, U.S. Bureau of Standards, April 15, 1922 (Second Bulletin)

- It is discussed at length in *Practical Radio* by Henry Smith Williams (1922) available on GoogleBooks and in many publications of the day.

# Three Independent Variables Determine Inductance: The Goal is to Couple the Inductances "Loosely" to Sharpen Tuning of Broad  Signals to Minimize Interference

- 1) The number of turns on the big coil between the antenna slider and the ground as the slider moves across the coil.
- 2) The switch position of the inner coil determining how many turns of it connect to the output binding posts; clock-wise is most turns engaged.
- 3) How deep the inner coil goes into the outer coil.

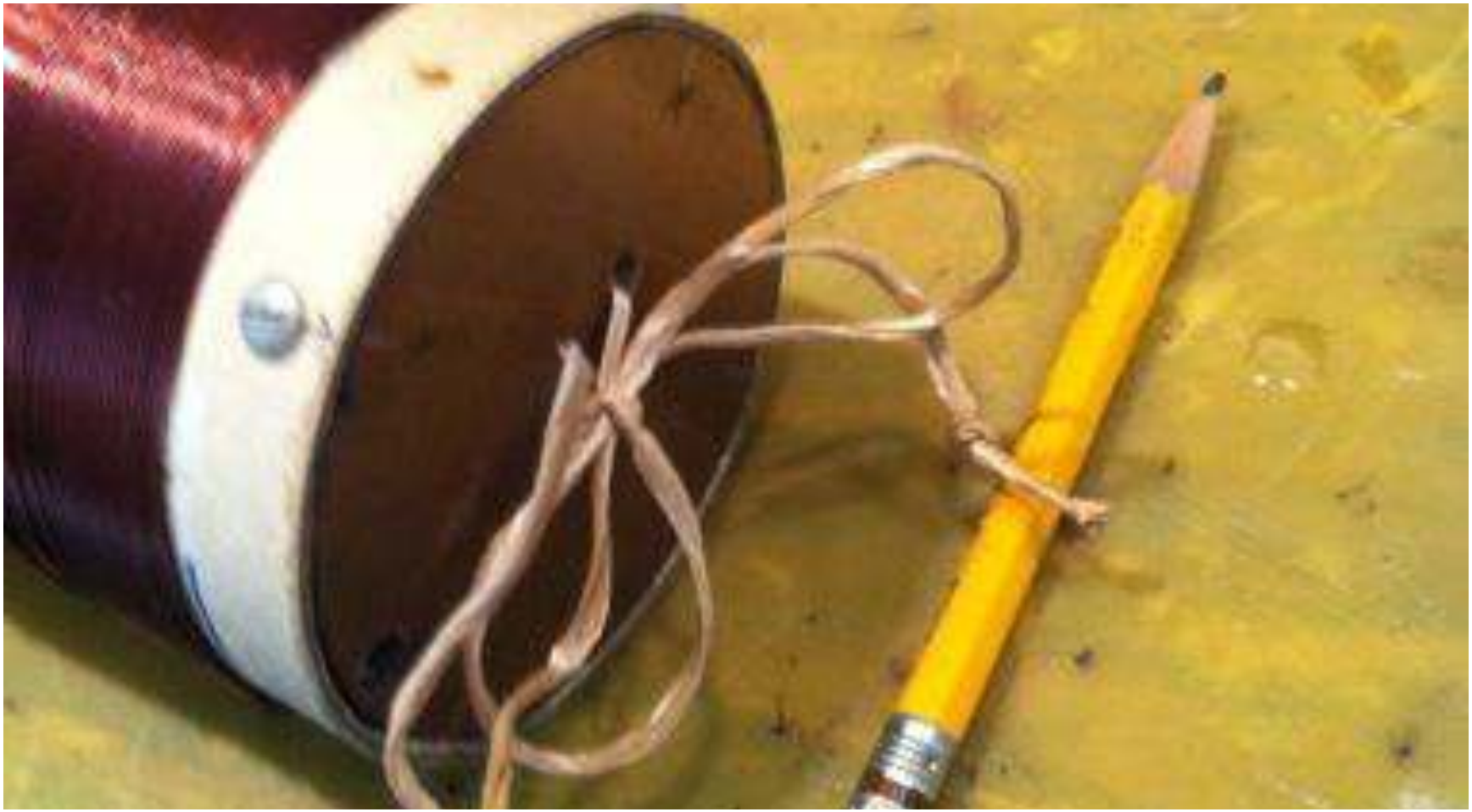
- The maximum and minimum inductances are determined by end positions for the three variables, but between them multiple settings may provide the same inductance – likely very hard to tune, especially with added variable capacitors!

# The Rods both Guide the Inner Coil and Provide the Contacts for it

In the holes in the switch face are small copper tubes making electrical contact with the rods. The rotor connects to one tube (and hence its rod) and the near end of the coil to the other tube and rod.

Mechanical pressure holds the rods in place with their ends inside the big coil touching the bases of the terminals on the back end of the coupler.

# This Cord Pulls Together Back of the Inner Coil (shown) and the Rotary Switch



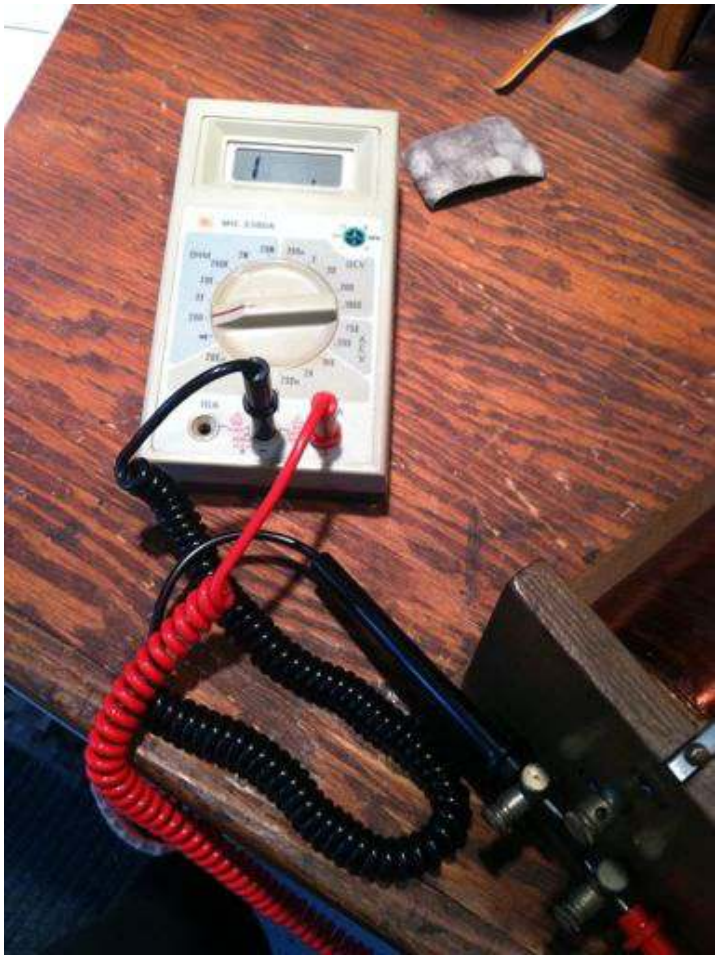
Like the Rods to the Contacts, Mechanical Tension Holds it together!

# The Screw Heads are the Rod Contacts inside the Big Coil

# The Binding Posts for the Sliding Coil,

(above which is one for the Earth for the large Coil
– The Antenna goes to the Slider)

# No Continuity in the Loose Coupler as found, at *any* Rotary Switch Setting



Also, no continuity between the big Coil "Earth" Binding Post and the big Coil -- a bad Connection *inside* the Coil.

Bummer!

# Looking into it …

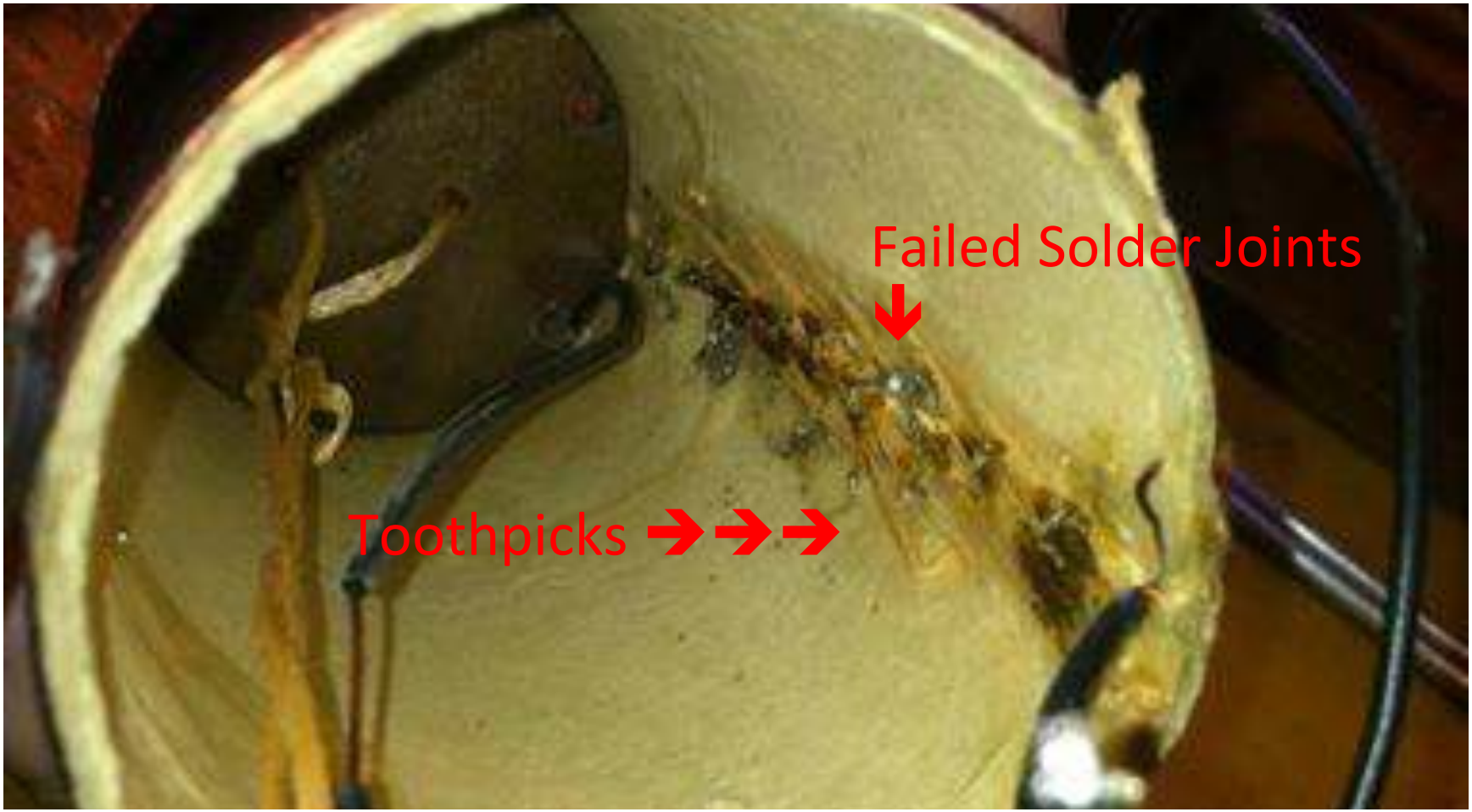
→→→ Copper Tubes that Slide over Rods as Inner Coil Moves ←←←

# All Leads to inside the Coil had De-Soldered Themselves

# The Sliding Coil Showing Insertion Holes

The Builder Pushed a “U” of Wire through the Coil Form after a Number of Turns and Held it in Place Inside with a Toothpick, and Soldered a Lead to each “U”.

# Inside the Inner Coil, as found

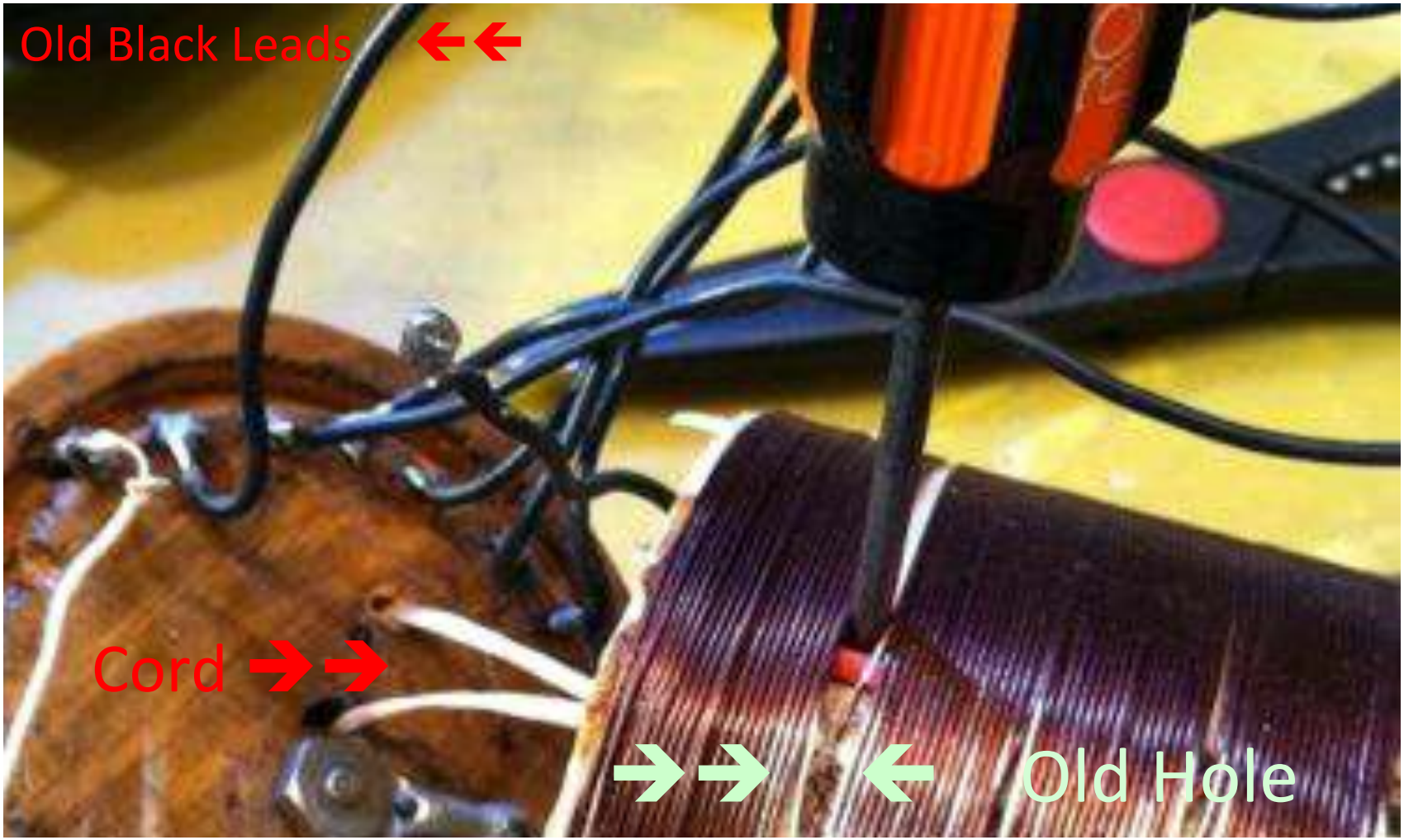


# Inserting the First New Lead for the Rotary Switch

This White Double Cotton Covered Wired Proved Hard to Work With – it Unravels!


New Lead Newly Soldered to Rotary Switch ➔➔
Inside of Rotary Switch ➘
Old Lead from Near End of Coil
Re-Soldered to Copper Tube ➔➔

# Making Holes into which New Leads were Threaded




with “U” Pushed In

# New Lead Soldered to the *Outside* of the Inner Coil

A few Turns Shorted, but there was no Practical Way to Solder *Inside* the Inner Coil

New BLUE leads Inserted through the Coil, Soldered to the Coil, and to the Switch, all Connections then Duly Insulated:

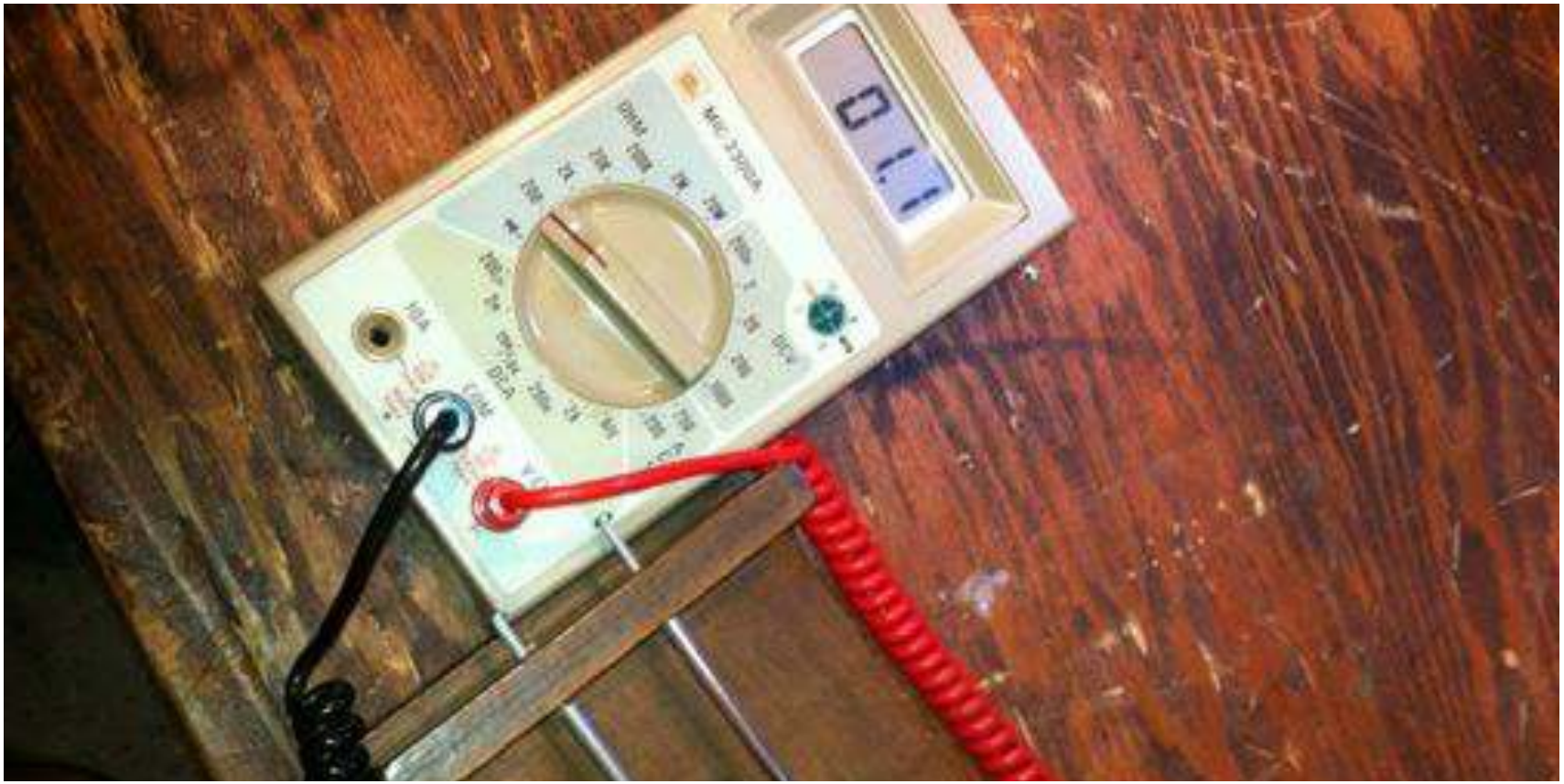
# Rods Polished and re-Inserted

Inner Coil
Re-Inserted
In Outer Coil

# Reconstructed Loose Coupler

# The test…

# Continuity!



# Interim Conclusions

- Someone likely home-built this Loose Coupler from a kit or maybe plans, between about 1908 and decades later. (Kits are available today).
- The coil winding, wood joining, switch contacts and fastenings all suggest a seasoned home constructor.
- The absence of any slider friction marks on the outer coil suggest it never worked as designed.
- The project was abandoned upon initial or later failure, judging from the fact that the lead connections inside the inner coil, *and* to the outer coil, all failed.

# Resurrection

- Two old Fahnstock clips have been added for test connections to each end of the large coil.
- One is for an antenna, the other for a ground.
- Only a long wire antenna is useful, but four antennas can be switched in for tests.
- The ground is an extensive outside ground screen, ground rods and multiple ground level and raised radials.
- The slider does not yet contact the coil wiring.

# Inductance Rough Calculations

- 2.0 milliHenries for the big outer coil @

270 turns on 3 inches for 6&3/4 inches.

- 1.2 milliHenries for the small inner coil @

220 turns on 2&5/8 inches for 5&1/2 inches,

but 120 microHenries for the smallest segment of the inner coil ( = 1/10).

For reference, One milliHenry at one MHz requires 25 pF for resonance; 2mH needs 13 pF.

# It Works!

## in the Standard Configuration:

- The Long Wire Antenna, and the good Ground, can be connected to the large outer Coil (2.3 milliHenries calculated from this data).
- The 1N34 Crystal Diode and Earpiece can be connected to the inner Coil, and the inner Coil can be slid in and out and switched.
- With the Inner Coil fully engaged, plus 20 pF Capacitance in Series with the Antenna, KCBS* 740 KHz can be heard well and another station KFBK 1530 KHz at 100+- pF.
  - * And briefly, one local SSB ham.

# Stations' Powers and Distances

- KCBS broadcasts at 50,000 Watts on 740 KHz from Novato, which is 30 (air) miles north west of K6VK.
- KFBK also broadcasts at 50,000 Watts on 1530 KHz with a very efficient antenna system from near Sacramento in Pleasant Grove, which is 70 (air) miles north east of K6VK.
- The long wire antenna at K6VK runs zig-zag north west to south east for more than 100 feet.

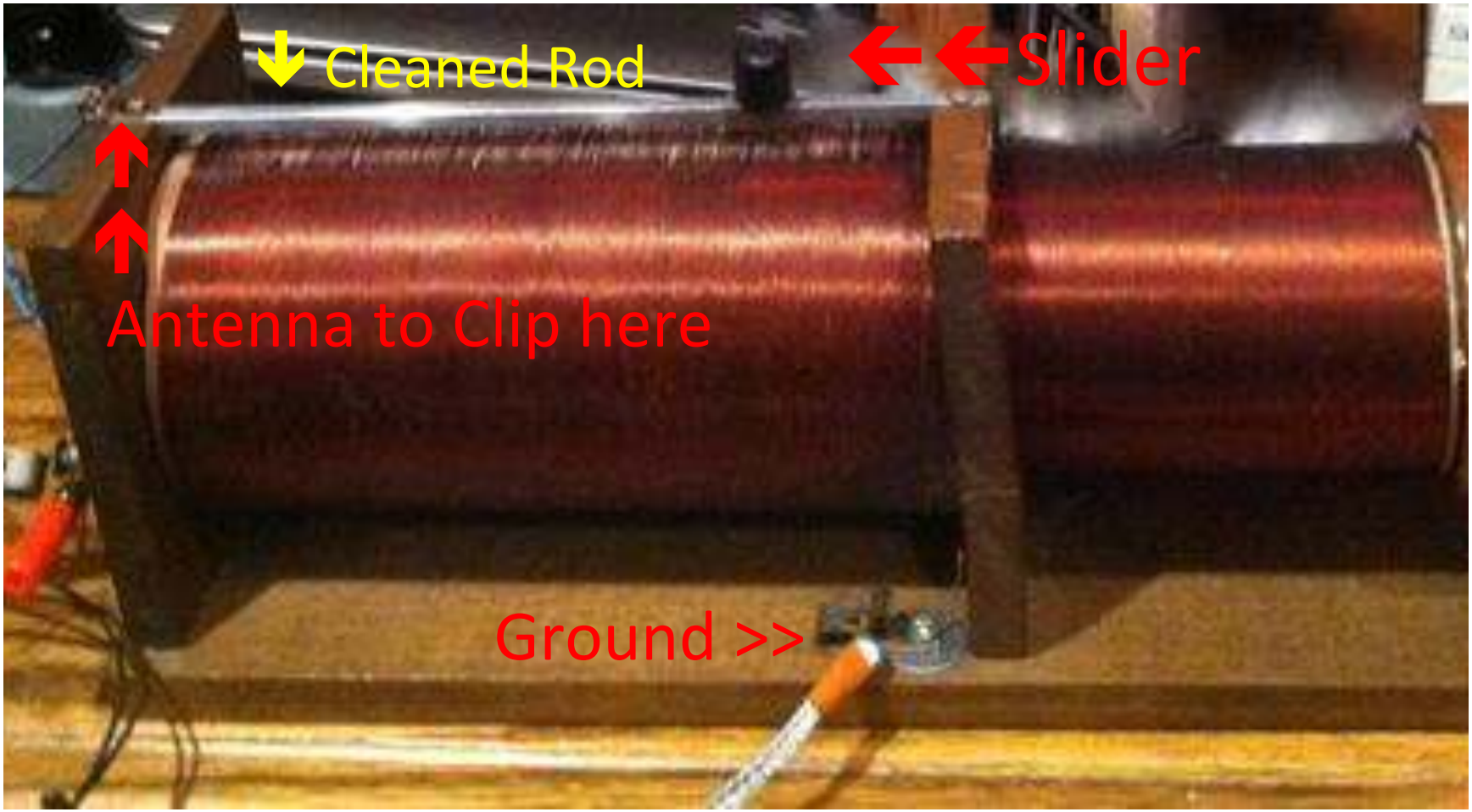
# Loose Coupler Working, Antenna to Large Coil


Was this Loose Coupler designed for 200 meters and up?

(The old time marine, broadcast and ham wavelengths).

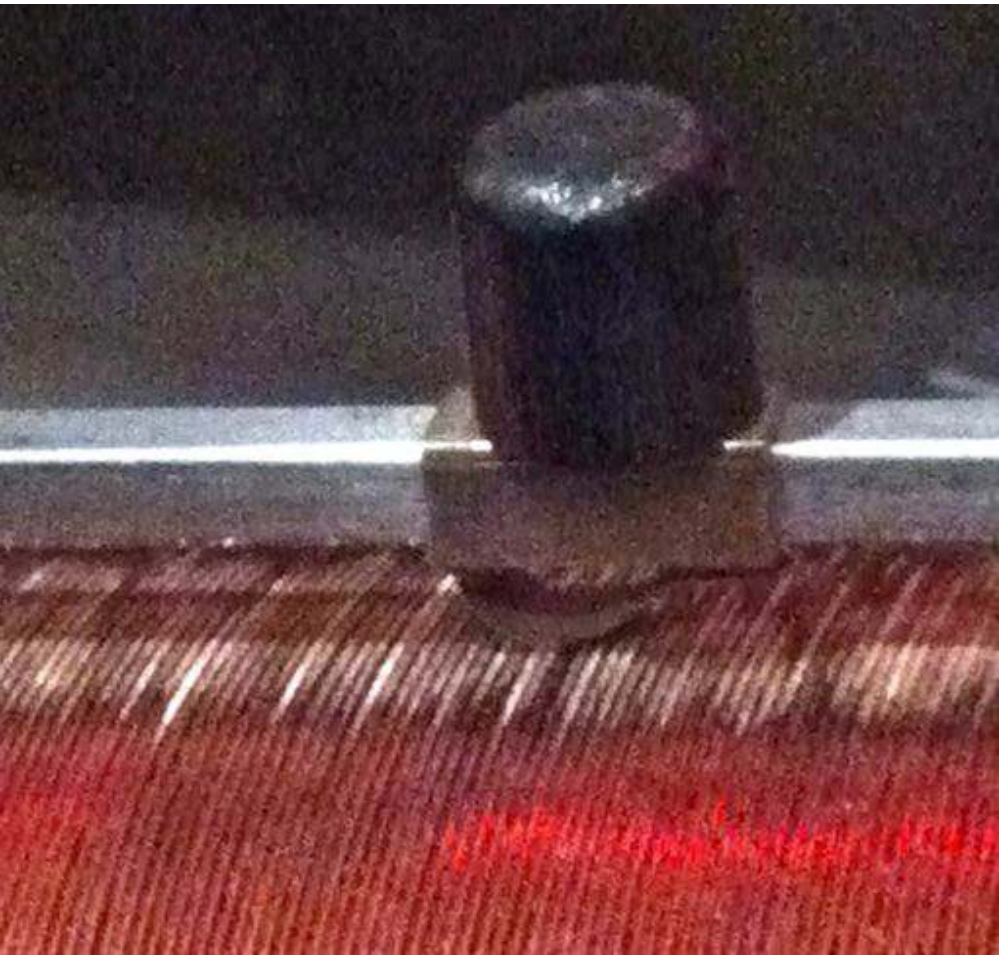
# Slider Activated -- on newly sanded Coil

(but Ground should go to *left* side of coil at terminal)




Several Stations KCBS 740, KFBK 1550 and some in between, depending on settings

# The Magic Slider



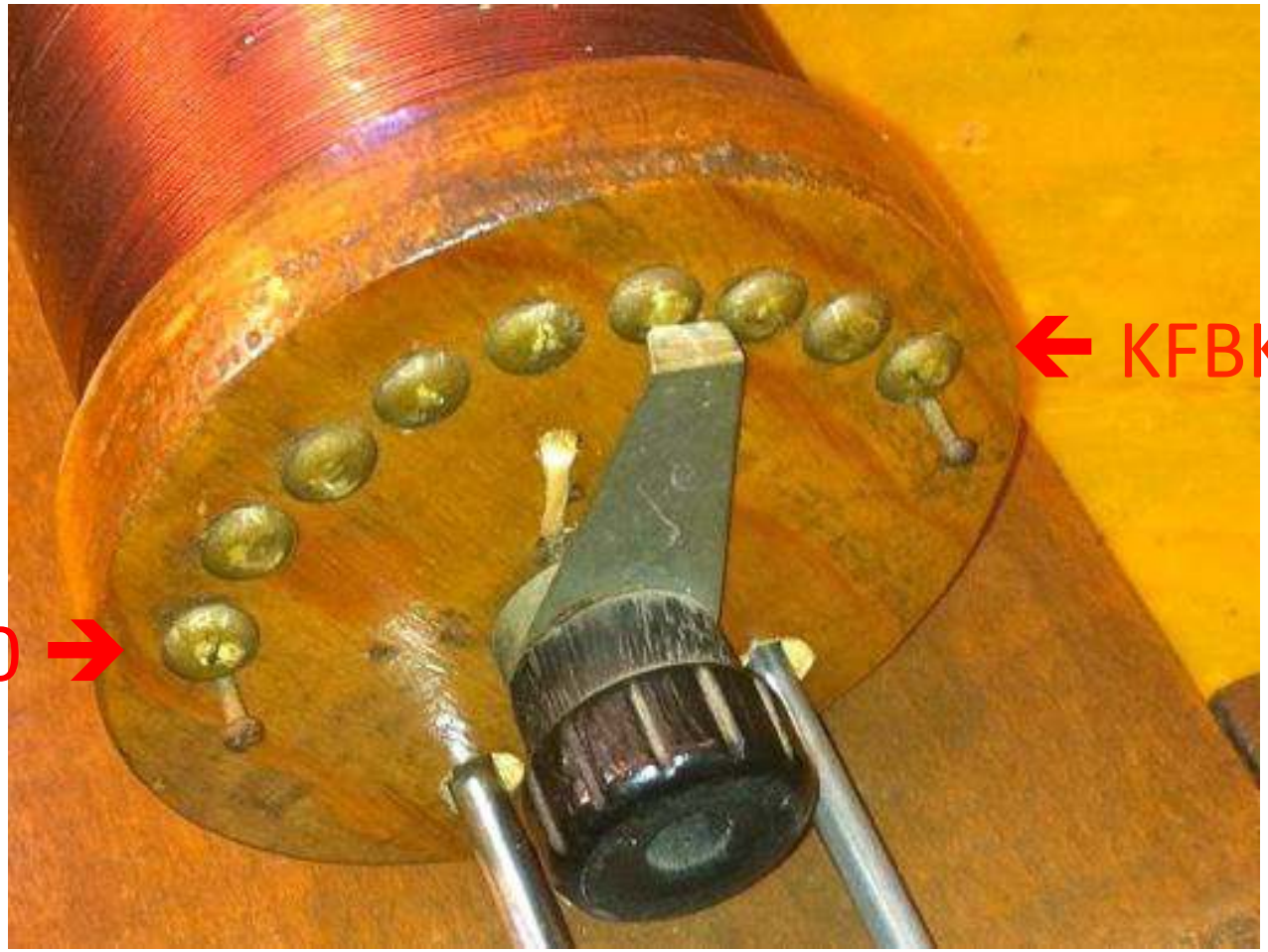
KCBS loudest at ½ big coil, inner coil about ½ in, and series cap tuned for maximum;
KFBK good with inner coil minimally inserted, slider left for maximal inductance, series cap tuned for maximum.

The slider seizes, making tuning a challenge …
Cured with Graphite! But a Signal Injector shows few sanded turns connect.

# Variable Capacitance Parallel to Large Coil (as Designed)

The Best Result so far:  KCBS at a good volume (recorded); slider ¾ down big coil, inner coil ½ in, variable capacitor at 70 pF ±.

# The Rotary Switch for the Sliding Coil Also Tunes the Coupler



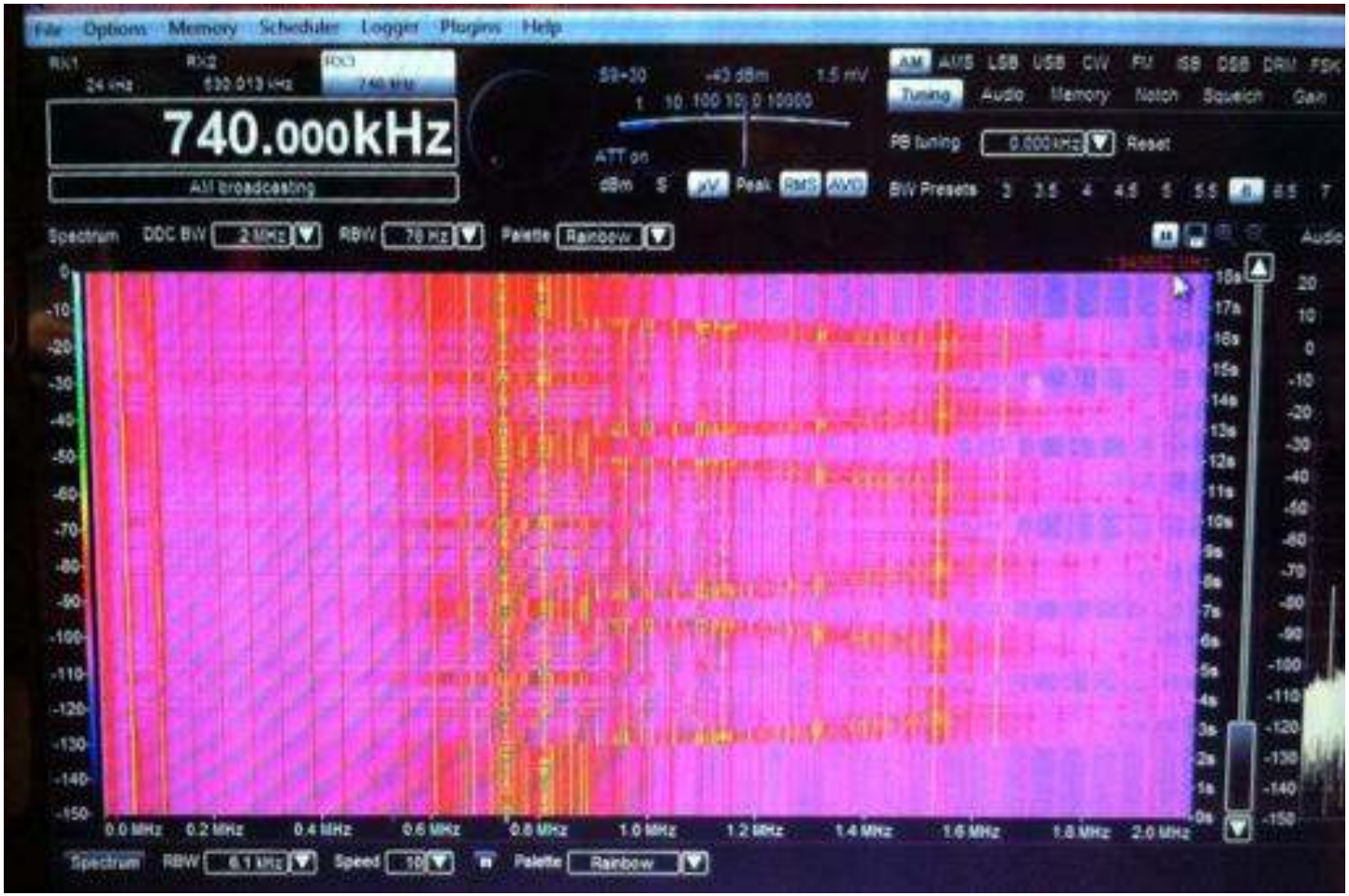

Inner Coil ½ in, Slider on Outer Coil ¾ over to the right (fewer turns engaged).

When tuned, moving the Inner Coil about an inch or so can bring a station sharply much higher up in volume, then sharply diminish the volume.

# Connected as Diagrammed 1922

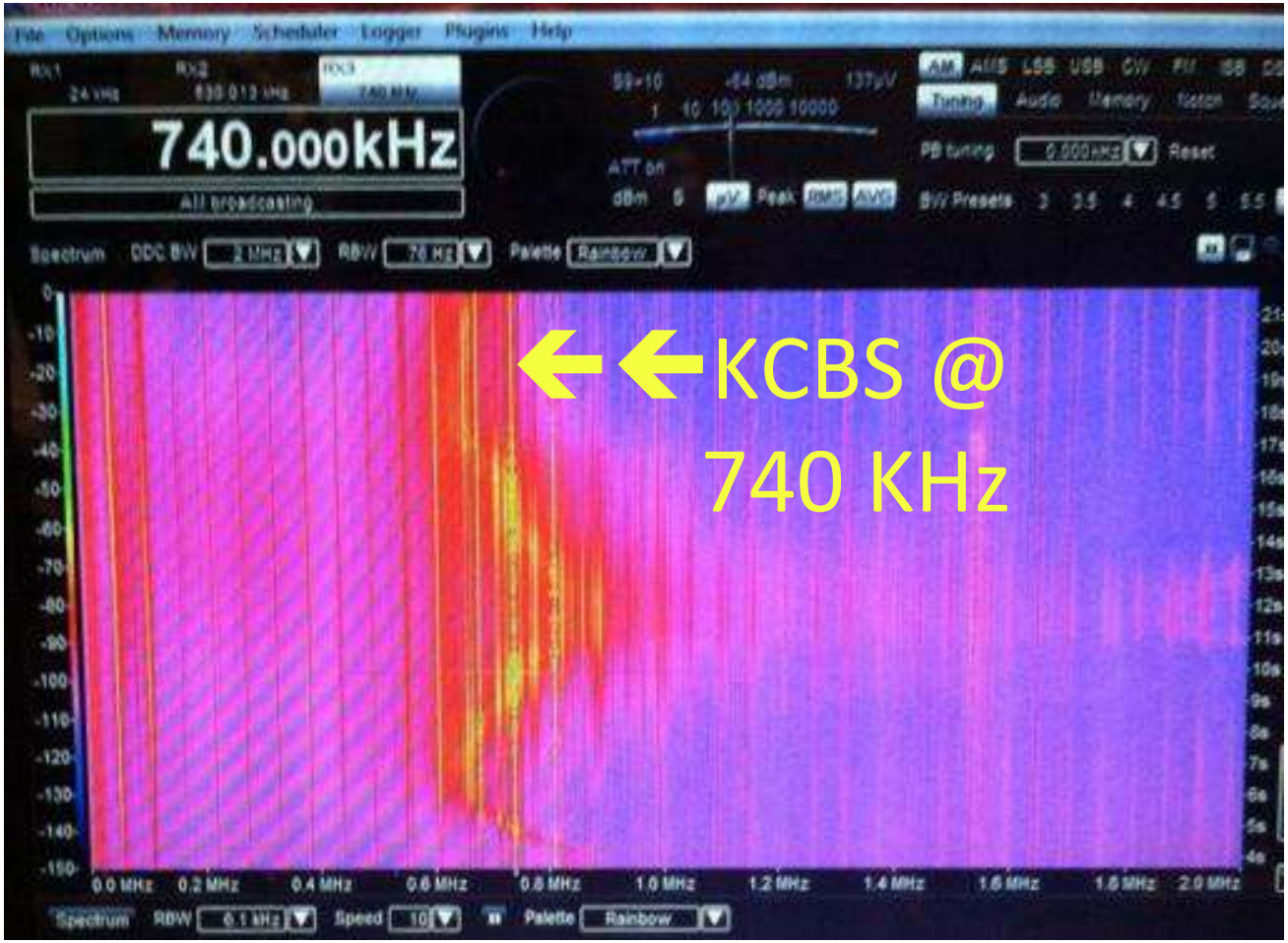
- Ground goes to Terminal with interior Lead to near (Left) side of big Coil.
- Ground also connects to one side of inner Coil.
- Antenna goes to Slider.
- Performance the same, but now Slider best at Left side of big Coil, inner Coil ⅔ engaged.
- It works well exactly as designed.

# Big Coil Slider -- Left, Right, Left:




Tunes KCBS 740 softer, higher frequencies come up but only KFBK 1530 audible on ’phone; effective up to maybe 2 MHz.

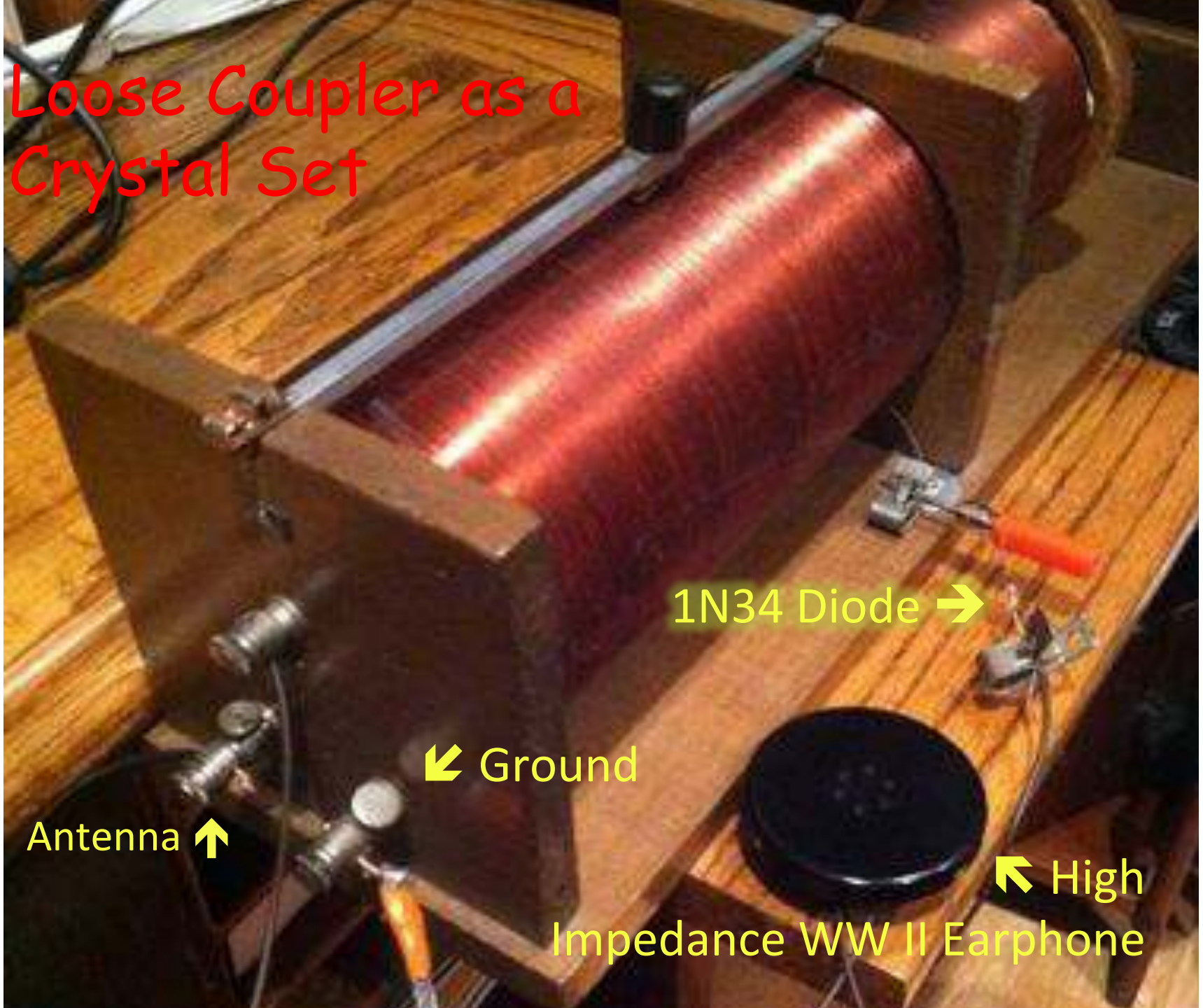
# Inner Coil, In & Out, Sharply Tunes 740 KHz



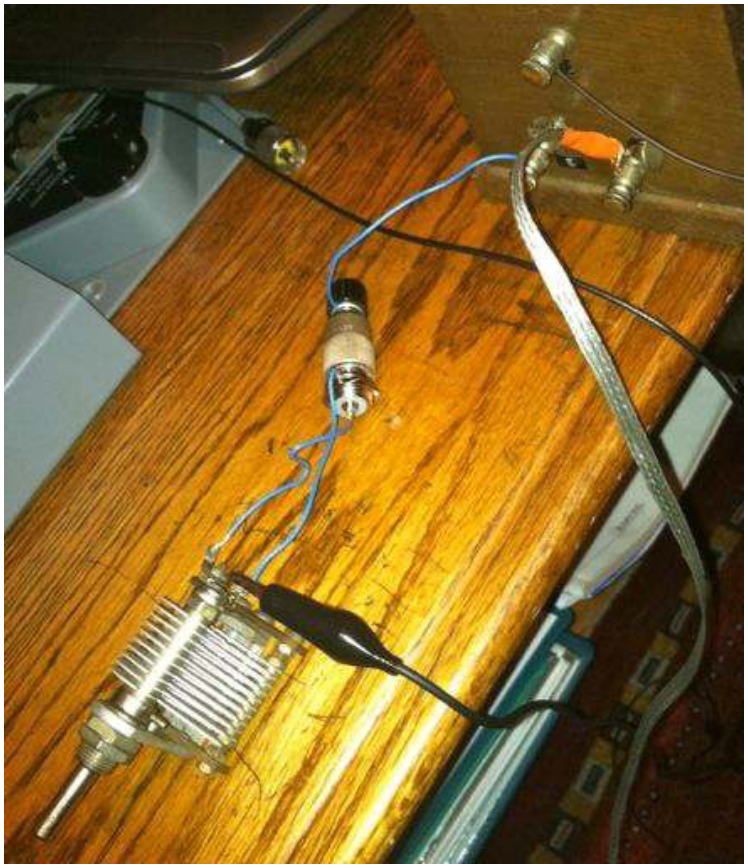

KCBS Maximum 4 mv ±, but movement of one inch ± can Minimize Audibility (100 microvolts ±); Variable Capacitor has no Effect.

# Another Test – As a Crystal Set (no Variable Capacitor):

- It works fine -- inverted -- when the inner coil is the primary connected to a long antenna and a ground.
- The outer coil is a fixed secondary to which a crystal diode (1N34) and the high impedance earpiece are connected in series.
- It tunes some by sliding in and out; very little variable capacitance in parallel detunes it.
- KCBS dominates with its two+ millivolt signal.


Loose Coupler as a Crystal Set
1N34 Diode
Ground
Antenna
High Impedance WW II Earphone

# Cap In Series with Antenna into Inner Coil Tunes Two Stations



Switch Clockwise = Max;
⅞ slid in; hand capacity helps.

KCBS 740 KHz (SF)
Maximal Capacitance
About 110 pF = 420 microHenries;

KFBK 1530 KHz (Sacto)
Minimal Capacitance
About 44 pF = 256 microHenries.

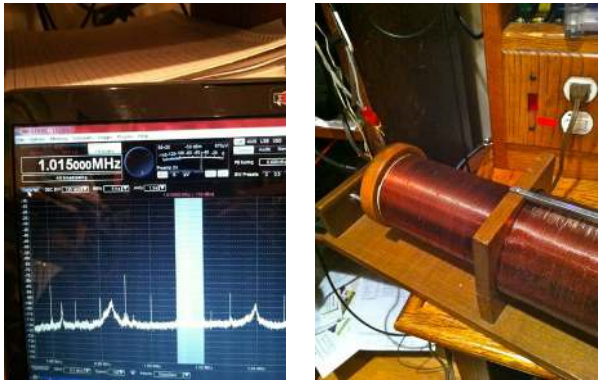
So Inner Coil < 1.2 milliHenries as calculated)
= about 340 microHenries.

# Tests with a Hickok OS-10 Signal Generator

Circa 1934

Set for 1.015 MHz,
Hum modulated

Top slider half way, with the inner coil mostly out, gives 675 microvolts, - 50 dBm; but moved in only about an inch, the signal drops to 175 microvolts and -62 dBm, => sharp tuning.




675 µv


175 µv

# So What Did It Do?
## Minimize Interference.

- In a radio spectrum of broadband spark signals circa 1910 and for a decade and more, the loose coupler circuit:
- 1) Peaked a desired signal, and
- 2) Diminished all other signals and broadband interference near in frequency to the desired signal by virtue of sharper tuning than any other available circuit in the days of spark.

# A Next Set of Tests:

- Improve all mechanical connections, presently erratic and intermittent –
- Test with a broadband signal generator, sweep generator or noise source, in order to
- Measure and record performance in selectivity improvement versus signal strength at various frequencies up to ten MHz.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