

# Tubes/Valves For CW QRP

RF From “Glowbugs”,  
Pete Juliano, N6QW



September 2021



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 **VIRTUAL CONVENTION**  
**2021** DEVOTED TO LOW POWER COMMUNICATION



## Product Disclaimer Notification!

For those who know N6QW, my speaking on Valve CW rigs is much like having a formal event where I show up with a Black Tuxedo complete with Brown Shoes. I can only hope what I share is accurate and truthful. Keep me honest.

A Real Departure from QRP SSB!

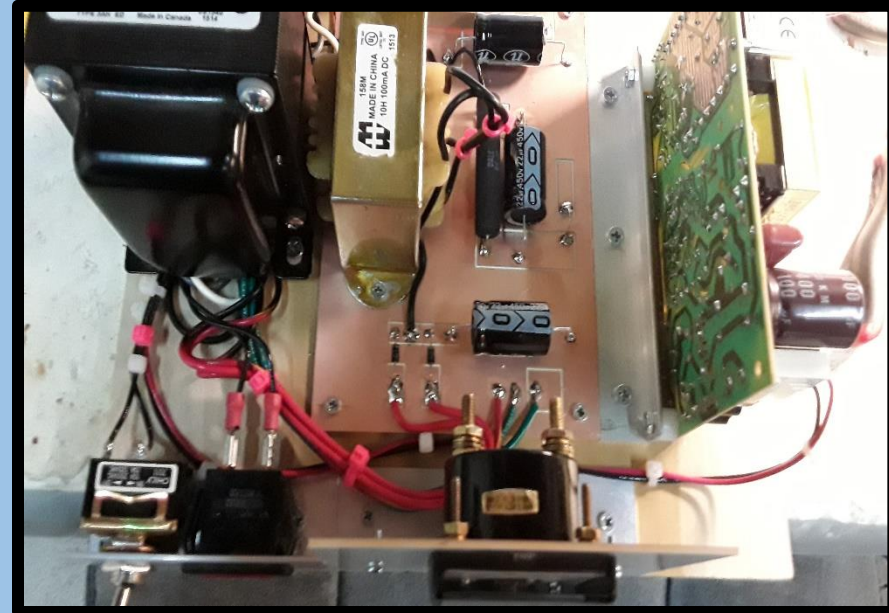
Pete Juliano, N6QW

Detailed Construction and Additional Information provided at [https://www.n6qw.com/Tubes\\_And\\_Valves.html](https://www.n6qw.com/Tubes_And_Valves.html)

September 2021

# A Cautionary Safety Alert!

- Tubes/Valves Use High Voltage DC!
- The “One Hand Rule”!
- Always Assume HV is Present!
- You can Smoke Parts just as easily with Tubes/Valves! (The Goal is an SPI\* of less than 1!)



**If It Is Built Right, It Will Work Right!**



\*SPI = Smoked Part Index!

Myth Busters:

You Can't Work QRP with Valves!

Solid State is Better than Valves!

Tubes/Valves = Too Hard to Build!

You Can't Find Parts!

**If It Is Built Right, It Will Work Right!**



# Why Build a Tube/Valve Type QRP Rig?

1910

1960

2021

Almost Exclusively Tubes/Valves

Almost Exclusively Solid State

Simple QRP Transmitter Topology ~ Time Continuum

- Tubes /Valves still available
- Metal Bashing (Reduces Stress)
- Parts Scavenger Hunts
- Relatively Simple Circuits
- Small Elite Group of Builders
- Overall = A Mind Challenge

- Many Concerns (Comfort Zone)
- High Voltage
- Portability
- Building cautions
- Signal Quality: Chirps & Clicks
- Support (Test Equipment, Tools)



# Where to Start the “Tube/Valve Journey”?

- Firstly, **TURN OFF** the Soldering Iron\* and **TURN ON** Research
- The Resources Hunt starts with SPRAT. See SM7UCZ SPRAT #106. His QRZ page features a Whaddon MK VII, QRP Tube XCVR. Also tour the FB column from Colin, G3VTT. Download the SPRAT index to search for tube/valve transmitters. [<http://www.gqrp.com/sprat.htm>]
- Older ARRL Handbooks prior to 1970
- N4TRB’s compendium of the RCA Ham Tips and GE Ham News
- You Tube videos Search on Tube/Valve Transmitters
- <https://qsl.net/ve7sl/tritet.html> (James Lamb W1CEI ~ 1933)



\* PSA: Please TURN OFF Your Nano VNA, as it is not required/needed during this Presentation!



# Amazing what a bit of Research will find!



## February 1959 ~ RCA Ham Tips “The Weekend Special”

### A Portable Tube/Valve QRP 40M CW Transceiver.

### We’ve heard of Machine Guns In Violin Cases. But This is a QRP Transceiver in a Typewriter Case

\* A bit of a connection ~ The Thompson Sub-Machine Gun was also known as the Chicago Typewriter!



N6QW’s 20M CW  
XCVR similar to this  
RCA Ham Tip. It is  
Solid State @ Five  
Watts Input.

<https://www.youtube.com/watch?v=a16EzO-JQ3w>





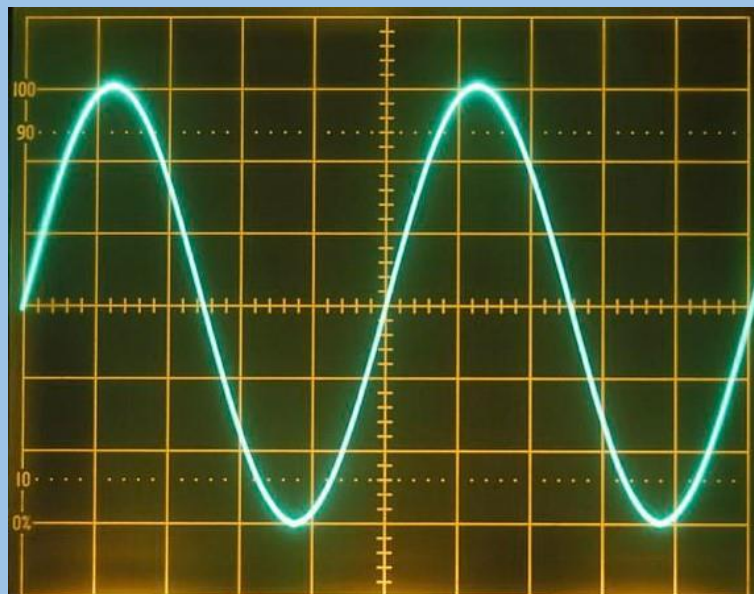
# A Roadmap For this Presentation.

- The Journey starts by what to look for in the research.
- By having criteria we establish a basis for an evaluation
- In the comparisons we can clearly see best practices and what to avoid
- Next we formulate a plan for the rig (based on the research)
- With the plan we develop a parts list
- Lack of part availability ~ fabricate a substitute
- Create a documentation trail
- Plan the rig layout
- Build in a logical sequence (measure twice, cut once)
- Set up a test plan (RBN and Web Based SDR receiver sites)
- Measure the results versus the expectations



# What are we looking for in the schematics?

The Goal of Any HB Rig.



A Clean Output!

- Many Circuits are Old and Do Not Comply with Current Regulations!
- Many Circuits cut corners and leave out features!
- Many Circuits leave out Critical Safety considerations!

- Key shaping/Key Click Filter
- Regulated Screen Voltage
- Low Voltage Keying
- Shielding/ Isolation
- Power Supply Filtering
- Voltage/Watt Rating of Parts
- Avoid Link Coupling
- Two Tubes “Mo Betta”
- Output Low Pass Filtering
- HV Physical Shielding
- Control of Feedback (Note Sound)
- Quality Components: SM/COG
- Wire size and HV Wire
- Metering Circuits
- Sidetone Monitoring
- Ease of Replication
- Type of Oscillator (Colpitts, Pierce)
- Key the Oscillator or Final (Or Both)
- Use of Standard Tubes/Valves/Parts
- Single Band or Multiple Bands

# Oscillator Tubes/Valves and Forms

## Three Types of Oscillators which we will discuss

- But the tube/valve used is important because Of what happens as you tune the tank to the Resonant frequency of the crystal – it stops!  
Preferred tubes: 6AG7, 6AH6, 6CL6, 5763
- My view --- Pick a form that reduces the various Chirps, Burps and Key Clicks which should be the Main concern ~ A Clean Signal. But equally Important --- SAFETY and SAFELY!

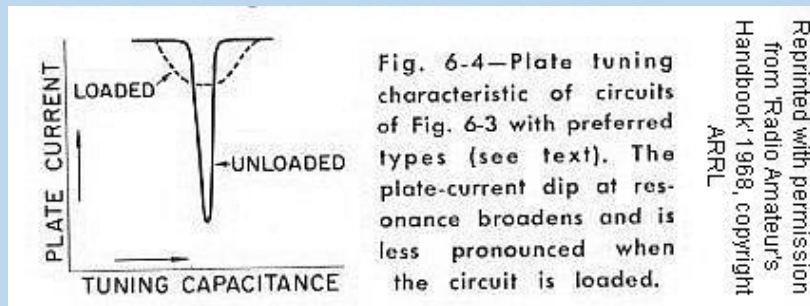
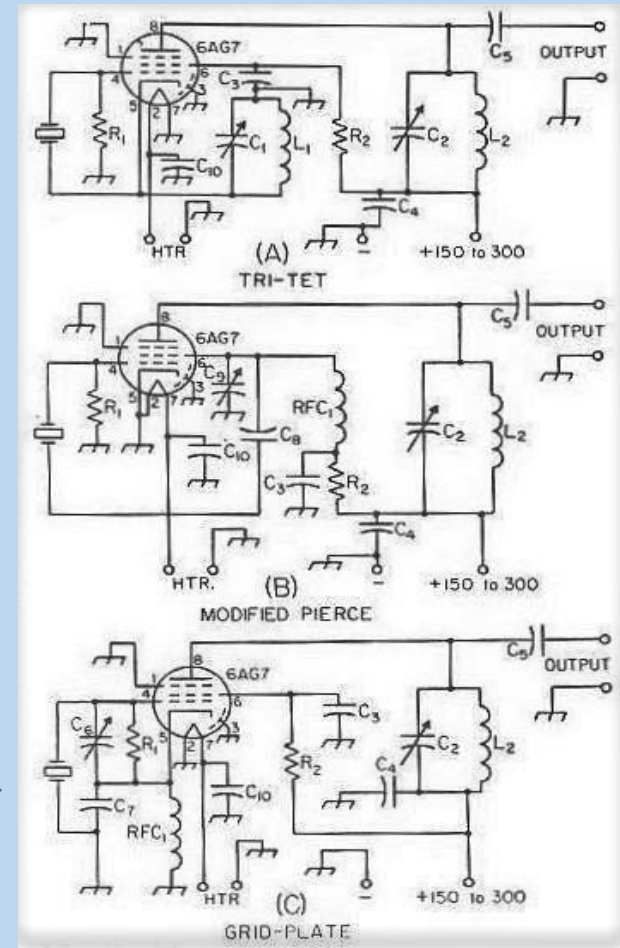


Fig. 6-4—Plate tuning characteristic of circuits of Fig. 6-3 with preferred types (see text). The plate-current dip at resonance broadens and is less pronounced when the circuit is loaded.

Reprinted with permission from Radio Amateurs' Handbook 1968, copyright ARRL



# What is/Makes an Oscillator?

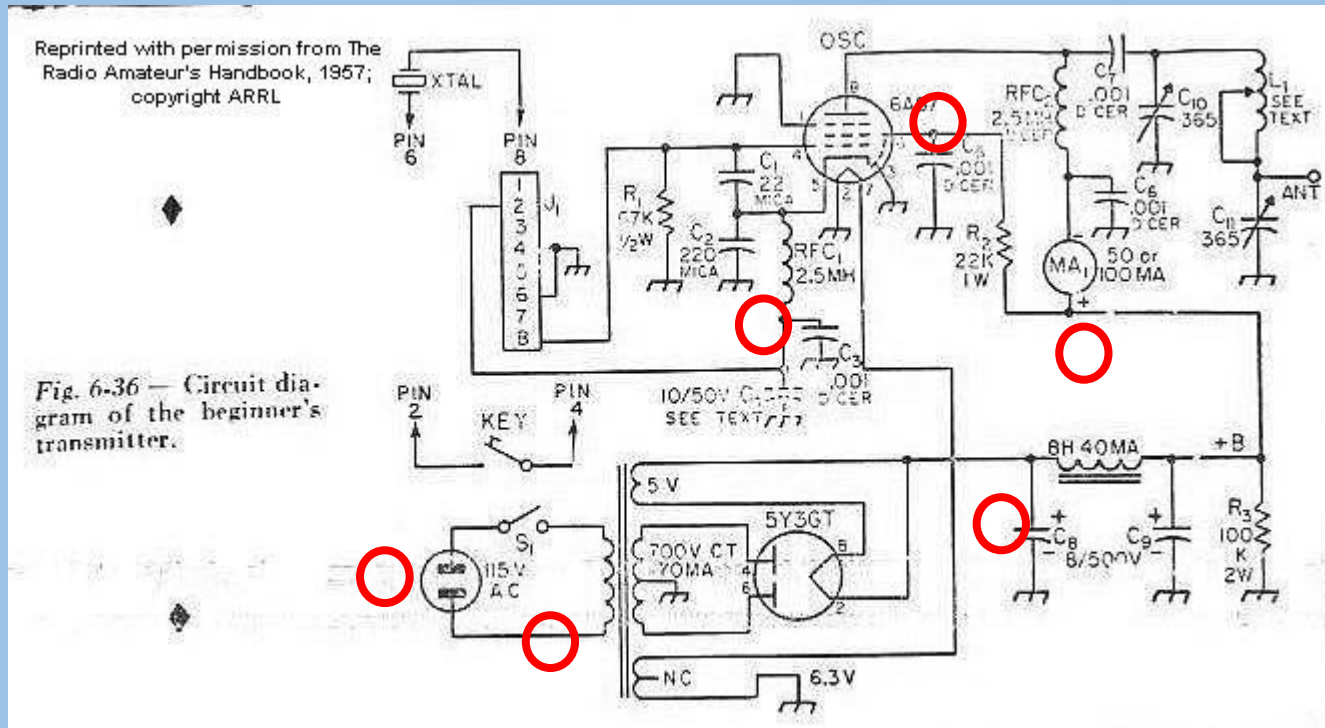
What is an easy way to envision an Oscillator?\*

- **A Non-Scientific Offering ~ An Oscillator is like an Amplifier with Feedback, only it is on Steroids. Oscillation criteria is met when  $KB = 1$ , a measure of that Feedback. This is known as the Barkhausen Criteria.**
- **The purpose of the Crystal (or LC Circuit) is to have that Oscillation occur on a single frequency. A quartz crystal when physically cut to exacting dimensions and excited by an electrical field will oscillate at a specific frequency.**
- **Is using crystal control limiting? Short answer: Yes! But QRP frequency watering holes have been pre-ordained so that lots of contacts can occur using just one crystal. ( 7.030, 14.060 are a couple of examples.)**

\* See: <https://www.electronicshub.org/oscillator-basics/>



# The Good, The Bad and the Ugly!



○ = Criteria Point

□ Good

✗ Bad

□ Ugly

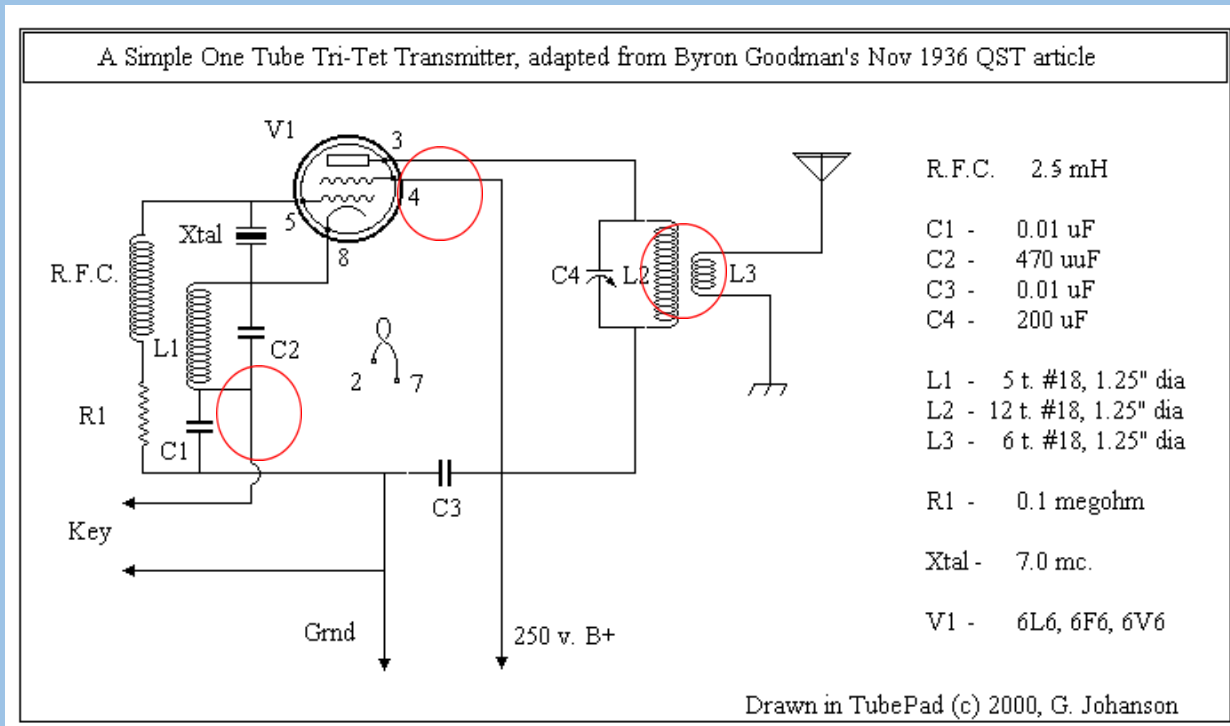
Grid-Plate Form

8 uf @ 60 Hz = 331 ohms  
 100 uf @ 60 Hz = 26.5 Ohms  
 (Much lower Impedance to 60 Hz)

$$C = 1 / (2 * F * V_{ppr})$$



# The Good, The Bad and the Ugly!



Good

Bad

Ugly

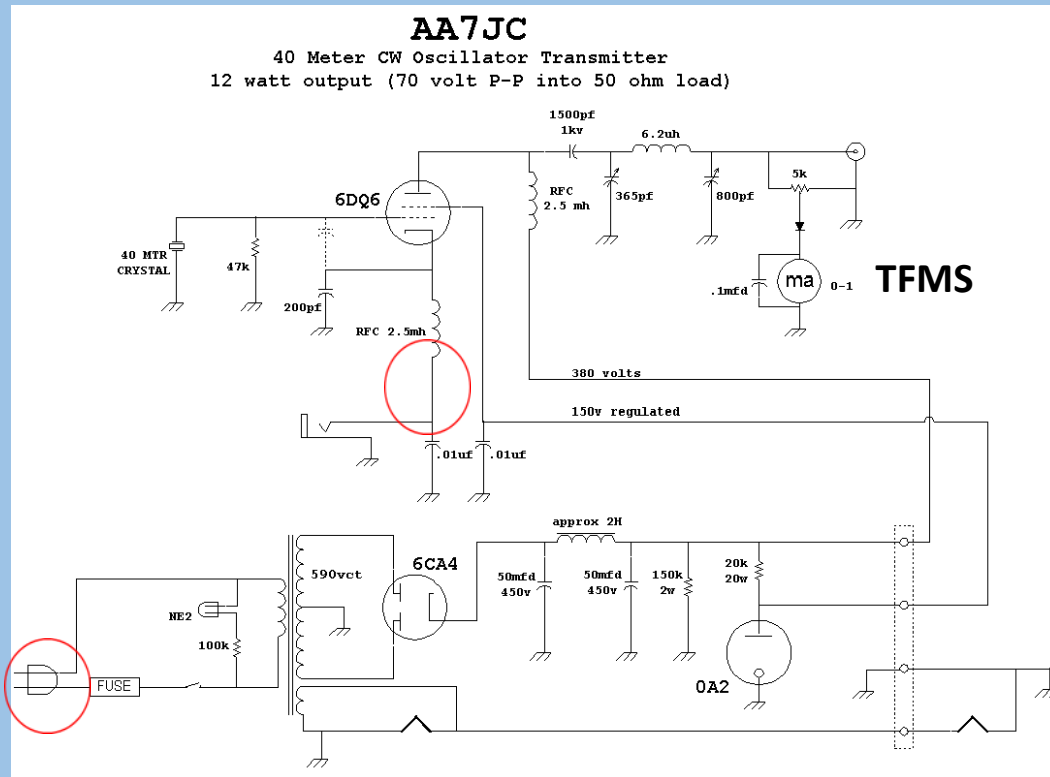
Tri-Tet Form

**Tri-Tet from 1933 = Stable Oscillator; But RICH in Harmonics!  
AKA "The Crystal Buster" – If L1C2 tuned to the XTAL, #@@%\$\$\$**





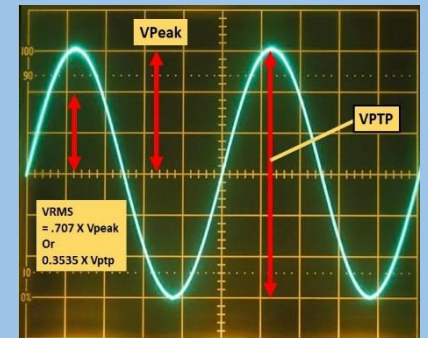
# The Good, The Bad and the Ugly!



Sort of Good

Bad

Ugly



Grid Plate Form

TKT

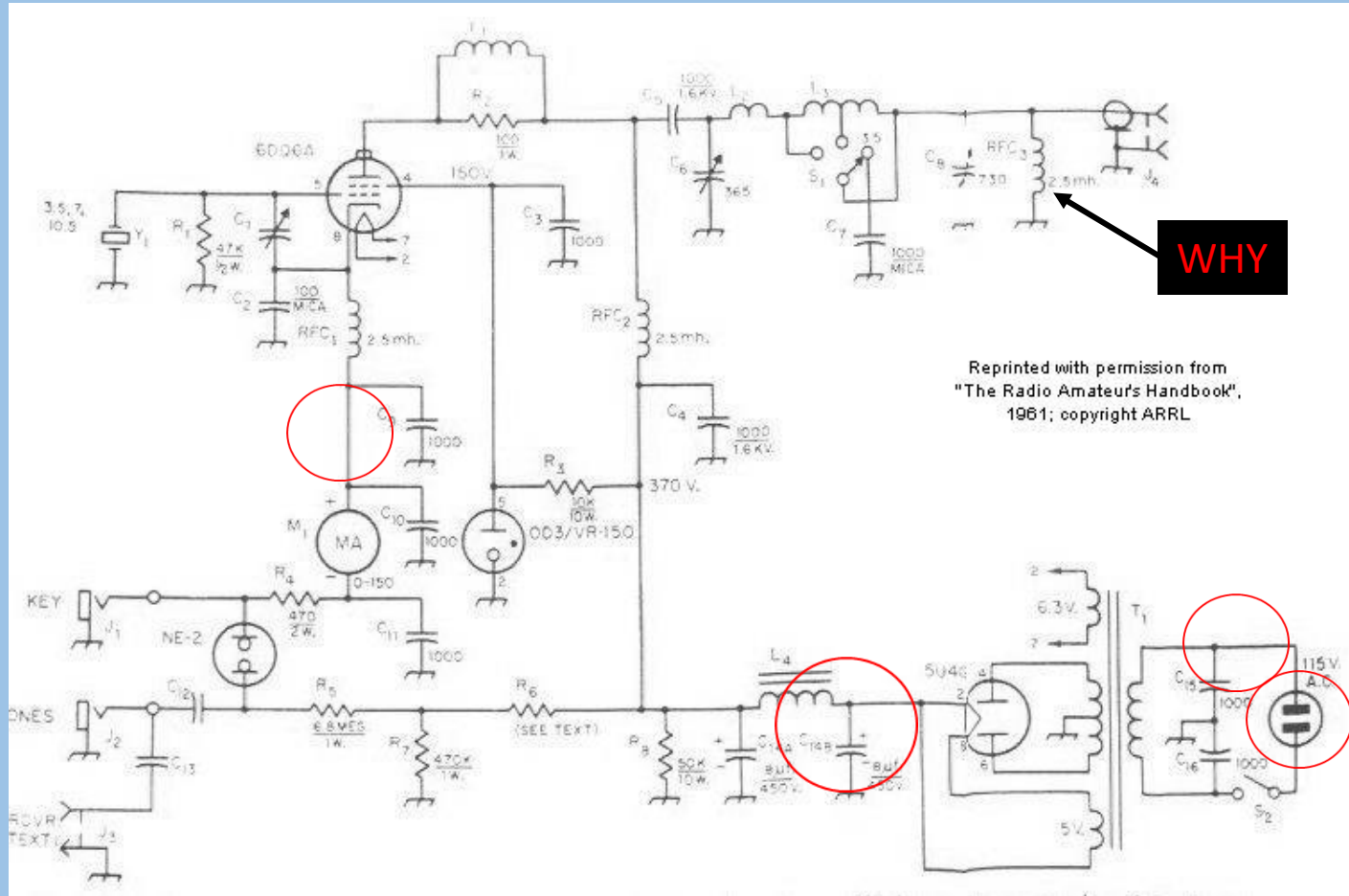
70 Volts PTP = 12.25 Watts,  $[(70^2) * 2.5] = 12,250$  Milliwatts and that is 40.88 dBm

Or for those who can only work in RMS  $(0.3535 * 70)^2 / 50 = 12.25$  Watts





# The Good, The Bad and the Ugly!

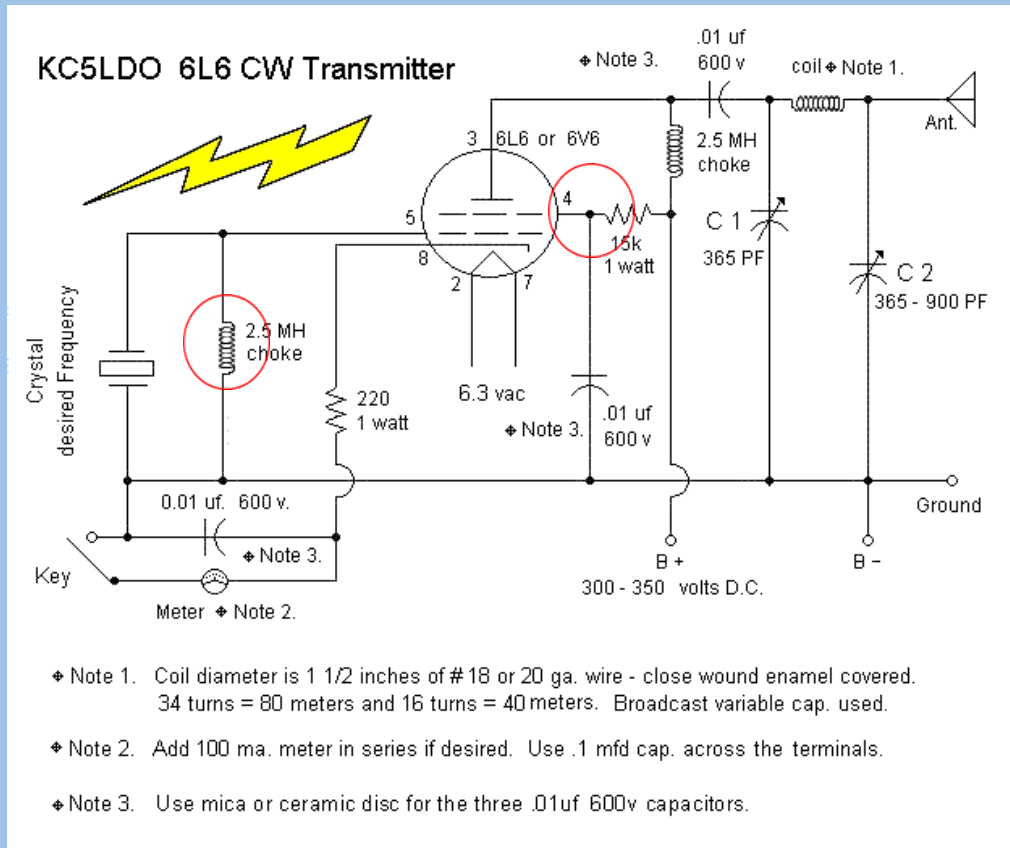


- Good
- Sort of Bad
- Ugly

**Grid Plate Form**



# The Good, The Bad and the Ugly!



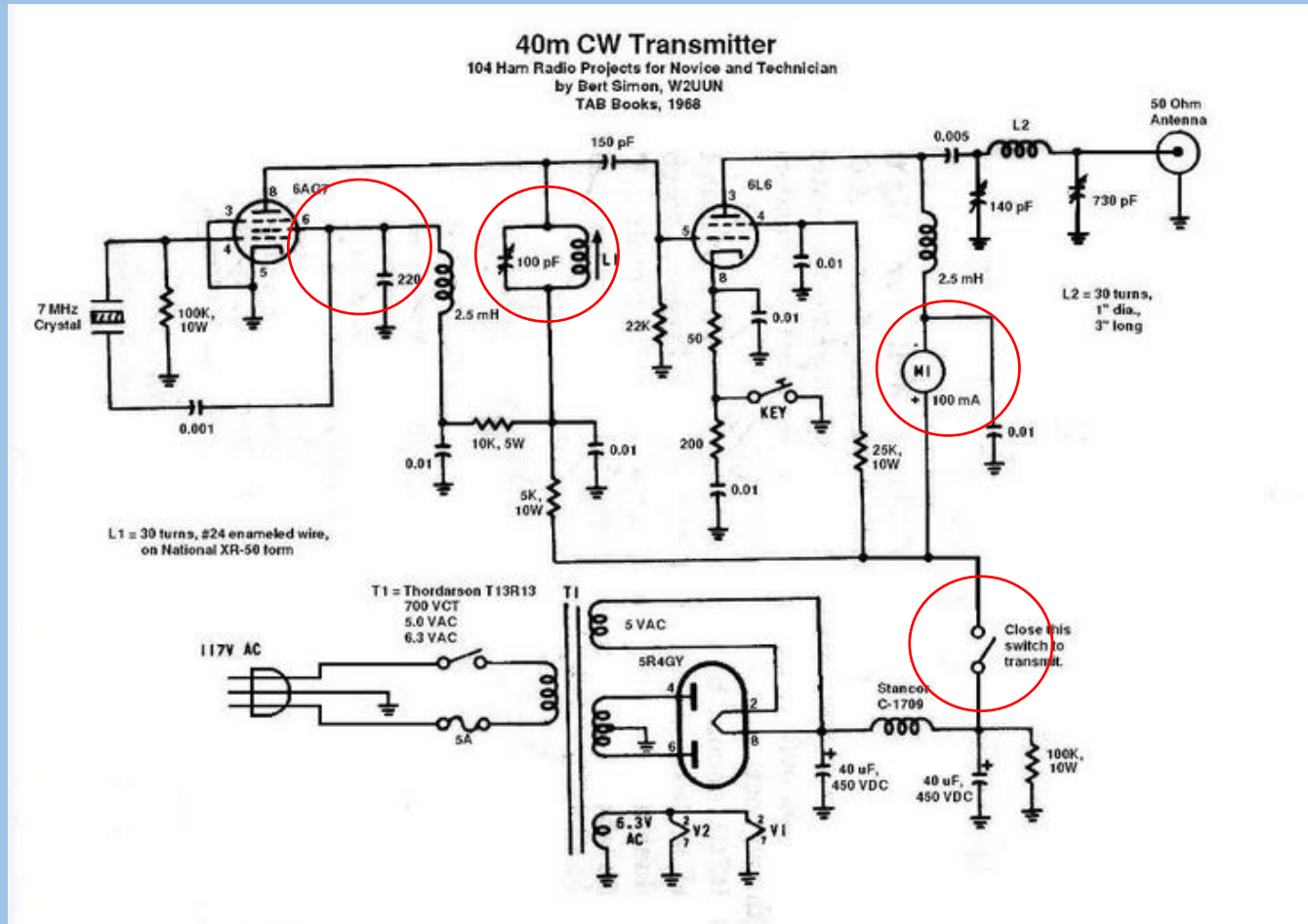
- Good
- Bad
- Ugly

**$F = (0.159) / (L * C)^{0.5}$**   
**with**  
 **$L = 0.0025$  Henry**  
 **$C = 10$  pF (  $10 * 10$  to the  $-12$  Farad)**  
 **$F = 1$  MHz resonant Frequency**

**Pull the Crystal and hit the Key. With a 10PF Interelectrode Capacitance = Spur!**



# The Good, The Bad and the Ugly!

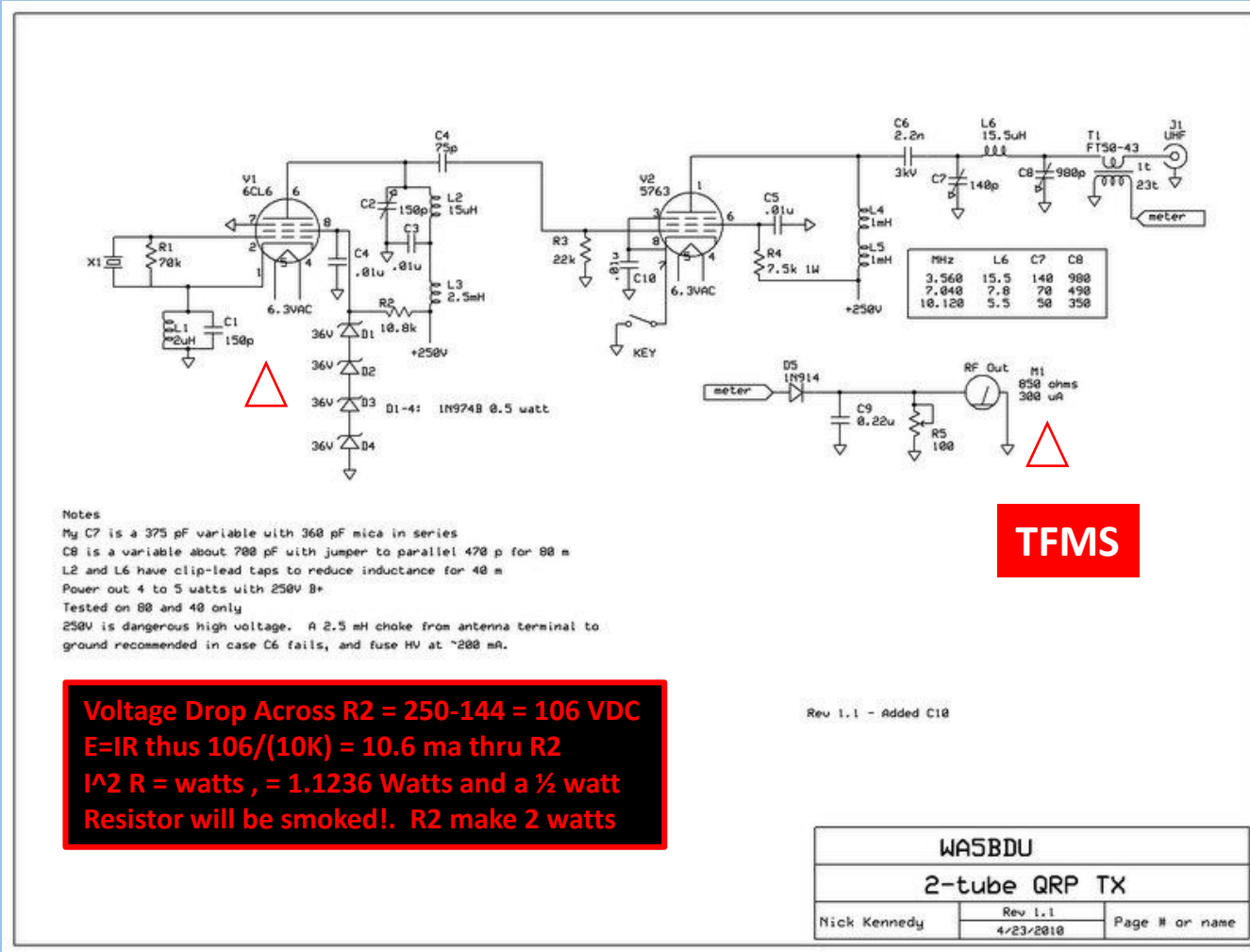


- Sort of Good
- Bad
- Ugly

Modified Pierce Form



# Where I would tilt toward!



- Sort of Good
- Bad
- Ugly

Tri Tet Form





# Where doth that lead us?

- An Intrinsically Safe Power Supply with Adequate Filtering & Bleeders
- Grid Plate or Tri-Tet Oscillator Form\*
- Regulated Screen Voltage on the Oscillator
- Key Click Filter (Richard Harris, G3OTK ~ Excellent Solution )
- [http://www.ivarc.org.uk/uploads/1/2/3/8/12380834/keyclicks\\_version\\_1.pdf](http://www.ivarc.org.uk/uploads/1/2/3/8/12380834/keyclicks_version_1.pdf)
- Metering of RF Output or in the Cathode Circuit
- Pi Network Output + Low Pass Filter
- Shielding between sections / High Voltage Screening
- Plug in Coils for Multi-Band Operation
- Make it large enough for those with FFS (Fat Finger Syndrome)
- High Quality and Voltage Rated parts



\*Radio Host and famous Ham Operator, Jean Shepherd loved the Tri – Tet – His 1<sup>st</sup> Rig!

# The Chosen Approach!

- A One Tube/Valve configuration with Pi-Network and LPF
- Tube/Valves ~ 6V6, 6F6 or 6L6 (Same “socketry”)
- 40 Meters is the band of choice (I have one rock at 7.030 MHz)\*
- The array of parts required were identified and that most parts are easily found except for 2.5 millihenry RF chokes. We will make these.
- We avoided “metal bashing”.
- A power supply of 250 VDC @ 100 ma and 6.3 VAC @ 2 amps is needed
- Capacitors have a voltage rating of 1KV except two that should be 1.6 KV
- Resistors are mostly 1/2 watt @ 5% but some power resistors are required
- The Pi-Network coil is wound on a plastic pill bottle or Air Dux Stock
- The Pi-Network will have a fixed value capacitance for the Load Control
- A W3NQN Low Pass Filter is hung on the output

\* Club Sales sells HC49 Crystals with wire leads at 7.028 and 7.030 MHz. Find a spent FT-243 Crystal remove the innards, solder in the crystal and you are there!



# The Chosen Approach cont'd!

- One Tube/Valve using a 6V6 (6F6, 6L6)
- Multi Tube/Valve designs are presented on the web link

Flexibility in the choice of Tubes/Valves and the Complexity of the build were Key factors in the choice of a single tube/valve.

A Website For Painful Details.

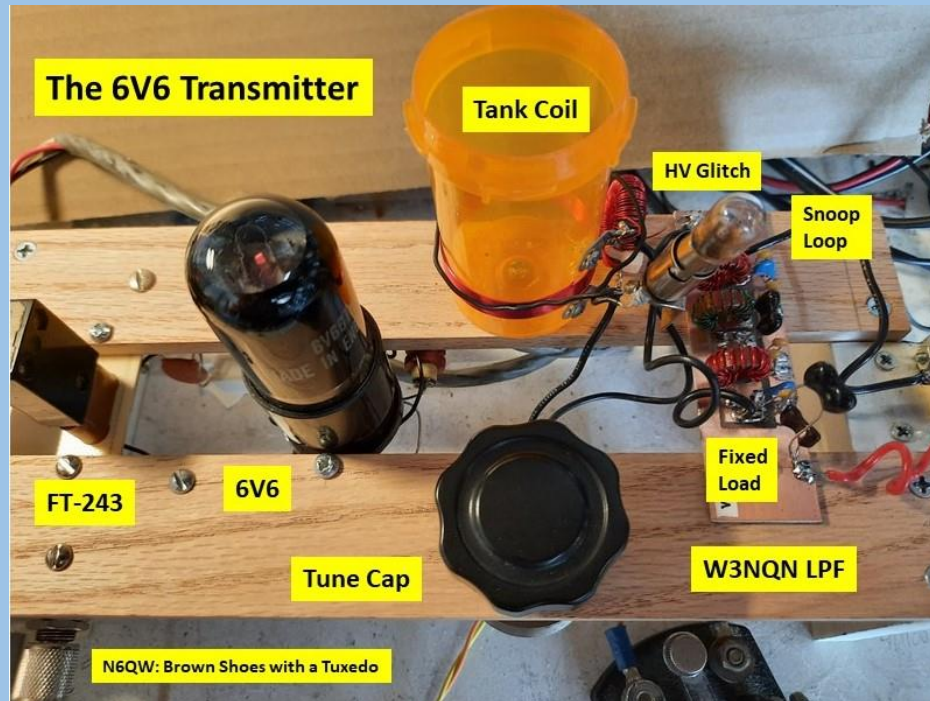
[https://www.n6qw.com/Tubes\\_And\\_Valves.html](https://www.n6qw.com/Tubes_And_Valves.html)

Chirp, Burps and Clicks! Crystal heating, (current passing through it) is a major factor in the production of Chirps. Mitigation involves typically not running things balls out! A cleaner signal but less Pout. Key Clicks arise from the making and breaking of the circuit (sort of abruptly). If you do a bit of sneaking up on the making and breaking = keying shaping, the clicks will be reduced. Burps *arise* from having overly seasoned with garlic, Bangers and Black Pudding washed down with Boddington Ale for lunch. This is a combination destined for the production of Burps and is non RF Related. The chosen approach must address these three factors!



# The Chosen Approach cont'd!

- One Tube using a 6V6 (6L6, 6F6)



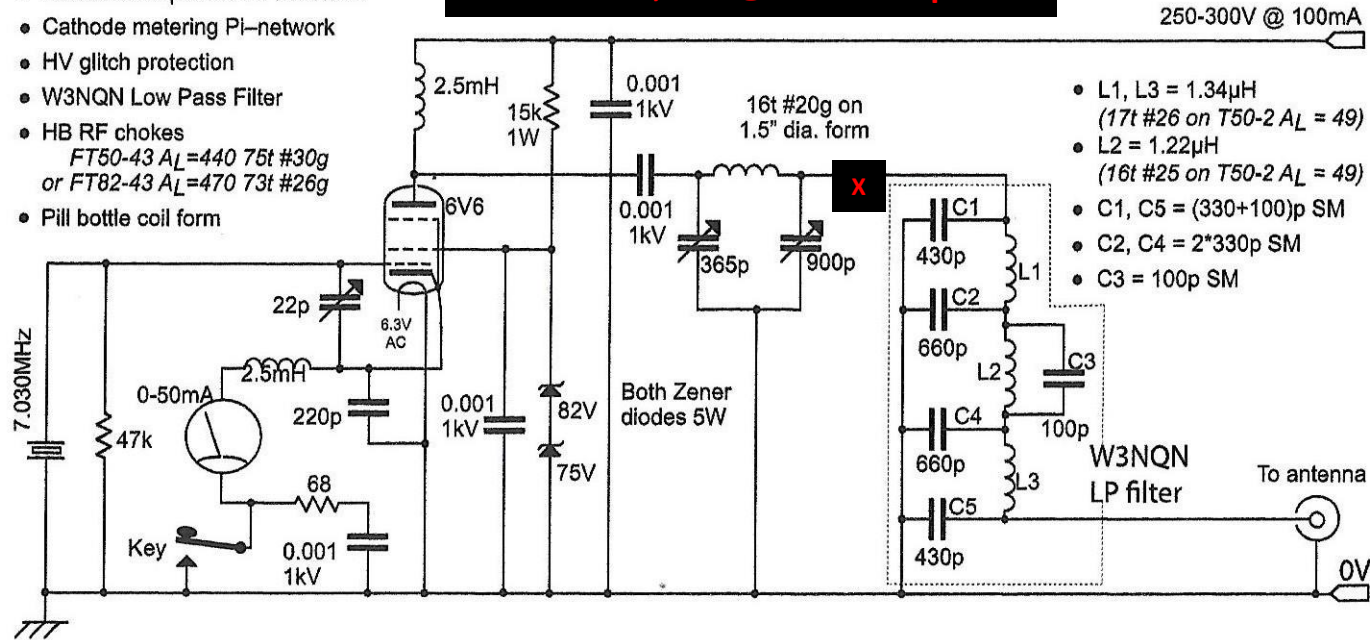
- Wooden Chassis
- 40M
- Key Click Filter
- Snoop Loop
- HV Glitch Protection
- Regulated Screen Supply
- Pi Network (Fixed Load)
- Reverse Beacon Network
- Trimmer Feedback Cap
- W3NQN LPF
- About 4 watts Output
- Grid/Plate Oscillator

If It Is Built Right, It Will Work Right!

# • One Tube using a 6V6 (6L6, 6F6)

- Regulated screen voltage
- Key click filter
- Feedback capacitor for best note
- Cathode metering PI-network
- HV glitch protection
- W3NQN Low Pass Filter
- HB RF chokes  
*FT50-43 A<sub>L</sub>=440 75t #30g*  
*or FT82-43 A<sub>L</sub>=470 73t #26g*
- Pill bottle coil form

**For 250 VDC, 15K @ 1 watt is OK**  
**For 300 VDC, 15k @ 2 W is Required!**



- L1, L3 = 1.34μH  
*(17t #26 on T50-2 A<sub>L</sub> = 49)*
- L2 = 1.22μH  
*(16t #25 on T50-2 A<sub>L</sub> = 49)*
- C1, C5 = (330+100)p SM
- C2, C4 = 2\*330p SM
- C3 = 100p SM

**X** = Install a 2.5 Millihenry Glitch Choke to Ground



# The Chosen Approach cont'd!

- One Tube using a 6V6 (6L6, 6F6)

REVERSE BEACON NETWORK

welcome main dx spots nodes FT8 downloads about contact us

showhide my last filters

showing spots for DX call: N6QW

rows to show: 20

de	dx	freq	cq/dx	snr	speed	time
WA7LNW	N6QW	7059.8	CW CQ	14 dB	14 wpm	1725z 13 Aug
W6YX	N6QW	7059.9	CW CQ	14 dB	15 wpm	1724z 13 Aug
WA7LNW	N6QW	7060.5	CW CQ	10 dB	15 wpm	1820z 07 Aug
W6YX	N6QW	7060.5	CW CQ	17 dB	15 wpm	1820z 07 Aug
W6YX	N6QW	7090.8	CW CQ	25 dB	15 wpm	1759z 07 Aug
WA7LNW	N6QW	7090.8	CW CQ	9 dB	15 wpm	1759z 07 Aug
WA7LNW	N6QW	7030.6	CW CQ	19 dB	15 wpm	2333z 27 Jul
K7M3G	N6QW	7030.6	CW CQ	10 dB	15 wpm	2333z 27 Jul
W6YX	N6QW	7030.6	CW CQ	15 dB	15 wpm	2333z 27 Jul
N6TV	N6QW	7030.6	CW CQ	10 dB	15 wpm	1737z 27 Jul
WA7LNW	N6QW	7030.6	CW CQ	18 dB	14 wpm	1737z 27 Jul
WA7LNW	N6QW	7030.6	CW CQ	19 dB	14 wpm	1735z 27 Jul
KO7SS	N6QW	7030.6	CW CQ	19 dB	14 wpm	1735z 27 Jul
W6YX	N6QW	7030.6	CW CQ	20 dB	14 wpm	1735z 27 Jul
W6YX	N6QW	7030.6	CW CQ	21 dB	15 wpm	1728z 26 Jul

Proof of Life...

Using the Reverse Beacon Network I was able to tell that the Rig was being heard and the frequency that was being transmitted. See the entries for August 13, 2021.

This had the W3NQN Filter.





# The Chosen Approach cont'd!



**Proof of Life...**  
Using my HL2 SDR to listen  
To the 6V6 Transmitter. This  
had the W3NQN Filter And  
The HB RF Choke on the RF  
Output. The Pout = 4 watts!

**Yes, I am Sending with my Left Foot!**

# The Chosen Approach cont'd!

- One Tube using a 6V6 (6L6, 6F6)



**Metal Shields were fabricated  
For the Front and Back of the  
Wooden Chassis = Shock Protection  
Note the metal is "hemmed" to add  
Stiffness. (Bent Over = Metal Bashing)**

# RF Chokes ~ TKT & Homebrewing

2.5 Millihenry RF Chokes = Hard to Find & Cost Like a King's Ransom

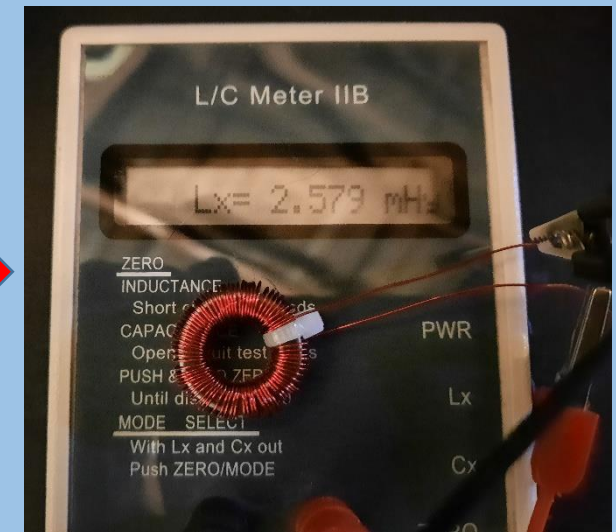
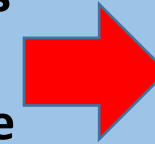
TKT: Why a 2.5 millihenry choke on the output? Answer = Safety!

If the Plate Blocking cap shorts you have HV on the Antenna.

The DC resistance is small (Shunt to Ground) but the Impedance

$Z = 2 * \pi * F * L$  @ 7 MHz and 0.0025 Henry the Z = 110K Ohms

Building a 2.5 millihenry Choke with a FT-50-43 core (Al = 440) the Number of Turns is 75 with #30 enameled wire. If we use the FT-82-43 Core then the Al = 470. and the number of Turns is 73 with #26 wire



Note: Club Sales stocks the FT-50-43 Cores

There are other methods for measuring your homebrew RF Choke. Those who are itching to use their Nano VNA, this is the time! Those with a DSO and RF Generator can also; but in either case you have to have a KNOWN VALUE close tolerance Capacitor. The Instrument is an AADE L/C Meter IIB, No longer available.



# Parts List ~ 6V6 Valve Transmitter

- 8 Pin (Octal) Socket
- FT-243 Crystal Socket\*
- 47k ½ Watt Resistor
- 22PF Trimmer Cap
- 220 PF COG or SM Cap
- .001 ufd 1KV Caps x 6
- .001 ufd 1.6KV Cap
- 2.5 millihenry chokes X 3 (HB Chokes)
- 15K, 10 Watt Resistor (JIC)
- 68 Ohm ½ watt Resistor
- 1.5 in Diameter Pill Bottle
- 365 PF Variable Cap
- 680 PF + 220 PF COG or SM Caps
- BNC or SO-239 Antenna Jack
- 5 Position Terminal Strip
- 3 Position Terminal Strip
- 82 Volt 5 watt Zener Diode
- 75 Volt 5 watt Zener Diode
- ¼ Key Jack
- 6V6 Tube/Valve (6F6, 6L6)
- 7.030 kHz Crystal
- T-50-2 Cores X 3
- 330 PF 300V SM/COG Caps X 6
- 100 PF 300V SM/COG Caps X 3
- #43 Pilot Lamp
- ¼" x 1.5"W x 10"L Oaks Strip X 2
- ½" x 2.75"W x 4.5"L end pieces X 2
- Power Cord 3 Conductor
- Spool #26 Wire, #16 Ins. hook up wire
- Solder Lugs, Nuts, Bolts, Knob, Wood Screws

\* A second octal tube/valve socket can be used as a Crystal Socket.



# Test Gear That You Might Need!

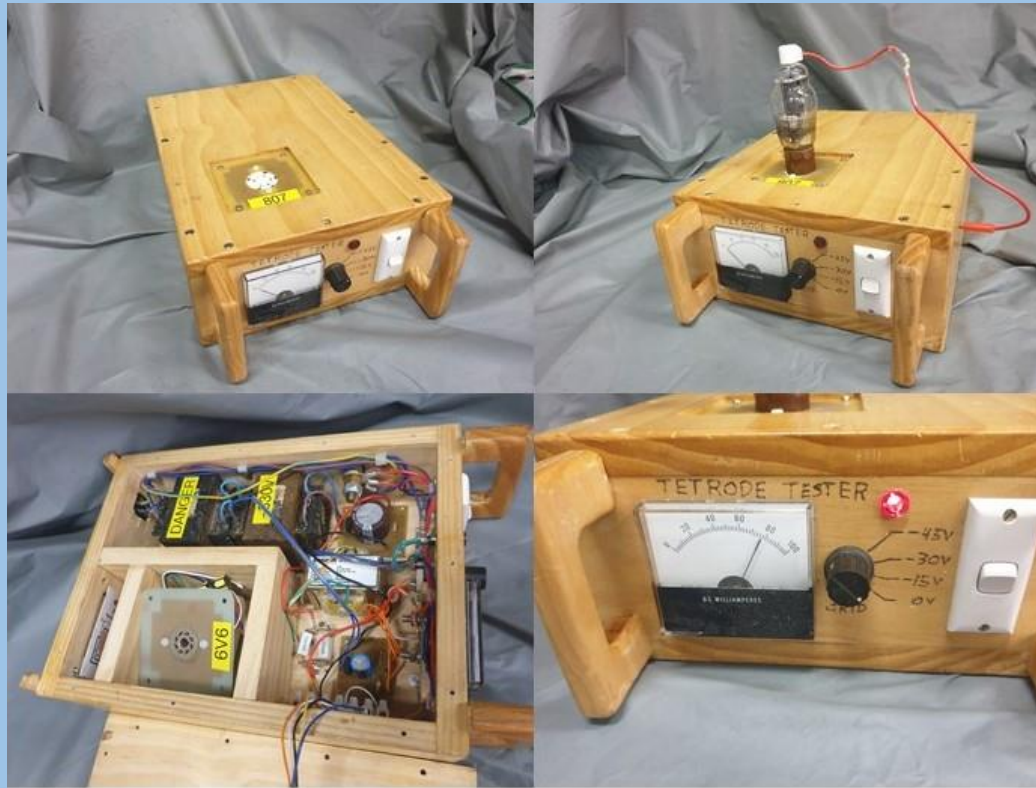
## Test Gear Likely Not Found in Most Shacks

- VOM good to 1000 VDC
- LCR Meter
- Snoop Loop (One Turn Loop with a Light Bulb)
- Non Metallic Screw Drivers
- Grid Dip Oscillator (So OK you could use your Nano VNA)
- Tube Tester
- SWR /Power Meter
- Heat Shrink Heat Gun
- DPDT Knife Switch (Old Fashioned TR Switch –It's Alive)





# Test Gear: Homebrew Valve Tester!



A bit of Innovation from the Designer! The Plate has “0” volts and the Cathode has a Minus (-) 300 Volts. Here is the case where the Cathode is always less positive than the Plate. ( $-300 < 0$ )

Did we move you from the Comfort Zone?

Valve Tester Built by VK2EMU, Peter O’Connell Based on the Design From Drew Diamond, Source : G-QRP Club Sales Radio Projects Vol 4



# Thank you for Riding Along with Me!



[craponthebench@gmail.com](mailto:craponthebench@gmail.com)

[https://www.n6qw.com/Tubes And Valves.html](https://www.n6qw.com/Tubes%20And%20Valves.html)

[www.n6qwradiogenius.us](http://www.n6qwradiogenius.us) (SDR Stuff)

<https://www.pastapete.com>

<https://www.n6qw.com>

<https://www.jessystems.com>



Another kind of Homebrew!

Info on suitable Power Supplies and more Transmitter designs  
Is located at [www.n6qw.com/Tubes And Valves.html](https://www.n6qw.com/Tubes%20And%20Valves.html)

**If it is built right, it will work right!**

