

Single Tube Radio Challenge

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1-Tube Reflex Radio for CHU

- CHU (Time Signal) receiver. Tuned to 3.33MHz.
- CHU is located in Barrhaven.
- In Barrhaven, you can pick it up with a rusty shovel, but in Downtown Ottawa it is surprisingly weak. I have been unable to pick it up with decent volume with a crystal set.
- This radio uses the “Reflex” Architecture.
- 1-Tube Pentode + Triode + germanium diode detector.
 - Pentode amplifies TWICE: a tuned RF amplifier and an audio amplifier
 - Triode is an audio amplifier.

CHU Transmitter Site

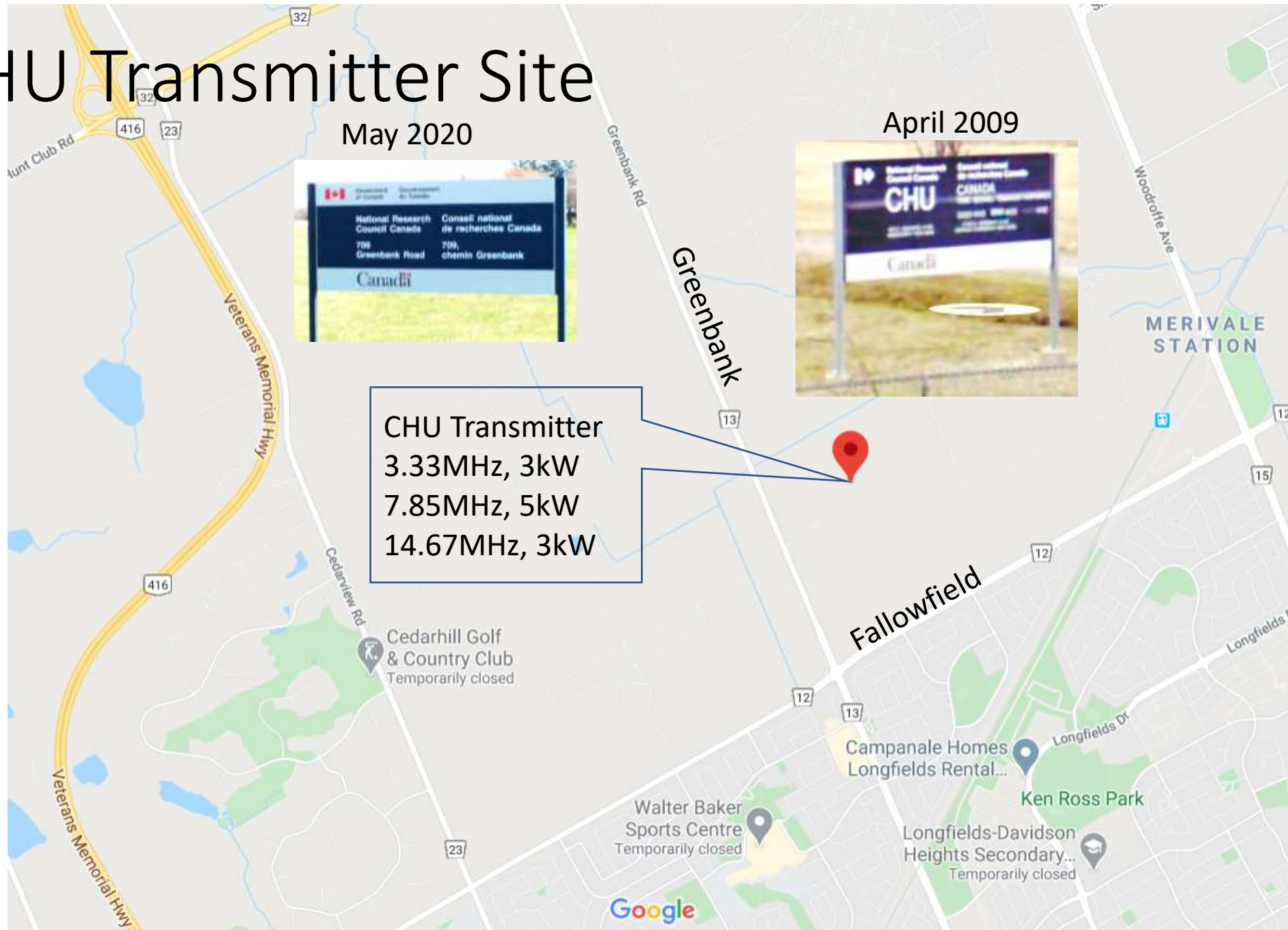
May 2020



April 2009



CHU Transmitter
3.33MHz, 3kW
7.85MHz, 5kW
14.67MHz, 3kW



CHU Transmitter Site. 3 antennas



CHU Transmitter Site

May 2020



Radio Design Notes

- Was not easy! Instability (RF oscillation) was a huge problem!
- I had to learn “neutralization”, Added “Cneut” to circuit.
 - Neutralization is a circuit that cancels the effect of the grid-plate capacitance that causes oscillation.
- R1 C1 added to de-Q the input a bit, make the circuit easier to operate.
- Shielding around plate circuit, careful (excessive?) supply decoupling.
- Though the box is wood, there is a copper ground plane underneath.
- There is also the potential of audio oscillation, as the audio signal alters the operating condition of the RF amplifier.
- And, a microphonic tube also caused some oscillation!
- Circuit is still “touchy”.

Radiotron Designer's Handbook 4th edition

1066

(ii) NEUTRALIZING CIRCUITS

26.8

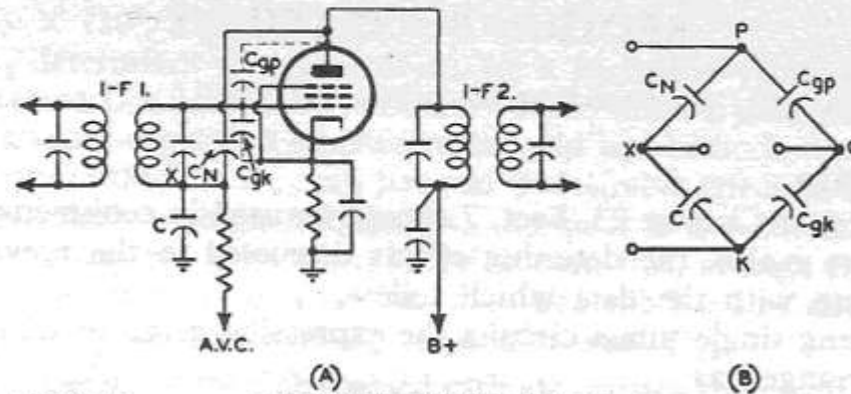


FIG. 26.19

I-F NEUTRALIZATION CIRCUIT

value required. The neutralization is generally not sufficiently critical to require different capacitance values in different receivers of the same type, as even partial neutralization is helpful and often sufficient.

Other circuits using various arrangements of inductance and capacitance for neutralization and stabilization can be found in the references. Two interesting alternatives (Refs. 79 and 80) to that of Fig. 26.19 are shown in Fig. 26.20.

Circuit (1) will be briefly discussed; circuit (2) should be self-explanatory. In both cases all the components have their usual values except C_3 in circuit (1), and L_a is an added inductance (in i-f and some r-f circuits) in circuit (2); the latter arrangement is of interest when the cathode is grounded for d.c. To obtain complete neutralization in circuit (1) it is required to make

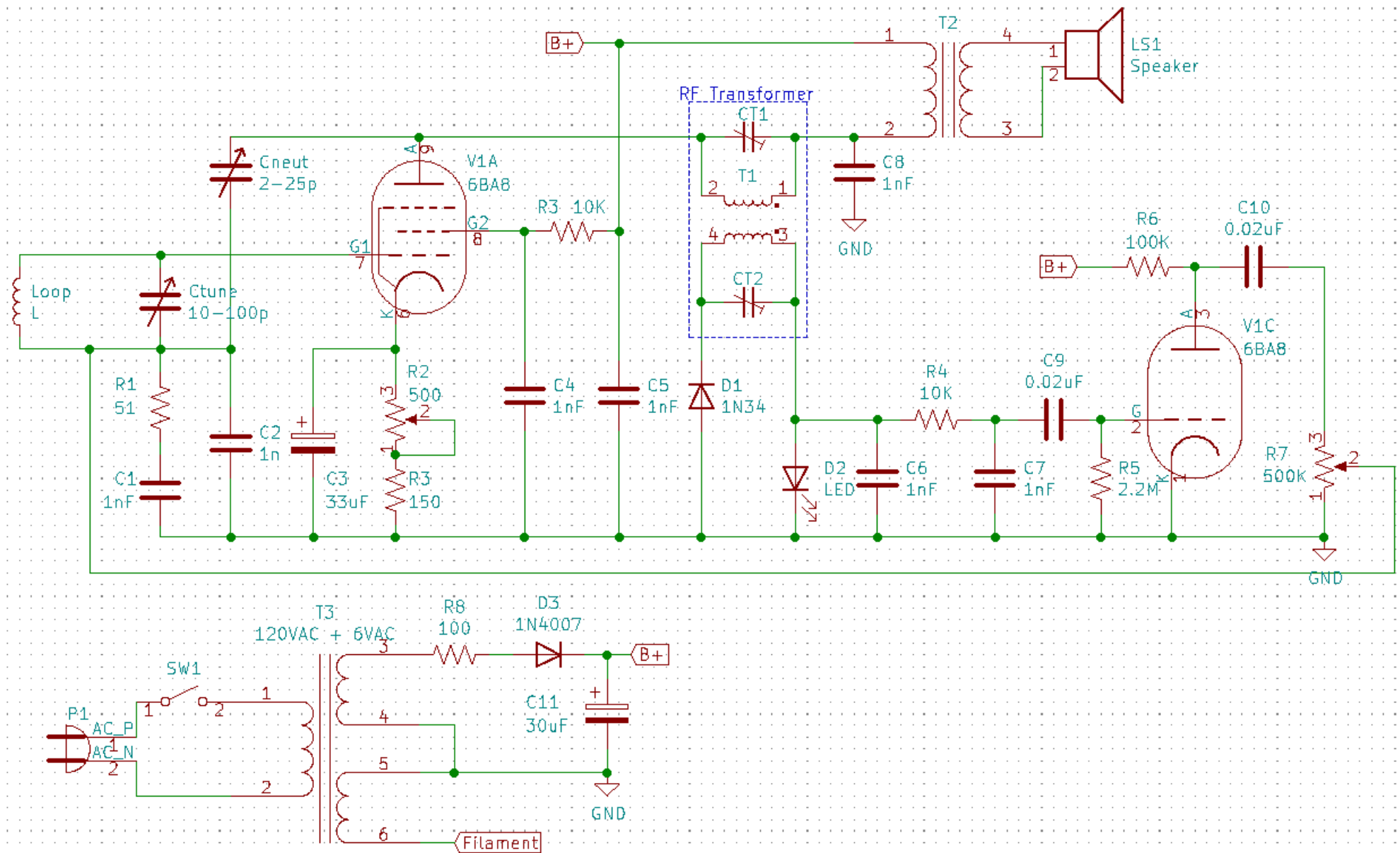
$$C_3 = C_1(C_{pk}/C_{gp}) \quad (51)$$

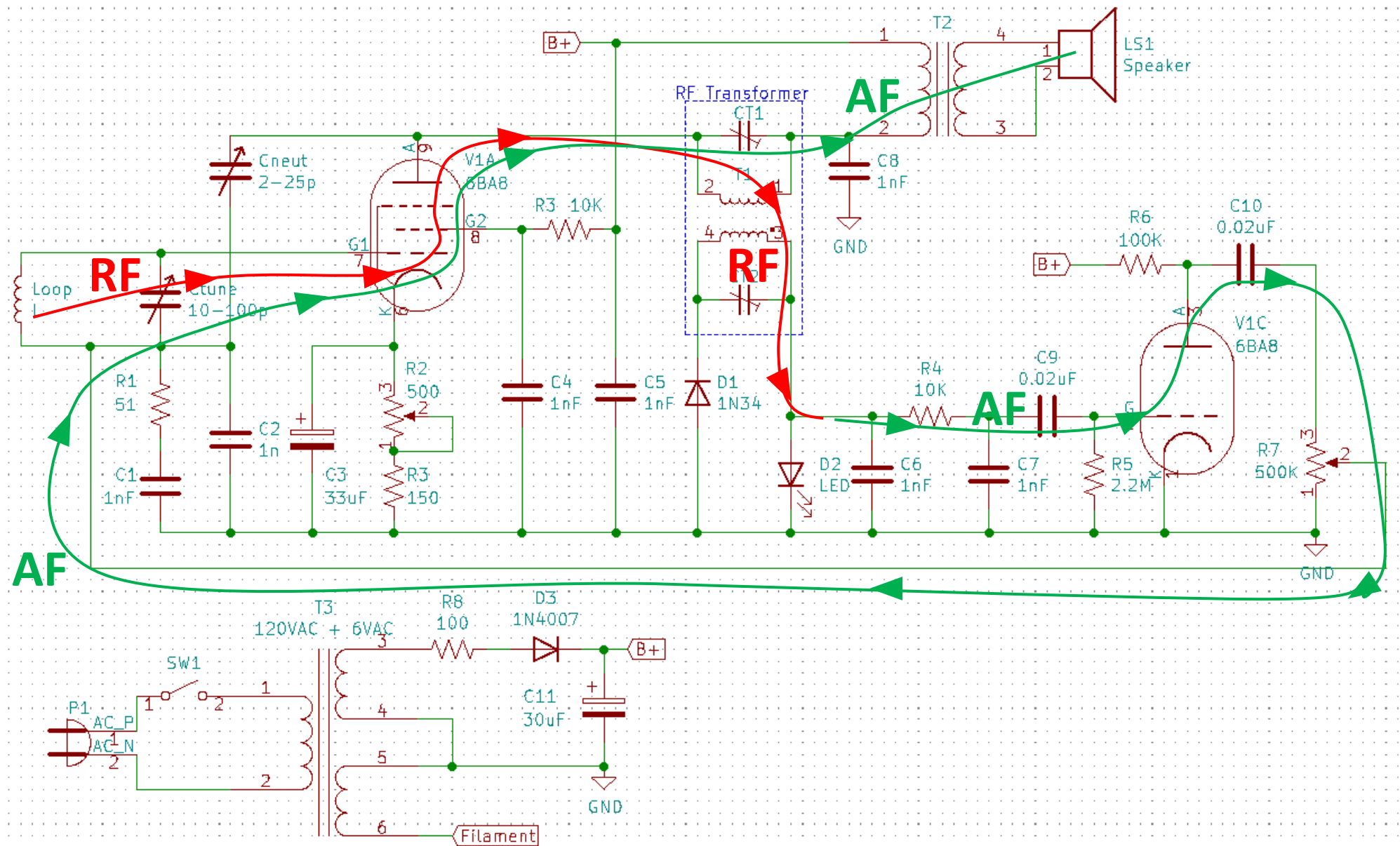
where C_1 = i-f tuning capacitor

C_{pk} = total plate-cathode capacitance including all strays

and C_{gp} = total grid-plate capacitance including all strays.

In a typical case for a 455 Kc/s i-f transformer $C_1 = 100 \mu\text{F}$, $C_{pk} = 10 \mu\text{F}$



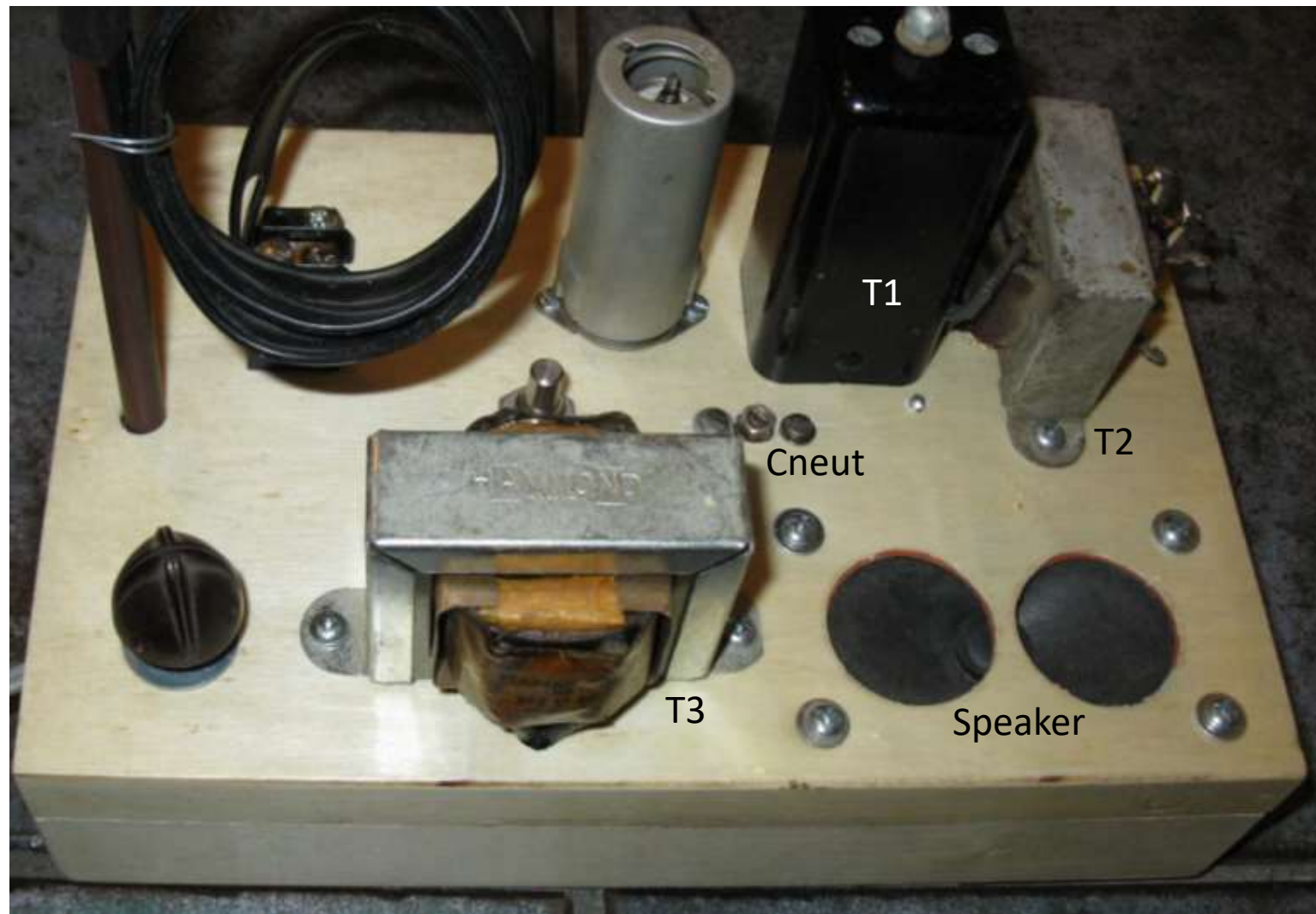


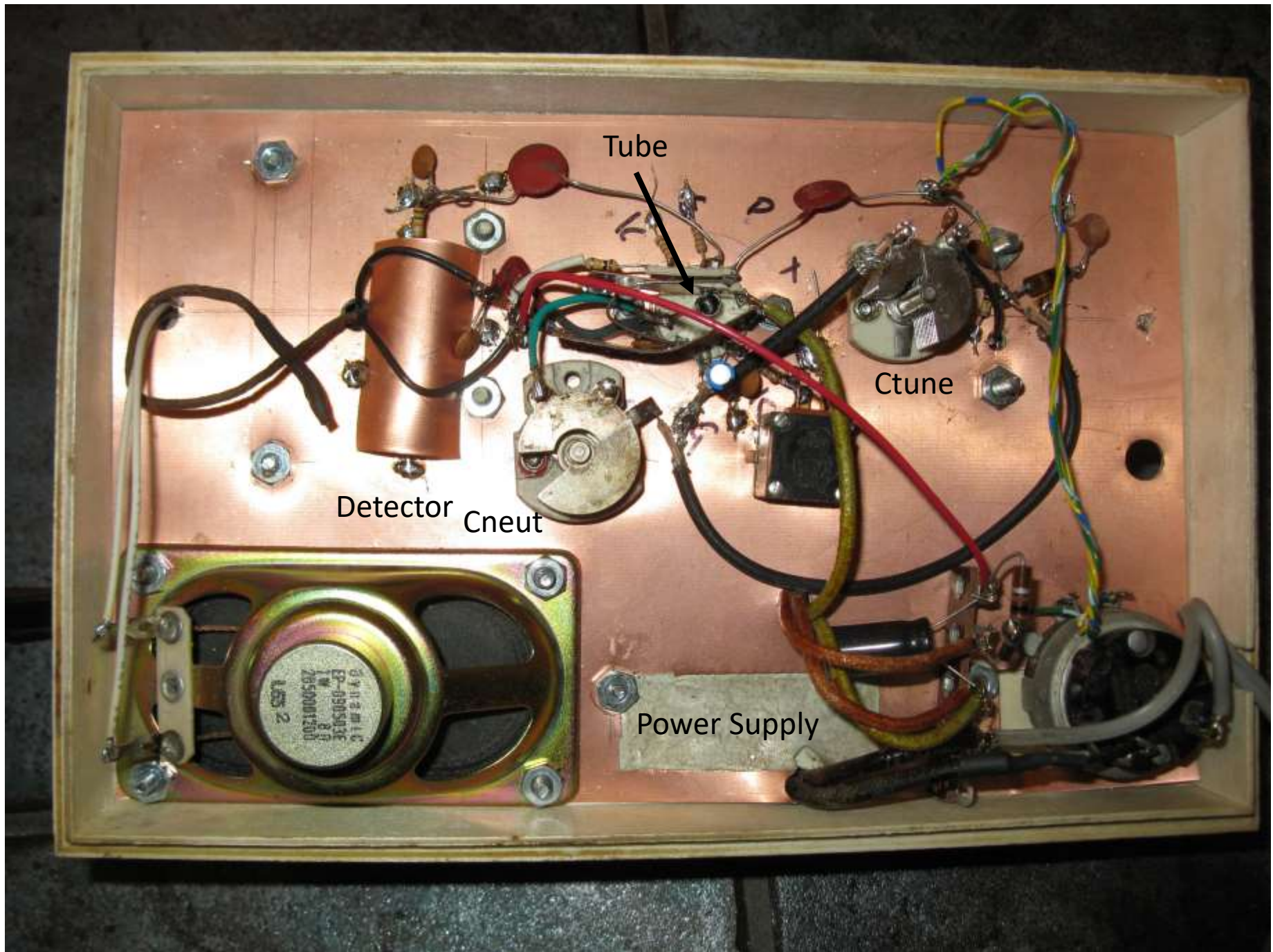
Tube Selection

- A figure of merit for the stability of a tube is g_m/C_{g-p} (see Radiotron Designer's Handbook, 4th ed, page 1065)
- I have new respect for the lowly 6AU6! I started with it. It has one of the best figures of merit for stability of any tube in its era.
 - 6AU6 (4500/0.0035pF). 6BA6 is similar, but lower g_m .
 - EF50 is also excellent at 6500/0.003pF.
 - 6EJ7 (a modern frame-grid tube) is probably the best at 15000/0.005pF.
 - All the triode+pentode tubes are worse.
 - So, using a multi-section tube made stability tougher to achieve.
- I tried 6AU8, 6AW8, 6BA8, 6BH8, 6EB8 (all have same pin-out). Different tuning required. Settled on 6BA8 (9000/0.03pF, 5X worse than 6AU6). Differences between these 5 tubes were not huge.

Component Notes

- R1 C1 de-Q the input, makes tuning easier.
- LED lights if the circuit is oscillating! Also serves as a limiter.
- R2 sets pentode current. Not critical.
- T2 is a high ratio output transformer.
- T1 is a Meissner 1.6MHz IF transformer with turns removed from both windings until they resonate at 3.33MHz. ($\sim 33\mu\text{H}$ each) The coils are also moved closer to each other.
- Ctune and both RF transformer trimmers are peaked at 3.33MHz. Cneut is adjusted to stop oscillation, and is critical.





Tube

Ctune

Detector
Cneut

Power Supply

Loop Antenna

- Wound with Litz wire.
- Basically 8 turns of wire, 26 cm in diameter.
- Inductance (measured) of 27 μH .
- Though it *looks* like a toroid inductor, that is not the intention. The loop antenna is wrapped around a foam “core” just to keep the wires apart (reducing interwinding capacitance). Since the core is non-magnetic, the toroid formation does not affect the inductance.

