# RF Band Switch Replacement

Dec 5 2022 w8ji

## Background of Switch Voltage

Peak anode (or plate) voltage in typical single-ended class AB amplifiers, tuned for maximum output at normal power levels, is commonly 170-180% of dc anode supply voltage. Let's use a common grounded grid 3-500 running near peak efficiency as an example.

With a typical 3200 Vdc anode supply, ***in properly tuned LINEAR operation,*** 3-500 anode voltage can reach as low as 800-volts on negative RF filament-cathode drive (positive grid-to-cathode) swings. This results in a negative 2400-volt movement on the plate tuning capacitor end of the tank.

Due to operating Q and a flywheel effect, and with a good tuned input circuit, tank waveforms are pretty good RF sinewaves. As filament-cathode drive voltage moves back positive with respect to the control grid, the plate current eventually goes to zero. The tube cuts completely off become an open circuit during the most positive cathode or negative grid portions of each RF cycle.

During device cutoff period, tank circuit "flyback energy" dumps back through the plate blocking capacitor into the tube. This pushes the tube's anode up positive above the supply an amount equal to the negative pull. Since the negative tank cycle reached -2400 volts peak, the tube anode gets pushed to 2400+3200 = 5600V. This is the normal operation limit when near peak efficiency and optimum output tuning for a given drive level.

While normal voltages are high, extreme voltages caused by sudden excess drive power above the tank tuned conditions (loading control adjusted too far closed for peak drive power), or by loss of load, are primary reasons tank components arc. Under conditions of mistuning or during certain load fault conditions, peak anode voltage can reach four times or more dc anode power supply voltage. This high voltage occurs because the tank circuit is not coupling excess stored energy out to the antenna or load. Tank ringing or flyback voltage stored in a lightly coupled tank will actually drive the tube anode far below zero volts when plate current normally is at maximum current. The negative anode swing causes plate current to quickly collapse, allowing the anode to be pushed well below negative by the tank.

High tank voltages, along with the high frequencies involved, require special care in wiring and soldering. All tank circuit connections should be smooth and rounded without sharp points protruding outward. The highest and most risky voltages are at the anode end of the tank system. This is why 160- or 80-meter plate tune padding capacitors and ten-meter taps are the most frequently damaged switch poles.

This picture shows typical voltage distribution in an amplifier band switch removed from a poorly-wired homebrew amplifier, but this is representative of all amplifiers with progressive shorting or “pick up and hold” switches.   The progressive shorting or pick-up-and-hold rotor is necessary to prevent inactive coil section tank taps from developing high voltages and arcing. The old National NCL2000 is one of the few commercial amplifiers where a pick-up-and-hold rotor was not used. Not using a pick-up-and-hold or at least a tap short at the mid-band tap for higher bands always results in an increased likelihood of switch damage while operating on higher bands (20-10 meters).

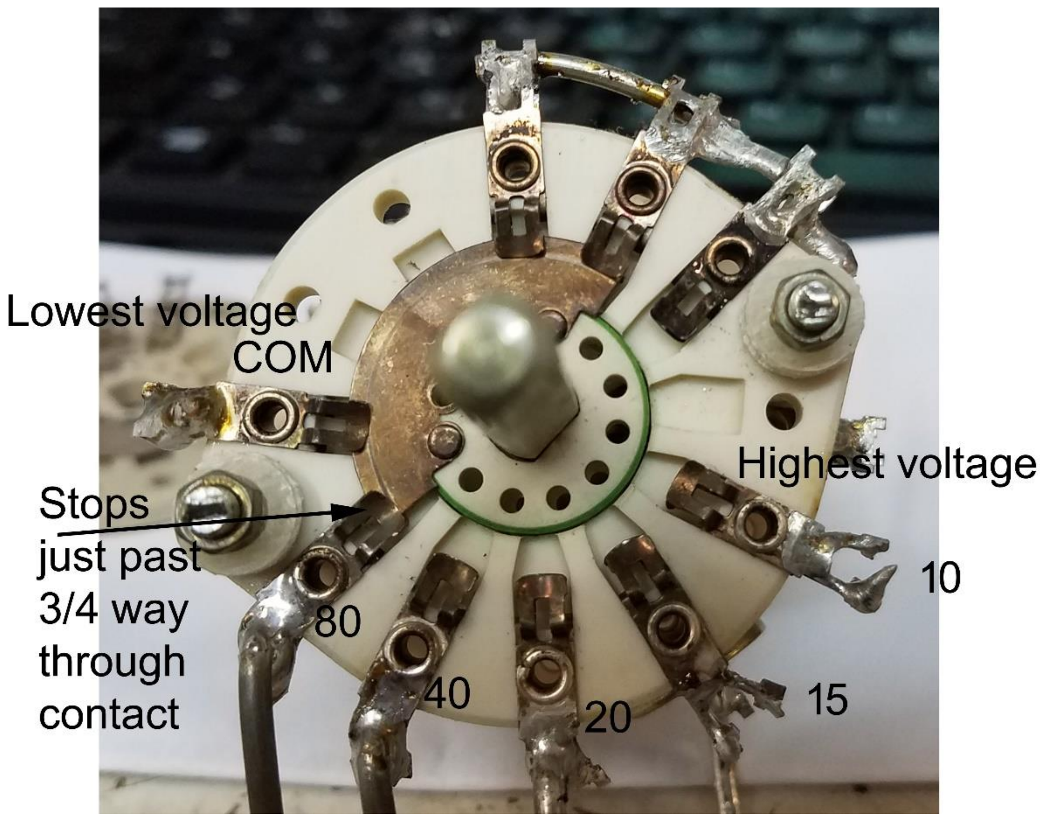


*Figure 1*

## Switch Wiring

Figure 2 is a typical padding wafer for switching in a plate tuning capacitor pad for 160M or 80M. The left lead should go to ground. It can be near the mounting screw because it is zero voltage. The right lead has full anode-end RF voltage to ground, which is almost the dc supply voltage. Peak voltage can become significantly higher than supply voltage if the tank is incorrectly loaded or loses load.

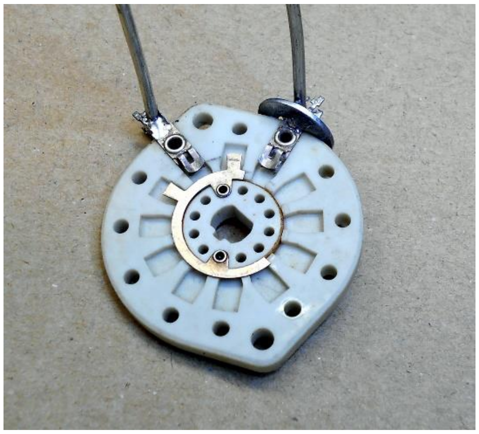

*Figure 2 plate C padding*

This wafer shows an anti-corona washer in place. The more rounded edge goes toward the switch. The washer spreads or disperses the localized contact electric field gradient, resulting in a substantial increase in contact voltage breakdown.

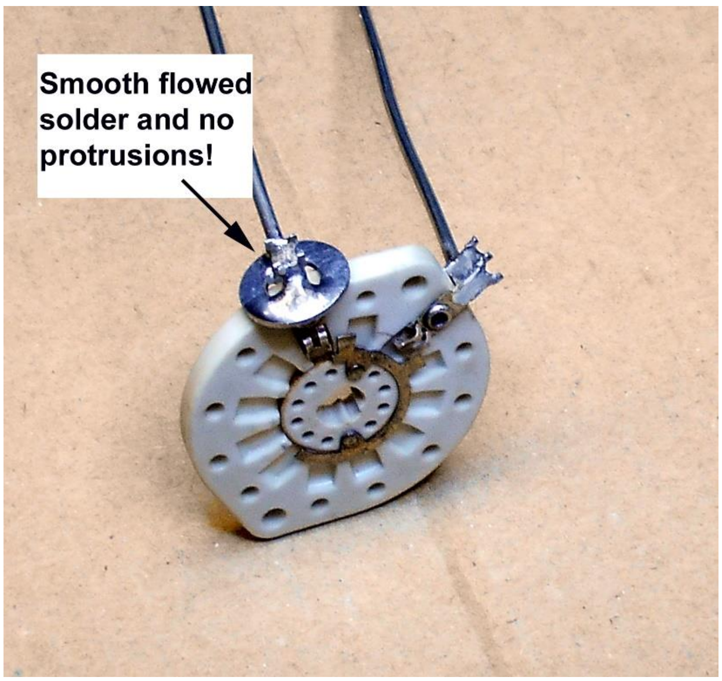


*Figure 3 anti-corona*

Bandswitch wires should generally be smooth solid wires. Braiding has several times more RF resistance for the same conductor cross section and should only be used on leads that must be flexible.

To make round wire fit rectangular switch lug eye wire can be worked flat in crotch of pliers.

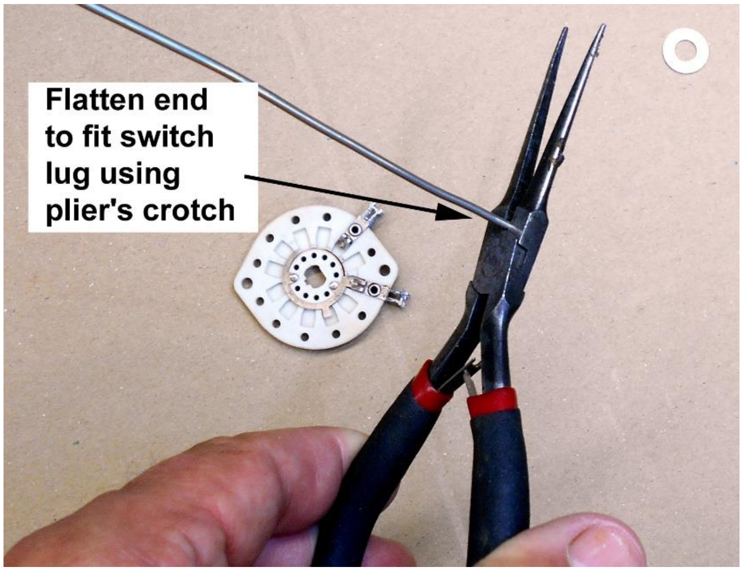


*Figure 4*

This factory stock AL80B Ameritron is an example of very poor wiring. Wiring like this creates a future bandswitch failure. Sooner or later, someone will be replacing this switch.

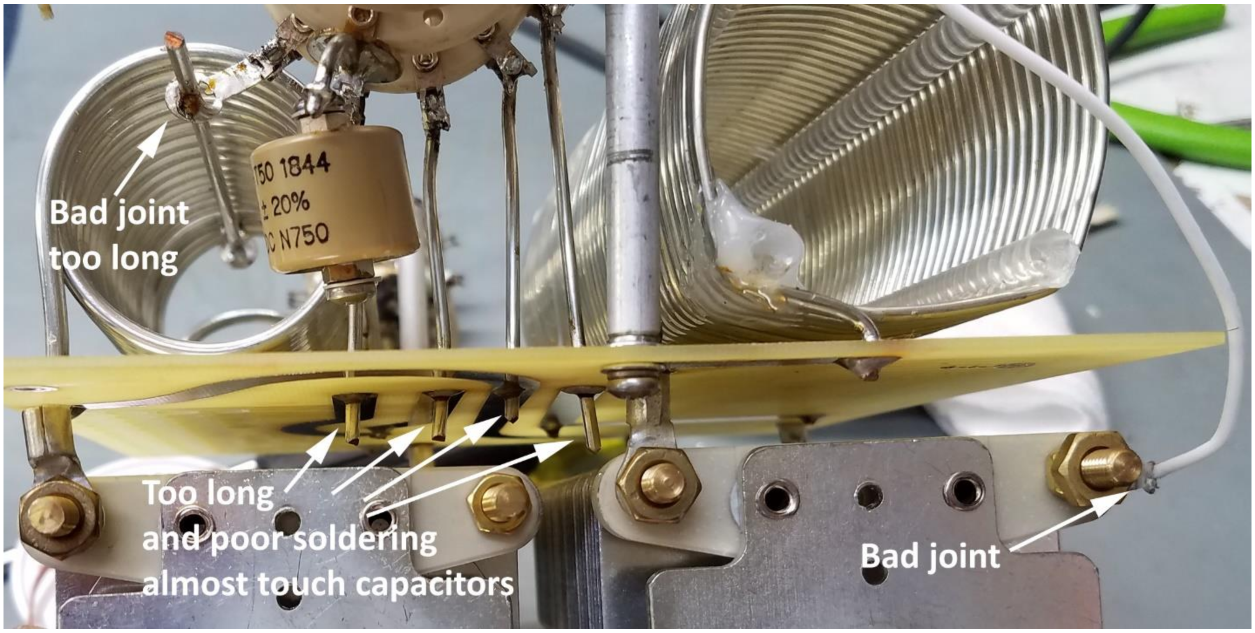


*Figure 5*

By preforming leads switch wiring can be professional. Bus wire can be pre-stretched or worked straight. The end is matched to the switch slot by working in a plier crotch, then the wire is formed and cut to fit before soldering. This allows use of larger wire.

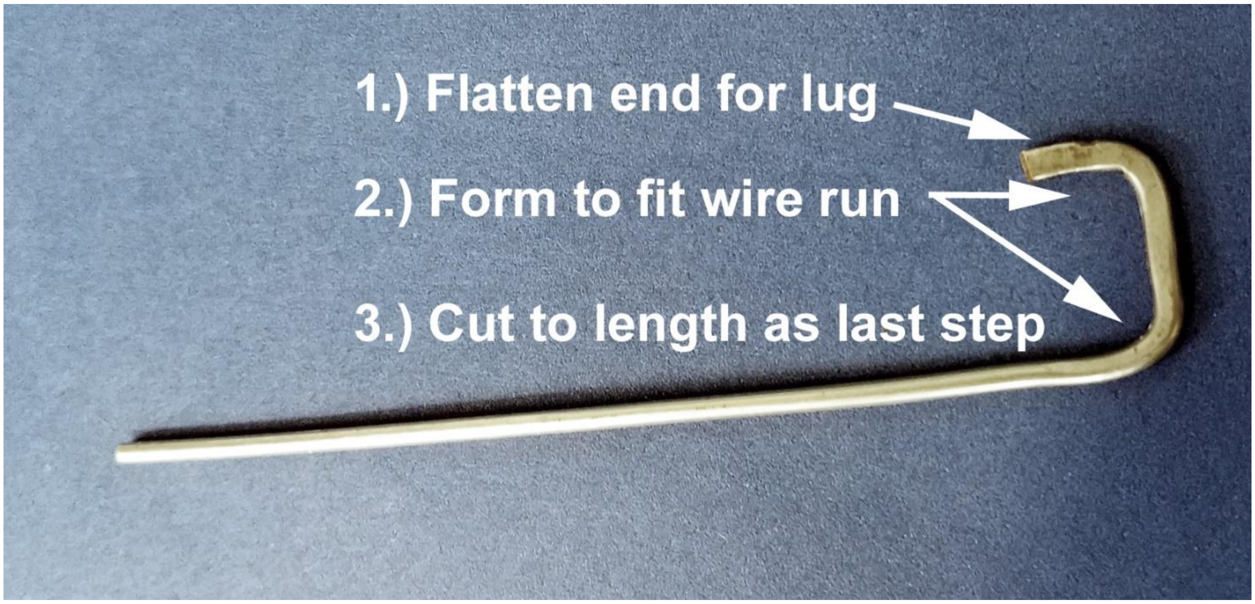


*Figure 6*

The result is wiring that looks professional and has high voltage breakdown. This is a corrected switch during replacement. All connections are smooth and round. The wires are preformed and fitted to eliminate unnecessary things like solder lugs. All wires and parts have good air gap.


*Figure 7*

Switches have slop in wafer screws to allow alignment tweaks. This is the proper final contact position. Never allow a rotor contact to extend beyond the fixed contact in the open direction, but the contact should always be past the pressure point of the contact

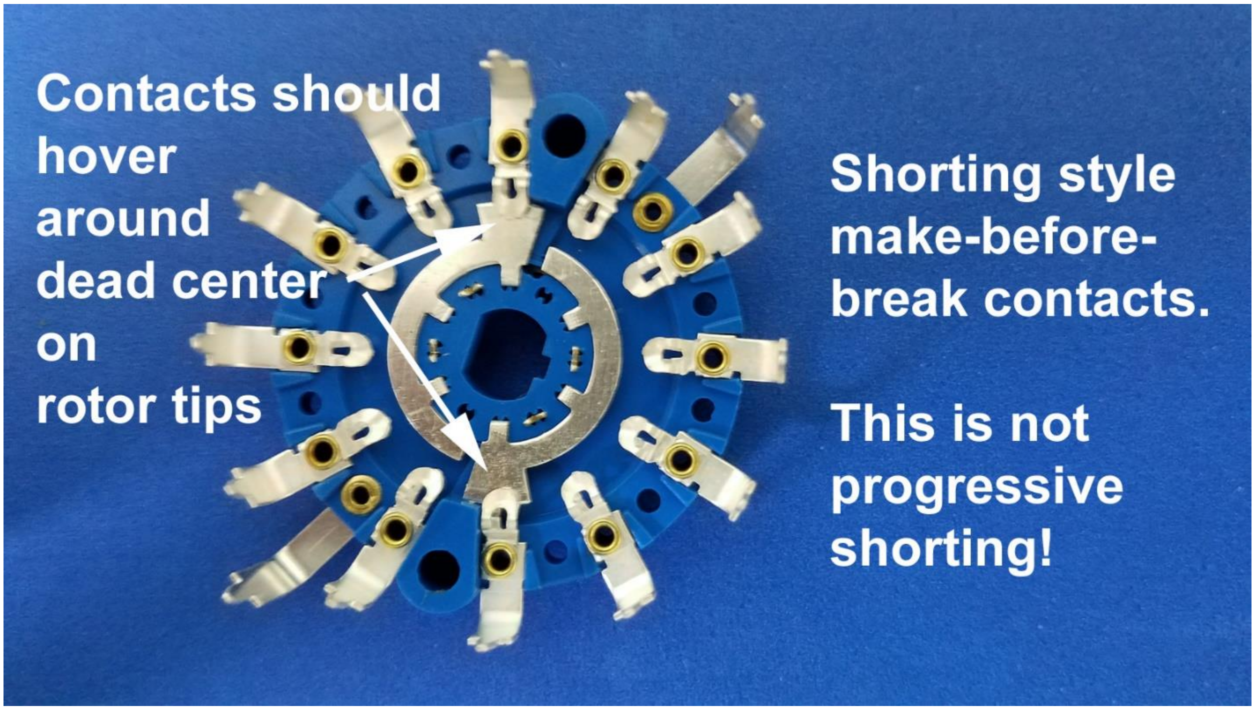


*Figure 8*

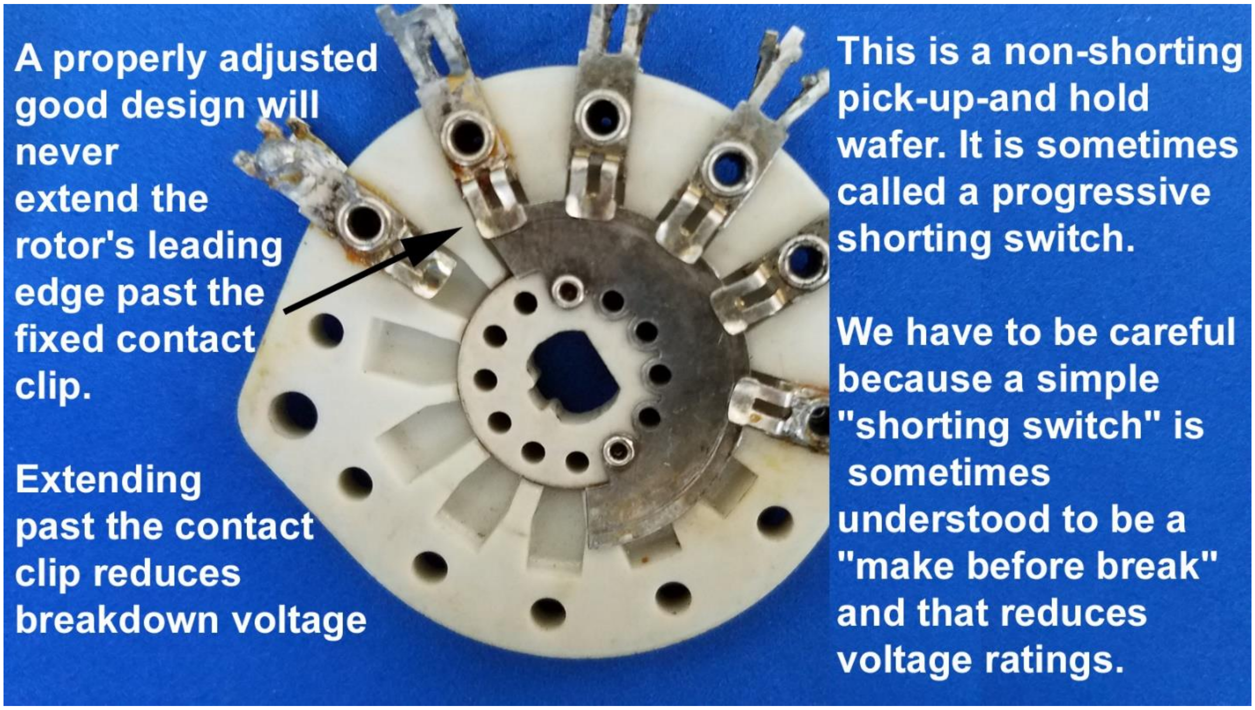


*Figure 9*