SB200/30L-1 Relay Buffer and Arc Protection Mods

Rev0 30 Apr, 2025

The Collins 30L1 and Heathkit SB-200 share nearly identical grid and bias circuitry. It appears Heath copied or patterned the relay and grid bias system after the 30L1. Unfortunately, the 30L-1 is a 1950s or earlier style design. Instead of more modern dynamically stable Zener referenced bias the 30L-1 used a moderate impedance voltage divider. The 30L-1 did not neutralize the tubes, floated the control grids through low value mica capacitors, and did not properly ground the plate tune capacitor. This resulted in chronic instability while increasing IMD.

Another issue is neutralization. Parallel tubes decrease stability at upper HF. Two 572B's or three 811 tubes are marginally stable at upper HF. Three 572B or four 811 tubes are beyond the safe threshold. This is why Heathkit, Gonset, and Ameritron neutralized their 4x 811 amplifiers. We have a neutralizing kit that retrofits most grounded grid amplifiers. The principle is the same as the AL572 Ameritron.

While generally "okay" with old tube rigs, the old 1950s design makes the SB200 series and 30L1 less safe and less compatible with common modern solid-state radios.

Bias Supply

The bias supply is a half-wave rectifier using a nominal 120Vac transformer winding. Collins used a 10uF bias filter capacitor, Heath used 20uF.

Heath very slightly improves audio-rate stability with C19, a 2 uF capacitor.

While the Heath filter is a slight improvement, the negative supply in both the Collins and the Heath units drive about 70mA quiescent current into the relay and padding resistor system. The bleeder (R15 Collins and R2 Heath) adds additional load of about 15mA, depending on voltage across the filter capacitor. Both units have filter too small for a halfwave rectifier with ~85mA load. Poor filtering introduces 60Hz ripple on the bias line.

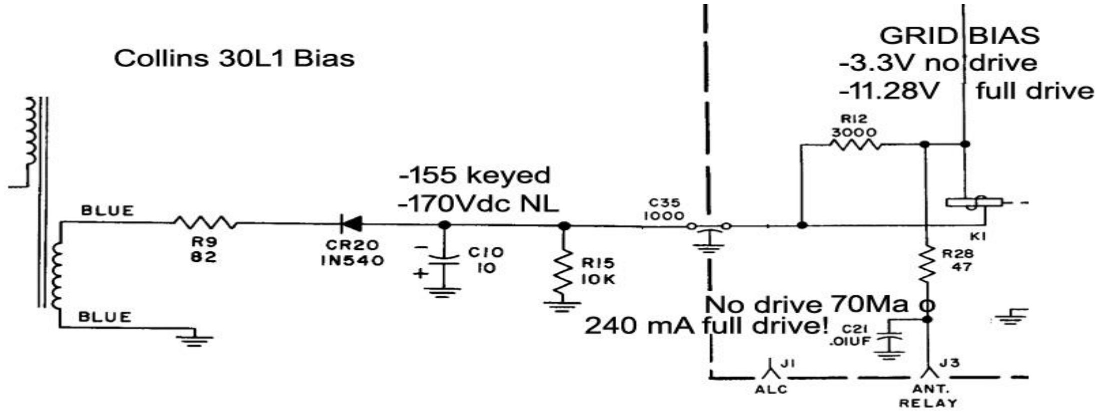


Figure 1 30L1 bias

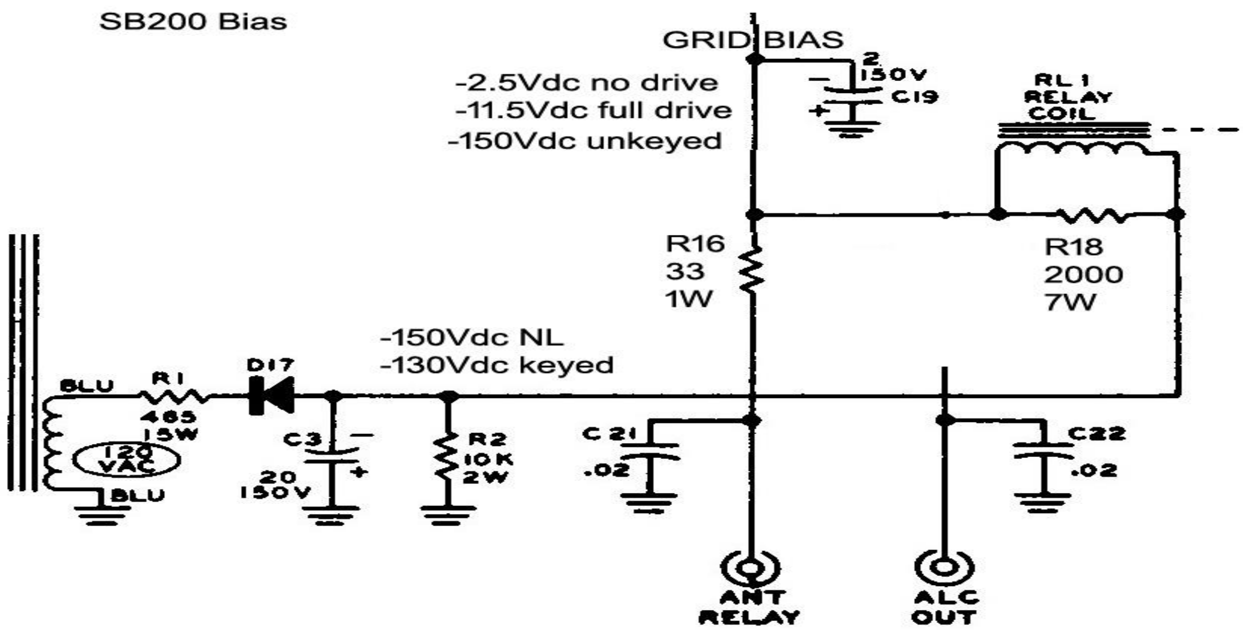


Figure 2 SB200 Bias

Bias Ripple Effects

Control grid voltage has a large influence on anode current. A good design never has ripple or anomalies in bias voltage, especially when using low-bias high-mu tubes. A good design also will not allow operating bias to move around with drive power modulation or changes. There is one exception to this. Bias can track modulation or drive envelope levels if in phase, linear, and at or near radio frequency rates. This can add negative feedback or linear gain compression. However, if that bias shift is altered in phase or does not linearly track, IMD (splatter) will significantly increase. Grid bias is very “loose” and non-linear in these amplifiers. The measured voltage changes are:

Amplifier	Bias keyed but no drive	Bias full or peak drive
SB-200	-2.5Vdc	-11.5Vdc
Collins 30L-1	-3.3Vdc	-11.3Vdc

IMD in both amplifiers varies considerably with operating band, amplifier tuning adjustments, the particular tubes, and even exciter characteristics. This bias system was the best compromise in the days before reliable high power Zener diodes and transistors became common. This system should not have been used in the 1960s and later.

The bias system in Collins 30L-1 and Heathkit SB200/201 with a URB200 system. The URB200 eliminates hum concerns, stabilizes bias, and reduces keying jack voltages to match any modern solid-state radio (about 3 volts at a few mA current).

URB SB200 (and 30L-1) Kit with Bias

This is the SB200 URB kit for relay buffering and bias:

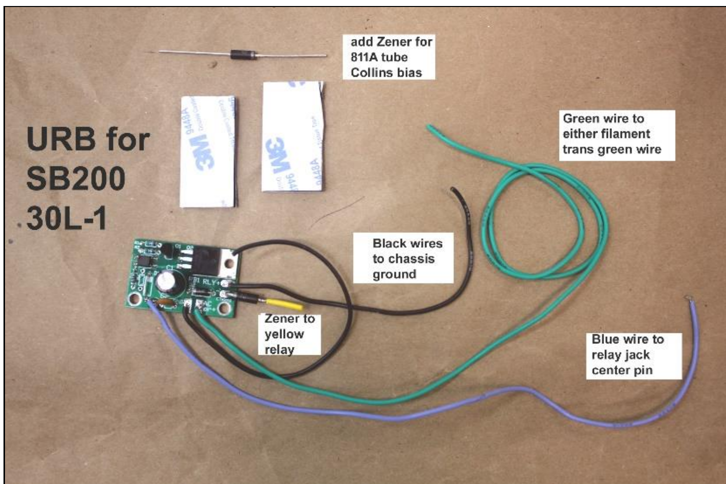


Figure 3 URB 200

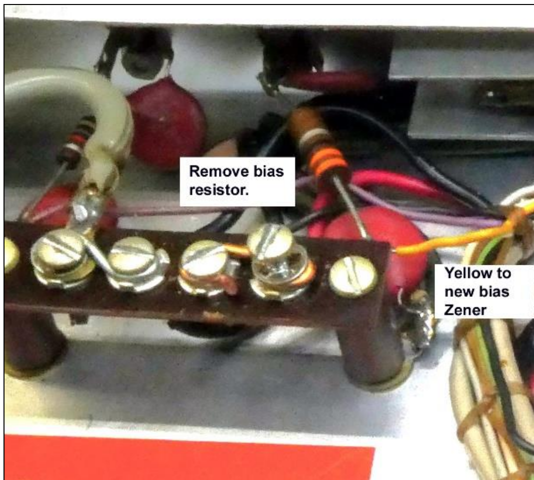


Figure 4 SB200 installation

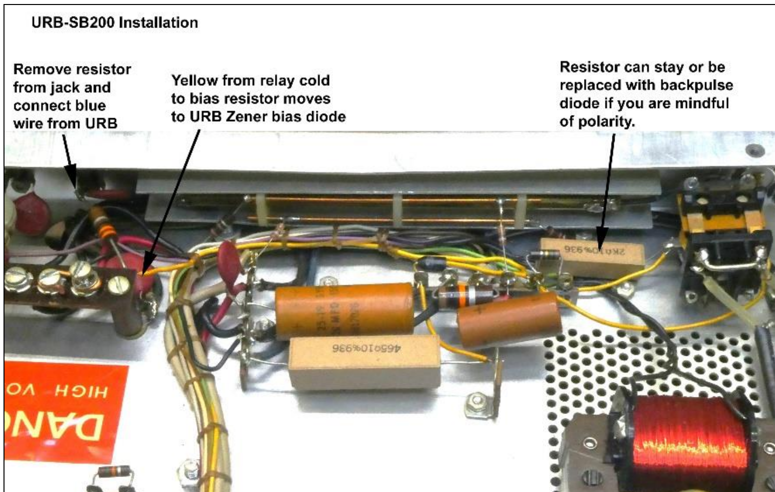


Figure 5 SB200 URB

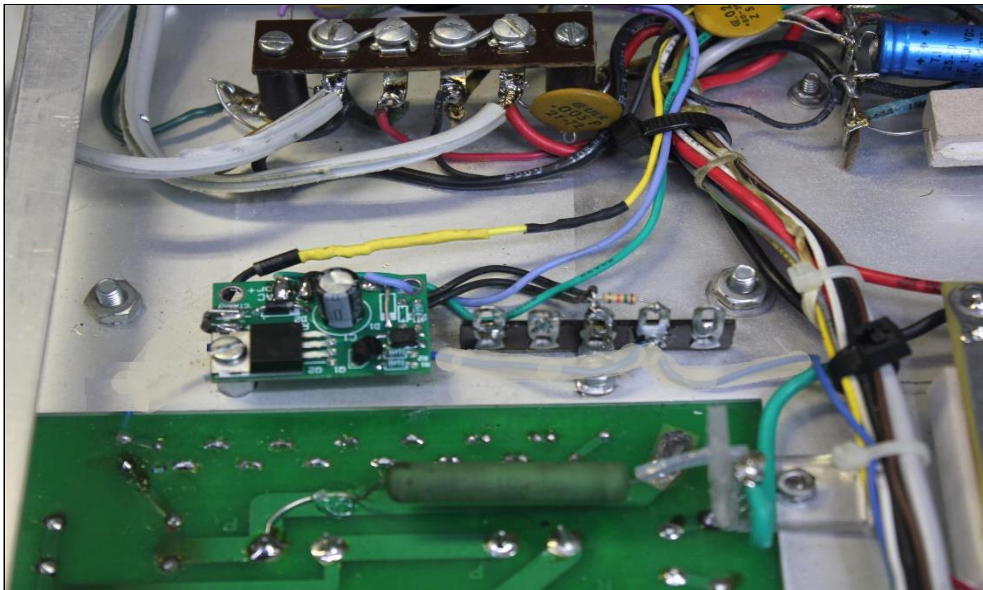


Figure 6 example SB200

For the Collins 30L-1 the connector mounting bracket must be removed:

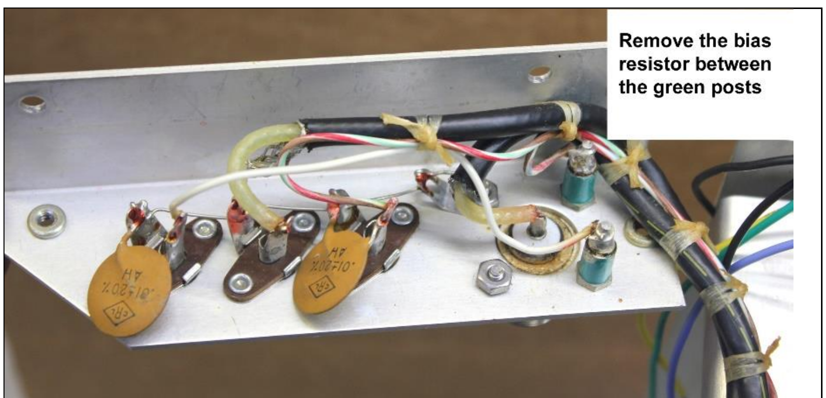


Figure 7 30L1 remove bias resistor

The photo's upper green post is from the relay. The lower post is from the relay jack.

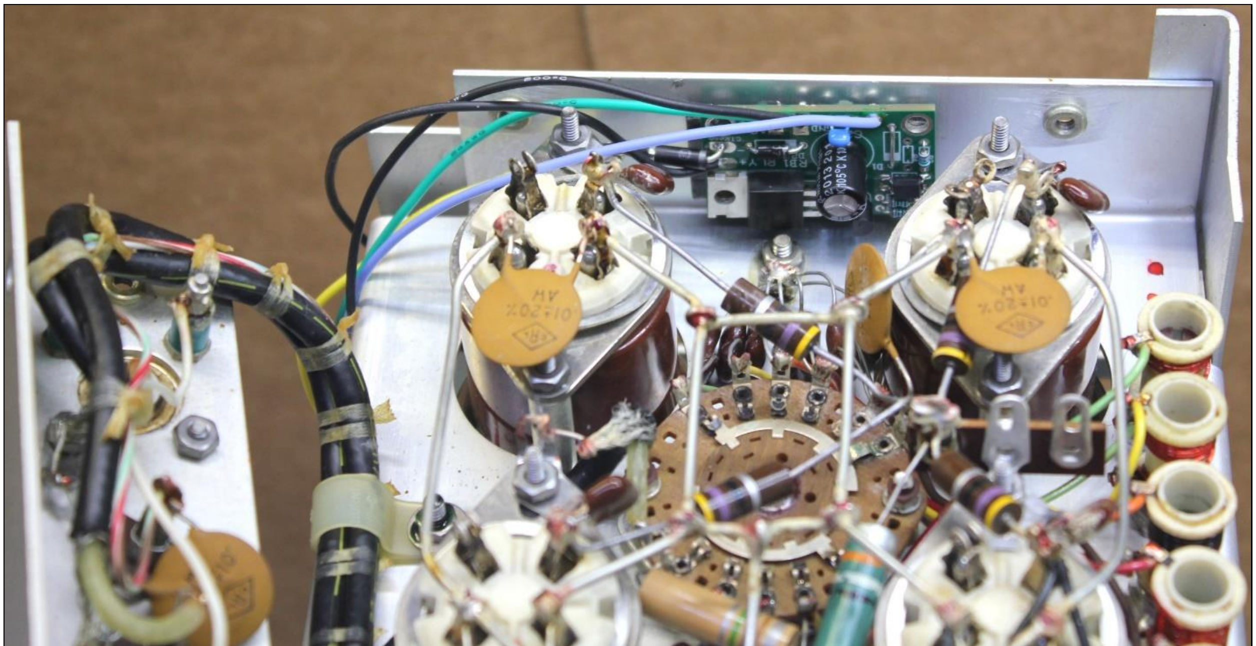


Figure 8 Board mounting spot uses tape

Be sure nothing shorts from the board bottom to the chassis. The transistor tab can be grounded, it just connects to one of the black ground wires

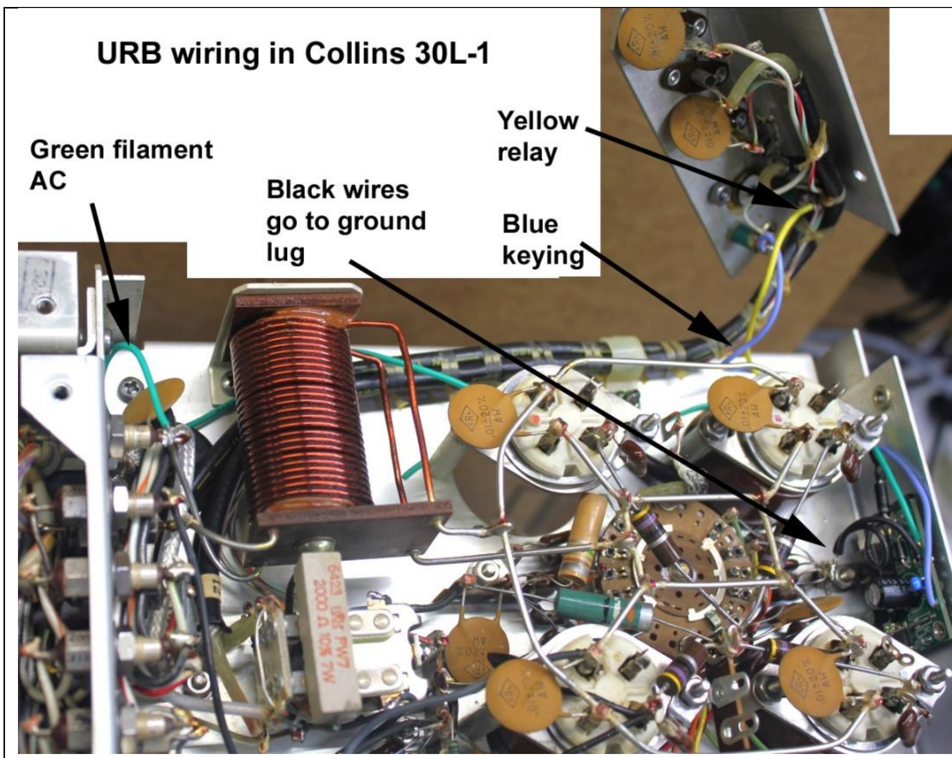


Figure 9 Collins 30L1 wiring

Arc Protection Improvement

Years ago, when circuits like the Collins 30L1 and SB200 were common, tubes had better manufacturing quality control. Tubes used better materials and had better workmanship, more care was taking in aging and pumping tubes down. Tube arcs or faults from the high-tension anode to other elements, unless the tube was seriously abused, were relatively rare.

This is no longer the case. The most common cause of tube arcs today are poorly manufactured and tested tubes.

Damage from Tube Faults

When tubes arc or fault, anode supply filter capacitors become a damaging energy source. Energy stored in the filter capacitors is limited only by capacitor and circuit path loop impedance, dozens or hundreds of amperes can flow. This surge collapses plate chokes, explodes meter shunts, destroys meters (commonly the grid meter), and can even kick back through the input circuit and damage the connected radio.

With modern tubes designs should provide a safe controlled path for anode-to-grid faults. An ideal design eliminates damage from minor quick arcs that quickly self-clear the tube debris or gas. To minimize damage from tube arcs:

1.) The positive supply should have as much surge impedance as reasonably practical. This slows the discharge time, limiting the peak current
2.) The grids should be directly grounded. This eliminates passing the fault plasma inside the tube along to the filament or cathode. (This is not always possible)
3.) A controlled path that can sustain high currents should return the fault current as directly as possible to the filter capacitors.

Retrofitting an older design is often a compromise.

SB200 or Collins 30L1 Simple Fault Protection

The Collins 30L1 has one of the worst control grid and bias systems used in amateur radio amplifiers. Unfortunately, Heathkit copied that basic system. The application of negative bias to the grids, rather than positive bias applied at the filament center tap, prevents directly grounding grids without extensive rewiring. While rewiring is possible and results in a much better system, it is far more invasive and time consuming. This modification confines arc damage to a smaller area. This modification takes the meter, meter shunts, bias system, and radio largely out of the fault path. It does this with a minimal number of components:

1.) Two 150V GDT’s at the filament pins
2.) One 1N5408 diodes at the grid common point as a positive shunt to chassis

3.) One 1N5408 diode (and bypass capacitor) for the negative supply return
4.) One 10 to 20-ohm, high voltage surge rated 7-watt or larger resistor. This resistor must be surge rated and carefully mounted. It adds to the existing capacitor and fault path impedance
5.) Additional meter protection as a meter safety, although the above usually offer adequate meter damage protection

The original circuit and fault paths in both amplifiers are:

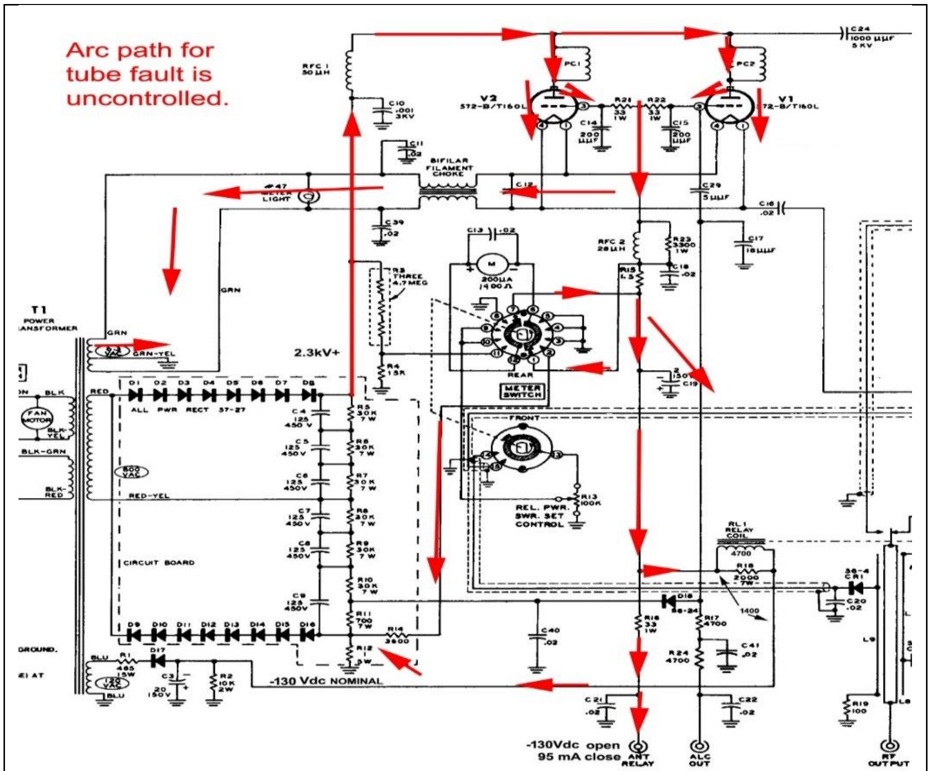


Figure 10 SB200 arc fault path

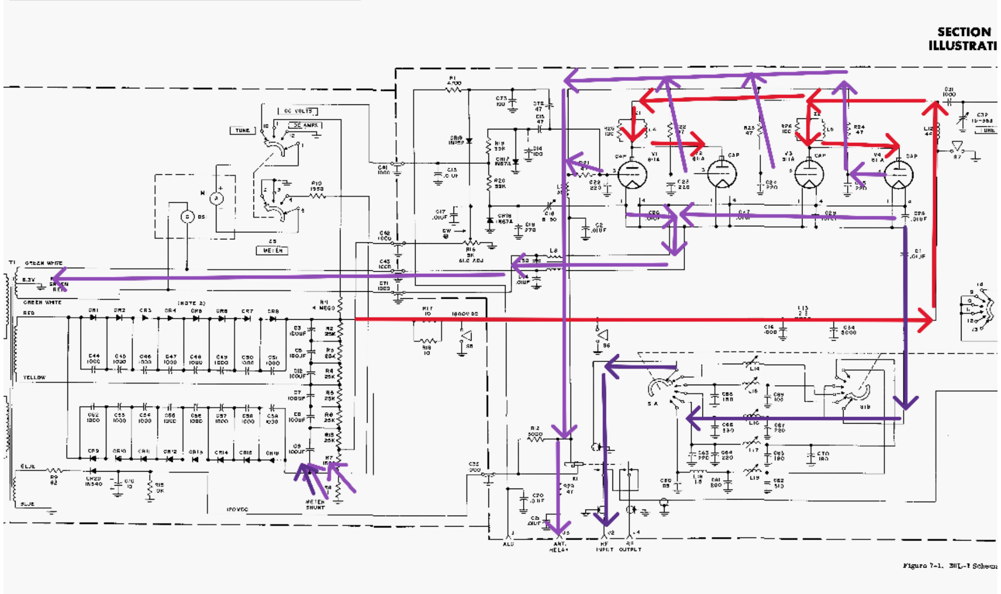


Figure 11 30L-1 arc path

Tracing the fault paths, we find common tube anode-to-grid faults split into multiple paths through components. With “dc floated grids” two paths go to the exciter. Stock unit tube arc paths do not run directly to the negative power supply but take circuitous damage paths that include the radio. This is why grid resistors and other parts “blow up”. While generally fine with old tube radios, a tube arc can severely damage solid-state radios.

Modified Circuit

This modification adds a negative power supply rail clamp, grid bias clamp, filament clamps, and surge resistance. It controls and confines the fault path, keeping destructive currents away from expensive or largely irreplaceable components. Some chokes and small readily replaceable components do remain in the fault path, there is no simple way to work around that without starting into major changes. Components like grid resistors are greatly improved to high-Joule surge resistant types:

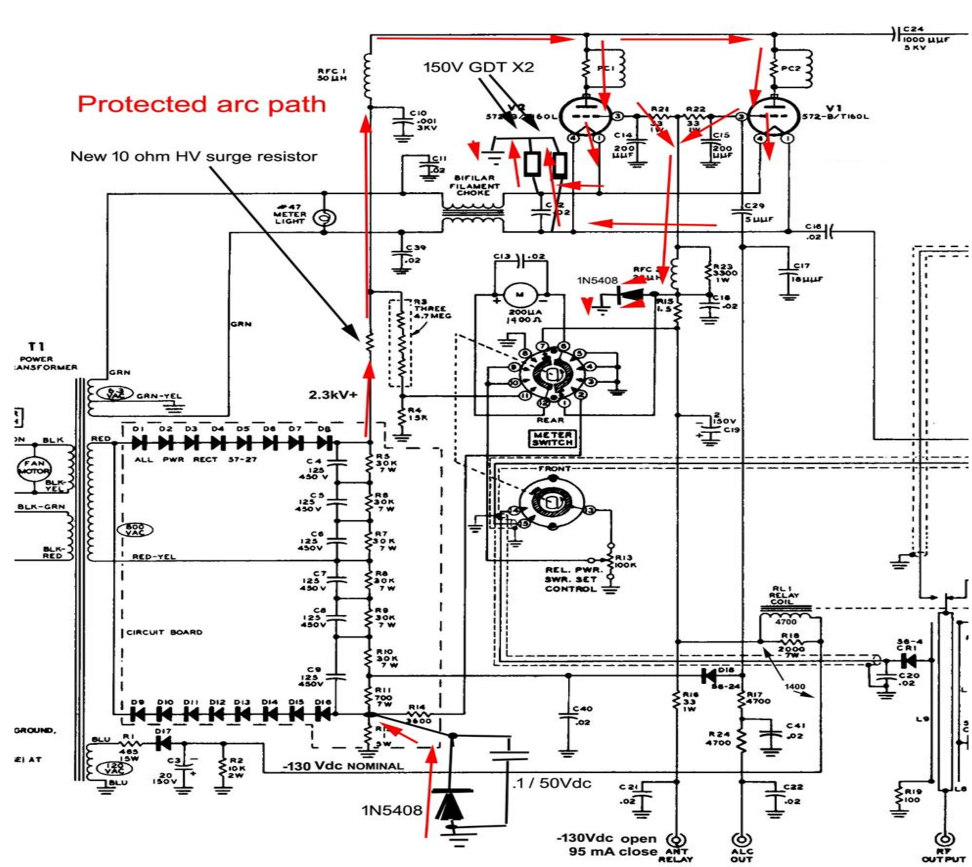


Figure 12 corrected Fault path example (SB200)

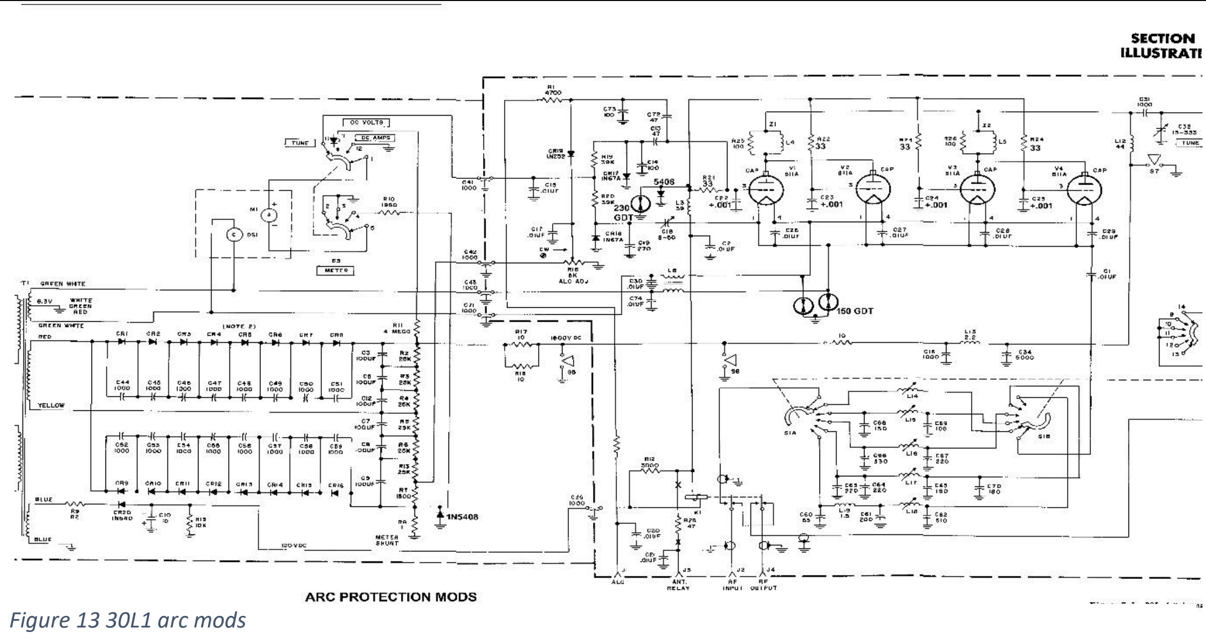
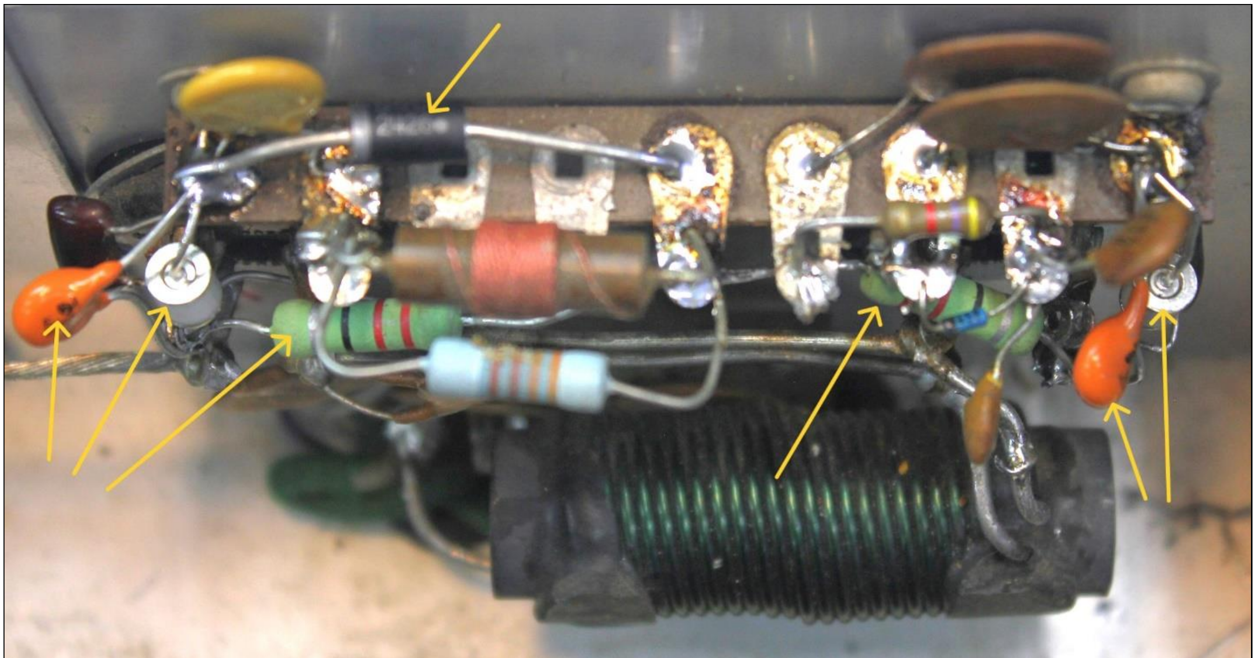


Figure 13 30L1 arc mods

30L1 Mod Pictures (1X 230V GDT grid common and 2X 150VGDT filament)



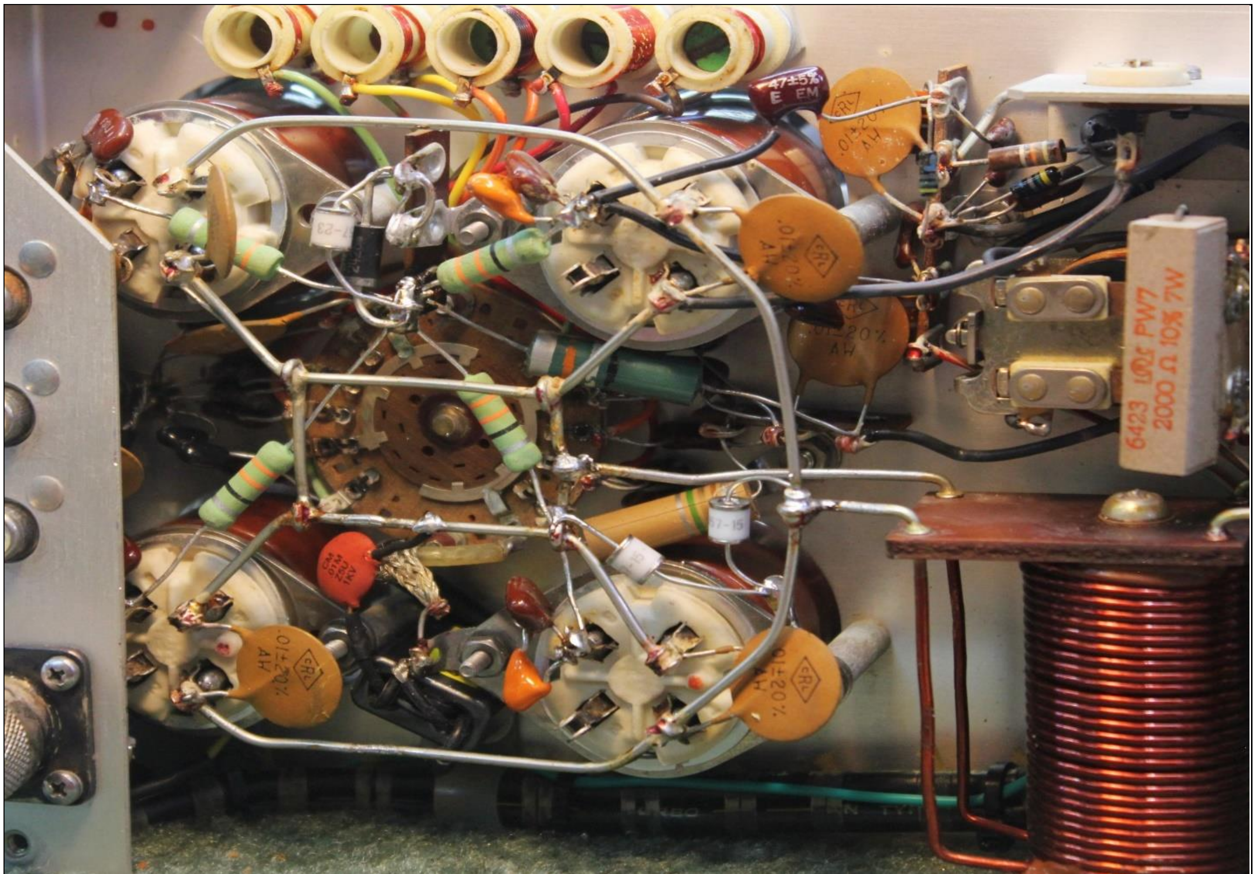


Figure 15 30L1 mods

SB200 mod pictures (2x 150V GDT filament, 2 x230V GDT grids)

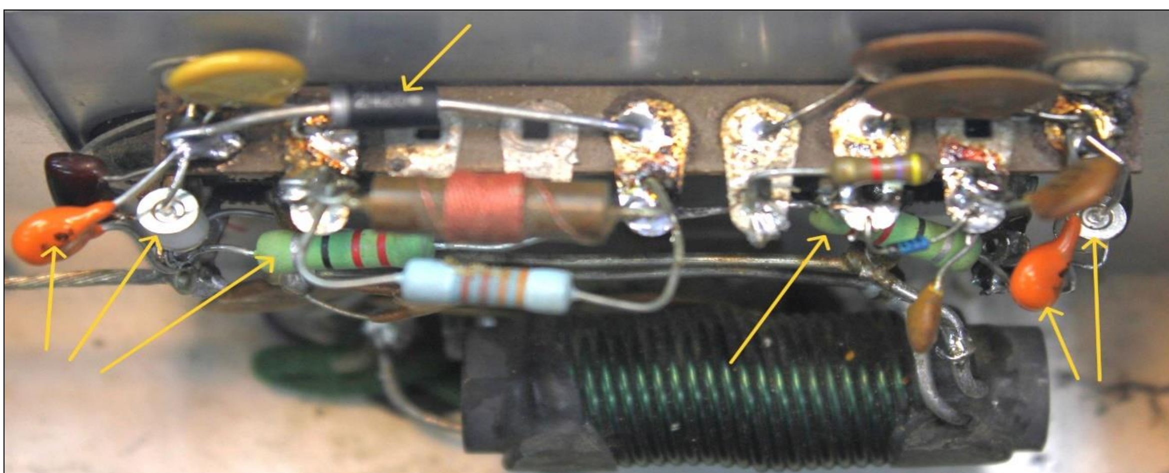


Figure 16 SB201 SB200 mods

-15 GDT (150V) on filaments. -23 GDT (230V) on grids! Grid resistor is 33 ohm surge rated but is not critical value as long as it is surge rated.

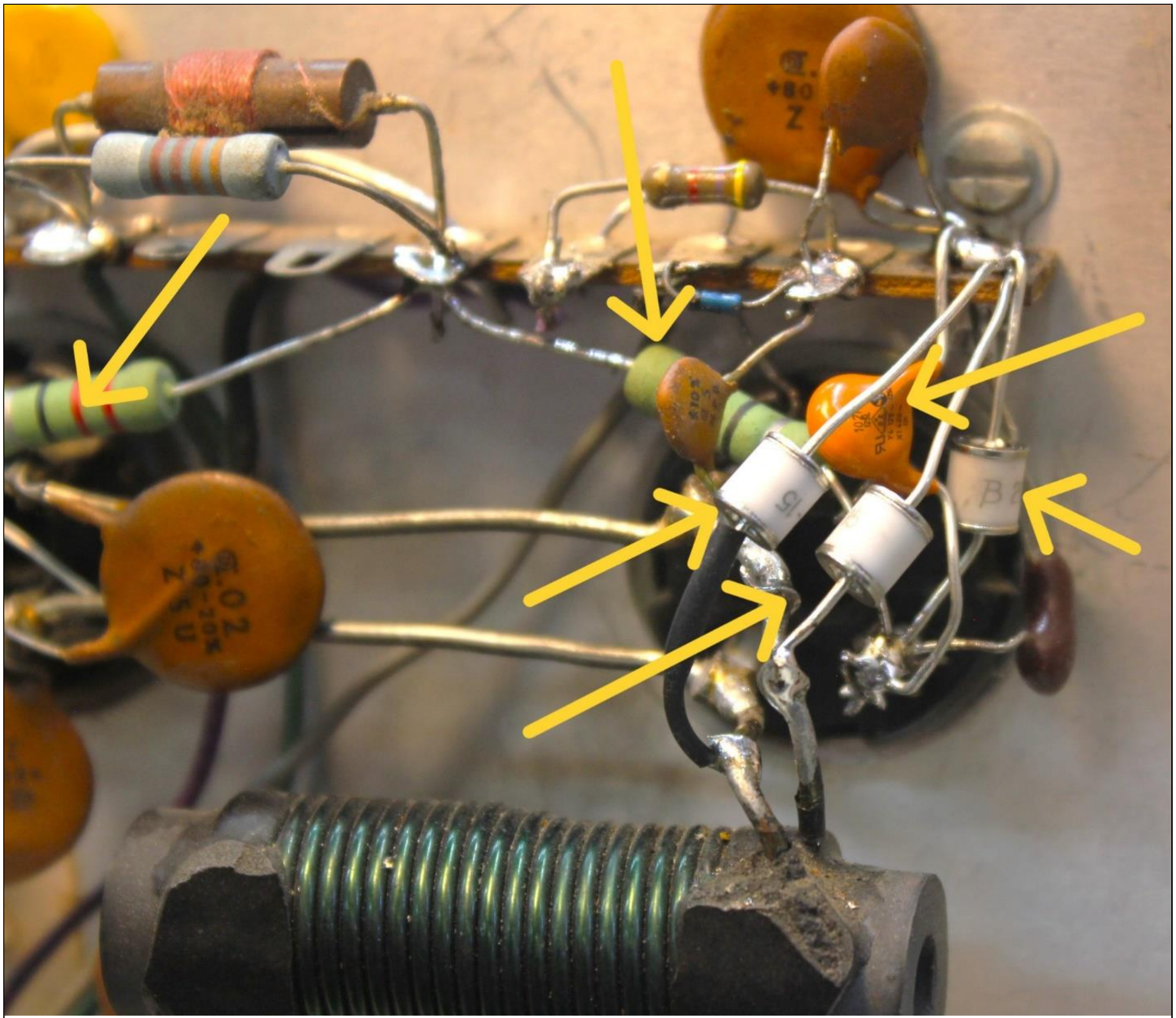


Figure 17 SB201 SB200 mods

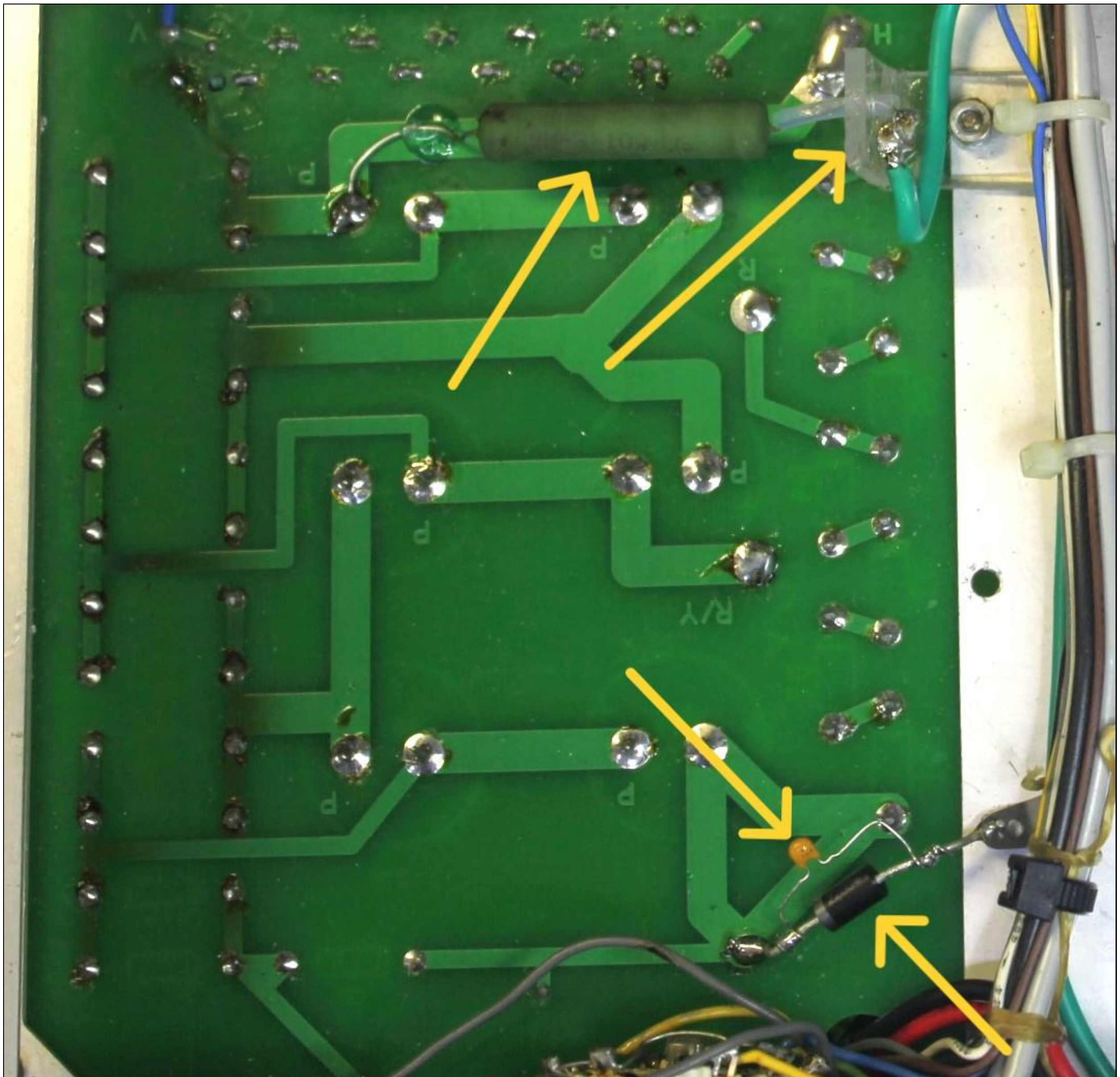


Figure 18 SB200 SB201 surge resistor and rail clamp

Thank you for using this kit. These instruction sheets take days to write. If you see any major errors, please let me know at Tom@ctrengineeringinc.com