Correcting Bias and Soft-key Issues in the Collins 30L1 / Heathkit SB200

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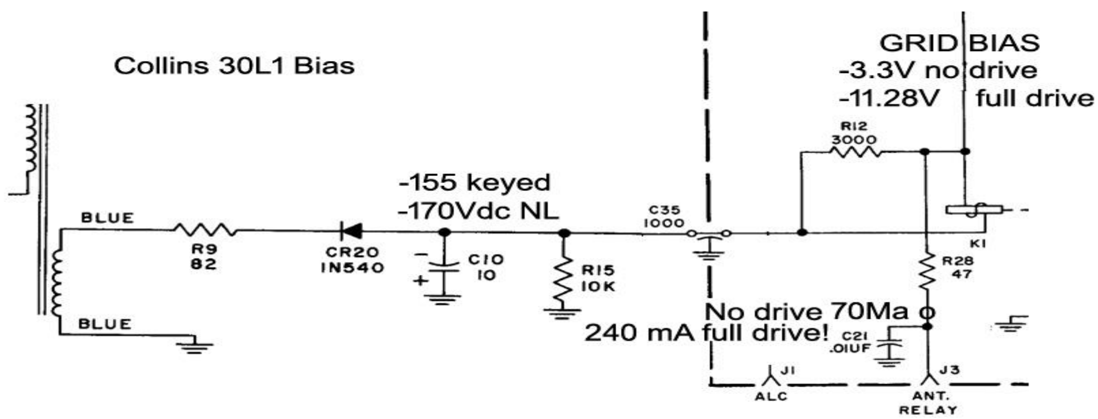
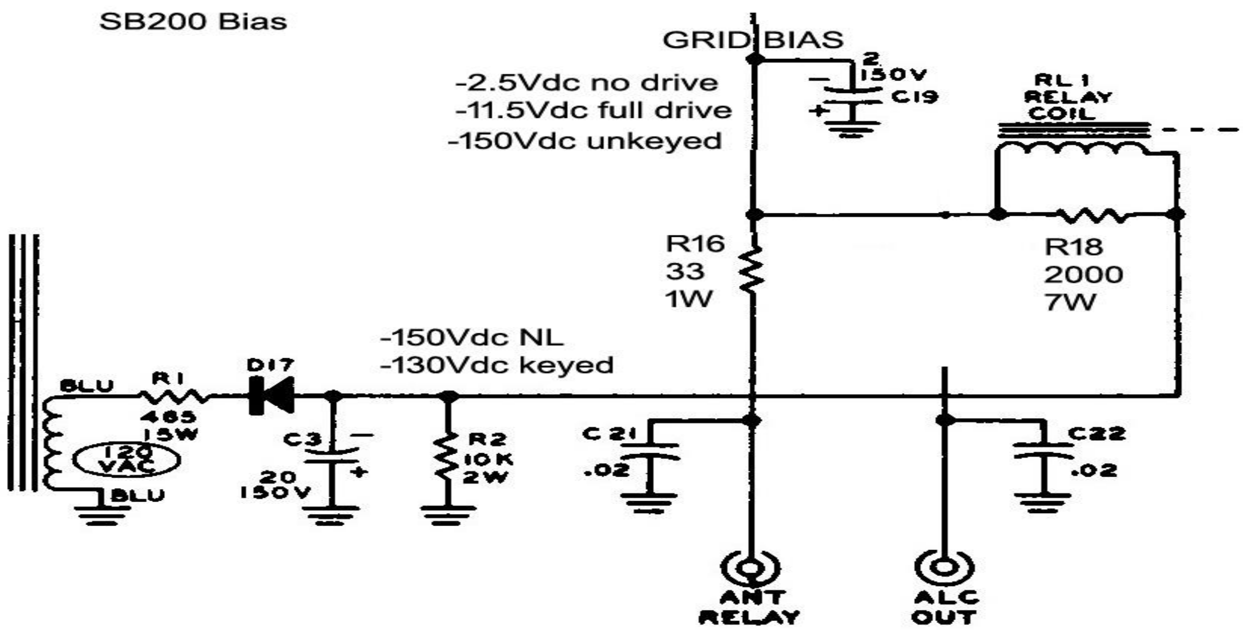
The Collins 30L1 and Heathkit SB-200 share nearly identical grid and bias circuitry. It appears Heath copied or patterned the relay and grid bias system after the 30L1. This is a factual technical analysis of that control grid system.

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.

While the Heath filter is an improvement, the negative supply in both drives about 70mA into the relay and padding resistor system. The bleeder (R15 Collins and R2 Heath)) adds additional load. Both filters are too small for a halfwave rectifier with ~85mA load. The following measured data is from actual stock amplifiers:





Control grids have the dominant effect on anode current. We never want ripple or anomalies in bias systems. We also never want bias systems to move around with modulation if that rate is several times envelope modulation rates or less. (Bias can track modulation or envelope levels if in phase and at or near radio frequency rates, since this adds negative feedback or linear gain compression.)

Taking tube bias into cutoff outside the normal bias for that class places the amplifier into shorter conduction angles, causing the tube to have distorted transfer and become a mixer of drive signals and modulated by out-of-phase or delayed bias changes.

Grid bias is very "loose" with drive levels in both amplifiers. While neither amplifier has stable predictable well-filtered operating bias, Heath added C19 to the already poor Collins bias system. C19 reduces bias hum and noise at the expense of increasing unwanted time lag in bias voltage RF envelope tracking. Latency in bias tracking decreases IMD performance at higher modulation rates (audio frequencies) on SSB, which is exactly the worst frequency range for SSB adjacent channel IMD products (transmitter channel bandwidth).

Precise deleterious changes vary with band, tuning, the particular tubes, and exciter characteristics. The only certain thing is in either amplifier, this bias scheme does not follow good engineering practices today. Engineering is always a compromise between complexity, cost, reliability, and acceptable results. This bias system may well have been the best compromise Collins could do in the 1950's or early 1960's, before reliable high power Zener diodes and transistor became common.

Soft-key Design Flaws

Universal relay buffer systems or "soft keys" are very challenging to design. Amplifier relay systems and radios are not standardized with regard to interfaces. Amplifier relay control voltages range from a few volts dc at small fraction of a milliampere up to 120 volts or more of any polarity and current. Most older radios could handle 120Vac or dc at a few amperes current, while almost all modern radios can be damaged with voltages over a few dozen volts dc and a few hundred mA, and require dc positive control lines. Some modern radios are damaged by as little as 15Vdc and 50mA, and require any buffer or interface to look like an open circuit when on standby.

Harbach faced these challenges and has an interface that works in many cases, but is a less than ideal for certain radio, wiring, and amplifier combinations. The radio world would be better for consumers if everyone got on the same page with interfaces.

All Harbach relay buffers I've seen use a shunt path to turn off a device, either a transistor or an opto-coupler. The basic designs all have thresholds in the one-volt area with very little current. Such low threshold voltages and extremely low sink or wetting currents are prone to ground loop, RF, and relay system hum. A more reasonable control would have a design target in the TTL logic voltage range of 2-3 volts threshold. The target wetting or sink current would ideally be 5-25 mA. This gives a control system transfer impedance of around 150 ohms or so, keeping relay contacts clean and being more immune to radio design variations and wiring ground loops. Relays would have a long reliable life with such an operating range, systems would be much more immune to hum and noise, and sensitive reed relays or transistors would be in a very comfortable operating range.