

1. Summary

5W Valve Amplifier. DIY.
HRSA \$5, Mar 2026.

1.1 Original Amplifier

DIY small aluminium chassis. Likely not finished. Based on RTV&H May 1964 2-3Watt Amplifier using 6GW8.

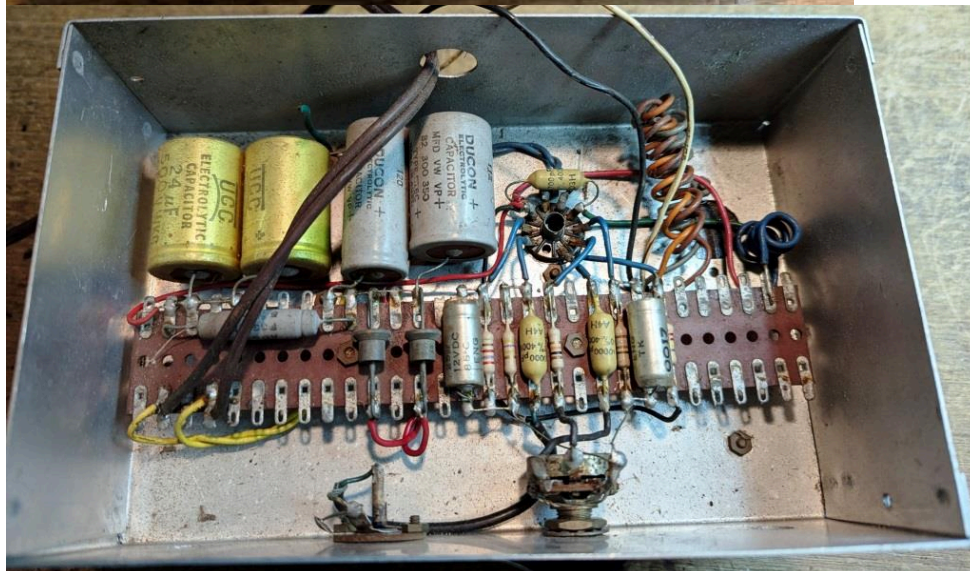
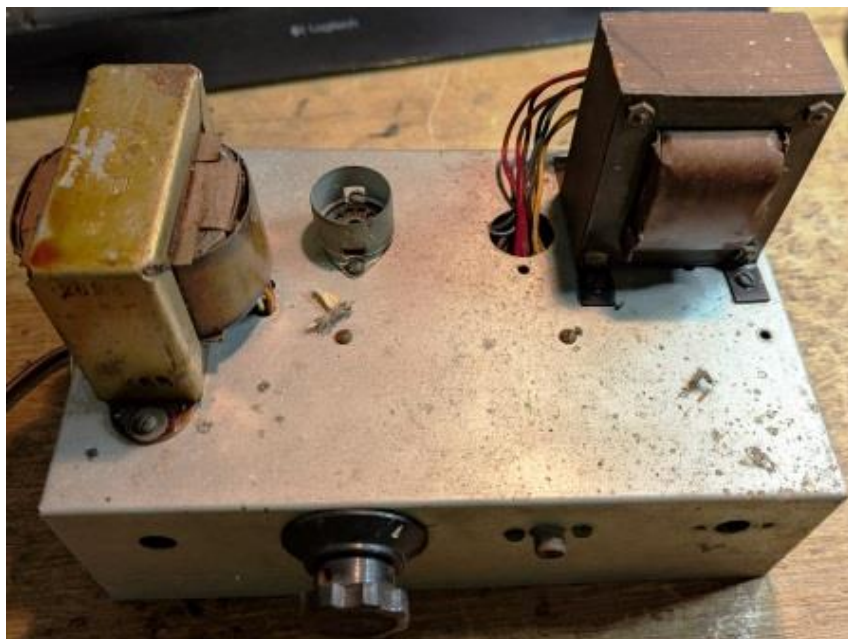
Components

Power Transformer ? A&R 1993. 240V yel/yel. 235-0-235V red-blk-red; 6V3 heater blu-blu.

Output Transformer A&R 2624 K68 SE 5W 5k,7K (Rd,Blu,Grn);
2,3,7,8,15 (BLK,Gry,BRN,Or,Wh)

Aim:

Convert into 6BQ5 SE amp with 12AX7 for input gain, and for feedback stage. Guitar signal input with input gain stage, or line signal input for hi-fi amp. Check OPT for SE 7k with 15.5% turns UL tap - secondaries of 15 to 8 = 1.1 Ω ; 15 to 3.7 = 3.7 Ω ; 15 to 2 = 6.0 Ω .



Measurements

Power transformer primary, secondary, and choke megger test ok.

Voltage rail levels and ripple. 259V 1.36V, 256V <20mV, 304V max

Rail	Idle levels (Mains 240V)
VS1	259V (1.36Vrms); turn-on peak 304V
VS2	256V (<20mVrms)
V2 cathode	8.2V (47mA)
Heater	
Sec HT	

Power transformer primary DC resistance: 71Ω.

Power transformer secondary DC resistance: 262Ω + 280Ω.

Choke marked 4048 50801 81762

DCR: 38Ω. 1.45H @ 116mA, 10.7Vac; 1.3H @ 232mA, 10.8Vac 2.1W

Output transformer 5k, 7k SE primary DC resistance: 310Ω, 380Ω.

5k primary tap taken to 6BQ5 screen, with 7k connected to B+, to give 15% turns UL. OPT primary and secondary polarities reversed, and blu 15% turns UL tap taken to screen with 270R stopper. Secondary side Wh taken to 0V and Blk used for GNFB.

Stable with 8dB f/b & 330pF comp across 10k, and no load. Just goes unstable with 4n7 only load at 270kHz – significant 55kHz gain and phase resonance - SQW response with noticeable shape.

F/b level changed to -6dB. 2.4cycles/10us, so same significant 55kHz gain and phase resonance – and just goes unstable with 4n7 only load at 240kHz – SQW response with noticeable shape.

Increased to 10dB fb. Increased comp to 600pF. 55kHz resonance more significant at 8R than 16R, and better at no load but unstable for 4n7 at 10us/2.2 = 220kHz.

Increased to 14dB f/b, and increased comp to 330+470+143= 940pF (needs more). 16R load seems low margin, with resonance around 200kHz. Plot of 2n2F only load indicates better control of sharp resonance near 280kHz, and stable. Unstable at 4n7 at 185kHz.

Added 6T inductor current feedback. 200kHz oscillation with 2n2.

Changed to 10T inductor. Too much roll-off without feedback, and no suppression of 200kHz.

Removed inductor and added 120pF-10k step across 110k, for 12kHz start and 130kHz stop. Just unstable at 4n7.

Tried with Wh-Or, and Brn, and Gry, used as direct feedback. Same level of feedback and 16R load used. No identifiable improvement for any secondary winding used.

Tried with RC across primary plate-to-screen. Started with 18k-66pF. Roll-off improved with 66pF raised to 166pF, but no noticeable change to 266pF, and worse with 18k lowered to 9k. Feedback comp C increase (from 260pF to 1nF) lowered ~90kHz resonance peak, but also lowered bandwidth roll-off start from 20kHz to circa 6kHz – just starting to be unstable with 4n7 only loading. Some identifiable improvement.

Significant 125kHz ringing at more than 16dB f/b, with no step, 100pF-18k, 140pF comp.

Output power vs cathode resistor value, at onset of clip; 10dB 16R; changing load R only.

- 240Vac 252Vdc, 7.7V, 51mA, 150R, 16R, 6Vrms, 2.3W f/b=10dB
- Vout at onset of clipping varied slowly (5.6V at 12R, 6.2V at 18R). 2HD went down as load increased. 16R gave 1% THD with equal 2-3HD levels at 3.7V (0.9W).
- Initial EMU measurements introduced clipping due to probe at 1:1.

Distortion sweep: 4Vrms 1W -23.6dB 500Hz vol max 0.96% THD, 0.91% 2H, 0.31% 3H. 10dB 16R UL, 18k-100pF, no step, 8k//140pF fb, 175R cathode. 240Vac, 261Vdc, 8.4V. REW sweeps at 1W, 2W (1.2% THD), 2.5W (2% THD), 3W (5% THD).

Pentode 11.5dB sweeps.

UL has slightly lower distortion >2H at 1W, 2W, with difference reducing with power. 2H at 2.5W quite different mid-band.

Schade style feedback with CR from pentode anode to triode 220R cathode. 330k with 47nF has 10Hz corner. Pentode mode (not UL). 9.4dB fb. Extra 5.6dB with gnfb. Opposite connection order: gnfb = 11.4dB, then added schade = 15dB total. 240Vac mains, 256V, 8.4V.

Into a matched 16R load, Schade fb by itself causes a hf roll off from 10kHz, due to the open-loop OPT response. Gnfb by itself causes a +1dB peak at 25kHz. With both Schade and gnfb, the response is flat to 20kHz. All show the 50-60kHz first resonance. Each setup is stable for 4n7 cap only loading (unstable for 10nF), but with a rising resonance peak around 220kHz, and with the Schade only setup also peaking at 60kHz. The squarewave response with Schade only fb shows little overshoot/ringing, whereas the gnfb only shows a noticeable overshoot and quickly damped 50kHz resonance, consistent with the frequency response plots. Distortion profile reduces for Schade and gnfb combined (15dB), and is down to 0.5% 1W midband. Interestingly, the 2W, 2.5W and 3W distortion responses show a distinct low region for 3rd harmonic around 50-60Hz, for any of the feedback setups.

Reverted to UL with default 11.4dB. schade was down at 7.2dB (due to UL), and total at 13.8dB (down from 15dB). Similar FR and SQW responses. Same stability with 4n7, but not 10nF.

Did FRs with UL at 1W, 2W, 2.5W, 3W but no f/b, at 240Vac – still with primary RC. 255V 8.2V
Did FRs with Pentode at 1W, 2W, 2.5W, 3W but no f/b, at 240Vac – still with primary RC. 255V 8.2V

1W Pentode bandwidth drop starts 400Hz to 12kHz, and UL starts 300Hz to 8kHz. Pentode response for 50-60kHz resonance more subdued, and UL is more abrupt. UL distortion at 1W is lower from 50Hz, with midband THD reduced from 3.1% to 2.6%, and 3rd from 1.2% to 0.7%. Midband 3rd is still below 2nd at 2W for UL, but not Pentode, and 3rd dominates at higher power.

With 10dB gnfb, 1W midband THD dropped from 2.6% to 0.9% for UL, and from 6.6% to 4.9% at 3W.

Input sensitivity for 3W, 16R. is 442mV (15.6x) into Input B, with UL and Schade and gnfb.

Cranked output power was 7.63Vrms, so 3.6W.

No change with humdinger.

To do: Input A gain.

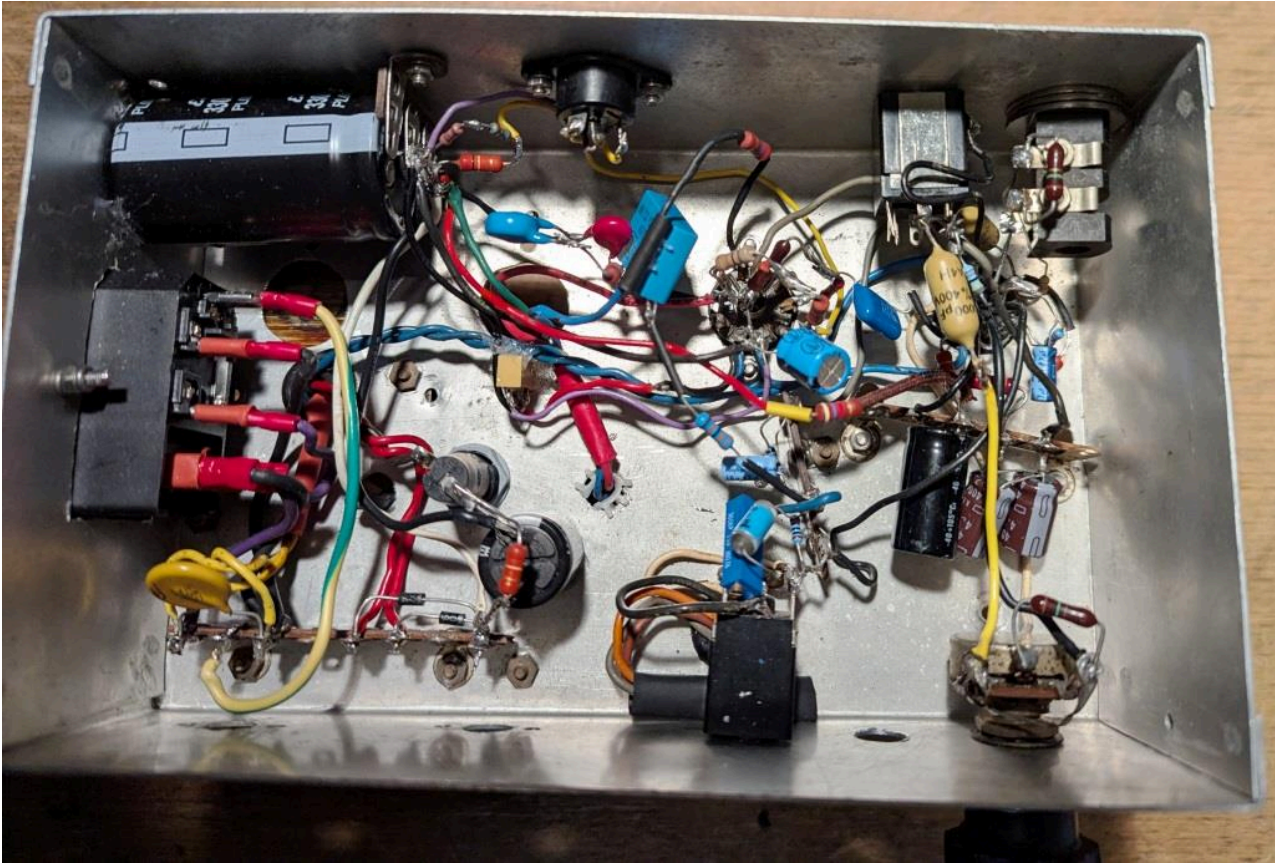
Schade description in RDH4, figure 7.33 on page 334.

<https://audiokarma.org/forums/threads/magnavox-flea-power-getting-more-out-of-the-8600-series-a-lot-more.665735/page-4>

- 17dB feedback.

<https://www.diyaudio.com/community/threads/6bq5-se-using-7k-primary-with-5k-tap-in-ul-mode.439501/#post-8288837>





2. Design Info

2.1 Input stage – 12AX7 triode

VS4 ~ 226V; Plate ~ 160V, cathode ~1.30V. Anode current ~ 0.6mA; cathode current ~0.6mA.

VS3 ~ 232V; Plate ~ 167V, cathode ~1.37V. Anode current ~ 0.59mA; cathode current ~0.57mA.

V1B cathode bias bypass LF corner $2k2//47\mu F = 1.5Hz$.

Coupling to output stage LF corner $47nF-1M = 3.4Hz$.

Output stage cathode bias bypass LF corner $175//220\mu F = 4.1Hz$.

OPT primary inductance may have a LF corner around 20Hz.

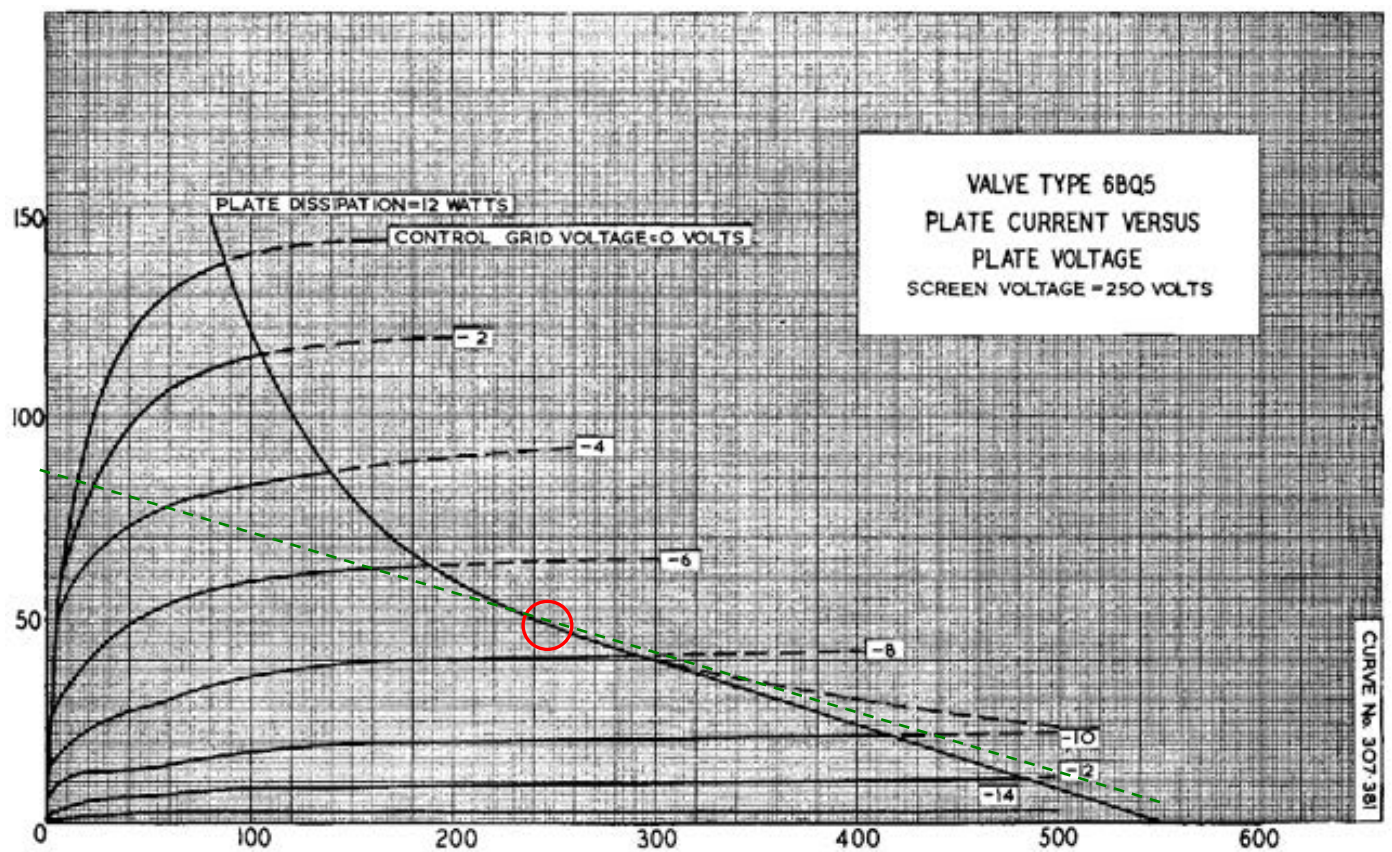
2.2 Output Stage – 6BQ5 Single-Ended

This Class A single ended output stage uses the 6BQ5 pentode with bypassed cathode bias. A $7k\Omega$ impedance is presented to the 6BQ5 plate by the A&R 2624 OPT with a nominal 15Ω speaker load on the full 15Ω speaker tap.

VS2 is lower than VS1 by about 2V: choke DCR of 38Ω and 50mA. Plate DC voltage is lower than VS2 by an amount up to $\sim 20V$; ie. OPT primary resistance of about 390Ω with idle current of 50mA. Cathode voltage has an idle bias of $\sim 9V$. So effective plate-cathode idle voltage is about $260-2-20-9=229V$, and screen-cathode voltage is about $260-2-9=249V$.

The maximum output valve bias current allowed is dependent on the maximum recommended plate and screen dissipation of $12+2W$ for the 6BQ5: $I_{bias(max)} = P_d / V_b = 12W / 230V = 52mA$.

With a cathode resistance of 175Ω , and cathode voltage of 8V, the plate idle current was 46mA.



2.3 Power Supplies

A standard CT full-wave rectifier circuit with UF4007 is used with 235V secondary HT windings with centre-tap, and 82uF capacitor input filter, followed by LC filter, giving 260V at 50mA.

The effective source resistance is comprised of the reflected power transformer primary resistance = $72\Omega \times (235/240)^2$ plus the secondary resistance = 268Ω ; which sums to 337Ω .

With choke, and 330uF VS2 filter, the ripple voltage is low enough not to be a concern.

Heater 1 6V3: $0.76 + 0.3 = 1.06A$.

MOV 330Vdc 1mA over-voltage protection for the OPT primary.

PSUD2 with 50mA loading on VS2 (266V, 5.4k Ω); 125mA T IEC fuse in CT based fuse in CT line.

Simulate period in PSUD2	10ms	50ms	continuous
Simulated RMS current	0.61A	0.58A	0.086A
Multiplier (based on 0.1A fuse rating)	6.1	5.8	0.86
IEC60127-2 Quick-acting F min limit multiplier	4	2.75	1

Simulate period in PSUD2	20ms	150ms	600ms	continuous
Simulated RMS current	0.57A	0.51A	0.32A	0.086A
Multiplier (based on 0.125A fuse rating)	4.6	4.1	2.6	0.68
IEC60127-2 Time-lag T min limit multiplier	10	4	2.75	1

Input stage operating idle current $\sim 0.5 \times 230V / 110k = 1mA$. For 10V drop from VS3 to VS4, $R \sim 10V / 1mA = 10k$.

FB stage operating idle current $\sim 0.5 \times 240V / 110k = 1mA$. For 10V drop from VS2 to VS3, $R \sim 10V / 2mA = 4k7$.

Bleed: 110k on VS1; 200k on VS2. $\sim 53Vdc$ after 1 minute from 320V unloaded.

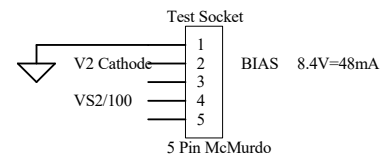
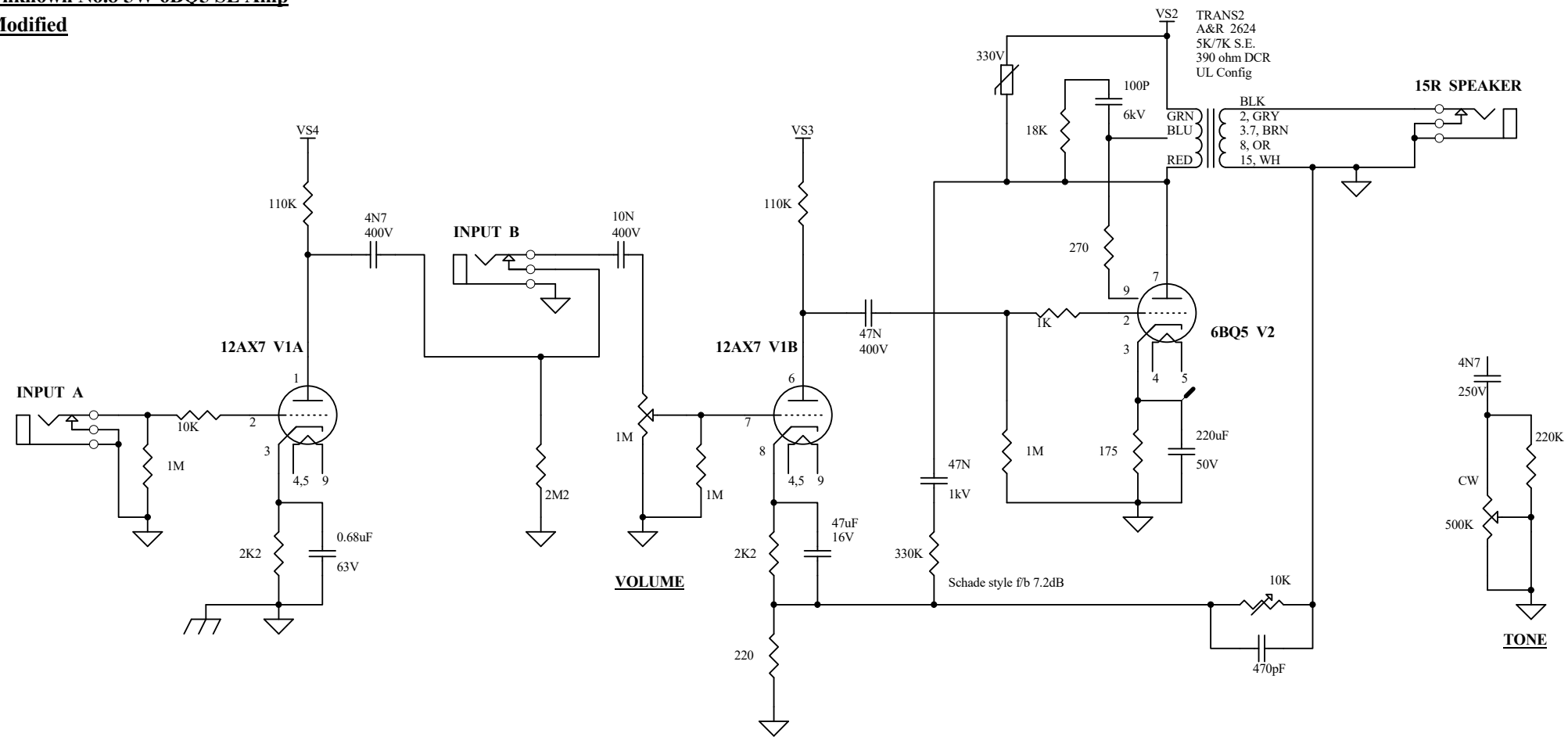
Monitoring via 5-pin McMurdo:

VS2 via 200k:1k8+270.

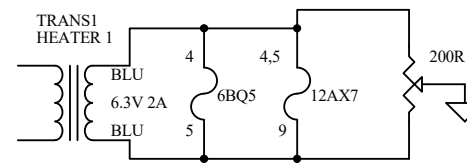
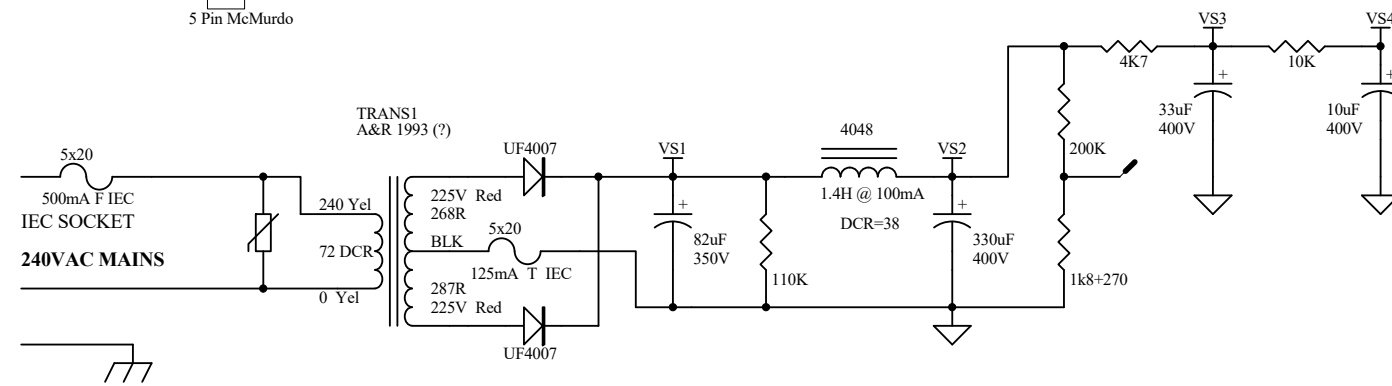
Cathode voltage via 175 Ω , so 8.7V nom for 50mA.

Unknown No.8 5W 6BQ5 SE Amp

Modified



VOLTAGE RAILS		VALVE QTY	
RAIL	IDLE	6BQ5	12AX7
VS1	260V	1	1
VS2	255V		
VS3	250V		
HEATER 1	6.4V		



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