1. Summary

Philips 982 25W valve amplifier. S.N. 1085. 2018

MIC-Phono input channel PA amplifier. 12AX7 mic preamp. 12AX7 mixer. 12AX7 tone recovery with cathode leg feedback. 12AX7 cathodyne PI with unbypassed cathode bias. EL34 common cathode biased PP with PP RC filter. GZ32 rectifier with 24uF cap filter to output stage, then 2k5 and 24uF filter to screen and PI stages, then 47k, 47uF to input stages. Front panel controls: MIC Volume; PU Volume; Tone. Rear panel: MIC & PU sockets; Com, 125, 250, 500 ohm outputs; mains AC fuse.

Output Transformer	A&R Type 2504 11?6. 25W nominal 6KΩ PP 5 output winding sections 0, 125Ω, 250Ω, 500Ω. 1.9Ω feedback winding.
Power Transformer	A&R Type 1791 1136 . 0-220V-240-260V; SH 300-0-300V @ mA; 6.3V CT 3.6A; 5V 2.3A.
POTs	Ducon.
Caps	Ducon TPA604 wax foils; UCC (5063 and 4863 codes) & Ducon E05F and ET1B 36 electrolytic;.
Valves	EL34 x2: none fitted 12AX7 x2: Holland ; Miniwatt Holland 6D 6AU6 x1: Radiotron red HG 28 GZ32 x1: 5V4G RCA H2E

Good general condition – modified – some coupling caps replaced. Added: front panel pot, 6AU6, rear panel input for PU. Swapped rear panel fuse for output jack. Mains fused moved to inside. The radiomuseum photos show a front panel power switch and indicator, but this item and Josh's don't.

Transformer and cap dates appear to indicate circa 1963 manufacture.

Issues: No mains switch. Speaker outputs floating. Distributed chassis grounding. OT secondaries.

2. Modifications

Target: Guitar amp with single front panel input; gain and master volume pots; tone pot; 6L6GC valves; 8Ω speaker.

- Added rubber feet.
- Added IEC mains switch fuse combo to rear panel. Removed old fuse/socket. 1.25A T IEC 5x20.
- Rewired mains just to 240V tap.
- 275VAC MOV (VE17 2750K) on power transformer primary; mains switch added.
- Added PT secondary CT fuse (250mA IEC F 5x20).
- Added series 1N4007 with GZ32 anodes.
- Replaced all electrolytic and coupling caps.
- Added 10Ω cathode current sense to V3, V4.
- Added 620VDC 1mA MOV (S05K385 TDK) across each primary half of output transformer.
- Removed 6AU6 input stage and front panel pot.
- Removed extra rear panel input and moved to front panel. Isolated mono switched input for guitar 1M leak and 10k stopper.

- Reconfigured grounding – distributed star with power point to chassis.
- 6L6GC replacing EL34.
- OT modified with feedback winding split and connected in series for 8 ohm.
- Added Speakon connector.
- 200R trimpot humdinger.
- Modified coupling cap and tone cap values and added input cap filter to restrain bandwidth.
- Changed 12AX7 to 12AU7 for V2 to provide appropriate stage gains that still allow overdrive.

To do:

- 5-pin McMurdo maintenance socket – locate in PU rear panel.
- Swap 5V4G as VS1 comes up too quickly.
- Try a new pair of 6L6GC.

Modified.

3. Measurements

Megger tested 1kV on PT and OT – ok.

No-load magnetising levels: Mains 246V, 315mA. HT 306Vrms, Heater 6.6Vrms.

Conditions	Idle, 247V, 0.52A	Onset of clipping	Cranked (8Ω load)
VS1 cathode	311V , 480mVrms 17.1V 69mA+69mA 19W+19W	 24V	304V 28V
VS2	290V ~20mVrms		298V
VS3	V		
Heater			
Sec HT			

Primary DCR = 6.6, 7.3, 8Ω.
Secondary 300-0-300 DCR = 54+56Ω.

A&R 2504 output transformer

Winding	Voltage rms	Turns ratio; Impedance for 1K5 pri; Spec level; DCR
Pri P-P: BLU-YEL	40.0	
Sec: WH to RD split	0.717	27.8; 1.9Ω; F/B; 62T
Sec: BLK to BLU	11.54	1.73; 503Ω; 500Ω; 1000T
Sec: BLK to YEL	8.2	2.45; 251Ω; 250Ω; 711T
Sec: BLK to GRN	5.82	3.42; 126Ω; 125Ω; 504T

Output transformer primary DC resistance: 65Ω + 92Ω

The winding section between 125Ω and 250Ω is effective 20Ω, with 20% of secondary turns.

The F/B winding can be separated in to two sections, which can then be connected in series to provide effective 7.8Ω, with 12% of secondary turns.

Input stage noticeably starts to compress only above 30Vrms out. Gain 2.19/0.04 = 55. FR at 10Vrms shows -3dB at about 35Hz and out past 80kHz. Stage CR output corner is 31Hz. Stage cathode RC is about 13Hz. Add 560pF shunt from input grid to gnd, and lowered CR output from 10nF to 4N7 400V to get -3dB at 90Hz and 18kHz.

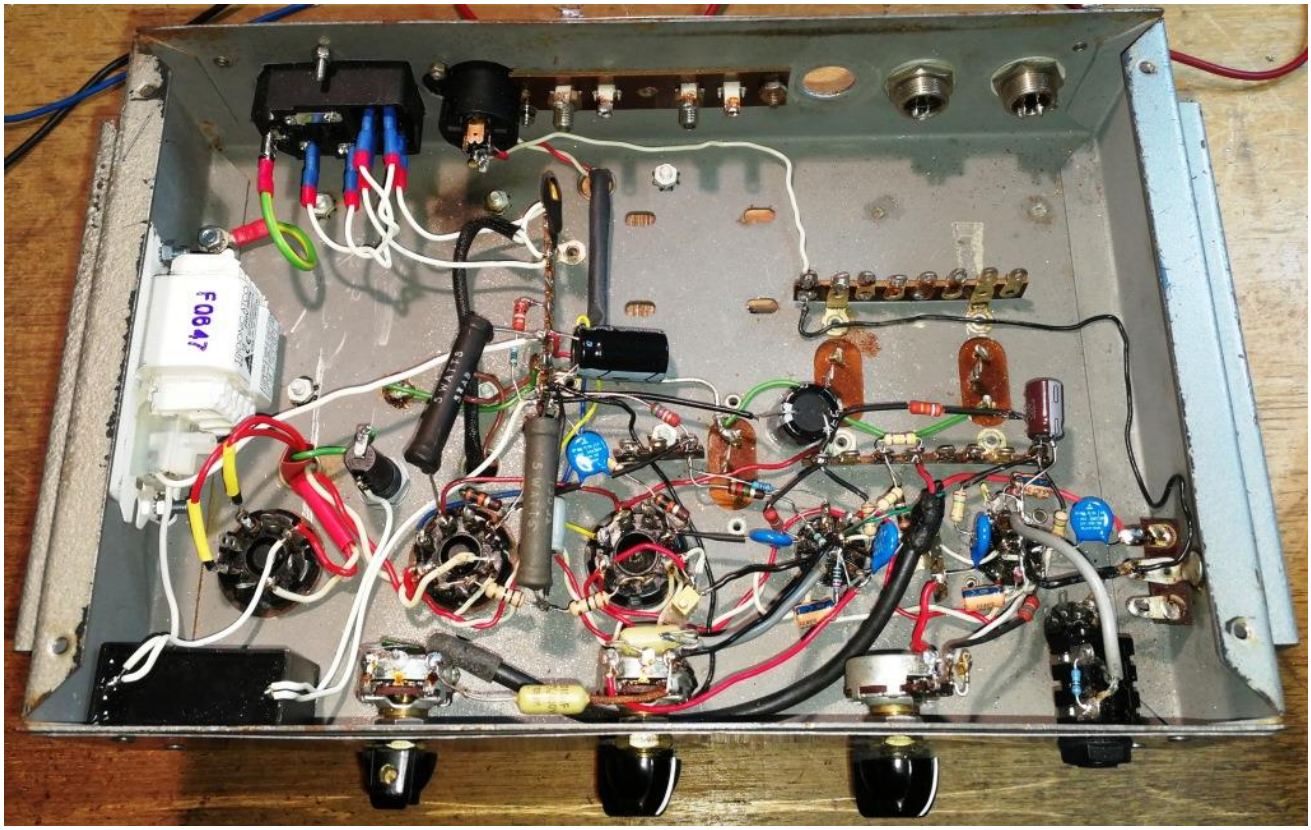
Too much gain with 12AX7 for V2, so changed to a 12AU7, and just changed cathode resistors from 1k8 to 4k for V2A, and from 2k2 to 4k7 for V2B. V2A cathode RC then lower at 6Hz.

Tone stage: lowered 47nF to 10nF to flatten HF response a bit at mid/max, and not cause severe hf loss at min setting. Insert 470k in to output, and lower 1M2 to 470k, to halve output signal level, and increase V2A grid stopper. Loading on V1B will remain nearly constant. Flattest response is with tone just more than +1 notch, with bandwidth

With Mic Vol pot top taken to PU Vol pot top with 0.5Vrms (ie. no tone stage), the output in to 8 ohm load is 426mV. Soft clipping starts about 8.3-8.7V, with gross output to 11.3V (16W) with 300V VS1. 1W (2.8V) output bandwidth from 200Hz to 20kHz. PI stage output CR is 72Hz. Output stage RC is 37Hz. PI stage input CR is 132Hz, so increase 10nF PI input to 22nF to lower bandwidth to 170Hz. Input stage output CR changes as two pots are the load – so CR=135Hz.

Total amp with 1W FR shows -3dB at 100Hz to 10kHz with flattest curve for Tone a bit more than +1 notch.

Output stage cathode bias is 16.3V for 295V VS1. Bias increase to 16.5V at 7W, then falls to 16.0V at 10.3W. Visual sine clipping starts at about 8W. Output can crank to 15W. Output valves were the best idle bias matched pair on hand, and a new pair should be tested. The 5V4G may be suspect, as VS1 rose quicker than the output stage valves conducted, and VS1 slowly ramped up to level once the output stage valves were conducting.

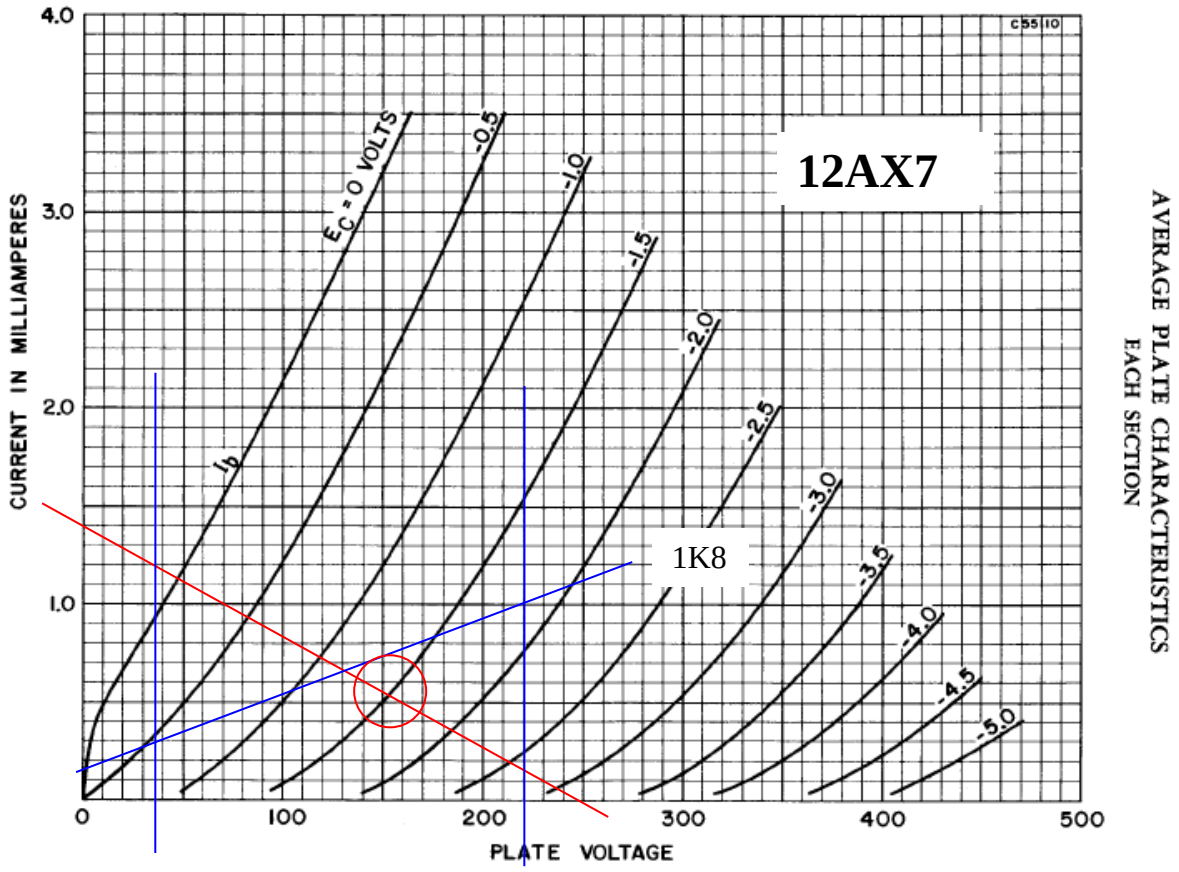


Modified.

4. Design

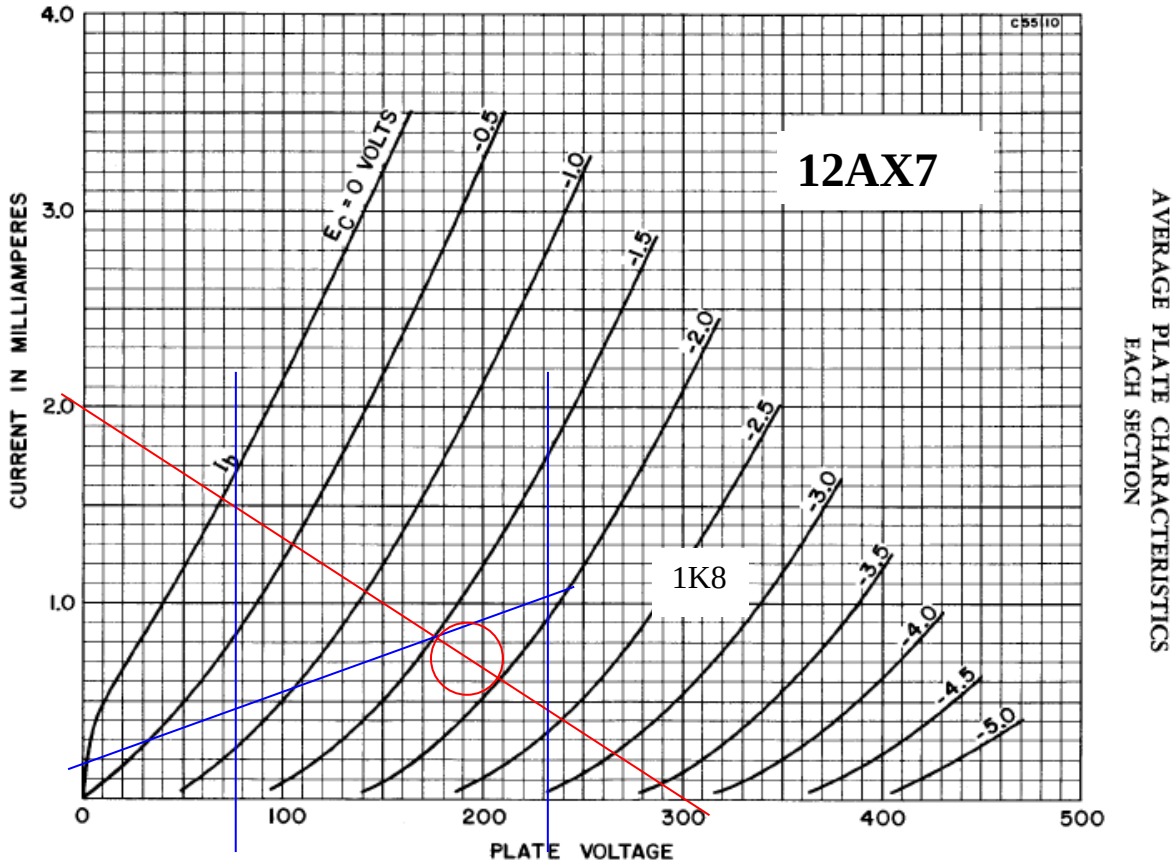
4.1 Input Stage – 12AX7 modified

For the first half 12AX7, V1A: supply voltage VS4 = 250V; Va=158V; Rk=1k8; Vk=1.08V; Ia=0.6mA; RLdc=150k.

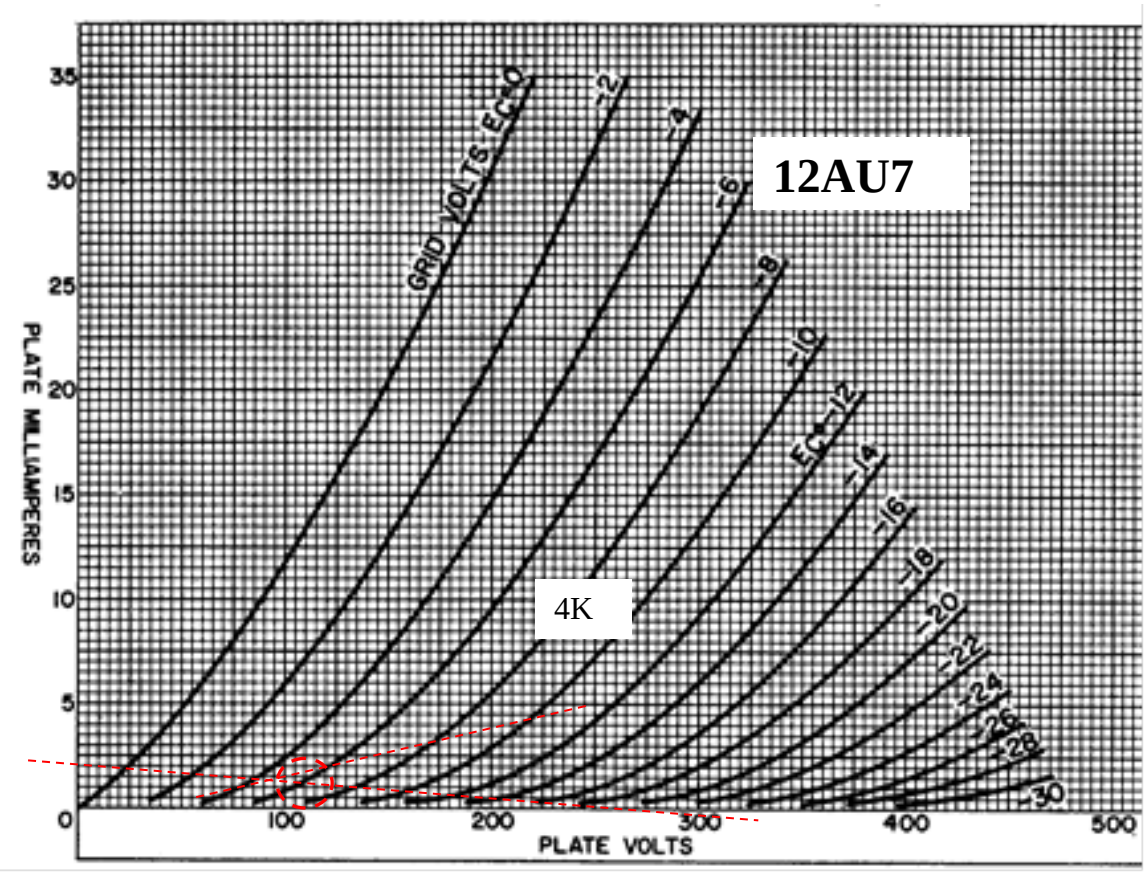


4.2 Tone recovery stage – 12AX7 modified

V2A: VS2 = 298V; Va=193V; Rk=1k8; Vk=1.22V; Ia=0.7mA; RLdc=150k.

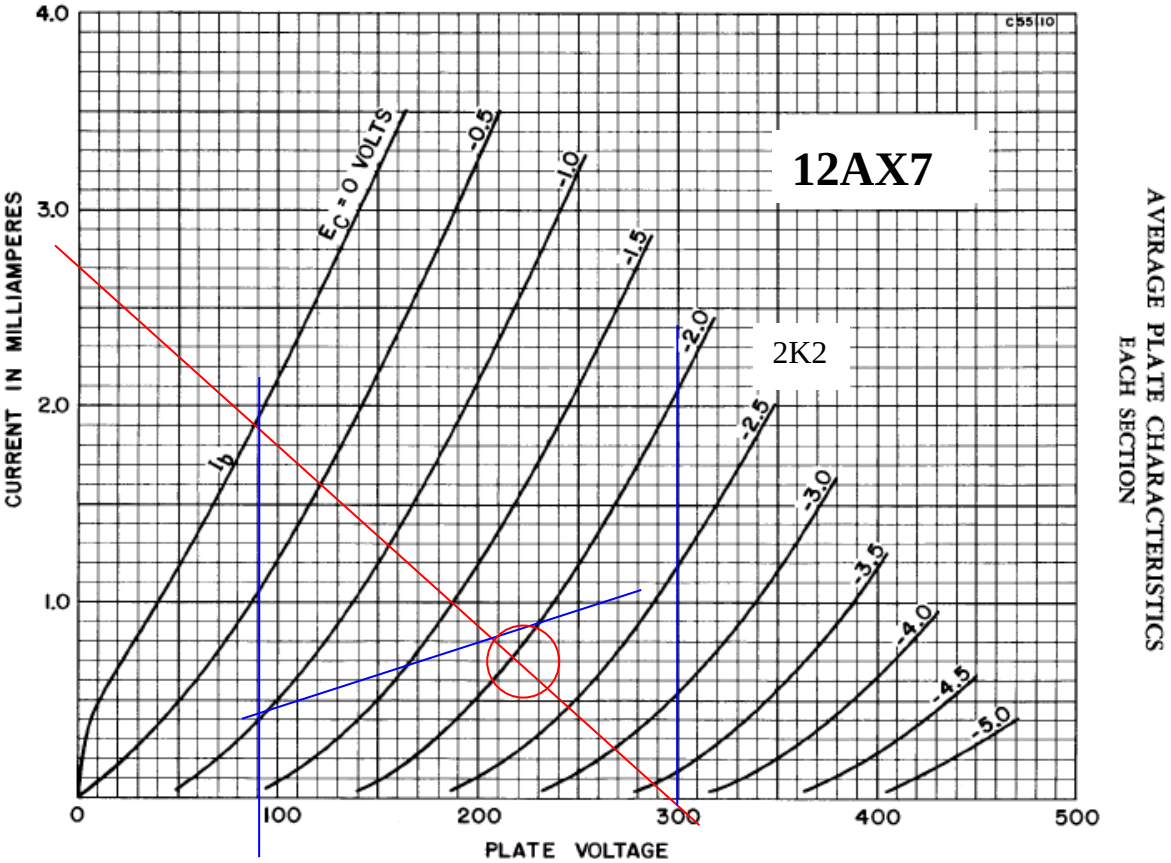


12AU7:
V2A: VS2 = 298V; Va=75.8V; Rk=1k8; Vk=2.67V; Ia=1.48mA; RLdc=150k.
Rk increased from 1k8 to 4k. RC corner lowers to 5Hz.
V2A: VS2 = 298V; Va=111V; Rk=4k; Vk=4.95V; Ia=1.25mA; RLdc=150k.


12AU7
4K
PLATE MILLIAMPERES
PLATE VOLTS
GRID VOLTS, EC=0
-2
-4
-6
-8
-10
EC=-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
0
5
10
15
20
25
30
35
100
200
300
400
500

4.3 PI Stage – 12AX7

V2B: VS2 = 298V; Va=262V; Rk=2k2; Vk=35.6V; Ia=0.9mA; RLdc=56+56k.

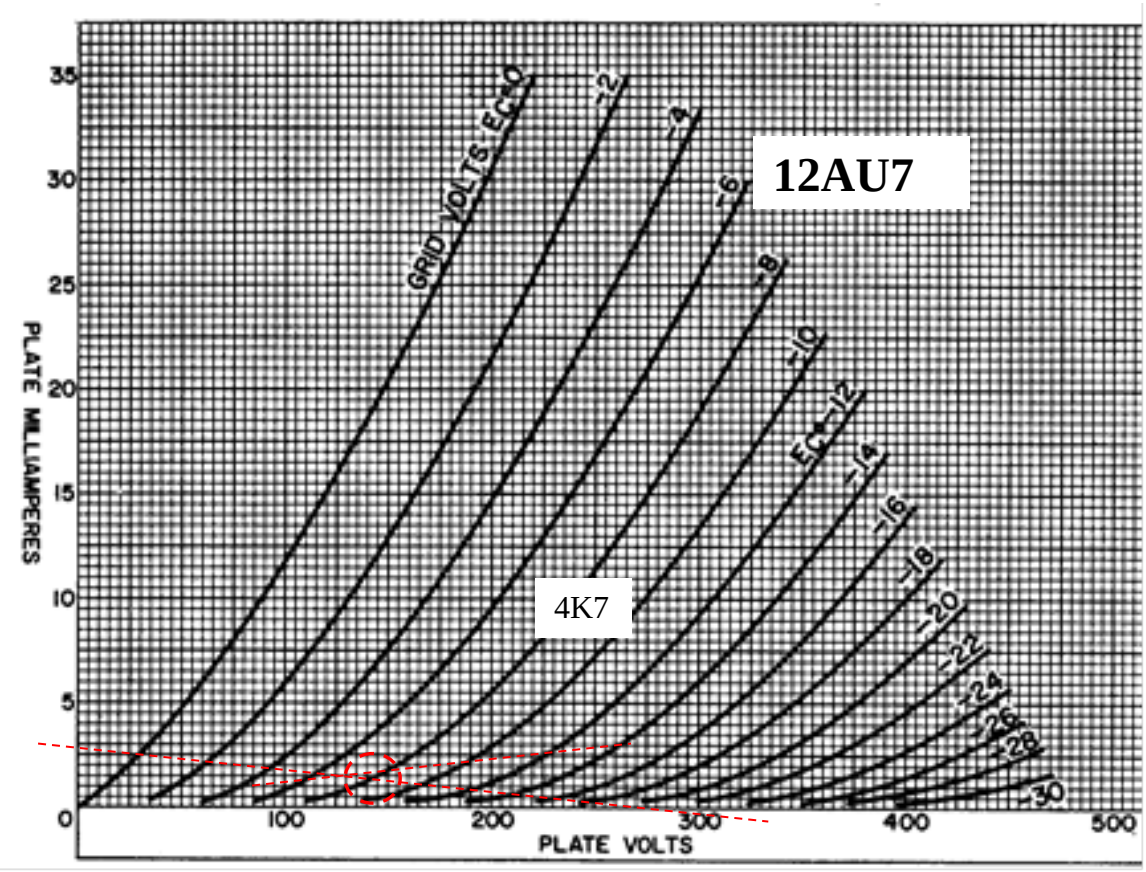


12AU7:

V2B: VS2 = 298V; Va=204.3V; Rk=2k2; Vk=97.5V; Vt=93.1V; Ia=1.67mA; RLdc=56+56k.

Rk increased from 2k2 to 4k7.

V2B: VS2 = 298V; Va=221V; Rk=4k7; Vk=82.6V; Vt=76.1V; Ia=1.38mA; RLdc=56+56k.



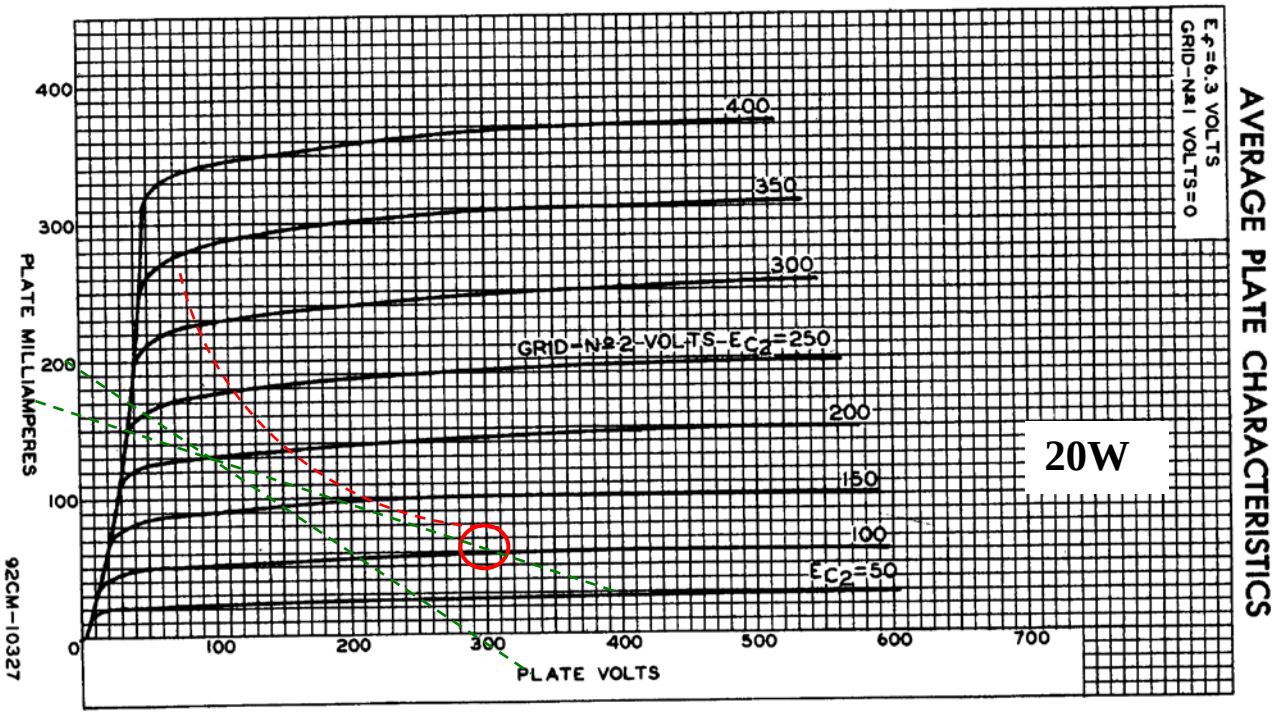
4.4 Output Stage

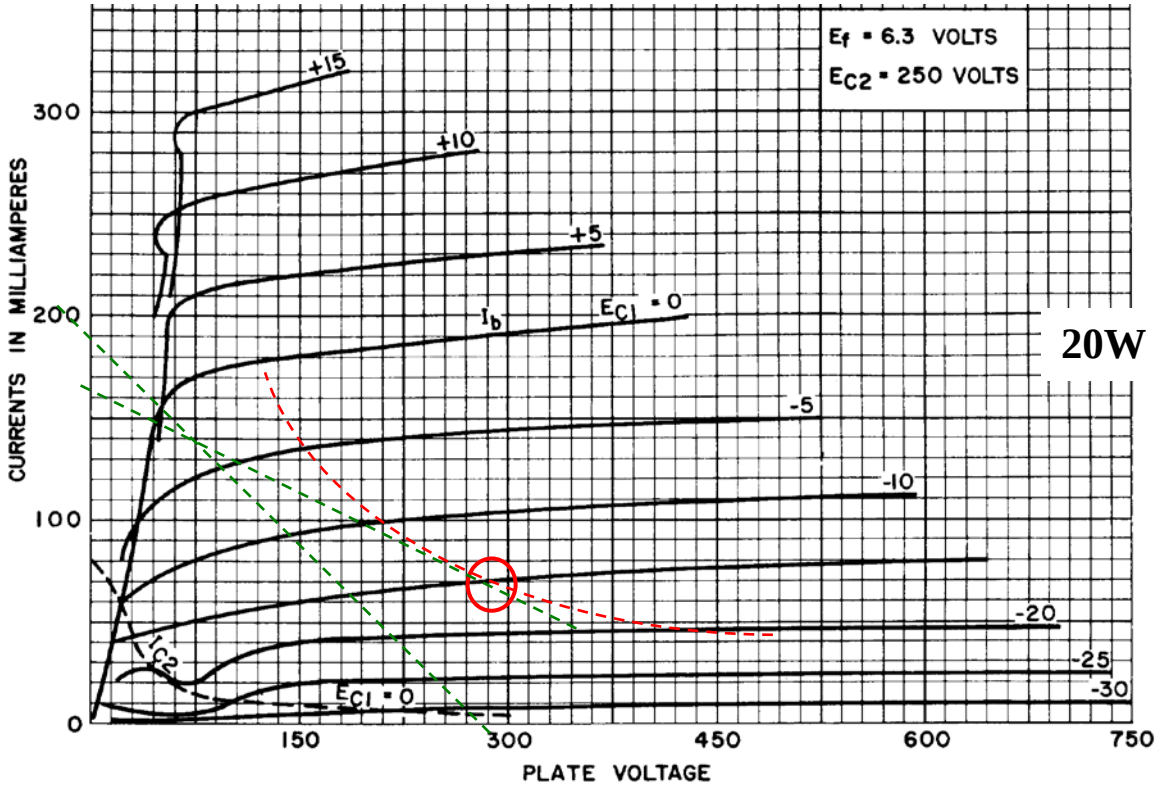
6L6GC are used (cheaper than EL34) and fit ok. Class AB push-pull output stage with cathode bias, one side is pushed into conduction and the other side is pulled into cutoff (class B), and there is a region of Class A overlap where both sides conduct equivalent levels of current. The 6kΩ impedance plate-to-plate OPT (8Ω speaker across split FB windings) presents signal currents into each tube with a 3kΩ impedance with all tubes conducting, changing to 1.5kΩ load impedance at higher levels.

As the output loading increases, the supply voltage VS1 to the output valve plates sags from about 315V towards 300V. Plate-cathode DC voltage is lower than VS1 by an amount from 5+20= 25V, up to 13+25=38V; where OPT half resistance is up to 92Ω and has current ranging from 60mA to a peak current of up to about 0.14A.

Screen supply voltage VS2 also sags from about 310 to 300V. And screen cathode voltage is lower than VS2 by an amount from 5+20=25V, up to 13+25=38V. 270Ω screen stoppers, and screen current increasing from about 65/8=8mA to about 40mA/tube.

The output valve idle cathode current is about 65mA, so idle plate+screen dissipation is about: Pd = (315-25) x 65mA = 18.9W, which is conservative 70% of max design level.





4.5 Powering

The GZ32 is rated to feed 16uF with secondary winding resistance of 50Ω from 300VAC, and up to 300mA loading for 280VDC output. PSUD2 with those conditions and using a 5V4G model (same voltage drop as GZ32) indicates a hot switch peak current of 1.35A, and a continuous peak current of 870mA.

The effective series resistance is 8Ω x $(300/240)^2$ +55Ω = 67Ω, and the expected cranked loading is <300mA, so the GZ32 is ok

A 10uF poly and 3H @ 100mAdc, DCR=140Ω (EC13) choke feed a 47uF main filter cap for VS1. is added in series with 560R dropper from VS1 to VS2 to reduce screen voltage ripple from 1.6Vrms to 0.29Vrms. Screen current should be less than 20mA average, and 4mA for VS3-4.

A steady-state continuous of 240mApk at idle, which appears to be fine for cranked output. The steady-state PT secondary CT current at idle is about 110mArms, and rising to 570mArms for a 10ms period for a hot switch event, which would allow a 200mA Fast IEC127 fuse to be used (min rating of 50ms at 2.75x rating multiplier).

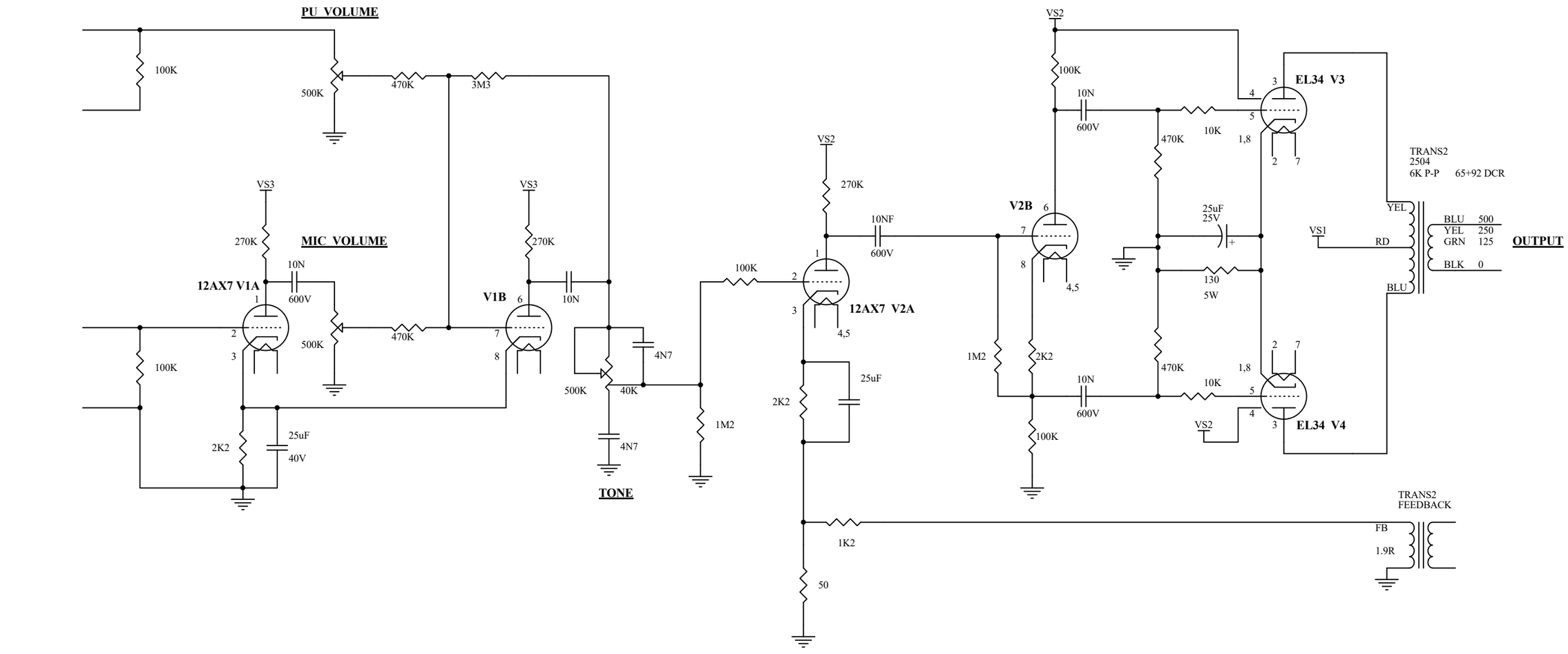
Full wave rectifier with 150mA hot idle load on 310V VS1. Max anticipated continuous VS1 load current about 150mA, requires about 250mArms CT current. IEC60127-2 0.25A F fuse chosen.

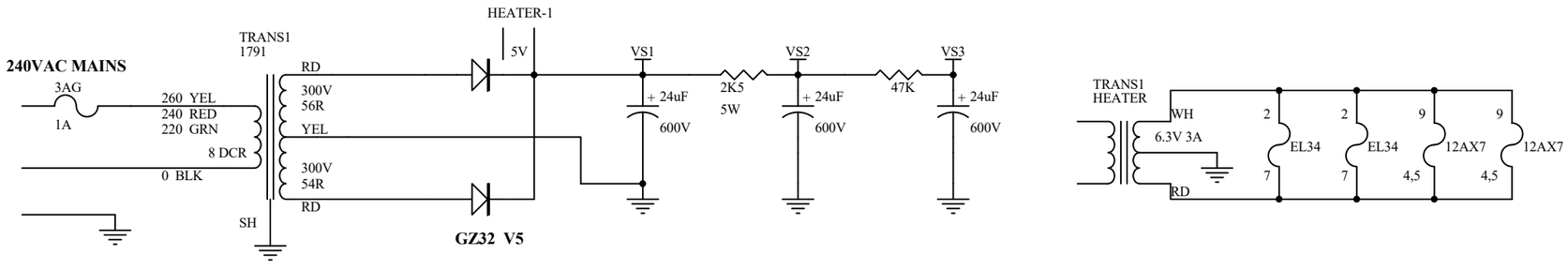
Simulate period in PSUD2	**20ms**	**150ms**	**600ms**	**continuous**
Simulated RMS current	0.63A	0.41A	0.29A	0.25A
Multiplier (based on 0.25A fuse rating)	2.6	1.7	1.2	1.0
IEC60127-2 Time-lag T min limit multiplier	10	4	2.75	1

Simulate period in PSUD2	**10ms**	**50ms**	**continuous**
Simulated RMS current	0.52A	0.58A	0.25A
Multiplier (based on 0.25A fuse rating)	2.1	2.3	1.0
IEC60127-2 Quick-acting F min limit multiplier	4	2.75	1

Original loading:
6.3V heater loading: 2x 1.5 + 2x 0.3 = 3.6A
5V heater loading: = 2.3A

PHILIPS 982, S.N. 1085
Original





VOLTAGE RAILS	
RAIL	IDLE
VS1	285V
VS2	250V
VS3	216V
HEATER-1	6.3V

VALVE	QTY
EL34	2
GZ32	1
12AX7	2

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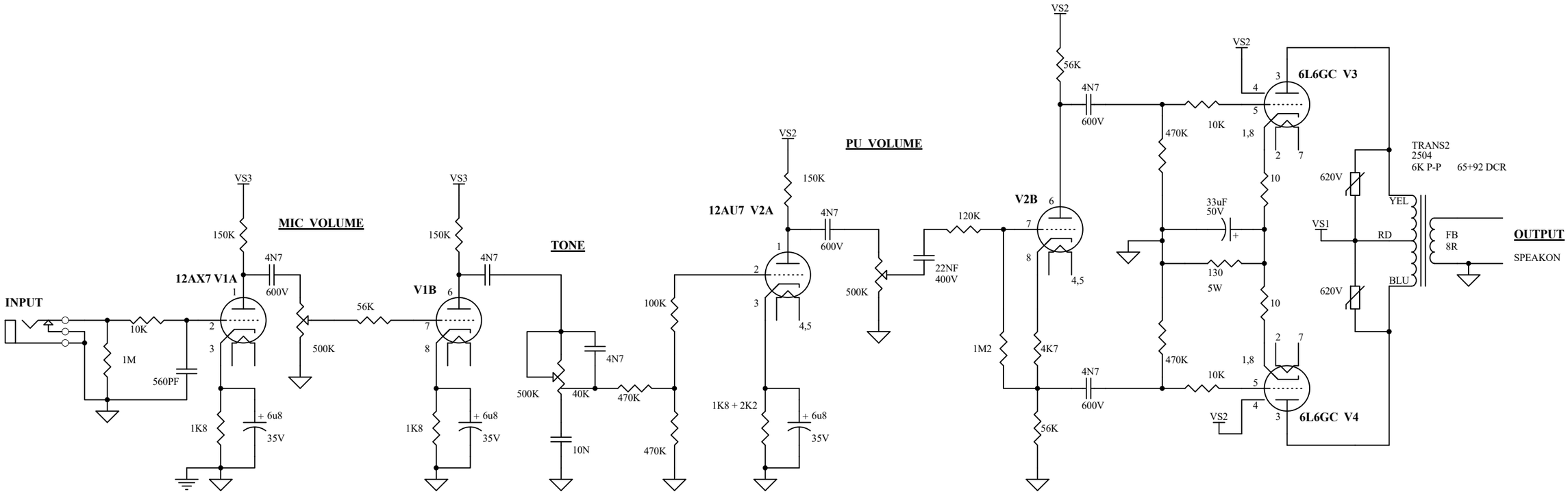

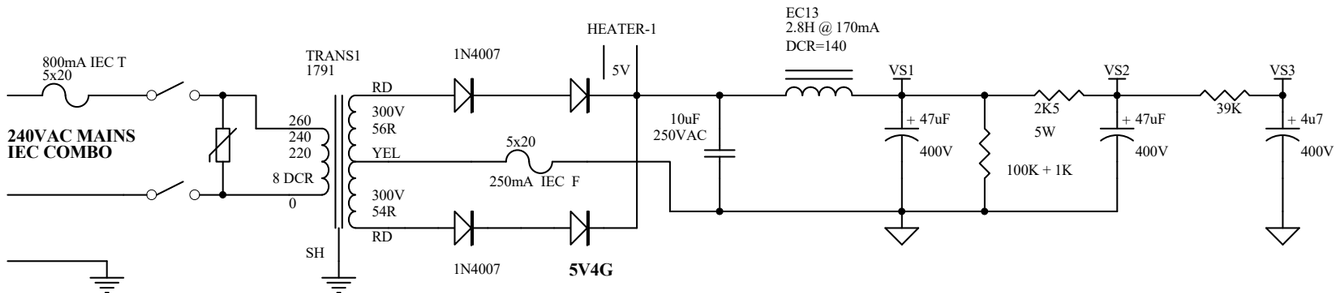

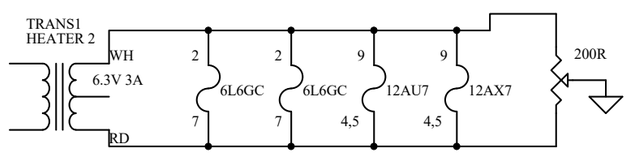

VOLTAGE RAILS		VALVE	QTY
RAIL	IDLE	6L6GC	2
VS1	310V	5V4G	1
VS2	300V	12AX7	1
VS3	250V	12AU7	1
HEATER-1	6.3V		

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