1. Summary

AWA G56825 15W valve amplifier. S.N. 277. Aug 2013.

MIC-Phono-Radio input channel 15W PA amplifier. 6AU6 mic preamp. 6AV6 Phono-Radio preamp. 6AU6 mixer. 12AU7 self-balancing, floating paraphase PI with separate unbypassed cathode biasing and output global feedback. Dual KT66 common cathode biased PP; no screen stoppers; RC filters on each plate and on one KT66 grid; separate feedback winding to PI stage driven cathode. 5V4G rectifier. Elevated dc voltage heater humdinger pot. Front panel controls: MIC Volume; Phono-Radio Volume; Phono-Radio Tone; Phon-Radio selector; MIC H.F. three setting switch; System L.F. two-setting switch; Monitor On-Off switch.

Output Transformer	AWA Type 1TJ57768 OP 5.6 15W 5kΩ PP 5 output winding sections 0, 40Ω, 100Ω, 150Ω, 300Ω, 600Ω. Panel: 8-15, 5-7, 3-4, 2, 1, x 600Ω speakers.
Power Transformer	AWA Type 1TK57761 OL 6538 6210 E3 265-0-265V @ ~?00mA (RD,BK,RD); 6V3 4.5A; 5V 2A.
POTs	AEROSTAT 355 AWA pots marked 56825T33 500M LOG IRC 100Ω /W PC5.
Resistors	RECO AA, AB; IRC AA
Caps	IMF MSP black foils; Ducon electrolytics. 94, 375, SOT 106 35 106 UCC can type ERL 94, ERR 25 Mustard 116H; Simplex SM
Valves	EL37 x2: Mullard 530 (on base), R61 ?0H (repaired base); (no other markings) 6AU6 x2: Miniwatt Wd C81, Wd 21 12AU7 x1: 41 6AV6 x1: ?? C8H (3U=??) 5U4G x1: 550

General good condition – dust coated; some old insulation; some areas of rust; cracked black wax caps; old electrolytics; fuse wire for fuse. Two knobs missing.

No dates obvious. 355 AWA pots are marked 56825T33. Parts appear to be early 1950's build.

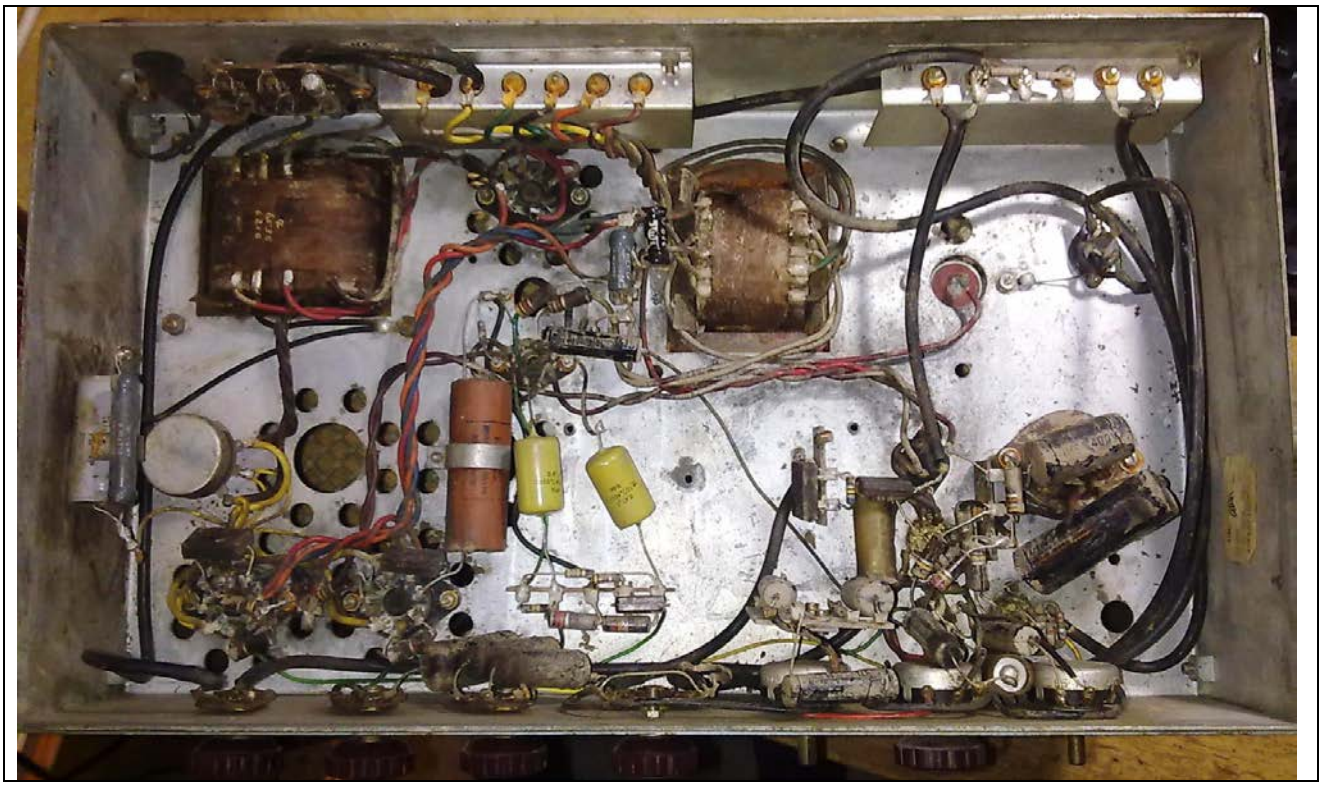
Schematic differences: R23=3k3. R26=470k. R38=320R 3W.

Issues: Old cables. Old capacitors. Dust coated switches and terminals and parts. Output impedance terminal use. AC fuses. No power switch. 5U4 rectifier is 3A heater (schematic indicates heater is 2A rated). Plate RC filter 470R/1.6nF = 210kHz corner frequency.

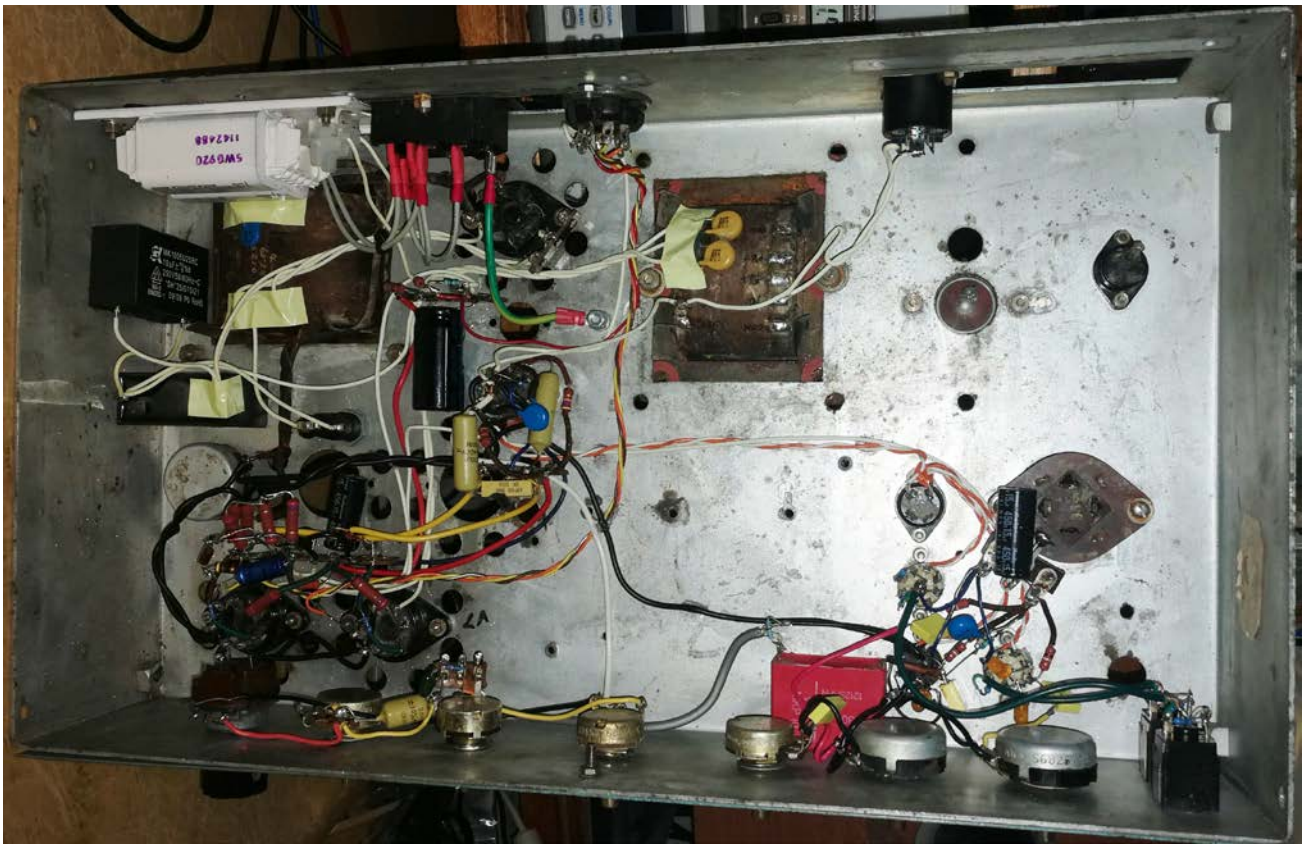
Aim: remove all circuitry – clean up chassis and useable part - start again.

EL37 came out 1946 and had a special rating for push-pull driver stage for higher powered triodes, and was subtly different than other valves - closest type was the KT77 (which came out 1950's specifically for UL): lower heater-cathode voltage rating than KT77; lower grid leak values; pins 1 & 6 removed; lower ra as pentode, but higher as triode.
WW Jan 1947 advert; ww May 1949 amp.
http://www.r-type.org/articles/art-057.htm

Photos original condition:



Photos after mods:



2. Modifications

- Added IEC socket/fuse/switch combo; MOV on power transformer primary.
- Added series ss diode to each 5V4G anode, and fuse to secondary CT.
- Added choke with low DCR to maintain high B+, and lower ripple. Used poly input cap to keep uF level low.
- Replaced all resistors. Added discharge loading to VS3.
- Can electrolytics left in place, but replaced all caps except mustards.
- Reconfigured grounding.
- Added two 6.5mm jacks to LHS of front panel – one to 6AU6, other to 6AV6.
- Added 10k grid-stopper for V1, V2 input – to allow general purpose input via PU.
- 6AU6 V1 input configured as low noise triode.
- 6AU6 V3 configured as typical pentode to provide sufficient gain before tone section, as a triode stage gain of x14 is not sufficient for output stage overdrive.
- V1, V2, V3 with 1.75V amber LED cathode bias.
- Reduced 470k mixer resistors to 220k to minimise impact on HF response and noise level.
- Replaced 4 front panel switches with pots: treble, mid, bass for Fender tone stack; master vol before PI stage.
- Added 100k grid stopper to 12AU7 V4 input.
- Tuned PI floating paraphase feedback resistors using 10T pot to balance output gains.
- Removed C21/R37, RC18/R34, C19/R35 networks.
- Added 270R screen stoppers.
- Added 612VDC MOV across each primary half of output transformer.
- Hard-wired 40Ω and 100Ω taps to new Speakon output socket, with ground connection - provides 13.4Ω impedance (15% of turns) for 5k PP loading – use 15Ω speaker to provide 5.6k PP loading.
- Added VS1 loading as remote sense divider.
- Rear panel octal wired for remote meter module with VS1/100 and cathode current sensing.

To do:

- Common cathode circuit needs to be made more robust, and perhaps reduce from 225R to 185R.
- Tweak PI balance for min output distortion.
- Input sensitivity.
- Rear panel opening barriers.
- Use the 2 switch contacts on rear of Monitor pot.

3. Measurements.

Mains circuit has >700Meg insulation resistance at 1kVdc
Unloaded PT secondary voltages: 280V, 6.8V with 242V and 0.16A mains
Power transformer primary DC resistance: 13.5Ω.
Power transformer secondary DC resistance: 56+60Ω.

Rail	Idle 243V 0.40A
VS0	288V 10.8Vrms
VS1	284V 190mVrms
VS2	272
VS3	263
VS4	17.0
V1 plate	
V2 plate	
V3 plate	
V4 plates	
Heater 1	6.4Vrms
Cathode	47mA, 51mA

25VAC 50Hz nominal applied to half-primary winding on output transformer

Winding	Voltage rms	Turns ratio; Impedance; Notes
Pri P-P:	2x 24.9	1 ; assumed to be 5k P-P
Sec: Com to 40	4.47	11.14; 40.3 Ω; based on 5k P-P
Sec: Com to 100	7.04	7.07; 100 Ω; based on 5k P-P
Sec: Com to 150	8.67	5.74; 151 Ω; based on 5k P-P
Sec: Com to 300	12.19	4.09; 300 Ω; based on 5k P-P
Sec: Com to 600	17.3	2.88; 603 Ω; based on 5k P-P
Sec: FB	2.24	22.23; 10.1 Ω; based on 5k P-P

OPT primary circuit has 370Meg insulation resistance at 1kVdc
Output transformer primary DC resistance: 137 + 145Ω 282R plate-to-plate.
Output transformer secondary DC resistance: 16Ω 600 winding.
Output transformer secondary f/b DC resistance: 1.3Ω winding.

The effective impedance of the winding between the 40R to 100R is 13.4Ω, and comprises 15% of secondary winding turns.
The effective impedance of the winding between the 150R to 300R is 25.1Ω.

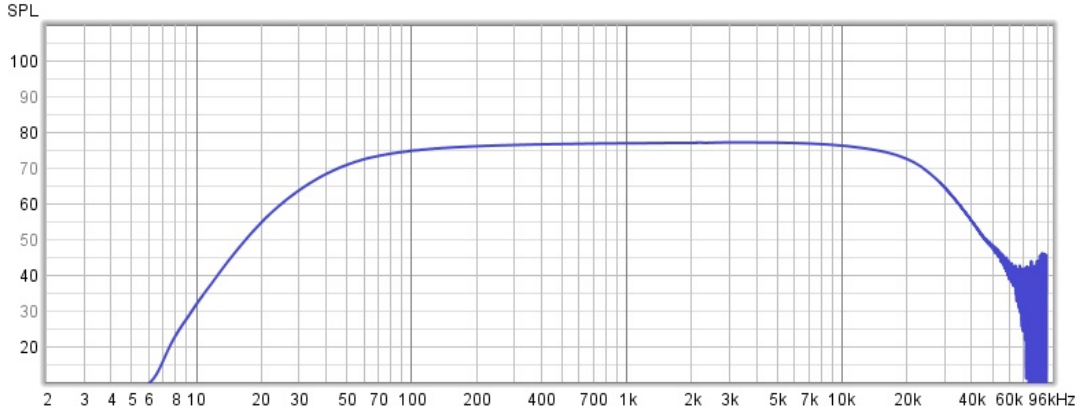
Parasitic resonance showing up at about 50kHz, and noticeable on spectrum with treble up. HF response was extended to beyond 20-30kHz, so changes made to roll-off above 10kHz were:

- V3 mixer stage HF gain dropped by 100pF bypass on 100k anode load.
- Tone stack treble bypass reduced to 82pF.
- PI stage anodes shunted by 100pF.

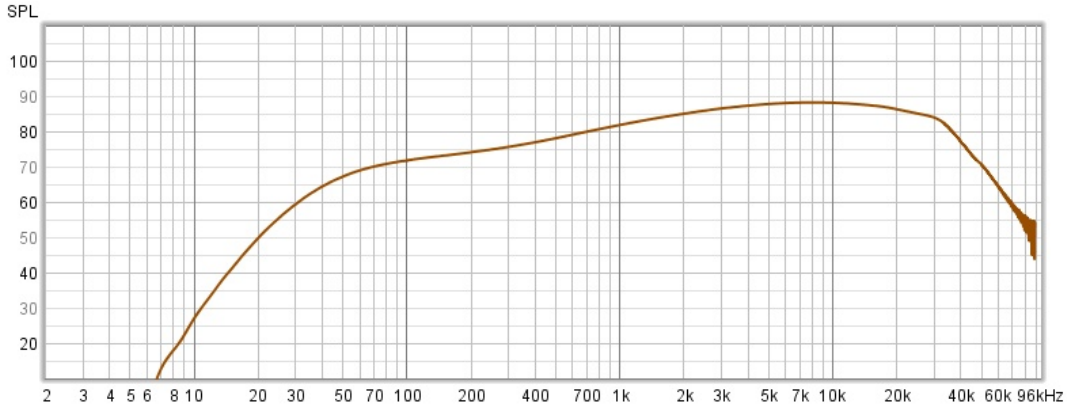
Modified stage mid-band voltage gains:

- V1 6AU6 grounded plate triode = 25.5x 25mV 638mV
- V2 6AV6 = 20x 19.5mV 386mV
- V3 6AU6 pentode = 26.4x 69.5mV 1.836V
- V4 12AU7 PI anode either side = 5x 356mV 1.79V
    - Pot trimmed for equal gain; Vol wiper input

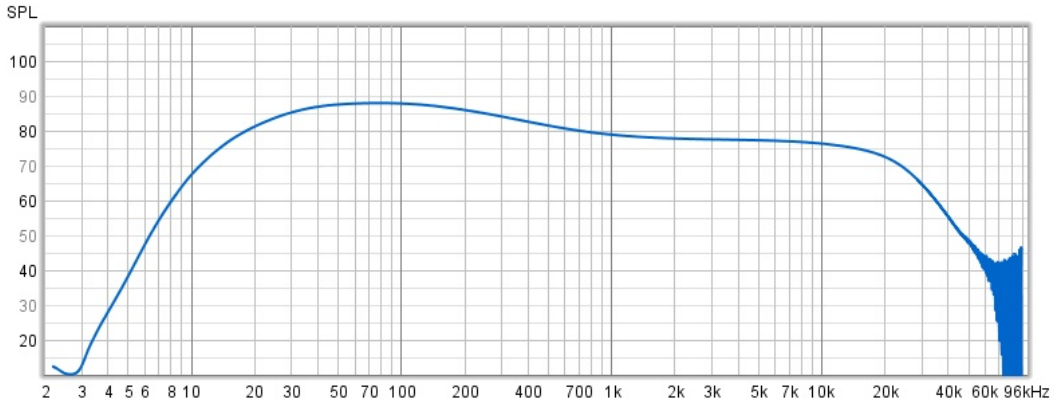
Input 1, 1W output, tone pot settings



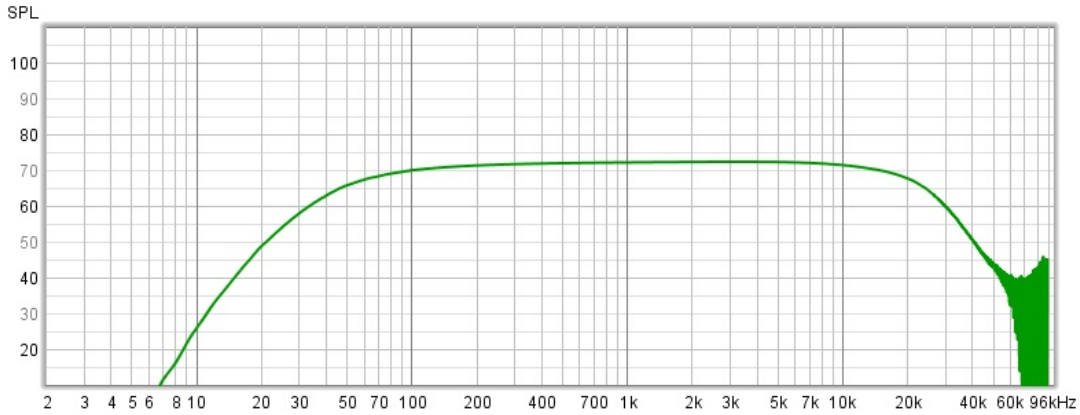
Treble=min Bass=min Middle=min 1W output default vol settings



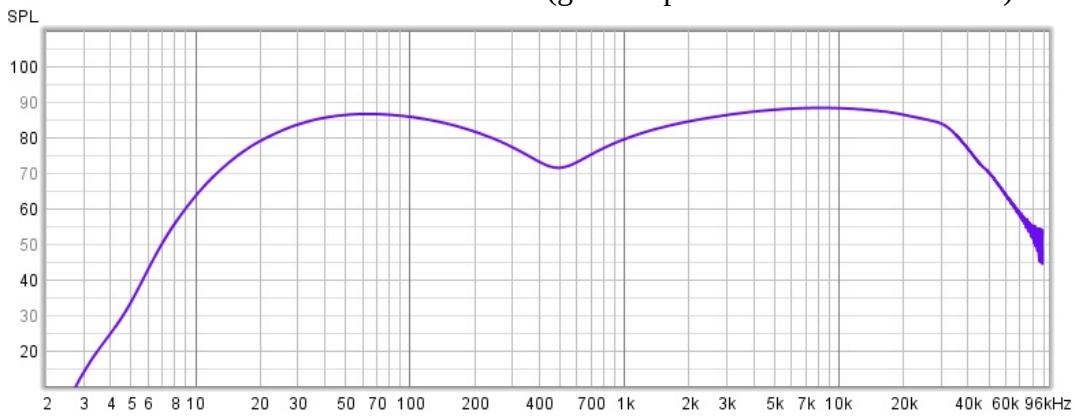
Treble=max Bass=min Middle=min +10dB at 5-15kHz



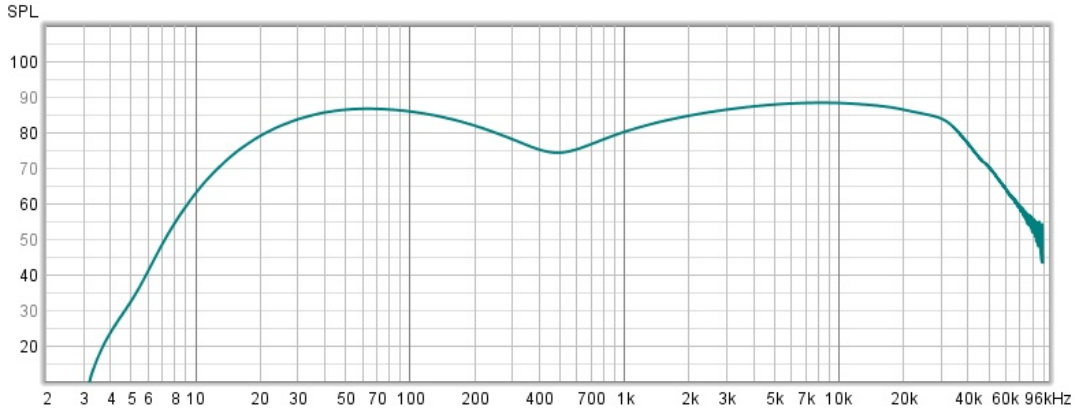
Treble=min Bass=max Middle=min +10dB at 60-100Hz



Treble=min Bass=min Middle=mid (gain drops too far for Middle=max)

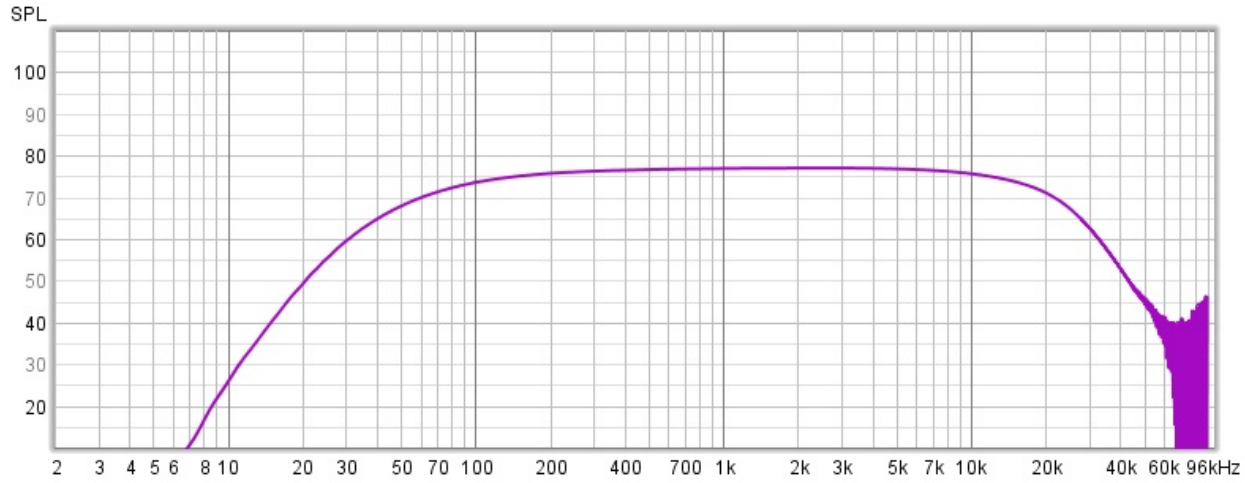


Treble=max Bass=max Middle=mid 15dB scallop

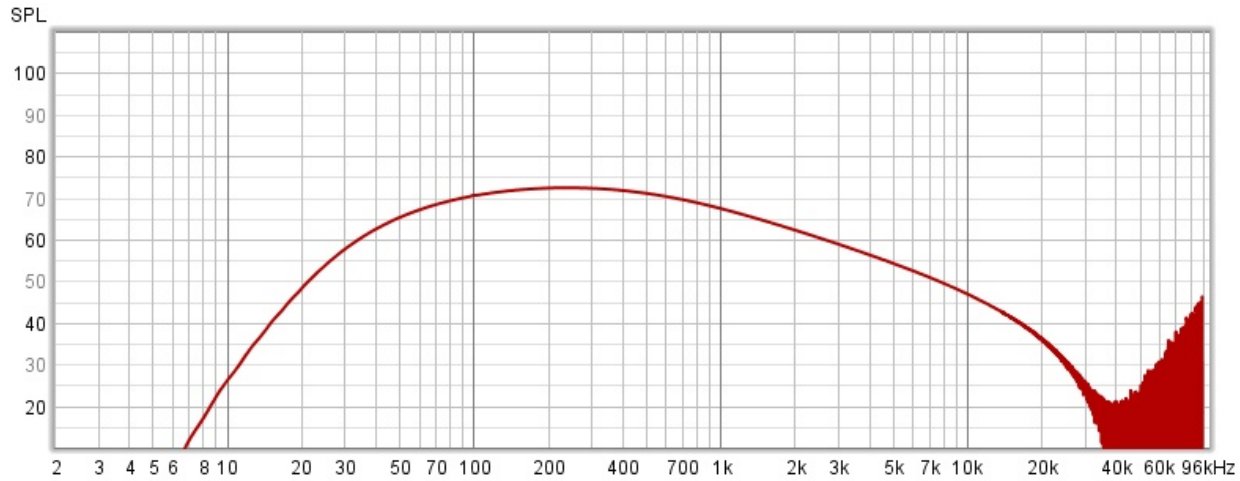


Treble=max Bass=max Middle=min

Input 2, 1W output, tone pot settings



Tone=max 1W output default vol settings



Tone=min -25dB at 10kHz

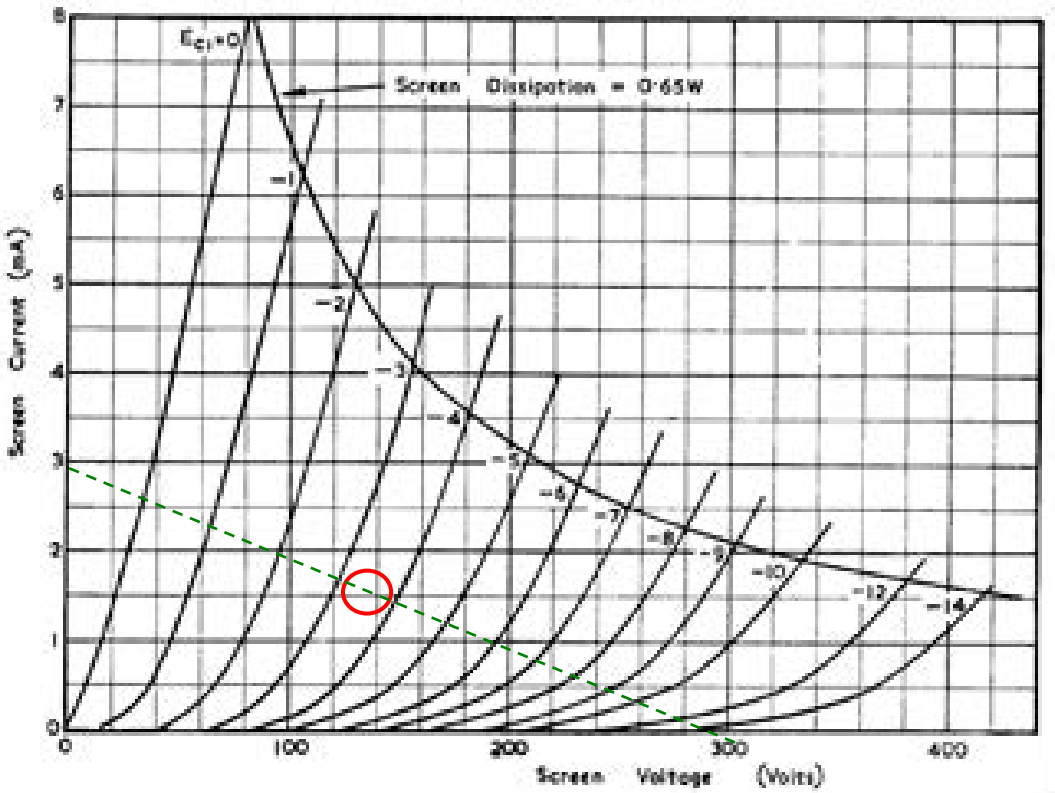
Humdinger set for lowest worstcase output hum (26mVrms with Input 2 Vol = max, main vol = max, Bass = max) when at one end.

Cranked output to 14W with ss clone rectifier and old EL37 pair (52mA each, VS1=292V).

4. General comments.

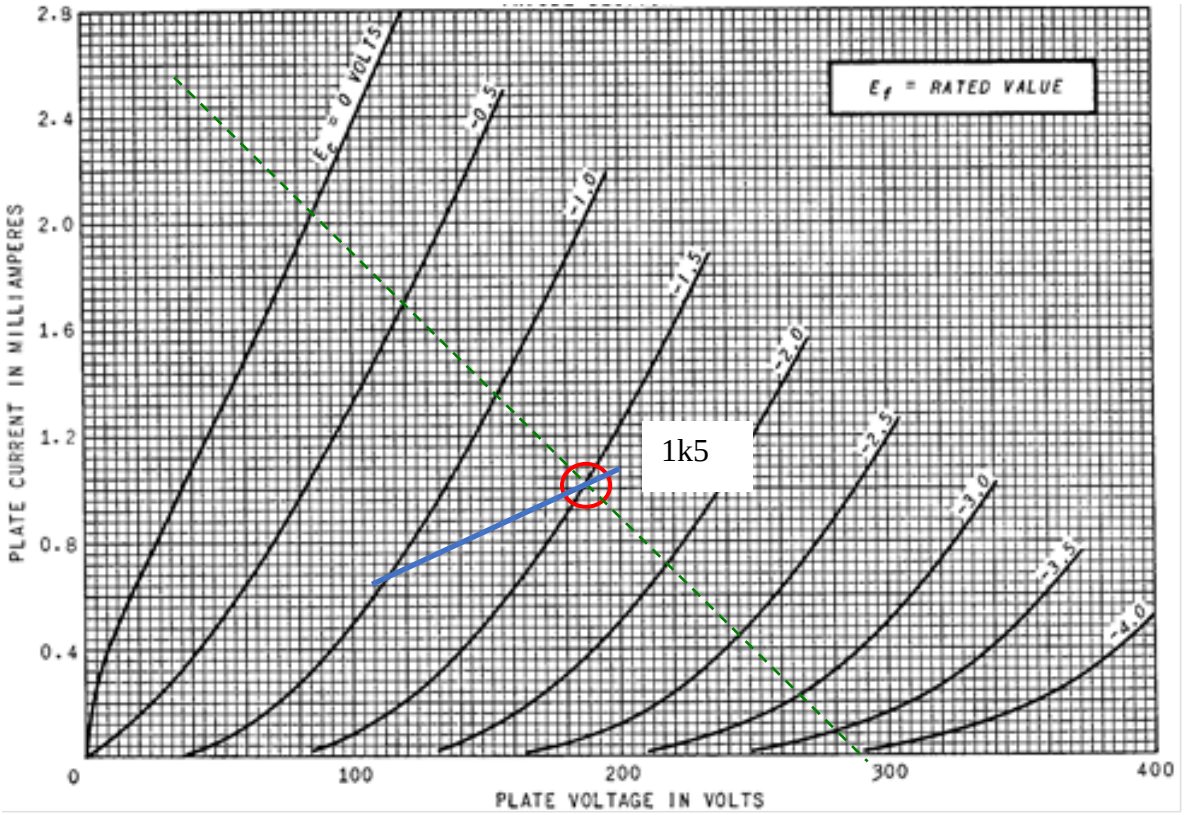
4.1 6AU6 grounded plate triode V1

With two amber LEDs bias is 3.5V, and anode voltage is 144V for VS3=290V.



4.2 6AV6 triode V2

With VS3=290V, Rk=1k5, anode voltage is 189V.

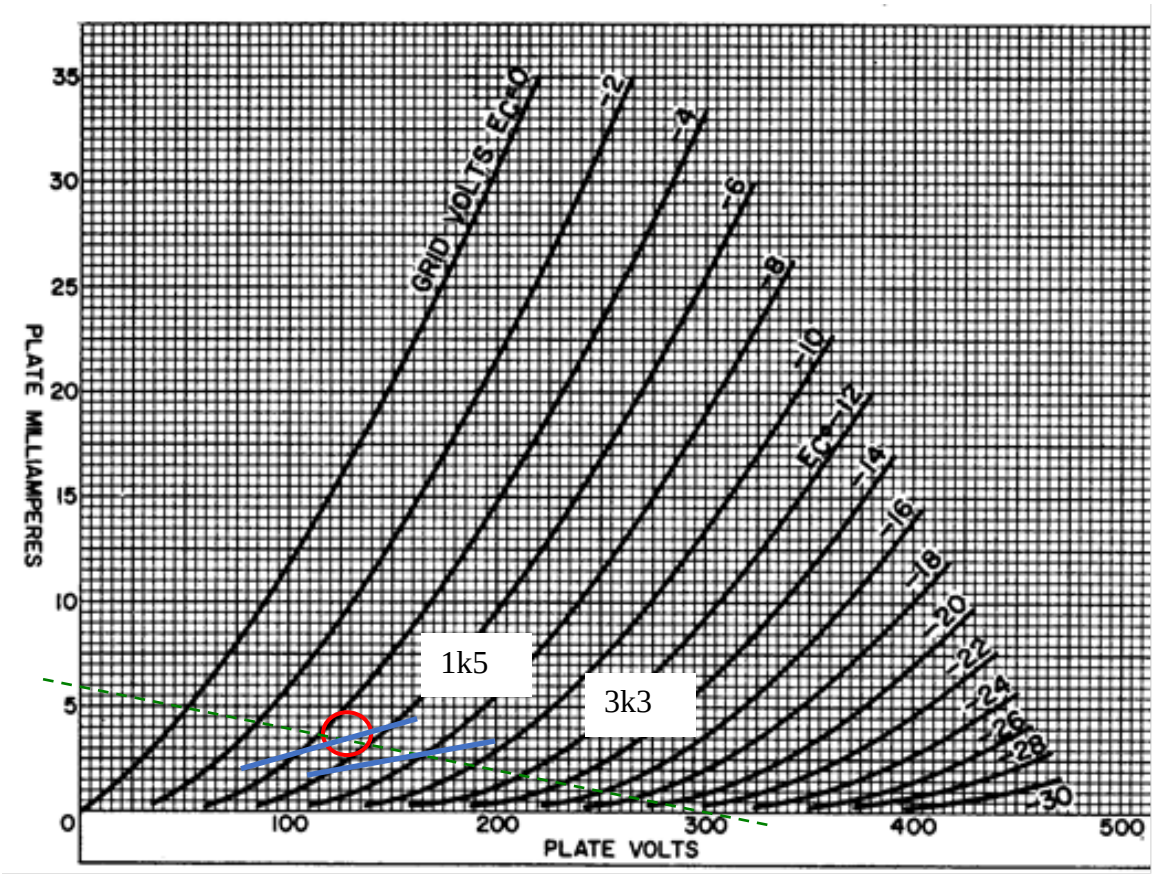


4.3 6AU6 pentode V3

With one amber LED bias is 1.82V, and anode voltage is 175V with about 1.15mA for VS3=290V and 470k screen dropper.

4.4 12AU7 V4

With VS2=295V, and Rk=2k7 for V4A and V4B, the anode voltages were 166-169V for 47k load, so close to centre biased and should provide unclipped drive for output stage.


GRID VOLTS EG=0
-2
-4
-6
-8
-10
EG=-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
1k5
3k3
PLATE MILLIAMPERES
PLATE VOLTS
0
5
10
15
20
25
30
35
100
200
300
400
500

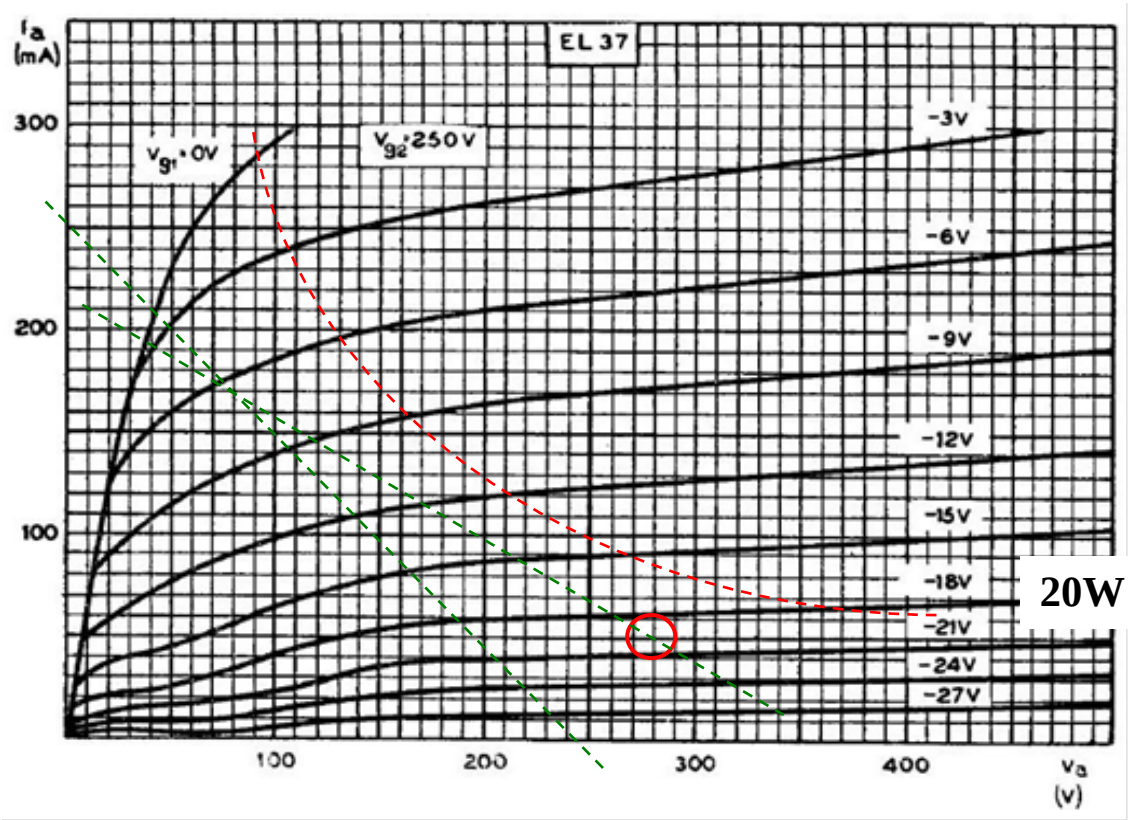
4.5 Output Stage

The Class AB push-pull output stage uses EL37. The cathodes use common bypassed 220Ω cathode resistor. The 5kΩ impedance plate-to-plate OPT presents signal currents into each tube with a 2.5kΩ impedance with all tubes conducting, changing to 1.25kΩ load impedance at higher levels for 13.4 ohm output loading – increase by 20% for nominal 16 ohm speaker loading.

EL37 power dissipation limiting design values are 25W and 6W. The output valve bias current was about 50mA, based on 22V across common 220R cathode resistor: Pd = (310-7-22)V x 50mA = 14W, which is conservative % of max design level. Cathode resistor dissipation peaks at about 220 x 0.14 x 0.14 = 4.4W.

Plate-cathode DC voltage will be lower than VS1 by an amount from 7+22= 29V, up to 23+30=53V; ie. OPT half resistance of about 137Ω with a peak current of up to about 0.18A, plus up to 30V bias. As the output loading increases, the supply voltage VS1 sags from about 310V towards 290V (check), and so Vak ranges from about 310-29=281V at idle, to 290-50=240V cranked.

Screen-cathode voltage is about 275V at idle. Screen current increase of up to about 20mA/tube could sag screen voltage by 5+6V with 270Ω screen stoppers and 560R dropper from VS1 to VS2.



5. Power Supply

Mains supply at 240Vac and idle with 38+39mA is 360mA, so 500mA T IEC fuse should be fine.

6.3V heater loading: 2x1.4 + 0.3 + 0.3 + 2x0.3 = 4A

The 5V4G has limits on the effective source resistance when feeding a capacitor-input filter. The effective source resistance is comprised of the reflected power transformer primary resistance = 14Ω x $(265/240)^2$ = 17Ω; plus the secondary resistance = 55Ω; which sums to 72Ω. Datasheet indicates operation in to 10uF with 375V needs 100Ω effective series resistance, so given 16uF filter may be nominal max capacitance level for 265V supply and 70Ω supply resistance.

Output stage idle could be up to 50+50=100mA, plus another 10mA for previous stages. Cranked load could be up to circa 180mA.

PSUD2 shows 5V4 continuous peak current of nearly 400mApk for 100mA dc load at 310V and 20uF input cap, which is under the 525mApk max limit – that limit is reached when load reaches about 150mA. The hot start peak is nearly 1.6Apk which is well below the 3.5Apk max limit.

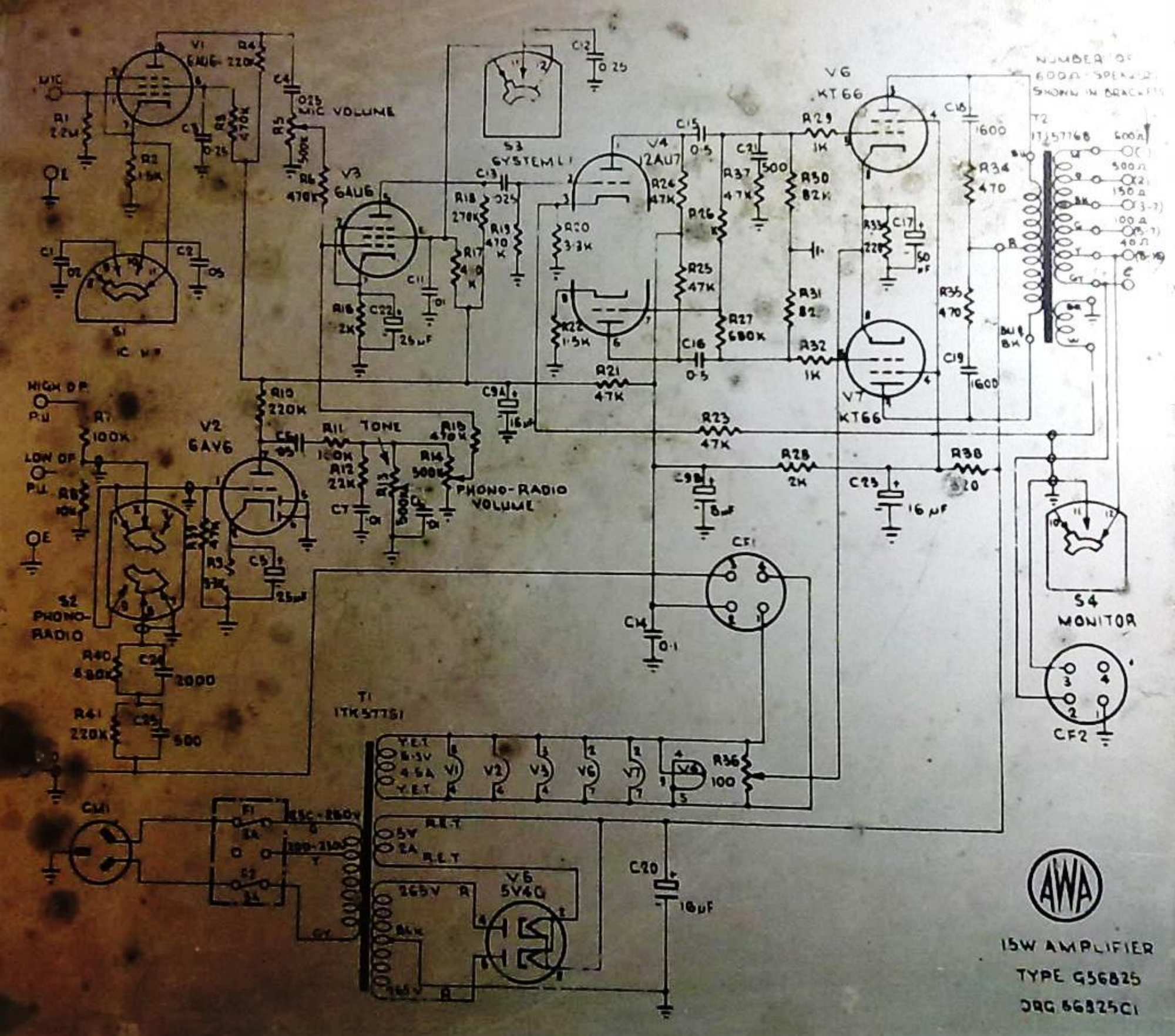
Schematic identifies 5V4, but chassis identified 5V4 (indirectly heated cathode) or 5R4 (directly heated cathode). 5V4/GZ42 would provide higher B+, and is preferred, given the low B+.

Fuse selection for HV secondary – use 315mA F IEC, as continuous may reach 0.25A in overdrive, although 250mA fuse .

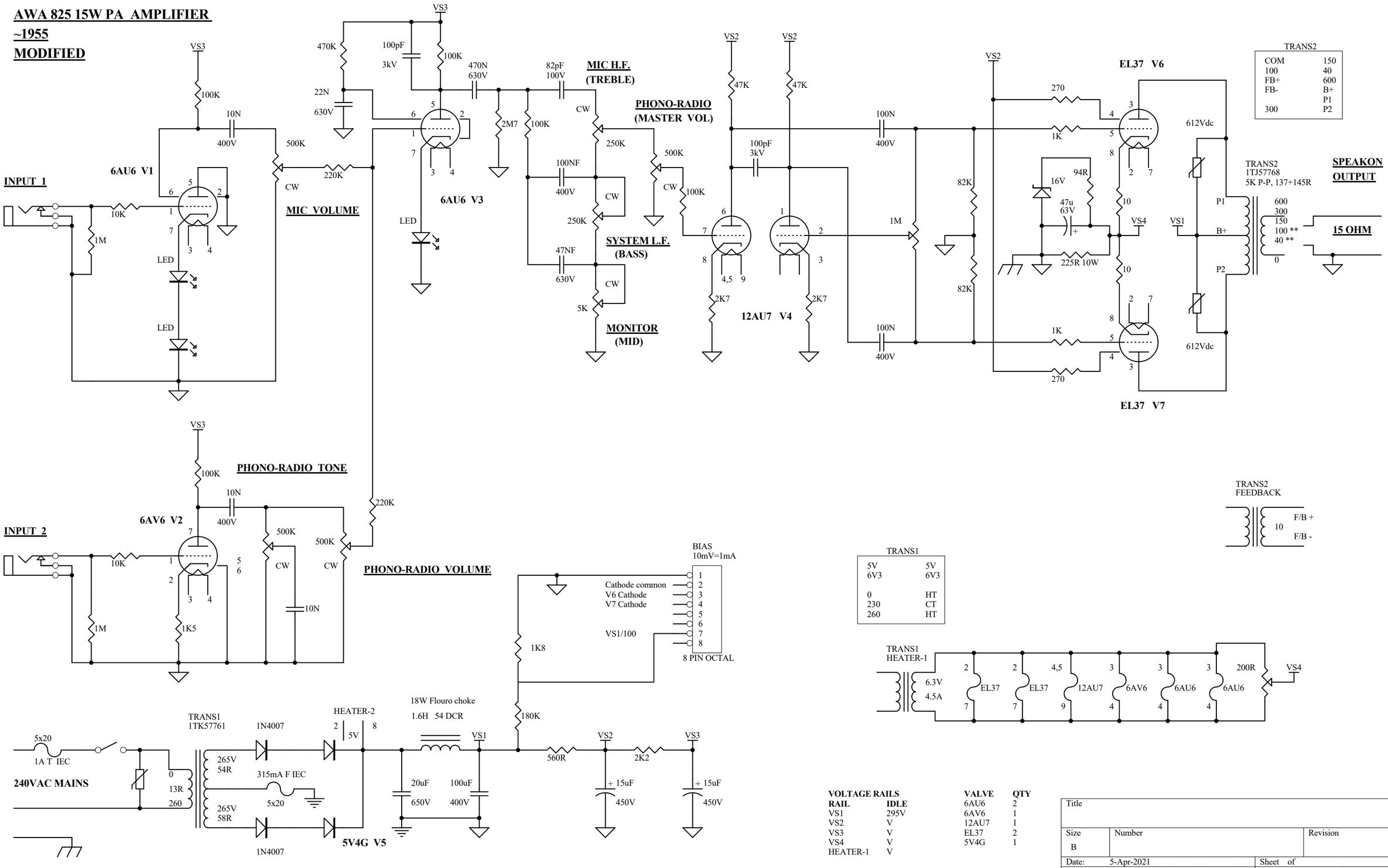
Simulate period in PSUD2	**10ms**	**20ms**	**50ms**	**150ms**	**600ms**	**continuous**
Simulated RMS current	0.76A		0.82A			0.23A
Multiplier (for 0.315A fuse rating)	2.4		2.6			0.73
IEC 60127-2 **F** min limit multiplier	4		2.75			1

Simulate period in PSUD2	**10ms**	**20ms**	**50ms**	**150ms**	**600ms**	**continuous**
Simulated RMS current	0.76A		0.82A			0.23A
Multiplier (for 0.25A fuse rating)	3.1		3.3			0.92
IEC 60127-2 **F** min limit multiplier	4		2.75			1

Simulate period in PSUD2	**10ms**	**20ms**	**50ms**	**150ms**	**600ms**	**continuous**
Simulated RMS current		0.83A		0.53A	0.32A	0.23A
Multiplier (for 0.25A fuse rating)		3.3		2.1	1.3	0.92
IEC 60127-2 **T** min limit multiplier		10		4.0	2.75	1


V1 6AU6
V2 6AV6
V3 6AU6
V4 12AU7
V6 KT66
V7 KT66
V8 5V4G
S1 MIC VOLUME
S2 PHONO-RADIO
S3 SYSTEM L.I
S4 MONITOR
PHONO-RADIO VOLUME
TONE
HIGH OP
LOW OP
T1 ITK577SI
T2 IT257768
CF1
CF2
NUMBER OF 600Ω SPEAKERS SHOWN IN BRACKETS
15W AMPLIFIER
TYPE G56825
DRG 66825C1

AWA 825 15W PA AMPLIFIER
~1955
MODIFIED



VOLTAGE RAILS	
RAIL	IDLE
VS1	295V
VS2	V
VS3	V
VS4	V
HEATER-1	V

VALVE	QTY
6AU6	2
6AV6	1
12AU7	1
EL37	2
5V4G	1

Title		
Size B	Number	Revision
Date: 5-Apr-2021		Sheet of
File: C:\Program Files\Design Explorer 99 SE\Examples\Projects\Amplifier Modules.ddb		