1. Summary

AWA 8 Watt Amplifier Model PA774, S.N. A?9973. eBay Nov 2011
Type 1G59774. DRG 59774C1.

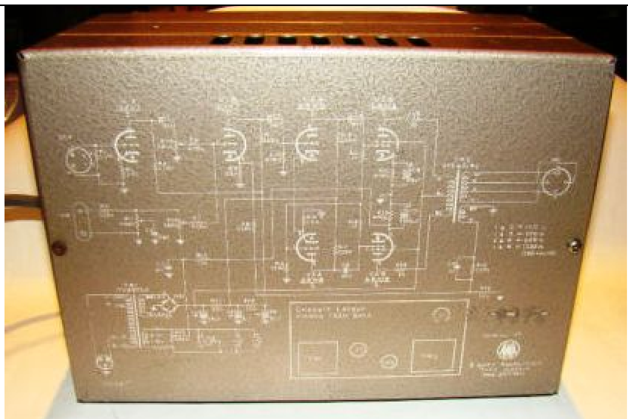
1.1 Original design

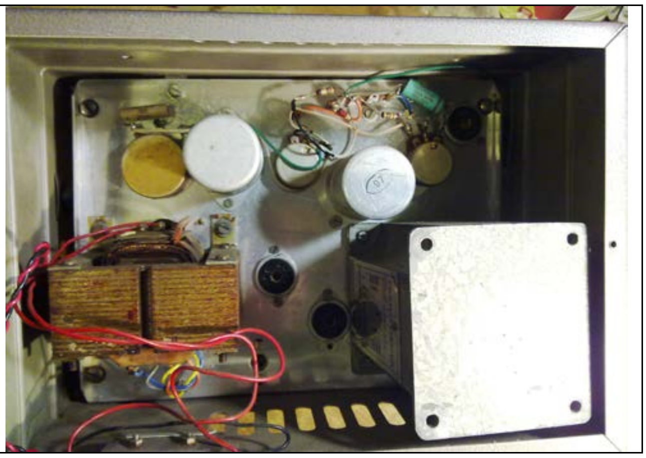
One microphone and one P.U. input channel PA amplifier. Half 12AX7 amplifier for MIC channel. PU input summing into half 12AX7 summing amplifier. 6BM8/ECL82 triodes for floating paraphrase splitter. 6BM8/ECL82 pentodes for PP output stage. Separate and bypassed cathode biased push-pull 6BM8 output, with isolated secondary feedback winding taken to the mixer stage cathode. 220V PP stage OT and screen supply from FC442 bridge diode rectifier and capacitor input filter. Series RC filtered supplies for PI stage, and for 12AX7 triodes. 6.3VAC heater supply DC elevated to 6BM8 cathode bias through humdinger pot. Vol pot for MIC input. Tone and Vol pots for P.U. input.

Power transformer	60720 BD8
	0,10,220,240V; 180-0V; 6.3V 1.8A.
Output Transformer	A&R OT 916-8 (0397); 12W, 8.5k
Valves	12AX7 Radiotron D2 UB 27 (??)
	6BM8 Radiotron 6F OG D8
	6BM8 Radiotron WE 27 D4
Diode	FC442 bridge
Capacitors	UCC HiQual 100 model (marked 2064 and 2264) and TFC model (marked 115 and 135)
	Ducon can (marked 97)
Pots	CTS45 K5
	59774T63

Modifications noted: A&R OT 916-8 (0397) was a replacement – UL taps direct to 6BM8 screens. Pot shaft soldered. 4-pin socket added – heater AC output. 330R cathode bias resistors for pentodes (not 470R). Top strap handle missing.

Same model, but possibly earlier as no serial number stamp, has an Oct 1962 plaque on it – eBay 19/09.





Design Issues:

- OT previously replaced with A&R OT916, but not well matched to 6BM8, and too hi-fi, and weight is buckling plate, and is over-powered. Replaced with Wurlitzer 500862 OT – 5k5 PP to 8 ohm, about 20-30W rating – size is fine – low-fi. 5k5 PP appears ok for 6BM8 pentode PP with 250V B+ and 200V screen.
- Bridge diode is weak/prone to fail. Replaced with W04.

1.2 Modified Design for Guitar Amp use

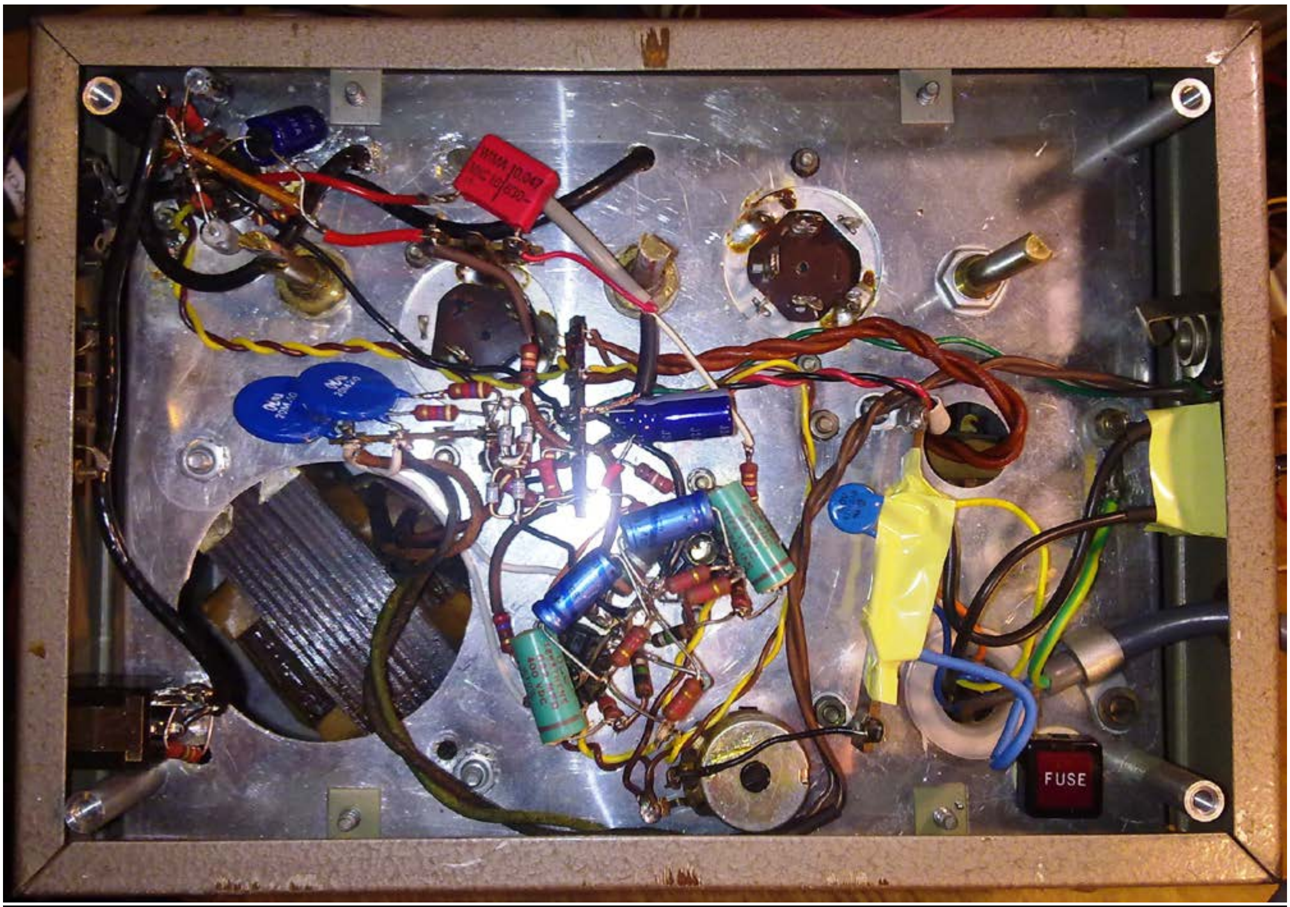
Inputs reduced to just one guitar input – isolated 6.5mm socket with tip grounded; changed R1 to 1M and 22K grid input added; added 4.7uF bypass across R2 and R9; R2 and R9 changed to 2K2. 47k grid stopper added to V1B, and 220k to V2A. R17 and R19 reduced from 220k to 100K, and V1 changed to 12AU7. PU circuitry and summer removed. Fender tone stack added with 500k treble pot (RV1 Phono Tone) and 500k bass pot (RV2 Phono Vol), and a fixed 10K mid setting used. Master Vol pot (RV3 MIC VOL) moved to V2A input, and with 3M3 from wiper to 0V.

Replaced AC cable. 1A AC fuse and switch added, with 275VAC MOV across PT primary. Added 200mA 5x20 T fuse for PT secondary and new W04 bridge rectifier and 100uF 385V cap for main filter. Added 820 and 15uF filter with 50k loading for VS2 to pentode screens, with 60V zener across 820 dropper to maintain screen voltage during overdrive (old mod). Reduced dropper R27 from 22k to 2k2 and R28 from 22k to 10k to keep VS3 and VS4 rails high. Heater DC elevation removed from humdinger pot. Distributed star 0V with one link to chassis.

Matched 6BM8 pair. 270R screen stoppers and 10K grid stoppers added to output pentodes. Added 330VDC MOV across each primary half winding. 6.5mm phono socket for 8 ohm output. Fitted top strap.

Monitoring of VS1/100, VS2/100, cathode sense V2B, cathode sense V3B, via 5-pin McMurdo. Cathode sense voltage 300mV = 30mA (meter 0300) for 18V across 600Ω, or 20.4Ω+1k2Ω in one leg.

To do:



2. Measurements

Modified amplifier. 240V mains

Rail	Idle	Idle 1k//4k7	Clip
VS1	240	230	
VS2	175	210	
VS3	175		
VS4	169		
V2,V3 Cathodes	25+25mA	30+31mA	
Heater 1	6.35		

Power transformer primary DC resistance: 59Ω.
Power transformer secondary DC resistance: 71Ω.

12VAC 50Hz nominal applied to Wurlitzer 500862 output transformer – half primary

Winding	Voltage rms	Turns ratio; Z @ 10K pri; Z @ 5K5
Pri P-HT: BLK to Red	53.4	
Pri: BLK to OR	106.6	
Pri: Red to OR	53.3	
Sec: GRN to BLK	4.08	83; 15Ω; 8Ω;

Wurlitzer 500862 output transformer primary DC resistance: 147, 200Ω plate B+ plate.
Power rating: looks like about 15-25W given 7868 datasheet for 6k6 PP output stage.

Hum at ~95mV with MIC VOL max, others min, and dominated by 50Hz and then 150Hz. 50Hz suppressed to 150Hz level with Phono Vol at max, and 80mVrms. Further suppressed to 30mVrms with Phono Tone at max. Hum at Min, Max, Max of 7mVrms and mainly from 100Hz.

With input connected, a general peak around 400-500Hz rises with Mic Vol in middle of span. Symmetric distortion then clipping at 7V into 8Ω, so 6W at 1kHz with 79mV input. Frequency response curves measured:

- Phono pots reversed.
- LF extension ok, but HF roll-off above 2kHz is pronounced.
- Input too sensitive to allow Mic Vol to get to max.

220k anode loads changed to 100k, and changed to 12AU7.

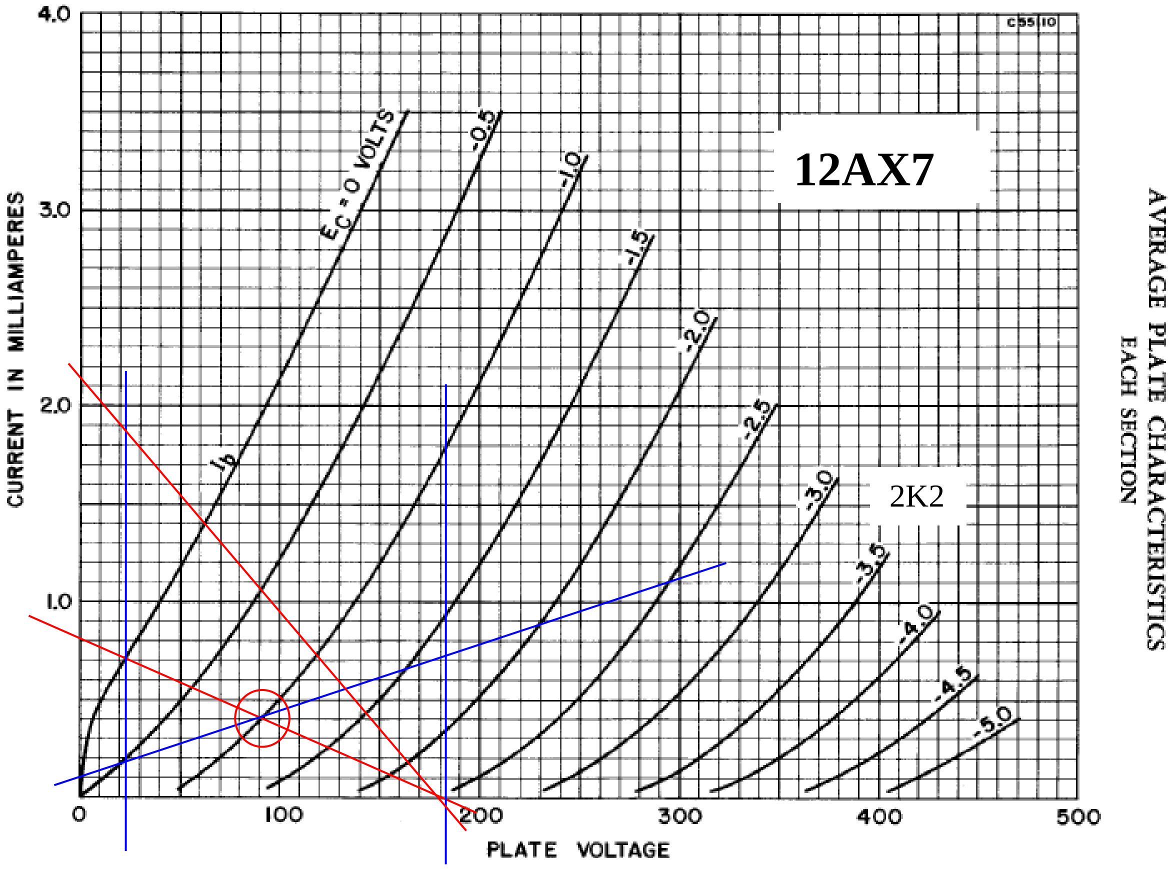
- 7Vrms 8Ω cranked for 30mVrms input and Mic Vol at max, and others at min.
- Mic Vol wiper max - flat FR 70Hz to 25kHz. Wiper mid shows treble roll-off from 2kHz.
- HD of output reduces for R21 imbalance.
- Dropped gain past 20kHz. RC (33k, 220pF) 22kHz filter at V2A grid pin1 to 0V.
- 1k//4k7 to raise VS2. 7.5V cranked (7W). 11mV sensitivity for 4W

To do:

3. Design Info

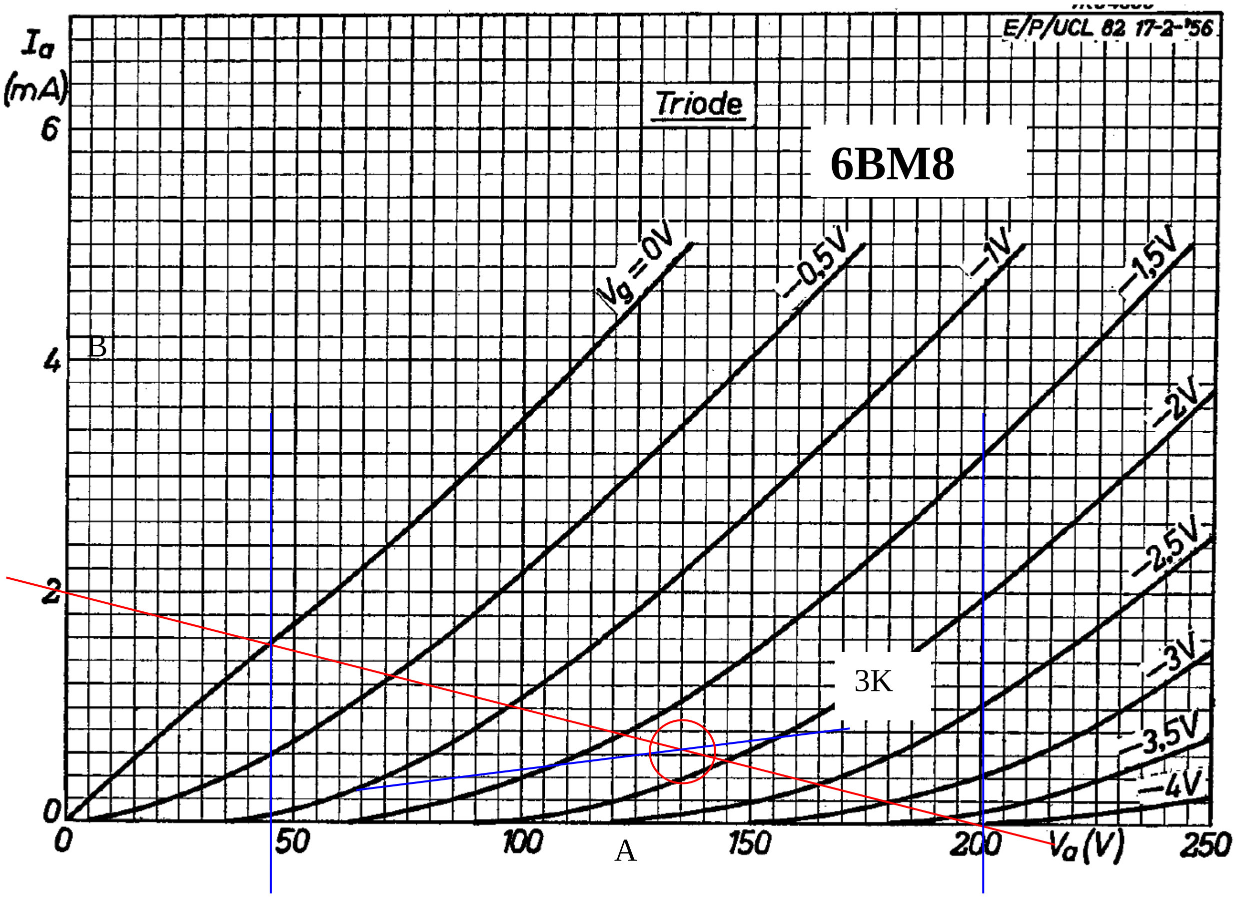
3.1 Input stage – 12AX7 - modified

For the first half 12AX7, V1A: plate voltage Vp = 180V; Va=90V; Rk=2k2; Vk=1.0V; Ia=0.4mA; RLdc=220k. Second half is quite similar.



3.2 Splitter stage – 6BM8 Triode

Unbypassed, cathode-coupled floating paraphase configuration phase splitter. Relatively high 1M grid leaks to common floating 220k retain effective grid leak to under 2M max design level, and retain high loading on 6BM8 triode outputs. The ratio of 1M to 220k is quite high, but the high gain of the triode provides a reasonable degree of balance for the PI. As triode anode loads were reduced from 220k to 100k, then the grid stoppers could be reduced from 1M to say 470k, and the triode grid leak raised from 220k to 470k, but the balance looked fine so no change made.



3.3 Output Stage

In this Class AB push-pull output stage, one tube is pushed into conduction and the other tube is pulled into cutoff, and there is a region of overlap where both tubes conduct equivalent levels of current. The cathodes are biased to +25V using separate common cathode resistors. The 5K5Ω impedance plate-to-plate OPT presents each pair of tubes with a 1.35KΩ load impedance (with a matched secondary load) for signal currents in Class B region, and 2.7K in Class A region.

As the output loading increases, the supply voltage VS1 to the output valve plates sags from about 245V towards 230V [check]. Plate DC voltage will be lower than VS1 by an amount up to ~40V; ie. OPT half resistance of about 150Ω with a peak current of up to about 0.13A, and 22V cathode bias.

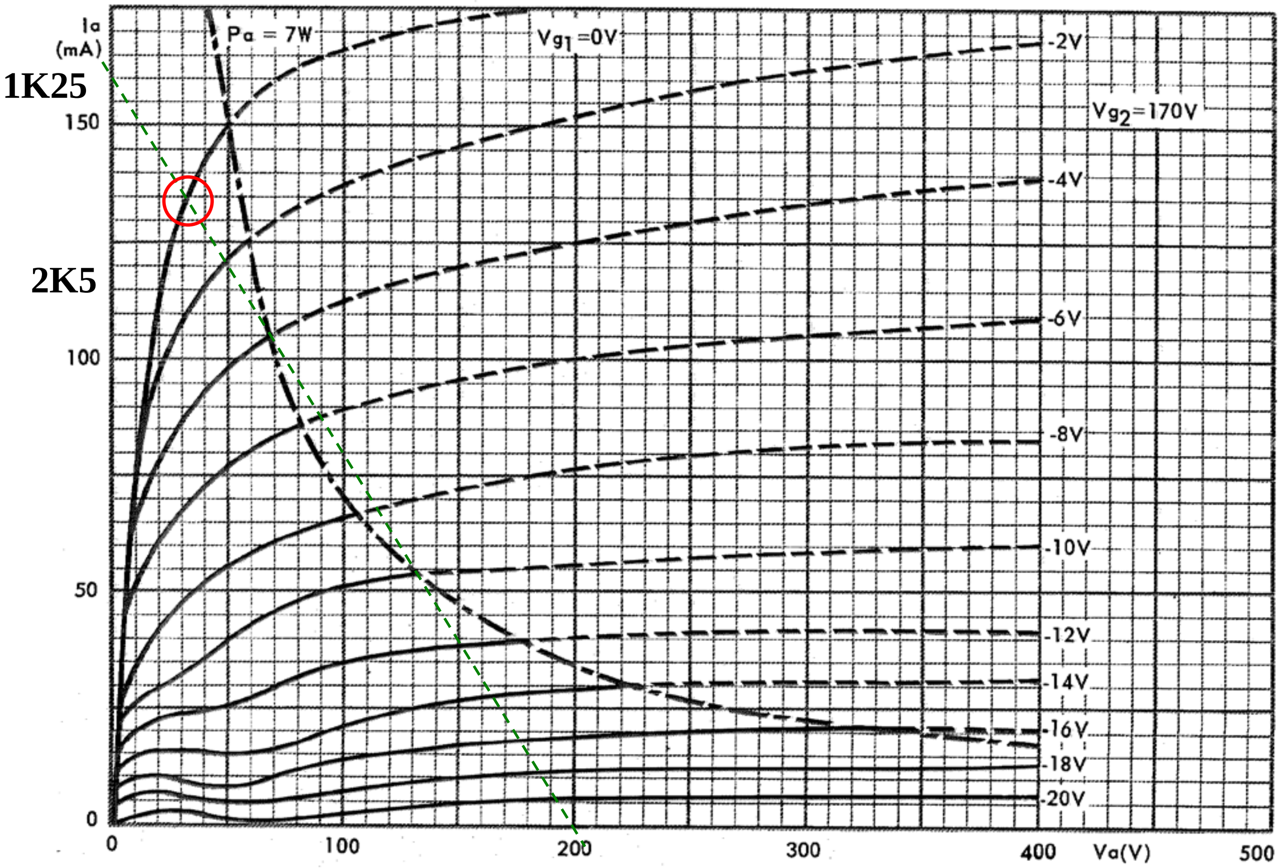
Screen voltage supply VS1 will vary from about 200V towards 170V under steady-state heavy load. Screen voltage lower than VS1 by ~ 35V due to the 270R stopper resistors at up to 50mA screen current per tube, and the 22V max cathode bias voltage. Peak screen power dissipation is then up to 50mA x 160V = 8Wpk, and about 200 x 0.008 = 1.6W average, which is a bit high.

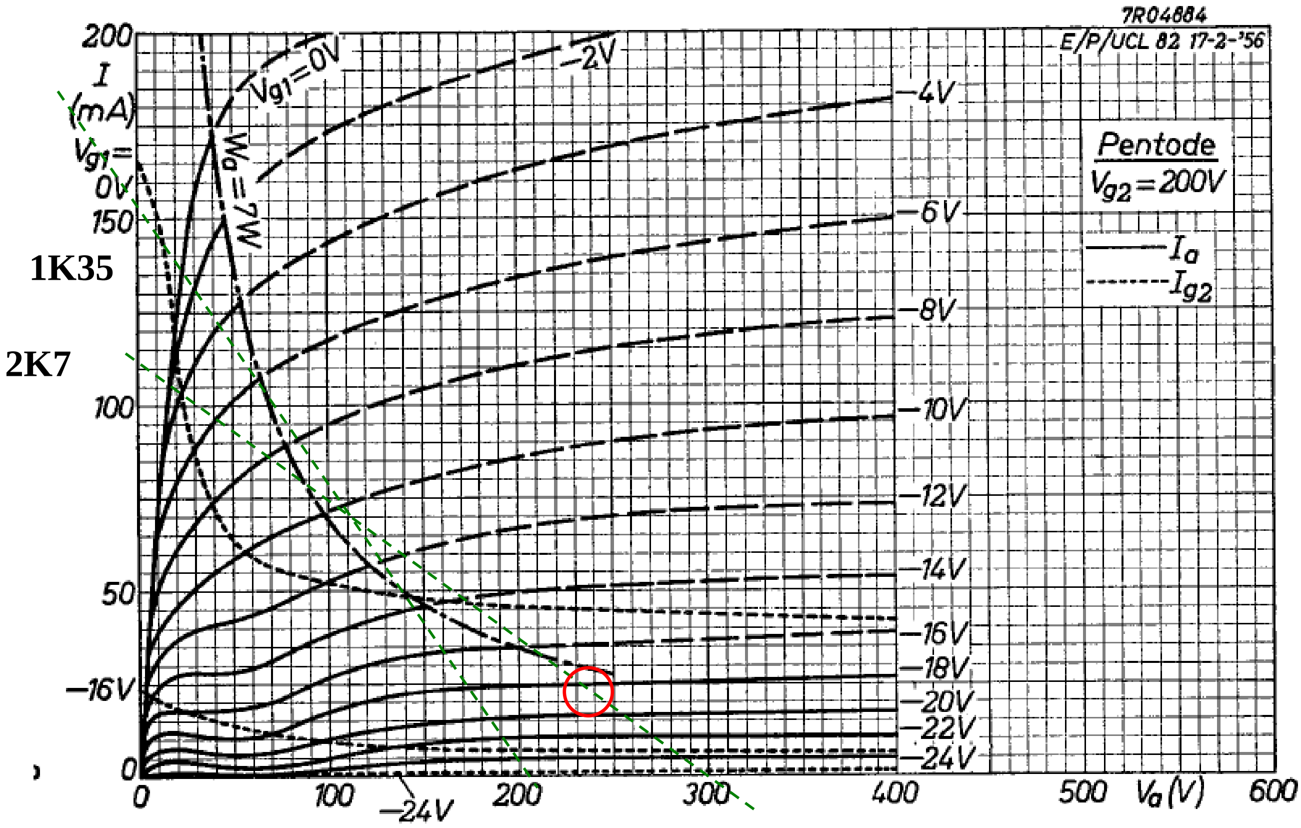
The maximum output valve bias current allowed is dependant on the maximum recommended plate dissipation of 7W, + 3.2W for the screen, for the 6BM8: Ibias(max) = Pd / Vb = 7W / (260-14V) = 28mA.

Assessing the 6BM8 plate curves, which shows the 7W constant power contour, indicate how the amp will dynamically exceed plate max design dissipation levels. Curves are for 170V and 200V screen level, with no compression influences, and the load lines are for 2.5K (5K P-P transformer push-pull) moving to 1.25K.

For a peak plate current of 130mA, then the nominal output power of the amplifier would be: $(Ipk)^2$ x Rpp / 8 = 0.13 x 0.13 x 5k / 8 = 10.5W. For this maximum signal condition, the rms OPT current draw is likely about 83mA (64% of peak), and the average VS1 power consumed is about 250x 0.083Arms =21W, and the OPT loss is about $(0.083)^2$ x 200Ω = 1W, and separate cathode bias loss is 0.5 x $(0.083)^2$ x 600Ω = 2W so the tube plates dissipate 21 - 10.5 - 1 – 2= 7W.

Cathode bias trimmed to 25mA nominal with 600R resistance and nominal 15V bias. Separate cathode resistances allow some trimming of each plate current – but no matching needed for existing valves. Although general comment is that common bias sounds better, the existing circuit format was retained. No limiting of the cathode bias voltage is used, and the bias shifts from 15V at idle to about 22V during gross overload.





3.4 Power Supplies

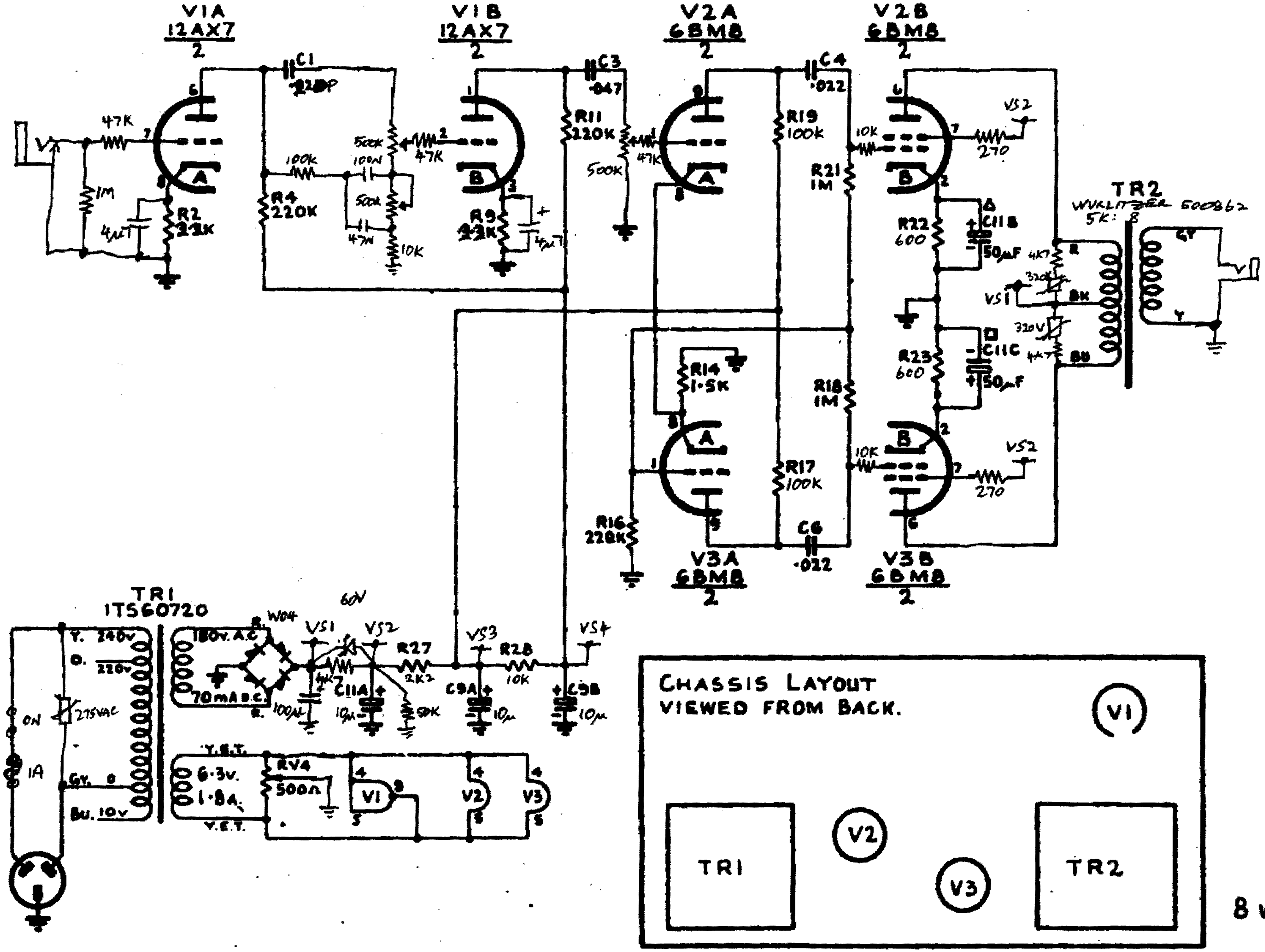
The full bridge rectifier circuit uses a 190V secondary HT winding. Only one 6.3VAC secondary is available for heaters. Heater loading is 0.3A + 2x 0.78A = 1.8A.

C11A is replaced with a 100uF 385V cap. Nominal idle load of 65mA at 235V. Max turn-on voltage of 265V no load. The ripple voltage of VS1 is mainly 100Hz, at a measured level of 2.2Vrms at idle (PSUD2 shows 4.5Vpp). No feedback used, so hum may be higher.

A 60V zener (30//30+30//30) added in parallel to the 4k7 dropper between VS1 and VS2 so that VS2 and lower supply rails sag at the same rate as VS1, rather than more abruptly when screen current spikes during overload. Nominal idle voltage difference between VS1 and VS2 is 50V.

Bridge rectifier with 65mA hot idle load on 250V VS1. Max anticipated continuous VS1 load current about 100mA, requires about 180mArms winding current. IEC60127-2 0.2A Time-delay fuse chosen.

Simulate period in PSUD2	20ms	40ms	100ms	500ms	continuous
Simulated RMS current	1.1A	0.84A	0.57A	0.3A	0.18A
Multiplier (based on 0.2A fuse rating)	5.5	4.2	2.75	1.5	0.9
IEC60127-2 Time-delay min limit multiplier	10	~7	~4.8	~2.9	1



SERIAL No

8 WATT AMPLIFIER
TYPE 1G59774
DRG. 59774C1
MODIFIED 2.