

## 1. Summary

AWA 8 Watt Amplifier Model PA774, S.N. A??97?. \$71 eBay Nov 2011  
Type 1G59774. DRG 59774C1.

### 1.1 Original design

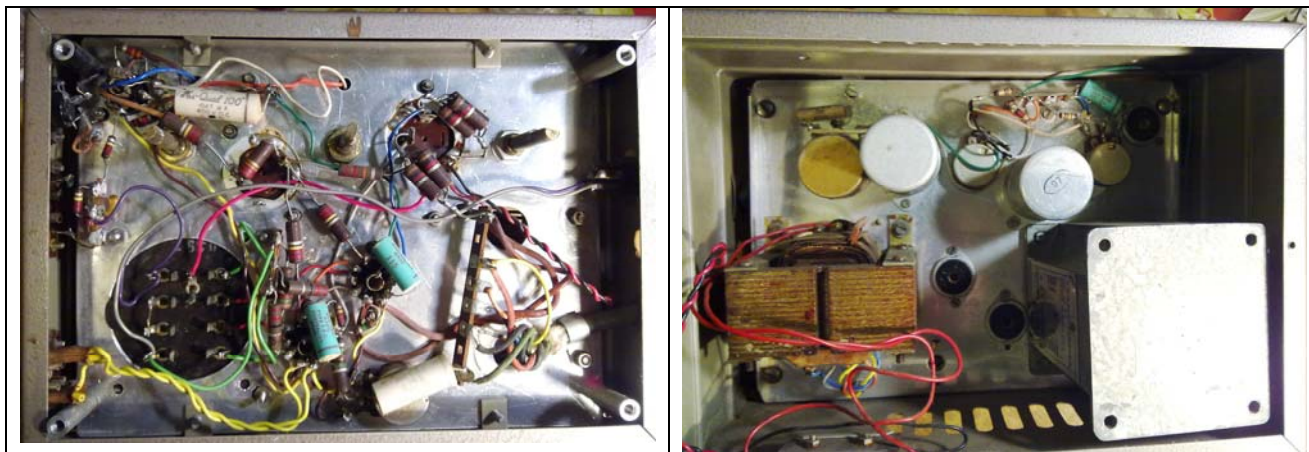
One microphone and one P.U. input channel PA amplifier. Half 12AX7 amplifier for MIC channel. PU input summing into half 12AX7 summing amplifier. 6BM8/ECL82 triodes for floating paraphrase splitter. 6BM8/ECL82 pentodes for PP output stage. Separate and bypassed cathode biased push-pull 6BM8 output, with 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) replacement – UL taps direct to 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 was replaced. A&R OT916 is not well matched to 6BM8, and too hi-fi, and weight is buckling plate, and is over-powered. Replace with Wurlitzer 500862 OT – 6k6 to 15 ohm, about 20-30W rating – size is fine – low-fi.
- Bridge diode is weak/prone to fail. Replace with W04.

### 1.2 Modified Design for Guitar Amp use

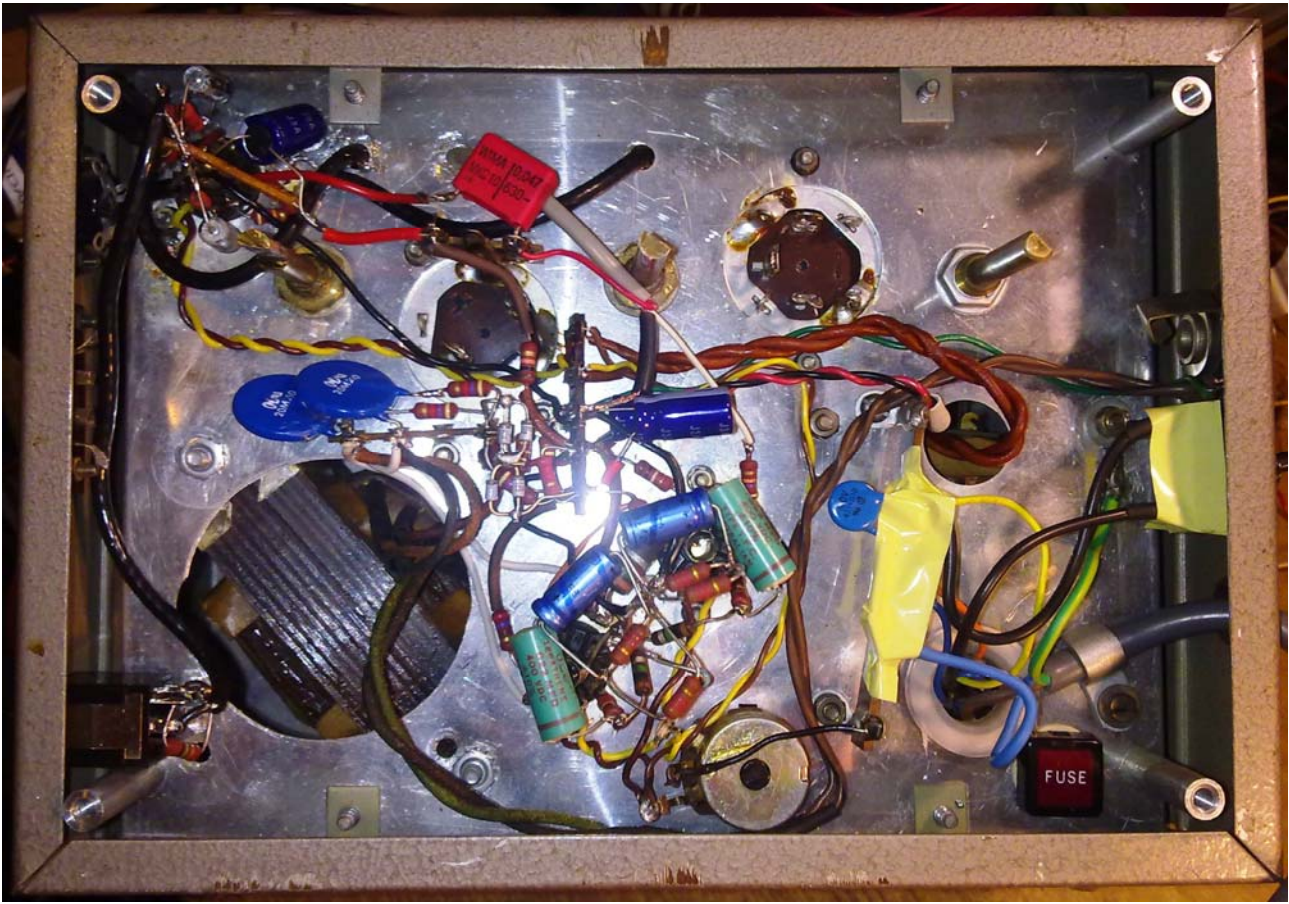
Inputs reduced to just one guitar input – isolated 6.5mm socket with tip grounded; changed R1 to 1M and 47K grid input added; added 4.7uF bypass across R2 and R9; R2 and R9 changed to 2K2. 47k grid stoppers added to V1B and V2A. R18 and R19 changed to 100K. PU circuitry and summer removed. Fender tone stack added with treble and bass pots using existing 500K, and 10K mid setting used. MIC VOL pot moved to V2A input – use with guitar VOL pot to control level in 12AX7 input stages.

Replaced AC cable. AC fuse and switch added, with 275VAC MOV across PT primary. Added new W04 bridge rectifier and 100uF 385V cap for main filter. Added 4k7 and 10uF filter with 50k loading for VS2 to pentode screens, with 60V zener across dropper to maintain screen voltage during overdrive. Reduced dropper R to 2k2 and 10k to get VS3 and VS4, to keep rails high. Heater DC elevation removed from humdinger pot.

270R screen stoppers and 10K grid stoppers added to output pentodes. Added MOV-R across each primary half winding with 35kHz corner frequency. 6.5mm phono socket for 8 ohm output.

#### To do:

- Check operation with guitar.
- Take measurements with normal mains.
- Reduce screen stoppers from 270 to 100R.
- Perhaps try with soft clamping of pentode cathode bias using say an 16V zener and 270R series resistance to give similar 37mA at 18V.



## 2. Measurements

Modified amplifier.

Rail	Idle	Clip
VS1	250	
VS2	200	
VS3	190	
VS4	180	
Heater 1		
Sec HT		

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;

Output transformer primary DC resistance: 147, 200Ω plate B+ plate.

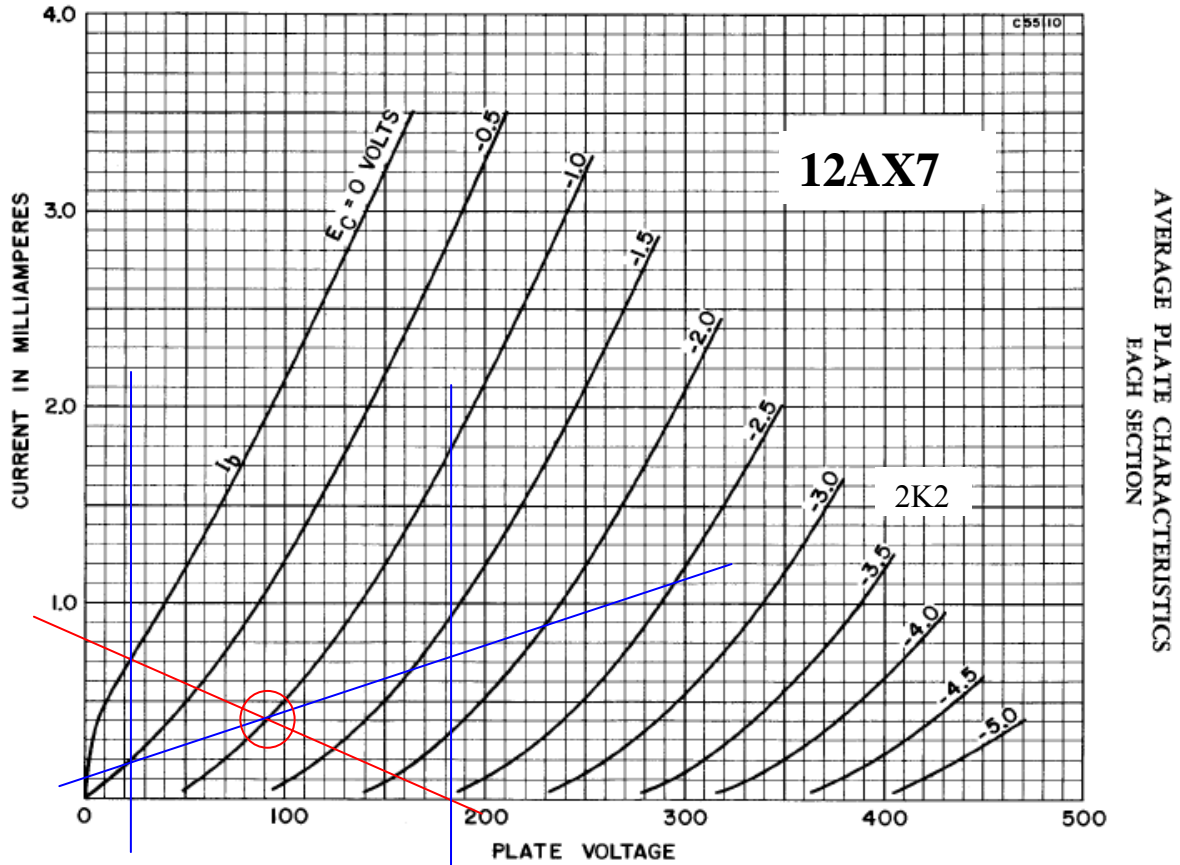
Power rating: looks like about 15-25W given 7868 datasheet for PP output stage.

Output starts clipping above about 2W, and overdrives gracefully to 8W output. Pentode cathode bias gets pulled high from about 15V to 22V.

### 3. Design Info

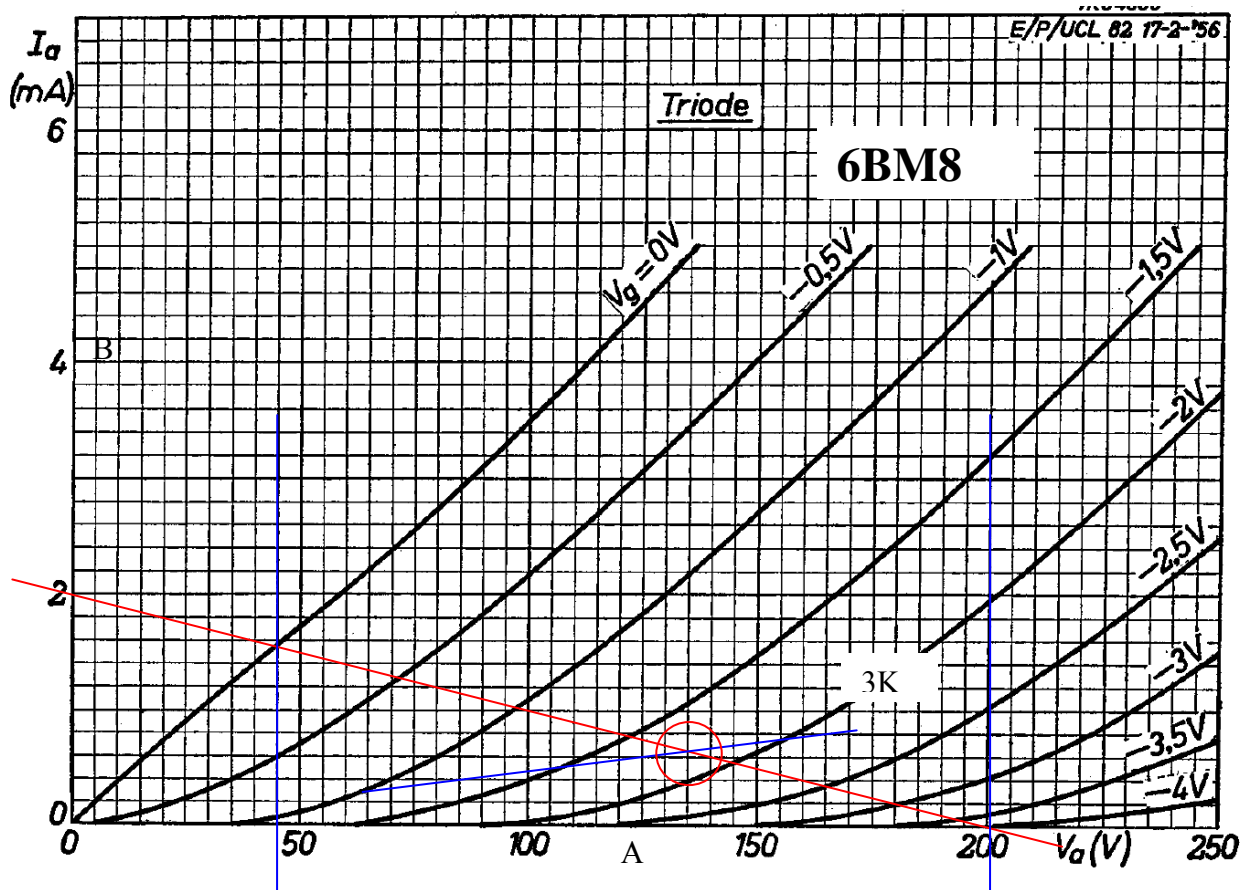
#### 3.1 Input stage – 12AX7 - modified

For the first half 12AX7, V1A: plate voltage  $V_p = 180V$ ;  $V_a=90V$ ;  $R_k=2k2$ ;  $V_k=1.0V$ ;  $I_a=0.4mA$ ;  $R_{Ldc}=220k$ . 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 5K $\Omega$  impedance plate-to-plate OPT presents each pair of tubes with a 1.25K $\Omega$  load impedance (with a matched secondary load) for signal currents in Class B region, and 2.5K in Class A region.

Determining a suitable bias current level is not an empirical design approach, rather it is based on the following recommendations:

- Start with the lowest bias current possible (ie. most negative grid bias voltage), and based on listening tests, increase the bias current until the sound character is acceptable, but:
- use the lowest possible bias current level, as this generally increases the life of the tubes, and decreases the chance of operating at excessive plate dissipation; and
- keep the bias current level below 70% of the recommended 7W design max plate dissipation (ie. <5W); and
- assess the dynamic loadline to see if it moves into region of increased plate dissipation.

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.

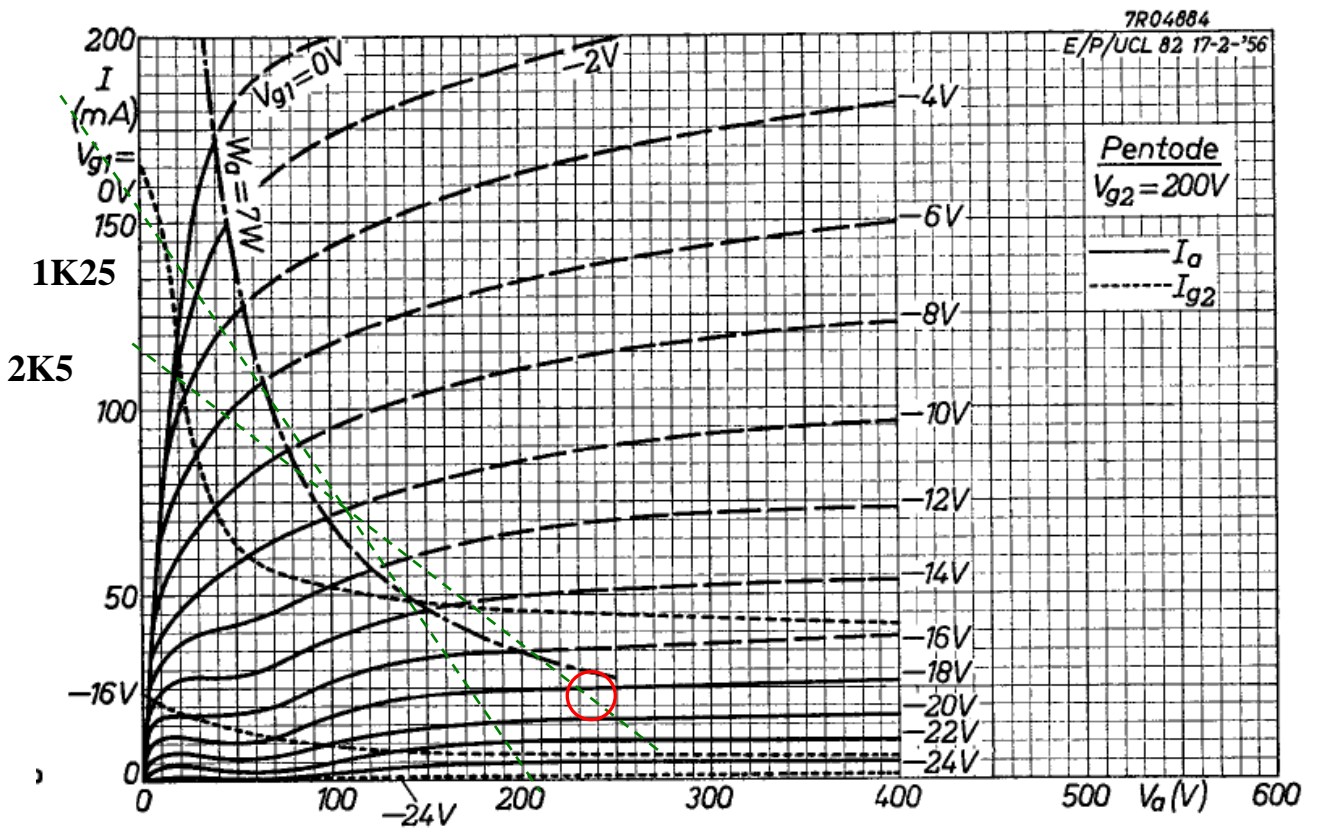
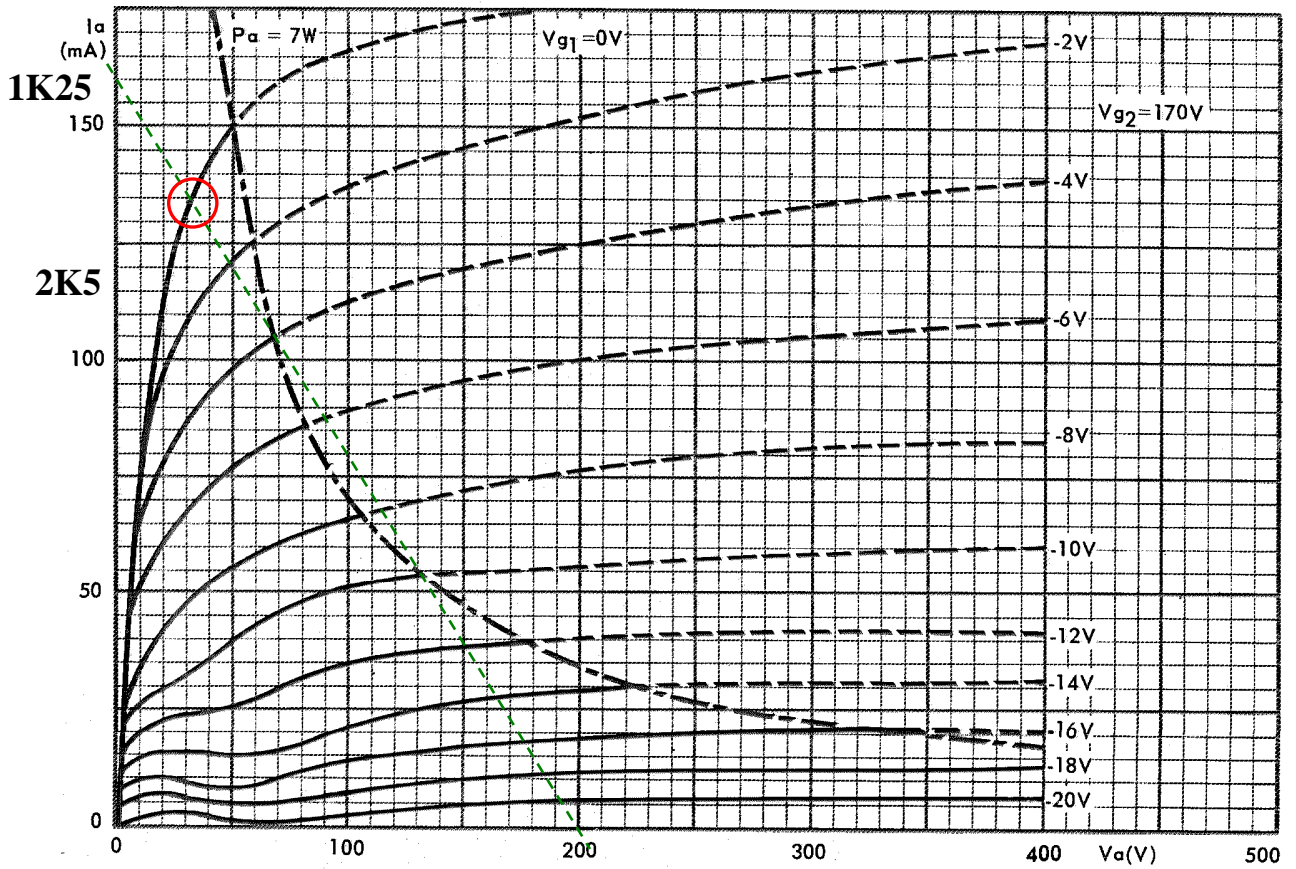
Screen voltage supply VS1 will vary from about 200V towards 170V under steady-state heavy load. Screen voltage lower than VS1 by ~35V due to the 270R stopper resistors at up to 50mA screen current per tube, and the 22V max cathode bias voltage. Peak screen power dissipation is then up to 50mA x 160V = 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:  $I_{bias(max)} = P_d / V_b = 7W / (260-14V) = 28mA$ .

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:  $(I_{pk})^2 \times R_{pp} / 8 = 0.13 \times 0.13 \times 5k / 8 = 10.5W$ . 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  $250 \times 0.083A_{rms} = 21W$ , and the OPT loss is about  $(0.083)^2 \times 200\Omega = 1W$ , and separate cathode bias loss is  $0.5 \times (0.083)^2 \times 600\Omega = 2W$  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.



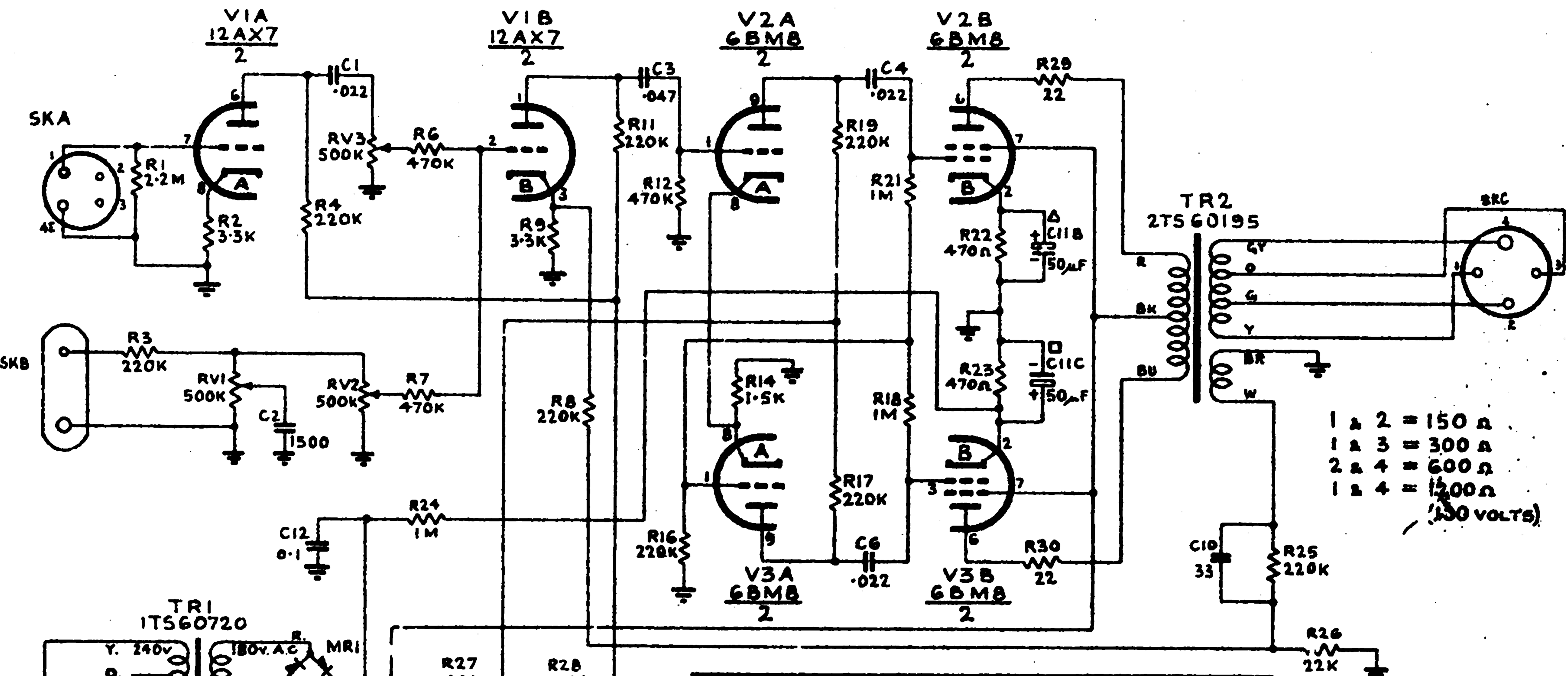
### **3.4 Power Supplies**

The full bridge rectifier circuit uses a 200V secondary HT winding. Only one 6.3VAC secondary is available for heaters. Heater loading is  $0.3\text{A} + 2 \times 0.78\text{A} = 1.8\text{A}$ .

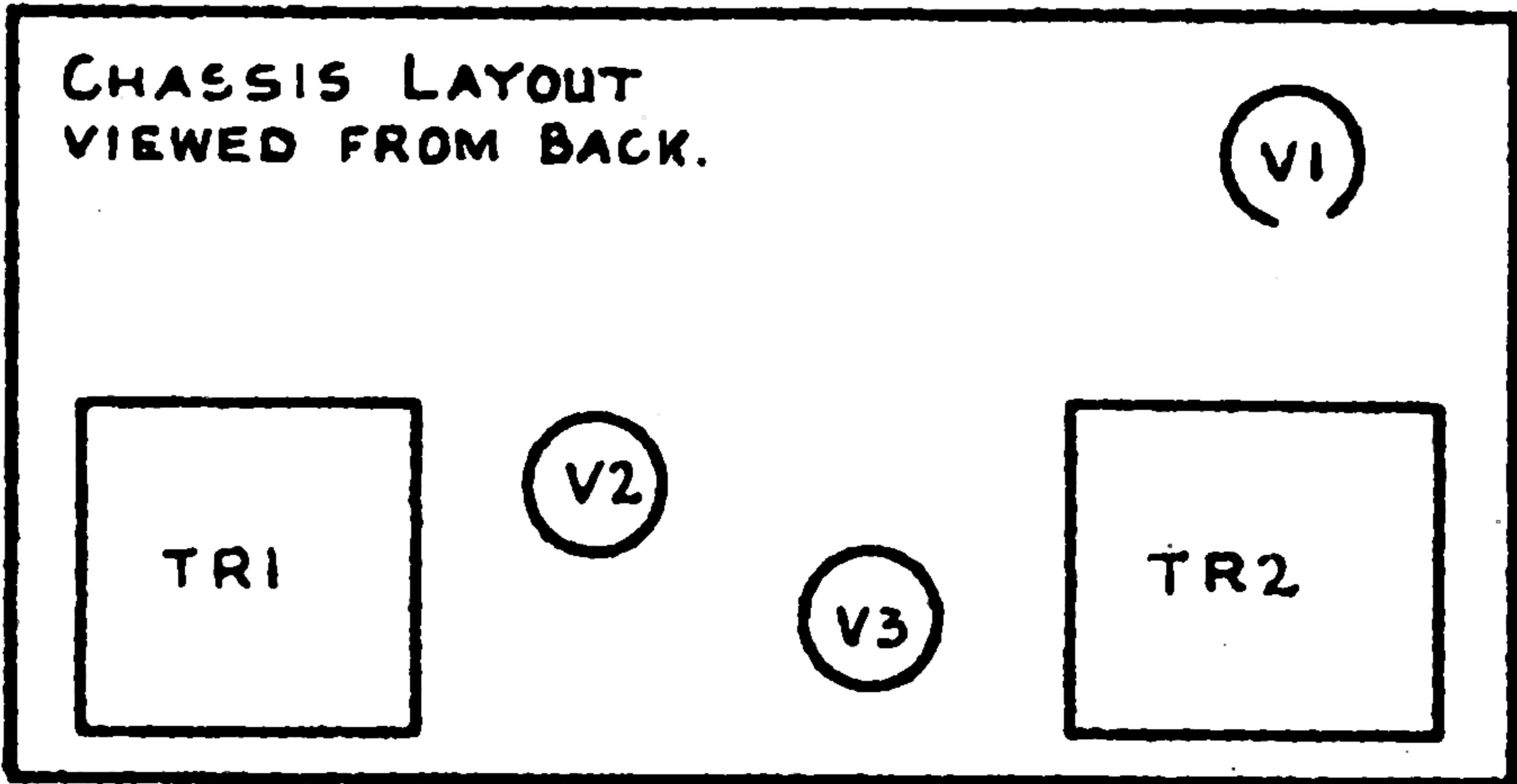
C11A is replaced with a 100uF 385V cap. The ripple voltage of VS1 is mainly 100Hz, at a measured level of 2.2Vrms under no load.

A 60V zener parallels 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 as screen current spikes during overload.





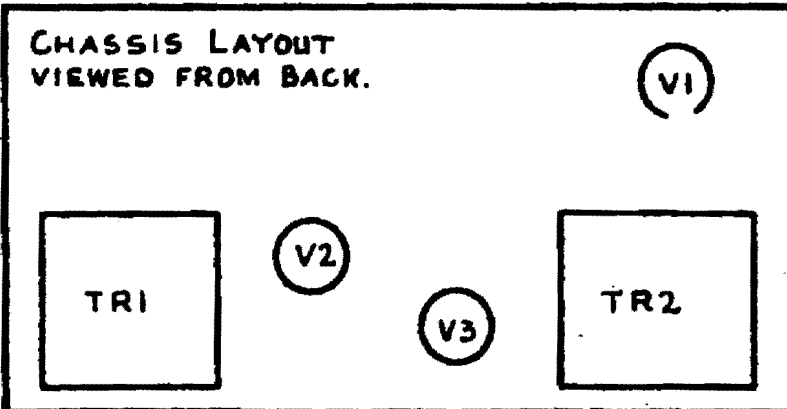
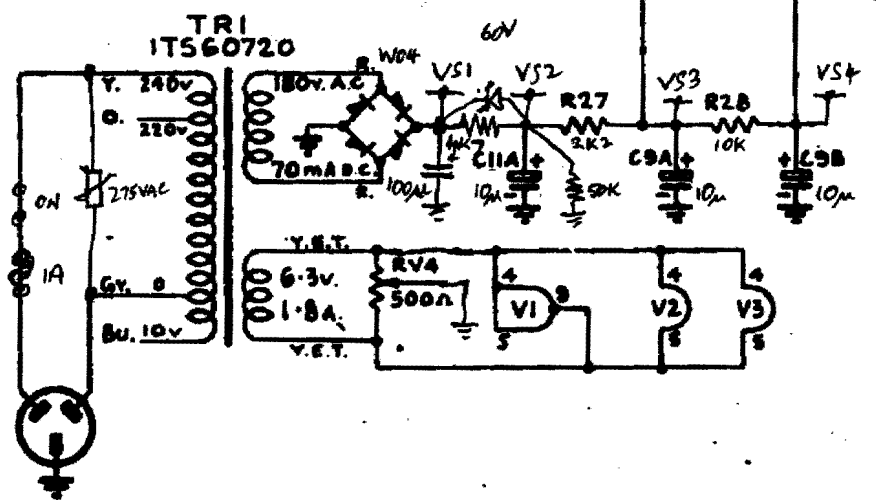
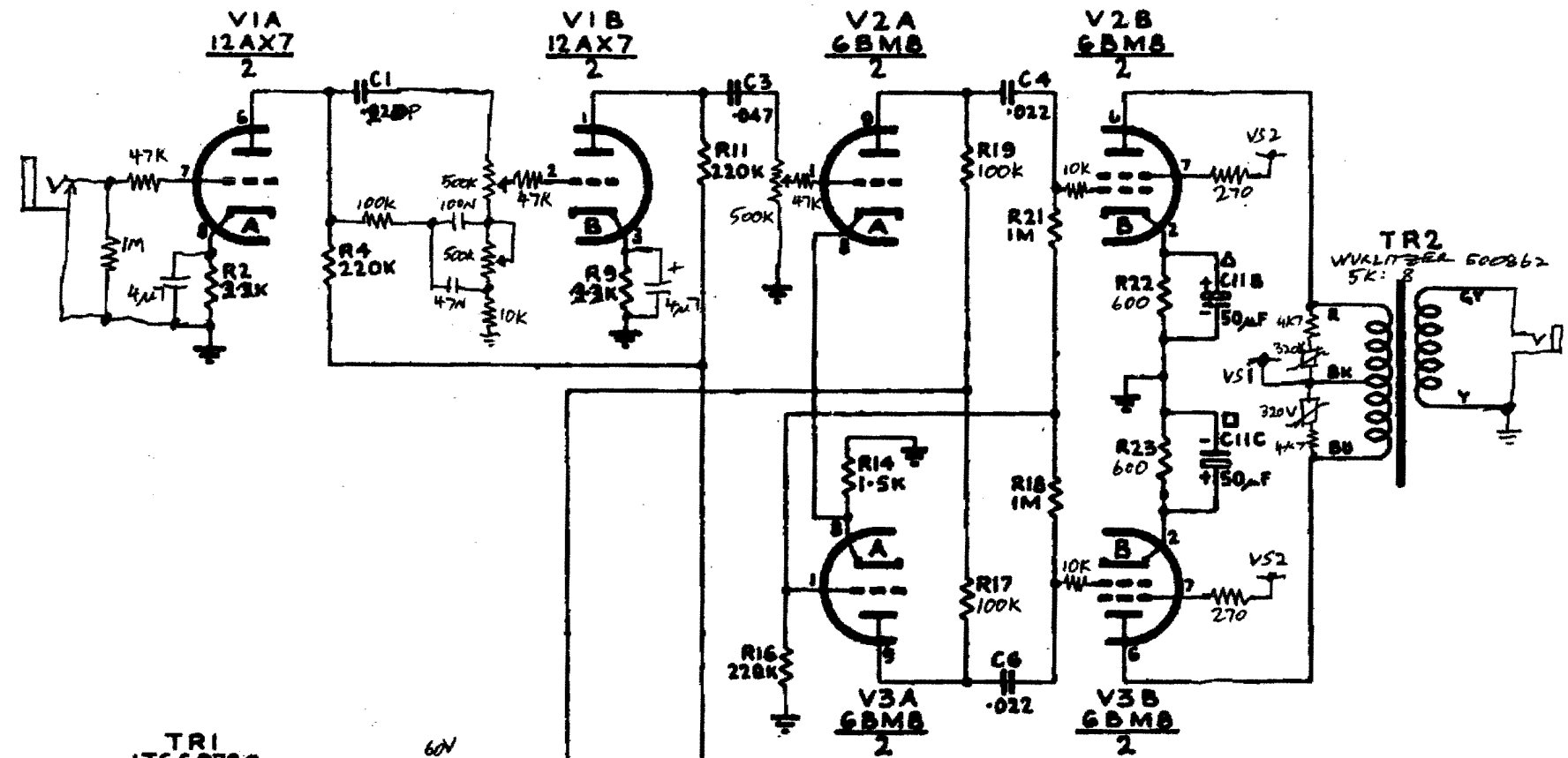
1 & 2 = 150 Ω  
 1 & 3 = 300 Ω  
 2 & 4 = 600 Ω  
 1 & 4 = 1200 Ω  
 (150 VOLTS)



SERIAL N<sup>o</sup>



**8 WATT AMPLIFIER**  
 TYPE 1G59774  
 DRG. 59774C1



SERIAL NO

8 WATT AMPLIFIER  
TYPE 1G59774  
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MODIFIED. 2.