1. Summary

AWA 1G8241 12W valve amplifier. S.N. 807.

P.U. Volume and MIC Volume front panel pots. Stepped switch tone control. MIC input with 50 / 200Ω configuration switch to MIC transformer primary. Rubber grommet isolated mount for 6J7 pentode preamp to MIC volume pot to 6L7, with MIC transformer secondary input and plate feedback. 6J7 triode PU preamp to PU volume pot to 6L7. 6L7's in Barne's phase inverter with fixed biased inputs and common cathode resistor, and screens bootstrapped to PP plates. 6V6 common cathode biased PP stage with screens connected to B+. Tone circuitry connected between 6V6 grids, and between PI screens.

Mains fused both poles. 2 non-synchronous 12V vibrators, with switch-over to use one or the other vibrator, with standby positions to remove 12V to push-pull CT and hence HT supply. 12V heater configuration. 6V indirectly heated diodes. 200Ω/2k7Ω fixed humdinger. Three RC supply filters.

Output Transformer	AWA Type 1TJ6997 12W nominal 6.75KΩ PP 6 output winding sections 0, 50Ω, 150Ω, 167Ω, 194Ω, 250Ω, 600Ω.
Power Transformer 1	AWA Type ITK14198. 0-110-220-240V; 335-0-335V @ ?mA ; 12V ?A; 8-0-8V ?A.
MIC Transformer	1TW14012. 50Ω, 50Ω, 70kΩ windings. 8-pin octal. Can and earth screen connections.
POTs	IRC. IRC PF5
Resistors	Old dot-style tube; old spray coloured cc; IRC WW 61 15
Caps	Ducon electro can & tube; UCC electro can 35, 35, 35 Ducon wax high seal red 266 AWA black wax with outside foil text and band; Simplex brown mica
Vibrator	V5123 Oak branded AWA; 12V 4A 100Hz non-synchronous 046
Valves	6V6GT x2: Miniwatt 21 TB, Miniwatt 5 QB 6J7 x2: can style KG, can style RCA 59EX9 H5 6K7 x1: can style RCA 8C 278 A K1 H 6L7 x1: can style Philips X5 6X5GT x2: Radiotron 22 GC, Radiotron 22 GC

Good general condition – unrestored, but with at least 2 caps and some resistors changed/added. No top chassis cover. Appears to have been painted. Mostly old dot-style tube resistors. Bent tab style bell-end mounting for OT. Top-cap grid wiring and some other wiring brittle. Likely all 6J7 originally.

Issues: All wiring old and brittle, including transformer lead-ins. Foil caps cracked. Burnt 50Ω humdinger resistor. 12VAC heater winding only so need to use pairs of same valve. High B+ for 6V6 even with 6X5 and cathode bias. 450VDC max HT limit from diodes, which may be exceeded for hi mains and no valves. Modified filter caps to give 64uF input filter on diodes. Compact layout of valves required metal preamp tubes. No benefit from Barnes mixer/PI if only single guitar input used.

Options:

- ss rectifier would provide 390Vdc at 100mA idle.
    - B+ too high for 6V6 PP.
    - 2x 1625: have 12V 0.45A heater so 0.9A – special 7-pin socket needed – insufficient width and possibly height – unsure of performance/balance.

    - 2x EL34: heater increases to 1.5A (so extra 1A) – may have to rotate base – design for lower PP impedance than 6k7.
    - 2x 7868: heater increases to 0.8A – different socket – separate fixed bias balancing. 4x stock and 6x sockets.
        - Extra 0.35A loading on heater alleviated by not using 2x 6X5 (0.6A).
        - Octal socket hole has indent – new socket needs mod added to align with pin 4 (best orientation for anode radiation, and pin 9 is anode).
        - Idle OPT primary winding loss in 173Ω increases from circa 0.3W (40mA) to circa 0.85W (70mA).
- 8-0-8V vibrator winding would provide fixed bias for output stage, or additional 20V for B+, or extra heater options for different output stage valves.

Target:

- Replace 2x 6X5 with ss rectifier to give higher B+ and allow higher heater current for PP stage valves.
- Replace octal 6V6 cathode biased PP with 9-pin 7868 fixed bias PP
- Use 8-0-8V vibrator supply for output stage fixed bias.
- Replace two signal inputs with one guitar input, using lowish gain pentode input stage.
- Use MIC and PU vol pots for sequential gain stages, and replace tone switch with dual tone pots, and replace Vibrator switch with Master vol pot for post PI MV.
- Replace power inputs with IEC fused/switched combo, and replace output connectors with single Speakon connector.

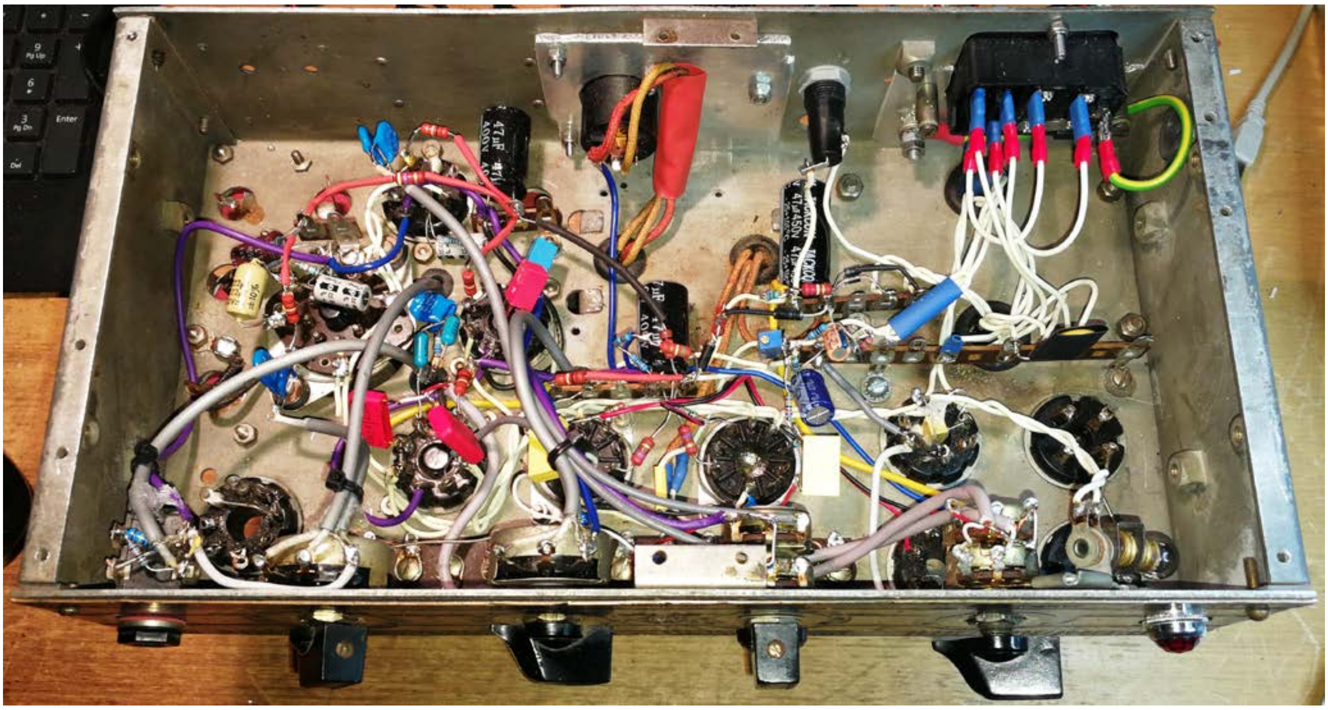


2. Modifications

- Restored power transformer: all wiring replaced; vibrator windings not used (but could be used to boost or buck the primary winding); primary windings connected in series for 240V.
- Added mains IEC fuse switch combo to custom add-on plate on rear.
- Added 275VAC MOV on power transformer primary
- Added PT secondary CT fuse.
- Added UF4007 ss full-wave rectifier, with 450V 47uF B+ cap.
- Added 2x series 22V 5W Zener dropper plus series 1k2Ω for VS2 (screen supply) to reduce VS2 to 350V and allow 400V e-caps.
- Added 270Ω 2W screen droppers and 10Ω cathode sense to V5, V6.
- Removed Phono input circuitry. Modified MIC V1A stage with 1M leak and 10k stopper. Reduced R6 from 220k to 100k.
- Added 620Vdc 1mA MOV (S05K385) across each primary half of output transformer.
- Added 10Ω cathode current sense to V5, V6.
- Add Speakon socket to custom add-on plate on rear A (allow room for 2x), and re-wire OPT secondary to just extend A, B, D for either 8 or 16 ohm, and use them for feedback if needed. Coiled un-used OPT secondaries inside base of Tx (C, E, F, G).
- Speaker connected across (A) 150Ω to (D) 250Ω winding section, and the 150Ω tap is grounded. Speaker loading aimed at 16Ω for 9.2kΩ PP.
- Replace 50/200 ohm MIC switch on front panel with insulated input socket.
- V1 – V3 set up for 6J7 pentodes with top-cap input grid.
- Bias adjustment with 1k trimpot for VS6.
- Using spare 6X5 socket for maintenance octal.
- Reconfigured grounding – distributed star with power point to chassis.
- Cleaned MIC and PU pots (minor scratchy portions)
- V4 set up for 6J5 (only had 1x good 6J5).

To do:

- Rejig tone.



3. Measurements

Megger tested 1kV on all PT winding and OT primaries – 1.2G mains to gnd; >2G others.

Primary 242V: DCR = 15+15+3Ω.
Secondary 340-0-340V, DCR = 200+217Ω ; 8.0-0-8.0V ; 13.7V (+9%)
13.7V O/C heater DCR = 280mΩ for ~ 2.0A rating (1.1W).
8.0-0-8.0V O/C vibrator DCR = 670mΩ so likely 1.3A capability (for 1.1W dissipation)

Rail	245Vac mains; idle 0.42A	Cranked 0.46A; 23W
VS1	375V (446V turn-on max); 4.5Vrms	355V
VS2	306V (387V turn-on max); 0.125Vrms	261V
VS3	266V	
VS4	259V	
Cathodes	49 + 49 mA (18W each)	54+68mA
Heater	12.35Vrms	

AWA 1TJ6997 output transformer

Winding	Voltage rms	Turns ratio; Impedance for 6.75K pri; Spec level; DCR
Pri P-P:	32.7+32.4	
Sec: F to G tan	19.35	3.35; 601.9Ω; 600Ω; 1000T 14.5Ω
Sec: F to D tan	12.25	5.29; 241.2Ω; 250Ω; 633T 7.3
Sec: F to C dark	10.98	5.90; 193.8Ω; ; 567T 7.2
Sec: F to B tan	10.18	6.37; 166.6Ω; ; 526T 7.1
Sec: F to A red	9.66	6.71; 150Ω; 150Ω; 499T 7.0
Sec: F blk to E tan	5.56	11.65; 49.7Ω; 50Ω; 287T 3.6

Output transformer primary DC resistance: 173Ω + 173Ω
Secondary winding sequence: F to E to A to B to C to D to G. D-G DCR=6.2

6V6 PP with screen= B+=285V indicates 8kPP primary (119% of 6k75).
The winding section between B to D is effective 6.9Ω, with 11% of secondary turns. An 8 ohm loading presents 8.2k PP.
The winding section between A to D is effective 10.9Ω, with 13% of secondary turns.
The winding section between A to E is effective 27Ω, with 21% of secondary turns.
Feedback could be taken from A or E, with B grounded, or alternatively from G, with D grounded.

Input transformer 1TW14012. ES=6; can=3; 50Ω=2-7, DCR=5.3Ω; 50Ω=4-8, DCR=5.3Ω; 70kΩ=1-5, DCR=1k75Ω. 20mVac on either 2-7, or 4-8, generated 730mV on 1-5, and 19.43mV on the other winding, to give a 37.6:1 voltage ratio and 70kΩ output impedance.

Overload levels:

- 1st stage has soft curving of one side up to 45Vrms on MIC pot top, then more defined soft clipping of one side
- 2nd stage clips on one side above 3.2Vrms input on MIC pot wiper, or 45Vrms on PU pot top
- Tone/PI stages clip on other side above 33Vrms on MV pot top for red side, or 3.2Vrms on PU pot wiper. White side of MV pot clips at above 22Vrms
- All pots max; onset of output clipping 13Vrms (10.7W), with input 0.6mVrms
- Max cranked output abt 19Vrms (24W)

Output noise:

- All pots min: 1.7mVrms (50Hz)
- MV max, others min: 76mVrms (100Hz then 200Hz)
    - 31mV with PI input disconnected
    - 33mV with PI input disconnected and 680k leak shorted.
- MV max, PU max, MIC min: 63mVrms
- MV max, PU max, MIC min: 2.3Vrms (100Hz then 50Hz)
- Screen dropper of 2x Zener and added 1k2 series.
- VS1 = 350Vdc 4.0Vrms (43+43mA) ; VS2 = 285Vdc 105mVrms.
- V1 6J7 has some noticeable noise.

4. Design - modified

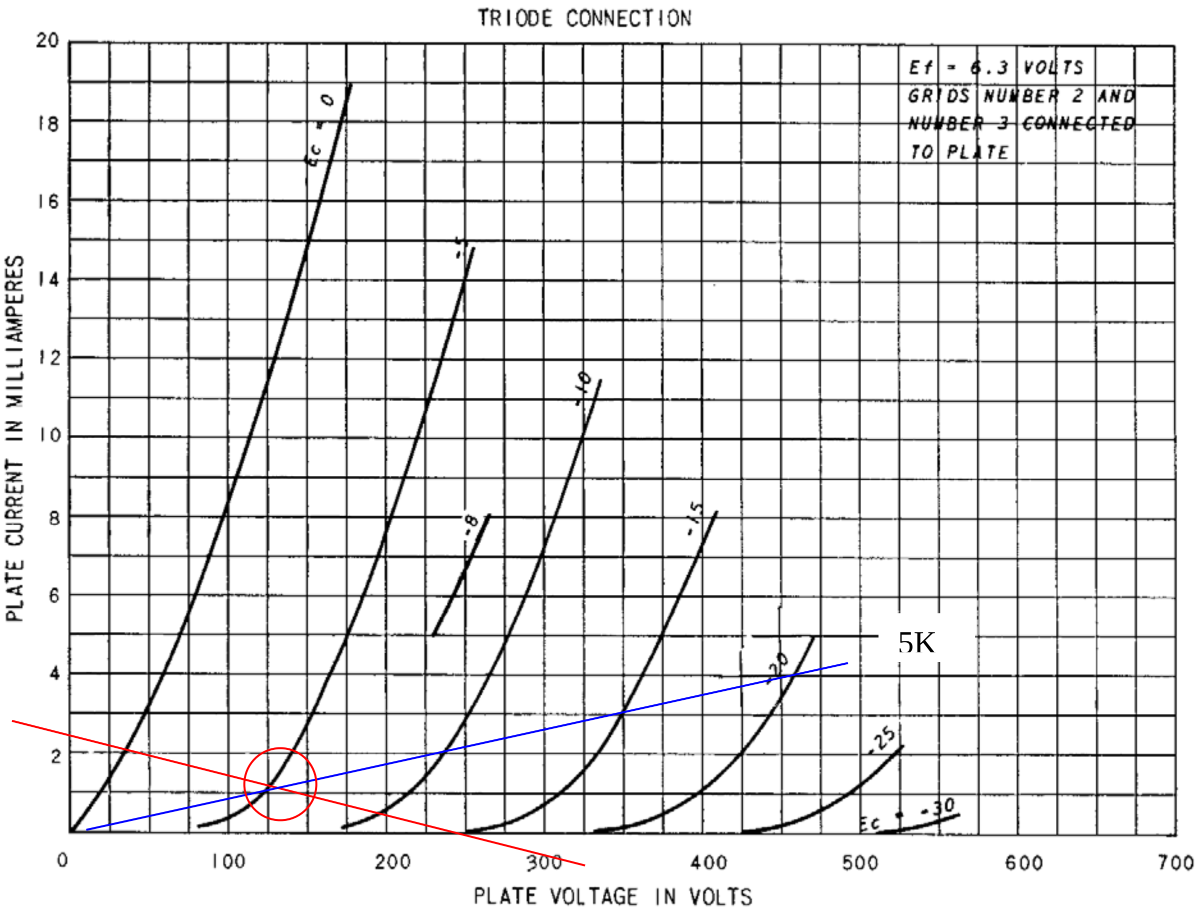
4.1 Input pentode stage – 6J7 pentode

6J7, V1, VS4 ~ 237V; 100k Plate ~ 141V (anode current ~ 0.96mA); 470k Screen ~ 110V (screen current ~ 0.27mA); cathode=4.7V; 3k9=1.2mA.
Using pin 6 as local star ground node. Voltage gain x57. 122mVin for 5% THD output. -3dB 105Hz to 22kHz MIC pot min, reducing to 13kHz with MIC pot max (note: MIC pot top voltage of 1Vrms with Keithley, but Keithley then disconnected for spectrum tests as it loads the HF response).

- V1 could also use 6K7, 6L7 as screen voltage is low enough.
- V1: 6J7p=141V, scr=109V ; 6L7p=181V, scr=41V ; 6K7p=100V, scr=77V

4.2 Input triode stage – 6J7 triode

6J7, V2; VS3 = 242V; Va=126V; Rk=4k7; Vk=5.5V; Ia=1.16mA; RLdc=105k. 1% THD at 14.4V PU pot top. Stage voltage gain x16.4.
-3dB 110Hz to 13kHz MIC pot max and PU pot min, and same with PU pot max (note: PU pot top voltage of 5Vrms with Keithley, but Keithley then disconnected for spectrum tests as it loads the HF response).



4.3 Tone triode stage – 6J7 triode

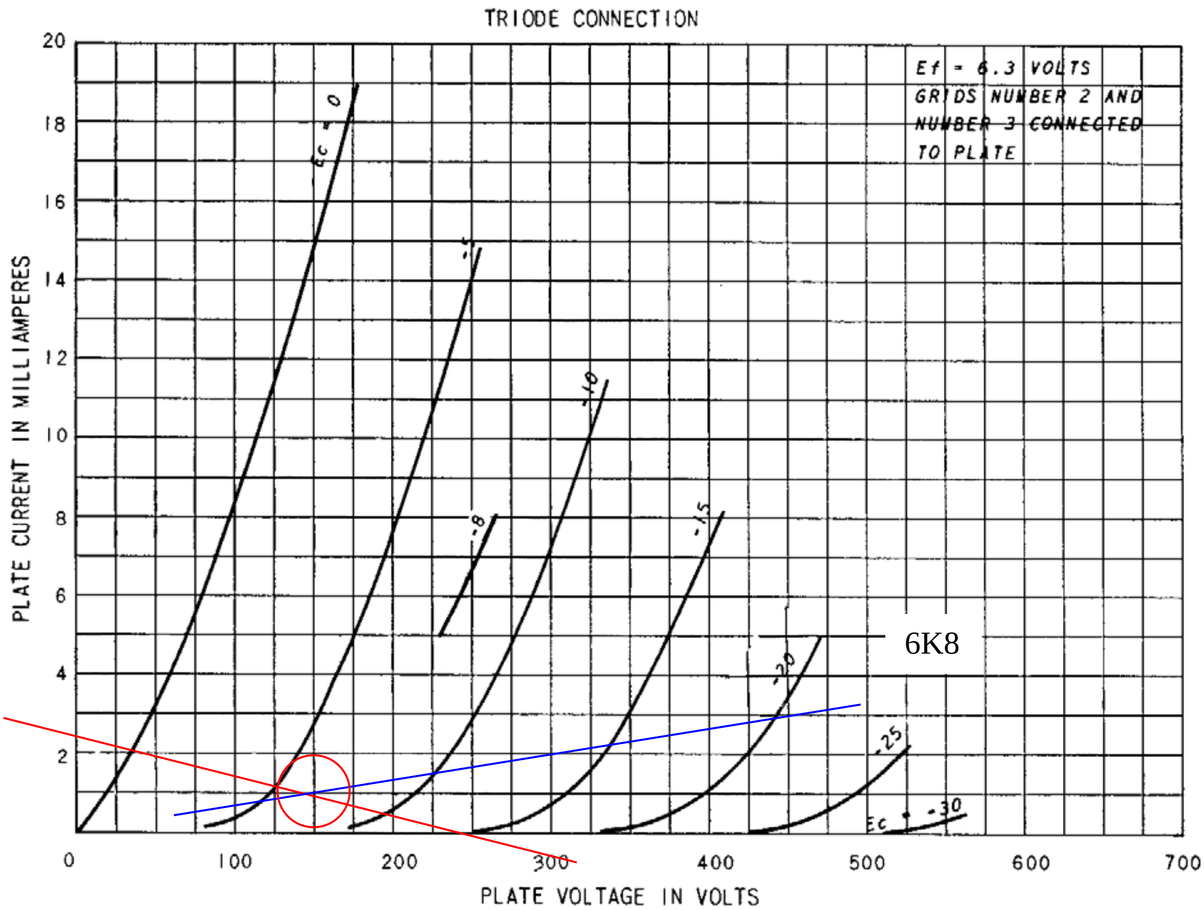
6J7, V3; VS3 = 242V; Va=142V; Rk=6k8; Vk=6.8V; Ia=1.0mA; RLdc=100k.

The cathode bypass will transition the mid-band gain from about 20x100k/(100k+8k) = 18.5 down to about 20x100k/(100k+8k+21x6k8) = 8 (ie. -7dB) from about 50Hz for 1uF. A tone pot section in series with the bypass cap would both raise that corner frequency and reduce the LF attenuation, so an additional 100nF bypass cap allows mid-band gain to increase even when the pot is at max.

A tone pot section can also be used to load the anode resistance and hence attenuate treble

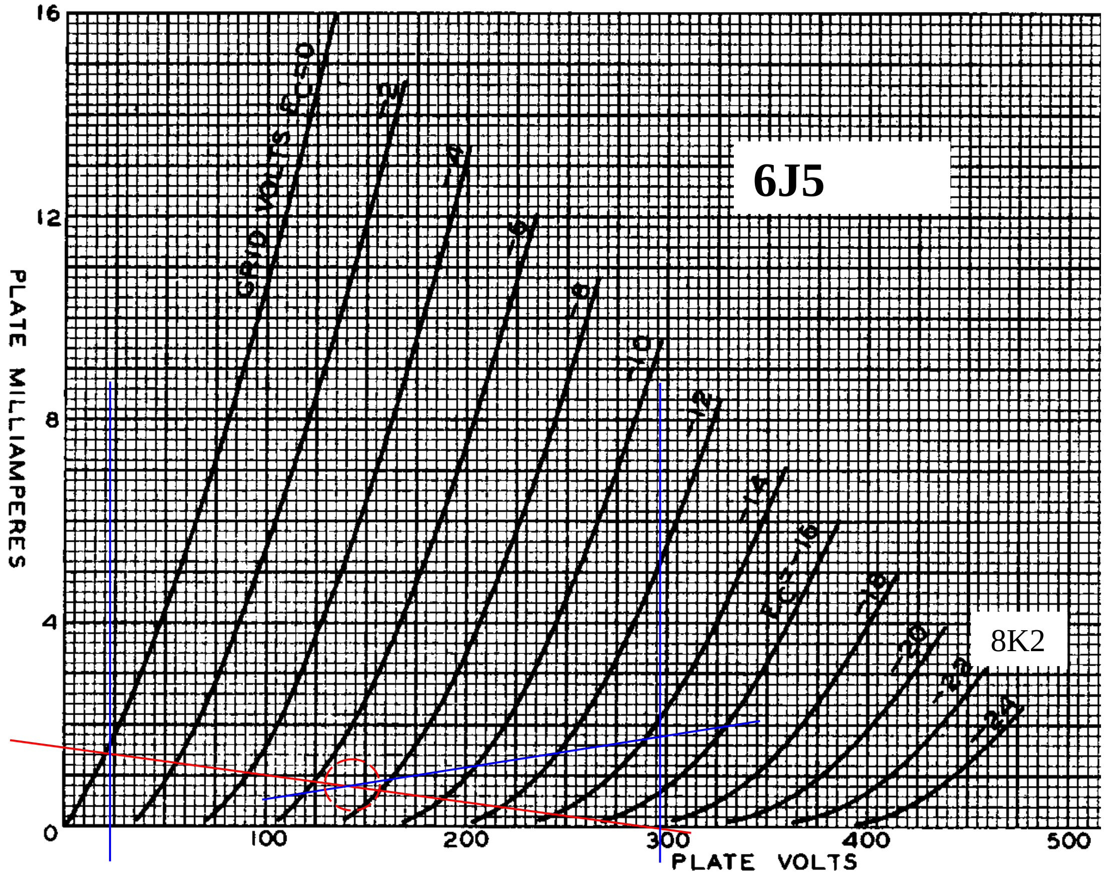
Output frequency spectrum (-3dB at 1W) with MIC pot mid and PU pot mid:

- Tone pot min = 130Hz to 8kHz
- Tone pot mid = 400Hz to 11kHz
- Tone control max = 400Hz to 12kHz



4.4 PI stage – 6J5 triode

6J5, V4; VS3 = 250V; Va=179V; Rk=8k2; Vk=74.5V; Ia=0.68mA; RLdc=208k.

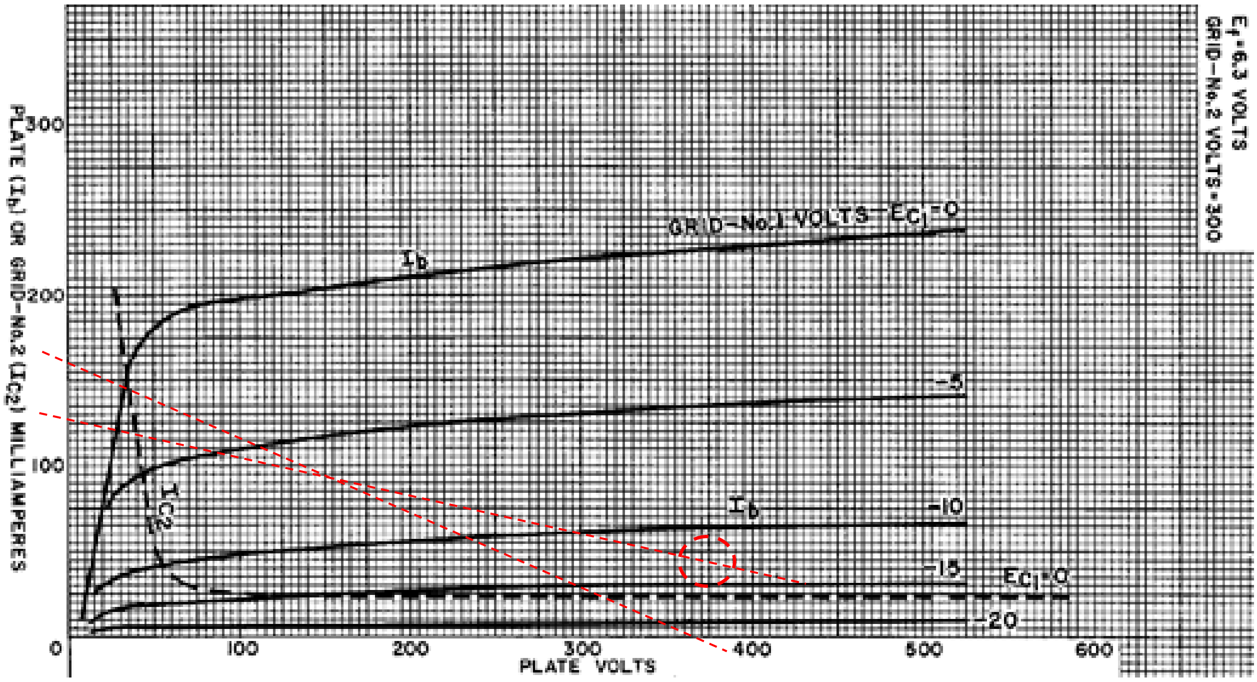


4.5 Output PP fixed bias stage

The max design output valve bias current allowed is dependent on the maximum recommended plate dissipation of 22x0.8 = 18W for 7868: Ibias(max) = Pd / Vb = 18W / 385V = 47mA.

Va reduced from VS1 by about 8V by OPT primary winding DCR.

With nominal 6.75kΩ PP, the secondary winding (A to D) presents 10.9Ω. The 7868 datasheet indicates max output (400V Va, 350Vscreen) from about 6.2k to 10k PP impedance, with distortion rising above 8kΩ PP. A nominal 15Ω speaker would present 9.3kΩ PP loading and seems a reasonable compromise.



7868 plate curves for 9k3 PP loading.

4.6 Powering

V5123 vibrator: larger pins 1,4 are for reed and coil connections. Smaller pins 2,3 are the primary contacts asynchronously connecting to the reed. Pin 4 is taken to +12V, as well as the push-pull CT tap, and pins 2,3 taken to the push-pull winding end taps on the power transformer. Pin 1 is taken to 0V. Each PP tab has capacitive suppression to 0V. The +12V connection to the CT is switched for standby mode (this removes the HT DC supply, but heaters are still on).

The power supply is typical full-wave rectified type using double diode 6X5GT and a 335-0-335VAC centre-tapped secondary. The effective input resistance of the transformer is about 33Ω x $(335/240)^2$ + 200Ω = 265Ω. 325VAC with 150Ω effective input impedance allows 4uF and 70mA loading per plate, so double diode allows up to 140mA, and possibly a bit more capacitive filtering.

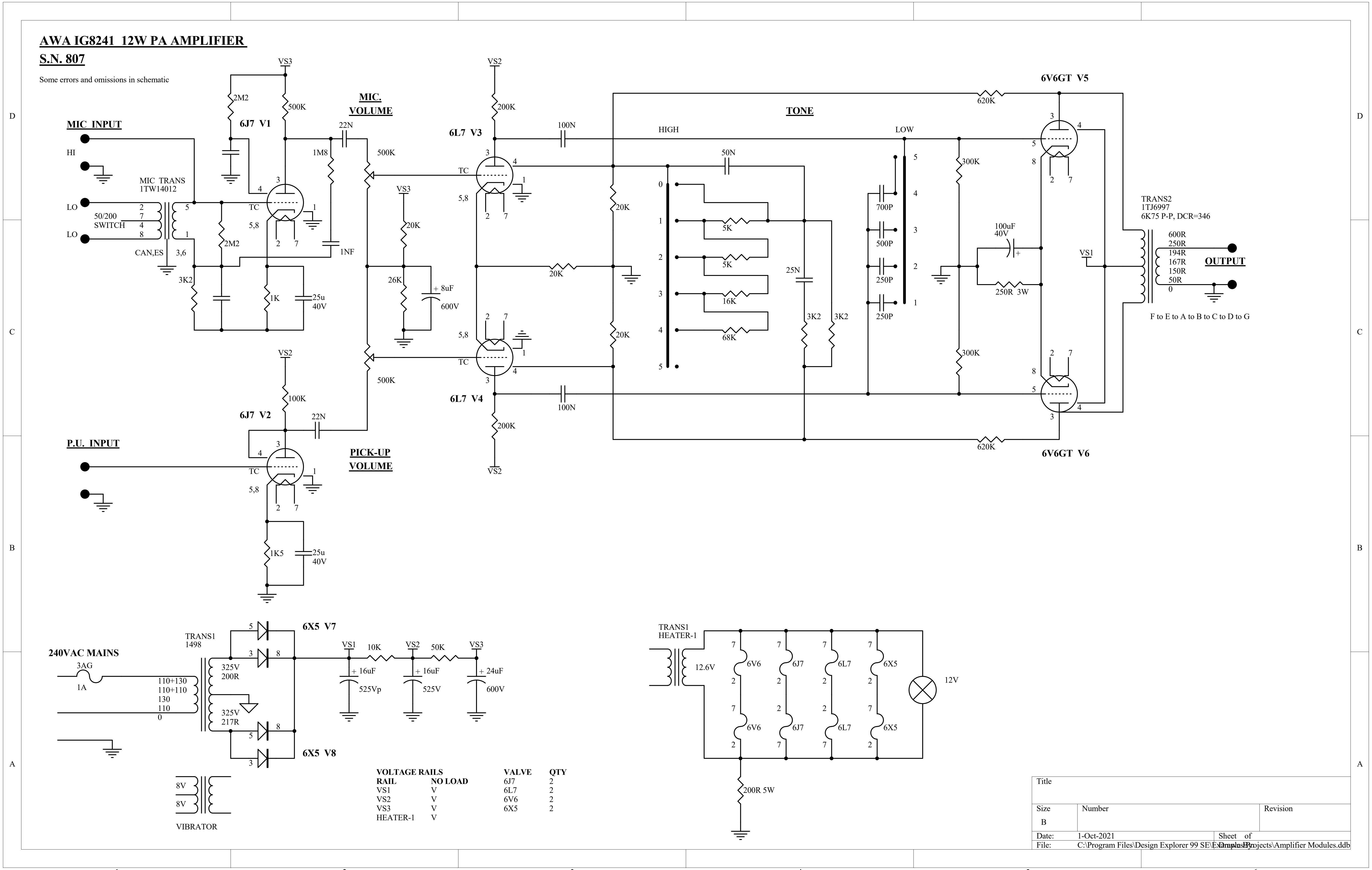
Nominal bias current about 40+40=80mA. PSUD2 indicates VS1 about 380V. Cathode bias about 20V, and another 10V drop. Idle loss about 350 x 0.04 = 14W which is on design centre max. B+ is well above design centre max of 250-285V. Could drop some B+ with additional filtering, although high Rs may suitably sag VS1.

12V heater loading (original): 0.6 + 0.45 + 2x0.3 + 0.1 = 1.75A.
12V heater loading (modified): 0.8 + 2x0.3 + 0.1 = 1.5A.

Assuming an output PP stage with up to 20W idle per tube (cathode 52mA x 380V) with fixed bias, and a VS1 idle draw of 110mA.

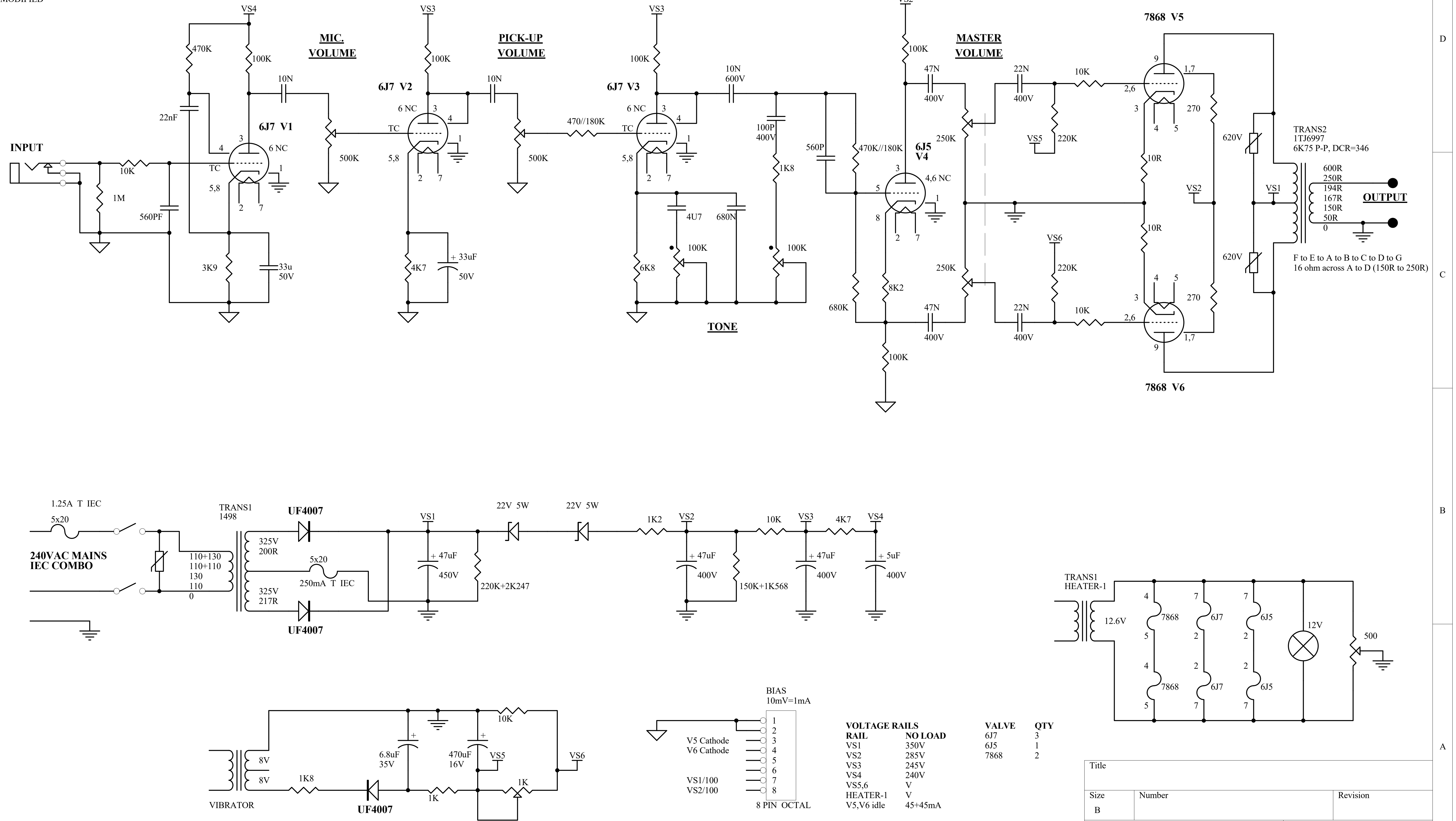
Full wave ss rectifier with 110mA idle load provides about 385V VS1. Max anticipated peak VS1 load current about 145mA, requires about 240mArms CT current, and half-secondary winding loss is up to 6W. IEC60127-2 0.25A T fuse chosen.

Simulate period in PSUD2	**20ms**	**150ms**	**600ms**	**continuous**
Simulated RMS current	0.90A	0.45A	0.30A	0.24A
Multiplier (based on 0.25A fuse rating)	3.6	1.8	1.2	1.0
IEC60127-2 Time-lag T min limit multiplier	10	4	2.75	1


AWA IG8241 12W PA AMPLIFIER
S.N. 807
Some errors and omissions in schematic
MIC INPUT
HI
LO
LO
50/200
SWITCH
MIC TRANS
1TW14012
CAN,ES
3,6
2M2
6J7 V1
500K
VS3
MIC.
VOLUME
22N
1M8
500K
1NF
2M2
3K2
1K
25u
40V
6L7 V3
VS2
200K
100N
TC
5,8
VS3
20K
26K
8uF
600V
20K
20K
20K
TONE
HIGH
LOW
50N
5K
5K
16K
68K
25N
3K2
3K2
700P
500P
250P
250P
300K
300K
100uF
40V
250R 3W
620K
6V6GT V5
6V6GT V6
TRANS2
1TJ6997
6K75 P-P, DCR=346
600R
250R
194R
167R
150R
50R
0
OUTPUT
VS1
F to E to A to B to C to D to G
6L7 V4
500K
6J7 V2
100K
22N
P.U. INPUT
PICK-UP
VOLUME
1K5
25u
40V
240VAC MAINS
3AG
1A
110+130
110+110
130
110
0
TRANS1
1498
325V
200R
325V
217R
6X5 V7
6X5 V8
VS1
10K
VS2
50K
VS3
16uF
525Vp
16uF
525V
24uF
600V
8V
8V
VIBRATOR
TRANS1
HEATER-1
12.6V
6V6
6J7
6L7
6X5
12V
200R 5W
VOLTAGE RAILS
RAIL NO LOAD
VS1 V
VS2 V
VS3 V
HEATER-1 V
VALVE QTY
6J7 2
6L7 2
6V6 2
6X5 2
Title
Size B
Number
Revision
Date: 1-Oct-2021
Sheet of
File: C:\Program Files\Design Explorer 99 SE\Examples\Projects\Amplifier Modules.ddb
Drawn By:
1 2 3 4 5 6
A B C D

AWA IG8241 12W PA AMPLIFIER
S.N. 807

MODIFIED



VOLTAGE RAILS

RAIL	NO LOAD
VS1	350V
VS2	285V
VS3	245V
VS4	240V
VS5,6	V
HEATER-1	V
V5,V6 idle	45+45mA

VALVE	QTY
6J7	3
6J5	1
7868	2

Title		
Size: B	Number	Revision
Date: 10-Nov-2021		Sheet of
File: C:\Program Files\Design Explorer 99 SE\Examples\Projects\Amplifier Modules.ddb		Drawn By:

15-Watt AC/Vibrator Amplifier

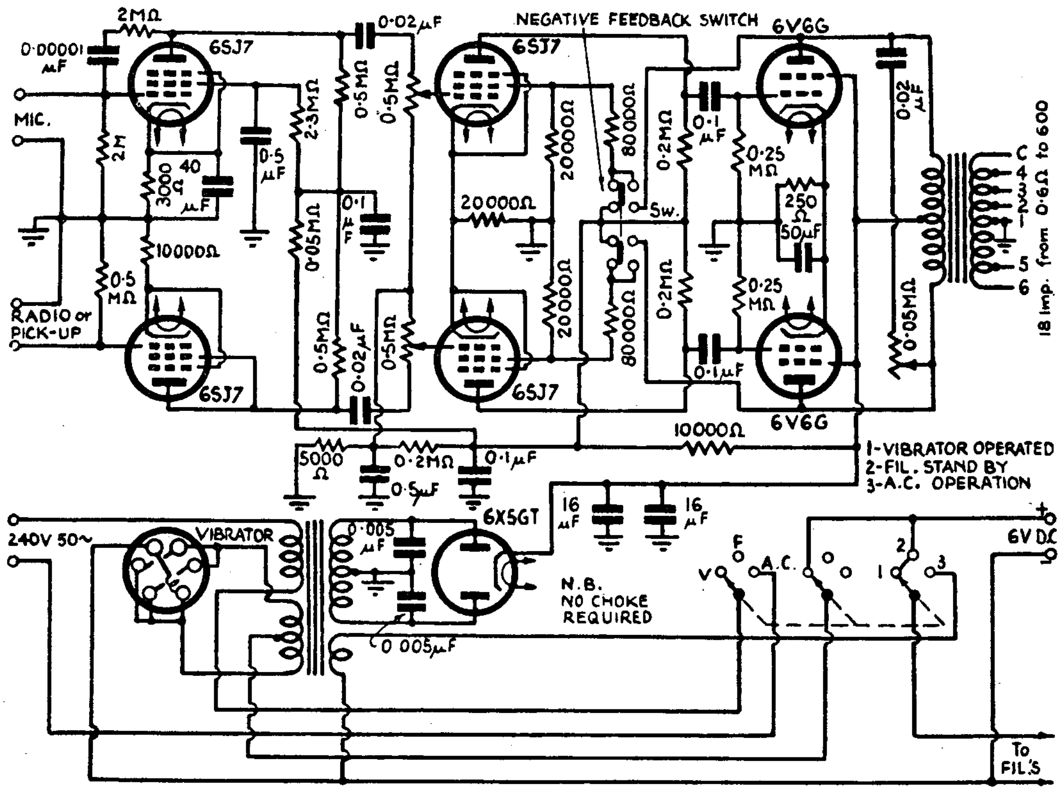
The circuit diagram on page 47 shows an amplifier system capable of delivering an AF output of 15 watts, which may be operated either from the AC mains of from a 6 volt accumulator. The arrangement, which was brought under notice by reader H. W. M. of Gulgong, NSW, is very similar to the AWA amplifier type 1G3241 which operates from AC mains or from a 12 volt battery. In the original circuit arrangement two vibrator units are provided, a switch being arranged so that the spare vibrator can be quickly switched into circuit should the other fail. The original arrangement also provided for low-impedance microphone input.

This version uses only one vibrator, which can be quickly changed should trouble occur. Two 6X5GT rectifiers are used. The plates in each valve are paralleled and each valve is used as a half-wave rectifier in a full-wave rectifier circuit. It will be seen that the rectifiers operate when the amplifier is being driven either by the AC mains or vibrator supply (6 volts).

The circuit uses a modified "Barnes" push-pull driver arrangement with two input channels, and the output is approximately 15 watts. Somewhat greater output is possible by switching out the negative feedback, which is obtained in rather an ingenious manner by feeding the screens of the push-pull drivers through resistors from the plates of the output valves. These resistors go to the normal HT supply when the feedback is switched out.

Particular note should be taken of the grid and cathode circuit arrangements for the push-pull driver stage. Both valves in this stage are fed independently with signals from the respective input stages and the required out-of-phase voltage for the other driver valve is obtained by the use of the unbypassed common cathode resis-

(Continued on page 47)



15-watt amplifier system which may be operated either from an AC supply or a 6-volt accumulator.

(Continued from page 45)

tor ("Barnes" system). However, the high value required (20,000 ohms) for this resistor to ensure adequate coupling would result in excessive grid bias if the grids were returned direct to ground, and to offset this, they are returned instead to a positive potential point provided by a voltage divider across the plate supply to the first stage—the nett difference between the cathode and grid return voltages being adjusted to the required bias voltage.

The entire arrangement is rather interesting and well worthy of careful study.