1. Summary

AWA 872 20W valve amplifier. S.N. Z177. Gratis Stephen (Brucer) Nov, 2014

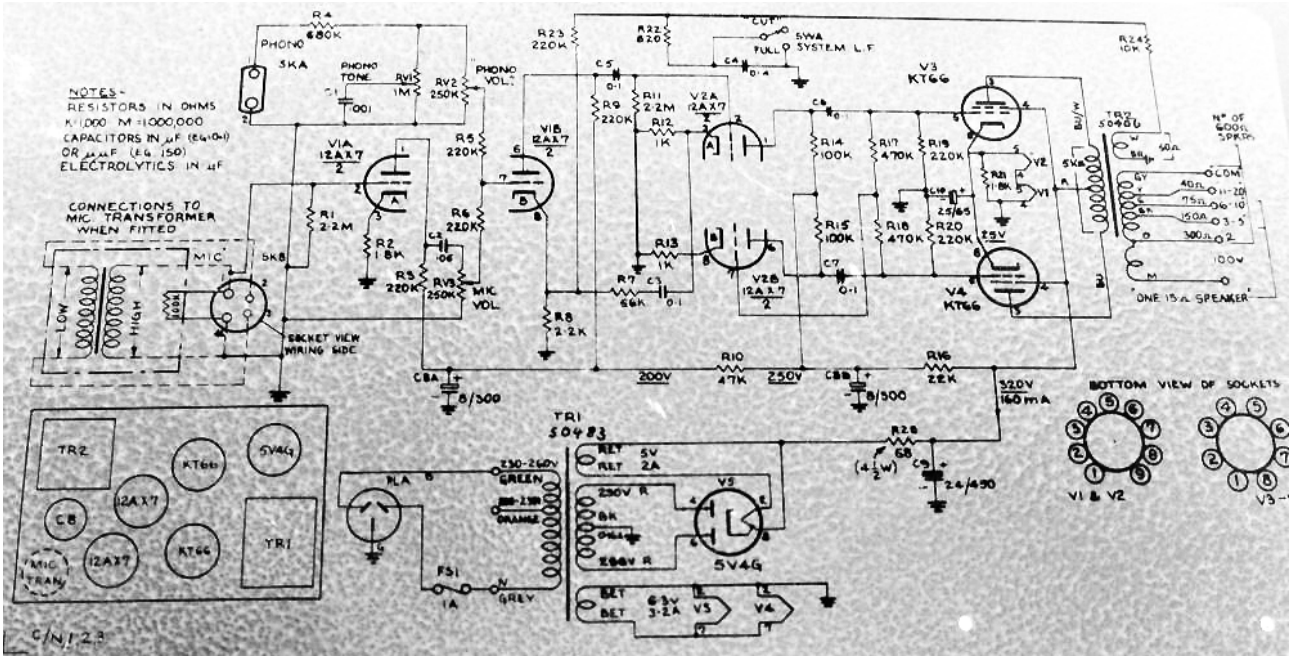
MIC-Phono input channel PA amplifier. 12AX7 mic preamp. 12AX7 mixer with feedback to cathode. 12AX7 self-balancing, floating paraphase PI with separate unbypassed cathode biases and local feedback. KT66 cathode biased PP using V1+V2 heater; separate feedback winding to PI stage driven cathode. 5V4G rectifier with series 68Ω 5W. Front panel controls: MIC Volume; Phono Volume; Phono Tone. Rear panel control: System L.F. two-setting switch.

Output Transformer	AWA Type 50486 CD4 . 20W nominal 5KΩ PP 5 output winding sections 0, 40Ω, 75Ω, 150Ω, 300Ω, 40Ω. 50Ω feedback winding. Panel: 11-20, 6-10, 3-5, 2 x 600Ω speakers, and 100V.
Power Transformer 1	AWA Type 50483 CD4 . 0-220V-250V (GRY,OR,GRN); 290-0-290V @ ~160mA (RD,BK,RD); 6V3 3.2A; 5V 2A.
POTs	IRC CTS 45 37268 C4 0.25MEG/C.
Caps	Ducon TPB wax foils; UCC (5063 and 4863 codes) & Ducon (353 code) electrolytic ;.
Valves	KT66 x2: none fitted 12AX7 x2: none fitted 5V4G x1: none fitted

Good general condition – unrestored and original caps. One knob missing its centre plate. Output sockets removed.

Cap dates appear to indicate circa 1964 manufacture. The amp was advertised in RTV&H from Nov 1963.

Issues: Mains cable cut and old. No mains switch. Fuse in neutral line. Speaker outputs floating. Main filter cap 0V returns via OT feedback wiring. HT level too high for normal idle bias at nominal mains. KT66 cost. R8 bad. OT mounting tabs a bit loose. OT primary half winding with high resistance.



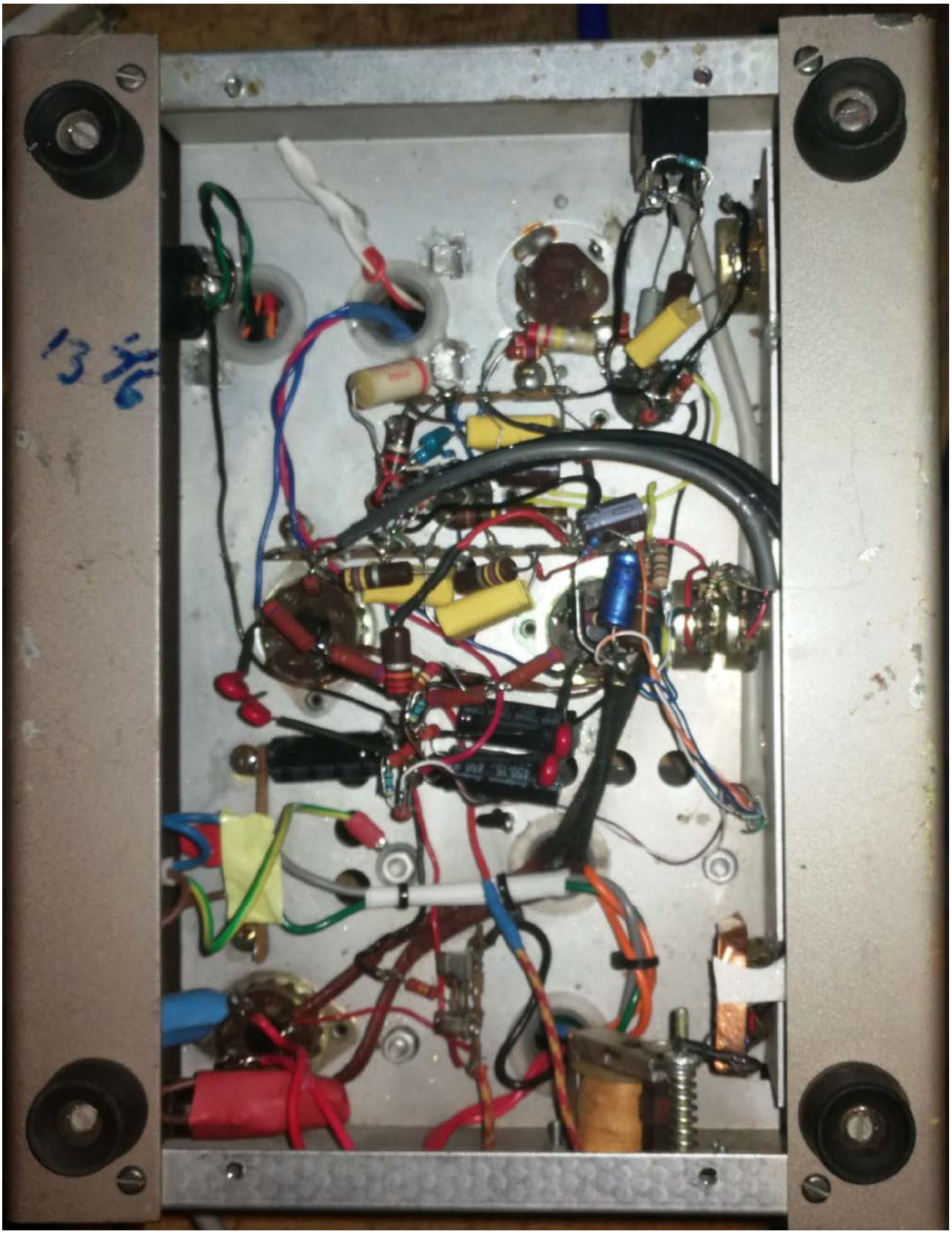
2. Modifications

Target: Guitar amp with single input; gain and master volume pots; tone with presence control; 6L6GC valves; 8 - 16Ω speaker.

- New mains cable; 275VAC MOV on power transformer primary; mains switch added.
- Added PT secondary CT fuse (400mA).
- Replaced all electrolytics: HT1 = 30uF 450V; HT2 = 15uF 450V; HT3 = 4.7uF 400V; HT4 = 4.7uF 400V. VS1 peaks after about 8 secs.
- Removed R26 68Ω series resistance with rectifier, and added series 1N4007 with 5V4G anodes.
- Added Wurlitzer 500407 choke, 4.1H @ 30mAdc (317Ω DCR), for VS2 filtering.
- Added 270Ω 3W screen droppers to V3, V4.
- Added 10Ω cathode current sense to V3, V4.
- Added 660VDC MOV (2x 2502 GEAQ) across each primary half of output transformer.
- 50486 OT replaced with spare 50486 OT from Mark Prentice.
- Speaker connected across 75Ω (GRN) to 150Ω (BLK) winding section (16% of turns), and the 75Ω tap is grounded. Speaker loading aimed at 16Ω for 6.4kΩ PP.
- Removed Phono input circuitry. Modified MIC V1A stage with 1M leak and 10k stopper. Reduced R6 from 220k to 100k.
- Reconfigured grounding – distributed star with power point to chassis.
- 6L6GC replacing KT66 (this may load B+ more for higher idle current). Present valves have reasonable balance at idle, but become unbalanced at overdrive.
- Replaced Phono Vol pot with dual gang 250k PPIMV. Replaced 220k grid-leaks with 1M5 // pot. Added 4k7 grid-stoppers, plus pot top half. Dual gang balance may be noticeable. Removed feedback circuitry.
- Lowered R5 from 220k to 110k (V1A plate load). Changed V1B plate load R9 to 47k+47k, with take-off in middle to drop gain.
- Half of Tone pot used as RC shunt on V1B output The other half as +4dB treble lift on V2A cathode bypass.
- Added 222.2k bleeds on VS1 and VS2 as voltage sense dividers. Added RJ45 plug for external meter box.
- Added 1R sense to fuse.
- Phono tone pot may get hum from choke and mains cabling. Added grounded metal shield.
- Added 24V 5W Zener with series 22Ω across V3/V4 cathode to constrain cathode voltage rise during overdrive to about 25V.

To do:

- Test with guitar



3. Measurements

Megger tested 1kV on PT and OT - ok.

Voltage rail regulation. 240Vrms mains

Conditions	Idle	Onset of clipping 14W	Cranked 19W
VS1 cathode	318V , 9.1Vrms 20.1V 75mA+71mA 22W+21W	312V 24V, 80+82mA	304V 28V, 81+98mA (no Zener cct)
VS2	318V 200mVrms		298V
VS3	256V		
VS4	234V		
Heater	6.5		
Sec HT	295		

Primary DCR = 11, 13Ω.
Secondary 290-0-290 DCR = 63+68Ω.

AWA 50486 CD4 output transformer

Winding	Voltage rms	Turns ratio; Impedance for 5K pri; Spec level; DCR
Pri P-P: DK/BL-RD-(BL-BRN-WH)	12.19+12.05	
Sec: WH to BRN	2.41	10.0; 50Ω; 50Ω; 320T 21.0Ω
Sec: OR to MV	7.54	3.19; 490Ω; 500Ω; 1000T 1.3Ω
Sec: GY to OR	5.86	4.11; 296Ω; 300Ω; 777T "2" 3.8Ω
Sec: GY to BLK	4.16	5.79; 149Ω; 150Ω; 552T "3-5" 2.7Ω
Sec: GY to GRN	2.95	8.17; 75Ω; 75Ω; 391T "6-10" 1.9Ω
Sec: GY to Y	2.155	11.18; 40Ω; 40Ω; 286T "11-20" 1.4Ω

Output transformer primary DC resistance: 100Ω + high Ω

AWA 50486 CA1 output transformer (from Mark Prentice)

Winding	Voltage rms	Turns ratio; Impedance for 5K pri; Spec level; DCR
Pri P-P: DK/BL-RD-(BL-BRN-WH)	12.35+12.16	
Sec: WH to BRN	2.44	10.0; 50Ω; 50Ω; 320T 20.7Ω
Sec: OR to MV	1.69	14.4; 24Ω; 25Ω; 222T 1.3Ω
Sec: OR to MV ,OR-OR	7.62	3.19; 491Ω; 500Ω; 1000T 5.1Ω
Sec: GY to OR	5.93	4.10; 297Ω; 300Ω; 778T "2" 3.8Ω
Sec: GY to BLK	4.24	5.74; 152Ω; 150Ω; 556T "3-5" 2.7Ω
Sec: GY to GRN	3.042	8.00; 78Ω; 75Ω; 399T "6-10" 1.9Ω
Sec: GY to Y	2.177	11.17; 40Ω; 40Ω; 286T "11-20" 1.4Ω

Output transformer primary DC resistance: 95Ω + 99Ω

The winding section between 40Ω and 75Ω is effective 5.5Ω, with 11% of secondary turns.
The winding section between 75Ω and 150Ω is effective 12.5Ω, with 16% of secondary turns. An 8 ohm loading presents 3.2k PP. A 16 ohm loading presents 6.4k PP.

If the 75Ω to 150Ω winding section is used for speaker connection, and the 75Ω tap is grounded, then either the 40Ω tap can be used as a 5.5Ω feedback winding, or the COM tap can be used as a 75Ω feedback winding.

5.5Ω feedback tap is 105/320 = 33% of original f/b. With System LF switch in CUT, the feedback level is (820/10.82k)*(2k2/222k) = 1/1330 (or 0.075%).

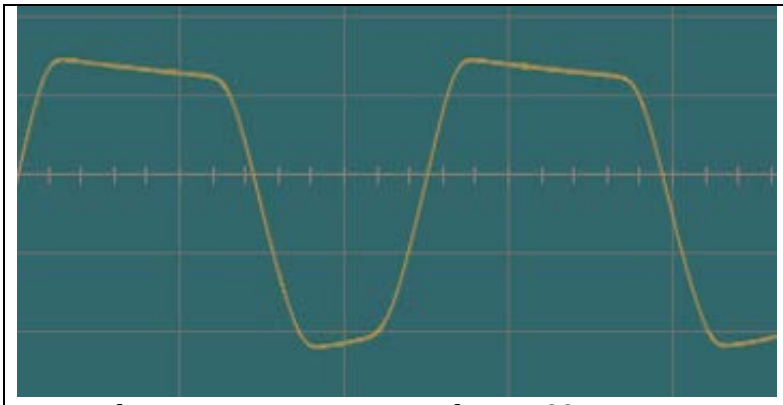
Input stage noticeably starts to compress above 20Vrms out. Gain 10/0.28 = 36. Next stage starts loading input stage above about 2V on gain wiper.

With PostPIMV at min, the PI output starts to compress above about 20V and then clip per side above about 33Vrms. Gain per side 10/0.04 = 250. Gain of V1B 0.4/0.04 = 10.

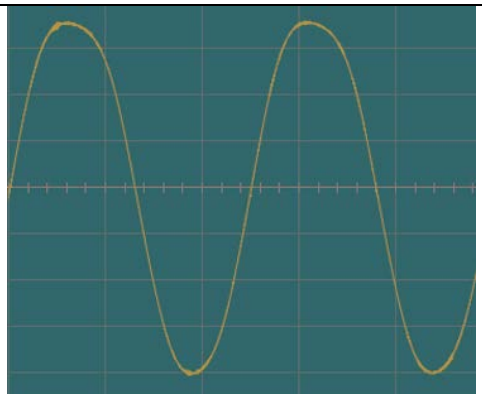
With standard setup, except feedback disconnected, and an input level that gave 1.5% THD output at 4W, the output in to 8.5Ω load reached 14W clean (2.2% THD) with Phono vol maxed, and cathode rose from 20.8 to 23.8V, and VS1 sagged from 318 to 312V, and cathode currents increased from 75/73mA to 80/82mA.

With same input level but Mic Vol raised to gave 7% THD at 4W output, the output reached 19.3W with 22% THD, and cathode rose to 27.4V, and VS1 sagged to 304V, and cathode currents increased to 81/98mA.

With higher Mic Vol setting to give 22% THD at 4W, the output was severely overloaded and VS1 sagged below 300V and output level sagged below 19W.



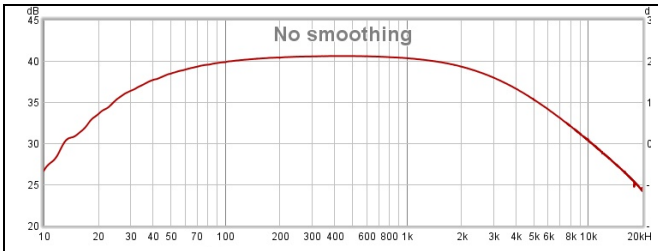
Mic Vol up causing PI stage overdrive, 400Hz.



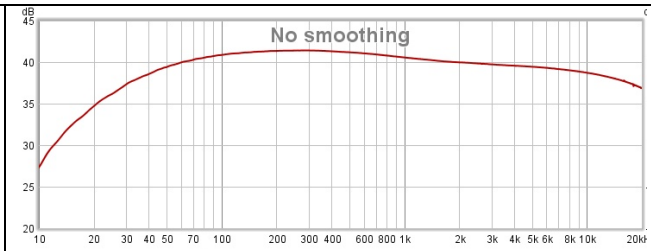
4W 8% THD 400Hz.

Phono Tone control.

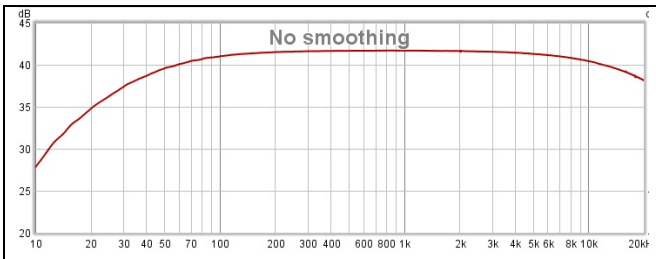
Frequency response is flat (-1dB) from 60Hz to 11kHz when tone pot is 70-90% CW as both RC shunting of V1B and cathode boost of V2A are negligible. Phono Tone pot treble variation from more than -5dB, to +5dB at 5kHz.



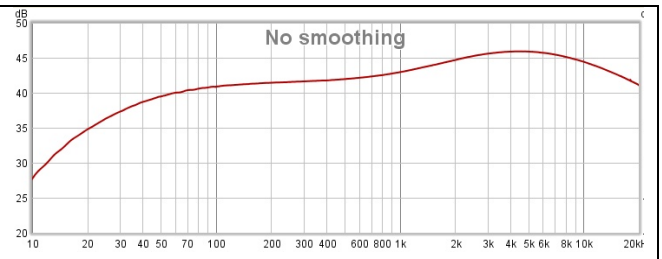
Phono Tone 0% CW



Phono Tone 50% CW



Phono Tone 90% CW



Phono Tone 100% CW

4. General comments.

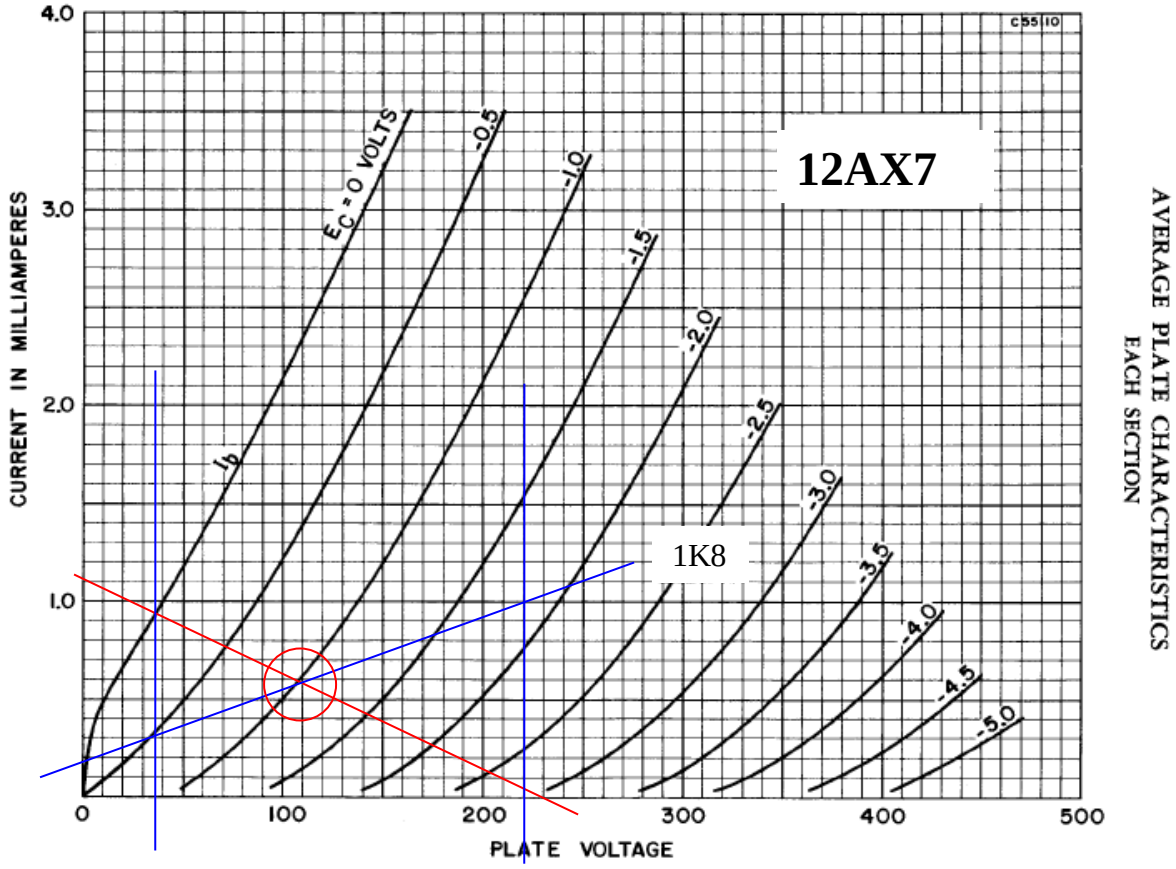
6.3V heater loading: 0.45A
5V heater loading: = 2A

The power supply is typical full-wave rectified type using double diode, indirectly heated cathode, 5V4G and a 290-0-290VAC centre-tapped secondary. The effective input resistance of the transformer is about 13Ω x $(290/240)^2$ + 65Ω = 84Ω. 375VAC with 100Ω effective input impedance allows up to 40uF and 175mA loading, so 290VAC and up to 30uF should be ok with R28 removed. PSUD indicates 0.51Apk steady state, and 1.6Apk transient. Peak steady state rating is 525mA, and about 3.5A transient peak.

The output stage bias is the heater loading of V1 and V2 (ie. 25.2V, 150mA nominal) plus about 14mA through the parallel 1k8. At the nominal 320V B+, the idle power is about 295x0.075 = 22W. However, an aging 6L6GC may not develop sufficient heater voltage at the nominal current for expected preamp operation. VS1 rises after about 8 secs, and reaches about 400V for a few seconds before output stage conduction brings it down. The output stage bias voltage is initially suppressed due to cold 12AX7 heaters, and causes a high initial 6L6 cathode current for a few seconds.

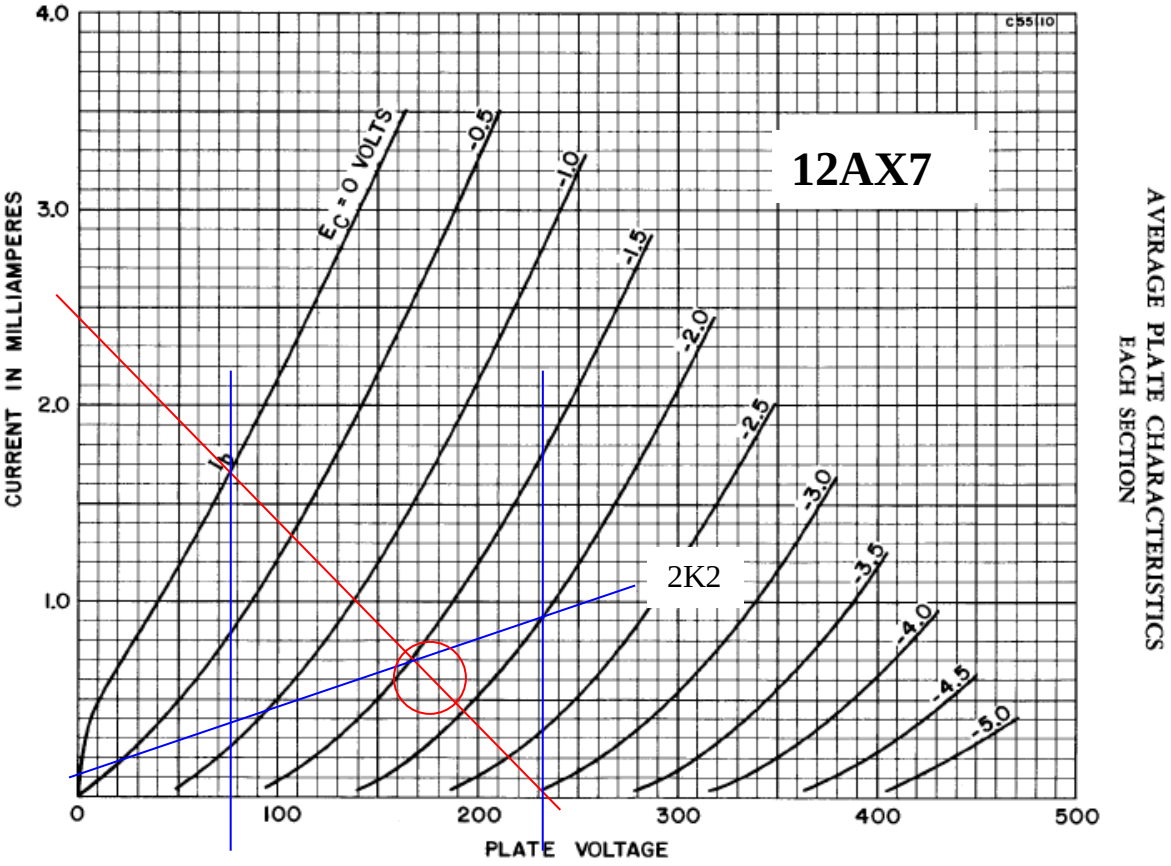
4.1 Input Stage – 12AX7 modified

For the first half 12AX7, V1A: supply voltage VS4 = 234V; Va=180V; Rk=1k8; Vk=0.97V; Ia=0.49mA; RLdc=110k.



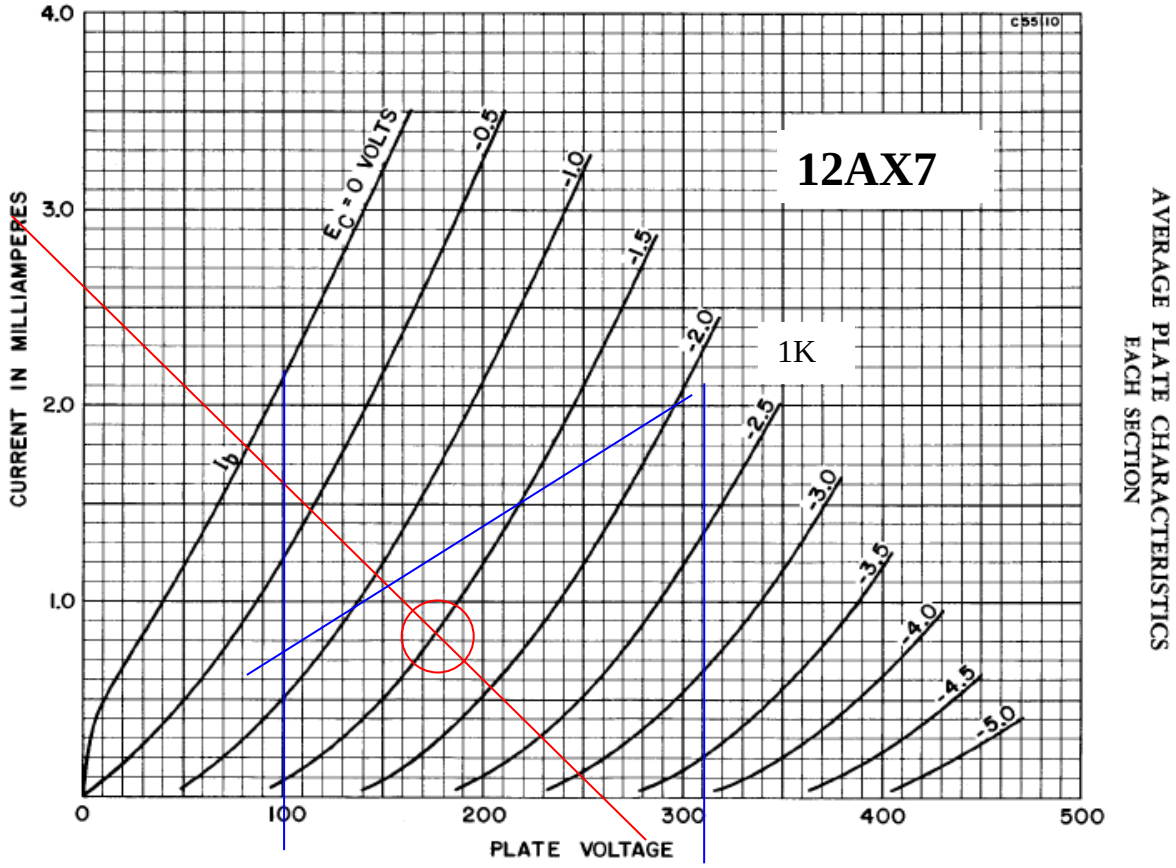
4.2 Feedback Stage – 12AX7 modified

For the second half 12AX7, V1B: supply voltage VS4 = 234V; Va=186V; Rk=2k2; Vk=1.1V; Ia=0.51mA; RLdc=94k.



4.3 PI Stage – 12AX7

Self-balancing, floating paraphase PI stage with separate unbypassed cathode bias resistors. For each half of PI, the 12AX7, V2: supply voltage VS3 = 256V; Va=171V & 175V; Rk=1k; Vk~0.9V; Ia=0.8mA; RLdc=100k. V2 heater ~10Vdc at idle.



4.4 Output Stage

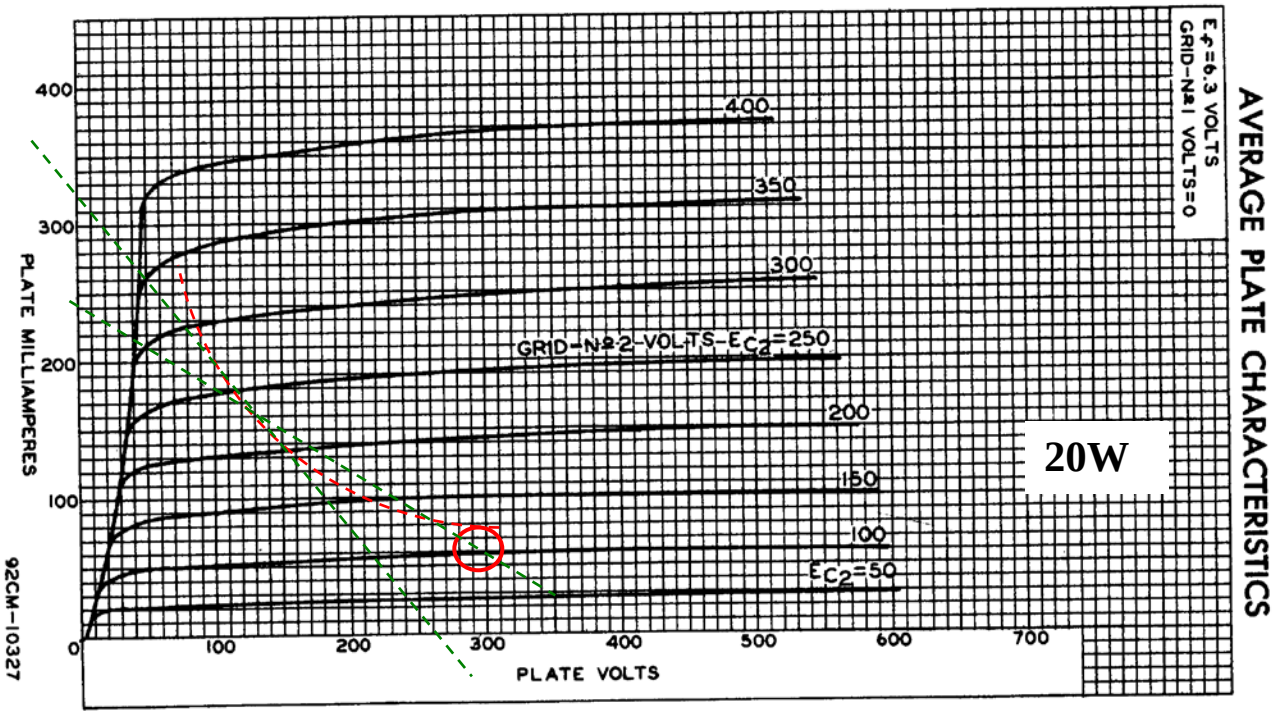
In this modified 6L6GC Class AB push-pull output stage with cathode bias, one side is pushed into conduction and the other side is pulled into cutoff (class B), and there is a region of Class A overlap where both sides conduct equivalent levels of current. A 3.2kΩ impedance plate-to-plate OPT (8Ω speaker across 75-150Ω taps) presents signal currents into each tube with a 1.6kΩ impedance with both tubes conducting, changing to 0.8kΩ load impedance at higher signal levels.

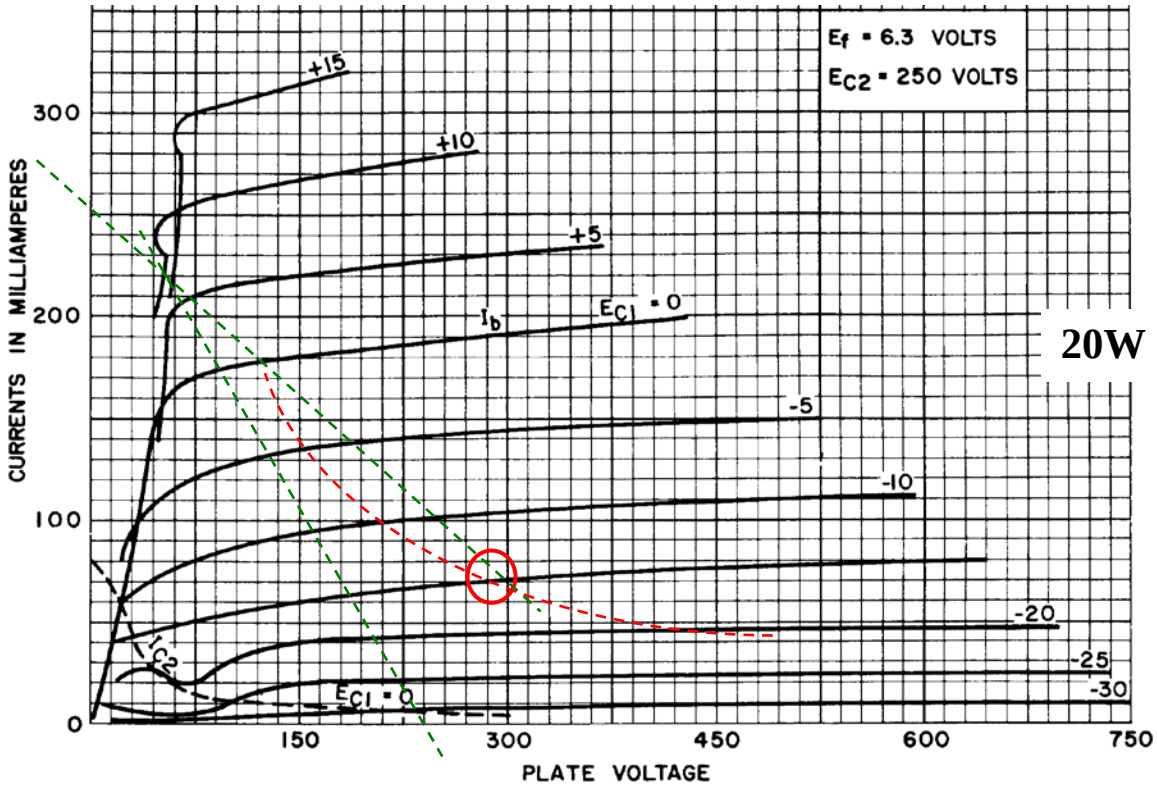
As the output loading increases, the supply voltage VS1 to the output valve plates sags from about 320V towards 300V. Plate-cathode DC voltage is lower than VS1 by an amount from 8+20= 28V, up to 14+28=42V; where OPT half resistance of about 100Ω has current ranging from 75mA to a peak current of up to about 0.14A.

Screen supply voltage VS2 also sags from about 320 to 300V. And screen cathode voltage is lower than VS2 by an amount from 3+20=23V, up to 10+28=38V. 270Ω screen stoppers, and screen current increasing from about 75/8=10mA to about 40mA/tube.

The output valve bias current is about 75mA, so idle plate dissipation is about: Pd = (320-28) x 75mA = 22W, which is conservative 70% of max design level.

The peak cathode voltage can rise to beyond 30V during sustained cranked operation, indicating total cathode current reaches 30/170 = 180mA. Fixed bias is constrained by shunting the cathode with a 24V 5W Zener and series 47R, to soak up 50mA at 26.5V with 1.2W dissipated in zener.





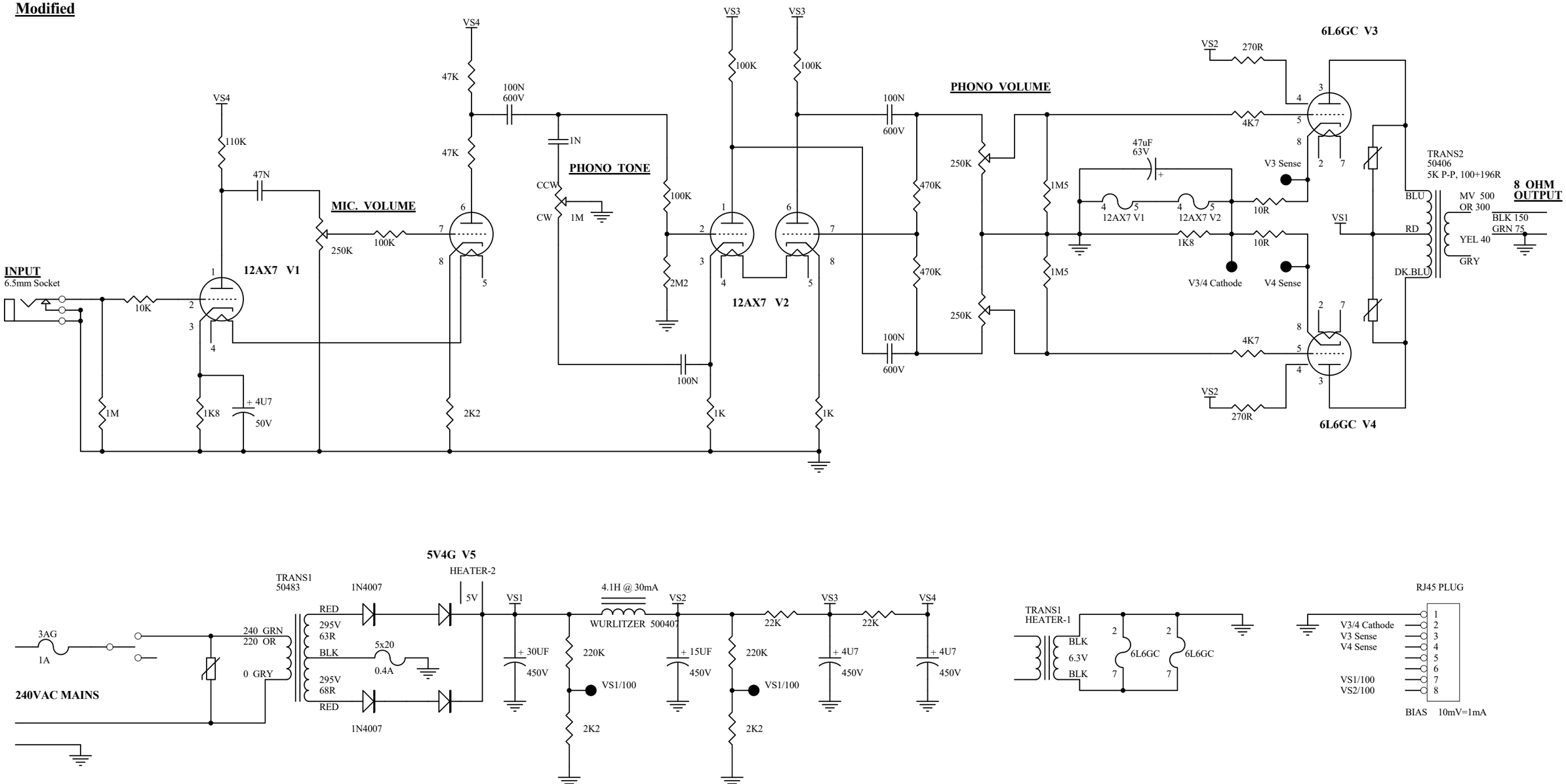
4.5 Maintenance

8-wire ethernet lead/plug T568B to go to meter assembly.

RJ45 Pin #	Wire	Circuit node	Nominal value (idle)
1	White/Orange	Gnd	0V
2	Orange	Cathode	1-2 = 21V
3	White/Blue	Cathode sense 1	2-3 = 700mV (70mA)
4	Blue	Cathode sense 2	2-4 = 700mV (70mA)
5	White/Green		
6	Green		
7	White/Brown	VS1	1-7 = 3.2V (320V)
8	Brown	VS2	1-8 = 3.1V (310V)

Idle (anode + screen) dissipation = 300V x 0.07 = 21W

AWA PA872 20W PA AMPLIFIER
Modified



VOLTAGE RAILS

RAIL	IDLE
VS1	320V
VS2	320V
VS3	256V
VS4	234V
HEATER	6.5V
V3/4 Cathode	20V
V3/4 sense	0.7 - 0.75V (70-75mA)

VALVE	QTY
12AX7	2
6L6GC	2

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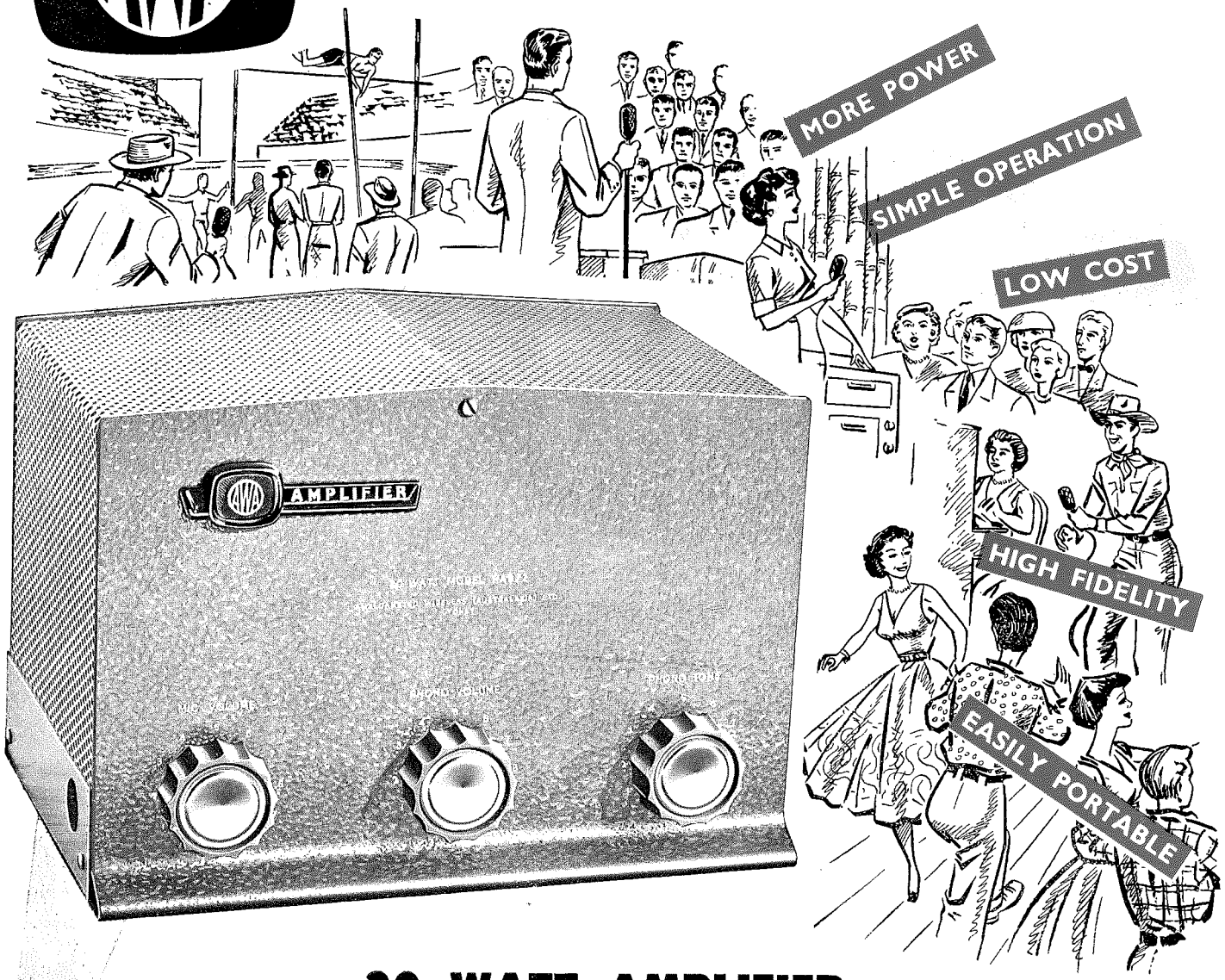
AWA FOREMOST IN SOUND



20 WATT AMPLIFIER
MODEL PA.872

A.W.A. Sound Amplification and Distribution Systems are in wide use throughout the Commonwealth for Schools, Hospitals, Cathedrals and Churches, Retail Stores, Public Halls, Hotels, Restaurants, Racecourses, Sports Grounds, Surf Clubs, Railways, Theatres, Factories, Canteens, Business Houses, Amusement Centres, Tourist Coaches and the like.

Whether your need is for fidelity musical entertainment, effective public speaking or clear industrial communication and direction, you will be served faithfully by this newly designed, compact and powerful unit.

Manufactured to Broadcast Equipment Standard.

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AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

AUSTRALIA'S NATIONAL WIRELESS ORGANISATION

Specification for Public Address Amplifier, Model PA.872

The A.W.A. Amplifier Model PA.872 is a mains operated (200-230, 230-260 volts—50 cycles) public address amplifier capable of an output of 20 watts.

Two simultaneous inputs are available, one for high impedance microphone 2.2MΩ and one for crystal pickup 0.7MΩ. An input transformer can be fitted when required for low impedance microphones.

A variable tone control is provided to attenuate the high frequency response of the pickup only. Low frequency attenuation of the whole amplifier is provided for feeding horn type loudspeakers.

The output may be fed to 2 to 20 600Ω speakers. Taps are provided to feed groups of either 2, 3-5, 6-10, 11-20 600Ω speakers. Provision is also made to feed a single speaker of the 12-16Ω class as an alternative.

A.W.A. amplifying and sound distribution apparatus and systems are designed, manufactured and installed by engineers and technicians with the background of world-wide knowledge and over forty-five years of ever-widening experience in electronic broadcasting and communication equipment. A complete range of audio system basic units is available.

The Company's wide resources in research, design, manufacture and service are a guarantee of quality sound equipment and installations.

Enquiries are invited and information and quotations will be gladly supplied.

AMPLIFIER PERFORMANCE . .

(1) SENSITIVITY
Pickup .3V input for full output, Microphone 2mV input for full output.

(2) FREQUENCY RESPONSE
±2db 50–10Kc.

(3) HARMONIC CONTENT
Less than 2% at overload point at 1000 cycles.

(4) NOISE LEVEL UNWEIGHTED
Standing — 60db below 20W.
Pickup — 60db „ „
Microphone — 35db „ „ at full gain.

(5) TONE CONTROLS
H.F. 0-20db attenuation at 10Kc.
L.F. -20db at 50 cycles in one step.

Controls

The following controls are fitted:
Microphone Volume.
Pickup Volume.
Pickup Tone.
Bass Cut (pre-set at rear of unit.)

Colour

Light plum and silver.

Valve Complement

Valve Type	Qty.
KT66	2
12AX7	2
5V4G	1

AWA PA872 photos from an eBay amp.