1. Summary

AWA 8 Watt Amplifier Type PA774, S.N. AF 9919. HRSA Feb 2023

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 floating paraphrase splitter provides high gain to PP pentode output stage. Cathode bias push-pull 6BM8 output, with isolated secondary feedback winding taken to the 2nd stage cathode. 220V plate supply from FC442 bridge diode rectifier and capacitor filter. Plate supply fed direct to the screen supply. Cascading resistor/cap dropping to the splitter voltage supply, and again to the input amp supplies. 6.3VAC heater supplied to all valves, and hum cancelling feedback taken to cathode of V3B. Vol pot for MIC input. Vol pot for P.U. input. Tone pot for P.U. input. Output load settings 150/300/600/ 1200Ω from 5K PP transformer.

Appears complete with only minor mods. Transformers marked with ‘60720’ and BD?; and ‘60195’ and BC?. Ducon caps with 2671, 2271 datecodes. Mustard with A4H. UCC caps with 2064 and 2264 datecode. Modifications noted were: caps and IRC WW’s with 70 19 datecodes. 6BM8 datecodes VM15 (1970 Dec) and WG20 (1971, Jul); Problems included: bad ecap cans; hard and cracking wire insulation; R14 1k65; R17-R19 >10%.

1.2 Modified Design for Guitar Amp use

- Replaced AC mains cable with side-wall mounted IEC/fuse/switch/indicator combo. 0.8A IEC T 5x20.
- Primary wiring direct to -10 and 240V PT terminals, with S14K300 MOV.
- 1k screen stoppers.
- HT UF4007 bridge rectifier to 47uF 400V, to 100R 2W to 47uF 400V.
- 270Ω 3W common cathode with 100uF 50V, then 10Ω to each cathode.
- Shorting guitar 6.5mm isolated input socket with 1MΩ load and 10k grid stopper.
- 150kΩ anode loads for both preamp stages, with un-bypassed 2k2 cathodes. 12AU7 used.
- C1 lowered from 22nF to 4n7. C3 lowered from 47nF to 10nF. C4&C6 lowered from 22nF to 10nF.
- Relocate tone and vol pot to before PI stage. Tone pot across vol pot for treble drop. Phono Vol pot across R26, with 1.2nF from wiper to 0V for treble gain.
- Balanced PI gains for reduced distortion.
- 2502 GEAQ MOVs on OPT pri.
- Fixed OPT output from 150 to 300 taps for 25Ω load, to shorting 6.5mm socket for 16Ω speaker. Removed wiring from COM and 1200. Grounded 150 tap.
- Added 5-pin maintenance socket for bias and VS1/100 monitoring.

Inputs reduced to just one guitar input – isolated 6.5mm socket with tip grounded; changed R1 to 1M and 10K grid input added; R2 and R9 changed to 2K2; R4 & R11 changed to 150K. PU circuitry and summer removed.

2. Measurements

Mains circuit IR >2G at 1kVdc.
PP circuit IR >2G at 1kVdc.

Voltage rail regulation.

Rail	Idle	5.2Wpk output
VS raw	234V (2.67Vrms)	
VS1	228V (0.85Vrms)	213V
VS2	222V (30mVrms)	208V
VS3	218V	
Heater 1	6.25	
Cathodes	16.5V, 32/32mA (6.8W, 6.8W)	47/47mA

Power transformer primary DC resistance: 62Ω. BL, GRY, OR, Y, (-10, 0, 220, 240)
Power transformer secondary DC resistance: 71Ω.

12VAC 50Hz nominal applied to output transformer 150R winding

Winding	Volts rms	Turns ratio; Pri Impedance; Spec level; Notes; turns %
Pri P-P: BLU to Vi	70.92	1 ; ; N/A; appears to be 5k P-P
Sec: Feedback; 16Ω dcr	7.04	10.07; N/A; 49Ω, based on 5k P-P 20.2
Sec: 150 to Com; 5Ω dcr	12.33	5.75; 4,960Ω; 150 Ω; based on 150 35.5
Sec: 300 to Com	17.43	4.07; 4,970Ω; 302Ω; based on 5k P-P 50.1
Sec: 1200 to Com; 18Ω dcr	34.79	2.04; 4,994Ω; 1201Ω; based on 5k P-P 100
Sec: 150 to 300; 2.2Ω dcr	5.04	14.07; N/A; 25.2Ω; based on 5k P-P 14.5
Sec: 1200 to 300; 9Ω dcr	17.28	4.1; N/A; 300Ω; based on 5k P-P 50

1200Ω winding stated as 100Vac, indicating 204Vac PP primary rated, and 20.4Vac feedback.
300 = OR; 150 = GR; 1200 = GRY; COM= Y
Feedback winding is sandwiched between inner prim, and outer secondary (1200 as outermost tap).
150 and 300 taps come out as a pair, so could be split.
Output transformer primary DC resistance: 77+73= 150Ω plate-to-plate.

DCR dissipation in OPT primary at idle is $150x0.033^2$ = 0.16W, which could increase to circa 0.4W if cranked. If the COM-150 and the 150-1200 winding sections were joined, the resulting DCR=14 could likely support at least 300mAdc (constant 1.3 to 1.5W) as they are the outermost windings. The peak nI of a half primary is circa 102Vt x 0.1A = 10 for a peak 100mA. An equivalent nI for the special secondary would be 85Vt x 0.12A. The dc volt drop at 0.12A is ~2V.

6BM8 matched pair 44,54 show 44 conducts first and takes full conduction for a few seconds. Swapped 44,55 pair in V2 & V3 locations to get balanced pentode drive levels. AC balance pot can null out 2HD, with 3HD remaining fairly constant.

Output to 9Vrms (5.2W) peak into 15.5Ω load. Distortion is quite low, rising above 4Vrms (1W), with 9Vrms (pk output setting) sinewave showing some cross-over distortion and one side starting to soft-clip, with gross overload causing severe clipping and Vrms reducing.

Feedback level 3.8dB with R8 disconnected.

- 1W distortion 0.5% THD from 300Hz to 1kHz, and rising outside, with nearly equal 2nd and 3rd, but 2nd dominant at higher frequencies.
- 4W distortion 5% THD from 50Hz to 3kHz, with 3rd dominant and flat, until 2nd dominates above 5kHz.

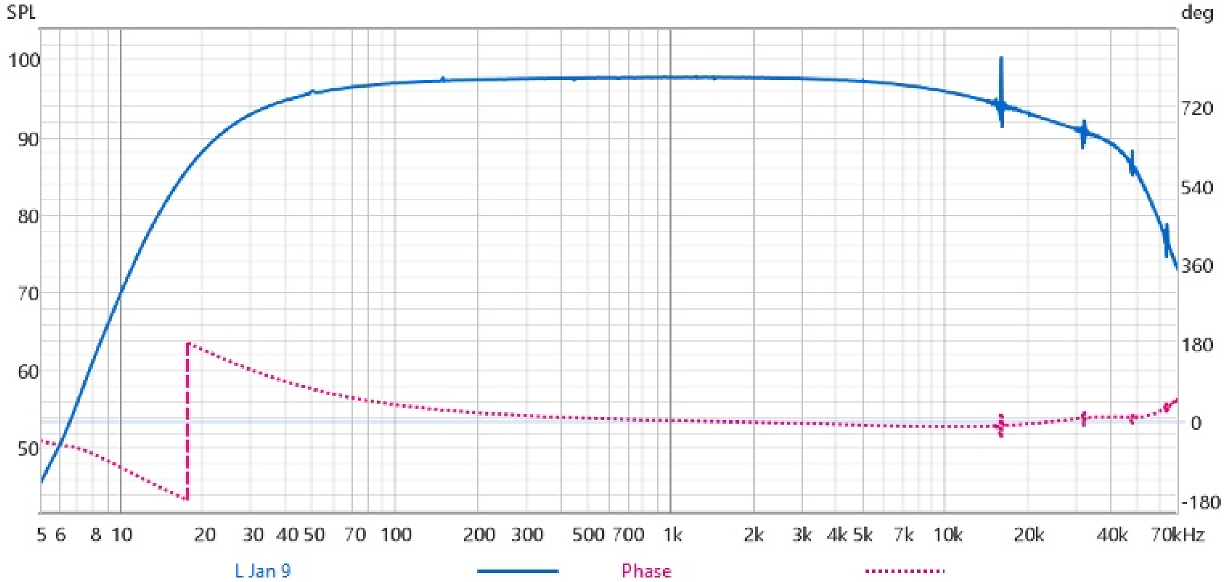
Signal gain for 6Vrms output on 15.5Ω, with tones at min and Vol at max.

- RV3 top at 15mV (RV3 at max)
- Input ~0.76mV, so first stage gain abt 20x.
- from V2A triode input to V2B pentode input ~ 9V/0.18V = 50x.

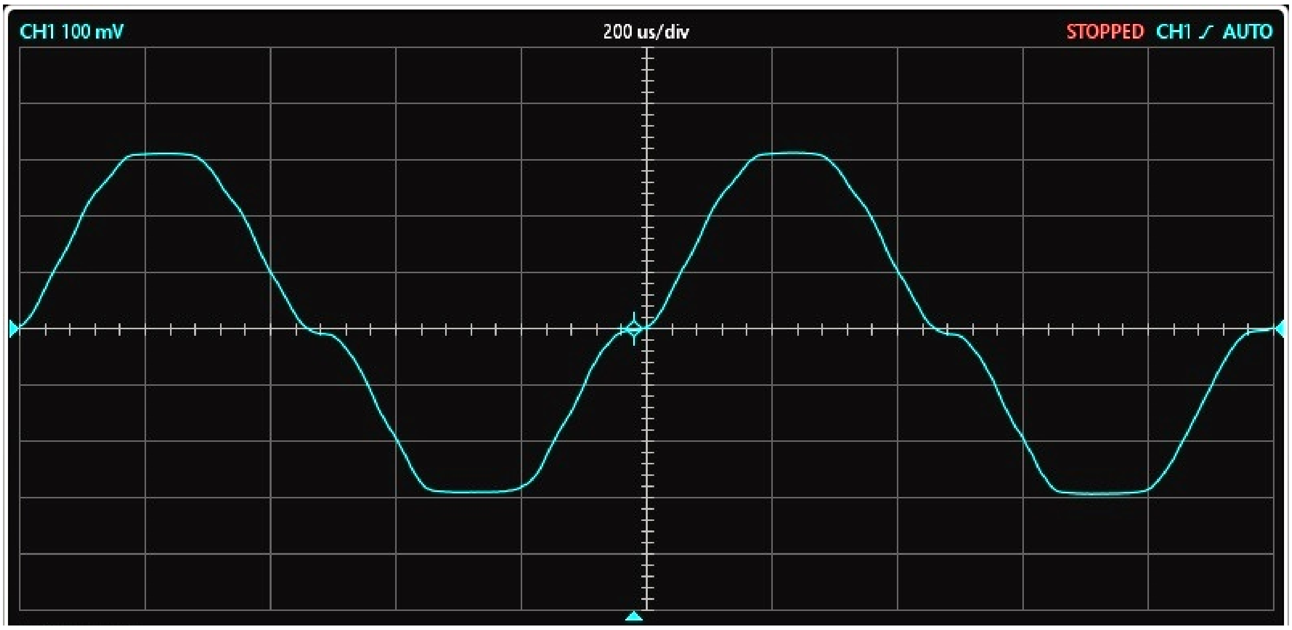
240Vac mains has heater voltage sitting at 6.25Vac at idle.

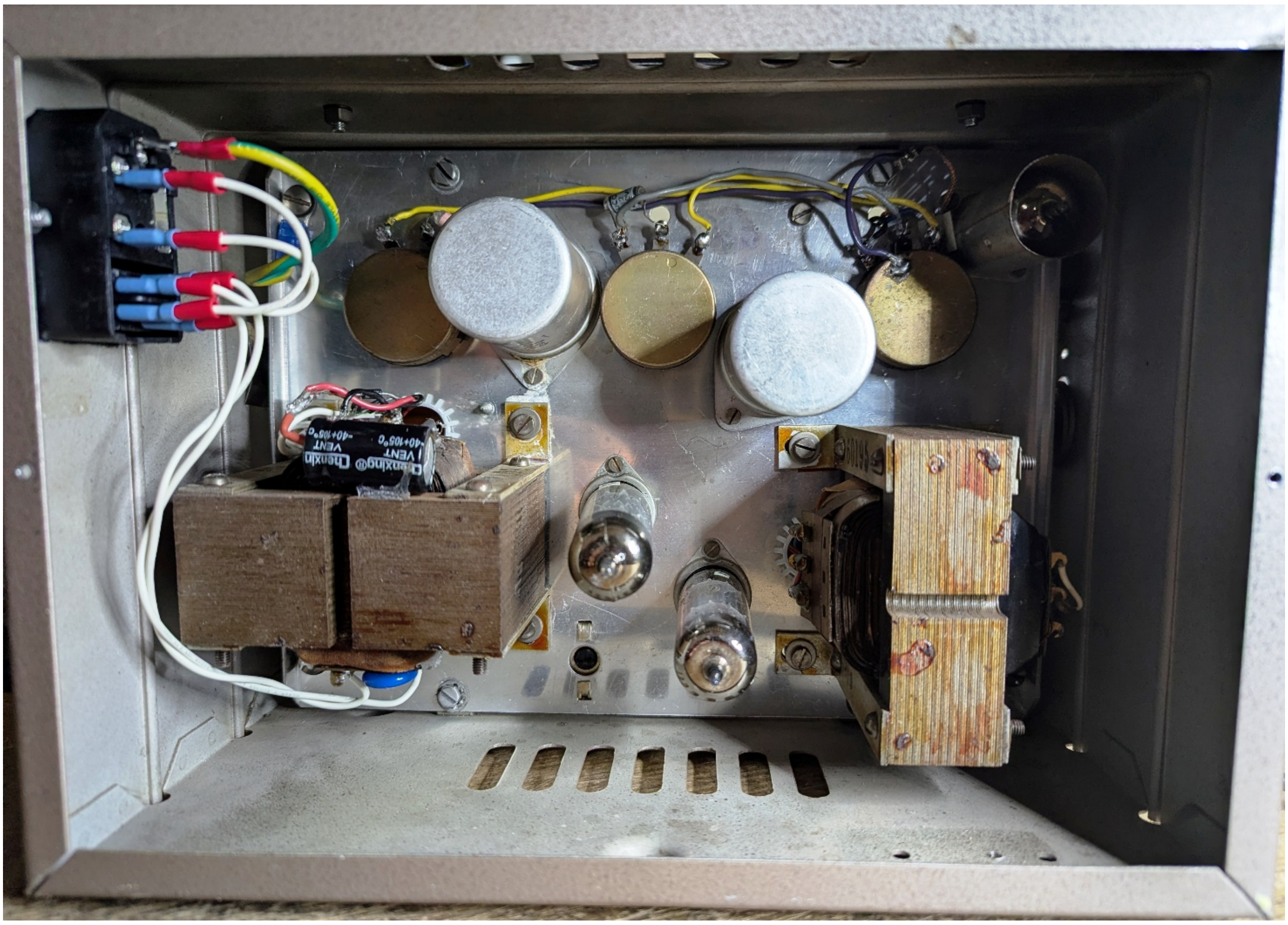
Phono Vol gives +5dB at 2-3kHz at max, and flat at min, but depends on Mic Vol setting. Phono tone gives treble cut from -2dB at 10kHz at max, to 2-3kHz corner and -9dB at 10kHz at min.

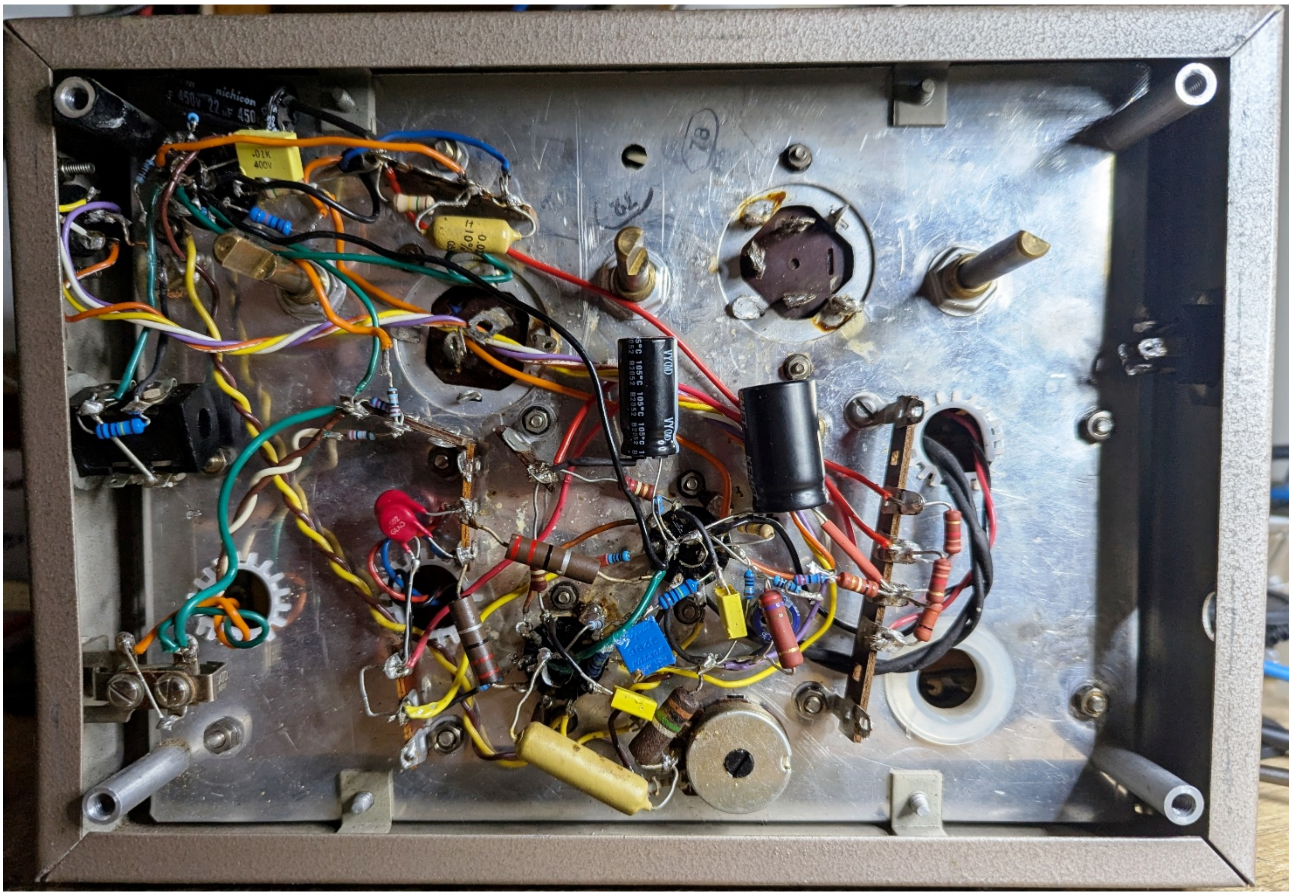
Example frequency response for Mic Vol = 90%, Phono Vol = min; Phono Tone = max.



5.4W cranked 1kHz waveform.



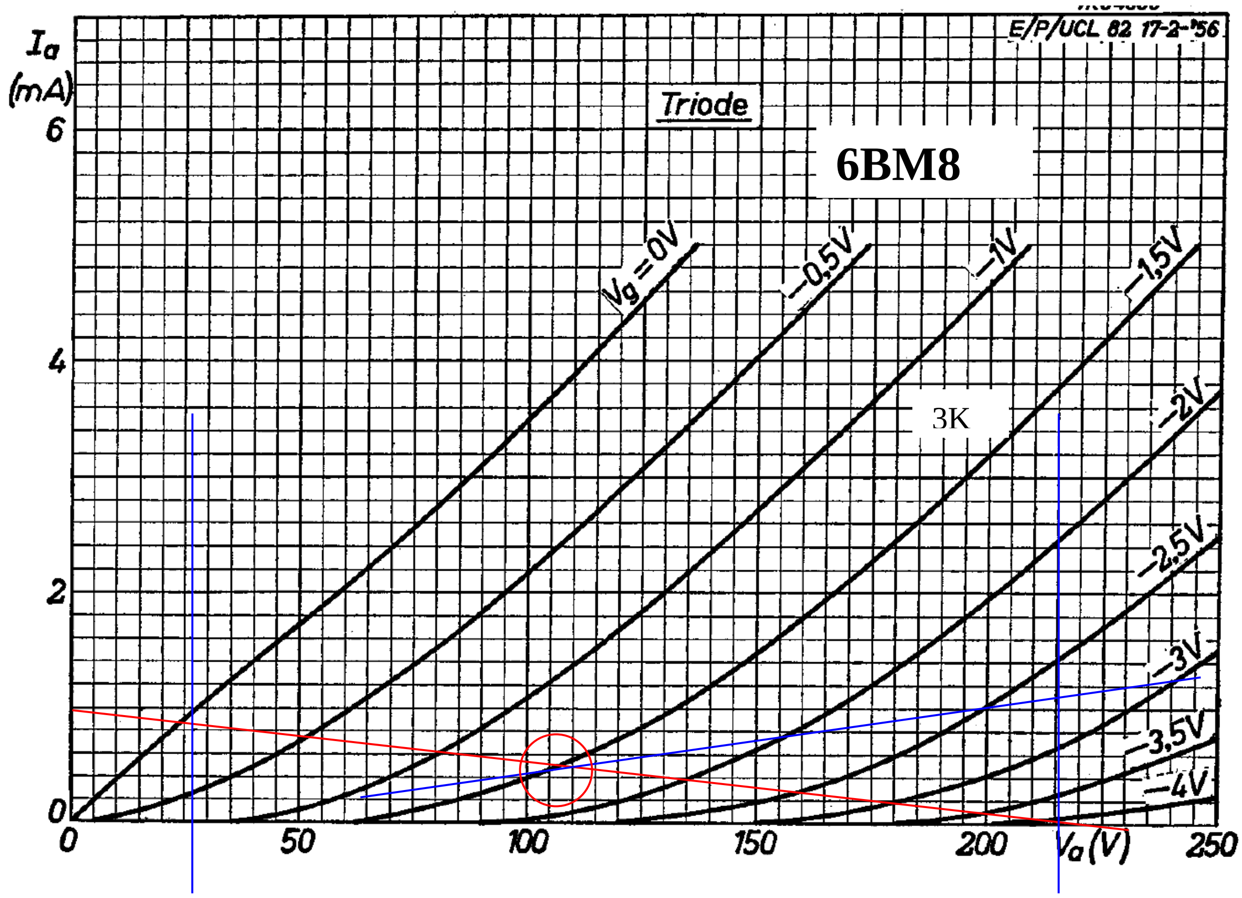




3. Design Info

3.1 Splitter stage – 6BM8 Triode

Cathode-coupled floating paraphase configuration phase splitter [Carpenter, Scroggie WW 1945] but with additional simplified/economy of parts. The output stage grid leaks form part of the floating difference signal presented to V3A, and the common cathode arrangement of the PI does not require capacitor bypass. An added 100k trimpot allows nulling of second harmonic level of the output, and sits at nominal ground voltage.



3.2 Output Stage

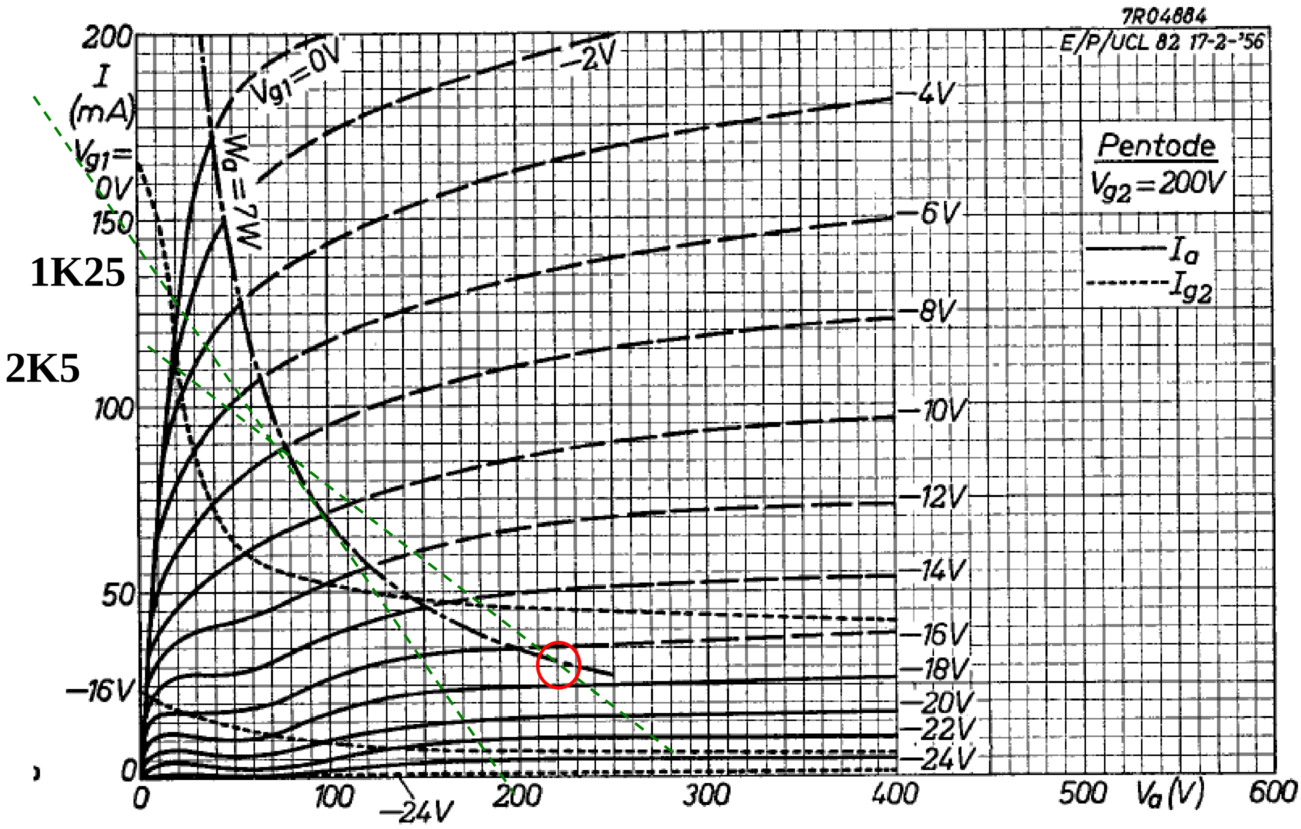
In this Class AB push-pull output stage, one tube is pushed into conduction and the other tube is pulled into cutoff, and there is a region of overlap where both tubes conduct equivalent levels of current. The cathodes are biased to +18V using a common cathode resistor. The 5KΩ impedance plate-to-plate OPT presents each tube with a 1.25KΩ load impedance (with a matched secondary load) for signal currents in Class B region, and 2.5K in Class A region.

The supply voltage VS1 to the output valve plates is about 230V. Plate-cathode voltage will be lower than VS1 by an amount up to ~17+3=20V; ie. OPT half resistance of about 76Ω and 22Ω stopper with an idle current of 0.03A, and 17V cathode bias. As the output loading increases, the supply voltage VS1 to the output valve plates sags to about 220V. Plate DC voltage will be lower than VS1 by an amount up to ~25+11=36V; ie. OPT half resistance of about 76Ω and 22Ω stopper with a peak current of up to about 0.12A, and 25V cathode bias.

Screen voltage supply VS2 will vary from about 200V towards 180V under steady-state heavy load. Screen voltage lower than VS2 by 17V at idle, and ~ 25+30=55V due to the 1kΩ stopper resistors at up to 30mA screen current per tube, and the cathode bias voltage. Peak screen power dissipation is then up to 30mA x 150V = 4.5Wpk, and about 180 x 0.008 = 1.4W average.

The maximum output valve bias current allowed is dependent on the maximum recommended plate dissipation of 7W, + 3.2W for the screen, for the 6BM8: Ibias(max) = Pd / Vb = 7W / (220-20V) = 35mA.

Assessing the 6BM8 plate curves, which shows the 7W constant power contour, indicates how the amp may dynamically exceed plate max design dissipation levels. Note that these curves are for a 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.



3.3 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 0.3A + 2x 0.78A = 1.8A.

C11A is replaced with a CRC 47uF, 100Ω, 47uF 450V filter to VS1. A UF4007 full bridge replaced the original bridge.

0V ground is distributed star, with single link to chassis from V1 socket spigot, although another link was used as the speaker output socket could not be easily isolated.


V1A
12AX7
V1B
12AX7
V2A
6BM8
V2B
6BM8
V3A
6BM8
V3B
6BM8
SKA
SKB
SKC
R1 2·2M
R2 3·3K
R3 220K
R4 220K
R6 470K
R7 470K
R8 220K
R9 3·3K
R11 220K
R12 470K
R14 1·5K
R16 220K
R17 220K
R18 1M
R19 220K
R21 1M
R22 470Ω
R23 470Ω
R24 1M
R25 220K
R26 22K
R27 22K
R28 22K
R29 22
R30 22
RV1 500K
RV2 500K
RV3 500K
RV4 500Ω
C1 ·022
C2 1500
C3 ·047
C4 ·022
C6 ·022
C10 33
C11A 40μF
C11B 50μF
C11C 50μF
C12 0·1
C9A
C9B 8μF
MR1
TR1
1TS60720
240V
220V
10V
180V A.C.
70mA D.C.
6·3V.
1·8A.
Y.E.T.
TR2
2TS60195
GY
O
G
Y
BR
W
BK
BU
1 & 2 = 150 Ω
1 & 3 = 300 Ω
2 & 4 = 600 Ω
1 & 4 = 1200 Ω
(100 VOLTS)
CHASSIS LAYOUT
VIEWED FROM BACK.
V1
V2
V3
TR1
TR2
SERIAL No.
AWA
8 WATT AMPLIFIER
TYPE 1G59774
DRG. 59774C1
CH.567.


V1A
12AU7
2
RV2
500K
1n2
RV1
500K
C2
1n
V1B
12AU7
2
V2A
6BM8
2
V2B
6BM8
2
R29
22
C1
22n
57V
MIC VOL
RV3
500K
R6
100k
10K
R1
1M
2.2V
R2
2K2
R4
150K
PHONO VOL
PHONO TONE
57V
R9
2K2
2.2V
C3
10N
R11
150K
R12
470K
C4
10N
R19
220K
R21
1M
1K
10
M3
17.3V
M2
R22
270
C11B
100uF
M1
100K
R14
1.5K
R18
1M
10
M4
R17
220K
1K
R8
220K
R24
1M
C12
220N
R16
220K
V3A
6BM8
2
C6
10N
V3B
6BM8
2
R30
22
100K
M5
1K
TR2
2TS60195
350Vdc
350Vdc
16 OHM SPEAKER
5.2W for 22mV input to V1B.
Input stage gain about 20x.
1 & 2 = 150 Ω
1 & 3 = 300 Ω
2 & 4 = 600 Ω
1 & 4 = 1200 Ω
130 VOLTS)
R25
220K
R26
22K
TR1
1TS60720
240v
220v
275VAC
180V. A.C
70mA D.C.
MR1
47uF
100
225V
R27
3K3
216V
R28
3K3
208V
C11A
47uF
C9A
22uF
C9B
22uF
800mA
IEC T
5x20
6.3V.
1.8A.
RV4
500Ω
V1
V2
V3
IEC COMBO
CHASSIS LAYOUT
VIEWED FROM BACK.
TR1
TR2
5-PIN MAINTENANCE SOCKET
M1, M2, M3, M4, M5
SERIAL No AF9919
8 WATT AMPLIFIER
TYPE 1G59774
DRG. 59774C1

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8-watt portable AMPLIFIER

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