1. Summary

#1: AWA PA829 20W AC/DC valve amplifier. S.N. 274. $125 Jan 2012
#2: AWA PA829 20W AC/DC valve amplifier. S.N. 315. $125 Jan 2012

Three MIC input channel PA amplifier, with switched Radio and P.U. inputs to MIC 1 channel, and four switched tone settings. 3x Z729/6AU6 input stages feeding 6AU6 mixer stage. 12AX7 self-balancing, floating paraphase PI with unbypassed cathode biases. Separate cathode biased KT66 PP; screens tied to B+; RC filters on each plate; separate feedback winding to cathode of PI input triode. Switched PA speaker loading from 1 to 20 speakers, with sockets for monitor speaker and V.U. meter. 12V non-synchronous vibrator or AC supply, with input connector used to select DC supply for heaters. Humdinger with decoupled DC elevation. Dual 6X4 rectifier with secondary winding bypass capacitors.

#1:

Output Transformer	AWA Type 2TJ57768 20W nominal ?000Ω PP 5 output winding sections 0,25Ω,70Ω,150Ω,300Ω,600Ω. Secondary turns ratios: 0-20-34-50-71-100%.
Power Transformer	AWA Type 1TK57805. 0-215-245V; 275-0-275V @ ~?00mA (RD,BK,RD); 6V3 5.6A; 12-0-12V vibrator.
POTs	IRC 56829T21.
Caps	UCC 'Superseal 85' and Ducon TPB wax foils; UCC & Ducon electrolytics.
Valves	KT66 x2: PK 4; SB Z; 6AU6 x4 12AX7 6X4 x2
Vibrator	V5123 non-synchronous 12V 4A 100Hz AWA

Excellent general condition – underneath almost pristine. Both KT66 marked with X. No case.

#2:

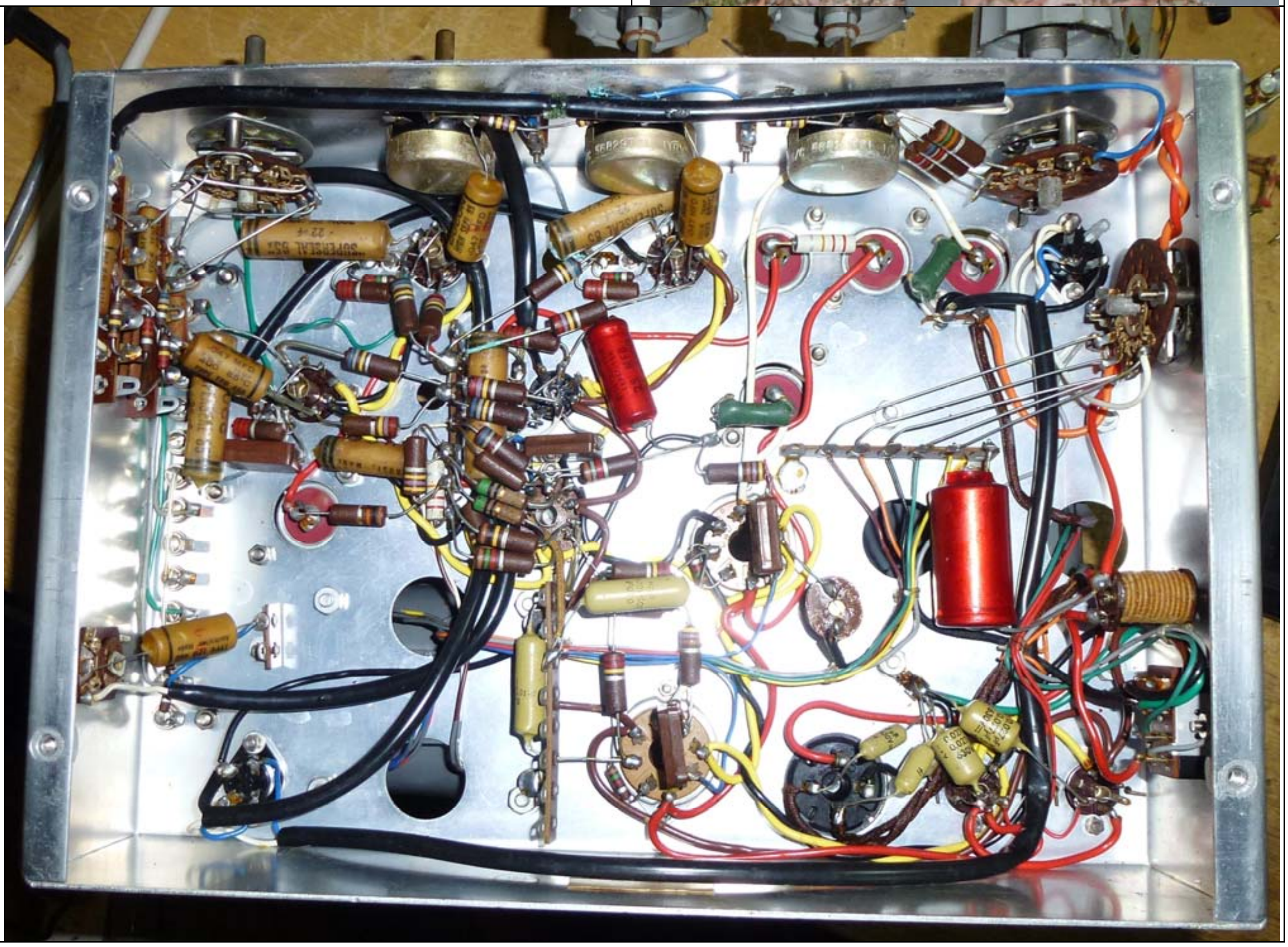
Output Transformer	AWA Type 3TJ57768 20W nominal ?000Ω PP 5 output winding sections 0,25Ω,70Ω,150Ω,300Ω,600Ω. Secondary turns ratios: 0-20-34-50-71-100%.
Power Transformer	AWA Type 2TK57805 0-215-245V; 275-0-275V @ ~?00mA (RD,BK,RD); 6V3 5.6A; 12-0-12V vibrator. Upright with steel bell-ends. 100x80mm footprint. 115mm high.
POTs	IRC 56829T21.
Caps	Ducon highseal TPB
Valves	KT66 x2: 7742 Z; UJ Z Z729 x3: Z729 Radiotron XJ 3; EF86 Telefunken; EF86 Mullard 8Y6 L8H5 6AU6: Radiotron JH27 12AX7: Radiotron JM24 6X4 x2: Radiotron KB 9;
Vibrator	V5123 non-synchronous 12V 4A 100Hz AWA; 0 40

Excellent general condition – underneath almost pristine. Some corrosion on lead wires. Both KT66 marked with X (one obviously milky getter). No case.

Issues:

AC supply not fused or switched, and connected to socket, and wiring is minimal insulation and is grouped with secondary cables. Chassis only - no original case. Missing knobs. Old electrolytics and leaky waxed foils. Switched speaker connection. Distributed chassis grounding. Microphonic V1-V4 sensitivity.

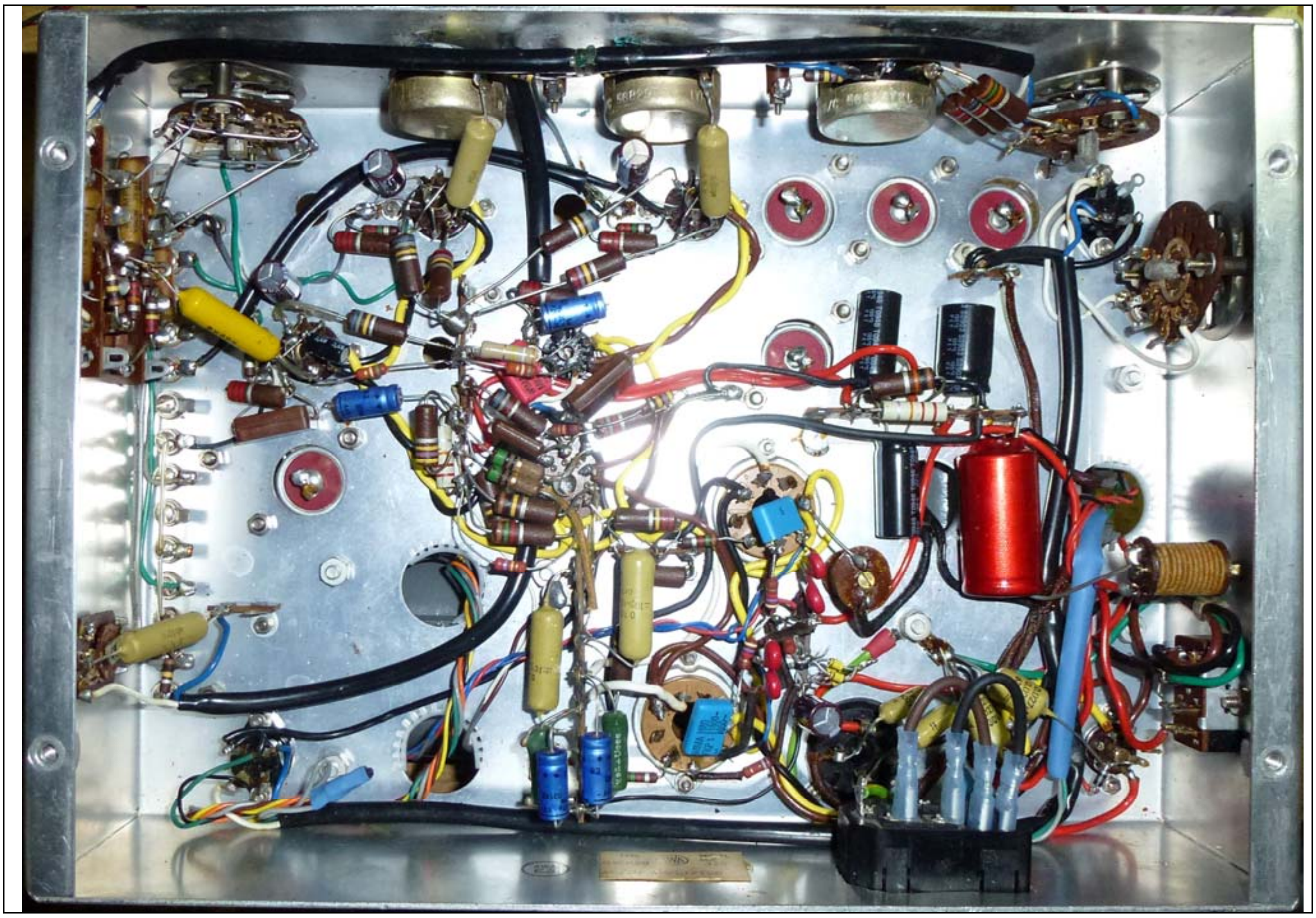
Comparison between amps:
Serial numbers are quite close. The PT and OT transformers are same spec but next version (it seems) with slight changes in core stampings and use of bell-ends. Everything else appears to be the same except input pentodes changed from 6AU6 to Z729/EF86 (pin wiring different).



2. Modifications

Unit #2 only:

- Megger checked transformers (but not PT secondary, and OT primary).
- Relocated V5 and V7 heater wiring to keep close.
- Hardwired output to 70-150 (GRN-BLK) OT tappings for 15Ω output (ie. bypass selector switch and lift 0R tap).
- Relocated OT secondaries from tag strip to SPKR socket, with unused taps insulated. Removed tagstrip wires to speaker output switch. Grounded GRN tap.
- Added series 1N4007 for each pair of 6X4 anodes.
- Separated AC mains cables and insulate.
- Separated 0V wiring for PT CT and filter cap.
- Added 10k grid-stopper to V5 pin2.
- Use tagstrip for HT replacement capacitors (22uF and 2x 15uF 450V) and relocate droppers.
- Relocated V6/V7 cathode resistors to tag strip next to V7, and locate new caps to tag strip, and take 0V to star point of main HT filter cap.
- Relocated feedback 0V to end of R33 1k8 cathode resistor.
- Unsolder mains lead-ins from connector and take to new mains switch/fuse/socket assembly – add MOV.
- Removed S4 flying lead – this has disabled the 12VDC powering option.
- Bridged CM1 pins 5, 7, 8 – this has hardwired the heaters for T1 powering.
- Added 47uF bypass cap on the heater elevation supply (removed leaky wax cap).
- Added 2x330VDC MOV across each OT primary-half.
- Added 680Ω screen stoppers to KT66, and added common 1k and 4.7uF filtering – check hum – can always add small choke if needed.
- Perhaps remove V2 and V3 normally, and short out mixer R26 (470k), and use the two VOL pots for loading on the output of the V1 tone circuits.
- Added 10k grid-stopper for V1 input – to allow guitar input.
- Replaced 0.22uF screen bypass wax caps with 4u7 400V electros – voltage rating to suit EF86's being pulled, and small enough to connect to local 0V. Only V1 left in.
- Replaced 0.047uF coupling wax caps with mustards (and one MKS).
- Tuned V1 and V4 screen and voltages.
- Tweaked R39 (//2M2) to give equal gains on both side of PI.
- Added 220uF 10V bypass on C31 to maintain bass response.
- Output valve socket pins 6 and 1 are now free. RC anode filters removed. Grid feed node that connected via pin 6 was moved to spare tags nearby.
- 6L6GC used to check levels (pin layout, grid leak, heater current, supply voltage ok). Can use KT66, 6L6, 6L6G, 6L6GC, 7027A.
-
- Add speaker connector to rear panel near SPKR socket.
- Work through a process to allow 12VDC powering (eg. remove AC mains fuse).



3. Measurements

Unit #2 only:
Megger test 1kV on PT mains, and 500V on OT primary and secondary – all ok.

Voltage rail regulation.

Rail	200Vrms	240Vrms	Mains 2x33V zeners		
	6L6GC	6L6GC	6L6GC		
VS1 Screen supply	250V/8.2Vrms 245V/2.5Vrms	300V	320V 251V		
VS2	170V		229V		
VS3	150V		212V		
VS4 heater dc					
Cathode	15.7/15.8V (48+48mA)	20/20V (60+60mA)	16.5/16.5V (50+50mA)		
Heater					
Sec HT					

215V O-GY ohm; 245V G-GY 31ohm: 275-0-275 90+90 DCR.

#1: 12VAC 50Hz nominal applied to output transformer

Winding	Voltage rms	Turns ratio; Impedance for K pri; Spec level; DCR
Pri P-HT: BU to RD		155+144
Sec: WH to BRN		; Ω; Ω; T 1.4R
Sec: GY to MV		; Ω; 600Ω; 1000T 26.8R
Sec: GY to OR		; Ω; 300Ω; 707T 14R
Sec: GY to BLK		; Ω; 150Ω; 500T 7.6R
Sec: GY to GRN		; Ω; 70Ω; 342T 5.4R
Sec: GY to Y		; Ω; 25Ω; 204T 3.3R

Output transformer primary DC resistance:
299Ω plate-to-plate k.

#2: 12VAC 50Hz nominal applied to output transformer

Winding	Voltage rms	Turns ratio; Impedance for K pri; Spec level; DCR
Pri P-HT: BU to RD		149+141
Sec: WH to BRN		; Ω; Ω; T 1.4Ω
Sec: GY to MV		; Ω; 600Ω; 1000T 25.7Ω
Sec: GY to OR		; Ω; 300Ω; 707T 14Ω
Sec: GY to BLK		; Ω; 150Ω; 500T 7.6Ω
Sec: GY to GRN		; Ω; 70Ω; 342T 5.4Ω
Sec: GY to Y		; Ω; 25Ω; 204T 3.1Ω

Output transformer primary DC resistance:
290Ω plate-to-plate k.

Signal gain of V1 ~26 at 1kHz at 1Vrms on C6/R18 node; starting to clip at 1.3Vout.
Signal gain of V4 ~91 at 1kHz at 1Vrms on V5 grid; starts to gross distort at ~5.5Vout.
Signal gain of V5 ~23 at 1kHz at 3Vrms on V6 grid. V7 grid trimmed to same output level (no feedback).

1Vout high frequency instability/noise when R15/C27 and R52/C28 removed. No noise when 680pF/4k7 filter applied across each plate-B+ primary half-winding.

Clean output to 10Vrms in to 16 ohm (6.3W). -3dB at about 50Hz and 10-12kHz.

4. General comments.

The OT section between 25-70 provides an 11.5Ω impedance (14% turns of secondary turns); between 70-150 provides a 15.1Ω impedance (16%). Although the #1 OT has exposed secondary winding terminations underneath outer insulation, there appears to be no common turns number groups.

The input pentodes appear to be typically biased, with 2k2 cathodes (1W for lower noise).

KT66's set up as per standard datasheet: 330R cathode for 350V.

6.3V heater loading: 2x 1.3A, 5x 0.3A, 2x 0.6 = 5.3A.

The 6X4 has limits on the effective source resistance when feeding a capacitor-input filter. The effective source resistance is comprised of the reflected power transformer primary resistance = 31Ω x $(275/240)^2$ = 40Ω; plus the secondary resistance = 90Ω; which sums to 130Ω. The Brimar datasheet indicates the effective source resistance should be 150Ω for a secondary supply of 325-0-325Vrms, based on 8uF and 70mA max load. Both anodes are in parallel, per secondary, and secondary is 275V, so direct feed to 16uF using 275-0-275VAC appears fine out to 140mA with 300VDC expected.

NTC NTH13D160LA for up to 1.7A; 16Ω cold would add 21Ω to effective secondary source resistance – not considered significant enough to use.

470Ω and 1600pF has a corner f=210kHz, with impedance reaching 10kΩ at f=10kHz. This was changed to 680pF/4k7 network (f=50kHz) across each half-winding to remove feedback instability.

6k8 and 400pF has a corner f=58kHz.

Pot R24 could be converted to a master volume pot, placed in parallel with R32.

Pot R25 could be converted to a single-pot tone for mid-scallop shaping at one end of wiper, and no change at other end. Tone circuit could be an RLC and load V4 pre the master volume.

V2 and V3 could be converted to an RIAA phono stage with outboard step-up transformer. Input terminals could be used as the phono stage output to allow it to be linked to V1 input, or alternatively S3 could be reconfigured to choose either phono or V1 stage inputs – depending on RIAA gain, the phono stage could inject in to V4 or V5.

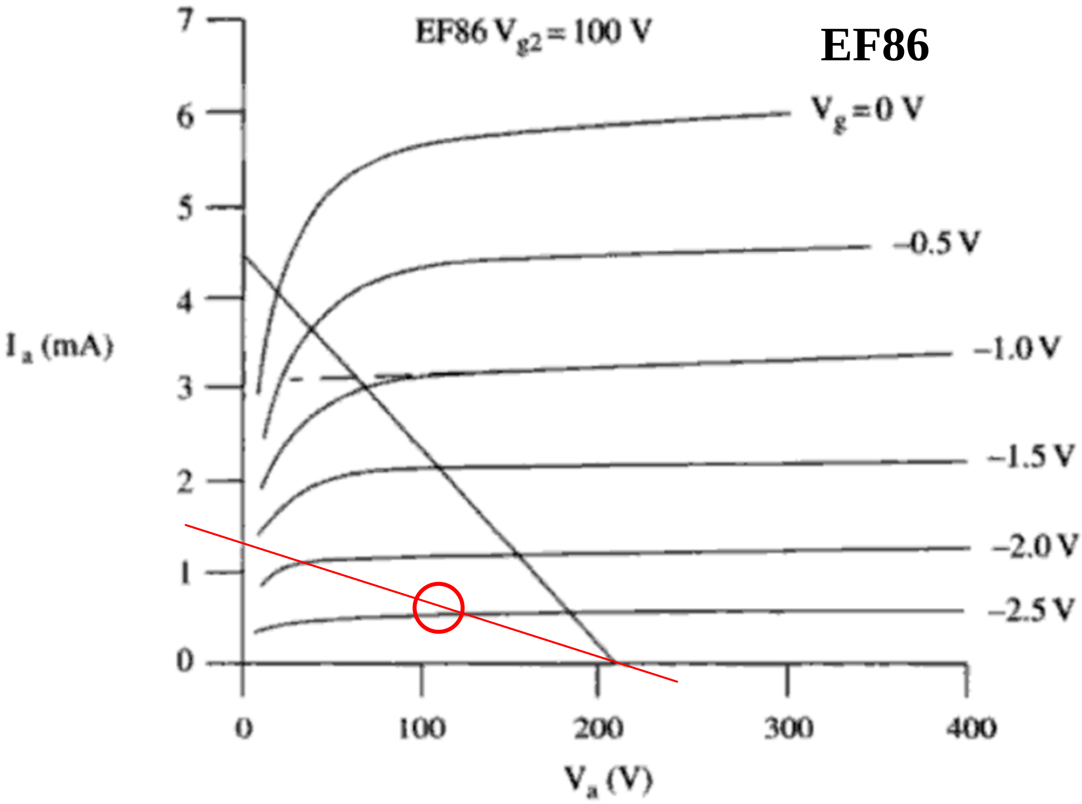
The 6AU6 and EF86 are prone to microphonic pickup. It would be almost impossibe to isolate each valve base, due to the heavy gauge resistor wire connections. The chassis would need to be spring isolated, and each valve could benefit from clamping to the chassis, or weighted down, to alleviate some level of light-weight free movement.

4.1 Input stage – EF86 Pentode

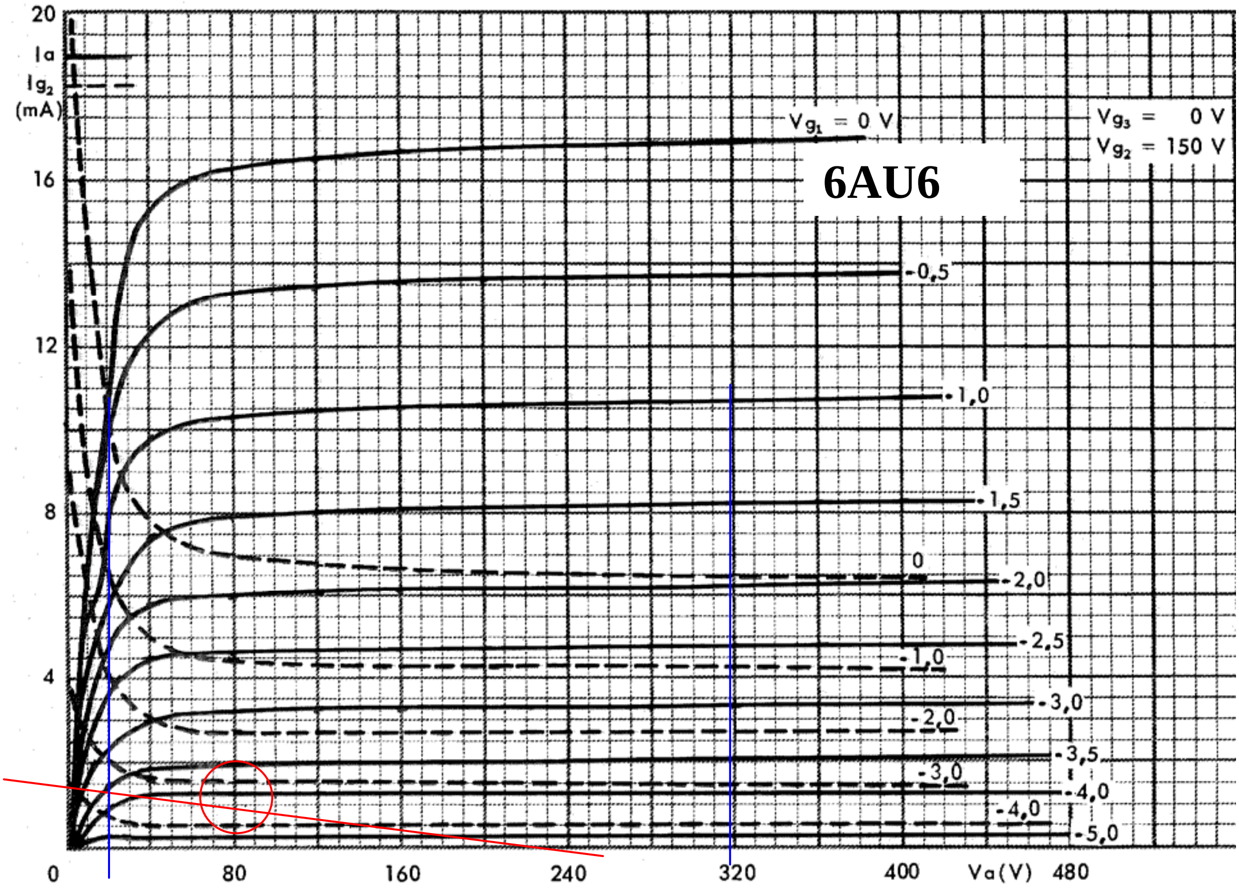
VS3=175V; V1 Plate=20V; screen=66V; cathode=V; 2k2=mA.
VS3=212V; V1 Plate=109V; screen=89V; cathode=2.2V; 2k2=1.0mA. 150k anode mod. V2,V3 out.

VS3=175V; V2 Plate=19V; screen=65V; cathode=V; 2k2=mA.
VS3=175V; V3 Plate=25V; screen=58V; cathode=V; 2k2=mA. Screen 0.15mA; anode .5mA

VS3=175V; V4 Plate=50V; screen=55V; cathode=1.3V; 2k2=mA. Screen 0.16mA; anode .42mA
VS3=212V; V4 Plate=103V; screen=99V; cathode=2.2V; 2k2=1.0mA. 150k anode & 390k screen mods. Screen 0.29mA; anode .72mA



Databook pentode curves only for screen Vg2=150V. The AC load line is about 150k, due mainly to the 270k plate load, and 470k grid leak of the PI.

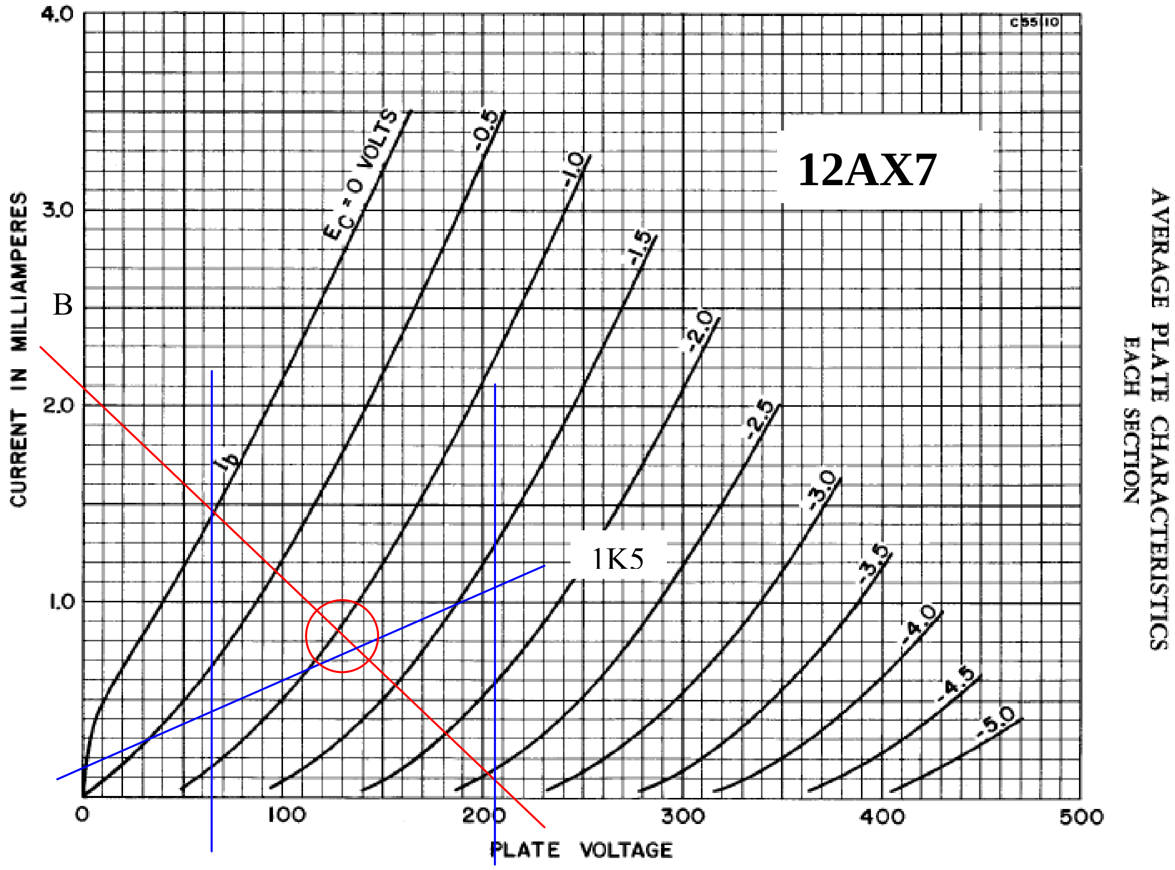

20
Ia
Ig2
(mA)
16
12
8
4
0
80
160
240
320
400
Va(V)
480
Vg1 = 0 V
Vg3 = 0 V
Vg2 = 150 V
6AU6
-0,5
-1,0
-1,5
0
-2,0
-2,5
-1,0
-3,0
-2,0
-3,5
-3,0
-4,0
-4,0
-5,0

4.2 Splitter stage – 12AX7

The splitter stage splits into two signals, 180 deg out of phase from one another, and presents a voltage amplified drive to the push-pull output stage. The original circuit is a floating paraphase phase splitter configuration with independent cathode bias resistors, which provides high voltage gain. The 220K resistors form the voltage divider so half of the top stage's output is applied to the grid of the lower stage. Phase shift between the two outputs introduces problems as frequency increases, and distortion can be significant, especially odd harmonics. NFB from the amp output is passed to the input stage cathode.

For the first half 12AX7, V5A, plate voltage VS2 = 229V; Va=139V; Rk=1k8//6k8; Vk=1.22V; Ia=0.9mA; RLdc=100k.

The second half has local feedback, so the effective output impedance may be lower.



4.3 Output Stage

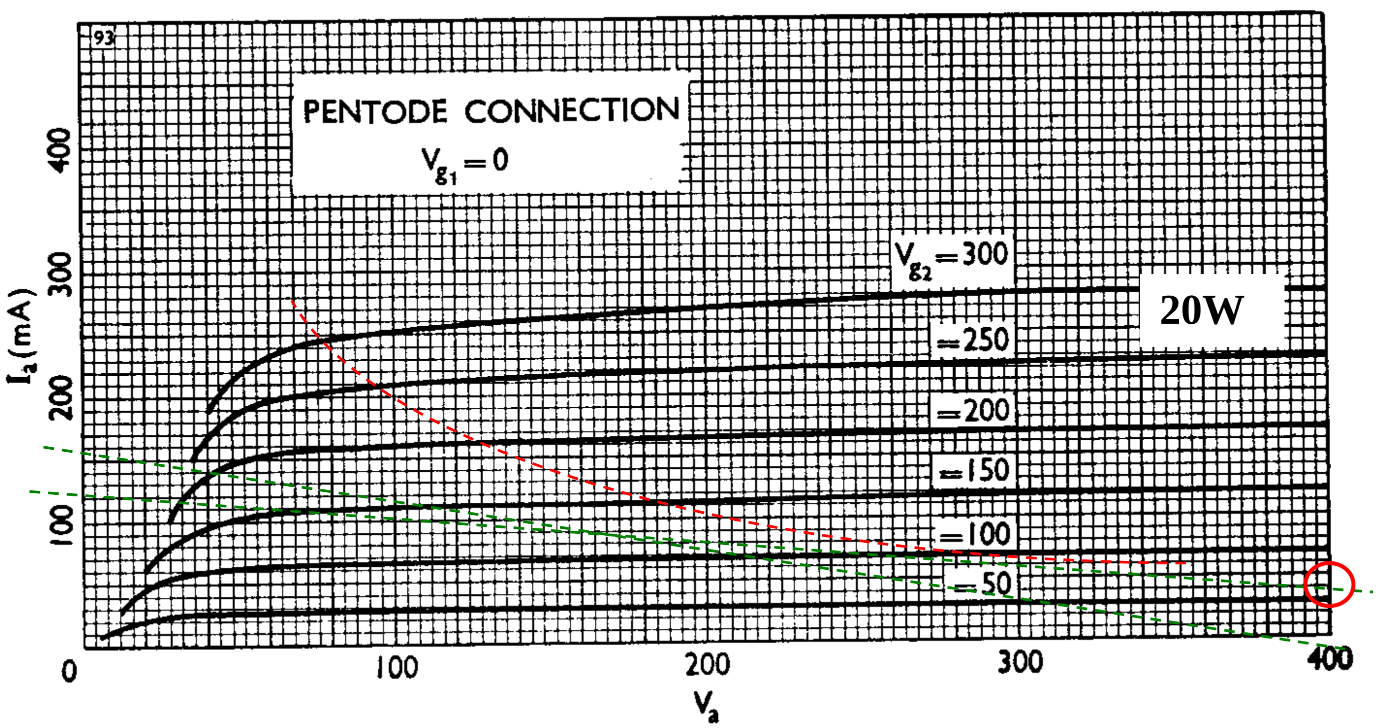
In this Class AB push-pull output stage, one side is pushed into conduction and the other side is pulled into cutoff (class B), and there is a region of Class A overlap where both sides conduct equivalent levels of current. The cathodes use separate bypassed 330Ω cathode resistors. The 9.6kΩ impedance plate-to-plate OPT presents signal currents into each tube with a 4.8kΩ impedance with both tubes conducting, changing to 2.4kΩ load impedance at higher levels.

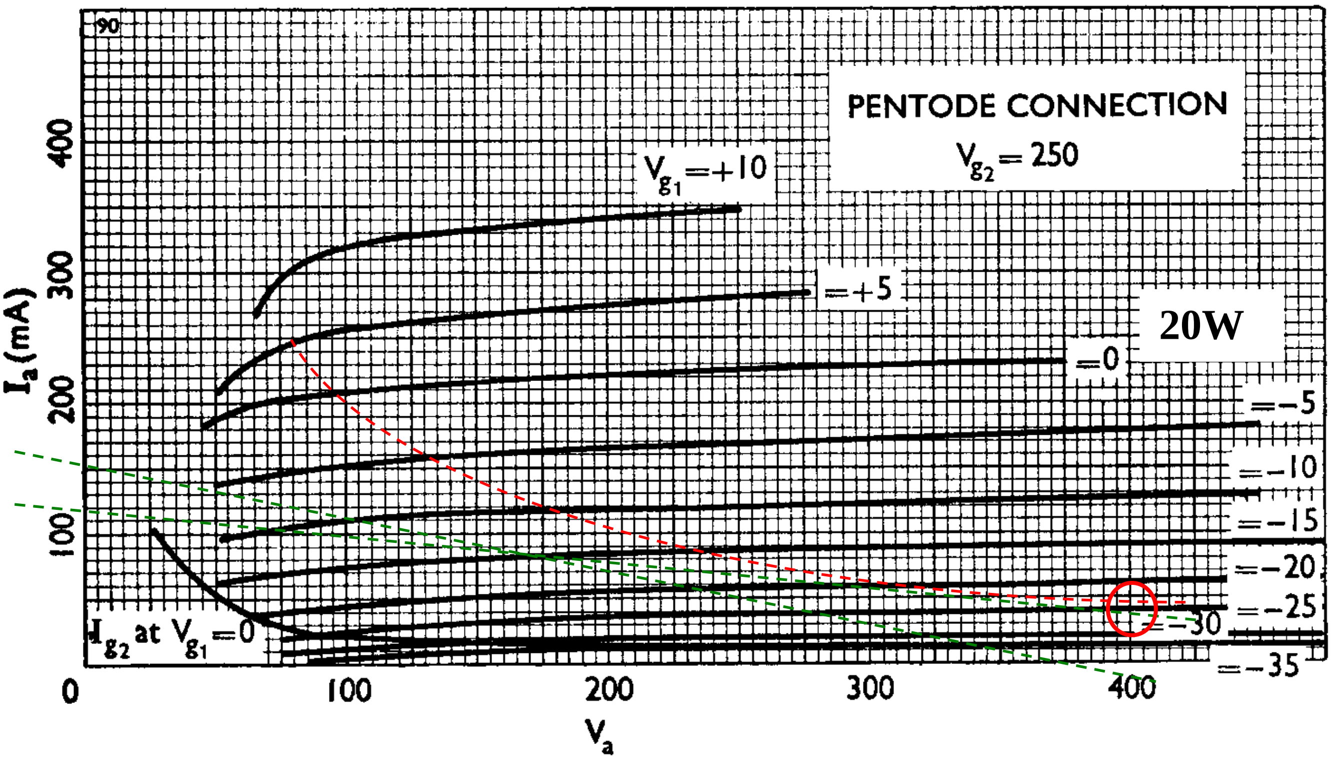
As the output loading increases, the supply voltage VS1 to the output valve plates sags from about 420V towards 400V (check). Plate-cathode DC voltage will be lower than VS1 by an amount from 3+20= 23V, up to 15+25=40V; ie. OPT half resistance of about 145Ω with a peak current of up to about 0.14A = 20V drop, plus 0.14 x 330 ~46V bias peak.

Screen-cathode voltage is filtered from VS1 by 1k and 4u7F (33Hz corner, so there will be some attenuation of 100Hz ripple), with idle voltage drop of about 1k x 2 x 0.04 / 7 = 11V, and screen sits about 680 x 0.04/7 = 4V lower due to 680Ω screen stoppers. Screen current increases up to about 140/7=20mA/tube, and so screen voltage may droop by about 0.04x1k + 0.02x680 = 54V, and screen-cathode voltage could reduce to about 400-20-46-54 = 280V.

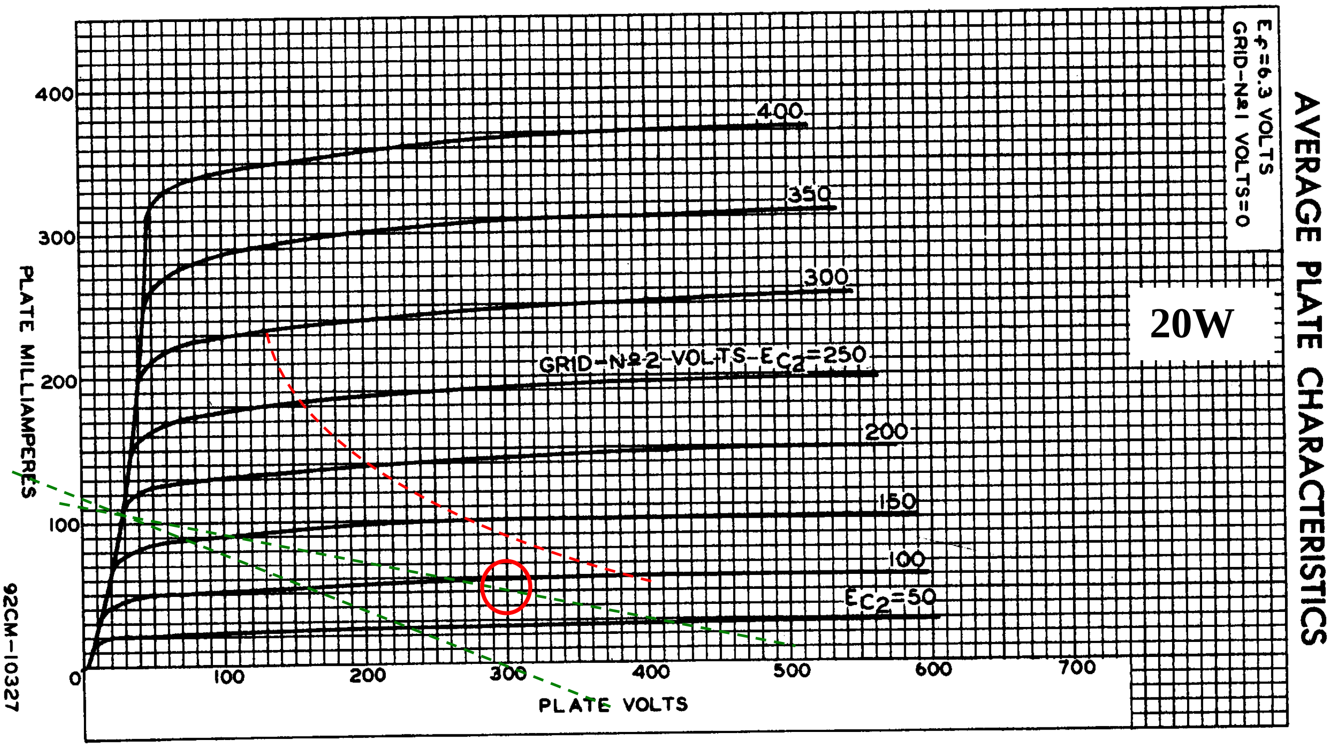
The output valve bias current was about 40mA, based on 13V across common 330R cathode resistor: Pd = 400V x 40mA = 17W, which is conservative 70% of max design level. Cathode resistor dissipation peaks at 330 x 0.14 x 0.14 = 6W.

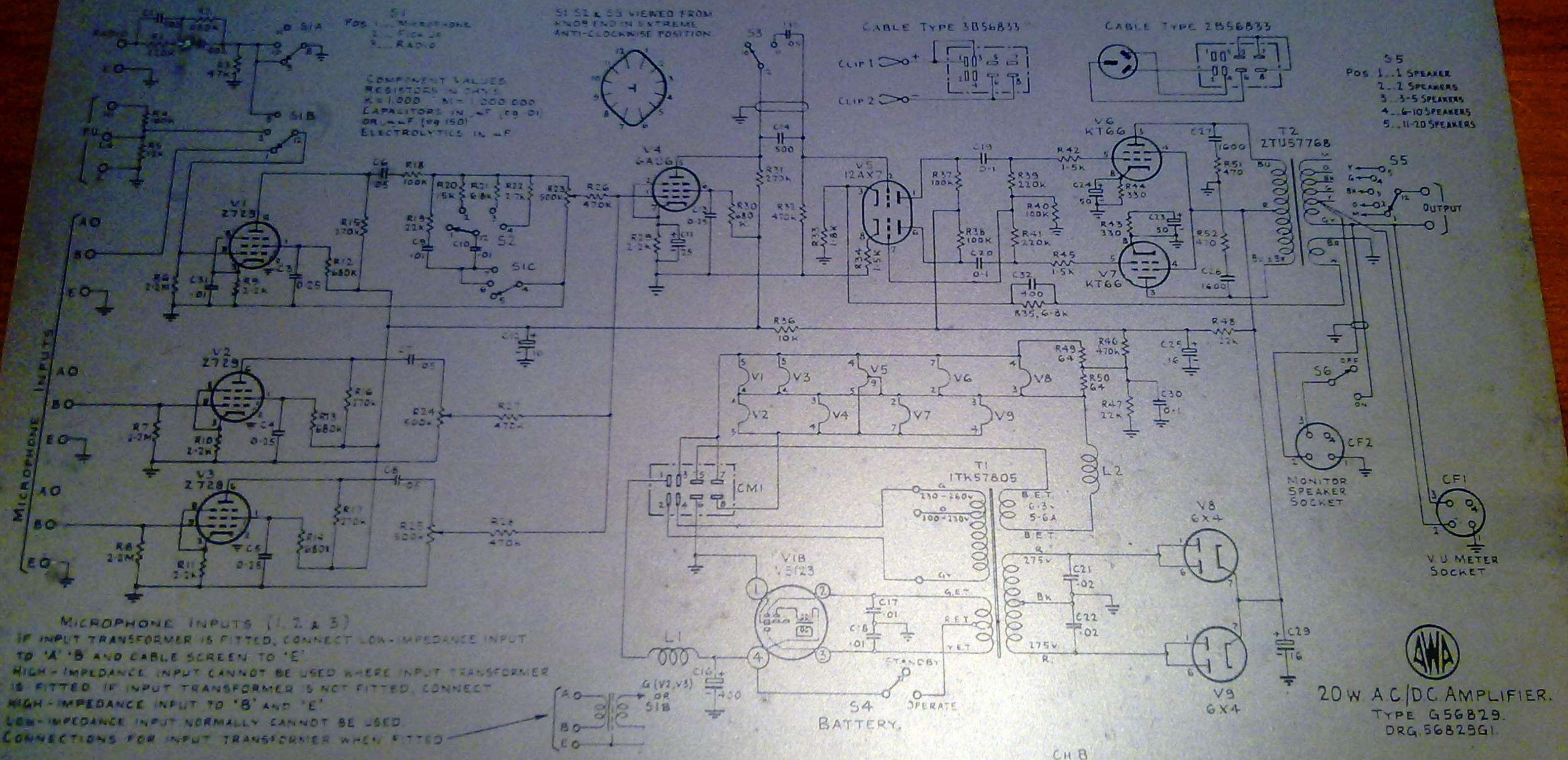
Assuming the loadline achieves a peak plate current of 140mA, then the nominal output power of the amplifier would be: $(Ipk)^2$ x Rpp / 8 = 0.14 x 0.14 x 9.6k / 8 = 23W. For this maximum signal condition, the rms OPT current draw is likely about 90mA (64% of peak), and the average VS1 power consumed is 420x0.09 =38W, and the OPT loss is $(0.09)^2$ x 145Ω = 1W, and the cathode resistor losses are ~6W, so the tube plates dissipate 38 - 23 - 3 - 1W = 11W, or 6W each.




90
PENTODE CONNECTION
V_{g_2} = 250
V_{g_1} = +10
= +5
= 0
20W
= −5
= −10
= −15
= −20
= −25
= −30
= −35
I_{g_2} at V_{g_1} = 0
I_a (mA)
400
300
200
100
0
100
200
300
400
V_a

6L6GC


AVERAGE PLATE CHARACTERISTICS
E_f=6.3 VOLTS
GRID-№1 VOLTS=0
20W
400
350
300
GRID-№2-VOLTS-E_{C2}=250
200
150
100
E_{C2}=50
PLATE MILLIAMPERES
PLATE VOLTS
0
100
200
300
400
500
600
700
92CM-10327


S1
Pos 1... Microphone
2... Pick up
3... Radio
S1 S2 & S5 viewed from knob end in extreme anti-clockwise position
Component values
Resistors in ohms
K = 1,000 M = 1,000,000
Capacitors in µF (eg ·01) or µµF (eg 150)
Electrolytics in µF
Cable type 3B56833
Clip 1
Clip 2
Cable type 2B56833
S5
Pos 1...1 Speaker
2...2 Speakers
3...3-5 Speakers
4...6-10 Speakers
5...11-20 Speakers
V1 Z729
V2 Z729
V3 Z729
V4 6AU6
V5 12AX7
V6 KT66
V7 KT66
V8 6X4
V9 6X4
V1B V5123
T1 1TK57805
T2 2TU57768
L1
L2
CM1
S1A
S1B
S1C
S2
S3
S4
S6
Output
Microphone inputs
Monitor speaker socket
CF2
CF1
V.U. meter socket
Battery
Standby
Operate
Microphone inputs (1, 2 & 3)
If input transformer is fitted, connect low-impedance input to 'A' 'B' and cable screen to 'E'
High-impedance input cannot be used where input transformer is fitted. If input transformer is not fitted, connect high-impedance input to 'B' and 'E'
Low-impedance input normally cannot be used.
Connections for input transformer when fitted
G (V2, V3) or S1B
20 W. A.C./D.C. Amplifier.
Type G56829.
DRG. 56829G1.
CH 8

PUBLIC ADDRESS AMPLIFIERS

DUAL OPERATION MAINS OR BATTERY

Type PA828 amplifiers may be operated from 240 volt or 6 volt battery supply, changeover being effected by alternate cables which are stowed in rear of housing. A standby switch is provided to conserve battery life.

5 WATT AMPLIFIER

TYPE PA 828

20 WATT AMPLIFIER

TYPE PA 829

Type PA829 20 watt mains or 12 volt battery amplifier provides all facilities necessary for P.A. Hiring.

These include two microphone channels with third optional channel for microphone or pickup. Either high or low output pickups can be used. Features include a battery saving switch and a bass cut switch to control L.F. response when using horn speakers. A plug-in V.U. meter and monitor speaker with their associated switches are ancillary units.

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