1. Summary

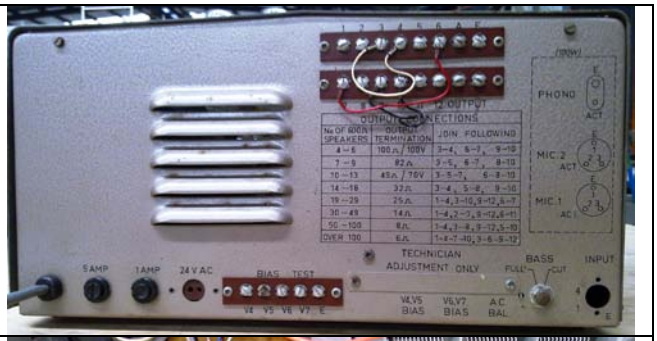
AWA PA1001BY 100W valve amplifier. S.N. EG9581. Mar 2012.

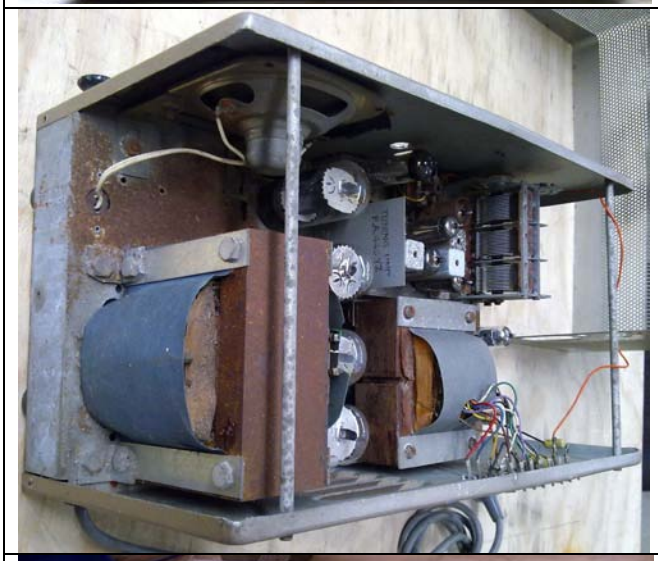
Multi-input channel 100W PA amplifier. Input channels with 12AX7 gain stage and output volume pot, and resistive mixed to EF86 gain stage with bass cut switch. Then 12AX7 output feedback stage to 12AX7 cathodyne PI stage with AC balance adjust. Then common-cathode 12AU7 see-saw bootstrapped driver to McIntosh unity coupled quad-6L6 PP output stage with screen-to-cathode capacitors. Each 6L6 has its own: grid coupling capacitor, grid leak and grid stopper resistors, cathode bias sense resistor, screen stopper and screen-cathode capacitor (2x 4u7 450V in series with balancing resistors), and 2uF cathode-bias shunt capacitors. A bias adjust pot is provided for each pair.

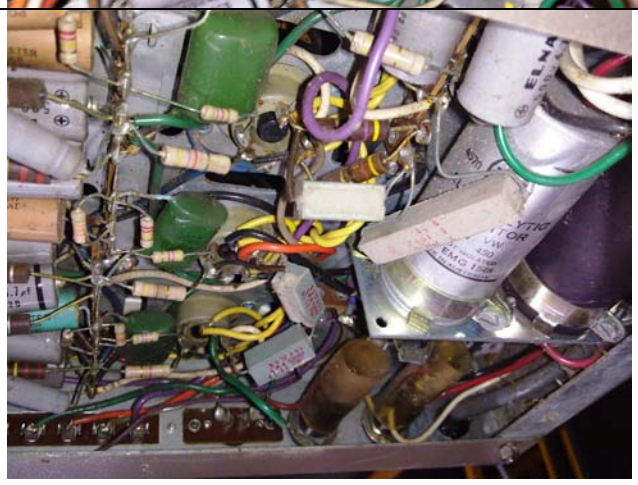
3A fuse after DP mains switch. Doubler on 250V secondary using 1N3196's; 100uF 450V caps, then 0.5A fuse for ~500V HT to PP stage. Half wave 1N3195 on 57V secondary for bias. 24VAC to rear panel socket. 6V3 with 47R-GND-47R humdinger. Socket to provide HT and heater and signal from radio. 4x 6L6GC, 1x 12AU7, 2x 12AX7, 1x EF86, plus radio tuning unit P.A.449 YZ.

Output Transformer	Type No. 100W nominal 3,000Ω PP primary Turns ratios pri/sec : 550-550-550-550 / 50-50,14-86,86-14,50-50 (terminals 1-2-3,4-5-6,7-8-9,10-11-12) 0-6-8-14-25-32-49-82-100Ω output winding configurations. Sections 1-2-3 & 10-11-12 are 12.5+12.5=25% of turns each group. Sections 4-5-6 & 9-8-7 are 4+21=25% of turns each group.
Power Transformer	52466-3. 200V @ mA (BRN,RD); 6V3 ~6A (BLK,BLK); 57V ~0.05A (GRY,VIO); 24V ~0.05A (GRN,GRN); 0-?-?-240V (GRY,OR,BLU,YEL).
Microphone Tx	78
POTs	.
Resistors	IRC PW5 (dates from 68 to 71)
Capacitors	Anocaps (dated 70)
Tuning unit	P.A.449 YZ EE9849
Speaker	Rola 4D 15Ω: 4D00 255/15 19H1C (3.5Wpk, DCR=18.5Ω)
Valves	6L6GC x4: 2x GE RL188-5; RCA 62EX2; ? EF86 x1: 12AX7 x2: ?; Radiotron VU 26 12AU7 x1: WF 16 EM80 (?) tuning eye x1: ? x1: Radiotron 6BE6 x1: AWV Notrol ?? 81 OA2 x1: USA 6BA6 x1: Radiotron V8

Poor to fair visual condition – corrosion on chassis top and top of tuner. Phono-radio front panel switch replaced by multi-input wafer switch – original switch moved to new position. New RCA socket added. Possibly dated around 1972 from cap and resistor markings (?) and use of greencaps and more modern small electrolytics, and no use of wax caps. 22K 5W look+ stressed. One 100R 5W cathode balance resistor changed, and one open-circuit. Some component leads show corrosion. Elna electrolytics starting to show some minor leakage. Tuner unit looks fine except for 2x 7W HT dropper wiring. Output stage valve bases have pins 1 and 4 joined, and pins 5 and 6 – which would indicate compatibility with 6L6GC as well as 7027A. 4x 6L6GC are badly mis-matched.







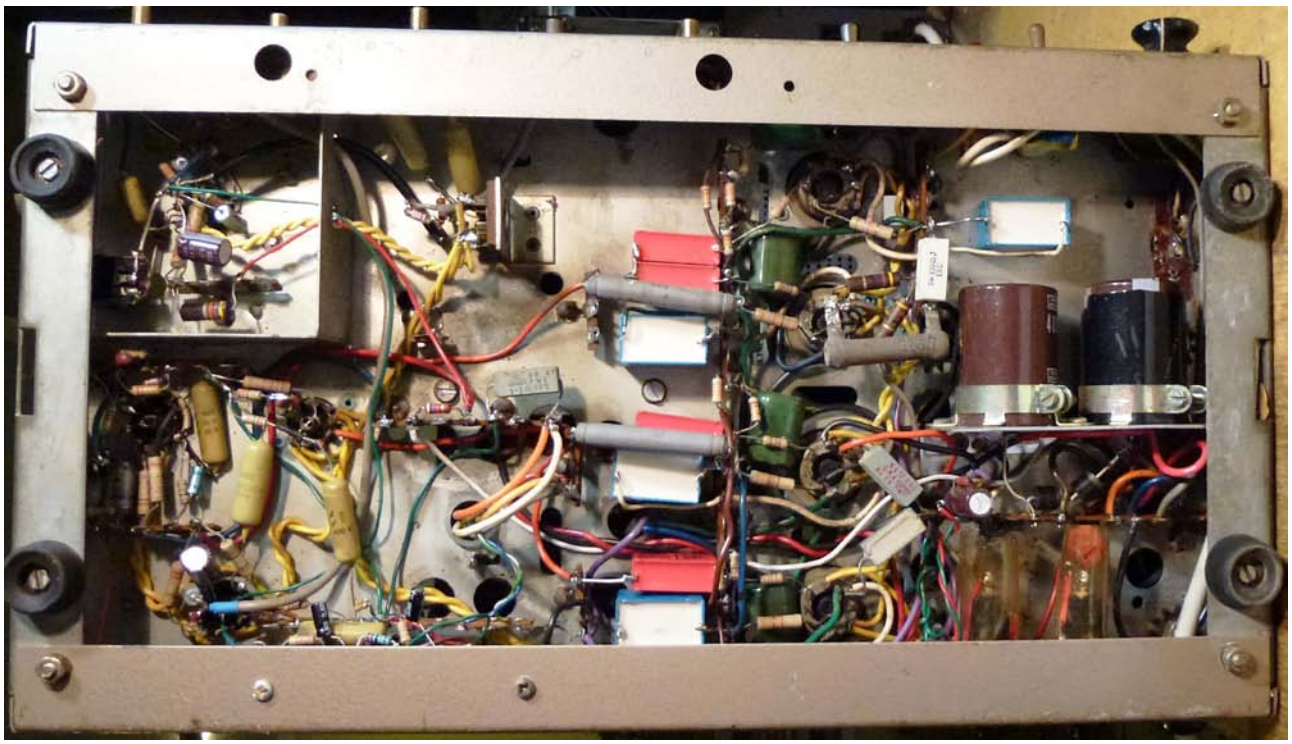
As found condition.

2. Modifications

- Megger tested Txs.
- Added PT primary MOV and NTH13D160LA NTC thermistor.
- Electrolytics replaced. 2u2F 760VDC polys used to replace 2x series 4u7 electrolytics for screen-cathode bypasses.
- Diodes replaced.
- 4N7F Y2 across 200V secondary.
- Disconnected radio unit – so 1.2A lower heater current loading.
- Replaced DC supply dropper/load configuration for VS2 – now VS2 is taken straight from half VS1 via RC.
- Grid stopper added to V3 driver, and to V2 PI.
- Bias supply changed to full-bridge, and bias supplies bypassed. Fail-safe connection of bias adjust pots.
- Removed MIC step-up transformer – not needed.
- Removed input selector switch and replaced with tone pot.
- Disconnected EF86 circuitry – removed valve (0.2A lower heater) – left circuit parts in place – rear panel bass full/cut and side panel socket don't function now.
- Connected 12AX7 input stages in series with second stage driving a Fender style 3-pot tone stack with VOL pot output to 12AX7 feedback stage (OT and PP cathode feedback removed).
- Guitar input isolated jack now on side panel (replaces one of the two microphone sockets).
- Tidied up wiring and introduced distributed star grounding.
- Replaced degraded PT outer insulation covering near 6L6's with nomex sheet.
- Removed 22nF's from speaker output to ground, and connected one end of OT secondary to gnd. Soldered links to OUTPUT terminals for fixed 6Ω 100W output.
- Reduced 1M2 grid leaks on V3 to 880k. Reduced 220k grid leaks on 6L6GC's to 100k.
- Added speaker Speakon socket on rear panel.
- Added LC filter after HT fuse on VS1 to suppress output hum via VS1 ripple on 6L6 screens and via bootstrapped drivers to 6L6 grids. 2H choke and 22uF-22uF series connection.

To do:

- Replace speaker with something reasonable – but mount on compliant surround.
- Power up EM80 and use for signal level? Radio chassis still in place with valves.
- Unused front panel switch – possibly monitor off.
- Lower mains primary fuse from 5A to 3A.
- Upgrade screen stoppers to 5W.
- Increase VS1 caps from 22uF to 100uF. Add MOV across HT fuse.
- Check frequency response; clipping level of stages and output stage overdrive.
- Use Tone Stack Calc to check pot size and response.



3. Measurements

Voltage rail regulation.

Rail					
VS1	B+; OT; radio				
VS2					
VS3					
VS4	EF86				
VS5	Bias				
Heater					
Sec HT					
Sec Bias					
Sec 24VAC					

3.5Ω Yell to Blu DC resistance.
YEL-OR: Ω
BLU-YEL: Ω
BLU-OR: Ω
BLU-GRY: Ω
200VAC; 2.5 ohm
GRN-GRN: 24VAC, Ω

12VAC 50Hz nominal applied to output transformer white-black

Winding	Voltage rms	Turns ratio; Z for 3K pri PP; Spec; Turns Ratio
Pri K-K: WH-BLK , OR-VIO	12.3,12.2	; 750Ω , 750Ω
Pri P-P: BLU-YEL , GRY-GRN	12.2,12.2	; 750Ω , 750Ω
Sec: WH to BRN (1-2)	1.13	44; 1.6Ω; Ω;
Sec: BRN to PUR (2-3)	1.13	44; 1.6Ω; Ω;
Sec: GRN to WH (4-5)	0.31	156; 0.12Ω; Ω;
Sec: WH to GRY (5-6)	1.94	25.6; 4.6Ω; Ω;
Sec: RED to BLU (7-8)	1.94	; 4.6Ω; Ω;

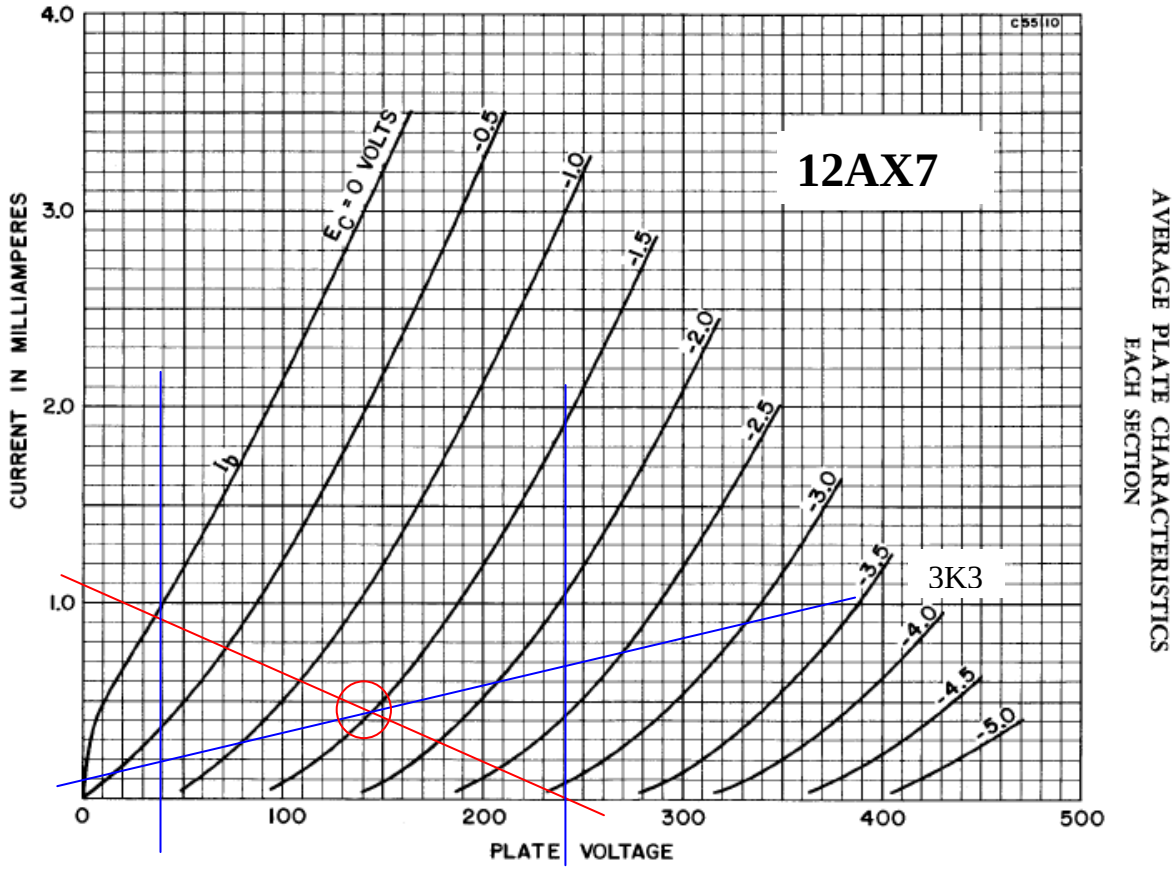
Sec: BLU to YEL (8-9)	0.31	;	0.12 Ω;	Ω;
Sec: OR to BLK (10-11)	1.13	;	1.6Ω;	Ω;
Sec: BLK to WH (11-12)	1.13	;	1.6Ω;	Ω;

Output transformer primary DC resistance: 24Ω each section.
Each group (1-3;4-6;7-9;10-12) is effectively 6.2Ω - so best to use all groups in parallel and connect to 8Ω or 4Ω speaker – this will give best OT winding interleaving and use 100% of secondary turns. Each group in series presents a single 100Ω winding.

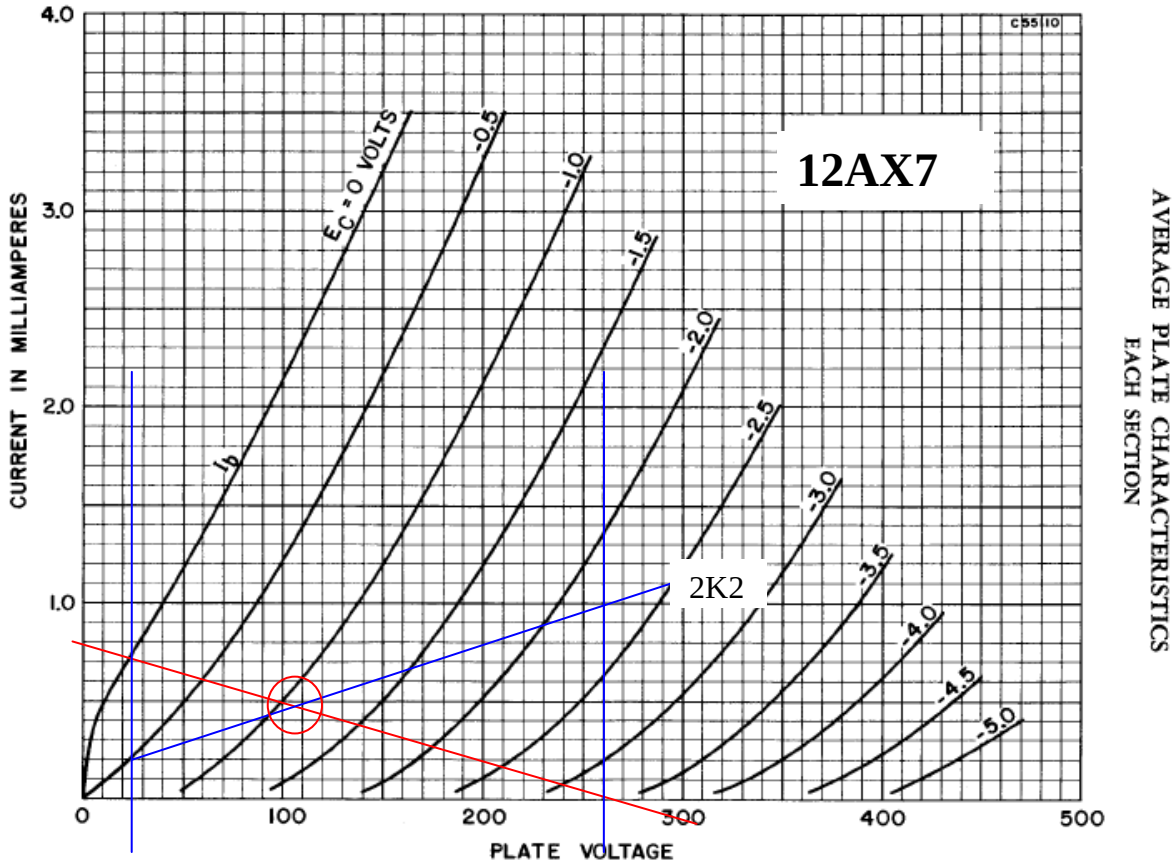
Microphone transformer '78'
Pri DCR = 50Ω; Sec DCR = 4.9kΩ.
Pri:Sec turns ratio = 28.3
Likely to be 50:40k or 150:120k impedance spec.

3.1 Input 12AX7 stages

Two input 12AX7 stages, V1: VS3=250V; Va=90V; Rk=3k3; Vk=1.5V; Ia=0.45mA; RLdc=220k. Next 12AX7 stage, V2A, uses same circuit, but higher VS2 supply.

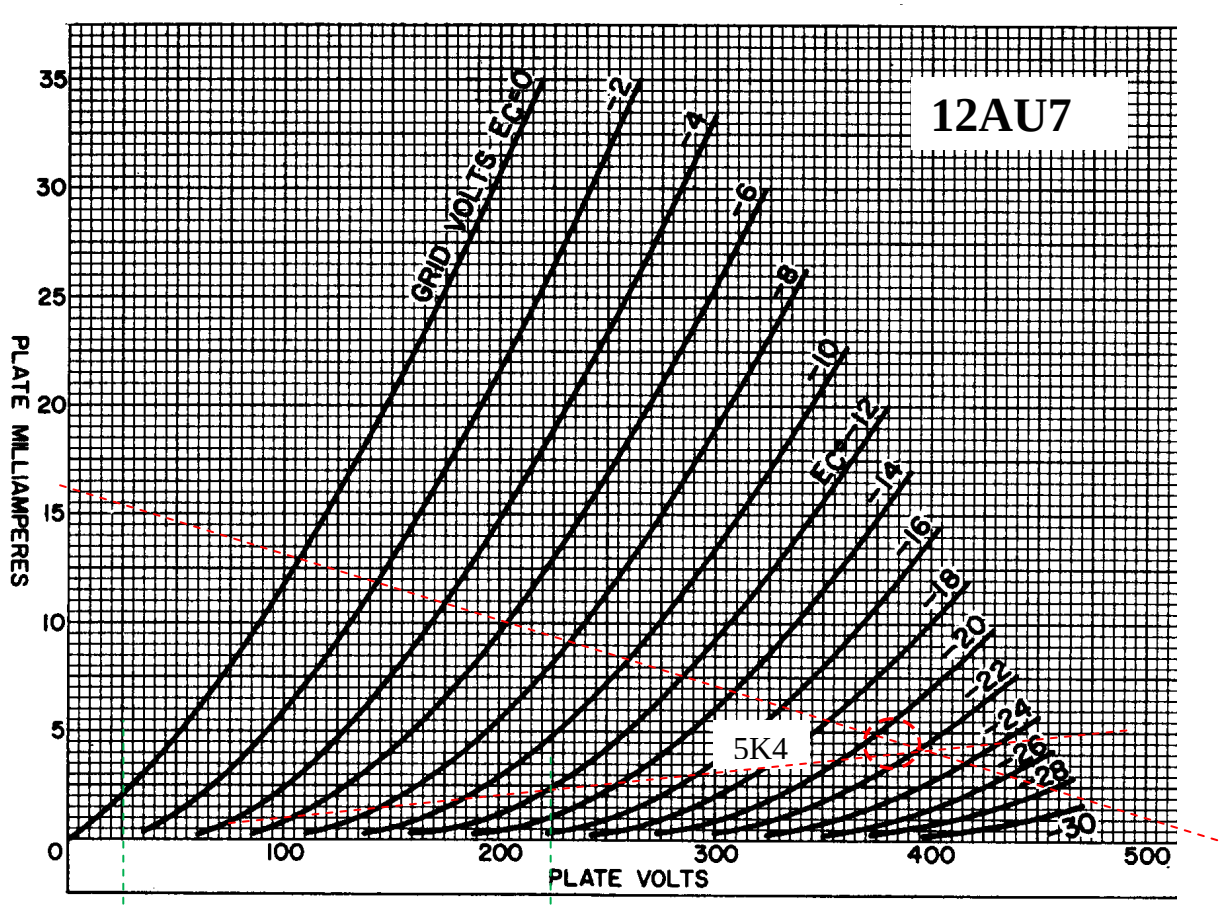


PI 12AX7 V2B: VS2=250V; Va=205V; Vc=95V; Rk=2k2; Vk=0.88V; Ia=0.4mA; RLdc=100 + 235k. Max voltage swing about +45V for anode to rail, and Vak can swing -80V from 110V at idle down to about 30V. Perhaps increase bias current a bit by reducing 2k2 to 1k8.



3.2 12AU7 driver section.

12AU7 common cathode push-pull driver, boot-strapped supply.
V3A, V3B; Vidle = ~VS1 = 550V; Va=400V; Rk=2k7 common; Vk=22V; Ia=4.0mA; RLdc=33k; Vak=380V.



3.3 PP Output Stage

Class AB push-pull output stage with fixed bias and paralleled tubes for each half. Unity coupled primary – but no tertiary winding to alleviate distortion from winding resistance. The effective 3KΩ impedance plate-to-plate OPT, presents each tube with 3k loading near idle, and 1.5k loading at heavier loading. Cathode currents sensed with independent 100R resistors.

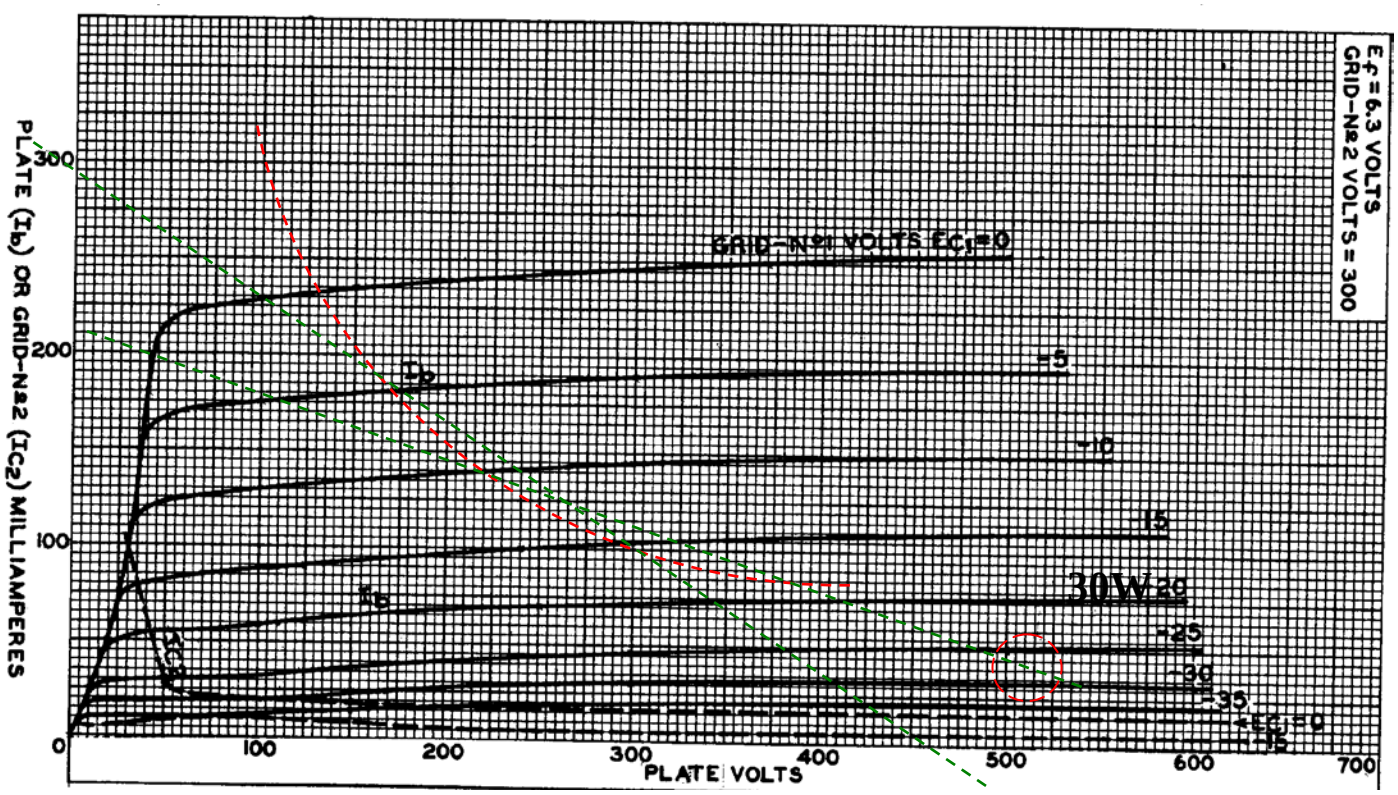
The supply voltage VS1 at idle current of 4x40mA is about 525V. Plate-cathode idle voltage will be lower than VS1 by 3.3x160mA + 48x80mA + 100x40mA = 8V; ie. an idle current of 40mA per tube, and OPT half resistance of about 48Ω, plus 100R sense resistor, plus 3R3 common cathode. At peak current of about 0.25A/tube, the plate-cathode voltage will be lower than VS1 by 1.65+24+25=50V. VS1 sags to about 510V at 60W output.

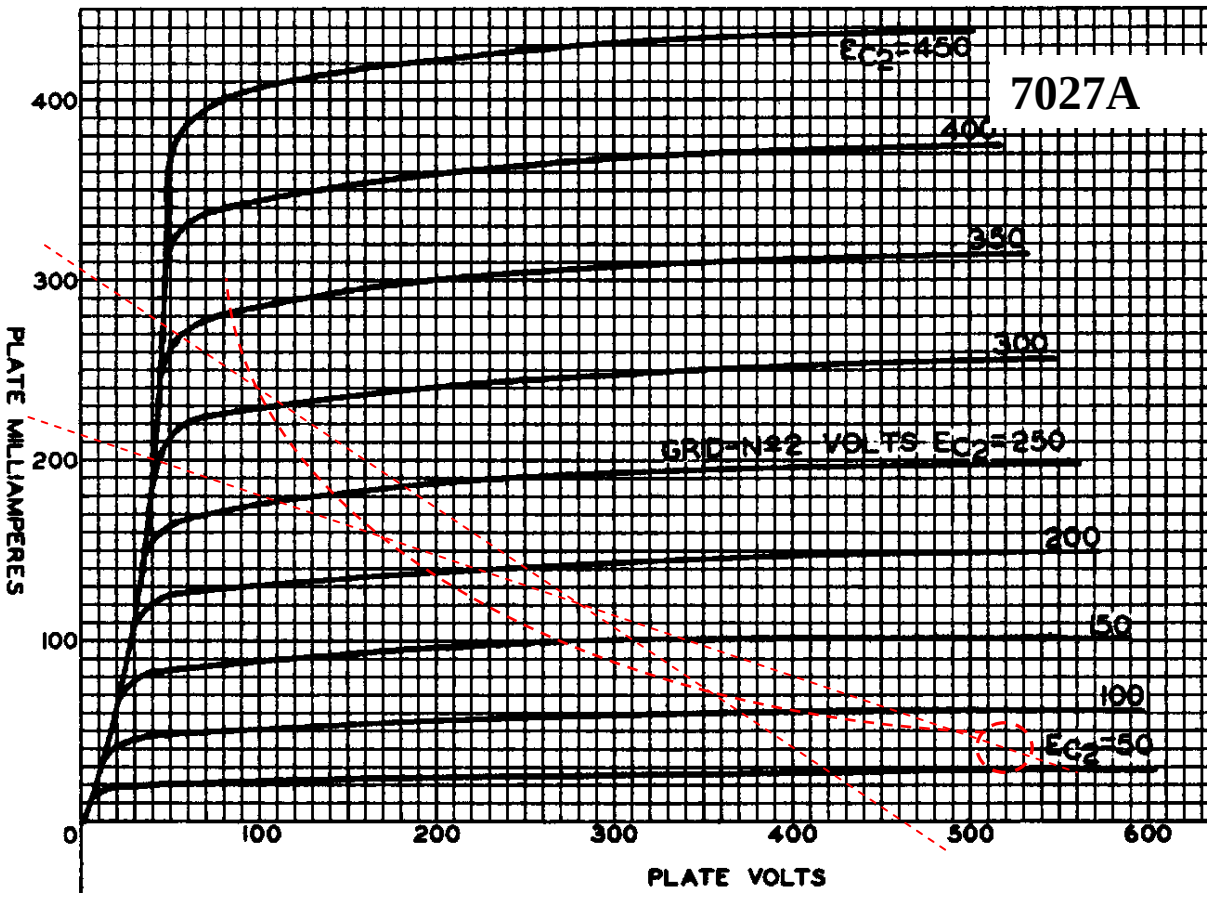
With the screen bootstrapped to the opposite anode, the screen supply tends to keep the screen voltage high during anode conduction, indicating the loadline could reach 250mA before clipping starts. If screen current gets to 30mA then the screen stopper of 4k7Ω will drop 150V, at a peak power dissipation of 4W.

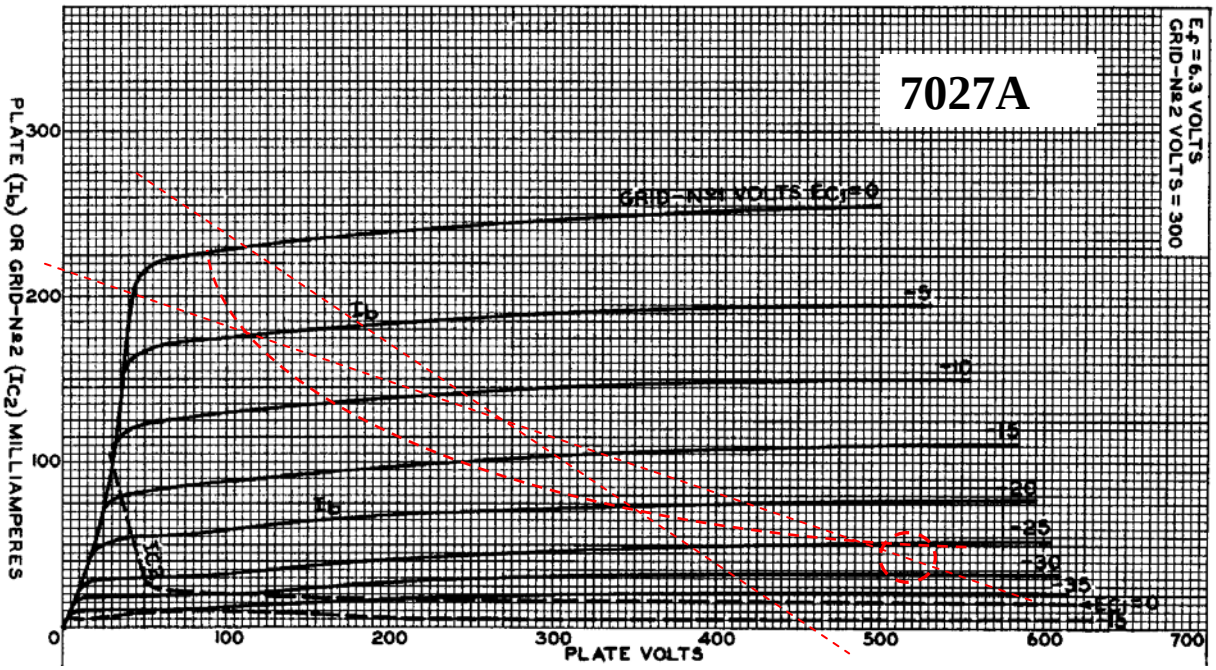
The max design output valve bias current allowed is dependent on the maximum recommended plate dissipation of 25W for the 7027A, and 21W for 6L6GC: Ibias(max) = Pd / Vb = 21W / 525V = 40mA.

The nominal output power of the amplifier will then be (Imax)2 x Rpp / 8 = 0.5^2 x 3k / 8 = 93W. The maximum signal average plate current is ~2x160mA, and with a 510V supply, the average supply power consumed is 163W, and so the tubes dissipate 163W – 93W – (3.3+48/2+100/4) x $(0.32)^2$ = 5W, or 65W/4, or 17W each.

Grid leak is 4k7 + 220k, which is greater than 100k datasheet max recommendation for fixed bias. The 2uF bypass to cathode buffers the DC grid-cathode bias against signal induced voltage across the 33k + Xk to the bias decoupling cap. Increasing the 2uF would reduce signal modulation on the 2uF, but would increase the rise time of the bias during power turn-on.







3.4 Powering

Doubler to 100uF and 100uF replaced by 470uF and 470uF, with preamp stages taken from mid-point to eliminate need for resistive droppers. Higher capacitance reduces ripple level, but is not excessive for a 100W amp. Diodes replaced with P600K to handle higher surge levels. 100k bleed resistor added across each 470uF (0.8W at 280V).

Existing 5A AC mains fuse retained, but better to reduce to 3A given softer start. Existing 1A 3AG VS1 fuse to OT retained.

NTH13D160LA 16Ω NTC in primary to alleviate turn-on surge from larger caps, and transformer in-rush, given PT effective resistance is about 5Ω. MOV on primary to alleviate any turn-off spike from leakage inductance.

Heater 1 (7027A x4; 12AX7 x2; 12AU7; EF86): 0.9 x 4 + 0.3 x3 + 0.2 + radio ~ 6A
Radio heaters: 4x 0.3A = 1.2A
Radio and EF86 removed = 4.5A.

PT 55V secondary full-wave rectified and filtered, with further RC filtering from bias voltage adjust pots for V4,V5 and V6,V7. Bias voltage passed to grids via 33k and 220k (now 100k) in series, but Vgk increased by approx +6V cathode level at idle.

No OT primary over-voltage protection added due to opposite phase clamping of anode windings from bootstrapped circuitry and screen drive.

3.5 Monitor speaker

The 15Ω 3.5Wpk monitor speaker was connected across terminals 4 to 5 winding section. The max voltage on 6.3R winding at 100Wrms output is about 25V. Voltage on 4-5 winding section is 0.31/1.13 = 27% of 25V = 6.8V which equates to 3Wrms. With 100R monitor pot, the power dissipation is 0.5W.

3.6 Bias Adjustments

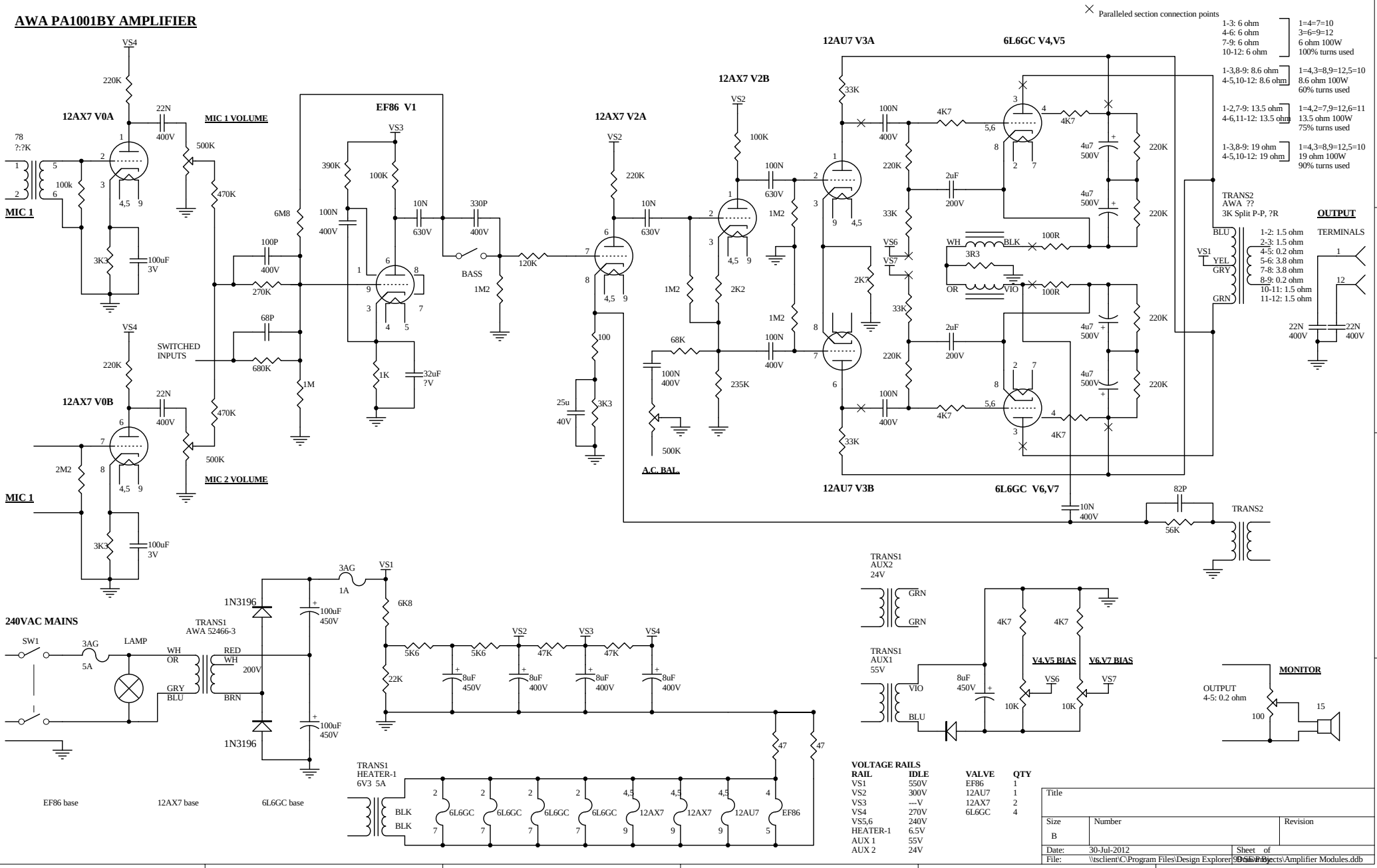
6L6GC cathode idle voltage will be about 6.4V for an idle current of 40mA per tube, based on 3R3 common resistance at 160mA (0.53V), plus OPT half resistance of about 24Ω at 80mA (1.9V), plus 100R sense resistor at 40mA (4V).

3.7 Maintenance

If output valves are not inserted then after turning off the AC mains, high voltage DC levels will take about 2 minutes to reduce to less than 60V.

Reset bias adjust pots fully counter-clockwise when changing 6L6GC valves, and then adjust pots clockwise to set idle cathode voltages to 6.4V max if both valves similar, otherwise reduce a bit.

AWA PA1001BY AMPLIFIER



VOLTAGE RAILS

RAIL	IDLE
VS1	550V
VS2	300V
VS3	---V
VS4	270V
VS5,6	240V
HEATER-1	6.5V
AUX 1	55V
AUX 2	24V

VALVE	QTY
EF86	1
12AU7	1
12AX7	2
6L6GC	4

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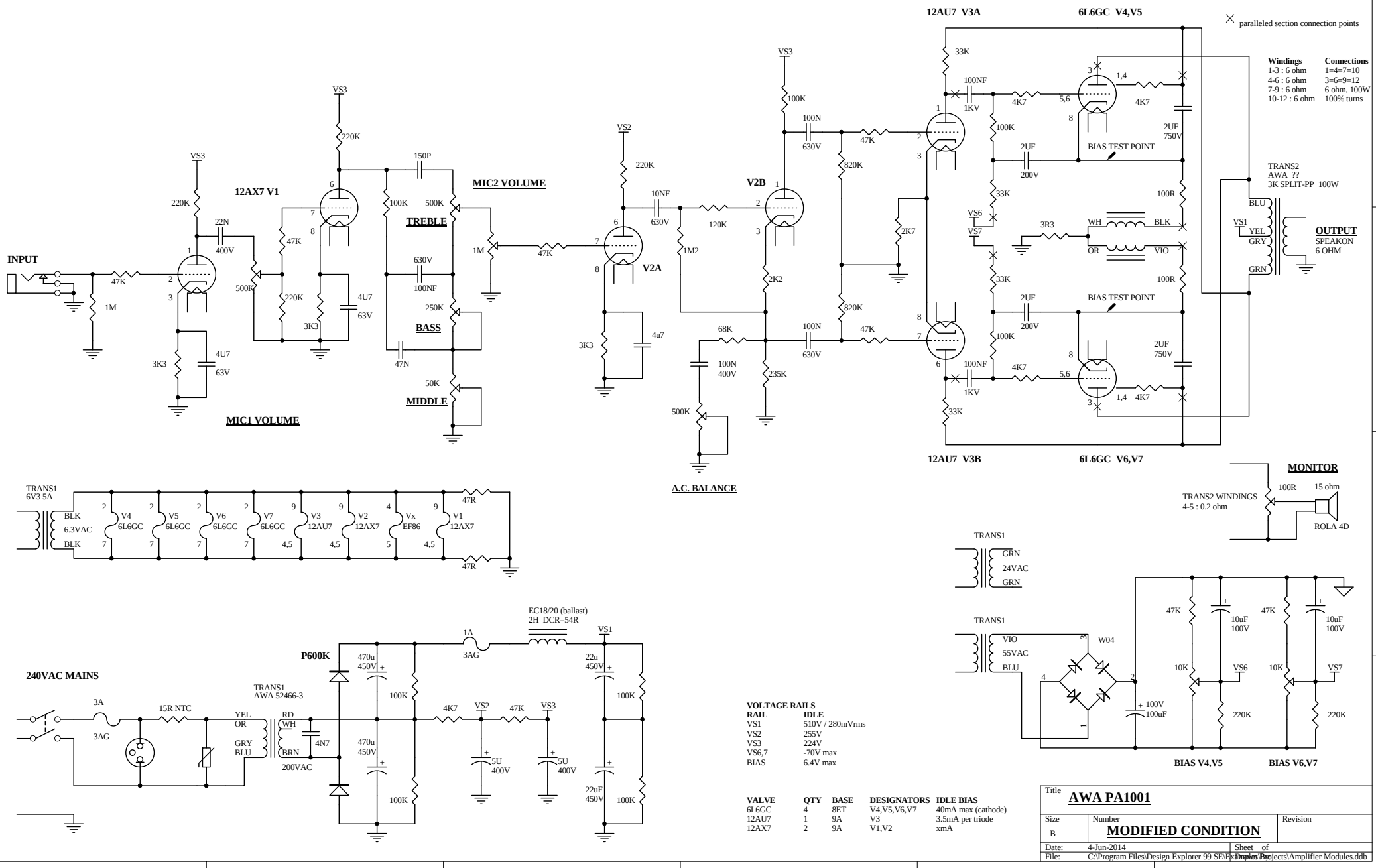

VOLTAGE RAILS

RAIL	IDLE
VS1	510V / 280mVrms
VS2	255V
VS3	224V
VS6,7	-70V max
BIAS	6.4V max

VALVE	QTY	BASE	DESIGNATORS	IDLE BIAS
6L6GC	4	8ET	V4,V5,V6,V7	40mA max (cathode)
12AU7	1	9A	V3	3.5mA per triode
12AX7	2	9A	V1,V2	xmA

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