# 1. Summary

AWA G56827 70W valve amplifier. S.N. 434. Mar 2012

MIC-Phono-Radio input channel PA amplifier. 6AU6 mic preamp. 6AV6 Phono-Radio preamp. 6AU6 mixer. 12AU7 self-balancing, floating paraphase PI with separate unbypassed cathode biases and local feedback. Quad KT66 cathode biased PP; screens stoppers; RC filters on each plate; separate feedback winding to PI stage driven cathode. 5R4GY rectifier with series resistors; 6AQ5 regulated screen voltage. Separate filament transformer; elevated dc voltage heater humdinger pot. Front panel controls: MIC Volume; Phono-Radio Volume; Phono-Radio Tone; Phon-Radio selector; MIC H.F. three setting switch; System L.F. two-setting switch; Monitor On-Off switch.

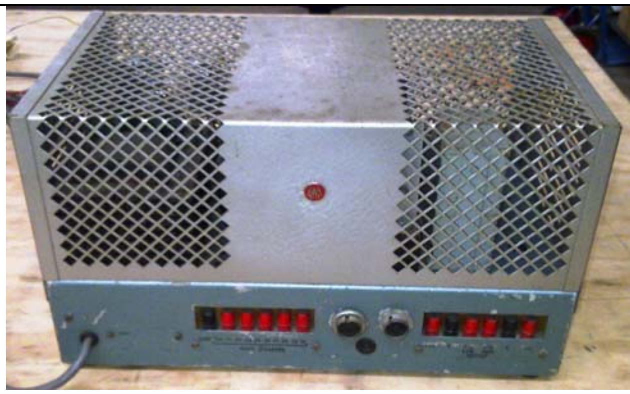
| | |
|---|---|
| Output Transformer | AWA Type 1TK57544 70W nominal 4,800Ω PP<br>5 output winding sections 0, 12R, 21R, 38R, 54R, 80R.<br>Panel: 50-70, 35-49, 25-34, 17-24, 12-16, x 600Ω speakers. |
| Power Transformer 1 | AWA Type 1TK57752.<br>600-0-600V @ ~?00mA (RD,BK,RD); 6V3 ?A; |
| Power Transformer 2 | AWA Type 1TS57753.<br>6V3 5.4A; |
| POTs | . |
| Caps | Ducon TPB wax foils; UCC & Ducon electrolytics. |
| Valves | KT66 x4: all marked with X<br>6AQ5 x1: Radiotron GB I5<br>6AU6 x2: Radiotron GI 19, GD 12<br>12AU7 x1: Gf<br>6AV6 x1: Radiotron EA 7<br>5R4GY x1: RCA 6-29A |

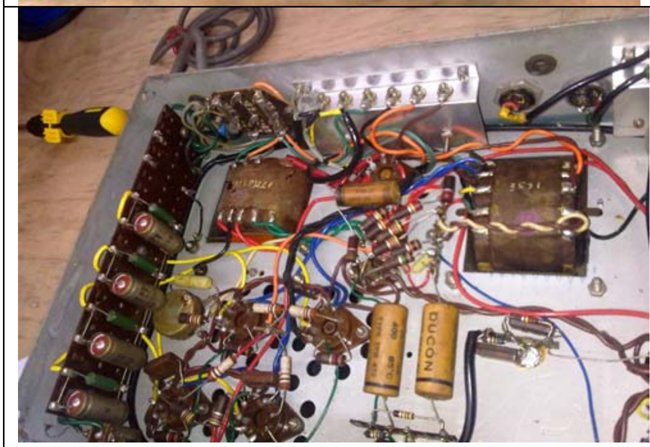
Very good general condition – underneath excellent, some old insulation. One knob broken. Mains switch added to front panel. Microphone socket input added to front panel, and two Mic sockets added to rear panel and connected to PU high and low inputs.

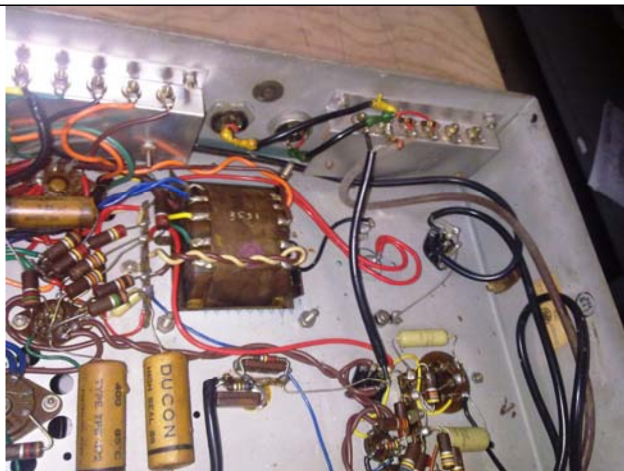
No dates obvious. UCC caps have a 47 marking. Superseals have red markings starting with 03 and 04. AWA pots are marked 56825T33. Parts appear to be mid 1950's build.

Schematic differences: Secondary HT winding series 220R 15W resistor in CT leg with 500mA fuse. 6AQ5 regulator heater pin 3 taken to cathode. 680k screen supply for V3.

Issues: Mains cable too old. Mains switch in neutral line and too close to capacitor and faulty. Mains wiring next to secondary wiring. Speaker outputs floating. Humdinger decoupling too small (?). Regulator 0V reference via humdinger pot cover. Main filter cap 0V returns via OT feedback wiring. Chassis grommet hard. No chassis grommet protection for filament transformer wires. HT level too high for normal idle bias at nominal mains. 6AQ5 operating voltage and turn-on peak is too high. KT66's, 5R4, 6AQ5 all in close proximity, along with CT resistor – too warm for high idle.








After mods:

## 2. Modifications

- New mains cable and MOV on power transformer primary, and reconfigured switch to active, and swapped contacts to other end.
- Megger checked mains/earth for primary side. Megger checked choke.
- Checked all resistor values – replaced R36, R54.
- Reconfigured grounding – power star point – PI valve star point. Add 0V link from humdinger pot to star PI point.
- Returned Mic input to rear connectors. Replaced front panel MIC connector with 6.5mm jack for direct in to MIC input (ie. MIC volume control along with MIC H.F. and System L.F. tone controls).
- Left can electrolytic in place, but replace all caps except mustards.
- Added 2K7/612VDC MOV across each primary half of output transformer (120pf/2k7 = 400kHz).
- Added 47k grid-stopper for V1, V2 input – to allow general purpose input via PU.
- Added MOV-R across each OT primary-half.
- Modify main HT filter cap wiring to return 0V to common KT66 cathode 0V chassis connection, and take CT resistor direct to filter cap.
- Tidied up some of the wiring. Added protection to filament transformer wiring going through chassis.

- Added 10k grid stopper to 12AU7 V4 input.
- Added 5H 200mA choke before 16uF – mainly to lower HT, but also to lower VS1 ripple. Added 390k VS1 load.
- Modified regulator divider and added 250V zener to grid tapping to better regulate/limit screen voltage at 214V (240V to cathode). The 1N4752A 33V zener regulates at 30.7V, so 7 zeners in series regulate 6AQ5 grid to 215V for VS1 above about 400V. Although 6AQ5 grid regulates closely, the cathode-grid voltage increases with anode voltage (due to the triode operating curves for a constant VS2 load), but this is alleviated from an increasing screen load.
- Tuned PI floating paraphase feedback resistors to balance output gains. Feedback around PI modified from 1M to 3M to even out HF response for driven and feedback sides of PI. 100pF bypass on driven 47k anode load to filter above 20kHz.
- MIC H.F. gain middle position modified to give flat response. Anode resistor bypassed by 5pF to filter above 20kHz.
- Reduced 470k mixer resistors to 47k to minimise impact on HF response and noise level.
- Bypassed MIC pot with 270k to lower base noise level (which is not supply ripple related, but is layout pickup from high impedance node).
- Added one-shot 555 timer and 12V relay to switch HT CT after 20 second delay.

To do:

- Initially use 6L6GT rather than KT66 and check levels (pin layout, grid leak, heater current, supply voltage ok).
- Measure voltage across CT 220R in AC mode.

# 3. Measurements

Megger test 1kV on PT mains, and choke.

Voltage rail regulation. 1TK57752 – no choke.

| Conditions | Variac input limited. No choke. Preamps in only | VS1 loaded – no choke |
|---|---|---|
| Vac | 185 | 245 |
| VS1 | 600V | 590V @ 164mA (97W)<br>20Vrms ripple |
| VS2 | 282V | |
| 6AQ5 grid | 247 | |
| VS3 | 264 | |
| VS4 | 188 | |
| VS5 heater dc | | |
| Heater | | 7.4 (no KT66's) |
| Sec HT | | 600-0-600 |

215V O-GY ohm; 245V G-GY ohm: 275-0-275 DCR.
Primary DCR = 4.4Ω for both transformers in parallel.
Secondary DCR = 50 + 53R for HT.

Voltage rail regulation. 1TK57752 – with 5H choke.

| Conditions | Variac input limited. Preamps in only | VS1 loaded. | VS1 loaded. 2uF before choke. |
|---|---|---|---|
| Vac | 210 | 245 | 245 |
| VS1 | 600V | 460V @ 128mA (59W)<br>6.8Vrms ripple | 522V @ 145mA (76W)<br>4.5Vrms ripple |

| | | | |
|---|---|---|---|
| VS2 | | | 247 |
| 6AQ5 grid | | | 215 |
| VS3 | | | |
| VS4 | | | |
| VS5 heater dc | | | |
| Heater | | | 7.5 |
| Sec HT | | | |

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

Signal generator 100Hz applied to 1TK57544 output transformer 80Ω tapping to 0V

| Winding | Voltage rms | Turns ratio; Impedance for 4.8K pri; Spec level; DCR |
|---|---|---|
| Pri P-P: BU to BL | 46.9 | |
| Sec: WH to BRN | 2.4 | 19.5; 12.6Ω; Ω; T |
| Sec: GY to MV | 6.1 | 7.7; 81.2Ω; 80Ω; 1000T "12-16" |
| Sec: GY to OR | 4.93 | 9.5; 53Ω; 54Ω; 821T "17-24" |
| Sec: GY to BLK | 4.15 | 11.3; 37.6Ω; 38Ω; 689T "25-34" |
| Sec: GY to GRN | 3.07 | 15.3; 20.6Ω; 21Ω; 512T "35-49" |
| Sec: GY to Y | 2.35 | 20.0; 12.1Ω; 12Ω; 387T "50-70" |

Output transformer primary DC resistance: 52Ω + 56Ω

Panel indicates range of 600Ω speaker loads: 50-70, 35-49, 25-34, 17-24, 12-16.
between 50-70 represents an impedance range from 11.1Ω to 7.5Ω
between 35-49 represents an impedance range from 17.1Ω to 12.2Ω
between 25-34 represents an impedance range from 24Ω to 17.6Ω
between 17-24 represents an impedance range from 35.3Ω to 25Ω
between 12-16 represents an impedance range from 50Ω to 37.5Ω

Inter-tapping impedances:
between the 38Ω and 80Ω taps provides an 7.7Ω impedance (31% or turns)
between the 12Ω and 38Ω taps provides an 7.4Ω impedance (30% or turns)
between the 12Ω and 54Ω taps provides an 15Ω impedance (43% or turns) ["50-70" to "17-24"]

| | No VS1 load | No VS1 load | No VS1 load | Idle |
|---|---|---|---|---|
| Vac | | 150 | 185 | |
| VS1 | 402 | 500 | 600 | |
| VS2 | 183 | 231 | 282 | 420V |
| 6AQ5 grid | 166 | 206 | 247 | |
| VS3 | 174 | 218 | 264 | |
| VS4 | 129 | 158 | 188 | |
| Vdrop (220Ω) | | | | 36V (160mA) |
| heater | | | | 6.5V |

Added 2uF MKP B32654 1kV before choke to boost VS1 to 520V at idle (500V anode/cathode), and added extra 33V zener to raise screen to ~260V, but idle loading kept VS1 to ~480V, so configuration not used.

MIC gain stage – 470k loading: Signal gain ~3.3V/0.16V=21. Frequency response -3dB at 50Hz and 6kHz, with no switched H.F. gain. Output of MIC stage doesn't overload to about 30Vrms output on MIC pot – with input of 1Vrms.

MIC H.F. gain first position gives 5dB attenuation at 10kHz relative to 1kHz. Middle position modified to give flat response (20nF down to 10nF). Third position gives 4dB gain at 10kHz relative to 1kHz. MIC pot and mixer interacts to also attenuate at higher frequencies – this was alleviated by reducing mixer resistors from 470k to 47k.

PI stage balanced by trimming floating paraphrase arms with no KT66's in circuit and nominal supply rails. KT66 grid signal level at onset of PI clipping is ~35-36Vrms (100Vp-p) for each side. Signal level at PI grid input is 3.5Vrms for clip onset at KT66 grids – so PI signal gain ~10. Signal level at PI grid input overloads above ~7Vrms from V3 (not MIC gain stage).

Output stage clipping above 30Wrms using variac, but waiting for 4x balanced KT66's or 807's or 6L6's.

## 4. General comments.

6.3V heater loading – main transformer: 0.45A
5V heater loading – main transformer: = 1.2A
6.3V heater loading – filament transformer: 4x 1.3A + 4x 0.3A = 6.4A

The 5R4 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 = $4.4\Omega \times (350/240)^2 = 10\Omega$; plus the secondary resistance = 50Ω; which sums to 60Ω. The RCA and other datasheets only indicate operation in to 4uF. With an effective source resistance of 60+220=280Ω for a secondary supply of 350Vrms, a capacitance larger than 16uF may be fine.

Regulator voltage includes a divider that maintains 6AQ5 grid at (220+47)/(100+220+220+47) = 45% of VS1 (ie. 200V for 450V VS1), and hence cathode (ie. VS2) is about 15V higher. The elevated humdinger pot sits at about 47/587 = 8% of VS1 (ie. about 36V). The grid voltage is filtered (0.22uF UCC superseal replaced by 4u7 400V electrolytic).

Loading on VS4 is ~ (174-129)/47k = 1mA
Loading on VS3 is ~ (183-174)/2.3k – 1mA = 2.9mA
Loading on VS2 is 3.9mA + 4x KT66 screens + tuner loading.

Plate RC filter 470R/1.6nF = 210kHz corner frequency.

Turn-on overshoot in VS1 to well beyond 600VDC until KT66's start conducting. Options are:

- MOV which starts to conduct at ~600VDC. Energy dissipation ~600Vx10mA=6W/s=6J for about 5-8 seconds. Continuous ratings of MOVs are not available, and likely to be at most about 1-2W continuous for a 27mm disk, so a small number of MOVs would be needed. Cool down rate of MOVs would be sympathetic with valve conduction.
- FET switched resistive load starts to conduct. Loading requirement at 600V approximately 20mA (30kΩ; 12W), so use 4x 33k 5W in parallel/series. Need 800V FET to operate in switched mode, not linear. Use TL431 to drive pnp to drive FET gate from common divided VS1. Extra loading when FET is turned on will introduce hysteresis, so FET should only stay on when mains surges VS1 above the turn-on level.

- Delayed HT turn-on. Use 12VDC relay with two 240VAC contacts in series with CT and 200R to 0V. Relay activated by 555 one-shot timer with 20 second delay (10 seconds not long enough to stop some overshoot), and powered from doubler (220uF/220uF) using heater. VS1 rises immediately to idle level with no overshoot. VS2 rise with 6AQ5 grid RC time constant of a few seconds. This option was chosen.

### *4.1 Output Stage*

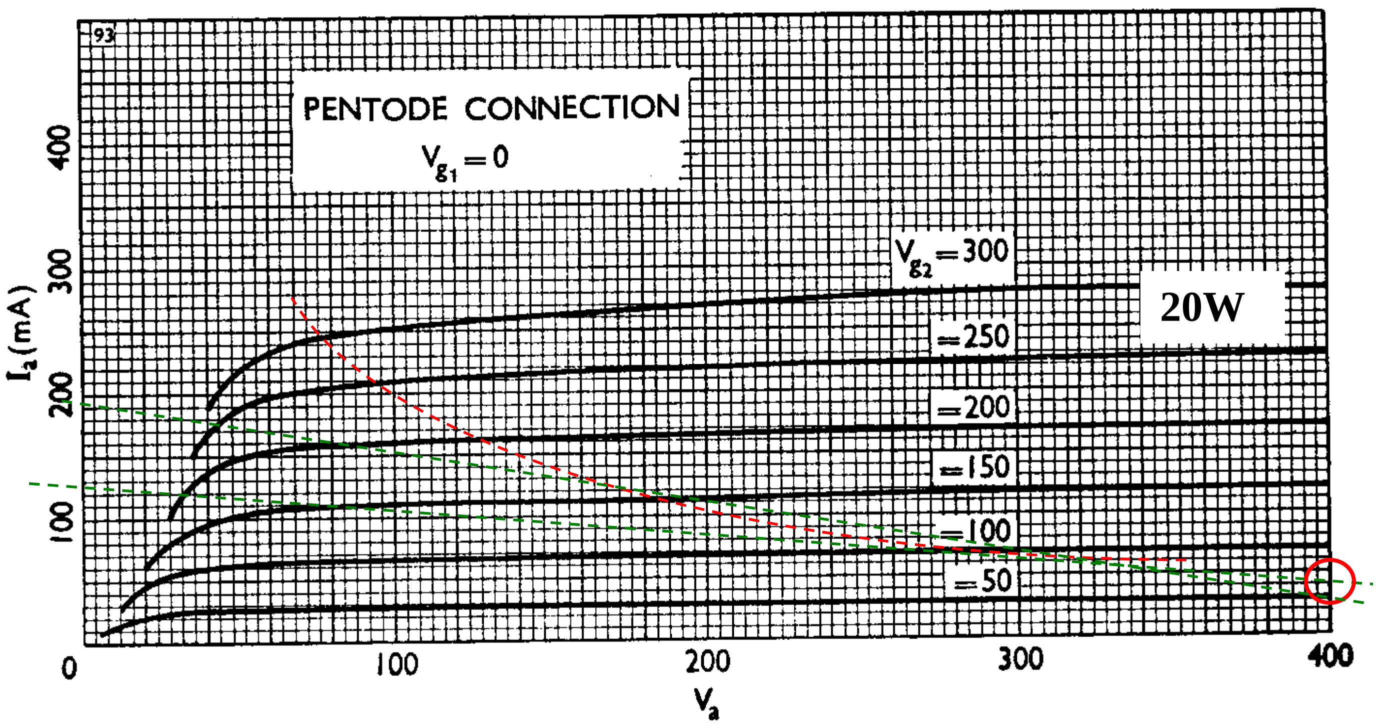
In this Class AB push-pull output stage, one side is pushed into conduction and the other side is pulled into cutoff (class B), and there is a region of Class A overlap where both sides conduct equivalent levels of current. The cathodes use separate bypassed 470Ω cathode resistors are grounded. The 4.8kΩ impedance plate-to-plate OPT presents signal currents into each tube with a 4.8kΩ impedance with all tubes conducting, changing to 2.4kΩ load impedance at higher levels.

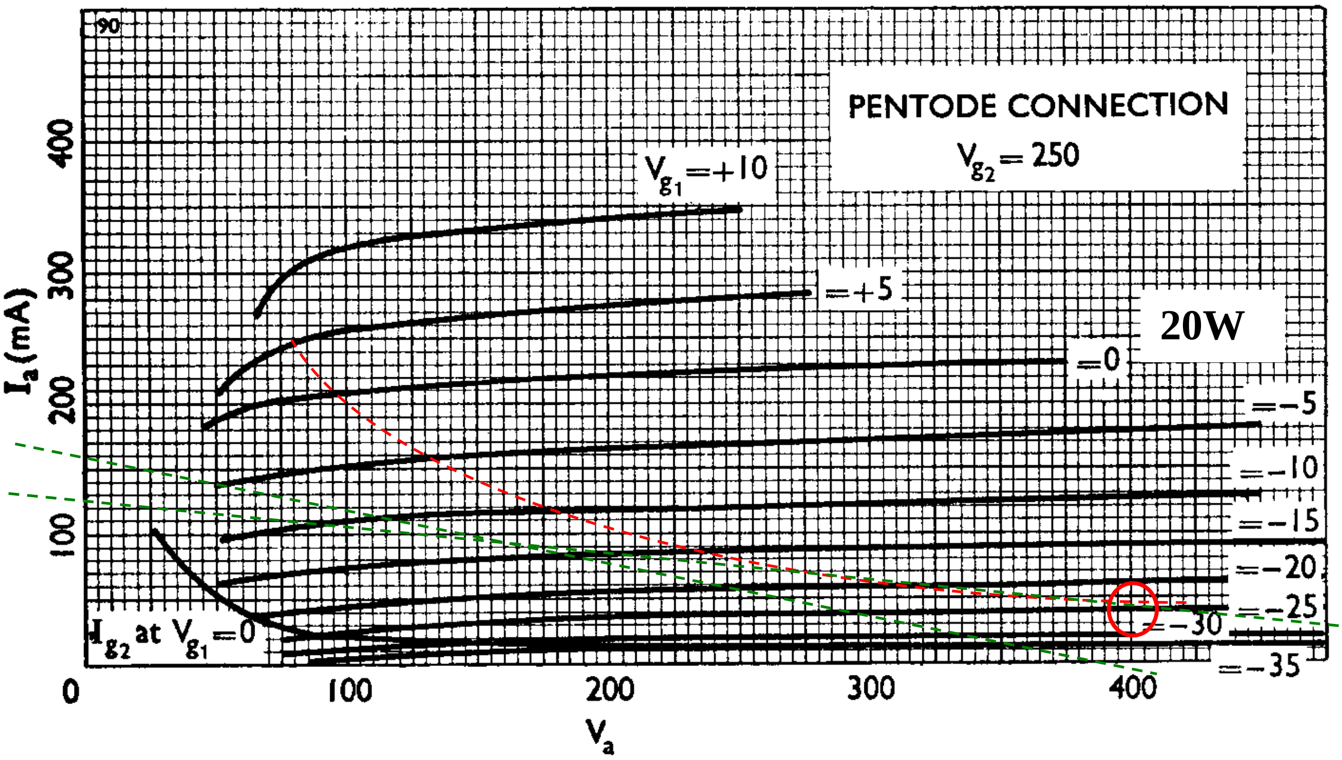
As the output loading increases, the supply voltage VS1 to the output valve plates sags from about 420V towards 400V (check). Plate-cathode DC voltage will be lower than VS1 by an amount from 3+20= 23V, up to 15+25=40V; ie. OPT half resistance of about 55Ω with a peak current of up to about 2x0.14A, plus ~25V bias.

Screen-cathode voltage is semi-regulated at about 230V – check variation at pk signal due to cathode bias increase and 100Ω screen stoppers. Screen current increases up to about 50mA/tube.

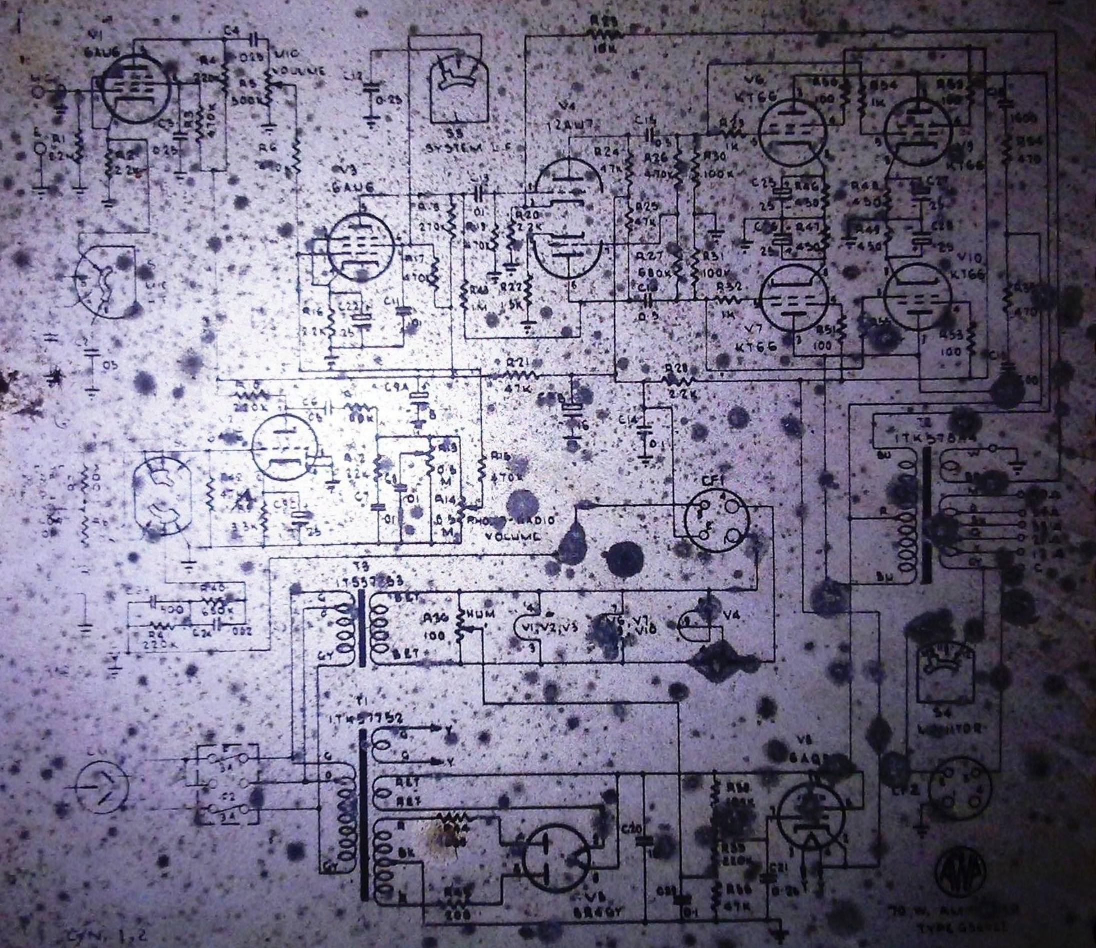
The output valve bias current was about 40mA, based on 20V across common 470R cathode resistor: Pd = 420V x 40mA = 17W, which is conservative 70% of max design level. Cathode resistor dissipation peaks at 470 x 0.14 x 0.14 = 9W.

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 = 0.28 x 0.28 x 4.8k / 8 = 47W. For this maximum signal condition, the rms OPT current draw is likely about 180mA (64% of peak), and the average VS1 power consumed is 420x0.18 =76W, and the OPT loss is $(0.21)^2$ x 55Ω = 2.5W, and the cathode resistor losses are ~6W, so the tube plates dissipate 105 - 65 – 6 - 3W = 30W, or 8W 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
$V_a$



V1
6AU6
MIC VOLUME
V3
6AU6
V4
12AU7
S3
SYSTEM L.F.
V6
KT66
V7
KT66
V9
KT66
V10
KT66
R29
10K
R21
47K
R28
2.2K
PHONO-RADIO
VOLUME
CF1
T1
T3
HUM
V4
V5
5R4GY
S4
MONITOR
CF2
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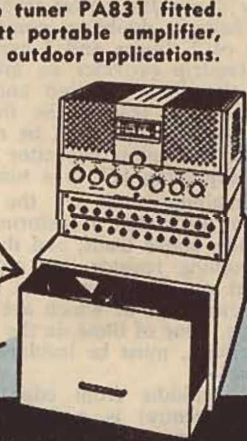

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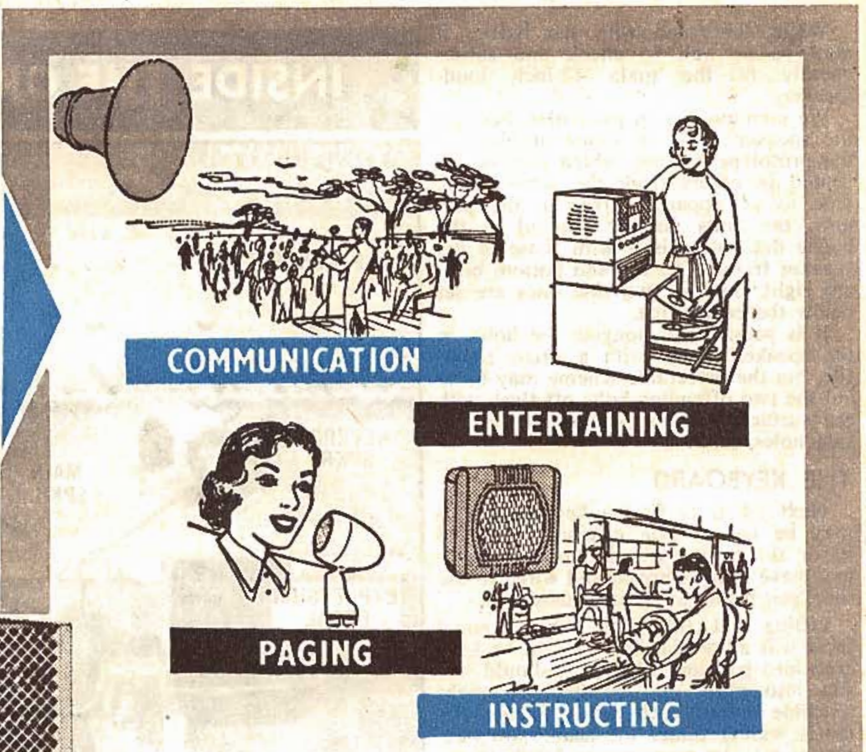


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