APPLICATION NOTE No. 35  
February 26, 1934

APPLICATION NOTE ON  
TRIODE OPERATION OF TYPE 42 AND TYPE 2A5 PENTODES

The 42 or the 2A5 when used as a triode in push-pull audio amplifiers gives good power output and low distortion. In this Application Note, operating conditions and performance results are given for these tubes in over-biased push-pull amplifiers having (a) fixed-bias voltage from a battery and (b) self-bias voltage from a cathode resistor. Both driver and output stages use the same tube type connected as a triode.

Optimum performance results for fixed- and self-bias conditions are shown in Figures 1 and 2, respectively. From these curves, it is apparent that the greatest power output is obtained with the fixed-bias condition. This represents the ideal case because the fixed bias from the low-resistance battery employed minimizes degenerative effects. When the grid-bias voltage is taken from the power-supply voltage divider (semi-fixed bias) or from a self-biasing resistor, the power output is reduced for two reasons. These are (1) that the bias-voltage fluctuates due to change in d-c plate current with signal and (2) that the by-passing of the a-c component around the biasing resistor may be inadequate. Ordinarily, the power output will be somewhat less with self-bias, because this arrangement generally has the poorest regulation. Semi-fixed bias will give results between the fixed- and the self-biased arrangements. The curves of Figure 2 show the optimum power output that can be obtained with the self-bias arrangement under the given conditions. In this case, sufficient capacity was used across the cathode resistor to reduce its impedance to a negligible value.

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The following Table gives the essential data for triode operation of two 42's or two 2A5's as over-biased push-pull audio amplifiers. This kind of amplifier is identified by us as a Class AB amplifier. Class AB operation is intermediate to Class A and Class B operation.

**Table I**

Driver tube: Type 42 or Type 2A5; plate volts = 250; grid volts = -20; screen tied to plate.

Output stage: Two Type 42's or Type 2A5's; with no signal input, plate volts = 350 and grid volts = -38.

<table>
<thead>
<tr>
<th></th>
<th>Fixed Bias</th>
<th>Self Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver Plate Load</td>
<td>24600</td>
<td>25200</td>
</tr>
<tr>
<td>Interstage Transformer Ratio</td>
<td>1.6 to 1</td>
<td>1.14 to 1</td>
</tr>
<tr>
<td>Primary to 1/2 Secondary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformer Efficiency</td>
<td>84.5</td>
<td>65.0</td>
</tr>
<tr>
<td>Peak Grid Voltage on Output Tubes (per Grid)</td>
<td>63.5</td>
<td>82.15</td>
</tr>
<tr>
<td>Peak Power Input to Grids of Output Tubes</td>
<td>366</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>366 Milliwatts</td>
<td>300</td>
</tr>
<tr>
<td>Plate-to-Plate Load</td>
<td>8000</td>
<td>8000</td>
</tr>
<tr>
<td>Power Output (5% Distortion)</td>
<td>18.4</td>
<td>14.8 Watts</td>
</tr>
<tr>
<td>Self-Biasing Resistor</td>
<td></td>
<td>730 Ohms</td>
</tr>
</tbody>
</table>

The following Table gives the characteristics of a 42 or a 2A5 for triode operation as a Class A audio amplifier.

**Table II**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate Voltage</td>
<td>250 max. Volts</td>
</tr>
<tr>
<td>Control Grid Voltage</td>
<td>-20 Volts</td>
</tr>
<tr>
<td>Plate Current</td>
<td>31 Milliamperes</td>
</tr>
<tr>
<td>Mutual Conductance</td>
<td>2300 Micromhos</td>
</tr>
<tr>
<td>Plate Resistance</td>
<td>2700 Ohms</td>
</tr>
<tr>
<td>Load Resistance</td>
<td>3000 Ohms</td>
</tr>
<tr>
<td>Power Output</td>
<td>650 Milliwatts</td>
</tr>
</tbody>
</table>

From Table I, it will be noted that the driver tube is required to supply peak input power of either 366 or 300 milliwatts to the grids of the power tubes. When transformer efficiency is taken into account, the driver must supply 434 and 460 milliwatts peak, or 217 and 230 milliwatts RMS, for the fixed- and self-bias conditions, respectively. These operating requirements are well within the capabilities of either the 2A5 or 42, since either type as a driver is capable of supplying 650 milliwatts (see Table II).
OPERATION CHARACTERISTICS
FIXED BIAS PUSH-PULL (CLASS AB*) - TRIODE CONNECTION

\[ E_f = 2.5 \text{ VOLTS FOR 2A5} \]
\[ E_f = 6.3 \text{ VOLTS FOR 42} \]

- **Rp** = PLATE-TO-PLATE LOAD = 8000 OHMS
- **T** = INTERSTAGE TRANSFORMER PRIM. VOLTAGE RATIO = 1/2 SEC.
- ***CLASS AB OPERATION IS INTERMEDIATE TO THAT OF CLASS A AND OF CLASS B**

\[ \text{D.C. PLATE MILLIAMPERES} \]
\[ \text{D.C. GRID MILLIAMPERES} \]
\[ \text{GRID MILLIAMPERES} \]
\[ \text{POWER OUTPUT-WATTS} \]
\[ \text{TOTAL HARMONICS} \]
\[ \text{TOTAL HARMONICS-PERCENT} \]

**MARCH 1, 1934**

**FIG. 1**

925-5461RI
RCA Radiotron

RCA-2A5, RCA-42
C-2A5, C-42

OPERATION CHARACTERISTICS
SELF BIAS PUSH-PULL (CLASS AB*) - TRIODE CONNECTION

E_f = 2.5 VOLTS FOR 2A5
E_f = 6.3 VOLTS FOR 42

TYPE 2A5 OR 42

BIAS-SUPPLY VOLTAGE

C = BY-PASS CONDENSER - 40 μf
R = SELF-BIASING RESISTOR - 730 OHMS
R_p = PLATE-TO-PLATE LOAD - 8000 OHMS
T = INTERSTAGE TRANSFORMER VOLTAGE RATIO PRIM. 1/2 SEC. = 1.14

*CLASS AB OPERATION IS INTERMEDIATE TO THAT OF CLASS A AND OF CLASS B

MAR. 5, 1934

FIG. 2

925-5460RI
RCA-2A5, RCA-42  C-2A5, C-42
AVERAGE PLATE CHARACTERISTICS
TRIODE CONNECTION

$E_f = 2.5$ VOLTS FOR 2A5
$E_f = 6.3$ VOLTS FOR 42
ERRATA NOTICE
ON
APPLICATION NOTE No. 35

In Application Note No. 35, "Triode Operation of Type 42 and Type 2A5 Pentodes," the tube symbol used in the diagrams of Fig. 1 (92S-5461) and Fig. 2 (92S-5460) is incorrect. Please replace these pages by the attached Fig. 1 (92S-5461R1) and Fig. 2 (92S-5460R1).