APPLICATION NOTE No. 40
June 14, 1934

APPLICATION NOTE
ON
HIGH POWER OUTPUT FROM TYPE 45 TUBES

Because of its use for so many years as a Class A amplifier with a power output rating of only two watts, the 45 is generally regarded as being incapable of handling the high output required of modern receivers. The facts are, however, that the type 45 can be used in push-pull amplifier combinations to provide from 12 to 19 watts output with a total harmonic content of five percent or less. This output is obtained by the use of a plate voltage of 275 volts (the maximum value) and by supplying some driving power to the grids of the 45's.

During an investigation of the merits of 45's as power output tubes, we operated them as Class A, Class AB, and Class B amplifiers and obtained power output as high as 19 watts. Under the simplest circuit conditions, however, power output of 12 to 13 watts can be expected.

DRIVER STAGE

To drive the 45's, the triode 56 and the triode-connected 59 are suitable tubes. Both the 56 and 59 are heater-cathode types of tubes having 2.5-volt heaters which afford freedom from hum. Since both types have relatively low plate impedance, the primary inductance of the interstage transformer can be made high enough to obtain good fidelity.

Table I shows how the driver tubes were used and gives the values of plate-to-plate load, the input-transformer ratio, and input-transformer efficiency for each single and dual driver combination. Where two driver tubes were used they were connected in push-pull. The driver plate voltage was 250 volts in all cases. The grid-bias voltage was supplied from batteries and was -13.5 and -28 volts for the 56 and 59, respectively. The driver can be operated self-biased with no appreciable increase in distortion. The data for the curves showing the current and voltage relations for the 45 vs. the driver input signal were taken under optimum conditions determined with the driver at the grid-current point.

The data of Table I show that for a given grid-bias voltage, the power output obtained is approximately the same whether the driver stage uses one or two tubes. This is because one driver tube will supply enough power to operate the 45's at or under their dissipation limit of 10 watts. A driver stage consisting of a 56 or two 56's is preferable in most cases to one employing a 59 because the power sensitivity of the 56 is better than that of the 59. The
choice of a single or dual 56-driver stage depends on the method of input
coupling to the driver, the overall power sensitivity (available input signal),
the interstage coupling-transformer design, and the permissible higher-order
harmonics.

The single 56-driver stage gives twice the power sensitivity of the dual
stage and can be resistance-coupled to the preceding stage. Furthermore, the
percentage of higher-order harmonics is about the same as for the dual stage.

With a dual stage, in comparison with a single stage, the interstage
coupling transformer can be of better design at the same cost or can provide
the same fidelity at lower cost. The fidelity is good in either case. The
coupling of a dual stage to a single preceding stage requires a transformer
or an inverter arrangement.

**OUTPUT STAGE**

A push-pull output stage of 45's was operated under conditions for
Class A, Class AB, and Class B service in order to ascertain the complete pos-
sibilities of the tubes at a plate voltage of 275 volts. The results of these
measurements are shown by curves and the data of Table I.

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**OPERATING CONDITIONS OF AMPLIFIER**

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<td>Method</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
</tr>
<tr>
<td>56 2</td>
<td>Fixed</td>
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<tr>
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<td>Fixed</td>
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</tr>
<tr>
<td>59 2</td>
<td>Self</td>
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</table>
R₀ and Rₐ

The total series resistance in the plate circuit of the 45's consists of: (1) rₚ, the plate resistance of the tube; (2) Rₚ, the load resistance; (3) Rₐ, the equivalent series resistance of the grid supply; and (4) R₀, the equivalent series resistance of the plate power supply. It will be noted that R₀ in self-biased circuits is the grid-bias resistor.

When R₀ and Rₐ are zero, the best plate voltage regulation and the maximum power output are obtained. It is, therefore, advantageous to use fixed bias instead of self bias and to have Rₐ as small as possible. If a voltage source of approximately zero resistance is used in place of the regular power supply and resistance is then introduced in series with this voltage source until it has the same voltage regulation as the power supply, the resistance added to the circuit would be the equivalent internal resistance Rₐ. In practice, this value is determined by plotting the voltage regulation curve of the power supply and measuring the slope of the line joining the voltage outputs at the zero-signal and maximum-signal operating conditions. The slope of this line represents Rₐ, the equivalent d-c resistance of the power supply.

Optimum Operation with Two Driver Tubes

The first group, 1-a to 1-d, represents ideal conditions for two 45's driven by two 56's. The grid bias and plate voltage were both taken from a battery supply so that the resistance in both plate circuit and cathode circuit is minimum. This condition is expressed by R₀ = 0 and Rₐ = 0. It is to be noted that under these operating conditions the optimum power output of 17 to 19 watts is obtained.

Normal grid-bias voltage for the 45 with a plate supply of 275 volts is -56 volts. In 1-a to 1-d, operation is shown with grid-bias voltages from -56 to -75 volts. Operation under the conditions of 1-b is as a Class A amplifier drawing grid current after power output exceeds 5.3 watts. Under the conditions of 1-c, operation is as an overbiased amplifier with grid current starting when the power output is 5.3 watts. For 1-d, the 45's are initially biased to 5 milliamperes plate current and operation is Class B with grid current beyond 5.0 watts of power output. 1-a is in the nature of a summary of curves 1-b, 1-c and 1-d.

Self-Biased Operation with Two Driver Tubes

Group 2 illustrates the more practical self-bias method of operation. Data for 2-a were taken with variation of the self-bias resistor to produce grid-bias voltages of -56 to -64 volts. The greatest power output was obtained with a bias of -56 volts (see 2-a); hence, this grid-bias value was used as the operating bias for determining the data given in 2-b, 2-c, 2-d and 2-e. Of the conditions represented by 2-b, 2-c and 2-d, that of 2-c is the most practical because Rₐ with a value of 500 ohms represents the approximate equivalent resistance of a power supply using a type 5Z3 rectifier. R₀, the grid-supply resistance, is 775 ohms for all three cases. The resistance affecting plate-supply regulation is equal to Rₐ + R₀. The power output obtained under these conditions is seen to be 13.2 watts with maximum signal. Semi-fixed bias operation with two driver tubes would provide power output
intermediate to that obtained with the fixed-bias method and the self-bias method of 1 and 2. Such operation can be provided by taking the bias voltage from the drop across the speaker field or a choke in the power supply. 2-e is a summary of the measurements of 2-a to 2-d.

**Optimum Operation with a Single 56 Driver**

Group 3 corresponds to Group 1 but applies to a single 56 driver. The data show that approximately the same power output can be realized with a single driver as with a dual driver and, furthermore, that there is some reduction in higher-order harmonics, or sizzle. In this group and in Group 4, only half the input signal to the driver tube is required as compared to that required for cases where two driver tubes are used.

**Self-Biased Operation with a Single 56 Driver**

Group 4 corresponds to Group 2 in that it applies to self-biased operation. However, a single driver is used. This gives only a slight reduction in power output as compared with two driver tubes. Sizzle varies over a wider range in this case than it did for the corresponding case with two drivers and is less in 4-b than in 2-c. The designer should choose between 2-c and 4-b and select the circuit best suited to his particular design requirements.

**Self-Biased Operation with One or Two 59 Driver Tubes**

Operating conditions for the 45's with one or two 59's in the driver stage are shown in 5-a and 5-b. The 59's are connected as triodes and used as a Class A amplifier. Although the 59's are operated well below their maximum output, a comparatively high driver-input signal is required to obtain sufficient signal to drive the 45's to their distortion limit. The higher-order harmonics are usually slightly greater than for the 56 as a driver. Two 59 driver tubes give approximately one watt greater output than two 56 driver tubes under similar self-bias conditions.

**Effects of $R_a$ and $R_b$ with Fixed-Bias Operation**

The resistance ($R_a$) has a greater influence on the power output than $R_b$. This is particularly noticeable as the power output approaches maximum and is illustrated by the curves of 2-c and 4-d. It is also shown by the data of Table I. Observe, for instance, 2-b and 2-c which show identical power outputs. In both of these cases, $R_a = 775$ ohms, but $R_b = 0$ ohms in one case and 500 ohms in the other case. Notice also 4-a and 4-b in which there is but 0.7-watt difference in the power output for a difference of 500 ohms in $R_b$; then notice the difference of 4 watts in power output between the fixed-bias condition and the self-bias condition of 1-b and 2-b, and the difference of 4.4 watts between the fixed-bias condition and the self-bias condition of 3-b and 4-a. Each comparison illustrates the point that a change in $R_b$ will not materially affect the power output but that a reduction of $R_a$ from 775 ohms to zero will allow an increase in power of approximately 30% over that obtained with self bias. Thus, if fixed-bias
operation can be had, 17 watts of audio output can be expected from two 45's. In order to obtain a fixed bias, a separate filament-type triode, preferably a 26 or 01A, can be used as a rectifier to supply a bias voltage substantially unaffected by the plate current of the 45's. The grid bias for all of the conditions mentioned is the normal value of -56 volts. Should still greater output be desired, it can be obtained by providing higher fixed-bias voltage in accordance with 1-c, 1-d and 3-c and by operating the amplifier Class AB or Class B. 1-c and 3-c illustrate Class AB operation while 1-d illustrates Class B operation.

Selection of Tubes for Output Stage

The pair of 45 tubes used in this investigation had average characteristics. The question naturally arises as to whether or not the tubes should be matched to obtain the reported results. In order to determine this, 45's were selected whose plate currents differed from the rated value by plus and minus 35 per cent. These tubes were operated in pairs under the conditions of 4-b with a single 56 driver, self-biased at -56 volts and with \( R_b = 500 \text{ ohms} \). The distortion did not exceed 7\% for any combination of tubes. The zero-signal and maximum-signal grid bias and plate voltage departed less than 5\% from the values obtained with the average pair. There was but a slight increase in the higher-order harmonics.

Plate-to-Plate Load

When using self bias, it is necessary to use a higher value of plate-to-plate load resistance than with fixed bias or semi-fixed bias in order to lessen plate-current swings, limit distortion, and prevent plate current cut-off at negative signal swings.

The plate-to-plate load is specified for each operating condition shown in the discussion and should be followed fairly closely. Too great a deviation from the specified load will change the operating conditions. For instance, should the plate-to-plate load be too low, the tube dissipation may exceed the maximum rated value of 10 watts; should the plate-to-plate load be too high, the full power output will not be realized. For either case the ratio of the interstage transformer would not be optimum.

Summary

As an output tube, the 45 when used in push-pull arrangements and operated beyond its grid-current point can provide power output of 12 to 13 watts for the simplest circuit conditions with comparatively low plate voltage of 275 volts, low distortion, low plate-current swings with resultant economy of transformer design, small input signal to driver, and low cost of tubes and amplifier components. If the user desires power output of the order of 17 watts or greater, it can be obtained by the use of an additional tube to provide the fixed-bias voltage.
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<td>RMS Volts (per tube)</td>
<td>Plate-Grid Plate</td>
<td>Primary 1/2 Secondary Efficiency</td>
<td>Zero-Signal Grid Grid</td>
<td>Max-Signal Grid</td>
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<td>(per tube)</td>
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<td>Grid</td>
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<td>Supply</td>
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<td>-56</td>
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* Also covered by curves of same figure number
# Plate volts = 250 and Grid volts = -13.5
* Plate volts = 260 and Grid volts = -28.0

Note 1: If d.c. is used on filaments of 40's, the 775 values of $R_2$ in Column 10 should be 760 ohms.

Note 2: Higher-order harmonics of Column 21 include 10% of fifth and all higher harmonics.
RELATIONSHIP BETWEEN BATTERY GRID-BIAS VOLS ON TYPE 45'SS AND POWER OUTPUT WATTS

BATTERY GRID-BIAS VOLS ON TYPE 45'SS

POWER OUTPUT WATTS

BATTERY GRID-BIAS VOLS ON TYPE 45'SS

INPUT SIGNAL VOLTS PER TYPE 45

GRID POWER INPUT PER TYPE 45

INTERSTAGE TRANSFORMER RATIO PRIM TO 1/2 SEC

LOAD RESISTANCE (PPL) - MILLEMETERS

MAX SIGNAL PLATE CURRENT PER TYPE 45

PLATE CURR PER TYPE 45

TOTAL HIGHER-ORDER HARMONICS X - PER CENT

MAX SIGNAL D-C PLATE MILLIAMPERES

TOTAL HIGHER-ORDER HARMONICS" X - PER CENT

LOAD RESISTANCE (PPL) - MMILLEMETERS

2000 SIGNAL OR MAX SIGNAL D-C PLATE MILLIAMPERES

1000 SIGNAL VOLS PEAK PER TYPE 45

GRID POWER INPUT PEAK PER TYPE 45

INPUT SIGNAL VOLTS PEAK PER TYPE 45

GRID POWER INPUT PEAK WATTS

INPUT SIGNAL VOLTS PEAK PER TYPE 45

GRID POWER INPUT PEAK WATTS

INTERSTAGE TRANSFORMER RATIO PRIM TO 1/2 SEC

POWER OUTPUT - TWO TUBES

INPUT SIGNAL VOLTS PER TYPE 45

GRID POWER INPUT PER TYPE 45

INTERSTAGE TRANSFORMER RATIO PRIM TO 1/2 SEC

FIG. IA
OPERATION CONSIDERATIONS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

E_f = 2.5 VOLTS A.C.

INPUT STAGE: CLASS A DRIVER - TWO TYPE 56
PLATE VOLTS = 250
GRID VOLTS = -13.5
PLATE-TO-PLATE LOAD = 86400 OHMS

OUTPUT STAGE: TWO TYPE 45
PLATE VOLTS = 275, FROM SUPPLY OF ZERO RESISTANCE
GRID VOLTS = -64, FROM SUPPLY OF ZERO RESISTANCE
OUTPUT LOAD, PLATE TO PLATE = 3400 OHMS
PEAK INPUT-SIGNAL VOLTS PER TUBE = 107.5
PEAK GRID POWER INPUT PER TUBE = 0.887 WATTS
HIGHER-ORDER HARMONICS (10% OF 5TH AND ABOVE) DO NOT EXCEED 1.97% PRIM.
INTERSTAGE TRANSFORMER: VOLTAGE RATIO 1/2 SEC. = 2.76
PEAK PLATE EFFICIENCY = 85.4%
**OPERATION CHARACTERISTICS**

**PUSH-PULL ARRANGEMENT WITH GRID CURRENT**

**EF = 2.5 VOLTS A.C.**

| INPUT STAGE: CLASS A DRIVER—TWO TYPE 56 |
| PLATE VOLTS = 250 | GRID VOLTS = -13.5 |

| OUTPUT STAGE: TWO TYPE 45 |
| PLATE SUPPLY = 275 VOLTS + ZERO-SIGNAL BIAS VOLTS AND HAS ZERO RESISTANCE |
| MAX.-SIGNAL PLATE VOLTS = PLATE SUPPLY - MAX.-SIGNAL GRID BIAS VOLTS |
| ZERO-SIGNAL BIAS VOLTS, FROM GRID BIAS RESISTANCE ($R_C$) |

**NOTE:** ALL VALUES ARE OPTIMUM FOR EACH ZERO-SIGNAL GRID BIAS VOLTAGE.

PLATE DISSIPATION FOR EACH TYPE 45 IS 10 WATTS OR LESS.

TOTAL HARMONIC DISTORTION IS HELD TO 5%.

*TOTAL HIGHER-ORDER HARMONICS INCLUDE 10% OF 5TH AND ABOVE.

CURVES MARKED (5) GIVE VALUES PER TYPE 45.

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**FIG. 2A**

MAY 25, 1934

RCA RADIOFON COMPANY, INC.

925-5523
OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

$E_f = 2.5$ VOLTS A.C.

INPUT STAGE: CLASS A DRIVER—TWO TYPE 56
PLATE VOLTS = 250
GRID VOLTS = -13.5
PLATE-TO-PLATE LOAD = 68000 OHMS

OUTPUT STAGE: TWO TYPE 45
ZERO-SIGNAL PLATE VOLTS = 275, FROM SUPPLY HAVING 500 OHMS RESISTANCE
MAX.—SIGNAL PLATE VOLTS = 251.6
ZERO-SIGNAL BIAS VOLTS = -56, FROM GRID—BIAS RESISTOR ($R_c$) OF 775 OHMS
MAX.—SIGNAL BIAS VOLTS = -70.5
OUTPUT LOAD, PLATE TO PLATE = 6000 OHMS
PEAK INPUT—SIGNAL VOLTS PER TUBE = 105
PEAK GRID POWER INPUT PER TUBE = 1,124 WATTS
HIGHER-ORDER HARMONICS (10% OF 5TH AND ABOVE) DO NOT EXCEED 2.43% PRIM.
INTERSTAGE TRANSFORMER: VOLTAGE RATIO 1/2 SEC. = 2.76
PEAK PLATE EFFICIENCY = 88.8%
OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

\[ E_f = 2.5 \text{ VOLTS A.C.} \]

INPUT STAGE: CLASS A DRIVER—TWO TYPE 56
PLATE VOLTS = 250, GRID VOLTS = -13.5
OUTPUT STAGE: TWO TYPE 45
ZERO-SIGNAL PLATE VOLTS = 275, FROM
SUPPLY HAVING RESISTANCE \( (R_b) \)
SHOWN IN TABLE
ZERO-SIGNAL BIAS VOLTS = -56, FROM GRID-
BIAS SUPPLY HAVING RESISTANCE
\( (R_c) \) SHOWN IN TABLE

<table>
<thead>
<tr>
<th>CURVE</th>
<th>TYPE OF BIAS</th>
<th>( R_c )</th>
<th>( R_b )</th>
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<tr>
<td>1</td>
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<td>2</td>
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<tr>
<td>4</td>
<td>SELF</td>
<td>775</td>
<td>1000</td>
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</table>

\( R_b \) & \( R_c \) EACH BY-PASSED WITH 8 UF CONDENSER

FIG. 2E

MAY 25, 1934
RCA RADIOTRON COMPANY, INC.
OPERATION CHARACTERISTICS
PUSH-PULL Arrangement With Grid Current

$E_f = 2.5$ Volts A.C.

Input Stage: Class A Driver—One Type 56
Plate Volts = 250 Grid Volts = -13.5

Output Stage: Two Type 45
Plate Volts = 275, From Battery of Zero Resistance
Grid Volts = Variable, From Battery of Zero Resistance

Note: All values are optimum for each bias voltage
Plate dissipation for each Type 45 is 10 Watts or less
Max. — Signal Power Output is optimum
For a Total Harmonic Distortion of 5%.

Fig. 3A

MAY 25, 1934
RCA Radiotron Company, Inc.
925-5517
OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

E_f = 2.5 VOLTS A.C.

INPUT STAGE: CLASS A DRIVER—ONE TYPE 56
   PLATE VOLTS = 250  GRID VOLTS = -13.5
   PLATE LOAD = 33100 OHMS

OUTPUT STAGE: TWO TYPE 45
   PLATE VOLTS = 275, FROM BATTERY OF ZERO RESISTANCE
   GRID VOLTS = -56, FROM BATTERY OF ZERO RESISTANCE
   OUTPUT LOAD, PLATE TO PLATE = 3900 OHMS
   PEAK INPUT—SIGNAL VOLTS PER TUBE = 91.5
   PEAK GRID POWER INPUT PER TUBE = 0.486 WATTS
   HIGHER-ORDER HARMONICS (10% OF 5TH AND ABOVE) DO NOT EXCEED 1.32% 
   INTERSTAGE TRANSFORMER: VOLTAGE RATIO PRIM. = 1.54
   TOTAL HARMONIC DISTORTION—PER CENT
   PEAK PLATE EFFICIENCY = 79.6%
OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

$E_f = 2.5$ VOLTS A.C.

INPUT STAGE: CLASS A DRIVER-ONE TYPE 56
PLATE VOLTS = 250  GRID VOLTS = -13.5
PLATE LOAD = 33565 OHMS

OUTPUT STAGE: TWO TYPE 45
ZERO-SIGNAL PLATE VOLTS = 275, FROM
supply having 500 OHMS resistance
MAX.-SIGNAL PLATE VOLTS = 250
ZERO-SIGNAL BIAS VOLTS = -56, FROM
GRID-BIAS RESISTANCE ($R_C$) OF
775 OHMS
MAX.-SIGNAL GRID BIAS VOLTS = -70.5
OUTPUT LOAD, PLATE TO PLATE = 5060 OHMS
PEAK INPUT-SIGNAL VOLTS PER TUBE = 99.6
PEAK GRID POWER INPUT PER TUBE = 0.461
WATTS
HIGHER-ORDER HARMONICS (10% OF 5TH
AND ABOVE) DO NOT EXCEED 2%
INTERSTAGE TRANSFORMER: VOLTAGE RATIO
1/2 SEC. = 1.38
PEAK PLATE EFFICIENCY = 80.6%
OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

$E_f = 2.5$ VOLTS A.C.

INPUT STAGE: CLASS A DRIVER—ONE TYPE 56
PLATE VOLTS = 250
GRID VOLTS = -13.5

OUTPUT STAGE: TWO TYPE 45
ZERO-SIGNAL PLATE VOLTS = 275, FROM
SUPPLY RESISTANCE ($R_B$) SHOWN IN
TABLE
ZERO-SIGNAL BIAS VOLTS = -56, FROM
GRID-BIAS SUPPLY HAVING
RESISTANCE ($R_C$) SHOWN IN TABLE

<table>
<thead>
<tr>
<th>CURVE</th>
<th>TYPE OF BIAS</th>
<th>$R_C$</th>
<th>$R_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FIXED</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>SELF</td>
<td>775</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>SELF</td>
<td>775</td>
<td>500</td>
</tr>
<tr>
<td>4</td>
<td>SELF</td>
<td>775</td>
<td>1000</td>
</tr>
</tbody>
</table>

$R_B$ & $R_C$ EACH BY-PASSED WITH 8 μF CONDENSER

FIG. 4D

MAY 28, 1934
RCA RADIotron COMPANY, INC.
925-5520
E_f = 2.5 VOLTS A.C.

OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

INPUT STAGE: CLASS A DRIVER—ONE TYPE 59 AS TRIODE
- PLATE VOLTS = 250
- GRID VOLTS = -28

OUTPUT STAGE: TWO TYPE 45
- ZERO-SIGNAL PLATE VOLTS = 275, FROM
  SUPPLY HAVING ZERO RESISTANCE
- ZERO-SIGNAL BIAS VOLTS = -56, FROM
  GRID-BIAS RESISTOR (R_C)
  OF 775 OHMS
- MAX.-SIGNAL BIAS VOLTS = -75
- OUTPUT LOAD, PLATE TO PLATE = 7350 OHMS
- PRIM. 1/2 SEC. = 1.33

INTERSTAGE TRANSFORMER: VOLTAGE RATIO: 1.33

FIG. 5A

MAY 28, 1934
RCA RADIotron COMPANY, INC.
925–5521
OPERATION CHARACTERISTICS
PUSH-PULL ARRANGEMENT WITH GRID CURRENT

Ef = 2.5 VOLTS A.C.

INPUT STAGE: CLASS A DRIVER—TWO TYPE 59 AS TRIODES
- PLATE VOLTS = 250
- GRID VOLTS = -28
- PLATE-TO-PLATE LOAD = 41200 OHMS

OUTPUT STAGE: TWO TYPE 45
- ZERO-SIGNAL PLATE VOLTS = 275, FROM
  SUPPLY HAVING ZERO
  RESISTANCE
- ZERO-SIGNAL BIAS VOLTS = -56, FROM
  GRID-BIAS RESISTOR (Rc) OF
  775 OHMS
- MAX.-SIGNAL BIAS VOLTS = -76
- OUTPUT LOAD, PLATE TO PLATE = 6020 OHMS
- PEAK INPUT-SIGNAL VOLTS PER TUBE = 118.8
- PEAK GRID POWER INPUT PER TUBE = 1.94
  WATTS
- HIGHER-ORDER HARMONICS (10% OF 5TH AND ABOVE) DO NOT EXCEED 3.93%
- INTERSTAGE TRANSFORMER: VOLTAGE RATIO 1/2 SEC. = 2.42
- PEAK PLATE EFFICIENCY = 92%

FIG. 5B

MAY 28, 1934
RCA RADIOTRON COMPANY, INC.
925-5522