



RCA MANUFACTURING COMPANY, INC.

A RADIO CORPORATION OF AMERICA SUBSIDIARY

Harrison, New Jersey

**RCA RADIOTRON
D I V I S I O N**

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**APPLICATION NOTE ON
OPERATING CONDITIONS FOR THE TYPE 53 TUBE**

The type 53 tube is a Class B Twin-Amplifier designed primarily for use in a-c operated receivers. Combining two high-mu triodes in one bulb, the 53 is capable of approximately 10 watts output with a plate supply of 300 volts, yet requires the chassis space of only a single tube.

The output and tone-quality capabilities of the 53, coupled with its economy of chassis space-requirements, do much to simplify the application of Class B output systems to moderately-priced a-c receivers. The 53 gives greater power output for a given plate-supply voltage than do the pentodes usually employed in a-c receivers of the medium-price group. The total distortion present in the output from the 53 is no higher than that of other output systems of the same power-handling ability.

The high output of the 53 is due to its design and the inherent efficiency of Class B amplifiers. The plate current of the 53 with no signal on the grids is considerably higher than that of other Class B amplifier tubes. The change in plate current from the no-signal value to the value at full output is relatively small compared with earlier types of Class B tubes. This feature of the 53 is largely responsible for its gradual rise of total distortion with output. The small change in plate-current drain with output obviates the necessity for a power-supply system having excellent regulation. One circuit arrangement made possible by the small change in the 53's plate-current drain provides for the operation of the speaker field as a series choke in the power-supply system.

DRIVER STAGE

Two combinations of driver stage and a 53 are shown in Fig. 1 and Fig. 2. The first combination employs a type 56 tube as a driver. The 56 is operated with a plate-supply voltage of 250 volts and a grid bias of -13.5 volts.

Under these conditions, the plate current of the 56 is 5.0 milliamperes. Curves of power-output from the 53, current per plate, current per grid, and total percent distortion versus signal input to the driver are shown for this combination in Fig. 1.

Fig. 2 shows a type 53 tube operated as a driver. When used as a driver, the 53 is operated with the two triode sections in parallel. Under these conditions, the plate-supply voltage is 294 volts, the grid bias is -6 volts, and the plate current is 7 milliamperes. Curves of power-output (Class B stage) from the 53, current per plate, current per grid, and total harmonic distortion versus the signal input to the driver are shown for this combination in Fig. 2.

The combination employing a 53 as a driver requires considerably less signal input for full output than does the combination employing the 56. However, the plate current required for the type 56 driver is slightly less than that for the 53. The use of the 53 as a driver has a further advantage in that the number of different tube types in the set may be reduced by one.

INPUT TRANSFORMER

Specifications for an input transformer suitable for use with the 53 are shown on an attached sheet. The curves of operating characteristics with the 53 and 56 driver were taken with this transformer.

Fidelity curves for the driver stage and the input transformer, as measured from the grid of the driver to the grids of the 53 output tube, are shown in Fig. 3. The curves show less than 10 percent drop in output voltage at 60 cycles per second with either a 53 or 56 driver. The high-frequency response is also good with either type of driver tube.

OUTPUT TRANSFORMER

Specifications for an output transformer suitable for use with the 53 are shown on an attached sheet.

In this design, the inductance of the primary is made relatively low for full output in order to avoid possible loud speaker damage caused by the large movement of the voice coil which might otherwise occur at low frequencies at the resonance point.

At medium values of power output, the inductance of the primary is considerably higher than at full output, due to the permeability-characteristic of the core. Consequently, the average efficiency of the transformer is improved, and the low frequency response at medium volume is enhanced.

The output transformer was designed for a 1.3-ohm voice coil. This reflects an effective plate-to-plate load of 12,400 ohms to the tubes. Due to the input transformer characteristics, a slightly higher load (15,600 ohms) gives approximately 10 percent more power output. A different output transformer is required however when the 15,600 ohm load is used.

The curves of operating characteristics for the 53 (Fig. 1 and Fig. 2) show that a power output of ten watts is obtained with over 50 percent plate efficiency. The measured distortion is small at low volume levels and increases gradually with increasing power output. A listening test demonstrates that the output quality is good at all volume levels up to the rated 10 watts output.

POWER-SUPPLY SYSTEM

Fig. 5 shows a typical power-supply system for the 53. This system was designed for use with a typical set having a total plate-current drain of 38 milliamperes exclusive of the output tube and driver. The resistances of the power transformer are shown on the diagram. A type 80 rectifier is used and gives sufficiently good regulation for satisfactory operation of the 53 output tube. The speaker field (L_1) is operated as a series choke in the power-supply system, thus eliminating a choke and reducing the total power consumption of the set. Although there is a small change in current through the speaker field, due to the change in plate current of the 53 from no signal to full output, satisfactory operation of the speaker is obtained at all volume levels. The necessary capacity of the filter condenser C_2 will range from two to ten microfarads depending on the amount of filtering required to give satisfactory low hum-levels.

The total plate current (I_5) of the output 53 will vary from 35 milliamperes with no signal to 50 milliamperes at full output. The voltage output of the power-supply system is 300 volts with no signal on the 53 output tube and 272 volts with full output.

R_1 and C_1 comprise the speaker-correction network, the function of which will be discussed under general comments on Class B designs. A less expensive, but probably less effective, speaker-correction network consists of a 14,500 ohm-resistor and a 0.017 μ f condenser connected in series between the plates of the output 53.

The operating characteristics of the 53, with the transformers S-99 and S-100, and this power-supply system, are shown in Fig. 4. The curves show a power output of 5.6 watts in the speaker-voice coil.

The regulation of the power-supply system corresponds to that of a constant voltage source supplying power through a 2,000-ohm resistance. If the speaker field in the power-supply system is replaced by a choke, and the speaker field is connected across the power-supply, the regulation can be reduced to the equivalent of a 1,000 ohm resistance. This improvement in regulation increases the power in the voice coil to 6.4 watts. The use of a power-supply system having nearly perfect regulation, such as obtained with a mercury-vapor rectifier tube and a transformer and choke having very low resistance, will increase the power in the voice coil to more than 7.0 watts. Since the efficiency of the output transformer is 70%, the actual power output from the 53 is over 10 watts.

GENERAL COMMENTS ON CLASS B DESIGNS

As a word of caution regarding Class B output systems, listening tests sometimes show the quality of the output to be very poor, although the circuit apparently has been designed properly. In such cases the trouble may be due to radio-frequency oscillation in the output tubes. This oscillation occurs only when an audio-frequency signal is applied to the grids. The result of these radio-frequency oscillations is an audible rasp in the output which easily can be mistaken for higher harmonics of the input signal. To determine if this rasping is due to oscillations, an a-c signal should be applied to the grids of the Class B output tubes, and the grid leads touched with a finger. If the rasping stops when the lead is touched, it is undoubtedly due to radio-frequency oscillations. A remedy for oscillation is effected by connecting small fixed-condensers between each grid and cathode of the Class B stage. Tests have shown that 0.0005 μf condensers are usually satisfactory. These condensers may not be required if a speaker-correction network of resistance and capacitance is employed between the plates and cathodes.

It may be desirable to employ a speaker-correction network between the plates of the output tube, in order to maintain a uniform load at all frequencies. For a 10,000-ohm plate-to-plate load on the Class B stage, a resistance of 11,500 ohms and a capacitance of 0.021 μf should be connected in series between the two plates. For an 8,000 ohm load, the resistance should be 9,000 ohms and the capacitance 0.026 μf . A more effective, but also more expensive, way of applying the correction network is obtained by balancing the network to the center tap of the interstage transformer. The value of resistance between each plate and center tap is one-half that given above, while the value of each capacitance is twice that given above.

The primary inductance of the output transformer should be high enough to give good low-frequency response; yet, at the same time, it should be kept sufficiently low to obtain good high-frequency response. Close coupling and low leakage-reactance are necessary for low distortion levels and good power-output at high frequencies.

INPUT TRANSFORMER S-99*

Core: Material - Grade Audio B, Gauge #26, Alleghany Steel
Company; or equivalent
Punching EI-75
Window 3/8" x 1 1/8"
Tongue 3/4"
Stack 3/4"
Joint Butt (tight)
Net section 3.2 sq. cm.
Mean length mag. circuit 13.3 cm.
Weight 0.62 lbs.

Winding: Traverse and Margin 1/16" + 15/16" + 1/16"
Form (inside dimensions) 25/32" x 25/32" x length 1 1/16"

Primary: Turns 5500 #40 enamelled.
Location over insulated secondary
Turns per layer 240
Layers 23
Insulation between layers 0.001" paper
Insulation over winding 0.015" "
Mean length of turn 5.1"
Resistance at 25° C. 2630 - ohms

Secondary: Turns 2200 #36 enamelled, tap at 1100 turns
Location next to core
Turns per layer 150
Layers 15
Insulation between layer 0.001" paper
Insulation under winding 0.045" "
Insulation over winding 0.015" "
Mean length of turn 4"
Resistance of 25° C. 318 ohms total

Efficiency approximately 74% at full load

Inductance of primary at 10.0 volts, 60 cycles and 5 ma.
d.c. is 50 henries

*Our design identification number.

OUTPUT TRANSFORMER S-100*

Core: Material - Grade Audio C, Gauge #29 Alleghany
 Steel Co., or equivalent
 Punching EI-75
 Window 3/8"x 1-1/8"
 Tongue 3/4"
 Stack 3/4"
 Joint 100% lap
 Net section 3.12 sq. cm.
 Mean length of mag. circuit 13.3 cm.
 Weight 0.62 lbs.

Winding: Traverse and Margin 1/16" + 15/16" + 1/16"
 Form (inside dimensions) 25/32" x 25/32"
 x Length 1-1/16"

Primary: Turns 3650, tap at 1825, #37 enamelled
 Location next to core
 Turns per layer 170
 Layers 22
 Insulation between layers 0.0015" paper
 Insulation over winding 0.015" paper
 Insulation under winding 0.045" paper
 Mean length of turn 4"
 Resistance at 25° C. 650 ohms total

Secondary: Turns 43 #20 enamelled
 Location over insulated primary
 Turns per layer 25
 Layers 2
 Insulation between layers 0.005" paper
 Insulation over winding 0.015" paper
 Mean length of turn 5.1"
 Resistance at 25° C. 0.192 ohms

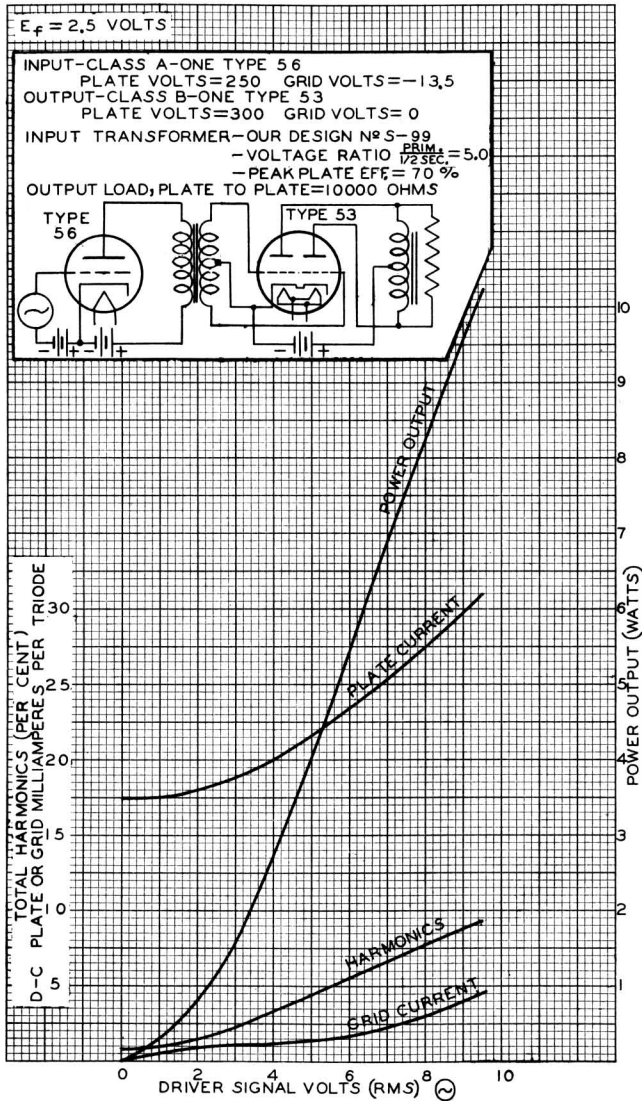
Efficiency approximately 71.5% at full load.

#Inductance of primary at full output, 60 cycles, is approximately 35 henries.

In order to avoid possible damage to the speaker at the low-frequency resonance point and to secure a more efficient design, the inductance of the primary is designed to decrease somewhat at full output. At medium values of power output the inductance of the primary, due to the permeability of the core, is considerably higher, giving better low-frequency response.

*Our design identification number.

OPERATION CHARACTERISTICS

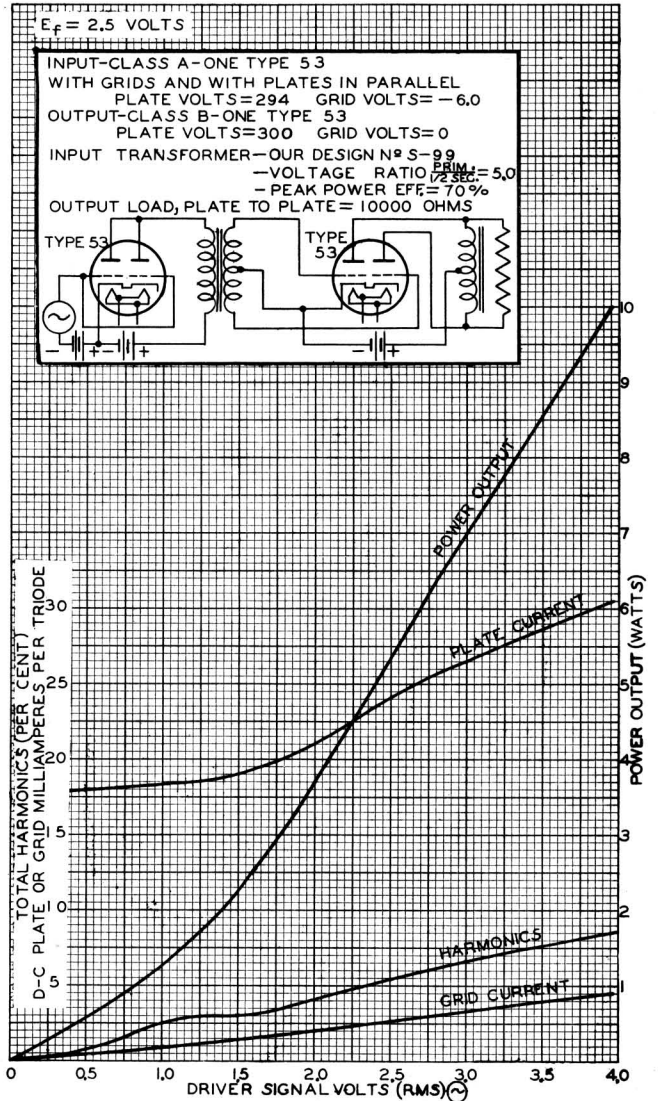


MAY 27, 1933

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92S-5320

OPERATION CHARACTERISTICS

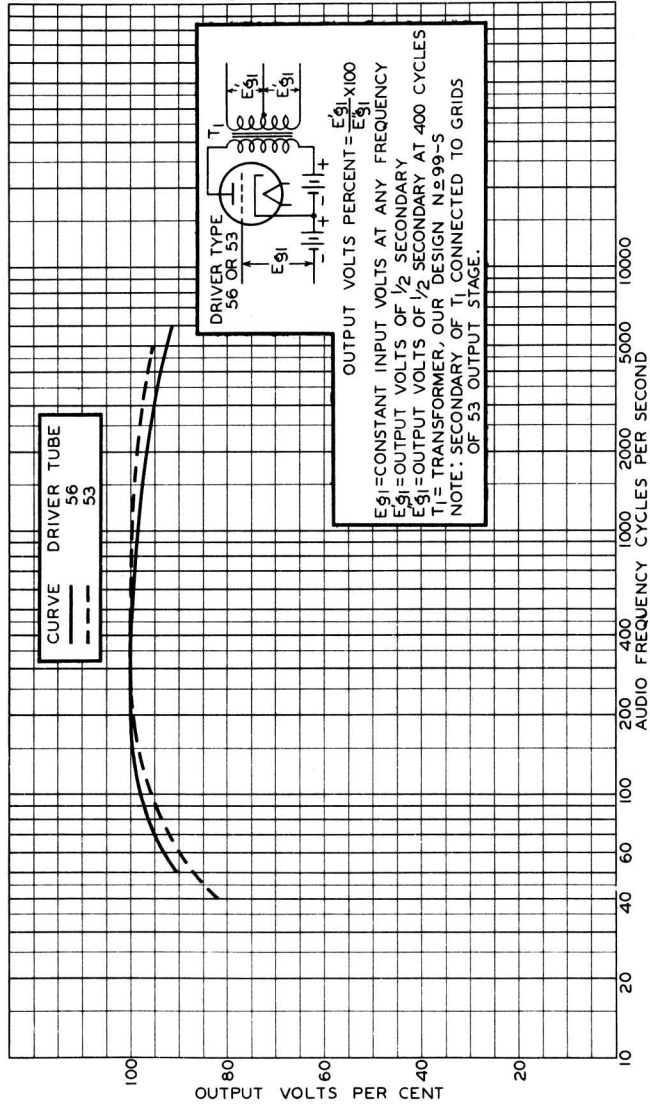


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FIG. 2

92S-5321

FIDELITY CHARACTERISTICS
DRIVER STAGE



OPERATION CHARACTERISTICS

