

## AC/DC Stereo Amplifiers Using Output Tubes Having 100-Milliampere Heaters

This Note discusses three recently developed power-output tubes and their application in ac/dc stereo amplifiers. These tubes, which are miniature types having high power sensitivity, are especially designed for use in series-heater-string circuits operating at a total heater voltage of 120 volts and a heater current of only 100 milliamperes. The Note describes and evaluates the performance of three series-string stereo amplifiers utilizing the new 100-milliampere tubes. These amplifiers, utilizing types 34GD5, 50FK5, and 60FX5, provide maximum power outputs ranging from 1.0 to 1.25 watts per channel.

### Stereo Amplifier Utilizing Type 34GD5

Fig.1 gives the circuit of an ac/dc stereo amplifier employing two 34GD5 beam power tubes in the output stages. At a plate voltage of 114 volts, a screen-grid (grid-No.2) voltage of 99 volts, and a peak grid-No.1 drive of 6.8 volts, each 34GD5 can provide a maximum power output of 1.0 watt at 10-per-cent total distortion to a 4-ohm voice coil. A peak input signal to each channel of 180 millivolts is required for maximum power output. The first column of Table I lists measured average operating characteristics for each output tube in this amplifier.

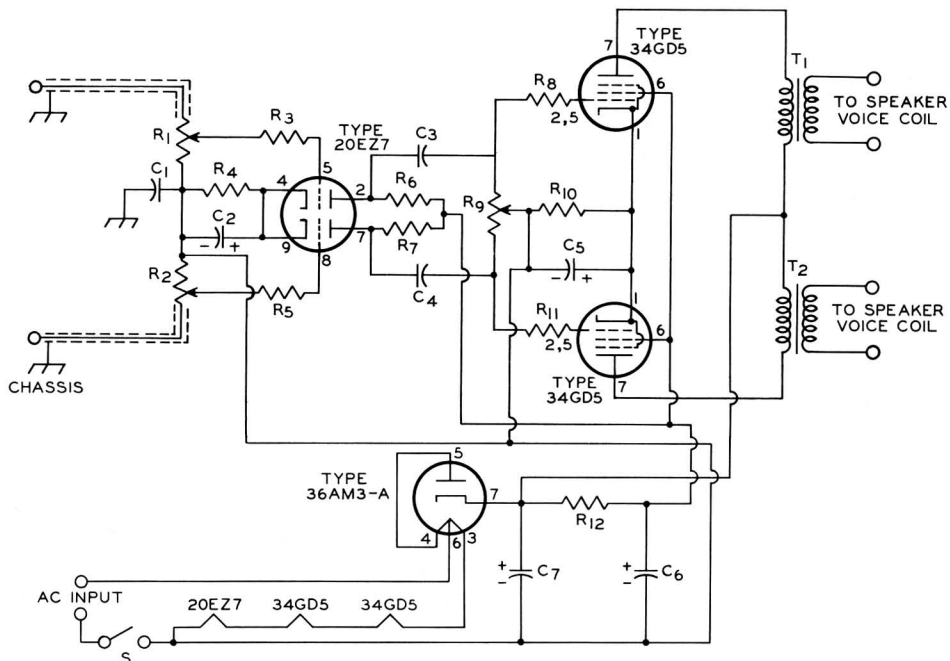
The circuit shown in Fig.1 is, essentially, a conventional resistance-coupled amplifier. Some special construction practices are necessary, however, as a result of the series-string arrangement. Because there is no transformer isolation in the amplifier, for reasons of safety the negative side of the power supply should be isolated from the chassis by means of a capacitor. This capacitance between B- and the chassis should not be greater than 0.1 microfarad. Although values as low as 0.03 microfarad cause no significant loss of gain from the cartridge input, hum pickup increases with low values of capacitance. When a 0.03-microfarad capacitor is used, for example, the ac voltage between the chassis and B- is approximately 3 volts peak-to-peak. This voltage is picked up and amplified by the 20EZ7 and appears as an ac hum at the speakers.



Use of a 0.1-microfarad capacitor reduces this hum voltage to about 1 volt peak-to-peak.

Placement of the isolation capacitor is critical. One lead should be connected to the low-voltage end of the 20EZ7 cathode-bias resistor at B- and the other lead to the point at which the shielded ground of the pick-up cable enters the chassis. Both leads of the isolation capacitor should be as short as possible. Because the amplifier may have a tendency to oscillate in the 20-kilocycle region depending on the placement of the isolating capacitor, a 10,000-ohm resistor in series with the control grid of each of the 34GD5's is used to suppress possible oscillations.

The 36AM3-A rectifier tube incorporates a tapped heater having a section which can be used as a surge limiter and fuse for the B+ supply. This 4-volt fuse section is between pins 4 and 6. The 32-volt section of the heater is connected between pins 6 and 3. Pin 6 should be tied directly to the line input. When the plate connection, pin 5, and pin 4 of the heater are connected together, ac voltage reaches the plate through the 4-volt section of the heater. This arrangement meets safety requirements for surge limiting in half-wave ac/dc rectifiers tied directly to the ac power line.



- C<sub>1</sub>: 0.1  $\mu$ f, 200 v., paper
- C<sub>2</sub>: 25  $\mu$ f, 25 v., electrolytic
- C<sub>3</sub>, C<sub>4</sub>: 0.047  $\mu$ f, 150 v., paper
- C<sub>5</sub>: 50  $\mu$ f, 25 v., electrolytic
- C<sub>6</sub>, C<sub>7</sub>: 50  $\mu$ f, 150 v., electrolytic
- R<sub>1</sub>, R<sub>2</sub>: Volume control, potentiometer, 1 megohm, ganged
- R<sub>3</sub>, R<sub>5</sub>: 1 megohm, 0.5 watt
- R<sub>4</sub>: 3300 ohms, 0.5 watt
- R<sub>6</sub>, R<sub>7</sub>: 220,000 ohms, 0.5 watt

- R<sub>8</sub>, R<sub>11</sub>: 10,000 ohms, 0.5 watt
- R<sub>9</sub>: Balance control, potentiometer, 0.5 megohm
- R<sub>10</sub>: 68 ohms, 1 watt
- R<sub>12</sub>: 1500 ohms, 2 watts
- S: Switch; single-pole, single-throw
- T<sub>1</sub>, T<sub>2</sub>: Output transformer for matching impedance of voice coil to 3000-ohm tube load (Stancor A-3825 or equivalent)

Fig.1 - Stereo amplifier utilizing 34GD5 beam power tubes.



The two 1-megohm volume controls should be ganged on a single shaft to simplify balance. If desired, tone controls can be added to the circuit. Any output transformer providing 2500 ohms impedance to the 34GD5 may be used.

	34GD5	50FK5	
Plate Voltage	114	124	volts
Grid-No.2 Voltage	99	109	volts
Maximum-Signal Plate Current	33	32	ma
Zero-Signal Plate Current	33.5	28	ma
Maximum-Signal Grid-No.2 Current	3.9	11	ma
Zero-Signal Grid-No.2 Current	1.8	8.5	ma
Peak AF Grid-No.1 Voltage	6.8	3.2	volts
Power Output to 4-ohm load	1.0	1.25	watts
Power Output at 105 volts line	0.75	1.0	watts

**NOTE:** Peak grid-No.1 input to the 20EZ7 is 0.18 volt for the 34GD5 amplifier; 0.092 volt for the 50FK5 amplifier. Total harmonic distortion for both amplifiers is 10 per cent.

*Table I - Measured average operating characteristics for each output tube in the stereo amplifiers shown in Figs.1 and 2.*

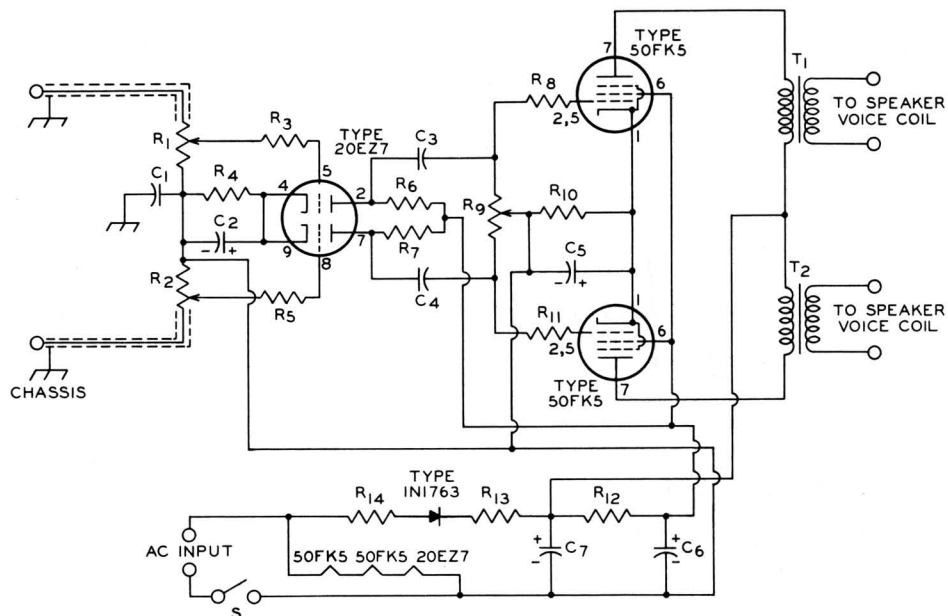
Because the gain of the amplifier is not sufficient to make external-hum pickup critical, use of a cover for the bottom of the chassis is not necessary. The unshielded bottom of the amplifier chassis should not, however, be placed in the magnetic field of an ac turntable motor. For minimum hum in the driver stage, the heater of the 20EZ7 should be placed at the "cold" end of the string. Heater pin1 of the 20EZ7 should be tied to B- at the same point at which the cathode-bias resistor, the isolating capacitor, and the common-ground shield of the cartridge lead are tied.

### **Stereo Amplifier Utilizing Type 50FK5**

In the circuit shown in Fig.2, the higher voltage output of a silicon rectifier and the greater sensitivity of the 50FK5 (as compared with that of the 34GD5) are used to provide a power output of 1.25 watts per channel. Except for some differences in the power supply and in the value of the output-stage cathode-bias resistor, the circuit design and construction are essentially the same as for the 34GD5 stereo amplifier.

The power supply of the 50FK5 amplifier requires a 6.8-ohm surge-limiting resistor for use in conjunction with the silicon rectifier and a 50-ohm series dropping resistor to limit the B+ voltage so that the maximum dissipation rating of the 50FK5 is not exceeded. The value of the filter resistor was reduced to 1000 ohms to raise the grid-No.2 and plate-supply voltage of the 20EZ7 high enough so that the maximum total distortion does not exceed 10 per cent.

The second column of Table I lists measured operating characteristics for each output tube in this amplifier. Fig.3 gives average curves of power output and distortion as functions of frequency for both the 34GD5 and 50FK5 amplifiers.



- C<sub>1</sub>: 0.1  $\mu$ f, 400 v., paper  
 C<sub>2</sub>: 25  $\mu$ f, 25 v., electrolytic  
 C<sub>3</sub>, C<sub>4</sub>: 0.047  $\mu$ f, 150 v., paper  
 C<sub>5</sub>: 50  $\mu$ f, 25 v., electrolytic  
 C<sub>6</sub>, C<sub>7</sub>: 50  $\mu$ f, 150 v., electrolytic  
 R<sub>1</sub>, R<sub>2</sub>: Volume control, potentiometer, 1 megohm, ganged  
 R<sub>3</sub>, R<sub>5</sub>: 1 megohm, 0.5 watt  
 R<sub>4</sub>: 3300 ohms, 0.5 watt  
 R<sub>6</sub>, R<sub>7</sub>: 220,000 ohms, 0.5 watt  
 R<sub>8</sub>, R<sub>11</sub>: 10,000 ohms, 0.5 watt  
 R<sub>9</sub>: Balance control, potentiometer, 0.5 megohm  
 R<sub>10</sub>: 33 ohms, 1 watt  
 R<sub>12</sub>: 1000 ohms, 2 watts  
 R<sub>13</sub>: 50 ohms, 10 watts  
 R<sub>14</sub>: 6.8 ohms, 1 watt  
 S: Switch; single pole, single throw  
 T<sub>1</sub>, T<sub>2</sub>: Output transformer for matching impedance of voice coil to 3000-ohm tube load (Stancor A-3825 or equivalent)

Fig. 2 - Stereo amplifier utilizing 50FK5 power pentodes.

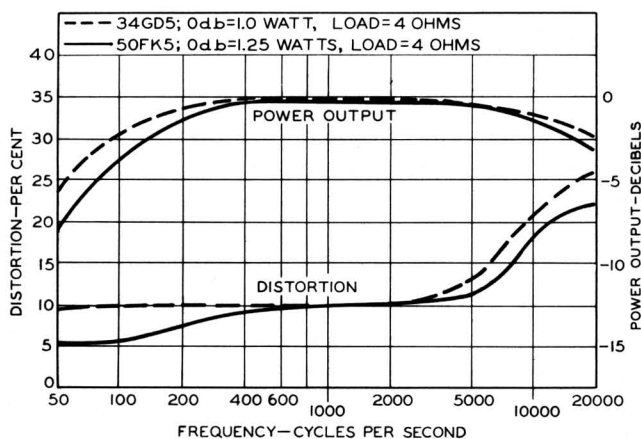


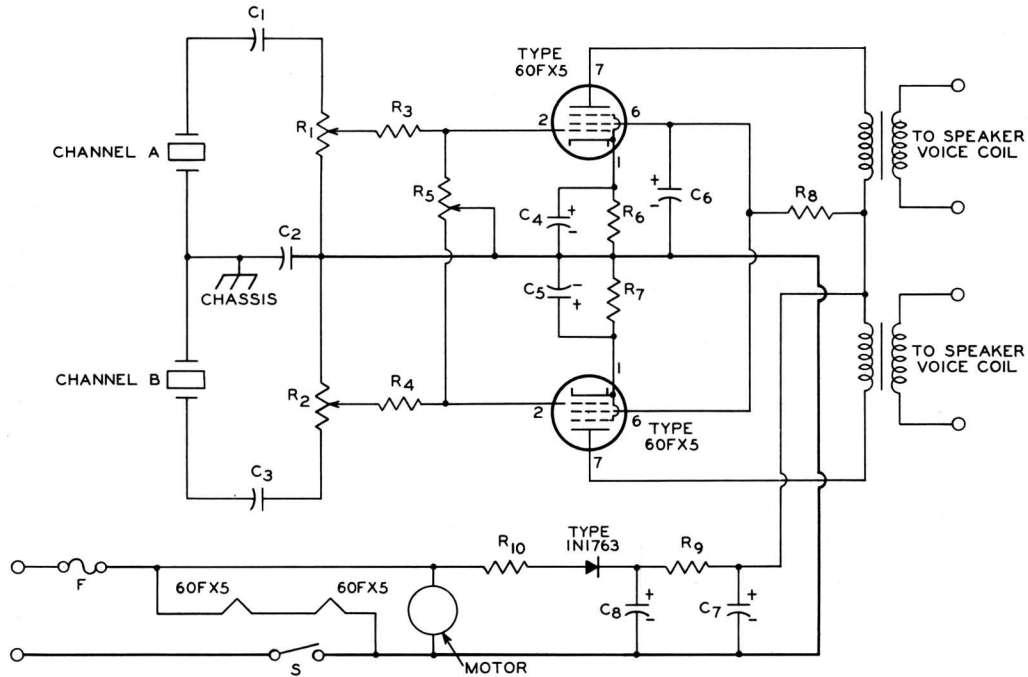
Fig. 3 - Power output and total harmonic distortion as functions of frequency for the stereo amplifiers shown in Figs. 1 and 2.

### Low-Cost Portable Stereo Amplifier Utilizing Type 60FX5

Fig. 4 gives the circuit of an ac/dc portable stereo amplifier employing two 60FX5 power pentodes. In stereo units utilizing high-output low-cost ceramic stereo cartridges, the high power sensitivity of the 60FX5 at low supply voltages eliminates the need for a preamplifying



stage. The 60FX5 provides a power output of 1.3 watts to a 3000-ohm transformer primary with only 3 volts peak drive on grid No.1. With a transformer having a good impedance match and 85-per-cent efficiency, this circuit supplies 1.1 watts of useful power output at the speaker.



- C<sub>1</sub>, C<sub>3</sub>: 0.022  $\mu$ f, 400 v., paper
- C<sub>2</sub>: 0.1  $\mu$ f, 400 v., paper
- C<sub>4</sub>, C<sub>5</sub>: 50  $\mu$ f, 25 v., electrolytic
- C<sub>6</sub>: 50  $\mu$ f, 150 v., electrolytic
- C<sub>7</sub>, C<sub>8</sub>: 50  $\mu$ f, 150 v., electrolytic
- F: Fuse, 3 amperes
- R<sub>1</sub>, R<sub>2</sub>: Volume control, potentiometer, 1.5 megohms, ganged
- R<sub>3</sub>, R<sub>4</sub>: 47,000 ohms, 0.5 watt

- R<sub>5</sub>: Balance control, potentiometer, 2 megohms
- R<sub>6</sub>, R<sub>7</sub>: 60 ohms, 1 watt
- R<sub>8</sub>: 220 ohms, 2 watts
- R<sub>9</sub>: 280 ohms, 2 watts
- R<sub>10</sub>: 12 ohms, 1 watt
- S: Switch; single pole, single throw
- T<sub>1</sub>, T<sub>2</sub>: Output transformer for matching impedance of voice coil to 3000-ohm tube load (Triad S-16X or equivalent)

Fig. 4 - Low-cost portable stereo amplifier utilizing 60FX5 power pentodes.

No special mounting or layout precautions are necessary for this amplifier other than the value and placement of the isolating capacitor between B- and the chassis. This capacitor should be connected to the same point on the chassis to which the common cartridge lead is tied. A value of 0.1 microfarad for the isolating capacitor is suggested so that full output is obtained from the pickup.

As with all single-ended amplifier circuits, especially ac/dc units, adequate screen-grid bypassing is necessary to minimize hum. Screen-grid filtering is obtained through use of a 220-ohm dropping resistor and a 50-microfarad electrolytic capacitor. Although separate cathode-bias resistors are used for better dynamic balance in the circuit shown, a single 30-ohm common cathode-bias resistor bypassed with a 50-microfarad electrolytic capacitor may also be used.



Measured operating conditions for each 60FX5 are listed in Table II; curves of power output and total distortion as functions of frequency are shown in Fig.5.

Plate Voltage	111	volts
Grid-No.2 Voltage	112	volts
Maximum-Signal Plate Current	32.5	ma
Zero-Signal Plate Current	36	ma
Maximum-Signal Grid-No.2 Current	13.5	ma
Zero-Signal Grid-No.2 Current	10	ma
Peak AF Grid-No.1 Voltage	2.7	volts
Power Output to 4-ohm load	1.1	watts
Total Harmonic Distortion	9.3	per cent

Table II - Measured operating characteristics for each 60FX5 in the low-cost portable stereo amplifier shown in Fig.4.

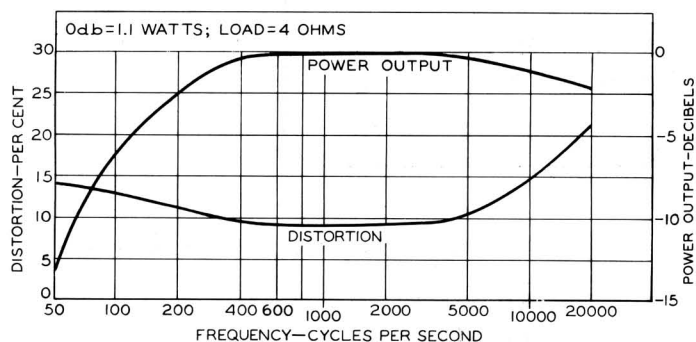


Fig.5 - Power output and total harmonic distortion as functions of frequency for the 60FX5 amplifier.

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