RCA High-Fidelity Amplifier Circuits

DESIGNED FOR USE WITH RCA HI-FI TUBE TYPES...

5879 6973 7025 7027-A 7199

RADIO CORPORATION OF AMERICA • ELECTRON TUBE DIVISION, HARRISON, N.J.
This booklet has been prepared to provide high-fidelity electronic enthusiasts, and others interested in high-fidelity amplifiers, with information on circuits, which can provide superior performance at moderate cost. These systems employ RCA tube types designed especially for use in high-fidelity applications, and include the most recent developments in circuit design.

The booklet discusses the performance requirements of high-fidelity amplifier systems, describes the functions of the various amplifiers, preamplifiers, and control units which are usually employed, includes construction hints, and provides voltage charts to facilitate checking the equipment. The booklet contains circuits for three power amplifiers having power outputs of 15, 30, and 50 watts, a bass-and-treble tone-control amplifier, preamplifiers for use with magnetic phonograph pickups, a preamplifier for use with a magnetic-type pickup head, and a microphone preamplifier. Also included are circuits for a two-channel mixer, and a balancing unit for stereo systems.

The tone-control amplifier, preamplifier, and mixer have matching gain and equal characteristics which permit them to be used singly, or in various combinations with any of the three power amplifiers. Each power amplifier circuit includes a power-supply which can be used to supply the heater and 6V-6 requirements of a complete audio system.

For those who are interested in economy amplifiers for use in non-critical entertainment applications, this booklet also gives circuits for a three-tube 4-watt "hi-fi" phonograph amplifier and a one-tube phonograph amplifier. Both amplifiers employ transformerless power supplies and provide excellent performance at minimum cost.

**PERFORMANCE REQUIREMENTS**

The performance capabilities of a high-fidelity amplifier are usually given in terms of its frequency response, total harmonic distortion, intermodulation distortion, maximum power output, and noise level.

To provide high-fidelity reproduction of audio program material, an amplifier should have a frequency response which does not vary more than 3 dB over the entire audio spectrum. General practice is to design the amplifier so that its frequency response is flat within ±1 dB from a frequency below the lowest to be reproduced to one well above the upper limit of the audible range.

Harmonic distortion and intermodulation distortion produce changes in program material which may have adverse effects on the quality of the reproduced sound. Harmonic distortion causes a change in the character of an individual tone by the introduction of harmonics which were not originally present in the program material. Harmonic distortion is expressed as a percentage of the output power. For high-fidelity reproduction, total harmonic distortion should not be greater than about 0.1% at the desired listening level.

Intermodulation distortion is a change in the waveform of an individual tone as a result of interaction with another tone present at the same time in the program material. This type of distortion not only alters the character of the modulated tone but may also result in the generation of spurious signals at frequencies equal to the sum and difference of the interacting frequencies. Intermodulation distortion, like harmonic distortion, is expressed as a percentage of the output power and should be less than 0.01% at the desired listening level. In general, any amplifier which has low intermodulation distortion will have very low harmonic distortion.

The maximum power output which a high-fidelity amplifier should deliver depends upon a complex relation of several factors, including the size and acoustical characteristics of the listening area, the desired listening level, and the efficiency of the loudspeaker system. Practically, however, it is possible to determine amplifier requirements in terms of room size and loudspeaker efficiency.

The acoustic power required to reproduce the loudest passages of orchestral music at concert-hall level in the average-size living room is about 0.4 watt. Because high-fidelity loudspeakers of the type generally available for home use have an efficiency of only about 3% per watt, the amplifier should therefore be able to deliver a power output of at least 4 watts. Since many wide-range loudspeaker systems, particularly those using frequency-divider networks, have efficiencies of less than 5% per watt, amplifiers used with such systems must have correspondingly larger power outputs.

The noise level of a high-fidelity amplifier determines the range of volume the amplifier is able to reproduce—this is the difference (usually ex...
CIRCUIT

FIFTEEN-WATT AMPLIFIER

The high-fidelity power amplifier shown in Fig. 1 can deliver 15 watts with less than 0.4 per cent total harmonic distortion and less than 1.5 per cent intermodulation distortion. It has a frequency response which varies less than ±0.5 db from 20 cps to 60,000 cps, and a sensitivity of 1.2 volts rms for 15 watts output. Total hum and noise with input shorted is 84 db below 15 watts.

This amplifier incorporates several design features which permit it to provide excellent performance with relatively inexpensive components. Features responsible for the very low hum and noise level are the use of an RCA 7199 low-noise triode-plate in the input and phase-splitter stages, a choke-capacitor filter in the B+ supply circuit, and the application of a positive voltage to the tube heaters to minimize hum due to heater-cathode leakage. The features responsible for the low distortion and excellent frequency-response characteristics of this amplifier are the use of RCA 6973 beam power tubes operated under class AB3 conditions with fixed bias in the output stage, the use of direct coupling between the input and phase-splitter stages, and the use of inverse feedback from the voice-coil winding of the output transformer to the outside of the input amplifier stage.

In addition to its excellent performance capabilities and low cost, this amplifier is extremely compact, and therefore, is particularly suitable for use in stereophonic systems.

THIRTY-WATT AMPLIFIER

The high-fidelity power amplifier shown in Fig. 2 can deliver 30 watts output with less than 0.7 per cent total harmonic distortion and less than 1.5 per cent intermodulation distortion. The frequency response of this amplifier is flat within ±0.5 db from 15 cps to 60,000 cps. The total hum and noise...
with the input shorted is 85 dB below 30 watts. Sensitivity is 1 volt rms input for 30 watts output. The amplifier is similar in design to the 15-watt amplifier shown in Fig. 1, except that it uses RCA-7027-A beam power tubes in the output stage, and a resistive network in the negative leg of the B-supply rather than a separate rectifier to supply the fixed bias voltages for the output tubes. The amplifier is also provided with a hum-balancing adjustment in the heater circuit.

**40-WATT AMPLIFIER**

The high-fidelity power amplifier shown in Fig. 3 is capable of outstanding performance at moderate cost. This four-stage amplifier can deliver 50 watts output with less than 0.1 per cent total harmonic distortion and less than 1 per cent intermodulation distortion; and has a frequency response flat within ±0.5 dB from 10 cps to 50,000 cps. Sensitivity is 0.4 volt rms input for fifty watts output. The total hum and noise is 70 dB below 50 watts. This amplifier, like the 15-watt and 30-watt high-fidelity amplifiers shown in Figs. 1 and 2 uses an RCA-7149 low-noise triode-pentode as an input amplifier, and phase-splitter, but has a push-pull driver stage using RCA-6C56 sharp-cut-off pentodes, and incorporates several other features which contribute to its superior performance. These features include the use of a 450-volt plate supply and a 400-volt electronically regulated grid-No. 2 supply for the RCA-7027-A beam power tubes in the output stage; the use of inverse-feedback loop from the plates to the grids of the output tubes, from the plates of the output tubes to the cathodes of the driver tubes, and from the voice-coil winding of the output transformer to the cathodes of the input amplifier. Additional features are the operation of all heaters at a positive voltage with respect to ground and use of a balancing adjustment (1000) in the heater-supply circuit to minimize hum, a grid-No. 2-voltage adjustment (128), a grid-No. 1 bias adjustment (235) for the RCA-7027-A output tubes, and an ac-biased current adjustment (R17) which may be used to balance the outputs of the push-pull stages. Instructions for making the ac-balance adjustment are given in the legend for Fig. 3.

**TONE-CONTROL AMPLIFIER**

Fig. 4 shows a high-fidelity two-stage tone-control
amplifier using an RCA-7025 low-noise twin triode. This amplifier has non-interacting bass and treble controls which can be adjusted to provide up to about 16 db boost or attenuation at 30 cps, and up to about 16 db boost or attenuation at 15,000 cps. With the bass and treble controls set at their midrange positions, the frequency response of the amplifier is flat within ±1 db from 30 cps to 15,000 cps. The amplifier has an overall voltage gain of approximately 2.5, and is designed to be used immediately ahead of any of the power amplifiers shown in Figs. 1, 2, and 3, or any power amplifier having similar characteristics. For operating convenience, the volume control on the power amplifier may be physically located on the tone-control channel. In this case, it is advisable to insert a 1-negohm resistor in place of the volume control on the power amplifier.

If partial compensation for the reduced high- and low-frequency sensitivity of the ear at low volume levels is desired, the volume-control potentiometer may be replaced by a "loudness control".

REPRODUCTION OF PHONOGRAPH RECORDS AND MAGNETIC-TAPE RECORDINGS

The frequency range and dynamic range which can be recorded on a phonograph record or on magnetic tape depend on a complex relation of several factors, including the composition, mechanical characteristics, and speed of the record or tape, the electrical and mechanical characteristics of the recording equipment, and other factors which are outside the scope of this booklet. To achieve wide frequency and dynamic ranges, manufacturers of commercial recordings use equipment which introduces a non-uniform relationship between amplitude and frequency. This relationship is known as a "recording characteristic." To assure proper reproduction of a high-fidelity recording, therefore, some part of the reproducing system must have a frequency-response characteristic which is the inverse of the recording characteristic. Most manufacturers of high-fidelity recordings use the RCA "New Orthophonic" (RiAA) characteristic for discos and the NAIR/T characteristic for magnetic tape.

The location of the frequency-compensating network or "equalizer" in the reproducing system will depend on the types of recordings which are to be reproduced and on the pickup devices used.

A ceramic high-fidelity phonograph pickup is usually designed to provide proper compensation for the RIAA recording characteristic when the pickup is operated into the loud resistance specified by its manufacturer. Since this type of pickup also has relatively high output (0.5 volt to 1.5 volts), it does not require the use of either an equalizer network or a preamplifier, and can be connected directly to the input of a tone-control amplifier and/or power amplifier of the type described in this booklet.

A magnetic high-fidelity phonograph pickup, on the other hand, usually has an essentially flat frequency-response characteristic and very low output (1 millivolt to 10 millivolts). Since a pickup of this type merely reproduces the recording characteristic, it must be followed by an equalizer network as well as by a preamplifier having sufficient voltage gain to provide the input voltage required by the tone-control amplifier and/or power amplifier. Many current designs include both the equalizing and amplifying circuits in a single unit.

A high-fidelity magnetic-tape pickup head, like a magnetic phonograph pickup, reproduces the recording characteristic and has an output of only a few millivolts. This type of pickup device, therefore, must also be followed by an equalizing network and preamplifier, or by a preamplifier which provides "built-in" equalization for the NAIR/T characteristic.

POAAMPLIFIERS

Figs. 5 and 6 are circuits of preamplifiers for use with high-fidelity magnetic phonograph pickups. Both preamplifiers are equalized for the RCA "New Orthophonic" (RiAA) recording characteristic, have similar voltage-gain characteristics, and use RCA tube types having exceptionally low hum and noise. These tubes are designed especially for use in high-fidelity equipment operating at low signal levels. The two-stage preamplifier circuit shown in Fig. 6 uses an RCA-7025 twin triode, and has a voltage gain of about 50. This preamplifier has a high-impedance output, and is recommended for use when the preamplifier is constructed on the same chassis as the power amplifier or tone-control amplifier. The preamplifier may also be used at distances of up to six feet from the amplifier without effect on its frequency response provided the capacitance of C3 is reduced by approximately
30 µf for each foot of shielded cable used for the rf connection between the preamplifier and the following amplifier.

The three-stage preamplifier circuit shown in Fig. 6 uses an RCA-5732 low-noise sharp-cutoff pentode as an input amplifier, one unit of an RCA-7025 as a voltage amplifier, and the other unit of the 7025 as a cathode-follower output amplifier. This preamplifier has a voltage gain of approximately 80, and low-impedance output. Because of the low-impedance output the preamplifier may be installed at distances up to 50 feet from the following amplifier without effect upon its frequency-response characteristics.

Fig. 7 is the circuit of a preamplifier for use with a high-fidelity magnetic-tape pickup head. This preamplifier is essentially the same as that shown in Fig. 6 except that its frequency response is equalized to provide the NARITB playback characteristic.

Fig. 8 shows the circuit of a one-stage preamplifier for use with a high-fidelity, high-impedance crystal or dynamic microphone. This amplifier uses an RCA-5937 low-noise sharp-cutoff pentode in a conventional circuit with high-impedance output, has a voltage gain of approximately 70, and a flat frequency response over the audio range. Because of its high output impedance this preamplifier should be constructed on the same chassis as the power amplifier and/or tone-control amplifier.

MIXER

Fig. 9 shows the circuit of a high-fidelity mixer which can be used to combine audio-frequency program material from two sources. In this circuit each mixer control is preceded by a one-stage voltage amplifier using one unit of an RCA-7025 low-noise triode and is separated from the common load resistor by a resistance-capacitance network. These features provide high-level mixing to minimize noise during adjustments, a very high degree of isolation between the two signal channels, and more than sufficient voltage gain to overcome the losses in the mixing potentiometers and isolating networks. The common 390,000-ohm load resistor may be used as the input resistor for the following tone-control amplifier or power amplifier.

Each section of the mixer can provide a voltage gain of about 7, and can handle an input signal of about 0.2 volt (200 millivolts) rms without overloading.

AMPLIFIER CONSTRUCTION

The results achieved from any high-fidelity amplifier system depend to a large degree upon the skill and care with which the system is constructed. Improper placement of transformers, other components, and wiring, and attempts to achieve excessive compactness, can easily result in instability, oscillation, hum, and other operating difficulties, as well as in damage to components by overloading. It is important, therefore, that construction of high-fidelity amplifier systems be undertaken only by persons who have had some experience in the layout, mechanical construction, and wiring of audio equipment.

It is impractical to give specific construction data for the various amplifiers and other units described in this booklet, because the best arrangement for each unit or combination of units will depend upon the requirements of the user. It is possible, however, to list some general considerations which should be observed in the construction of any high-fidelity amplifier system.

Any amplifier having two or more stages should be constructed with a straight-line layout so as to provide minimum separation between the signal input and output circuits and terminals. Power-supply connections, particularly those carrying ac, should be isolated as far as possible from signal connections, especially from the input connection. Signal-carrying conductors, even when shielded, should not be cabled together with power-supply conductors. Internal wiring for ac-operated tube beamers, switches, pilot-light sockets, and other devices, should be twisted and placed flat against the chassis. All connections to the ground side of the circuit in each unit should be made to a common bus of heavy wire. This bus should be connected to the chassis only at the point of minimum signal voltage—i.e., at the signal-input terminal of the unit, as shown by the ground symbol in the circuit diagrams.

All internal wiring handling signal voltages should be as short as possible, and as far as possible above the chassis to minimize losses at the higher audio frequencies due to stray shunt capacitance. All connections between units should be made with shielded cable having a capacitance of not more than 30 µf per foot, such as Alpha Type
1249 or 1704, Hohner Type 8401 or 8410, or equivalent cable.

The power amplifiers and power-supply units described in the booklet dissipate large amounts of heat and, therefore, should be constructed and installed in such a manner as to assure adequate ventilation for the tubes and other components.

A boom power tube or rectifier tube should be separated by at least 1½ tube diameters from any other tube or component on the same side of the chassis.

Power amplifiers and power-supply units which are to be installed horizontally (that is, with tubes vertical) in cabinets or on shelves should be provided with mounting feet, perforated bottom covers, and a number of small holes around each tube socket to permit relatively cool air to enter from below and provide ventilation for the under side of the chassis and tubes.

If a power amplifier, tone-control amplifier, and one or more preamplifiers are to be constructed on the same chassis, the mechanical layout should be planned so that the circuits operating at the lowest signal levels are farthest from the output stage and power supply. Amplifier units which normally operate at comparable signal levels but are not used simultaneously—such as preamplifiers for tape pickup bands and magnetic phonograph pick-ups—may be installed side by side on the same chassis without danger of interaction. Units which operate simultaneously, however—such as the channels of a stereophonic system—should not be installed side by side on the same chassis without careful consideration to placement of components and wiring, and the possible use of shielding, to prevent interaction.

When an amplifier, preamplifier, mixer or other unit requiring heater power is located more than five or six feet from its power-supply unit, the heater-current conductors in the power-supply cable must be large enough to assure that each tube receives its rated heater voltage. In cases where very large heater currents or very long power-supply cables are involved, it may be desirable to install a heater-supply transformer or, near the amplifier unit. If such a transformer is installed on or near a preamplifier for a magnetic-type pickup head, a magnetic phonograph pickup, or a dynamic microphone, the transformer should be completely shielded and carefully positioned to prevent its field from inducing hum in the pickup device.
RCA TUBES FOR HIGH-FIDELITY

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Ratings</th>
<th>General Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied Voltage</td>
<td>80-00</td>
</tr>
<tr>
<td></td>
<td>Standing Current</td>
<td>200-000</td>
</tr>
<tr>
<td>5879</td>
<td>-50</td>
<td>+50</td>
</tr>
<tr>
<td>6973</td>
<td>100-000</td>
<td>+200-200</td>
</tr>
<tr>
<td>7025</td>
<td>120-000</td>
<td>+200-200</td>
</tr>
<tr>
<td>7027-A</td>
<td>150-000</td>
<td>+200-200</td>
</tr>
<tr>
<td>7199</td>
<td>180-000</td>
<td>+200-200</td>
</tr>
</tbody>
</table>

- The dc component must not exceed 100 watts.

SOCKET CONNECTIONS
BOTTOM VIEW

The 8073, 7025, 7027-A, and 7199 are on a Single-Maximum basis; type 5879, on a Design-Level basis.
### AUDIO APPLICATIONS

#### TYPICAL OPERATION AND CHARACTERISTICS

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>Grid No. 1</th>
<th>Grid No. 2</th>
<th>Load Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A, Amplifier</td>
<td>500</td>
<td>1200</td>
<td>2200</td>
</tr>
<tr>
<td>Push-Pull Class AB, Amplifier</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Push-Pull Class AB, Amplifier*</td>
<td>200</td>
<td>400</td>
<td>800</td>
</tr>
</tbody>
</table>

#### Grid No. 2

<table>
<thead>
<tr>
<th>Type</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>1200</td>
<td>2200</td>
</tr>
<tr>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>200</td>
<td>400</td>
<td>800</td>
</tr>
</tbody>
</table>

#### Total Harmonics Distortion Reference Points

<table>
<thead>
<tr>
<th>Power</th>
<th>Input Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>1200</td>
</tr>
<tr>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>200</td>
<td>400</td>
</tr>
</tbody>
</table>

* Obtained from the primary winding of the output transformer.

# Obtained from taps on the primary winding of the output transformer.

The taps are located on each side of the center tap (Fig. 1) so as to supply 50% of the plate signal voltage to grid No. 2 or each output tube.

---

* Equivalent Gain for 

- **7025**
- **7027-A**
- **7199**

---

For more detailed information, please refer to the provided diagrams and specifications.
15-WATT HIGH-FIDELITY AUDIO AMPLIFIER CIRCUIT

FIGURE 1

PERFORMANCE SPECIFICATIONS:

Sensitivity = 1.5 volts rms for 15 watts output;
Total Harmonic Distortion = 0.4% at 15 watts;
Hum and Noise = 84 db below 15 watts with input shorted;
Intermodulation Distortion = 1.5% at 15 watts.
Frequency Response = flat ±1 db from 20 cps to 10,000 cps.
30-WATT HIGH-FIDELITY AUDIO AMPLIFIER CIRCUIT

FIGURE 2

PERFORMANCE SPECIFICATIONS:

Sensitivity = 1 volt rms for 30 watts output;

Hum and Noise = 0.1 db below 20 watts with input shorted;

Frequency Response = Flat ± 0.5 db from 15 cps to 40,000 cps;

Total Harmonic Distortion = 0.7% at 30 watts;

Intermodulation Distortion = 1.5% at 30 watts.
HUM-BALANCE ADJUSTMENT

Short circuit the audio-input terminals of the amplifier. Connect the amp to the ac line and adjust the hum-balance potentiometer (Rg) for minimum hum from the broadcast.

DC-VOLTAGE MEASUREMENT CHART

<table>
<thead>
<tr>
<th>Channel</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>U9S85</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>U7E85</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>U6</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>U5</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
</tr>
</tbody>
</table>

All voltages ±20% with 400 ohms, 400 volts, unless otherwise specified.
VOLT RMS PERFORMANCE SPECIFICATIONS:
Sensitivity = 0.4 volt rms for 50 watts output;
Hum and Noise = 70 dB below 50 watts with input shorted;
Frequency Response = Flat = 1 db from 10 to 50000 cps;
Total Harmonic Distortion = 0.1% at 50 watts;
Intermodulation Distortion = 1% at 50 watts.
**PRELIMINARY ADJUSTMENTS**

To avoid possible damage to the tubes and components in the output stage of the 50-watt power amplifier shown in Fig. 3, and to minimize hum, the following adjustments should be made before the amplifier is placed in operation:

1. Remove the 54608 rectifier tube from its socket and connect a d-c voltmeter between B minus and the junction of R6 and R10, with the positive lead of the meter on B minus. Set the meter on a range which provides a full-scale reading of at least 500 volts.

2. Connect the amplifier to the d-c voltmeter to a range which provides a full-scale reading of at least 500 volts, and connect it between B minus and the A at the 6077 socket, with the negative lead of the meter on B minus. Connect the loudspeaker to the voice coils of the amplifier. Replace the 54608 rectifier tube in its socket.

3. Connect the amplifier to the ac line and, after approximately one minute, adjust the grid-No. 2-voltage-control potentiometer (R11) until the meter reads 400 volts. Disconnect the amplifier from the ac line and remove the meter.

4. Short-circuit the audio-input terminals of the amplifier. Connect the amplifier to the ac line and adjust the heat-balance potentiometer (R11) for minimum hum from the loudspeaker.

5. Remove the short circuit from the audio-input terminals of the amplifier and set the volume control at its maximum clockwise (maximum-volume) position. Adjust the ac-balance control (R8) for minimum hum from the loudspeaker.

---

**DC-VOLTAGE MEASUREMENT CHART**

<table>
<thead>
<tr>
<th>TUBE</th>
<th>PIN NUMBER</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>567</td>
<td>R-type</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>6077</td>
<td>...</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>120</td>
</tr>
<tr>
<td>6066</td>
<td>...</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>120</td>
</tr>
<tr>
<td>6067</td>
<td>...</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>120</td>
</tr>
<tr>
<td>6307</td>
<td>...</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>120</td>
</tr>
<tr>
<td>7022-A</td>
<td>...</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>120</td>
</tr>
<tr>
<td>7109</td>
<td>...</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>110</td>
<td>120</td>
</tr>
</tbody>
</table>

All voltages ±15% measured with no load on speaker. Under the following conditions: tone voltage 770 volts ac, 60 cps, 340 ohms input. All resistors ±10%, unless otherwise specified. All capacitors ±20%, unless otherwise specified.
HIGH-FIDELITY TONE-CONTROL AMPLIFIER

![Diagram of the amplifier circuit](image)

**Parts List**
- C1: 22 µF, 450 volts
- C2: 0.047 µF
- C3, C4: 33 µF
- C5: 220 µF
- C6: 0.0022 µF
- R1: 0.047 megohm
- R2: 0.33 megohm
- R3: 0.50 megohm
- R4: 150,000 ohms
- R5: 2,000,000 ohms
- R6: 0.1 megohm
- R7: 3,000,000 ohms
- R8: 4,000,000 ohms
- R9: 0.1 megohm
- R10: Bass-Control Potentiometer, 0.1 megohm
- R11: Treble-Control Potentiometer, 0.1 megohm

**Performance Specifications**
- +1.56 dB bass and treble boost.
- -16 dB bass and treble cut.
- Sensitivity: 0.5 volts for output of 1.26 volts with controls set for flat response.

**DC Voltage Measurement Chart**

<table>
<thead>
<tr>
<th>Type</th>
<th>Pin Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>M408</td>
<td>240/280</td>
<td>+15</td>
<td>+15</td>
<td>-17.5</td>
<td>-105</td>
<td>0</td>
<td>+4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Voltages vary with the type of power amplifier used as follows:
  15-watt amplifier (Fig. 2)...
  30-watt amplifier (Fig. 3)...
  60-watt amplifier (Fig. 3)...

All voltages 0.5 volt from pin to pin, unless otherwise specified.

*All voltages are with 177 volt ac, 60 cps, no input.
HIGH-FIDELITY PREAMPLIFIER
(RIAA Equalization)
for use with Magnetic Phonograph-Pickup

PARTS LIST:
- C1: 25 µF, 25 volts
- C2: 25 µF, 450 volts
- C3: 1 µF
- C4: 25 µF, 25 volts
- C5: 25 µF, 450 volts
- C6: 0.0036 µF
- C7: 0.01 µF
- C8: 330 µF
- C9: 0.22 µF
- R1: Value depends on type of magnetic pickup used. Follow phono manufacturer's recommendations.
  - R2: 3700 ohms
  - R3: 0.1 megohm
  - R4: 3900 ohms
  - R5: 0.1 megohm
  - R6: 0.17 megohms
  - R7: 3700 ohms
  - R8: 0.01 megohm
  - R9: 15000 ohms, 1 watt
  - R10: 20000 ohms

NOTE:
All resistors 0.5 watt, ±10% unless otherwise specified.
All capacitors 400 volts, unless otherwise specified.

PERFORMANCE SPECIFICATIONS:
Sensitivity — 3 millivolts rms for output of 0.55 volt at frequency of 1000 cps.

DC VOLTAGE MEASUREMENT CHART

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PIN NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>7025</td>
<td>+1.5</td>
</tr>
</tbody>
</table>

*This voltage will vary with the type of power amplifier used or 50/60 Hz.
25-watt amplifier (Fig. 1): +1.3, +1.5
25-watt amplifier (Fig. 1): +1.5, +1.0
50-watt amplifier (Fig. 1): +1.5, +1.0
50-watt amplifier (Fig. 2): +0.9, +1.0
50-watt amplifier (Fig. 2): +0.9, +1.0

All voltages ±20% referred from pin to ground with a 10000 ohm load.
Sensitivity: 3 millivolts rms for output of 0.55 volt at frequency of 1000 cps.
HIGH-FIDELITY PREAMPLIFIER
(RIAA Equalization)
for use with Magnetic Phonograph-Pickup

FIGURE 6

PERFORMANCE SPECIFICATIONS:
Sensitivity — 3 millivolts rms for output of 0.84 volt at 1000 cps.
PARTS LIST

C1: 40 µF, 450 volts
C2: 0.1 µF
C3: 25 µF, 25 volts
C4: 0.25 µF
C5: 0.03 µF
C6: 0.005 µF
C7: 15 µF, 25 volts
R4: 15kΩ
R5: 40 µF, 450 volts

R1: Value depends on type of pickups. Use manufacturer's recommendations.
R2: 100kΩ
R3: 500 ohms
R6: 0.47 megohm
R7: 1500 ohms
R8: 20kΩ
R9: 0.68 megohm
R10: 1500 ohms
R11: 1000Ω
R12: 1500 ohms
R13: 3900Ω
R14: 0.47 megohm
R15: 4700Ω

NOTE:
All resistors 0.5 watt, ±10%, unless otherwise specified.
All capacitors 400 volts, unless otherwise specified.

DC-VOLTAGE MEASUREMENT CHART

<table>
<thead>
<tr>
<th>TUBE</th>
<th>PIN NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>5FY9</td>
<td>1 2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>7027</td>
<td>150 1 2 3 4 5 6 7 8</td>
</tr>
</tbody>
</table>

*This voltage will vary with type of power amplifier used as follows: with power amplifier (C1): 0.15 to 0.45 volts with power amplifier (C2): 0.15 to 0.45 volts with power amplifier (C3): 0.15 to 0.45 volts with power amplifier (C4): 0.15 to 0.45 volts with 50 watt amplifier (C5): 0.15 to 0.45 volts

All voltages ±10%, measured from 6V to 19V with a multimeter under the following conditions: line voltage 115 volts ac, 60 cycles, 110Vac choke.
HIGH-FIDELITY PREAMPLIFIER
(NARTB Equalization)
for use with Tape-Head Pickup

FIGURE 7

PERFORMANCE SPECIFICATIONS:

Sensitivity = 3 millivolts rms for output of 0.35 volts at 1000 cps.
C1: 0.047 μF
C2: 40 μF, 450 volts
C3: 0.1 μF
C4: 25 μF, 25 volts
C5: 0.92 μF
C6: 0.015 μF
C7: 25 μF, 25 volts
C8: 0.022 μF
C9: 40 μF, 450 volts
C10: 0.47 μF
R1: 1 megohm
R2: 0.1 megohm
R3: 1000 ohms
R4: 0.47 megohm
R5: 0.22 megohm
R6: 3200 ohms
R7: 3300 ohms
R8: 3.3 megohms
R9: 1500 ohms
R10: 0.1 megohm
R11: 1500 ohms
R12: 15000 ohms
R13: 0.47 megohm
R14: 4700 ohms

**NOTES:**
- All resistors 1/4 watt, ±10%, unless otherwise specified.
- All capacitors 450 volts, unless otherwise specified.

**DC-VOLTAGE MEASUREMENT CHART**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>5079</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98</td>
<td></td>
<td>75</td>
<td>95</td>
<td>18</td>
</tr>
<tr>
<td>7025</td>
<td>-190</td>
<td>0</td>
<td>1.3</td>
<td></td>
<td>-295</td>
<td>-17</td>
<td>-19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This voltage will vary with the type of power amplifier used as follows:
10-watt amplifier (Fig. 8) | -90 volts
10-watt amplifier (Fig. 9) | -5 volts
10-watt amplifier (Fig. 10) | -45 volts

All voltages ±15%, measured from 60°C to ground with 1000 ohms under the following conditions: Line voltage 110 volts ac, 60-cycle no signal input.*
HIGH-FIDELITY PREAMPLIFIER
for use with Low-Output Microphones

PARTS LIST
C1: 25 µf, 25 volts
C2: 0.047 µf
C3: 0.22 µf
C4: 40 µf, 450 volts
R1: 22 megohms
R2: 0.3 megohm
R3: 1000 ohms
R4: 0.47 megohm
R5: 22000 ohms

PERFORMANCE SPECIFICATIONS
Sensitivity — 3 millivolts rms for output of 200 millivolts

NOTES:
All resistors 0.5 watt, ±10%,
unless otherwise specified.
All capacitors 400 volts, unless
otherwise specified.

DC VOLTAGE MEASUREMENT CHART

<table>
<thead>
<tr>
<th>TUBE</th>
<th>PIN NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>E87U</td>
<td>0</td>
</tr>
</tbody>
</table>

All voltages ±20% measured from pin to ground with a test instrument.

* This voltage will vary with the type of power amplifier used as follows:
  25-watt amplifier (Fig. 2): 3.6 in., 3.6 out
  20-watt amplifier (Fig. 2): 3.6 in., 3.6 out
  30-watt amplifier (Fig. 2): 3.6 in., 3.6 out
All voltages ±20% measured from pin to ground with a test instrument.

*10 Volt input.
HIGH-FIDELITY TWO-CHANNEL MIXER

DC-VOLTAGE MEASUREMENT CHART

<table>
<thead>
<tr>
<th>TUBE TYPE</th>
<th>PIN NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>7202</td>
<td>-185</td>
</tr>
</tbody>
</table>

*This voltage will vary with the type of power amplifier used as follows:
10-watt amplifier (4, 6, 9) = +40 volts
20-watt amplifier (4, 6, 9) = +20 volts
50-watt amplifier (4, 6, 9) = +15 volts
* All voltages are measured from pin 3 to 8 with a millivoltmeter, unless otherwise specified.
BALANCING UNIT
for TWO-CHANNEL STEREOPHONIC SYSTEMS

PARTS LIST
R1, R2, 0.1 megohm
R3, Balance-Control Potentiometer, 0.5 megohm, linear taper
R4, R5, Volume-Control Potentiometers, ganged, 1 megohm, audio taper

NOTE
All resistors 0.5 watt, ± 10%

ADJUSTMENT OF THE STEREO BALANCING UNIT

For proper operation of a stereo system, the output levels of the two channels should be equal. A typical method for balancing the two channels follows:

1. Connect the output of a monaural signal source, such as an audio signal generator or a test record, to both the right and left channel inputs. Use a frequency of 1000 cps as a test frequency.

2. Set the ganged volume-control potentiometers (R4 and R5) to provide a comfortable listening level.

3. Measure the ac voltage developed across the voice coil of the speaker in each channel, with a Volt-Ohm-Voltmeter.

4. Adjust the balance-control potentiometer (R3) so that the voltages across both voice coils are equal.
ECONOMY PHONOGRAPH AMPLIFIER

PARTS LIST
- C1: 0.02 uF
- C2: 0.082 uF
- C3, C4: 4.7 uF, 150 volts
- F1: Fuse, 1 amp
- R1: Volume Control Potentiometer, 0.5 megohm, audio taper
- R2: 10000 ohms
- R3: 220 ohms
- R4, R5: 50 ohms
- R6, R7: 22 ohms
- R8: 3300 ohms, 1 watt
- R9: 210 ohms. 10 watts
- T1: Output transformer, primary impedance 1000 ohms, secondary impedance to match speaker voice coil

NOTE
- All resistors 0.5 watt, ±20% unless otherwise specified
- All capacitors 400 volts, unless otherwise specified.

DC-VOLTAGE MEASUREMENT CHART

<table>
<thead>
<tr>
<th>TUBE TYPE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>30V6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>217 KΩ</td>
<td></td>
<td></td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>5G25</td>
<td>+2.7</td>
<td>0</td>
<td></td>
<td></td>
<td>895</td>
<td>-120</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All voltages ±20% measured from pin to ground with a Voltmeter under the following conditions: Line voltage 115 volts, 40 ohm re signal input.
### CONTENTS

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Requirements</td>
<td>2</td>
</tr>
<tr>
<td>Circuits</td>
<td>3</td>
</tr>
<tr>
<td>Reproduction of Phonograph Recordings and Tape Recordings</td>
<td>5</td>
</tr>
<tr>
<td>Amplifier Construction</td>
<td>6</td>
</tr>
<tr>
<td>Tube Data Chart</td>
<td>8 &amp; 9</td>
</tr>
<tr>
<td>Circuit Diagrams and Parts Lists:</td>
<td></td>
</tr>
<tr>
<td>15-Watt Amplifier</td>
<td>10</td>
</tr>
<tr>
<td>30-Watt Amplifier</td>
<td>12</td>
</tr>
<tr>
<td>50-Watt Amplifier</td>
<td>14</td>
</tr>
<tr>
<td>Tone-Control Amplifier</td>
<td>16</td>
</tr>
<tr>
<td>Pre-amplifier for Magnetic Phonograph</td>
<td></td>
</tr>
<tr>
<td>Pickup (1 Tube)</td>
<td>17</td>
</tr>
<tr>
<td>Pre-amplifier for Magnetic Phonograph</td>
<td></td>
</tr>
<tr>
<td>Pickup (2 Tubes)</td>
<td></td>
</tr>
<tr>
<td>Pre-amplifier for Tape-Head Pickup</td>
<td>20</td>
</tr>
<tr>
<td>Pre-amplifier for Low-Output Microphone</td>
<td>22</td>
</tr>
<tr>
<td>Two-Channel Mixer</td>
<td>23</td>
</tr>
<tr>
<td>Balancing Unit for Two-Channel</td>
<td></td>
</tr>
<tr>
<td>Stereophonic System</td>
<td>24</td>
</tr>
<tr>
<td>Economy Phonograph Amplifier</td>
<td>25</td>
</tr>
<tr>
<td>Low-Cost Hi-Fi Amplifier</td>
<td>26</td>
</tr>
</tbody>
</table>

### PARTS LIST

- C1: 260 µf, 150 volts
- C2, C3: 40 µf, 150 volts
- C4, C5, C6: 0.01 µf
- C7, C9: 0.005 µf
- C8: 0.001 µf
- C10, C11: 10 volts
- C12: 0.022 µf
- C13: 0.033 µf
- C14: 0.02 µf
- P: Fuse, 3 amperes
- R1: 5.6 ohms, 10 watts
- R2: 1300 ohms, 2 watts
- R3: 30 ohms
- R4: Re Tone-control potentiometer, 2 megohms
- Rp: 0.18 megohm
- R6: 0.32 megohm
- R7: 47000 ohms
- R8: 0.12 megohm
- R10: 10000 ohms
- R11, R12: 25 ohms
- R13: R14: 0.0141 megohm
- R15: Loudness control potentiometer, 1.5 megohms
- R16: R17: 0.25 and 0.5 megohm
- R18: 88 ohms
- R19: 2700 ohms
- R20: 12000 ohms
- R21: 0.1 megohm
- R22: 5500 ohms
- R23: 0.9 megohm
- R24: 37.7 ohms, 1 watt

### NOTES

- YY and B- are heater and B supply terminals respectively for second channel (not shown) of stereophonic system
- All resistors 0.5 watt, ±20%, unless otherwise specified
- All capacitors 400 volts unless otherwise specified
QUALITY IS AS QUALITY DOES

With RCA tubes, as with everything manufactured by RCA, quality is built-in to stay-in. From the initial concept on a designer's board to the finished product ready for installation — quality is the watchword, the standard to which all RCA tubes must adhere. Quality control begins during the designing stage. Quality control continues during the manufacturing period. Finally each tube type is subjected to rigorous performance tests. AND WHAT DOES THIS MEAN TO YOU? With RCA quality control and rigid manufacturing standards, RCA tubes insure top performance.