Price 35 Cents

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.

Form No. HF-110

THIS booklet has been prepared to provide hobbyists, electronic technicians, and others interested in construction of high-fidelity amplifier systems with laboratory-tested 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 a high-fidelity amplifier system, 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-tape 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, preamplifiers, and mixer have matching gain and output 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 B+ 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 1 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 region.

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 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 2 per cent 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 5 per cent the amplifier should therefore be able to deliver a power output of at least 8 watts. Since many wide-range loudspeaker systems, particularly those using frequency-divider networks, have efficiencies of less than 5 per cent, 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 — that is, the difference (usually ex-

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pressed in decibels) between the loudest and softest sounds in program material. Since the greatest volume range utilized in electrical program material at the present time is about 60 db, the noise level of a high-fidelity amplifier should be at least 60 db below the signal level at the desired listening level.

CIRCUITS

FIFTEEN-WATT AMPLIFIER

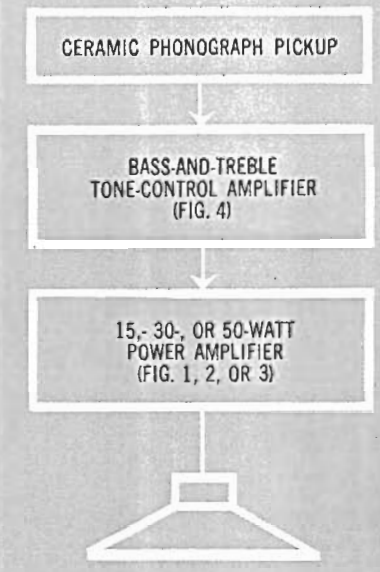
The high-fidelity power amplifier shown in Fig. 1 can deliver 15 watts with less than 0.4 per cent total harmonic distortion and less than 1.5 per cent intermodulation distortion. It has a frequency response which varies less than ± 0.5 db from 20 cps to 60,000 cps, and a sensitivity of 1.2 volts rms 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-pentode 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 AB_1 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 cathode of the input amplifier stage.

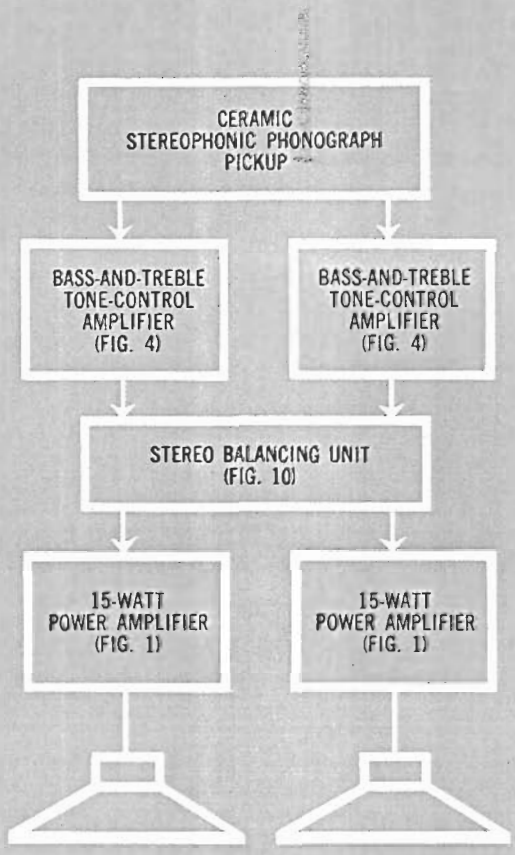
In addition to its excellent performance capabilities and low cost, this amplifier is extremely compact, and therefore, is particularly suitable for use in stereophonic systems.

THIRTY-WATT AMPLIFIER

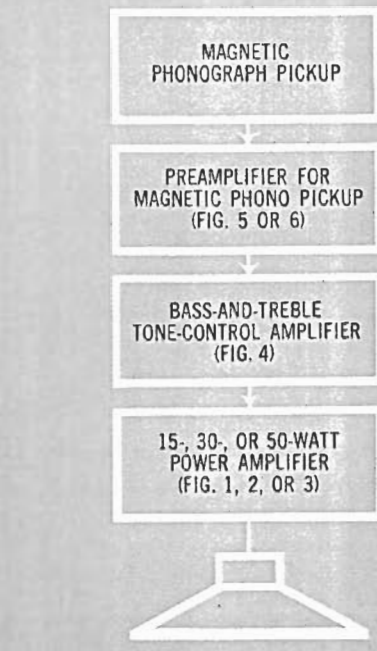
The high-fidelity power amplifier shown in Fig. 2 can deliver 30 watts output with less than 0.7 per cent total harmonic distortion and less than 1.5 per cent intermodulation distortion. The frequency response of this amplifier is flat within ± 0.5 db from 15 cps to 40,000 cps. The total hum and noise



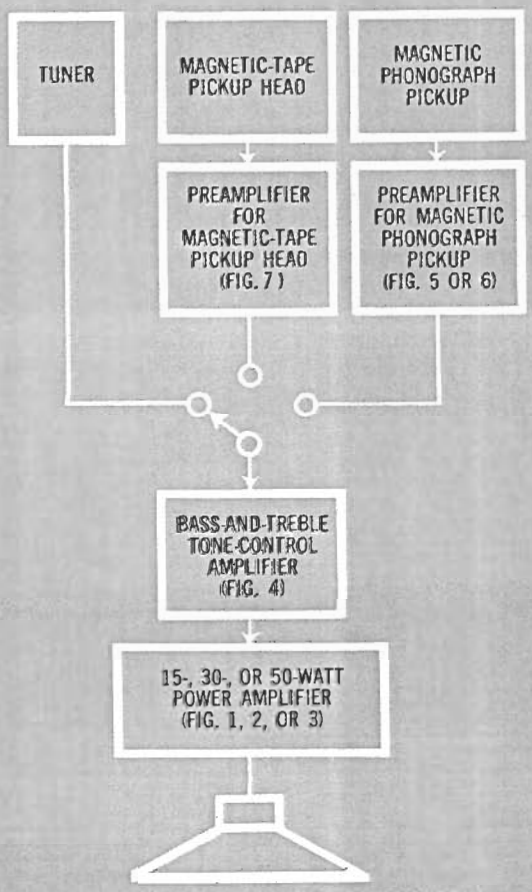
SIMPLE SYSTEM FOR HIGH-FIDELITY REPRODUCTION OF MONAURAL PHONOGRAPH RECORDINGS



STEREOPHONIC VERSION OF THE SYSTEM SHOWN IN BLOCK DIAGRAM (ABOVE). THE CORRESPONDING CONTROLS IN THE TWO BASS-AND-TREBLE TONE-CONTROL AMPLIFIERS MAY BE GANGED TOGETHER



SYSTEM FOR REPRODUCTION OF MONAURAL PHONOGRAPH RECORDINGS, USING A MAGNETIC PICKUP



SYSTEM FOR HIGH-FIDELITY REPRODUCTION OF MONAURAL PHONOGRAPH RECORDINGS, TAPE RECORDINGS, AND BROADCAST PROGRAMS

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.

FIFTY-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-7199 low-noise triode-pentode as an input amplifier and phase-splitter, but has a push-pull driver stage using RCA-6CB6 sharp-cutoff 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 loops 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 cathode 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 (R30) in the heater-supply circuit to minimize hum, a grid-No. 2-voltage adjustment (R39), a grid-No. 1 bias adjustment (R33) for the RCA-7027-A output tubes, and an ac-balance adjustment (R_{17}) 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 mid-range positions, the frequency response of the amplifier is flat within ± 1 db from 30 cps to 15,000 cps. The amplifier has an over-all 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 chassis. In this case, it is advisable to insert a 1-megohm 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 discs and the NARTB 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 load 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 NARTB characteristic.

PREAMPLIFIERS

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. 5 uses an RCA-7025 twin triode, and has a voltage gain of about 150. 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 and/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 C_8 is reduced by approximately

30 $\mu\mu$f for each foot of shielded cable used for the af connection between the preamplifier and the following amplifier.

The three-stage preamplifier circuit shown in Fig. 6 uses an RCA-5879 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 180, 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 NARTB playback characteristic.

Fig. 8 shows the circuit of a one-tube preamplifier for use with a high-fidelity, high-impedance crystal or dynamic microphone. This amplifier uses an RCA-5879 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 twin-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 overheating. 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 maximum 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 heaters, 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 $\mu\mu$f per foot, such as Alpha Type

1249 or 1704, Belden Type 8401 or 8410, or equivalent cable.

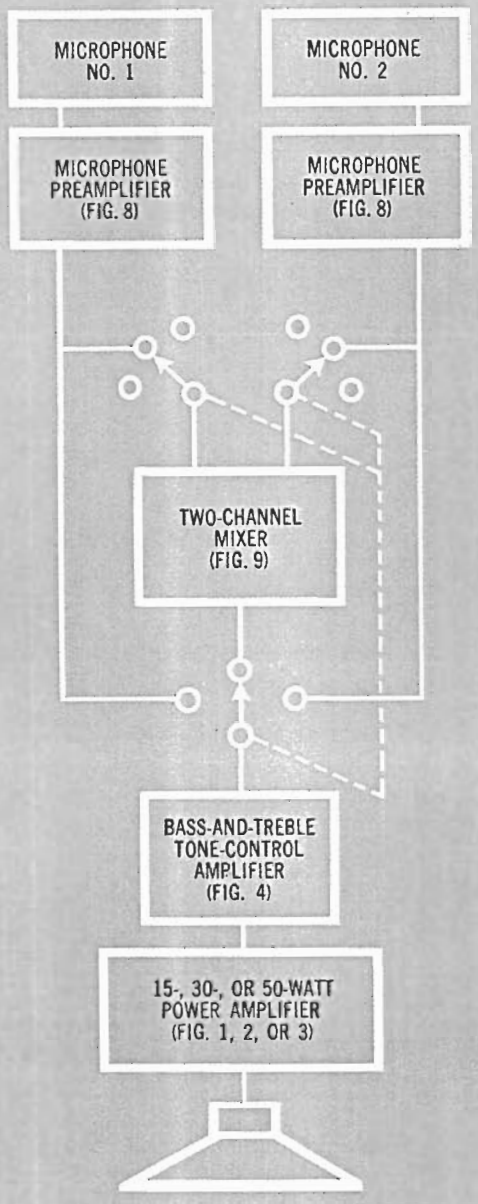
The power amplifiers and power-supply units described in the booklet dissipate large amounts of heat and, therefore, should be constructed and installed in such a manner as to assure adequate ventilation for the tubes and other components.

A beam 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.

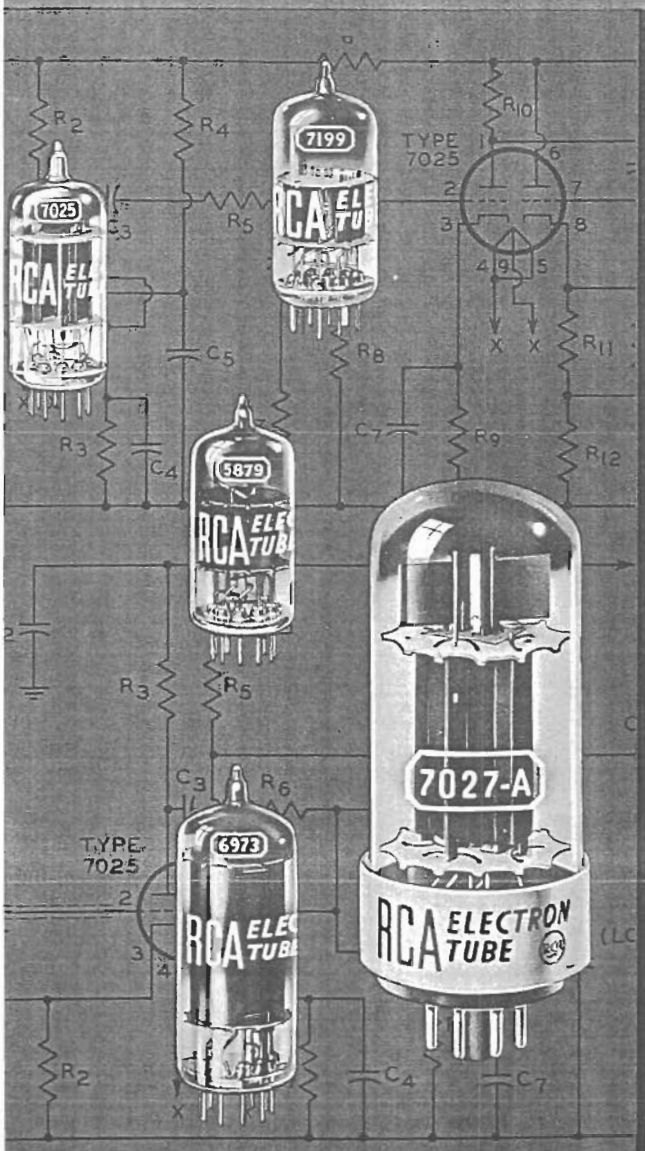
If a power amplifier, tone-control amplifier, and one or more preamplifiers are to be constructed on the same chassis, the mechanical layout should be planned so that the circuits operating at the lowest signal levels are farthest from the output stage and power supply. Amplifier units which normally operate at comparable signal levels but are not used simultaneously — such as preamplifiers for tape pickup heads and magnetic phonograph pickups — usually 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 on or near the amplifier unit. If such a transformer is installed on or near a preamplifier for a magnetic-tape 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.



SYSTEM FOR MIXED OR INDIVIDUAL OPERATION OF TWO MICROPHONES

RCA TUBES FOR HIGH-FIDELITY

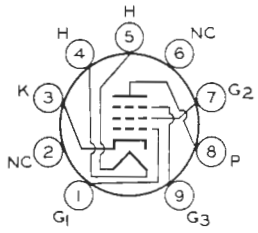


Type	Name	GENERAL DATA — Electrical: Cathode Volts	Cathode Amps.	Mechanical: Maximum Dimensions Inches Length	Diam.	MAXIMUM RATINGS † Plate Volts	Grid-No. 2 Volts	Plate Dissipation Watts	Grid-No. 2 Input Watts	Peak Heater-Cathode Volts
5879	Sharp-Cutoff Pentode	6.3	0.15	2 3/16	0.875	300	150	1.25	0.25	+90 −90
						250	—	1.5	—	+90 −90
6973	Beam Power Tube	6.3	0.45	3 1/16	0.875	440	330	12	2	+200▲ −200
						410	—	12	1.75	+200▲ −200
7025	High-Mu Twin Triode	6.3 12.6	0.3 0.15	2 3/16	0.875	330	—	1.2	—	+200▲ −200
7027-A	Beam Power Tube	6.3	0.9	4 5/8	1.63	600	500	35	5	+200▲ −200
						600	—	35	4.5	+200▲ −200
7199	Medium-Mu Triode—Sharp-Cutoff Pentode	6.3	0.45	2 3/16	0.875	330	—	2.4	—	+200▲ −200
						330	165	3	0.6	+200▲ −200

▲ The dc component must not exceed 100 volts.

†Types 6973, 7025, 7027-A, and 7199 on a Design-Maximum basis; type 5879, on a Design-Center basis.

SOCKET CONNECTIONS
BOTTOM VIEW



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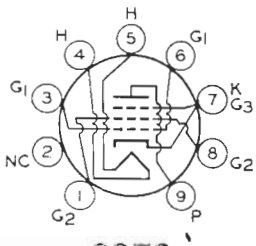


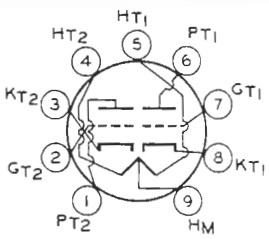
6973

AUDIO APPLICATIONS

SERVICE		TYPICAL OPERATION AND CHARACTERISTICS													
Values to right give operating conditions and characteristics for indicated use. In push-pull service, values are for two tubes		Plate Supply Volts	Grid-No. 2 Supply Volts	Cathode Resistor or Grid Volts: Ohms	Cathode Resistor or Grid Volts: Volts	AC Plate Resistance Ohms	Transconductance Micromhos	Amplification Factor	Peak AF Grid-to-Grid Volts	Plate Current Ma.	Grid-No. 2 Current Ma.	Load Resistance (Plate-to-Plate) Ohms	Total Harmonic Distortion %	Power Output Watts	Type
Class A_1 Amplifier	Pentode Conn.	250	100	—	—3	2000000	1000	—	—	1.8	0.4	Grid No. 3 tied to cathode			5879
	Triode Conn.•	100 250	— —	— —	—3 —8	17000 13700	1240 1530	21 21	— —	2.2 5.5	•Grids-No. 2 & 3 tied to plate				
Push-Pull Class AB_1 Amplifier	Fixed Bias	250 350 400	250 280 290	— — —	—15 —22 —25	— — —	— — —	— — —	30 44 50	105 106 107	16 14 13.7	8000 7500 8000	2 1.5 2	12.5 20 24	6973
	Cathode Bias	300 310	300 310	230 270	— —	— —	— —	— —	48 55	96 92	14 14	5500 6000	2 4	15 17	
Push-Pull Class AB_1 Amplifier•	Fixed Bias	375	*	—	—33.5	•Grid No. 2 of Each Tube Connected to Tap on Plate Winding of Output Transformer			67	95	—	12500	1.5	18.5	
	Cathode Bias	370	#	355	—				62	84	—	13000	1.2	15	
Class A_1 Amplifier	Each Unit	100 250	— —	— —	—1 —2	80000 62500	1250 1600	100 100	— —	0.5 1.2	Equivalent Hum & Noise Voltage (Referred to grid)= 1.8 μ volts rms, average.				7025
Push-Pull Class AB_1 Amplifier	Fixed Bias	400 450 540	300 350 400	— — —	—25 —30 —38	— — —	— — —	— — —	50 60 76	152 194 220	17 19.2 21.4	6600 6000 6500	2 1.5 2	34 50 76	7027-A
	Cathode Bias	400 380 425	300 380 425	200 180 200	— — —	— — —	— — —	— — —	57 68.5 86	128 170 196	16 20 20	6600 4500 3800	2 3.5 4	32 36 44	
Push-Pull Class AB_1 Amplifier•	Cathode Bias	410	#	220	—	•Grid No. 2 of Each Tube Connected to Tap on Plate Winding of Output Transformer			68	155	—	8000	1.6	24	
Class A_1 Amplifier	Triode Unit	215	—	—	—8.5	8100	2100	17	—	9	Equivalent Hum & Noise Voltage (Referred to grid)		10 μ volts rms, median		7199
	Pentode Unit	100 220	50 130	1000 62	— —	1000000 400000	1500 7000	— —	— —	1.1 12.5			35 μ volts rms, median		

* Obtained from taps on the primary winding of the output transformer. The taps are located on each side of the center tap (B+) so as to apply 50 per cent of the plate signal voltage to grid No. 2 of each output tube.

Obtained from taps on the primary winding of the output transformer. The taps are located on each side of the center tap (B+) so as to supply 43 per cent of the plate signal voltage to grid No. 2 of each output tube.



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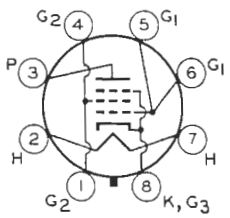
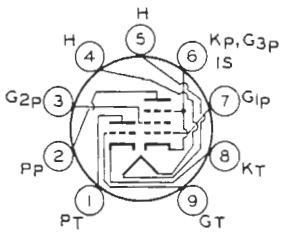


7027-A



7199

15-WATT HIGH-FIDELITY AUDIO AMPLIFIER CIRCUIT

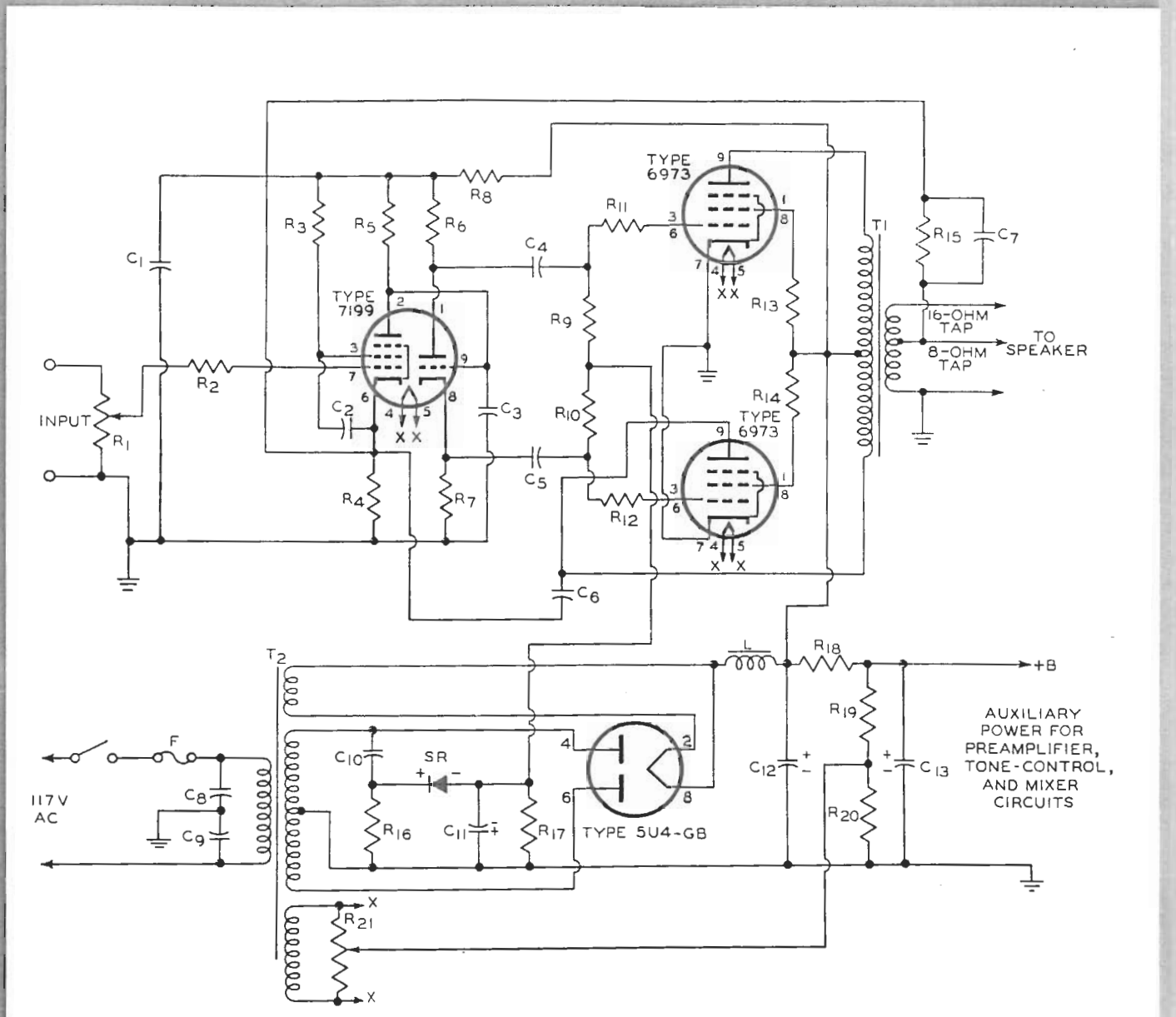
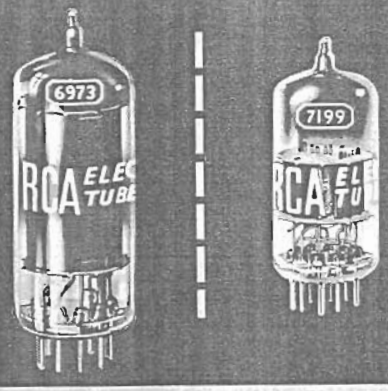


FIGURE 1

PERFORMANCE SPECIFICATIONS:

Sensitivity = 1.2 volts rms for 15 watts output;
Hum and Noise = 84 db below 15 watts with input shorted;
Frequency Response = flat ±½ db from 20 cps to 60000 cps;
Total Harmonic Distortion = 0.4% at 15 watts;
Intermodulation Distortion = 1.5% at 15 watts.

UTILIZING TYPES
RCA-6973
RCA-7199



C_1: 40μf, 450 volts
C_2, C_4, C_5: 0.25 μf
C_3, C_6: 3.3 $\mu\mu$f, 600 volts
C_7: 150 $\mu\mu$f
C_8, C_9: 0.05 μf, 600 volts
C_{10}: 0.02 μf, 600 volts
C_{11}: 100 μf, 50 volts
C_{12}: 80 μf, 450 volts
C_{13}: 40 μf, 450 volts
F: Fuse, 3 amperes
L: Filter Choke, 3 h., 160 ma., 75 ohms or less, Triad C13X, or equivalent
R_1: Potentiometer, 1 megohm
R_2: 10000 ohms
R_3: 0.82 megohm
R_4: 820 ohms
R_5: 0.22 megohm
R_6, R_7: 15000 ±5% ohms, 2 watts
R_8: 3900 ohms, 2 watts
R_9, R_{10}: 0.1 megohm
R_{11}, R_{12}: 1000 ohms
R_{13}, R_{14}: 100 ohms
R_{15}: 8200 ohms
R_{16}: 15000 ohms, 1 watt
R_{17}: 68000 ohms
R_{18}: 4700 ohms, 2 watts
R_{19}: 0.27 megohm, 1 watt
R_{20}: 47000 ohms
R_{21}: Potentiometer, 100 ohms
SR: Selenium Rectifier, 20 ma., 135 volts rms
T_1: Output Transformer for matching impedance of voice coil to 6600-ohm plate-to-plate tube load. Stancor A-8056, or equivalent.
T_2: Power Transformer, 360-0-360 volts rms, 120 ma., Stancor 8410, or equivalent.

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

HUM-BALANCE ADJUSTMENT

Short-circuit the audio-input terminals of the amplifier. Connect the amplifier to the ac line and adjust the hum-balance potentiometer (R_{21}) for minimum hum from the loudspeaker.

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
5U4-GB	—	+305	—	360 ac	—	360 ac	—	+305	—
6973	+300	—	−25	+50	+50	−25	0	+300	+295
7139	+210	+78	+40	+50	+50	+1	0	+85	+78

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

30-WATT HIGH-FIDELITY AUDIO AMPLIFIER CIRCUIT

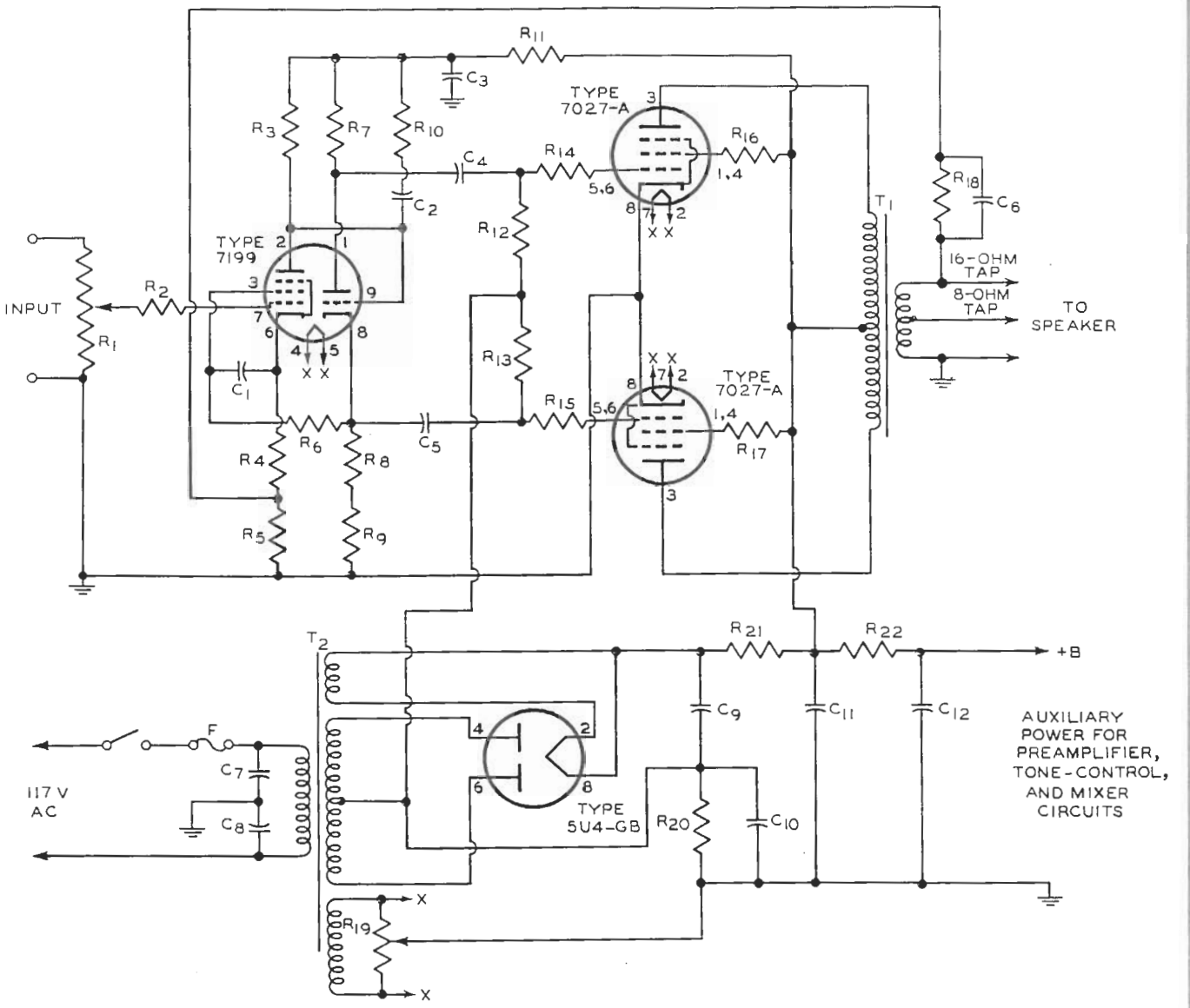


FIGURE 2

PERFORMANCE SPECIFICATIONS:

Sensitivity = 1 volt rms for 30 watts output;
Hum and Noise = 84 db below 20 watts with input shorted;
Frequency Response = Flat ± 0.5 db from 15 cps to 40000 cps;
Total Harmonic Distortion = 0.7% at 30 watts;
Intermodulation Distortion = 1.5% at 30 watts.

UTILIZING TYPES

RCA-7199

RCA-7027-A

PARTS LIST

C_1: 25 μf, 50 volts
C_2: 22 $\mu\mu$f, 600 volts
C_3: 80 μf, 600 volts
C_4, C_5: 0.25 μf, 600 volts
C_6: 0.01 μf, 600 volts
C_7, C_8: 0.05 μf, 600 volts
C_9, C_{11}: 40 μf, 600 volts
C_{10}: 100 μf, 50 volts
C_{12}: 20 μf, 450 volts
F: Fuse, 3 amperes, 150 volts
R_1: Potentiometer, 1 megohm
R_2: 10000 ohms
R_3: 220000 ohms
R_4: 820 ohms
R_5: 10 ohms
R_6: 180000 ohms
R_7: 15000 ±5% ohms, 2 watts
R_8: 15000 ±5% ohms, ½ watt
R_9: 1000 ohms
R_{10}: 22000 ohms
R_{11}: 2000 ±10% ohms, 2 watts
R_{12}, R_{13}: 100000 ohms
R_{14}, R_{15}: 1000 ohms
R_{16}, R_{17}: 56 ohms
R_{18}: 270 ohms
R_{19}: Potentiometer, 100 ohms, ½ watt
R_{20}: 220 ±10% ohms, 10 watts
R_{21}: 50 ±10% ohms, 10 watts
R_{22}: 10000 ±10% ohms, 2 watts
T_1: Output Transformer for matching impedance of voice coil to 5000-ohm plate-to-plate tube load. Stancor A-8053, or equivalent.
T_2: Power Transformer, 375-0-375 volts rms, 160 ma., Thordarson T22R33, or equivalent.

NOTE:

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

HUM-BALANCE ADJUSTMENT

Short-circuit the audio-input terminals of the amplifier. Connect the amplifier to the ac line and adjust the hum-balance potentiometer (R_{19}) for minimum hum from the loudspeaker.

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
5U4-GB	—	+400	—	375 ac	—	375 ac	—	+400	—
7027-A	+390	0	+390	+390	–30	–30	0	0	—
7199	+280	+105	+45	0	0	+1.1	0	+115	+105

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

50-WATT HIGH-FIDELITY AUDIO AMPLIFIER CIRCUIT

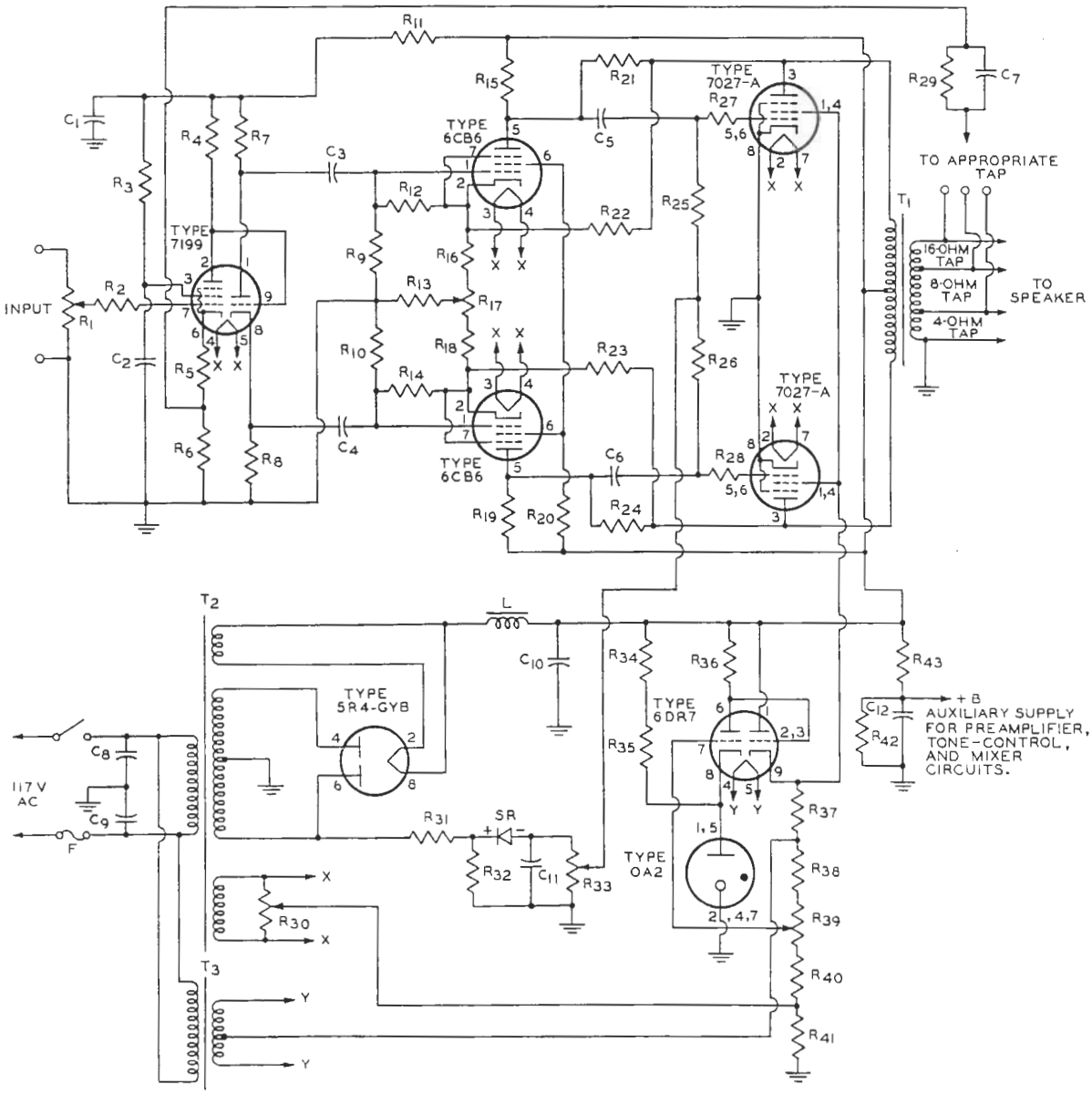


FIGURE 3

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.

UTILIZING TYPES

RCA-7199
RCA-7027-A

C_1, C_2: 40 μf, 450 volts
C_3, C_4: 0.02 μf
C_5, C_6: 1 μf
C_7: 4-ohm tap; 0.002 μf
8-ohm tap; 0.0015 μf
16-ohm tap; 0.001 μf
C_8, C_9: 0.05 μf, 600 volts
C_{10}: 20 μf, 600 volts
C_{11}: 100 μf, 150 volts
C_{12}: 40 μf, 450 volts
F: Fuse, 5 amperes
L: Filter Choke, 8 h., 250 ma., 60 ohms or less. Thordarson 20C56, or equivalent.
R_1: Potentiometer, 0.5 megohm
R_2: 4700 ohms
R_3: 0.82 megohm
R_4: 0.22 megohm
R_5: 820 ohms
R_6: 10 ohms
R_7, R_8: 15000 ohms, 2 watts
R_9, R_{10}: 1.5 megohms
R_{11}: 33000 ohms, 2 watts
R_{12}, R_{14}: 1.3 megohms
R_{13}: 47 ohms
R_{15}, R_{19}: 0.15 megohm
R_{16}, R_{18}: 390 ohms
R_{17}: 500 ohms
R_{20}: 0.15 megohm, 1 watt
R_{21}, R_{24}: 0.33 megohm, 1 watt
R_{22}, R_{23}: 0.12 megohm, 2 watts
R_{25}, R_{26}: 0.1 megohm
R_{27}, R_{28}: 4700 ohms
R_{29}: 4-ohm tap; 600 ohms
8-ohm tap; 820 ohms
16-ohm tap; 1200 ohms
R_{30}: Potentiometer, 100 ohms
R_{31}: 0.12 megohm
R_{32}, R_{34}, R_{35}, R_{37}: 33000 ohms, 2 watts
R_{33}: Potentiometer, 50000 ohms
R_{36}: 0.27 megohm, 1 watt
R_{38}: 10000 ohms, 1 watt
R_{39}: Potentiometer, 25000 ohms, 2 watts
R_{40}: 15000 ohms, 2 watts
R_{41}: 12000 ohms, 2 watts
R_{42}: 0.22 megohm, 2 watts
R_{43}: 22000 ohms, 2 watts
SR: Selenium Rectifier, 20 ma., 135 volts rms
T_1: Output transformer for matching impedance of voice coil to 5000-ohm plate-to-plate tube load. Acrosound TO340, or equivalent.
T_2: Power transformer, 600-0-600 volts rms, 200 ma., Thordarson 22R36, or equivalent.
T_3: Filament transformer, 6.3 volts Center Tapped, 1 ampere, Thordarson 21F08, or equivalent.

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

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 this amplifier is placed in operation.**

(1) Remove the 5R4-GYB rectifier tube from its socket and connect a dc voltmeter between B minus and the junction of R_{25} and R_{26}, 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 50 volts.

(2) Connect the amplifier to the ac power line and adjust the bias-control potentiometer (R_{33}) until the meter reads 40 volts. Disconnect the amplifier from the power line, and remove the meter.

(3) Set the dc voltmeter to a range which provides a full-scale reading of at least 500 volts, and connect it between B minus and Pin 9 of the 6DR7 socket, with the negative lead of the meter on B minus. Connect the loudspeaker to the audio-output terminals of the amplifier. Replace the 5R4-GYB rectifier tube in its socket.

(4) Connect the amplifier to the ac line, and, after approximately one minute, adjust the grid-No. 2-voltage-control potentiometer (R_{39}) until the meter reads 400 volts. Disconnect the amplifier from the ac line and remove the meter.

(5) Short-circuit the audio-input terminals of the amplifier. Connect the amplifier to the ac line and adjust the heater-balance potentiometer (R_{30}) for minimum hum from the loudspeaker.

(6) 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 (R_{17}) for minimum hum from the loudspeaker.

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
6A2	+150	0	—	0	+150	—	0	—	—
5R4-GYB	—	+460	—	600 ac	—	600 ac	—	+460	—
6CB6	+3	+6	+65	+65	+175	+120	+6	—	—
6DR7	+460	+360 to +400	+360 to +400	+250	+250	+360 to +400	+125 to +150	+150	+400
7027-A	+400	+65	+450	−400	−40	−40	+65	0	—
7199	+335	+110	+55	+65	+65	+1.3	0	+120	+110

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

HIGH-FIDELITY TONE-CONTROL AMPLIFIER

UTILIZING TYPE RCA-7025

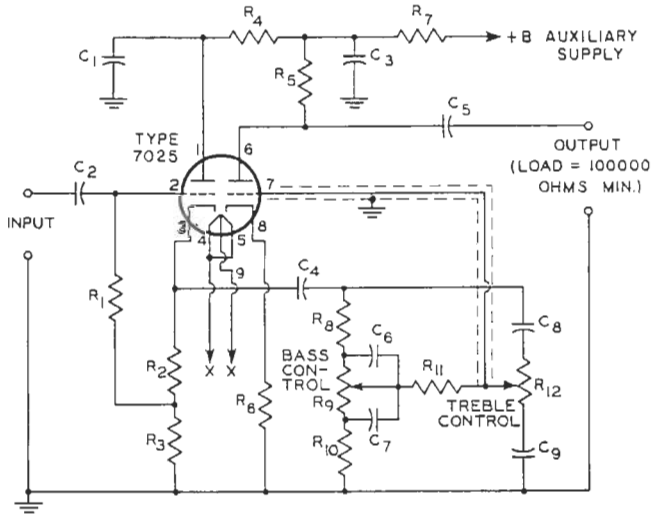


FIGURE 4

PARTS LIST

C_1: 20 μf, 450 volts
C_2: 0.047 μf
C_3: 20 μf, 450 volts
C_4: 0.1 μf
C_5: 0.22 μf
C_6: 0.0022 μf
C_7: 0.022 μf
C_8: 220 $\mu\mu$f
C_9: 0.0022 μf
R_1: 0.47 megohm
R_2: 1500 ohms
R_3: 15000 ohms
R_4: 22000 ohms
R_5: 0.1 megohm
R_6: 1000 ohms
R_7: 15000 ohms
R_8: 0.1 megohm
R_9: Bass-Control Potentiometer, 1 megohm
R_{10}: 10000 ohms
R_{11}: 0.1 megohm
R_{12}: Treble-Control Potentiometer, 1 megohm

NOTE:

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

PERFORMANCE SPECIFICATIONS:

+16 db bass and treble boost, −16 db bass and treble cut.
Sensitivity = 0.5 volt rms for output of 1.25 volts with controls set for flat response.

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
7025	+240	+16	+17.5	*	*	+165	0	+1	*

*This voltage will vary with the type of power amplifier used as follows:
15-watt amplifier (Fig. 1) . . . . . +50 volts
30-watt amplifier (Fig. 2) . . . . . 0 volts
50-watt amplifier (Fig. 3) . . . . . +65 volts

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

HIGH-FIDELITY PREAMPLIFIER (RIAA Equalization) for use with Magnetic Phonograph-Pickup

UTILIZING TYPE RCA-7025

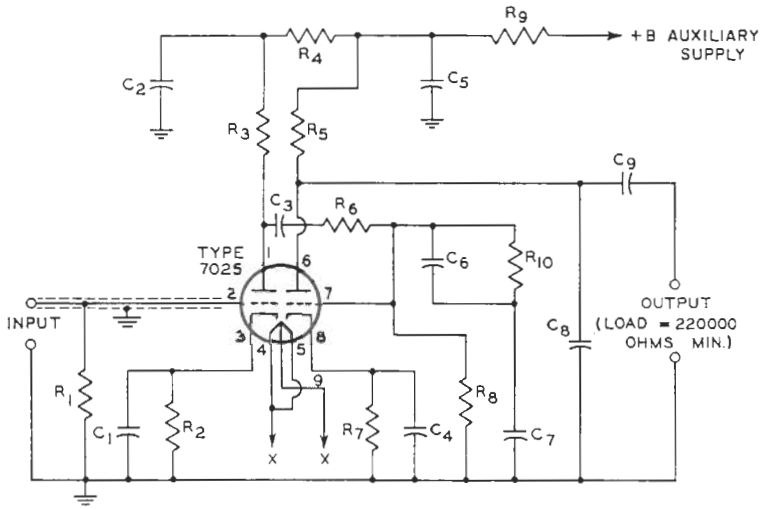


FIGURE 5

PARTS LIST

C_1: 25 μf, 25 volts
C_2: 20 μf, 450 volts
C_3: 0.1 μf
C_4: 25 μf, 25 volts
C_5: 20 μf, 450 volts
C_6: 0.0035 μf
C_7: 0.01 μf
C_8: 180 μμf
C_9: 0.22 μf
R_1: Value depends on type of magnetic pickup used. Follow pickup manufacturer's recommendations.
R_2: 2700 ohms
R_3: 0.1 megohm
R_4: 39000 ohms
R_5: 0.1 megohm
R_6: 0.47 megohm
R_7: 2700 ohms
R_8: 0.68 megohm
R_9: 15000 ohms, 1 watt
R_{10}: 22000 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

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
7025	+195	0	+1.5	*	*	+210	0	+1.6	*

*This voltage will vary with the type of power amplifier used as follows:
15-watt amplifier (Fig. 1) . . . . . +50 volts
30-watt amplifier (Fig. 2) . . . . . 0 volts
50-watt amplifier (Fig. 3) . . . . . +65 volts

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

HIGH-FIDELITY PREAMPLIFIER

(RIAA Equalization)

for use with Magnetic Phonograph-Pickup

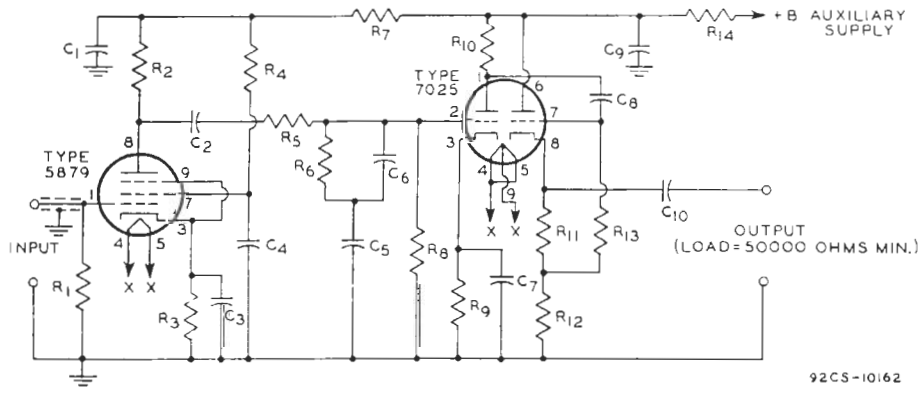


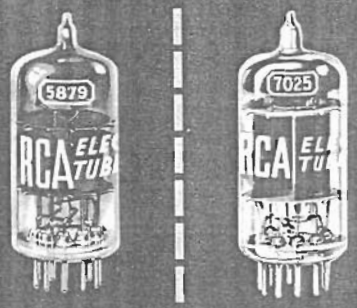
FIGURE 6

PERFORMANCE SPECIFICATIONS:

Sensitivity — 3 millivolts rms for output of 0.54 volt at 1000 cps.

UTILIZING TYPES

RCA-5879
RCA-7025



C_1: 40 μf, 450 volts
C_2: 0.1 μf
C_3: 25 μf, 25 volts
C_4: 0.22 μf
C_5: 0.02 μf
C_6: 0.005 μf
C_7: 25 μf, 25 volts
C_8: 0.022 μf
C_9: 40 μf, 450 volts
R_1: Value depends on type of magnetic pickup used. Follow pickup manufacturer's recommendations.
R_2: 100000 ohms
R_3: 1000 ohms
R_4, R_5: 0.47 megohm
R_6: 15000 ohms
R_7: 22000 ohms
R_8: 0.68 megohm
R_9: 1500 ohms
R_{10}: 100000 ohms
R_{11}: 1500 ohms
R_{12}: 15000 ohms
R_{13}: 0.47 megohm
R_{14}: 4700 ohms

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

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
5879	0	—	+1.8	*	*	—	+75	+95	+1.8
7025	+190	0	+1.3	*	*	+285	+17	+19	*

* This voltage will vary with the type of power amplifier used as follows:
15-watt amplifier (Fig. 1) . . . . . +50 volts
30-watt amplifier (Fig. 2) . . . . . 0 volts
50-watt amplifier (Fig. 3) . . . . . +65 volts

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

HIGH-FIDELITY PREAMPLIFIER

(NARTB Equalization)

for use with Tape-Head Pickup

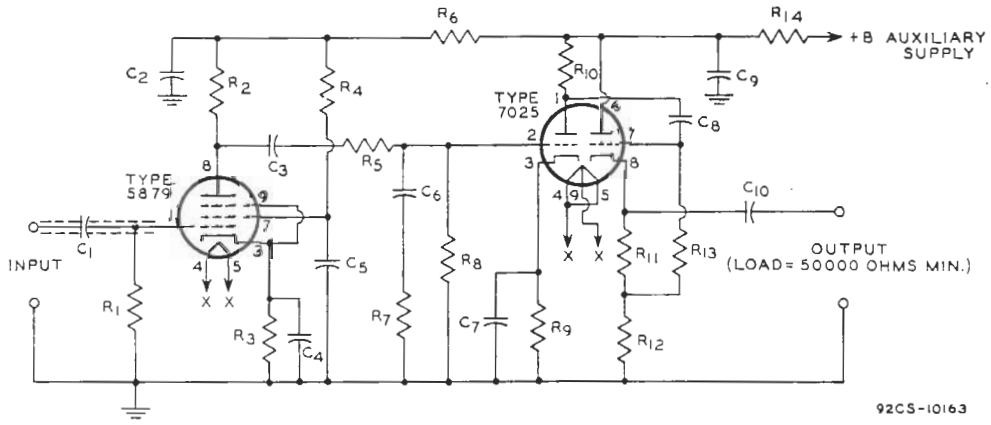


FIGURE 7

PERFORMANCE SPECIFICATIONS:

Sensitivity — 3 millivolts rms for output of 0.55 volts at 1000 cps.

UTILIZING TYPES
RCA-5879
RCA-7025

PARTS LIST

C_1: 0.047 μf
C_2: 40 μf, 450 volts
C_3: 0.1 μf
C_4: 25 μf, 25 volts
C_5: 0.22 μf
C_6: 0.015 μf
C_7: 25 μf, 25 volts
C_8: 0.022 μf
C_9: 40 μf, 450 volts
C_{10}: 0.47 μf
R_1: 1 megohm
R_2: 0.1 megohm
R_3: 1000 ohms
R_4: 0.47 megohm
R_5: 0.22 megohm
R_6: 22000 ohms
R_7: 3300 ohms
R_8: 3.3 megohms
R_9: 1500 ohms
R_{10}: 0.1 megohm
R_{11}: 1500 ohms
R_{12}: 15000 ohms
R_{13}: 0.47 megohm
R_{14}: 4700 ohms

NOTE:

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

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
5879	0	—	+1.8	*	*	—	+75	+95	+1.8
7025	+190	0	+1.3	*	*	+285	+17	+19	*

*This voltage will vary with the type of power amplifier used as follows:
15-watt amplifier (Fig. 1) . . . . . +50 volts
30-watt amplifier (Fig. 2) . . . . . 0 volts
50-watt amplifier (Fig. 3) . . . . . +65 volts

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

HIGH-FIDELITY PREAMPLIFIER

for use with Low-Output Microphones

UTILIZING TYPE RCA-5879

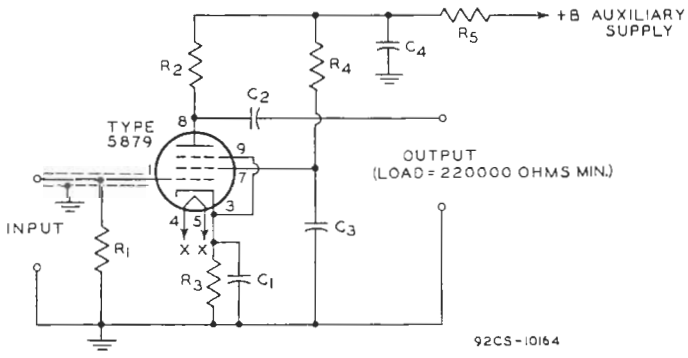


FIGURE 8

PARTS LIST

C_1: 25 μf, 25 volts
C_2: 0.047 μf
C_3: 0.22 μf
C_4: 40 μf, 450 volts
R_1: 2.2 megohms
R_2: 0.1 megohm
R_3: 1000 ohms
R_4: 0.47 megohm
R_5: 22000 ohms

PERFORMANCE SPECIFICATIONS:

Sensitivity = 3 millivolts rms for output of 220 millivolts

NOTE:

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

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
5879	0	—	+1.8	*	*	—	+78	+98	+1.8

*This voltage will vary with the type of power amplifier used as follows:
15-watt amplifier (Fig. 1) . . . . . +50 volts
30-watt amplifier (Fig. 2) . . . . . 0 volts
50-watt amplifier (Fig. 3) . . . . . +65 volts

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

HIGH-FIDELITY TWO-CHANNEL MIXER

UTILIZING TYPE RCA-7025

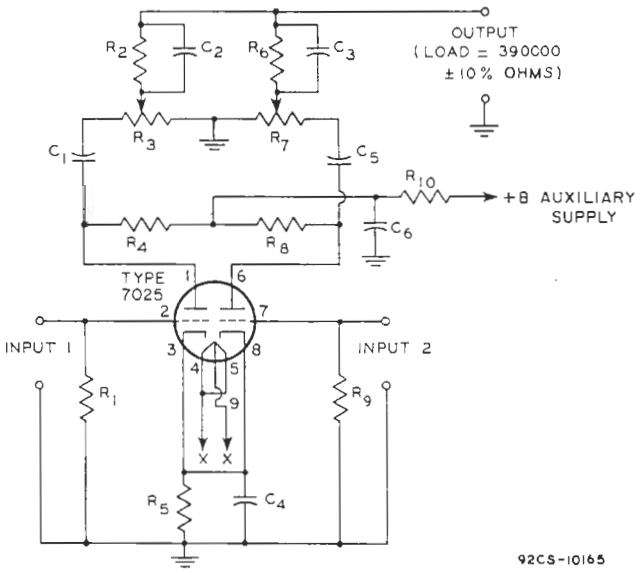


FIGURE 9

PARTS LIST

C_1: 0.1 μf
C_2, C_3: 47 $\mu\mu$f
C_4: 25 μf, 25 volts
C_5: 0.1 μf
C_6: 20 μf, 450 volts
R_1: Value depends on output load required for previous stage or type of input device. Should not exceed 2.2 megohms.
R_2: 0.47 megohm
R_3: Volume Control Potentiometer, 0.5 megohm
R_4: 0.1 megohm
R_5: 1000 ohms
R_6: 0.47 megohm
R_7: Same as R_3
R_8: 0.1 megohm
R_9: Same as R_1
R_{10}: 22000 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 20 millivolts

DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
7025	+185	0	+1.5	*	*	+185	0	+1.5	*

*This voltage will vary with the type of power amplifier used as follows:
15-watt amplifier (Fig. 1) . . . . . +50 volts
30-watt amplifier (Fig. 2) . . . . . 0 volts
50-watt amplifier (Fig. 3) . . . . . +65 volts

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

BALANCING UNIT for TWO-CHANNEL STEREOPHONIC SYSTEMS

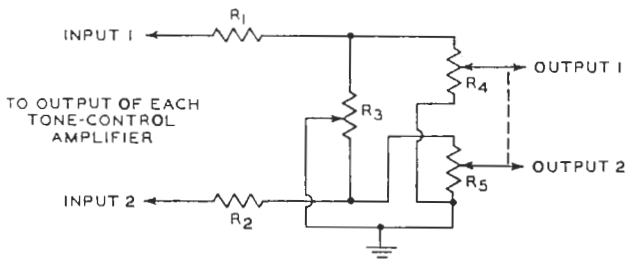


FIGURE 10

PARTS LIST

R_1, R_2: 0.1 megohm
R_3: Balance-Control Potentiometer, 0.5 megohm, linear taper
R_4, R_5: 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 (R_4 and R_5) 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-Ohmyst.
4. Adjust the balance-control potentiometer (R_3) so that the voltages across both voice coils are equal.

ECONOMY PHONOGRAPH AMPLIFIER

UTILIZING TYPE RCA-50EH5

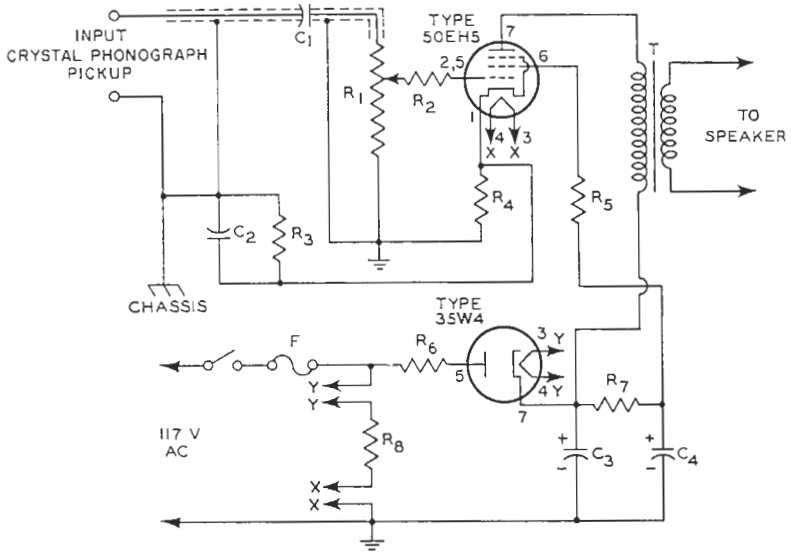


FIGURE 11

PARTS LIST

C_1: 0.02 μf
C_2: 0.082 μf
C_3, C_4: 40 μf, 150 volts
F: Fuse, 1 amp
R_1: Volume-Control Potentiometer, 0.5 megohm, audio taper
R_2: 10000 ohms
R_3: 220 ohms
R_4, R_5: 56 ohms
R_6: 22 ohms
R_7: 3300 ohms, 1 watt
R_8: 210 ohms, 10 watts
T: Output transformer, primary impedance 3000 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

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
35W4	—	—	—	—	117 ac	—	+125	—	—
50EH5	+2.7	0	—	—	0	+95	+120	—	—

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

LOW-COST HI-FI AMPLIFIER

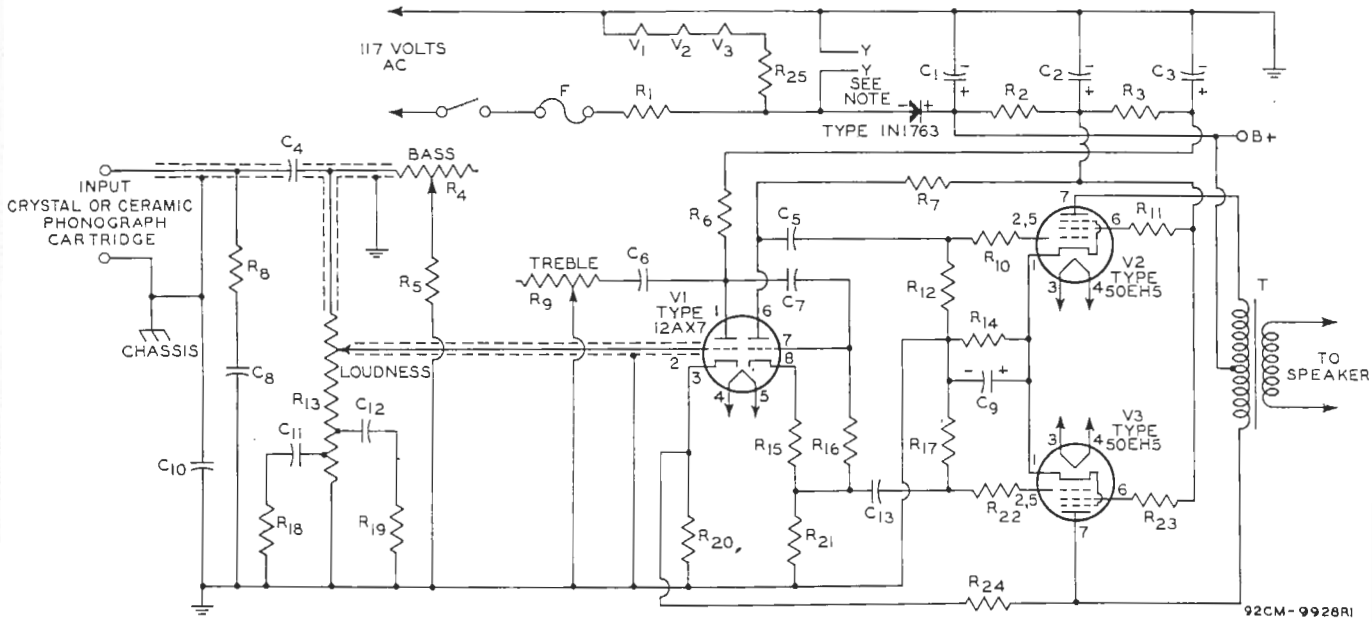


FIGURE 12

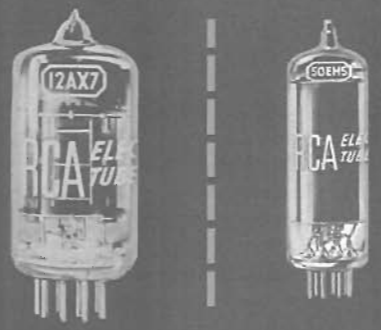
DC-VOLTAGE MEASUREMENT CHART

TUBE TYPE	PIN NUMBER								
	1	2	3	4	5	6	7	8	9
12AX7	+75	0	+1	—	—	+85	+33	+35	—
50EH5	+4	0	—	—	0	+120	+140	—	—

All voltages ±20% measured from pin to ground with a VoltOhmyst under the following conditions: Line voltage 117 volts ac, 60 cps; no signal input.

UTILIZING TYPES

RCA-12AX7
RCA-50EH5



PARTS LIST

C_1: 250 μf, 150 volts
C_2, C_3: 40 μf, 150 volts
C_4, C_5, C_{13}: 0.01 μf
C_6, C_7: 0.005 μf
C_8: 0.001 μf
C_9: 25 μf, 10 volts
C_{10}: 0.082 μf
C_{11}: 0.03 μf
C_{12}: 0.02 μf
F: Fuse, 3 amperes
R_1: 5.6 ohms, 10 watts
R_2: 1200 ohms, 2 watts
R_3: 22 ohms
R_4, R_9: Tone-control potentiometer, 2 megohms
R_5: 0.18 megohm
R_6: 0.22 megohm
R_7, R_{21}: 47000 ohms
R_8: 0.12 megohm
R_{10}, R_{22}: 10000 ohms
R_{11}, R_{23}: 56 ohms
R_{12}, R_{16}, R_{17}: 0.47 megohm
R_{13}: Loudness control potentiometer, 1.5 megohms tapped at 0.25 and 0.5 megohm
R_{14}: 68 ohms
R_{15}: 2700 ohms
R_{18}: 12000 ohms
R_{19}: 0.1 megohm
R_{20}: 5600 ohms
R_{24}: 3.9 megohms
R_{25}: 27 ohms, 1 watt
T: Output transformer, primary impedance 6000 ohms (plate-to-plate), secondary impedance to match speaker voice coil

NOTE

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

CONTENTS

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.

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