

# CIRCUIT DESCRIPTION

Each major section of the Receiver will be described separately in the following Circuit Description. For ease of explanation, the Source switch will be described in the FM position.

Follow the circuit on the Block Diagram (fold-out from Page 66) and on the Schematic (fold-out from Page 79) while reading the Circuit Description. The letter-number designations (R4, C115, R212) for all resistors, capacitors, and diodes have been placed into the following groups to make them easier to locate on the chassis and Schematic.

1 - 99	FM tuner section.
100 - 199	Amplifier section.
200 - 299	Power supply section.

## FM TUNING UNIT

The FM signal from the antenna is applied to the primary of balanced input transformer T1 in the FM tuning unit. The secondary of transformer T1 forms a tuned circuit with trimmer capacitor C1 and capacitors C2 and C1A (antenna section of tuning capacitor). The signal selected by this tuned circuit is coupled through capacitor C3 to RF amplifier transistor Q1.

The signal is amplified by transistor Q1. The RF tuned circuit of Q1 selects the desired signal and couples it through capacitor C8 to the base of mixer transistor Q2. The RF tuned circuit consists of coil L2, trimmer capacitor C6, and capacitors C7 and C6A (RF portion of tuning capacitor).

The local oscillator transistor, Q3, operates at a frequency that is 10.7 mc higher than the received FM signal. The oscillator frequency is determined by a tuned circuit composed of coil L4, trimmer capacitor C14, and capacitors C13 and C14A (oscillator portion of tuning capacitor). The output signal from this oscillator is coupled through capacitor C10 to the base of mixer transistor Q2.

A small DC voltage is coupled from the ratio detector circuit through resistor R5 to diode D1 in the collector circuit of the oscillator. This DC voltage, which changes as the tuning is

changed, is used as an AFC (automatic frequency control) voltage to lock-in the local oscillator frequency with the station being tuned in.

The oscillator frequency is locked-in by the AFC voltage in the following manner: The capacitance between the elements of diode D1 changes when the AFC voltage that is applied to it changes. This capacitance is connected in series with capacitor C19, and these two capacitances are connected in parallel with part of coil L4. Thus, when the capacitance of diode D1 is changed by the AFC voltage, the total capacitance across coil L4 is changed. This change in the tuned circuit capacitance changes the frequency of the oscillator in such a way as to maintain proper tuning.

The oscillator and the received FM signals are mixed in transistor Q2 to produce a 10.7 mc IF (intermediate frequency) signal, that is coupled through transformer T2 and capacitor C21 to the first IF amplifier transistor, Q4. The amplified IF signal from the collector of transistor Q4 is coupled through transformer T3 to the base of second IF amplifier transistor Q5. This IF signal is again amplified by transistor Q5, coupled through transformer T4, and amplified by transistor Q6. From Q6 the signal is coupled through transformer T5 and amplified by the fourth IF amplifier transistor Q7.

A portion of the signal voltage is taken from the collector of transistor Q6 and rectified by diode D2 to produce an AGC (automatic gain control) voltage. This AGC voltage, which increases and decreases with the strength of the received FM signal, is coupled through resistors R14 and R12 to the base of transistor Q4, where it automatically controls the gain of the IF signal.

The AGC voltage is then coupled from the emitter of transistor Q4, through resistor R10, to the base of RF amplifier transistor Q1. This automatically controls the gain of the FM signal in the tuner section.

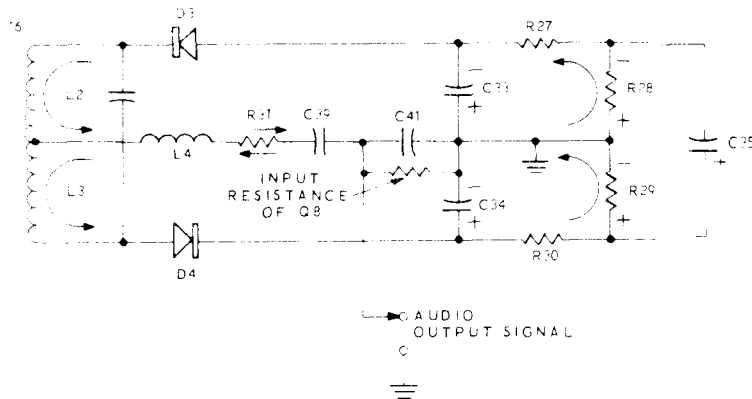


Figure 11

All, or only one of the IF amplifier stages may operate as limiters. For a very weak signal, **only** the fourth IF amplifier Q7 may be limiting, and transistors Q4, Q5, and Q6 would be amplifying the IF signal. For a very strong signal, all four IF amplifiers may be acting as limiters. This limiting action removes amplitude modulation from the FM signal. Limiting action is also provided by the self-limiting characteristics of the ratio detector circuit.

## RATIO DETECTOR CIRCUIT

From the collector of transistor Q7, the IF signal is coupled through resistor R26 and ratio detector transformer T6 to the ratio detector circuit. This circuit, which separates the audio signal from the 10.7 mc IF signal, is shown redrawn for greater clarity and simplified in Figure 11. Transformer T6 is represented in this figure by primary coil L1, a center tapped secondary composed of coils L2 and L3, and a third or tertiary winding, L4. L4 is just a few turns of wire tightly wrapped around the bottom of primary L1. NOTE: In the actual circuit, choke L5 and coil L6 are also connected in series with coil L4, resistor R31, capacitor C39, and resistor R39,

Consider a separate voltage to be induced by the primary into each of the windings, L2, L3, and L4. L4, which is closely coupled to the primary introduces a voltage that is in series with both L2 and L3. This voltage across L4 is relatively constant in amplitude as long as the voltage across L1 does not change. (Remember, the voltage across L1 will stay relatively constant due to the limiting action of transistor Q7.)

Notice that each diode has its own separate loop through which its current flows (indicated by the arrows). Current flowing in diode D3 is controlled by the voltage induced in L2 and L4 which charges capacitor C33. The current flowing in diode D4 is controlled by the voltage induced in coils L3 and L4 which charges capacitor C34. Current flows through L4 in both directions, since this coil is common to both current loops,

The two currents flow through capacitors C33 and C34 in the same direction. Electrolytic capacitor C35 is connected across both of these capacitors through resistors R27 and R30. This large capacitor keeps the total voltage across these two capacitors from changing, thus, any amplitude changes on the IF signal are damped out by this capacitor.

The audio output signal from the ratio detector circuit is applied to the base of Q8. Note that the two loop currents are flowing in opposite directions through coil L4, resistor R31, capacitor C39, and the input resistance of Q8. At the FM IF center frequency of 10.7 mc, the diode currents are equal, thus they cancel each other out and no voltage appears across the input resistance of Q8.

When the IF frequency deviates from 10.7 mc due to FM modulation (audio signal), the current in one diode loop increases while the current in the other loop decreases. These changes are caused by a change in phase relationship in the signal current across coils L2 and L4, and L3 and L4. Now current flows through the input resistance of Q8 in the direction of the larger signal, and an output voltage is developed

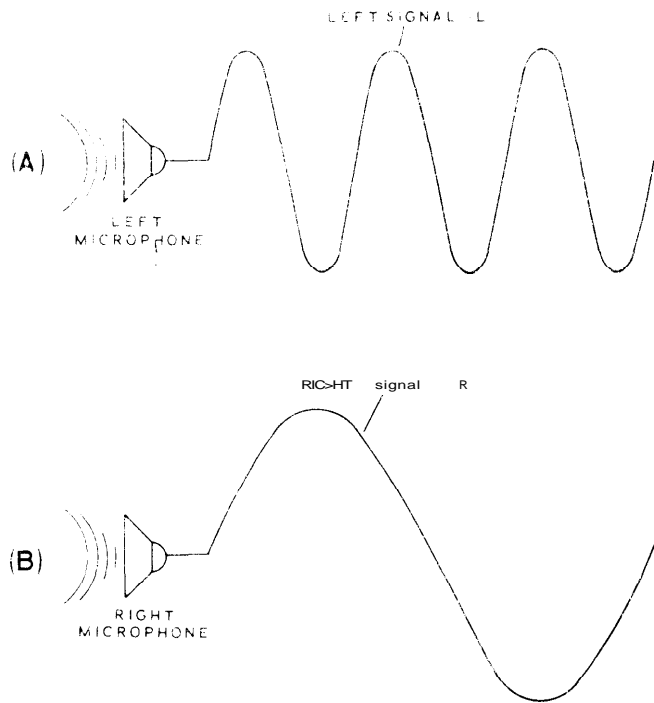


Figure 12

across the input resistance of Q8, The amplitude of this output voltage is determined by how far the IF frequency deviates from the center frequency of 10.7 mc. The frequency of this audio output voltage is determined by how often the frequency deviates from 10.7 mc.

The slug in the secondary of coil T6 is used to balance the ratio detector circuit. Capacitor C36 and L5 removes any remaining 10.7 mc IF signal from the audio signal. Resistors R28 and R29 are load resistors for diodes D3 and D4.

## FM STEREO MULTIPLEX CIRCUIT

Figures 12A and 12B show two sample signals that might appear from the left (L) and right (R) channel microphones of a radio station that is broadcasting a stereo FM signal. The transmitting circuits then combine these signals to produce the L+R signal shown in Figure 13A and the L-R subcarrier signal shown in Figure 13B. The L-R subcarrier signal is a suppressed carrier amplitude modulated signal on a 38 kc subcarrier, and is called the subcarrier channel.

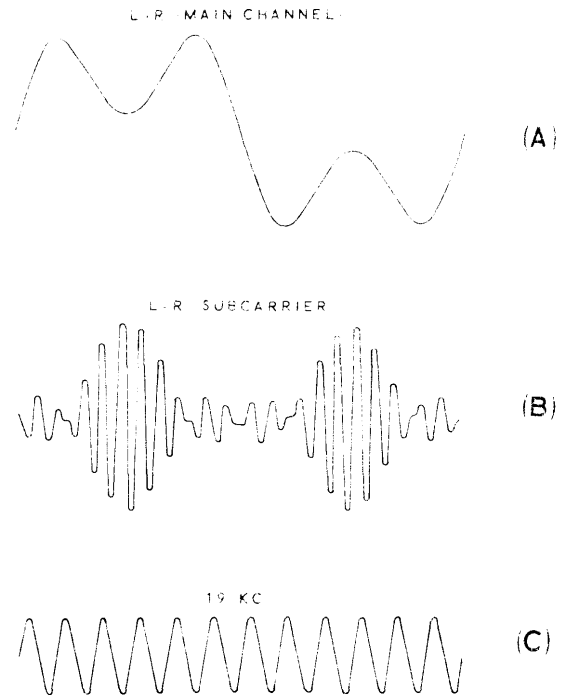


Figure 13

These two signals, L+R and L-R, are then combined with the 19 kc pilot signal shown in Figure 13C. This whole complex signal modulates the FM carrier and is then radiated from the broadcasting antenna.

Figure 14 shows the locations of the different components that modulate an FM stereo signal. The "main channel" signal is from 50 cps to 15 kc. Monaural FM tuners use only this part of the signal, and the remaining parts are attenuated by the tuners de-emphasis network,

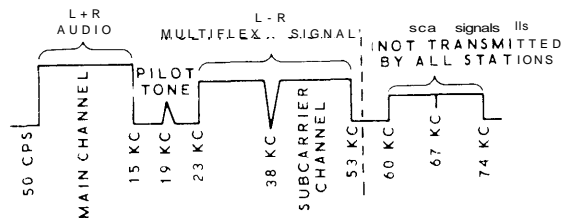


Figure 14

A 19 kc pilot signal is transmitted to give the proper phasing for the demodulated subcarrier channel. The 38 kc subcarrier channel is AM modulated from 23 kc to 53 kc.

A second subcarrier signal is transmitted by some stations at 67 kc. This is usually a commercial music signal. This signal is called the SCA (Subsidiary Communications Authorization) channel.

The signal that is used for stereo multiplex operation is coupled from the ratio detector, through capacitor C39 and the SCA filter, to audio amplifier transistor Q8. The SCA filter, which consists of coil L6 and capacitors C40 and C41, removes the 67 kc SCA signal. These signals are not used for stereo reception.

The complete stereo multiplex signal consists of the (L+R) main channel, the (L-R) subchannel, and the 19 kc pilot signal. The complete stereo signal is amplified by transistor Q8 and coupled through capacitor C43 to 19 kc amplifier transistor Q9. The collector circuit of transistor Q9 is tuned to 19 kc by coil L7 and capacitor C44. Phase control R43 and capacitor C45 are connected across a portion of coil L7 so the phase of the 19 kc signal can be adjusted. The 19 kc signal is then coupled to the base of the 38 kc oscillator transistor, Q10, where it locks the 38 kc oscillator in phase and frequency with the transmitted 38 kc subcarrier signal,

The 38 kc oscillator signal from transistor Q10 is applied through transformer T7 to the base circuits of switching detector transistors Q11 and Q12. At the same time, the main channel (L+R) and subchannel (L-R) signals are coupled from the emitter of transistor Q9 to the emitters of transistors Q11 and Q12,

When the main channel and subchannel signals are combined with the 38 kc oscillator signal in the switching detector circuit, the 38 kc carrier that was removed at the transmitter (suppressed carrier transmission) is reinserted into the stereo signal (waveform 3 on Block Diagram),

Figure 15 shows the various waveforms that are present in the switching detector circuit. Waveform 1 is the suppressed carrier stereo

and main channel signal that comes from transistor Q9. Waveform 2 is the 38 kc oscillator signal that is reinserted in the stereo signal at the same phase and frequency as the original 38 kc carrier. Remember, this 38 kc oscillation was locked at the correct frequency and phase by the 19 kc pilot signal from Q9.

The actual detection process takes place in the following manner: When waveform 3 is applied to the switching detector transistors, Q12 **only** conducts on that part of the waveform that carries the L waveform. Thus, **only** the L waveform 4 appears at its output. Transistor Q11 **only** conducts on the R portion of the 38 kc waveform, thus **only** the R waveform 5 appears at its output. These are the left and right signals originating at the broadcasting station.

In Figure 16, the 38 kc signal is shown superimposed on the stereo signal. At each 38 kc peak on the L waveform, Q12 conducts and Q11 is cut off. At each 38 kc peak on the R waveform, Q12 is cut off and Q11 conducts. The L signal from transistor Q12, charges capacitor C54; the R signal from transistor Q11, charges capacitor C55.

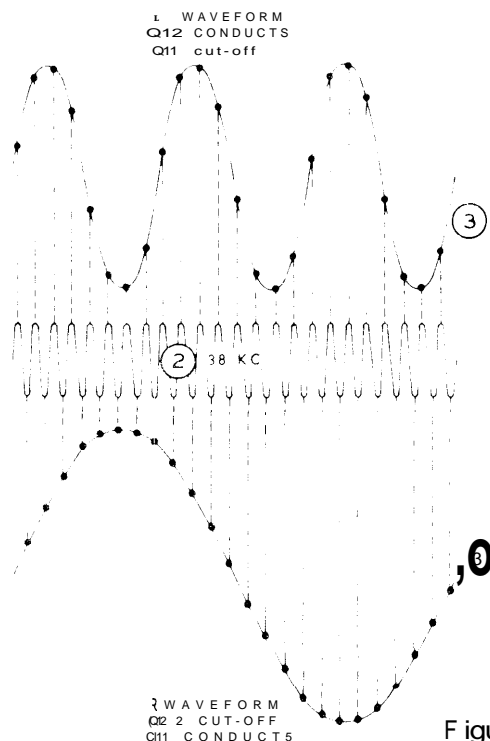


Figure 16

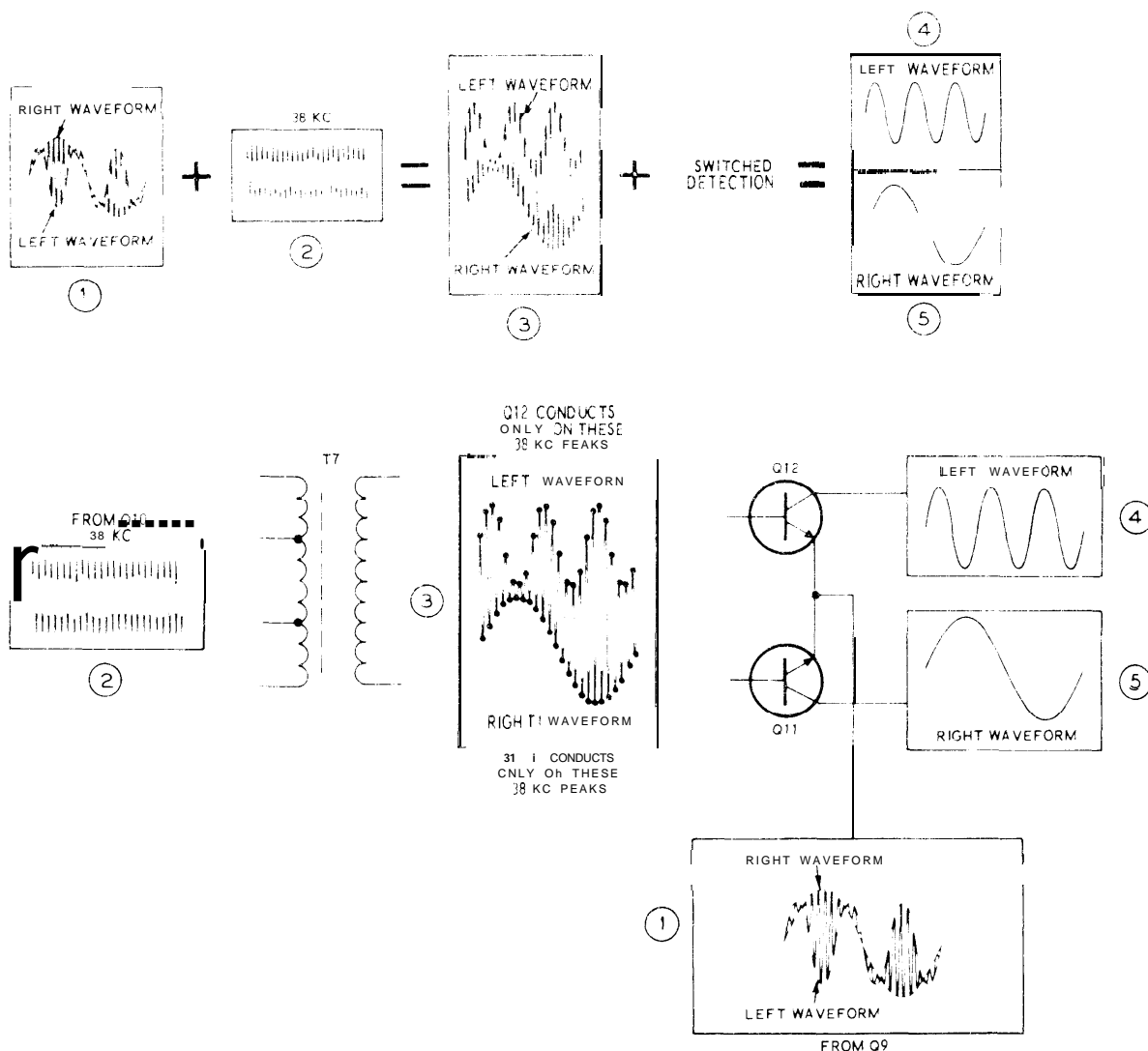


Figure 15

The left and right channel audio signals then are applied to individual 38 kc PEC filters that remove any remaining 38 kc signal. Proper de-emphasis of each signal is provided by the combinations of the PEC components and capacitors C57 and C58. The stereo signals are then connected to the Left and Right channel outputs.

When the Phase switch is in the "out" position, a 38 kc bandpass filter is connected into the circuit (coil L8 and capacitor C52). This circuit allows only the 38 kc subcarrier channel to pass through to transistors Q11 and Q12. The phase control is used to adjust for proper phasing

between the reinserted 38 kc carrier and the 38 kc subcarrier signal. This insures maximum separation from the receiver. (The Phase control is adjusted by listening for maximum sound in the subcarrier signal: the presence of main channel sound would make this adjustment impossible.)

A small amount of the 19 kc signal is coupled from coil L7, through capacitor C38, to the base of stereo indicator amplifier transistor Q13. This 19 kc signal is only present when a stereo signal is being broadcast.

Transistor Q13 does not conduct current until the positive peaks of the 19kc signal are applied to it. Then it only conducts until the time constant of resistor R35 and capacitor C38 cause it to stop conducting. The current pulses that result are applied to transistor Q14 and amplified. These pulses, produce an average level of 6 volts across the stereo indicator lamp. This, in turn, causes the lamp to light, indicating that an FM stereo signal is being received.

## MONOPHONIC FM OPERATION

The monophonic signal is coupled from the ratio detector circuit to the base of transistor Q8. After amplification, this signal is coupled to transistor Q9. Q9 acts only as an emitter follower since no 19 kc signal is present.

The monophonic signal is then coupled through capacitor C52 to the emitters of transistor Q11 and Q12. No oscillator signal is coupled to transistors Q11 and Q12, since the 38 kc oscillator circuit is disabled by the Source switch.

Transistors Q11 and Q12 will conduct when no 38 kc signal is applied to their bases. Then the same monophonic signal is present at the collectors of transistors Q11 and Q12. These signals are then coupled through the de-emphasis circuits to the Left and Right channel outputs,

## LEFT CHANNEL AMPLIFIER

The complete amplifier section of the Receiver consists of a left channel amplifier and a right channel amplifier. The left and right amplifiers are identical; therefore, in order to simplify this description, only the left channel amplifier will be discussed.

The FM signal from the FM tuner section is applied through resistor R105 and Source switch contacts 6 and 3 to the base of transistor Q1. Resistor R111 is used to provide the proper load impedance for the phono cartridge. Transistor Q1 operates as a high-gain low-noise amplifier to increase the level of the incoming signal.

The amplified signal from the collector of Q1 is applied directly to the base of transistor Q3. Transistor Q3 amplifies the signal again. DC feedback is applied from the emitter of Q3 to the base of Q1 through resistor R117. From the collector of Q3, for Phone operation, a portion of the signal is applied through a frequency selective network, which consists of capacitors C105 and C109, resistor R125, and the Source switch. This network provides RIAA equalization.

The equalized signal from the collector of Q3 is applied through capacitor C107 to Volume control R129. The amount of signal required to produce the desired listening level is tapped off by the slider portion of the Volume control. This signal voltage is applied through the Bass and Treble control circuits to the base of amplifier transistor Q5.

The signal from Cl07 is also applied through isolation resistors R181 and R183 to the Tape Cut-pot jack.

Transistor Q5 further amplifies the signal. A small portion of the signal from the collector of Q5 is applied as feedback through capacitor Cl17 and part of the tone control network to the base of Q5. The output signal from the collector of Q5 is coupled through capacitor C119 and resistor R149 to the base of transistor Q7. Transistors Q7 and Q9 are direct-coupled amplifiers which further amplify the signal. The amplified signal from the collector of Q9 is coupled through capacitor Cl25 to the base of driver transistor Q11.

The amplified signal from the collector of Q11 is applied to the bases of the output transistors, Q13 and Q15. Diode D101 determines the AB operating point of the output transistors, eliminates crossover distortion, and also provides temperature stability.

Transistors Q13 and Q15 are connected as a push-pull output stage. The output signal from this stage is applied through capacitor C129 and the switch contacts on the rear of the Bass control to the speakers. The output signal is also applied across a voltage divider network made up of resistors R173 and R175. The voltage divider applies a portion of the signal through resistor R151 and capacitor Cl21 as overall negative feedback to the base of transistor Q7. If a stereo headphone set is plugged into the

Phone jack, the signal is applied to the headphones. The speaker can be disconnected using the switch on the Bass control.

## POWER SUPPLY

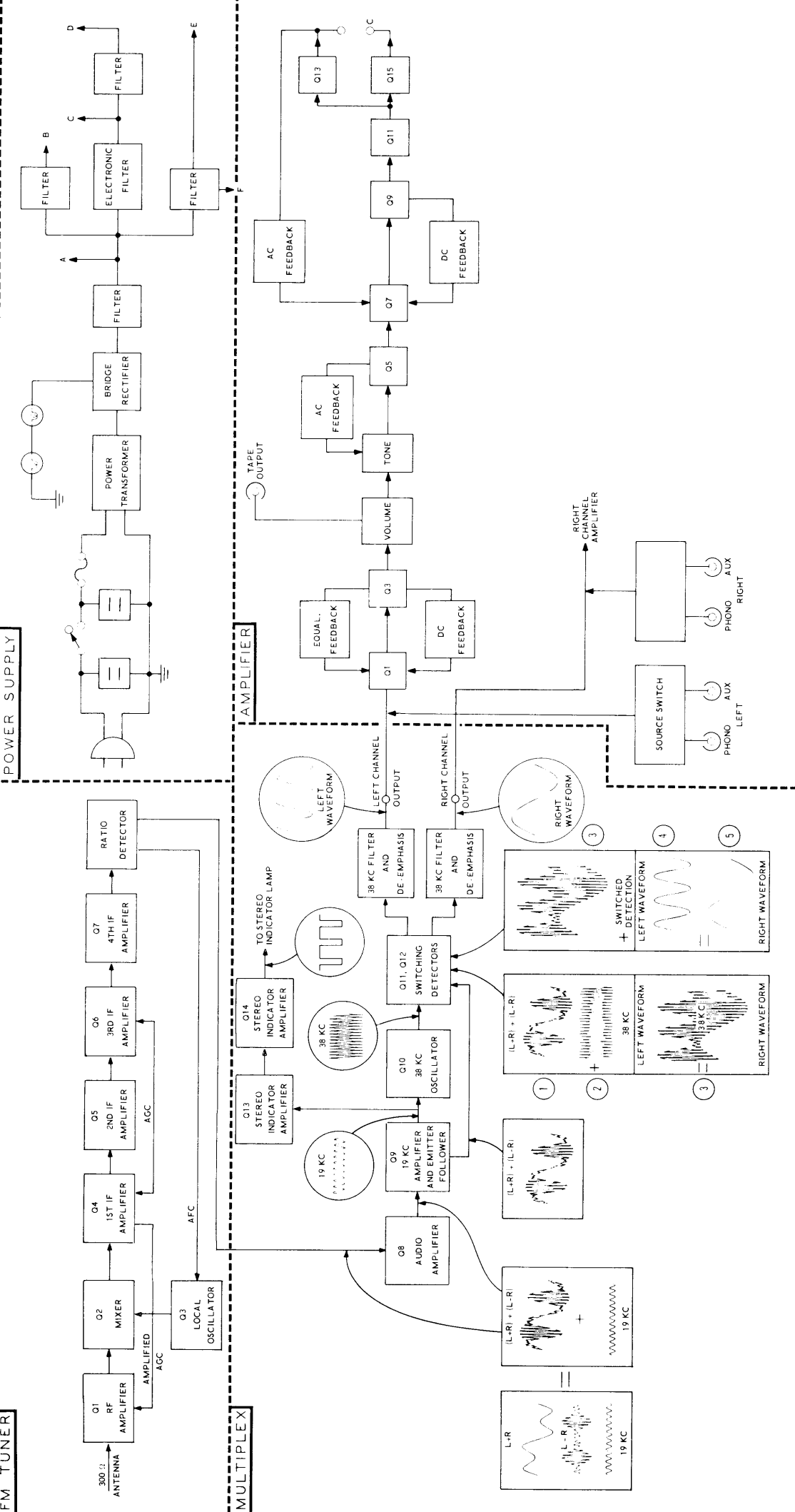
The fused transformer-operated power supply uses four silicon diodes, 0200 through D203, in a bridge rectifier circuit. Capacitor C201 filters the supply voltage for the power output stages. Resistor R201 and capacitor C202 provide the supply voltage for the stereo indicator lamp.

An electronic filter, consisting of transistor Q100, resistors R205, R206, and R207, and capacitor C205, provide filtering for preamplifier transistors, Q3, Q4, Q5, and Q6. The final filtering for high-gain low-noise preamplifiers Q1 and Q2, is accomplished by resistor R208 and capacitor C207.

The supply voltage for the Tuner section is obtained through resistors R201 and R202. Capacitors C202 and C203, provide filtering.

The DC voltage for the pilot lamps is obtained from the junction of diodes D200 and D202. Dropping resistor R200 lowers the voltage to the proper lamp operating voltage. The switched AC socket and the primary of the power transformer are activated by the On-Off switch. The unswitched AC socket is connected directly across the line and supplies power continuously.

## POWER SUPPLY





## INPUT CONNECTIONS

Shielded cables, terminated in standard phono plugs, should be used to connect all signal sources to the input sockets of your Receiver. The following information gives the correct input connections for the various types of signal sources.

### Phmo Input

For magnetic or variable reluctance phono cartridges.

### Auxiliary Input

For use with most high level signal sources such as a television receiver or tape recorders with preamplifier output. A record changer or a turntable equipped with a crystal or ceramic stereo cartridge may also be connected to the AUX INPUTS. However, the BASS control should be turned up in order to compensate for the low frequency losses when using these cartridges.

### Ground Terminal

In some cases the mechanism of a turntable or a changer is not connected to the audio cable shield. To reduce hum in these cases, a separate ground wire should be connected from the turntable to this ground terminal.

## TAPE OUTPUT

When connecting this Amplifier to a tape recorder, the high level input of the recorder should be used. This input is sometimes called High Level, Radio, or Line Input. AT NO TIME SHOULD A TAPE RECORDER BE CONNECTED TO THE AMPLIFIER SPEAKER CONNECTIONS, as serious damage could result to the Receiver.

## AC OUTLETS

### Switched AC Outlet

For supplying power to devices such as record changers, which may then be controlled by the On-Off switch on the Amplifier.

### Normal AC Outlet

For supplying power to devices such as record changers or tape decks, which may be damaged if power is removed without turning off the mechanism.

## SPEAKER CONNECTIONS

- ( ) If your left speaker has a lug marked "common," or C, connect a wire from this lug to the COM (common) connecting screw of the LEFT SPEAKER output terminal. If your left speaker lugs are not marked, connect a wire from either of these lugs to the LEFT SPEAKER output terminal.
- ( ) Connect the other left speaker wire to the other LEFT SPEAKER connecting screw.
- ( ) If your right speaker has a lug marked "common," or C, connect a wire from this lug to the COM (common) connecting screw of the RIGHT SPEAKER output terminal. If your right speaker lugs are not marked, connect a wire from either of these lugs to the RIGHT SPEAKER output terminal.
- ( ) Connect the other right speaker wire to the other RIGHT SPEAKER connecting screw.

### Speaker Phasing

NOTE: If the "common" lugs of your left and right speakers were marked, this phasing procedure can be disregarded: the connections made in the preceding steps provided proper phasing for your speakers.

The two speakers should be connected so that they are "in-phase." "In-phase" means that both speaker cones move in the same direction at the same time, when driven by identical signals.

If multiple-speaker systems are used, phasing refers to the low-frequency speaker in each system.)

Speaker phasing can be determined easily in the following manner: Disconnect both phono input cables, and set the SOURCE switch to the PHONO (M) input. Introduce a hum in both channels by inserting a length of bare wire or a screwdriver in one of the empty input sockets: then advance the VOLUME controls until a hum is heard.

Place the speakers side by side. Note the loudness of the hum when you stand directly in front of and between the speakers. Now interchange the two speaker wires on one channel. When the loudest hum is heard the speakers are in phase.

## Speaker Placement

Generally, for stereo listening, the two speakers should be spaced four to eight feet apart. They should be placed along a wall either facing straight ahead or "firing in" slightly toward each other's axis. The optimum positions can best be determined by experiment. A great deal depends upon the size and acoustics of the room and upon the high frequency dispersion characteristics of the speakers. Identical speakers or speaker systems are recommended.

Correct speaker spacing also depends to some extent upon the listener's position and distance from the speakers. In other words, if the listening position is restricted to one that is relatively close to the speakers, some improvement could probably be obtained by moving the speakers closer together.

Remember that stereophonic reproduction is striving to recreate, as accurately in position as possible, not only the sounds that originate at the "right" or left", but also those near the center. Best results will be obtained if you experiment with speaker and listening positions: this will help you arrive at the best set of conditions for your installation.

## Stereo Headphone Jack

A set of stereo headphones can be plugged directly into this jack. The external speakers are disconnected when the switch on the BASS control is pulled out. Program material can be tape recorded by plugging the high level input of the tape recorder into this jack.

Figure 8 shows a type of plug that can be installed on the end of a stereo headphone or tape recorder cable. The tip of the plug connects to the right channel of the jack.

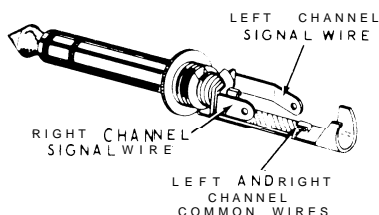


Figure 8

## INDOOR ANTENNAS

Several types of indoor TV and FM antennas are available that will provide satisfactory mono FM operation of the Receiver in strong signal areas, or from strong local stations. For stereo FM however, an outdoor antenna should be used.

A simple folded dipole antenna can be made as shown in Figure 9, from standard 300  $\Omega$  twin lead. This antenna can be placed on the rear of a large cabinet or nailed or stapled to a piece of wood to reinforce it. Best reception will be obtained from the stations that are broadside to this antenna. Weakest reception will occur with those stations that face the ends of the antenna.

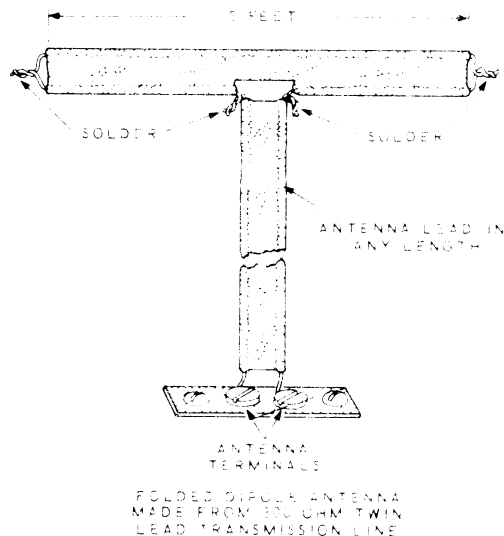


Figure 9

## OUTDOOR ANTENNAS

To receive weaker stations, or in weak signal areas, an outdoor antenna will be necessary. BEST RECEPTION FOR STEREO FM WILL OCCUR WITH A COMMERCIAL FM OUTDOOR ANTENNA. A VHF TV antenna can also be used as an FM antenna, since FM stations are actually located between TV channels 6 and 7.

Do not connect a TV antenna to both the TV set and the Receiver at the same time, unless a TV antenna coupler is used, or a weak and distorted signal may occur in both units. Pad type couplers are not recommended because large amounts of signal are lost in them. Use a pre-amplifier type of coupler instead, where there is no loss of signal.

# OPERATION

Refer to Figure 10 for the location of the front panel controls.

## SOURCE SWITCH

NOTE: This is a three wafer switch: it allows the inputs of both channels to be selected simultaneously. It also turns the 38 kc oscillator off when inputs other than stereo FM are used,

When the SOURCE switch is in one of the monophonic **M** positions, the input signals from both the left and right channels will be combined and heard in both the left and right speakers. In the stereo **S** positions, all signals from the left Channel Inputs will be heard **only** in the left speaker, and all Right Channel **signals** will be heard **only** in the right speaker,

In the monophonic **M** FM position, the same signal is present at the Left and Right output sockets. In the stereo **S** FM position (when tuned to a station that is broadcasting stereo), one channel signal is heard in the left speaker and the other channel signal is heard in the right speaker,

NOTE: The **S** FM position should **only** be used when a station is broadcasting stereo; otherwise, subchannel noise may be heard on regular FM programs. Also, noise may be heard from stations that broadcast a Subsidiary Communications Authorization SCA signal.

## VOLUME

The dual-concentric clutched VOLUME control allows the listening level of each channel to be adjusted simultaneously or individually. Maximum volume is obtained when the knobs are rotated fully clockwise.

## BASS CONTROL AND SPEAKER ON-OFF SWITCH

The BASS control is of dual-tandem construction. The low frequency response is simultaneously varied by the same amount in both channels. Flat response is obtained when the knob is at approximately 12 o'clock. Clockwise rotation produces boost, and counterclockwise rotation produces cut of the low frequencies. Pulling the control knob out, disconnects the speakers and allows private listening with headphones.

## TREBLE CONTROL AND POWER ON-OFF SWITCH

The TREBLE control is of dual-tandem construction. The total response is simultaneously varied by the same amount in both channels. Flat response is obtained when the knob is at approximately 12 o'clock. Clockwise rotation produces boost, and counterclockwise rotation produces cut of the high frequencies.

The On-Off switch is located on the TREBLE control. Pull the TREBLE control knob out to turn the Receiver ON, and push the knob in to turn it OFF.

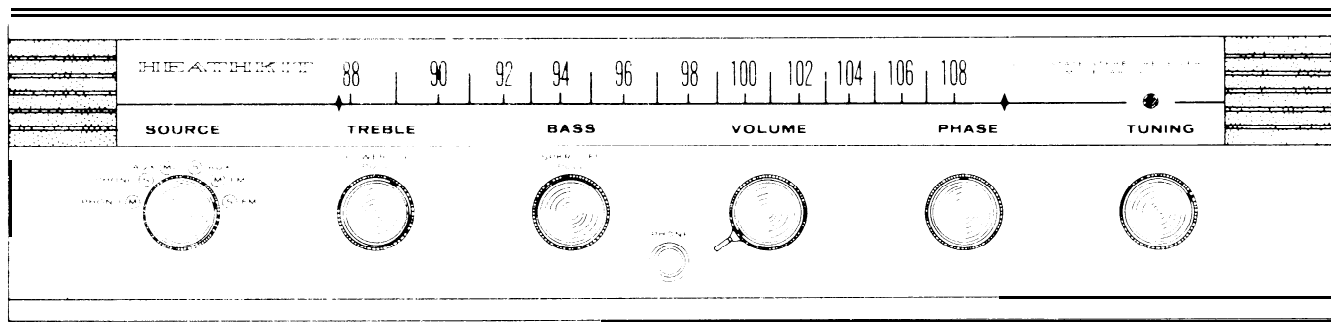


Figure 10

## TUNING

This control changes the dial setting and tunes in the desired station.

## STEREO INDICATOR LAMP

This indicator will light with a steady glow when an FM station that is broadcasting a stereo signal is tuned in, if the SOURCE switch is in the (S) FM, (M) FM, (S) AUX, or (M) AUX positions. Note that in some cases it may flicker on and off due to the noise between stations. It may also light for short periods of time on stations that use a "Commercial Killer" signal. This signal eliminates the commercials from the music that these stations sell to business establishments.

## PHASE CONTROL AND SWITCH

This control and switch is only used when tuned to a station that is broadcasting an FM stereo signal. The SOURCE switch must be set at the (S) FM position. When you tune to different stations, the Phase control will produce maximum stereo separation by correcting any transmitted phase errors.

To set the PHASE control, pull the knob out to activate the switch, and adjust the control in either direction for the loudest output signal. Then push the knob back in without disturbing the control setting,

## HOW TO GET THE MOST OUT OF YOUR RECEIVER

Use the following procedure to get the greatest possible enjoyment out of this high quality Stereo Receiver. The Receiver should be connected to good quality speakers. The speakers should be placed far enough apart to provide good stereo separation: approximately 4 to 8 feet.

Set the SOURCE switch to the (S) FM position,

Tune in a station that is broadcasting stereo, as indicated by a steady glow of the stereo indicator lamp.

Pull out the PHASE control knob and adjust this control in either direction for the loudest output. Then push the knob back in without disturbing the setting of this control.

NOTE: The Phase control adjusts the phase of the 38 kc reinserted carrier. It may be necessary to readjust this control when tuning to another station, to correct transmitted phase errors and obtain maximum stereo separation.

Set the SOURCE switch to the (M) FM position.

Adjust the volume controls to produce an equal sound level from each speaker at the desired listening level.

To receive monophonic FM programs, always set the SOURCE switch to the (M) FM position. This will produce the best signal-to-noise ratio,

# ALIGNMENT WITH INSTRUMENTS

This alignment procedure requires the use of test equipment. It should only be performed by those who have instrument alignment experience.

## IF ALIGNMENT

Equipment needed: A high impedance input DC VTVM, and an RF generator that is accurate at 10.7 mc, A Heathkit VTVM and the Heathkit FM0-1 Test Oscillator, or their equivalents, may be used,

( ) Set the Receiver controls as follows:

SOURCE switch to **(M)** FM.

PHASE switch pushed in.

TUNING to low frequency end of dial,

Refer to Figures 4 and 5 (fold-out from Page 65) for coil, transformer, and TP (test point) locations. Complete the adjustments given in the Alignment Chart below.

## IF ALIGNMENT CHART

PREPARATION	RF GENERATOR		VTVM	ADJUST	
	Connect To	Frequency And output	Connect To	Transformer	For VTVM Reading
Connect a jumper wire between points X and Y on the FM-Multiplex circuit board.	Antenna input terminals.	10.7 mc (without modulation). Set generator output for 2 volts on VTVM.	TP1	Bottom slug of T6	Maximum reading.
		10.7 mc (without modulation). Reduce generator output to maintain 2 volts on VTVM.	TP1	Top and bottom slugs of T5	
				Top and bottom slugs of T4	
				Top and bottom slugs of T3	
				Top and bottom slugs of T2	
				Repeat each step above until no further improvement is obtained.	
Remove jumper wire from between points X and Y.	Antenna input terminals.	10.7 mc without modulation.	TP2	Top slug of T6	Zero reading.
			TP2	If necessary, readjust top slug of T6.	

## FRONT END ALIGNMENT

Equipment needed: An RF generator and a high input impedance DC VTVM.

Complete the steps in the following Alignment Chart.

FRONT END ALIGNMENT CHART

STEP	RF GENERATOR		CONNECT VTVM TO	RECEIVER TUNED TO	ADJUST FOR MAXIMUM VTVM READING
	Connect To	Frequency And Output			
1.	Antenna terminals. NOTE: It may be necessary to loosely couple RF generator leads to Tuner input.	90 mc	TP1	To maximum reading near 90 mc	T1
2.	Readjust the dial pointer so it coincides with the 90 mc marking on the dial.				
3.	Antenna terminals	106 mc	TP1	106 mc	C14
4.	Antenna terminals	106 mc	TP1	106 mc	C1 and C6
5.	Repeat steps 1, 3, and 4 until no further improvement can be obtained.				

## STEREO ALIGNMENT

Equipment needed: Audio generator and AC VTVM. The Heathkit Models IG-72 or IG-82 Audio Generators and the Model IM-21 AC VTVM, or their equivalents may be used.

- ( ) Disconnect the negative lead of capacitor C39 from the circuit board at point R, See Figures 4 and 5 (fold-out from Page 65),

Complete the steps in the Stereo Alignment Chart and the steps that follow the chart.

STEREO ALIGNMENT CHART

PREPARATION AND CONTROL SETTINGS	AUDIO GENERATOR		VTVM	ADJUST	
	Connect To	Frequency And output		Coil	For VTVM Reading
SOURCE switch to $\text{M}$ FM. PHASE switch pulled out.	Negative (-) lead of capacitor C39.	<b>38 kc</b> ( $\pm 200$ cps) .01 volt rms output.	TP3	<b>L8</b>	Maximum reading (about .2 volt rms).
Push PHASE switch in. Adjust PHASE control to about <b>2</b> o'clock position.		<b>67 kc</b> .1 volt rms output.		L6	Minimum reading (about <b>.007</b> volt rms).

- ( ) Disconnect the AC VTVM and the audio generator from the Receiver.
- ( ) Reconnect the negative (-) lead of capacitor C39 to the circuit board at point R and solder the connection.

NOTE: To obtain the most accurate alignment, coil L7 and transformer T7 should be adjusted by using an FM stereo broadcast signal, rather than by using instruments.

- ( ) Adjust coil L7 and transformer T7 by completing the steps under FM Stereo Adjustments on Page 48.

This completes the Stereo Alignment,

## CHANNEL SEPARATION TESTS

If an FM stereo generator is available, this generator may be used to check channel separation. To check separation, coil L7 and transformer T7 must be adjusted as outlined in the following steps.

Equipment needed: FM stereo generator and AC VTVM. If desired, an oscilloscope may also be used.

- ( ) Disconnect the negative (-) lead of capacitor C39 from the circuit board at point R,
- ( ) Connect the FM stereo generator output lead to the negative (-) lead of capacitor c39.
- ( ) Connect the AC VTVM (and oscilloscope if desired) to the RIGHT TAPE OUTPUT socket of the Receiver.
- ( ) Set the SOURCE switch on the Receiver to the S FM position.
- ( ) Set the FM stereo generator to the right channel output and use the 19 kc pilot signal with a 1 kc multiplex signal.
- ( ) Adjust coil L7 for maximum brilliance of the stereo indicator lamp.
- ( ) Pull out the PHASE switch, then adjust the PHASE control fully clockwise.

NOTE: Complete the following adjustments very carefully to obtain good stereo listening.

- ( ) Adjust transformer T7 as follows:
  1. Turn the slug (not more than one turn in either direction) until the sound output is clear,
  2. Turn the slug counterclockwise to the point where the sound output just starts to become garbled, Note the position of the flag on the alignment tool.

3. Turn the slug clockwise 1/4 turn.

- ( ) Readjust coil L7 until a null or minimum sound output is obtained. NOTE: If there are two nulls, use the null adjustment that is closer to the top of the coil. The proper adjustment should be close to the point of maximum brightness of the stereo indicator lamp.
- ( ) Turn the PHASE control counterclockwise for a maximum output reading, then push the PHASE switch in.
- ( ) Note the output reading on the VTVM. Then change the FM stereo generator to the left channel output and note the VTVM output reading for this position. The difference between the two output readings is the right channel separation, usually expressed in db (decibels).
- ( ) Disconnect the VTVM (and oscilloscope if used) from the RIGHT TAPE OUTPUT socket and connect it to the LEFT TAPE OUTPUT socket of the Receiver.
- ( ) Turn the channel switch of the FM stereo generator to the right channel position, then to the left channel position, Note the output reading on the VTVM for each position. The left channel separation is the difference between these two readings.
- ( ) Disconnect the FM stereo generator, AC VTVM, and oscilloscope (if used) from the Receiver.
- ( ) Reconnect the negative lead of capacitor C39 to the circuit board at point R; then resolder the connection.

This completes the Channel Separation Tests.



# SPECIFICATIONS

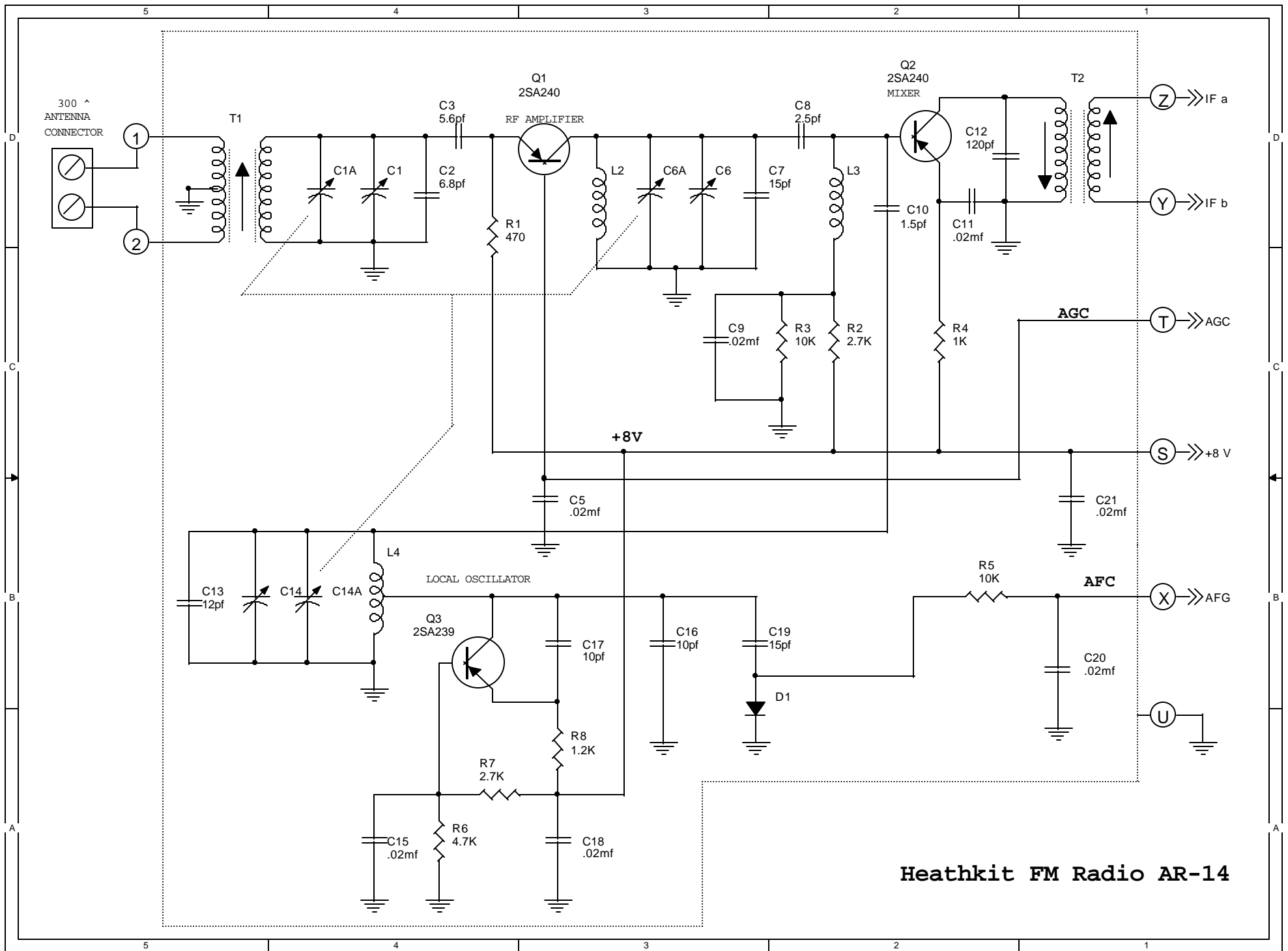
## FM SECTION

Tuning Range. . . . .	88-108 mc,
Antenna Input Impedance. . . . .	300 $\Omega$ , balanced input.
Sensitivity, . . . . .	5 microvolts,*
Intermediate Frequency (IF). . . . .	10.7 mc,
Hum And Noise. . . . .	-50 db, 1 watt reference.
Audio Frequency Response. . . . .	Monophonic : 0 to -3 db from 20 to 15,000 cps.
Harmonic Distortion. . . . .	1% or less.*
Image Ratio. . . . .	-45 db,*
Capture Ratio. . . . .	3 db,*
AFC Correction. . . . .	150 kc per volt.
AM Suppression. . . . .	-35 db,*
IF Rejection. . . . .	-80 db,*
Separation. . . . .	30 db at 1000 cps.

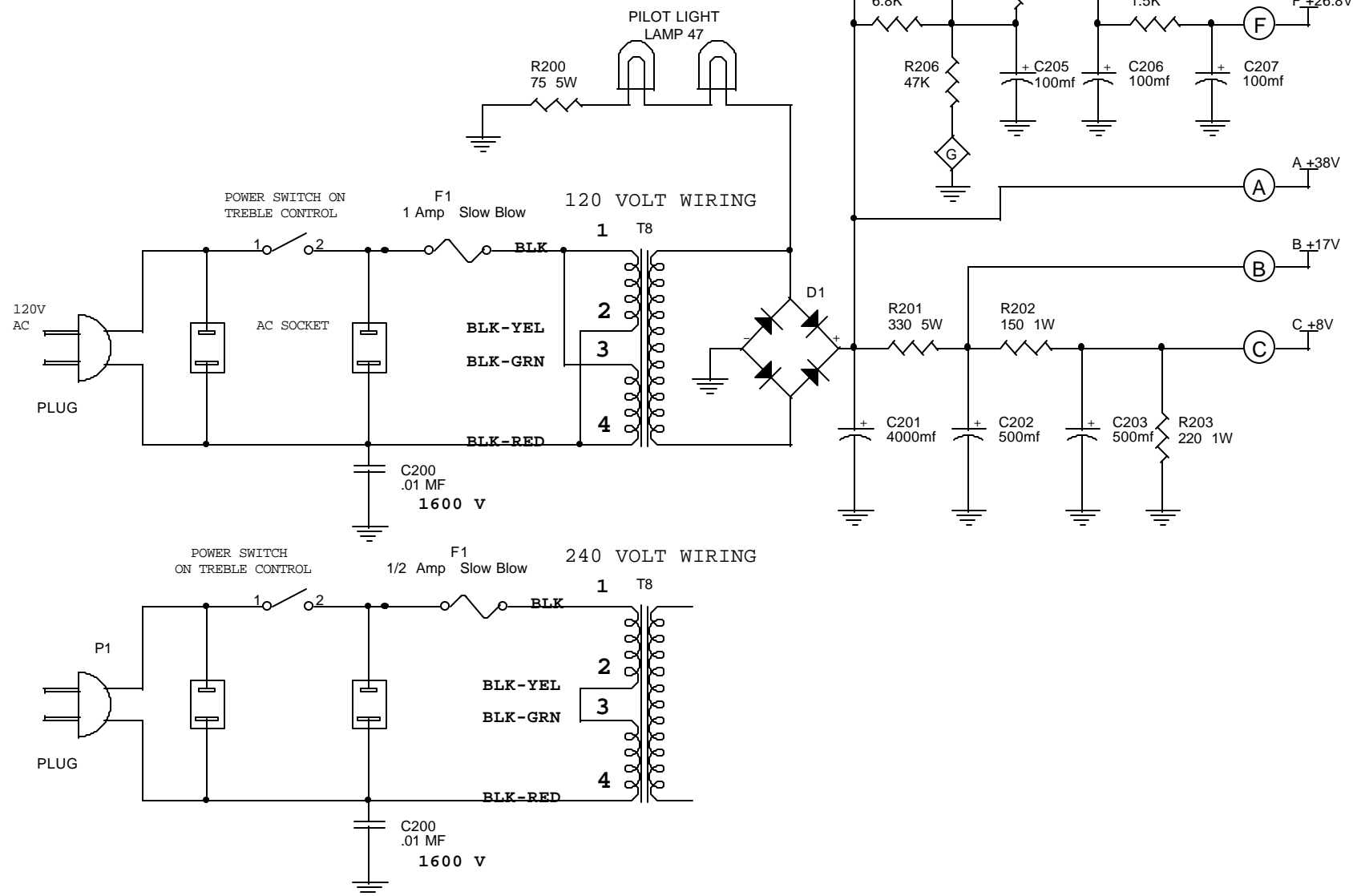
## AMPLIFIER SECTION

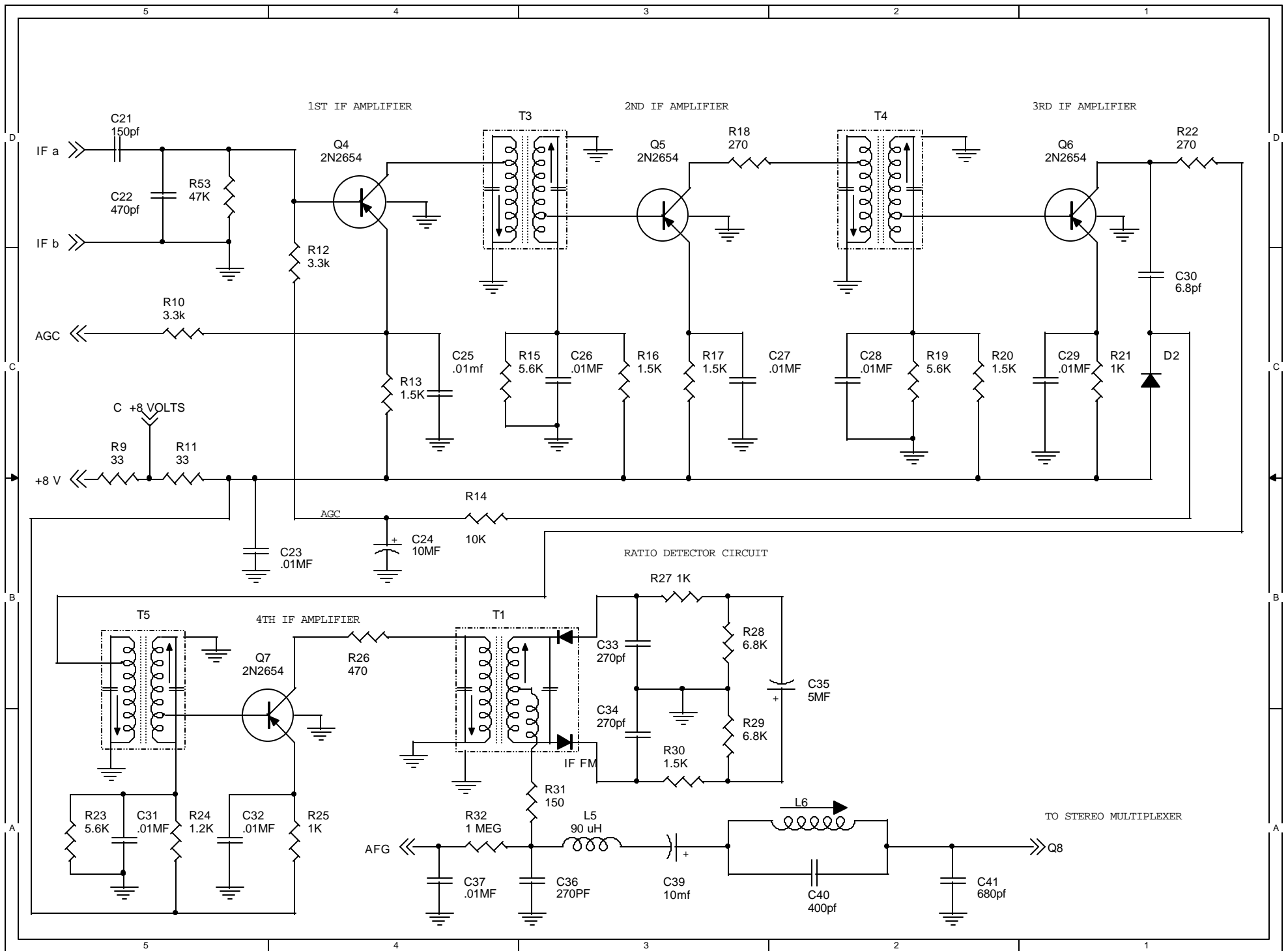
Continuous Power Output.     . . . . .	10 watts per channel.
Music Power Output. . . . .	15 watts per channel.*
Speaker Output Impedance. . . . .	4 through 16 $\Omega$ .
Tape Output Impedance. . . . .	3500 $\Omega$ .
Damping Factor, . . . . .	50 or higher.
Hum And Noise,. . . . .	Phono: -60 db; 10 MV reference-input shorted. Auxiliary: -63 db; input shorted.

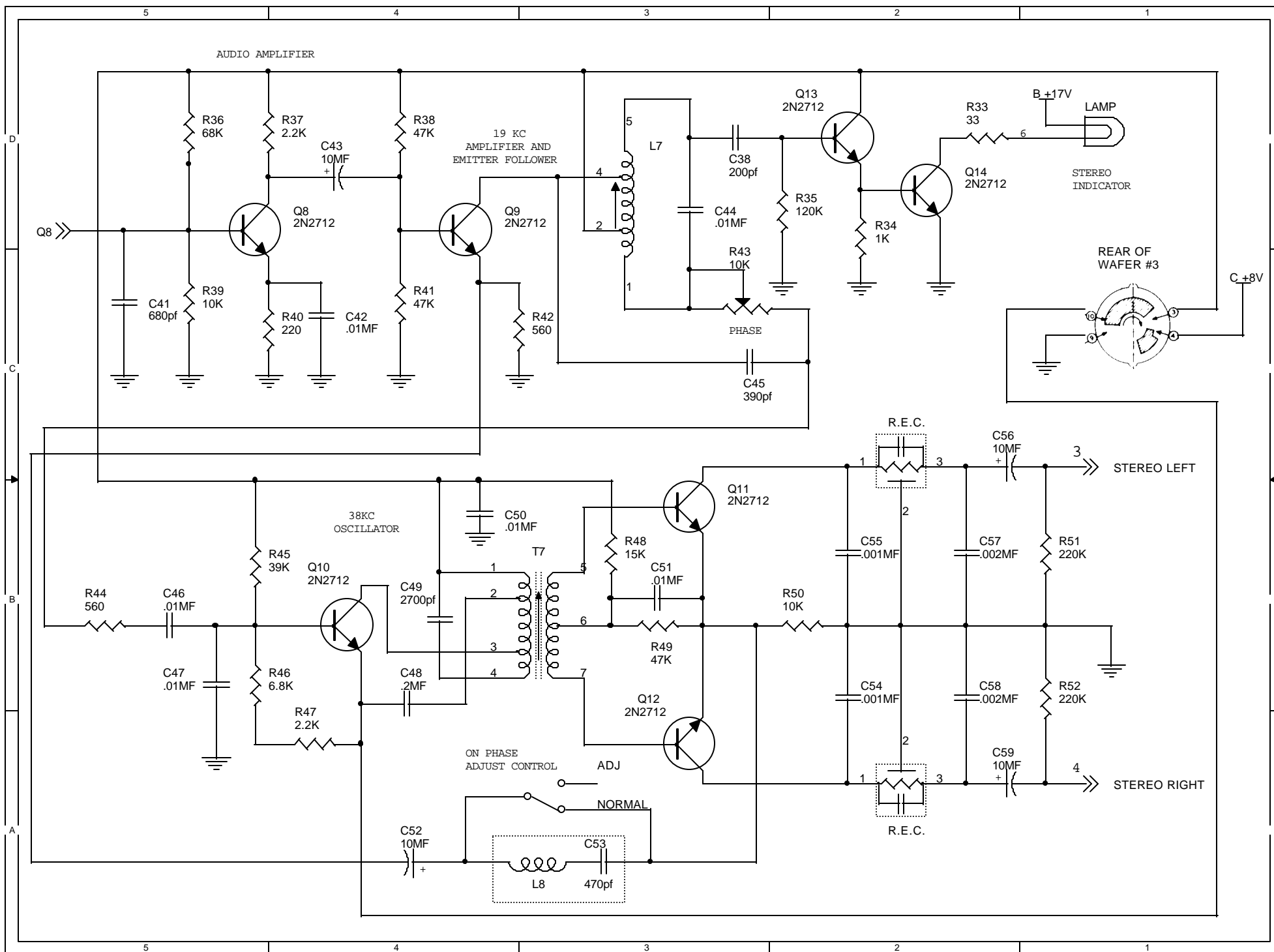
\*Rated IHF (Institute of High Fidelity) Standards.

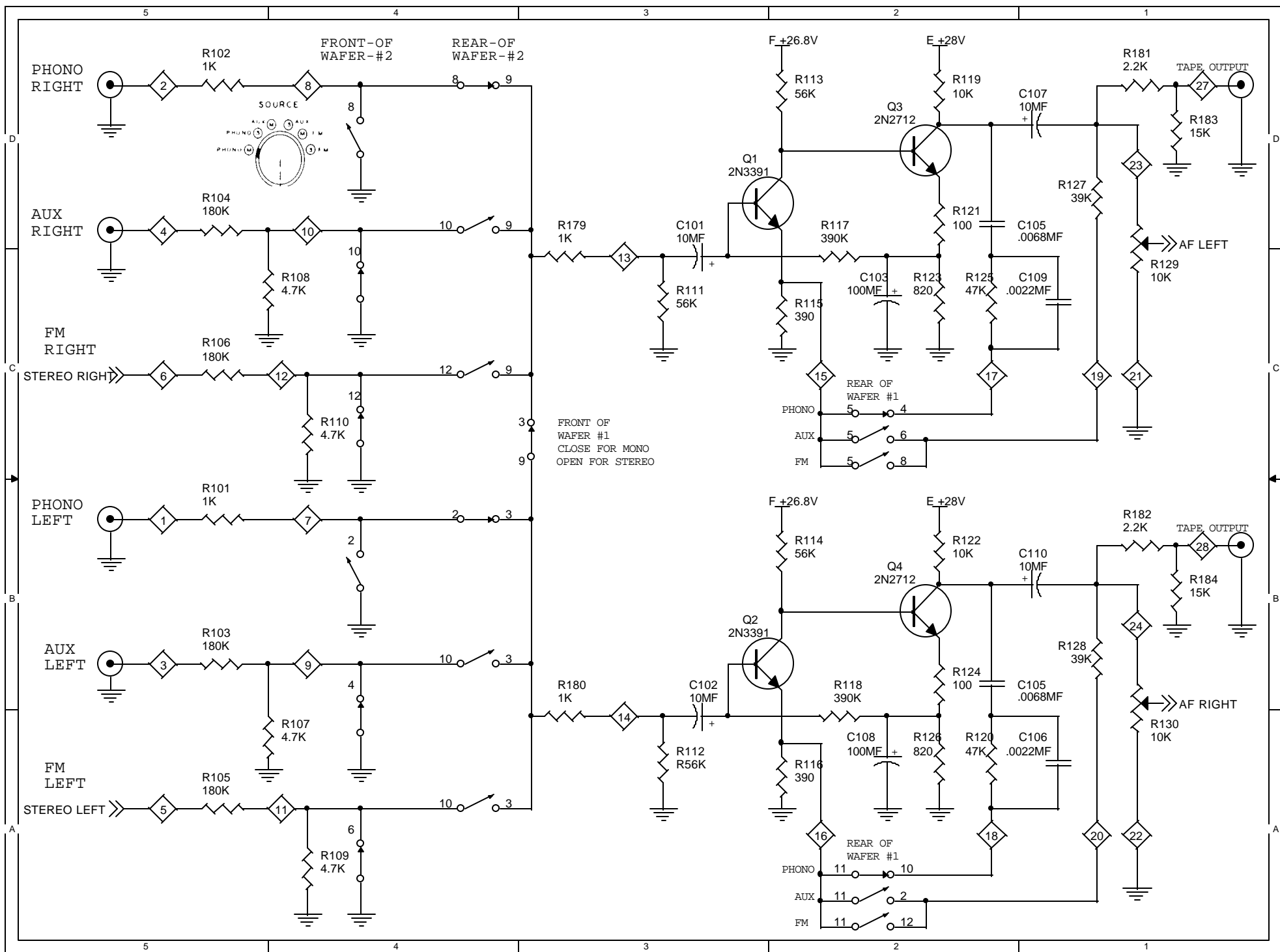


# POWER SUPPLY

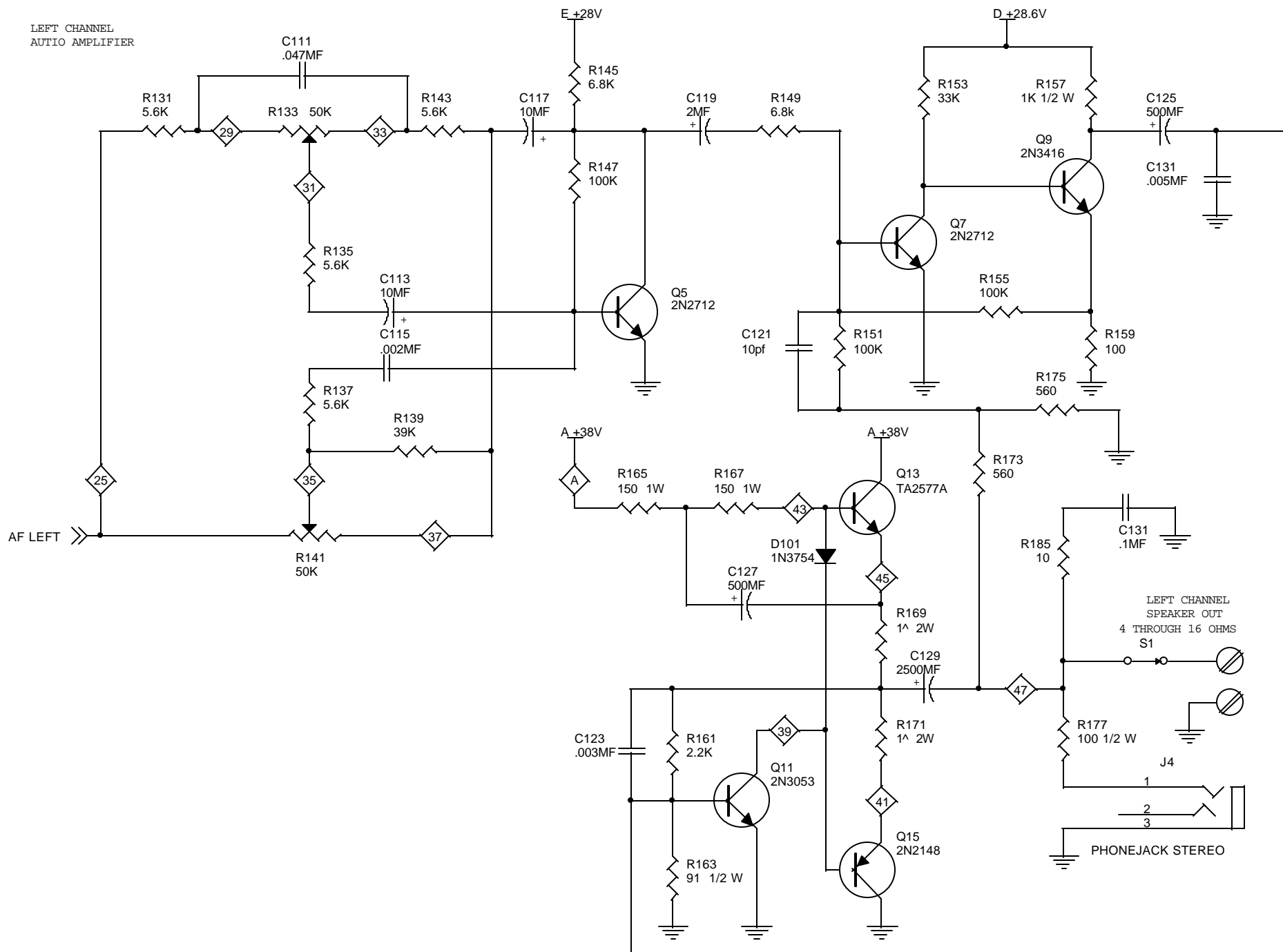








LEFT CHANNEL  
AUDIO AMPLIFIER



RIGHT CHANNEL  
AUDIO AMPLIFIER

