Assembly and Operation of the

HEATHKIT by Daystrom

STEREO TUNER

MODEL AJ-41

HEATH COMPANY,
BENTON HARBOR,
MICHIGAN

a subsidiary of DAYSTROM, INCORPORATED

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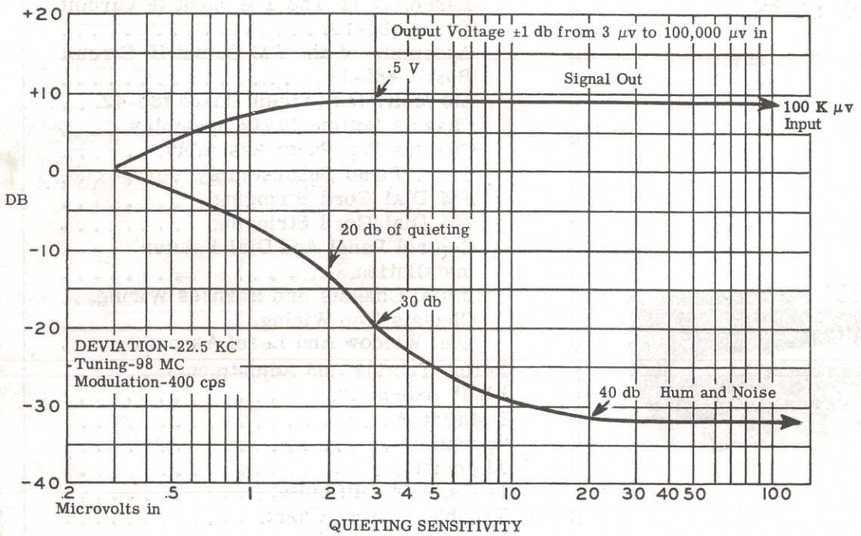
SPECIFICATIONS

FM SECTION

Tuning Range	88 to 108 megacycles.
Intermediate Frequency (IF)	10.7 megacycles.
Antenna	300 Ω balanced.
Output Impedance (Cathode Follower)	Variable to 4000 Ω.
Output Voltage	Nominal .5 volt with 3 μv, 30% modulation in.



QUIETING SENSITIVITY

Quieting Sensitivity	2 μv for 20 db of quieting. 3 μv for 30 db of quieting. 20 μv for full quieting, 40 db.
Audio Frequency Response	±2 db from 20 to 20,000 cps.
Maximum Deviation Sensitivity	5 μv, 400 cps, 100% modulation in. (Minimum signal with 100% modulation that will pass through the tuner without exceeding rated distortion).
Deviation Sensitivity	20 kc (1100 μv in). (Minimum deviation required to produce rated output).
Harmonic Distortion	Less than 1% (1100 μv, 400 cps, 100% modulation).
Intermodulation Distortion	Less than 1%.

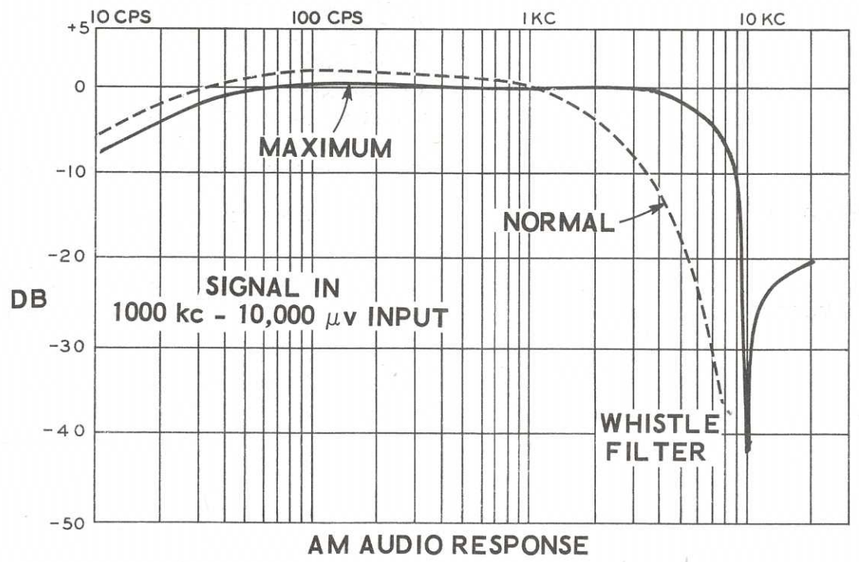
Image Ratio	40 db.
Capture Ratio	12 db.
AFC Correction Factor	12 db.
Amplitude Modulation Suppression	25 db.
Hum And Noise	40 db below 30% modulation (20 μv in).

FM STEREO CONVERTER SECTION

Audio Frequency Response	±2 db from 50 to 15,000 cps.
Subcarrier Bandpass	±3 db from 23,000 to 53,000 cps.
Channel Separation	30 db at 1 kc. 25 db at 10 kc.
Hum And Noise	-55 db relative to 1 volt rms output.
Output Impedance (Cathode Follower)	Variable to 4000 Ω, each channel.
Outputs	LEFT CHANNEL-RIGHT CHANNEL.

AM SECTION

Tuning Range	535 to 1620 kc.
Sensitivity, Normal Position. (At antenna terminals through standard IRE dummy antenna. Reference output: .1 volt rms.)	1400 kc 3 μv. 1000 kc 4 μv. 600 kc, 8 μv.
Sensitivity Change, Normal To Maximum	-5 db.
Intermediate Frequency (IF)	455 kc.



AM AUDIO RESPONSE

Antenna	Built-in rod, with provisions for external straight wire.
Output Impedance (Cathode Follower)	Variable to 4000 Ω.
Output Voltage	Nominal .3 volt.
IF Band Width	Normal: 14 kc (6 db down). Maximum: 20 kc (6 db down).
Image Ratio	1400 kc, 50 db. 600 kc, 75 db.
Harmonic Distortion	Less than 1%.
Hum And Noise	35 db below 30% modulation (1000 kc with 100 μv in).
IF Rejection Ratio	1400 kc, 42 db. 600 kc, 38 db.
10 KC Rejection	40 db.

GENERAL

Tube Complement	5 - 6AU6 2 - 6BA6 1 - 6BS8 or 6BZ7 1 - 6AB4 2 - 12AT7 1 - 6AL5 1 - 6BE6 2 - 12AU7 1 - 12BH7
Front Panel Controls	POWER switch, AFC control. FM STEREO PHASE AM FIDELITY switch, FM SQUELCH control. MODE SELECTOR. AM TUNING. FM TUNING. Individual AM and FM TUNING METERS.
Power Supply	Transformer-operated, silicon rectifiers.
Power Requirements	117 V, 50/60 cps, 100 watts.
Dimensions -	
Overall	5-1/4" high x 15-1/2" wide x 14-1/4" deep.
Panel Mounting	Cutout 4-1/4" x 14-1/2"; depth 12-7/8".
Net Weight	18-1/2 lbs.
Shipping Weight	22 lbs.

INTRODUCTION

As compared to many quality tuners available on the high fidelity market, your AJ-41 Tuner has many interesting features, some of which are quite unique. The Tuner will receive monophonic AM or FM, or stereo FM. Individual meters monitor AM and FM tuning, a neon lamp is incorporated to indicate when a FM stereo signal is received. Another feature is a FM squelch circuit, which eliminates between-station noise when tuning across the FM band. Cathode follower output stages provide low line impedance, to avoid hum and high frequency losses in the interconnecting audio cables. With a FM stereo output, the cathode followers perform separately as left and right channel output stages; on monophonic AM or FM, the two output stages are tied together and supply the same information to both the left and right channel amplifiers of a stereo system.

Heavy die-cast flywheels are used on the tuning controls to give smooth tuning action. A "unitized" chassis design provides for rigidity and ease of kit assembly. The sections of the tuner are built up separately before being incorporated into the final assembly.

Control versatility is essential to good performance from a high quality tuner. All controls are arranged to offer maximum versatility without an excessive number of knobs.

The Separation control, the Meter Adjust controls, and the Output Level controls are on the rear apron of the chassis. AM and FM TUNING controls, the POWER switch, AM FIDELITY, FM-AFC, MODE SELECTOR, SQUELCH and FM STEREO PHASE controls are on the front panel.

Completely separate circuits are used for the AM and FM portions of the Tuner to avoid compromising performance. The multiplex circuit is used only in the STEREO position of the MODE SELECTOR switch. Silicon diode rectifiers are used in the power supply because of their long life, dependability, and the fact that essentially no heat is generated in this type of rectifier. A choke is used in conjunction with the silicon rectifiers to improve regulation and to minimize hum. The heavy duty, electrostatically-shielded power transformer isolates the circuitry from the power line.

CIRCUIT DESCRIPTION

NOTE: A fold-out schematic is provided and may be used when following the Circuit Description. Also, to help you locate parts on the Schematic, the letter-number designations for the parts are coded as follows:

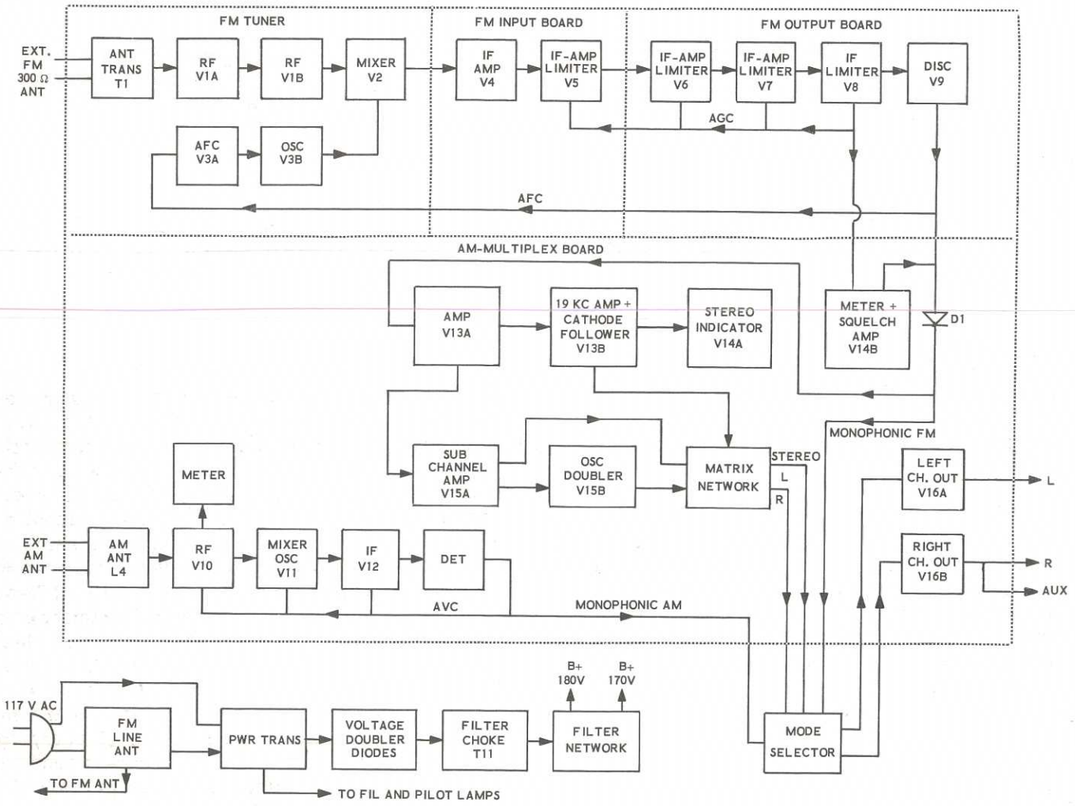
#1 to 99 - Chassis parts and FM front end.
#100 to 199 - FM input circuit board.
#200 to 299 - FM output circuit board.
#300 to 399 - AM-Multiplex circuit board.

For example: Resistor R6 is in the FM front end; capacitor C109 is on the FM input circuit board; resistor R211 is on the FM output circuit board; etc.

The simplified Figures in the Circuit Description will help you to understand how the individual sections of the Tuner work.

FM TUNER

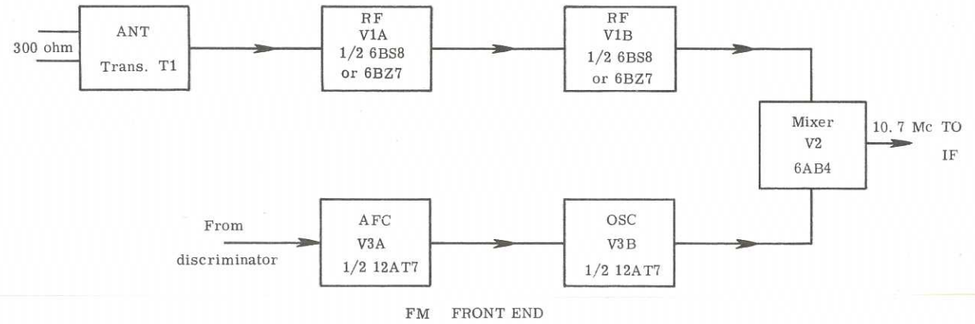
Basically, the FM tuner consists of a cascode RF (Radio Frequency) amplifier, a triode mixer, a separate double triode which performs the functions of oscillator and reactance tube for AFC, an IF and limiter system, a dual diode wideband discriminator, a tuning meter circuit, and a cathode follower output.



BLOCK DIAGRAM

FM RF signal is coupled to the antenna input transformer T1 from an outside antenna or the built-in line antenna. See Figure 1. The input, or primary winding of T1 is center tapped to ground to reduce noise in the input circuits. Signal from the output winding, or secondary, is connected to the input grid of the cascode RF amplifier and to a tuning capacitor. A coil and capacitor will create a resonant circuit when connected together in this fashion. This is desirable because more voltage output is available at the resonant frequency and the circuit tends to reduce sensitivity to unwanted signals that are above or below the tuned resonant frequency. Another reason for the use of a transformer in this circuit is that a good impedance match can be obtained between the antenna and the tube, keeping antenna efficiency high.

Signal from the antenna transformer is amplified in the first triode of tube V1, and is coupled from the plate and its associated load RFC1 (Radio Frequency Choke), through capacitor C6, to the cathode of the second triode section of V1. This half of the tube is operated as a "grounded-grid" amplifier, since the control grid is connected directly to ground and signal is applied to the cathode and its load, RFC2. A grounded-grid amplifier operates in the same fashion as a conventional amplifier, for the signal voltage to be amplified appears between cathode and grid; it does not matter which element has signal applied to it. The main advantage of grounded-grid operation is a substantially better signal-to-noise ratio. Output from this stage is developed across plate load R2 and is coupled through capacitor C8 to the grid circuit of the mixer, V2. Connection of a



FM FRONT END

Figure 1

dual triode in the fashion just described is known as a "cascode" type RF amplifier, which is noted for high gain with low noise at high frequencies.

A tuned circuit is used in the grid circuit of mixer tube V2, to further increase selectivity and gain. It consists of L1 (L stands for inductor or choke) and C1B, which is the second section of the FM tuning capacitor. Energy from the tuned circuit is amplified by V2 and coupled to the first IF (Intermediate Frequency) transformer, T2. Transformer T2 will be discussed in greater detail later.

Both the conversion oscillator and the AFC (Automatic Frequency Control) reactance circuit are contained in tube V3 and its associated components. The oscillator is a tickler feedback type made up of the second half of V3, oscillator coil L2, resistance R8, capacitors C17, C18 and tuning section C1C. C1C and the grid section of L2 are the main components in the tuned circuit which is the primary frequency determining part of the oscillator. Any energy in this circuit is coupled to the grid of V3 through capacitor C17 and across resistor R8, which acts as a grid return.

Energy in the grid circuit will be amplified by the tube and coupled to the plate portion of the oscillator coil in such a manner that positive feedback, or regeneration, exists.

Positive feedback will add to the energy in the grid tuned circuit and thus sustain oscillation at the frequency determined by the inductance and capacitance in the grid circuit. Output from the oscillator is coupled to the cathode of the mixer, V2, through capacitors C11 and C12.

As previously mentioned, RF signal from the cascode amplifier is coupled to the grid of mixer tube V2, and is amplified. Also, the oscillator output is fed to the cathode of the same tube and is amplified in similar fashion. Since the oscillator and RF signals are both present in V2, they mix in such a manner that the sum and difference of the two frequencies are present at the output of the triode, as well as the RF and oscillator signal. The oscillator frequency is selected so it is always 10.7 mc (Megacycles) higher than the frequency of the RF signal. Therefore, the difference will always be 10.7 mc. It is to this frequency that the IF transformers are tuned. This function of changing frequencies is known as the Superheterodyne Principle. Improved selectivity and gain are obtained due to the fixed tuned IF transformers, which are designed to give optimum performance at one frequency only. Another advantage of the IF transformer is that primary-to-secondary coupling can be closely controlled due to single frequency operation, thus making it possible to control the IF signal bandwidth to any reasonable desired amount.

Automatic frequency control action is derived in the first half of tube V3, which is connected as a reactance tube. Essentially, this triode is connected as a DC amplifier with the grid connected through multiple decoupling (R217, R218, R5, C13 and C215 connected in a low-pass filter configuration to remove all audio from the discriminator DC output) to the FM discriminator output. When the tuner is properly tuned to a FM station, the DC (Direct Current) component at the discriminator will be 0 volts. As the tuner is detuned in either direction, the DC voltage will vary proportionally plus or minus in respect to ground, depending on which

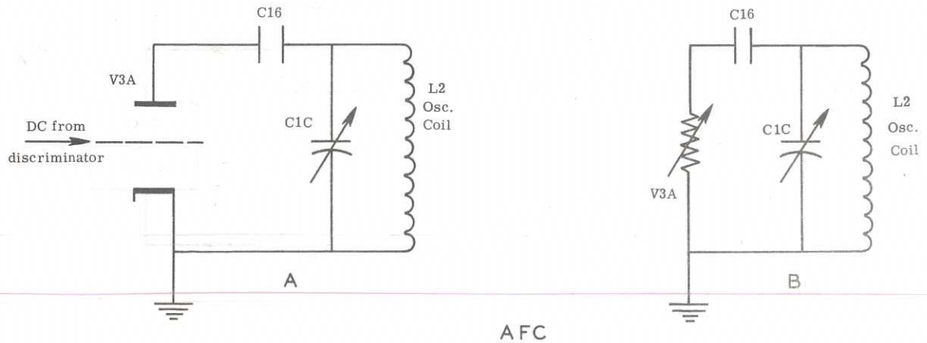


Figure 2

way the tuning is changed. See Figure 2A. Varying DC voltage at the grid of V3 will cause the plate current to change substantially, which in turn causes the plate resistance of the tube to change.

With negative grid voltage, plate current decreases and plate impedance or resistance increases; the converse occurs when the grid voltage goes in the positive direction. This tube can be regarded as a remote controlled variable resistor when looking at the tube from plate to ground. Note that the plate is connected through a small capacitor, C16, to the plate of the oscillator triode, the other half of V3. The oscillator "sees" the reactance tube circuit as a capacitor and variable resistance in series from the oscillator plate to ground. See Figure 2B.

When a negative voltage is applied to the reactance tube, the plate impedance becomes very high and could be regarded as an open circuit in series with capacitor C16, thus removing C16 from the circuit. In the opposite extreme, plus voltage on the reactance tube grid will cause plate impedance to be quite low, and this could be interpreted as a short circuit in series with capacitor C16, placing this capacitor from the oscillator plate almost directly to ground. Thus it is evident that the effective value of C16 in relation to the oscillator plate circuit can be varied continuously. Varying capacity in the oscillator plate circuit will be reflected to the grid tuning circuit, making it possible to change oscillator frequency by varying DC voltage on the grid of the control tube. Any tendency for the tuner to drift off of proper tuning on a given station will be reflected as a change in the DC output from the FM discriminator. Connections are made to the discriminator and reactance tube in such a manner that the oscillator will be tuned in the direction that will compensate for the tuner drift. AFC action also aids tuning, since a station will be "pulled in" as soon as any signal appears at the discriminator. AFC can be defeated by shorting out the control voltage with AFC control R11.

All parts discussed up to this point (except the discriminator, T2, R217, R218, C215 and R11 are contained in the prewired and prealigned FM front end. Although this front end could have been furnished in kit form, it is not good practice to do so in a unit as critical to alignment and components as this is. Inclusion of a precision aligned front end eliminates the need for high cost equipment for alignment, since it becomes the alignment standard for the remainder of the circuit.

Going back to the first IF transformer, T2, the difference frequency from the mixer V2 is passed by the transformer, while all other signals present at the plate of V2 are rejected. Output from the transformer is connected to the control grid of the first IF amplifier pentode, V4, and is amplified by the tube, then coupled to the second IF transformer, T3. Any residual unwanted signal that might remain is eliminated by this transformer and the desired 10.7 mc IF signal is passed on to the grid of the next stage, V5. Essentially tbe same thing happens in T4, V6, T5, V7, L3 and V8, which is primarily a limiter. Note that the circuits from V4, V5 and V6 are

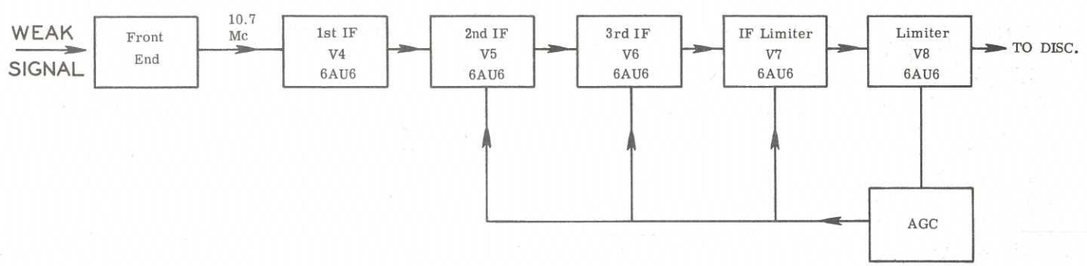


Figure 3

exactly the same except for some minor variations in component values. Parameters for V7 and V8 are somewhat different, for V7 will usually be operating as a limiter and V8 will always be limiting when any signal is tuned in. V7 operates as a plate limiter because the plate and screen voltages are supplied through a common high value load resistor, R207, which keeps the tube operating voltage very low. A tube with low voltage cannot handle high level signals and will therefore clip or limit very readily. V8 operates as a grid and plate limiter, because the grid and cathode circuit are connected as a diode, or rectifying circuit, which will not pass positive going signal but will let the negative portion of the signal pass undistorted to be amplified by the tube and coupled to the discriminator transformer, T6.

With a very weak incoming signal, only stage V8 will be limiting; all other stages will operate as IF amplifiers with a stage gain of approximately 10 per stage. See Figure 3. As signal level becomes stronger, V7 soon becomes unable to handle the level and plate clipping starts, causing the gain to drop off toward unity or 1. This gain dropoff will tend to hold the signal level constant at V8, thus avoiding overdriving and possible "paralyzation" of the circuit. Further increase in input signal level will cause the grid circuit of V6 to overdrive and go into limiting and so cause the gain of this stage to drop toward unity. With very strong signals, the same thing happens at V5. Because of this "consecutive-limiting" design feature, gain is highest when needed for pulling in weak FM stations, but it is very low when tuned to strong local stations, avoiding overloading and distortion. See Figure 4. Consecutive limiting combined with effective AGC, which will be discussed in subsequent paragraphs, minimizes audio output variations when tuning from weak to strong stations and reduces undesirable responses to "airplane flutter" and signal fading.

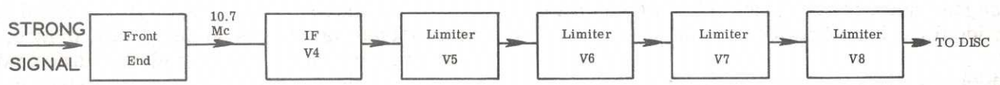


Figure 4

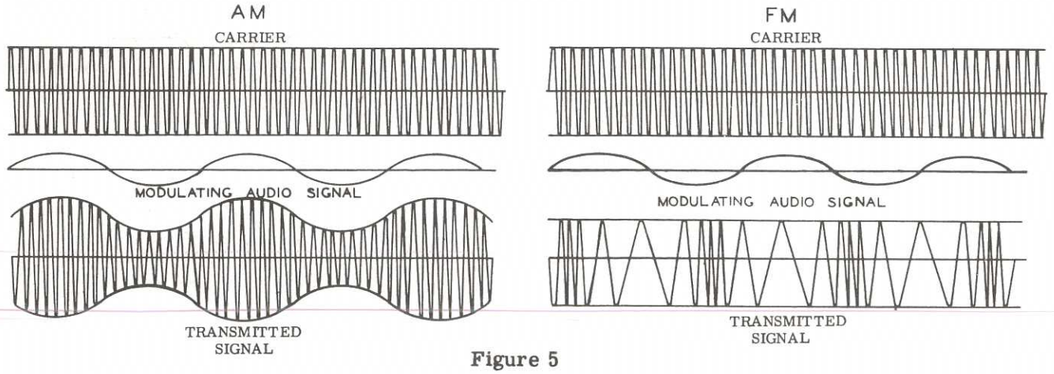


Figure 5

Detection of a FM signal involves a different principle than that used for AM demodulation, due to the different nature of the transmitted signal. Amplitude modulation, AM, refers to a constant frequency RF signal (carrier) whose amplitude is varied (modulated) in accordance with the intelligence being transmitted. For frequency modulation, FM, the carrier amplitude is held constant and the instantaneous carrier frequency is varied above and below the unmodulated carrier frequency at a rate determined by the intelligence being transmitted. See Figure 5.

Thus it is apparent that any amplitude variations on a FM signal contribute nothing to the detected audio and so amplitude variations can be clipped off in the IF or limiter stages. Random noise, ignition pulses from gasoline engines, electric motors, and static from electrical storms are all forms of amplitude modulation which come through an AM receiver as interference. These are eliminated or substantially reduced in a FM receiver, due to its AM suppressing action. Hence, the quiet performance of FM which makes it so ideal for high fidelity listening.

A wideband discriminator is used to demodulate the FM signal in this Tuner. The circuit is made up of discriminator transformer T6, dual diode V9, C211, C216, R215 and R216. A discriminator is essentially a phase detector whose operation relies on the 90 degree phase shift that exists between the primary and secondary of a transformer at resonance. The output winding of the transformer is connected to the two plates of the diode and to the "hot" end of the input winding through capacitor C211, which is connected to a center tap on the output winding.

C211 serves to hold the center of the output winding at a fixed reference in respect to the primary while blocking the DC plate voltage on V8 from the detector circuit. In the diode cathode circuit, one cathode is connected to ground and the other to C354 and the diode load balancing network (R215 and R216). Capacitor C216 is connected across the cathodes as an RF bypass and also reduces the effect of capacitive unbalance in the circuit.

If the discriminator circuit is redrawn as in Figure 6, it can be seen that it is a type of bridge balancing circuit, with R215, R216 and both halves of V9 as arms of the bridge. At resonance (proper receiver tuning with no modulation), 90 degrees of phase shift exists in T6 and the currents in both halves of V9 are the

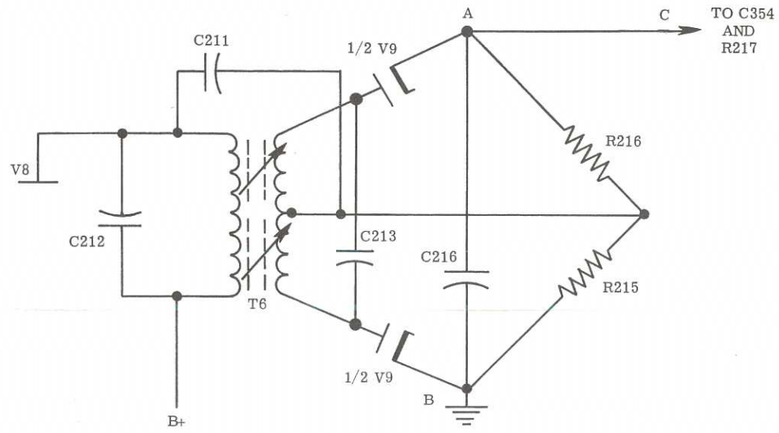


Figure 6

same. R215 and R216 are the diode loads for V9. The junction of these resistors is connected back to the transformer center tap so that with equal diode current, the voltage drop across the resistors is equal and in opposite directions. The resultant output voltage from point "A" to "B" is 0 volts. In this case, the bridge is in balance or null. When the bridge is unbalanced by a shift of frequency from resonance, the currents become unbalanced due to a change in phase shift in T6 and a difference in voltage drop will exist across R216 and R215. The difference voltage becomes the discriminator output. Carrier deviation in one direction will cause a positive voltage difference and deviation in the opposite direction will cause a negative difference, or bridge unbalance. Very slow changes of frequency will cause a DC shift in discriminator output at "C" and this voltage is used for AFC. Fast changes are regarded as audio output which is passed through C354, D1 and C355 to the de-emphasis network R341 and C356.

R341 and C356 act both as a de-emphasis network and RF filter to keep IF energy out of the audio system. De-emphasis is required to restore the audio to a "flat" response since high frequency pre-emphasis is used at the transmitter. This is done to improve signal-to-noise ratio at the receiver. De-emphasis at the receiver attenuates high audio frequencies at the same rate as they were pre-emphasized at the transmitter, and the resulting response is "flat." The same principle is used in the modern RIAA equalized LP record. Most noise picked up by, and generated in, the receiver falls in the high audio frequency range and this noise is attenuated by the de-emphasis network at the same time the audio is flattened out.

Audio and control signal for multiplex operation is taken out ahead of the de-emphasis network since all information needed for multiplex operation is of high frequency nature.

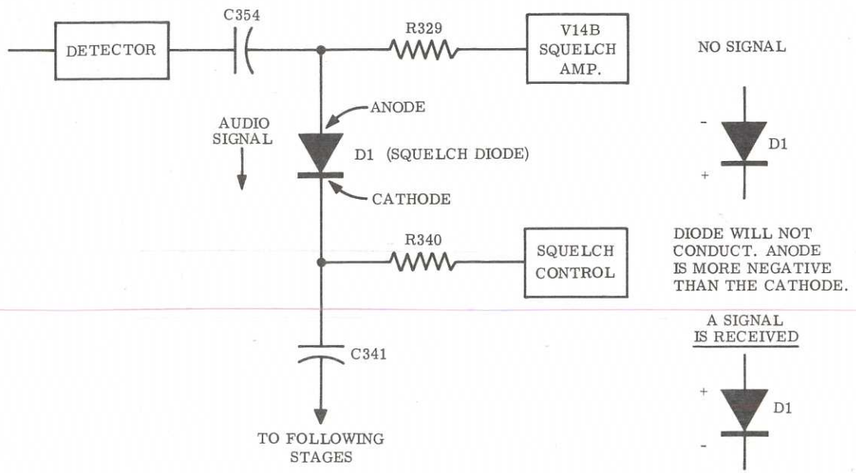


Figure 7

The audio signal from detector V9 is coupled through capacitor C354 to the anode of squelch diode D1; the signal must pass through this diode to get to the following stages. See Figure 7. Squelch diode D1 acts as a switch. The opening and closing of the switch is determined by the polarity of the DC voltage across the diode. The DC voltages across the diode are determined by the plate voltage of tube V14B (meter and squelch amplifier) and by the setting of the SQUELCH control.

The cathode of diode D1 connects through resistor R340 to the SQUELCH control. Resistor R12, SQUELCH control R13, and resistor R14 form a voltage divider between B+ and ground.

The anode of diode D1 is connected through R329 to the plate of tube V14B. AGC voltage from the last limiter tube, V8, is coupled through resistor R326 to the grid of tube V14B.

During no-signal operation, the anode of D1 is held more negative than the cathode. The amount of this voltage can be varied by the SQUELCH control. This prevents the diode from conducting and the noise signals cannot pass on to the following stages.

When a signal is received, the AGC voltage applied to the grid of tube V14B causes the tube to draw less current and thus the plate voltage becomes more positive. Because this voltage is applied through R329 to the anode of D1, the anode will now become more positive than the cathode, allowing the diode to conduct.

The SQUELCH control setting may be varied from the fully counterclockwise position, in which case diode D1 is always conducting, to the fully clockwise position, in which case a very strong signal will be required to make D1 conduct.

The FM tuning meter is also actuated by tube V14B. This tube is operated as a DC amplifier with the meter acting as part of its plate load. When a signal is received, the AGC voltages applied to the grid causes the tube to draw less current and the meter deflects to the right a corresponding amount. Under no-signal conditions, the AGC voltage causes the tube to draw more current and the meter deflects to the left.

On monophonic FM, the audio signal is taken from the de-emphasis network R341 and C356 through the MODE switch, to the grid of V16A and V16B, the cathode follower output stages.

FM STEREO CONVERTER

The converter circuit makes it possible to receive stereo broadcasts. FM stations broadcasting stereo, transmit a complex signal which a monophonic FM tuner will receive as a standard monophonic program. See Figure 8. However, a stereo FM tuner will receive this complex signal and separate it into its original counterparts, left and right channel stereo. Since FM transmitters are capable of broadcasting a complex signal, a subcarrier is used for the multiplex part of the signal.

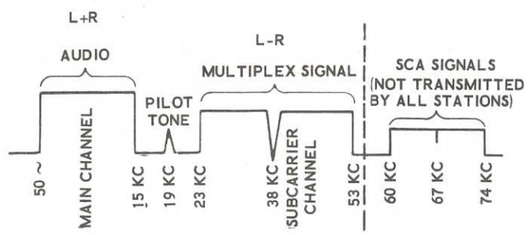


Figure 8

So that the two channels can be identified during this description, the left channel will be represented as a sine wave and the right as a spike.

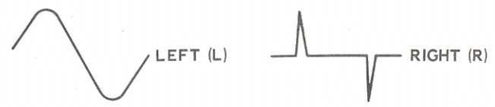


Figure 9

See Figure 9. These waveforms are for illustration purposes only and are not likely to be transmitted. If these two signals were added together (L + R) and the instantaneous sum of their voltage plotted, they would appear as shown in Figure 10A. If the two signals were combined in such a way that the R signal were subtracted from the L signal (L - R), the instantaneous difference in the voltage would be represented as in Figure 10B. The difference part of the signal (L - R) is transmitted on a 38 kc subcarrier. A pilot signal of 19 kc is also broadcast by the transmitter and will be represented as shown in Figure 10C.

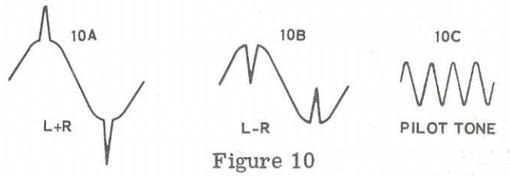
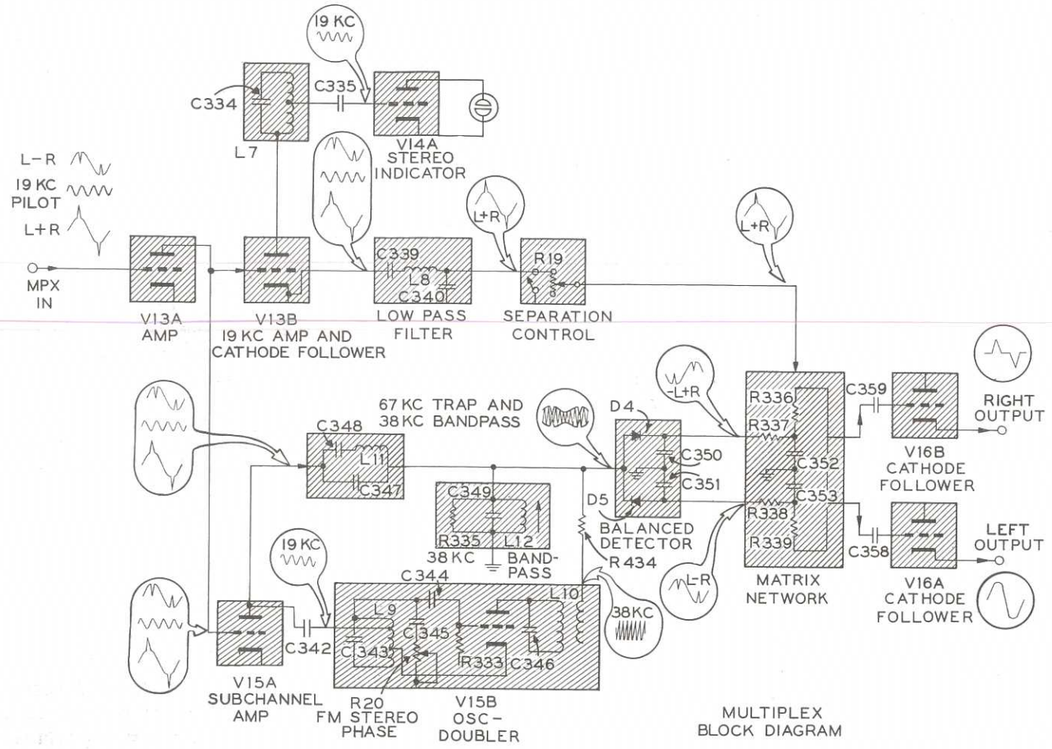


Figure 10

A Block Diagram of the Multiplex Circuit is furnished with some components shown on it for clarification. The Circuit Description may be followed best by using the Block Diagram in conjunction with the Schematic.



MULTIPLEX
BLOCK DIAGRAM

The signal for stereo operation is coupled through C355 to the grid of V13A. Basically, this signal consists of the L+R main channel, L-R subchannel, and the 19 kc pilot signal. These signals are then amplified by tube V13A.

Tube V13B acts as an impedance matching stage between V13A and the low-pass filter, consisting of coil L8 and capacitor C340, which passes only the L+R signal. This signal can then be adjusted to the proper level by the SEPARATION control for insertion into the matrix network. The switch across the SEPARATION control is used to turn the L+R (main channel) signal off when adjusting the 19 kc oscillator frequency and phase.

The output of V13A is also applied to the grid of tube V15A, which is the subchannel amplifier. The L-R signal is coupled from the plate of tube V15A through the 67 kc ("SCA")filter, consisting of C347, C348, and L11 to the tuned circuit formed by C349 and L12.

"SCA" (Subsidiary Communications Authorization) is a commercial music channel, transmitted on the same FM carrier as the stereo program. See Figure 8.

The output from V15A is also fed through C342 to the 19 kc tuned circuit, L9 and C343, of oscillator-doubler stage V15B. This tuned circuit accepts only the 19 kc pilot signal, which locks the oscillator to this frequency. Tuned circuit L10 and C346 in the plate of V15B doubles the 19 kc oscillator signal, providing a 38 kc carrier signal. Capacitor C345 and control R20 across the 19 kc tuned circuit provide a fine adjustment of the frequency and enables the phase of the 38 kc carrier to be accurately set for reinsertion with the L-R subchannel information.

The 38 kc carrier is then coupled from the secondary of L10 through R334 to the tuned circuit consisting of C349 and L12. Thus, the 38 kc carrier is reinserted with the L-R subchannel signal across this tuned circuit.

The resulting composite signal is then demodulated by balanced diode detectors D4 and D5. Since diodes D4 and D5 are connected in opposite directions in the balanced detector circuit, a demodulated L-R signal will appear across C351 and -L+R signal across C350.

R336, R337, and C352 form a matrix and de-emphasis network for the right channel; R338, R339 and C353 are the counterparts for the left channel. The matrix network is used to recombine the L - R and -L+R signals with the L+R signal as follows:

If we add L+R to L-R, as shown in Figure 11A, the instantaneous sum will be 2L. The spikes, or R portion of the waves, cancel out each other, while the rest of the waves, or L portion, re-enforce each other to reproduce the original left channel sine wave. This left channel signal is connected from the output of the matrix through the MODE switch to the grid of V16A, the left channel cathode follower output tube.

If L+R is added to -L+R, as shown in Figure 11B, the result will be 2R. The sine waves, or L portion of the waves, will now cancel each other, and the instantaneous sum of the (R) spikes will produce 2R. The output of this side of the matrix network is applied through the MODE switch to the grid of V16B, the right channel cathode follower output tube.

V13B has a tuned plate circuit which is tuned to the 19 kc pilot signal frequency. C335 couples this signal to the grid of stereo indicator amplifier V14A. Thus, when a stereo FM station is tuned in, the pilot signal is amplified and the indicator will light with a steady glow. In some instances the indicator may momentarily flicker on noise when tuning. Also some monaural stations use a "Commercial Killer" which may cause the indicator to light during the commercial. The converter circuit is used only when the MODE switch is in the STEREO position.

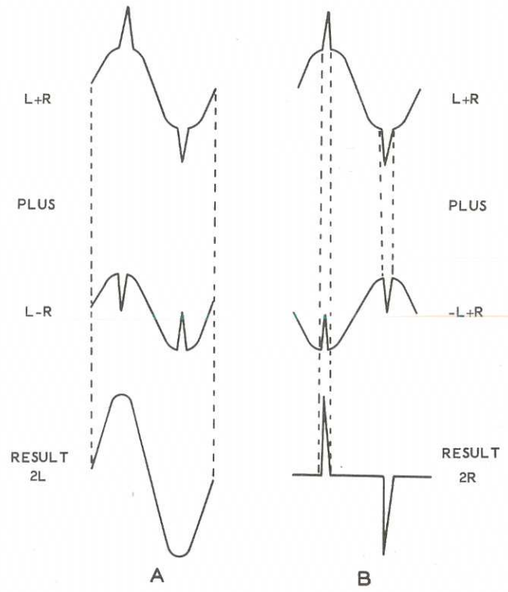


Figure 11

AM TUNER

The AM tuner is similar to the FM tuner in principle, although the frequencies involved are much lower and the signal handling requirements are different. It consists of a tuned RF amplifier stage, a combination oscillator-mixer, an IF stage featuring a FIDELITY switch, a voltage doubler detector, a whistle filter, and a tuning meter. See Figure 12.

The received signal is picked up in the ferrite rod and coupled into the secondary winding of AM antenna L4. An external antenna can be connected to the primary coil of L4, which will increase the incoming signal strength. The secondary winding of the antenna L4 and the first section of variable capacitor C301A combine to form a tuned circuit for RF amplifier V10. A

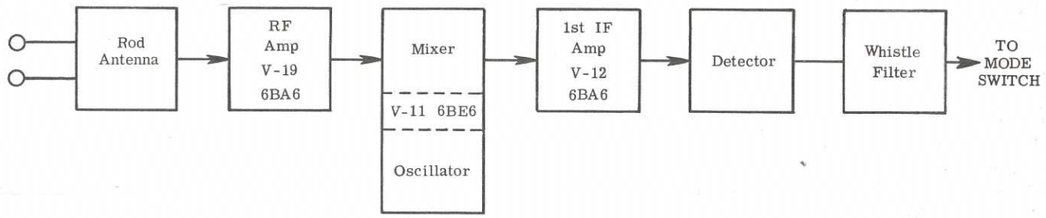


Figure 12

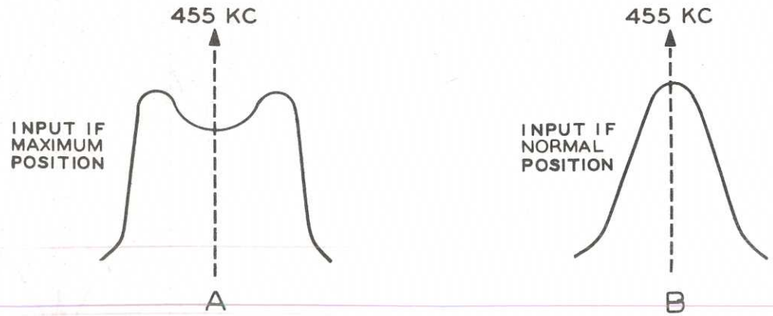


Figure 13

tuned RF amplifier is used to increase overall gain, and improve receiver selectivity. The amplified RF signal from V10 is coupled to the grid circuit of mixer tube V11 and tuned by the last section of the AM tuning capacitor C301B to further increase the gain and selectivity. V11 has two functions and is referred to as a "pentagrid" converter because of its five grids. The first grid and cathode along with oscillator coil L5, and the middle section of the AM tuning capacitor C301C are the main components of the local oscillator, operating at a frequency of 455 kc above the incoming signal. A tuned circuit is connected between the first grid and ground, with the cathode connected to the tap on the oscillator coil, thus providing feedback to maintain oscillation. The upper grids and the plate of the tube function as a mixer amplifier. Present at the plate of the tube are the desired RF and oscillator fundamental frequencies as well as the sum and difference of these frequencies. All of these are passed to the primary winding of input IF transformer T8. The IF transformers of the AM tuner are resonant at the difference frequency, 455 kc. This difference frequency is coupled through T8 to the grid of the IF amplifier V12.

Generally an AM station is permitted to transmit a signal with an audio range of 10 kc. However, in some areas where different stations are not broadcasting on adjacent channels, a station may transmit an audio range of 15 kc, which is considered high fidelity AM.

The AM portion of the Tuner is designed to receive both the standard and high fidelity signals. T8 has a special winding which is connected to the AM FIDELITY switch with a MAXIMUM and a NORMAL position. See Figure 13.

With a high fidelity, or a strong local station, tuned in the AM FIDELITY switch can be placed in the BROAD position, if some distortion or adjacent channel interference is encountered, the switch should be placed in the NORMAL position. The AM FIDELITY switch changes the third coil of T8 so it adds to, or subtracts from, the coupling in the coil.

The amplified 455 kc IF signal from the plate of V12 is coupled through transformer T9 to the detector stage, which consists of secondary winding of T9, diodes D2, and D3, capacitors C325, C326, C327, C328, and resistors R315 and R316, which are arranged as a full-wave voltage-doubler detector circuit. See Figure 14.

Diode D3 conducts when the top of the secondary winding of T9 swings positive with respect to the bottom, placing a negative charge to the top of capacitor C326 with respect to ground. D2 is an open circuit to current flow during this time and does nothing. When the top of the winding swings negative with respect to the bottom, D2 conducts, placing a negative charge to the top of capacitor C325, with respect to ground. D3 is an open circuit to current flow and does nothing. Capacitor C325 and C326 being connected in series, adds the two voltages and applies the sum of these voltages across the detector load resistor R316. Capacitors C327, C328, and resistor R315, constitute a filter network to ground for the IF carrier with little attenuation to the low frequency audio signal.

The DC voltage appearing across R316 is directly proportional to the strength of the incoming signal. This negative DC voltage is applied through R317 to the control grid of each of the preceding tubes in the form of an

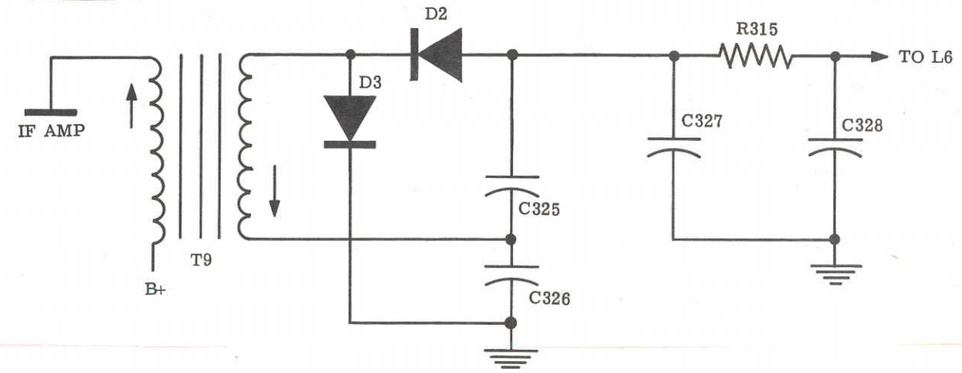


Figure 14

AVC (Automatic Volume Control) and functions as did the AGC of the FM tuner, to maintain a constant audio output level regardless of input signal level. See Figure 15. Capacitor C331 acts to keep the audio signal off the AVC line. Resistors R301, R304, R311, and capacitors C302, C309, and C319 provide additional decoupling.

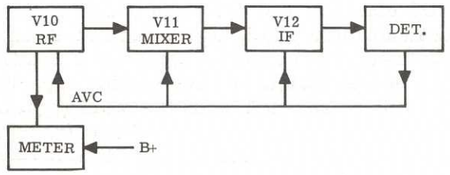


Figure 15

The AM meter circuit is basically a balanced bridge circuit. See Figure 16. The meter is connected between the screen of V10 and the arm of the control. Under no-signal condition, the screen of V10 draws current through resistors R303, R16, R17, and the meter. In this condition, the meter control is adjusted, so that the bridge is unbalanced and the meter indicates no signal (left side). When a signal is tuned in, AVC is applied to the grid of tube V10 causing the screen to draw less current thereby approaching balance of the bridge and allowing the meter to deflect to the right. AM stations are tuned for maximum deflection of the meter.

Coil L6, capacitor C329, and resistor R316 constitute a narrowband rejection filter (whistle filter), which eliminates the 10 kc beat signal between two adjacent broadcast signals; this beat is normally present in wideband AM tuners.

With the MODE switch in the AM position, the B+ supply voltage is cut off on the FM output and multiplex stages and the audio output from the AM tuner is connected to both cathode follower output stages, V16A and V16B.

The cathode follower output stages serve to lower the output impedance, which allows the use of long connecting cables to the amplifier without the loss of high audio frequencies. Coil L14 and capacitors C25 and C26 form a 38 kc filter and high frequency rolloff network in the Right channel output. Coil L13 and capacitors C22 and C23 form a similar network in the Left channel output. These networks enable stereo broadcasts to be tape recorded by eliminating the unwanted converter signals (38 kc, 57 kc, 76 kc, etc.) which could beat with the recorder erase head signals.

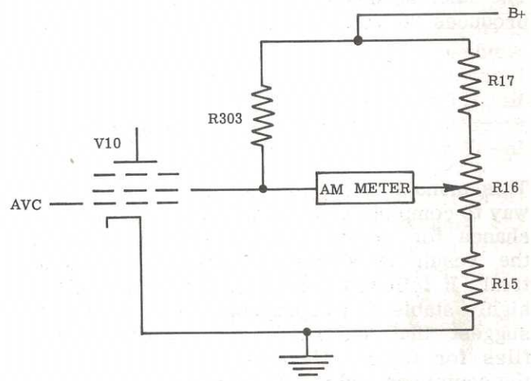


Figure 16

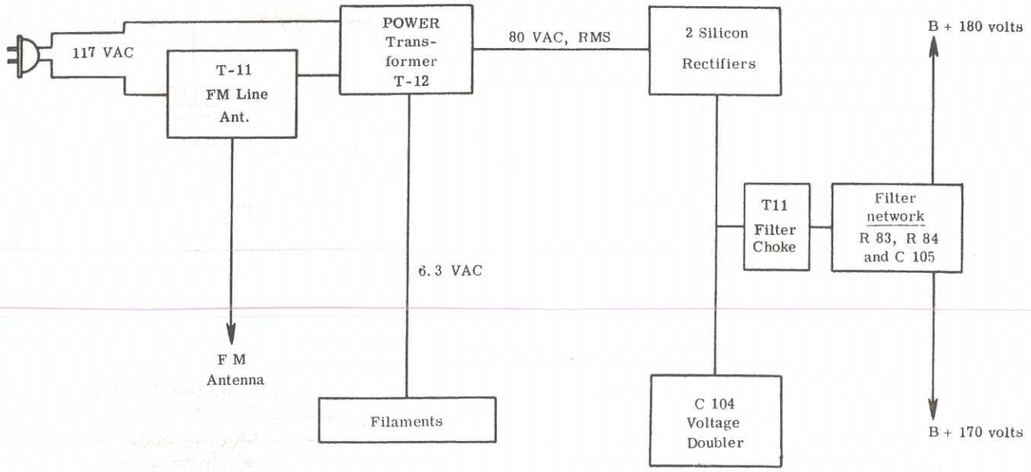


Figure 17

POWER SUPPLY

FM line antenna coil L15 is in series with the 117 V AC line to the primary winding of the power transformer. See Figure 17. When the output or secondary of this coil is connected to the FM antenna input terminals, it enables the FM signals picked up in the AC power lines to be coupled into the tuner. The 6.3 V AC secondary winding is used to power the filaments of all the tubes as well as the pilot lamps.

The other secondary winding of the transformer produces 80 volts AC to feed a full-wave voltage-doubler rectifier circuit. On the positive swing of the voltage from the bottom of this winding, D7 conducts and applies a positive charge across capacitor C28B. On the negative swing of the voltage, D6 conducts applying a positive charge across C28A. The two section capacitor being series connected, adds the two charges together, doubling the supply voltage from the transformer and applies to the filter network C29A, T11, C29B, R23, and C29C. Capacitor C29A, choke T11, and capacitor C29B remove the ripple energy remaining on the DC voltage after the rectification. Resistor R23 and capacitor C29C provide additional filtering and decoupling for the more sensitive stages.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be highly stable and dependable performance. We suggest that you retain the manual in your files for future reference, both in the use of the equipment and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacements section and supply the information called for therein. Include all inspection slips in your letter to us.

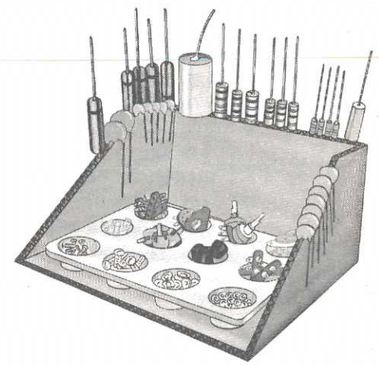
Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.

2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a penknife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

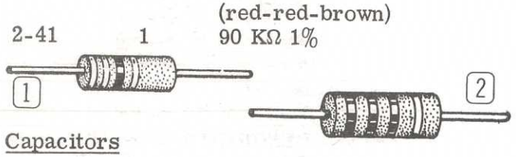


PARTS LIST

NOTE: The circled numbers in the Parts List are keyed to the circled numbers on the pictures of the parts to aid in parts identification.

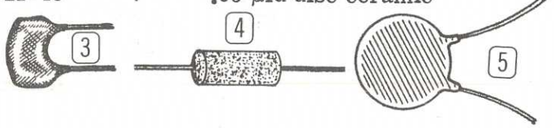
PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
① 1-3	2	100 Ω 1/2 watt (brown-black-brown)
1-66	2	150 Ω 1/2 watt (brown-green-brown)
1-42	4	270 Ω 1/2 watt (red-violet-brown)
1-48	2	390 Ω 1/2 watt (orange-white-brown)
1-8	2	820 Ω 1/2 watt (gray-red-brown)
1-9	3	1 KΩ 1/2 watt (brown-black-red)
1-11	2	1.5 KΩ 1/2 watt (brown-green-red)
1-44	3	2.2 KΩ 1/2 watt (red-red-red)
1-19	1	6.8 KΩ 1/2 watt (blue-gray-red)
1-20	1	10 KΩ 1/2 watt (brown-black-orange)
1-21	3	15 KΩ 1/2 watt (brown-green-orange)
1-22	3	22 KΩ 1/2 watt (red-red-orange)
1-23	1	27 KΩ 1/2 watt (red-violet-orange)
1-24	1	33 KΩ 1/2 watt (orange-orange-orange)
1-67	1	39 KΩ 1/2 watt (orange-white-orange)
1-25	4	47 KΩ 1/2 watt (yellow-violet-orange)
1-47	3	56 KΩ 1/2 watt (green-blue-orange)
1-50	4	68 KΩ 1/2 watt 5% (blue-gray-orange)
1-102	3	82 KΩ 1/2 watt (gray-red-orange)

PART No.	PARTS Per Kit	DESCRIPTION
Resistors (cont'd.)		
1-26	7	100 KΩ 1/2 watt (brown-black-yellow)
1-27	3	150 KΩ 1/2 watt (brown-green-yellow)
1-29	4	220 KΩ 1/2 watt (red-red-yellow)
1-31	3	330 KΩ 1/2 watt (orange-orange-yellow)
1-33	2	470 KΩ 1/2 watt (yellow-violet-yellow)
1-35	5	1 megohm 1/2 watt (brown-black-green)
1-36	2	1.5 megohm 1/2 watt (brown-green-green)
1-37	4	2.2 megohm 1/2 watt (red-red-green)
1-71	2	4.7 megohm 1/2 watt (yellow-violet-green)
1-120	1	12 megohm 1/2 watt (brown-red-blue)
[1] 1A-26	1	15 KΩ 1 watt (brown-green-orange)
[2] 1B-13	1	220 Ω 2 watt (red-red-brown)
2-41	1	90 KΩ 1%

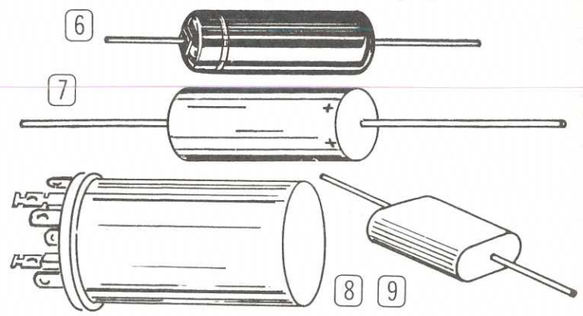


Capacitors

[3] 20-102	2	100 μμf mica
20-108	2	200 μμf mica
20-115	1	300 μμf mica
20-106	1	390 μμf mica
20-107	1	680 μμf mica
20-122	4	1000 μμf mica
20-132	1	10,000 μμf mica
[4] 21-28	1	10 μμf tubular ceramic N750
[5] 21-6	1	27 μμf disc ceramic
21-32	6	47 μμf disc ceramic N750
21-75	5	100 μμf disc ceramic
21-17	1	270 μμf disc ceramic
21-56	2	470 μμf disc ceramic
21-36	23	.002 μfd disc ceramic
21-26	2	.003 μfd disc ceramic
21-16	9	.01 μfd disc ceramic
21-31	3	.02 μfd disc ceramic
21-48	7	.05 μfd disc ceramic

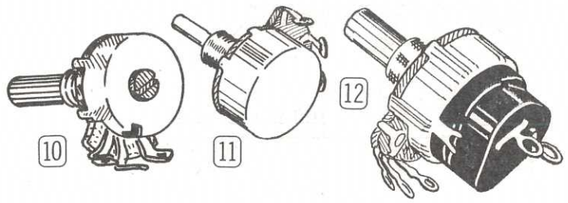


PART No.	PARTS Per Kit	DESCRIPTION
Capacitors (cont'd.)		
[6] 23-28	3	.1 μfd 200 V tubular molded
[7] 25-39	1	2 μfd tubular electrolytic
[8] 25-58	1	50-50 μfd electrolytic
25-70	1	100-40-40 μfd electrolytic
26-72	1	3-gang variable capacitor
[9] 27-25	2	.1 μfd 200 V mylar



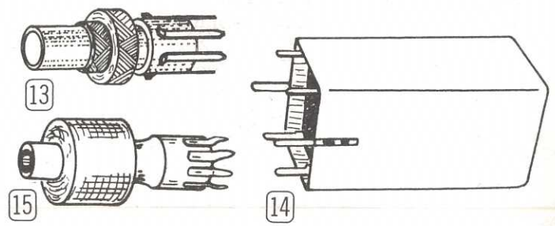
Controls-Switches

[10] 10-78	2	15 KΩ control
[11] 10-113	1	10 KΩ miniature control
10-121	2	100 KΩ miniature control
[12] 19-74	1	20 KΩ control w/switch
19-75	1	200 KΩ control w/switch
19-76	1	7.5 megohm control w/switch
63-302	1	3-position rotary switch

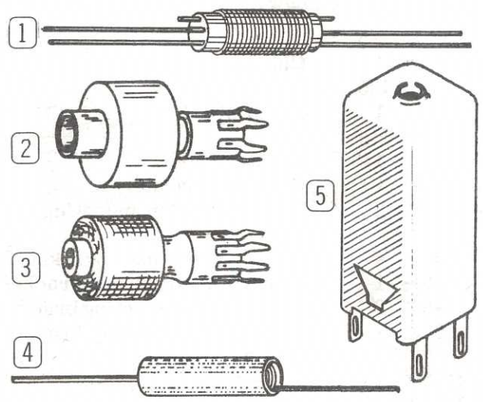


Coils-Chokes-Transformers

[13] 40-129	1	AM oscillator coil
[14] 40-132	1	AM mixer coil
[15] 40-133	1	Filter coil
40-134	1	10.7 mc impedance coupling coil

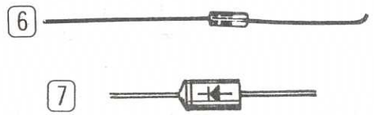


PART No.	PARTS Per Kit	DESCRIPTION
Coils-Chokes-Transformers (cont'd.)		
[1] 40-149	1	FM line antenna coil
40-447	1	AM rod antenna
[2] 40-448	1	19 kc oscillator coil
40-449	1	38 kc doubler coil
40-450	1	19 kc trap coil
40-451	1	38 kc trap coil
40-452	1	67 kc trap coil
[3] 40-453	1	Whistle filter coil
[4] 45-35	2	Filament choke
45-48	2	38 kc filter choke
46-32	1	Filter choke
[5] 52-18	1	AM input IF transformer
52-21	1	FM input IF transformer
52-22	2	FM interstage IF transformer
52-23	1	FM interstage IF limiter transformer
52-55	1	AM output IF transformer
53-3	1	FM discriminator transformer
54-126	1	Power transformer

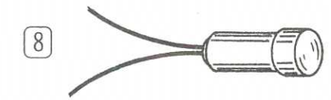


Diodes-Rectifiers-Tubes-Lamps-Fuse

[6] 56-4	2	Crystal diode (red-green-violet)
56-5	1	Silicon diode (red-red-blue)
56-11	2	Crystal diode (matched pair) (black-blue-black)

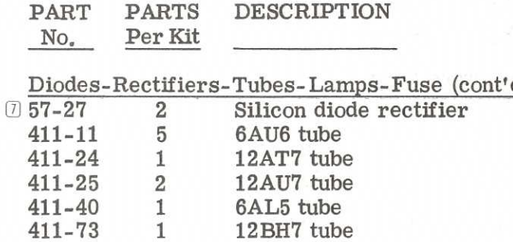


PART No.	PARTS Per Kit	DESCRIPTION
Diodes-Rectifiers-Tubes-Lamps-Fuse (cont'd.)		
[7] 57-27	2	Silicon diode rectifier
411-11	5	6AU6 tube
411-24	1	12AT7 tube
411-25	2	12AU7 tube
411-40	1	6AL5 tube
411-73	1	12BH7 tube
411-90	2	6BA6 tube
411-91	1	6BE6 tube
[8] 412-13	1	Neon lamp
412-20	4	Pilot lamp
421-1	1	1.5 ampere fuse

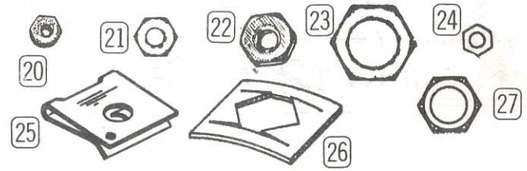


Hardware

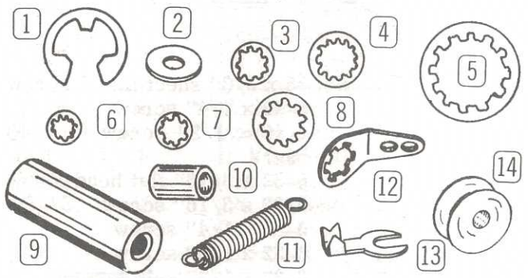
[9] 250-8	15	#6 x 3/8" sheet metal screw
[10] 250-49	32	3-48 x 1/4" screw
[11] 250-34	4	4-40 x 1/2" screw (in 4-40 bag)
[12] 250-70	2	6-32 x 3/16" flat head screw
[13] 250-138	10	6-32 x 3/16" screw
[14] 250-56	26	6-32 x 1/4" screw
[15] 250-89	13	6-32 x 3/8" screw
[16] 250-127	2	6-32 x 1/2" self-tapping screw
[17] 250-26	4	6-32 x 5/8" screw
[18] 250-100	4	6-32 x 5/16" setscrew
[19] 250-16	2	8-32 x 3/16" setscrew



[20] 252-1	32	3-48 nut
[21] 252-3	41	6-32 nut
[22] 252-4	4	8-32 nut
[23] 252-7	6	Large control nut
[24] 252-15	8	4-40 nut (in 4-40 bag)
[25] 252-22	2	6-32 speednut
[26] 252-32	1	Push-on speednut
[27] 252-39	3	Small control nut

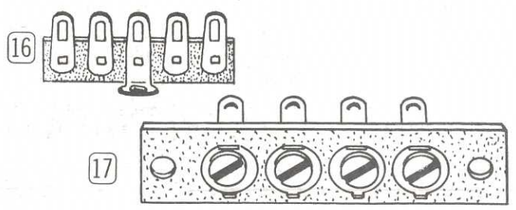


PART No.	PARTS Per Kit	DESCRIPTION
Hardware (cont'd.)		
[1] 253-11	4	E washer
[2] 253-27	2	1/16" thick spacer washer
[3] 254-1	59	#6 lockwasher
[4] 254-2	4	#8 lockwasher
[5] 254-4	2	Large control lockwasher
[6] 254-7	56	#3 lockwasher
[7] 254-9	8	#4 lockwasher (in 4-40 bag)
[8] 254-14	3	Small control lockwasher
[9] 255-11	2	1" tapped spacer
[10] 255-13	4	#6 x 1/4" spacer
[11] 258-1	2	Dial spring
[12] 259-1	2	#6 solder lug
[13] 259-11	2	Spade lug
[14] 466-7	4	Pulley

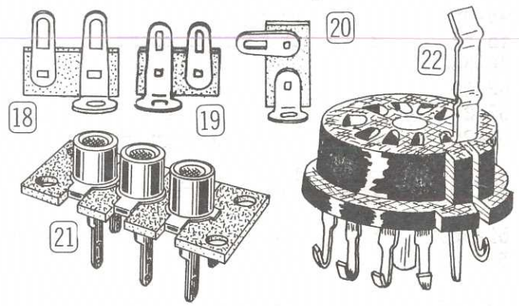


Wire-Sleeving-Insulators		
73-4	2	Rubber grommet
[15] 75-24	1	Line cord strain relief
89-1	1	Line cord
134-49	1	Cable harness
134-36	2	Shielded cable with plugs
344-1	1	Length red hookup wire
	1	Length green hookup wire
344-2	1	Length stranded hookup wire
346-1	1	Length sleeving

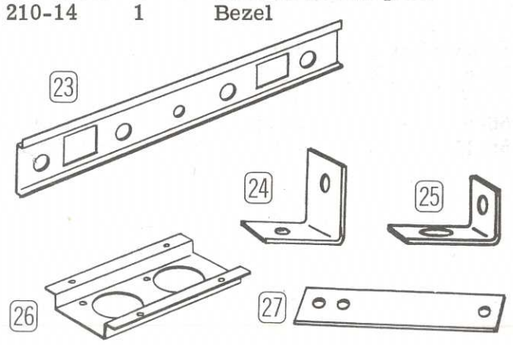
Terminal Strips-Sockets-Plugs		
423-1	1	Fuse holder
[16] 431-11	2	5-lug terminal strip



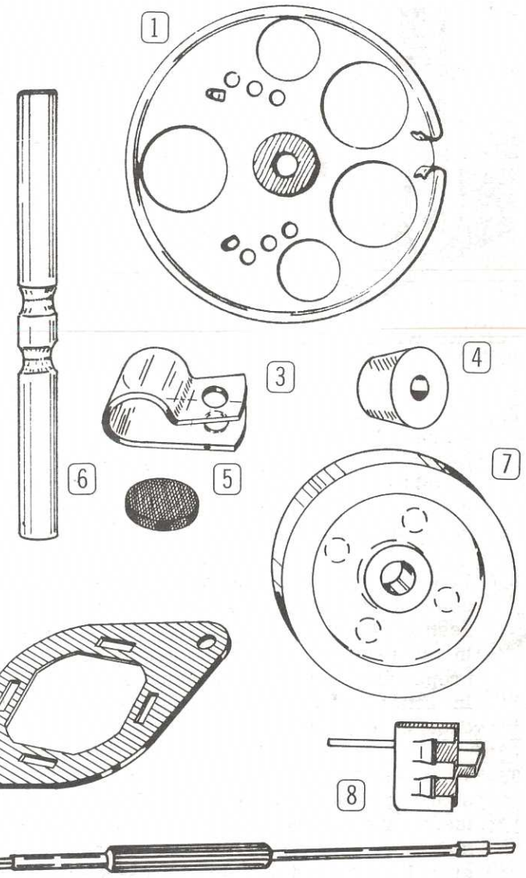
PART No.	PARTS Per Kit	DESCRIPTION
Terminal Strips-Sockets-Plugs (cont'd.)		
[17] 431-13	1	4-screw lug terminal strip
[18] 431-14	2	2-lug terminal strip
[19] 431-16	1	2-lug terminal strip
[20] 431-50	1	1-lug terminal strip
[21] 434-76	1	Triple phono socket
[22] 434-78	4	9-pin tube socket
434-80	9	7-pin tube socket
434-83	4	Pilot lamp socket



Metal Parts		
90-M161	1	Cabinet shell
200-M348F715	1	Chassis
203-M220F435	1	Front panel
203-M308F714	1	Control panel
[23] 203-M309	1	Control subpanel
[24] 204-M102	2	Terminal strip mounting bracket
[25] 204-135	4	Pulley mounting bracket
[26] 204-M181	1	Capacitor mounting bracket
[27] 204-M484	2	AM antenna mounting bracket
205-M263	1	Dial parts mounting bracket
205-M264F	1	Dial rail plate
205-M265	1	Chassis bottom plate
210-14	1	Bezel



PART No.	PARTS Per Kit	DESCRIPTION
Miscellaneous		
85-18F217	1	FM input circuit board
85-19F712	1	FM output circuit board
85-42F713	1	AM-Multiplex circuit board
[1] 100-M252	2	Drive pulley
100-M301	2	Dial cord
110-5	1	FM front end assembly
[2] 206-68	3	9-pin tube shield
206-77	9	7-pin tube shield
[3] 207-22	2	Plastic clamp
[4] 261-17	4	Plastic feet
[5] 263-7	1	Felt pad
391-17	1	Nameplate
407-77	2	Meter
[6] 453-103	2	Dial shaft
[7] 454-2	2	Flywheel
462-117	4	Pointer knob
462-120	2	Dial knob
462-154	1	Small knob
[8] 463-23	2	Dial pointer
[9] 481-1	2	Capacitor mounting wafer
[10] 490-1	1	Alignment tool
446-23F416	1	Dial window (plastic)
331-6		Solder
595-538	1	Manual



PROPER SOLDERING TECHNIQUES

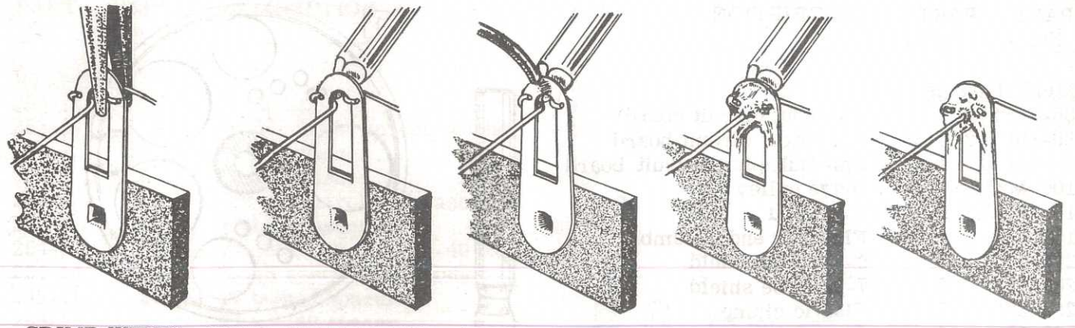
Only a small percentage of customers find it necessary to return equipment for factory service. By far the largest portion of malfunctions in this equipment are due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 30 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly. Keep the iron tip clean by wiping it from time to time with a cloth.

CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, all wire used is the type with colored insulation (hookup wire). In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the assembly step.



CRIMP WIRES | HEAT CONNECTION | APPLY SOLDER | ALLOW SOLDER TO FLOW | PROPER SOLDER CONNECTION

2. To avoid breaking internal connections when stripping insulation from the leads of transformers or similar components, care should be taken not to pull directly on the lead. Instead, hold the lead with pliers while it is being stripped.

3. Leads on resistors, capacitors, and similar components are generally much longer than need be to make the required connections. In these cases, the leads should be cut to proper length before the part is installed. In general, the leads should be just long enough to reach their terminating points.

4. Wherever there is a possibility of bare leads shorting to other parts or to the chassis, the leads should be covered with insulating sleeving. Where the use of sleeving is specifically intended, the phrase "use sleeving" is included in the associated assembly step. In any case where there is the possibility of an unintentional short circuit, sleeving should be used. Extra sleeving is provided for this purpose.

5. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the lead is too large to allow bending or if the step states that it is not to be crimped, position it so that a good solder connection can still be made.

6. Position the work, if possible, so that gravity will help to keep the solder where you want it.

7. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.

8. Then place the solder and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

9. Remove the solder and then the iron from the completed joint. Use care not to move the leads until the solder is solidified.

A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly. In some cases, it may be necessary to add a little more solder to achieve a smooth, bright appearance.

ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

CIRCUIT BOARD WIRING AND SOLDERING

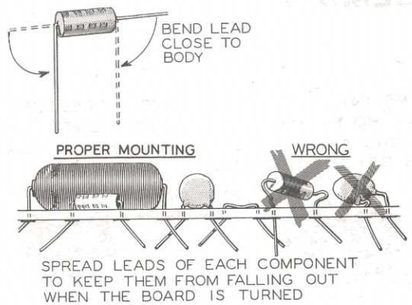
Before attempting any work on the circuit board, read the following instructions carefully and study the Figures. It is only necessary to observe the following basic precautions to insure proper operation of the unit the first time it is turned on.

Proper mounting of components on the board is essential for good performance. A good general rule to follow is that all components on the board should be mounted tightly to the board, unless instructions state otherwise. All leads should be kept as short as possible to minimize the effects of stray capacity in the wiring. Proper and improper methods of mounting are illustrated in the accompanying Figures.

NOTE: Exercise care not to damage resistors or capacitors when bending the leads as shown.

Tubular capacitors and resistors will fit properly if the leads are bent as shown. Disc capacitors will generally fit in place with no lead preparation other than determining that the leads are straight. Components with lugs normally require no preparation unless the lugs appear to be bent, in which case they can be straightened with pliers.

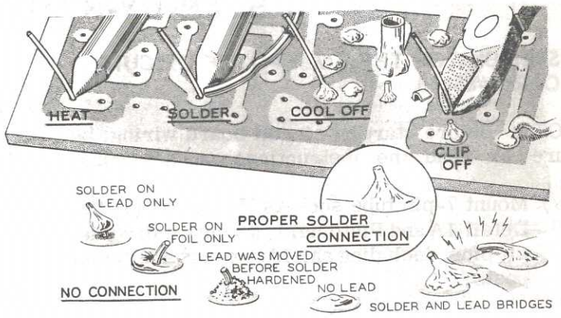
Parts should be inserted as instructed, and the leads bent outward, as illustrated, to lock them in place. When a group of parts have been installed on a circuit board, solder each lead to the foil pattern and clip off the excess wire.



The actual technique of soldering leads to a circuit board is quite simple. Position the tip of the soldering iron so that it firmly contacts both the circuit board foil and the wire or lug to be soldered, as shown. The iron should be held so that solder is not likely to flow to adjacent foil conductors or connections. The solder should immediately be placed between the iron and the joint to be soldered. Remove the length of solder as soon as its end begins to melt and flow onto the lead and foil. Hold the tip of the iron in place only until the solder begins to flow outward over the foil; then remove the iron quickly.

Avoid overheating the connection. A soldering pencil or small iron (approximately 30 watts) is ideal for use in circuit board work. If only a high wattage iron or soldering gun is available, precautions must be taken to avoid circuit board damage due to overheating and excess solder.

The use of excessive amounts of solder will increase the possibility of bridging between foil conductors or plugging holes which are to be left open for wires which may be added later on. If solder is accidentally bridged across insulating areas between conductors, it can be cleaned off by heating the connection carefully and quickly wiping or brushing the solder away with a soft cloth or clean brush. Holes which become plugged can be cleared by heating the area immediately over the hole while gently pushing the lead of a resistor through the hole from the opposite side, and withdrawing the



lead before the solder rehardens. Do not force the lead through; too much pressure before the solder has time to soften may separate the foil from the board.

In cases where foil does become damaged, repairs can usually be made with little difficulty. A break in the foil can be rejoined with a small piece of bare wire soldered across the gap, or between the foil and the lead of a component. "Hairline" breaks can usually be repaired by bridging them with a small amount of solder.

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each wire and part in colored pencil on the Pictorial as it is added.

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a wire to lug 1 (S-2)," it will be understood that there will be two wires connected to the terminal at the time it is soldered. (In cases where a wire passes through a terminal or lug and then connects to another point, it will count as two wires, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation (R1, C1, etc.) on the Schematic, its designation will appear at the beginning of the assembly step which directs its installation.

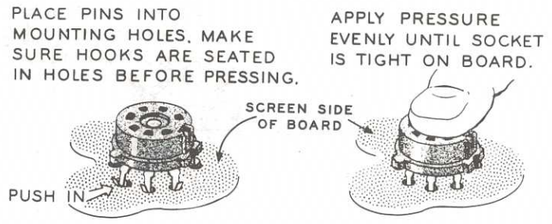
STEP-BY-STEP ASSEMBLY

ASSEMBLY OF THE FM INPUT IF CIRCUIT BOARD #85-18

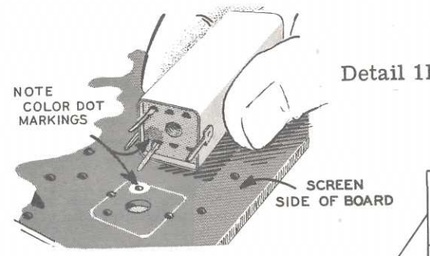
NOTE: Before starting circuit board wiring, be sure to read the instructions on soldering.

(√) Mount 7-pin tube sockets V4 and V5 (S). See Detail 1A and Pictorial 1. (S) means to solder all pins, including shield clip pins and center posts.

The remaining steps for the assembly of this circuit board are presented surrounding the illustration of the circuit board in Pictorial 1.



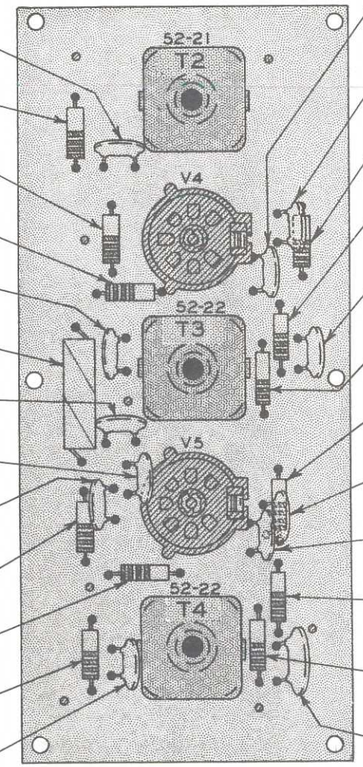
Detail 1A



Detail 1B

Be careful not to cover unused holes when soldering.

1. (↻) .002 µfd ceramic capacitor
2. (↓) 150 Ω resistor (brown-green-brown)
3. (↻) 150 Ω resistor (brown-green-brown)
4. (↙) 56 KΩ resistor (green-blue-orange)
5. (↓) .002 µfd ceramic capacitor
6. (↙) R. F. choke #45-35
7. (↓) .002 µfd ceramic capacitor
8. (↓) .002 µfd ceramic capacitor
9. (↻) .002 µfd ceramic capacitor
10. (↓) 100 Ω resistor (brown-black-brown)
11. (↻) 56 KΩ resistor (green-blue-orange)
12. (↙) 390 Ω resistor (orange-white-brown)
13. (↻) .002 µfd ceramic capacitor
14. (↓) Now solder and cut off the leads of the components that have been installed so far.



15. (↓) .002 µfd ceramic capacitor
16. (↓) .002 µfd ceramic capacitor
17. (↓) 820 Ω resistor (gray-red-brown)
18. (↓) 100 KΩ resistor (brown-black-yellow)

See note below.

19. (↓) 100 µµf ceramic capacitor
20. (↓) 2.2 megohm resistor (red-red-green)
21. (↓) 820 Ω resistor (gray-red-brown)
22. (↓) .002 µfd ceramic capacitor
23. (↓) .002 µfd ceramic capacitor
24. (↓) 4.7 megohm resistor (yellow-violet-green)
25. (↓) 100 KΩ resistor (brown-black-yellow)
26. (↓) 100 µµf ceramic capacitor
27. ( ) Now solder and cut off the leads of the remaining components.

NOTE: There are two types of 100 µµf capacitors, disc ceramic and mica. Be sure to use the type called for in the step.

Pictorial 1

(↓) T2. Mount the #52-21 transformer. Observe the red dot (S). See Detail 1B.

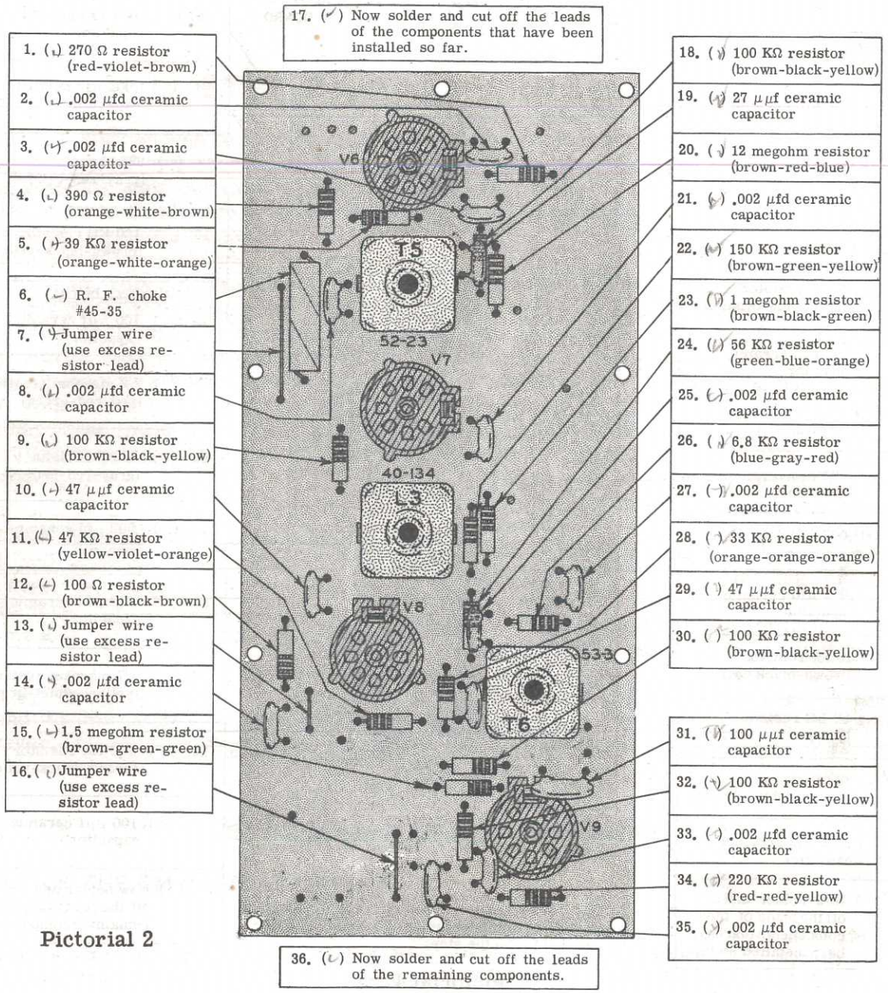
(↙) T3, T4. Mount the two #52-22 IF transformers. Observe the red dot (S).

(↙) Now check the entire circuit board over to make sure that all components are in place and all are soldered. Then set the circuit board aside to be mounted on the chassis later.

ASSEMBLY OF THE FM OUTPUT IF CIRCUIT BOARD #85-19

( ) Mount 7-pin sockets V6, V7, V8 and V9 (S).

Next perform the steps around Pictorial 2.



Pictorial 2

( ) T5. Mount the #52-23 transformer. Observe the red dot (S).

( ) L3. Mount the #40-134 coil. Observe the red dot (S).

( ) T6. Mount the #53-3 transformer. Observe the red dot (S).

( ) Now check over the entire circuit board to make sure that all components are in place and all are soldered. Then set the circuit board aside to be mounted on the chassis later.

AM AND MULTIPLEX CIRCUIT BOARD #85-42

Perform all of the steps around Pictorials 3A and 3B.

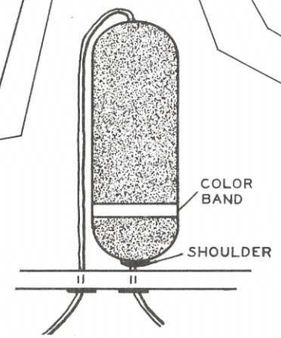
( ) Mount 7-pin tube sockets at V10, V11 and V12 (S).

( ) Mount 9-pin tube sockets at V13, 14, 15 and 16 (S).

Detail 3A

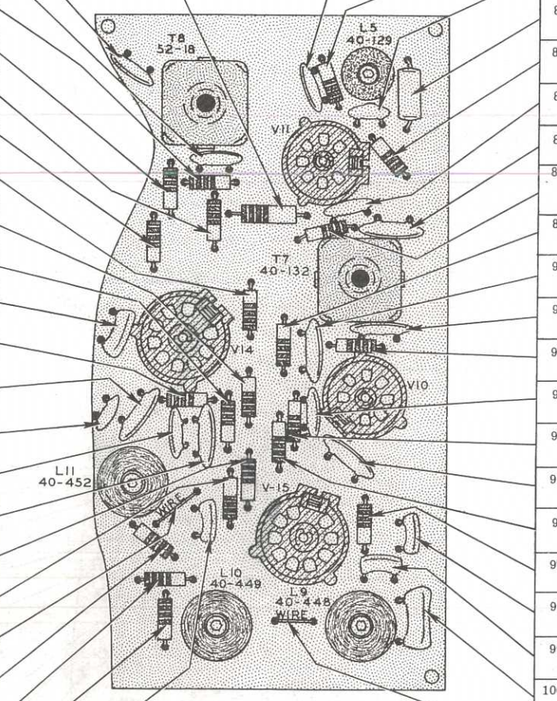
Pictorial 3A

1. ( ) .01 µfd disc ceramic capacitor.
2. ( ) 1 KΩ resistor (brown-black-red).
3. ( ) 47 µµf disc ceramic capacitor.
4. ( ) D3, Crystal diode. Place band markings exactly as shown (red-green-violet).
5. ( ) 90 KΩ resistor (precision).
6. ( ) D2, Crystal diode. Place band markings exactly as shown (red-green-violet).
7. ( ) 1000 µµf mica capacitor.
8. ( ) 22 KΩ resistor (red-red-orange).
9. ( ) 270 µµf disc ceramic capacitor.
10. ( ) 1.5 megohm resistor (brown-green-green).
11. ( ) 1 megohm resistor (brown-black-green).
12. ( ) 2.2 KΩ resistor (red-red-red).
13. ( ) .05 µfd disc ceramic capacitor.
14. ( ) .05 µfd disc ceramic capacitor.
15. ( ) .003 µfd disc ceramic capacitor.
16. ( ) 2.2 KΩ resistor (red-red-red).
17. ( ) 1 megohm resistor (brown-black-green).
18. ( ) .05 µfd disc ceramic capacitor.
19. ( ) 22 KΩ resistor (red-red-orange).
20. ( ) 1 megohm resistor (brown-black-green).
21. ( ) 2 µfd electrolytic capacitor. Place the positive end as shown in Detail 3A.
22. ( ) 2.2 KΩ resistor (red-red-red).
23. ( ) 47 KΩ resistor (yellow-violet-orange).
24. ( ) .1 µfd tubular capacitor. Position as shown in Detail 3B.
25. ( ) .003 µfd disc ceramic capacitor.
26. ( ) .1 µfd mylar capacitor.
27. ( ) D1, Silicon diode. Place band marking exactly as shown (red-red-blue).
28. ( ) Now solder and cut off the leads of the components that have been installed so far.
29. ( ) 47 µµf disc ceramic capacitor.
30. ( ) 100 µµf disc ceramic capacitor.
31. ( ) 47 µµf disc ceramic capacitor.
32. ( ) 82 KΩ resistor (gray-red-orange).
33. ( ) .01 µfd disc ceramic capacitor.
34. ( ) .01 µfd disc ceramic capacitor.
35. ( ) 270 Ω resistor (red-violet-brown).
36. ( ) .02 µfd disc ceramic capacitor.
37. ( ) 100 µµf disc ceramic capacitor.
38. ( ) 150 KΩ resistor (brown-green-yellow).
39. ( ) 68 KΩ resistor 5% (blue-gray-orange).
40. ( ) 68 KΩ resistor 5% (blue-gray-orange).
41. ( ) 1000 µµf mica capacitor.
42. ( ) 68 KΩ resistor 5% (blue-gray-orange).
43. ( ) 68 KΩ resistor 5% (blue-gray-orange).
44. ( ) D4. Crystal diode. Place band markings exactly as shown (black-blue-black).
45. ( ) D5. Crystal diode. Place band markings exactly as shown (black-blue-black).
46. ( ) 100 µµf mica capacitor.
47. ( ) .002 µfd disc ceramic capacitor.
48. ( ) 1.5 KΩ resistor (brown-green-red).
49. ( ) 1 megohm resistor (brown-black-green).
50. ( ) 680 µµf mica capacitor.
51. ( ) .1 µfd mylar capacitor.
52. ( ) 470 µµf disc ceramic capacitor.
53. ( ) 150 KΩ resistor (brown-green-yellow).
54. ( ) 470 µµf disc ceramic capacitor.
55. ( ) 100 KΩ resistor (brown-black-yellow).
56. ( ) Now solder and cut off the leads of the remaining components.



Detail 3B

57. ( ) 15 KΩ 1 Watt resistor (brown-green-orange)
58. ( ) .01 μfd disc ceramic capacitor.
59. ( ) .01 μfd disc ceramic capacitor.
60. ( ) 2,2 megohm resistor. (red-red-green).
61. ( ) 1 KΩ resistor (brown-black-red).
62. ( ) 2,2 megohm resistor (red-red-green).
63. ( ) 82 KΩ resistor (gray-red-orange).
64. ( ) 47 KΩ resistor (yellow-violet-orange).
65. ( ) 330 KΩ resistor (orange-orange-yellow).
66. ( ) 2,2 megohm resistor (red-red-green).
67. ( ) 1000 μμf mica capacitor.
68. ( ) 4,7 megohm resistor (yellow-violet-green).
69. ( ) .05 μfd disc ceramic capacitor.
70. ( ) 100 μμf mica capacitor
71. ( ) .01 μfd disc ceramic capacitor.
72. ( ) .05 μfd disc ceramic capacitor.
73. ( ) 15 KΩ resistor (brown-green-orange).
74. ( ) 1,5 KΩ resistor (brown-green-red).
75. ( ) Jumper wire (use excess resistor lead).
76. ( ) 10 KΩ resistor (brown-black-orange).
77. ( ) 22 KΩ resistor (red-red-orange).
78. ( ) 15 KΩ resistor (brown-green-orange)
79. ( ) 390 μμf mica capacitor.
80. ( ) Now solder and cut off the leads of the components installed so far.



81. ( ) .01 μfd disc ceramic capacitor.
82. ( ) 270 Ω resistor (red-violet-brown).
83. ( ) 47 μμf disc ceramic capacitor.
84. ( ) 10 μμf N750 tubular capacitor.
85. ( ) 27 KΩ resistor (red-violet-orange).
86. ( ) .01 μfd disc ceramic capacitor.
87. ( ) .05 μfd disc ceramic capacitor.
88. ( ) 330 KΩ resistor (orange-orange-yellow). (Leave room for T7.)
89. ( ) 82 KΩ resistor (gray-red-orange).
90. ( ) .02 μfd disc ceramic capacitor.
91. ( ) .02 μfd disc ceramic capacitor.
92. ( ) 1 KΩ resistor (brown-black-red).
93. ( ) .01 μfd disc ceramic capacitor.
94. ( ) 270 Ω resistor (red-violet-brown).
95. ( ) .05 μfd disc ceramic capacitor.
96. ( ) 330 KΩ resistor (orange-orange-yellow).
97. ( ) 220 KΩ resistor (red-red-yellow).
98. ( ) 300 μμf mica capacitor.
99. ( ) 1000 μμf mica capacitor.
100. ( ) 10,000 μμf mica capacitor.
101. ( ) Jumper wire (use excess resistor lead).
102. ( ) Now solder and cut off the remaining component leads.

Pictorial 3B

( ) L5. Mount the #40-129 coil (S).

( ) L6. Mount the #40-453 coil (S).

( ) L7. Mount the #40-133 coil (S).

( ) L8. Mount the #40-450 coil (S).

( ) L9. Mount the #40-448 coil (S).

( ) L10. Mount the #40-449 coil (S).

( ) L11. Mount the #40-452 coil (S).

( ) L12. Mount the #40-451 coil (S).

( ) T7. Mount the #40-132 transformer. Observe the red dot (S).

( ) T8. Mount the #52-18 transformer. Observe the red dot (S).

( ) T9. Mount the #52-55 transformer. Observe the red dot (S).

Set the completed board aside temporarily.

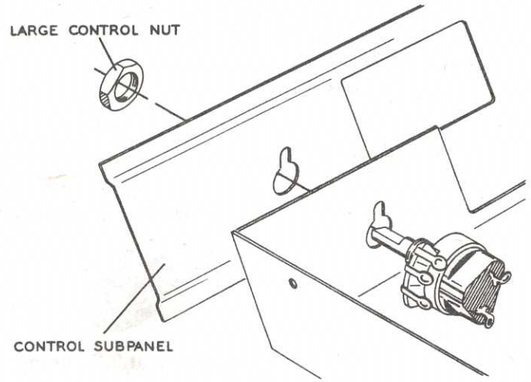
CHASSIS BOTTOM PARTS ASSEMBLY

Refer to Pictorial 4 (fold-out from Page 33) for the following steps.

NOTE: For ease of assembly, the Tuner is put together in several subassemblies, which are then mounted on the main chassis. Care should be taken to follow the written instructions and illustrations as closely as possible.

( ) Locate the control subpanel and position it on the front of the chassis as shown. Now mount the AFC control (#19-76) at A, using a large control nut as shown in Detail 4A. Bend the two rear control lugs as shown in Pictorial 4. Make sure the remaining subpanel and chassis holes are aligned with each other when tightening the control nut.

( ) Mount the FM STERO PHASE control (#19-74) at B, using a large control nut as shown in Detail 4A. Bend the two rear control lugs as shown in Pictorial 4.



Detail 4A

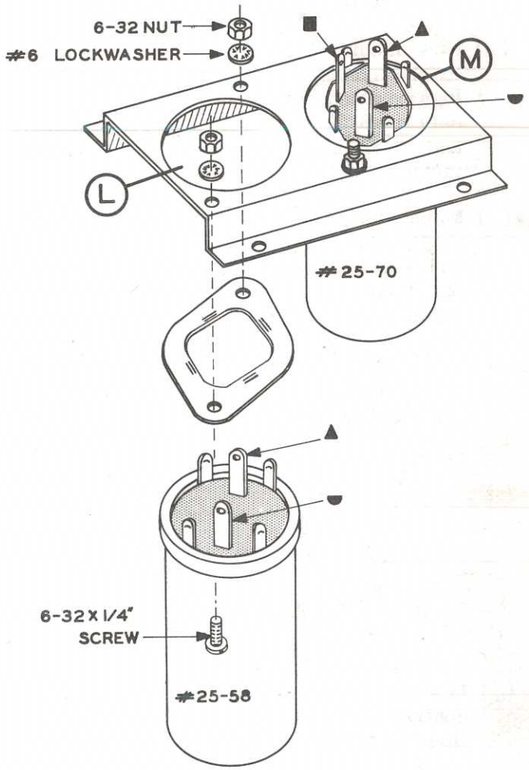
( ) Mount the AM FIDELITY-FM SQUELCH control (#19-75) at C, using a large control nut as shown in Detail 4A.

( ) Mount the MODE SELECTOR switch (#63-302) at D, using a large control nut.

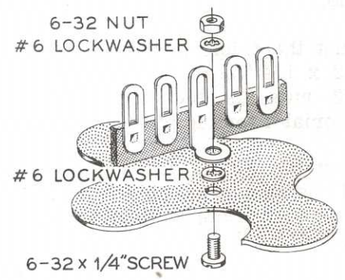
( ) Mount 5-lug terminal strips at H and J, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts as shown in Detail 4B. Position each terminal strip as shown in Pictorial 4.

( ) Install rubber grommets at AD and AH.

( ) Mount the two capacitor mounting wafers in the filter capacitor bracket, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts as shown in Detail 4C.



Detail 4C



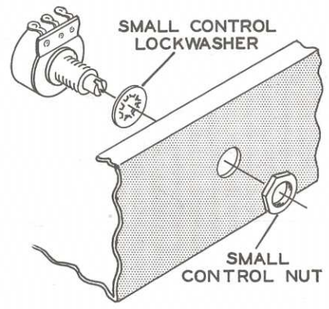
Detail 4B

( ) Position the lugs with the markings as shown, then mount the #25-58 filter capacitor at L on the bracket as shown in Detail 4C. Twist the mounting lugs 1/8 turn.

( ) In a like manner, mount the #25-70 filter capacitor at M on the capacitor bracket. Position the lugs as shown in Detail 4C.

( ) Now mount the filter capacitor assembly to the chassis from the bottom with the lugs positioned as shown in Pictorial 4. Use only two 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts in the front two bracket mounting holes.

( ) Mount the AM METER control (#10-121) at N, using a small control lockwasher and a small control nut as shown in Detail 4D. Position the control as shown in Pictorial 4.



Detail 4D

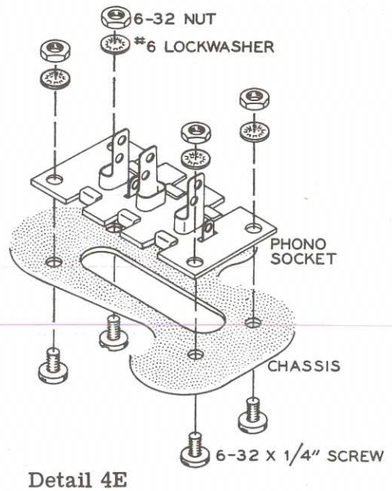
( ) In a similar manner, mount the FM METER control (#10-121) at P. Note the lug positions as shown in Pictorial 4.

( ) Similarly, mount the FM Stereo Separation control (#10-113) at R. Note the lug positions.

( ) Mount the triple phono socket at S, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts as shown in Detail 4E. See Pictorial 4 for lug positioning.

( ) Mount the RIGHT LEVEL control (#10-78) at T, using a large control lockwasher, and a control nut. Note the lug position. See Pictorial 4.

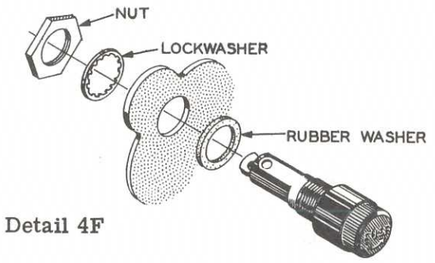
( ) In a like manner, mount the LEFT LEVEL control (#10-78) at U. Note the lug positioning.



Detail 4E

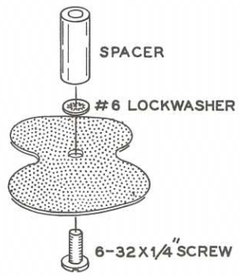
( ) Mount the power transformer at AF, using #8 lockwashers and 8-32 nuts. See Pictorial 4 for positioning.

( ) Mount the fuse holder at K as shown in Detail 4F. Use the hardware supplied with the fuse holder.



Detail 4F

( ) Mount one of the 1" spacers at AE, using a 6-32 x 1/4" screw and #6 lockwasher as shown in Detail 4G.



Detail 4G

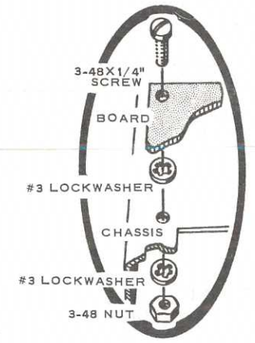
CHASSIS TOP PARTS ASSEMBLY

Refer to Pictorial 5 (fold-out from Page 33) for the following steps.

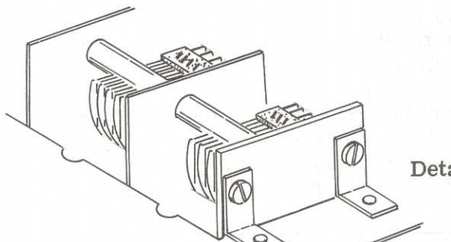
( ) Mount the FM front end (#110-5) to the top of the chassis at BA, using 3-48 x 1/4" screws, #3 lockwashers, and 3-48 nuts as shown in Detail 5A. See Pictorial 5 for proper positioning. Be careful not to damage the tubes during the remaining kit assembly, and leave the capacitor plates fully meshed (closed). Be sure that no leads are between the front end and the chassis.

( ) Locate the AM variable tuning capacitor (#26-72) and mount it on the chassis at BB, using 6-32 x 3/16" screws and #6 lockwashers as shown in Detail 5B. See Pictorial 5 for the mounted position of this capacitor. Leave the capacitor plates fully meshed.

( ) Mount the AM-Multiplex circuit board (#85-42) at BC, using 3-48 x 1/4" screws, #3 lockwashers, and 3-48 nuts exactly as shown in Detail 5C. Make sure the board is positioned as shown in Pictorial 5. Use lockwashers between the circuit board and the chassis, as well as under the nuts.

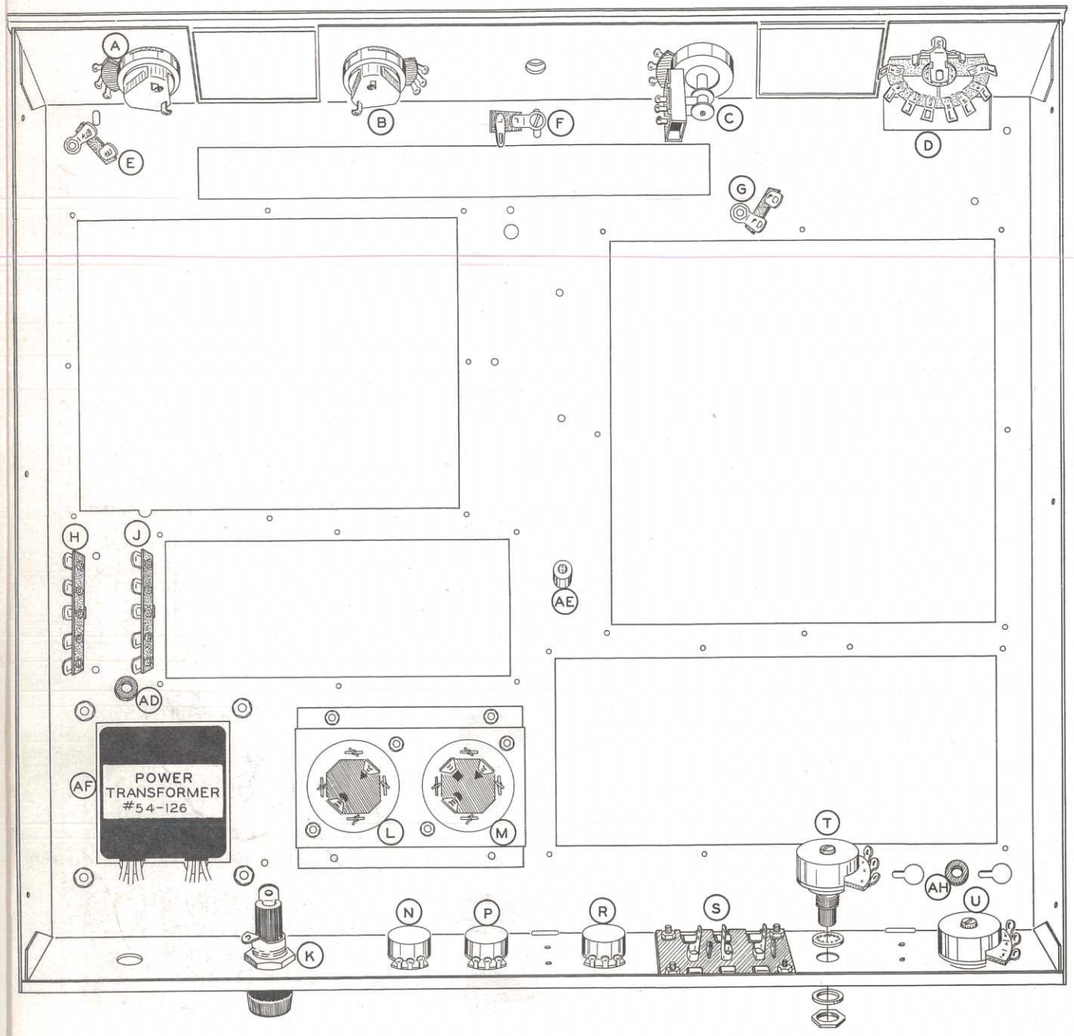


Detail 5C

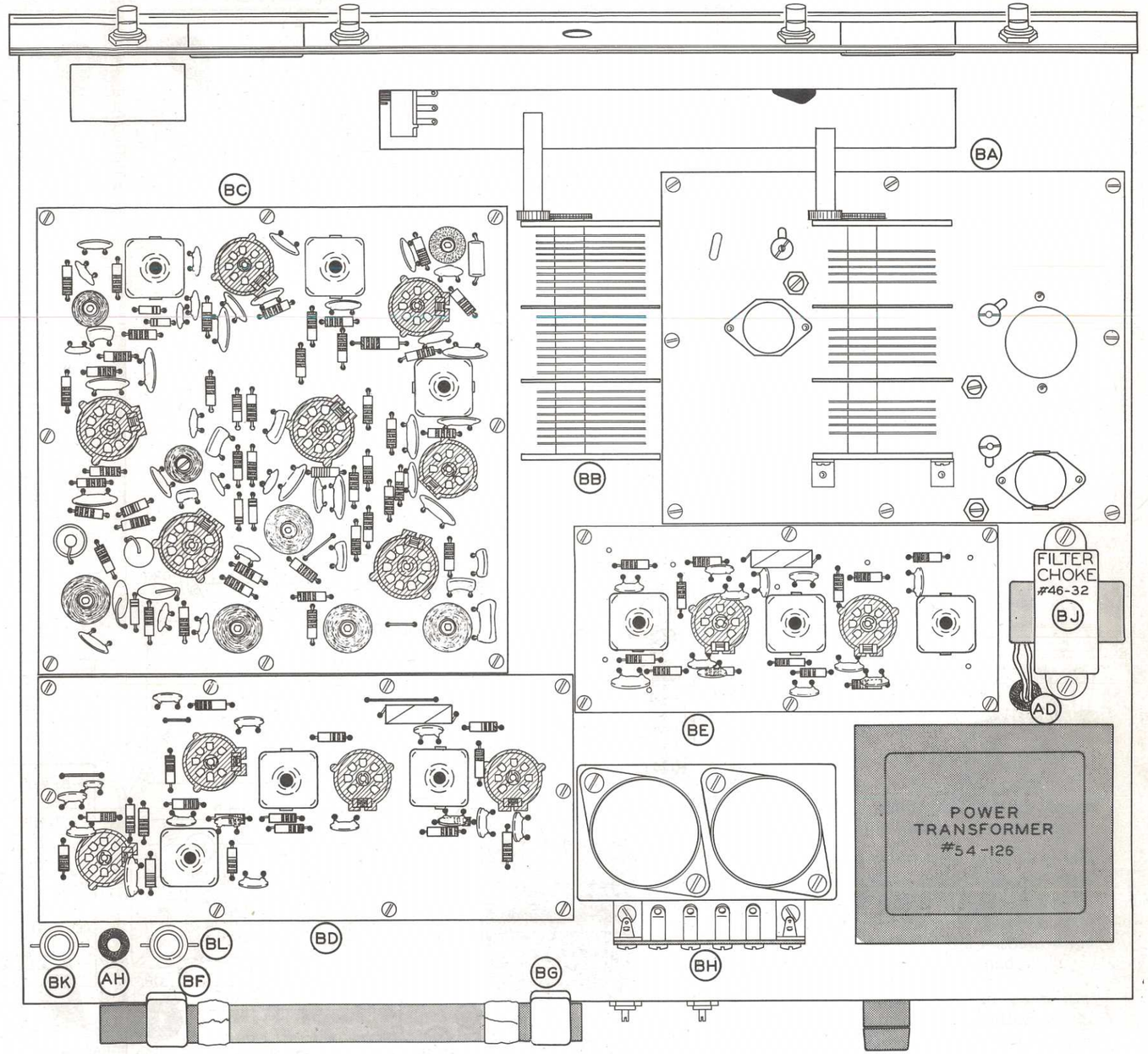


Detail 5A

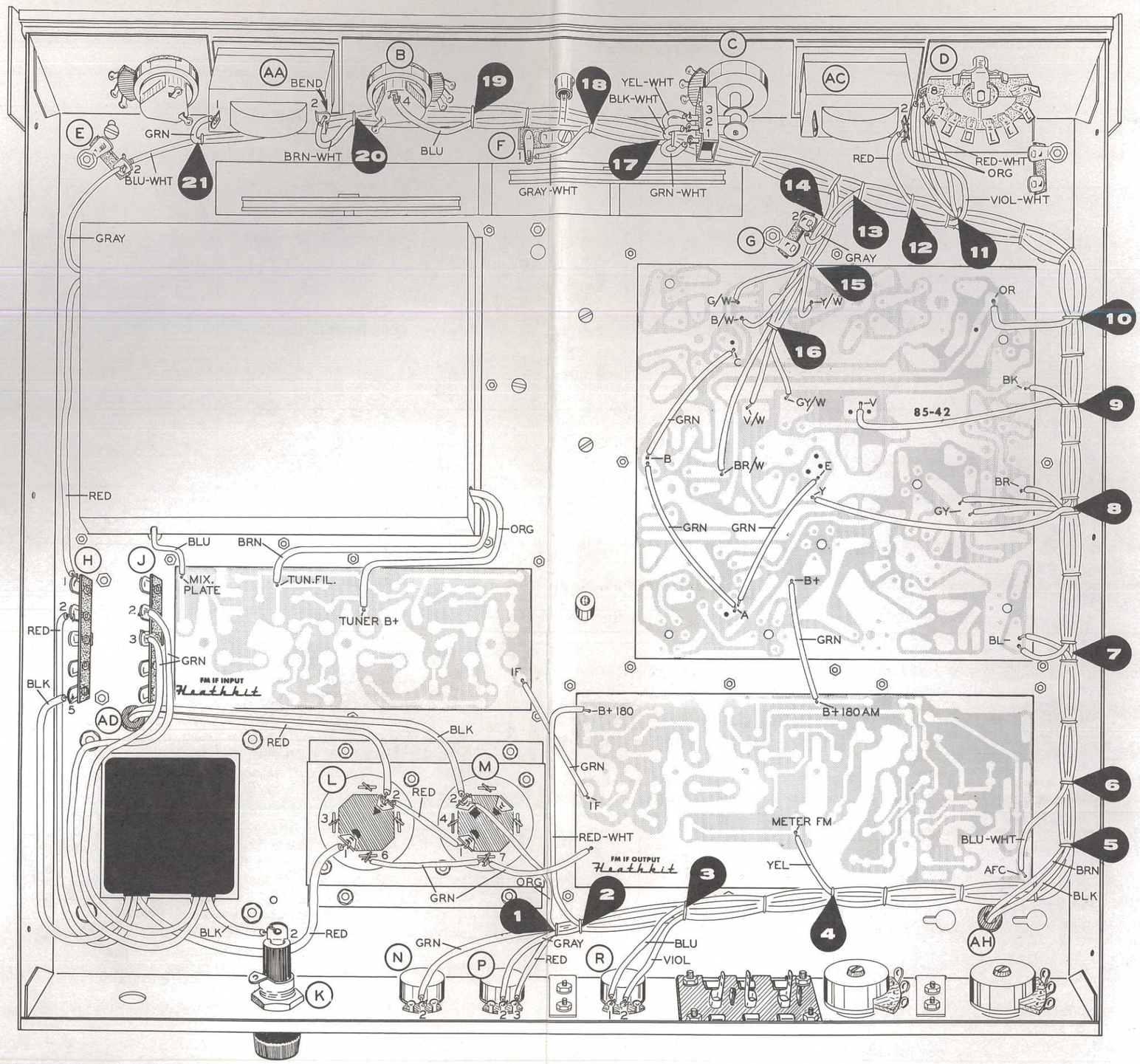
Detail 5B



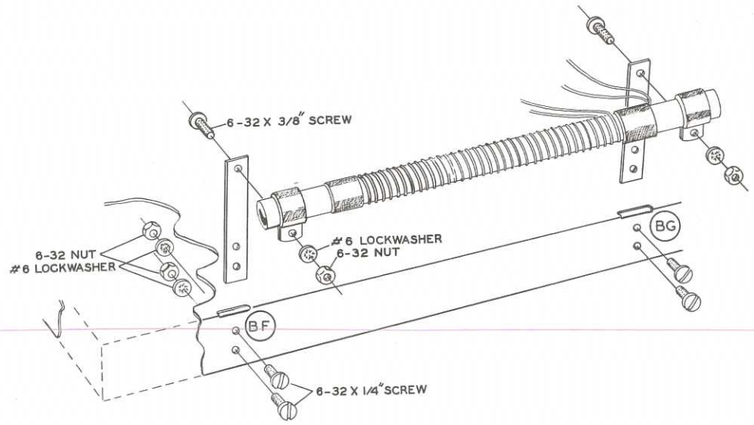
Pictorial 4



Pictorial 5



Pictorial 10



Detail 5D

(✓) In a similar manner, mount the FM Output IF circuit board (#85-19) at BD, using 3-48 x 1/4" screws, #3 lockwashers, and 3-48 nuts. Refer to Detail 5C for mounting and to Pictorial 5 for positioning of the circuit board.

(✓) Mount the FM Input IF circuit board (#85-18) at BE, using 3-48 hardware as installed in the two previous circuit boards. See Pictorial 5 for proper board positioning.

(✓) Referring to Detail 5D, slip the two plastic clamps over the AM rod antenna (#40-447) as shown. Then mount the two antenna mounting brackets to the clamps, using 6-32 x 3/8" screws, #6 lockwashers, and 6-32 nuts. Position the antenna so the leads breakout toward the front of the chassis.

(✓) Insert the mounting brackets of the AM rod antenna assembly in the slotted chassis holes at BF and BG. See Detail 5D and Pictorial 5. Use 6-32 x 1/4" screws, #6 lockwashers and 6-32 nuts to secure the brackets to the chassis.

(✓) Referring to Detail 5E, mount the two terminal strip mounting brackets on the 4-lug (screw-type) terminal strip. Use 6-32 x 1/4" screws, #6 solder lugs, and 6-32 nuts as shown.

(✓) Mount the 4-lug (screw-type) terminal strip on the chassis at BH, using 6-32 x 1/4" screws (through the chassis and capacitor bracket), #6 lockwashers, and 6-32 nuts. See Pictorial 5.

(✓) Insert the leads of the filter choke (#46-32) down through grommet AD and mount the choke at BJ. See Pictorial 5. Use 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts.

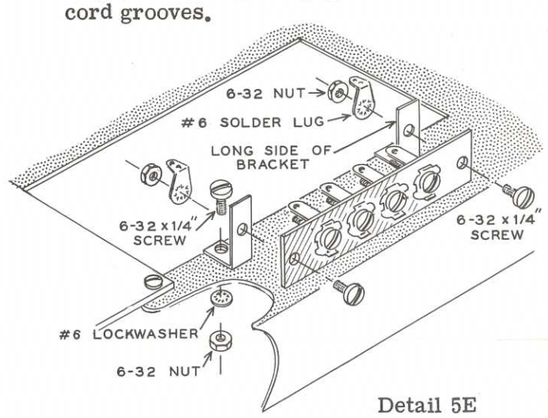
Set the chassis aside temporarily.

FRONT PANEL SUBASSEMBLY

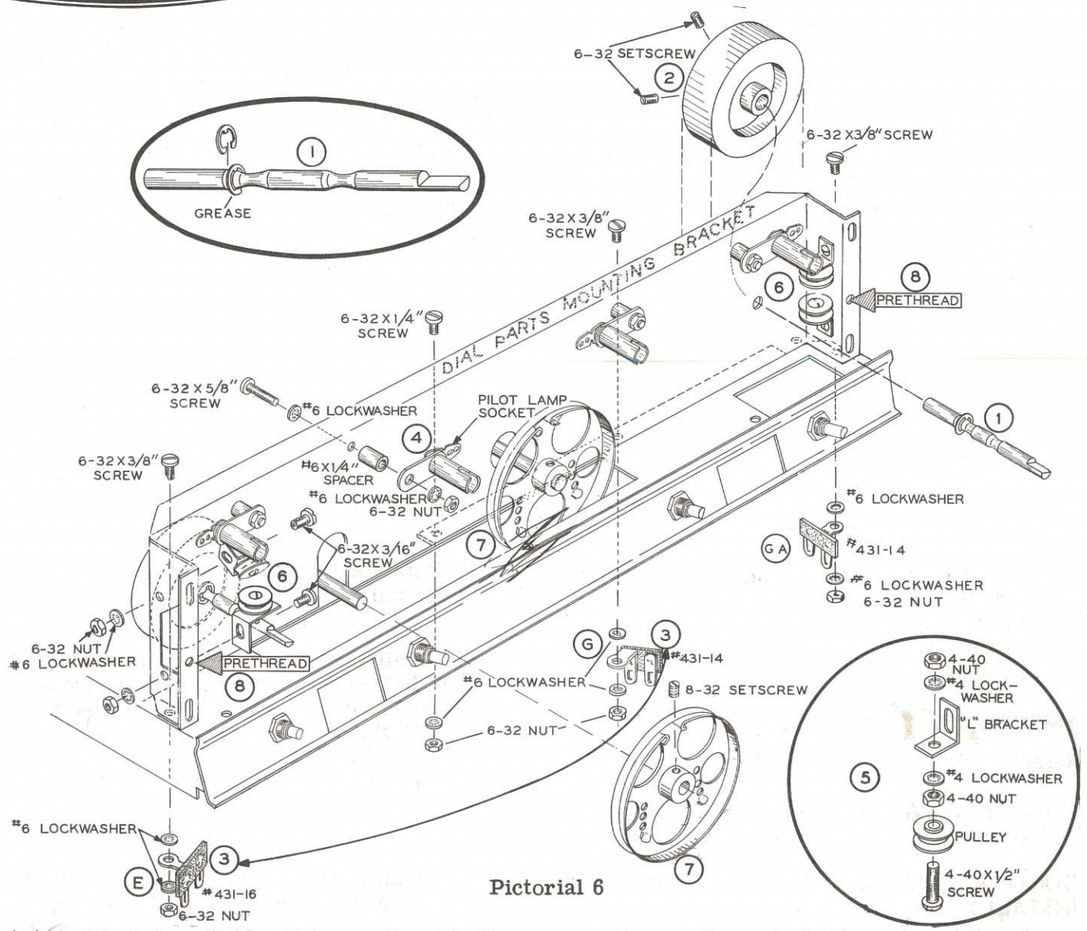
Refer to Pictorial 6 for the following steps.

NOTE: The step numbers correspond to the numbers on the Pictorial.

(✓) 1. Place an E ring in the front groove of each of the dial drive shafts. See Detail 6A. Install the shafts through the dial parts mounting bracket. Then install the second E ring in the rear groove of each shaft. Place a small amount of grease or vaseline on the dial drive shafts between the two E rings. Do not get any grease in the dial cord grooves.



Detail 5E



Pictorial 6

(✓) 2. Start two 6-32 setscrews in each flywheel, and install a flywheel on each drive shaft. Tighten each setscrew securely.

(✓) 3. Mount the dial parts mounting bracket to the chassis and mount 2-lug terminal strips G and GA, using 6-32 x 3/8" screws, #6 lockwashers, and 6-32 nuts. Mount 2-lug terminal strip E to the chassis as shown, using the hardware indicated. Install 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts in the remaining bracket mounting holes. See Pictorial 4 for positioning of the terminal strips.

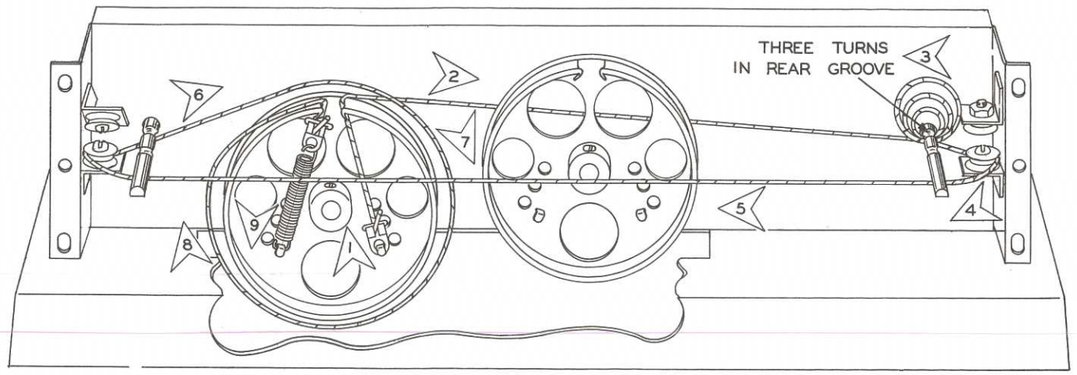
(✓) 4. Mount the four pilot lamp sockets, using the hardware shown.

(✓) 5. Assemble the four dial cord pulleys to the L brackets as shown in Detail 6B. Leave the nut holding the pulley loose enough to allow the pulley to turn freely.

(✓) 6. Mount the four dial cord pulleys to the dial parts mounting bracket, using 6-32 x 3/16" screws, #6 lockwashers, and 6-32 nuts. Position each pulley as shown so that it just clears the edges of the cutouts when the mounting screws are tightened.

(✓) 7. Start an 8-32 setscrew in each dial drum. Turn each tuning capacitor to the fully closed position. Now position each drum so that the end of the tuning capacitor shaft is flush with the drum bushing. The string exits should be positioned straight up. Now tighten the setscrews.

(✓) 8. Prethread the two indicated holes in the dial parts mounting bracket, with one of the 6-32 self-tapping screws supplied.



Pictorial 7

FM DIAL CORD STRINGING

Refer to Pictorial 7 for the following single step.

(√) Start with arrow #1 and string the FM dial cord as shown by the consecutive arrow heads. Use a dial cord spring to hook to the tab in the pulley. Open the end of the spring so that it fits over the tab.

AM DIAL CORD STRINGING

Refer to Pictorial 8 for the following single step.

(√) String the AM dial cord in a manner similar to that used for FM dial cord stringing.

CONTROL PANEL AND DIAL POINTER INSTALLATION

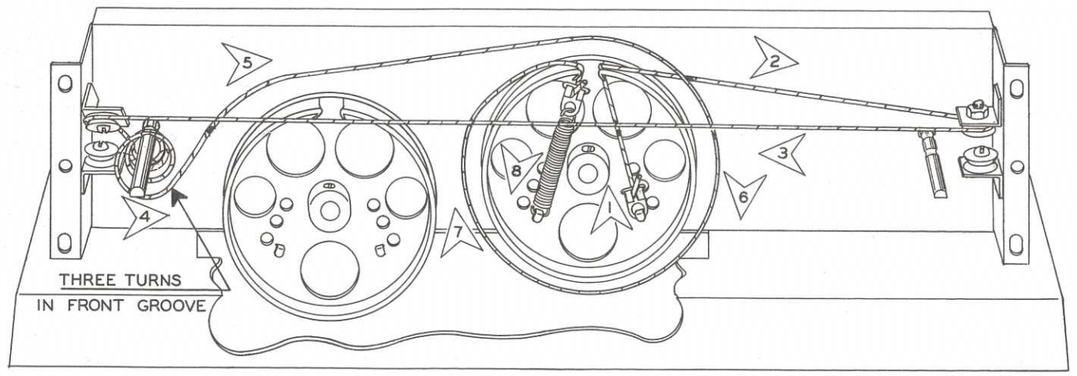
Refer to Pictorial 9 for the following steps.

NOTE: Step numbers correspond to the numbers on the Pictorial.

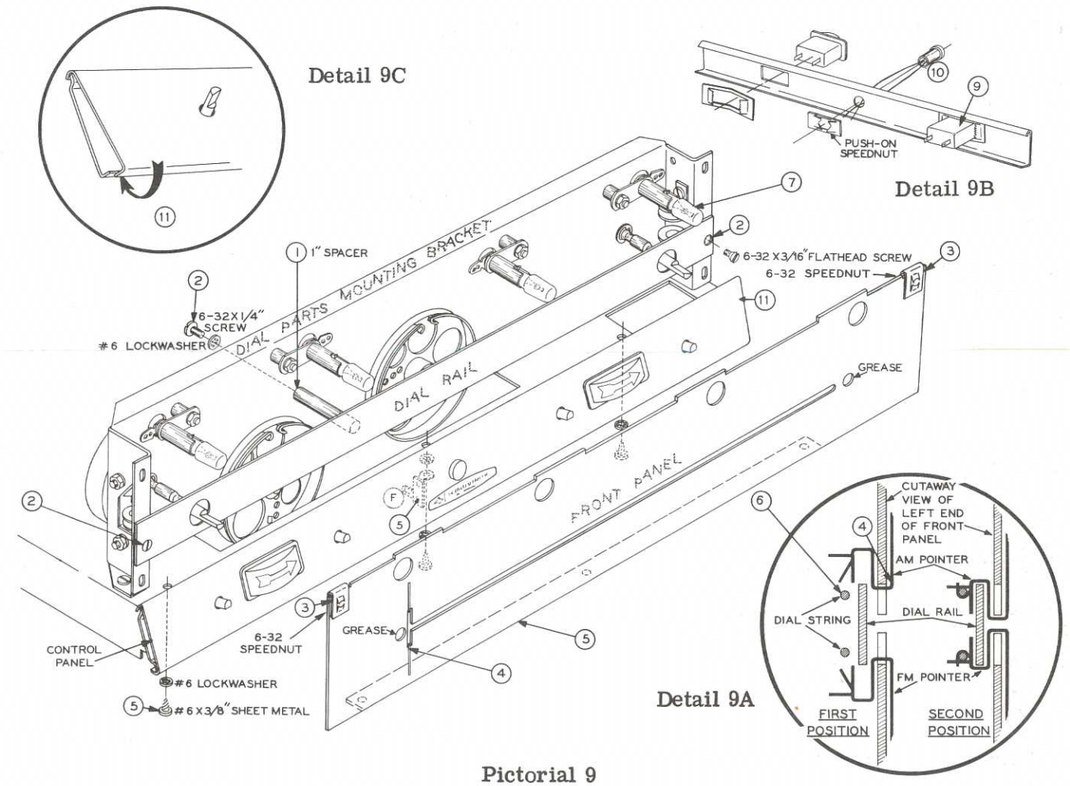
(√) 1. Install a 1" spacer on the threaded stud of the dial rail.

(√) 2. Install the dial rail (with the two drive shaft holes nearest the top edge) to the dial parts mounting bracket as shown. Use 6-32 x 3/16" flat head screws in the prethreaded mounting bracket holes. Use a 6-32 x 1/4" screw and #6 lockwasher in the threaded spacer.

(√) 3. Install 6-32 speednuts on the two holes in the front panel as indicated. Be sure to install each with the smooth side on the back of the front panel.



Pictorial 8



Pictorial 9

(√) 4. Place the two dial pointers through the front panel slot as shown. Hold the pointer positioned at the extreme ends of the vertical slot (see Detail 9A). Now place the front panel in position, then drop the upper pointer and raise the lower pointer on the dial rail. Now slide the pointer approximately 1-1/2" to the right. Place some grease or vaseline on the dial drive shafts where they rub in the front panel.

(√) 5. Temporarily fasten the front panel to the chassis with #6 x 3/8" sheet metal screws and #6 lockwashers. Also, mount a 1-lug terminal strip at F on the chassis, using the hardware shown. See Pictorial 4 for positioning of the terminal strip.

(√) 6. Attach the dial string to their respective pointers. Do not crimp the pointer fingers too tightly since later the pointers will be moved on the strings to permanently align them to the dial window markings. See Detail 9A.

(√) 7. Install the four #47 pilot lamps. If necessary, adjust the sockets for proper alignment with the front panel.

(√) 8. Make sure that both the AM and FM tuning capacitors are fully closed.

(√) 9. Install the two tuning meters on the control panel. Make sure that the "TUNE" lettering on the meters is placed properly with respect to the lettering on the front of the panel. See Detail 9B.

(√) 10. Install the stereo indicator red neon lamp in the control panel with a push-on speednut. See Detail 9B.

(√) 11. Turn all controls so the flat of the shafts face down and install the control panel to the chassis as shown in Detail 9C. The control panel will fit loosely at this time.

INITIAL CHASSIS AND HARNESS WIRING

Refer to Pictorial 10 (fold-out from Page 34) for the following steps.

( ) Locate the cable harness and shape it as shown in Pictorial 10. Note the wires that are associated with each breakout number.

NOTE: In the following steps, connect the colored harness breakout wires as indicated. Refer to Pictorial 10 for the routing and connection for each wire.

Connect the wires from breakout #1 of the cable harness as follows:

( ) Orange wire to lug 2 of capacitor M (NS).

( ) Green wire to lug 2 of control N (S-1).

( ) Gray wire to lug 2 of control P (NS).

( ) Red wire to lug 3 of control P (S-1).

( ) Connect the red-white wire from breakout #2 to the hole marked "B + 180" on the FM Output IF circuit board (S-1).

( ) Connect the blue wire from breakout #3 to lug 1 of control R (S-1).

( ) Connect the violet wire from breakout #3 to lug 2 of control R(S-1).

( ) Connect the yellow wire from breakout #4 to the hole marked "METER FM" on the FM Output IF circuit board (S-1).

( ) Insert the brown and black wires from breakout #5 in grommet AH and leave them free to be connected later.

( ) Connect the blue-white wire from breakout #6 to the hole marked "AFC" on the FM Output IF circuit board (S-1).

Connect the following harness wires to the indicated holes on the AM-Multiplex circuit board:

( ) Either blue wire from breakout #7 to one of the "BL" holes (S-1).

( ) The other blue wire from breakout #7 to the other "BL" hole (S-1).

( ) One of the gray wires from breakout #8 to one of the "GY" holes (S-1).

( ) The other gray wire from breakout #8 to the other "GY" hole (S-1).

( ) Yellow wire from breakout #8 to "Y" (S-1).

( ) Brown wire from breakout #8 to "BR" (S-1).

( ) Violet wire from breakout #9 to "V" (S-1).

( ) Black wire from breakout #9 to "BK" (S-1).

( ) Orange wire from breakout #10 to "OR" (S-1).

( ) Brown-white wire from breakout #16 to "BR/W" (S-1).

( ) Violet-white wire from breakout #16 to "V/W" (S-1).

( ) Gray-white wire from breakout #16 to "GY/W" (S-1).

( ) Black-white wire from breakout #15 to "B/W" (S-1).

( ) Green-white wire from breakout #15 to "G/W" (S-1).

( ) Yellow-white wire from breakout #15 to "Y/W" (S-1).

Connect the following harness wires as directed:

( ) Gray wire from breakout #14 to lug 2 of terminal strip G (NS).

( ) Red wire from breakout #12 to lug 2 of meter AC (NS).

( ) Violet-white wire from breakout #11 to lug 2 of meter AC (S-2). If this lead will not go through the hole, wrap it over the lug.

( ) Both orange wires from breakout #11 to lug 8 of switch D (S-2).

( ) Red-white wire from breakout #11 to lug 7 of switch D (S-1).

( ) Yellow-white wire from breakout #17 to lug 3 of control C (S-1).

( ) Black-white wire from breakout #17 to lug 2 of control C (S-1).

( ) Green-white wire from breakout #17 to lug 1 of control C (S-1).

( ) Gray-white wire from breakout #18 to lug 1 of terminal strip F (NS).

( ) Blue wire from breakout #19 to lug 4 of control B (S-1).

( ) Brown-white wire from breakout #20 to lug 2 of meter AA (S-1). Bend the meter lug to clear the FM tuning pulley.

( ) Green wire from breakout #21 to lug 1 of meter AA (S-1).

( ) Blue-white wire from breakout #21 to lug 2 of terminal strip E (NS).

Connect the wires from the FM front end as follows:

( ) Gray wire to lug 2 of terminal strip E (NS).

( ) Red wire to lug 1 of terminal strip H (NS).

( ) Blue wire to the hole marked "MIX PLATE" on the FM input IF circuit board (S-1).

( ) Brown wire to the hole marked "TUN FIL" on the FM input IF circuit board (S-1).

( ) Orange wire to the hole marked "TUNER B+" on the FM input IF circuit board (S-1).

Route and connect each of the following power transformer leads as shown in Pictorial 10.

( ) Longer red lead to lug 2 of terminal strip H (NS).

( ) Shorter red lead to lug 1 of capacitor L (S-1).

( ) Longer black lead to lug 5 of terminal strip H (NS).

( ) Shorter black lead to lug 2 of the fuse holder (S-1).

( ) Longer green lead to lug 2 of terminal strip J (NS).

( ) Shorter green lead to lug 3 of terminal strip J (NS).

( ) Connect the red filter choke lead coming from grommet AD to lug 2 of capacitor L (NS).

( ) Connect the black filter choke lead coming from grommet AD to lug 2 of capacitor M (NS).

( ) Solder lug 3 to the capacitor mounting wafer of capacitor L (S-1).

( ) Solder lug 4 to the capacitor mounting wafer of capacitor M (S-1).

For wiring the remainder of the Tuner, you will need 32 lengths of green wire and 17 lengths of red wire. The lengths of wire needed are listed below. Cut each wire now and strip 1/4" of insulation from each end. Lay the wires in the exact sequence listed so they will be easy to identify when performing the wiring steps. The few minutes needed to prepare these wires now should save both time and effort when you start wiring.

( ) GREEN:		( ) RED:
2"	1-3/4"	1-3/4"
2"	6"	9-3/4"
2-1/2"	4-7/8"	6-1/2"
2-1/4"	4-1/2"	7"
2-1/2"	1-1/2"	3"
2-3/4"	10"	3-3/4"
2-3/8"	9-1/4"	3-3/4"
4-1/4"	2"	5-1/8"
2"	10-1/2"	6-1/8"
1-1/2"	3-1/8"	9-3/4"
2"	7-5/8"	2-3/4"
2-1/4"	10-1/8"	1-1/2"
2-1/4"	5"	10"
3-3/4"	3-3/4"	2"
2-7/8"	5"	2-1/4"
1-3/4"	3-3/8"	2-1/4"
		4-3/8"

( ) Connect a 2" green wire from lug 6 of capacitor L (S-1) to lug 7 of capacitor M (NS).

( ) Connect another 2" green wire from lug 7 of capacitor M (NS) to the nearest unmarked hole in the FM output IF circuit board (S-1).

( ) Connect a 2-1/2" green wire between the two holes marked "IF" one in the FM output IF circuit board (S-1) and the other in the FM input IF circuit board (S-1). Run this wire under the red-white harness wire.

( ) Connect a 1-3/4" red wire from lug 2 of capacitor L (NS) to lug 1 of capacitor M (S-1).

( ) Connect a 2-1/4" green wire from the hole marked "B + 180 AM" on the FM output IF circuit board (S-1) to the hole marked "B+" on the AM-Multiplex circuit board (S-1).

Connect the following three wires on the AM-Multiplex circuit board as indicated. See Pictorial 10 for the proper location of each of these wires.

( ) 2-1/2" green wire from "A" (S-1) to "E" (S-1).

( ) 2-3/4" green wire from "A" (S-1) to "B" (S-1).

( ) 2-3/8" green wire from "B" (S-1) to "C" (S-1).

Refer to Pictorial 11 (fold-out from Page 41) for the following steps.

NOTE: Be sure to route and connect each wire as shown in the Pictorial.

( ) Connect a 9-3/4" red wire from lug 1 of terminal strip H (S-2) to lug 3 of capacitor M (NS).

( ) Connect a 6-1/2" red wire from lug 1 of terminal strip J (NS) to lug 2 of capacitor L (S-3).

( ) Connect a 4-1/4" green wire between the two holes marked "AGC" on the FM output IF (S-1) and FM input IF (S-1) circuit boards. When soldering to the FM input IF circuit board, be careful not to short it to the chassis.

( ) Connect a 7" red wire from lug 2 of capacitor M (NS) to the hole marked "B+ 180" on the FM input IF circuit board (S-1). Route this wire exactly as shown.

( ) Strip a total of 1/2" of insulation from one end of a 3" red wire and insert this end through lug 1 (NS) to lug 2 (S-2) of control P. Now solder lug 1 (S-2). Connect the other end of this wire to lug 3 of capacitor M (NS).

( ) Connect a 2" green wire from lug 2 of phono connector S (NS) to lug 3 of control R (S-1).

( ) Connect a 1-1/2" green wire between lugs 2 (NS) and 5 (NS) of phono connector S.

( ) Connect another 2" green wire from lug 2 of phono connector S (S-3) (under the cable harness) to the nearest unmarked hole in the FM output IF circuit board (S-1).

( ) Connect a 2-1/4" green wire from lug 5 of phono connector S (S-2) to lug 1 of control T (NS).

( ) Connect a 2-1/4" green wire from lug 1 of control T (NS) to lug 1 of control U (NS).

( ) Connect one end of a 3-3/4" red wire to lug 3 of control T (NS). Insert the other end of this wire through grommet AH and leave the end free to be connected later.

( ) Connect one end of a 3-3/4" green wire to lug 3 of control U (NS). Insert the other end of this wire through grommet AH and leave the end free to be connected later.

( ) Connect a 470 KΩ (yellow-violet-yellow) 1/2 watt resistor from lug 4 of switch D (NS) to lug 1 of terminal strip GA (S-1).

( ) Connect a 470 KΩ (yellow-violet-yellow) 1/2 watt resistor from lug 4 of switch D (S-2) to lug 2 of terminal strip GA (NS).

Connect the following wires on the AM-Multiplex circuit board as indicated. See Pictorial 11 for the proper location of each wire.

( ) 2-7/8" green wire (route under the cable harness) from "C" (S-1) to "D" (S-1).

( ) 1-3/4" green wire from "E" (S-1) to "F" (S-1).

( ) 1-3/4" green wire from "F" (S-1) to "H" (S-1).

( ) Connect one end of a 6" green wire to the hole marked "D" (S-1). Insert the other end of this wire through chassis hole AJ and leave it free for connection later.

( ) Connect a 4-7/8" green wire from "G" (S-1) to lug 6 of switch D (S-1).

( ) Connect a 4-1/2" green wire from "N" (S-1) to lug 5 of switch D (S-1).

( ) Connect a 3-3/4" red wire from "AM" (S-1) to lug 2 of terminal strip GA (S-2).

( ) Connect a 5-1/8" red wire from "R" (S-1) to lug 3 of switch D (S-1).

( ) Connect a 6-1/8" red wire from "M" (S-1) to lug 2 of switch D (S-1).

( ) Connect a 1-1/2" green wire from lug 2 of terminal strip G (NS) to lug 1 of meter AC (S-1).

( ) Connect a 10-1/2" green wire from "X" (S-1) to lug 1 of switch D (S-1). Route exactly as shown.

( ) Connect a 9-1/4" green wire from "Z" (S-1) to lug 5 of control C (S-1).

( ) Connect a 9-3/4" red wire from "J" (S-1) to lug 3 of control B (S-1). Route exactly as shown.

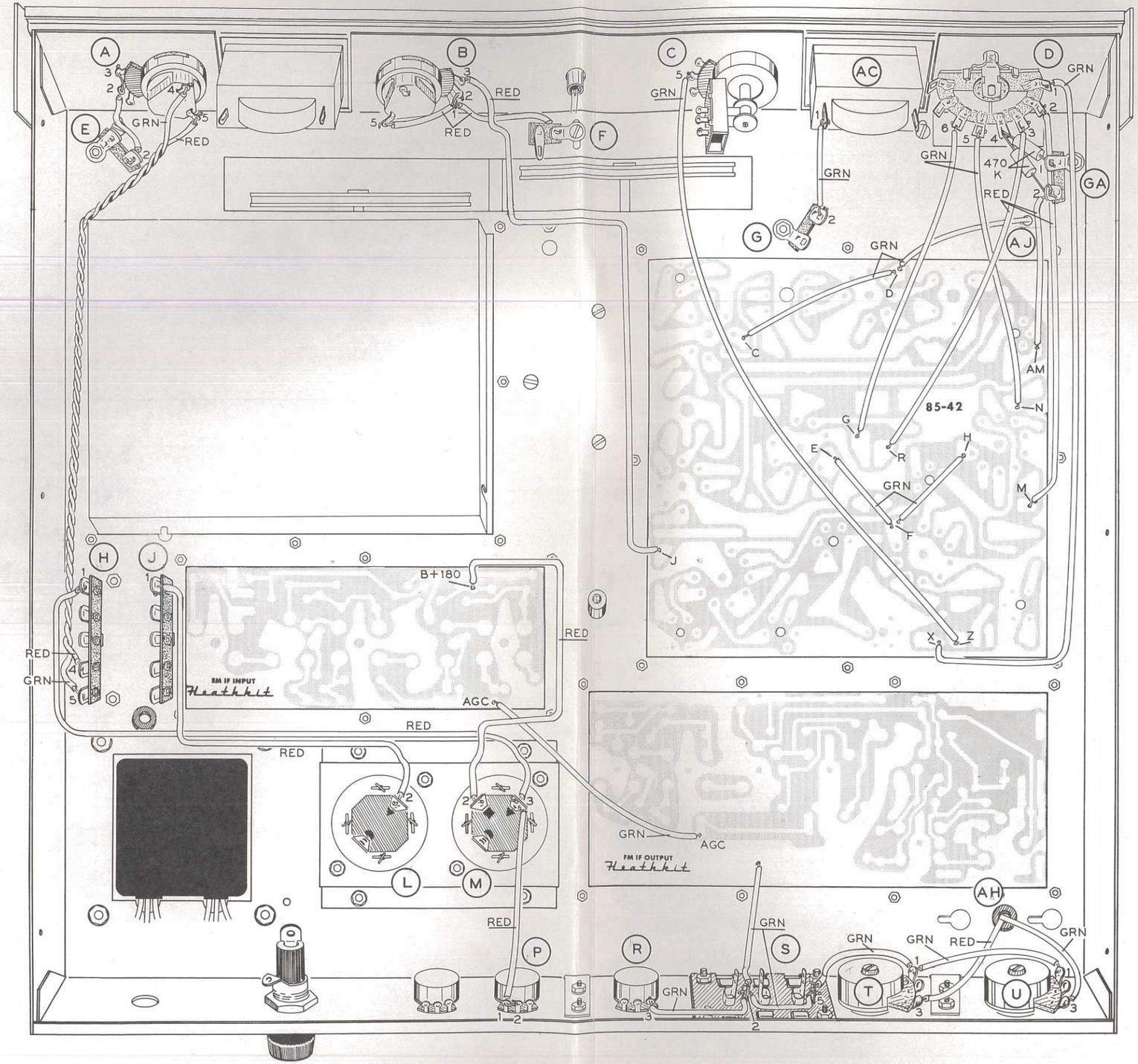
( ) Strip a total of 1/2" of insulation from one end of a 2-3/4" red wire and insert this end through lug 1 (NS) to lug 2 (S-1) of control B. Connect the other end of this wire to the hole in the mounting foot of terminal strip F (NS).

( ) Connect a 1-1/2" red wire from lug 1 (S-3) to lug 5 (S-1) of control B.

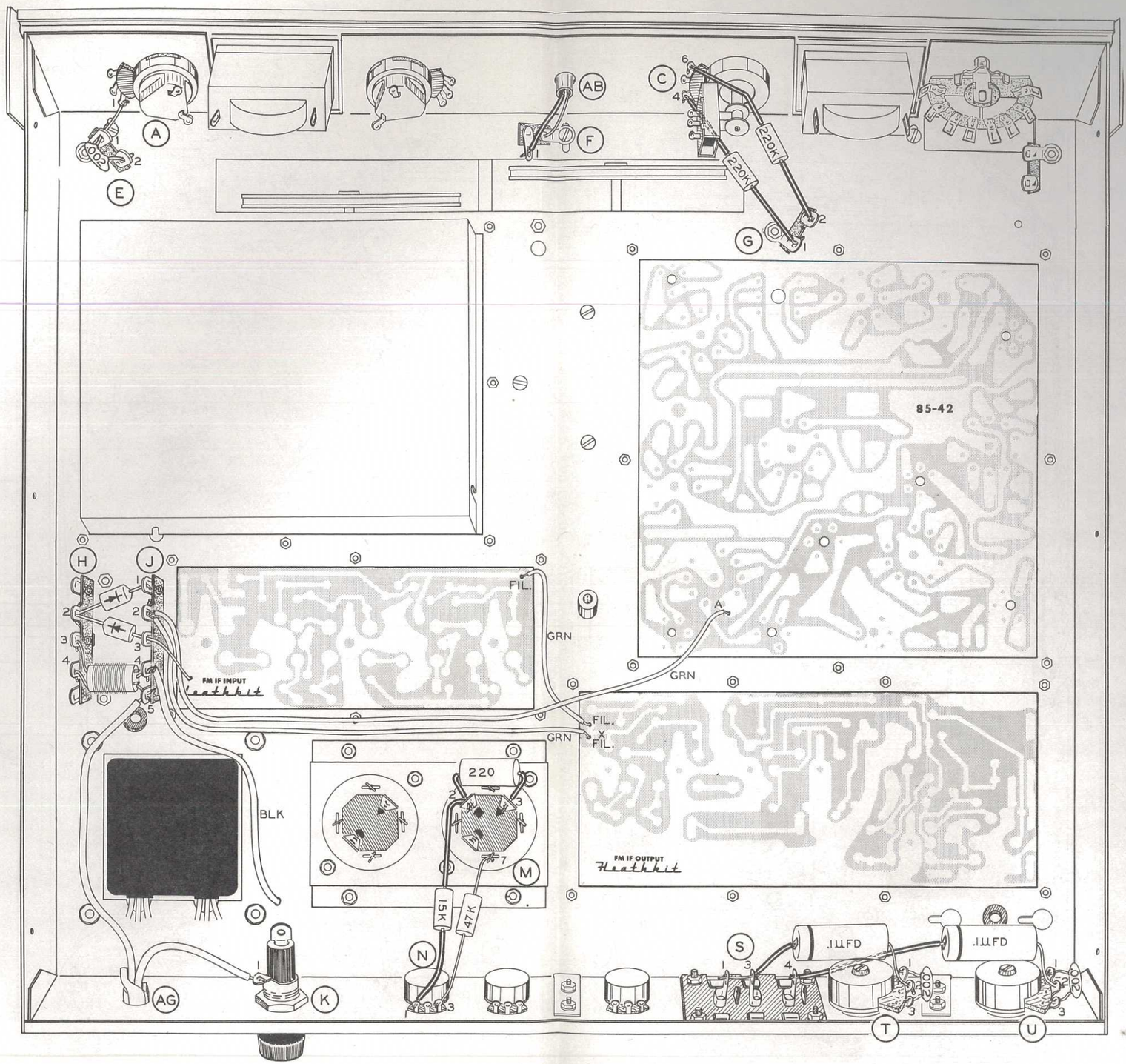
( ) Strip a total of 1/2" of insulation from one end of a 2" green wire and insert this end through lug 2 (NS) to lug 3 (S-1) of control A. Now solder lug 2 (S-2). Connect the other end of this wire to lug 2 of terminal strip E (NS).

( ) Twist a 10" green wire and a 10" red wire together with about 2 turns per inch.

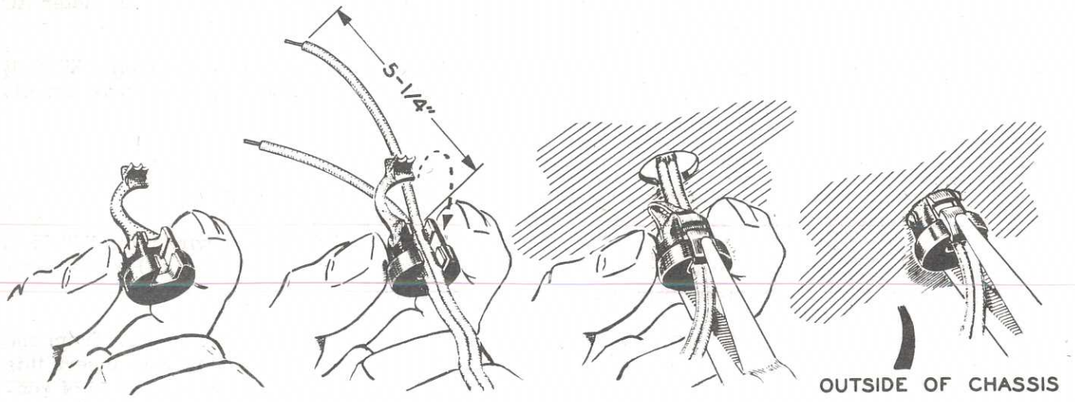
( ) At one end of this twisted pair, connect the green wire to lug 4 (S-1) and the red wire to lug 5 (S-1) of control A. At the other end, connect the green wire to lug 5 (S-2) and the red wire to lug 4 (NS) of terminal strip H. Route this twisted wire as shown.



Pictorial 11



Pictorial 12



Detail 12A

Refer to Pictorial 12 (fold-out from Page 42) for the following steps.

( ) Place the line cord strain relief on the line cord at a point 5-1/4" from the bare end as shown in Detail 12A. Now separate the insulation between the two line cord wires up to the strain relief. Cut off 2-1/2" of wire from one of the line cord wires and strip off 1/4" of insulation from the end. Now melt a small amount of solder on the end of both bare line cord wires.

( ) Insert the line cord and strain relief at AG on the rear apron of the chassis as shown in Detail 12A.

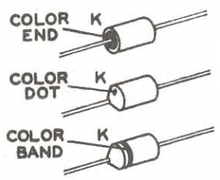
( ) Connect the shorter line cord wire to lug 1 of the fuse holder (S-1) and the longer wire to lug 5 of terminal strip J (NS).

( ) Connect a 3-1/8" green wire between the holes marked "FIL" on the FM input IF (S-1) and FM output IF (S-1) circuit boards. Route this wire under the red and red-white wires.

( ) Connect a 7-5/8" green wire from lug 2 of terminal strip J (NS) to the hole marked "X FIL" on the FM output IF circuit board (S-1).

( ) Connect a 10-1/8" green wire from lug 2 of terminal strip J (S-3) to the hole marked "A" on the AM-Multiplex circuit board (S-1).

( ) Insert the lead on the unmarked end of a silicon diode through lug 3 of terminal strip J (NS) to the nearest small unmarked hole on the FM input IF circuit board (S-1). Now solder lug 3 of J (S-3). Connect the other diode lead (the marked end) to lug 2 of terminal strip H (NS).



NOTE: WHEN INSTALLING SILICON DIODES, THE CATHODE END SHOULD BE PLACED AS DIRECTED. THE CATHODE END IS MARKED WITH EITHER COLOR END, COLOR DOT, OR COLOR BAND. IN THE ILLUSTRATIONS, THE SYMBOL K INDICATES THE CATHODE END.

( ) Connect the lead on the marked end of the remaining silicon diode to lug 1 of terminal strip J (S-2). Connect the other lead of the diode to lug 2 of terminal strip H (S-3).

( ) Position the FM line cord antenna coil (#40-149) between terminal strip H and J as shown in Pictorial 12. Connect the two leads nearest terminal strip H to lugs 3 (S-1) and 4 (S-2) as shown. Connect the other two leads to lugs 4 (NS) and 5 (S-2) of terminal strip J.

( ) Cut a 7-1/2" length of stranded hookup wire and strip 1/4" of insulation from each end. Melt a small amount of solder on the exposed stranded wires and connect one end to lug 4 of terminal strip J (S-2). Insert the other end through the hole under the fuse holder and leave it free to be connected later. Save the remaining length to be used later.

( ) Connect a 47 KΩ (yellow-violet-orange) 1/2 watt resistor from lug 3 of control N (S-1) to lug 7 of capacitor M (S-3).

( ) Connect a 15 KΩ (brown-green-orange) 1/2 watt resistor from lug 1 of control N (S-1) to lug 2 of capacitor M (NS). Use sleeving on both leads.

( ) Connect a 220 Ω (red-red-brown) 2 watt resistor between lugs 2 (S-5) and 3 (S-3) of capacitor M. Use sleeving on both leads.

( ) Connect a .002 μfd disc ceramic capacitor between lugs 1 (S-3) and 3 (S-2) of control T.

( ) Connect another .002 μfd disc ceramic capacitor between lugs 1 (S-2) and 3 (S-2) of control U.

( ) Connect the lead on the banded end of a .1 μfd tubular capacitor (or shouldered end) to lug 4 of phono connector S (S-1). Use sleeving on this lead and position the capacitor as shown in Pictorial 12. Connect the other lead to lug 2 of control U (S-1).

( ) Insert the lead on the banded or shouldered end of the remaining .1 μfd tubular capacitor through lug 3 (NS) to lug 1 (S-1) of phono connector S. Now solder lug 3 (S-2). Use sleeving on this lead and note the position of the capacitor. Connect the other lead to lug 2 of control T (S-1).

( ) Connect a 220 KΩ (red-red-yellow) 1/2 watt resistor from lug 1 of terminal strip G (S-1) to lug 4 of control C (S-1). Use sleeving on both leads.

( ) Connect another 220 KΩ (red-red-yellow) 1/2 watt resistor from lug 2 of terminal strip G (S-3) to lug 6 of control C (S-1). Use sleeving on both leads and position the resistor as shown.

( ) Pass one lead of a .002 μfd disc capacitor through lug 1 of terminal strip E (NS) to lug 1 of control A (S-1). Connect the other lead of this capacitor to lug 2 of terminal strip E (S-4). Now solder lug 1 of terminal strip E (S-2).

( ) Connect one of the stereo indicator lamp leads to the hole in the mounting foot of terminal strip F (S-2).

( ) Connect the other stereo indicator lamp lead to lug 1 of terminal strip F (S-2). Use sleeving on this lead.

CHASSIS TOP WIRING

Refer to Pictorial 13 for the following steps.

( ) Insert the free end of the green wire coming from hole AJ of the chassis through the top right corner hole of the dial parts mounting bracket and connect it to lug 1 of socket PL1 (NS).

( ) Connect a 5" green wire from lug 1 of PL1 (S-2) to lug 1 of PL2 (NS).

( ) Connect a 3-3/4" green wire from lug 1 of PL2 (S-2) to lug 1 of PL3 (NS).

( ) Connect a 5" green wire from lug 1 of PL3 (S-2) to lug 1 of PL4 (S-1).

( ) Connect a 2" red wire between lug B of the AM tuning capacitor (S-1) and the hole marked "TUNE B" of the AM-Multiplex circuit board (S-1).

( ) Connect a 2-1/4" red wire between lug C of the AM tuning capacitor (S-1) and the hole marked "TUNE C" of AM-Multiplex circuit board (S-1).

( ) Connect a 2-1/4" red wire between lug A of the AM tuning capacitor (S-1) and the hole marked "TUNE A" of the AM-Multiplex circuit board (S-1).

( ) Connect a 4-3/8" red wire from the hole marked "RED" (S-1) to the other hole marked "RED" (S-1) of the AM-Multiplex circuit board.

( ) Connect a 3-3/8" green wire from the hole marked "GRN" on the AM-Multiplex circuit board (S-1) to the hole marked "GRN" on the FM output IF circuit board (S-1).

( ) Mount the two #45-48 chokes at positions BK and BL. Align the mounting tab of each choke with the cutout in the chassis. Press down on the choke until the locking clips snap into place. See Detail 13A.

( ) Connect a 200 $\mu\mu$f mica capacitor between lugs 1 (NS) and 2 (NS) of coil BK.

( ) Connect a 200 $\mu\mu$f mica capacitor between lugs 1 (NS) and 2 (NS) of coil BL.

( ) Connect the black wire coming from grommet AH to lug 1 of coil BK (S-2).

( ) Connect the red wire coming from grommet AH to lug 2 of coil BK (S-2).

( ) Connect the green wire coming from grommet AH to lug 1 of coil BL (S-2).

( ) Connect the brown wire coming from grommet AH to lug 2 of coil BL (S-2).

( ) Connect the long wire coded with red paint, that comes from the rod antenna, to the hole marked "ANT RED" of the AM-Multiplex circuit board (S-1).

( ) Connect the other long rod antenna wire to the hole marked "ANT" on the AM Multiplex circuit board (S-1).

( ) Connect the short wire coded with black paint coming from the rod antenna to lug 3 of terminal strip BH (S-1).

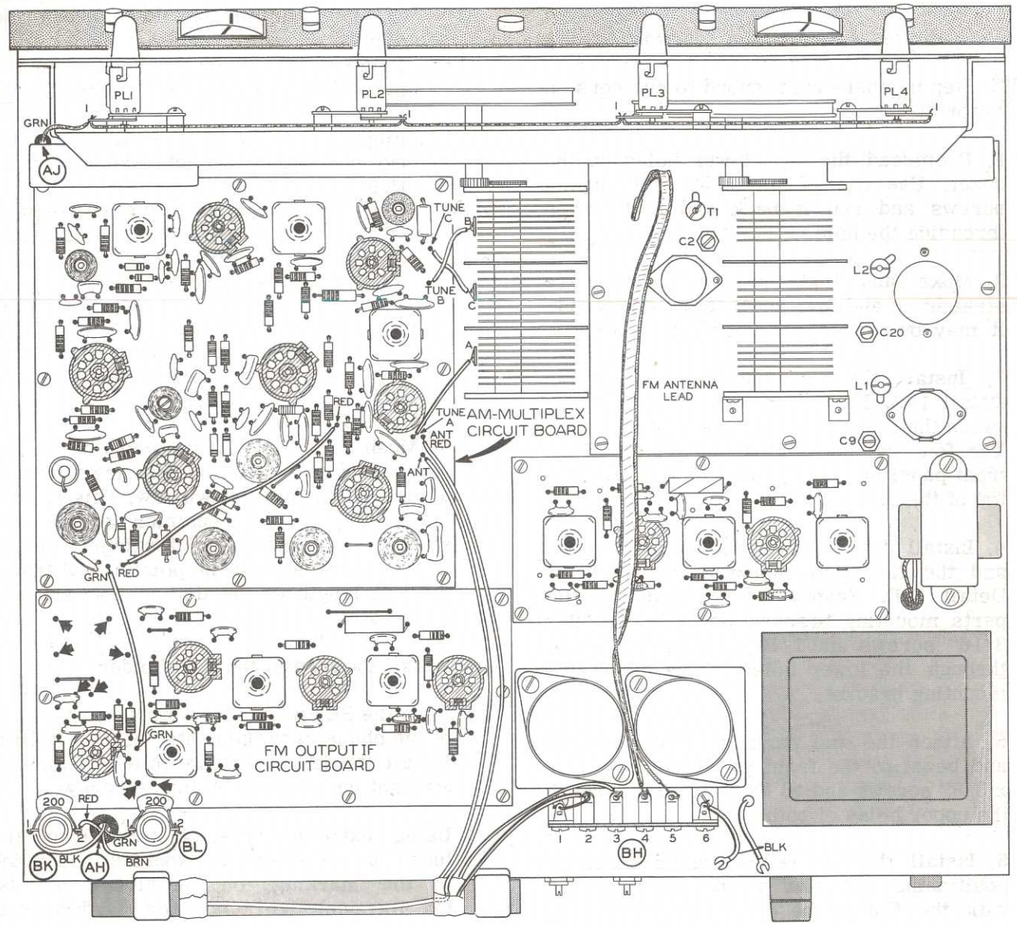
( ) Connect the remaining rod antenna wire to lug 2 of terminal strip BH (NS).

( ) Strip all the insulation from a 5/8" wire and connect this bare wire between lugs 1 (S-1) and 2 (S-2) of terminal strip BH.

( ) Connect the FM antenna twin-lead coming from the FM front end to lugs 4 (S-1) and 5 (S-1) of terminal strip BH.

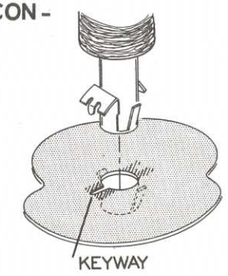
( ) Install a spade lug on the end of the stranded wire coming through the chassis near the power transformer (S-1).

( ) Install a spade lug on one end of the remaining length of stranded wire (S-1). Connect the other end to lug 6 of terminal strip BH (S-1).



NOTE: THE BLACK ARROWS (➡) INDICATE EIGHT HOLES ON THE FM OUTPUT IF CIRCUIT BOARD THAT WILL HAVE NO CONNECTION TO THEM.

Pictorial 13



Detail 13A

DIAL WINDOW AND BEZEL ASSEMBLY

Refer to Pictorial 14 for the following steps.

NOTE: Step numbers correspond to numbers on the Pictorial.

(✓) 1. Prethread the two lower holes on the bezel. Use one of the 6-32 self-tapping screws and run it back and forth when threading the hole.

(✓) 2. Make sure that the dial pointers are straight up and down and that they do not rub. It may be necessary to bend them slightly.

(✓) 3. Install the dial window as shown in Detail 14A. The bottom edge is located between the front panel and the control cover. The four raised sections on the top of the front panel are positioned in the slots on the top of the dial window.

(✓) 4. Install the bezel between the front panel and the dial parts mounting bracket. See Detail 14B. Fasten the bezel to the dial parts mounting bracket, using two 6-32 x 3/16" screws and 1/16" spacer washers, through the lower holes in the dial parts mounting bracket.

(✓) 5. Attach the dial parts mounting bracket and bezel to the front panel with two 6-32 x 3/8" screws and #6 lockwashers, through the upper holes of both parts.

(✓) 6. Install the two larger tuning knobs by positioning the flat of the knob in line with the flat of the dial drive shafts and pushing them onto the shaft.

(✓) 7. In a like manner, install the four switch and control knobs.

( ) 8. Install the nameplate as follows:

A. The surface to which the nameplate is to be applied should be clean and dry.

B. Remove the paper backing from the nameplate. A pin or pointed knife can be used to remove any paper that might remain in back of the nameplate. Do not touch the adhesive with your fingers.

C. Apply the nameplate to the control panel, completely covering the printed outline. Use even finger pressure; this is the key to good adherence.

(✓) Now tighten the three #6 x 3/8" sheet metal screws that were used temporarily to hold the front panel to the chassis. See step 5 on Pictorial 9.

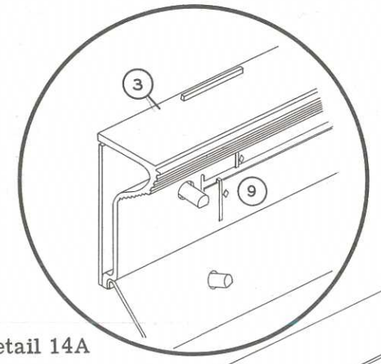
(✓) 9. Mesh (close) both tuning capacitor plates and align the pointers over their respective diamonds on the dial window. This is done by sliding the dial pointer on the dial string. Now crimp the pointer fingers tighter if necessary so that the pointer will travel the full length of the dial without slipping on the string.

( ) Install the fuse in the fuse holder.

(✓) Turn the SEPARATION control (on the rear of the chassis) to the center of its rotation. Install the knob with the white dot pointing straight up, and tighten the setscrew.

( ) Using extreme care, install all of the tubes in their proper sockets according to the markings on the circuit boards. Do not push the tubes too hard as this could crack a circuit board. Support the circuit boards from the bottom when installing the tubes.

This completes the assembly of your Tuner. Proceed to Initial Test.



Detail 14A

Pictorial 14

Detail 14B

INITIAL TESTING AND ADJUSTMENTS

Carefully inspect the wiring of the Tuner for any obvious short circuits, loose wire clippings, or solder splashes; especially recheck the silicon diode rectifiers to make sure they are properly installed.

( ) Place the controls in the following positions.

POWER - in
AFC - OFF
FM STEREO PHASE - in, and at half rotation point.
AM FIDELITY - in
FM SQUELCH - OFF
MODE SELECTOR - AM
Level Controls - Maximum clockwise

( ) Connect one of the prepared audio cables from the FM "A" output socket of the Tuner to the left channel input socket of the amplifier. Connect the other audio cable from the FM "B" output socket to the right channel input socket of the amplifier. See Figure 19.

( ) Plug the Tuner into a 117 V AC outlet and pull the POWER switch out. The dial lamps and tubes should light. If difficulty is encountered, turn the Tuner off and refer to the In Case of Difficulty section on Page 60 of the manual.

( ) If no difficulty is experienced in the preceeding step, rotate the AM TUNING control over its entire range.

Strong local stations should be heard, even though they might appear to be off frequency according to the dial markings.

( ) If there is a FM station in your area, connect the FM line antenna and the ground lead to the FM antenna screws. Connect a 300 Ω FM or TV antenna to the FM antenna screws if only distant FM stations are available. See Figure 19 on Page 52. Switch the MODE SELECTOR switch to FM. Turn the FM TUNING control to tune in a station. Find the correct frequency of this station in the radio listing of your local newspaper, then slide the dial pointer to indicate the correct frequency. Now crimp the fingers of the dial pointer to the dial cord. Be careful not to cut the dial cord.

( ) The FM section of the Tuner is completely prealigned and should require no adjustment. If improper operation definitely indicates that alignment is necessary, refer to the FM Alignment section on Page 57 of the manual.

( ) Install the tube shields on all tubes except V15. Be sure the ground clips are between the shield and the tubes.

AM TUNING METER ADJUSTMENT

Place the MODE SELECTOR switch in the AM position. Turn the AM TUNING control until the Tuner is off station at a quiet point on the dial. Adjust the AM METER control so that the meter indicator is at the left edge of the arrow.

FM TUNING METER ADJUSTMENT

Place the MODE SELECTOR switch in the FM position and tune the FM TUNING control until the tuner is off station at a quiet point on the dial (minimum meter deflection). Adjust the FM METER control so that the meter indicator is at the left edge of the arrow.

ALIGNING THE AM TUNING SECTION

If you have encountered no difficulty, you may assume that the Tuner is wired correctly and that the components are operating properly. The FM section as well as the AM coils and transformers of the tuner are prealigned. However, it would be impossible to prealign the AM tuning capacitor since it is installed separately.

Alignment of the AM tuning section may be accomplished quite easily, there are two general methods. One uses instruments and the other does not use instruments. Instrument alignment may show some improvement over alignment without instruments; satisfactory results, however, should be obtained with either procedure. The alignment procedure without instruments is given in the following paragraphs. If you wish to align this AM tuning section with instruments, refer to the Alignment section on Page 57 of this manual.

ALIGNMENT WITHOUT INSTRUMENTS

Turn the Tuner on and place the MODE SELECTOR switch in the AM position. Allow the tuner to operate for at least 30 minutes before starting the alignment. This warmup time will allow all parts to reach their normal operating temperature.

( ) Push in the AM FIDELITY switch.

( ) Tune in a station of known frequency near 1400 kc on the dial.

NOTE: In the following steps, refer to the chassis lettering and to Figure 18 for the location of the coils and tuning capacitor trimmers. Tube V1, the 6BZ8 or 6BS8 may be removed for ease in adjustment. CAUTION: Make sure the FM tuning capacitor plates are fully meshed (closed) to prevent damage while adjustments are being made.

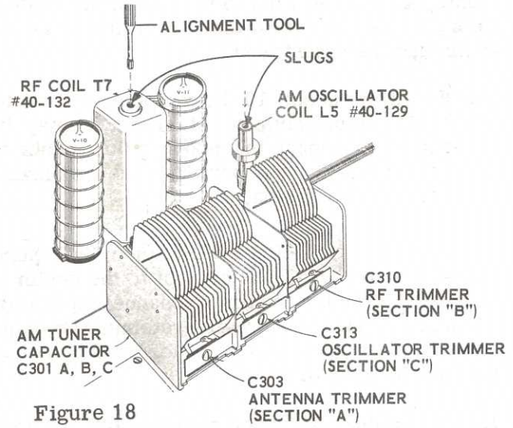


Figure 18

( ) If the correct frequency of the known station is higher than the dial pointer now indicates, turn oscillator trimmer C313 clockwise until the station is received with the dial pointer at the correct marking on the dial.

( ) If the station's correct frequency is lower than the dial pointer now indicates, turn trimmer capacitor C313 counterclockwise until the station is received at the correct marking on the dial.

( ) Adjust RF trimmer C310 and antenna trimmer C303 for the loudest and clearest audio output.

( ) Repeat the preceding alignment procedure in the same order. This time, observe the AM TUNING meter and peak each trimmer for maximum meter indication.

Now detune the station by turning the AM TUNING control, and without looking at the dial pointer, retune the station for maximum meter indication. Check the dial pointer setting. If it has returned to the proper frequency setting, continue with the rest of this alignment procedure; if not, repeat the adjustments of trimmers C313, C310, and C303 until the dial pointer falls at the correct frequency of the known station with maximum tuning meter indication.

( ) Tune in a station of known frequency near 600 kc. The station and dial frequency should agree. Unless there is a large difference between the station frequency and the dial pointer indication, no adjustment should be made. If some adjustment is necessary, first set the dial pointer to the proper frequency marking with the AM TUNING control; adjust the slug of oscillator coil L5, using the plastic alignment tool, for maximum tuning meter indication. Next, adjust the slug of RF transformer T7 for maximum tuning meter indication.

( ) Recheck the station near 1400 kc to make sure that the setting has not changed. If it has changed, repeat the entire alignment procedure until there is no difference between the dial pointer settings and the correct station frequencies.

( ) The AM IF transformers may be adjusted using the signal from a station. First, tune in a station with a weak interference-free signal at, or near, the low end of the band. Use the plastic alignment tool to adjust the top and bottom slugs of transformers T8 and T9 for maximum indication on the tuning meter.

This completes the alignment of the AM portion of the Tuner.

FM DISCRIMINATOR ADJUSTMENT FOR PROPER AFC ACTION

A simple test for proper AFC action and discriminator adjustment can be made as follows. Turn the AFC control full counterclockwise to its OFF position, and carefully tune in a station for maximum meter deflection. Now turn the AFC control fully clockwise to its MAX position while watching the tuning meter. If the meter indication does not change, the discriminator adjustment is correct. If the change is a pointer-width or more, adjust the discriminator transformer T6 (#53-3) as follows.

With the AFC off, tune in a station for maximum meter deflection. Now turn the AFC on and carefully insert the long end of the alignment tool down through the top slug of T6 to engage the bottom slug. Rotate the slug slightly (not more than one-quarter turn) in either direction while watching the tuning meter. If this causes the reading of the meter to increase, continue rotation in this direction to the point where maximum meter deflection is achieved. If the meter indication decreases, rotate the slug in the reverse direction and adjust for maximum deflection of the meter. Normally, one-half to one turn of the slug is all that will be required.

AM WHISTLE FILTER ADJUSTMENT

If no oscillator or meter is available for the following adjustment, leave the coil at its preadjusted position. This preadjusted position will give good performance in most cases.

Connect an audio oscillator through a .01 μfd capacitor to test point #5 (see Page 68). Tune the oscillator to 10 kc and adjust the output to about 1 volt. Connect an AC meter to one of the output jacks on the tuner, and adjust the slug of L6 for minimum output.

FM STEREO MULTIPLEX ADJUSTMENTS

Place the MODE SELECTOR switch in the STEREO position. Tune in a station that is known to be broadcasting a stereo multiplex signal. Set the SEPARATION control to the center of its range. Pull the FM STEREO PHASE knob "out" and set the control to the center of its range. The station should now be producing a sound output in each speaker. This sound may be garbled or distorted, but this will be taken care of by adjusting the oscillator coil.

A stereo signal must be used to make the following adjustments. If the station you have tuned in is broadcasting a monophonic (non-stereo) signal, there will be very little sound from the speaker systems. If this is the case, and no stereo program is being broadcast, tune the FM tuner to a station that usually broadcasts stereo. Leave the Tuner on, with the FM STEREO PHASE knob pulled "out". Now nothing will be heard from the speakers until a stereo signal is received.

When a stereo signal is received, insert the alignment tool in the slug of coil L9. Now carefully adjust the slug (not more than one turn in either direction) first in one direction and then in the other, until you hear the clearest reproduction from the speaker systems. If there are two or three maximum loudness points, adjust the slug to the one in the center. Remove the alignment tool carefully so as not to disturb the adjustment.

NOTE: After about 10 hours of operation to allow all components to stabilize, it may be necessary to repeat the above adjustments to assure continued good performance and maximum stereo separation.

Push the FM STEREO PHASE knob "in." Next, adjust the SEPARATION control to the center of its rotation, or for maximum channel separation as heard from the speaker systems. Maximum channel separation can be recognized by one of the following conditions:

1. Maximum difference between the program material heard from the left and right speaker systems.

2. In instances when the FM station broadcasts material on only one channel, set the CHANNEL SEPARATION control for minimum sound from one of the speaker systems.

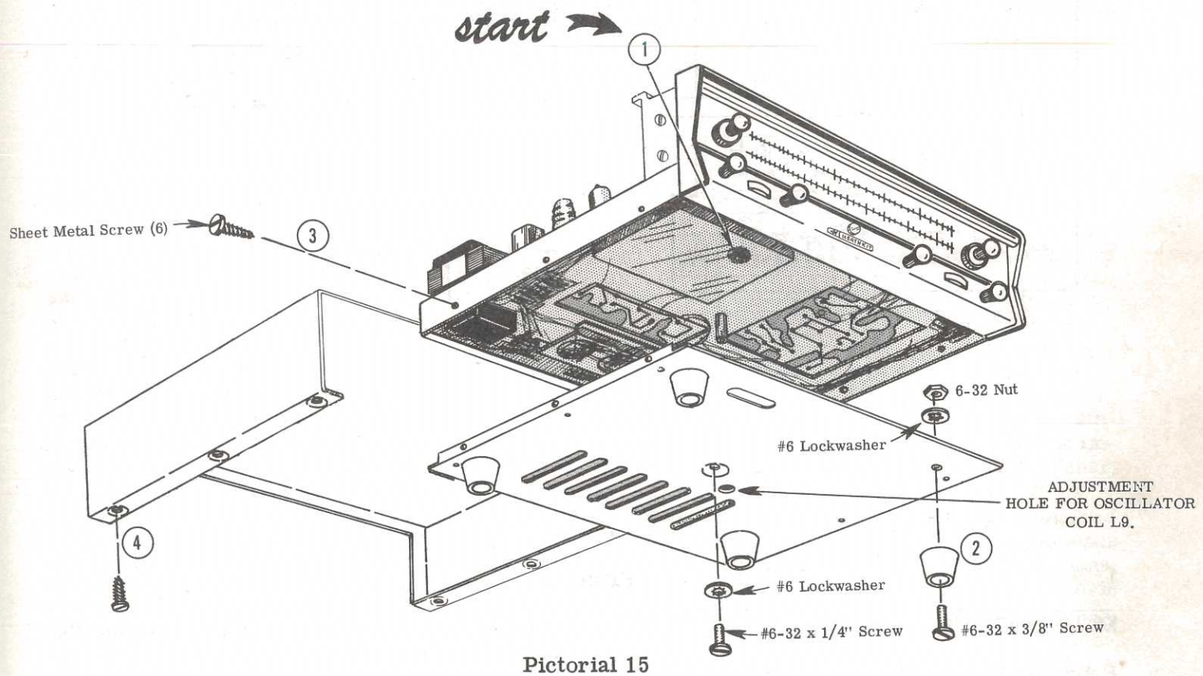
Once the CHANNEL SEPARATION control has been set properly, it should not have to be readjusted.

Next, adjust the slug of coil L7 for the brightest glow of the STEREO indicator lamp.

LEFT AND RIGHT LEVEL CONTROL ADJUSTMENT

Tune in any monophonic AM or FM station. Adjust the LEFT and RIGHT LEVEL controls for equal output levels from both speaker systems. This adjustment should be done with a low level signal, one which does not overdrive the input stage of the amplifier and cause distortion.

FINAL ASSEMBLY



Pictorial 15

If the tuner is to be panel mounted, install the bottom cover without the feet, then follow the instructions given in the INSTALLATION section.

If the tuner is to be used with the cover installed, proceed as follows.

Refer to Pictorial 15 for the following steps.

( ) 1. Remove the backing from the felt spacer and stick the spacer to the bottom surface of the preassembled FM front end. This spacer should be positioned just behind the FM tuning drum.

( ) 2. Mount the four plastic feet as shown. Use 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts.

( ) 3. Mount the bottom plate to the chassis using six sheet metal screws and one 6-32 x 1/4" screw with lockwasher. The edge of the bottom cover must fit inside the bottom edge of the control panel.

( ) 4. Slide the cover over the tuner from the back and fasten to the bottom plate using six sheet metal screws

This completes the assembly of the Tuner.

INSTALLATION

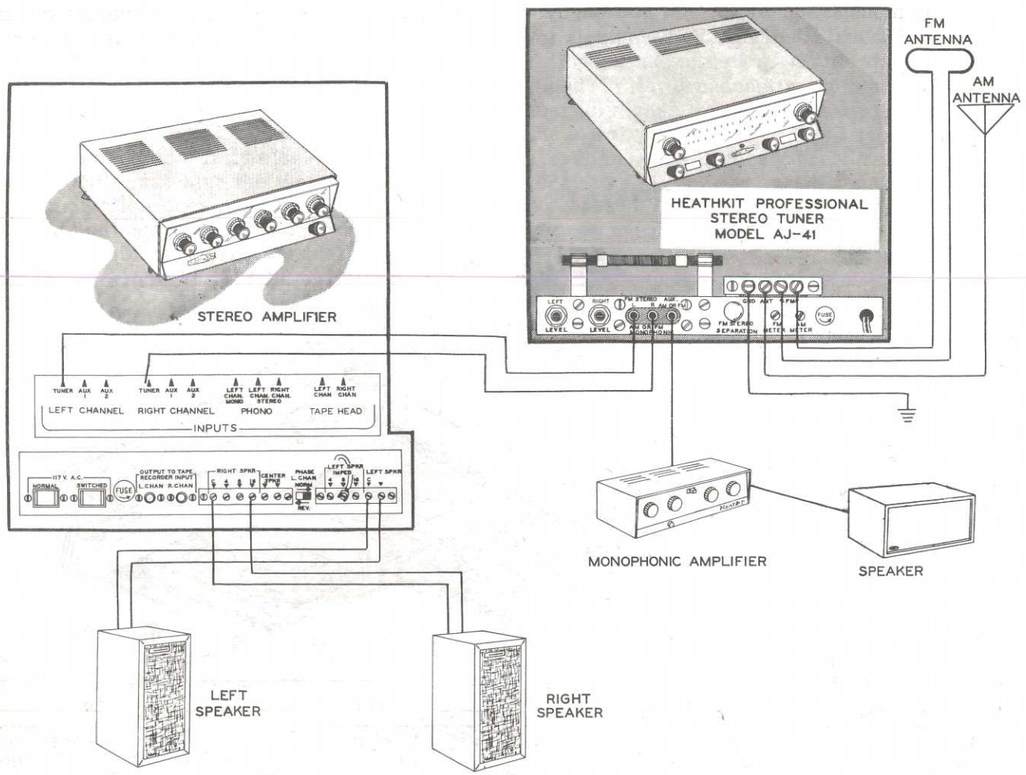


Figure 19

MOUNTING THE TUNER

Refer to Figure 19 for aid in installing the tuner in your system.

One of the main considerations in mounting the Tuner is to make sure there is adequate ventilation. Do not enclose the Tuner so that the heat from the tubes will not be able to flow away in a normal manner.

The Tuner can be panel mounted in a custom installation by removing the feet and the cabinet.

It is not recommended that the Tuner be vertically mounted, hanging from the front panel alone. Some other means of added support will be necessary to hold the Tuner up, keeping the weight off of the front panel. Also, provisions should be made to allow the trapped heat to flow out from under the front panel.

AUDIO CONNECTIONS

Connect one of the audio cables from the LEFT output socket of the Tuner to the left channel tuner input of your amplifier. Connect the other audio cable from the RIGHT output socket of the Tuner to the right channel input of your amplifier.

The AUX output socket can be connected to a monophonic amplifier to supply AM or FM to a monophonic sound system such as home music or intercom system.

INSIDE ANTENNAS

Both the AM and FM sections of the Tuner contain built-in antennas. The AM section has a rod antenna mounted on the rear of the tuner. The signal response of this rod antenna may be directional.

For best AM operation, the Tuner should be positioned to keep the rod antenna well away from large metallic objects and house wiring, which can radiate a substantial amount of noise.

The FM section contains a coil that picks up the FM signals present on the power lines. This "line cord antenna" may be connected to the antenna terminals with the two stranded hookup wires near the antenna terminals.

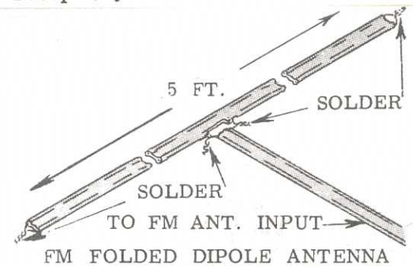
OUTSIDE ANTENNAS

To receive the weaker stations, or in weak signal areas, an external antenna will be necessary.

An AM antenna, consisting of a long wire placed as high above the ground as possible, connected to the AM antenna terminal at the rear of the Tuner, should improve AM reception. A ground connection should then be made by connecting a wire from the "GND" terminal to a ground rod or cold water pipe.

A TV antenna can always be used as an FM antenna since the FM stations are actually tuned in between TV channels 6 and 7. Do not hook a TV antenna to both the TV set and the FM Tuner at the same time unless a TV antenna coupler is used. If the two units are both connected to the antenna without a TV coupler to separate them, a weak and distorted signal will result on both units.

A simple folded dipole antenna can be made of standard 300 Ω twin lead as shown in Figure 20. This antenna can be placed on the rear of a large cabinet or nailed or stapled to a piece of wood to reinforce it. Keep the antenna broadside to the stations you wish to receive for best reception.



FM FOLDED DIPOLE ANTENNA MADE FROM 300 OHM TWINLEAD TRANSMISSION LINE

Figure 20

Best reception of all would be from a commercial FM outside antenna with a 300 Ω impedance to match the antenna input of the Tuner.

Be sure that the leads of the internal antenna of the Tuner are disconnected from the antenna terminals before connecting an external antenna. It is also advisable to use approved TV lead-in lightning arrestors with an outside antenna.

OPERATION

FRONT PANEL CONTROLS

POWER SWITCH

The POWER switch is a push-pull switch located on the rear of the AFC control. The knob should be pulled OUT to turn the Tuner ON and pushed IN to turn the Tuner OFF.

AFC CONTROL

The AFC control is used to vary the amount of AFC (automatic frequency control) voltage required for minimum drift and ease of tuning. In the OFF position there is no AFC; in the MAX position, full AFC is applied to the tuning unit.

It is often difficult when using the same amount of AFC, to tune in a weak station that is near a strong station. This is because the AFC tries to "lock in" on the strong station. Turning the AFC "OFF" makes possible the sharper, more careful tuning that is needed for weak stations. Turning the AFC control up again should "lock in" the weak station.

FM STEREO PHASE CONTROL AND SWITCH

This control and switch are used only when tuned to a FM stereo station. To set this control the knob should be pulled OUT, to activate the switch. In this position, only the subchannel information will be heard (see Circuit Description).

The STEREO PHASE control is adjusted, first in one direction and then in the other, until you hear the clearest reproduction from the speaker systems. If there are two or three maximum points, adjust the control to the center maximum point.

Push the knob back in without disturbing the setting of the control. This control allows the user to obtain maximum separation. It should be adjusted each time a stereo station is tuned in.

NOTE: If this adjustment can not be made, return to the section entitled "FM Stereo Multiplex Adjustments" on Page 50, and repeat the adjustment of coil L9 as described there. If the cabinet and bottom plate are on the unit, this adjustment can be made through the round hole in the bottom plate. See Pictorial 15.

STEREO INDICATOR LAMP

This indicator will light up with a steady glow when a FM station that is broadcasting stereo is tuned in. In some cases it may flicker on noise between stations. It may also light for short periods of time on stations that use a "Commercial Killer" signal to eliminate the commercials from the music so that it may be sold to business establishments.

AM FIDELITY SWITCH

The AM FIDELITY switch selects a normal bandwidth (IN position) or a broad, high fidelity bandwidth (OUT position) for the AM section of the Tuner.

FM SQUELCH CONTROL

The FM SQUELCH control is used to adjust the squelch circuit to eliminate the noise that is heard when tuning between stations. This control should be adjusted in a clockwise direction only far enough to eliminate the noise between stations. If it is turned to MAX, only the strong stations will be heard. To receive a very weak station, it may be necessary to turn the control completely off.

MODE SELECTOR SWITCH

The MODE SELECTOR switch selects the desired signals and connects them to the output jacks at the rear of the Tuner.

In the FM position, the same monophonic signal is present at the LEFT, RIGHT and AUX output jacks.

In the AM position, the AM signal is present at the LEFT, RIGHT and AUX output jacks.

In the STEREO position one channel signal is at the LEFT output jack, and the other channel signal is at the RIGHT and AUX output jacks. NOTE: The stereo position should be used only when a station is broadcasting stereo so that the multiplex noise is not present on regular FM programs.

AM TUNING METER

The AM TUNING meter indicates how strong the signal is that is being received from the tuned-in AM station. Each AM station should be tuned for maximum indication (strongest signal) on the meter.

FM TUNING METER

The FM TUNING meter indicates the signal strength of the tuned-in FM station. Each FM station should be tuned for maximum indication on the meter.

AM AND FM TUNING CONTROLS

By turning the TUNING controls you can change the dial setting to select the station you desire to listen to. The AM TUNING selects the AM stations, and the FM TUNING selects the FM stations.

REAR PANEL CONTROLS

LEFT AND RIGHT LEVEL CONTROLS

These controls are adjusted so that each output jack of the Tuner will give the same amount of audio signal to the inputs of the amplifier.

FM STEREO SEPARATION CONTROL

The FM STEREO SEPARATION control is adjusted for maximum stereo channel separation in your system. Normally the control will be set to about the center of its rotation. Usually once it is adjusted, it need not be changed. Maximum channel separation can be recognized by one of the following conditions:

1. Maximum difference between the program material heard from the left and right speaker systems.

2. In instances when the FM station broadcasts material on only one channel, set the CHANNEL SEPARATION control for minimum sound from one of the speaker systems.

AM AND FM METER CONTROLS

These controls determine the operating range of the meters. They should be adjusted according to the TUNING METER ADJUSTMENT instructions given previously in the manual.

HOW TO GET THE MOST OUT OF YOUR TUNER

The following procedure is presented to help the new user realize the most enjoyment that this high quality Stereo Tuner is capable of providing. The Tuner should be connected, as illustrated, to a good quality stereo amplifier or two separate amplifiers. The speakers should be placed far enough apart to provide good stereo separation; approximately 4 to 8 feet.

1. Set the Tuner controls as follows:

   POWER switch pulled out to ON
   AFC control to OFF
   FM STEREO PHASE control in and set it to the center of its range
   AM FIDELITY in
   FM SQUELCH to OFF
   MODE SELECTOR to FM
   Separation control (on rear apron) to the center of its range

2. Tune in a station broadcasting stereo as indicated by a steady glow of the STEREO TUNER indicator and maximum deflection of the FM TUNING meter. NOTE: In order to reduce the inherent noise in the multiplex system, the selected station signal must be strong enough to produce at least 1/3 scale deflection of the FM TUNING meter.

3. Adjust the Level controls of the amplifier to produce equal volume from each speaker at the desired listening level.

4. Make sure that the speakers are in phase. This can be accomplished by standing between the speakers and switching the polarity of the voice coil leads on one of the speakers. The connections that give the indication that the sound comes from between the speakers is correct. Most HEATHKIT stereo amplifiers have a phase switch to reverse the speaker leads.

5. Turn the MODE SELECTOR switch to the STEREO position.

6. Pull out the FM STEREO PHASE knob and carefully adjust it, first in one direction and then in the other, until you hear the clearest reproduction from the speaker systems. If there are two or three maximum points, adjust the control to the center maximum point. Now push the knob in without disturbing the setting of the control.

   NOTE: This control adjusts the frequency and phase of the 38 kc reinserted carrier. Because the phase angle of this carrier is critical (±3 degrees) it may be necessary to periodically repeat step 6 to obtain maximum separation.

7. The Separation control on the rear apron should be left in the middle of its range unless there is program material on one channel only, such as commercials and announcements that are switched from one channel to the other; thus the sound will come from only one speaker. If the station you are listening to broadcasts in this manner the Separation control should be adjusted for minimum output in the channel not being used. Once this adjustment is made, the control should always be left in that position.

8. Turn the AFC control to MAX. This control should always be in this position unless you want to tune in a weak station adjacent to a strong station.

9. Turn the FM TUNING off station so that only a loud hiss is heard. Now adjust the FM SQUELCH control clockwise until the loud hiss is no longer heard. The FM SQUELCH control should be left in this position unless you want to receive a very weak station. This adjustment is best made with the AFC control in the OFF position.

10. To receive all FM programs not in stereo, turn the MODE SELECTOR switch to the FM position. This will produce the best signal-to-noise ratio.

11. To receive AM programs turn the MODE SELECTOR switch to the AM position and adjust the AM TUNING for maximum AM TUNING meter deflection on each station.

12. On strong AM stations, the AM FIDELITY switch (FM SQUELCH knob) may be pulled out for maximum fidelity. The normal position is in.

ALIGNMENT

The following pages contain the instrument alignment procedures for the AM, FM, and FM Stereo Multiplex sections of this tuner. Refer to Figure 21 (Page 66) for transformer and coil locations.

NOTE: Before alignment is started, make sure that when the tuning capacitor plates are fully closed the dial pointers line up with their respective diamonds on the dial window.

AM ALIGNMENT

Equipment needed: AM Signal Generator, such as HEATHKIT Model TO-1, RF-1, LG-1, or a generator of comparable quality.

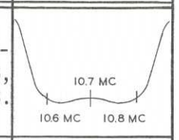
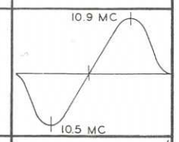
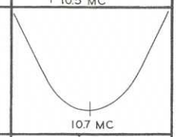
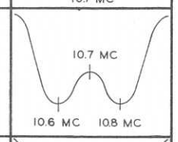
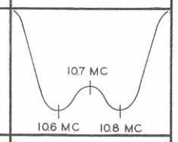
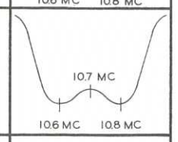
AM FIDELITY switch to "IN" position.		Connect AM signal generator to:	Set frequency of AM generator modulated at 400 cycles to:	Set AM Dial of Tuner to:	Adjust for maximum deflection of tuning meter.
Keep output attenuator so that tuning meter deflects approximately 1/8".	1	AM antenna terminal.	455 kc	1600 kc	Top and bottom slug of T8 and T9.
	2	Loosely coupled to rod antenna (lay hot lead of generator close to rod).	600 kc	600 kc	L5 and T7.
	3	Loosely coupled to rod antenna.	1400 kc	1400 kc	C303, C313 and C310.
	4	Repeat steps 2 and 3 until no change is noticed.			

FM ALIGNMENT

Equipment needed: A Sweep Generator, such as the HEATHKIT Model TS-4A or FMO-1 and an oscilloscope, such as the HEATHKIT Model IO-30.

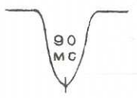
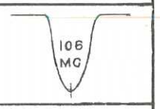
NOTE: The test points (TP) referred to in the alignment can be found in Figures 22, 23, 24A, and 24B (Page 67, 68, and 69). These figures show the foil side of the circuit boards, including the R and C numbers.

NOTE: Before alignment is started, make sure that when the tuning capacitor plates are fully closed the dial pointers line up with their respective diamonds on the dial window.

Remove tube V13, 12AU7.		Connect Sweep Generator to:	Sweep Generator and Marker Generator frequency.	Connect Scope to test point: (TP)	Adjust: For maximum gain and bandwidth.	Adjust: For Figure
Overall Response Check.	1	Ungrounded tube shield over mixer tube V2.	10.7 mc approximately 2 mc sweep width.	To 1 thru 100 KΩ resistor.	Top and bottom of T2, T3, T4, T5 and L3.	
Discriminator Response.	2	"	"	To 2 thru 100 KΩ resistor	T and B of T6.	
If unable to obtain desired pattern.	3	Grid pin 1 of V7.*	"	To 1 thru 100 KΩ resistor	L3	
Keep output from Signal Generator low enough to prevent IF limiting.	4	Pin 1 of V6.	"	"	T and B of T5.	
	5	Pin 1 of V5.	"	"	T and B of T4.	
	6	Pin 1 of V4.	"	"	T and B of T3.	
	7	Repeat Step 1.				
	8	Repeat Step 2.				

*NOTE: Connect lugs 3 and 4 of T5 together for this step only.

FRONT END ALIGNMENT

Tuner and Sweep Generator tuned to:		Connect Sweep Generator to:	Sweep Generator and Marker Generator frequency.	Connect Scope to test point:	Adjust: For maximum gain and bandwidth.	Adjust: For Figure
90 mc	9	Antenna terminal matched to 300 Ω.	90 mc approximately 2 mc sweep.	To 3 thru 100 KΩ resistor	L2, L1 and T1.	
106 mc	10	Antenna terminal matched to 300 Ω.	106 mc	To 3 thru 100 KΩ resistor	C20, C2 and C9.	
	11	Repeat steps 9 and 10 until no further improvement can be obtained.				
	12	Reinstall tube V13, 12AU7.				

FM STEREO MULTIPLEX ALIGNMENT

Equipment needed: An audio VTVM, such as the HEATHKIT Model IM-21, an Audio Generator, such as the HEATHKIT Model AG-10, and an oscilloscope, such as the HEATHKIT Model IO-30.

( ) 1. Refer to the top side of the chassis. Disconnect one lead of capacitor C355 (.1 μfd) from the AM-MULTIPLEX circuit board.

( ) 2. Short pin 7 of tube V15B to ground (chassis) with a short clip lead. See Figure 24A on Page 68.

( ) 3. Connect a generator through a .05 μfd capacitor to pin 7 of tube V13A, and set it to 67 kc. Adjust the generator output level to 0.3 volt rms.

( ) 4. Connect one lead of a 47 KΩ resistor to test point 4. Connect an AC VTVM to the other lead of this resistor with short unshielded leads. Connect an oscilloscope to the VTVM with a low capacity probe. See Figure 24A.

( ) 5. Plug the Tuner in and turn it on. Set the MODE switch in the STEREO position. Push the PHASE switch in and set the control to the center of its range.

( ) 6. After the unit has warmed up, adjust coil L11 (#40-452) for minimum output. The voltmeter should read about .02 volt rms, or less. NOTE: This adjustment will be quite sharp.

( ) 7. Disconnect the shorting clip lead from pin 7 of tube V15B.

( ) 8. Set the generator to 19 kc ±100 cps. Adjust the output level to 0.1 volt rms.

( ) 9. Adjust coil L9 (#40-448) for maximum output. Observe the scope to make sure the 38 kc output is locking on the 19 kc input signal (evidenced by amplitude difference of adjacent peaks). NOTE: This adjustment will be very sharp and should be made carefully.

( ) 10. Next, adjust coil L10 (#40-449) for maximum output. NOTE: This adjustment will also be quite sharp and should be peaked carefully.

( ) 11. Finally, adjust coil L12 (#40-451) for maximum output. NOTE: This coil will be very broad and the slug will probably have to be rocked back and forth to find the peak.

( ) 12. The voltmeter should read about 10 volts rms.

( ) 13. Reset the generator to 1000 cps and adjust its output level to .5 volts.

( ) 14. Remove the scope and voltmeter lead from test point 4 and connect them to the LEFT CHANNEL OUTPUT jack. Set the voltmeter on the 3 volt range.

( ) 15. Set both OUTPUT LEVEL controls fully clockwise.

( ) 16. With the CHANNEL SEPARATION control in the maximum counterclockwise position, there should be no output (voltmeter on the 3 volt range).

( ) 17. With the CHANNEL SEPARATION control in the maximum clockwise position, the voltmeter should read between 1 and 1.5 volts rms and the scope should show an undistorted sine wave.

( ) 18. Remove the scope and voltmeter lead from the LEFT CHANNEL OUTPUT jack and connect it to the RIGHT CHANNEL OUTPUT jack.

( ) 19. Repeat steps 16 and 17 to check the RIGHT CHANNEL OUTPUT jack.

( ) 20. Remove the scope and voltmeter from the RIGHT CHANNEL OUTPUT jack.

( ) 21. This completes alignment of the Multiplex section of the tuner.

NOTE: No adjustment of coil L8 (#40-450) should be made unless a multiplex or stereo generator is available. This adjustment determines the amount of high frequency separation, and the factory preset adjustment of the coil should be very close. However if you desire to check the setting of this coil, and you have a stereo generator, adjust the coil (#40-450) for maximum separation at 10 kc (should be about 25 db).

( ) 22. Reconnect the lead of capacitor C355 that was disconnected in step 1.

IN CASE OF DIFFICULTY

VISUAL CHECKS

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair, malfunction due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the SOLDERING TECHNIQUES section of this manual.

3. Check to be sure that all tubes are in their proper locations. Make sure that all tubes light up properly.

   The IF transformers can be identified by the number stamped on the outside of the can. They should also be checked to insure proper location.

4. Check the tubes with a tube tester or by substitution of tubes of the same types and known to be good.

5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.

   A possible spot for short circuits to occur is on the circuit board. A small piece of wire or bit of excess solder can short across an adjacent pair of foil conductors. Open circuits can also occur on the boards. These are more difficult to locate because they are usually caused by hairline cracks in the foil. If a crack is found, it can be repaired by soldering a small piece of bare wire across it.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm vacuum tube voltmeter. Voltages may vary ±10% due to line voltage variations.

8. A review of the Circuit Description and Block Diagram will prove helpful in indicating where to look for trouble. The circuit board illustrations on Page 67, 68, and 69 should be used to locate circuit points on the circuit board.

TROUBLESHOOTING PROCEDURES

Troubleshooting procedures must be employed to locate troubles that cannot be found by the visual checks. First, the area where the trouble is must be found, then the trouble itself must be located. To find the area that is malfunctioning, the noise injection method described below can be used. Then, to find the trouble itself, use additional careful visual checks in this area, and check the voltages with a voltmeter, as previously described.

NOISE INJECTION TEST

To localize troubles down to more specific areas, a noise injection test can be made, using the blade of a metal screwdriver with a well insulated handle. If a stage is operating normally and the blade of the screwdriver is touched to the tube grid, a low level pop or click will be heard from the speaker of the amplifier connected to the tuner. The actual noise in this test comes from touching the blade of the screwdriver first to the input (grid) and then to the output (plate) of a tube. Hold the screwdriver by the insulated handle only.

CAUTION: Do not touch the blade of the screwdriver while any part of your body is in contact with any conductor or metal object.

The click or pop should be much louder when the input is touched than it was when the output was touched. For example, if the grid (Pin 1) of V4 produces a louder noise than that which is obtained when the plate (Pin 5) is touched, the stage is probably operating correctly. If the noise produced at the plate is louder than that produced at the grid, the tube or some associated component may be suspected of being defective or improperly installed.

This test is always started from the output of the unit and progresses toward the front end or input. For example, start at Pin 1 of V8 and then move to Pin 1 of V7, etc. The noise should become louder as the test proceeds toward the front end.

This test may be performed in the MULTIPLEX, AM, and FM sections, with the exception of the FM front end. If a reasonable response is obtained at the grid (Pin 1) of V4 and yet no FM station is heard when an antenna is connected, the tubes or components in the front end may be suspected.

The tests described above do not apply to the power supply, AVC, AGC, SQUELCH, STEREO INDICATOR, or metering circuits.

Power supply troubles are usually indicated by overheated components or wires. If a resistor or wire overheats, it usually indicates that there is a short in that particular circuit. An overheated transformer usually indicates a short in the filament circuit, or a direct short in the B+ circuit. Very rarely is the transformer the source of trouble.

TROUBLESHOOTING CHART

DIFFICULTY	POSSIBLE CAUSE
Dead tuner, filaments not lit.	AC line cord, fuse, bad AC switch, open FM line cord antenna coil L15, power transformer.
Dead tuner, filaments lit but no output.	Open or shorted output cable, level controls turned counterclockwise, no B+, silicon rectifiers, open T11 or R23, filter capacitors.
Some tube filaments not lit.	Cold solder connections on circuit board filament wiring.
AM all right, FM and FM STEREO dead.	Check tubes V1 through V9 and V16, open diode D1, the level controls R21 and R22, check voltages in FM section. Check tube V14B and corresponding squelch circuitry.
FM all right, AM dead, all filaments lit.	Output cable, level controls, MODE selector switch, tubes V10 through V12 and V16.
Noise but no sound, AM or FM.	Check antennas, MODE selector switch, RF and oscillator tube defective, the AM V10 and V11. FM V1 and V3.
AM or FM tuning meter does not swing to the left side when tuner is first turned on and tubes have warmed.	Open meter or leads, check tube V14B and associated components for FM, check tube V10 and associated components for AM.
AM or FM tuning meter does not indicate signal (swing to right).	AM: check AVC circuit. FM: check AGC circuit.
Hum.	Reverse AC line plug in outlet, filter capacitors C28 and C29, heater to cathode leakage in tubes.
Low level AM audio.	Level controls turned too far counterclockwise, antenna open, alignment.
Whistles.	Open filter or bypass capacitors, alignment of 10 kc whistle filter, L6.
FM AFC inoperative.	Control R11, tube V3 defective, discriminator transformer T6 alignment, shorted AFC lead.
Distorted output.	AM: V16, filter capacitors, coupling capacitors C358, C359, crystal diodes D2 and D3. FM: V16 and V9, alignment of T6, shorted FM IF tubes V4 through V8, filter capacitors, coupling capacitor C358, C359.
Dial setting of AM tuning changes radically when AM FIDELITY switch is pushed "in."	AM tuning not tracking, repeat alignment of AM Tuner.

DIFFICULTY	POSSIBLE CAUSE
Nonlinear AFC action.	Alignment of the bottom slug of T6. Resistor R5 changed value.
No FM Squelch and no FM meter action.	Check tube V14B, resistors R328, R329, R326, R327, and control R18. Capacitors C337, or C338 shorted. Open FM meter.
FM meter all right, but no FM Squelch action.	Diode D1 shorted. Check resistors R329, R340, R12, R14, control R13, capacitors C354, C355, C357 and C356.
FM all right, FM STEREO dead.	Tube V13 defective. Capacitor C332 open.
FM STEREO output all right on monarual signal, but garbled on stereo signal.	Misadjustment of coil L9 (40-448) and/or stereo phase control R20. Capacitor C342 open.
FM Stereo subchannel dead (no output when phase switch is "out").	Signal is not stereo (see circuit description and operation sections on "Commercial Killers.") Check tube V15, capacitor C341, coils L11, L12, diode D4 and D5.
Little or no FM Stereo separation.	Signal is not stereo (see above). Misadjustment of coil L9 (40-448) and/or stereo phase control R20. Stereo phase switch is in the "out" position. Main channel dead, check tube V13B, coil L8, capacitors C339, C340, control R19, resistors R336 and R339. Separation control R19 misadjusted.
FM Stereo indicator fails to operate on stereo signals.	Misadjustment of coil L7. Open or shorted capacitors C334, C335, or coil L7. Check tube V14A. Faulty indicator (NE-2).

MECHANICAL TROUBLESHOOTING

DIFFICULTY	POSSIBLE CAUSE
No flywheel action of tuning knobs.	Setscrews not tight in flywheel, tuning shafts binding, improper dial cord stringing.
Tuning shafts bind.	Shaft not in line, mounting plate bent.
Dial cords slip.	Check dial cord tension and stringing, oil on dial cord, dial pointer binding.

SERVICE INFORMATION

SERVICE

If, after applying the information in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units, and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit model number and date of purchase, if available. Also mention the date of the kit assembly manual. (Date at bottom of Page 1).

5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed equipment to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although charges for local service are generally somewhat higher than for factory service, the amount of increase is usually offset by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your

kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally, improper operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.

B. Identify the type and model number of kit in which it is used.

C. Mention date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrument must be returned for service, these instructions should be carefully followed.

All tubes and shields should be installed in their sockets. The bottom plate and cabinet should be properly installed. Be sure to return all audio cables.

Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

ATTACH A LETTER TO THE OUTSIDE OF THE CARTON BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Also, include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by insured parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

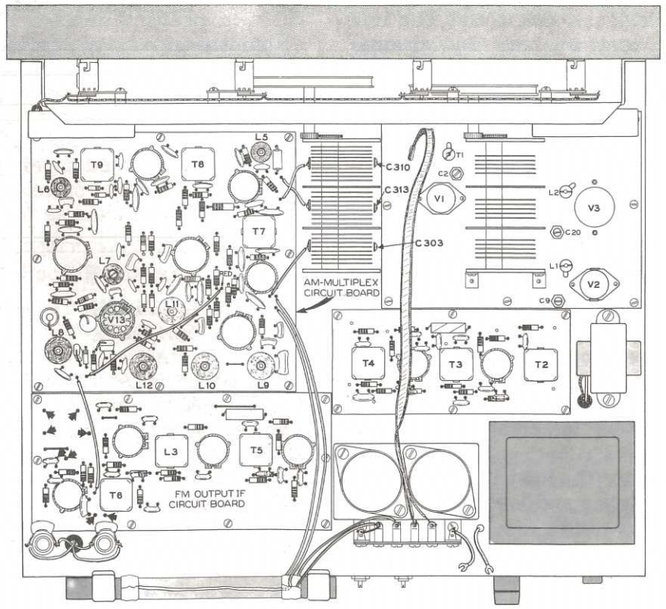
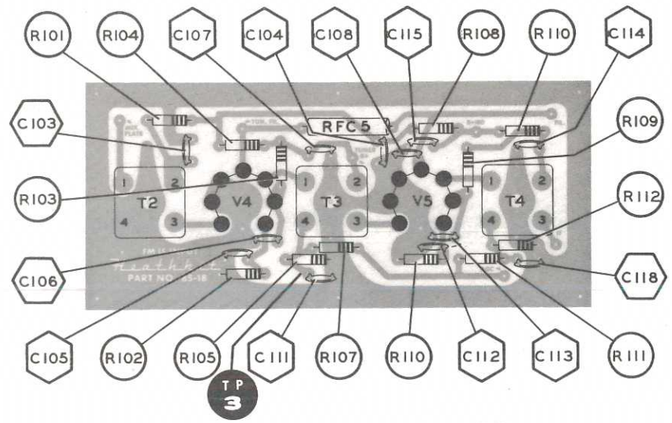


Figure 21

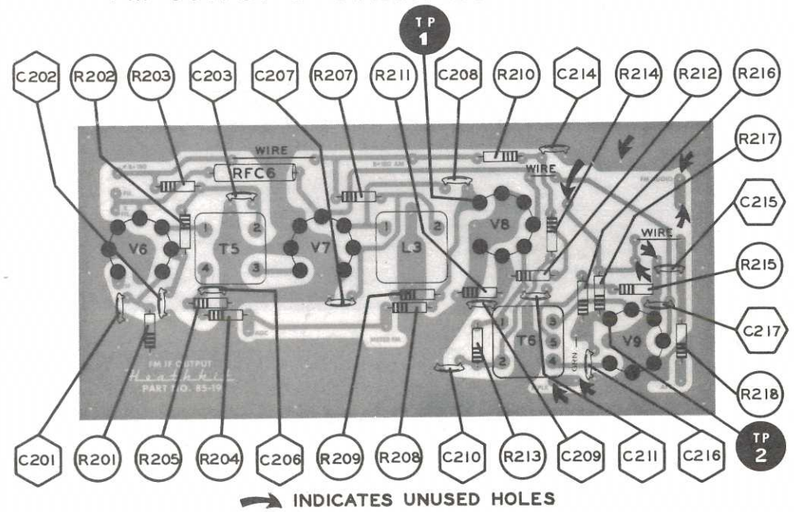
FM INPUT IF CIRCUIT BOARD # 85-18



FOIL SIDE OF BOARD

Figure 22

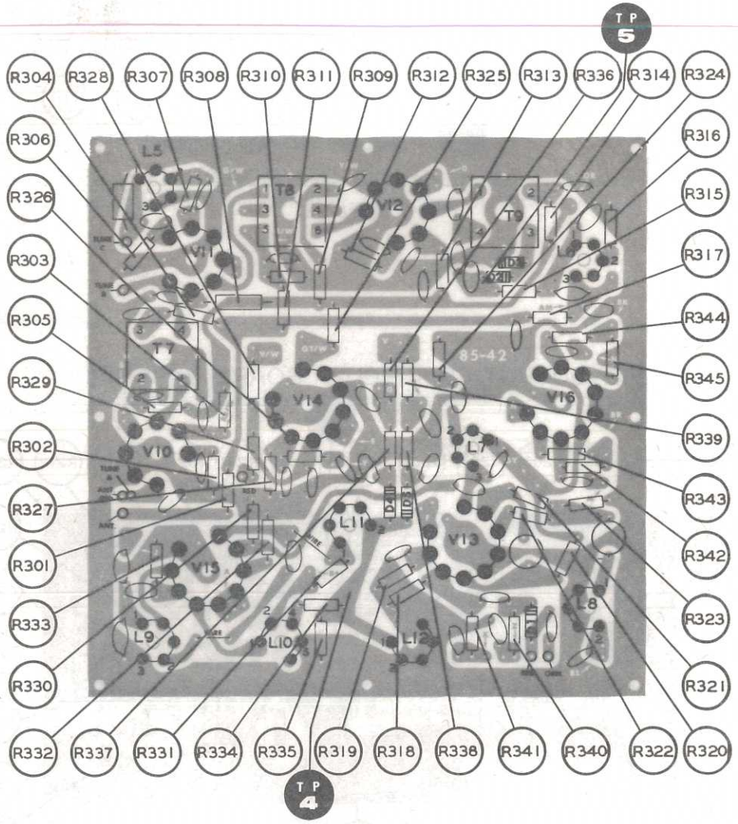
FM OUTPUT IF CIRCUIT BOARD # 85-19



FOIL SIDE OF BOARD

Figure 23

AM – MULTIPLEX CIRCUIT BOARD #85-42

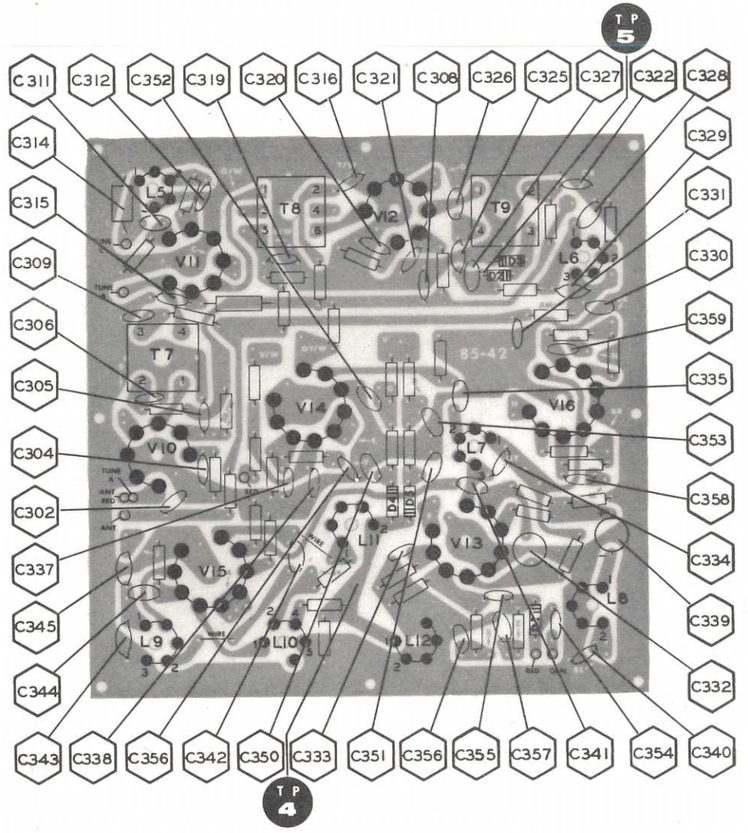


RESISTORS

FOIL SIDE OF BOARD

Figure 24A

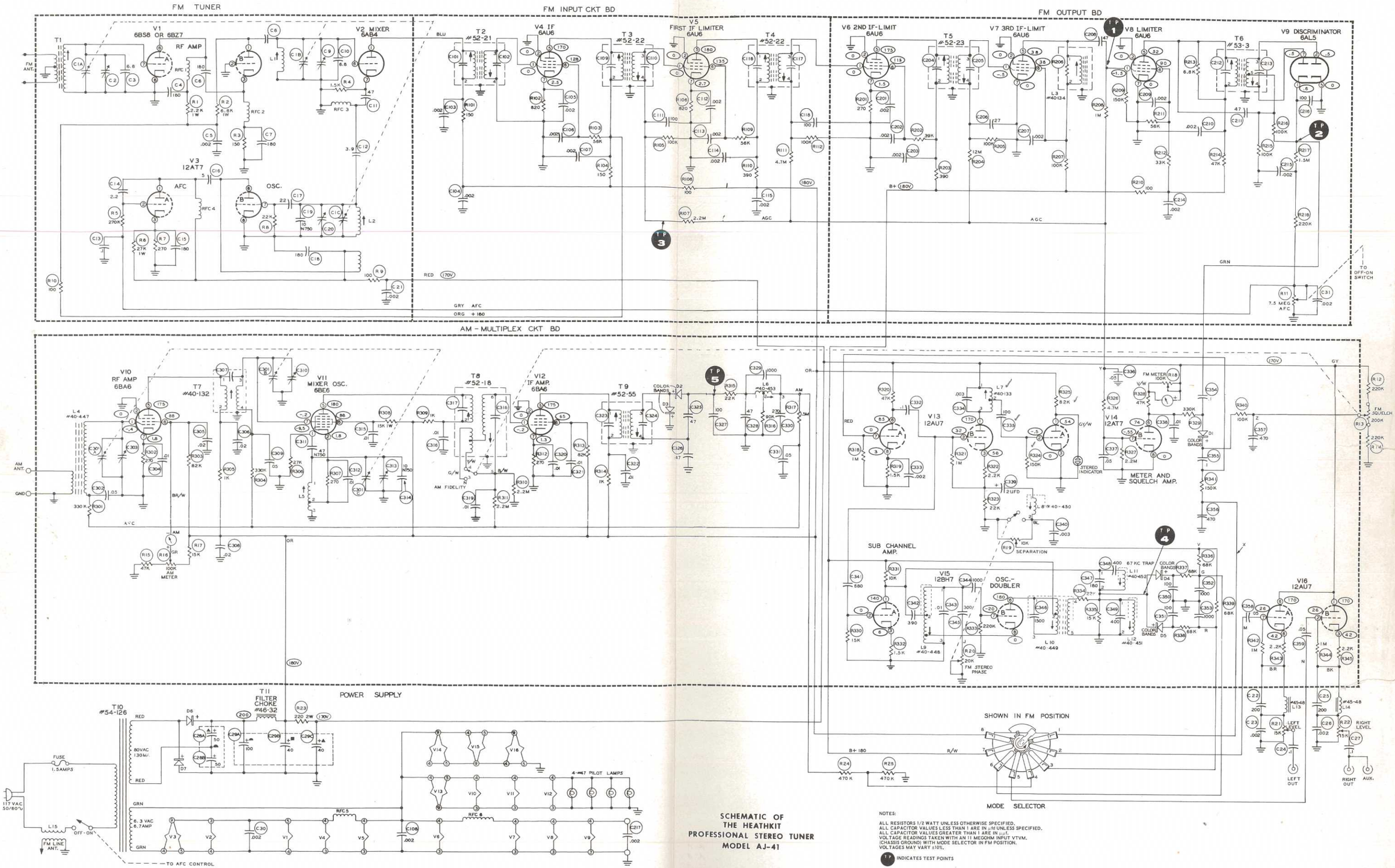
AM – MULTIPLEX CIRCUIT BOARD #85-42



CAPACITORS

FOIL SIDE OF BOARD

Figure 24B



SCHEMATIC OF THE HEATHKIT PROFESSIONAL STEREO TUNER MODEL AJ-41

NOTES:

ALL RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ALL CAPACITOR VALUES LESS THAN 1 ARE IN µfd UNLESS SPECIFIED.
ALL CAPACITOR VALUES GREATER THAN 1 ARE IN µµf.
VOLTAGE READINGS TAKEN WITH AN 11 MEGOHM INPUT VTVM, (CHASSIS GROUND) WITH MODE SELECTOR IN FM POSITION.
VOLTAGES MAY VARY ±10%.

(TP) INDICATES TEST POINTS

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.