INSTRUCTION BOOK FOR

The National *Criterion* AM-FM TUNER

The National Criterion is a superb, 14-tube superheterodyne tuner offering the utmost in versatility and performance. Designed for use either with or without the National Horizon 5 preamplifier, the Criterion is completely compatible with all standard high fidelity music systems as well as the National Horizon series of amplifiers. In addition to the usual features found in high quality tuners, the Criterion offers binaural reception, freedom from adjacent channel and co-channel interference (accomplished by its unique design, and high capture ratio), provision for multiplex operation, plus a panel-selected FM Mutamatic circuit. It may be used as a self-contained unit housed in its colorful protective dust cover or mounted, with extreme simplicity, into any cabinet or panel of the user's choice.

CASCODE FRONT END: Provides the maximum possible sensitivity in the FM frequency range.

FM IF CHANNEL: 8 tuned circuits are used to provide a highly selective intermediate frequency pass band. This enables the selection of adjacent-channel stations without introducing inter-channel interference.

CAPTURE EFFECT: The extremely high capture ratio of 0.8 eliminates annoying interference from weaker signals in the same channel as the desired signal.

INSTANTANEOUS LIMITER: 2 cascaded 6BN6's with instantaneous limiting action are used to eliminate the short impulse interference so characteristic at FM frequencies. This type of limiting also contributes to the tuner's high capture ratio.

WIDE BAND DISCRIMINATOR: The wide frequency response and freedom from critical tuning of the FM channel is made possible by the use of an exceptionally wide band discriminator circuit.

Please use this manual. It has been prepared with the prime purpose of enabling the user to obtain full satisfaction from this product.

NATIONAL COMPANY, INC., National MALDEN & MELROSE, MASS.

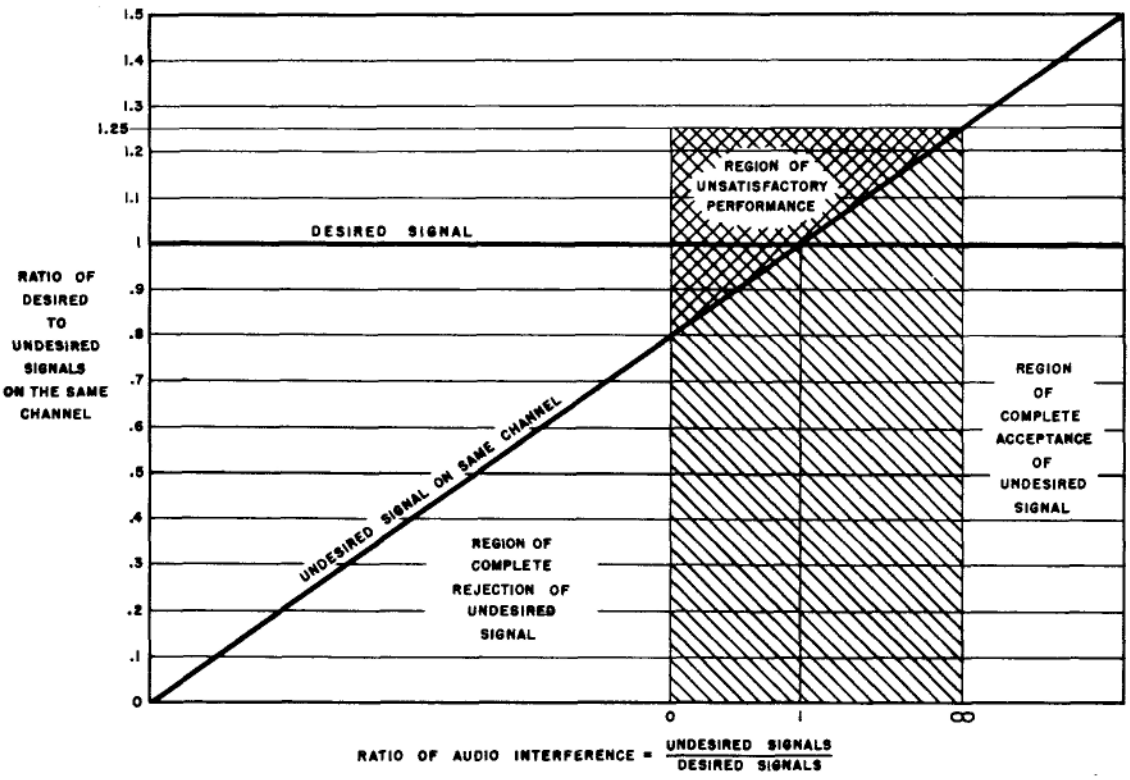


Figure 1. Capture Ratio Characteristics

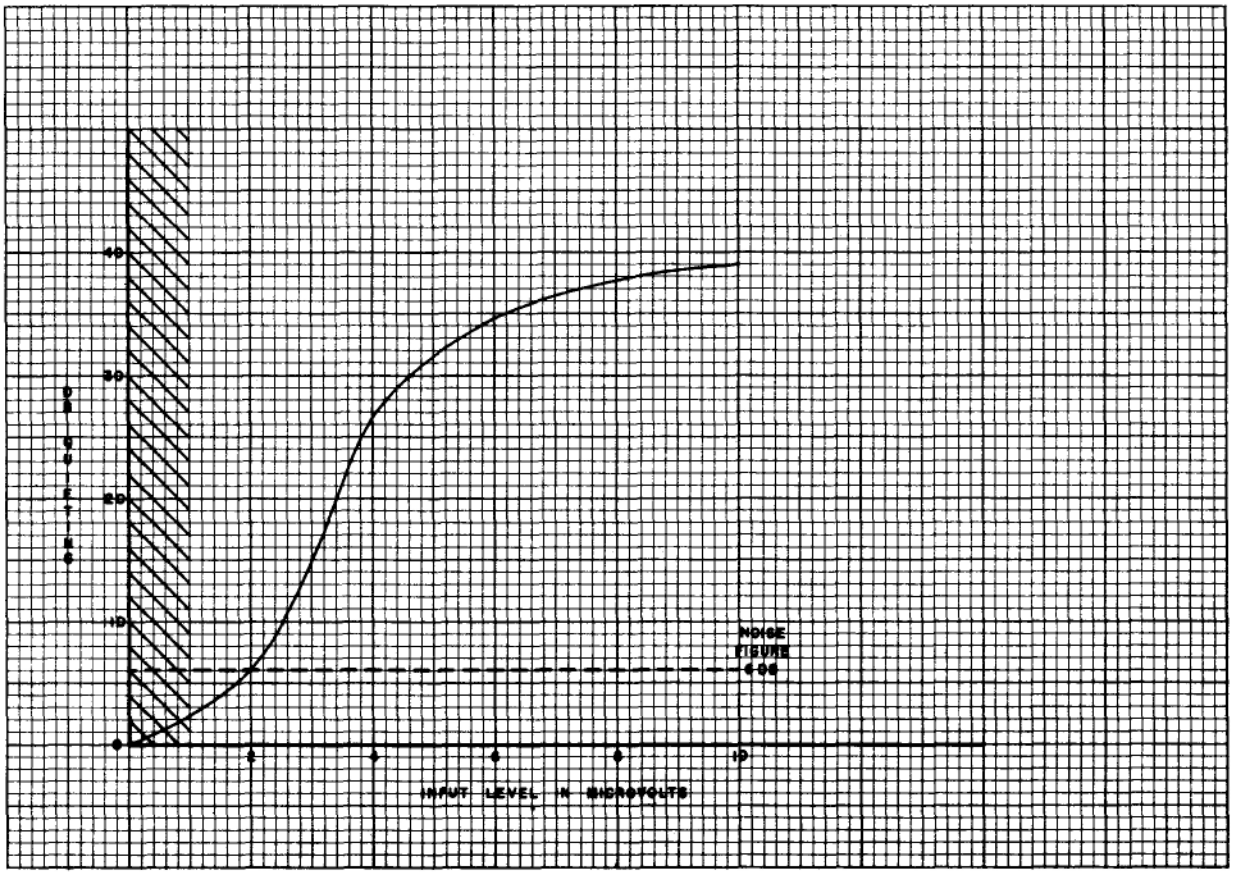


Figure 2. Quieting Sensitivity Including Theoretical Noise Limitations

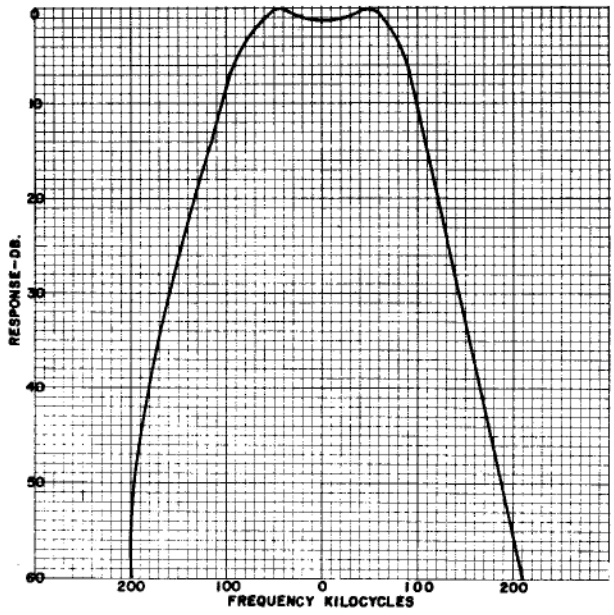


Figure 3. FM Selectivity Characteristic Curve

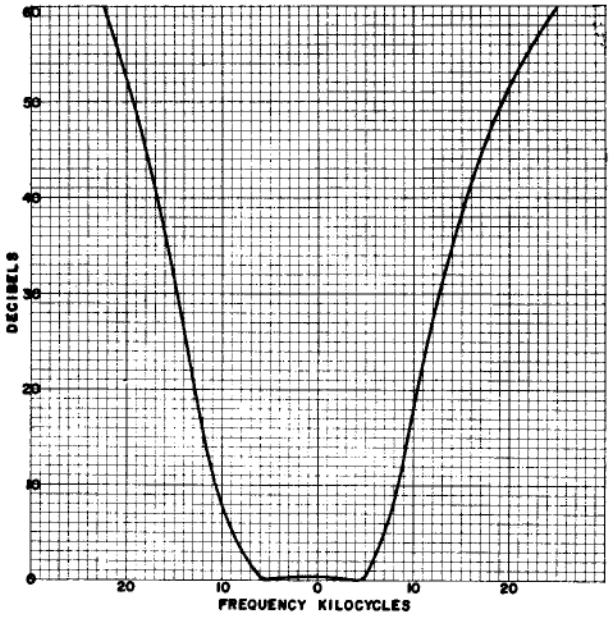


Figure 4. AM Selectivity Characteristic Curve

SIMULTANEOUS AM-FM: Two independent channels are used, each with individual tuning and volume controls, to provide this unique flexibility of operation.

BINAURAL PROVISION: The tuner may be used to receive simultaneous binaural AM-FM broadcasts and feed them to any binaural audio system.

MULTIPLEX PROVISION: This feature provides for the latest in broadcasting techniques which use the multiplex system for binaural transmissions.

FM AGC: AGC is utilized in the FM as well as the AM section of the tuner to maintain the optimum in passband characteristics of the IF amplifier.

OVERLOAD CHARACTERISTIC: The front end design provides a high degree of freedom from overload and spurious responses as well as 60 db of image rejection. A four section tuning capacitor is used instead of the usual two or three section type.

AM SELECTIVITY: The AM portion of the tuner has been designed specifically to provide faithful audio reproduction up to 8 kc. The IF pass band is adequate to provide satisfactory high fidelity performance. The overall sensitivity is sufficient to insure optimum quieting on any signal strong enough to provide high quality audio.

PREAMPLIFIER: A removable plate on the front panel permits the insertion of the National Horizon 5 preamplifier, bringing all the desired controls and compensation features required for high fidelity phonograph reproduction directly to the front panel of the tuner.

PRINTED CIRCUITS: Printed circuitry is used to take full advantage of the latest electronic techniques, resulting in complete uniformity in manufacturing, freedom from drift, and conservation of chassis space.

LOW IMPEDANCE OUTPUT: Cathode followers are used to provide low impedance output to permit the use of longer output cable lengths.

FM MUTAMATIC: An efficient squelch circuit is provided to eliminate inter-station background noise when tuning. The Mutamatic feature may be switched out when tuning weak signals.

RECORDER OUTPUT: A constant level output is available, which is not affected by the volume controls, to provide a constant audio level for use with recording equipment. This output is a moderate impedance output. De-emphasis has not been included to permit use of long shielded interconnecting cables without excessive loss of high frequencies.

HUM LEVEL: The level of hum throughout the tuner is maintained at 60 db below the rated output.

FM TUNING CAPACITOR: A four-section tuning capacitor provides excellent selectivity characteristics, at the same time contributing to the freedom of front-end overload.

AM DETECTOR: A high-fidelity, low-distortion detector is used to take full advantage of the wide-band IF characteristics.

INTERLOCKS: All shock hazard is avoided by the incorporation of interlock switches in the AC primary circuit.

DRIFT: The effect of oscillator drift is negligible without resorting to troublesome AFC circuits.

FM DISTORTION: The total FM distortion is essentially zero.

POWER INPUT: 117 VAC, 60 cps, 80 W, 0.7 amp.

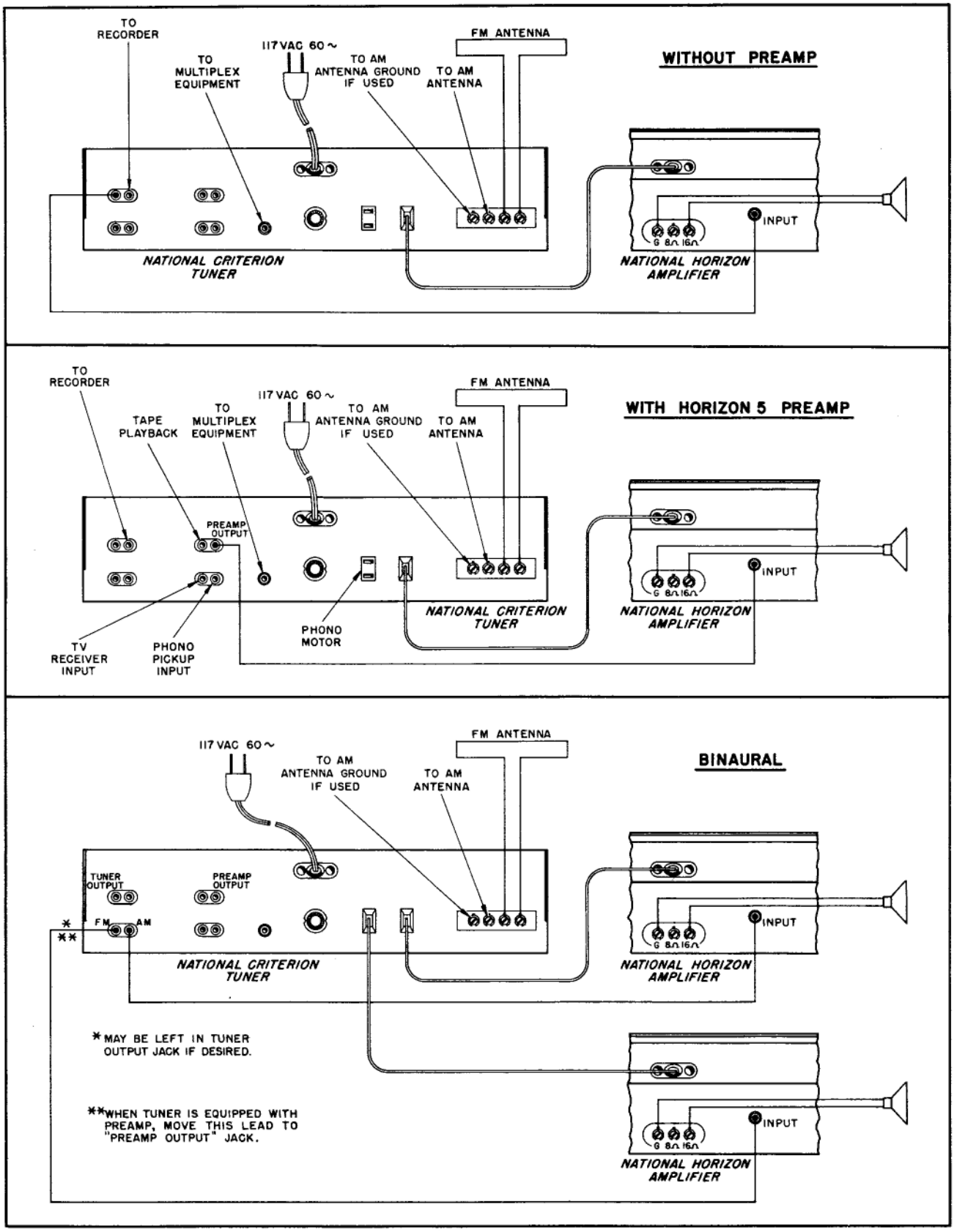


Figure 5. Typical Installation Plans

PREPARING TO OPERATE

Examine the tuner immediately after unpacking to make certain that no apparent damage has been incurred during shipment. Do not discard any packing material until all the following items have been located and identified.

1 AC line cord (if tuner is without dust cover)
1 4-foot shielded audio output interconnecting cable
1 FM twinlead indoor antenna
1 AM indoor antenna
1 Console mounting strip
3 Wood screws for mounting strip

NOTE: In the case of the tuner supplied less the dust cover, two metal strips are fastened at the ends of the underside of the chassis to facilitate packing. These strips should be removed immediately after the tuner is taken from the carton. The tuner cannot be mounted with these strips in place. Refer to the paragraph on Cabinet Installation.

ELECTRICAL CONNECTIONS

All the input and output connectors of the Criterion tuner are located on the back drop of the chassis. See Figure 5. Connections to the various jacks should be made in the following manner:

TUNER OUTPUT: This connector is used when the tuner is not equipped with the plug-in preamplifier Connection may be made to the main power amplifier or to the preamplifier if this unit is mounted separately from the tuner. The tuner supplies up to 3 volts of audio on either FM or AM at this point which is ample for the National Horizon series of amplifiers as well as the majority of high quality amplifier units. The four-foot cable furnished with the tuner is fitted with proper plugs to make connection to the National amplifiers. When connecting to other amplifier equipment it may be necessary to modify one end of the cable to suit the requirements of the amplifier input connector. In such cases, make certain that the shield braid is grounded. Since the Criterion tuner provides a low impedance output, the cable length may be increased to as much as 20 feet if desired without affecting frequency response.

RECORDING SIGNAL OUTPUT: This jack is provided for making connections to the input of most standard tape or disc recorders. This is a high impedance output with a constant level of one volt rms which is not affected by the volume controls of the tuner. The output is switched between AM or FM as selected by the Selector switch.

FM-AM BINAURAL OUTPUTS: These two jacks provide low impedance outputs from the FM section and AM section respectively. They are intended to be used with two independent amplifier-speaker systems for binaural reception of simultaneous AM-FM broadcasts. The cable specifications for the Tuner Output jack will also apply to the Binaural Output jacks.

TAPE PLAY BACK INPUT: This jack may be used only when the National plug-in preamplifier is used in conjunction with the tuner. The output of a tape recorder or any similar audio device with approximately one volt or more output may be permanently connected to this jack and selected when the Selector switch on the preamplifier is in the Tape position.

TV INPUT: A one-volt audio signal from a TV tuner may be connected to this jack and selected at the TV position of the preamplifier Selector switch. Probably the most convenient point for obtaining this voltage is across the volume control of the TV set.

WARNING

Since high voltages are present in TV receivers this connection should only be made by a competent TV serviceman.

PHONO INPUT: High Fidelity phono equipment utilizing magnetic or reluctance type cartridges may be connected to the Phono Input jack. The plug-in preamplifier has provisions for accommodating either the 10 or 30-millivolt type cartridge. A slide switch on the preamp is accessible through a cutout in both the preamp and tuner dust covers. Slide this switch toward the panel for 30 mv. pickups and toward the rear for 10 mv. pickups. When the selector switch is set at any one of the seven record compensation positions the phono pickup is connected to the preamp circuits and the Selector switch may be used to provide the desired compensation.

PREAMP OUTPUT: When the Criterion tuner is equipped with the plug-in preamp, the Preamp Output jack is used, in place of the Tuner Output jack, for connecting the tuner to the main amplifier. By so doing, all the switching and control functions of the preamplifier are used to adjust volume and tone for the system. This brings into play the Loudness control of the preamplifier so that speaker output can be varied with automatic frequency compensation.

FM MULTIPLEX ONLY: This jack provides a high impedance output from the FM section of the tuner only. Multiplex transmissions of binaural programs are contemplated by the broadcasting industry at the

present time. When the FM stations start transmitting this type of signal, equipment will be available for connection to the Criterion tuner for separation of the multiplexed signals.

A.C. OUTLETS: Two A.C. outlets are provided for convenience in connecting other units of the system. Units connected to these outlets are turned on and off by the A.C. switch on the tuner or preamp.

OPERATING INSTRUCTIONS

The National Criterion tuner is an extremely versatile instrument and may be operated with or without the National Horizon 5 preamplifier.

1. OPERATION WITHOUT THE PREAMPLIFIER

Two separate tuning controls are provided, each having its own calibrated slide-rule dial. The volume controls for AM and FM reception are located adjacent to their respective tuning knobs. The remaining control selects the desired mode of operation (AM, FM, Binaural or Mutamatic). The On-Off switch is part of the AM volume control and is disabled when the preamp is plugged in.

a. To tune an AM signal first set the selector control at AM. Adjust the AM tuning control to the frequency of the desired broadcast station and adjust the AM volume control to suit.

b. To tune an FM signal set the selector switch at FM MUTAMATIC. In this position tuning to the desired signal is accomplished without annoying interstation background noise. Adjust the tuning control to the channel desired and set the FM volume control to suit. If the signal being tuned is very weak it may be desirable to set the selector switch at FM rather than FM MUTAMATIC. This permits a station to be heard which normally would not be strong enough to override the squelch threshold.

c. Binaural operation requires the use of two complete amplifier-speaker installations. To operate the Criterion tuner with this type of equipment set the selector switch at AM. Tune the desired signal by means of the AM tuning control and adjust the volume to the proper level. Switch the selector to FM and tune the same broadcast on the FM band using the FM tuning and FM volume controls. Set the selector switch at Binaural. Note: The proper setting of the volume controls will be determined by the requirements of the associated binaural audio equipment.

d. If "off the air" recordings are to be made and the recorder is properly connected to the Recording Signal Output jack, the tuning procedure may follow either a. or b. above. The volume controls may be adjusted for desired listening level without affecting the 1-volt rms level reaching the recorder. The recorder volume control is adjusted for proper recording level.

2. OPERATION WITH THE PREAMPLIFIER

When the National Horizon 5 preamplifier is used, the tuner is operated in the same manner as above except that for AM or FM reception both volume controls are set at maximum and the Loudness control of the preamp is used to adjust the audio level. The switch portion of the Loudness control now functions as the ON-OFF switch for both the tuner and preamp. To receive binaural signals when the preamp is in the tuner first set the FM volume control at maximum. Adjust the Loudness control of the preamp to the desired listening level. Set the FM volume control at minimum. Adjust the AM volume control to the desired level without disturbing the Loudness control. Return the FM volume control to maximum. Make all further level adjustments with the Loudness control. The Selector switch on the preamp must be set at the Tuner position. The other settings of the Selector are covered in detail in the instructions accompanying the preamp. The wide range of the Bass and Treble controls may be used to full advantage.

CABINET INSTALLATION

Mounting the Criterion tuner into a cabinet or panel is extremely simple. Only one 7 by 15 inch horizontal cutout is required. Primary consideration should be given to the cutout location in terms of outward appearance, control accessibility etc. Since the tuner is installed through the front of the cabinet, connections at the rear of the chassis need not be accessible from the rear of the cabinet. All connecting cables, provided they have sufficient slack, may be plugged into the tuner through the panel cutout before sliding the tuner into place.

When the desired cutout location has been determined lay out the rectangle, making certain that it is square with the sides of the cabinet. Use care in making the cuts being particularly careful to see that the bottom edge of the cutout is straight and level.

Refer to Figure 6 for the proper method of securing the mounting strip. The mounting strip supplied is marked FRONT along one edge. This edge must be flush with the front surface of the cabinet. The tabs protruding from the ends of the strip must point upwards toward the top of the cutout. Six screwholes

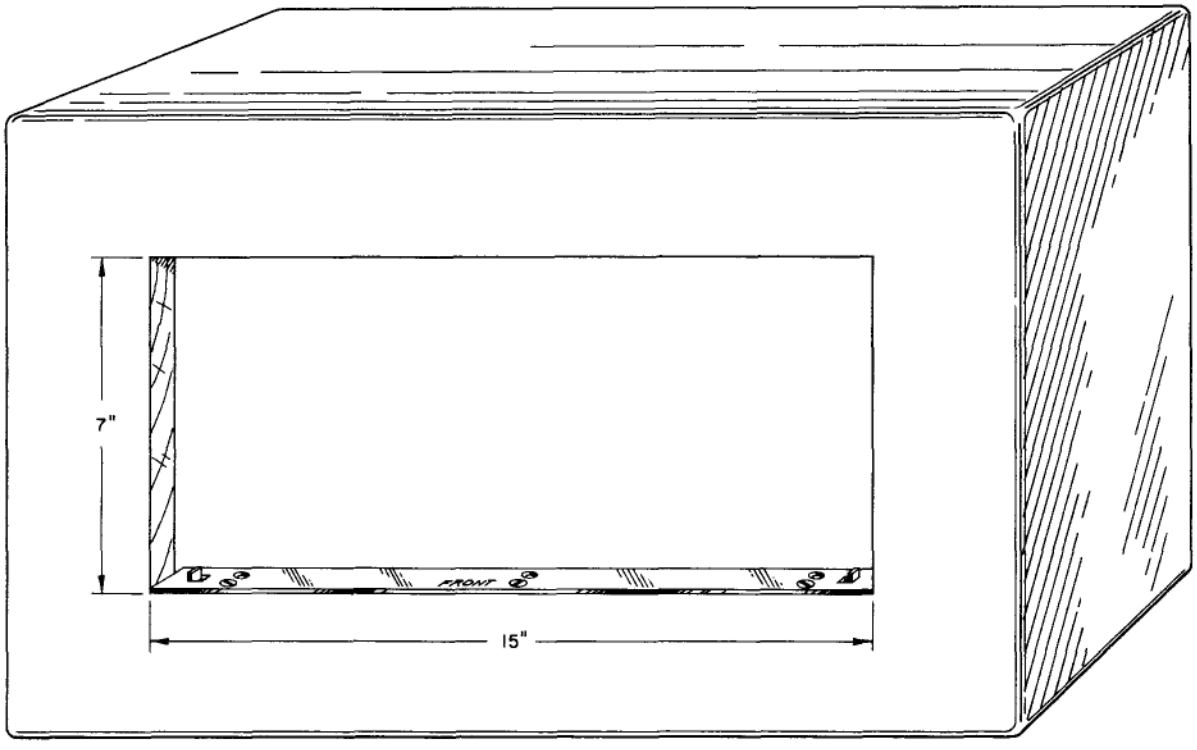


Figure 6. Method of Mounting Tuner in Custom Cabinet

are provided. If the cabinet is constructed of 3/8 inch or thicker stock, the three front holes are used to secure the strip to the bottom edge of the cutout. If the stock is 1/4 inch thick or less, a strip of wood at least 1/2 inch thick must be glued along the inside of the cutout flush with the bottom edge. This will supply sufficient thickness to hold the screws and the three rear holes of the mounting strip may be used.

Once the mounting strip is secured to the cabinet all that is required is to slide the tuner through the cutout with the top of the panel tilted toward you. When the slots in the bottom of the tuner engage the studs in the mounting strip, release the top of the panel. The weight of the tuner chassis will hold the unit securely in the cabinet.

REMOVAL FROM CABINET

If the tuner has been properly mounted in a custom cabinet it is only necessary to tilt the top of the panel toward you, lift the panel about 1/4 inch to clear the mounting studs and withdraw the tuner far enough to disconnect the input and output cables after which the tuner may be removed from the cabinet.

If the tuner is equipped with a metal dust cover, remove the four felt feet from the bottom of the dust cover and slide the tuner out of the cover. When replacing the tuner use care to align the AC interlock connection between the chassis and dust cover.

Removal of the plug-in preamplifier is accomplished by loosening the captive thumbscrew at each end of the preamp panel and withdrawing the preamp. To re-install simply reverse the above procedure.

REALIGNMENT PROCEDURE

1. FM IF ALIGNMENT

The superior performance of the National Criterion tuner is due, in a large measure, to the excellent characteristics of the IF amplifier, cascade limiters and wide band detector. Alignment of these stages should not be undertaken by means of the customary peaking methods. Only a competent serviceman equipped with the following specialized test instruments should perform this alignment.

1. Harvey 205TS Sweep Generator or equivalent.
2. Dumont 208 Oscilloscope or equivalent.
3. RCA WG-264 R.F. Probe or equivalent.
4. Tank Loading Resistor-1000 ohms, 1/2 watt.
5. Tuning Wand such as General Cement no. 8606-D.

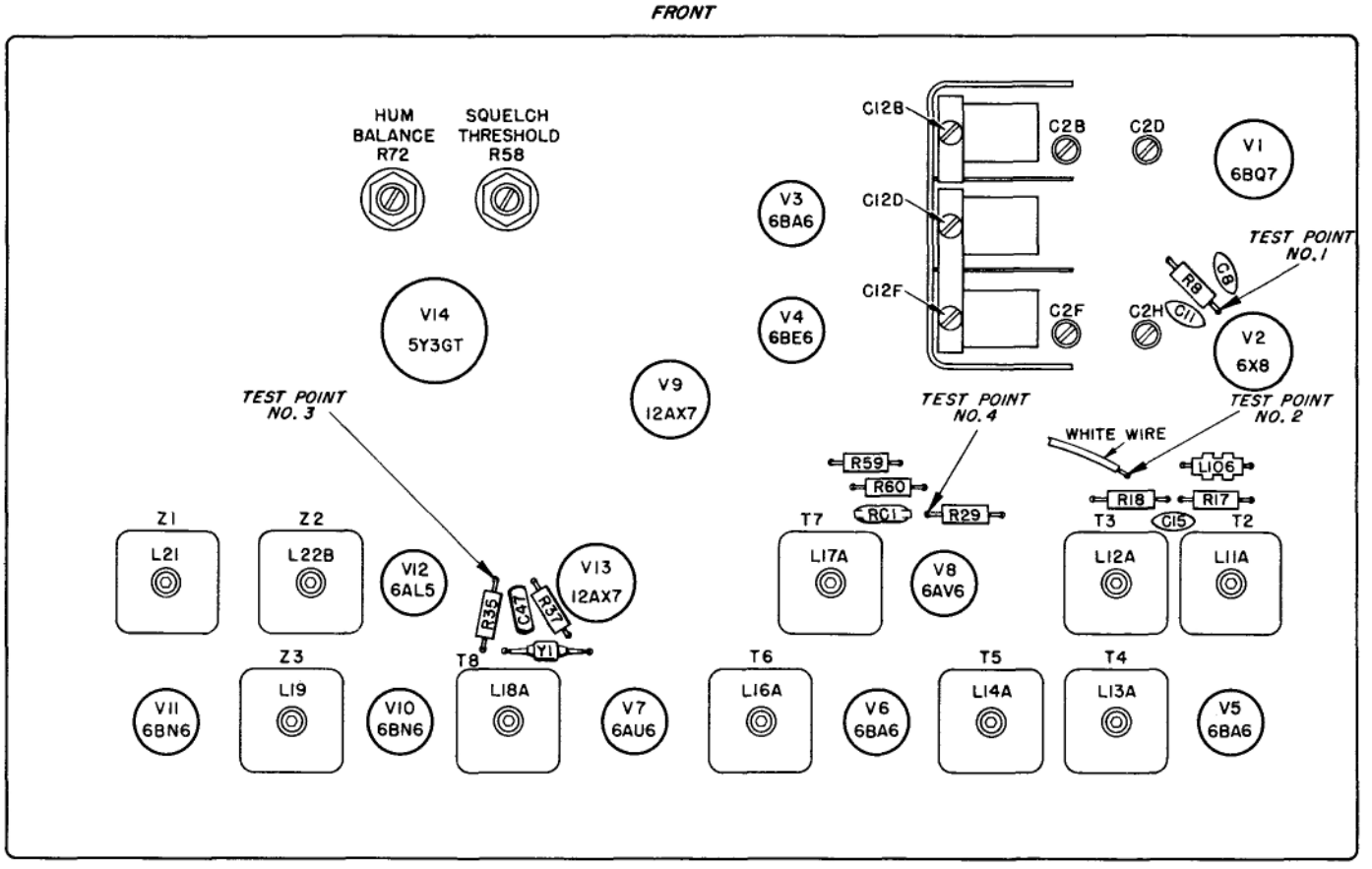


Figure 7. Alignment Adjustments and Test Point Locations

6. Signal Generator providing 10.7 mc. and 455 kc. marker signals.

During normal use of the Criterion tuner realignment will not be required. Changing tubes will not appreciably disturb the alignment. Only in the event of a major repair or severe damage will it be necessary to completely realign the IF or limiter stages and caution should be exercised before disturbing any adjustments.

a. CHECKING IF FOR PROPER ALIGNMENT

The first step in the alignment process is the observation of the IF characteristic on the oscilloscope. See Figure 7 for alignment adjustment and test point locations. Proceed as follows:

Step 1. Connect the sweep generator between the grid (pin 7) of V2 and chassis. This is most conveniently accomplished by connecting the "hot" lead from the generator to test point no. 1 and the ground lead to the frame of the AM tuning capacitor. Also connect a 10-ohm resistor from pin 7 of V2 to ground. Short leads must be used.

Step 2. Set the generator center frequency at 10.7 mc. with a 4-mc. sweep deviation.

Step 3. Short the FM AGC to ground by means of a jumper between test point no. 2 (junction of C33 and R47) and chassis.

Step 4. Connect the oscilloscope to the IF observation point, test point no. 3 (junction of R35 and C47), using a 60-cycle sweep.

Step 5. Set the selector switch of the tuner to the FM Mutamatic position.

Step 6. Adjust the output of the sweep generator to a level just high enough to provide a usable scope pattern.

Step 7. Readjust the generator sweep width and center frequency to produce the optimum view of the IF pass band. The scope pattern should appear as in Figure 8A. The minimum possible input must be used. Too much signal will distort the IF pass band pattern.

Step 8. If the scope pattern is not symmetrical, check the adjustment of T4 by means of the tuning wand and readjust to obtain the correct scope pattern. In most cases this adjustment should restore the IF alignment to proper operating condition. If it does not do so, proceed with the complete realignment.

b. DETAILED FM IF ALIGNMENT

If the previous steps indicate the necessity for complete realignment proceed as follows:

Step 1. Connect the sweep generator to test point no. 1 using a 1000 ohm resistor in series with the "hot" lead and a 10-ohm resistor from grid to chassis.

Step 2. Using the RF Probe, connect the oscilloscope to the plate of V5, (pin 5).

Step 3. Set the sweep generator center frequency at 10.7 mc. with a sweep rate of 60 cycles and a sweep width of at least 300 kc. Set the marker signal at 10.7 mc.

Step 4. Using test clips with short leads, connect the 1000-ohm resistor across the primary of T4.

Step 5. Reduce the generator output to a level just high enough to produce a usable scope pattern. The pattern should appear as in Figure 8B.

Step 6. Tune L11A and L11B of T2 for maximum gain as indicated by the vertical size of the scope trace, at the same time keeping the trace precisely centered on the 10.7 mc. marker.

Step 7. Move the 1000-ohm resistor to the primary of T6 and move the RF Probe to the plate of V6 (pin 5).

Step 8. Adjust L13A and L13B of T4 for maximum gain centered on 10.7 mc. Maintain the minimum possible generator output for usable scope pattern.

Step 9. Move the resistor to the primary of T8. Remove V11 from its socket. Connect the RF Probe to the plate of V8 (pin 7). Adjust L16A and L16B of T6 in the manner outlined in Step 8.

Step 10. Short the AGC bus by connecting a jumper between test point no. 2 and chassis.

Step 11. Connect the oscilloscope to test point no. 3 using the DC probe.

Step 12. Adjust L18A and L18B of T8 for optimum IF passband, keeping the generator output at minimum. This will complete the FM IF alignment. Remove the AGC jumper unless detector alignment is to be performed.

c. FM DETECTOR ALIGNMENT

For normal alignment of the FM detector only a slight readjustment of Z2 will be required. To accomplish this proceed as follows:

Step 1. Connect the oscilloscope at the FM Output jack J2B.

Step 2. Set the selector switch of the tuner at FM Mutamatic and set the FM volume control at its maximum clockwise position.

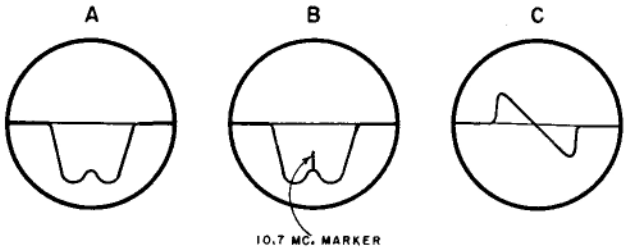


Figure 8. Alignment Waveforms

Step 3. Connect the sweep generator and short the AGC as in paragraph b. above.

Step 4. With the generator output level just high enough to produce a usable pattern, the trace should appear as in Figure 8C.

Step 5. Adjust L22A of Z2 for maximum linearity of the trace.

Step 6. Remove all test equipment.

2. AM IF ALIGNMENT

The AM IF amplifier of the Criterion tuner has been designed for wide passband characteristics while, at the same time, providing optimum selectivity consistent with this characteristic. IF Alignment by the usual peaking methods would jeopardize the overall performance. The following instructions must be adhered to.

Step 1. Connect the sweep generator to the control grid of the AM mixer (pin 7 of V4). Use a 1000-mmfd capacitor in series with the "hot" lead.

Step 2. Set the generator center frequency at 455 kc. with a 50-kc. sweep and supply a marker at 455 kc.

Step 3. Connect the 1000-ohm resistor across the primary of T5.

Step 4. Using the R.F. Probe, connect the oscilloscope to the plate of V5 (pin 5).

Step 5. Set the selector switch of the tuner to AM.

Step 6. Adjust the generator output to a level just high enough to produce a usable trace. The pattern should look like Figure 8A.

Step 7. Adjust L12A and L12B of T3 for maximum gain, keeping the pattern symmetrical and centered on the 455-kc. marker.

Step 8. Move the 1000-ohm jumper to the primary of T7 and adjust L14A and L14B of T5 as in step 7.

Step 9. Remove the 1000-ohm jumper and connect the oscilloscope to the AM IF observation point, test point no. 4.

Step 10. Adjust L17A and L17B of T7 for optimum bandpass characteristics. Remove test equipment.

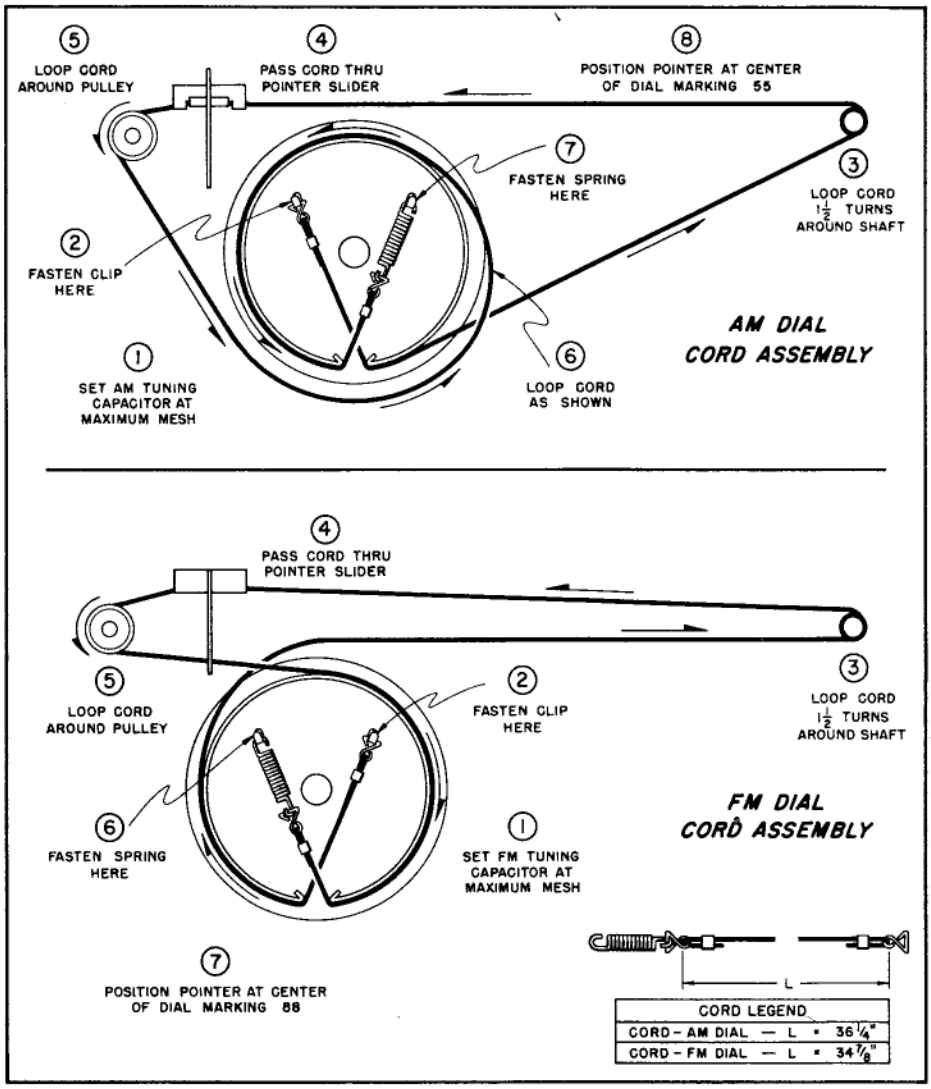


Figure 9. Dial Cord Stringing Instructions

PARTS LIST

SYM-BOL	DESCRIPTION	NAT. CO. PART NO.
C2	Variable, 4 sections	T442-1
C12	Variable, 3 sections	T441-1
E1	Printed Circuit, IF	T605-1
E2	Printed Circuit	T606-1
E3	Dummy Panel	T671-2
E4	Terminal Panel, antenna	T454-2
J1	Phono-jack, dbl, Cinch type 8113	T579-1
J2	Phono-jack, dbl, Cinch type 8113	T579-1
J3	Phono-jack, single, Cinch 8171	T458-1
J4	Receptacle, A.C., Cords type CC-2	L283-1
J5	Jack, 16 contacts, Amphenol 26-4200-16S modified	T448-1
J6	Receptacle, A.C., Alden 402ACE	T452-1
J7	Receptacle, A.C. Alden 402ACE	T452-1
J8	Phono-jack, dbl, Cinch type 8113	T579-1
J9	Phono-jack, dbl, Cinch type 8113	T579-1
L2	R.F. Coil	T618-1
L3	R.F. Coil	T619-1
L4	R.F. Coil	T617-1
L7	R.F. Coil	T566-1
L8	R.F. Coil	T567-1
L9	Choke, R.F., 2 uh	SB:2602
L10	Choke, R.F., 100 uh	SA:3003
L15	Choke, R.F., 100 uh	SA:3003
L20	Choke, R.F., 100 uh	SA:3003
L23	Choke, R.F., 2 uh	SB:2602
P1	Dummy Plug	SB:2800
R30	Variable, 100,000 ohms log taper, with SPST switch IRC type Q	T578-2
R58	Variable, 500,000 ohms, A taper Clarostat type 47	T013-7
R72	Variable, 1,000 ohms, A taper, IRC type RQ11-108	T013-8
RC1	Diode Filter	T604-1
SW1	Rotary switch, 8 pole, 4 position, Grigsby-Allison type 4MLW	T453-1
T1	Antenna Coil, includes L6A, L6B	T565-1
T2	IF Transformer	T608-1
T3	IF Transformer	T608-7
T4	IF Transformer	T608-2
T5	IF Transformer	T608-8
T6	IF Transformer	T608-3
T7	IF Transformer	T608-9
T8	IF Transformer	T608-4
T9	Power Transformer, pri 117 VAC, 60 cycles; sec 300-0-300 v at 110 ma DC, 5 v at 2 amps, 6.3 v at 5 amps and 6.3 v at 1 amp	T580-1
W1	Power Cord, AC, Cords 18/2POSJ-64	L284-1
XF1	Fuseholder Littlefuse type 34201	E510-1
Y1	Germanium Diode type 1N60	T614-1
Z1	Coil Assembly	T608-6
Z2	Coil Assembly	T609-1
Z3	Coil Assembly	T608-5

CONDITIONS
Selector Switch
VTVM used for
117 VAC, 60 cy
No input signal
Tolerance ±10%

TUBE	PIN 1	2
V1	200	110
V2	0	-2 t
V3	-0.7**	1.7
V4	-8 to -10	0
V5	-0.5**	0
V6	-0.5**	0
V7	-0.5**	0
V8	-0.5**	0
V9	190	11
V10	-0.7	0
V11	-0.7	0
V12	0	-8
V13	190	120
V14	117AC	*

*5 VAC across pin
**Tolerance ±20%.

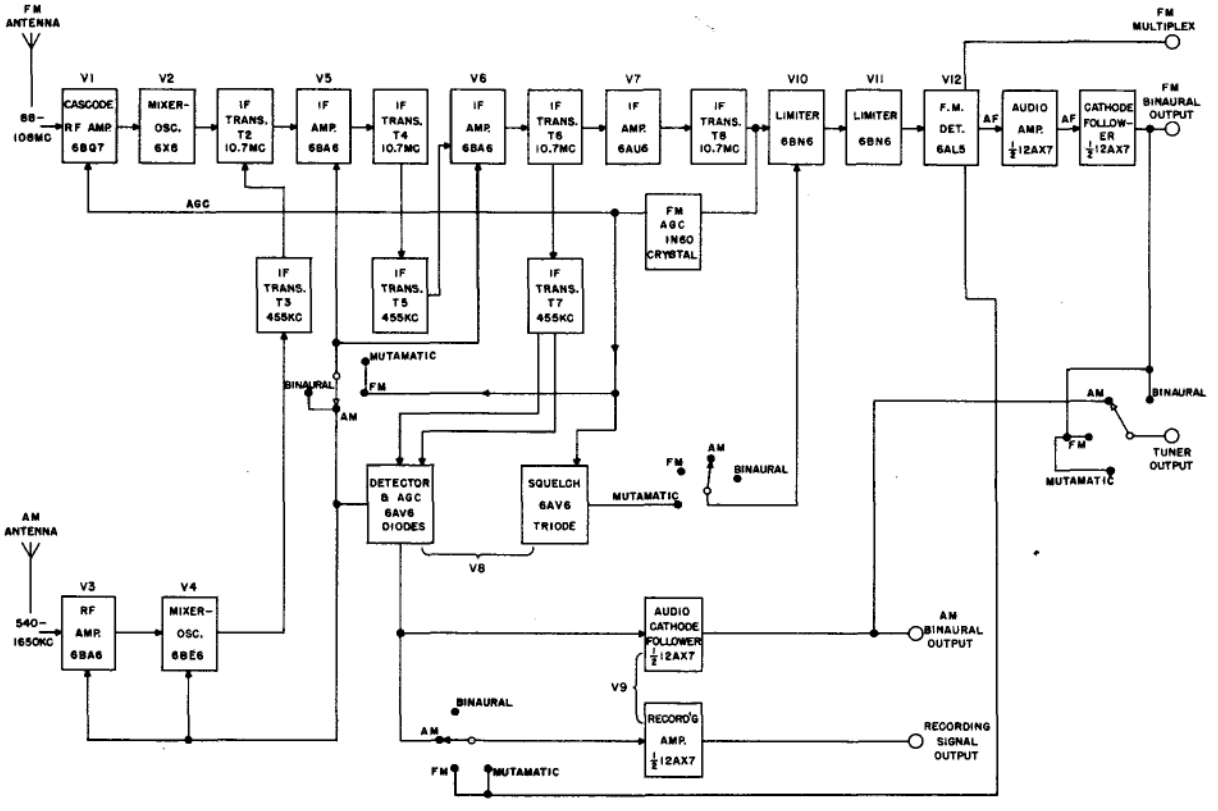


Figure 10. Functional Block Diagram

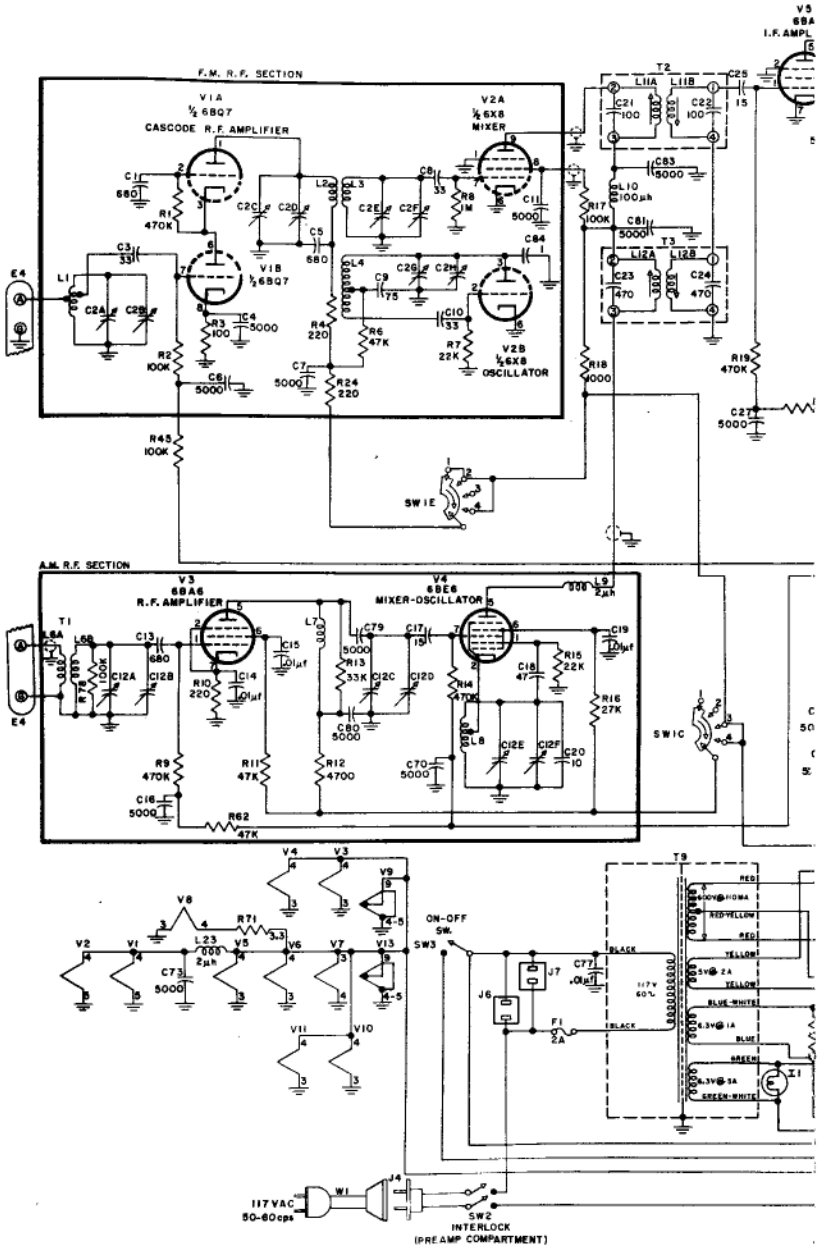
TABLE 1. TUBE SOCKET VOLTAGES

at FM.
ll measurements.
le input.

unless otherwise noted, all readings DC except as noted.

	3	4	5	6	7	8	9
	110	6.3AC	0	110	-0.5**	0.8**	---
-4	75	6.3AC	0	0	-1.5 to -3	90	200
*	0	6.3AC	170	100	1.7**	---	---
	0	6.3AC	200	70	-0.7**	---	---
	0	6.3AC	210	100	0	---	---
	0	6.3AC	210	100	0	---	---
	6.3AC	0	210	100	0	---	---
	0	5.5AC	-0.5 to -0.7	-0.7 to 1.0	30**	---	---
	12	0	0	140	-0.5	1	6.3AC
	0	6.3AC	100	5 to 7	190	---	---
	0	6.3AC	100	5 to 7	190	---	---
	6.3AC 20	20	-4 to -7	0	-4 to -7	---	---
	120	0	0	120	0	1	6.3AC
	200	300AC	20	300AC	117AC	*	---

2 and 8. 350 volts D.C. to ground.



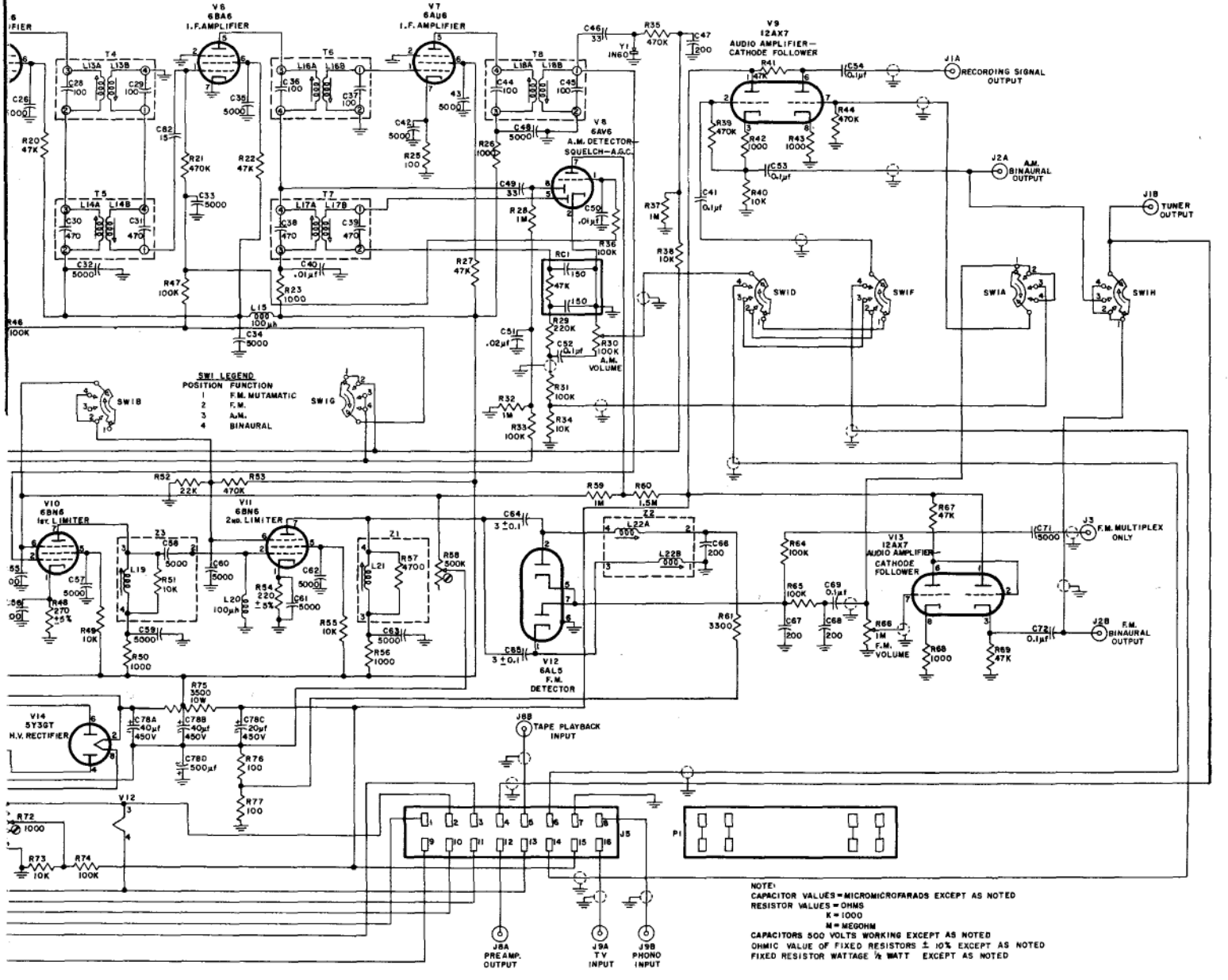


Figure 11. Schematic Diagram

3. FM RF ALIGNMENT

Correct alignment of the FM RF section requires the use of a signal generator capable of covering the range of 87 to 109 megacycles. A typical unit is the Boonton 202A. In addition, a DC vacuum tube voltmeter is required and an insulated alignment tool with a narrow screwdriver blade. If the calibration of the generator is at all questionable it is suggested that an FM broadcast station at each end of the dial be used as a frequency standard. Proceed as follows:

Step 1. Connect the signal generator to the FM antenna terminals. Set the frequency at 109 mc. and set the tuner dial at the same frequency.

Step 2. Connect the VTVM at the FM AGC line (test point no. 2).

Step 3. Adjust oscillator trimmer C2H to produce maximum AGC voltage, reducing the generator output as necessary.

Step 4. Adjust mixer trimmer C2F for maximum AGC, rocking the generator frequency slightly to insure optimum tuning.

Step 5. Repeat step 4, adjusting C2D and C2B.

Step 6. Set the generator frequency and tuner FM dial at 87.5 mc.

Step 7. Obtain maximum AGC voltage by adjustment of L4, L3, L2 and L1. The air wound coils are adjusted by very slightly compressing or separating the turns.

Step 8. Repeat the entire process (steps 4 through 7) until no further adjustment is required at either end of the dial. During this entire procedure, make certain that the generator output is just high enough to produce a usable AGC voltage. Disconnect the test equipment.

4. AM RF ALIGNMENT

For alignment of the AM front end, a standard signal generator covering the broadcast band (500 to 1650 kc.) is required. The procedure is straightforward and conforms to standard service techniques.

Step 1. Connect the signal generator at the AM antenna terminals. Set the frequency of the generator and tuner at 1650 kcs.

Step 2. Connect the VTVM at the AM AGC line, test point no. 4, (junction of RC1 and R29).

Step 3. Adjust oscillator trimmer C12F to obtain AGC voltage.

Step 4. Adjust mixer and antenna trimmers C12D and C12B for maximum meter reading.

Step 5. Disconnect all test equipment.

5. ADJUSTMENT OF HUM BALANCE RESISTOR

The hum balance resistor R72 is factory adjusted for proper operation and these instructions should be carried out only if the resistor setting is inadvertently disturbed or the control replaced.

a. If the tuner is used without the preamp set the selector switch at FM. Disconnect the FM antenna. Turn the FM volume control on full and adjust R72 for minimum audible hum as heard from the speaker system.

b. If the Horizon 5 preamp is used with the tuner set the Selector of the preamp at any of the 7 Phono Compensation positions. Set the Loudness control full on and adjust R72 for minimum hum.

6. MUTAMATIC ADJUSTMENT

This control is factory adjusted for normal squelch threshold level. If readjustment is desired turn the control (R58) fully counterclockwise. Set the Selector of the tuner at FM Mutamatic and set the tuning dial at a point where only noise is heard. Turn R58 in a clockwise direction until the background noise just disappears. Turn the control about 5 degrees further in the clockwise direction. The Mutamatic is now properly set and will "pull-in" on all but the weaker signals, yet block out annoying inter-station noise.