OPERATING INSTRUCTIONS

UNIVERSAL TELEVISION-FM ALIGNMENT GENERATOR

Model 610 A

HICKOK

WORLD FAMOUS

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 DUPONT AVENUE • CLEVELAND 8, OHIO

The Standard of Quality for Over 40 Years

GUARANTEE

Hickok testing equipment is guaranteed against inaccuracy or defect in material or workmanship for a period of 90 days after DATE OF ORIGINAL PURCHASE BY DEALER FROM JOBBER. Adjustment under terms of this guarantee will be made by the factory or our repair station without charge. This guarantee does not cover transportation charges to or from our factory or repair station. FAILURE TO RETURN ATTACHED CARD PROPERLY EXECUTED WITHIN 10 DAYS VOIDS GUARANTEE.

OPERATING INSTRUCTIONS

FOR

UNIVERSAL

TELEVISION-FM ALIGNMENT GENERATOR

MODEL 610A

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 Dupont Avenue

Cleveland 8, Ohio

Form I-610A-550

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LIST OF ILLUSTRATIONS

FIGURE 1.1 - UNIVERSAL TELEVISION ALIGNMENT SIGNAL GENERATOR, MODEL 610A

TECHNICAL DATA SHEET

(One Complete Unit)

Quan.	Name	Type	Stock No.	Dimensions	Weight
1	Universal Television-FM Alignment Signal Generator	610A	902-172	13" x 16" x 7"	24 lbs.
1	Instruction Book		2490-143		
1	Output Lead, 48" black		3030-41	48"	
1	Ground Lead, black		12450-99	48"	
1	Ground Lead, shielded		12450-173	24"	

TECHNICAL CHARACTERISTICS

1. Power Supply Required: 105-125 V, 50-60 cycles, a-c

2. Power Consumption: 35 watts at 115 volts

3. Frequency Modulated Range: 0-40 mc.
   35-75 mc.
   75-115 mc.
   150-230 mc.

4. Deviation: TV-0-15 mc.
   FM-0-1.5 mc.

5. Sweep Frequency: 60 cycles

6. Marker Frequency Range: oscillating "pip" or absorption "dip"
   19-31 mc. - 30-48 mc. Fundamental

7. Modulation:
   a. Amplitude Modulated Frequency Range: 19-31 mc. 30-48 mc, variable output.
   b. Modulation Frequency: 400 cycles, appx. 50%

8. External Marker Frequency: 1 mc. to 250 mc.

9. External Crystal Jack on Panel---Internal Oscillator

10. RF Output: Continuously variable from 0 to 0.5 volts with multiplier steps
    X1, X10, X100, X1K, X10K.

11. Phasing Control

12. Tube Complement:

	TUBE	STOCK NO.	FUNCTION
V1	6J6	20875-71	Output
V2	6J6	20875-71	75-150 Mc Osc.
V3	6J6	20875-71	75-115 Mc Osc.
V4	6J5	20875-12	Modulator
V5	6X5GT	20875-22	Rectifier
V6	6SN7GT	20875-19	Crystal and Marker Oscillator
	#47 G.E.	12270-12	Pilot Lamp

GUARANTEE

HICKOK TESTING EQUIPMENT IS GUARANTEED AGAINST INACCURACY OR DEFECT IN MATERIAL OR WORKMANSHIP FOR A PERIOD OF 90 DAYS AFTER DATE OF SHIPMENT FROM OUR FACTORY. ADJUSTMENT UNDER TERMS OF THIS GUARANTEE WILL BE MADE BY THE FACTORY OR OUR REPAIR STATION WITHOUT CHARGE. THIS GUARANTEE DOES NOT COVER TRANSPORTATION CHARGES TO OR FROM OUR FACTORY OR REPAIR STATIONS.

THIS GUARANTEE EXPRESSLY DOES NOT COVER VACUUM TUBES OF ANY DESCRIPTION WHICH ARE SHIPPED WITHIN OR AS ACCESSORIES TO ANY INSTRUMENT. (THESE TUBES ARE GUARANTEED BY THE TUBE MANUFACTURER.)

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Address all service inquiries to The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

OPERATING INSTRUCTIONS FOR
TELEVISION ALIGNMENT GENERATOR
MODEL 610A

SECTION I
DESCRIPTION.

1.1 PURPOSE:

To meet the rigid requirements of the radio engineer and television serviceman in the design and alignment of television receivers, the Model 610A Television Alignment Generator has been developed. This versatile instrument covers all television bands, intermediate frequency ranges, and provides markers for the checking of response curves and alignment of sound traps. Provisions have also been made for the insertion of crystals to permit setting receiver local oscillators to exact frequency.

1.2 DESCRIPTION:

a. The panel with its satin-smooth finish; the case with its blue Hammertex exterior; the louvres in the back for cooling; the carrying handle on the top; the extremely clear marking on all panel controls, scales, and connectors; the four blister feet on both the bottom and back of the case for convenient use in either a horizontal or vertical position---all make for a welcome and functional addition to your matched Hickok service equipment.

b. Since the Model 610A was designed for FM-television receiver alignment, its capabilities are as follows:

1. It generates a frequency modulated signal with sweep width, center frequency, and output level - all adjustable to meet the needs of FM-television receivers.

2. Provisions are made in the generator to produce marker pips from a variable oscillator or from a crystal controlled oscillator. If 'blip' type markers are not preferred, an absorption circuit can be substituted which makes an indentation type marker on your response curve. Figures 4.5 through 4.9 illustrate the use of markers. Figures 4.5, 4.8 and 4.9 illustrate the 'blip' type of markers, and Figure 4.6 illustrates the absorption type of marker. These will be found under Section IV, Alignment Procedure.

3. Pure RF or amplitude modulated RF with variable output is provided for the alignment of sound traps.

4. Crystal controlled RF, modulated or unmodulated, is available for the setting of the receiver's local oscillator to any of the 12 standard television channels, or for IF alignment.

5. A 4.5 mc. crystal is supplied for inter-carrier IF alignment.

SECTION II
THEORY

2.1 GENERAL:

Since a thorough understanding of the theory of operation of this instrument will enable the user to make more satisfactory alignments, a brief discussion of visual alignment in general and a detailed discussion of the operation of the Model 610A will be given.

2.2 VISUAL ALIGNMENT REQUIREMENTS:

Television receivers have extremely wide band amplifiers and therefore it is necessary to see a response curve (Figures 4.5 and 4.6 Section IV) of the amplifier in order to align the stages properly. A response curve is the graphic representation of the output of a tuned circuit as the frequency applied to it approaches and passes through its resonant point. In the Model 610A generator the frequency output is changed from a frequency below resonance to one above resonance for the tuned IF stage, or stages, of the television receiver. Since we connect an oscillograph to the detector load of the receiver, a voltage will appear across the vertical plates of the scope that varies with the output of the tuned circuit as the sweep generator Model 610A presents the frequencies to its input. The driving source that changes the frequency of the FM generator of the 610A is 60 cycle AC.

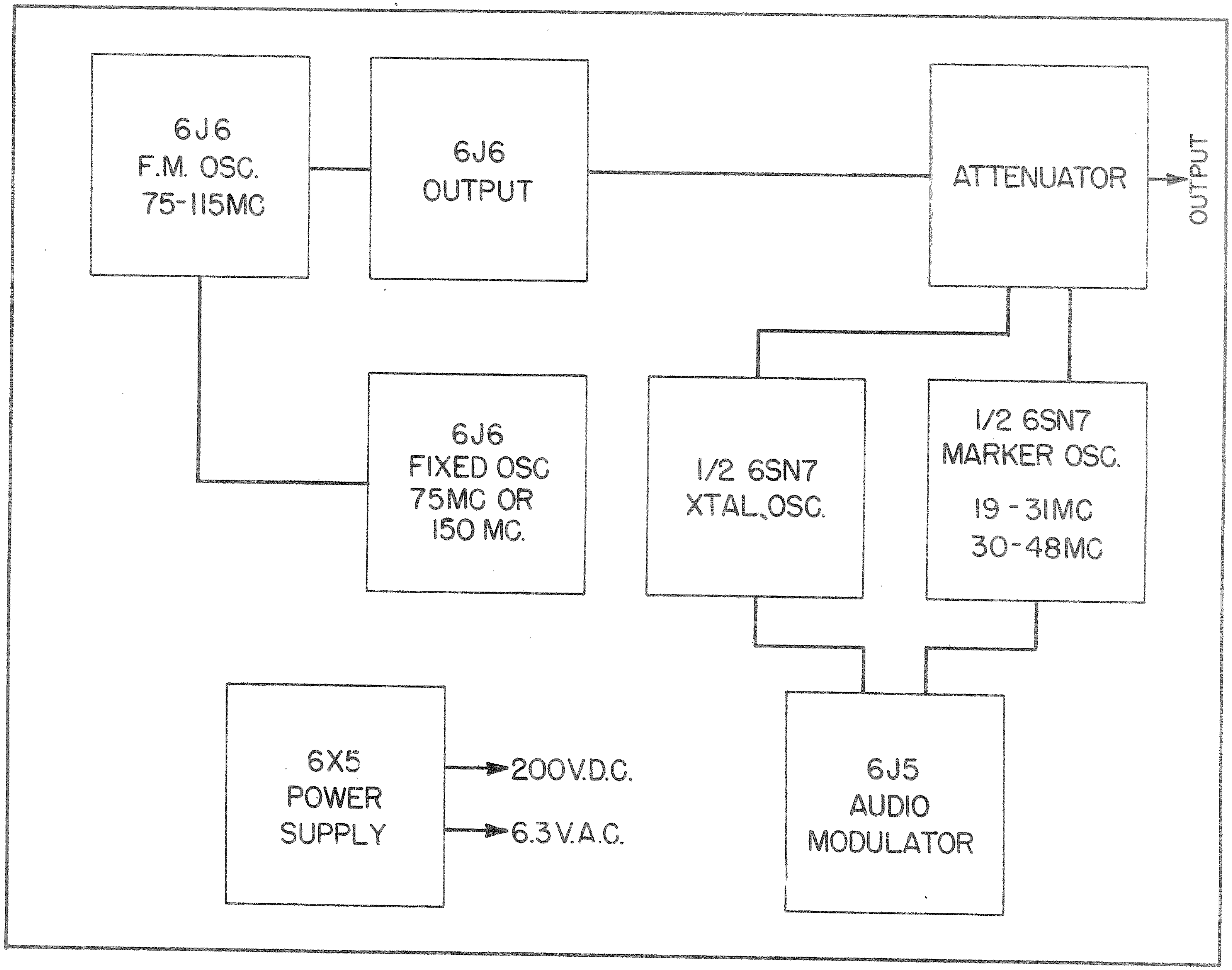

FIG. 1.2 - BASIC CIRCUIT, BLOCK DIAGRAM

Therefore, if the same voltage is applied to the horizontal plates of the scope, the beam will sweep from left to right in step with the changing frequency output of the generator. It should be clear then that the two voltages acting on the scope beam will make it trace out an exact response of the circuit being aligned.

2.3 DISCUSSION OF THE MODEL 610A CIRCUITS - THE BLOCK DIAGRAM:

The block diagram of the generator is shown in Figure 1.2 and it will be helpful to refer to it when reading the discussions of the component circuits.

2.4 POWER SUPPLY:

a. The conventional type power supply operates normally from a 105-125 volt, 60 cycle AC source. The low pass filter on the primary side of the transformer prevents leakage of the RF back through the line.

b. Approximately 200 volts is developed from each side of the high voltage secondary winding to ground, while the 6.3 volt filament winding has one side grounded.

c. A type 6X5 tube is used in a full-wave rectifier circuit that develops approximately 200 volts DC at 50 ma. through an RC filter.

2.5 FM OSCILLATOR:

a. In order to produce the sweep frequencies necessary, a 6J6 miniature dual triode with both sections in parallel is used. The most novel feature of the 610A is that this FM oscillator has its tank inductance controlled by the position of the dynamic drive.

Since the resonance of the tank will change with changing inductance, the output frequency of the oscillator is set by the position of the drive with respect to the tank circuit's inductor.

b. As the 60 cycle AC control voltage on a dynamic motor is increased, the drive varies from the 1/8" rest distance (from the inductor) and the frequency sweep width is increased.

c. Furthermore, the tank is tuned by the main variable condenser giving frequency coverage from 75 to 115 mc.

2.6 FIXED OSCILLATORS:

a. Section 2.5 explains how we can have center frequencies available from 75 to 115 mc, but to increase the range of the instrument to cover the television requirements two fixed oscillators are employed. In a type 6J6 tube one section is connected to a tank circuit which will oscillate at 75 mc and the other triode section, to a tank circuit designed to operate at 150 mc. When heterodyning the 75 mc fixed oscillator against the main variable oscillator, frequencies from zero to 40 mc are obtained. When heterodyning the 150 mc against the first harmonic of the main varable, the frequency range of 35 to 75 mc is available.

b. The RANGE control automatically employs either fixed oscillator when it is needed.

2.7 MIXER AND OUTPUT STAGE:

A 6J6 tube, with both sections tied in parallel, is used as a mixer and output amplifier for the FM and fixed oscillator frequencies. The output stage has two functions:

a. It serves to isolate any output loading from the oscillators.

b. It is also utilized as a limiter to remove amplitude modulation.

2.8 CRYSTAL CONTROLLED OSCILLATOR:

a. To adjust the receiver oscillator to the sound carrier of any local television channel or to provide for crystal marker frequencies, provisions have been made in the crystal oscillator circuit for the insertion of crystals of the desired frequencies. When tone modulation is desired, an internal 400-cycle oscillator is used to modulate the crystal controlled output.

b. When the RANGE switch is in any position but STANDBY, the insertion of the proper crystal will cause the oscillator to function.

c. Modulation is accomplished by setting the INT. MARKER control to MOD.

2.9 VARIABLE "MARKER" OSCILLATOR:

a. The crystal oscillator discussed in section 2.8 used one-half of a type 6SN7 tube, while the other half is used as a variable oscillator.

b. Since standard television IF and trap frequencies fall in the 20 to 30 mc and 30 to 40 mc ranges, the variable Colpitts oscillator with link coupling has an extremely large and well calibrated dial over these bands.

c. Setting the INT. MARKER to the OSC position places marker pips on the response curve traced on the scope. Tuning the variable oscillator dial will make the pip move on the response curve so that the dial reading will be the exact frequency of the curve at the pip position.

d. In addition to the oscillator type marker, an absorption type is also available covering the same frequency range. In changing the circuits from oscillator to absorption type marker, the resistor is connected into the plate circuit to stop oscillations. The absorption type marker is preferred by some servicemen since it can not in any way affect the response curve in connection with which it is being used.

2.10 MODULATION:

The variable oscillator can be modulated for sound trap adjustment by setting the INT. MARKER from CW to MOD. This circuit uses a 6J5 triode producing a fixed 50% modulation.

2.11 ATTENUATOR:

Sweep generator, crystal oscillator, and variable marker signals are all fed into an attenuator network that provides for step changes of output level. The sweep generator and marker signals can be attenuated gradually throughout any one step of output level.

SECTION III

OPERATION

3.1 CONTROLS:

Reference to Fig. 3.1 or the Model 610A itself will be most helpful in familiarizing yourself with the operation of the various controls on the generator.

a. MEGACYCLE SWEEP: This variable resistor, R13 on the schematic diagram (Fig. 7.1), regulates the amount of voltage supplied to the dynamic motor. Larger voltages increase the deviation as discussed in the THEORY section. The amount of deviation can be varied from 0-15 mc or 0-1.5 depending on position of FM-TV switch.

b. FREQUENCY ADJUSTMENT: Capacitor C6 is the tunable element that changes the center frequency of the sweep generator. Frequency is read on the main tuning dial. The FM-TV switch is located directly below the megacycle sweep dial, and selects either 0-1.5 mc sweep for FM alignment or 0-15 mc for TV alignment.

c. RANGE SELECTOR: A six position switch, S2, is used to determine frequency range of the instrument. 'Stand-By' position on the switch removes the plate voltage from all tubes, while 'Sweep Off' turns off the main variable oscillator and permits the marker oscillators to operate, and either may be amplitude modulated.

d. OUTPUT CONTROL: R32 regulates the amount of sweep generator output that is fed to the attenuator network.

e. OUTPUT MULTIPLIER: The attenuator ratio is selected by the switch S7, and the sweep output determined by the setting of the 'Output Control' is regulated further in steps of 10.

f. MARKER FREQUENCY SELECTOR: A control to select either 19-31 mc. marker frequency or 30-48 mc. marker frequency.

g. MARKER FREQUENCY: The frequency of the variable marker or the absorption marker is determined by this dial which controls C26. Section 2.9 explains the absorption marker function in detail.

h. MARKER INJECTION: Since the amount of marker signal used can seriously affect the response curve shown on the scope, R37 is used to attenuate the marker signal to any desired level. If the marker is not used, the control should be rotated to its 'Off' position.

i. PHASING: A phase shift network, R16 and C22, is used to correct for possible displacement of the return trace from the forward trace (Reference Fig. 4.7). Should Hickok oscilloscope Models RFO-5, 195, 305 or 505 be used in connection with alignment, these scopes have provision for self-contained horizontal sweep and phasing control and therefore, connection between the horizontal sweep voltage of the Model 610A and the horizontal circuits of these scopes is not normally necessary.

j. GROUND: It is impossible to overemphasize the necessity for a good ground in all high frequency alignment work. For that reason, two ground posts have been provided, and a firm electrical connection MUST be made between the generator, oscilloscope, and receiver. If the sweep pattern changes when any connection is touched or moved, then additional grounding, or grounding at a different place on the chassis of the receiver, is necessary. A grounding strap has been included with the Model 610A for this purpose.

k. POWER: This switch S8 turns the instrument on and off.

l. OUTPUT: A coaxial type cable is provided for coupling the output connector to the circuit under alignment. Several precautions MUST be taken when using the generator. Since no coupling capacitor is built into the output, serious damage may result if the cable is connected to a source of high voltage. Although the chassis of the receiver and the other equipment used have a common ground, the grounding clip at the end of the output cable must be connected.

m. PILOT LIGHTS: Two pilots are used to indicate the operation of the generator. The green light is on when the 610A is set for "Stand By"---no voltage on the plates of the tubes but heaters are operating. When the redlight is on, the plate voltage has been applied by the "Range Selector" and the generator is in operation.

n. CRYSTAL: Crystals may be plugged into the external holder to permit accurate adjustment of the receiver oscillator. Extremely accurate pips may also be generated for fixed markers on the response curve when proper crystals are used. Crystals are available from the factory for any frequency between 10 mc. and 215 mc.

o. EXTERNAL MARKER: An external signal generator may be connected between this post and "GND" to provide an additional marker frequency if it is desired. Since this binding post is internally connected to the marker oscillator and crystal oscillator circuits, it is possible to obtain from this binding post outputs directly from either of these oscillators. Paragraph 4.9b, Section IV explains the occasion where this might be useful.

p. HORIZONTAL: Horizontal deflection voltage for the oscilloscope used is available at this post and may be connected to the horizontal input to the scope.

q. INTERNAL MARKER: When the switch, S5, is in the "OSC" position, a pip is seen, but the "ABS" position changes the pip to a dip in the response curve. The marker is usually used while S4, the "Internal Marker" control is in the "CW", or pure RF position. When using the marker oscillator for trap adjustment, this switch may be thrown to the "Mod." position.

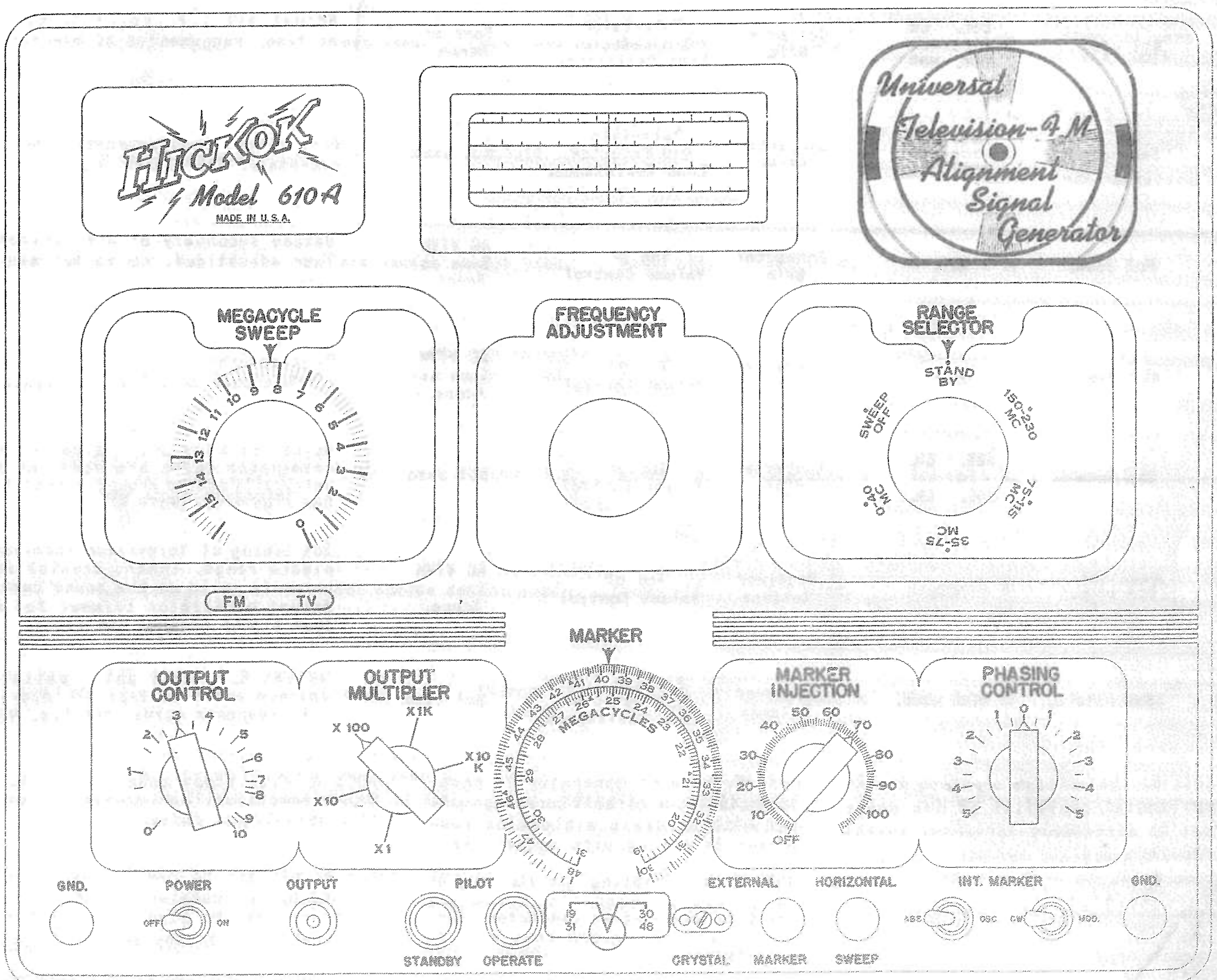

Fig. 3.1 - Model 610A, Panel View

ALIGN	DEVIATION	FREQUENCY ADJUSTMENT	RANGE	OUTPUT CONTROL	OUTPUT MULTIPLIER	MARKER FREQUENCY	
1. Accompanying sound traps	Not used.	Not used.	Sweep off.	Not used.	See note B.	Sound I.F.	Suff Conve on DC
2. Adjacent sound traps	Not used.	Not used.	Sweep off.	Not used.	See note B.	Adjacent Channel Sound Frequency	Suff Conve on DC
3. Television I.F. Amp. Overcoupled	10 mc.	Picture I.F.	Picture I.F.	See note A	See note B.	Set to freq. of response curves as recommended by manufacturer.	See
4. Television I.F. Overcoupled.	10 mc.	Picture I.F.	Picture I.F.	See note A.	See note B.	As above	See
5. Television I.F. Overcoupled Overall Response.	10 mc.	Picture I.F.	Picture I.F.	See note A.	See note B.	As above	See
6. Television I.F. Stagger tuned.	Not used.	Not used.	Sweep off.	Not used.	See note B.	Freq. of 1st I.F. primary	See
7. Television I.F. Stagger tuned.	Not used.	Not used.	Sweep off.	Not used.	See note B.	Freq. of next I.F. coil	See
8. Television I.F. Stagger tuned.	10 mc.	Picture I.F.	Picture I.F.	See note A.	See note B.	Set to values recommended by manufacturers.	See
9. Sound I.F. Amplifier	Not used.	Not used.	Sweep off.	Not used.	See note B.	Sound I.F.	See
10. Discriminator Secondary	Not used.	Not used.	Sweep off.	Not used	See note B.	Sound I.F.	See
11. Discriminator Primary and Secondary scope alignment	2 mc.	Sound I.F.	Sound I.F.	See note A.	See note B.	Sound I.F.	See
12. Television Oscillator	Not used.	Not used	Sweep off.	Not used.	See note B.	Not used. Use crystal.	See
13. R.F.	10 mc.	Channel Frequency	Channel Frequency	See note A.	See note B.	Not used.	See

NOTE A. The output control should always be at a minimum needed to get a convenient deflection on scope or voltmeter. Distortion can be noted on a pattern by a distinct flat top caused by clipping in some stage.

NOTE B. This is a step attenuator and should also be kept as low as possible, consistent with satisfactory signal.

NOTE C. An output control has b[illegible] added so the marker amplitude may changed independent of the "swe[illegible] frequency. Adjust sufficiently [illegible] visible mark on sweep pattern [illegible] not enough to distort patte[illegible]

FIG. 3.2 -

MARKER INJECTION	PHASING	INTERNAL MARKER	CONNECT GENERATOR TO (Note E)	CONNECT SCOPE TO (Note F & H)	CONNECT VTVM TO	REMARKS
ufficient for venient Signal on scope or DC on VTVM.	Not used.	OSC. and MOD. or OSC. and CW.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	When using scope, use Mod. Signal. When using DC VTVM, use CW. Signal.
ufficient for venient Signal on scope or DC on VTVM.	Not used.	OSC. and MOD. or OSC. and CW.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	Adjust all sound traps for minimum indication on meter or scope.
ee note C.	See note D.	OSC. CW. or ABS.	Grid of last video	Television 2nd Detector Load Resistance.	Not used.	Use jumper across primary of transformer preceding grid, to which connection is made. See Fig. 4.2
ee note C.	See note D.	OSC. CW. or ABS.	Grid of preceding video stage	Television 2nd Detector Load Resistance.	Not used.	As above. Continue until last video I.F. transformer is adjusted.
ee note C.	See note D.	OSC. CW. or ABS.	Converter Grid.	Television 2nd Detector Load Resistance.	Not used.	Only slight readjustments should be necessary.
ee note C.	Not used	OSC. CW. or OSC. MOD.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	When using scope, use Mod. Signal. When using DC VTVM, use CW. Signal.
ee note C.	Not used	OSC. CW. or OSC. MOD.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	Adjust all I.F. coils to maximum at freq. recommended by manufacturers.
e note C.	See note D.	ABS. CW. or OSC. CW.	Converter Grid.	Television 2nd Detector Load Resistance.	Not used.	Only slight readjustments should be necessary. See Figure 4.1
e note C.	Not used.	MOD.	Converter Grid.	Top of Volume Control	AC VTVM Same as Scope.	Detune secondary of discriminator. Then adjust I.F. coils for maximum output.
e note C.	Not used	MOD.	Converter Grid.	Top of Volume Control	AC VTVM Same as Scope.	Tune secondary of discriminator to minimum between two signal peaks.
e note C.	See note D.	ABS. CW. or OSC. CW.	Converter Grid.	Top of Volume Control	Not used.	Adjust primary until sides of discriminator curve are equal or symmetrically spaced around marker freq. See Figure 4.3 (Note G)
e note C.	Not used.	MOD.	Receiver Antenna	Top of Volume Control	AC VTVM Same as Scope.	Set tuning of television receiver to middle range. Insert crystal whose harmonic falls on the sound carrier. Adjust oscillator trimmer for minimum signal between two peaks.
e Note I	See note D.	Not used.	Receiver Antenna	Picture I.F. 2nd Detector Load Resistance.	Not used.	Adjust R.F. coil until pattern is maximum and like typical television I.F. response curve. See Fig. 4.6

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NOTE D. The voltage supplied to the horizontal amplifier of the scope has an adjustment for phase so the forward trace and retrace will coincide.

NOTE E. Be sure generator is never connected to a circuit carrying voltage without using a blocking condenser in series with output lead.

NOTE F. An isolating resistor may be advisable between the scope and point to which it is connected. Generally 5000 to 15,000 ohms will be satisfactory.

NOTE G. With scope connected, I.F. transformers may be touched up for more symmetrical curve.

NOTE H. To sharpen the oscillator marker pip and to remove some hash caused by the receiver, a .01 mfd. condenser may be placed across the vertical input to the scope.

NOTE I. Marker dial should be turned clear to either end of dial.

OPERATION CHART

ALIGN	DEVIATION	FREQUENCY ADJUSTMENT	RANGE	OUTPUT CONTROL	OUTPUT MULTIPLIER	MARKER FREQUENCY	MARKER INJECTION	PHASING	INTERNAL MARKER	CONNECT GENERATOR TO (Note E)	CONNECT SCOPE TO (Note F & H)	CONNECT VTVM TO	REMARKS
1. Accompanying sound traps	Not used.	Not used.	Sweep off.	Not used.	See note B.	Sound I.F.	Sufficient for Convenient Signal on scope or DC on VTVM.	Not used.	OSC. and MOD. or OSC. and CW.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	When using scope, use Mod. Signal. When using DC VTVM, use CW. Signal.
2. Adjacent sound traps	Not used.	Not used.	Sweep off.	Not used.	See note B.	Adjacent Channel Sound Frequency	Sufficient for Convenient Signal on scope or DC on VTVM.	Not used.	OSC. and MOD. or OSC. and CW.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	Adjust all sound traps for minimum indication on meter or scope.
3. Television I.F. Amp. Overcoupled	10 mc.	Picture I.F.	Picture I.F.	See note A	See note B.	Set to freq. of response curves as recommended by manufacturer.	See note C.	See note D.	OSC. CW. or ABS.	Grid of last video	Television 2nd Detector Load Resistance.	Not used.	Use jumper across primary of transformer preceding grid, to which connection is made. See Fig. 4.2
4. Television I.F. Overcoupled.	10 mc.	Picture I.F.	Picture I.F.	See note A.	See note B.	As above	See note C.	See note D.	OSC. CW. or ABS.	Grid of preceding video stage	Television 2nd Detector Load Resistance.	Not used.	As above. Continue until last video I.F. transformer is adjusted.
5. Television I.F. Overcoupled Overall Response.	10 mc.	Picture I.F.	Picture I.F.	See note A.	See note B.	As above	See note C.	See note D.	OSC. CW. or ABS.	Converter Grid.	Television 2nd Detector Load Resistance.	Not used.	Only slight readjustments should be necessary.
6. Television I.F. Stagger tuned.	Not used.	Not used.	Sweep off.	Not used.	See note B.	Freq. of 1st I.F. primary	See note C.	Not used	OSC. CW. or OSC. MOD.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	When using scope, use Mod. Signal. When using DC VTVM, use CW, Signal.
7. Television I.F. Stagger tuned.	Not used.	Not used.	Sweep off.	Not used.	See note B.	Freq. of next I.F. coil	See note C.	Not used	OSC. CW. or OSC. MOD.	Converter Grid.	Television 2nd Detector Load Resistance.	Same as Scope.	Adjust all I.F. coils to maximum at freq. recommended by manufacturers.
8. Television I.F. Stagger tuned.	10 mc.	Picture I.F.	Picture I.F.	See note A.	See note B.	Set to values recommended by manufacturers.	See note C.	See note D.	ABS. CW. or OSC. CW.	Converter Grid.	Television 2nd Detector Load Resistance.	Not used.	Only slight readjustments should be necessary. See Figure 4.1
9. Sound I.F. Amplifier	Not used.	Not used.	Sweep off.	Not used.	See note B.	Sound I.F.	See note C.	Not used.	MOD.	Converter Grid.	Top of Volume Control	AC VTVM Same as Scope.	Detune secondary of discriminator. Then adjust I.F. coils for maximum output.
10. Discriminator Secondary	Not used.	Not used.	Sweep off.	Not used	See note B.	Sound I.F.	See note C.	Not used	MOD.	Converter Grid.	Top of Volume Control	AC VTVM Same as Scope.	Tune secondary of discriminator to minimum between two signal peaks.
11. Discriminator Primary and Secondary scope alignment	2 mc.	Sound I.F.	Sound I.F.	See note A.	See note B.	Sound I.F.	See note C.	See note D.	ABS. CW. or OSC. CW.	Converter Grid.	Top of Volume Control	Not used.	Adjust primary until sides of discriminator curve are equal or symmetrically spaced around marker freq. See Figure 4.3 (Note G)
12. Television Oscillator	Not used.	Not used	Sweep off.	Not used.	See note B.	Not used. Use crystal.	See note C.	Not used.	MOD.	Receiver Antenna	Top of Volume Control	AC VTVM Same as Scope.	Set tuning of television receiver to middle range. Insert crystal whose harmonic falls on the sound carrier. Adjust oscillator trimmer for minimum signal between two peaks.
13. R.F.	10 mc.	Channel Frequency	Channel Frequency	See note A.	See note B.	Not used.	See Note I	See note D.	Not used.	Receiver Antenna	Picture I.F. 2nd Detector Load Resistance.	Not used.	Adjust R.F. coil until pattern is maximum and like typical television I.F. response curve. See Fig. 4.6

NOTE A. The output control should always be at a minimum needed to get a convenient deflection on scope or voltmeter. Distortion can be noted on a pattern by a distinct flat top caused by clipping in some stage.

NOTE B. This is a step attenuator and should also be kept as low as possible, consistent with satisfactory signal.

NOTE C. An output control has been added so the marker amplitude may be changed independent of the "sweep" frequency. Adjust sufficiently for visible mark on sweep pattern but not enough to distort pattern.

NOTE D. The voltage supplied to the horizontal amplifier of the scope has an adjustment for phase so the forward trace and retrace will coincide.

NOTE E. Be sure generator is never connected to a circuit carrying voltage without using a blocking condenser in series with output lead.

NOTE F. An isolating resistor may be advisable between the scope and point to which it is connected. Generally 5000 to 15,000 ohms will be satisfactory.

NOTE G. With scope connected, I.F. transformers may be touched up for more symmetrical curve.

NOTE H. To sharpen the oscillator marker pip and to remove some hash caused by the receiver, a .01 mfd. condenser may be placed across the vertical input to the scope.

NOTE I. Marker dial should be turned clear to either end of dial.

FIG. 3.2 - OPERATION CHART

SECTION IV

ALIGNMENT PROCEDURE

NOTE: Before using the 610A for the alignment of television sets it would be well to refer to and read paragraph 5.1, Section V.

4.1 GENERAL:

a. Manufacturers of television receivers usually supply complete and detailed information as to the method of alignment for their particular receivers and in all cases the method suggested by the manufacturer should give the best results on his equipment. Nevertheless, a generalization of the alignment procedure will help in an understanding of the method of employment of the Model 610A. Basically, the alignment for all receivers follows the same pattern. An understanding of the methods suggested in the following pages will put the owner of a Hickok 610A Television Alignment Generator in position to save much valuable time in the interpretation of manufacturer's instructions (usually requiring the employment of several pieces of equipment not needed when the 610A is used).

b. Again, you are cautioned as to the absolute necessity for a solid ground connection. Best results are obtained when a metal bench top is used---and, additional grounding may be necessary if the sweep pattern is changed when any piece of equipment or lead wire is touched. If additional grounding is found necessary, a ground strap is included as part of the Model 610A generator.

c. Television alignment methods are common sense methods and follow closely to ordinary radio alignment theory, so a good radio service man should have no difficulty in the profitable application of his alignment generator.

d-1. In the following discussion the order of alignment is as follows:

TELEVISION IF SOUND TRAPS: Since the sound and the picture beat against the same oscillator, the sound frequency (4.5 mc. from the picture) will come through the video circuits and cause the picture to weave and bob along with the audio, unless provisions are made to trap the sound. Traps are adjusted before video IF alignment because there is a possibility that later adjustment will upset the alignment.

d-2. TELEVISION ADJACENT CHANNEL TRAPS: According to FCC regulations, adjacent channels (for example, 5 and 6) must be at least 75 miles apart but FM sound from 5 may interfere with the picture of 6 on receivers located between the two stations. Since the sound of 5 may beat against the receiver local oscillator and end up in the video IF frequency band, some receivers make provisions for this possibility by adding a trap set for the adjacent channel frequency. This trap should also be adjusted before video alignment.

d-3. TELEVISION IF AMPLIFIERS: These are aligned next, and the order of alignment should start with the amplifier feeding the detector. Stages are then aligned in order - working back toward the RF section.

d-4. SOUND CHANNEL: Here, the alignment can be made using methods that have already been employed on FM receivers.

d-5. TELEVISION RECEIVER OSCILLATOR: This is an important adjustment and manufacturer's specifications should be followed closely.

d-6. TELEVISION RF AMPLIFIER: This is the last adjustment, and the overall response curve and the sensitivity of the set can be checked at this point.

4.2 TELEVISION IF SOUND TRAPS:

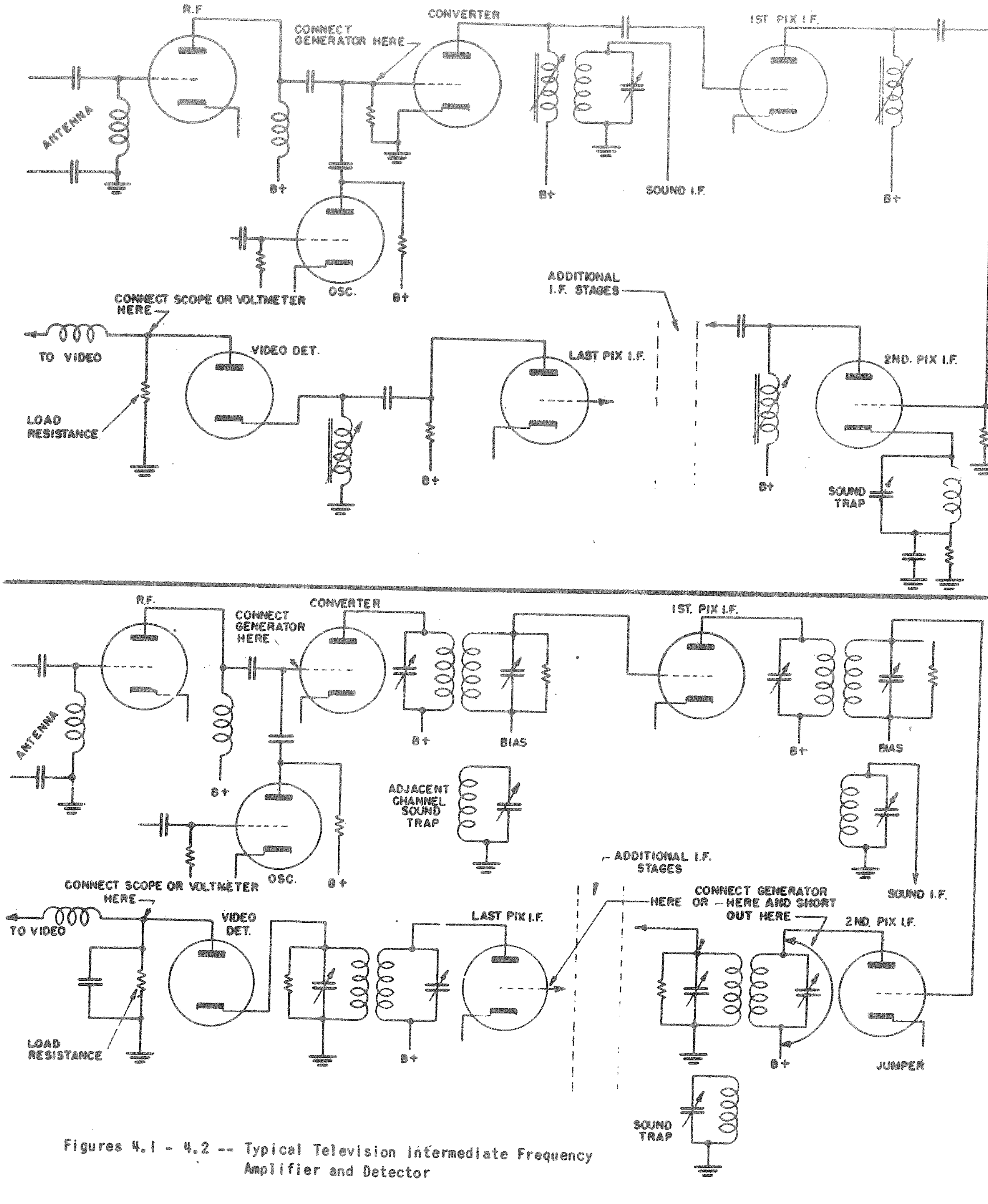
a. For this adjustment of the sound traps, the output of the signal generator 610A should be connected to the mixer grid or to one of the IF amplifier grids. Checking the circuit diagram of the receiver will reveal other possible locations for this connection, since all that is required is that the signal is fed in ahead of the traps that are to be adjusted. A 1000 mmf. capacitor is recommended so that AVC action will not be affected. If changing channels or tuning the receiver changes the pattern, then one of the signal generator oscillators is beating with the receiver local oscillator. When this happens, remove the oscillator tube while adjusting the sound traps and IF amplifiers.

b. Set the controls on the 610A as follows:

- 'Range Selector' to 'Sweep off'.
- 'Marker' to the sound trap frequency.
- 'Marker Injection' to one-half on.
- 'Multiplier' and 'Output' to a range and setting that gives a convenient reading.
- 'Int. Marker' to 'OSC' and set 'Mod.' or 'CW' as desired.

Other controls are not used.

c. The above settings turn off the sweep oscillators and only allow the marker variable oscillator to operate modulated or unmodulated. All that is necessary for these trap adjustments is that the frequency you wish to trap be applied to the circuits, and the adjustments made until the unwanted frequencies show a MINIMUM output on an indicator.



Figures 4.1 - 4.2 -- Typical Television Intermediate Frequency Amplifier and Detector

d. The indicator may be an oscilloscope, DC voltmeter, or AC voltmeter connected across the video detector load resistor. (See Figures 4.1 and 4.2). When an oscilloscope or AC voltmeter is used, the marker oscillator should be modulated. It is sometimes advisable, especially when connecting a scope to this point, to insert an isolating resistance of 10,000 to 50,000 ohms in series with the scope lead and the video detector load resistance. For a more sensitive adjustment, a vacuum tube voltmeter may be connected across the load resistor, but usually the scope is employed in the alignment of the video circuits, and it may be left across the detector load resistor during the entire video alignment. When using the scope as an indicator, the horizontal amplifier may be shut off and a thin vertical line will result. When the traps are properly adjusted, the line will get to its minimum length. In some receivers the contrast control affects the bias on IF tubes. In this instance, set the contrast sometimes called "Picture" control to one-half rotation or to the value recommended by the manufacturer.

e. After the signal generator and indicator have been connected, adjust the "Output Control" to give a convenient reading on the indicator. Always use the minimum output necessary as a protection against overloading. Starting from the last trap and moving forward, adjust all accompanying sound traps for minimum indication on the scope or other indicator. As traps approach the correct setting, the signal generator output may have to be increased.

f. If the receiver being aligned has adjacent channel traps, reset the "Marker" to the corresponding frequency and repeat the procedure.

4.3 TELEVISION IF AMPLIFIERS:

a. Most service men take for granted the the fact that a television channel is 6 mc. wide and don't give it another thought. If you stop to consider that an entire broadcast band can be put into just one television channel 600 times, you'll have some conception of the nature of the problem involved in getting a wide enough band pass in the video amplifiers.

b. All of the tricks that were used to sharpen up an IF response curve in a communication receiver had to be applied backwards in order to make the IF amplifiers broad enough.

c. For the most part, the broad band characteristics of a television receiver are obtained in one of two ways: the transformers are overcoupled, or stagger tuned.

The two methods require slightly different techniques of alignment and will be discussed separately.

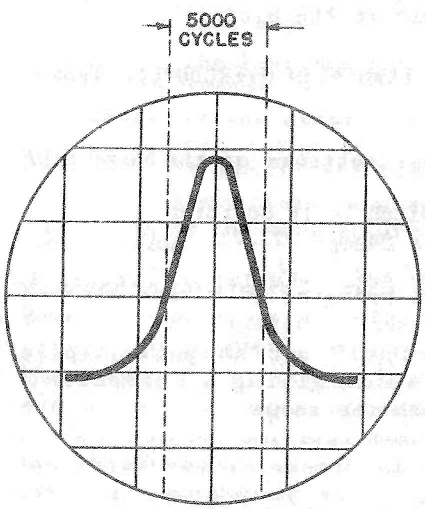


Fig. 4.3 - Band Pass Characteristics of Ordinary Broadcast Receivers.

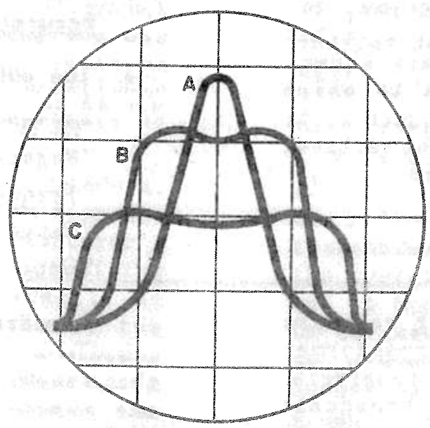


Fig. 4.4 - Effect on Response Curve of Resistive Loading or Over-coupling--IF Stages

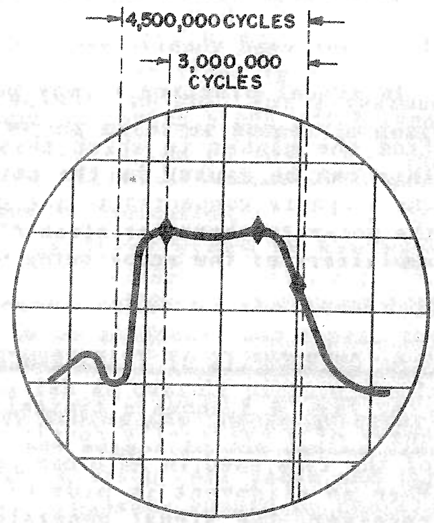


Fig. 4.5 - Television IF Response Curve with Oscillator Markers ---"Pips"

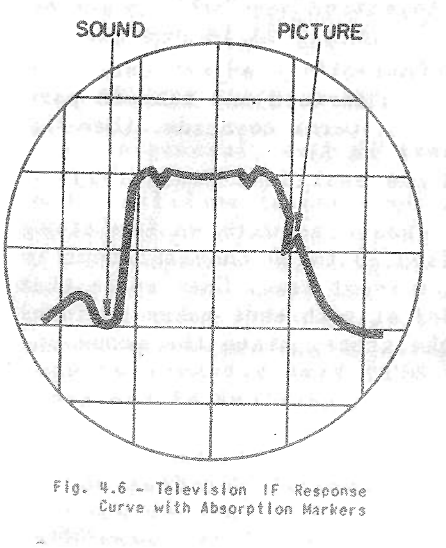


Fig. 4.6 - Television IF Response Curve with Absorption Markers

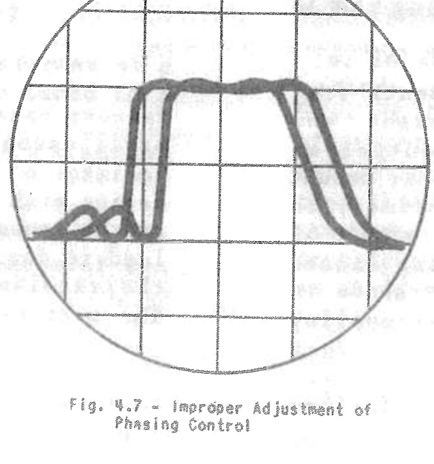


Fig. 4.7 - Improper Adjustment of Phasing Control

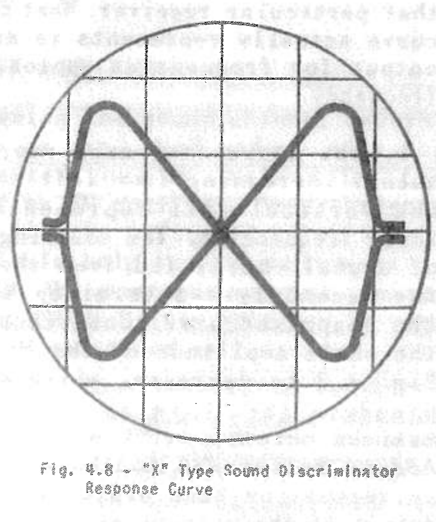


Fig. 4.8 - "X" Type Sound Discriminator Response Curve

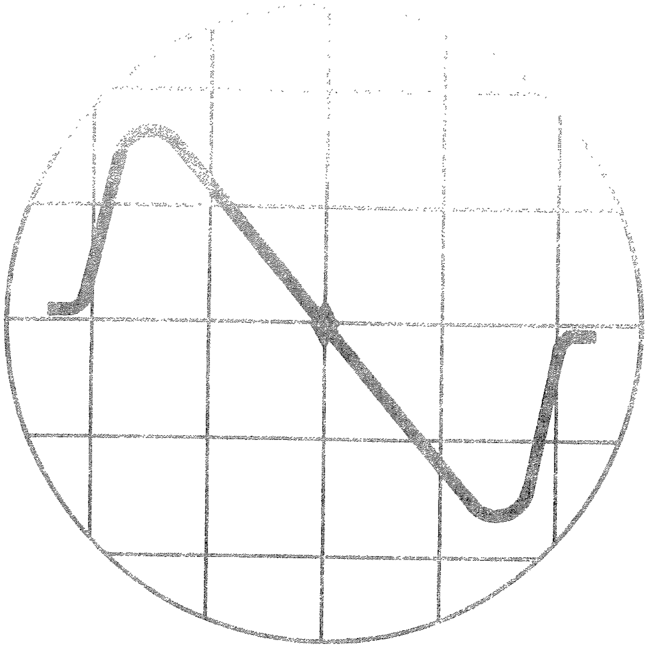


Fig. 4.9 - "S" Type Sound Discriminator Response Curve

In actual practice it may be normal for any of the above curves to appear inverted from the manner in which they are shown. This can be caused by the point to which the scope is connected in the circuit or by the polarity characteristics of the vertical amplifiers of the scope being used.

4.4 OVERCOUPLED IF TRANSFORMER:

a. Fig. 4.3 shows a typical IF response curve of a critically coupled transformer of the type used in AM broadcast receivers. When an alignment is made of a broadcast receiver, the signal generator is set to the frequency of the IF amplifiers. These are tuned for a maximum indication on an output meter, and let it go at that. Actually, the response curve was being moved (as shown in Fig. 4.3) over to the IF for that particular receiver. What that response curve actually represents is an increasing output for frequencies approaching the IF frequency.

b. The horizontal axis represents frequency increasing from left to right, and the vertical axis represents output at those frequencies. The coupling---or amount of signal energy fed from the primary to the secondary---determines the shape of the response curve. Undercoupling caused the whole amplitude of the curve shown in Fig. 4.3 to decrease, while overcoupling broadens the curve making two distinct maximum points, or "humps" on the curve. Adding resistance to the circuit further increases the band width, but reduces the output of the circuit as shown in Fig. 4.4, curves A, B and C.

[illegible]

d. Fig. [illegible] represents a typical picture IF response curve with various frequencies marked. Note particularly that the picture frequency is not on the peak of the response, but is located 40 to 50% down the slope. This is necessary owing to the nature of television transmission in the United States. Vestigial side band transmission, where one complete side band and a portion of the other is used. Since the small portion of the lower side band that is transmitted duplicates information, provisions must be made in the receiver to de-emphasize this repetition. For that reason, the video carrier does not ride in at a maximum on the response of the set.

e. Note the small response to one side of the large video response curve. The dip between the small and large response curves represents the sound channel---which should have no output in the video circuit, or sound will appear in the picture.

4.5 VIDEO IF ALIGNMENT OF OVERCOUPLED TRANSFORMERS:

a. The control settings of the Model 610A are as follows:

"FM-TV" Switch to TV position.

"Megacycle Sweep" ------- Appx. 10 mc.

"Frequency Adj."--Center of Picture IF

"Range Selector" --------------- 0-40

"Output Control" and "Output Multiplier" ---to a value giving a convenient reading on the scope.

b. To be certain that you are not driving the stages of the receiver too hard, use the maximum gain on your scope and the minimum output from the 610A that doesn't cause hash to appear on the sweep pattern.

"Marker"---- to the frequency of the desired pip.

"Marker Injection"--- "Off" position until it is needed.

"Phasing Control"--- adjust until the forward and retrace patterns coincide. (See Fig. 4.5)

In most cases the vertical amplifier of an oscilloscope should require an isolating resistor of from 10 to 50 thousand ohms in series with its input lead. Coax cable that can be grounded at both ends makes an ideal lead-in for the scope, since the scope and the receiver MUST have a common ground. The vertical input terminal of the scope goes to the detector load resistor through the isolating resistor, and the horizontal input to the horizontal terminal on the signal generator. Reference is made to Section III, paragraph 3.1h, regarding Hickok scopes.

c. The output of the signal generator is connected to the grid of the last video IF amplifier through a 1000 mmf. capacitor. (See Figs. 4.1 and 4.2 for typical television circuits.)

d. Since the primary of the transformer preceding the grid where the signal is applied may act as trap (putting a hole in the response curve), connect a jumper across the primary coil shorting out the tank. In the circuit illustrated in Figure 4.2 a jumper would be connected across the primary of the transformer, the secondary of which is fed from the signal generator. Referencing Figure 4.1 where the signal generator might be connected in at the grid of a tube which is preceded by a single tuned circuit, a jumper should be connected around this tuned circuit.

e. Each manufacturer supplies alignment charts or response curves, and the accompanying instructions should be followed to the letter. Although each stage may have a separate chart, the addition of the various stages should lead to an overall trace similar to that shown in Fig. 4.5.

f. After the last video stage is aligned, remove the jumper and repeat the alignment procedure on the stage preceding the one just adjusted. Drop back stage by stage until all IF amplifiers have been aligned to give the overall response necessary as specified by the manufacturer.

g. During the entire alignment procedure, markers should be injected on the response trace as recommended by the manufacturer's charts. This will be an aid in emphasizing the right frequencies on each chart. As explained in the earlier sections, two types of markers are provided, both being set by the same "Marker" dial. When using the internal oscillator as a marker, the "Int. Marker" switch should be turned to "OSC", and pips will result as shown in Fig. 4.5. The absorption marker will make indentations in the pattern as shown in Fig. 4.6, and the amplitude of either type marker may be changed by adjustment of the "Marker Injection" control.

4.6 STAGGER TUNED IF AMPLIFIERS:

a. In general, each IF transformer of a stagger tuned amplifier may be tuned to a different frequency, so that a different method than that described in Paragraph 4.5 is required for alignment. If the receiver is not badly out of alignment, or the manufacturer's service instructions state otherwise, the signal generator can best be connected to the converter grid, so that an overall picture may be seen at all times. Set the controls as follows:

"FM-TV" Switch to TV position.

"Mc. Sweep" ---- 10mc.

"Frequency" ---center of IF Response Curve

"Range" --- Sweep Off (Temporarily)

"Output and Multiplier" --- minimum setting that gives an indication.

"Marker" --- to the center frequency of the first IF coil to be aligned.

"Injection" --- Adjust for a convenient output on the lowest range of the indicator.

"Int. Marker" --- "OSC" and "CW or Mod."

b. As in the adjustment of the sound traps, an oscilloscope or a VTVM may be used for the indicator. Again the "Int." marker is set to "Mod." when the scope is used, but for the D.C. VTVM indicator, set the marker to "CW". When using this method of alignment, the scope or meter should be connected across the video detector load through a 10 or 50 thousand ohm isolating resistor. The scope internal sweep may be set at 400 cycles in order to see the modulating signal, or the horizontal amplifier may be turned off and a thin vertical line will result. Since all that you wish to see is a maximum indication on the scope, the latter method may prove more satisfactory.

c. The marker has already been set to the frequency of the first video IF coil to be aligned so adjust the coil for a maximum indication on the meter or scope. To guard against tube saturation be sure that you have used the smallest amount of signal that gives you an indication.

d. After the first video IF has been aligned, set the marker oscillator to the next frequency---that of the second IF transformer to be aligned---and repeat the the operation. Each IF is aligned in turn, and at the finish an overall picture should be checked by tuning the "Range Selector" to "0-40mc." and adjust to the center frequency of the IF strip. All peaks and the video carrier frequency should be checked against the markers suggested by the manufacturer. The "Marker" oscillator is used for this operation, and while the sweep is tracing out the response curve, slight readjustments may be made on the trimmers for best results.

4.7 SOUND IF AMPLIFIER:

a. In aligning the sound channel several methods may be used, and undoubtedly you have discovered your own method for the alignment of an FM receiver. Nevertheless, two methods will be presented in this section that should help in the employment of the Model 610. These methods are not limited to television FM receivers, but may be used on standard FM radios as well.

b. In general, most television receivers utilize as a discriminator or sound detector, either the Foster-Seeley type of circuit or the ratio type of detector discriminator combination. Figure 4.10 illustrates the Foster-Seeley type of discriminator circuit. If the scope is connected across the output of this circuit it should be connected through an isolating resistor of at least 50,000 ohms to the high end of the load network or, in some cases, it may be connected at the high side of the volume control. When connected at this point a response curve such as shown in Figures 4.8 or 4.9 should be obtained.

This type of discriminator circuit is always preceded by a limiter stage as indicated in Figure 4.10. By connecting at point A, the limiter grid load resistance, a response curve such as illustrated in Fig. 4.3 may be obtained which would give the overall sound IF response characteristics. The band width, as indicated in Figure 4.3, of 5000 cycles for broadcast receivers, will in general, in the case of television sound IF stages, be from 150 kc. to 250 kc.

c. The other type of detector, known as the ratio detector, is illustrated in Fig. 4.11. In the case of the ratio detector, the scope or the indicating voltmeter should be connected at the high end of the volume control. With the scope so connected, the response curves of ratio as well as Foster-Seeley discriminators, are indicated by Figures 4.8 and 4.9. It might be noted in both cases that the marker pip has been inserted at the exact sound frequency. In the case of ratio detectors it is generally impossible, due to the fact that no limiter is used, to be able to display the overall response curve as illustrated in Figure 4.3, independent of the discriminator stage.

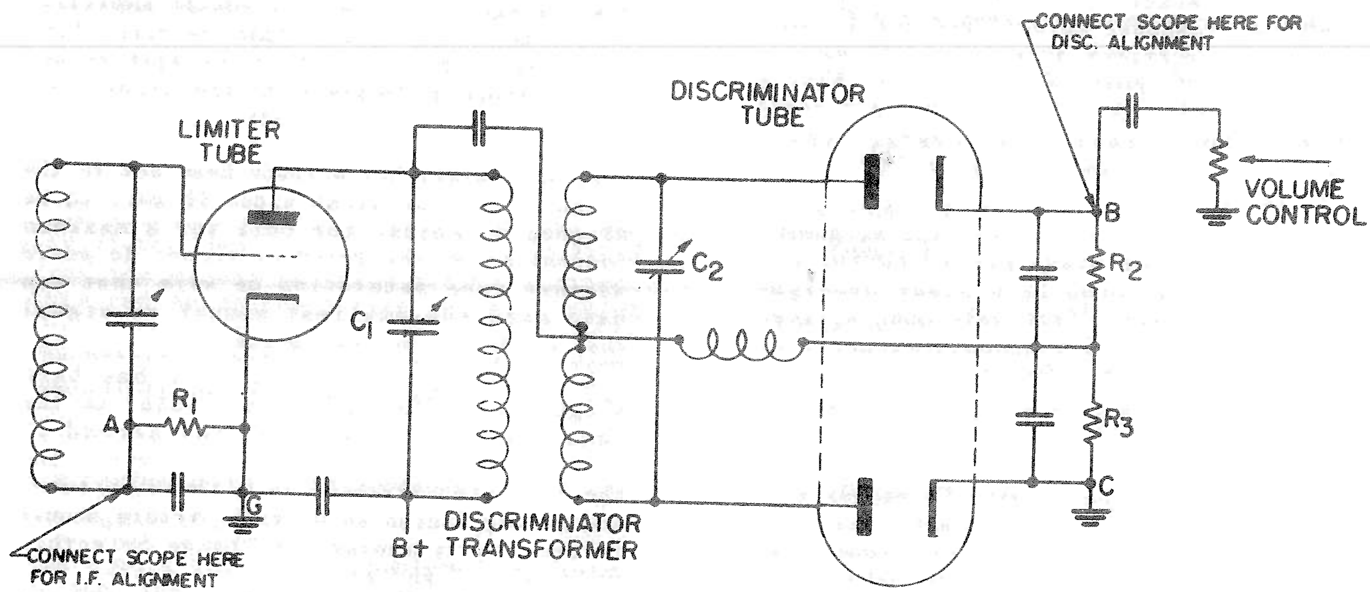


Fig. 4.10 - Foster-Seeley Type Discriminator Circuit

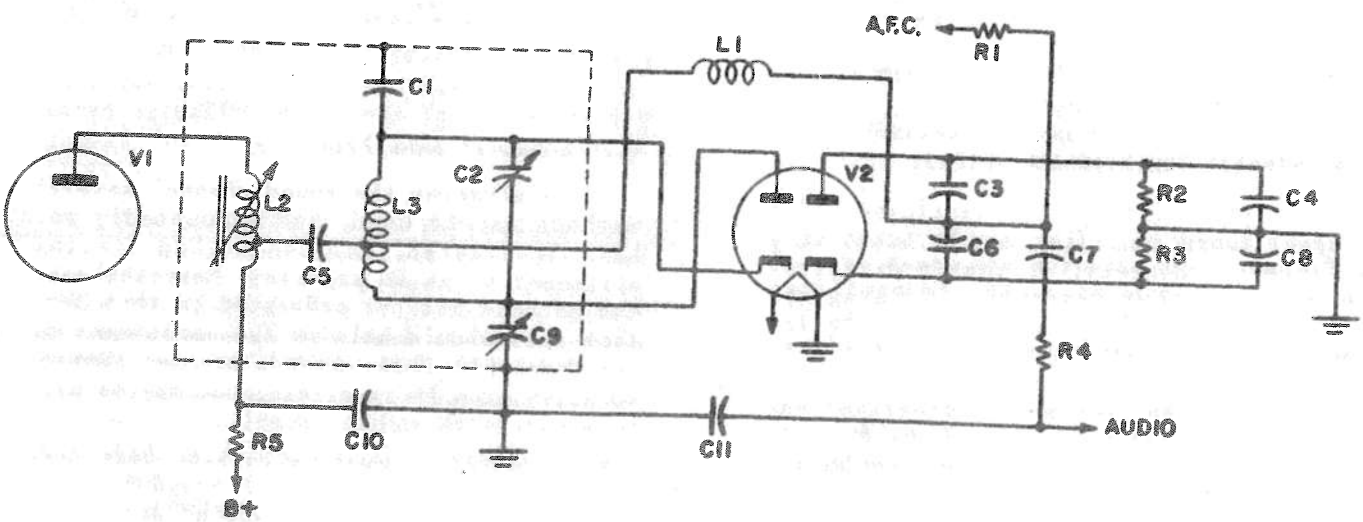


Fig. 4.11 - Ratio Detector Type Discriminator Circuit

d. In the first method, the signal generator is connected through a 1000 mmf. condensor to the converter or first video IF grid. The oscilloscope is connected through an isolating resistor to the high end of the volume control, or into a special jack provided on some television receivers. Manufacturer's specifications will tell you the location of this jack, if one is employed. The controls on the Model 610A are now set as follows:

"Range Selector to "Sweep Off".

"Marker" to the frequency of the sound IF amplifier.

"Int. Marker" to "Mod".

"Marker Injection" --- advanced until the signal can be seen on the scope or heard from the loudspeaker.

All other controls with the exception of the "Output Multiplier" and "Output Control" are not used.

e. Should a crystal of proper frequency for the sound channel be available, it could be connected into the jack provided on the front panel and either modulated or unmodulated signal used. In this case, the internal marker is turned "Off" and the crystal is used as the source of frequency for IF alignment.

f. If no signal is heard, the secondary of the discriminator should be detuned widely until an indication is present. Next, adjust all sound IF transformers for the strongest signal, and then readjust the secondary of the discriminator for a minimum signal.

g. For the final adjustment of the discriminator, a sweep signal is best used and a discriminator response curve obtained. Set the "Frequency Adjustment" and the "Range Selector" to the proper frequency for the sound channel, and use the "Int. Marker" as described in the video alignment section. Adjust the primary and secondary of the discriminator until the pattern looks like Fig. 4.9. For best results, the two humps are symmetrical about the marker when it is set for the center frequency of the sound IF. This adjustment should be made so that the two peaks are of maximum amplitude and come in at marker frequencies specified by the manufacturer.

h. Sometimes adjustments can be more easily made on the discriminator if an "X" pattern is traced on the scope. In obtaining the "X" pattern as shown in Fig. 4.8, the vertical amplifier input is connected as before, but the horizontal amplifier is set for internal saw tooth sweep. Adjust the sweep frequency to approximately 120 cycles, and switch the scope sync. selector to "external" The synchronization voltage then applied to the external sync. binding post may be obtained by tapping off the input filter of the receiver power supply. (See Figure 4.12) If the receiver uses a full wave rectifier, the input ripple will be 120 cycles and "sync." the sweep pattern in to form an "X",

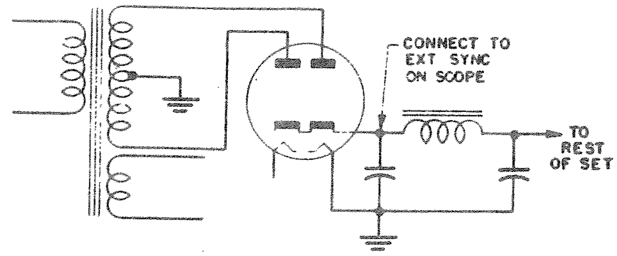


Fig. 4.12 - Receiver Power Supply--120 Cycles for "X" Type Discriminator Trace

i. The crossover point on the "X" should be the location of the IF marker.

j. An alternate method of adjusting the FM section of the receiver makes use of the sweep generator throughout the entire alignment, and in many cases this is a more rapid, satisfactory procedure.

k. In the employment of this method, the discriminator is aligned first using the sweep method just discussed, but the generator is connected to the grid of the sound IF tube preceding the discriminator.

l. After the discriminator is aligned to conform to Figures 4.8 or 4.9, connect the generator to the grid of the mixer (or converter) and align all sound IF amplifiers for a maximum discriminator sweep pattern that shows no distortion. It should be clear that a properly aligned IF strip will give the maximum undistorted discriminator response.

4.8 OSCILLATOR ADJUSTMENT:

a. To obtain proper adjustment of the receiver oscillator, connect the generator to the antenna input and set the channel selector of the receiver to the channel needing alignment. The "fine tuning" adjustment of a receiver not having automatic frequency control should be turned to the middle of its range.

"Band Selector" to "Sweep Off".

"Output Multiplier" to "X10K".

"Marker Injection" to "Full On".

"Int. Marker" to "Mod".

Other Controls not used.

b. With reference to Figure 4.10, the scope or indicating AC voltmeter would be connected at the high end of the volume control. If a DC voltmeter is used, it should be connected at the point marked "B" at the high end of the discriminator load resistors. If the ratio type detector as illustrated in Figure 4.11 is concerned, a scope or AC voltmeter could also be connected at the high end of the volume control. If a DC voltmeter is used, it should be connected at the junction of C3 and C6.

c. Employing a crystal whose harmonic falls exactly on the sound carrier frequency will give the best results in the oscillator adjustment. A socket is provided on the front of the panel for the insertion of the crystal, and adjustment of the oscillator is necessary until a 400 cycle sound is heard from the speaker or observed on the scope. Since the center frequency of the discriminator is nonresponsive to an AM signal, but each side of this frequency is, proper adjustment is at a point of minimum signal. Rotation of the oscillator adjustment in either direction should give a louder tone. Using a VTVM at the discriminator or ratio detector center will show positive readings on one side and negative readings on the other side of the IF frequency. Some receivers employing automatic frequency control require a setting of the discriminator center voltage at a value other than zero. Care should be taken to consult manufacturer's alignment instructions on receivers using automatic frequency control.

4.9 RF ADJUSTMENT

a. This is usually a trimming-up adjustment where the generator is connected to the antenna, and the sweep is set for the middle of the channel being aligned. The "Mc. Sweep" should be set for about 10 mc., and the scope connected to the video detector load resistance as before. At this point RF trimmers are adjusted until the response is a maximum corresponding to the typical trace of Fig. 4.5.

b. It will be noted in Figure 4.5 that markers have been inserted on the overall response curve. In order to obtain such markers in receivers which have one stage of RF preselection, it may be necessary to connect from the "External Marker" binding post to some place along the IF stages. The reason for this being that in receivers where preselection is found, the marker frequencies which are in the vicinity of 20 mc. will probably not ride through the RF stages as these stages are tuned for channel frequencies from 44 mc. on up and would probably reject the lower frequency IF markers. When making such a connection, the marker injection control can be used to control the strength of the markers.

c. It is possible on some receivers, tuned to channel 2, to get two response curves close to each other, and this fact may cause some confusion unless it is clarified.

d. Since Channel 2 covers 54 to 60 mc., the fixed oscillator of the signal generator must be employed to heterodyne with the sweep oscillator. In this instance the sweep oscillator operates from 129 to 135 mc., and beats with the 75 mc. to give the required 54 to 60 mc. If the receiver uses a sound IF of 21.25 mc., and the sound carrier comes in at 59.75 mc., the receiver local oscillator will have to be set at 81 mc. to get the IF frequency. The 81 mc. will beat with the variable oscillator in the Model 610A to produce a difference of 54 to 60 mc. This frequency may then be picked up by the receiver to produce a response curve displaced from the desired curve, but of much lower amplitude. Adjustment of the fine tuning will move the parasite curve in a direction opposite to that of the main curve.

4.10 PRELIMINARY NOTES

a. Under certain circumstances it may be advisable to terminate the output cable from the 610A in a non-inductive (not wire wound) resistor of approximately 50 to 100 ohms, before connecting to the receiver under test. If such termination does not affect the response curve, it is not necessary. If it does affect the curve, it is probably advisable.

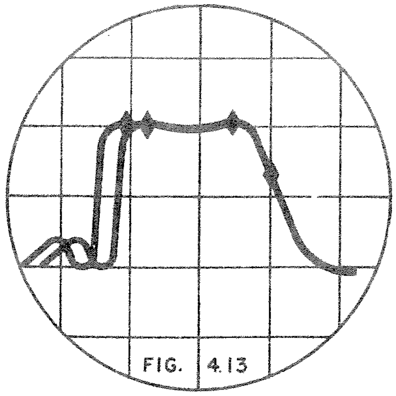
b. It is always imperative to render the local oscillator in the receiver inoperative in making any alignments in the IF stages. This can generally be done by removing the local oscillator tube or by any temporary electrical connection which would cause this local oscillator to cease operating.

c. Response Curves - The response curves illustrated in Figures 4.5 and 4.6 are the type which would be ordinarily expected when using the Model 610A with Hickok oscillographs having provisions for return elimination.

When using other scopes where return elimination is not available, a condition might exist in which, for example, Figure 4.5 might appear as illustrated in Figure 4.13 or Figure 4.14.

If the phasing control had been adjusted so that the left hand side of the forward and reverse trace overlapped, the other, or high frequency, side of the trace might fall as illustrated in Figure 4.14. Likewise, if the phasing control had been so adjusted that the right side of the trace were made to overlap, then the left hand side might appear as illustrated in Figure 4.13.

In any case, this would not be detrimental to the proper alignment of a television receiver since markers are always used to



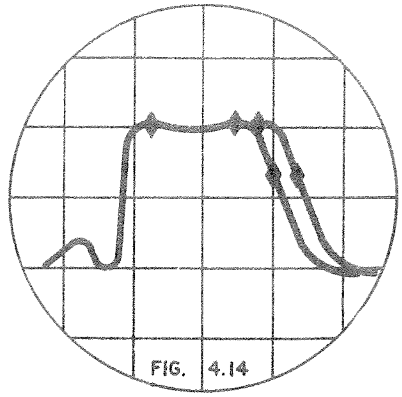


Fig. 4.13 - 4.14 - Video IF Response Curves

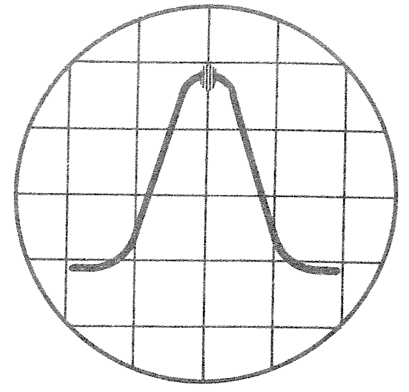


Fig. 4.15 - Sound IF Response Curve

identify frequencies along the various parts of the curve. The fact that the forward and reverse overall trace might vary somewhat in width would still not affect the alignment curve or proper alignment of IF stages. In some receivers the two curves may exactly overlap, and in certain other cases, they may be displaced slightly as illustrated in the above Figures.

If the double trace is in any way confusing to the operator and the scope being used has provisions for Z axis or intensity modulation, it would only be necessary to apply 60 cycle voltage of the proper value to the intensity modulation input to eliminate either of the traces.

d. Inter-Carrier Sound (I.C.S.) Systems - Many of the sets on the market today, especially the 7" electrostatic deflection type, are using what is know as inter-carrier IF stages. In the other type of IF systems described later in this book, the sound is generally separated shortly after the first detector and fed through its own IF amplifier stages, generally tuned for approximately 21.25 mc. The picture or video IF amplifiers are tuned to 4.5 mc. above this, (25.75 mc.), and have one or more traps tuned to the sound IF frequency to eliminate any sound interference with the video stages.

In the inter-carrier sound systems the principle is somewhat different in that the sound and picture IF frequencies are carried through the same IF amplifier stages which are capable of passing both the 21.25 and the 25.75 mc. frequencies.

With reference to Figure 4.16, it will be noted that the first video amplifier follows the second detector and from this the amplifier is fed through a choke, L1, the video signal, which is again amplified and applied to the control grid of the picture tube. The plate of this first video amplifier is also fed through capacitor C1, a signal to the sound IF amplifiers and detector tuned to 4.5 mc.

As a brief example of how this system operates, you might consider the transmitter being on the air with both the video and sound carriers, but neither of these carriers being modulated. Since the sound carrier is always 4.5 mc. above the picture carrier at the second detector, these two carrier frequencies will heterodyne against each other to produce an unmodulated 4.5 mc. signal. Since the sound carrier is frequency modulated and the picture carrier amplitude modulated, as soon as the sound carrier begins to be frequency modulated by the audio signal there will be a frequency modulated signal generated centering around 4.5 mc. This frequency modulated signal carrying the sound is taken from the plate of the first detector tube and amplified at this frequency and applied to the FM detector and subsequently amplified by audio frequency amplifiers.

The alignment of intermediate frequency stages employing the intercarrier system is very similar to that employed in aligning video stages in the other type of receivers.

The signal may be fed in at the first detector and the scope connected at the video detector or output of the first video amplifier.

The manufacturers will always give typical response curves showing markers at various points along the response curve. In a case of intercarrier IF's, however, the response curve is generally wider from the band pass characteristic standpoint than the video response curve of receivers not using I.C.S. systems since it has to pass a band width of 4.5 mc. In this I.C.S. system, of course, there are no sound traps in the IF stages to be aligned.

After obtaining the proper response curve, the signal generator should be adjusted to produce a signal frequency modulated with center frequency at 4.5 mc. This signal is generally best fed in at the control grid of the first video amplifier as it is generally customary to take the signal from the output of the video amplifier and apply this signal to the first sound intermediate frequency transformer at 4.5 mc. The MEGACYCLE SWEEP

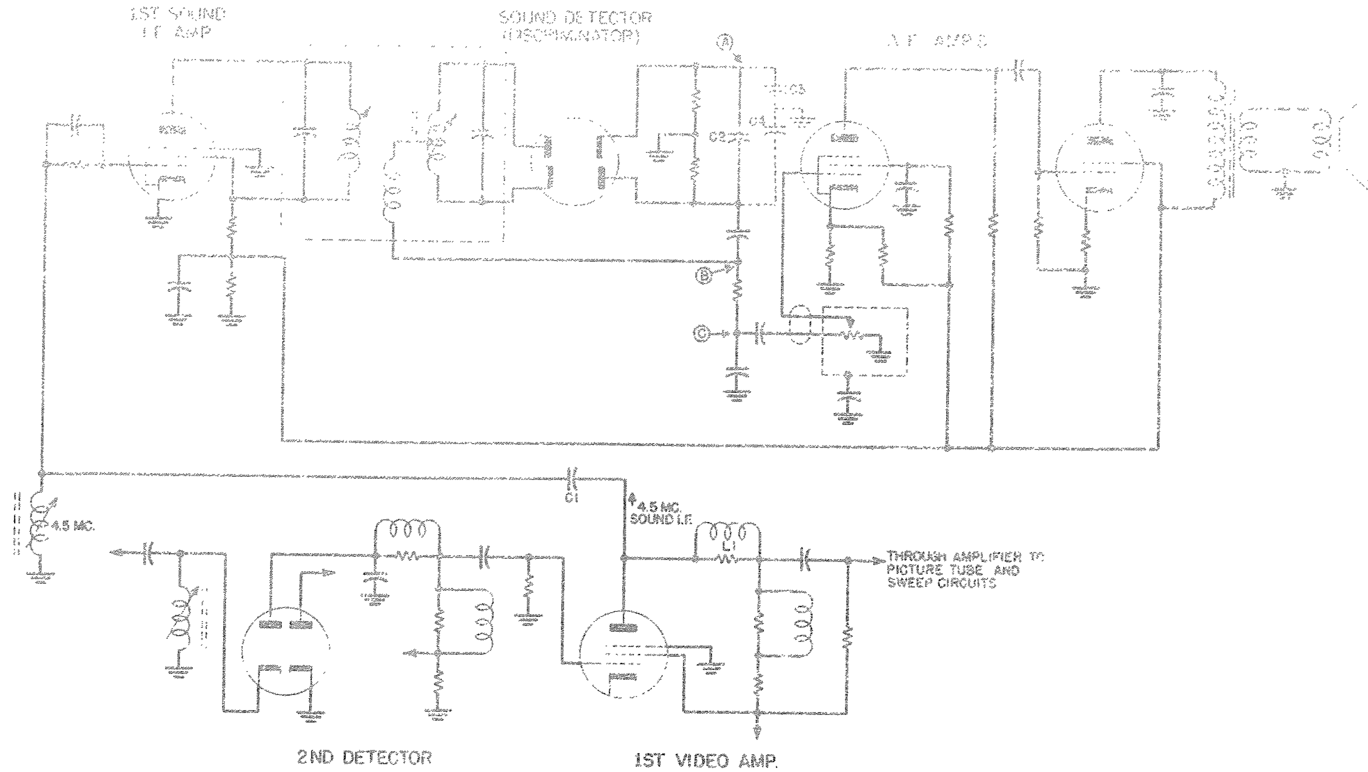


Fig. 4.16 - Inter-carrier Sound IF Systems

control should be retarded to a sweep of approximately 1 mc.

For alignment of intercarrier sound IF stages at 4.5 mc, a crystal ground to this frequency is supplied with the Model 610A. If an accurate conventional signal generator is available which could produce a signal at 4.5 mc.,this might be fed in at the external marker binding post and be used in place of the crystal, although it is very important that the sound intermediate frequency stages be aligned as accurately as possible at 4.5 mc. If the signal generator is being used to supply this marker frequency, some means should be used to check its accuracy at this point.

At the present time, most television manufacturers utilizing intercarrier sound systems are also using ratio type detection for their sound channel.

In ratio type detection there is always a large electrolytic condenser connected across the discriminator load. In some cases, two electrolytics are used, one for each side of the load back to ground. By disconnecting the electrolytic condenser C2, or condenser C3 and C4, and connecting the oscilloscope at the high side of the discriminator load resistors, point (A), a response curve of the intermediate frequency stages may be obtained. This response curve should, in general, appear similar to that indicated in Figure 4.15 with the 4.5 mc. marker centered as illustrated. With this connection the intermediate frequency transformer may be aligned for maximum symmetry and height of the response curve consistant with keeping the marker in the center of the curve.

By reconnecting the electrolytic condensers, the discriminator transformer primary and secondary may be aligned to obtain a response curve as illustrated in Figure 4.8. The scope should, in this case, be connected at point C or at point B, as illustrated in Figure 4.16

SECTION V

SUPPLEMENTARY DATA

5.1 GENERATING FREQUENCIES AND THEIR ACCURACIES IN THE 610A:

In the Model 610A, four ranges of frequencies are available: 0-40, 35-75, 75-115, and 150-230 mc.

In generating frequencies in the range of 0-40 mc, and 35-75 mc., two oscillators are used. One is a variable frequency oscillator covering the range of 75-115 mc and frequency modulated with the deviation variable from 0-15 mc. (0-7.5 mc. each side of center frequency). The other is a fixed frequency unmodulated oscillator operating at 75 mc. or 150 mc.

a. 0-40 MC. RANGE: When the main dial on this range is indicating 0 mc., the variable frequency oscillator is operating at 75 mc. and heterodyned against the fixed oscillator also operating at 75 mc. The resultant frequency, 75 mc. minus 75 mc., would be 0 mc. When the main dial is turned to indicate 40 mc. on this range, the main variable oscillator is then operating at 115 mc. and the resultant heterodyned output frequency will be 115 mc. minus 75 mc., or 40 mc. Thus, the main tuning dial on this range is calibrated in terms of the frequency difference between the main variable and the fixed oscillator.

b. 35-75 MC. RANGE: In this range, the main tuning dial is calibrated in terms of the difference between the main variable and the 150 mc. fixed oscillator. Thus, with the main variable oscillator operating at 75 mc. the dial will indicate 75 mc. as 150 mc. minus 75 mc. = 75 mc. With the main variable operating at 115 mc. the dial will indicate 35 mc. as 150 mc. minus 115 mc. = 35 mc.

c. 75-115 MC. RANGE: When operating on this range, the fixed oscillators are rendered inoperative and the dial calibrated directly in terms of the fundamental frequency being generated by the main variable oscillator.

d. 150-230 MC. RANGE: In this range the main dial is calibrated in terms of the second harmonic of the main variable oscillator. In this connection, it might be stated that when turning the range switch to this range the fundamental sweep deviation of the main variable oscillator is reduced to half that indicated by the megacycle sweep dial. If this were not done, the deviation, as a result of using the second harmonic of the main variable oscillator, would be double that indicated by the deviation dial.

5.2 ACCURACY OF THE VARIOUS RANGES:

a. In factory calibration the accuracy of the 75-115 mc. oscillator is held to plus or minus one division on the 75-115 mc. scale on the main dial. This represents a potential error of ± .2 mc. or ±.2%. Actually, we do not feel we can guarantee this range in service to hold such a high degree of accuracy as 0.2% as various factors such as shipping, handling, etc., may contribute to eventual errors in excess of this. Nominally we, as many other manufacturers of signal generators, guarantee frequency accuracy to approximately ± 1%. Actually, we feel that an accuracy of ± 0.5% may be maintained in the field under normal conditions.

Assuming a case where the error in this oscillator might be as much as 0.5%, this could conceivably result in an error at, for example, 100 mc., of 0.5 mc.

b. We also hold the 75 mc. fixed oscillator to an accuracy of ± 0.1% or ± .075 mc. Here again, we can not normally expect to hold this oscillator to such an accuracy under all conditions. We are sure, however, that barring some major change in components or other factors, that this oscillator will hold to well within 0.5% or ± .375 mc.

Now to consider what effect these potential errors of the main variable oscillator and fixed oscillator might have when heterodyning these two together to produce frequencies in the 0-40 mc. or 35-75 mc. range.

c. 0-40 MC. RANGE: Assume the 610A were being used on the 0-40 mc. range to produce a frequency centering around 25 mc. which is the frequency of the IF stages in television receivers. To produce this 25 mc., the main variable oscillator would be operating at 25 mc. above the 75 mc. fixed oscillator, or 100 mc. We assume an extreme case but still within the realm of possibility, an error of 0.5% in both oscillators. The main variable oscillator might be off as much as 0.5% of 100 mc., or .5 mc. The fixed oscillator might be off as much as 0.5% of 75 mc. or .375 mc. If, by some remote chance, these two errors existed in such magnitude and additive, the potential error frequencywise, might be as much as .5 mc. plus .375 mc., or .875 mc. Such an error in 25 mc. being generated as indicated by the dial would result in an error frequencywise of approximately .875 mc. in 25 mc., or 3.5%.

d. To analyze the negligible effect of such an error, or one even in excess of this, in a practical case of alignment, let us assume for the moment that the 610A generator calibration of both oscillators were exactly accurate but we had no marker oscillators to use in connection with it.

The generator is being used to display the the response curve of an IF strip, the sound traps of which are tuned to 21.25 mc. and the picture IF tuned to 4.5 mc. above this, or 25.75 mc. (a common practice). In this case, we might get the response curve illustrated in the figure below:

All we would know from this curve would be that the center of the curve was at the

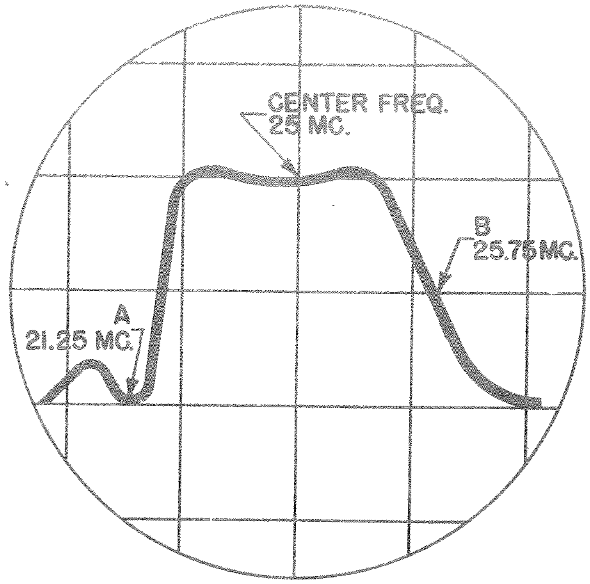


Fig. 5.1 Typical Response -- 25 MC I-F Strip

frequency setting of the main tuning dial. This would, for all practical purposes, not tell us the frequency of the dip at point "A" which is supposed to be at 21.25 mc., nor would it tell us that the 50% down point at the right side of the curve, point "B", was at the picture frequency which is supposed to be 25.75 mc.

It becomes evident therefore, that the main FM oscillator becomes only the vehicle or means of generating a response curve and that a marker oscillator is the instrument necessary to give meaning to that response curve in terms of frequency.

In actual practice, the operator turns the range selector switch to a range covering the desired frequency band and then rotates the main tuning dial without particular reference to its exact reading until the response curve is centered on the screen. He then uses the marker oscillator which is accurate to .25% and proceeds to make the necessary adjustments in the receiver to bring the proper frequencies, as recommended by the manufacturer, into their proper places on the IF response curve.

Obviously then, since the main FM oscillator is merely the vehicle, its calibration accuracy within reasonable limits (5, or even 10%), is, for all practical purposes, of minor importance.

e. The foregoing explanation of the use of the FM oscillator and marker oscillators holds equally true of the overall response curve or for that of the "front end" or RF section only. The only difference being that when displaying an RF response curve only for any one of the 12 channels where the marker frequency would be other than 19-31 mc., the marker may be supplied by an external crystal in the crystal oscillator circuit of the 610A or, with less accuracy, by an external signal generator fed in at the external marker binding post.

It is for this reason that we incorporate in the 610A a marker oscillator covering from 19-31 mc.. which is held to an accuracy of much better than .2%, and as long as this marker oscillator is this accurate and used for establishing the exact frequency of the response curve, it is not necessary that the main variable oscillator accuracy be held to any closer than that to which it is held in the Model 610A.

f. Consideration was given in the design of the 610A not to calibrate the main dial in terms of frequencies which could be read to as close as .2%, since this main dial accuracy was not of paramount importance. It would have been quite possible to have merely calibrated the dial, for example, between 20-30 mc. with a line indicating that 20-30 mc. was being generated between the points now identified as exactly 20 and exactly 30 on the main tuning dial. This would have, for practical purposes, been perfectly satisfactory as we are not depending upon the accuracy of the main dial, but rather on the marker oscillator, to establish exact frequencies necessary in IF alignment. Likewise, we could have calibrated the main dial in terms of channels rather than in exact megacycles. For example, channel 2 covers from 54-60 mc. and a line could have been put on the main dial between the points now occupied by 54 and 60 mc's. indicating that within these limits existed channel 2, and likewise, for all other channels. It was our thought, however, that it would be more convenient and a feature desirable by the serviceman, to have a dial indicating in megacycles directly rather than merely in channels or approximate megacycles.

Looking at it from a practical standpoint, if we are aligning, for example, IF stages, the generator is actually sweeping at least 5 mc. either side of center frequency which can be assumed to be approximately 25 mc., or frequencywise, the generator is constantly varying 20% either side of the frequency indicated by the main tuning dial.

Some manufacturers have elected to either calibrate their generators in terms of channels or, in some cases, even stated that on for example, band "A", as the vernier knob was rotated, the frequency changed from approximately 10 to 50 mc. and depended upon the operator to be able to set this knob in such a manner as to give him the frequencies required within this range.

g. It is the purpose of this explanation to give you the basic action and accuracies to be expected in the Model 610A and to point out that this instrument is capable of accurately aligning any television receiver. A crystal jack is incorporated in the front panel and crystals are available for any frequency within the range of the Model 610A. These crystals are available at a very nominal cost and when used in connection with the Model 610A, permit frequencies to be generated to an accuracy of .005% throughout the entire range of frequencies covered by this television alignment generator.

h. AM-FM RECEIVERS: From the foregoing, it will be evident that the 610A would in no way be considered a practical generator for the alignment of amplitude-modulated receivers. However, it can readily be used in connection with the alignment of FM receivers.

5.3 GENERAL:

a. You now possess one of the finest and most versatile pieces of equipment for high frequency work on the market. Don t make the mistake of putting your alignment generator on the shelf in the "shiny-equipment-to-impress-the-customer" class. Because the name is "Alignment Generator" does not mean that it should be saved for alignment only.

b. You are probably familiar with the method of signal tracing employed in AM receivers. By using the same procedure, but with your alignment generator, you can isolate difficult video and audio troubles.

5.4 SWEEP SHOOTING THE VIDEO CIRCUITS:

a. Probably the best way to use this method is to practice on a receiver fresh from the factory and proven to be in good operating condition. Connect the scope to the video detector as in the alignment procedure, and feed the signal generator in at the grid of the last video IF amplifier, with the controls set as follows:

"FM-TV" Switch to TV position.

"Megacycle Sweep"----- --- 10 mc.

"Frequency Adj" --- to the center frequency of the stage under alignment.

"Range Selector" --- 0-40

"Output Control" and "Output Multiplier" --- to a value giving a convenient deflection on the scope.

Other controls not used.

b. Note the setting of the amplifier on the scope, and also record the "Output Control" and "Output Multiplier" settings on the generator. Make a rough sketch of the scope picture on a data sheet, and you now have a record of the response of a good stage. Repeat this whole process stage by stage and make a record of each operation. Now, when a receiver with trouble in the IF that cannot be easily located comes into the shop, repeat these tests. If any response curve differs from the recorded values, the receiver may merely need an alignment, and this should be done. If the generator output has to be turned up too high to get the same deflection on the scope that was recorded from the good receiver, then that stage is at fault. Always start sweep shooting at the last video IF and work toward the front of the set.

c. Sometimes, a loose connection or a faulty capacitor will give you a bad time. Using the method of sweep shooting, you can look at the response and apply some "seat of the pants" radio methods to the television receiver. You can squeeze capacitors and poke around with your rubber gimmick while watching the response curve. If anything jumps, you may have found the trouble.

d. At any rate you can see the possibilities of sweep shooting as a method of isolating troubles. Watch the high-voltage when using this method, or the response curve may not be the only thing that jumps.

5.5 SWEEP SHOOTING THE AUDIO CIRCUITS:

a. The method of sweep shooting in the audio circuits follows exactly as the method in the video circuits. The scope and generator are connected and adjusted for an alignment and records are made of stage sensitivity and wave form. When the trouble set arrives, comparisons can be made and the stage giving the trouble isolated.

5.6 CHECKING TELEVISION TUBES IN THE RECEIVER:

a. While the sweep shooting method is being used to check gain per stage, the tube of a low gain stage may best be checked by straight substitution of a new tube. If the response pattern jumps up to its normal value, then the trouble was the tube and it can be replaced.

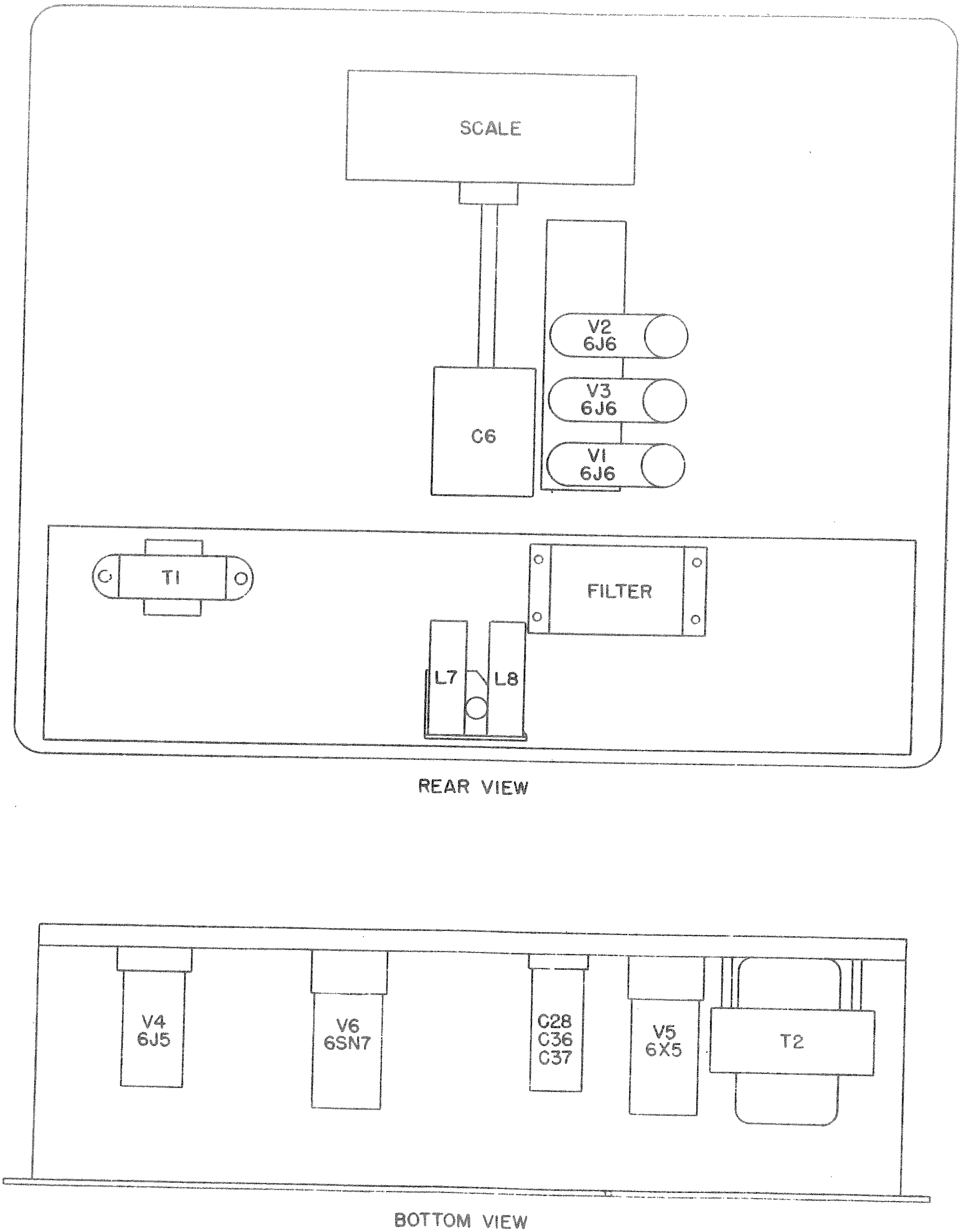


Figure 5.2 - LOCATION OF TUBES ON CHASSIS

SECTION VI PARTS LIST

PARTS LIST FOR MODEL 610A

NOTE: There is a minimum charge of $1.50 for shipment of any one order

REF SYMBOL	HICKOK CODE NUMBER	NAME AND DESCRIPTION	FUNCTION
C1	3110-11	CAPACITOR: Special, 500 mmf	
C2		CAPACITOR: Same as C1	
C3	3110-4	CAPACITOR: Special, 15 mmf, 500 WVDC, 10%, zero temp. coef., ceramic	
C4		CAPACITOR: Same as C1	
C5	3115-1	CAPACITOR: 3 - 12 mmf, trimmer	
C6	3120-22	CAPACITOR: 41.6 mmf, dual variable	
C7		CAPACITOR: Same as C1	
C8	3115-6	CAPACITOR: 1-8 mmf, trimmer	
C9		CAPACITOR: Same as C5	
C10		CAPACITOR: Same as C3	
C11		CAPACITOR: Same as C3	
C12		CAPACITOR: Same as C1	
C13		CAPACITOR: Same as C1	
C14	3110-12	CAPACITOR: Special, 1000 mmf, ceramic	
C15		CAPACITOR: Same as C14	
C16		CAPACITOR: Same as C1	
C17		CAPACITOR: Same as C14	
C18		CAPACITOR: Same as C1	
C19	3105-2	CAPACITOR: .005 mfd, 600 V, paper	
C20	3105-135	CAPACITOR: .1 mfd, 400 V, tubular	
C21	3105-133	CAPACITOR: .05 mfd, 200 V, tubular	
C22		CAPACITOR: Same as C19	
C23	3095-8	CAPACITOR: 470 mmf, 500 V, 10%, mica	
C24	3105-4	CAPACITOR: .01 mfd, 400 V, paper	
C25	3115-2	CAPACITOR: 6.5-35 mmf, trimmer	
C26	3120-24	CAPACITOR: 45.7 mmf, dual variable	
C27		CAPACITOR: Same as C23	
C28	3085-42	CAPACITOR: 5 mfd, 250 V, electrolytic (C28, C36, C37 in same can)	
C29		CAPACITOR: Same as C5	
C31		CAPACITOR: Same as C5	
C32	3095-5	CAPACITOR: 100 mmf, 500 V, 10%, mica	
C33	3105-134	CAPACITOR: .1 mfd, 200 V, tubular	
C34	3095-9	CAPACITOR: 1000 mmf, 500 V, 10%, mica	
C35	3110-14	CAPACITOR: 5 mmf, ceramic, special	
C36		CAPACITOR: 20 mfd, 350 V, electrolytic, (See C28)	
C37		CAPACITOR: 10 mfd, 350 V, electrolytic, (See C28)	
C38		CAPACITOR: Same as C25	
C39		CAPACITOR: Same as C32	
C40		CAPACITOR: Same as C33	
L1	3320-67	COIL ASS'Y: 150 mc fixed osc., 2½ turns #15 tinned copper	
L2	3320-67	COIL ASS'Y: 75 mc fixed osc., 6 turns #15 tinned copper	
L3	3250-27	CHOKE: .5 microhenrys, 20 turns #30 enamel wire	

Price will be furnished upon request

NOTE: There is a minimum charge of $1.50 for shipment of any one order

REF SYMBOL	HICKOK CODE NUMBER	NAME AND DESCRIPTION	FUNCTION
L4		CHOKE: Same as L3	
L6	3250-10	CHOKE ASS'Y: 250 turns #36 SEE copper wire	
L7	3320-69	COIL ASS'Y: 19-31 mc marker freq.	
L8	3320-68	COIL ASS'Y: 30-48 mc marker freq.	
L9	3250-17	CHOKE ASS'Y: 50 turns #32 wire apprx. 7.5 microhenrys	
L10		CHOKE ASS'Y: Same as L9	
R11	16925-67	POTENTIOMETER: 20 ohms, 2 W, linear, wire wound	
R13	16925-66	POTENTIOMETER: 6 ohms, 2 W, wire wound	MC DEVIATION
R16	16925-22	POTENTIOMETER: 500,000 ohms, linear carbon	PHASING
R32	16925-34	POTENTIOMETER: 200 ohms, linear, carbon	OUTPUT
R37(S3)	16925-108	POTENTIOMETER: 400 ohms, linear, carbon, dual, with switch	MARKER INJECTOR
R1	18422-332	RESISTOR: 3300 ohms, 1 W, 10%	
R2	18432-332	RESISTOR: 3300 ohms, 2 W, 10%	
R3	18412-332	RESISTOR: 3300 ohms, 1/2 W, 10%	
R4	18412-102	RESISTOR: 1000 ohms, 1/2 W, 10%	
R5		RESISTOR: Same as R1	
R6	18411-472	RESISTOR: 470 ohms, 1/2 W, 10%	
R7		RESISTOR: Same as R4	
R8	18412-122	RESISTOR: 1200 ohms, 1/2 W, 10%	
R9		RESISTOR: Same as R4	
R10		RESISTOR: Same as R8	
R12	18421-101	RESISTOR: 100 ohms, 1 W, 5%	
R14	18415-102	RESISTOR: calibration	
R15	18414-102	RESISTOR: 100,000 ohms, 1/2 W, 10%	
R17	18412-472	RESISTOR: 4700 ohms, 1/2 W, 10%	
R18	18413-751	RESISTOR: 75,000 ohms, 1/2 W, 5%	
R19	18412-222	RESISTOR: 2200 ohms, 1/2 W, 10%	
R20	18423-102	RESISTOR: 10,000 ohms, 1 W, 10%	
R21		RESISTOR: calibration	
R22	18414-332	RESISTOR: 330,000 ohms, 1/2 W, 10%	
R23	18410-471	RESISTOR: 47 ohms, 1/2 W, 5%	
R24		RESISTOR: Same as R23	
R25		RESISTOR: Same as R23	
R26	18411-181	RESISTOR: 180 ohms, 1/2 W, 5%	
R27	18420-152	RESISTOR: 15 ohms, 1 W, 10%	
R28	18450-39	RESISTOR: 5.6 ohms, 5%	
R29		RESISTOR: Same as R28	
R30		RESISTOR: Same as R28	
R31	18410-331	RESISTOR: 33 ohms, 1/2 W, 5%	
R33		RESISTOR: Same as R15	
R34	18422-181	RESISTOR: 1800 ohms, 1 W, 5%	
R35	18411-101	RESISTOR: 100 ohms, 1/2 W, 5%	
R36	18575-79	RESISTOR: 1800 ohms, 5 W, 10%, wire wound	
R38		RESISTOR: Same as R8	

Prices will be furnished upon request

PARTS LIST FOR MODEL 610A

NOTE: There is a minimum charge of $1.50 for shipment of any one order.

REF SYMBOL	HICKOK CODE NUMBER	NAME AND DESCRIPTION	FUNCTION
R39	18415-332	RESISTOR: 3.3 megohms, 1/2 W, 10%	
R40	18413-272	RESISTOR: 27,000 ohms, 1/2 W, 10%	
S1	19911-9	SWITCH: toggle, S.P.S.T.	FM-TV
S2	19912-184	SWITCH: rotary, 2 sec, 3 pole, 6 pos.	RANGE SELECTOR
S3(R37)		SWITCH: On back of potentiometer R37	MARKER INJECTOR
S4		SWITCH: Same as S1	CW-MOD
S5		SWITCH: Same as S1	OSC-ABS
S6	19912-156	SWITCH: rotary, 1 sec, 4 pole, 2 pos.	MC MARKER
S7	19912-106	SWITCH: rotary, 1 sec, 5 position	OUTPUT MULT.
S8		SWITCH: Same as S1	POWER
T1	20800-52	TRANSFORMER: Audio	
T2	20800-78	TRANSFORMER: Power	
V1	20875-71	TUBE: 6J6, miniature, glass	OUTPUT
V2		TUBE: Same as V1	75-150 MC OSC.
V3		TUBE: Same as V1	75-115 MC OSC.
V4	20875-12	TUBE: 6J5	MODULATOR
V5	20875-22	TUBE: 6X5GT	RECTIFIER
V6	20875-19	TUBE: 6SN7GT	MARKER-XTAL OSC.
	2360-15	BINDING POST: black	
	4160-76	DIAL ASS'Y: FM Sweep	
	4160-77	DIAL ASS'Y: Band Selector	
	4160-82	DIAL ASS'Y: Marker Frequency	
	10300-11	JACK: Pin, Black	
	11500-11	KNOB ASS'Y: with pointer	
	12270-12	LAMP: #47 G.E., 6-8 Volts, .15 Amp.	
	19350-30	SOCKET: Octal, crimp-on	
	19350-56	SOCKET: Crystal	
	19350-104	SOCKET ASS'Y: Panel light,red jewel	
	19350-111	SOCKET ASS'Y: Panel light, green jewel	
	19350-117	SOCKET: 7-pin miniature, ceramic	

Price of replacement parts furnished upon request.

Crystals for all of the 12 channels are available from stock and code numbers run consecutively. For example, Channel 2 - #3870-5, Channel 3 - #3870-6, etc. Other I.F. frequency crystals are also available. Specify frequency when ordering.

In ordering parts or materials for this instrument, the serial number must be given in order to identify properly the material required.

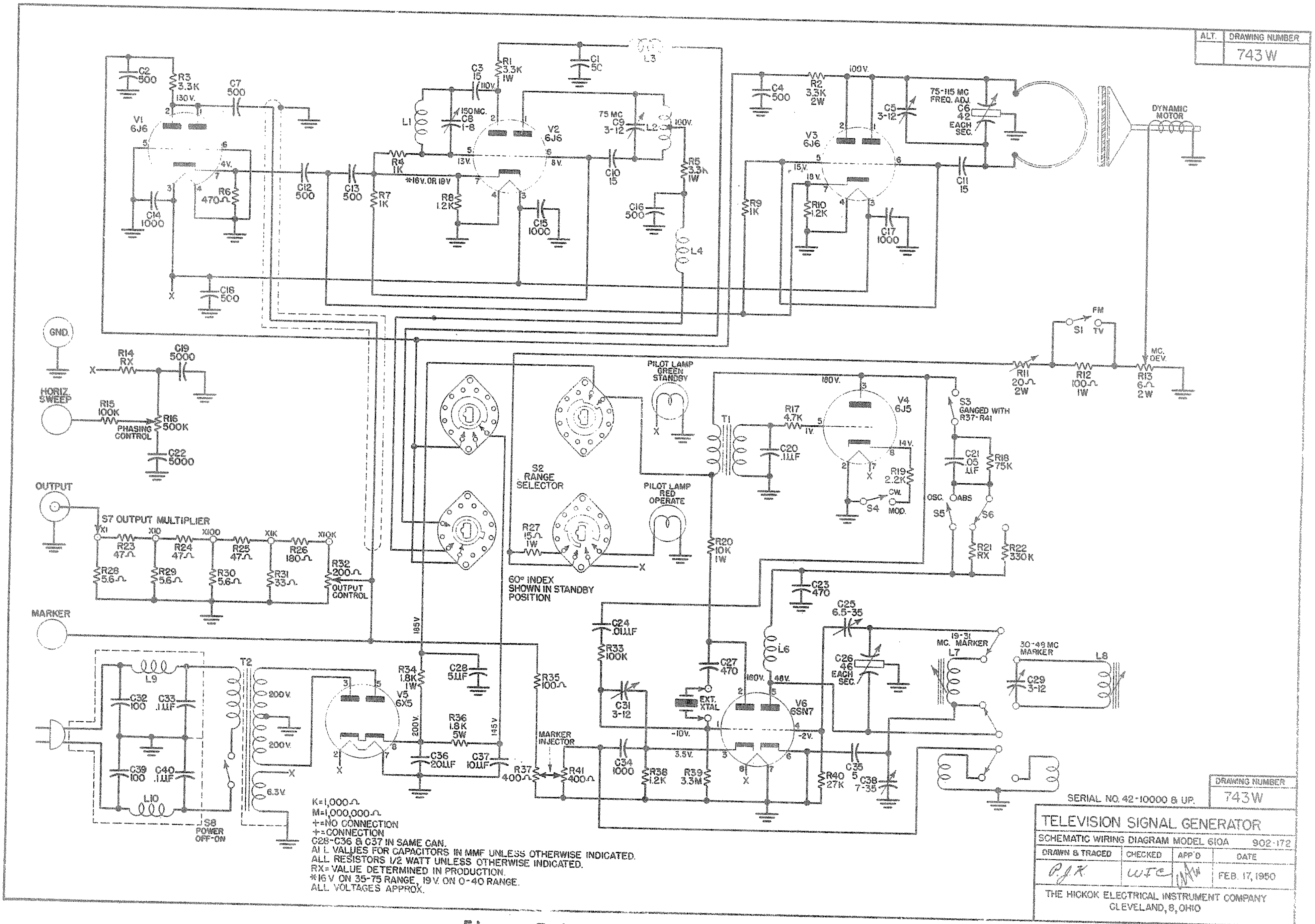


Figure 7.1 - MODEL 610A SCHEMATIC