RCA VICTOR

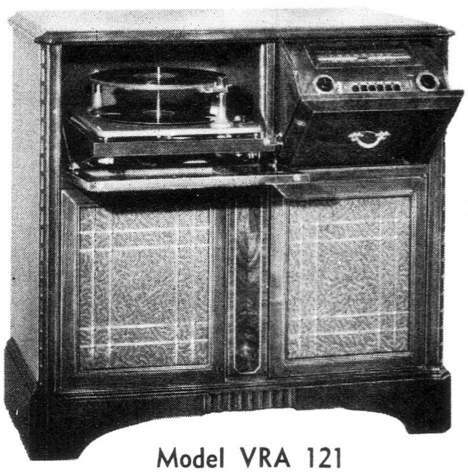
MODELS 121 & VRA 121

Twelve-Tube, Four-Band, A.M.-F.M. Superheterodyne Radio (121) & Radio-Phonograph Combination (VRA121)

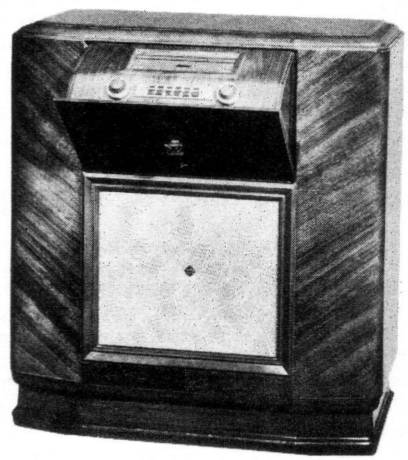
TECHNICAL INFORMATION AND SERVICE DATA

—1947 No. 5—

SERVICE DIVISION • RCA VICTOR COMPANY LIMITED • MONTREAL



Model VRA 121



Model 121

Electrical and Mechanical Specifications

FREQUENCY RANGE

Standard Broadcast S.B. ---------- 540-1600 k.c.
Short Wave 49-31 M ---------- 5.7-12.0 mc
25-19 M ---------- 11.5-15.8 mc
Frequency Modulation ---------- 88-108 mc
Intermediate Frequency AM ---------- 455 kc
Intermediate Frequency FM ---------- 10.7 mc
Tuning Drive Ratio ---------- 20 to 1

POWER OUTPUT

Undistorted ---------- 9 watts
Maximum ---------- 12 watts

POWER SUPPLY RATINGS

Rating A (121) ---- 105-125 volts, 50-60 cycle, 120 watts
Rating B (121) ---- 105-125 volts, 25-60 cycle, 120 watts
Rating A (VRA 121) 105-125 volts, 50-60 cycle, 140 watts
Rating B (VRA 121) 105-125 volts, 25-60 cycle, 140 watts

LOUDSPEAKER

Type ---------- 12 inch Electrodynamic
Voice coil impedance ---------- 2.2 ohms at 400 cycles

PHONOGRAPH

Type ---------- Automatic
Record Capacity ------- Twelve 10-inch or Ten 12-inch
Turntable Speed ---------- 78 r.p.m.

RADIOTRON COMPLEMENT OF RADIO CHASSIS

(1) Type 6BA6 ---------- RF Amplifier
(2) Type 6BA6 ---------- Mixer
(3) Type 6BE6 ---------- Oscillator
(4) Type 6BA6 ---------- 1st IF
(5) Type 6BA6 ---------- 2nd IF
(6) Type 6AL5 ---------- F.M. Ratio Detector
(7) Type 6AT6 ---------- A.M. Det., A.V.C. & 1st A.F.
(8) Type 6U5 ---------- Tuning Indicator

RADIOTRON COMPLEMENT OF AMPLIFIER CHASSIS

(1) Type 6SC7 ---------- Phase Inverter
(2) Type 6F6G ---------- Power Output
(3) Type 6F6G ---------- Power Output
(4) Type 5U4G ---------- Full Wave Rectifier
Pilot Lamps (2) ------ Mazda No. 51 6-8 volts, 0.2 amp.
(1) ------ Mazda No. 47 6-8 volts, 0.15 amp.

CABINET DIMENSIONS (inches)

	Height	Width	Depth
121	36	34	$14\frac{7}{8}$
VRA 121	$36\frac{3}{32}$	$39\frac{1}{2}$	$18\frac{17}{32}$

PICKUP

Type ---------- Crystal
Impedance ---------- 100,000 ohms at 1,000 cycles
Average Output ---------- 1.4 volts at 400 cycles across 500,000 ohm load

GENERAL DESCRIPTION

The RCA Victor Model 121 AM-FM radio and the Model VRA-121 AM-FM radio phonograph combination are housed in console cabinets of striking beauty. The AM-FM receiver is a twelve tube, four band superheterodyne using the most up-to-date circuits for high quality radio and phonograph reproduction. Features of the design include: Built-in folded dipole antenna for F.M. reception; Built-in short wave antenna; Adjustable standard broadcast loop antenna; Miniature tubes for improved high frequency performance; Highly selective RF stage; Separate oscillator tube for improved oscillator stability; Iron core R.F.; oscillator and I.F. coils; Push-button tuning of six Standard Broadcast stations by means of pretuned circuits; "Amplitude Ignorer" for improved rejection of AM when receiving FM; Ratio detector for high quality FM reproduction; Automatic volume control circuits; Tuning indicator tube; Full range variable tone control; Tone compensated volume control; Push-pull output stage and twelve inch duo-cone electrodynamic loudspeaker. The Model VRA-121 uses a Type 960001-4 automatic record changer mechanism with high fidelity, low noise crystal pickup. Refer to the 960001-4 Service Note for adjustment details and list of replacement parts for this mechanism.

A COMPARISON OF F.M. AND A.M.

Since the new F.M. receiver circuits and the frequencies on which F.M. operates are new to the home receiver field, it is important that the serviceman be informed of the differences between F.M. receivers and the conventional A.M. receivers.

A conventional A.M. receiver operates with a signal in which the intelligence is transmitted by means of amplitude variations while the frequency remains fixed. An F.M. receiver, however, operates with a signal in which the intelligence is transmitted by means of frequency variations while the amplitude remains fixed. Noise, which consists largely of amplitude variations passes readily through an A.M. receiver which responds to these variations. In an F.M. receiver, special circuits are provided to minimize the response to amplitude variations so that noise free reception is assured with all except very weak signals. Where the signals picked up by the built-in folded dipole antenna are too weak, an outside F.M. antenna is necessary.

Due to the very high frequencies used for F.M. (88 to 108 megacycles) certain differences may be noticed in this type of reception. It is known that in some locations, particularly urban areas, a type of distortion peculiar to F.M. may be experienced. This is in no way a fault of the receiver but rather a physical phenomena caused by the signal being reflected from some object resulting in two or more paths for the transmitted signal. The reflected signal, arriving late and out of phase, tends to amplitude modulate the F.M. signal. This distortion may appear as a strange buzz, rattle or swish. It may even give the effect of an overloaded audio stage. In other cases an increase in noise level may be noticed. Choosing a different location for the receiver may eliminate the trouble since the directive folded dipole antenna housed in the cabinet will be oriented differently. In severe cases, an outside dipole and reflector pointing in the right direction may correct the trouble.

For further details on antennas for F.M. refer to the External Antennas section on this page.

CIRCUIT ARRANGEMENT

The circuit for A.M. reception uses a tuned R.F. stage in which the loop antenna is used as part of the first tuned circuit. This is followed by a mixer stage with separate oscillator tube. The use of a separate oscillator tube and the incorporation of temperature compensating capacitors in the tuned circuits greatly reduces the oscillator drift. The use of a separate oscillator tube also increases the gain of the mixer on the short-wave bands.

Primaries and secondaries of the 455 kc. A.M. and 10.7 mc; F.M. I.F. transformers are connected in series in the plate and grid circuits of the I.F. amplifier stages, except for the secondaries of the last transformers which are connected to the A.M. and F.M. detectors respectively. The 10.7 mc I.F. transformers have relatively little effect on the 455 kc. A.M. I.F. signals due to low inductance of their coils and the two stage I.F. amplifier operates in the conventional manner.

A double diode triode acts as A.M. detector, A.V.C. and first audio amplifier. A phase inverter follows and drives the push-pull pentode output stage.

The circuit for F.M. reception uses a tuned R.F. stage designed to match a 300 ohm antenna. This is followed by a mixer stage with separate oscillator tube. Temperature compensating capacitors and other precautions have been taken to make the oscillator as stable as possible consistent with the frequency at which it operates. The use of a separate oscillator tube provides more gain in the mixer, in addition to the improved stability just mentioned. All high frequency circuit connections are critical as to length and care must be taken that these lengths are maintained when any repair work is done.

As previously explained, the F.M. and A.M. I.F. transformers are connected in series. The 455 kc I.F. transformers have relatively little effect on the 10.7 mc. F.M. I.F. signals due to the low reactance of the capacitors in the 455 kc transformers, so that the two stage amplifier operates in the conventional manner. In the first I.F. stage an unbypassed cathode resistor is used to compensate for the variation in input capacity of the tube with a change in A.V.C. voltage. The second I.F. amplifier stage incorporates an "amplitude ignorer" circuit which provides noise suppression additional to that obtained in the ratio detector. The ratio detector is discussed in detail on pages 10 and 11. The audio amplifier is the same one used for A.M. reception and uses the triode section of the double diode triode as the first A.F. amplifier, a double triode phase inverter and a push-pull pentode output stage.

EXTERNAL ANTENNAS

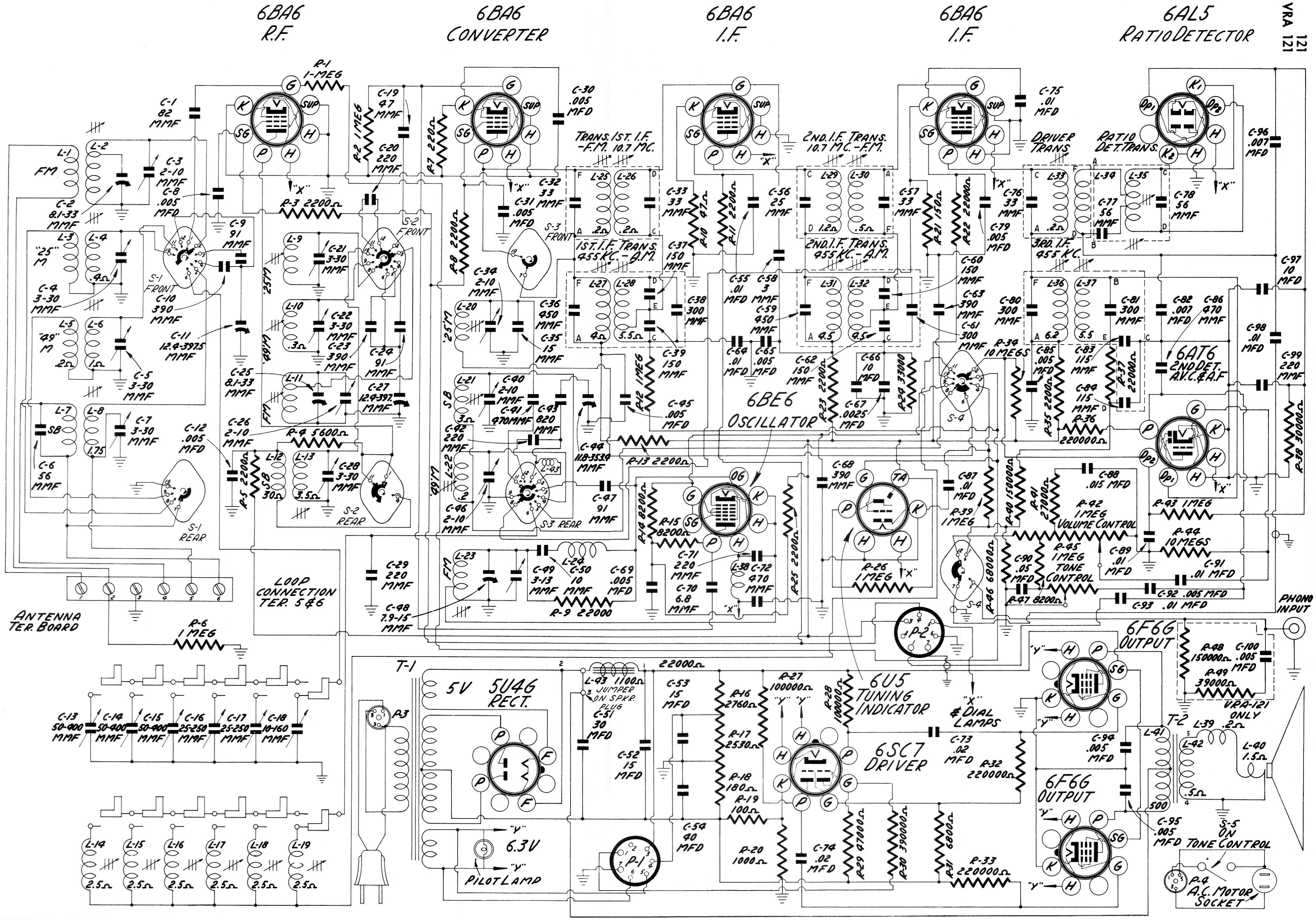
If reception is not satisfactory on one or more of the four bands, using the built-in cabinet antennas, an external antenna may be used. Connections to the antenna terminal board for operation with the internal antennas are as follows:

Terminals 1 and 2	—Internal folded dipole F.M. antenna
Terminal 3	—Ground
Terminal 4	—No connection
Terminal 5	—Loop antenna (green lead)
Terminal 6	—Loop antenna (black lead) and Internal short wave antenna.

An external antenna for broadcast and short wave reception, when required, is connected to terminal 4.

If an external F.M. antenna is to be used, disconnect the internal folded dipole antenna and connect in its place the leads from the external antenna.

Two general types of F.M. antennas are used. These are the folded dipole and the folded dipole with reflector, both of which are used with a 300 ohm transmission line. The reflector element used is somewhat longer than the folded dipole element. These antennas are directive and must be oriented for maximum signal pickup from the desired stations. The folded dipole picks up a maximum signal from stations at right angles to the direction in which the dipole is pointing. The folded dipole with reflector is similarly directive but provides additional signal pickup from the side of the folded dipole away from the reflector and rejects signals from the reflector side of the folded dipole.



NOTE—Terminals No. 11 on front and rear sections of S2 are connected together.

Fig. 1—Schematic Diagram-Range Switch Shown in F.M. Position.

NOTE—A resistor R-50, 3.3 megohms, should be shown connected from terminal 3 on S4 to pin 7(DP1) of 6AL5 Ratio Detector.

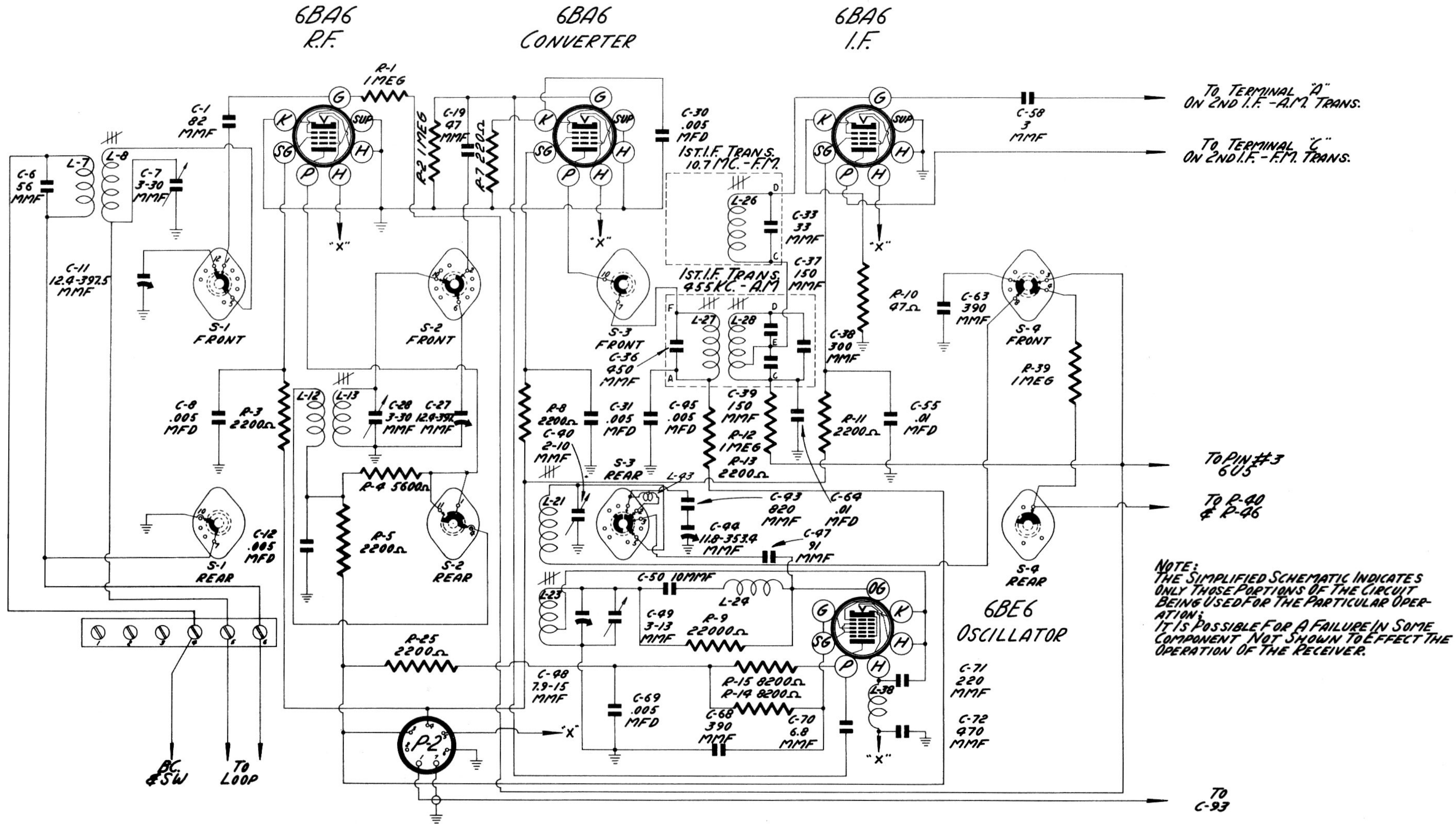


Fig. 3—Simplified Schematic of R.F. Circuits in S.B. Position.

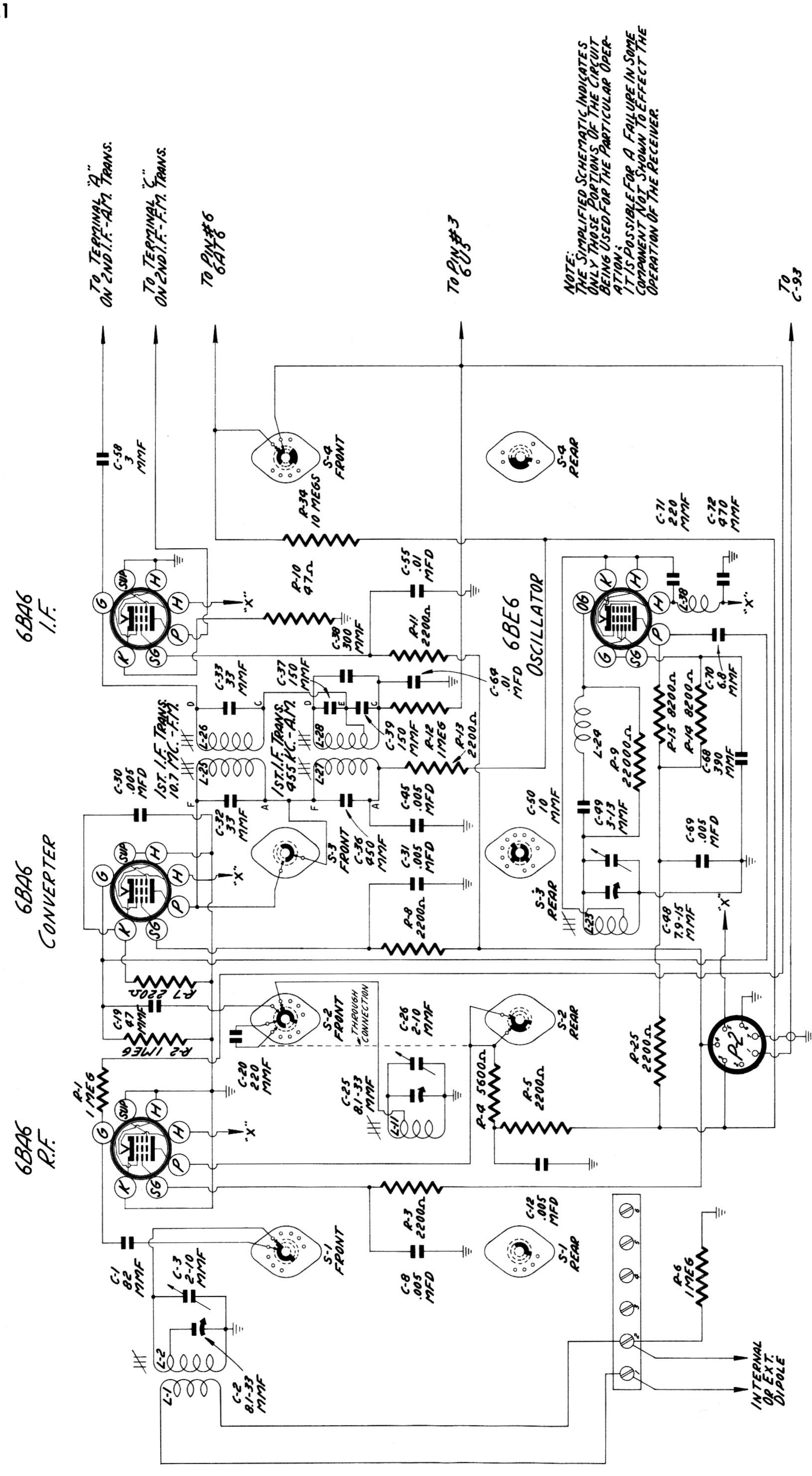


Fig. 2—Simplified Schematic of F.M., R.F. Circuits.

RADIOTRON SOCKET VOLTAGES

TYPE	PLATE	SCREEN GRID	CONTROL GRID	CATHODE	HEATER
6BA6 R.F.	200 (A.M.) 140 (F.M.)	90	—0.5		6.3 A.C.
6BA6 Mixer	200	90		1.6	6.3 A.C.
6BE6 Osc.	140	115	-6 to -10 (F.M.) -25 to -8 (S.B.) (Low to Hi ends)		6.3 A.C.
6BA6 1st I.F.	200	90	—0.5	0.5	6.3 A.C.
6BA6 2nd I.F.	200	125 (A.M.) 100 (F.M.)		2.5 (A.M.) 0 (F.M.)	6.3 A.C.
6AT6 A.M. Det. & 1st A.F.	75				6.3 A.C.
6AL5 Ratio Det.					6.3 A.C.
6SC7 Phase Inverter	155 (Pin 2) 145 (Pin 7)		—23	—20	6.3 A.C.
6F6G Output	375	230	—23		6.3 A.C.
6F6G Output	375	230	—23		6.3 A.C.
5U4G Rect.	370 A.C. (Pin 4) 370 A.C. (Pin 6)				5.0 A.C.
6U5 Indicator	230		—0.5		
"B" voltage measured from Rectifier Fil. (5U4G) to Gnd. — 390 Volts.					

Note:—All the above values hold within plus or minus 20% when measured with a RCA Voltohmyst or equivalent, on a line voltage of 115 volts. All voltages are measured to chassis.

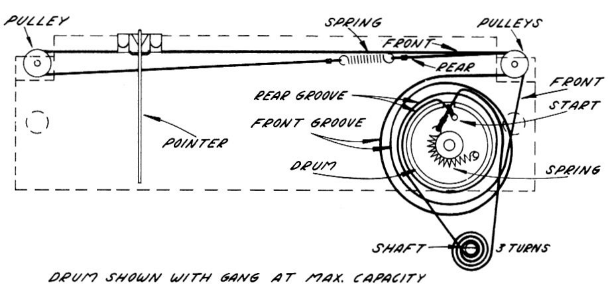


Fig. 4 — Dial Cord Stringing

ROLL-OUT AND TILT-OUT MECHANISMS

These mechanisms should ordinarily require little attention. Occasional lubrication of the record changer roll-out tracks with a light grease may be required to keep them operating freely. The radio tilt-out balance arm mechanism has a friction nut adjustment which is provided so that the door may be set to close fully and yet respond to light operating pressure. To adjust this friction nut first loosen the two set screws found around the rim. When adjustment is completed, re-tighten the set screws to prevent movement of the nut.

CRITICAL LEAD DRESS

(Make lead dress before alignment)

1. C91 and C92 must be dressed up against the chassis.
2. The lead from pin 5 of the 6BA6 R.F. amplifier tube to pin 1 on S2 rear must be kept short.
3. Dress lead connected from pin 5 of the 6BA6 mixer tube to pin 7 on S3 front away from chassis.
4. Lead from L11 to pin 3 on S2 front must be kept short.
5. Dress green lead from antenna terminal board pin 5 away from chassis.
6. Dress blue lead from C28 R.F. trimmer away from all adjacent components.
7. Dress all leads away from S2.
8. Twisted leads going to ON-OFF switch must be dressed against edge of chassis.
9. C68 leads must be kept short.
10. Dress lead from pin 3 of 6AL5 to pin 3 of 6AT6 away from pin 1 (grid) of 6AT6.
11. All F.M. coil connections must be kept to the exact length of the original (one-sixteenth inch difference in length may be excessive).
12. All wiring in the receiver is critical as to length and placement. It is therefore important when servicing, that extreme care should be taken so as not to disturb more of the wiring than absolutely necessary.

NOTE: Keep tuning capacitor grounding brushes clean and under correct tension for proper contact.

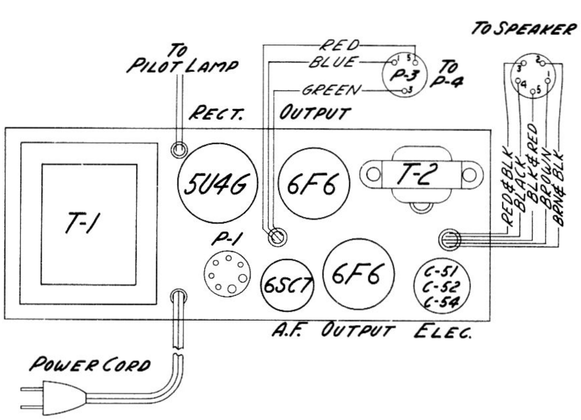


Fig. 5 — Amplifier Tube Layout

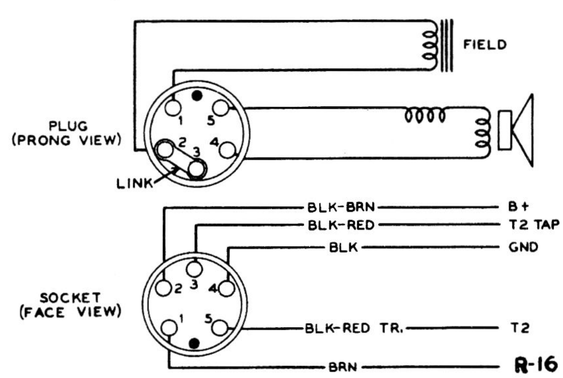


Fig. 6 — Speaker Connections

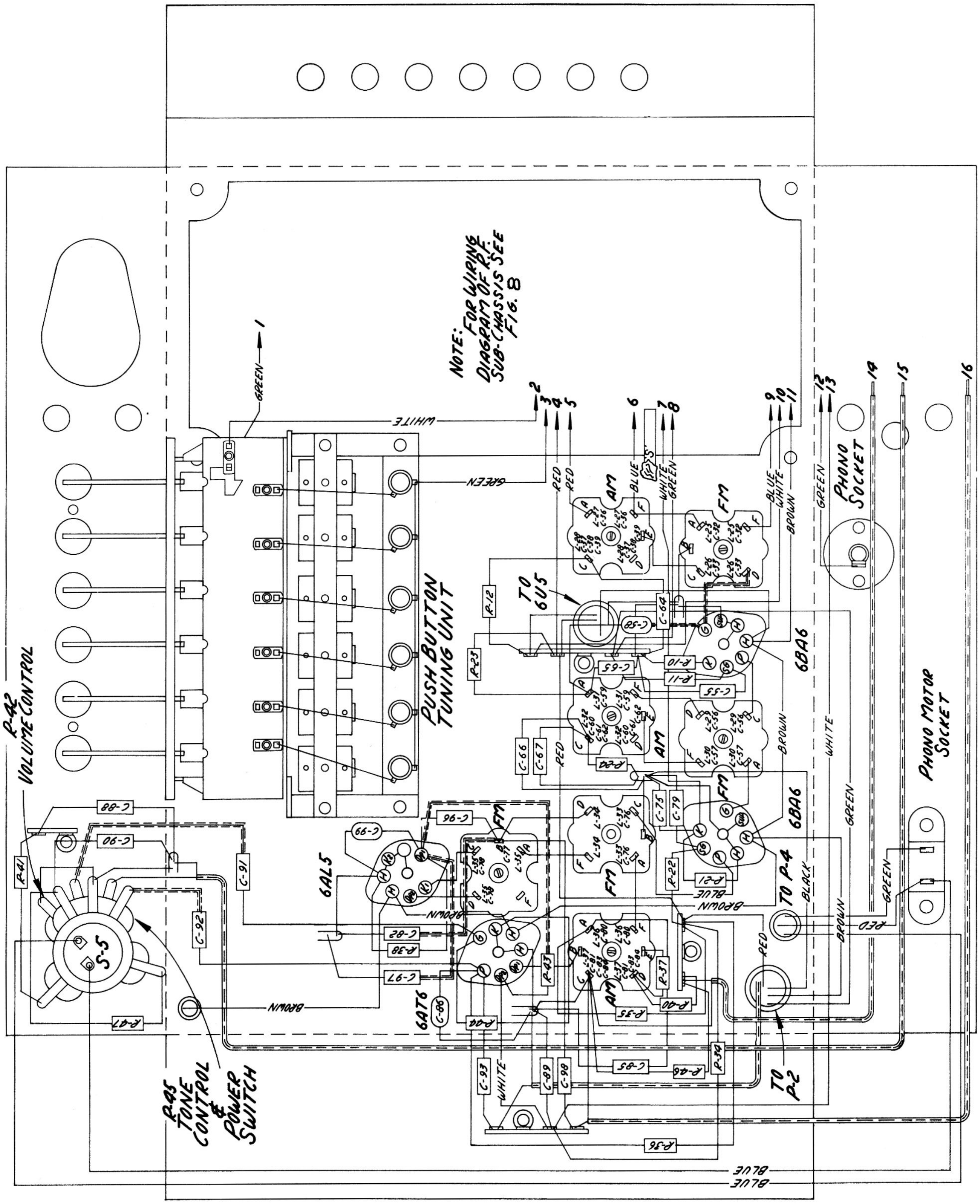


Fig. 7—Wiring Diagram of Main Chassis.

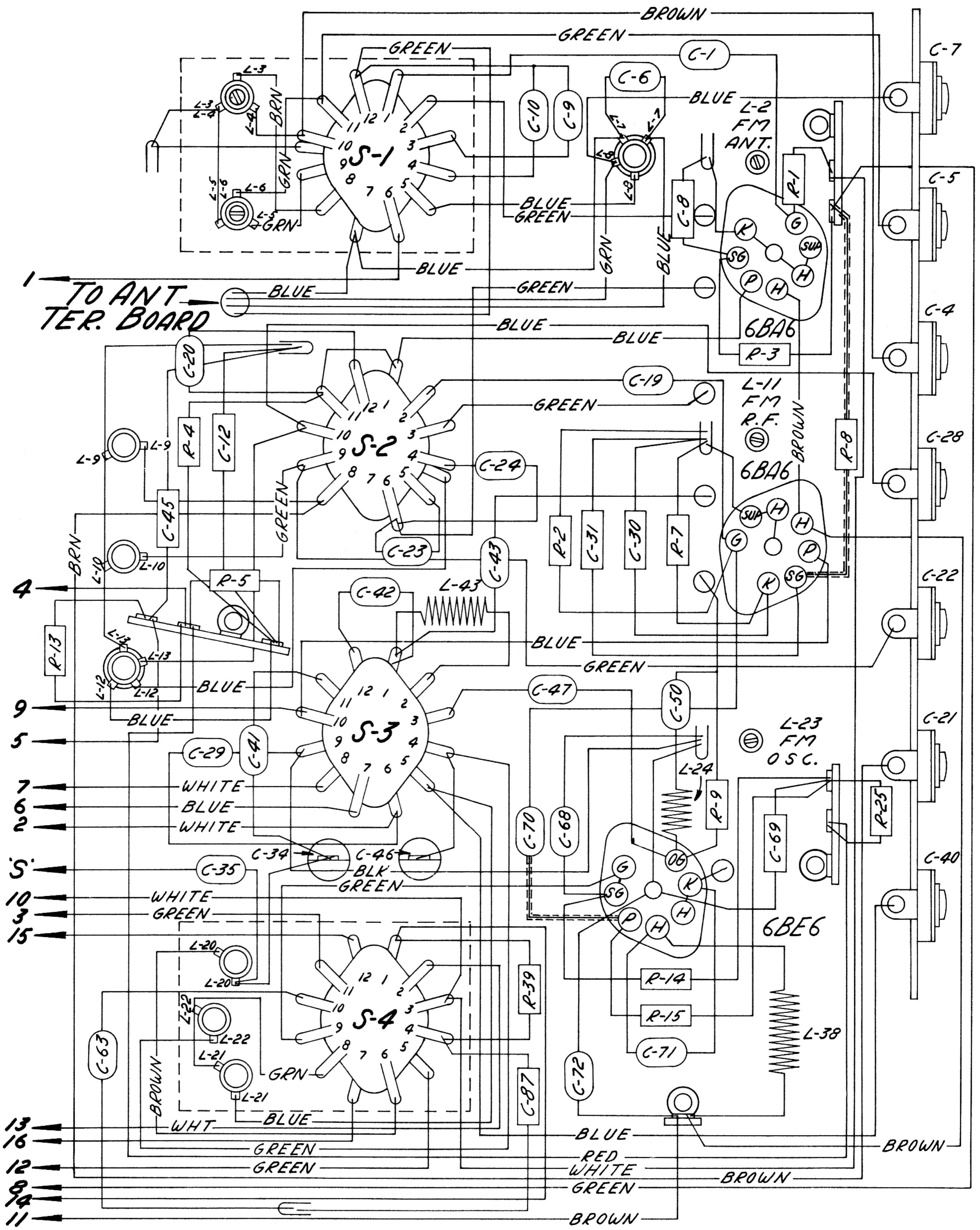


Fig. 8—Wiring Diagram of R.F. Sub-Chassis.

ALIGNMENT PROCEDURE

Make lead dress (page 5) before alignment

Before aligning set, completely mesh the gang and set the dial pointer on the mechanical maximum calibration point at the extreme left hand end of the dial. (See Fig. 9.)

When making a complete alignment follow in proper sequence the tabulated form below.

If only a portion of the circuit is to be aligned select the portion required, followed by the remaining steps in the chart. Any adjustments made on the FM 10.7 mc. I.F.'s make it necessary to realign the A.M. 455 kc. I.F.'s.

For "S.B.", 49-31M and 25-19M band alignment use output meter across voice coil keeping Test Oscillator output as low as possible to prevent AVC action.

Cathode-ray oscilloscope and sweep signal generator alignment of the 455 kc. A.M. I.F. transformers is the preferable method. Connect oscilloscope across the volume control. If the required equipment is not available use the method outlined below.

PUSH BUTTON ALIGNMENT

The push buttons may be adjusted for any six stations on the S.B. band. The preferable arrangement is to adjust for stations in order of frequency. Proceed as follows:

1. Turn "Range Selector" to S.B. position and manually tune in the first station, say 560 kc.
2. Turn "Range Selector" to P.B. position and press button No. 1 located at the left on the front panel.
3. Referring to Fig. 10, adjust core and trimmer No. 1 for a peak at 560 kc. This adjustment can be made with the assistance of the "Magic Eye". To align the push buttons with set still in cabinet, unfasten "Magic Eye" from its bracket and face to the rear.
4. Proceed to adjust the other five stations in order of frequency, as outlined above.

When a station is inaudible due to reception conditions a test oscillator may be substituted for the station signal.

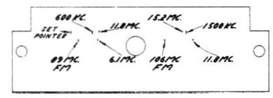


Fig. 9 — Alignment Calibration Markers

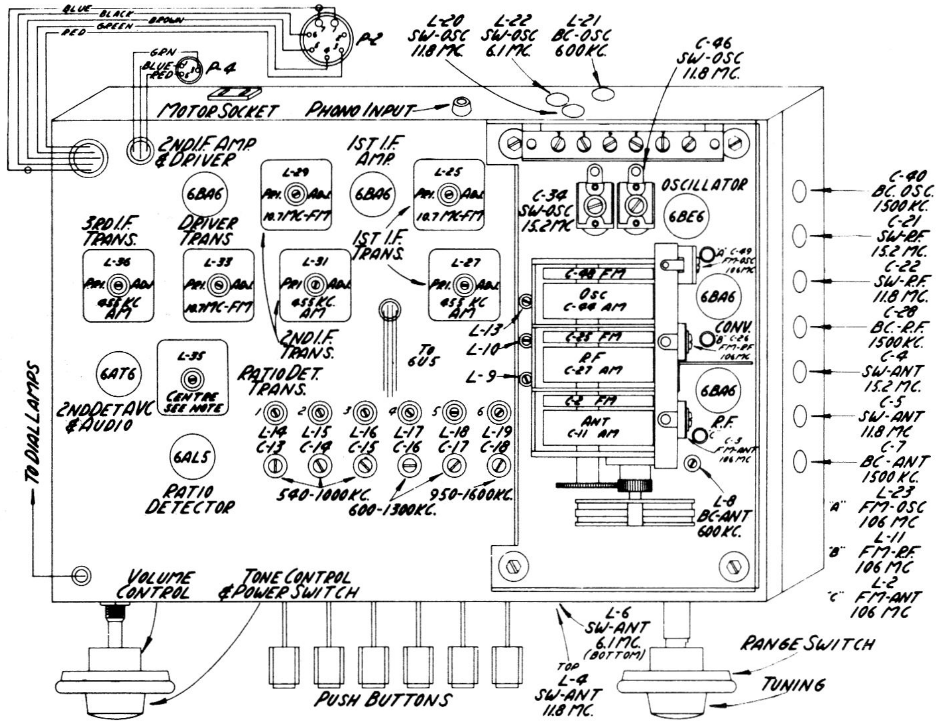


Fig. 10 — Chassis Layout and Alignment Adjustments

ALIGNMENT CHART

ORDER OF ALIGNMENT		TEST OSCILLATOR: CONNECT "HI" SIDE TO	TEST OSCILLATOR: CONNECT "LO" SIDE TO	TEST OSCILLATOR: DUMMY ANTENNA	TEST OSCILLATOR: FREQUENCY SETTING	RANGE SELECTOR	RECEIVER DIAL SETTING	CIRCUIT TO ADJUST	ADJUSTMENT SYMBOLS	NOTES
F.M. RATIO DETECTOR ALIGNMENT	1	Connect a 1000 ohm resistor between lugs "C" and "D" of the ratio detector trans. Connect DC probe of a Voltohmyst to the negative lead of the 10 mfd elec. capacitor C-97. The common lead of the meter is connected to the chassis.								
	2	6BA6 2nd I.F. Grid	Ground	.01 mfd	10.7 MC 30% Mod. 400 Cy. Am.	F.M.	Max. Cap (Fully Meshed)	Driver Transformer	L-33 Det. Trans.	For Max. D.C. Voltage Across C-97
	3	Remove meter leads and disconnect the 1000 ohm resistor from "C" and "D" on ratio det. trans. Connect two 100,000 ohm resistors (within 1% of being equal) in series across C97. Connect the common lead of the Voltohmyst to the centre point of the 100,000 ohm resistors and the D.C. probe to pin "B" of ratio det. trans. Use 30 volt scale for preliminary alignment. Complete alignment using 3 volt scale								
	4	Same	Same	Same	Same	Same	Same	Ratio Det. Trans.	Bottom Core L-35	†† For Zero D.C. Balance
		Near the correct core position the zero point is approached rapidly and continued adjustment causes the indicated polarity to reverse. A slow approach to the zero point is an indication of severe detuning, and the bottom core should be turned in the opposite direction..								
	5	Same	Same	Same	Same	Same	Same	Ratio Det. Trans	Top Core L-35	†† For Minimum Audio Output
		NOTE:- Two or more points may be found which will satisfy the condition required. Top core should be correctly adjusted when approximately 1/8 inch of threads extend above the can, therefore, it is desirable to start adjustment with the top core in its furthest "in" position and turn out, while adjusting the bottom core, until the first point of minimum AF and minimum DC is reached. †† The zero DC balance and the minimum AF output should occur at the same point: if such is not the case, the two cores should be adjusted until both occur with no further adjustment of either core. It may be advantageous to adjust both cores simultaneously, watching the Voltohmyst, and an output meter connected across the voice coil for the point at which both zero DC and minimum output occurs.								
	6	Reconnect Voltohmyst as in step 1, omitting 1000 ohm resistor.								
	7	Repeat step 2, omitting 1000 ohm.								
	8	Remove all connections.								

ALIGNMENT CHART

Section	Order of Alignment	Test Oscillator: Connect "HI" Side To	Test Oscillator: Connect "LO" Side To	Test Oscillator: Dummy Antenna	Test Oscillator: Frequency Setting	Range Selector	Receiver Dial Setting	Circuit To Adjust	Adjustment Symbols	Notes
F.M. I.F. ALIGNMENT	9	Connect the DC probe of a Voltohmyst to the negative lead of the 10 mfd electrolytic capacitor C97 and the common lead of the meter to chassis ground.								
	10	6BA6 1st I.F. Grid	Ground	.01 mfd.	10.7 MC 30% Mod. 400 Cy.Am.	F.M.	Max.Cap (Fully meshed)	2nd I.F. Trans.	L-29 and L-30	*Adjust test Osc. Output for 6-10 Volts developed across C-97 use very short leads
		* Top and bottom cores alternately loading primary & secondary of each trans. with 1000 ohms while the opposite side of the same trans. is being adjusted. Adjust all trans. for max. voltage across C-97. This method is known as alternate loading which involves the use of a 1000 ohm resistor to load the plate winding while the grid winding of the same transformer is being peaked. Then the grid winding is loaded with 1000 ohm resistor while the plate winding is being peaked. When the windings are loaded, it is necessary to increase the 10.7 MC input since the gain will decrease and the voltage across C97 will be less.								
	11	6BE6 Mixer grid	Same	Same	Same	Same	Same	1st I.F. Trans.	L-25 and L-26	* Adjust test Osc. Output for 6-10 Volts developed across C-97 use very short leads
A.M. I.F. ALIGNMENT	12	6BA6 2nd I.F. Grid	Ground	.01 mfd.	455 KC 30% mod. 400 Cy.Am.	S.B.	High Freq. end of Dial	3rd I.F. Trans.	L-36 and L-37	Adjust for max. Voltage across Voice Coil.
		It is necessary to alternately load the primary and secondary of each 455 KC I.F. trans. with 10,000 ohms while the opposite side of the same trans. is being adj.								
	13	6BA6 1st I.F. Grid	Same	Same	Same	Same	Same	2nd I.F. Trans.	L-31 and L32	Same
	14	6BE6 Mixer Grid	Same	Same	Same	Same	Same	1st I.F. Trans.	L-27 and L-28	Same
S.B. ALIGNMENT	15	#4 on Ant. Ter.Board	Ground	200 mmf.	1500 KC 30% Mod. 400 Cycles	S.B.	1500 KC.Calibration point on dial plate	Oscillator	C-40	Same
	16	Same	Same	Same	Same	Same	Same	R.F.	C-28	Same
	17	Same	Same	Same	Same	Same	Same	Ant.	C-7	Same
	18	Same	Same	Same	600 KC 30% Mod. 400 Cy.Am.	Same	600 KC.Calibration point on dial plate	Oscillator	L-21	Same
	19	Same	Same	Same	Same	Same	Same	R.F.	L-13	Same
	20	Same	Same	Same	Same	Same	Same	Ant.	L-8	Same
	21	Repeat steps 15 to 20 for max. output.								
49-31M ALIGNMENT	22	#4 on Ant. Ter.Board	Ground	300 Ohms	11.8 MC 30% Mod. 400 Cy.Am.	49-31M	11.8 MC Calibration point on right hand end of dial plate	Oscillator	C-46	Same
	23	Same	Same	Same	Same	Same	Same	R.F.	C-22	Same
	24	Same	Same	Same	Same	Same	Same	Ant.	C-5	Same
	25	Same	Same	Same	6.1 MC 30% Mod. 400 Cy.Am.	Same	6.1 MC Cal. point on dial plate	Oscillator	L-22	Same
	26	Same	Same	Same	Same	Same	Same	R.F.	L-10	Same
	27	Same	Same	Same	Same	Same	Same	Ant.	L-6	Same
	28	Repeat steps 22 to 27 for max. output.								
		NOTE:- To guard against the possibility of alignment of L-22 and C-46 to image freq., tune the test Oscillator and receiver to 11.8 MC. Then adjust test oscillator to 12.71 (image freq.). By increasing the test oscillator output, a signal should be heard. Next, tune test oscillator and receiver to 6.1 MC. Retune test oscillator to 7.01 MC (image freq.) and increase test oscillator output. A signal should then be heard. If these image freq. cannot be heard, the set is incorrectly aligned. Therefore repeat steps 22 to 28.								
25-19M ALIGNMENT	29	#4 on Ant. Ter.Roard	#3 on Ant. Ter.Board	300 Ohms	15.2 MC 30% Mod. 400 Cy.Am.	25-19M	15.2 MC Calibration point on dial plate	Oscillator	C-34	Adjust for Max.Voltage across voice coil
	30	Same	Same	Same	Same	25-19M	Same	R.F.	C-21	Same
	31	Same	Same	Same	Same	25-19M	Same	Ant.	C-4	Same
	32	Same	Same	Same	11.8 MC 30% Mod. 400 Cy.Am.	25-19M	11.8 MC Calibration point on left hand end of dial plate	Oscillator	L-20	Same
	33	Same	Same	Same	Same	25-19M	Same	R.F.	L-9	Same
	34	Same	Same	Same	Same	25-19M	Same	Ant.	L-4	Same
	35	Repeat steps 29 to 34 for maximum output.								
		NOTE:- To guard against the possibility of alignment of L-20 and C-34 to image frequency, tune the test oscillator and receiver to 15.2 MC, then set test oscillator to 16.11 MC (image frequency). Increase the test oscillator output; A signal should be heard. Then tune test osc. and receiver to 11.8 MC. Reset test osc. to 12.71 MC (image frequency) and increase test osc. output; A signal should be heard. If these image frequencies cannot be heard, the receiver is incorrectly aligned, Therefore repeat steps 29 to 35.								
F.M. ALIGNMENT	36	#1 on Ant. Ter.Board	#2 on Ant. Ter.Board	150 Ohm Resistor in Series with each Lead	106 MC 30% Mod. 400 Cy.Am.	F.M.	106 MC Calibration point on dial plate	Oscillator	C-49	Adjust for Max.Voltage across C-97 (Use Voltohmyst)
	37	Same	Same	Same	89 MC 30% Mod. 400 Cy.Am.	Same	89 MC Calibration point on dial plate	Oscillator	L-23	Same
		NOTE:- Two points may be found to fulfill the requirements. Use the one with the longest threaded end extending out of the transformer.								
	38	Repeat steps 36 and 37 for exact calibration.								
	39	Remove connections or turn test oscillator off				Same	106 MC Calibration point on dial plate	R.F.	C-26	Same
		NOTE:- Two points can be found having the greatest noise voltage developed. Use the one with the greater capacity (tighter adjustment).								
	40	Same	Same	Same	Same	Same	89 MC Calibration point on dial plate	R.F.	L-11	Same
		NOTE:- Two points may be found to fulfill the requirements. Use the one with the longest threaded end extending out of the transformer.								
	41	Repeat steps 39 and 40 for maximum output.								
	42	#1 on Ant. Ter.Board	#2 on Ant. Ter.Board	150 Ohm Resistor in Series with Each Lead	106 MC 30% Mod. 400 Cy.Am.	Same	106 MC Calibration point on dial plate	Ant.	C-3	Same
	43	Same	Same	Same	89 MC 30% Mod. 400 Cy.Am.	Same	89 MC Calibration point on dial plate	Ant.	L-2	Same
	44	Repeat steps 42 and 43 for maximum output.								

THE RATIO DETECTOR

The ratio detector, appearing in RCA post-war f-m receivers, is a new device for converting a frequency modulated carrier to an audio signal, while at the same time offering a high degree of attenuation to any incident amplitude modulation. The relative insensitivity to amplitude variations, which is an inherent characteristic of ratio detectors, enables them to be used without the usual preceding limiter stage, thus affording the use of a high gain i-f stage instead of the low-gain limiter.

Theory of Operation

A brief review of the theory of the discriminator detector will help the serviceman to understand the action of the ratio detector.

Figure 1 portrays a conventional discriminator stage, and it can be seen that it consists essentially of two diode rectifiers which are differentially connected so that the d-c potentials across their respective load resistors are subtractive. These two d-c voltages (across R1 and R2 in Figure 1) are proportional to the a-c voltages applied to the diodes. The a-c voltage applied to each diode is the vector sum of E1 and the voltage across that half of L1 which is connected to the diode plate, as shown in the diagrams of Figure 4. E1 has practically the same amplitude and phase as the voltage across the tank in the limiter plate circuit. The current in this same tank circuit induces a voltage in L1, which causes a circulating current to flow in the resonant circuit composed of L1 and C1. E2 and E3 are the voltage drops which occur across each half of L1 as a result of this circulating current. When the carrier frequency is equal to the frequency at which the discriminator transformer is tuned (Fig. 4A), the a-c voltage applied to diode 1 equals that applied to diode 2, therefore the rectified voltages are equal and since they are bucking voltages, the output of the discriminator is zero.

When the carrier frequency increases during a half cycle of modulation, the phase relations between E1, E2 and E3 change in accordance with Figure 4B, and it is evident that the vector sum of the voltages applied to diode 2 exceeds the vector sum of the voltages applied to diode 1, resulting in a higher rectified voltage across R2 than across R1. The instantaneous difference of the rectified voltages appears as a negative voltage in the discriminator output. Figure 4C shows the condition occurring when the carrier frequency swings below the resonant frequency of the discriminator transformer, the end result being a positive voltage at the output of the discriminator.

The important fact in discriminator action is that the output voltage is proportional to the difference between Ediode 1 and Ediode 2. This is true because the d-c voltages appearing across R1 and R2 vary directly with Ediode 1 and Ediode 2, respectively, and the instantaneous output voltage is the difference between the rectified voltage drops.

In considering the effect of amplitude variation on discriminator output, refer again to the vector diagrams of Figure 4. An increase in the amplitude of the voltage applied to the discriminator would increase all of the vectors in the diagram proportionately. In other words, the effect would be as though the vector diagrams were enlarged photographically. It can be seen that while the phase relationships would remain the same, the difference between Ediode 1 and Ediode 2 would increase, so long as the frequency of the applied voltage differed even slightly from the receiver i-f. Thus components of amplitude modulation would be detected and passed on to the audio amplifier. Ordinarily, discriminators are preceded by limiters which remove most of the amplitude variation from the f-m carrier, but the discriminator itself is not a device capable of rejecting amplitude modulation, except when the instantaneous frequency of the applied carrier is exactly equal to the resonant frequency of the discriminator transformer. This condition occurs only twice in every modulation cycle.

Note that while an increase in the amplitudes of the vectors in Figure 4 results in a proportionate increase in the difference between Ediode 1 and Ediode 2 for off-resonant conditions, the ratio of Ediode 1 to Ediode 2 is a constant, as far as amplitude variations are concerned. Therefore, a detector responsive only to changes in the ratio of Ediode 1 to Ediode 2, and insensitive to changes in the difference between these voltages would be a detector capable not only of converting frequency variations to audio variations, but of rejecting any amplitude modulation. Such a detector is the ratio detector.

DISCRIMINATOR

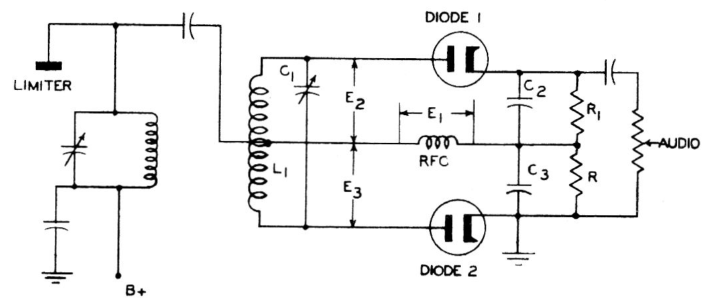


FIG. 1

RATIO DETECTOR

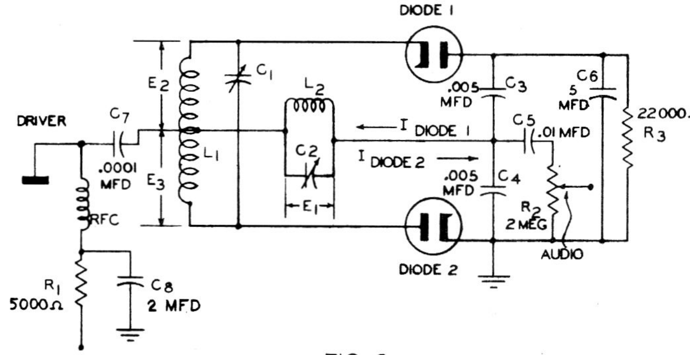


FIG. 2

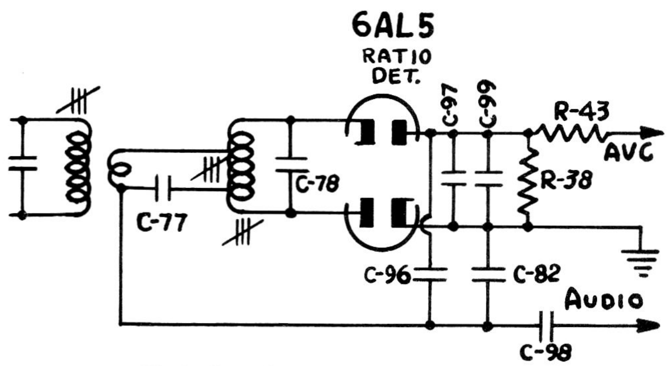


FIG.3 - RATIO DETECTOR

A schematic of the fundamental ratio detector is shown in Figure 2. C7 and C4 have very little reactance at the intermediate frequency, so it is evident that the parallel resonant circuit L2 C2 is the true load for the driver stage, this stage being shunt fed. A driver stage, in this case, is nothing more than a conventional i-f amplifier preceding the ratio detector. L2 is inductively coupled to L1, therefore a comparison of Figures 1 and 2 will show that as far as the a-c voltages applied to the diodes are concerned, these circuits are almost exactly similar, indeed, the same vector diagrams used in the analysis of Figure 1 can be used to portray the a-c voltages across the diodes in Figure 2. Here the similarity ends, because the ratio detector method of extracting intelligence from the f-m carrier differs greatly from previously used methods. Diode 1, R3, and diode 2 complete a series circuit fed by the a-c voltage across L1. Since the two diodes are in series, they will conduct on the same half cycle, and the rectified current through R3 will cause a negative potential to appear at the plate of diode 1. The time constant of R3 C6 is usually about 0.2 second, so that the negative potential at the plate of diode 1 will remain constant even at the lowest audio frequencies to be reproduced.

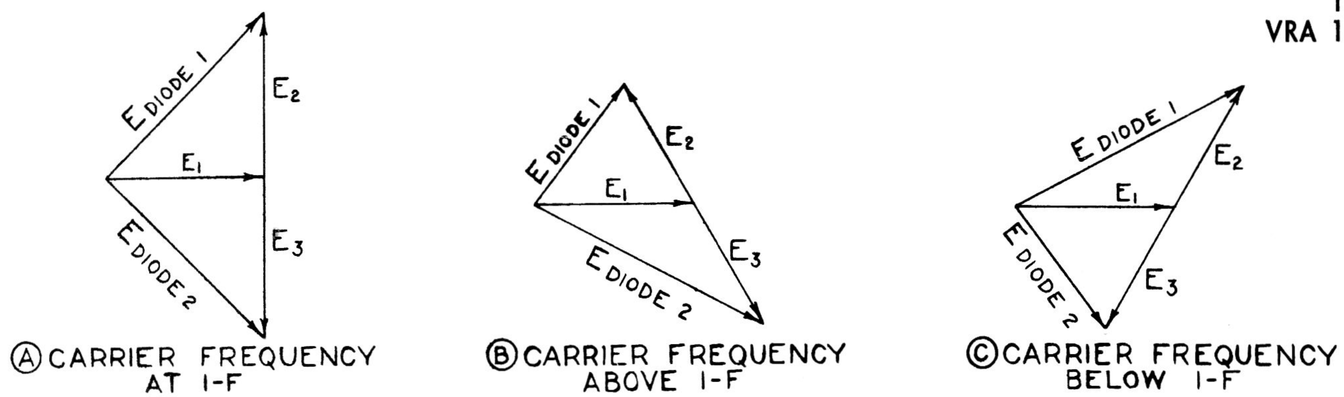


Fig. 4

C3 will be charged by the rectified current through diode 1 to a voltage proportional to the voltage represented by vector Ediode 1 (Figure 4), and C4 will be charged through diode 2 in proportion to the vector Ediode 2. Since the magnitudes of these vectors differ according to the instantaneous frequency of the carrier, the voltages across C3 and C4 will differ proportionately, the voltage across C3 being the larger of the two voltages at carrier frequencies below the i-f, and the smaller at frequencies above the i-f.

Note that the voltages across C3 and C4 are additive and that their sum is fixed by the constant potential across R3. Therefore, while the ratio of these voltages will vary at an audio rate, their sum will always be constant and equal to the voltage across R3. The potential at the junction of C3 and C4 will vary at an audio rate when an f-m carrier is applied to the detector, hence the audio voltage is extracted at this point and fed into the audio amplifier.

There is no direct d-c return path across either C3 or C4; the reason for this is twofold. Firstly, a direct return path is not needed because whenever the potential of the junction of C3 and C4 is raised or lowered in accordance with the frequency of the voltage applied to the detector, there will be a point on R3 having a potential equal to the voltage across C4. This point will shift up and down on R3 in synchronism with the audio voltage across C4. If this point could be connected to the junction of C3 and C4, a d-c return for each diode would be provided, but no current would flow through the connection because there would be no difference of potential between the point on R3 and the junction of C3 and C4. Since no current would flow through this connection, a direct return path would be useless.

Secondly, a peculiar form of distortion, apparent at low carrier levels; is evident if a resistance is connected directly across C4. This distortion is caused by C4 discharging through the resistance whenever the carrier level falls below the level at which the diodes are biased off by the voltage across R3. The effect of the distortion is to add a long peak to one loop of the audio cycle.

The rejection of amplitude modulation in the ratio detector may be explained as follows: A rapid increase in the amplitude of the carrier applied to the ratio detector will tend to increase the d-c voltages across C3 and C4. The sum of these voltages must always be equal to the voltage across C6. The voltage across C6 cannot change with a rapid increase in the amplitude of the carrier, due to the large time constant of R3 and C6. Therefore, this constant potential across C6 prevents the voltages across C3 and C4 from rising with an increase in the strength of the carrier. A reduction in carrier amplitude is prevented from appearing as a reduction in the voltages across C4 in the same way. The constant voltage across C6 can be considered to be a stabilizing voltage; i.e., it stabilizes the ratio detector output against amplitude modulation of the applied carrier.

The time constant of R3 C6 is not too large to prevent average changes in carrier level from appearing as changes in voltage across R3; in other words the voltage across R3 is proportional to the average strength of the received carrier. Thus this voltage serves as an excellent AVC voltage.

There is no "threshold" effect apparent in the ratio detector; i.e., there is no minimum carrier level which must be applied to the detector to cause noise attenuation as in other types of f-m detectors requiring the use of a limiter stage.

The Ratio Detector used in this receiver, differing only in the method of applying i-f energy to L1 and C1, is shown in Figure 3. This circuit, as well as any other ratio detector circuit, can be broken down and analyzed in almost the same manner as was the basic ratio detector circuit of Figure 2.

REPLACEMENT PARTS FOR MODELS 121 & VRA121

Insist on genuine factory tested parts, which are readily identified and may be purchased from authorized dealers.

STOCK NO.	DESCRIPTION	
	RECEIVER ASSEMBLIES	
S-3612	Capacitor-Trimmer bank (C4,C5,C7, C21,C22,C28,C40)................	
S-3615	Capacitor-Trimmer bank (C13,C14, C15,C16,C17,C18)...............	
S-3613	Capacitor-Trimmer (C34,C46).......	
S-3614	Capacitor-Trimmer (C3,C26)........	
S-3611	Capacitor-Ceramic Trimmer (C49)...	
S-4181	Capacitor-Ceramic 3 MMF (C58).....	
39043	Capacitor-Ceramic 6.8 MMF (C70)...	
45466	Capacitor-Ceramic 10 MMF (C50)...	
31353	Capacitor-Ceramic 15 MMF (C35)...	
39042	Capacitor-Ceramic 47 MMF (C19)...	
70599	Capacitor-Ceramic 56 MMF (C6)....	
33104	Capacitor-Ceramic 82 MMF (C1)....	
71021	Capacitor-Ceramic 91 MMF (C9,C47, C24)..........................	
71920	Capacitor-Ceramic 220 MMF (C20, C29,C42,C71,C99)..............	
39642	Capacitor-Ceramic 390 MMF (C10, C23,C63,C68)..................	
39644	Capacitor-Ceramic 470 MMF (C41, C72,C86)......................	
39650	Capacitor-Ceramic 820 MMF (C43)...	
S-3647	Capacitor-.007 MFD (C82, C96)..........................	
S-3646	Capacitor-.005 MFD (C8,C12, C30,C31,C69,C45,C65,C79,C85, C92,C100).....................	
S-3644	Capacitor-.0025 MFD. (C67)........	
S-3653	Capacitor-.05 MFD. (C90)........	
S-3649	Capacitor-.015 MFD. (C88)........	
S-3648	Capacitor-.010 MFD. (C64,C55,C75, C89,C91,C98,C87,C93)...........	
36718	Capacitor-Electrolytic 10 Mfd. (C66,C97).....................	
S-3616	Condenser-Variable (C11,C27,C44, C2,C25,C48)...................	
S-3598	Push Button-Coil (L14,L15,L16, L17,L18,L19)..................	
S-3599	Coil Assembly SW. Osc. (L20)......	
S-3600	Coil Assembly SW. Osc. (L22)......	
S-3601	Coil Assembly B.C.Osc. (L21)......	
S-3602	Coil Assembly FM. Ant. (L2).......	
S-3603	Coil Assembly FM. R.F. (L11)......	

REPLACEMENT PARTS FOR MODELS 121 & VRA121–Cont'd

Insist on genuine factory tested parts, which are readily identified and may be purchased from authorized dealers.

STOCK NO.	DESCRIPTION
S-3604	Coil Assembly FM. Osc. (L23).......
S-3605	Coil Assembly BC. R.F. (L12,L13)...
S-3606	Coil Assembly BC. Ant. (L7,L8).....
S-3607	Coil Assembly SW. Ant. (L4)........
S-3608	Coil Assembly SW. Ant. (L6)........
S-3685	Coil Assembly SW. RF. (L9)........
S-3686	Coil Assembly SW. RF. (L10)........
S-3681	Choke R.F. (L24,L43)...............
S-3901	Choke R.F. (L38)...................
S-4160	Drum-Dial Drum.....................
S-3621	Indicator-Station Selector pointer.
S-3609	Loop Assembly (121) (Broadcast)....
S-3949	Loop Assembly (VRA121) (Broadcast).
30732	Resistor 47 ohms 1/2 watt (R10)....
30880	Resistor 150 ohms 1/2 watt(R21)....
14561	Resistor 220 ohms 1/4 watt (R7)....
34767	Resistor 2200 ohms 1/2 watt(R15,R3, R5,R8,R13,R11,R25,R23,R35).
30734	Resistor-5600 ohms 1/2 watt (R4)...
14250	Resistor-8200 ohms 1/2 watt (R14, R47)......................
30492	Resistor-22,000 ohms 1/2 watt (R22, R37)......................
30409	Resistor-27,000 ohms 1/2 watt (R41)
3152	Resistor-30,000 ohms 1/4 watt (R38)
30685	Resistor-33,000 ohms 1/2 watt (R24)
30694	Resistor-39,000 ohms 1/2 watt (R49)
14138	Resistor-68,000 ohms 1/2 watt (R46)......................
14020	Resistor-150,000 ohms 1/4 watt(R40, R48)......................
14583	Resistor-220,000 ohms 1/2 watt(R36)
30652	Resistor-1 Megohm 1/2 watt (R1, R2,R6,R12,R26,R39,R43).....
31417	Resistor-3.3 Megohm 1/2 watt(R50)...
30992	Resistor-10 Megohm 1/2 watt (R34, R44)......................
S-3617	Switch-Range Switch (S1,S2,S3,S4)..
S-3618	Switch-Push Button.................
S-3620	Scale-Dial Scale...................
S-3622	Shaft-Drive Shaft..................
51384	Socket-Tube Socket (Miniature).....
S-2824	Socket-AC..........................
S-3593	Transformer-I.F. 1st A.M. (L27,L28, C36,C37,C38,C39)...........
S-3593	Transformer-I.F. 2nd A.M. (L31,L32, C59,C60,C61,C62)...........
S-3594	Transformer-I.F. 3rd A.M. (L36,L37, C80,C81,C83,C84)...........
S-4010	Transformer-I.F. 1st F.M. (L25,L26, C32,C33)...................
S-4011	Transformer-I.F. 2nd F.M. (L29,L30, C56,C57)...................
S-3703	Transformer-Driver (L33,L34,C76)...
S-3702	Transformer-Ratio Det.(L35,C77,C78)
S-3619	Volume & Tone Control-1 Meg.(R42).. 1 Meg.(R45)
13867	Cap-Dust Cap (Pkg.3)...............
S-3589	Cone-Cone & Voice Coil Assy. (L40).
S-3587	Speaker............................
S-3588	Field Coil (L43)...................
	AMPLIFIER ASSEMBLIES
S-3646	Capacitor-.005 Mfd. (C94,C95)......
S-3650	Capacitor-.020 Mfd. (C74,C73)......
37877	Capacitor-Electrolytic 16 Mfd.(C52)
36599	Capacitor-Electrolytic 30-15-40 Mfd.(C51,C53,C54).............
S-3628	Cable-Speaker Cable................
S-3629	Cable-Power Cable(Rec.to power Supply)
34765	Resistor-100 ohms 1/2 watt (R19)...

STOCK NO.	DESCRIPTION
34766	Resistor-1000 " 1/2 " (R20)..
14659	Resistor-6800 " 1/2 " (R31)..
30787	Resistor-47,000" 1/2 " (R29)..
3252	Resistor-100,000" 1/2 " (R27, R28)..
14583	Resistor-220,000 ohms 1/2 watt (R32,R33)...............
11988	Resistor-390,000 ohms 1/2 watt(R30)
S-4161	Resistor-Bleeder Resistor(R16, R17,R18)..............
32537	Socket-Tube Socket (Octal).......
S-3591	Transformer-Power 60 cycle (T1)..
S-3592	Transformer-Power 25 cycle (T1)..
S-3590	Transformer-Output(T2)(L39,L41, L42).
	MISCELLANEOUS ASSEMBLIES
S-3610	Antenna F.M. (121)Folded dipole).
S-3590	Antenna F.M.(VRA121) " " .
38375	Button-Push Button...............
S-4017	Board-Ant.Terminal Board.........
32634	Cord-Drive Cord (Universal)(50").
S-4167	Clamp-Back cover clamp (Pkg.3)...
S-4163	Cloth-Grille cloth (VRA 121).....
S-4162	Decal-121-VRA121(front panel)....
36386	Decal-VRA121 Record Drawer.......
S-3636	Grille-Metal Speaker grille(VRA121)
S-4170	Gear-Drive Gear..................
S-4171	Gear-Sleeve gear.................
S-4172	Grommet-Chassis mounting(Pkg.3)..
S-4026	Handle-Door handle (VRA121)......
13103	Jewel-Indicator jewel............
72147	Knob-Range.......................
72148	Knob-Tone........................
72149	Knob-Tuning......................
72150	Knob-Volume......................
11765	Lamp-Pilot Lamp Mazda #51........
31480	Lamp-Indicator lamp Mazda #47....
S-3948	Marker-Station Marker............
5118	Plug-Cable plug (3 pins).........
12568	Plug-Speaker plug (5 pins) ......
S-4183	Plug-Power cable plug (7 pins)...
11984	Plug-Loop connector..............
4982	Spring-Range Knob retaining spring(Pkg.5)................
14270	Spring-Tone Knob retaining spring (Pkg.2)....................
30330	Spring-Volume knob retaining spring(Pkg.3)................
30900	Spring-Tuning knob retaining spring(Pkg.5)................
30585	Spring-Drive cord tension(Pkg.2).
34053	Spring-Push Button retaining spring (Pkg.5)...............
31611	Screw-Set Screw for gear #8-32 x 1/4 (Pkg.10)................
14278	Socket-Phono Socket..............
5119	Socket-Cable socket (3 pins).....
12493	Socket-Speaker cable(5 pins).....
S-4164	Socket-Power cable (7 pins)......
S-4168	Support-Door fall support........
	AUTOMATIC RECORD CHANGER MECHANISM
	Refer to Model No.960001-4 Service Note for Replacement Parts & Service Data.
	PULLOUT MECHANISM
S-4165	Door balancing Ass'y.(121).......
S-4182	Door balancing Ass'y(VRA 121)....
S-4166	Spring-balancing spring..........
S-4027	Drawer Slide(1 set)(record player)
S-3742	Pull out Mechanism(record player) VRA 121.........................
S-4169	Hex Nut (door balancing Ass'y)
S-4176	Set Screw (Pkg.3) " " "
S-4177	Spring Washer (Pkg.3) " " "
S-4178	Stud (door balancing Ass'y)......
S-4179	Rubber Washer (Pkg.2) (door balancing Ass'y)......
S-4180	Fibre Washer (Pkg.5)............

All parts and prices subject to change or withdrawal without notice