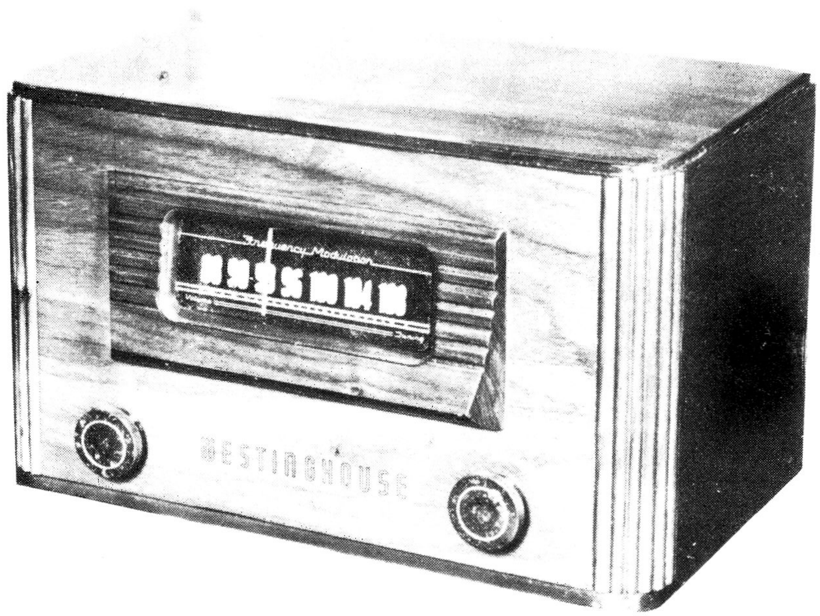
NOVEMBER **RADIO** SECTION RS-241

SERVICE MANUAL

WESTINGHOUSE MODEL FM-894

8 TUBE FREQUENCY MODULATION CONVERTER



CANADIAN WESTINGHOUSE COMPANY, LIMITED

Service Department - Hamilton, Ont.

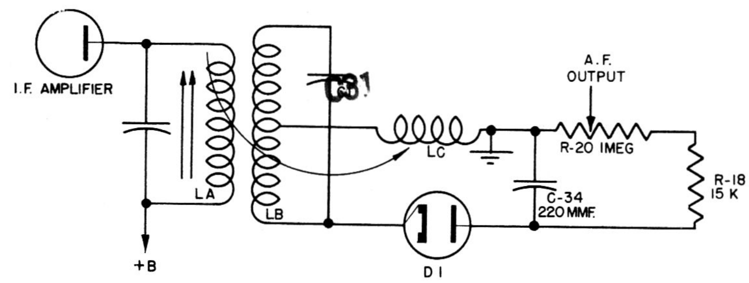


FIGURE A

ACTION OF A RATIO DETECTOR

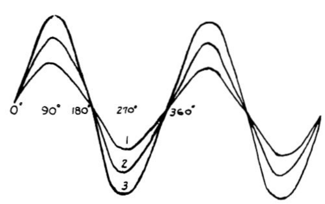
Usually the action of the Ratio Detector is explained by referring the service technician back to the Fostei-Seeley discriminator and attempting to show wherein the two types are similar and dissimilar. This explanation will avoid such back references and go directly to the points involved.

First to avoid confusion caused by the word "ratio" disregard this term. It serves as a name only, but does not help to understand how the circuit operates.

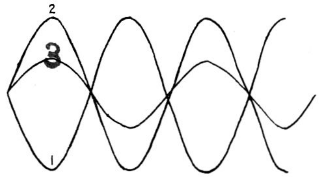
Look at Fig. A. La is the primary of the last I.F. transformer. It is coupled to Lb and Lc. Lb is a center tapped coil and is tuned to resonance with the rated I.F. frequency. Lc is untuned. Because it is untuned, the I.F. voltage induced across it by La will be 90° out of phase with the current in La.

The phase of the voltage across Lb on the other hand depends largely on the incoming I.F. signal frequency as Lb is part of a resonant circuit. If we assume a signal is coming in at exactly the resonant frequency of Lb and C31, the voltage across Lb will be in phase with the current in La. (It could also be 180° out of phase depending on the winding polarity. In either case the same explanation holds good).

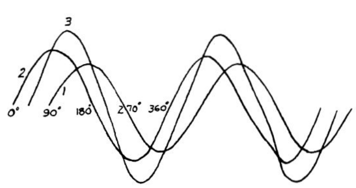
Thus we have two voltages across Lc and Lb acting in series to cause current through D1 and the resistors R18 and R20. These two voltages are 90° out of phase. Consider what this means by referring to Fig. B.



Here is a case where two voltages 1 and 2 are in phase. The resultant voltage (3) is the sum of the two.



Here is a case where two voltages 1 and 2 are 180° out of phase. The resultant voltage 3 is the difference of the two.



Here is a case where two voltages 1 and 2 are 90° out of phase. The resultant voltage 3 is greater than either 1 or 2, but less than the sum of 1 and 2.

FIG B

This means that when two different AC voltages of the same frequency are in series, the resulting voltage depends on the phase difference between them. The greatest resultant occurs when they are in phase. The least resultant when they are 180° out of phase. If we start with two voltages 90° out of phase, we will have a certain resultant normal voltage, which we can call N. If now one voltage can be varied in phase, the resultant voltage will increase when the two voltages are less than 90° out of phase, and decrease when they are more than 90° out of phase.

This is exactly what happens when an FM signal reaches the circuit of Fig. A.

An FM signal is one whose frequency is varying. When the FM signal is at the center value, the voltages induced across Lb and Lc are 90° out of phase, and we can express the resultant normal voltage as having a value N. When the signal is modulated to a lower frequency, the tuned circuit Lb C31 behaves more like an inductance and the voltage across Lb is more nearly in phase with the voltage across Lc. The resultant is greater than N. When the signal is modulated to a higher frequency, the tuned circuit behaves more like a condenser and the voltage across Lb is more than 90° out of phase with the voltage across Lc. The resultant is less than N.

The overall effect of a signal that is frequency modulated at an audio rate is to produce a resultant voltage, acting on the rectifier and resistors, that is varying in accordance with the audio modulation. These two out of phase voltages convert the frequency modulation to an amplitude modulation and an audio voltage is produced across the resistors. Detection, therefore, takes place in the usual way.

While this circuit is an FM detector, it is not used in this form because it is obviously also susceptable to AM signals including the usual kinds of interference inherent in AM reception.

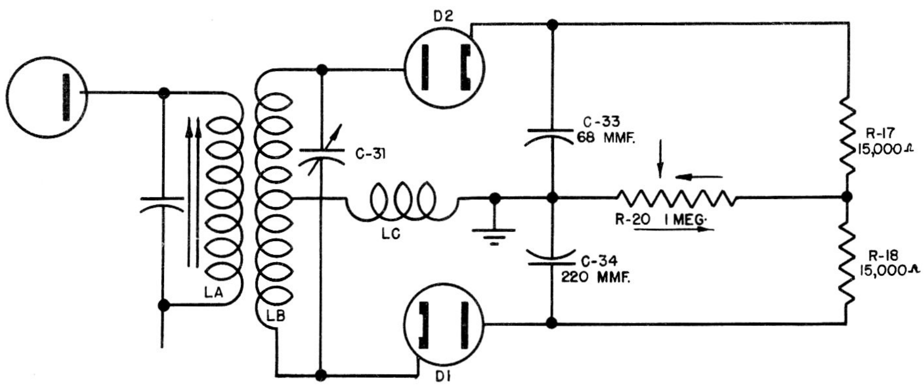


FIGURE "C"

Now consider the circuit of Fig. C with the added diode D2 and resistor R17. Let an unmodulated signal at center frequency be applied. We already know that the induced voltage in the lower half of Lb in series with the induced voltage in Lc will be 90° out of phase and will have a resultant voltage N acting on the diode D1 and resistor. Due to the polarity of the rectifier D1, this will tend to drive current through R20 in the direction of the lower arrow. Similarly, the voltage across the upper half of Lb will be 90° out of phase with the voltage across Lc and a similar resultant voltage to N will act through D2 and R17 to force current through R20. This time however the polarity of the rectifier is such that the force is exerted in the direction of the upper arrow. These two resultant voltages therefore cancel each other and no current flows through R20.

Next let the signal be modulated to a lower frequency. We already know that this will bring the induced voltage across the lower half of Lb and Lc more nearly in phase and <u>will increase</u> the resultant voltage trying to make current flow in the direction of the lower arrow. But the voltage induced in Lc is trying to make current flow up through the upper half of Lb when it is acting down through the lower half of Lb. Thus when the voltage across Lc goes further in phase with the voltage across the lower half of Lb, it is going further out of phase with the voltage across the upper half and <u>reduces</u> the net voltage trying to cause current to flow in the direction of the upper arrow.

With the force in the direction of lower arrow increased and the opposing force decreased, it is obvious that an increase in frequency causes current to flow through R20 in the direction of the lower arrow. By similar reasoning A DECREASE in frequency causes current through R20 in the opposite direction. If the frequency deviation or modulation is at an audio rate an A.F. voltage will be developed across R20 aided by the capacitors C33 and C34 and FM detection is accomplished.

If the frequency does not vary, no voltage is developed across R20 hence anv AM signal or normal electrical interferences are rejected.

This is strictly true at resonance only. A.M. rejection away from resonance is accomplished as a more complicated function of the various component values especially the value of R17 and R18.

It will be noted that the actual schematic includes several other components, C32 is a 4 mfd. capacitor across R17 and R18. This permits the D.C. voltage across R17 to be used for A.V.C. purposes.

Several interesting points in connection with this circuit are -

(1) In the actual schematic the load on the I.F. transformer is substantially that of the 2 diodes in series with the 2 resistors R17 and R18. In the circuit of Fig. A the transformer load is a much higher resistance and if one diode of an actual set became inoperative the volume might increase but with an inability to reject AM or electrical interference.

(2) If either C33 and C34 were removed F.M. Detection would still occur but AM rejection would be impaired.

(3) Some FM detection will still occur if the 4 mfd. capacitor is shorted but the circuit balance which results in AM rejection is upset.

(4) The actual circuit also includes two loading resistors these are intended to help balance the circuit insofar as AM rejection is concerned.

Two methods of alignment are presented in the following pages. Alignment should not be touched unnecessarily. The usual symptom of misalignment is not lack of sensitivity but poor tone quality particularly on loud passages.

The first method, using an F.M. Signal Generator is the one used at the factory. The second method outlined, uses more conventional equipment (A.M. Signal Generator) and requires extreme care and some patience.

F.M. Converter Alignment - using frequency modulated signal generators.

Equipment Required - 1 - an F.M. Generator capable of

(1) signal output on 10.7 mcs and on the 88 - 108 mcs range variable up to .1 volt. With sweep voltage output, variable with deviation, for oscilloscope.

(2) frequency deviation variable up to 150 kcs.

(3) simultaneous modulation by both amplitude and frequency methods, the modulating frequencies being in the ratio of approximately 7 to 1, e.g. 400 cycle F.M. and 3000 A.M. This is used for operation 2 only.

2 - an oscilloscope with external horizontal sweep connection and vertical and horizontal amplifier of the usual sensitivity.

3 - a .01 mfd. capacitor used as blocking capacitor for I.F. alignment connected in series with the high side of the signal generator output.

4 - a 68 ohm 1/2 watt non-inductive resistor used as dummy antenna for R.F. Alignment.

5 - a special R.F. probe with the circuit shown in Fig. 1 used between the oscilloscope vertical connections and the Point #1 detailed in the alignment procedure.

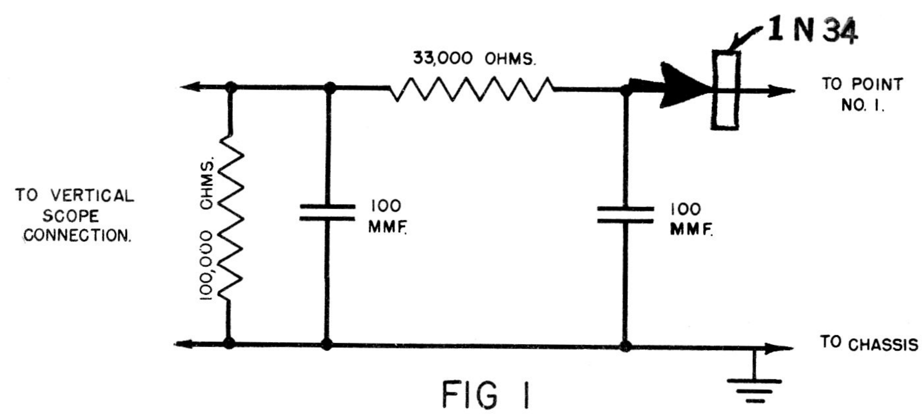


FIG 1

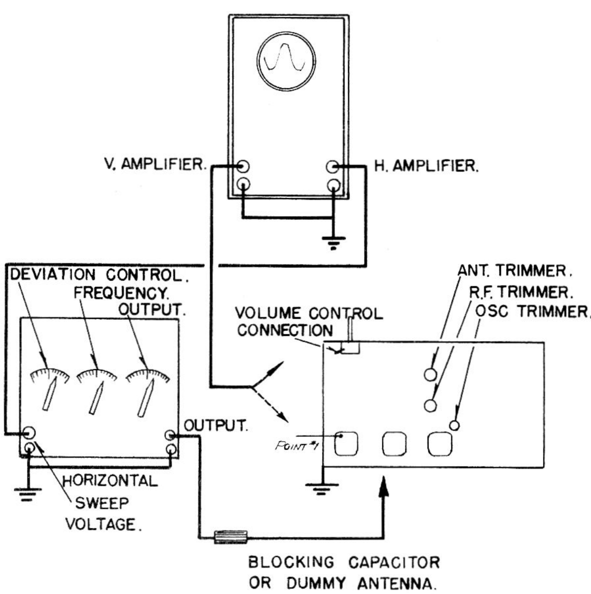
6 - any standard output meter for operations 8, 9, and 10.

7 - 2700 Ω non-inductive resistor 1/2 watt for loading in operations 3, 4, 5, and 6.

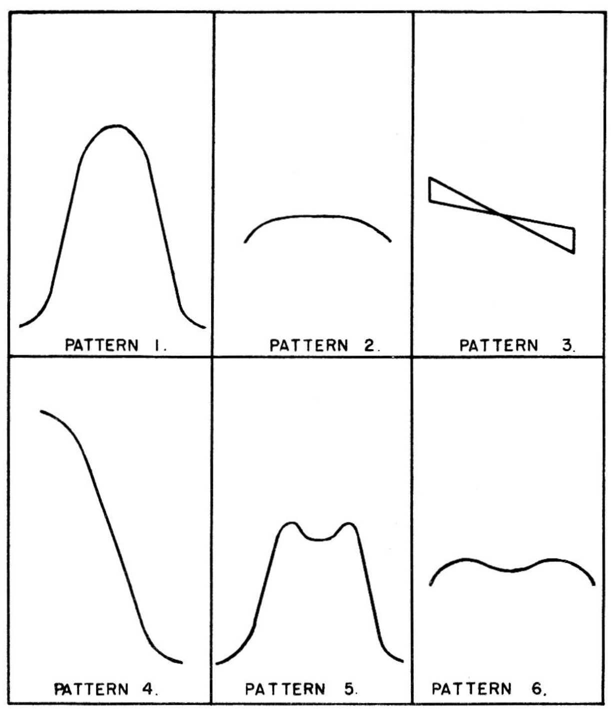
I.F. and Detector Alignment - using F.M. generator set at 10.7 megacycles

Oper.	Alignment	Signal Input	Deviation in Kcs.	Input Connection	Scope Connection	Other Conditions	Adjustment	Patterns
1A	Detector Primary	0.1 volt	150 Kc.	2nd. I.F. Grid	Through probe to Point #1	Secondary Shorted	Top Core for Max. Height and Symmetry	#1
B	Detector Primary	0.1 volt	22.5 Kc.	2nd. I.F. Grid	Through probe to Point #1	Secondary Shorted	Top Core for Max. Height and Symmetry	#2
2	Detector Secondary	0.1 volt	22.5 Kc.F.M. 400 cycle 30% A.M.	2nd. I.F. Grid	To Volume Control	Secondary Short Removed	Secondary Trimmer C21 for Symmetry	#3
3	2nd. I.F. Primary	0.1 volt	150 Kc.	1st. I.F. Grid	Through probe to Point #1	2700 ohms across Detector Primary 2nd. I.F. Bottom Core turned completely in	Top Core for Max. Height and Symmetry	#1
4A	2nd. I.F. Secondary	Approx. 3200 Microvolts	150 Kc.	1st. I.F. Grid	Through probe to Point #1	2700 ohms across Detector Primary	Bottom Core	#5
4B	2nd. I.F. Secondary	Approx. 3200 Microvolts	75 Kc.	1st. I.F. Grid	Through probe to Point #1	2700 ohms across Detector Primary	Top and Bottom Cores Simultaneously	#6
5	1st. I.F. Primary	Approx. 3200 Microvolts	150 Kc.	Mixer Grid	Through probe to Point #1	2700 ohms across Detector Primary 1st. I.F. Bottom Core turned completely in	Top Core for Max. Height of Symmetry	#1
6A	1st. I.F. Secondary	Approx. 3200 Microvolts	150 Kc.	Mixer Grid	Through probe to Point #1	2700 ohms across Detector Primary	Bottom Core	#5
6B	1st. I.F. Pri. & Sec.	Approx. 3200 Microvolts	75 Kc.	Mixer Grid	Through probe to Point #1	2700 ohms across Detector Primary	Top and Bottom Cores Simultaneously	#6
7	2nd. I.F. Secondary	Approx. 3200 Microvolts	As necessary for Pattern	Mixer Grid	Volume Control	Remove Resistor	Bottom Core	#4

Note:- Point #1 used for Probe Connection is the dummy terminal on the 3rd. I.F. Transformer



EQUIPMENT CONNECTIONS.



F.M. CONVERTER ALIGNMENT PATTERNS.

Oscillator and R.F. Alignment - Deviation set at zero and A.M. turned "off"

Operation	Frequency	Alignment	Adjust
8	108 mc.	Osc. Coverage	Osc. Trimmer C6 - for Max. output on output meter
	88 mc.	Osc. Coverage	Osc. Coil Turn Spacing for Max. output on output meter
	108 mc.	Osc. Coverage	Readjust Osc. Trimmer for Max. output on output meter
9	108 mc.	R.F. Alignment	R.F. Trimmer C4 - for max. output on output meter
	88 mc.	R.F. Alignment	R.F. Coil Turn Spacing for max. output on output meter
	108 mc.	R.F. Alignment	Readjust R.F. Trimmer for max. output on output meter
10	108 mc.	Ant. Alignment	Ant. Trimmer C2 - for max. output on output meter
	88 mc.	Ant. Alignment	Ant. Coil Turn Spacing for max. output on output meter
	108 mc.	Ant. Alignment	Readjust R.F. Trimmer for max. output on output meter

Note:- It will be necessary to rock the tuning capacitor while adjusting trimmers for maximum output.

F.M. Converter Alignment - using a standard amplitude modulated signal generator.

Equipment Required - a standard A.M. signal generator capable of signal output on 10.7 mcs. and on the 88 - 108 mc. Range

- a 20,000 ohm/volt D.C. voltmeter used on the 10 or 50 volt range. This meter is connected across the 4 mfd. capacitor C32 and used as an indication of maximum output for operations 2 to 9 inclusive.
- a .01 mfd. capacitor used as blocking capacitor for I.F. alignment connected in series with the high side of the signal generator output.
- a 68 ohm 1/2 watt non inductive carbon resistor used as dummy antenna for R.F. Alignment.
- a 4700 ohm 1/2 watt carbon resistor connected in series with a .1 mfd. capacitor. This network is used as a load for the I.F. transformer under alignment and is connected with the capacitor at the chassis end.

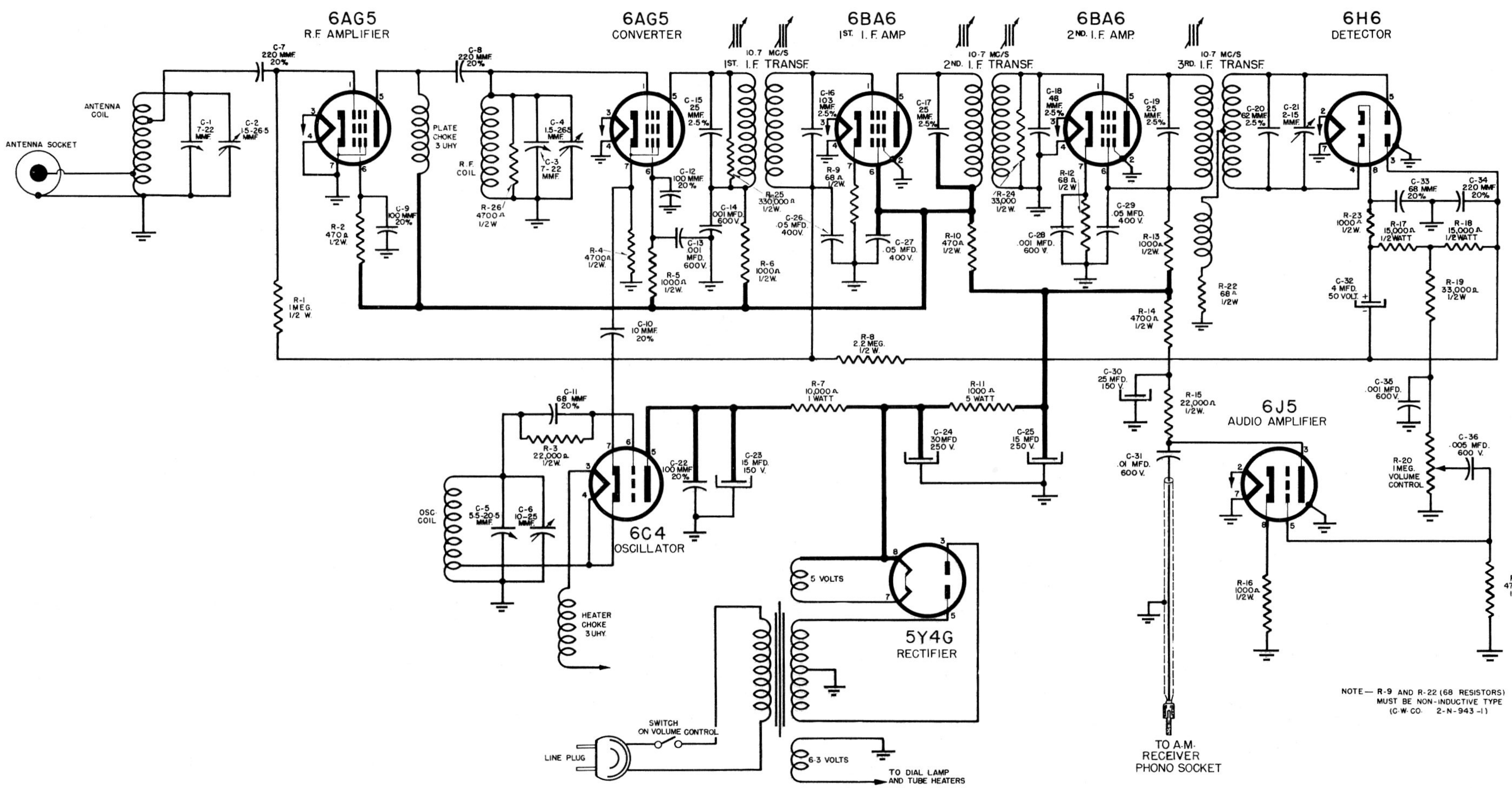
I.F. AND DETECTOR ALIGNMENT/USING A.M. GENERATOR

Oper.	Apply Signal To	Position of Loading Network	Adjust
1	2nd. I.F. Grid	-	C21 for Minimum Speaker Output
2	1st. I.F. Grid	Plate of 1st. I.F. to Chassis	Bottom Core of 2nd. I.F. Trans.-Max. Reading on Meter
3	1st. I.F. Grid	Grid of 2nd. I.F. to Chassis	Top Core of 2nd. I.F. Trans.-Max. Meter Reading
4	1st. I.F. Grid	-	Top Core of 3rd. I.F. Trans.-Max. Meter Reading
5	1st. I.F. Grid	-	Recheck (1) for Minimum Fundemental Frequency Audio Output
6	Converter Grid	Plate of Converter to Chassis	Bottom Core of 1st. I.F. Trans.-Max. Reading
7	Converter Grid	Grid of 1st. I.F. to Chassis Remove Loading Network	Top Core of 1st. I.F. Trans.-Max. Reading

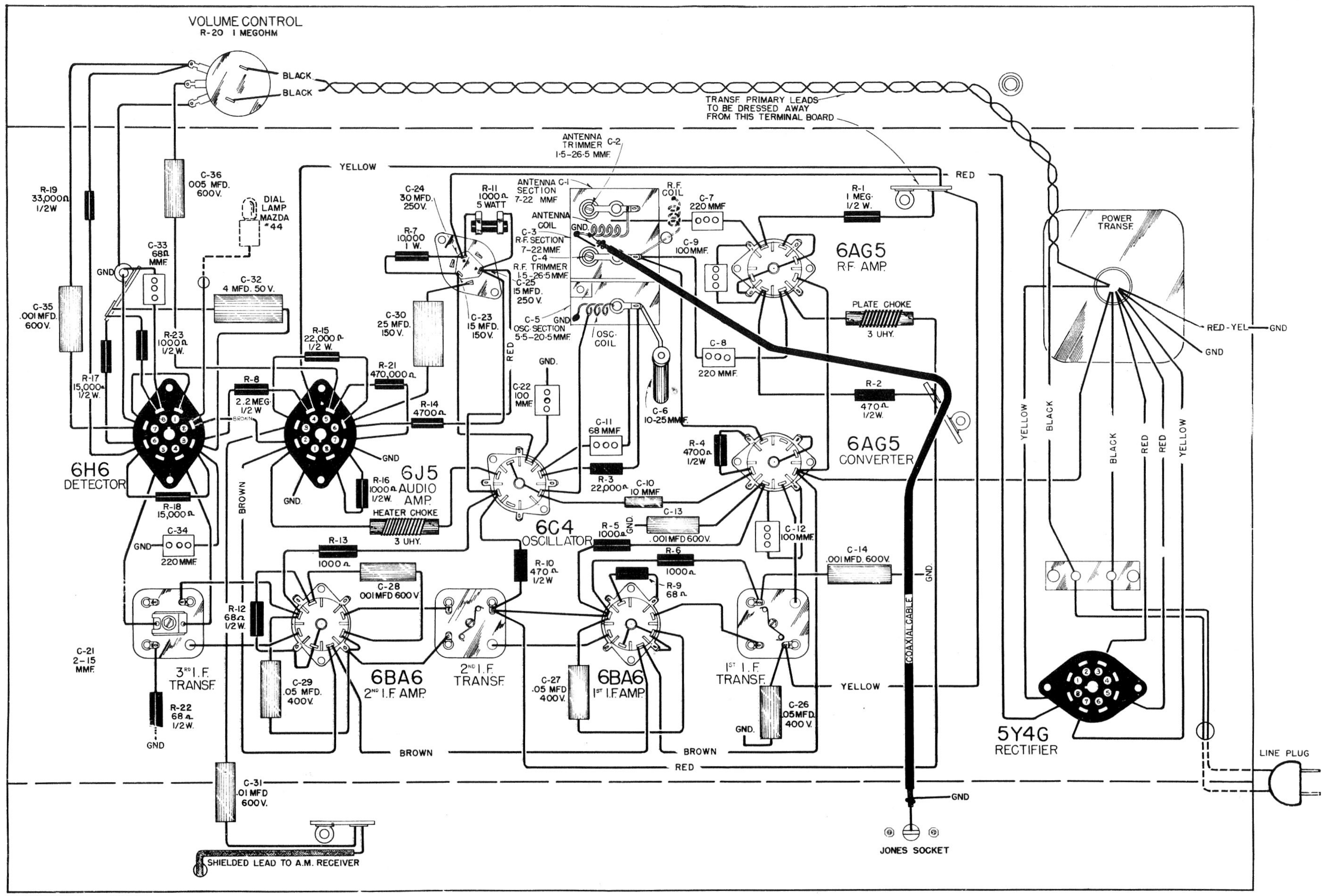
OSCILLATOR AND R.F. ALIGNMENT - APPLY SIGNAL TO ANTENNA POST THROUGH 68 OHM DUMMY ANTENNA

Operation	Frequency	Align	Adjust
1	108	Osc. Coverage	Osc. Trimmer C6 for Max. Meter Reading
2	88	Osc. Coverage	Osc. Coil Turn Spacing for Max. Meter Reading
3	108	Osc. Coverage	Recheck C6
4	108	R.F. Alignment	R.F. Trimmer C4 for Max. Meter Reading
5	88	R.F. Alignment	R.F. Coil Turn Spacing for Max. Meter Reading
6	108	R.F. Alignment	Recheck C4
7	108	Antenna Alignment	Ant. Trimmer C2 for Max. Meter Reading
8	88	Antenna Alignment	Ant. Coil Turn Spacing for Max. Meter Reading
9	108	Antenna Alignment	Recheck C2

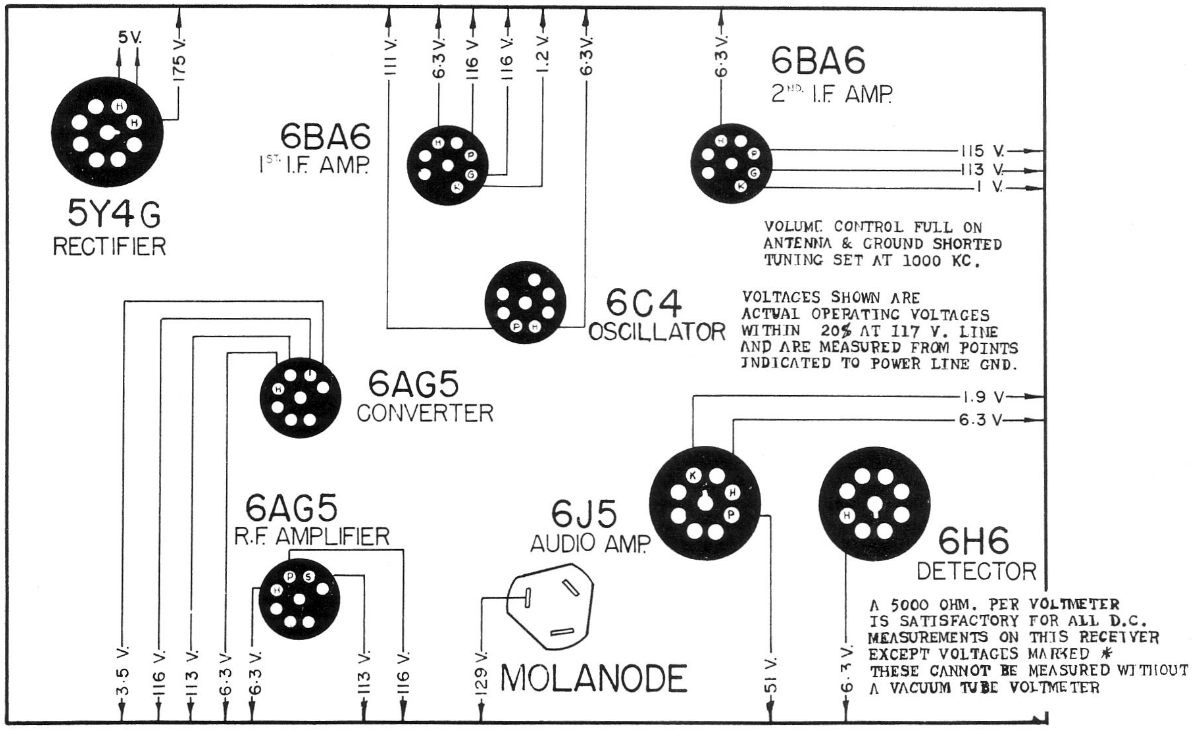
Note:- It will be necessary to rock the tuning capacitor while adjusting trimmers for maximum output.



F.M. 894 SCHEMATIC DIAGRAM



MODEL FM-894 PICTURE DIAGRAM



SOCKET READINGS

GENUINE CANADIAN WESTINGHOUSE PARTS

PART		DESCRIPTION	KEY NO.	PART NO.	LIST
ANTENNA	-	Stratovision Antenna less Jones Plug.....		2-N-940-1	9.00
CABINET	-	Walnut..................................		1-K-112-1	16.50
CABLE	-	Coaxial Amphenol RG-58/U 6" lg...........			.30
CAPACITOR	-	Molanode................................	C23,C24, & C25	572083-14	2.00
CAPACITOR	-	Variable complete with drum.............	C1,C2,C3,C4, & C5	3-M-533-1	4.75
CAPACITOR	-	Moulded 10 Mmf..........................	C10	2-N-666-1	.20
COIL	-	R. F. Coil (Ant.).......................		3-M-911-3	.90
COIL	-	R. F. Coil (R.F.).......................		3-M-911-2	.90
COIL	-	R. F. Coil (Osc.).......................		3-M-911-1	.90
COIL	-	R. F. Choke.............................		2-N-732-501	.90
CONTROL	-	Volume complete with switch.............	R20	2-M-233-8	1.30
DIAL	-	Glass Scale.............................		3-M-665-1	1.20
KNOB	-	Brown Plastic...........................		95055-1	.25
LINE	-	Transmission 75 ft. lg..................			3.00
PLUG	-	Jones Antenna...........................		2-N-657-3	1.70
PLUG	-	Phono...................................		1-N-91-3	.12
POINTER	-	White...................................		2-N-18-2	.55
RESISTOR	-	68 ohm 1/2 watt.........................	R9,R12, & R22	2-N-943-1	.15
RESISTOR	-	Wirebound 1000 ohm......................	R11	1-N-733-5	.48
SOCKET	-	Tube....................................		2-N-318-1	.25
SOCKET	-	Tube Bakelite Miniature.................		2-N-654-1	.18
SOCKET	-	Tube Mica Miniature.....................		2-N-654-2	.20
SOCKET	-	Jones Antenna...........................		2-N-657-1	1.90
SPRING	-	To fit knob - 95055-1........(Pkg. of 5).		K-82890	.15
TRANSFORMER	-	Power 25 cycle & 60 cycle...............		571207-43	5.50
TRANSFORMER	-	1st. I. F...............................		3-M-666-501	2.90
TRANSFORMER	-	2nd. I. F...............................		3-M-667-501	2.90
TRANSFORMER	-	3rd. I. F...............................		3-M-664-501	3.00
TRIMMER	-	Corning Glass...........................	C6	2-N-665-501	1.10

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