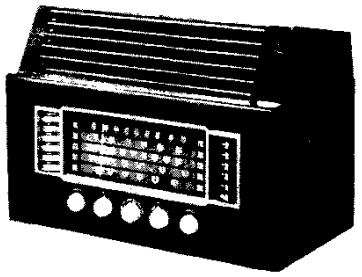
General Electric Co.

Model: X-415	Chassis:	Year: Pre 1950
Power:	Circuit:	IF:
Tubes:		
Bands:		

Resources

- Riders Volume 18 - GE 18-4
- Riders Volume 18 - GE 18-5
- Riders Volume 18 - GE 18-6
- Riders Volume 18 - GE 18-7
- Riders Volume 18 - GE 18-8
- Riders Volume 18 - GE 18-9
- Riders Volume 18 - GE 18-10
- Riders Volume 18 - GE 18-11
- Riders Volume 18 - GE 18-12

MODEL X-415 GENERAL ELECTRIC CO.



SPECIFICATIONS

CABINET:

Model	X415
Material	Wood
Color	Mahogany
Height	14½ in.
Width	20 in.
Depth	12⅛ in.

ELECTRICAL RATING (INPUT):

50–60 Cycles Nominal Voltage	105 Watts Range in Volts
110	103–117
125	117–133
150	140–160
200	185–213
225	213–234
245	234–260

OPERATING FREQUENCIES:

Standard Band	540 to 1600 kc
Short Wave 1	9.4 to 9.9 mc
Short Wave 2	11.6 to 12.1 mc
Frequency Modulation 1	42 to 50 mc
Frequency Modulation 2	88 to 108 mc
AM I-F Frequency	455 kc
FM I-F Frequency	10.7 mc

POWER OUTPUT (117 volts line):

Undistorted	4.0 watts
Maximum	5.5 watts

LOUDSPEAKER:

Type	Alnico PM
Size	8 inches
Voice Coil Impedance (400 cps)	3.5 ohms

ANTENNA INPUTS:

Broadcast and Shortwave—conventional antenna
FM—300-ohm input for folded dipole

TUBE COMPLEMENT:

R-F Amplifier	6AK5
Converter	6AK5
Oscillator	6AK5
1st I-F Amplifier	6SG7
2nd I-F Amplifier	6SV7
FM Limiter—AM Detector	6SH7
Discriminator—1st A-F Amplifier	6AQ7-GT
Power Amplifier	6V6GT
Rectifier	5Y3GT
Dial Lamp (2)	G-E No. 44

GENERAL INFORMATION

THE TUNING SYSTEM

The "r-f end" of the receiver is unusual in a number of respects. Variable inductance tuning is employed instead of using a conventional tuning capacitor. This design makes possible two distinct advantages. First, it provides a high efficiency FM circuit in the 88 to 108 megacycle range which would not be possible with the more conventional methods of tuning. Second, it provides stable short-wave spread-bands which tune as easily as the broadcast band. Other advantages are also obtained but the two mentioned above are the most important.

Tuning is accomplished by an "elevator" which consists of a rigid plastic horizontal plate raised and lowered by means of a windlass controlled by the tuning knob at the panel. From this plate are suspended three powdered iron cores which tune the broadcast r-f, converter, and oscillator coils; and three tuning "vanes" which tune three low-inductance circuits. These latter circuits are employed in both FM bands and both short wave bands, with the exception of the antenna circuit for the shortwave spread bands when a broad tuned antenna coil is used and the r-f guillotine tuner is switched out. They are called "guillotine" tuners because of their appearance.

FACTS ABOUT "GUILLOTINE" TUNING

The "guillotine" tuners are designed primarily for the 88–108 megacycle FM band where special technique is needed to realize high gain and circuit stability. Ordinary coils, tuned by a variable capacitor are inefficient at these frequencies, first, because of the low inductances required to reach these frequencies when a variable tuning capacitor is employed and, second, because shunt capacity reduces the gain of the amplifier circuit; shunt capacity must be kept very low. Another disadvantage of standard tuning arrangements at these frequencies is that common coupling is obtained through the shaft of a ganged tuning capacitor unless insulated single sections are used (cumbersome and costly). Common coupling of this type tends to cause oscillation or general instability and precludes high gain per stage. The guillotines make possible short leads, completely isolated sections, stable tuning, high Q circuits, low shunt capacity, and location of each tuner in the best physical and electrical position in the assembly. Furthermore, since the shunt capacity is small and the inductance is consequently at its highest corresponding value, the additional unavoidable inductance introduced in the wiring, bandswitch, etc., produces a minimum of circuit losses and unbalance.

The guillotine tuner consists of a heavy, silver-plated, two-turn square coil, rigidly supported between two plastic posts. A flat, solid vane slides up and down between the two turns. It is guided in grooves in the plastic posts so that it passes between the two sections of the coil without touching them. The posts are so moulded and the coil so constructed that the whole assembly is held rigidly at a predetermined spacing. The tuning vane is raised and lowered by the tuning elevator. When the elevator is all the way up (set tuned to lowest frequency), the vane is completely above the coil which then acts as a simple two-turn coil. As the set is tuned toward the higher frequencies, the vane moves downward into the field of the coil until, finally, it is all the way in. The vane reduces the inductance of the coil through two principles. First, it acts as a shorted turn, and thus reduces inductance directly; second, it provides a barrier between the two turns of the coil which reduces the mutual coupling and thus also reduces inductance.

The tuners described above are identified as T2, T4, and T5, on the schematic diagram.

FM BANDS

Guillotine tuners T2, T5, and T4 are used as the tuned circuits for the r-f amplifier, converter, and local oscillator respectively, in both FM bands. In the higher frequency band, the tuner is used with only a small shunt trimmer for adjusting distributed capacity. In the lower band, a higher value shunt trimmer is used to reduce the frequency. The layout of band switch, tuners, and tube sockets is arranged to give the shortest possible leads when the FM bands are in use. The lead length in the other bands is not nearly so critical.

SHORT WAVE SPREAD-BANDS

Bandspread tuning in the short wave bands is obtained in the converter and oscillator circuits by inserting the guillotine tuners in series with a higher inductance so that the two inductances together form the "L" part of the short wave tuned circuit. The small percentage change in inductance obtained in the tuner provides smooth, wide, and stable tuning. The "C" part of the tuned circuit consists primarily of a shunt trimmer. Switching from one short wave band to the other is accomplished by selecting a different shunt trimmer.

The converter grid circuit, as an example, includes L7 and T5 in series in both the SW1 and SW2 bands. Tuner T5 is in the ground end of the circuit and the signal is fed into the grid end through C10. The shunt tuning capacity is either C56 or C57, depending upon which of the two short wave bands is used. Additional oscillator coupling capacitors, C72 or C73, are also added to compensate for the lower coupling through C67 when the higher shunt capacitors are in the circuit.

In the r-f stage, a section of the antenna tracking coil is used as the grid circuit. It is tuned for resonance by a shunt capacitor (C54 and C55) and a shunt inductance (L20). Because a tuned circuit of this type is inherently broad, tuning through the relatively narrow spread-band offers little advantage and is not done.

STANDARD BROADCAST BAND

When manual tuning is employed (Band Switch in STD position), the receiver employs an r-f stage, a converter, and an oscillator, all of which are tuned by iron slugs suspended from the tuning elevator. In the automatic position (Band Switch in the AUTO position), the r-f stage is not used. Instead, a separate antenna coil is used which couples the antenna directly into the converter. A separate coil is used in order to make the tuning circuit independent of the dial tuning mechanism so that it may be tuned by trimmers in the push-button assembly.

Switching from manual to automatic tuning is accomplished in the oscillator by using an oscillator coil which is tuned by a separate shunt inductance. In manual tuning, the inductance is one which is tuned by the tuning elevator. In automatic tuning, a fixed shunt capacity (C76) plus one of a series of push-button selected coils tunes the oscillator.

I-F AMPLIFIER

The i-f amplifier consists of a composite 455 kc and 10.7 mc circuit. The electrical changes required to transfer between AM and FM service are made by the Band Switch. When the switch is in either the FM1 or FM2 position, the amplifier operates at 10.7 megacycles and delivers the i-f signal into an FM discriminator circuit. When the switch is in any of the other positions, the amplifier operates at 455 kc. Screen voltage is removed from the tube which acted as an FM limiter and this tube then acts as an AM diode detector. Thus, the AM audio signal appears across R16 while the FM audio signal appears across R22. A section of the Band Switch switches the audio input circuit from one to the other. The AVC bus is also shorted out for FM.

STAGE GAIN AND VOLTAGE CHECKS

Stage gain measurements by vacuum tube voltmeter or similar measuring devices may be used to check circuit performance and isolate trouble. The gain values listed may have tolerances of 20%. Readings taken with low signal so that AVC is not effective.

(f) *R-F and I-F Stage Gains*

Signal applied through IRE dummy antenna:

Antenna post to V1 grid	4	@	1000 kc
Antenna post to V1 grid	2	@	9.6 mc
Antenna post to V1 grid	2	@	11.8 mc

Signal applied through 300-ohms, including signal generator impedance:

Dipole terminals to V1 grid	1.5	@	45 mc
Dipole terminals to V1 grid	2	@	98 mc

These checks with oscillator tube (V3) removed:

V1 grid to V2 grid	13	@	1000 kc
V1 grid to V2 grid	6	@	9.6 mc
V1 grid to V2 grid	9	@	11.8 mc
V1 grid to V2 grid	13	@	45 mc
V1 grid to V2 grid	10	@	98 mc

These checks with oscillator tube (V3) removed:

V2 grid to V4 grid	23	@	455 kc
V2 grid to V4 grid	37	@	10.7 mc
V4 grid to V5 grid	23	@	455 kc
V4 grid to V5 grid	58	@	10.7 mc
V5 grid to V6 grid	40	@	455 kc
V5 grid to V6 grid	17	@	10.7 mc

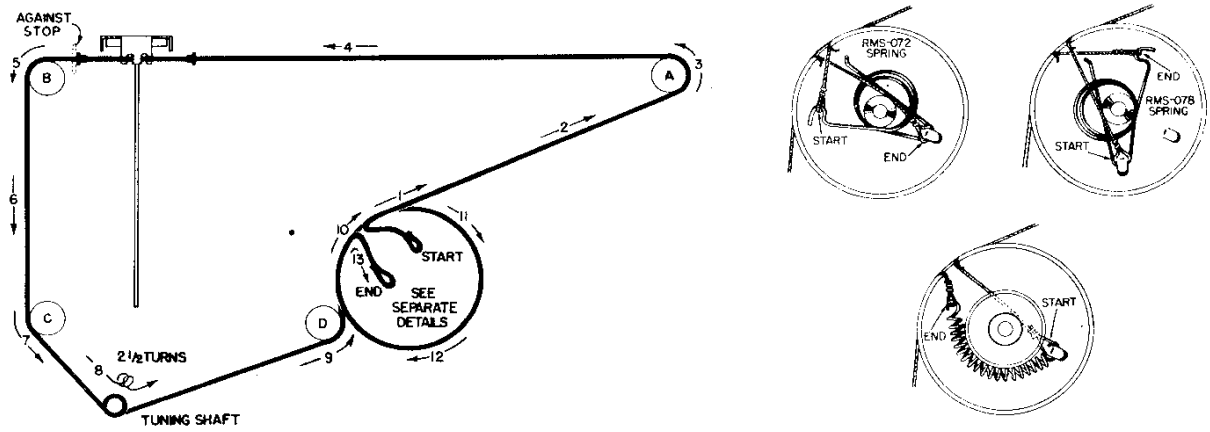


Figure 1—Dial Stringing Diagram Showing Spring Details at Right

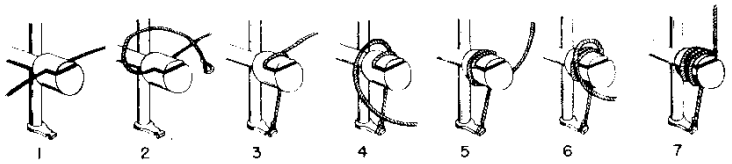


Figure 2—Elevator Windlass Stringing Procedure

(2) *Audio Gain*

.07 volts at 400 cps across volume control with control set at maximum will give approximately ½ watt output across the speaker voice coil.

(3) *Oscillator Grid Bias*

D-c voltage developed across R5 (average):

13 v. @ 1000 kc 2.7 v. @ 11.8 mc
2.7 v. @ 9.6 mc 5.5 v @ 45 mc
7 v. @ 98 mc

(4) *Socket Pin Voltages*

Fig. 8 shows typical tube pin voltages. All readings should be made from the pins to ground unless otherwise indicated.

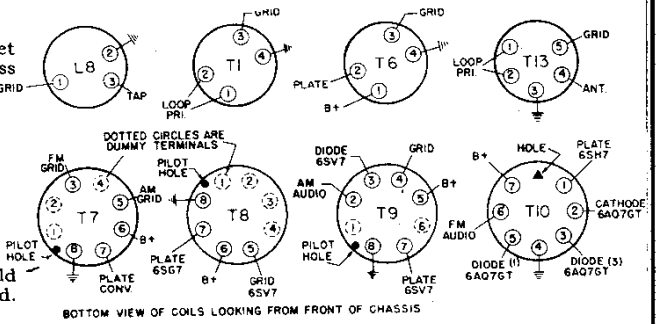


Figure 3—Terminal Identification of Coil Assemblies (Numbers correspond with schematic

REPLACEMENT OF DRIVE CORDS

Dial Stringing

Push the tuning elevator all the way down and string the dial as shown in Figure 1. This illustration shows the stringing as viewed from behind the dial scale, as you would see it when working on it. The number and arrows indicate the progression of the dial cord from start to finish. The procedure will be easier if pulley C is by-passed until the rest of the work is finished after which the cord can be pulled tight over that pulley. During the procedure, locate the two brass eyelets so that they fall between pulleys A and B. When finished, crimp the eyelets on the cord in the proper positions to act as minimum and maximum stops for the tuning mechanism and clip the pointer on the cable half-way between the eyelets.

Separate detail drawings are given to show the three different methods of attaching the ends of the cord. The arrangement with the standard helical spring was used in some earlier production receivers. If the cord and spring are to be replaced, the Type 1 spring should be used. It fits the same drum and is an improved type. The Type 2 spring should be used with the later type of drum (with two tabs). When stringing the mechanism with either the Type 1 or Type 2 spring, load the spring by pulling the hook over the projection at the other end of the spring, string the dial and, as a final step, release the hook so that it pulls up the slack in the dial cord.

Elevator Stringing

The step-by-step procedure for stringing the elevator windlass is shown in Figure 2. (The view is from the rear of the mechanism.) This is done with the elevator up. Start by inserting the metallic cord in the slot as shown in 1. Then loop the left-hand free end over (2) and solder it to the lug provided at the bottom of the vertical shaft (3). The other free end is then given two turns around the pulley, first on one side of the first half turn (4-5) and then on the other side (6-7). In making these two loops, the free end of the cord passes on *this* side of the end which is already secured. Similarly, in view 2, the end which is to be secured to the bottom of the shaft, passes on *this* side of the right-hand free end of the cord. Observe these relationships. Finally, after completing the seven steps shown, pull the upper end of the cord through the hole in the top of the elevator mechanism and solder it to the spring provided.

Concluding Comments

After replacing the dial cord or the elevator cord, it may be found that some correction in relative positioning is needed. This can be done by loosening the set screws in the large drive pulley directly behind the dial scale and re-positioning it on the shaft. The object, of course, is to permit the tuning control to drive the elevator through its full tuning range. Slight errors in final setting are not serious since leeway is provided in the location of the dial pointer itself.

WIRING OF BAND SWITCH

In order to facilitate repair, replacement, and circuit tracing, a table and diagrams are supplied with reference to the connections made in the band switch. If used properly, these will be of invaluable aid. The remarks which follow are intended to clarify the make-up of the tables and diagrams—read them carefully before using the table.

The table is broken down into six parts, one for each switch wafer. Section 1 is nearest the front and section 6 is the rearmost wafer.

Individual lugs on each wafer are numbered from 1 to 12, depending upon their position on the wafer. The method of numbering is illustrated in Fig. 5. In determining the number, turn the chassis upside down and look from the front toward the rear of the chassis. Thus, lugs 1 and 12 are the ones which are at the bottom when the set is in its normal position; lugs 3 and 4 are on the side with the broadcast band coils; and lugs 9 and 10 are on the side with the 6AK5 tubes. The numbering refers to lugs whether they be on the front or rear of the wafer.

Fig. 4 shows the physical location of various components and terminals to which reference is made in the table.

In those cases where a component symbol number is given in column two, instead of a wire, that component is connected by its own lead wire directly to the switch lug and the connection of the *other* end of the component is given in the last column.

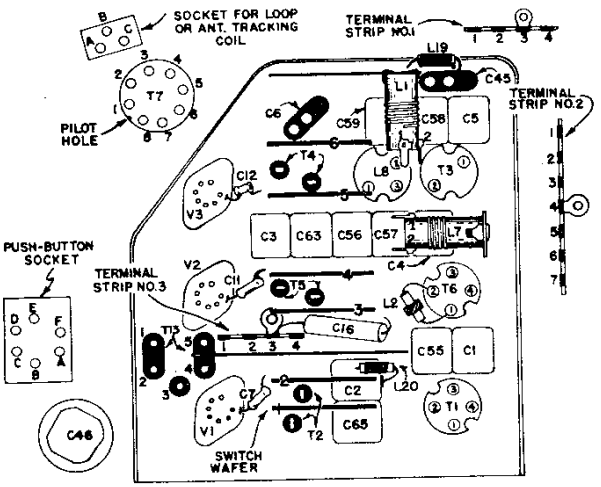


Figure 4—Physical Location of Components Listed in Band Switch Wiring Table

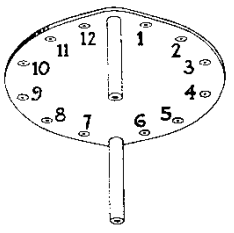


Figure 5—Identification of Switch Lugs —Set Inverted and Viewed from Panel

WIRING OF BAND SWITCH

(Wire length given from end to end before stripping)

SECTION 1

At this lug—	—connect this—	—the other end of which is connected to this—
1	Insulated wire, 5" lg.	Antenna transformer T13, terminal 4
2	a. Insulated wire, 11½" lg. b. Insulated wire, 2" lg. c. Capacitor C50	Antenna terminal at rear of chassis Switch section 1, lug 6 Switch section 2, lug 1
3	Capacitor C52	Switch section 2, lug 3
4	a. Insulated wire, 1¼" lg. b. Insulated wire, 14" lg. c. Insulated wire, 5½" lg.	Antenna transformer T1, terminal 1 Antenna tracking coil, terminal A Antenna transformer T13, terminal 2
5	a. Short bare bus b. Resistor R15	Ground lug on C65 Switch section 1, lug 11
6	See lug 2b, above	
7	Insulated wire, 11" lg.	Terminal strip 1, lug 4
8	Capacitor C31	Front terminal of T2
9	a. Insulated wire, 9" lg. b. Insulated wire, 7" lg.	Terminal strip 2, lug 5 Filter capacitor, C46C
11	See lug 5b, above	

SECTION 2

At this lug	—connect this—	—the other end of which is connected to this—
1	See section 1, lug 2c	
3	a. Insulated wire, 2½" lg. b. See section 1, lug 3	Trimmer C1, lug nearer T1
4	Insulated wire, 1½" lg.	Trimmer C55, lug nearer T1
5	Coil L20	Ground lug on trimmer C2
6	Short bare bus	Trimmer C65, left-hand terminal*
7	Short bare bus	Trimmer C2, left-hand terminal*
8	Capacitor C7	Tube socket V1, pin 1
9	Insulated wire, 4" lg.	Antenna transformer T13, terminal 1
10	Insulated wire, 3½" lg.	Antenna transformer T1, terminal 2
11**	Insulated wire, 11½" lg.	Antenna tracking coil, terminal C

SECTION 3

At this lug—	—connect this—	—the other end of which is connected to this—
1	Shielded wire, 8¾" lg.	Terminal strip 2, lug 6
2	Insulated wire, 1½" lg.	Switch section 3, lug 12
3	a. Insulated wire, 2½" lg. b. Capacitor C16 c. Choke L3	Converter coil T6, terminal 1 Ground lug on terminal strip 3 Switch section 3, lug 11
4	Insulated wire, 7½" lg.	Terminal strip 2, lug 3
5	Insulated wire, 1⅜" lg.	Converter coil T6, terminal 2
6	Short bus with spaghetti	Chassis
7	Short bare bus	Terminal strip 3, lug 4
10	Shielded wire, 10½" lg.	Terminal strip 2, lug 2
11	a. See lug 3c, above b. Capacitor C10	Switch section 4, lug 3
12	a. See lug 2, above b. Shielded wire, 7¾" lg.	Push-button socket, Terminal B

SECTION 4

At this lug—	—connect this—	—the other end of which is connected to this—
1	a. Insulated wire, 5½" lg. b. Insulated wire, 7¼" lg.	Antenna transformer T13, terminal 5 Push-button socket, terminal F
2	Insulated wire, 2½" lg.	Trimmer C4, lug nearer T6
3	a. See Section 3, lug 11b b. Short bus with spaghetti c. Short jumper	Coil L7, terminal 2 (toward front) Switch Section 4, lug 4 (adjacent)
4	See lug 3c, directly above	
5**	Short bare bus	Trimmer C63, lug nearer front
6	Capacitor C88	Tuner T5, left-hand terminal*
7	Short bare bus	Tuner T5, left-hand terminal
8	Capacitor C11	Tube socket V2, pin 1
9	a. Capacitor C72 b. Insulated wire, 2½" lg.	Section 5, lug 11 Trimmer C56, front terminal
10	a. Capacitor C73 b. Insulated wire, 2½" lg.	Section 5, lug 12 Trimmer C57, front terminal
12	Bus with spaghetti, 2½" lg.	Coil L7, terminal 1

SECTION 5

At this lug—	—connect this—	—the other end of which is connected to this—
1	a. Bus with spaghetti, 1¾" lg. b. Resistor R33	Coil L1, terminal 1 Section 5, lug 4
2	a. Insulated wire, 3" lg. b. Insulated wire, 1⅜"	Coil L8, terminal 1 Section 6, lug 4
4	See Section 5, lug 1b	
5	Bus with spaghetti, 3" lg.	Coil L1, terminal 2
6	a. Bus with spaghetti, 3" lg. b. Bus with spaghetti, 1½" lg.	Capacitor C45, left-hand terminal* Section 5, lug 10
7**	Short bare bus	Tuner T4, left-hand terminal*
8	Capacitor C12	Tube socket V3, pin 1
9	Insulated wire, 4" lg.	Trimmer C5, lug nearer T3
10	a. See Section 5, lug 6b b. Capacitor C41	Section 6, lug 6
11	a. Insulated wire, 3¾" lg. b. See Section 4, lug 9a	Trimmer C59, lug nearer front
12	a. Insulated wire, 3½" lg. b. See Section 4, lug 10a	Trimmer C58, lug nearer front

SECTION 6

At this lug—	—connect this—	—the other end of which is connected to this—
1	Insulated wire, 4½" lg.	I-F transformer T7, terminal 8
2	Bus with spaghetti, 1½" lg.	Coil L1, terminal 2
4	See Section 5, lug 2b	
5	Insulated wire, 12" lg.	Push-button socket, terminal A
6	a. Bus with spaghetti, 2" lg. b. Capacitor C75 c. See section 5, lug 10b	Trimmer C45, center terminal Ground at C59
7	Short bare bus	Trimmer C6, center terminal
8	Bare bus, 1" lg.	Tube socket V3, pin 7
9	Insulated wire, 2¼" lg.	I-F transformer T7, terminal 5
10	Insulated wire, 2¾" lg.	I-F transformer T7, terminal 3
12	Insulated wire, 3½" lg.	Coil L8, terminal 3

* Looking from front, chassis inverted.
** Double lug (front and rear) soldered together.

MODEL X-415 GENERAL ELECTRIC CO.

ALIGNMENT

EQUIPMENT REQUIRED:

1. Test Oscillator with tone modulation. (See Table.)
2. D-C Voltmeter or Microammeter. (See notes 2 and 3.)
3. A-C Voltmeter, 2-volts. (See note 6.)
4. Insulated hex wrench, ¼", (See steps 1, 10, 13.)
5. .01 MF Paper Capacitor. (See steps 1 to 5.)
6. 400-ohm, ½ watt resistor. (See steps 16 to 21.)
7. 200 mmf. mica capacitor. (See steps 22 to 28.)

Important detailed instructions and references in connection with the alignment table which follows are keyed in by means of column 7, headed "See Note." The notes are included in numerical order after the table. They are important —refer to them carefully.

Step	Signal Generator Frequency	Signal Input Point	Band Switch	Dial Setting	Adjust	See Note	Remarks
				F-M I-F ALIGNMENT			
1	10.7 mc	6SH7 grid thru .01 mf	FM1	.....	C49 for zero**	1, 2	Adjust C49 for *zero* meter reading. Apply 1 volt signal input.
2	See last column	6SH7 grid thru .01 mf	FM1	.....	Signal Generator	1, 2	Detune signal generator to point of *maximum* meter reading.
3	As in step 2	6SG7 grid thru .01 mf	FM1	.....	Peak C48	1, 2	
4	10.7 mc	6SV7 grid thru .01 mf	FM1	.....	Peak C28	1, 3	6AQ7GT tube removed from its socket.
5	10.7 mc	6SG7 grid thru .01 mf	FM1	.....	Peak C26	1, 3	6AQ7GT tube removed from its socket.
6	10.7 mc	Conv. grid directly	FM1	.....	Peak C24 & L10	1, 3, 4	6AQ7GT tube removed from its socket.
				AM I-F ALIGNMENT			
7	455 kc	Conv. grid directly	STD	.....	Peak C86 & C61	5, 6	
8	455 kc	Conv. grid directly	STD	.....	Peak C15 & C23	5, 6	
9	455 kc	Conv. grid directly	STD	.....	Peak C13 & C14	5, 6	
				FM R-F ALIGNMENT			
10	88 mc	DIPOLE terminals	FM2	88 mc—6.8 to 6.9 in.*	Peak C6**	1, 3, 7, 10	Set dial accurately—then adjust C6.
11	98 mc	DIPOLE terminals	FM2	For max. output	Peak C3	1, 3, 8	Tube dial for maximum output, then peak C3 while rocking dial.
12	98 mc	DIPOLE terminals	FM2	Do not change	Peak C2	1, 3	
13	43 mc	DIPOLE terminals	FM1	43 mc—6 to 6.1 in.*	Peak C45**	1, 3, 7	Set dial accurately—then adjust C45.
14	46 mc	DIPOLE terminals	FM1	For max. output	Peak C63	1, 3, 8	Tune dial for maximum output, then peak C63 while rocking dial.
15	46 mc	DIPOLE terminals	FM1	Do not change	Peak C65	1, 3	
				S.W. R-F ALIGNMENT			
16	11.8 mc	Antenna thru 400-ohms	SW2	11.8 mc—4.5 to 4.6 in.*	Peak C58	5, 6, 7, 10	Set dial accurately—then adjust C58.
17	11.8 mc	Antenna thru 400-ohms	SW2	Do not change	Peak C57	5, 6, 8	Peak C57 while rocking dial.
18	11.8 mc	Antenna thru 400-ohms	SW2	Do not change	Peak C54	5, 6	C54 is located on back apron of chassis.
19	9.6 mc	Antenna thru 400-ohms	SW1	9.6 mc—4.5 to 4.6 in.*	Peak C59	5, 6, 7, 10	Set dial accurately—then adjust C59.
20	9.6 mc	Antenna thru 400-ohms	SW1	Do not change	Peak C56	5, 6, 8	Peak C56 while rocking dial.
21	9.6 mc	Antenna thru 400-ohms	SW1	Do not change	Peak C55	5, 6	
				BROADCAST R-F ALIGNMENT			
22	1620 kc	Antenna via 200 mmf	STD	Extreme right-hand position	Peak C5	5, 6	
23	1620 kc	Antenna via 200 mmf	STD	Extreme right-hand position	Peak C4	5, 6	
24	1620 kc	Antenna via 200 mmf	STD	Extreme right-hand position	Peak C1	5, 6,	
25	1500 kc	Antenna via 200 mmf	STD	1500 kc—1.4 to 1.5 in.*	Osc. coil T3 iron slug	5, 6, 7, 9	T3 iron slug is the rear one on the left side. Adjust for peak.
26	1000 kc	Antenna via 200 mmf	STD	For max. output	Conv. coil T6 iron-slug	5, 6, 9	T6 iron slug is the center one on the left side. Adjust for peak.
27	1000 kc	Antenna via 200 mmf	STD	Do not change	R-F coil T1 iron slug	5, 6, 9	T1 iron slug is the front one on the left side. Adjust for peak.
28	580 kc	Antenna via 200 mmf	STD	For max. output	Peak L8	5, 6, 8	Peak L8 while rocking dial.
29							Repeat steps 22 to 28.

* Important! See Note 7.
** Use insulated hex wrench, ¼".

18-210

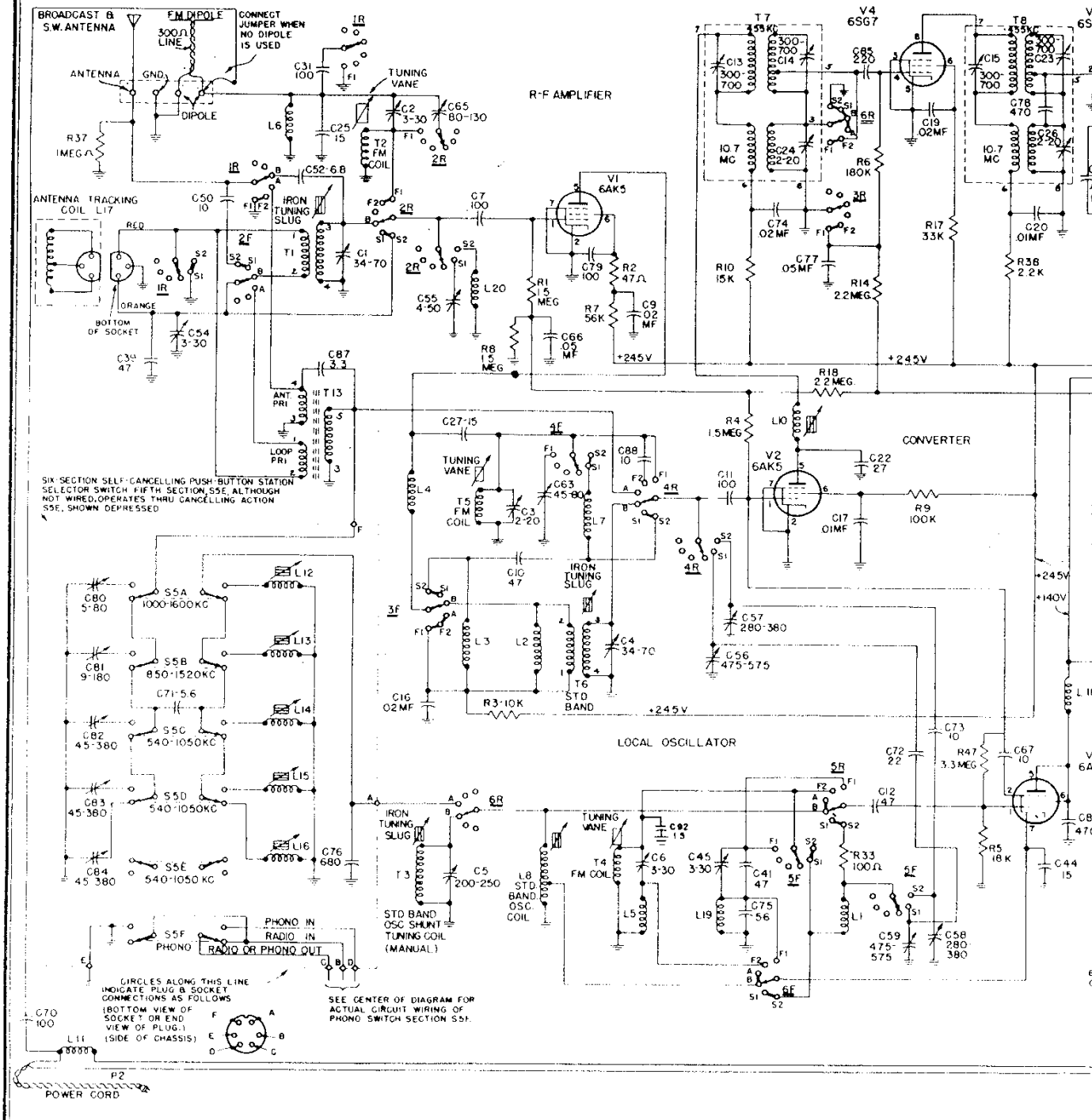
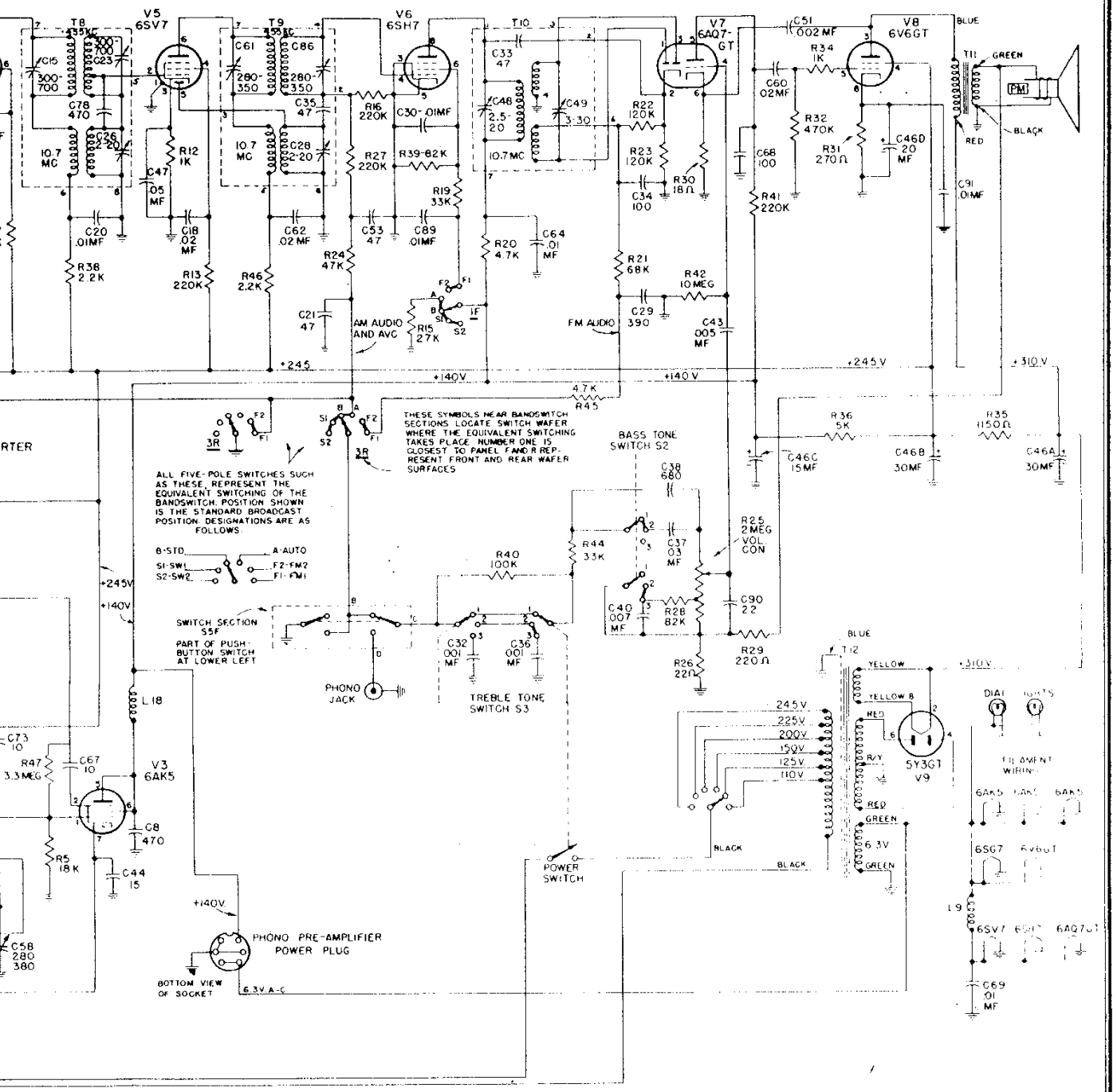


Figure 6—Schematic Diagram, M



—Schematic Diagram, Model X415

Notes in Connection with Alignment Table

1. Use *unmodulated* signal.
2. Connect 20,000-ohm-per-volt meter from junction of R21 and C29 to chassis. Use ten-volt scale. (Steps 1-3.)
3. Connect 20,000-ohm-per-volt meter from grid pin 4 of 6SH7 to chassis with a 200,000-ohm resistor in series. The resistor must be connected directly to the grid so that capacity loading will be negligible and so that the meter is isolated from the i-f signal voltage. Keep signal generator output down so that the meter indicates not more than one volt at the grid (5 micro-amperes through 200,000-ohms). (Alignment steps 4 to 6, 10 to 15.)
4. Connect signal generator directly to the converter grid at some convenient point. The generator lead must be shielded up to this connection so that not more than 1/16 inch of exposed lead exists. Ground the shield solidly by clamping it firmly to the chassis or a shield as close to the connection as possible. (Steps 6-9.)
5. Use 400-cycle modulation. (Steps 7 to 9, 16 to 28.)
6. Connect a standard output meter across speaker voice coil. Turn volume control fully on. Keep signal generator output down so that the meter indicates not more than ½ watt output (2 volts) during alignment. (Steps 7 to 9, 16 to 28.)
7. If dial scale is not available, index pointer as follows: Turn pointer to right-hand limit of travel. Mark the dial back plate at a reference edge of the pointer slider. Then set pointer by turning dial knob until the indicated dimension exists between the reference edge and the mark.
8. "Rocking" consists of adjusting the indicated adjuster while turning the dial a small amount back and forth through peak output. The object is to find the maximum peak. Rocking is necessary and is permissible only when interlocking circuits are being adjusted.
9. The main tuning iron slugs are suspended from the left side of the tuning "elevator." They are individually adjustable by loosening the locknut and turning the supporting screw into which the suspending wire is soldered.
10. *Two* oscillator settings will give response. The higher frequency response point is the correct one; the other is the image. If in doubt, start with the trimmer screw loosened completely and adjust for the *first* response.

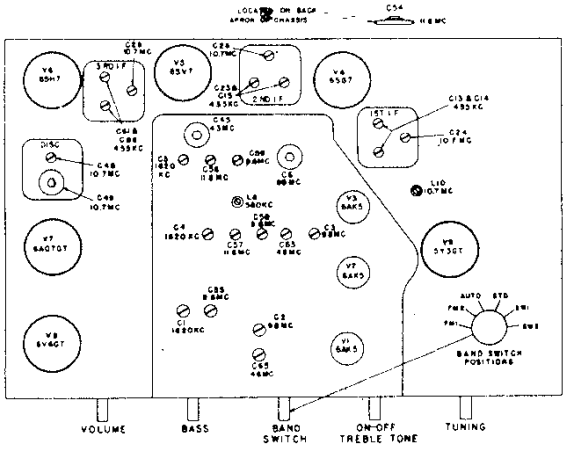


Figure 7—Location of Tubes and Adjusters

PHONO CONNECTION

A phono jack is located at the right on the rear of the chassis and a plug to fit this jack is provided with the receiver. This plug may be connected to the leads of any crystal pick-up of a record player. The receiver will now reproduce record recordings.

If the record player uses the General Electric Electronic pick-up, RPX-010, a phono pre-amplifier must be used for which a power receptacle is provided on the receiver chassis. The pick-up, RPX-010, is connected to the input jack of the pre-amplifier and the output cable of the pre-amplifier is then connected to the phono jack on the receiver chassis.

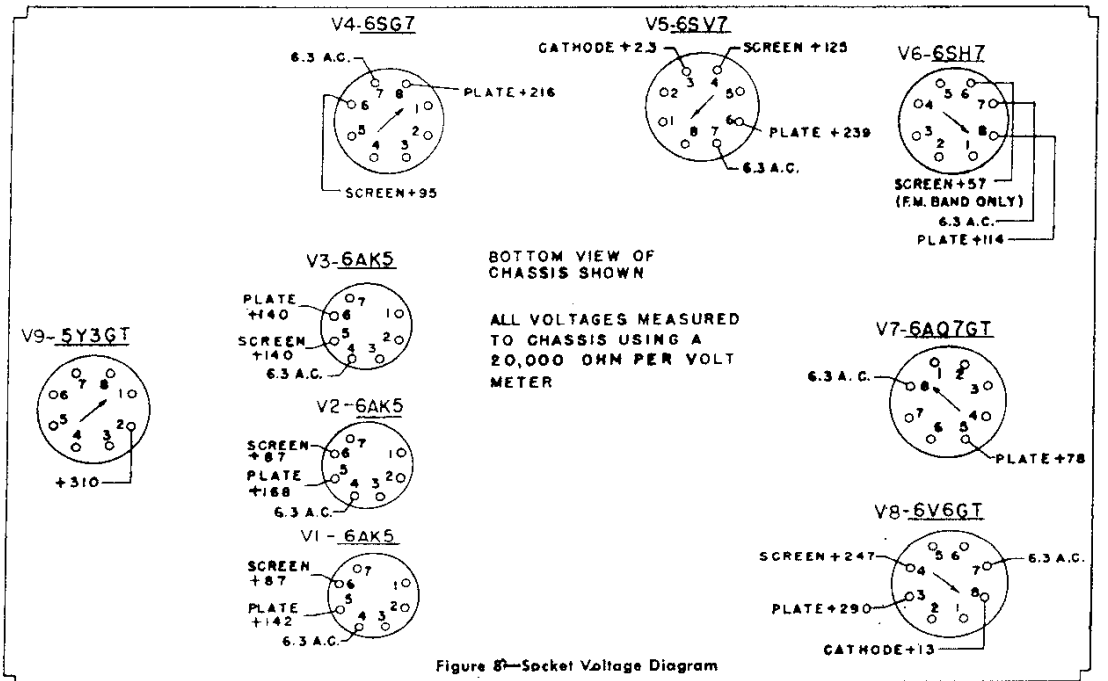


Figure 8—Socket Voltage Diagram

MODEL X-415

GENERAL ELECTRIC CO.

REPLACEMENT PARTS LIST

Part No.	Symbol	Description
UNIVERSAL REPLACEMENT PARTS		
UCC-039	C43	CAPACITOR—.005 mfd., 600 v., paper
UCC-040	C17, 30, 64, 69, 89, 91	CAPACITOR—.01 mfd., 600 v., paper
UCC-041	C9, 18, 74	CAPACITOR—.02 mfd., 600 v., paper
UCC-042	C37	CAPACITOR—.03 mfd., 600 v., paper
UCC-045	C47, 66, 77	CAPACITOR—.05 mfd., 600 v., paper
UCG-2048	C76	CAPACITOR—680 mmfd., silver mica
UCN-506	C52	CAPACITOR—6.8 mmf., ceramic
UCU-020	C21, 53	CAPACITOR—47 mmf., mica
UCU-028	C68	CAPACITOR—100 mmf., mica
UCU-048	C38	CAPACITOR—680 mmf., mica
UCU-520	C10	CAPACITOR—47 mmf., mica
UCU-528	C31, 70, 79	CAPACITOR—100 mmf., mica
UCU-536	C85	CAPACITOR—220 mmf., mica
UCU-1042	C29	CAPACITOR—390 mmfd., mica
UCU-1504	C73	CAPACITOR—10 mmfd., mica
UCU-1512	C72, 90	CAPACITOR—22 mmfd., mica
UCU-1520	C39	CAPACITOR—47 mmfd., mica
UCU-1544	C8	CAPACITOR—470 mmfd., mica
UCW-1004	C50	CAPACITOR—10 mmf., ceramic
UCW-1014	C22	CAPACITOR—27 mmf., ceramic
UCW-1020	C41	CAPACITOR—47 mmf., ceramic
UCW-1028	C34	CAPACITOR—100 mmf., ceramic
UCW-2022	C75	CAPACITOR—56 mmf., ceramic
UIC-001		CEMENT—Speaker cone replacement cement
UJB-014		TERMINALS—4 lug terminal strip
UJB-018		TERMINALS—2 lug terminal strip
UOP-802		SPEAKER—8" permanent magnet speaker
UOX-007		CONE—Replacement cone and voice coil for speaker
URD-007	R30	RESISTOR—18 ohms, ½ w., carbon
URD-009	R26	RESISTOR—22 ohms, ½ w., carbon
URD-017	R2	RESISTOR—47 ohms, ½ w., carbon
URD-025	R33	RESISTOR—100 ohms, ½ w., carbon
URD-033	R29	RESISTOR—220 ohms, ½ w., carbon
URD-041	R12	RESISTOR—470 ohms, ½ w., carbon
URD-049	R34	RESISTOR—1000 ohms, ½ w., carbon
URD-057	R38, 46	RESISTOR—2200 ohms, ½ w., carbon
URD-065	R20, 45	RESISTOR—4700 ohms, ½ w., carbon
URD-077	R10	RESISTOR—15,000 ohms, ½ w., carbon
URD-085	R19, 44	RESISTOR—33,000 ohms, ½ w., carbon
URD-089	R24	RESISTOR—47,000 ohms, ½ w., carbon
URD-091	R7	RESISTOR—56,000 ohms, ½ w., carbon
URD-093	R13, 21	RESISTOR—68,000 ohms, ½ w., carbon
URD-095	R28, 39	RESISTOR—82,000 ohms, ½ w., carbon
URD-097	R9, 40	RESISTOR—100,000 ohms, ½ w., carbon
URD-099	R22, 23	RESISTOR—120,000 ohms, ½ w., carbon
URD-103	R6	RESISTOR—180,000 ohms, ½ w., carbon
SPECIALIZED REPLACEMENT PARTS (Cont'd)		
	C84	CAPACITOR—45-380 mmf., push-button antenna trimmer
RCX-015	C5	CAPACITOR—200-250 mmf., trimmer capacitor
	C58	CAPACITOR—280-380 mmf., trimmer capacitor
	C59	CAPACITOR—475-575 mmf., trimmer capacitor
RCX-022	C3	CAPACITOR—2-20 mmf., trimmer capacitor
	C4	CAPACITOR—34-70 mmf., trimmer capacitor
	C56	CAPACITOR—475-575 mmf., trimmer capacitor
	C57	CAPACITOR—280-380 mmf., trimmer capacitor
	C63	CAPACITOR—45-80 mmf., trimmer capacitor
RCX-023	C1	CAPACITOR—34-70 mmf., trimmer capacitor
	C55	CAPACITOR—4-50 mmf., trimmer capacitor
RCX-024	C2	CAPACITOR—3-30 mmf., trimmer capacitor
	C65	CAPACITOR—80-130 mmf., trimmer capacitor
RCY-011	C54	CAPACITOR—3-30 mmf., trimmer
RCY-017	C6, 45	CAPACITOR—3-30 mmf., air trimmer
RDB-001		PUSH-BUTTON—Black push button used at bottom of strip only
RDB-004		PUSH-BUTTON—Black push-buttons used in upper five positions only
RDC-019		CORD—Hoist cord 61½" long
RDC-021		CORD—Dial drive cord
RDE-016		ESCUTCHEON—For dial scale and push-buttons
RDG-003		BACK PLATE—Large metal panel plate
RDK-004		KNOB—Black knob, plain
RDK-032		KNOB—Black control knob with pointer
RDO-001		ESCUTCHEON ORNAMENT—Left-hand plastic escutcheon ornament
RDP-016		POINTER—Dial pointer and slide
RDP-022		POINTER—Dial pointer
RDS-018		SCALE—Tuning dial scale
REX-002		CORE—Iron core with glass tubing for broadcast antenna, r-f, and oscillator coils
RHC-007		PIN—Hairpin cotter for securing shaft through push-buttons
RHC-009		PIN—Hairpin cotter for idler wheel
RHC-010		SPRING CLIP—Holds FM coil assembly
RHE-001		EYELET—For connecting FM coil links
RHM-016		CLIP—Mounting clip for L1 and L7
RHM-024		LINK—Hoist link holding end of hoist cord
RHM-025		RING—Retaining ring for flywheel
RHM-026		COIL LINK—Rectangular coil link for assembling FM coils T2 and T5
RHM-027		COIL LINK—Rectangular coil link for assembling FM coil, T4
RII-001		POST—Mycalex posts for assembling all FM coils
RJC-001		CONTACT PIN—For speaker connection
RJJ-004		RECEPTACLE—Pre-amp. and push-button receptacle
RJP-004		PLUG—Phono input plug
RJP-005		PLUG—Plug for push-button cable
RJP-010		SOCKET—Phono input jack
RJS-003		SOCKET—Octal socket for V5, V6, and V7
RJS-012		PLATE—For mounting electrolytic
RJS-027		SOCKET—Dial light socket
RJS-030		SOCKET—Octal socket for V4, V8, and V9
RJS-044		TUBE SOCKET—Tube socket for V1, V2, and V3
RJS-051		RECEPTACLE—3 pin receptacle for antenna tracking coil
RLA-009	T1	COIL—Broadcast band antenna coil
RLA-011	L6	COIL—FM antenna choke coil

Part No.	Symbol	Description
UNIVERSAL REPLACEMENT PARTS (Cont'd)		
URD-105	R16, 27, 41	RESISTOR—220,000 ohms, ½ w., carbon
URD-113	R32	RESISTOR—470,000 ohms, ½ w., carbon
URD-121	R37	RESISTOR—1.0 meg., ½ w., carbon
URD-125	R1, 4, 8	RESISTOR—1.5, meg., ½ w., carbon
URD-129	R14, 18	RESISTOR—2.2 meg., ½ w., carbon
URD-133	R47	RESISTOR—3.3 meg., ½ w., carbon
URD-145	R42	RESISTOR—10.0 meg., ½ w., carbon
URD-1079	R5	RESISTOR—18,000 ohms, ½ w., carbon
URE-035	R31	RESISTOR—270 ohms, 1 w., carbon
URE-073	R3	RESISTOR—10,000 ohms, 1 w., carbon
URE-083	R15	RESISTOR—27,000 ohms, 1 w., carbon
URE-085	R17	RESISTOR—33,000 ohms, 1 w., carbon
SPECIALIZED REPLACEMENT PARTS		
RAB-051		BACK—Cabinet back
RAD-016		BRACKET—For band switch mounting at front
RAV-038		CABINET—Model X-415 cabinet
RAX-007	L12, 13, 14, 15, 16	COIL—Push-button coils mounted on bracket
RAX-008		BRACKET—Bracket and roller fork for elevator shaft
RCC-001	C40	CAPACITOR—.007 mfd., 600 v., paper
RCC-035	C32, 36	CAPACITOR—.001 mfd., 600 v., paper
RCC-040	C20	CAPACITOR—.01 mfd., 600 v., paper
RCC-041	C16, 19, 60, 62	CAPACITOR—.02 mfd., 600 v., paper
RCC-056	C51	CAPACITOR—.002 mfd., 1000 v., paper
RCE-029	C46A	CAPACITOR—30 mfd., 400 v., dry electrolytic
	C46B	CAPACITOR—30 mfd., 400 v., dry electrolytic
	C46C	CAPACITOR—15 mfd., 400 v., dry electrolytic
	C46D	CAPACITOR—20 mfd., 25 v., dry electrolytic
RCW-001	C12	CAPACITOR—47 mfd., ceramic
RCW-013	C67, 88	CAPACITOR—10 mmf., ceramic
RCW-014	C25, 27, 44	CAPACITOR—15 mmf., ceramic
RCW-015	C87	CAPACITOR—3.3 mmf., ceramic
RCW-017	C92	CAPACITOR—1.5 mmf., ceramic
RCW-060	C71	CAPACITOR—5.6 mmf., ceramic
RCW-1028	C7, 11	CAPACITOR—100 mmf., ceramic
RCX-011	C80	CAPACITOR—5-80 mmf., push-button antenna trimmer
RCX-011	C81	CAPACITOR—9-180 mmf., push-button antenna trimmer
	C82	CAPACITOR—45-380 mmf., push-button antenna trimmer
	C83	CAPACITOR—45-380 mmf., push-button antenna trimmer
SPECIALIZED REPLACEMENT PARTS (Cont'd)		
	L19	COIL—FM oscillator cathode choke coil
	L20	COIL—SW loop shunt coil
RLA-016	T13	COIL—Push-button antenna coil
RLA-020		COIL—Antenna tracking coil
RLB-005	T2, 5	COILS—FM antenna coil and FM RF coil
RLB-006	T6	COIL—Broadcast band RF coil
RLB-007	L5	COIL—FM oscillator cathode choke coil
RLB-008	L3	COIL—SW band RF plate choke coil
RLB-009	L2	COIL—Broadcast band plate choke dummy
RLB-010	L4	COIL—FM RF plate choke coil
RLC-013	T4	COIL—FM band oscillator coil
RLC-014	T3	COIL—Broadcast band oscillator coil
RLC-015	L1	COIL—SW oscillator loading coil
RLC-016	L8	COIL—Broadcast band oscillator shunt coil
RLC-017	L7	COIL—SW band RF loading coil
RLF-003	L9	COIL—Filament choke coil
RLI-002	L11	CHOKE—Power line choke
RLP-004	L10	COIL—FM IF plate coil
RLP-006	L18	COIL—Oscillator plate choke coil
RMC-012		CLAMP—For holding cover on RF unit
RMC-013		CLIP—Support for clamp RMC-012
RMC-014		CLIP—For holding shielded phono cable
RMM-009		SPACER—Metal sleeve on hoist pulley shaft
RMM-010		VANE—Tuner vane for FM coils T2 and T5
RMM-011		VANE—Tuner vane for FM oscillator coil, T4
RMR-002		ROLLER—Presses against hoist shaft
RMS-032		SPRING—Maintains push-button tension
RMS-039		WASHER—"C" washer on idler pulley
RMS-040		SPRING—Flat spring against hoist pulley shaft
RMS-041		SPRING—Wire spring against hoist pulley shaft
RMS-042		SPRING—Hoist cord tension spring
RMS-043		SCREW—Iron core adjusting screw
RMS-044		SPRING—Guide wire spring in elevator plate
RMS-072		SPRING—Type 1 dial cord spring (earlier production)
RMS-078		SPRING—Type 2 dial cord spring (later production)
RMU-016		SHAFT—Manual tuning shaft
RMW-016		PULLEY—Main tuning drum
RMW-017		PULLEY—Small idler pulley
RMX-018		FLYWHEEL—Flywheel with setscrew
RMX-019		PULLEY—Hoist pulley and shaft
RMX-021		PLATE AND SHAFT—Elevator top plate and vertical shaft
RRC-014	R25	VOLUME CONTROL—2 meg. potentiometer tapped at 1 meg.
RRC-031	S2	SWITCH—Bass tone switch
RRT-002	R35, 36	RESISTOR—1150 and 5000 ohm, w.w.
RSP-002	S5	SWITCH—Push-button switch
RSW-023	S1	SWITCH—Band change switch
RSX-003	S3	SWITCH—Treble tone and power switch
RSX-005		SWITCH—Push-button switch assembly, complete
RTD-001	T10	TRANSFORMER—Discriminator
RTL-017	T7	TRANSFORMER—1st I-F transformer
RTL-018	T8	TRANSFORMER—2nd I-F transformer
RTL-019	T9	TRANSFORMER—3rd I-F transformer
RTO-011	T11	TRANSFORMER—Output transformer
RTP-045	T12	TRANSFORMER—Power transformer
RWL-004		CORD—Power cord
RWX-004		WIRE—Guide wire for pointer
RCY-005		LIST—Station call letters