

# The Crosley Service Bulletin

No. A 1

The Crosley Radio Corporation, Cincinnati, Ohio

March 15, 1931

## Chassis 120

### The Superheterodyne Receiver

By building a radio-frequency amplifier to operate at one frequency only, in the long-wave region, it is possible to obtain highly efficient and selective radio-frequency amplification. The superheterodyne receiver makes use of an amplifier of this type in conjunction with an arrangement for converting the desired signals into the frequency to which the fixed amplifier is tuned.

Model 120 Crosley superheterodyne serves as a good example. The circuit of this receiver may be divided into six units, as shown in Figure 1. It consists of a tuned radio-frequency amplifier, a first detector, an oscillator, an intermediate radio-frequency amplifier, a second detector, and an audio-frequency amplifier.

The intermediate amplifier is the radio-frequency amplifier of fixed tuning, referred to above. It is an efficient, selective radio-frequency amplifier, tuned permanently to a frequency of 175 kilocycles (that is, a wave length of about 1710 meters).

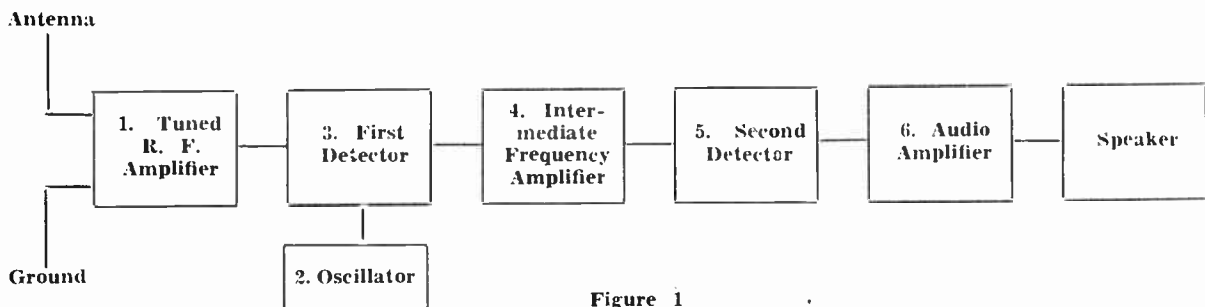


Figure 1

The incoming signal must be converted to a frequency of 175 kilocycles before the intermediate amplifier will accept it. To do this, use is made of the fact that when two oscillations or vibrations are combined, the resultant is a vibration of intermediate frequency which changes in amplitude periodically at a rate equal to the difference in frequency of the two vibrations. Thus, if it is desired to receive a signal of 600 kilocycles frequency, one can combine with this an r. f. current from an oscillator tube operating at 775 kilocycles, and the resultant will be an oscillatory current of intermediate frequency, periodically changing in amplitude at a rate of 175 kilocycles. This periodic change in amplitude is known as the "beat frequency".

In order for the beat frequency to appear as an actual oscillatory current instead of a

simple change in amplitude, the combined signals from the station and the oscillator must be sent through a detector. This detector delivers to the intermediate amplifier the 175 kilocycle beat-frequency signal, carrying the audio-frequency modulations of the station signal.

From the intermediate frequency amplifier, the 175 kilocycle signal is fed into a second detector, which separates out the audio modulations. The audio current is then amplified in the audio-frequency stage, and delivered to the loudspeaker.

The purpose of the tuned radio-frequency amplifier preceding the first detector is to select one only of the two signal frequencies which will give a 175 kilocycle beat for a given tuning of the oscillator. That there are two such signal frequencies will be apparent from a little consideration. Suppose the oscillator is tuned to 775 kilocycles, for example. The beat frequency is the difference between this frequency and that of the incoming signal. A signal of either 600 or 950 kilocycles is

exactly 175 kilocycles different in frequency from the oscillator, and consequently either of these two signals will produce a 175 kilocycle beat frequency.

The tuned radio-frequency amplifier preceding the first detector selects one of these signals and rejects the other. This amplifier is tuned by a variable condenser operated simultaneously with the tuning condensers of the first detector and oscillator stages by the station selector knob on the front of the receiver.

### Functions Of The Various Circuits

Summarizing, the functions of the various portions of the superheterodyne circuit shown in the schematic diagram are as follows:

1. **R. F. Amplifier.** To pre-select one of the two station signals which will give a 175 kilocycle beat when combined with the oscillator frequency.

2. **Oscillator.** To produce an oscillatory current of such frequency that when it is combined with the pre-selected signal a beat frequency of 175 kilocycles will be produced. The frequency of the oscillator must, of course, be changed for each new station signal frequency—in other words, the tuning of the oscillator must be changed as that of the first radio-frequency stage is changed.

3. **First Detector.** To convert the amplitude variations constituting the beat frequency into a modulated current.

4. **Intermediate Frequency Amplifier.** To amplify the 175 kilocycle modulated carrier delivered by the first detector.

5. **Second Detector.** To separate out the audio modulation of the 175 kilocycle carrier delivered to it by the intermediate frequency amplifier.

6. **Audio Amplifier.** To amplify the audio-frequency current from the second detector.

of 165 kilocycles (775 minus 610 equals 165). Converting these two beat frequencies into wave lengths, we find a wave length of about 1714 meters for the desired signal and one of about 1818 meters for the interfering signal—a difference of 104 meters, which is sufficient to enable the intermediate amplifier to retain one and reject the other.

**Characteristics of Superheterodynes**

A few words about certain peculiarities of superheterodynes may be worth while. It is possible that in testing a number of superheterodynes on the work bench in various stages of disassembly that the oscillator signal from one chassis may be picked up by another. This does not mean that superheterodynes of the 120 type "radiate". The tuned pre-selector stage combined with complete shielding of the oscillator coil and tube, effectively blocks radiation as the receiver is normally operated.

If, when receiving some signals, the volume control is turned up so far that the first detector is overloaded, a whistling note will be heard. This is a perfectly normal characteristic of superheterodynes, and does not mean that anything is wrong with the receiver. When the volume is adjusted for normal reception, the whistle does not occur.

Unless the oscillator tube functions normally, signals will not, of course, be heard. It is essential that only high quality tubes be used in the oscillator socket. If signals are not received, try another oscillator tube before looking further for the trouble.

If signals are still not heard after trying a new oscillator tube, one may check the circuits quickly as follows:

1. Remove top of condenser shield, and remove antenna wire from antenna post. Touch antenna wire against the padding condenser on top of the first detector tuning condenser (the first tuning condenser toward the front of the chassis). Tune the receiver to a powerful signal (if there is any doubt about what stations are on the air, check this with another receiver which is operating normally). If signals are received, the circuits are alright from the first detector through the other stages to the speaker. If signals are not received, the oscillator may not be functioning, or there may be an open circuit or short in one of the later circuits.

2. If signals are received under above conditions, change antenna wire to padding condenser on top of first radio frequency stage tuning condenser (the middle condenser of the gang). If the radio-frequency amplifier is functioning properly, the loudness of the sig-

X Audio Output X	X Second Detector X Oscillator X First R. F. Amplifier	X Rectifier
X Intermediate Amplifier	X First Detector	

Front of Chassis  
Fig. 2—Position of Tubes

**Why Superheterodynes Are More Selective**

A conception of why the superheterodyne method makes possible sharper tuning may be gained by considering what happens to the wave length separation between stations when they are converted to the intermediate frequency. For example, suppose the receiver is tuned to a signal of 600 kilocycles frequency, and there is a powerful signal in the adjacent channel at 610 kilocycles. Converting these frequencies into wave lengths, we find the 600 kilocycle signal to correspond to a wave length of 500 meters, and the 610 kilocycle signal to a wave length of about 490 meters—a difference of but 10 meters, which is not great enough to be separated with ease by a multi-stage radio-frequency amplifier.

Now suppose the incoming signal is combined with an oscillator signal of 775 kilocycles frequency, in order to obtain a beat frequency of 175 kilocycles for amplification by the intermediate amplifier. The 610 kilocycle interfering signal will produce a beat frequency

nal should be increased considerably. If no signal is received, or if the volume is the same or reduced, (provided, of course, that signals are received in condition "1") a defect in the first radio-frequency circuit is indicated.

3. If signals are received normally under the conditions outlined in (2) but not when the antenna is connected to the antenna terminal, an open circuit is indicated in the antenna circuit.

#### Aligning Tuning Condensers

The tuning condensers of the first radio-frequency, first detector, and oscillator stages must be aligned so that they track together. This is done by means of padding condensers, much the same as in the case of other Crosley receivers, except that both high and low frequency adjustments are provided.

The alignment of the tuning condensers is a process requiring considerable skill, and should only be undertaken when absolutely necessary, and only by those who have had extensive servicing experience. While station signals can be used for aligning, it is advised that a local modulated oscillator be employed. The procedure for aligning the tuning condensers of chassis 120 is as follows:

1. Leaving the shield cover in place, tune to a signal between 1300 and 1500 kilocycles.

2. Turn the volume control all of the way on. If all signals within the required range are too loud, connect a 0.00025 m. f. fixed condenser between the "A" and "G" terminals, and then couple the antenna very loosely to the local-distance switch leads.

3. If, when carefully tuned to the middle of the band, the dial reading does not correspond to the frequency of the signal, but is not more than two channels off, set the dial at the correct frequency, and adjust the padding condenser on the oscillator tuning condenser (the tuning condenser farthest toward the rear of the chassis) until the signal is loudest. Check the tuning by re-adjusting the station selector. It may not be possible to regulate the oscillator padding condenser so that the oscillator condenser is properly aligned with the **exact** dial setting, in which case align the padding condenser with a dial setting as close to the actual frequency as practicable.

4. After aligning the oscillator padding condenser, carefully adjust the padding condensers on the other two tuning condensers until the signal is received with greatest volume.

5. Tune to a signal of about 600 kilocycles frequency. If the dial setting, when carefully adjusted, is not more than one channel different from the actual frequency of the signal, it is possible to align the low frequency track-

ing, **but do not make this adjustment unless absolutely necessary.** The low frequency aligning adjustment is at the rear of the chassis, back of the shield, and is sealed at the factory. Break the seal, and insert a screwdriver **made of bakelite or other insulating material** in the adjusting screw. Set the tuning dial at the actual frequency of the signal, and adjust for best volume. If it is not possible to align the condenser with the dial set at the exact signal frequency, set the dial as close to the exact frequency as practicable.

6. If a screwdriver of insulating material is not available, adjustment may be made with an ordinary screwdriver by turning the screw slightly, removing the screwdriver, and retuning—repeating this process (being sure to turn the screw in such a direction that the tuning approaches more nearly the desired frequency, of course) until the dial setting agrees with, or approximates, the actual signal frequency.

#### Aligning Intermediate Frequency Stages

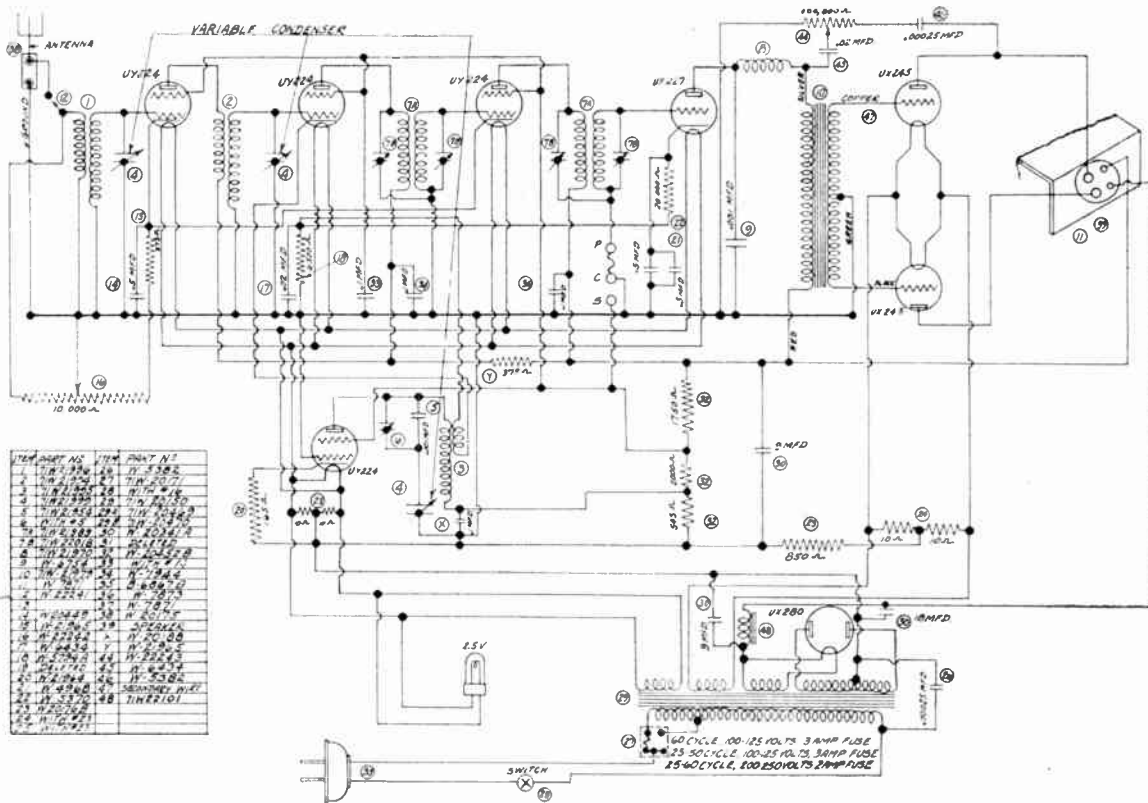
The intermediate amplifier and detector circuits must be tuned accurately to 175 kilocycles. They are aligned carefully at the factory, and no change should be necessary. In order to align them, an accurately tuned local oscillator operating at 175 kilocycles is essential.

Alignment of the intermediate frequency circuits should be undertaken only when absolutely necessary. The procedure for aligning the intermediate frequency amplifier, first detector output, and second detector output circuits to 175 kilocycles is as follows:

1. A local oscillator tuned accurately to 175 kilocycles frequency is required. Such instruments are supplied by the Weston Electrical Instrument Co., The Jewel Co., the General Radio Corporation, etc.

2. Remove the oscillator tube from the chassis. Remove the clip wire from the top of the intermediate frequency amplifier tube. Connect the test oscillator output from the control grid of the intermediate amplifier to ground. Adjust the two screws on either side of the rear r. f. coil (the coil between the intermediate frequency amplifier socket and the output tubes) until the oscillator signal gives the largest reading on the output meter.

3. Replace intermediate frequency amplifier tube, connecting screen grid clip to top of tube. Remove the first detector tube. Connect the oscillator output from the first detector grid to ground, and adjust the two screws at either side of the front r. f. coil for maximum reading on the output meter. Slight readjustment of the screws beside the rear coil may improve the output somewhat.



CIRCUIT MODEL 120

**Specifications of Model 120**

Model 120 is a superheterodyne receiver for operation from alternating current electric house-lighting circuits. Chassis are supplied for operation from 110 volts, 25 cycles; 110 volts, 60 cycles; or 220 volts, 25 to 60 cycles.

**Installation Notes**

Because of the extreme sensitivity of this type of receiver, an aerial of only moderate length is required. A short indoor aerial will usually suffice. Too long an aerial may result in overload, with consequent unsatisfactory operation.

This receiver is supplied with phonograph pick up terminals in the grid circuit of the second detector. The pick up must be connected to the detector circuit through an audio coupling transformer, and a volume control must be provided, since the volume control on the receiver operates in the radio-frequency end of the circuit. Crosley phono motor boards, properly designed for use with this chassis, are supplied with phonograph combinations. It is merely necessary to connect the marked leads from the pick up switch to the

terminals "P", "C", and "S" on the chassis, and to break the wire between terminals "P" and "C". If the pick up is later disconnected, a wire must be connected between terminals "P" and "C" for radio reception.

For further information refer to the instruction book accompanying the receiver.

**Circuit**

This receiver employs eight tubes, as follows: a -24 type tuned radio-frequency amplifier, a -24 type first detector, a -24 type oscillator, a -24 type intermediate frequency amplifier, a -27 type second detector, two -45 type power tubes in push pull as an audio-frequency amplifier, and a -80 type rectifier.

The portion of the circuit up to the output of the second detector has to do with radio-frequency currents. Coupling in this portion of the circuit is accomplished by air-core, radio-frequency transformers, tuned by variable condensers.

The first radio-frequency stage, the first detector, and the oscillator are tuned by variable condensers operated simultaneously by the station selector knob on the front of the re-



ceiver. The output circuit of the first detector, the circuits of the intermediate frequency amplifier, and the input circuit of the second detector are tuned to the fixed frequency of 175 kilocycles by small adjustable condensers.

Coupling between the second detector and push pull output stages is by means of an iron-core, audio-frequency transformer.

The oscillator is of the pliodynatron type. In this type of oscillator, one of the grids is kept at a somewhat more positive potential than the plate of the tube. Use is made of secondary electrons ejected from the plate, which are attracted back to this positive grid. A high quality screen grid tube, of the -24 type is used. The fundamental theory of the pliodynatron may be found in the more advanced radio texts; it will suffice to say here that as developed in the Crosley laboratories it represents an oscillator of superior stability and operating characteristics.

A power transformer with a power switch and voltage adjustment in the primary circuit furnishes the various tube circuits with the required voltages. Compensation for line voltages is made by placing the fuse in the primary circuit of the transformer in either of two sets of clips, one of which connects more primary turns in the circuit than the other.

There are four secondaries on the power transformer. One supplies the heaters of the screen grid and -27 type tubes, a second supplies the filaments of the -45 power tubes, a third supplies the filament of the -80 rectifier tube, and the fourth is the high-voltage secondary connected to the plates of the -80 rectifier tube.

A middle tap on the high-voltage secondary represents the negative side of the plate supply circuit, and a lead from the rectifier filament represents the positive side of this circuit. The positive plate supply circuit passes through a filter system consisting of an audio-frequency choke and a Mershon condenser, and thence continues through the field coil of the loud-speaker.

Returning from the speaker, the plate supply circuit connects through the primary of the audio frequency transformer and a plate choke to the plate of the second detector, through

the primary of the coupling transformer to the plate of the intermediate frequency amplifier, through an isolating resistor and the radio-frequency transformer primaries to the plates of the first detector and first radio-frequency amplifier tubes, and through two bleeder circuit resistors to the plate of the oscillator tube. Connection to the plates of the push pull output tubes is made inside the speaker by means of a middle tap on the primary of the output transformer.

The plate circuit is connected to the screen grids of the first radio-frequency amplifier, the first detector, and the intermediate frequency amplifier through a bleeder resistor. Biasing is accomplished by means of resistors in the emitter circuits of the various tubes, much the same as in other Crosley chasses.

The volume control is a variable resistor in the antenna circuit which increases the radio-frequency and intermediate frequency bias to decrease the volume. A local-distance switch is also provided, the connections of which are evident from the circuit diagram. A variable resistor and condensers in the audio circuit serve as a tone control.

**Voltage Limits**

**Filament Voltages**

All tubes but output and rectifier ...	2.4 to 2.6
Output tubes .....	2.3 to 2.5
Rectifier tube .....	4.6 to 5.2

**Plate Voltages**

1st R. F. and Intermediate Amplifiers	150 to 170
Oscillator .....	16 to 25
1st Detector .....	145 to 165
2nd Detector .....	135 to 155
Output .....	245 to 275
Rectifier (A. C. voltage) .....	260 to 290 each plate

**Screen Grid Voltages**

All screen grid tubes .....	85 to 95
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**Control Grid Voltages**

1st R. F. and Intermediate Amplifiers .	2.5 to 3.5
Oscillator .....	0.5 to 1.5
1st Detector .....	6.0 to 8.0
2nd Detector .....	13.0 to 17.0
Output tubes .....	50 to 58.0

To be measured with speaker connected, volume control on full, and line voltage of 117½ (235 for 220 volt receivers) with fuse in "High" position, or of 107½ (215 for 220 volt receivers) with fuse in "Low" position. Measure plate and grid voltages with a high-resistance D. C. voltmeter (600 ohms or more per volt) from plate or grid tube contact to emitter contact. Use a low range A. C. meter for filament voltages.

Parts List

INSTRUCTIONS FOR ORDERING—Give part number, and description of part, and serial number of set on which part is to be used. If article wanted is not listed separately, then that part of complete assembly containing this article should be ordered. Goods shipped on open account to Crosley Wholesale Distributors only. Cash must accompany Dealer and Consumer Orders. Prices are subject to the usual trade discounts.

Qty.	Part No.	Description	List Price				
			Each				
			\$4.00				
1	D-22004-B	Chassis .....		1	W-6174	Guard Thumb Nut .....	.05
5	W-7873	Socket (5 Prong) .....	.30			PARTS UNDER CHASSIS	
4	W-7871	Socket (4 Prong) .....	.25	1	W-20449	0.5-0.1 Mfd. Condenser .....	\$1.25
7	W-7874	Socket Guide .....	.10	1	W-20452	Fixed Resistance (Candohm 2000-1750-545 ohms) .....	1.00
1	W-7872	Socket Guide (Speaker) .....	.10	2	W-4968	0.5 Mfd. Fixed Condenser (2 paper) .....	1.20
1	W-21297	Socket Guide (280) .....	.10	1	W-7944	0.1-0.1 Mfd. Fixed Condenser	1.10
1	W-22017	I. F. Transformer Assembly	3.50	1	W-21965	Flexible Resistor (375 ohms)	.30
	W-22018	Base Assembly .....	1.00	1	W-22242	Volume Control and Switch Assembly .....	2.25
	W-21989	Coil Assembly .....	1.50	1	W-21965	Flexible Resistor (375 ohms)	.30
	W-21983	Coil Socket .....	.05	1	W-20177	Bottom Bracket .....	.05
	W-21992	Rubber Spacer .....	.05	1	W-21974	Mounted Resistor Assembly..	2.00
	W-21993	Grid Connector .....	.25	1	W-20829	Mounting Strip .....	.20
	W-21991	Coil Shield .....	.50	1	W-5794	Resistor, 6500 ohms .....	.60
1	W-22003	Tube Shield .....	.25	1	W-5370	Resistor, 20000 ohms Red, black, orange spot .....	.60
1	W-21295	I. F. Transformer Assembly	3.25	1	W-6434	0.02 Mfd. Fixed Condenser	.35
	W-22018	Base Assembly .....	1.00	1	W-21964	Flexible Resistor (165 ohms)	.30
	W-21989	Coil Assembly .....	1.50	1	W-5340	Stiffened Sleeveing .....	.10
	W-21983	Coil Socket .....	.05	1	W-21970	Plate Choke .....	.75
	W-21992	Rubber Spacer .....	.05	1	W-6754	0.001 Mfd. Fixed Condenser	.35
	W-21987	Coil Shield .....	.50	1	W-21954	Oscillator Condenser Assem- bly (.001 Mfd. Fixed) (50 to 300 Var.) .....	1.50
1	W-21781	Variable Condenser Gang.....	16.00	1	W-21940	Mounting Plate .....	.50
3	W-22228	Adjusting Plate .....	.10	1	W-21994	R. F. Transformer (Inter- stage) (Front) .....	2.00
3	W-22229	Mica .....	.10	1	W-21996	R. F. Transformer (Anten- na) (Center) .....	2.00
3	W-22230	Washer .....	.05	1	W-21995	R. F. Transformer (Oscilla- tor) (Rear) .....	2.00
3	W-22231	Screw .....	.05	3	W-21969	Coil Shield .....	.50
3	W-22299	Trimmer Clamp Screw .....	.05	1	W-20188	0.1 Mfd. Fixed Condenser...	.60
3	W-21973	Grid Connector .....	.25	1	W-22243	Tone Control .....	1.50
1	W-22001	Dial Assembly .....	2.75	1	W-6431	0.02 Mfd. Fixed Condenser...	.35
	W-22002	Dial Strip Only .....	.25	1	W-5382	0.00025 Mfd. Fixed Condenser	.35
1	W-5749	Drive Rope .....	.50	1	W-20177	Bottom Bracket .....	.05
1	W-20376	Shadow Box Assembly .....	1.00	1	W-20176	Fixed Resistance (Candohm) 850-10-10-10-10 ohms .....	1.00
1	W-20431	Drive Pulley .....	.25	1	W-5382	0.00025 Mfd. Fixed Condenser	.35
1	W-20435	Spring Washer .....	.05	1	W-22101	Filter Choke .....	3.00
1	W-21947	Inner Bracket .....	.15	1	W-22105	Filter Choke Bracket .....	.20
1	W-20209	Outer Bracket .....	.10	1	W-22099	Terminal Board (Wire Ter.)	.50
1	W-21979	Push Pull Transformer .....	7.00	1	W-20266	Terminal Board (P. C. S.)...	.50
1	C-21948	Cond. Gang and Tube Shield	1.25	1	R-6867	Cable .....	1.50
1	C-21948	Shield Cover .....	2.00	1	W-20175	Terminal (A. & G.) .....	.50
1	W-20341	Merston Condenser .....	7.50	1	W-22244	Switch (Local-Distance) .....	.80
1	W-22107	Merston Socket .....	.15	1	C-20205	Chassis Bottom .....	.75
1	W-21275	Merston Cap .....	.30	1	W-20485	Knob (large) .....	.40
1	W-4742	Cap Screw .....	.05	2	W-20486	Knob (small) .....	.35
1	W-4741	1-36 Square Nut .....	.05				
1	W-4794	Stiffened Sleeveing (4 3/4") .....	.10				
1	W-20150	Power Trans. 110 V. 60 Cy.	14.00				
1	W-20469	Power Trans. 110 V. 25 Cy.	14.00				
1	W-20470	Power Trans. 220 V. 25 Cy.	14.00				
1	W-20171	Fuse Panel .....	.30				
1	W-7983	Fuse, 3 amp. .....	.10				
2	W-21263	Fuse Insulator (fibro) .....	.05				
1	W-20321	Fuse Guard .....	.35				
1	W-20322	Fuse Guard Insulator (fibro)	.05				

# The Crosley Service Bulletin

No. A-2

The Crosley Radio Corporation, Cincinnati, Ohio

August 15, 1931

## Model 122

### Specifications

This is a superheterodyne receiver quite similar in general design to Model 120, except that it is built on a compact midget chassis. It is for operation from A. C. house lighting circuits and is supplied for 110 volt 25 to 50 cycles, 110 volt 60 cycles, or 220 volt 25 to 60 cycles.

The receiver has seven tubes, a -35 radio-frequency amplifier, a -24 pliodynatron oscillator, a -24 first detector, a -35 intermediate frequency amplifier, a -24 second detector, one pentode a. f. amplifier, and a -80 rectifier.

### Installation Notes

The receiver is quite sensitive and requires an antenna of but moderate size.

Care should be taken to use only -24 type tubes of the highest quality for the oscillator. An imperfect oscillator tube will, of course, make reception poor or impossible.

### Circuit

For a discussion and explanation of the operation of superheterodynes in general, and a discussion of some of their general characteristics, refer to Service Bulletin No. A-1, March 15, 1931, describing chassis 120.

The circuit of this receiver is quite similar to that of Model 120. It incorporates one stage of tuned radio-frequency amplification, an oscillator, a first detector, an intermediate frequency amplifier stage tuned to 175 kilocycles, a second detector, and pentode audio stage.

Air core radio-frequency transformers are used between the antenna circuit and the radio-frequency amplifier tube, the radio-frequency amplifier tube and the first detector, the first detector and intermediate-frequency amplifier tube, and between the intermediate amplifier and the second detector. Coupling between the second detector and the pentode audio stage is by means of resistance coupling.

The grid circuits of the radio frequency and first detector tubes, and the plate circuit of the oscillator are tuned by variable condensers operated together by the station selector. These are equipped with aligning condensers, for adjusting the tuning condensers so that they track together. (See Service Bulletin No. A-1).

The primary and secondary of the intermediate frequency transformer, between the first detector and the intermediate frequency amplifier, are tuned by small, adjustable condensers. These circuits are adjusted accur-

ately to 175 kilocycles at the factory, and should not be readjusted unless absolutely necessary, and then only with adequate equipment.

The oscillator is of the special Crosley pliodynatron type.

The power transformer has a power switch in its primary circuit, and has three secondaries. One of these secondaries supplies the filament of the rectifier tube, a second supplies the filaments of the other tubes, and a third is the high voltage secondary connected to the plates of the rectifier.

The negative side of the plate supply circuit is connected from a middle tap of the high voltage secondary through the speaker field coil, to the chassis. This method of connecting the field coil utilizes it for a filter choke for the entire plate supply. Two mershon condensers are employed, one from each side of the field coil to the positive high voltage supply.

The positive side of the plate supply circuit is connected from one side of the rectifier filament to the high side of the voltage divider from which taps are taken off to supply the plates and screen grids of all tubes but the output stage. Connection to the plate of the pentode output tube from the positive plate supply circuit is made inside the speaker, through the primary of the output transformer.

The positive plate supply circuit connects to the detector plate through a 60,000 ohm filter resistor, a 300,000 ohm coupling resistor, and a radio-frequency choke coil. It is connected to the plate of the intermediate-frequency amplifier, first detector, and radio-frequency tube through the primaries of the interstage radio-frequency and intermediate-frequency transformers.

The biasing of all tubes but the pentode is accomplished by resistors in the emitter circuits. The pentode tube obtains its bias by returning its grid through a one megohm hum filter resistor to the negative side of the field coil. The voltage across the field coil furnishing the bias. The volume control varies the biasing resistance in the emitter circuits of the radio-frequency and intermediate-frequency amplifier tubes and varies the resistance between antenna and ground.

A series resistor and condenser connected from the pentode plate to the chassis is used as a tone control.

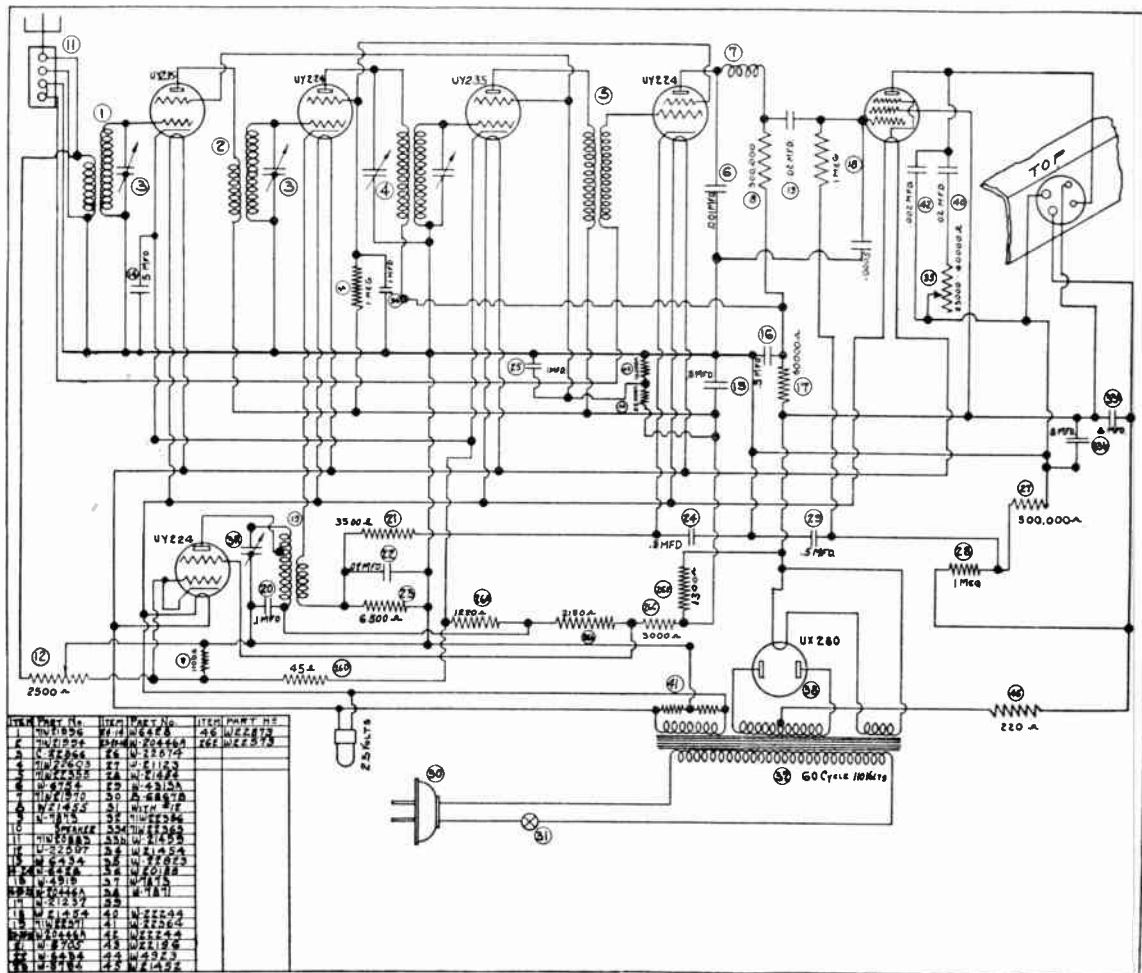


Fig. 1—Circuit Diagram Model 122

NOTE: Item 13 in above parts list should be No. W21876, item 44 should be No. W5370, and item 26 E should be W22996

**Alignment of Tuning Condensers and Intermediate-Frequency Amplifier**

The procedure is similar to that for Model 120, described in Bulletin No. A-1, March 15, 1931, except that only the first intermediate frequency transformer need be adjusted. The second is inherently tuned to 175 kilocycles and cannot get out of adjustment. Aligning has been further simplified by the elimination of the series padding condenser which is in the oscillator circuit of Model 120. The rotaplates of the oscillator tuning condenser have been so designed as to make this adjustment unnecessary.

The alignment of the tuning condensers is a process requiring considerable skill, and should only be undertaken when absolutely necessary, and only by those who have had extensive servicing experience. While station signals can be used for aligning, it is advised that a local modulated oscillator be employed. The procedure for aligning the tuning condensers is as follows:

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1. Tune to a signal between 1300 and 1400 kilocycles.
2. Turn the volume control all of the way on. If all signals within the required range are too loud, connect a 0.00025 m. f. fixed condenser between the "A" and "G" terminals, and then couple the antenna very loosely to a wire connected to the "A" terminal.
3. If, when carefully tuned to the middle of the band, the dial reading does not correspond to the frequency of the signal, but is not more than two channels off, set the dial at the correct frequency, and adjust the padding condenser on the oscillator tuning condenser (the tuning condenser nearest the front of the chassis) until the signal is loudest. Check the tuning by re-adjusting the station selector. It may not be possible to regulate the oscillator padding condenser so that the oscillator con-



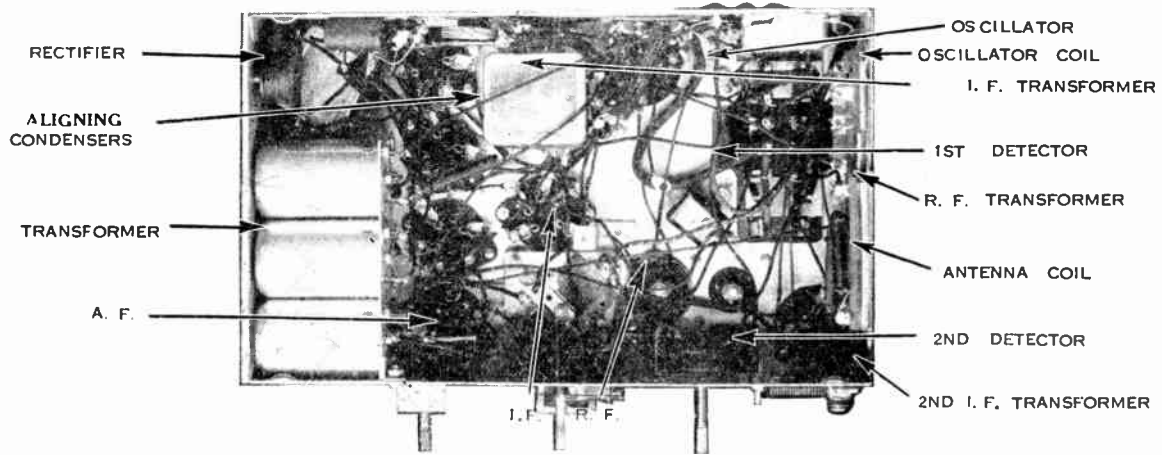


Fig. 2—Bottom View, Model 122 Chassis

denser is properly aligned with the exact dial setting, in which case align the padding condenser with a dial setting as close to the actual frequency as practicable.

4. After aligning the oscillator padding condenser, re-tune to a frequency between 1300 and 1400 kilocycles and carefully adjust the padding condensers on the other two tuning condensers until the signal is received with greatest volume.

5. If a screwdriver of insulating material is not available, adjustment may be made with an ordinary screwdriver by turning the screw slightly, removing the screwdriver, and re-tuning—repeating this process (being sure to turn the screw in such a direction that the tuning approaches more nearly the desired frequency, of course) until the dial setting agrees with, or approximates, the actual signal frequency.

**Aligning Intermediate Frequency Stages**

The primary and secondary circuits of the intermediate amplifier transformer must be tuned accurately to 175 kilocycles. They are aligned carefully at the factory, and no change should be necessary. In order to align them, an accurately tuned local oscillator operating at 175 kilocycles is essential. The procedure is as follows:

1. A local oscillator tuned accurately to 175 kilocycles frequency is required. Such instruments are supplied by the Weston Electrical Instrument Co., The Jewel Co., the General Radio Corporation, The Radio Products Co., etc.

2. Remove the oscillator tube from the chassis. Remove the clip wire from the first

**Voltage Limits**

Filament Voltages	
All tubes but rectifier .....	2.3 to 2.5
Rectifier tube .....	4.6 to 5.0
Plate Voltages	
1st R. F. and Intermediate Amplifiers	170 to 200
Oscillator .....	28 to 38
1st Detector and 2nd Detector .....	185 to 215
Output .....	260 to 300
Rectifier (A. C. voltage) .....	280 to 320
	each plate
Screen Grid Voltages	
1st R. F. and Intermediate Amplifiers	45 to 55
1st Detector and 2nd Detector .....	60 to 80
Oscillator .....	80 to 100
Output .....	260 to 300
Control Grid Voltages	
1st R. F. and Intermediate Amplifiers	1.5 to 2.5
1st Detector .....	6.0 to 8.0
2nd Detector .....	8.0 to 10.0
Output tube .....	18.0 to 22.0

To be measured with speaker connected, volume control on full, and line voltage of 117½ (235 for 220 volt receivers). Measure plate and grid voltages with a high-resistance D. C. voltmeter (600 ohms or more per volt) from plate or grid tube contact to emitter contact. Use a low range A. C. meter for filament voltages.

detector tube. Connect the test oscillator output from the first detector grid to ground, and adjust the two screws at either side of the front

I. F. coil for maximum reading on the output meter. Always re-align the tuning condenser after aligning the I. F. amplifier.

**Parts List**

**INSTRUCTIONS FOR ORDERING**—Give part number, and description of part, and serial number of set on which part is to be used. If article wanted is not listed separately, then that part of complete assembly containing this article should be ordered. Goods shipped on open account to Crosley Wholesale Distributors only. Cash must accompany Dealer and Consumer Orders. Prices are subject to the usual trade discounts.

Qty.	Part No.	Description	List Price Each	Qty.	Part No.	Description	List Price Each
<b>CHASSIS</b>							
1	D-22376C	Chassis .....	.75	1	W-22469	Spacer .....	.05
2	W-7871	Socket (4 prong) .....	.25	1	W-22464	Spring .....	.06
6	W-7873	Socket (5 prong) .....	.30	<b>PARTS UNDER CHASSIS</b>			
1	W-22818	Socket Guide (Pen.) .....	.10	1	W-22006	Fixed Resistance (2 Lug)....	.00
3	W-22819	Socket Guide (224) .....	.10	1	W-22364	Fixed Resistance (3 Lug)....	.30
2	W-22820	Socket Guide (235) .....	.10	1	W-22574	Fixed Resistance (5 Lug)....	1.00
1	W-7874	Socket Guide (280) .....	.10	1	W-21452	Flexible Resistance (1100	
1	W-21297	Socket Guide (280) .....	.10			ohms) .....	.25
1	W-22522	Guide Socket (280) .....	.15	1	W-4313	.5 Mfd. Fixed Condenser .....	.75
1	W-20583	Terminal Board (A & G) .....	.20	1	W-21123	Resistor (500,000 ohms) .....	.30
1	W-22356	Power Trans. (110 V. 60 Cy.) .....	8.00	1	W-21454	Resistor (Megohm) .....	.30
	W-22357	Power Trans. (110 V. 25 Cy.) .....	8.00	2	W-22244	.02 - .002 Fixed Condenser	.60
	W-22358	Power Trans. (220 V. 25 Cy.) .....	8.00	1	W-22873	Flexible Resistance (220	
2	W-21485	Merphon Socket .....	.10			ohms) .....	.30
2	W-21459	Merphon Condenser (8 mf.) .....	2.50	1	W-21876	Resistor (10,000 ohms) .....	.25
1	W-22384	Merphon Insulator Cup .....	.15	1	W-6428	.5 - .5 Mfd. Fixed Condenser	1.25
1	W-23112	Volume Control and Switch		1	W-7753	.1 - .5 - .1 Mfd. Fixed Con.	1.50
		Assembly .....	1.50	1	W-21237	Resistor (60,000 Ohms) .....	.25
1	W-22603	I. F. Transformer Assembly	1.75	1	W-21455	Resistor (300,000 Ohms) .....	.30
	W-22018	Base Assembly .....	.60	1	W-6434	.02 Mfd. Condenser .....	.40
	W-22604	Coil Assembly .....	1.00	1	W-22822	Fibre Retainer .....	.05
	W-21983	Coil Socket .....	.05	1	W-22823	Tone Control .....	1.00
	W-21992	Rubber Spacer .....	.05	1	W-5794	Resistor (6500 ohms) .....	.25
	W-21993	Grid Connector .....	.10	1	W-6434	.02 Mfd. Fixed Condenser ...	.40
	W-21991	Coil Shield .....	.25	1	W-21970	Plate (choke) .....	.50
1	W-22362	Tube Shield .....	.25	1	W-22703	R. F. Transformer (Antenna)	1.00
1	W-20125	Shield Base .....	.15	1	W-22704	R. F. Transformer (Inter-	
1	W-22825	Detector Shield .....	.25			stage) .....	1.00
	W-5654	Rubber Grommet .....	.10	1	W-22705	R. F. Transformer (Oscilla-	
1	W-22826	Shielded Grid Connector .....	.20			tor) .....	1.00
1	C-22366	Variable Condenser Gang ...	7.00	3	W-22374	Coil Shield .....	.20
2	W-21973	Grid Connector .....	.10	1	B-22373	Mounting Plate .....	.15
1	W-22513	Grid Connector .....	.10	1	W-6705	Resistor (3500 ohms) .....	.30
1	W-22330	Dial Drum .....	.60	1	W-6706	Resistor (25000 ohms) .....	.30
1	W-22332	Dial Strip .....	.40	1	W-6754	.001 Mfd. Fixed Condenser ...	.25
1	W-22334	Drive Rope .....	.15	1	W-20188	.1 Mfd. Fixed Condenser .....	.50
1	W-22460	Drive Bracket .....	.15	1	W-21454	Resistor (1 meg.) .....	.30
1	W-22461	Drive Shaft with pulley ...	.25	1	W-4919	.5 Mfd. Fixed Condenser ...	.75
1	W-22462	Stop Washer .....	.05	1	W-22355	I. F. Trans. (Choke Type) ..	1.00
1	W-22463	Stop Washer .....	.05	1	W-22377	Bottom Bracket .....	.65
1	W-22329	Dial Light Assembly (with-		1	B-6867	Cable .....	.30
		out lamp) .....	.20	1	C-22369	Bottom .....	.20
1	W-22465	Spacer .....	.05	1	W-22986	.0005 Mfd. Fixed Condenser ..	.25
1	W-22331	Idler Pulley & Bracket .....	.30				

**Changes In Model 122**

The following changes as compared with the circuit diagram shown herein will be found in some chasses.

1. The pentode grid resistor is 300,000 ohms instead of 1 megohm as shown on the diagram.

2. The volume control resistor is 650 ohms instead of 2500 ohms, as shown.

3. The 3,000 ohm resistor shown on the diagram just to the left and above the power transformer is changed to 1790 ohms.

4. The 1100 ohm resistor shunted across a portion of the volume control is deleted.

5. The 25,000 ohm resistor in the r. f. screen grid circuit is replaced by a 20,000 ohm resistor.

**Changes In Parts List**

The following changes in the parts list of Model 122 receivers apply to later chasses.

Old Part Number	Description	New Part Number
W-22597	Volume Control and Switch Assembly .....	W-23112
W-21452	Flexible Resistance (1100 ohms) .....	Deleted
W-22574	Fixed Resistance (5 Lug)	W-22574-A
W-6706	Resistor (formerly 25,000 ohms, now 20,000 ohms)	W-5370
W-21454	Resistor (formerly 1 megohm, now 300,000 ohms)	W-21455



duction of a push-pull pentode output system, with push pull audio transformer instead of a single resistance-coupled output stage, and the change of the detector circuit from screen-grid to triode.

The tubes used are the same as chassis 122 with the exception of the detector, which employs a -27 instead of a -24, and the output, which utilizes two pentodes instead of one.

### Model 124

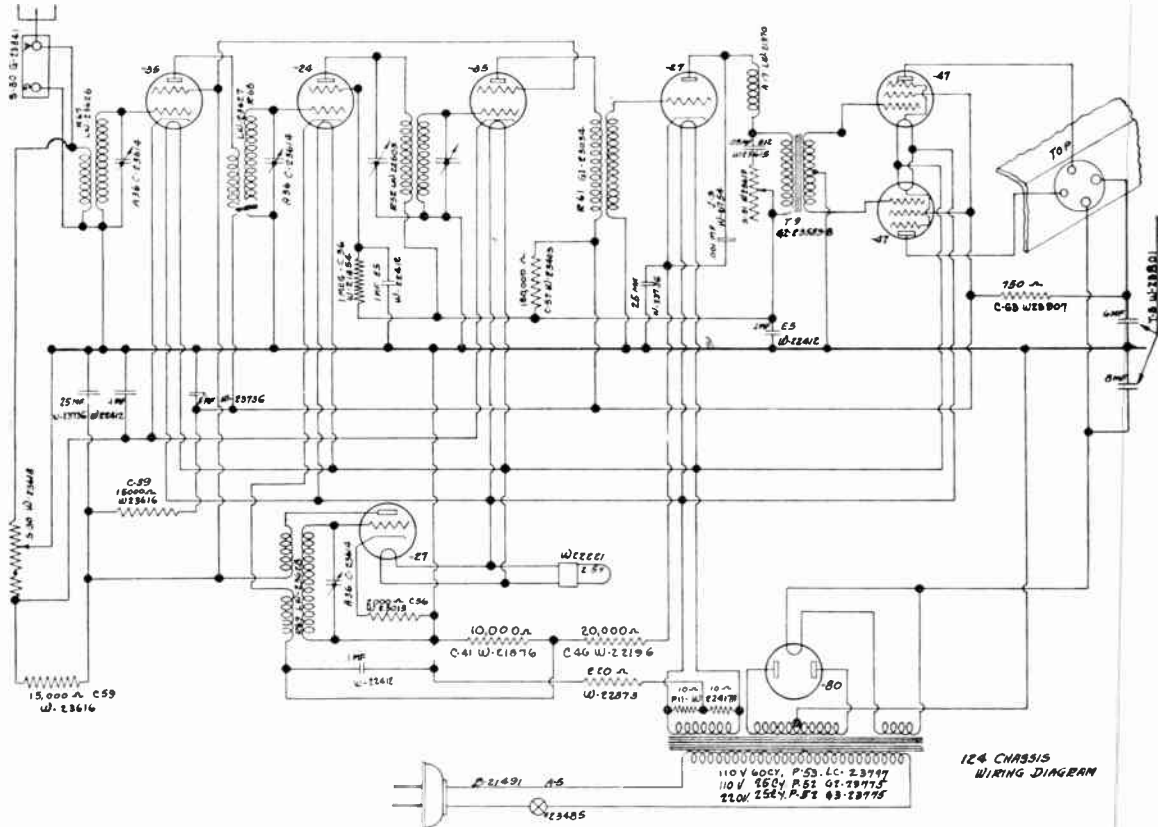


Fig. 4—Circuit Diagram, Model 124

This receiver is very similar in circuit to chassis 123, with the following exceptions:

1. There are no phonograph pick up terminals.
2. A -27 type oscillator is used instead of a -24.

The mechanical layout is quite different.

A circuit diagram is reproduced herewith (Figure 4). The numbers on the circuit diagram correspond with those on the parts list, and may be used for identifying the various parts.

For a description of the various features of the circuit, and for aligning instructions, refer to the discussions of Models 122 and 123.

### Voltage Limits

<b>Filament Voltages</b>	
All tubes but rectifier .....	2.3 to 2.5
Rectifier .....	4.6 to 5.0
<b>Plate Voltages</b>	
R. F. and I. F. Amplifiers and Output .....	235 to 265
First Detector .....	170 to 190
First and Second Detectors .....	60 to 80
Rectifier, D. C. Voltage .....	300 to 340
<b>Screen Grid Voltages</b>	
R. F. and I. F. Amplifiers .....	80 to 100
First Detector .....	55 to 65
Output .....	230 to 270
<b>Control Grid Voltages</b>	
R. F. and I. F. Amplifiers .....	1.5 to 2.5
First Detector and Oscillator .....	7 to 9
Second Detector .....	18 to 22
Output .....	15 to 18

Important: See note under "Voltage Limits,"



Parts List—Model 124

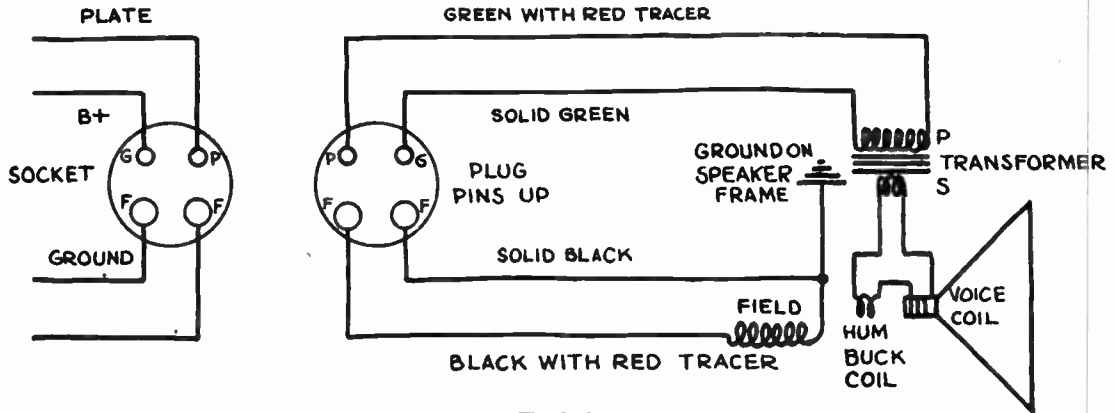
INSTRUCTIONS FOR ORDERING—Give part number, and description of part, and serial number of set on which part is to be used. If article wanted is not listed separately, then that part of complete assembly containing this article should be ordered. Goods shipped on open account to Crosley Wholesale Distributors only. Cash must accompany Dealer and Consumer Orders. Prices are subject to the usual trade discounts.

Qty.	Part No.	Description	List Price	Qty.	Part No.	Description	List Price
1	D-23508D	Chassis .....	.75				
1	G1-23800	Four prong Socket (Speaker) .....	.20	1	W-23618A	Volume Control & Switch.....	.15
1	G2-23800	Five Prong Socket (24) .....	.25	1	W-23619	Tone Control .....	1.00
2	G3-23800	Five prong Socket (27) .....	.25	1	LB-23625	R. F. Coil Unit Assembly.....	3.50
2	G4-23800	Five prong Socket (35) .....	.25	1	LW-23626	Antenna Coil .....	.75
2	G5-23800	Five prong Socket (47) .....	.25	1	LW-23627	Interstage Coil .....	1.00
1	G6-23800	Four prong Socket (80) .....	.20	1	LW-23628	Oscillator Coil .....	.75
1	G1-23841	Terminal board (A&G) .....	.20	3	LW-23374	Coil Shield .....	.20
1	LAW-22603	I. F. Coil Assem. (Tuned)..	1.75	1	B-23624A	Mounting Plate .....	.10
1	LAW-21991	Coil Shield Assembly .....	.25	1	G1-23034B	I. F. Coil (Untuned) .....	.50
1	LAW-21903B	Tube Connector Assembly .....	.10	1	LW-21970	Plate Choke .....	.50
1	LAW-22018C	Base Assembly .....	.60				
1	G2-23583B	A. F. Transformer Assembly	3.00				
1	C-23614	Variable Tuning Condenser	6.00				
1	G1-23629	Condenser Gang Bracket (Included in Price of Condenser) .....					
2	G1-23623	Tube Connectors .....	.10	1	W-23615	.05 Mfd. ....	.25
1	LAW-23600	Dial Light Bracket Assem.	.15	1	W-22412	.1 - .1 - .1 - .1 Mfd.....	1.10
1	G1-23686	Dial Drive Assembly .....	.80	1	W-6754	.001 Mfd. ....	.25
1	LC-23797	Power Trans. 110V.-600c/y.....	5.00	1	W-22688	.1 Mfd. ....	.25
1	G2-23775	Power Trans. 110V.-25c/y. ....	7.00	1	W-22995	.5 - .1 Mfd. ....	1.00
1	G3-23775	Power Trans. 220V.-25c/y. ....	7.00	1	W-23736	.25 - .5 - .25 Mfd. ....	1.50
		<b>Resistors</b>		1	W-23621	6 Mfd. ....	1.50
1	W-23013	2,000 Ohm Flexible (Red, red spot, black end) .....	.25	1	W-23622	8 Mfd. ....	1.60
1	W-21454	1-Megohm (Brown, green spot, black end) .....	.30	1	W-23801	6, and 8, Mfd. ....	3.00
1	W-23463	150,000-Ohm (Brown, yellow spot, green end) .....	.30	1	W-23633	Condenser Shelf .....	.05
1	W-21876	10,000-Ohm (Brown, orange spot, black end) .....	.25	1	W-23634	Condenser Clamp .....	.05
1	W-22196	20,000-Ohm (Red, orange spot, black end) .....	.25	1	B-21491	Cable and Plug .....	.50
2	W-23616	15,000-Ohm (Brown, orange spot, green end) .....	.30	1	C-23613A	Bottom .....	.20
1	W-23907	750-Ohm Flexible (Purple, brown spot, green end).....	.25	1	C-23630A	Tube and Condenser Shield..	.20
1	W-22873	220-Ohm Flexible (Red, brown spot, red end) .....	.30	1	W-23880	Thumb Screw .....	.05
1	W-22417	10-10-Ohm (divided) Resist-		3	G1-23472	Knob .....	.10
				1	LB-21932C	Tonnaboard Assembly .....	.20
				1	L-23734	1-H Cabinet (Play Boy) .....	5.10
				1	L-23730	1-J Cabinet (Cheerio) .....	20.35
				1	L-23732	1-K Cabinet (Merrymaker)..	28.35
				1	L-23802	1-L Cabinet (Announcer) .....	38.35
				1	L-23815	1-M Clock Cab. (Playtime)..	38.35
				1	L-23596	287 Speaker (1-H, 1-J Cab.)	8.00
				1	L-23804	306 Speaker (1-K, 1-L, 1-M Cabinet) .....	10.00
				1	LC-23813	Clock Assembly (110V 600c/y)	10.00
					L-23814	Clock Assembly (110V 500c/y)	10.00
					L-23831	Clock Assembly (110V 250c/y)	10.00
					L-23833	Clock Assembly (220V 250c/y)	10.00
					LC-24085	Clock Assembly (8 Day) .....	10.00

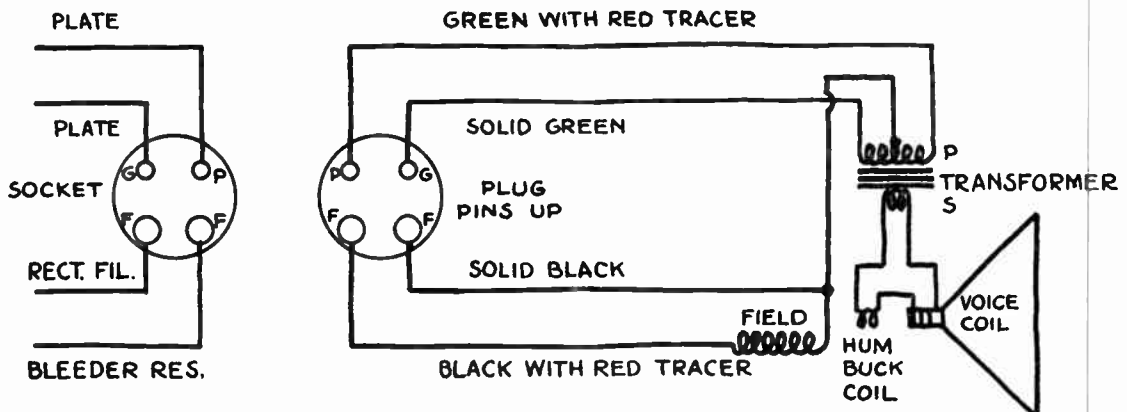
New List Prices On Fixed Condensers, Effective August 10, 1931

Part No.	Mfd. Capacity	List Price	Part No.	Mfd. Capacity	List Price
W-4013	1. ....	1.00	W-22995	.5 - .1 .....	1.00
W-4313	.5 .....	.75	W-4922	.003 .....	.30
W-4919	.5 .....	.75	W-4512	.0008 .....	.30
W-4924	.00025 .....	.25	W-2096	1. ....	1.25
W-4968	.5 .....	.75	W-2929	1. - 1. ....	2.50
W-5382	.00025 .....	.25	W-3207	1. ....	1.25
W-20499	.00025 .....	.25	W-3326	.1 - .1 .....	1.25
W-5943	.1 .....	.50	W-4233	.5 .....	.75
W-6171	.1 .....	.50	W-4232	.5 - .5 .....	1.50
W-6754	.001 .....	.25	W-4381B	.1 - .1 .....	1.50
W-7753	.1 - .5 - .1 .....	1.50	W-4381	.06 - .06 .....	1.50
W-7847	.0001 .....	.25	W-4760	.1 .....	.50
W-7944	.1 - .1 .....	.75	W-4606	.1 .....	.50
W-20103	.0002 .....	.25	W-5197	1. ....	1.25
W-20186	.25 - .3 - .25 .....	1.75	W-5863	.5 - .5 .....	1.75
W-23736	.25 - .5 - .25 .....	1.50	W-5862	.1 - .1 .....	1.75
W-20187	.25 .....	.75	W-6128	.5 - .5 .....	1.25
W-20188	.1 .....	.50	W-5522	.1 - .1 - .005 .....	1.50
W-20389	.00005 .....	.30	W-6434	.02 .....	.40
W-20446	.1 - .5 - .1 .....	1.50	W-23191	.01 .....	.25
W-20447	.1 .....	.65	W-22816B	.0015 - .02 - .0005 .....	.75
W-20448	.1 .....	.50	W-22244	.02 - .002 .....	.60
W-20449	.1 - .5 .....	1.15	W-20156	8. ....	4.00
W-23615	.05 .....	.25	W-21456	.1 - .1 - .1 .....	1.00
W-22412	.1 - .1 - .1 - .1 .....	1.10	W-22986	.0005 .....	.25
W-22688	.1 .....	.25			

Diagrams of Speaker Connections Models 122, 123, 124



SPEAKERS 297 AND 305-J FOR CHASSIS 122



SPEAKER 287 FOR CHASSIS 123; SPEAKERS 306-J AND 306-M FOR CHASSIS 124

# The Crosley Service Bulletin

No. A 3

The Crosley Radio Corporation, Cincinnati, Ohio

April 15, 1931

## Model 91

### Specifications

Model 91 is a chassis for installation in automobiles or motor boats. In many respects it is similar to Model 90, described in Crosley Service Supplement No. 11, but it incorporates many improvements.

### Installation Notes

The installation of this receiver is fully covered in the instruction book accompanying the receivers and in Crosley Service Supplement No. 9.

### Circuit

The circuit includes two stages of radio-frequency amplification, a detector and two stages of audio-frequency amplification. Type -24 tubes are used in the radio-frequency and detector stages, and type -12-A tubes in the audio-frequency stages.

The radio-frequency and detector grid circuits are tuned by variable condensers, operated simultaneously by the station selector on the control panel. These tuning condensers are shunted by small aligning condensers, used to adjust the radio-frequency circuits so that they are tuned together at a given station-selector setting. The aligning condensers may be reached from the front of the receiver, with the cover in place, through three small holes near the top of the cover. They should be adjusted with the cover in place and the receiver in operation, using a socket wrench to turn the adjusting screws.

For further information as to procedure in aligning condensers, refer to Crosley Service Supplement No. 7.

The power supply for this receiver is obtained from the car storage battery, and a 180 volt B battery. A unique feature of the receiver is that the various B and C voltages required are taken care of by resistance units in the receiver, so that but two leads are required for the B and C supply, connected to the plus and minus terminals of the B battery. This arrangement not only makes it simple to connect the receiver, but it insures longer life of the batteries. An equal drain is placed upon each battery, and this results in considerably longer service. Furthermore, because of the self-biasing feature it is unnecessary to make C battery adjustments as the B batteries decrease in voltage.

The ungrounded side of the car storage battery is connected to the filaments of the tubes. The return filament circuit is through the

grounded receiver frame. The filaments of the radio-frequency tubes are connected in series, so that each has a voltage across it from 2 to 2½ volts, depending upon the terminal voltage of the car storage battery. The audio-frequency filaments are in parallel. A ballast resistor of approximately 3 ohms is in the ungrounded side of the A circuit which is connected to these filaments.

The audio filaments are shunted by a two-section resistor, each section of which has a resistance of 25 ohms. The minus B lead is connected to the middle tap of this resistor, so that reversing the polarity of the A supply does not affect the B and C voltages applied to the audio tubes. This precaution is necessary on account of the fact that in some automobiles the positive side of the car storage battery is grounded, so that the negative side must be connected to the filament lead from the receiver control panel.

Upon examination of the circuit diagram, it will be seen that one branch of the positive B circuit goes through the armature of the speaker to the plate of the audio output tube, that another branch goes through the primary of the audio-frequency transformer to the plate of the first audio tube, and that a third branch goes to the detector and radio-frequency plates and screen grids. Connection to the detector plate is through a detector plate coupling resistor of approximately 150,000 ohms and a radio-frequency choke. Connection to the plate of the radio-frequency tubes is made through the primaries of the radio-frequency transformers. The screen grids of the radio-frequency tubes are connected together, and through a 60,000 ohm screen resistor to the positive B circuit. The screen grid of the detector tube is connected through a one megohm screen resistor to the positive B circuit.

The antenna circuit is connected to the first r. f. stage, the first r. f. stage to the second r. f. stage, and the second r. f. stage to the detector by means of air-core radio-frequency transformers. The detector is resistance coupled to the first audio stage, and the first audio stage is coupled to the output stage by an iron-core audio-frequency transformer.

Biasing of the audio-frequency tubes is accomplished by means of the voltage drop across a biasing resistor, of approximately 750 ohms resistance, in the minus B lead. The return B current from the radio-frequency and detector tubes flows from their emitters to the

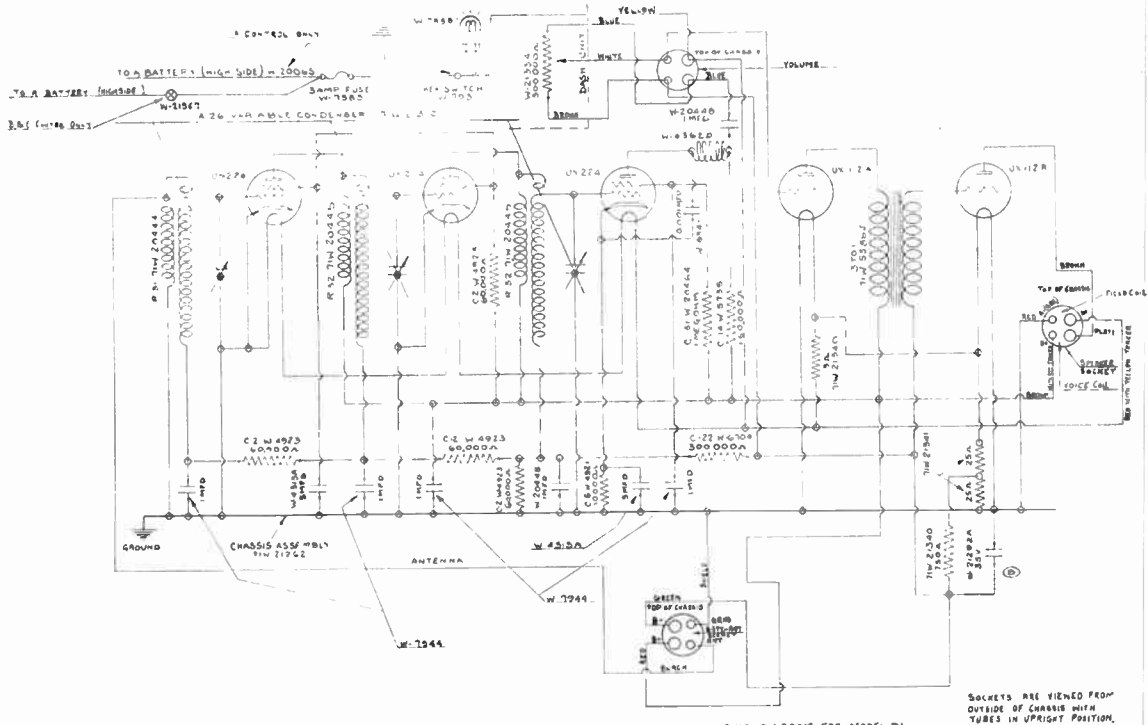


Fig. 1—Circuit Diagram Model 91

chassis and thence through a 60,000 ohm detector grid automatic volume control resistor and a 300,000 ohm bias resistor to the -B circuit. The 300,000 ohm resistor thus acts as a shunt bias resistor for the audio-frequency tubes. The drop in the automatic volume control resistor applies a bias to the grids of the detector and radio-frequency tubes. In addition there is a 10,000 ohm bias resistor in the emitter circuit of the detector tubes.

Manual volume control is obtained by means of the variable contact of the first audio grid-coupling resistor. Automatic volume control is accomplished in much the same way as in Model 77 and Model 84 chasses. If a signal of sufficient strength is received to cause current to flow in the grid circuit of the detector tube, the resultant drop due to grid current in the automatic volume control resistor increases the bias applied to the grids of the radio-frequency and detector tubes, thus automatically reducing the amplification. The grids of the radio-frequency tubes are connected to the negative side of this automatic volume control resistor through 60,000 ohm r. f. isolating resistors. One-tenth m. f. condensers complete the r. f. circuits from the radio-frequency and detector grids to the chassis.

A main bias by-pass condenser is connected from the -B circuit to the chassis. A 1/10 m. f. audio coupling condenser is used in the circuit

coupling the detector and first audio tubes. The 0.001 m. f. condenser shown shunted between the detector plate and detector emitter is for the purpose of by-passing radio-frequency current.

The field coil of the loud speaker obtains

(Continued on Page 4)

**Voltage Limits**

	For Rated Battery Voltages
<b>Filament Voltages</b>	
R. F. and Detector Tubes .....	2.0
A. F. Tubes .....	4.7
<b>Plate Voltages</b>	
R. F. Tubes .....	160-180
Detector Tube .....	40-50
A. F. Tubes .....	160-180
<b>Control Grid Voltages</b>	
R. F. Tubes .....	1.0-2.0
Detector Tube .....	2.0-3.0
A. F. Tubes .....	9.0-11.0
<b>Screen Grid Voltages</b>	
R. F. Tubes .....	90-110
Detector Tube .....	5-10

The above voltages are to be measured with the speaker connected and the tubes in place. For plate and grid voltages use a high-resistance (800 ohms or more per volt) D. C. voltmeter. Measure plate and grid voltages from plate or grid socket contact to negative filament contact.

Note: Correct measurement of 1st A F bias can only be obtained with volume control "off".



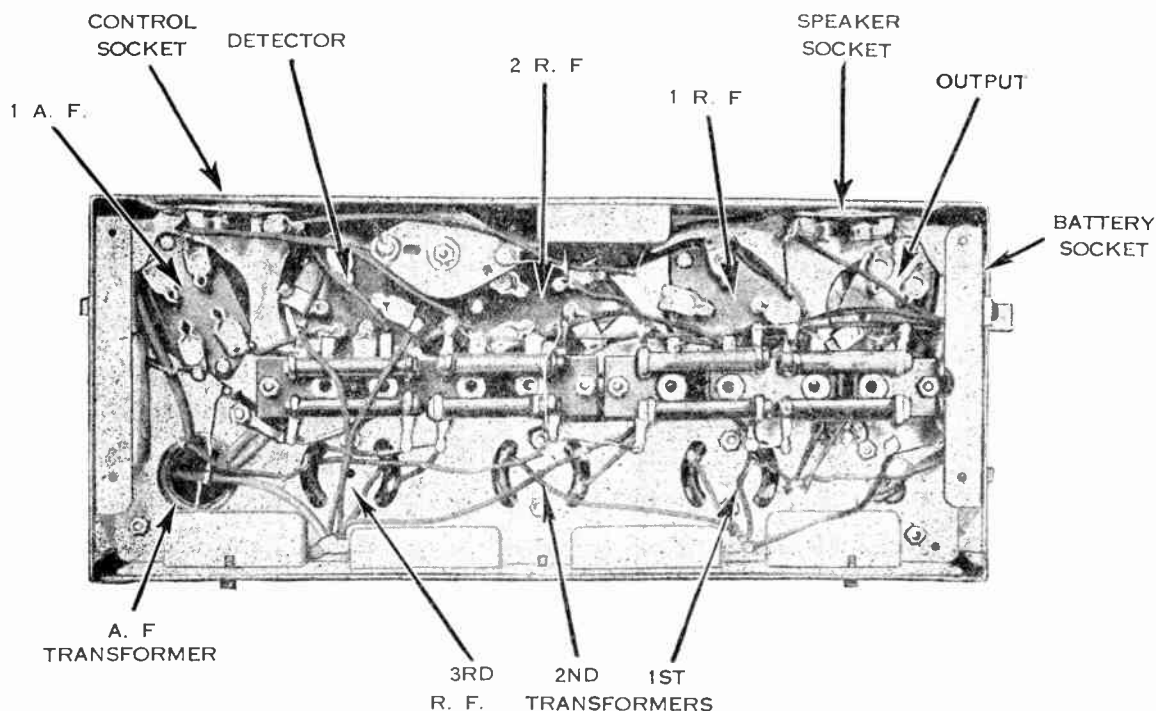


Fig. 2—Bottom View Model 91 Chassis

**Continuity Tests**

NOTE—In order to make the test procedure as simple as possible, certain tests are omitted which are taken care of by the voltage limits in the accompanying table.

Circuit	Remarks	Correct Test	Incorrect Test
<b>Using 50 Volt D. C. Voltmeter in Series With 45 Volt "B" Battery, or Other Standard Circuit Tester.</b>			
Antenna to Ground (Chassis)		Practically Full Scale (about 45 volts)	Open antenna transformer primary or faulty connections
Emitters to Chassis R. F. Stages		Practically Full Scale	Faulty connection or open circuit
Emitter to Chassis, Detector Stage		Part Scale	Faulty connection or open resistor shorted Condenser.
Operating Grids R. F. and Detector Stages to Chassis		Part Scale	No reading indicates open resistor or faulty connections. Full scale indicates short.
Operating Grids A. F. Stages to B—.	Volume Control connected but turned all the way off.	Part Scale	No reading indicates open resistor or faulty connections. Full scale indicates short.
Screen Grids R. F. and Detector Stages to B+.		Part Scale	No reading indicates open resistor or faulty connections. Full scale indicates short.
Plates R. F. and A. F. Stages to B+.	Speaker connected	Practically Full Scale	Faulty connections or open transformer primary or speaker armature
Plate Detector Stage to B+.		Part Scale	No reading indicates open choke, open resistor, or faulty connections. Full scale indicates short.

For methods of testing condensers, see Service Supplement No. 10, Page 3.

(Continued from Page 2)

its current from the A circuit.

The antenna tap is connected to the un-

grounded side of the antenna transformer primary. The ground connection is made by grounding the receiver chassis to the car frame.

**Parts List**

**INSTRUCTIONS FOR ORDERING**—Give part number, description of part, and serial number of receiver on which part is to be used. If article wanted is not listed separately, then that part of complete assembly containing this article should be ordered. Goods shipped on open account to Crosley Wholesale Distributors only. Cash must accompany Dealer and Consumer orders. Prices are subject to the usual trade discounts.

Qty.	Part No.	Description	List Price Each	Qty.	Part No.	Description	List Price Each
<b>CABINET</b>							
1	W-21888A	Housing .....	2.00		W-21315	<b>TYPE "A" DASH CONTROL COMPLETE</b> .....	7.00
1	W-21887	Front Cover .....	.50	2	W-7019	Knob .....	.20
1	W-21553A	Drive Bracket Hole Cover .....	.10	2	W-7047	Spring .....	.05
1	W-21554A	Drive Bracket Cover .....	.15	1	W-7046	Fuse Panel .....	.35
1	B-21555A	Chassis Bottom .....	.25	1	W-7959C	Mounting Plate & Dial Light Clip Assembly .....	.80
1	W-21714	Battery Plug Bracket .....	.10	1	W-21316	Dial & Gear .....	.50
<b>CHASSIS</b>							
1	C-21528	Chassis .....	.75	1	W-7928A	Escutcheon .....	.80
5	W-7871	Socket (4 Prong) .....	.25	1	W-7931A	Key Switch .....	1.25
3	W-7873	Socket (5 Prong) .....	.30	1	W-7907A	Pinion .....	.20
2	W-7872	Socket Guide .....	.10	1	W-7958A	Pinion Shaft .....	.15
3	W-7874	Socket Guide .....	.10	1	W-21334	Volume Control .....	1.75
1	W-21622	Socket Guide (Speaker) .....	.10	2	W-7880	Mounting Clamp .....	.05
1	W-21623	Socket Guide (Volume Control) .....	.10	1	W-7882A	Dial Light Receptacle .....	.05
1	W-21624	Socket Guide (Battery-Antenna) .....	.10	1	W-4907	Tension Spring .....	.05
2	W-20445	R. F. Transformer .....	2.50	1	W-4751A	Cable Clamp .....	.05
1	W-20444	R. F. Transformer (Antenna) .....	2.50	1	W-7012A	Dial Bushing .....	.10
3	W-22208	Grid Connection .....	.25	1	W-7983A	Fuse (3 amp.) .....	.10
3	W-20092C	R. F. Coil Shields .....	.50	1	W-20057	Key Switch Insulator Sleeve .....	.05
1	W-21292A	Electrolytic Condenser .....	2.00	1	W-20069	Switch to Fuse Lead .....	.10
1	W-5385	A. F. Transformer .....	3.25	1	B-21368A	Dash Control Cable (Standard 20" long) .....	1.25
1	W-21310	Variable Condenser Assembly .....	12.00	1	B-21386A	Dash Control Cable (Special 32" long) .....	2.50
2	B-21325	Tube Shield .....	.20	1	W-7908	Adapter Shaft .....	.10
<b>DRIVE</b>							
1	W-21300	Condenser Drive Assembly .....	3.25	1	W-21308	<b>TYPE "B" DASH CONTROL COMPLETE</b> .....	7.00
	W-21547	Spindle Stop .....	.10	1	W-21935	<b>TYPE "C" DASH CONTROL COMPLETE</b> .....	7.00
2	K-1	Cotter Pin .....	.05	1	W-21556	Dial & Gear .....	.50
2	W-20157	Set Screw .....	.05	1	W-21557	Pinion .....	.20
1	W-21548	Stop Nut .....	.10	1	W-21558	Pinion Shaft .....	.15
1	W-21540	Drive Spindle .....	1.00	1	W-21559	Pinion Shaft Spacer .....	.05
1	R-21550	Condenser Drive Pulley .....	1.25	2	W-4907	Tension Spring .....	.05
1	W-20634	Condenser Drive Cord (2 used) .....	.25	1	W-21560	Drive Support Bracket .....	.10
	W-21968	Tension Spring .....	.25	1	W-7946	Fuse Panel .....	.35
	W-21551	Spindle Stop Spring .....	.15	1	W-21561	Sub-Panel .....	.80
1	W-21575	Condenser Drive Bracket Assembly .....	.75	1	W-21365	Cable Clip .....	.05
<b>PARTS UNDER CHASSIS</b>							
2	W-4313	.5 Mfd. Fixed Condenser .....	1.20	1	W-21334	Volume Control .....	1.75
2	W-7944	.1-1 Mfd. Fixed Condenser .....	1.10	1	W-7983A	Fuse (3 amp.) .....	.10
2	W-20448	.1 Mfd. Fixed Condenser .....	1.00	1	W-21562	Dial Light Socket .....	.25
1	W-4362	Plate Choke .....	.50	1	W-21563	Dial Stud .....	.05
1	W-6941	.001 Fixed Condenser .....	.40	1	W-21564	Dial Light Housing .....	.10
1	W-21341	Mounted Resistor Assembly .....	3.30	1	W-2282C	Fibre Washer .....	.05
1	W-21574	25 -25 Ohm Resistance .....	.60	1	W-7931A	Key Switch .....	1.25
3	W-4923	60,000 Ohm Resistor .....	.60	2	W-20068	Switch Leads (18" long) .....	.05
1	W-5735	150,000 Ohm Resistor .....	.60	1	W-21565	Escutcheon (large, for type B) .....	.80
1	W-21340	Mounted Resistor Assembly .....	3.30	1	W-21600	Escutcheon (small, for type C) .....	.50
1	W-21573	3 -750 Ohm Resistance .....	.60	2	W-5311	Screw (for type B) .....	.05
	W-4921	10,000 Ohm Resistor .....	.60	2	W-21936	Mounting Clamp (for type C) .....	.10
	W-4923	60,000 Ohm Resistor .....	.60	2	W-21937	Mounting Screw (for type C) .....	.05
	W-6704	300,000 Ohm Resistor .....	.60	2	W-7919	Knob .....	.20
	W-20464	1 Meg. Resistor .....	.60	2	W-7947	Spring .....	.05
<b>MISCELLANEOUS</b>							
1	W-21362	Battery Box (Standard type) .....	2.00	1	W-21368A	Dash Control Cable (Standard 20" long) .....	1.25
1	W-21363	Battery Box Lid (Standard type) .....	.75	1	W-21386A	Dash Control Cable (Special 32" long) .....	2.50
1	W-21365	Cable Clip .....	.05	1	C-21617A	<b>279 SPEAKER</b> Speaker Frame .....	1.75
1	W-22337	Battery Box (Oblong type) .....	2.00	1	W-21655	Type C Dynacone Motor Assembly .....	8.00
1	W-22338	Battery Box Lid (Oblong type) .....	.75	1	W-21619	Name Plate .....	.50
1	W-21572	"B" Battery Fuse Unit Assembly .....	.50	1	W-21659A	Cone .....	1.00
	W-20109	Fuse (1/4 amp.) .....	.10	1	W-1629G	Outer Cone Nut .....	.05
2	W-21370	"B" Battery Connector Cable .....	.10	1	W-1495J	Outer Cone Clamp .....	.05
2	W-20284	Universal Joint .....	1.00	1	W-1496K	Inner Cone Clamp .....	.05
1	W-7941	Drive Shaft (12" long) .....	.10	1	W-5874	Inner Cone Nut .....	.05
7	B-21367B	Battery Cable (8' 6" long) .....	4.00	1	B-21369A	Speaker Cable (Standard 10 1-2" long) .....	.75
3	W-4751A	Cable Clamp .....	.05	1	B-21649A	Speaker Cable (Special 30" long) .....	2.00
	W-20068	Eliminator .....	.80				
	W-20070	Spark Plug Suppressor .....	.60				
	W-20071	Distributor Head Suppressor .....	.70				

# The Crosley Service Bulletin

No. A-4

The Crosley Radio Corporation, Cincinnati, Ohio.

October 1, 1931

## Model 125

### Specifications

This is a midget superheterodyne, utilizing five tubes. It is for operation from A. C. house-lighting circuits, 110 volts 60 cycles, 110 volts 25 to 50 cycles, or 220 volts 25 to 60 cycles.

The five tubes are: a -24 type combined oscillator and first detector, a -35 or -51 variable mu intermediate frequency amplifier, a -24 screen grid detector, a -47 or PZ pentode output tube, and a -80 rectifier.

### Installation Notes

An indoor antenna or an outdoor aerial of moderate length may be used. The sensitivity of this receiver is about the same as that of a moderate size tuned radio frequency receiver, and it may be used satisfactorily with any aerial which would be adequate for such a receiver.

Be sure to use only tubes of the best quality in the -24 oscillator socket. Proper results cannot be obtained with a poor oscillator tube.

### Circuit

The operation of the superheterodyne circuit, and the general characteristics of superheterodyne receivers are discussed in Service Bulletin A-1.

The circuit of this receiver is necessarily somewhat different from the circuits of other Crosley superheterodynes, previously described, because of the simplifications that have been introduced in order to limit the number of tubes to five.

Instead of being coupled directly to the first tube, as in other Crosley models, the antenna-ground system is coupled to the detector-oscillator through a double tuned selector circuit. This increases the selectivity of the circuit.

The first tube acts both as a detector and oscillator. The oscillator circuit is tuned by a variable condenser—one of the three comprising the station selector gang—as shown on the diagram. The other two station selector condensers tune the grid circuit of the detector-oscillator and the pre-selector circuit.

The detector-oscillator is coupled to the intermediate frequency amplifier stage by an I. F. transformer, both primary and secondary of which are tuned to 175 kilocycles by small adjustable condensers shunted across them. These circuits must be tuned accurately to 175 kilocycles for efficient operation. A radio-frequency choke is in the grid circuit of the I. F. tube.

The I. F. amplifier tube is coupled to the second detector by an untuned intermediate frequency transformer.

There is an r. f. choke in the second detector plate circuit, the ends of which are grounded through by-pass condensers of 0.0005 and 0.00025 m. f. capacity. The second detector is resistance coupled to the audio-output tube by means of a 300,000 ohm detector plate coupling resistor and a 0.02 m. f. coupling condenser. The negative end of the coupling resistor is grounded through a 0.1 m. f. hum filter condenser.

A grid leak of 1 megohm resistance is connected in the audio grid circuit. Tone control is accomplished by means of a 0.05 m. f. condenser in series with a variable resistor, connected from the audio plate to ground.

The power transformer has a switch in its primary circuit. There are three secondaries. One supplies the filament of the -80 tube, a second supplies the filaments of all the other tubes, and the third supplies the high voltage to the plates of the -80 rectifier tube.

The negative plate supply circuit is connected from a middle tap on the high-voltage power transformer secondary through a 350 ohm audio biasing resistor to the chassis and to the middle of a resistor across the filament leads to the tubes.

The positive plate supply circuit, from the rectifier filament, is connected directly to one side of the 8. m.f. filter condenser, and through the speaker field to the plates, etc., of the various tubes. Upon returning to the receiver, this positive circuit is connected to one side of the 6 m. f. filter condenser. Thence it continues through a 40,000 ohm detector plate hum filter resistor, and then branches, one side going through the plate coupling resistor, and detector plate choke to the plate of the second detector, and the other branch going through the oscillator coil, and the first I. F. transformer primary to the plate of the detector-oscillator tube. From the high side of the 40,000 ohm series resistor, a branch of the circuit passes through a 20,000 ohm screen resistor to the screen grids of the detector-oscillator and I. F. amplifier tubes and through an additional resistor of 1 megohm resistance to the screen grid of the second detector. The low side of the 20,000 ohm screen resistor is by-passed to ground through a 0.1 m. f. condenser. A 15,000 ohm resistor is connected

from the low side of the 20,000 ohm resistor to the emitter of the I. F. amplifier.

The biasing of the various tubes is accomplished by the voltage drops in resistors. A 6,500 ohm resistor in the emitter circuit of the detector-oscillator tube supplies the necessary bias for that stage. This bias resistor is shunted by a 0.001 m. f. by-pass condenser. The bias resistor in the emitter circuit of the I. F. amplifier is part of the volume control unit. The volume is varied by simultaneously changing the volume of this stage and the value of a resistor shunted across the antenna coil from aerial to ground. A 40,000 ohm resistor is used in the second detector emitter circuit for biasing. The audio tube is biased by the previously mentioned 350 ohm resistor connected in a circuit which leads from a mid tap on the filament shunt resistor through a 1 megohm audio grid hum filter condenser and the 1 megohm audio grid leak to the grid of the audio tube.

**Alignment of Tuning Condensers and Intermediate Frequency Amplifier**

The tuning condenser adjustments are made densers and the intermediate frequency amplifier is exactly the same as that for Model 122, described in Service Bulletin No. A2.

The timing condenser adjustments are made from the top of the chassis through the three

holes in the condenser shield; the I. F. transformer adjustments through the holes at the left side of the chassis, near the front, as viewed from the front of the receiver.

**Voltage Limits**

The following data shows the average voltages which will be obtained when measurements are made on Model 125 Chassis using a voltmeter of 1000 ohms resistance per volt. Some of these voltages do not represent actual voltages present at the tube elements. A typical example of this is the grid voltage of the pentode tube, which is actually about 16 volts, but only shows about 1 volt when measured in this way.

**Screen Grid Voltages**

- Pentode ..200 to 230
- I. F. .... 75 to 95
- 1st Det. ... 75 to 95
- 2nd Det. 15 to 25 (250V scale), 3-8 (50V scale)

**Plate Voltages**

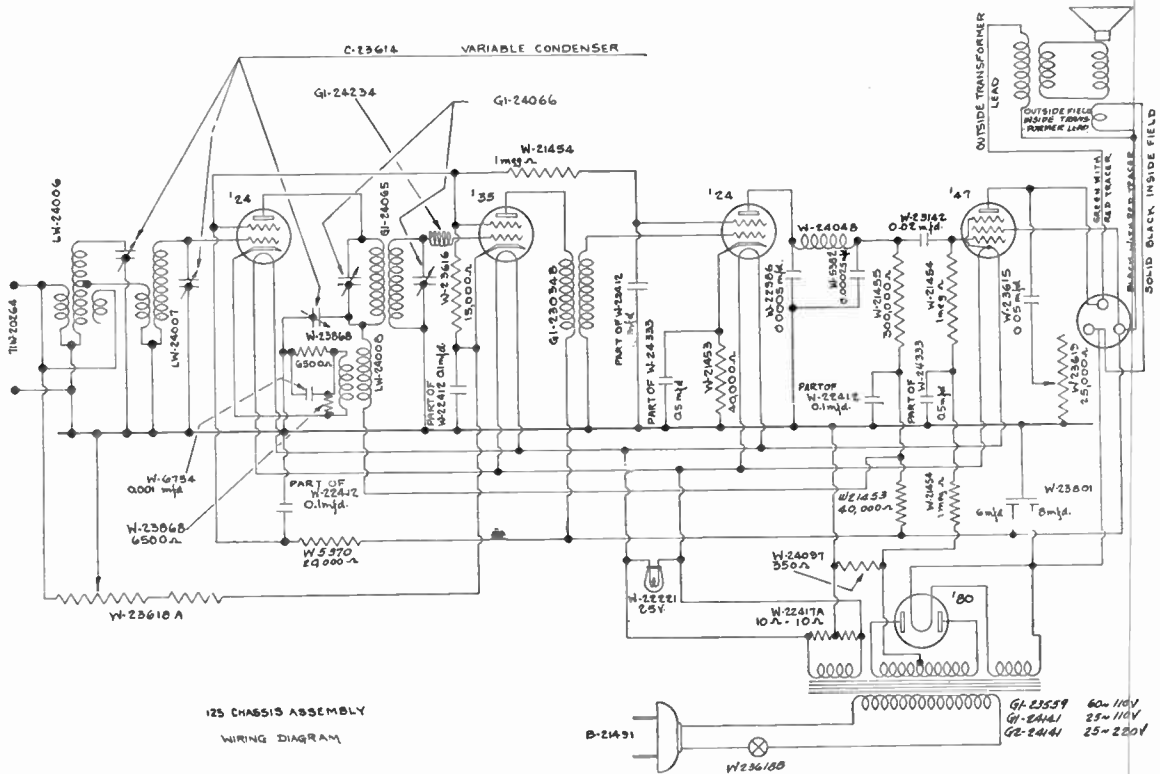
- Pentode 200 to 230
- I. F. ....200 to 230
- 1st Det. ..160 to 180
- 2nd Det. 75 to 90 (250V scale), 20-30 (50V scale)

**Control Grid Voltages**

- Pentode ..0.5 to 1.5
- I. F. ....1.5 to 2.5 (20-30 vol. cont. off)
- 1st Det. ..5.5 to 7.5
- 2nd Det. ..4.0 to 6.0

**Filament Voltages**

- All tubes but rectifier .....2.3 to 2.5
- Rectifier tube .....4.6 to 5.0





## SPECIFICATIONS

The Crosley Model A-157 auto radio is a single unit, five-tube superheterodyne receiver, incorporating A. V. C. and many advanced features in circuit design. The power supply unit is an integral part of the receiver chassis and uses a primary type vibrator.

## TUBES AND VOLTAGE LIMITS

The following table gives the functions of the tubes

used, together with the voltage readings between the tube socket contacts and the receiver chassis. Voltage readings taken with a 1000 ohm per volt, 500 volt voltmeter (except filaments) with receiver in operating condition and no signal input. The filament voltages should be measured with an accurate low range D.C. voltmeter (approximately 0 to 10 volts). Voltage limits may vary plus or minus 10% of values given.

### TUBE SOCKET VOLTAGE READINGS

Tube	Function	H	P	S	Su	K	Ga	Go
6A8-G	Oscillator-Modulator	6.0	220	90	—	0	90	0
6U7-G	I-F Amplifier	6.0	220	90	0	0	—	—
6Q7-G	Diode Detector & A-F Amp.	6.0	110	—	—	0	—	—
6K6-G	Output	6.0	200	220	—	0	—	—
6X5-G	Rectifier	6.0	—	—	—	220	—	—

Power Output approximately 4 Watts.  
 Battery Drain approximately 5.7 Amperes at 6 Volts.

## ALIGNMENT PROCEDURE

All the circuits in this receiver are very accurately adjusted at the factory and normally should need no further adjustment. However, if it is definitely known that an adjustment is necessary the circuits can best be properly aligned with the use of a modulated signal generator and an output meter.

### CONNECTING OUTPUT METER

Connect the output meter to P and S of the 6K6G Output tube. Be sure the meter is protected from D.C. by connecting a condenser (.1 mfd. or larger—not electrolytic) in series with one of the leads.

#### 1. Tuning I-F Amplifier To 455 Kilocycles.

(a) Connect the output of the signal generator through a .02 mfd., or larger, condenser to the top cap of the 6A8G Osc-Mod. tube, leaving the tube's grid clip in place. Connect the ground lead from the signal generator to the receiver chassis frame. **KEEP THE GENERATOR LEADS AS FAR AS POSSIBLE FROM THE GRID LEADS OF THE OTHER SCREEN GRID TUBES.**

(b) Adjust the station selector so that the rotor plates of the tuning condenser are completely disengaged and turn Vol. Cont. to maximum position (RIGHT).

(c) Set the signal generator to 455 kilocycles.

(d) Adjust both trimmers located on the 2nd I-F transformer for maximum output. Fig. 2.

(e) Adjust both trimmers located on the 1st I-F transformer for maximum output.

(f) Repeat operations (d) and (e) for more accurate adjustments.

**IN ORDER TO PREVENT A. V. C. ACTION ALWAYS USE THE LOWEST SIGNAL GENERATOR OUTPUT THAT WILL GIVE A REASONABLE OUTPUT METER READING.**

#### 2. Aligning R-F Amplifier.

(a) Connect the output lead from the signal generator through a .00025 mfd. condenser to the "ANT" connection of the receiver.

(b) Set the signal generator to 1400 kilocycles.

(c) Adjust the station selector to 140 on the dial.

(d) Adjust the trimmer on the "OSC" section of the tuning condenser for maximum output.

(e) Adjust the trimmer on the "ANT" section of the tuning condenser for maximum output.

(f) Readjust the station selector for maximum output. **DO NOT READJUST THE OSC. TRIMMER.**

(g) Repeat operation (e) for more accurate adjustment.

#### 3. Adjusting Antenna Compensating Condenser.

(a) Set the signal generator to 600 kilocycles.

(b) Tune in the 600 kilocycle signal with the station selector for maximum output.

(c) Adjust the antenna compensating condenser. Illustration No. 9, Fig. 3, for maximum output.

(d) Repeat operations (b) and (c) alternately until no further improvement can be obtained.

(e) Set the signal generator to 1400 kilocycles again.

(f) Tune-in the 1400 kilocycle signal with the station selector for maximum output.

(g) Readjust the trimmer on the "ANT" section of the tuning condenser for maximum output.

It will be necessary to adjust the antenna compensating condenser to the car antenna after the receiver has been installed in the car.

(a) After the installation is complete, tune-in a WEAK station between 55 and 65 on the dial.

(b) Adjust the antenna compensating condenser for maximum volume in the speaker.

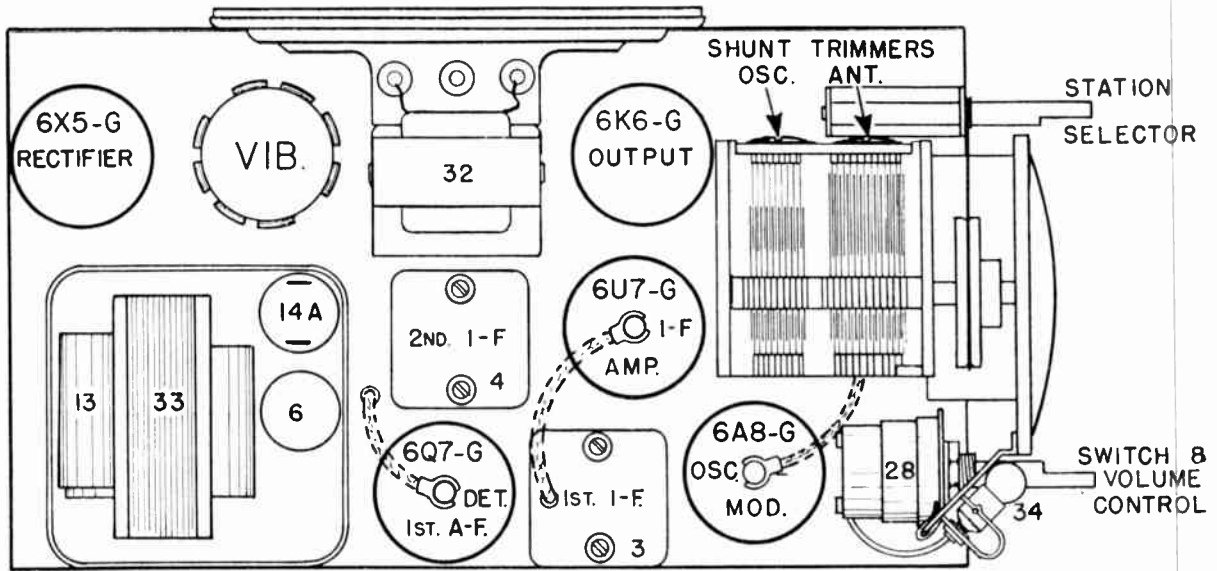


Fig. 2 Top View A-157

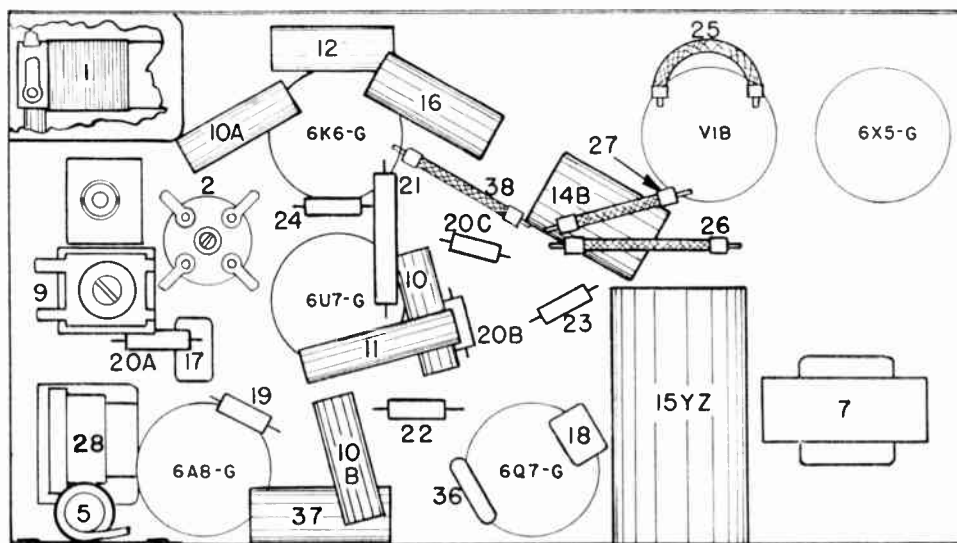


Fig. 3 Bottom View A-157

## PARTS LIST—MODEL A-157

Figures in first column refer to parts in Diagrams.

Item No.	Part No.	Description	Item No.	Part No.	Description
1	G137-32000	Antenna Coil	26	W -23012A	Resistor 40 Ohm $\frac{3}{4}$ W.
2	G137-32002	Oscillator Coil	27	W -24537	Resistor 60 Ohm $\frac{1}{2}$ W.
3	G149-32004	1st I-F Assembly, 455 Kc.	28	-50042	Vol. Cont. 1 Meg. & Switch
4	G148-32004	2nd I-F Assembly, 455 Kc.	29	G178-36400	Socket, Octal
5	G16 -32977	Motor Noise Choke		W -50142	Tube Shield, Plain Half
6	G21 -28067	"A" Filter Choke		W -50143	Tube Shield, Cut-out Half
7	G16 -29535	"B" Filter Choke		W -31210	Tube Shield Ring
8	G36 -33001	Var. Tuning Cond., 2 Section	30		NONE
	C -50137	Dial Face (Glass)	31	G105-28807	Socket (Vibrator)
	W -50135	Support Ring (Dial)		W -50123	Gnd. Clip (Vibrator)
	B -50136	Support Bracket (Dial)	32	263-BL7 "U"	Speaker, Spec. 5-S-21
	W -50133	Dial Mask		-44062	V. C. & Cone Assembly
	G2 -43564	Pulley and Hub Assembly		-44063	Output Trans.
	-41582	Drive Cord	33	G15 -32769	Power Transformer
	W -50134	Shaft (Drive)		W -50130	P. T. Shield
	W -50128	Mtg. Bracket (Shaft)	34	W -43567	Dial Light Bulb
	W -43549	Retaining Ring (Shaft)		W -43568	Bracket—Dial Light
9	-38998A	Condenser Ant. Comp.	35	G25 -32750	"A" Lead Assembly
10ABC	W -32380	Condenser .05 Mf. 200 V.		W -32757	Fuse, 12 Amp.
11	W -37226	Condenser .02 Mf. 160 V.		W -32777	Fuse Cap (Female)
12	W -23191A	Condenser .01 Mf. 400 V.		W -32776	Fuse Insulator
13	W -50170	Condenser .01 Mf. 1000 V.		W -31393	Fuse Cap (Male)
14AB	W -50161	Condenser .5 Mf. 120 V.	36	G6 -34002	Condenser .000025 Mfd. 200 V.
15ZY	W -50160	Condenser 4 Mf. 350 V.	37	W -32750	Condenser .05 Mfd. 400 V.
16	W -50105	Condenser .1 Mf. 160 V.	38	W -22514	Resistor 750 Ohm $\frac{1}{2}$ W.
17	G1 -34002	Condenser .00025 Mf. 200 V.	38	W -35581	Resistor 1000 Ohm $\frac{3}{4}$ W.
18	G3 -34002	Condenser .0005 Mf. 200 V.		W -38038I	Distr. Suppressor
19	-35928	Resistor 60,000 Ohm $\frac{1}{4}$ W.		W -29754	Gen. Condenser
20ABC	-35601	Resistor 300,000 Ohm $\frac{1}{4}$ W.		W -50167	Mtg. Bracket (Set)
21	-37377	Resistor 20,000 Ohm 1W.		-25846	Mtg. Screw (Set)
22	-35602	Resistor 1 Megohm $\frac{1}{4}$ W.		-6213	Mtg. Nut
23	-35927	Resistor 2 Megohm $\frac{1}{4}$ W.		-35065	Mtg. Bolt
24	-36322	Resistor 500,000 Ohm $\frac{1}{4}$ W.		-35147B	Ant. Connecting Lead (Extra)
25	W -35467	Resistor 220 Ohm $\frac{1}{2}$ W.		W -50164	Knob

