MODEL D-51

Five-Tube, Superheterodyne, Automobile Receiver

ELECTRICAL SPECIFICATIONS

Power Supply	6.3 Volts (Storage Battery)
Current Consumption	5.8 Amperes
Tuning Range	540 KC. to 1600 KC.
Maximum Power Output	3.5 Watts (Audio)
Undistorted Power Output	1.75 Watts (Audio)
Loudspeaker Size and Type	6 Inch-Electrodynamic
Pilot Lamp	Mazda No. 50, 6–8 Volts
Radiotron Complement	(1) G.E.-6D6 RF. Amplifier (2) G.E.-6A7 Oscillator and First Detector (3) G.E.-6D6 IF. Amplifier (4) G.E.-6B7 Second Detector, AF. Amplifier and AVC. (5) G.E.-41 Power Output
Alignment Frequencies	175 KC. (IF.); 1400 KC. (RF.); 600 KC. (RF.)

PHYSICAL SPECIFICATIONS

Receiver Case Dimensions	
Height	9 Inches
Width	9 Inches
Depth	6 Inches
Operating Controls	(1) Station Selector (2) Volume Control–Battery Switch (3) Speech Control

GENERAL DESCRIPTION

This automobile receiver represents the results of thorough development, design, and substantial manufacture. Noteworthy technical improvements have been applied in achieving marked advantages of installation, operation, and efficiency of performance.

Model D-51 is a single unit receiver; containing the radio chassis, power conversion adjunct and loudspeaker all in one housing.

New engineering features incorporated in this instrument are: the inclusion of ignition suppression means within the circuits of the receiver; a "speech control" switch for improving reproduction of a continuous program of talking; a "plug-in" type of synchronous rectifier-vibrator for obtaining high voltage plate supply; and a "stream-lined" control unit.

The receiver is compactly constructed without sacrifice of electrical efficiency. Mounting supports consist of three 1/4 inch studs, which lessen the dangers of the set vibrating as a unit, but rather maintaining the same rigidity as the structure to which it is attached.

The main operating controls are located on the remote control unit which normally mounts on the steering column. A subordinate "speech control" is mounted on the receiver case.

DESCRIPTION OF ELECTRICAL CIRCUIT

The electrical arrangement of the receiver is pictured in the schematic of Figure 2. A corresponding wiring layout is shown in Figure 3, where the actual physical relations of parts and coding of conductors are given.

Five Radiotrons are used, forming the total tube complement around which the superheterodyne circuit is built. In sequence, there is an r-f stage, a dual first detector-oscillator stage, a single i-f stage, a second detector-audio amplifier-a.v.c. stage, and a pentode output stage. Five tuned circuits operate upon the desired signal to strengthen its magnitude and reject the undesired signals and interference.

Current for operation of the receiver is obtained from a standard 6.3 volt storage battery. This current is filtered through several chokes and by-passed to ground by a number of capacitors before being applied to the Radiotron filaments and the high voltage conversion unit. The number and arrangement of the filter elements is such as to gain a very great reduction in the amount of interference conducted into the r-f circuits by the current supply wiring.

The following details elaborate the functions and features of the various stages of the receiver:

Starting at the antenna, an r-f signal is impressed across a special transmission line, which in conjunction with a "noise filter," acts selectively to the entire standard broadcast range and drastically attenuates signals and interference outside the limits of the band (540–1600 kc.). Instead of the ground for the antenna input coil appearing at the usual point on the chassis frame, the low end of the coil is extended as part of the transmission line to the outer termination of the antenna lead-in shield, where it grounds to the frame of the car. With this arrangement, the r-f disturbances circulating in the car frame (ground) do not become mutual to the receiver input. The transmission line section of the antenna lead-in also has characteristics favorable to the operation of the "noise filter." Its length, conductor sizes, insulation, etc., are precisely designed to have a critical capacitance (represented by dotted lines on schematic), which resonates with the inductance of the input system to produce a band-pass filter having an acceptance band between 540 kc. and 1600 kc., and sharply defined cut-off below and above these two limits. By using this antenna filter system and minimizing capacity coupling between primary and secondary of antenna coupling transformer, it is generally possible to dispense with the usual spark plug and distributor suppressors, without encountering serious interference on latest types of cars.

The signal is passed from the input coil by transformer action to the r-f stage control grid. A G.E.-6D6 at this point performs the function of an r-f amplifier, its super-control property being adapted as means of preventing cross-modulation and securing a wide range of automatic volume control. The first (front) section of the tuning condenser is connected to sharply tune the secondary of the antenna coupling transformer.

A second r-f coupling transformer transmits the signal to the following receiver stage, which comprises a combination first detector and local oscillator. The secondary inductance of this transformer is tuned by the second (center) section of the variable capacitor and connects to the detector grid of the G-E.-6A7 Radiotron. By proper arrangement of the several elements within this tube, a local oscillator system is established, which generates the correct frequency and causes it to mix with the incoming signal. The difference frequency beat (i-f) of these two combined signals is detected by the tube and transferred by a closely coupled transformer to the intermediate frequency amplifier tube, a G.E.-6D6. Both windings of this i-f transformer are tuned by trimmers. The second i-f transformer which joins the G.E.-6D6 tube to the second detector stage has only one trimmer, that being in shunt with its primary winding.

The G.E.-6B7 second detector stage receives the i-f signal on its diode plates. Detection takes place as a result of the rectifying action of the diodes and develops a current through resistors R7 and R17. The d-c voltage drop in the resistance R7 plus R17 is used for automatically regulating the control grid bias of the r-f and first detector stage, and thus the amplification becomes dependent upon the signal strength. This process (a.v.c.) compensates for fading signals and reduction of signals due to change of antenna direction and shielding effects of buildings, bridges, etc. A smaller portion of the d-c voltage obtained by detection is tapped from the juncture of R7 and R17 and carried to the control grid of the i-f stage. This likewise furnishes automatic volume control.

The audio and d-c components of the detected signal are selected from the manual volume control resistor (R17) by its movable arm, and applied to the control grid of the G.E.-6B7; amplification results and the signal passes on to the power output stage. The variable d-c applied to the grid prevents overload. A resistance-capacitance coupling system conveys the signal from the second detector stage to the G.E.-41 output tube. In this coupling arrangement, a "speech" control is used for shorting capacitor C34, the effect in the open position being attenuation of the lower frequencies and consequent improvement of speech intelligibility. The circuit composed of R21 and C37 effects the proper fidelity balance.

The power amplifier stage delivers to the loudspeaker a high level audio signal. Correct matching relations between the speaker and output stage are maintained by the output transformer.

Heater connections of the Radiotrons are wired multiple, and supplied through a carefully filtered system. One heater terminal of each tube is grounded.

High voltage for plate and bias supply is generated by inversion, transformation and mechanical rectification; these three functions occurring in the "synchronous rectifier-vibrator." This vibrator is adapted for convenient removability by having its base constructed for "plug-in" mounting. Simple means are provided for correcting the vibrator input to agree with the ground polarity of the car by having the vibrator reversible. The vibrator may be inserted in two possible positions. As normally shipped, it is plugged in to operate with "positive" car ground. On a car having "negative ground," it will be necessary to withdraw the vibrator, rotate the unit 180 degrees and re-insert into the new position.

SERVICE DATA

The general mechanical layout of the receiver is judiciously arranged to facilitate tests, adjustments and repairs that may become necessary. All pertinent information needed for proper servicing is presented by the schematics, wiring diagrams and the text of this booklet. Resistor and capacitor values are shown adjacent to their respective parts on the diagrams. Note that d-c resistances are given for all inductive coils and windings.

LINE-UP ADJUSTMENTS

As in all standard receivers, this instrument must be in correct electrical alignment in order to obtain maximum efficiency and best quality of performance. The circuits should be re-aligned after each major servicing or repair operation, and whenever there are positive indications that the adjustments have

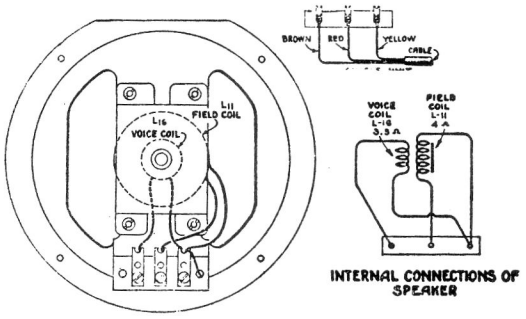

Figure 1—Loudspeaker Wiring

deviated from normal by ordinary usage. These indications will be present together and will have the nature of low sensitivity, poor tone quality, and irregular double-peaked tuning.

The important requirements in re-adjusting the line-up trimmers are the use of proper oscillator and indication equipment and adherence to a definite procedure. Certain standard service instruments, useful for receiver adjustments, have been devised and made available by the manufacturer of this receiver. These are illustrated and described on page 2.

(1) PREPARATORY DETAILS

(a) Dial Calibration—The tuning-condenser flexible shaft operates the dial pointer through a gear mechanism within the control unit. To adjust their mechanical relations so that accurate scale calibration obtains:—Rotate the station selector knob until the variable tuning capacitor is at full mesh, which will carry the dial pointer to its minimum frequency position; then remove the tuning knob, loosen the set screw in the bushing and rotate the bushing until the pointer sets exactly opposite the last radial line at the low frequency end of the scale. (The line referred to is the second one counter-clockwise of the 550 kc. mark.)

(b) General Procedure—The "Output Indicator" should be attached to the voice coil circuit of the loudspeaker, and for each adjustment, the oscillator output increased until a noticeable registration or glow occurs on the indicator. The signal from the oscillator should be held as low as possible consistent with getting a good indication, with the receiver volume control set at its maximum position. This method of procedure prevents the automatic volume control from affecting the adjustments.

(2) I. F. ADJUSTMENTS

Three trimmers are provided in the i-f system, two on the first transformer and one on the second transformer. The locations of the adjustment screws are shown in Figure 4.

(a) Tune the "Full Range Oscillator" to 175 kc. and connect its output to the first detector control grid and chassis ground. Tune the station selector to a point where no signals are received.

(b) Tune each of the trimmer capacitors, C17, C14 and C13, in order. C17 should be set for maximum (peak) output. C14 and C13 should be roughly adjusted for maximum output and then carefully "trimmed" so that a flat-topped response is obtained. This may be checked by shifting the external oscillator frequency through a range two kilocycles each side of 175 kc. and noting whether or not the receiver output remains substantially constant.

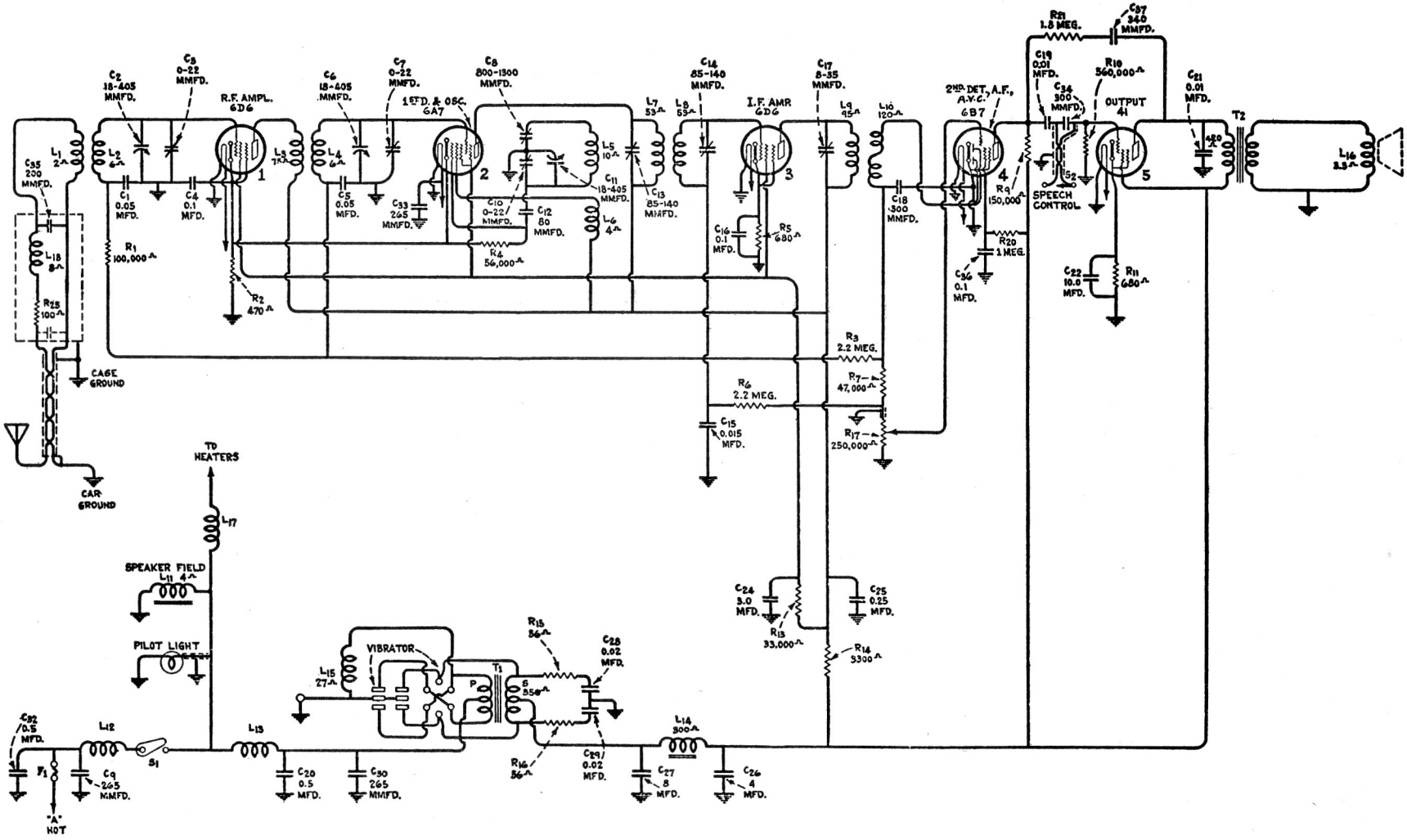

Figure 2—Schematic Circuit Diagram

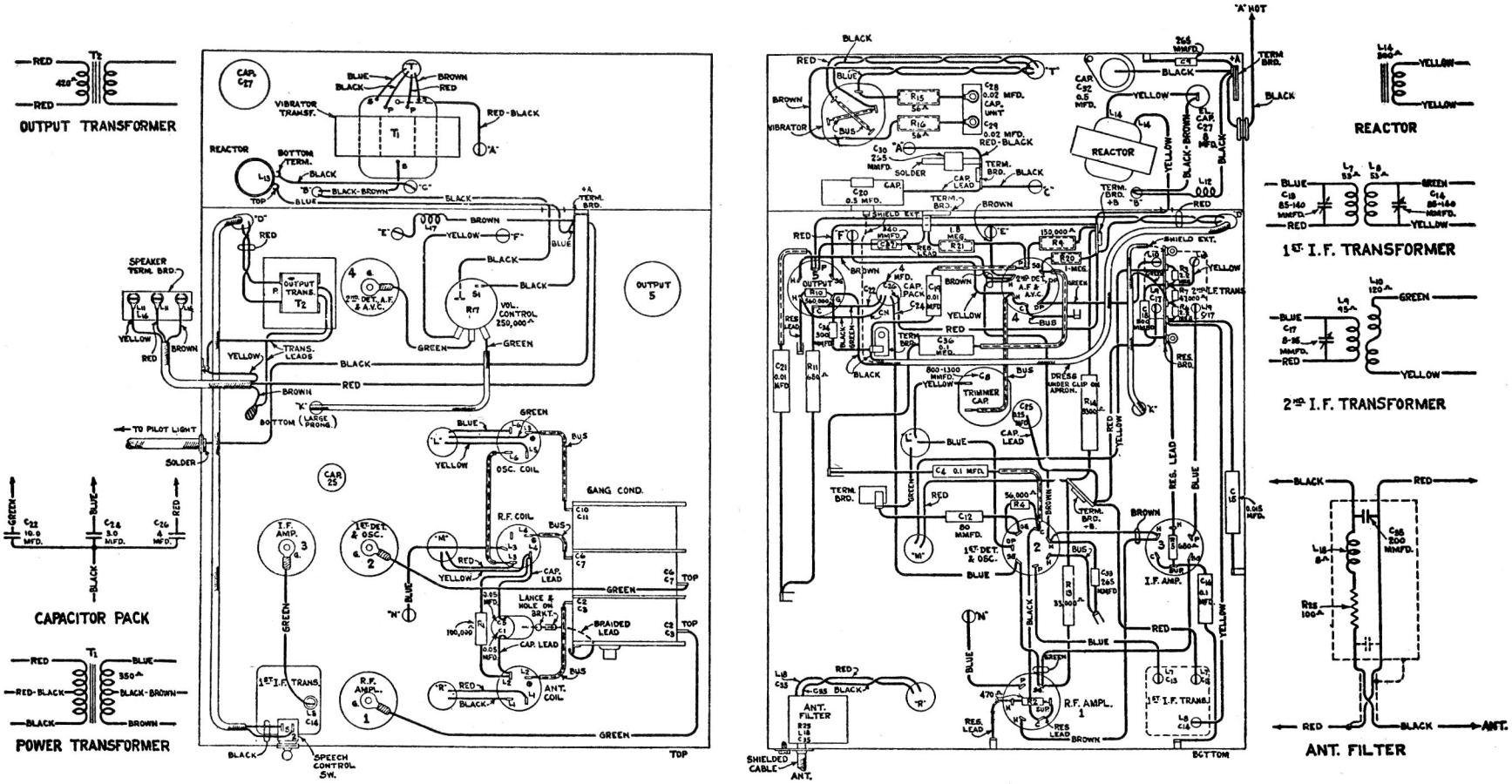

Figure 3—Chassis Wiring Diagram

(3) R. F. DETECTOR AND OSCILLATOR ADJUSTMENTS

Three high-frequency adjusting capacitors are provided for alignment at 1400 kc., and one trimmer is used for the low frequency line-up at 600 kc. The "Full Range Oscillator" should be connected to the antenna-ground input at the outer end of the lead-in shield through a 300-ohm series resistance in the antenna side.

(a) Tune the external oscillator to a frequency of 1400 kc. and turn the station selector knob until the dial pointer is at the 1400 kc. scale marking.

(b) Adjust the oscillator trimmer, C-10; the detector trimmer, C7; and the r-f trimmer, C3, for maximum (peak) receiver output.

(c) Set the external oscillator to a frequency of 600 kc. and rotate the station selector until this signal is accurately tuned on the receiver. Adjust the oscillator trimmer C8, simultaneously rocking the tuning condenser slowly through the signal until the maximum obtainable output results from the two combined operations. This adjustment should be made irrespective of dial calibration.

(d) Recheck the adjustment of the 1400 kc. oscillator trimmer, as in (b), to correct any reflective errors caused by the procedure of (c.)

RADIOTRONS

Under ordinary usage within the ratings specified for voltage supply, tube life will be consistent with that obtained in other applications. Their deterioration and approach to failure is usually evidenced by noisy or intermittent operation, loss of sensitivity and distorted tone quality.

It is not feasible to test the Radiotrons in the receiver sockets, due to likelihood of errors being caused by the associated circuits. Their removal and check with standard tube-testing apparatus is therefore advisable.

In this receiver the Radiotrons are compactly placed and snugly fitted into tight-gripping sockets to protect against vibration and to insure positive electrical connections. They should be withdrawn by exerting a direct pull on the tube.

To replace the tubes having the form-fitting shields, attach the shield to the tube and orient the grid lead opening in proper relation to the tube base, and insert the tube into its socket so that the shield clamps slide into their correct position on the outer surface of the shield.

CIRCUIT VOLTAGES

The voltages indicated at the socket contacts on Figure 4 will serve to assist in analizing defective circuit conditions. The values specified should hold within $\pm 20\%$ when the receiver is normally operative. They are actual operating values and do not take into account inaccuracies due to voltmeter resistance. A meter having a multiplier of at least 1000 ohms per volt should be used, and the amount of circuit resistance shunted by the meter resistance duly considered when the two are comparable.

SYNCHRONOUS RECTIFIER-VIBRATOR

The vibrator power unit used in this receiver is of rugged design and construction. It has been carefully adjusted by means of special equipment to insure quiet operation over an extensive period of life. No adjustments should be attempted on a vibrator suspected to be in defective condition, but a renewal installed. A convenient plug-in base is provided for effecting a quick replacement.

SPEAKER CONE ALIGNMENT

In the event the cone coil becomes mis-aligned, it will be necessary to correct its position by an adjustment provided on the speaker assembly. A small round-head brass screw installed on pole piece adjacent to the terminal strip is used to clamp the cone coil mounting. To center the cone, loosen the screw and insert a small $\frac{1}{16}$" rod or nail into the hole next to the screw and pry the coil mounting into the position giving normal speaker operation. The screw should then be retightened.

TUNING CONDENSER DRIVE

Smooth control should be obtained over the entire tuning range of the variable condenser. If there is any irregularity noticed, the following corrective steps should be taken:

Check the action of the gear mechanism for presence of binding or back-lash at every point within the tuning range. A bind may be due to improper mesh between the small pinion gear and large gears on the rotor shaft. To correct such a condition, remove the coupling on the pinion of the tuning gear, insert a screw-driver through the hole in the case and loosen the two screws holding gear plate. The mesh of the gears should be adjusted to a position which gives smooth operation.

Gear back-lash is prevented by the compression spring between the large gears on the rotor shaft. To check for this back-lash, rotate the pinion slowly in both directions, observing the free gear (on rotor shaft) carefully to determine if it shifts without turning the rotor.

If back-lash is apparent, the large gear assembly should be removed and the free gear moved (against the spring compression) 2 to $3\frac{1}{2}$ teeth in relation to the fixed gear and the assembly slid in place on the shaft and in mesh with the pinion. The set screws should then be securely tightened.

MISCELLANEOUS SERVICE HINTS

(a) The grounding of the outer end of the antenna input lead is quite critical, in that ignition interference may be minimized by selecting the proper point of attachment to the car frame, determined by experiment for each individual installation.

(b) In some cars, ignition interference may be introduced through lack of antenna lead shielding. In such cases, a shield should be placed over the exposed section of antenna lead and carried as near as possible to the actual antenna. It should be solidly grounded.

(c) Interference in the form of a grating scratch may arise from static collecting on the front wheels of some cars due to road surface friction in dry weather. The insulation caused by the grease of the wheel hub enables this action to develop. A number of devices are available through automotive supply dealers which are designed to eliminate this type of trouble. They all serve to form a grounding tie between the hub and the axle, and thus drain the static to the frame of the car (ground).

(d) If the flexible tuning shaft is installed so that it protrudes through the insulating coupling at the receiver end and makes intermittent contact with the metal of the pinion gear, some r-f disturbance will result. The shaft should therefore be inserted into the coupling just far enough to be properly secured by the set screw.

(e) The screws holding the chassis to the case must all be in place and tightly installed, inasmuch as they appreciably affect the ground resistance of the assembly and will consequently have a bearing on the amount of ignition noise received.

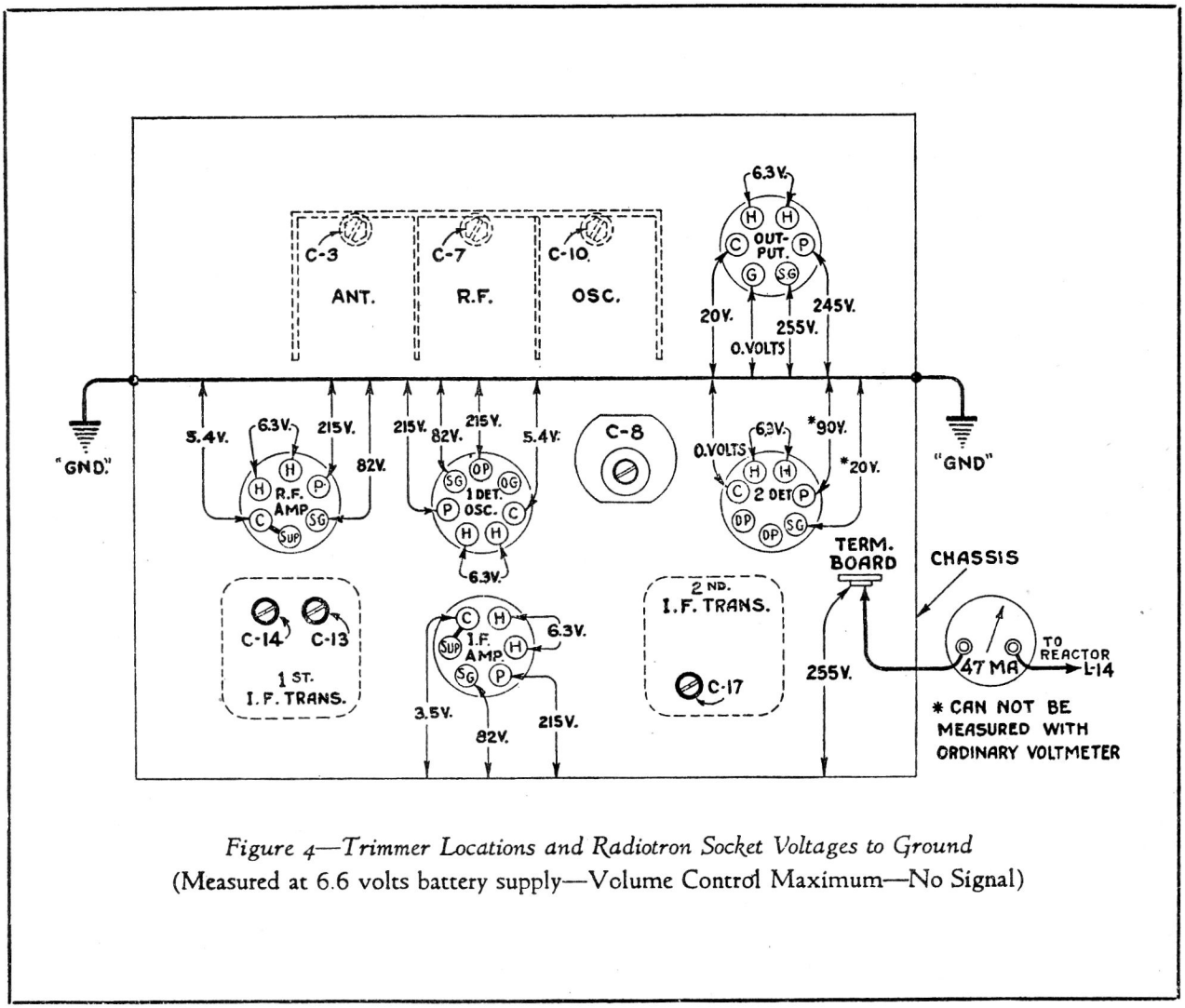

Figure 4—Trimmer Locations and Radiotron Socket Voltages to Ground
(Measured at 6.6 volts battery supply—Volume Control Maximum—No Signal)

REPLACEMENT PARTS—D-51

KEY NO.	STOCK NO.	DESCRIPTION
		RECEIVER ASSEMBLIES
	4993	Bumper — Rubber bumper — used under variable condenser bracket assembly—Package of 5
	4965	Cable — 2 Conductor Shielded — Approx. 17 inches long — To speech control switch
	S-1404	Cap—Grid contact cap—Package of 2
C-8	4955	Capacitor—Adjustable capacitor
C-12	5021	Capacitor—80 mmfd
C-9, C-30, C-33, C-38	5078	Capacitor—265 mmfd
C-34	3981	Capacitor—300 mmfd
C-18	4248	Capacitor—300 mmfd
C-37	5022	Capacitor—340 mmfd
C-21	4882	Capacitor—.01 mfd
C-19	4883	Capacitor—.01 mfd
C-4, C-16	4791	Capacitor—0.1 mfd
C-36	4885	Capacitor—0.1 mfd
C-15	4792	Capacitor—.015 mfd
C-25	4967	Capacitor—.25 mfd
C-32	5019	Capacitor—.5 mfd
C-20	4960	Capacitor—.5 mfd
C-27	4961	Capacitor—8.0 mfd
C-28, C-29	4964	Capacitor Pack—Comprising two .02 mfd. capacitors
C-1, C-5	5016	Capacitor Pack—Comprising two .05 mfd. capacitors
C-22, C-24, C-26	4958	Capacitor Pack—Comprising one 3. mfd., one 10. mfd. and one 4. mfd. capacitors
	5020	Clamp—Metal clamp with screw—for antenna filter shielded cable—Package of 5
L-1, L-2	4950	Coil—Antenna Coil
L-12	4968	Coil—Choke Coil
L-17	4969	Coil—Choke coil (15 turns approximately 23 inches—length)
L-5, L-6	6967	Coil—Oscillator coil
L-3, L-4	6966	Coil—R.F. Coil
C-2, C-3, C-6, C-7, C-10, C-11	4948	Condenser—3 Gang Variable Tuning condenser
	4954	Filter—Antenna filter
	4972	Lead—Power lead with male section of connector—Chassis end
	7766	Lead—Power lead with clip and female section of fuse connector
	4966	Lead—Single connector dial lamp lead—With female section of connector—Chassis end
L-14	4962	Reactor
L-13	4963	Reactor
R-15, R-16	5034	Resistor—56 ohms—Carbon type—1/2 watt
R-2	5030	Resistor—470 ohms—Carbon type—1/4 watt
R-15	5031	Resistor—680 ohms—Carbon type—1/4 watt
R-11	5026	Resistor—680 ohms—Carbon type—1 watt
R-14	5032	Resistor — 3300 ohms — Carbon type—2 watts
R-13	5033	Resistor — 33,000 ohms — Carbon type—1 watt
R-7	5132	Resistor — 47,000 ohms — Carbon type—1/10 watt
R-4	5029	Resistor — 56,000 ohms — Carbon type—1/4 watt
R-1	S-1354	Resistor — 100,000 ohms—Carbon type—1/4 watt
R-9	5027	Resistor — 150,000 ohms—Carbon type—1/4 watt
R-10	5035	Resistor — 560,000 ohms—Carbon type—1/4 watt
R-20	3033	Resistor—1 megohm—Carbon type 1/4 watt
R-21	5028	Resistor — 1.8 megohm — Carbon type—1/4 watt
R-3, R-6	5131	Resistor—2,200,000 ohms—Carbon type—1/10 watt
	5129	Ring — Radiotron Shield Ring — Package of 10
	3584	Ring—Retaining ring for antenna, R.F. or oscillator coils—Package of 2
	3623	Shield—Antenna R.F. or oscillator coil shield
	4953	Shield — First intermediate frequency transformer shield
	4956	Shield — Second intermediate frequency transformer shield
	5037	Shield—Radiotron Shield
	4946	Socket — Six contact radiotron socket
	4959	Socket—Six contact vibrator socket.
	4947	Socket—7 contact radiotron socket.
S-2	5001	Switch—Speech control switch
L-7, L-8, C-13, C-14	4951	Transformer — First intermediate frequency transformer
L-9, L-10, C-17	4952	Transformer—Second intermediate frequency transformer
T-2	4957	Transformer—Output transformer.
T-1	7859	Transformer—Vibrator transformer.
L-15	7857	Vibrator—complete
R-17, S-1	5018	Volume Control
		CONTROL BOX ASSEMBLIES
	4987	Bezel—Station selector dial bezel
	7865	Box—Control Box complete
	7864	Bracket—Mounting bracket and rear section of control box housing
	4988	Crystal — Station selector dial crystal
	S-1514	Dial—Station selector dial
	4981	Gear—18 Tooth intermediate drive gear
	4978	Gear — Indicator drive gear and shaft
	7862	Housing—Front section of control box housing
	7863	Housing—Centre section of control box housing
	4990	Indicator—Station selector indicator—Package of 2

REPLACEMENT PARTS—D-51

KEY NO.	STOCK NO.	DESCRIPTION
	4985	Knob—Station selector or volume control knob—Package of 2
	4991	Lamp—Dial Lamp
	7866	Plate—Bearing plate assembly—Comprising plate, gear and shaft, volume control shaft, station selector shaft, pinion and spring
	4986	Screw—Oval fillister head machine screw — Fastens bracket and centre section of control box housing
	3652	Screw—No. 8-32-⅛ inch headless set-screw for station selector or volume control shaft—Package of 5
	4983	Shaft—Station selector drive shaft
	4979	Shaft—Volume control drive shaft
	4984	Socket—Dial lamp socket
	4982	Spring—Holding spring for station selector or volume control knob—Package of 10
	4980	Spring—Tension Spring—Package of 5
		FLEXIBLE SHAFT ASSEMBLIES
	5000	Bracket—Volume or tuning condenser flexible shaft bracket — Bracket mounted on housing
	4994	Nut—Knurled locking nut for condenser drive or volume control flexible shafts. Package of 2
	7854	Shaft—Tuning condenser—Flexible (steering column) drive shaft — 31⅜ inches long
	7856	Shaft—Volume control or tuning condenser — Flexible (dash mounting) drive shaft 9 5/16 inches long
	7855	Shaft—Volume Control—Flexible (steering column) shaft 27⅞ inches long
		REPRODUCER ASSEMBLIES
	4970	Cable—3 Conductor reproducer cable
L-16	9602	Cone—Reproducer cone
	9576	Housing — Reproducer housing — Top cover of receiver
L-11 L-16	9577	Reproducer—Complete
	4995	Screw — Reproducer mounting screw—Package of 10
		HOUSING ASSEMBLIES
	7868	Case—Receiver housing assembly—complete
	7869	Cover—Bottom cover of receiver housing assembly
	4999	Screw—No. 8-¼" slotted hex head self-tapping screw—used to assemble housing—Package of 10
		MISCELLANEOUS PARTS
	4287	Body—Antenna connector body—Package of 4
	4289	Body — Fuse Connector body — Package of 4
	4288	Cap—Antenna or fuse connector—Package of 4
	4293	Capacitor—0.5 mfd. ammeter capacitor
	5025	Capacitor — 0.5 mfd. generator capacitor
	6516	Connector—Fuse connector—Complete
	4973	Coupling—Tuning condenser shaft coupling
	4974	Coupling—Volume Control shaft coupling
	4286	Ferrule—Antenna or fuse connector ferrule and bushing—Pack. of 4
	5023	Fuse—15 ampere—Package of 2
	4290	Insulator—Fuse connector Insulator—Package of 5
	4976	Lead—Antenna lead assembly
	4975	Lead—Dial lamp lead—control box end
	S-1469	Screw—No. 8-32 3/16" headless set screw for couplings—Pack. of 10
	4284	Spring—Antenna or fuse connector spring—Package of 5
	4992	Stud—Receiver mounting stud and nuts—Package of 3
	5024	Suppressor—Distribution suppressor