SECTION III

CHARGING SYSTEM

A. COMPONENTS

A.C. GENERATOR:

The alternating current generator (alternator) is a continuous-output diode rectified generator.

The rotor, which carries the field winding, is mounted in ball bearings at both ends. Each bearing has a sealed-in grease supply which eliminates the need for periodic lubrication. Two brushes and two slip rings are used. One brush conducts the current provided by the voltage regulator to one end of the field coil; the other brush conducts the current from the other end of the rotating field coil to ground.

The three phase stator windings are assembled on the inside of a laminated core that forms the center section of the generator frame. Nine rectifier diodes are connected to the stator windings (three to each phase lead). The diodes change the generator A.C. voltages to D.C. voltage coming out of the B positive and the D positive terminals of the generator.

The A.C. generator is standard equipment on all Opel Rallye cars and all cars equipped with heatable rear window to take care of the additional electrical load due to the fog lights. The additional output ability (28 amperes) plus the ability to charge at idle (approximately 5 amperes) will keep the battery fully charged even with the heaviest possible continuous electrical load.

If the generator will not meet output specifications when supplied with full field current, the assembly must be overhauled. If the voltage regulator does not limit maximum voltage within specifications, adjust the voltage regulator. If steady voltage regulation, within specifications, cannot be achieved, the voltage regulator assembly must be replaced.

The generator regulator contains only one unit – a single contact voltage regulator. Since the A.C. generator field is grounded inside the generator, the voltage contacts are in series with the field.

Field current is supplied from the D+ terminal of the generator, goes through small red wire to the voltage contacts in the regulator, comes out of the regulator through a black wire, into the DF terminal of the generator, and through the field winding to ground inside the generator.

The diodes in the generator, since they act like one-way check valves, make a cutout relay unnecessary; battery current can flow only as far as the diodes, but cannot discharge through the generator. However, whenever generator voltage is higher than battery voltage, current flows freely through the diodes in the other direction to charge the battery.

A current regulator is not necessary. Any A.C. generator is limited by its design in regard to maximum current output. Regardless of current need, an A.C. generator cannot put out more than its rated current output, and, therefore cannot over heat and damage itself due to excessive output.

D.C. GENERATOR

The direct current generator is a conventional generator with an externally completed field circuit. The armature is supported by a ball bearing at the drive end and a sintered bronze bushing at the commutator end. For lubrication of the bushing, it is necessary to remove the plastic plug in the end frame to gain access to the bushing area.

Once the generator has been in operation, a residual magnetism remains to induce voltage as the armature is rotated. The strength of the magnetic field rapidly increases as voltage is induced. As speed and magnetic field strength are increased, voltage is increased. After the generator has reached cut-in speed, the voltage regulator keeps the voltage within specified limits.

The regulator consists of two units: a double- contact voltage regulator and a cutout relay. The voltage regulator, equipped with a diode, keeps generator voltage almost constant regardless of speed and load conditions. It also protects the generator from damaging overload and the battery from overcharge.

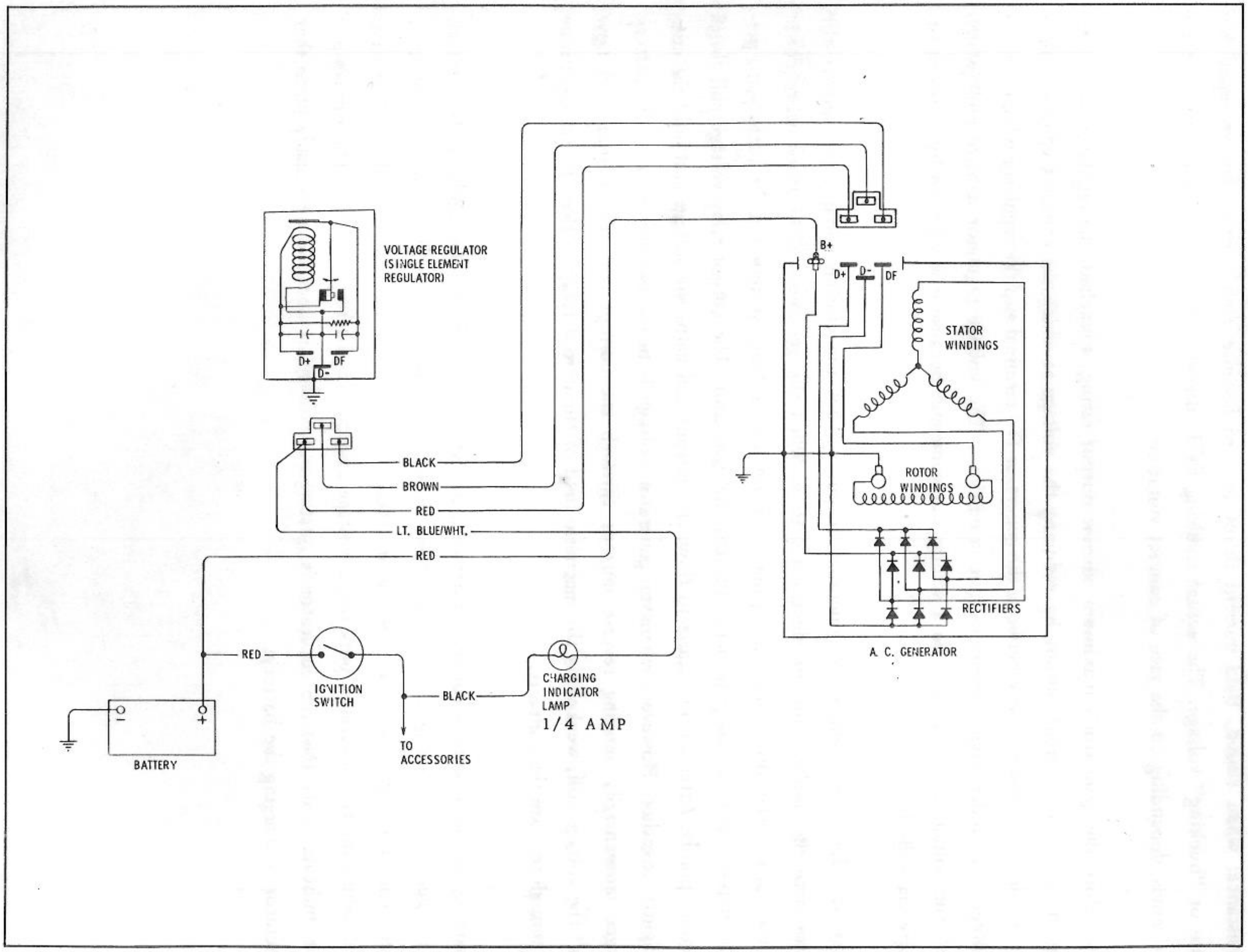
The field circuit is grounded by means of two sets of contacts in the voltage regulator. The lower range contacts, when closed, complete the field circuit direct to ground; when open, the field circuit goes to ground through a resistance. The lower range contacts vibrate to regulate the voltage during slow speed operation or when the electrical accessories and battery need a lot of current.

During high speed operation or when current needs are low, the field strength as regulated by the resistance will still produce more generator output than is needed. Under these conditions, the regulated voltage will rise slightly, the voltage regulator armature will pull down farther, and operation will be on the upper range contacts. When these contacts are open, the field circuit is controlled by the resistance; when closed, field current drops to zero because each contact has an equal but opposite or "bucking" voltage. The actual resulting field current will be somewhere between these two extremes, depending on the rate of contact vibration.

Shortly before the generator's maximum current output rating is reached, the regulator starts controlling the generator current output by reducing the voltage at which the contacts vibrate. This is made possible by a resistance wire between the generator D– terminal and the regulator which reduces the voltage coil under high current output conditions. The voltage regulator control coil (which "bucks" the voltage coil) will still be a strong electromagnet because it is supplied by a low-resistance wire via a diode.

The cutout relay closes whenever generator output reaches the closing voltage, to connect the generator with the battery and the electrical system. When the generator RPM drops below cut-in speed, the cutout relay disconnects the generator from the electrical system and the battery, to prevent the battery from discharging back through the generator. The cutout relay voltage coil closes the contact points. After current starts to flow, the current coil helps the voltage coil hold the contacts tightly together. However, whenever generator voltage is below battery voltage, the battery discharges momentarily sending reverse current through the current coil. The current coil now "bucks" the voltage coil, weakening the magnetic field of the cutout relay so that the spring is now strong enough to open the contacts.

The charging indicator lamp is connected between the ignition switch and the regulator D+ terminal. Current supplied from the ignition switch flows through the light to ground through the generator armature. The lamp lights whenever generator voltage is much less than battery voltage. The lamp goes out whenever the generator puts out a voltage approaching battery voltage. When the lamp is out, this indicates only that the generator is putting out voltage. It does not necessarily mean that the generator is charging the battery.



KADETT WIRING—AC GENERATOR & REGULATOR

B. CHARGING SYSTEM TESTING

IGNITION SWITCH "OFF" – INDICATOR LAMP "ON"

1. Disconnect D+ terminal. If light now goes "Off", replace voltage regulator.

2. If light stays "On", check for short in ignition switch and printed circuit.

IGNITION SWITCH "ON" – INDICATOR LAMP "OFF" WITH ENGINE STOPPED

1. Detach wiring harness connector from regulator and connect jumper from harness D– terminal to ground. If lamp does not light, check for blow fuse, burned-out bulb, defective bulb socket, or open in D– lead between regulator and ignition switch.

2. If lamp lights, re-connect jumper from D– harness terminal to DF harness terminal. If lamp now lights, replace regulator.

3. If lamp does not light, leave jumper in place and connect second jumper from generator DF terminal to ground. If lamp does not now light, DF lead between regulator and generator is open.

4. If lamp lights, generator field is open-circuited and generator should be removed and repaired.

IGNITION SWITCH "ON" – INDICATOR LAMP "ON" WITH ENGINE IDLING

1. A loose generator drive belt can cause this condition. Belt should be tightened or replaced, if necessary.

2. With engine idling, connect jumper lead from regulator base to a good engine ground. If indicator light goes out, repair regulator ground circuit to engine.

3. If indicator light remains on, stop engine and turn ignition switch to "On" position.

4. Using test prod, connect voltmeter from regulator D– terminal to ground. A zero reading indicates an open resistance lead between the ignition switch and the regulator.

5. If above was not the trouble, connect voltmeter from regulator D+ terminal to ground. A zero reading indicates an open circuit and the wiring to this connection should be repaired or replaced.

LOW BATTERY (DISCHARGED)

1. Be sure that the discharged battery has not been caused by accessories having been left on for extended periods. Then check indicator lamp for normal operation. Any deviation from normal operation should be checked as outlined in "Indicator Lamp Signs Trouble" portion of this booklet.

2. A loose, slipping generator drive belt can cause this condition. Belt should be tightened or replaced, if necessary.

3. Check for defective or worn out battery. Clean battery posts and cable clamps to eliminate resistance.

4. Using test prod, connect voltmeter from regulator D– terminal to ground. Turn ignition switch to "On" position. If reading is zero, resistor or lead between ignition switch and D– regulator terminal is open and should be repaired or replaced.

5. Disconnect battery ground strap. Connect an ammeter between "BAT" terminal of generator and ground. Reconnect battery ground strap. Remove connector body from regulator and make jumper connection between DF and D+ in connector body.

6. Turn headlights on high beam and heater blower motor on high speed. Operate engine at 1500-2500 r.p.m. as required to obtain maximum current output.

   CAUTION: Run engine to obtain maximum current output (amps) but do not exceed 16 volts.

7. If ampere output is within 10 percent of rated output as indicated on the generator frame, generator is good. Check regulator setting adjustment according to 14 volts ± .5 volt at 2500 RPM.

8. If ampere output is not within 10 percent of rated output, generator should be removed and repaired.

BATTERY USES TOO MUCH WATER (OVERCHARGED)

1. Check for defective or worn out battery.

2. Inspect all connections to make sure they are clean and tight.

3. If 1 and 2 are satisfactory, regulator setting must be lowered.

NOISY GENERATOR

1. Adjust electrical loads and engine speeds to get generator noise. With engine running, remove wiring harness connector body from generator. If noise disappears, go to Step 2.

2. Stop engine, remove drive belt, and repeat test conditions in 1 above. If noise remains, generator is not the source of the complaint. If noise disappears, check generator and other accessories driven by the same belt for mechanical defects. Repair as needed.

3. If noise disappeared in Step 1, stop engine, reconnect generator connector body and disconnect battery ground strap. Connect ammeter between "BAT" terminal of generator and wire attached to it. Connect voltmeter between "BAT" terminal of generator and ground. Disconnect connector body from regulator and connect jumper between DF and D+ connection. Reconnect battery ground strap.

4. Turn headlights on high beam and heater blower motor on high speed. Operate engine at 1500-2500 r.p.m. as required to obtain maximum current output.

   CAUTION: Run engine to obtain maximum current output (amp) but do not exceed 16 volts.

5. If ampere output is within 10 percent of rated output as indicated on the generator frame, generator is electrically good. The noise is a normal magnetic sound which is typical of a high-performance generator. This should be explained to the customer, as there is no indication of a defect or potential failure within the generator.

6. If the ampere output is not within 10 percent of rated output, the generator should be removed and repaired. The objectionable noise was caused by the electrical defect.

ALTERNATOR CHECKS

To check an alternator for output, connect a jumper lead from the generator output or "BAT" terminal to the field or DF terminal, a voltmeter from the "BAT" terminal to ground, and an ammeter in the circuit at the "BAT" terminal. Operate the alternator at specified speed, adjust the variable load connected across the battery to obtain specified voltage, and observe the current output. If the output does not meet specifications, disassemble the generator for checks of the rotor, stator, and diodes.

The rotor windings may be checked by connecting a battery, ammeter and voltmeter to the edge of the slip rings. If the current draw is above specifications, the windings are shorted, and if the current draw is low, excessive resistance is indicated.

An ohmmeter may be used in place of the battery and ammeter. The specified resistance may be calculated by dividing the voltage by the current listed in the specifications booklet. A low resistance indicates shorted windings, and a high resistance an open or poor connection.

An ohmmeter connected from either slip ring to the shaft should show a high resistance. A low resistance indicates the field windings are grounded.

A test light may be used in place of an ohmmeter to check for opens and grounds, but the test light will not check for shorts. When connected across the slip rings, failure to light indicates an open. The windings are grounded if the lamp lights when connected from either slip ring to the shaft.

Checks on the stator should be made with all diodes disconnected from the stator. It is not practical to check the stator for shorts due to the very low resistance of the windings.

To check the "Y"-connected stator for opens, connect an ohmmeter or test light across each two pairs of terminals. A high ohmmeter reading, or no light, will reveal an open winding.

The stator winding may be checked for grounds by connecting an ohmmeter or test light from either terminal to the stator frame. The windings are grounded if the ohmmeter reads low, or if the lamp lights.

Diodes when disconnected from the stator can be checked for defects with an ohmmeter having a 1½ volt cell. Using the lowest range scale, connect the ohmmeter leads to the diode case and the diode stem, and then reverse the connections. If both readings are very low, the diode is shorted. If both readings are very high, the diode is open.

SECTION IV

IGNITION SYSTEM

A. COMPONENTS

The ignition coil consists of a laminated non-magnetic iron core enclosed by two coils; the primary winding and the secondary winding.

The primary circuit consists of the power source (battery), the ignition switch, the ignition coil primary winding, the distributor breaker points with ignition condenser connected in parallel, and all connecting low tension wiring.

The secondary circuit consists of the ignition coil secondary winding, the spark plugs, all connecting high tension wiring, the distributor cap and the rotor.

When the ignition switch is turned on and the breaker points are closed, current flows through the ignition coil primary winding and produces a magnetic field around the coil windings.

When the breaker points are separated by the revolving distributor cam, the magnetic field collapses and induces a high voltage surge in the secondary winding, producing a spark between the spark plug electrodes. The ignition condenser, which is connected in parallel with the breaker points, prevents arcing between the separated breaker contacts, and current flow after the breaker points have been separated, thus causing a very rapid collapse of the magnetic field around the ignition coil.

The ignition distributor breaks the primary current, distributes the high voltage surges induced in the coil secondary winding to the spark plugs according to the engine firing order and sets ignition timing in relation to engine RPM and load.

The combined ignition switch and steering lock can be switched to any one of the below listed positions. Insert key with notch pointing upward.

(Fully counterclockwise) Lock position. Ignition locked, steering locked, only with key removed. Electrical circuits disconnected except to main lighting switch and dome lamp. The key can be removed.

G– (First position clockwise from lock) Garage position. The key and lock assembly must be pushed "in" to reach this position from lock. The steering is unlocked and the ignition is off. The electrical circuits are the same as in lock position. The key can be withdrawn and the switch can be placed in any remaining position except lock. The engine can be started and driven with or without a key.

1– (On position.) All electrical circuits controlled by ignition switch are completed through the switch. The key cannot be removed while switch is in drive position.

11– (Start position.) The ignition key must be released as soon as engine starts. The switch then returns automatically to the on position.

B. IGNITION SYSTEM TESTING

CAR WILL NOT START BUT CRANKS O.K.

1. Hold a spark plug wire 1/4" away from engine block and crank engine.
2. If strong spark is seen, check timing. (Reset timing if necessary.) If timing is O.K., trouble is not with ignition system.
3. If no spark or an intermittent spark is seen, remove distributor cap-to-coil lead from the coil.
4. Ground the coil tower to engine block and crank engine.
5. If strong spark is seen between coil tower and the grounding instrument, check distributor cap and rotor for cracks or carbon tracking. Check lead between distributor and coil for broken or burned terminals or cracks in insulation. Replace defective parts.
6. If no spark or intermittent spark is seen, connect jumper wire from battery "+" terminal to coil "+" terminal.
7. Ground the coil tower to engine block and crank engine.
8. If strong spark is seen, remove jumper wire and check wiring, connections and switches between the battery "+" terminal and the coil "+" terminal. Opens, high resistance, or intermittent contact will require repair or replacement.
9. If no spark or intermittent spark is seen, remove jumper wire and disconnect distributor lead from the coil "–" terminal.

10. Connect test light from coil "–" terminal to engine block and turn ignition switch to crank position. If lamp does not light, replace coil.

11. If lamp lights, hook test light from battery "+" terminal to distributor lead which is still detached from the coil.

12. If necessary, rotate distributor by jogging engine until points close.

13. If lamp lights, check condenser and points. Replace defective parts.

14. If lamp does not light, hook test lamp from battery "+" terminal to connection of distributor lead and contact points. Make sure points are closed.

15. If lamp lights, replace distributor lead to coil. If lamp does not light, proceed to next check.

16. Connect test lamp from battery "+" terminal to the screw holding points in place. If lamp lights, replace points and check capacitor.

17. If lamp does not light, distributor plate or distributor is not grounded. Check plate-to-distributor ground wire or distributor-to-engine block connection.

ENGINE STARTS BUT WILL NOT CONTINUE TO RUN

1. Connect jumper wire from battery "+" terminal to ignition coil "+" terminal and start engine. If engine does not continue to run, problem is not ignition.

2. If engine runs, remove jumper and disconnect leads from battery "+" terminal and coil "+" terminal.

3. Connect ohmmeter and measure resistance between the ends of the leads just detached. Ignition switch should be in the "run" position.

4. If resistance exceeds 2.5 ohms, check wires and connections for loose or intermittent contact, check by-pass resistor and ignition switch for opens.

5. If resistance is 1.0 to 2.5 ohms, check the output of the ignition coil.

6. If resistance is less than 1.0 ohm, replace shorted by-pass resistor and replace contact points.

ENGINE RUNS ROUGH – POOR POWER OR GAS MILEAGE

1. Check all tune-up specifications (timing, dwell, carburetion, fouled plugs, etc.). If settings are improper, correct as required.

2. If settings are O.K., check both centrifugal and vacuum advance of distributor and correct with replacement parts, if necessary.

3. If distributor advance mechanisms are within specifications, check coil available voltage and plug required voltage.

   High requirements or low availability of voltage will require a replacement of parts.

   If coil and plugs are O.K., the problem is not in the ignition system.

SECTION V

INSTRUMENTS AND GAUGES

FUSES

1) KADETT

Fuse Position		Items on Fuse
1	(8 Amp)	Windshield Wipers Horn Parking Brake Light
2	(5 Amp)	Directional Signal Stop Lights Reverse Lights Brake Warning Light
3	(8 Amp)	Generator Light Oil Light Heater Fan Cigar Lighter Fuel Gauge Temperature Gauge
4	(5 Amp)	Dome Light Hazard Warning System Clock Warning Buzzer
5	(5 Amp)	Parking Lights – Left Side Tail Lights – Left Side
6	(5 Amp)	Parking Lights – Right Side Tail Lights – Right Side I. P. Lights

2) RALLYE KADETT

Fuse Position	Items on Fuse
1	Windshield Wiper Horn

Fuse Position	Items on Fuse
2	Reverse Lights Directional Signals Brake Warning Light Stop Lights
3	Temperature Gauge Fuel Gauge Oil Pressure Light Cigar Lighter Oil Pressure Gauge Blower Motor Tachometer Ammeter
4	Warning Flasher Ignition Buzzer Dome Light Clock
5	Side Marker Lights – Left Side Tail Lights – Left Side Parking Lights – Left Side
6	I. P. Lights Side Marker Lights – Right Side Tail Lights – Right Side Parking Lights – Right Side License Plate Lights

3) G.T.

Fuse Position	Items on Fuse
1	Horn Windshield Wipers Reverse Lights
2	Brake Warning Light Warning Flasher Directional Signals Fuel Gauge Stop Lights Ammeter Oil Pressure Gauge Temperature Gauge
3	Heater Fan Radio
4	Emergency Flasher Dome Light Generator Light Oil Pressure Light

5	Parking Lights – Right Side Side Marker Lights – Right Side Tail Lights – Right Side
6	Parking Lights – Left Side Side Marker Lights – Left Side Tail Lights – Left Side
7	License Plate Lights I. P. Lights

The heated back window and fog lights are on separate fuses located in the engine compartment.

Dealer installed radios on Kadett and Rallye are controlled by an in-line fuse and not through the fuse block.

CHECKING GAUGES AND SENDING UNITS

(The following information was obtained from tests performed on a 1970 Rallye Kadett)

NOTE: Always check fuse first and then check for proper grounds and connections.

Temperature Gauge and Sending Unit

The sending unit is a ground unit with a variable resistor.

1. Grounding the lead at the sending unit produces a full scale reading on the gauge.
2. Disconnecting the lead at the sending unit produces a zero reading on the gauge.

If the temperature gauge is giving an imporper reading and the two above checks produce the desired results, the sending unit should be replaced. If the two above checks do not produce the desired results, the fault is in the gauge unit or wiring.

Oil Pressure Gauge, Indicator Light, and Sending Unit

The oil pressure sending unit is a ground unit with two connectors. The post connector controls the gauge unit and has a variable resistor. The snap-on connector controls the indicator light and has an "On–Off" switch. Both lead wires are dark blue with a green stripe.

If improper gauge reading is the problem, the following check should be performed:

1. Disconnecting the lead at the sending unit produces a full gauge reading.
2. Grounding the lead at the sending unit produces a zero gauge reading. If the above results are obtained, the problem is with the sending unit. If the above results are not obtained, the problem is with the gauge unit or wiring.

To check the oil pressure gauge unit the following should be done:

1. Disconnect the blue with green wire at the gauge unit. A full scale reading should be noted.

2. Using a jumper wire, ground the terminal with blue/green wire still disconnected. A zero scale reading should be noted.

If the two above checks do not produce the desired results, replace the gauge unit.

If oil pressure indicator light is "On" at all times, disconnect lead at sending unit. If light goes out, replace sending unit. If light stays "On", check for ground in wiring.

If oil pressure indicator light does not come "On", ground lead at sending unit. If light now comes "On", replace sending unit. If light does not come "On", check bulb. If bulb is not the problem, check for open circuit.

Fuel Tank Gauge and Sending Unit

The sending unit is a ground unit with a variable resistor.

1. Disconnecting the lead wire at the sending unit will produce a full gauge reading.

2. Grounding the lead at the sending unit produces a "zero" gauge reading. If the fuel gauge is giving an improper reading and the two above checks produce the desired results, the sending unit should be replaced. If the two above checks do not produce the desired results, the fault is in the gauge unit or wiring.

   Fuel gauge unit reading will vary upon acceleration and deceleration.

Ammeter Gauge and Indicator Light

The ammeter gauge and indicator light can indicate problems with the charging circuit.

The ammeter gauge has two lead wires. One wire, red, is connected to the alternator. The other wire, red/white, is connected to the battery. Whenever battery voltage is greater than the output of the alternator, the gauge shows "Discharge." If the alternator output is greater than the battery output, the gauge shows "Charge." This is done through an inductor coil. To check the operation of the gauge unit connect an ammeter in series with the gauge unit and determine if the two units agree. If the two units do not agree, replace the gauge unit.

Brake Warning Light and Sending Unit

The sending unit is a ground unit with an "On–Off" switch.

If warning light is on at all times, check brake fluid level. If level is correct, disconnect lead at sending unit. Light should not go "Off". If light goes off replace sending unit. If light is still on, check flash unit and wiring for grounds.

If warning light does not come "On" when tester bar is depressed, ground lead at sending unit. Light should now come "On". If light does not come "On", replace bulb and check. If light still does not come "On" replace dash unit.

The test bar located at the dash unit only checks the operation of the brake warning indicator light. It does not test the brake system.

Tachometer

The tachometer measures the engine RPM. At the instrument gauge unit there are four terminals and five lead wires. The two gray wires control the instrument light. The brown wire is a ground wire for the instrument light. The black wire is a power lead from the ignition switch. The green wire is the lead from the distributor. An inductor coil in the gauge controls the needle fluctuation. To test the gauge unit hook up a tachometer to the engine and determine if the two units agree. If the two units do not agree, replace tachometer.

Electrical Clock

The electrical clock is a spring wound unit. The red lead supplies power. The brown lead is a ground wire. The gray lead controls the instrument light.

Windshield Wiper

The green wire is power. The yellow wire is for slow speed operation. The white wire is for high speed operation. The blue wire will cause a test light to flash with wipe speed. The wiper motor is grounded through the case to the car frame. The lilac (2) wires supply power from the ignition switch to the wiper switch.

Use a test light to check for power through system with plug connector disconnected at wiper motor.

11 Prong Connector at I. P.

The following wires are connected to the 11 prong connector:

Wire Color	Controls
Brown	Ground
Brown	Ground
Gray	I. P. Lights
Black	Power
Blue/White	Generator Light
Blue/Green	Oil Pressure Light
Blue	Temperature Gauge
White	Headlight High Beam Indicator
Blue	Fuel Gauge
Black/Gray	Directional Signal Indicator

General Comments

Black or red wires are usually power. Brown wires are usually ground. Brown wire at wiper motor is ground wire for I. P. lights and gauges. There are no fuses or circuit breakers in the headlight system.