SECTION 10-B
ELECTRICAL TROUBLE DIAGNOSIS

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SERVICE BULLETIN REFERENCE

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10-7 BATTERY AND CABLES—TROUBLE DIAGNOSIS

a. Quick Check of Battery and Cables

Whenever electrical trouble develops it is desirable to make a quick check of the battery and cables to make certain that this source of current is in good condition, securely connected, and is functioning properly. This check will also give a good check on the cranking system.

1. Turn on the lights. They should burn steadily and with normal brilliance.

2. With lights burning, operate the cranking motor. Either have the headlights shining on a wall so their brilliance can be noted, or have someone watching the headlights.

3. When cranking motor solenoid switch is closed, one of four things will normally happen: (1) the lights will stay bright and engine will be cranked at normal speed; (2) the lights will go out; (3) lights will dim considerably; (4) lights will stay bright but no cranking action will take place. The first named condition indicates that there is nothing wrong with the battery, cables, and cranking system. The other conditions indicate trouble as follows:

4. *If lights go out* as cranking motor solenoid switch is closed, it indicates a poor connection in the circuit between battery and cranking motor. Check battery cables and clean and tighten loose or corroded terminals (par. 10-21).

5. *If lights dim considerably* as cranking motor solenoid switch is closed, it indicates that the battery is run down, or there is a condition in cranking motor or engine which causes an excessive current drain on the battery. A low battery will be indicated by a clattering noise in cranking motor solenoid because the battery cannot sustain the voltage required to hold solenoid plunger "in" after switch contacts close and the "pull in" winding is shorted out. Test battery with hydrometer (par. 10-19) and give it a high discharge test (par. 10-20). If battery is found to be in good condition check cranking motor (par. 10-36).

6. *If lights stay bright but no cranking action occurs* when cranking motor solenoid switch is closed, it indicates an open circuit in cranking motor, switch, or control circuit. See paragraph 10-9.

b. Undercharge Failure of Battery

The most frequent trouble experienced with storage batteries is failure to maintain a state of charge sufficient to crank the engine and also furnish current to the ignition system, lights and accessories. Failure to maintain a proper state of charge may be due to one or more of the following conditions.

1. *Operating Conditions.* When determining cause of premature failure of a battery,

consideration must be given to the conditions under which the car is operated.

In very low temperatures the capacity of a storage battery is considerably reduced and the energy required for cranking the engine is considerably increased, therefore, a higher average state of charge is required in cold weather.

Frequent starting, particularly in cold weather, accompanied by short runs may take more energy from the battery for cranking than the generator can replace in the limited running time. This condition is aggravated by night driving when lights are turned on.

When the car is operated under these conditions an occasional booster charge may be required to keep the battery at a safe state of charge.

2. *Low Charging Rate.* In case of premature battery failure the charging rate of generator should always be checked and adjusted if below specifications. See paragraph 10-26 and 10-29.

3. *Internal Condition.* The internal condition of the battery may be such that it cannot hold a charge satisfactorily. Check electrolyte level and specific gravity and give battery a high discharge test, (par. 10-18, 10-19, 10-20).

c. High Discharge Failure of Battery

One of the most common causes of battery failure is overcharging, that is, continued input of excessive charging current after the battery has reached a fully charged condition.

One evidence that battery is being overcharged is the need for frequent addition of water to the battery in order to maintain the electrolyte level above the tops of the battery separators, since overcharging causes rapid water loss. When this becomes evident the charging rate of generator should be immediately checked and adjusted (par. 10-26 and 10-29) to avoid internal damage to battery.

Another evidence of overcharging when this has continued for an appreciable period of time, is the external appearance of battery. If the positive ends of cell covers are pushed up it indicates that the positive plates have swelled as a result of overcharging. A battery in such condition usually require replacement to insure dependable service.

10-8 GENERATING SYSTEM—TROUBLE DIAGNOSIS

When any complaint is registered regarding the operation of the generator or regulator, trouble diagnosis should be governed by the following points.

a. Charge Indicator Reading

The charge indicator does not indicate total charging rate of generator since it does not indicate current supplied to electrical units other than the battery. To interpret the indicator reading correctly the condition of battery must be known; therefore the battery should be tested (par. 10-19) before making any other check.

b. Fully Charged Battery and Low Indicator Reading

This is a normal condition. Discharge battery by cranking engine for several seconds, then note indicator reading with engine running above idle speed. Charge indictor should show a high charging rate for a short time until energy removed from battery has been restored, after which indicator will return to near zero.

c. Fully Charged Battery and High Indicator Reading

In analyzing trouble of this nature, the effect of battery temperature must be considered. Where the battery is operating at high temperature, a high charging rate may be obtained even with a normal voltage regulator setting and with otherwise normal operation of the equipment. If battery is not operating at high temperature, this condition indicates improper operation of the generating system which will result in battery overcharge and high voltage in the electrical system. Inspect and test generator (par. 10-26).

d. Low Battery and Low or No Indicator Reading

This condition may be caused by high resistance in the charging circuit due to loose connections or defective leads, inoperative generator, or defective generator regulator. Inspect and test generator and charging circuit wiring (par. 10-26) and if source of trouble is not found test generator regulator (par 10-29). Burned resistance units, winding, or fused regulator contacts result from open circuit operation or high resistance in charging circuit. Check for these conditions carefully.

10-9 CRANKING SYSTEM—TROUBLE DIAGNOSIS

a. No Cranking Action When Accelerator Pedal is Pressed

1. Make sure ignition switch is turned on. On cars equipped with Dynaflow Drive, control lever must be in neutral (N) or parking (P) position.

2. Make quick check of battery and cables (par. 10-7). If battery is low the solenoid usually will produce a clattering noise, because a nearly discharged battery will not sustain the voltage required to hold solenoid plunger in after solenoid switch has been closed.

3. If cranking motor operates but drive pinion does not engage flywheel ring gear, drive assembly is sticking on armature shaft. Remove motor to free up drive assembly.

4. If cranking motor does not operate, note whether solenoid plunger is pulled into solenoid when control circuit is closed. Ordinarily the plunger makes a loud click when it is pulled in. If plunger is pulled in, control circuit is okay and trouble is in solenoid switch or cranking motor. Exert pressure against shift lever to make sure plunger makes full travel and is not sticking. The cranking motor must be removed for repairs to switch or motor. (par 10-39, 10-40, 10-41).

5. If plunger is not pulled into solenoid when control circuit is closed, the control circuit is open, the relay is inoperative, or solenoid is at fault.

6. Use screwdriver to ground relay terminal to which wire with green crossing tracers is connected. If cranking motor then operates when control circuit is closed, the circuit from relay to ground through generator is open. Ground the "A" terminal of generator with jumper wire, and if cranking motor then operates look for dirty commutator, worn out brushes, or open field coils in generator, and for defective contacts in voltage and current regulators.

7. If cranking motor does not operate with relay terminal grounded (step 6) disconnect wire having black parallel tracers from relay and connect a 6-volt test lamp between this wire and ground. If lamp lights when accelerator pedal is pressed, control circuit to relay is okay and trouble is in relay or solenoid. Remove cranking motor for inspection and test of solenoid switch, (par. 10-39).

8. If, in step 7, control circuit to relay was found open (test lamp did not light) check for loose connections or broken wires. Use jumper wire to bridge across terminals of accelerator vacuum switch and neutral safety switch (Dynaflow cars only) to check these units. If vacuum switch appears to be cause of open circuit, make sure that throttle linkage is not sticking and holding throttle partially open, which would prevent switch from making contact. Check accelerator vacuum switch timing (par. 10-32 or 10-33).

b. Cranking Speed Abnormally Low

Abnormally low cranking speed may be caused by low battery or defective cables, defective solenoid switch, defective cranking motor, or an internal condition of engine.

1. Make quick check of battery. If low battery is indicated, test battery (par. 10-19 and 10-20). If defective cables are indicated, test cables (par. 10-21).

2. If battery and cables are okay, test cranking motor and solenoid switch (par. 10-37).

3. If cranking motor and solenoid switch test okay, the trouble is due to an internal condition of engine. This may be due to use of engine oil which is too heavy for prevailing temperatures. NOTE: *In cold weather always depress clutch pedal when cranking engine to avoid the load caused by stiff lubricant in transmission.* Car owners should be given this instruction. Tight pistons or bearings also impose a heavy load on the cranking motor.

c. Drive Pinion Clash After Starting

If drive pinion clash occurs immediately following disengagement of pinion from flywheel ring gear after engine has started running, try starting engine by holding accelerator pedal to the floor until engine has reached a speed between 15 and 20 MPH. If clash occurs, check the following points.

1. Make quick check of battery (par. 10-7). If low battery is indicated check electrolyte (par. 10-19)and cranking voltage (par. 10-20). Replace low battery with fully charged battery and test for clash again. A low battery will cause drive pinion clash because the generator voltage, which builds up quickly to maximum, causes a momentary voltage between generator and battery great enough to cause solenoid switch relay to close again and operate the solenoid.

2. If clash occurs with properly charged battery, test closing voltage of generator cut-

out relay (par. 10-29). A high closing voltage will cause drive pinion clash.

3. If battery and cutout relay are up to specifications, test cut-in and cut-out voltages of solenoid swich relay (par. 10-38).

4. If source of trouble has not been found, check accelerator vacuum switch timing (par. 10-32 or 10-33). *Clash of drive pinion from this cause usually occurs while driving at low speed rather than on initial starts.*

d. Delayed Disengagement of Drive Pinion

Delayed disengagement of drive pinion from flywheel ring gear can be identified by a "zooming" sound as cranking motor is speeded up by the engine. This condition may be caused by dirty generator commutator and brushes, oxidized voltage regulator contact points, sticking solenoid plunger or cranking motor drive assembly, or by a weak shift lever return spring.

1. Inspect generator commutator and brushes and clean if dirty (par. 10-26).

2. Inspect voltage regulator contact points and clean if oxidized or pitted (par. 10-30).

3. If solenoid plunger or cranking motor drive assembly is sticking, or shift lever return spring is weak, cranking motor must be removed so that these parts may be properly inspected and cleaned. See paragraph 10-39 (c) for pinion travel adjustment and paragraph 10-41 (b) for test of shift lever return spring.

10-10 IGNITION SYSTEM—TROUBLE DIAGNOSIS

If engine trouble has arisen which seems to be due to improper operation of the ignition system, it may be desirable to make a quick preliminary check of the ignition system before making a complete analysis, in order to determine whether the ignition system is actually at fault. The quick checks described in this paragraph may be used but it must be understood that they are no substitute for the complete ignition system inspection (par. 10-44) that should be used if it appears that ignition is faulty. The checks to be made depend on whether the engine will or will not run.

a. Engine Will Not Run

1. Make quick check of battery and cables (par. 10-7) if cranking motor does not turn engine at normal cranking speed.

2. Pull coil high tension cable from distributor cap and hold the lead terminal about $\frac{3}{16}$" from a clean ground point on engine. If a good spark occurs while engine is being cranked, the primary circuit and the secondary circuit to this point may be considered to be okay. Proceed with steps 3 through 6.

3. Remove distributor cap and check interior for moisture, corroded terminal segments, and check terminal sockets for corrosion. Check rotor for corrosion. Clean off corrosion and wipe distributor cap dry (par. 10-44).

4. Remove spark plug cover and inspect ignition cables for possible short circuits and corroded terminals. Remove and inspect spark plugs (par. 10-48).

5. If cause of trouble has not been found, check centrifugal and vacuum advance mechanism (par. 10-44) and check ignition timing (par. 10-47).

6. If engine still fails to run, the trouble is probably due to causes other than ignition, such as lack of fuel, carburetion, or compression loss.

7. If spark did not occur at coil high tension lead (step 2, above) then observe charge indicator while cranking engine. A small fluctuating reading indicates that the primary circuit is probably okay. Check ignition coil (par. 10-49) and check condenser (par. 10-50).

8. If charge indicator does not register any reading while engine is being cranked, the primary ignition circuit is open. Check for loose connections, broken leads, defective switch, distributor contact points not making contact, and open primary winding in coil (par. 10-49). Visual inspection of points and the use of a test lamp or voltmeter will locate the source of this trouble.

9. If charge indicator shows a steady reading of several amperes while engine is being cranked, then the primary circuit is not being interrupted by the contact points in the normal manner. Check contact point adjustment (par. 10-45). If they are properly adjusted check primary circuit for ground in wiring, condenser (par. 10-50) or coil (par. 10-49).

b. Engine Runs, But Not Satisfactorily

1. When missing, loss of power, or hard starting is present a complete checkup of the ignition system is in order, since these conditions may result from anything from a low battery to defective spark plugs, or from other engine conditions not related to ignition. In this case, the complete periodic inspection of ignition system given in paragraph 10-44 should be used.

2. Detonation may be caused by improper

timing (par. 10-47), improper operation of centrifugal or vacuum advance mechanism (par. 10-44), contact points improperly adjusted (par. 10-45) worn distributor bearings or a bent shaft, dirty or wrong heat range spark plugs (par. 10-48). It may also be caused by overheating, excessive carbon in cylinders, or by low octaine fuel.

3. Overheating may be caused by one or more of the conditions which contribute to detonation, as well as by faults in engine cooling system.

10-11 LIGHTING SYSTEM—TROUBLE DIAGNOSIS

a. Thermo Circuit Breaker Vibrates—Lights Flicker

When the thermo circuit breaker vibrates and causes lights to flicker it indicates a short in one of the lighting circuits, which may be traced as follows:

1. Pull switch successively to each lighting position. If circuit breaker vibrates in all positions except "off" the trouble should be found in the tail lamp and license lamp circuit.

2. If the circuit breaker vibrates in "parking" position only, look for a short in parking lamp circuit.

3. If the circuit breaker vibrates in "driving" position and is normal in all others, inspect headlight wiring circuit and lamp assemblies. If both filaments in headlamps burn at same time, headlamp unit should be replaced.

4. If the circuit breaker vibrates with lighting switch in all positions, including "off" position, the ground will be found in one of the following circuits: Lighting switch to stop light switch, lighting switch to instrument panel light switch, glove compartment light, map light, clock, and the dome light on the Series 40. The trouble can be traced to the particular defective circuit by removing above connections one at a time.

If the trouble is in the dome light circuit, the circuit breaker will not vibrate when the six-way connector is disconnected.

5. If the circuit breaker vibrates only when the service brakes are applied, the ground will be found in circuit from stop light switch to rear signal lamp.

Where tracing wiring circuits refer to wiring circuit diagrams in Section 10-J.

b. Lamps Fail to Burn

In general, failure of any lamp indicates a burned out bulb, an open circuit in the wiring, a defective switch, or a burned out fuse. See paragraph 10-53 for test of lighting switch. See wiring circuit diagrams in Section 10-J.

c. Lights Flare up Excessively when Engine is Speeded Up

This condition is caused by high voltage in electrical system due to one or more of the following:

1. Electrolyte in battery low or weak (par. 10-18, 10-19).

2. High resistance in circuit between generator and positive post of battery *due to loose or dirty connections* (par. 10-26).

3. Poor ground between generator and crankcase.

4. Voltage regulator adjusted too high or inoperative (par. 10-29).

10-12 SIGNAL SYSTEMS—TROUBLE DIAGNOSIS

a. Stop Lights

If stop light fails to burn, check lamp bulb, wiring circuit, and stop light switch. On *1949 Series 50-70,* check direction signal fuse on fuse block which also protects the stop lamp circuit. *On 1948 models* the stop lamp circuit is protected by the thermo circuit breaker on lighting switch. See chassis wiring circuit diagrams in Section 10-J.

If stop light burns when brake pedal is released, check stop light switch, also check brake pedal clearance (par. 8-11) and check for dragging brakes. If the compensating port in brake master cylinder is plugged by foreign material, or is covered by the piston primary cup when brake pedal is released, high pressure will be maintained in hydraulic system and stop light switch will remain closed.

b. Direction Signal Lights—1948 Models.

An inoperative *right* indicator light may be caused by a burned out bulb at *right* indicator or a *right* signal lamp. The opposite applies for inoperative left indicator light.

If bulbs are found okay, look for open circuit. See chassis wiring diagrams in Section 10-J.

If signal lights are inoperative on both turns, look for blown fuse or defective flasher.

c. Direction Signal Lights—1949 Series 50-70

An inoperative *right* indicator light may be caused by a burned out *left front* signal lamp

bulb. If left signal lamp flashes on left turn, however, trouble is in indicator bulb. The opposite applies for inoperative left indicator light.

If both indicator lights flash rapidly but dimly *at the same time,* look for burned out bulb in either the front or rear signal lamp on side for which signal switch is set. If bulbs are okay check for improperly connected wires at tail lamp or terminal block beside radiator. If both indicator lights burn dimly at the same time, without flashing, look for burned out bulb at both front and rear signal lamps.

If neither the signal, stop, or back-up lights burn, replace direction signal fuse. If stop and back-up lights burn but none of signal lights burn, replace flasher. If both indicator lights remain on with signal switch in neutral position, replace flasher.

If flasher, or fuse, continually burns out, check for short circuit (ground) in indicator light sockets or at terminal blocks beside radiator.

d. Horns Fail to Blow

1. Bridge between horn (H) and battery (B) terminals of horn relay with heavy jumper wire or screwdriver. If horns do not blow, adjust horns (par. 10-60).

2. If horns blow when (H) and (B) terminals are bridged, ground relay terminal (S) to which small black wire is connected. If horns do not blow, adjust horn relay (par. 10-61).

3. If horns blow with (S) terminal grounded, check for open circuit in wiring between relay and horn button and check horn button contacts, using 6-volt test lamp. This circuit can be broken at horn cable connector on left side of steering column jacket.

10-13 INSTRUMENTS AND CLOCK—TROUBLE DIAGNOSIS

a. Temperature Gauge

If the temperature gauge appears to be defective it can be tested before removal. Drain water from radiator, then carefully remove the vapor pressure bulb from cylinder head. Place bulb in a pail of hot water, also, put a reliable thermometer in water, and allow to set for three minutes. If gauge pointer registers the same as the thermometer, the gauge is okay, otherwise it will be necessary to replace the complete gauge assembly. When pressure bulb is installed in cylinder head be sure to attach bond strap on tube to the dash with clean tight connection to avoid radio interference.

b. Gasoline Gauge

If gasoline gauge shows full under all conditions look for an open circuit in line between dash and tank units. If gauge shows *empty under all conditions* look for ground in wiring between dash and tank units or for reversed connections on dash unit. See chassis wiring circuit diagrams in Section 10-J.

If check of wiring does not disclose cause of trouble, test dash unit, wiring circuit, and tank unit (par. 10-67).

c. Electric Clock

If clock gains or loses time it may be regulated by moving the regulator located on back of clock (par. 10-66).

If clock does not run, check the fuse. If fuse is blown, check clock wiring circuit for short; see chassis wiring circuit diagrams in Section 10-J.

With a Borg electric clock, the most frequent cause of clock fuse blowing is low voltage at the clock which will prevent a complete wind and allow clock contacts to remain closed. This may be caused by any of the following: discharged battery; corrosion on contact surface of battery terminals; loose connections at battery terminal on cranking motor solenoid switch, charge indicator, light switch feed wire or terminal connection on back of clock. Therefore, if in reconnecting battery or clock it is noted that the clock is not ticking always check for blown fuse, and examine the circuits at the points indicated to determine and correct the cause.

d. Speedometer

If speedometer pointer wavers, look for a kinked cable and test speedometer head for tightness or binding (par. 10-68).

If speedometer registers neither speed nor mileage look for broken cable. If cable is okay, remove head for repairs by an authorized AC Speedometer service station. If speedometer shows speed but not mileage, or vice versa, the head must be removed for repairs.

If speedometer speed and mileage readings are not accurate first check tires for proper size. If tires are of correct size check speedometer driven gear for correct number of teeth (par. 4-3, c). If tires and driven gear are correct, remove speedometer head and have it checked by an authorized AC Speedometer service station.