ELECTRICAL AND INSTRUMENTS

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

A 12-volt electrical system is used to ensure optimum ignition performance, high generator wattage output necessary with the modern accessories and the necessary starting motor power for the high compression engine.

The higher voltage of the 12-volt system should continually be kept in mind when working on 12-volt equipment. Accidental short circuits that may not damage similar 6-volt units will be more apt to damage 12-volt units. Arcs that occur around the battery, since they are larger, will be more apt to ignite any gas escaping from the battery. In addition, tools involved in accidental short circuits may be severely damaged.

The complete wiring diagram (less accessories) for all models is shown schematically in Figs. 12-1 and 2.

To simplify the job of localizing electrical difficulties, it is convenient to subdivide the complete electrical system as follows:

1. Charging Circuit.
2. Starting Circuit.
3. Ignition Circuit.
4. Lighting Circuit.

These subdivisions will be followed in covering the electrical equipment used.

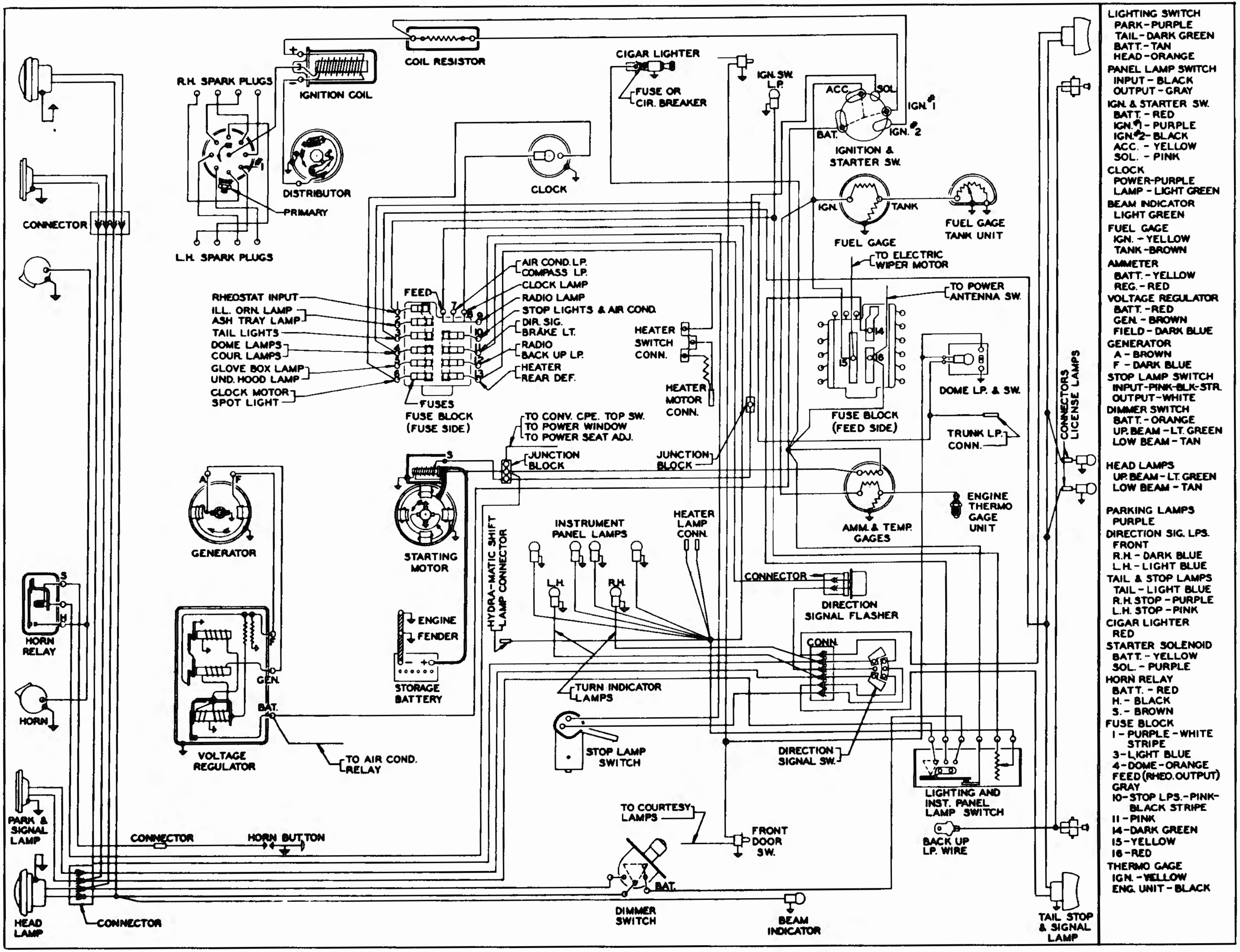


Fig. 12-1 Schematic Wiring Diagram Including Interior Lighting for Super Chief 4 dr. Sedans and Safaris, and all Chieftains

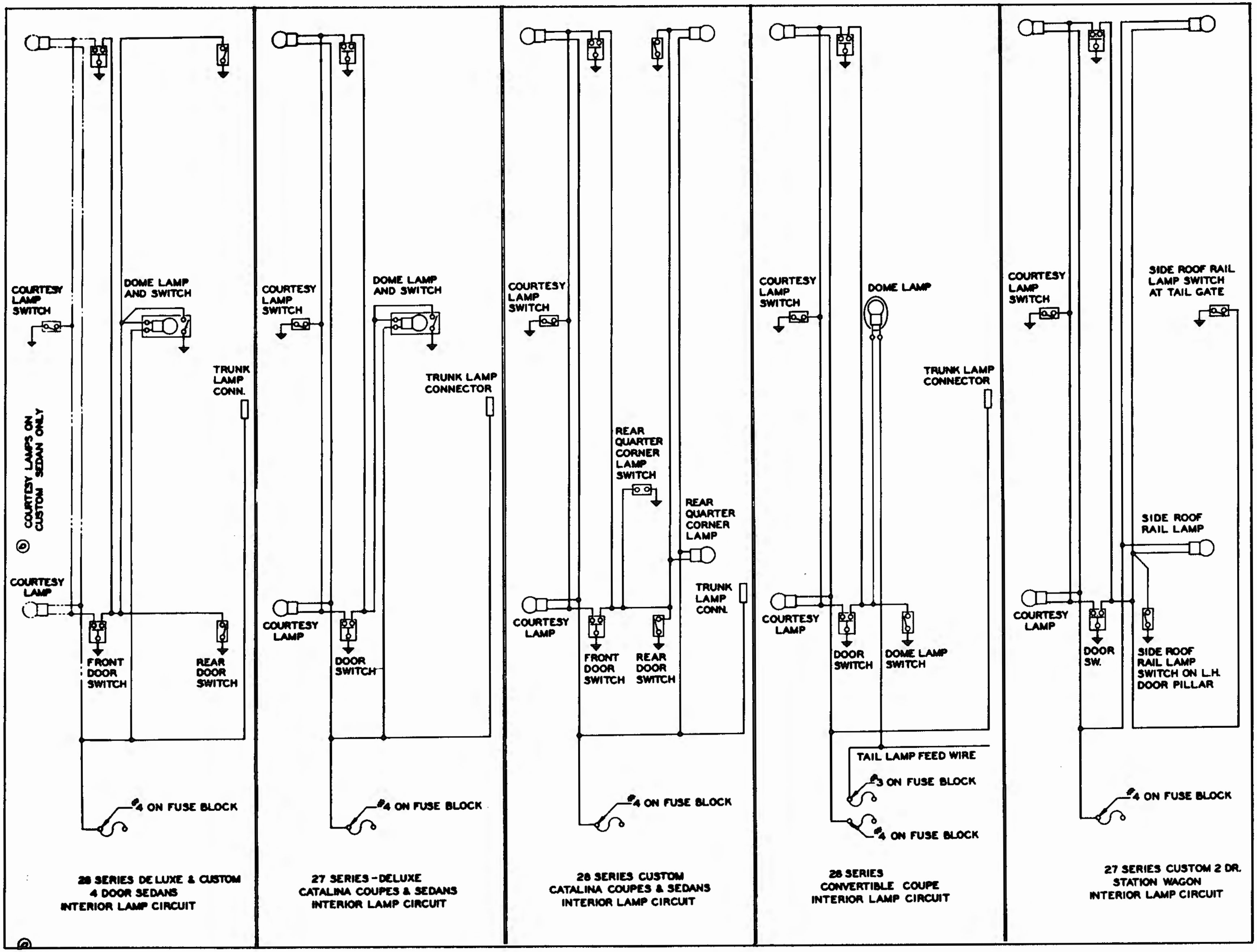


Fig. 12-2 Interior Lighting Circuits for Models not shown in Fig. 12-1

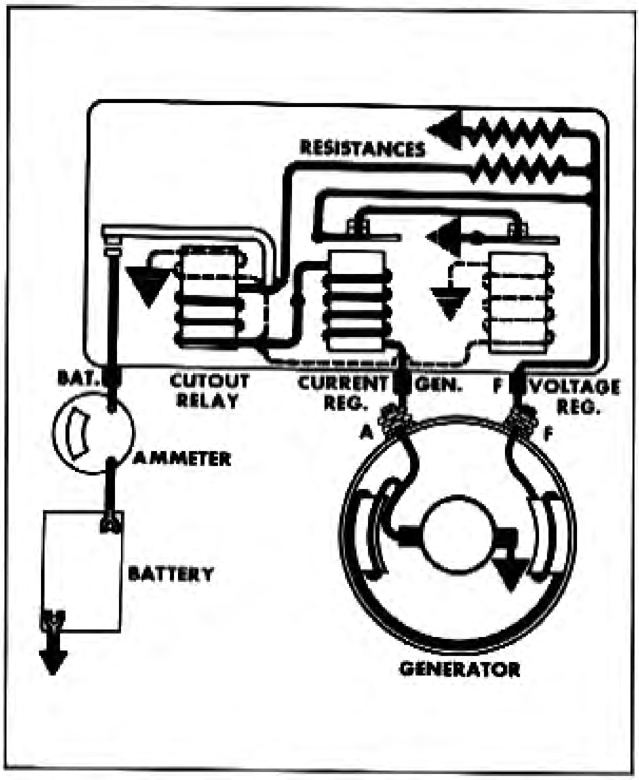


Fig. 12-3 Circuit Diagram of Charging Circuit

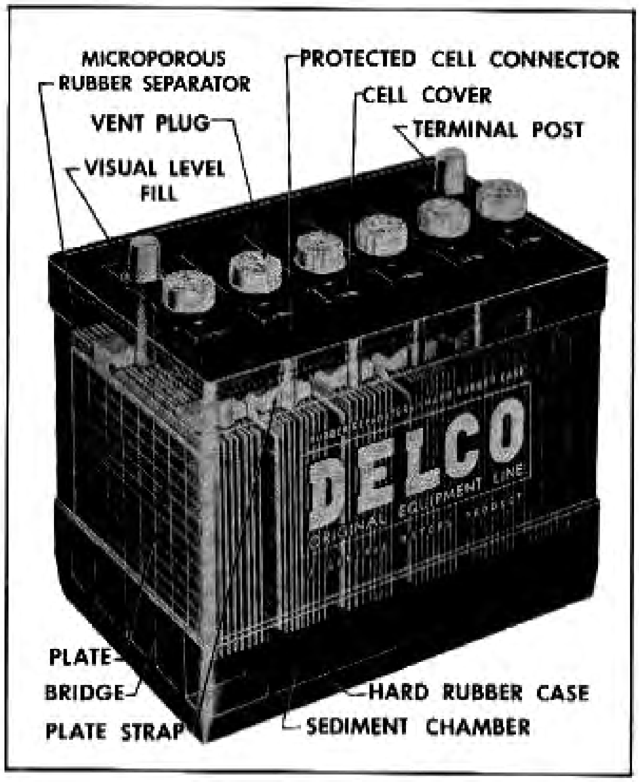


Fig. 12-4 Twelve Volt Battery

CHARGING CIRCUIT DESCRIPTION

The charging circuit includes the battery, generator, regulator, and ammeter. The simplified wiring diagram shown in Fig. 12-3 illustrates this circuit.

BATTERY

Two different batteries are standard equipment. The 2SMR53, 9 plate, 53 ampere hour battery is used on cars equipped with Synchro-Mesh transmission and 8.5:1 compression ratio engine (Fig. 12-4). This battery is designated catalog number 458.

A 60 ampere-hour battery is used as standard equipment on all Hydra-Matic equipped cars with 10:1 compression ratio engine. This battery is a Delco Model 558, 9 plate, 60 ampere-hour battery. It is a "High Plate" battery which gets increased capacity by having plates which extend deeper into the battery case.

The 3SMR72 11 plate, 72 ampere-hour battery is used for heavy duty. This battery is designated catalog number 670.

These batteries have a specific gravity of 1.260-1.280 at full charge at 80° F. The battery date code is located on the second cell cover from the positive post end of the battery. This date code should always be included in product information reports or correspondence about batteries.

All three batteries are equipped with "Visual Level" cell covers to facilitate checking electrolyte level and to lessen the possibility of overfilling the battery. These covers have a long, circular, tapered vent well with two small vertical slots diametrically opposite. Viewed from above, with the battery vent plugs removed, the lower end of the vent well appears as a ring with small portions of the circumference missing. As water is added to the cell, the surface of the rising liquid contacts the slotted lower end of the vent well causing a distortion of the reflecting surface of the liquid which is very noticeable. Thus, the lower end of the vent well serves as a reference point in determining proper electrolyte level. The cell is properly filled when the surface of the electrolyte touches the bottom of the vent well. If some overfilling occurs, the amount can be estimated readily by the height of liquid in the vent well itself.

A metal hold-down placed over the top of the battery when mounted in the car is attached by two bolts which fasten it to the battery support.

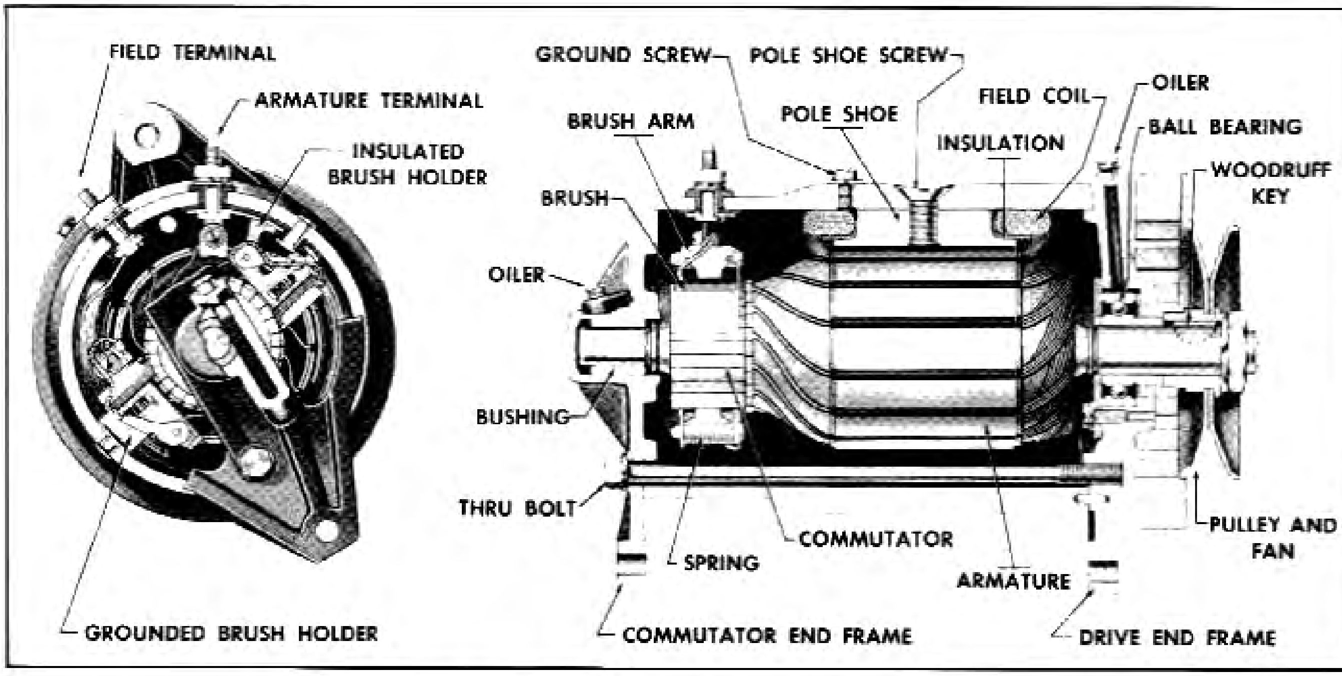


Fig. 12-5 Cross Section of Generator

GENERATOR

Delco-Remy 12-volt, two-brush, shunt generators (Fig. 12-5) are used. The armature in each of these generators is supported by a ball bearing in the drive end frame and by a porous bronze bushing in the commutator end frame. The generator is cooled by a fan mounted on the drive end. Generator output is controlled by a current and voltage regulator.

The standard installation uses a 12-volt, 25-ampere generator, models with air conditioning use a 12-volt, 35-ampere generator and the heavy duty options are a 12-volt, 35-ampere generator and an extra high output 12-volt, 40-ampere generator.

REGULATOR (FOR 25 AMP. AND 35 AMP. GENERATORS)

A Delco-Remy three-unit, waterproof, 12-volt regulator is used on all car models. The regulator is designed for use with a negative grounded battery and a shunt type generator. The regulator contains a cut-out relay, a voltage regulator unit, and a current regulator unit.

CUT-OUT RELAY—The purpose of the cut-out relay is to close and open the charging circuit between the generator and battery. When the generator voltage reaches the value for which the cut-out relay is adjusted, the contact points close and current flows from the generator toward the battery. When generator voltage falls below battery voltage, the contact points open to prevent battery discharge through the generator while the engine is idling or stopped.

VOLTAGE REGULATOR—The purpose of the voltage regulator unit is to limit the system voltage to a safe maximum. Vibrating contacts of the voltage regulator limit voltage by intermittently inserting resistance in the generator field circuit as required. With system voltage properly limited, electrical accessories are protected and the battery is not subjected to excessive overcharging.

CURRENT REGULATOR—The purpose of the current regulator unit is to prevent overheating of the generator armature by limiting generator output. Vibrating contacts of the current regulator limit current output by intermittently inserting resistance in the generator field circuit as required.

REGULATOR (FOR HEAVY DUTY 40 AMP. GENERATOR)

Due to the higher field currents required with the 40-ampere generator a new regulator was developed incorporating a double contact voltage regulator.

The regulator contains three units (Fig. 12-6)—a cutout relay, a current regulator, and a voltage regulator. The cutout relay and current regulator

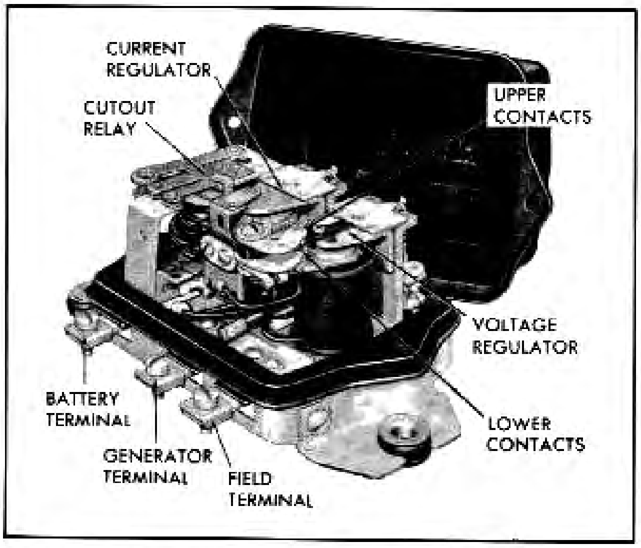


Fig. 12-6 Double Contact Heavy Duty Regulator

are of the conventional type and are checked and adjusted in the normal manner. The double contact voltage regulator is basically the same as the standard voltage regulator with two major exceptions (1) Lower value of regulating resistor (2) An extra set of contacts (herein designated as the "lower set") which is connected across the generator field. The charging circuit for the heavy-duty double contact voltage regulator is shown in Fig. 12-7.

CAUTION: *Never ground the generator field with this regulator connected to generator. This will burn up the lower set of contact points of the voltage regulator.*

OPERATION

When the generator field requirements are high—relatively low speed and high load—the regulator operates on the "upper set" of contacts in the same manner as a standard regulator.

When the generator field requirements are low—relatively high speed and low load—the resistance inserted in the field circuit when the upper contacts open is no longer sufficient to control the generator voltage. Then, the voltage will increase slightly which pulls the armature down to operate on the lower set of contacts. With the regulator operating on the lower contacts the generator field is shorted out when the contacts close and the regulating resistor is in series with the field when they are open. Operation on the lower set of contacts is a vibrating action much like that of the upper contact.

AMMETER

The ammeter is connected in the charging circuit and indicates whether current is flowing into or out of the battery. While the ammeter indicates whether or not the battery is being charged, it is not intended

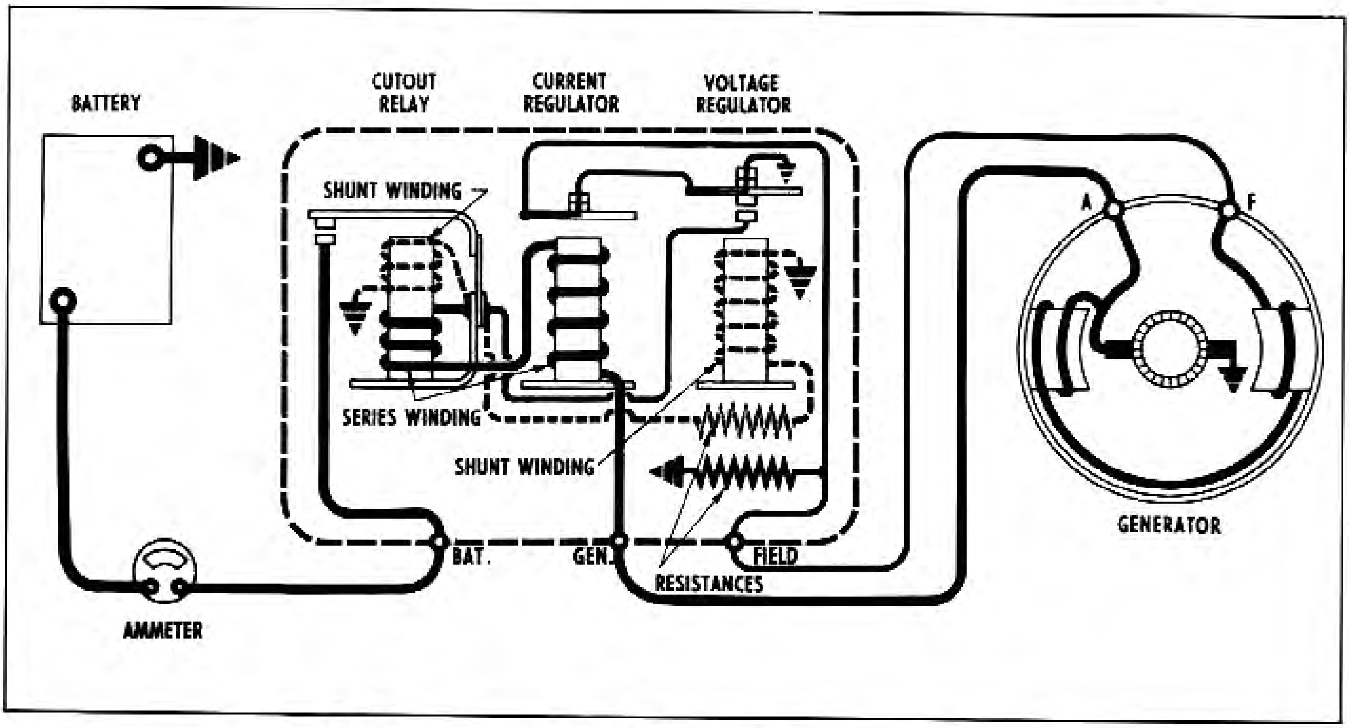


Fig. 12-7 Charging Circuit With Double Contact Voltage Regulator

to indicate the amount and no attempt should be made to interpret the ammeter reading in amperes.

Due to the vibrating action of the contact points in the current and voltage regulator units, the ammeter needle may oscillate under certain operating conditions. Unless the regulator has oxidized contact points (see CHECK FOR OXIDIZED REGULATOR CONTACT POINTS, page 12–12) this oscillation does not indicate any regulator trouble and *it must not be used alone as a basis for replacing the regulator.*

GROUND STRAP—DASH TO ENGINE

Two dash to engine ground straps are used on cars equipped with radio.

CHARGING CIRCUIT—PERIODIC SERVICE

BATTERY

Liquid level in the battery should be checked every 2,000 miles or once a month. In extremely hot weather, the checking should be more frequent. If the liquid level is found to be low, water should be added to each cell *until the liquid level rises to the bottom of the vent well. DO NOT OVERFILL!* Distilled water, or water passed through a "demineralizer", should be used for this purpose in order to eliminate the possibility of harmful impurities being added to the electrolyte. Many common impurities will greatly shorten battery life.

The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down bolts should be kept properly tightened. Particular care should be taken to see that the tops of 12-volt batteries are kept clean of acid film and dirt because of the high voltage between the battery terminals. For best results when cleaning batteries, wash first with a dilute ammonia or soda solution to neutralize any acid present and then flush off with clean water. Care must be taken to keep vent plugs tight so that the neutralizing solution does not enter the cell. The hold-down bolts should be kept tight enough to prevent the battery from shaking around in its holder so as not to damage the battery case, but they should not be tightened to the point where the battery case will be placed under a severe strain.

To insure good contact, the battery cables should be tight on the battery posts. The battery ground cable must always be connected to the battery support as well as the engine to insure a good ground circuit through the fender skirt to the regulator. If the battery posts or cable terminals are corroded, the cables should be disconnected and the terminals and clamps cleaned separately with a soda solution and a wire brush. After cleaning apply a thin coating of petrolatum on the posts and cable clamps to help retard corrosion.

GENERATOR

The hinge cap oilers of the generator should be filled with light engine oil once at each vehicle lubrication period. However, if the oil reservoir in the commutator end frame should become exhausted through failure to add oil at each vehicle lubrication period, the oil cup should be filled *three times consecutively,* allowing time between fillings for the oil to saturate the wick. The hinge cap oiler on the drive end frame, however, never should be filled more than once at each lubrication period. CAUTION: Do not fill oil cups with engine running.

Periodic servicing of the generator should include an inspection of the commutator and brushes for cleanliness and wear. If the commutator is dirty it should be cleaned as outlined under GENERATOR, page 12-21. If the brushes are worn down to less than half their original length, they should be replaced.

REGULATOR

Normally, periodic service of the regulator is not required. However, it may occasionally be necessary to clean the regulator contact points as outlined under REGULATOR INSPECTION AND ADJUSTMENT, page 12–18.

CHARGING CIRCUIT—CHECKS AND ADJUSTMENTS ON CAR

WIRING

Excessive voltage drop in the charging circuit tends to keep the battery in an undercharged condition. To check for excessive voltage drop (resulting from loose connections or other high resistance) in the charging circuit, make connections as shown in Fig. 12-8 and proceed as follows:

1. Ground the "F" terminal of the regulator.

2. Turn off all accessories and operate the generator at a speed which will produce a charge rate of 20 amperes.

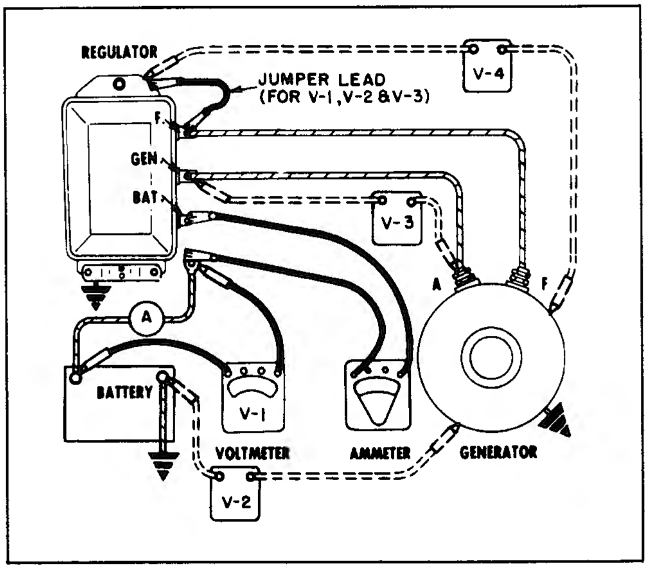


Fig. 12-8 Testing for Voltage Drops in Charging Circuit

3. Measure the voltage drop at V_1, V_2 and V_3. Readings V_1 plus V_2 should not exceed 0.5 volt. Reading V_3 should not exceed 0.3 volt. If the voltage drop exceeds these limits, excessive resistance is indicated in the circuit checked.

4. With the engine stopped, turn on the full lighting and accessory load (approximately 20 amperes). Measure the voltage drop at V_4 (Fig. 12-8). If this voltage drop exceeds 0.1 volt, excessive resistance is indicated in this portion of the charging circuit.

If excessive resistance is found, check the wiring for defects, and replace if necessary. Clean and tighten all connections. NOTE: Remove the ground jumper lead at the "F" terminal of the regulator after completion of these checks.

BATTERY

Measure the specific gravity of the electrolyte in each battery cell. Correct the specific gravity readings for temperature. (When electrolyte temperature is above 80 degrees F, add 4 points (.004) to the reading for each 10 degrees above 80 degrees F. When the electrolyte temperature is below 80 degrees F, subtract 4 points for each 10 degrees below 80 degrees F.). If the specific gravity is less than 1.215, @ 80° F, recharge the battery. If the specific gravity is above 1.215 but the variation between cells is more than 25 points (.025), it is an indication of shorted cells, acid loss or a worn-out battery, and the unit should be removed from the car for further checking to determine whether or not it should be replaced.

When the specific gravity of each cell is above 1.215 and variation between cells is less than 25 points, the battery may be checked under load. This can be done by briefly applying a heavy electrical load to the battery by means of a carbon pile or other suitable equipment and measuring the terminal voltage of the battery. The load in amperes should equal three times the ampere-hour rating of the battery. (Example: For 558 battery, load equals $3 \times 60 =$ 180 amps.) Terminal voltage under this load should be not less than 9.0 volts. If test equipment for loading the battery is not available, the cranking motor may be used as a load. (CAUTION: Disconnect distributor to coil primary wire when using the cranking motor as a load. This prevents the engine from firing.) When using the cranking motor for this test, the terminal voltage of the battery should be not less than 9.0 volts. If the terminal voltage is less than 9.0 volts during either of these checks, the battery should be removed from service for further checking to determine whether or not it should be replaced. CAUTION: Do not operate the cranking motor for more than 30 seconds at a time.

REGULATOR

Four regulator electrical checks can be made on the car — the settings of the cutout relay, voltage regulator, and current regulator, and a check for oxidized regulator contact points. Mechanical checks and adjustments requiring removal of the regulator from the car are discussed under REGULATOR INSPECTION AND ADJUSTMENT, page 12-18.

The regulator cover must be in place and the regulator must be at operating temperature when the electrical settings are checked. For best results, the electrical checks should be made in the following order.

1. Voltage regulator setting.

2. Cut-out relay closing voltage.

3. Current regulator setting.

4. Check for oxidized contact points.

The procedure required for making each of these checks follows: NOTE: If special testing equipment is used, follow the manufacturer's instructions.

TESTING AND ADJUSTING 25 AND 35 AMPERE VOLTAGE REGULATORS

Methods for checking and adjusting the voltage regulator setting are discussed in the following paragraphs. However, it is seldom necessary to check and adjust the voltage regulator setting as long as

(1) the battery remains satisfactorily charged without excessive use of water and (2) there is no evidence of damage to lights or other voltage-sensitive equipment.

To check the voltage regulator setting, proceed as follows:

1. Connect a ¼-ohm fixed resistor (approximately 25 watts capacity) into the charging circuit at the "BAT" terminal of the regulator and connect a voltmeter from the "BAT" terminal to ground (Fig. 12-9).

2. Operate the engine at 1600 r.p.m. for at least 15 minutes, with ¼-ohm resistor in circuit and regulator cover in place, to bring the regulator to operating temperature.

3. Place a thermometer near the regulator so that the bulb of the thermometer will be about ¼" from the cover.

4. Cycle the generator by stopping the engine, restarting, and returning to 1600 engine r.p.m.

5. Note the voltmeter reading and regulator ambient temperature (temperature of air about ¼" from regulator). The voltmeter reading found represents the voltage regulator setting *at the ambient temperature noted. The setting will be different at other temperatures.* Regulator specifications are based on checks made at an ambient temperature of 125°F. If the temperature is above 125°F, the regulator will limit voltage to a higher value or if below 125°F, the same regulator will limit voltage to a lower value. A voltage correction factor must, therefore, be applied to the voltage reading before it can be compared with specifications on page 12-53.

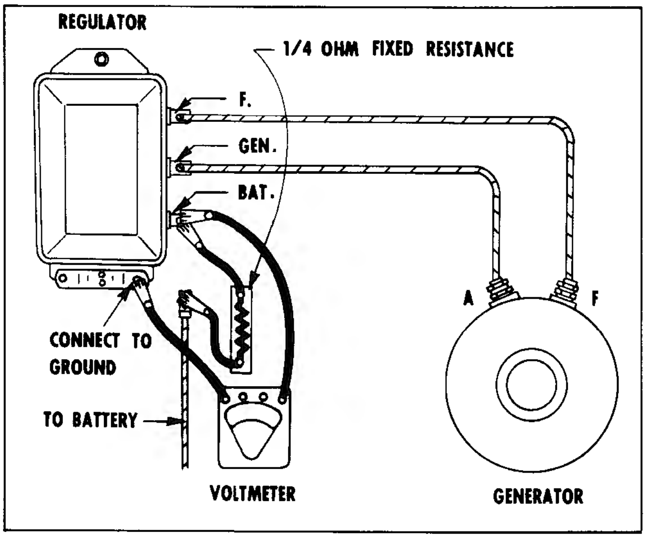


Fig. 12-9 Connections for Testing Voltage Regulator

VOLTAGE CORRECTION FACTORS FOR REGULATOR SETTINGS AT DIFFERENT REGULATOR AMBIENT TEMPERATURES

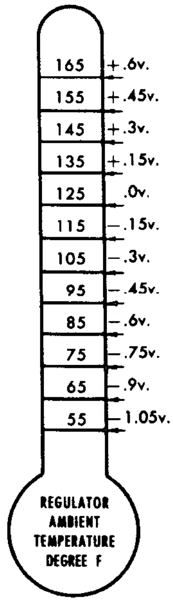
Correction can be made for ambient temperature by adding .15 volt to the operating voltage regulator setting for every 10 degrees that the ambient temperature is above 125 degrees. For every 10 degrees the ambient temperature is below 125 degrees, .15 volt must be subtracted from the operating regulator setting.

EXAMPLE NO. 1

Operating Voltage Setting	14.2 V
Regulator Ambient Temperature	165° F
Correction Factor	+.6 V
"Corrected" Voltage Regulator Setting*	14.8 V

EXAMPLE NO. 2

Operating Voltage Setting	14.6 V
Regulator Ambient Temperature	105° F
Correction Factor	−.3 V
"Corrected" Voltage Regulator Setting*	14.3 V



** Note—Corrected voltage regulator setting should be within the normal range, 13.8 to 14.8 volts.*

Fig. 12-10 Voltage Regulator Temperature Correction Chart

Correcting the Voltage Regulator Setting for Regulator Ambient Temperature—Figure 12-10 shows the voltage correction factor to be applied to the voltage setting at different ambient temperatures. To obtain the "corrected" voltage regulator setting, note the correction factor in Figure 12-10 that corresponds most nearly with the regulator ambient temperature noted in Step 5, and apply it to the voltage reading observed in Step 5. (See examples shown in Figure 12-10).

When the "corrected" voltage regulator setting falls *within* the normal range given in the specifications and the battery condition has been *satisfactory, the voltage regulator setting should not be disturbed.*

When the "corrected" voltage regulator setting falls *inside or outside* the normal range given in the specifications but battery condition has been *unsatisfactory, tailor the voltage regulator setting* as follows:

TAILORING THE VOLTAGE REGULATOR SETTING

NOTE: The desired voltage regulator setting is that which keeps the battery in a satisfactory state of charge without causing excessive water usage (as evidenced by water consumption exceeding one ounce per cell each 1000 miles). In order to obtain the desired setting, tailor the voltage regulator setting.

a. When the battery uses too much water and the "corrected" voltage setting is above the normal range, lower the "corrected" setting to 14.3 volts and check for an improved condition over a reasonable service period. When the battery uses too much water and the "corrected" voltage setting is *within* the normal range, lower the setting 0.1 or 0.2 volt and check for an improved condition over a reasonable service period. Repeat until the battery remains charged with a minimum use of water.

b. When the battery is consistently undercharged and the "corrected" voltage setting is *below* the normal range, increase the "corrected" setting to 13.8-14.5 volts and check for an improved condition over a reasonable service period. When the battery is consistently undercharged and the "corrected" voltage setting is *within* the normal range, increase the setting 0.1 volt and check for an improved condition over a reasonable service period. Repeat until the battery remains charged with a minimum use of water. NOTE: Avoid "corrected" settings above 14.8 volts as these may cause damage to lights and other voltage-sensitive equipment.

It rarely will be found necessary to use a voltage regulator setting outside the normal range in order to correct battery conditions. Batteries which do not respond to voltage regulator settings within the normal range usually will be found to be (1) batteries used in cars that are operated consistently at low speeds or in heavy traffic, or (2) batteries that have abnormal charging characteristics.

(1) When a car is operated consistently at low speeds or in heavy traffic the battery may remain undercharged even with a voltage regulator setting of 14.8 volts. Under these operating conditions, generator output and charging time may be insufficient to offset electrical loads on the battery. Periodic recharging of the battery from an outside source or replacement of the original generator with a special generator will be required in these cases.

(2) Batteries suspected of having abnormal charging characteristics should be removed for a complete check. If the checks outlined under BATTERY CHARGING, page 12-13, indicate that the battery is still serviceable. a voltage regulator setting outside the normal range may be adopted provided it does not cause damage to lights or other voltage-sensitive equipment or cause the battery to use water. NOTE: Bulb life will be shortened by setting the voltage regulator above the specified voltage.

On new cars or on other applications where no battery history is available, any "corrected" voltage regulator setting found within the normal range may be considered satisfactory unless local conditions or subsequent battery performance indicate the need for tailoring the voltage regulator setting.

When the need for changing the voltage regulator setting has been established, proceed as follows: Remove the regulator cover and turn adjusting screw clockwise to raise the setting, counterclockwise to lower the setting. Before taking the new reading after each adjustment, replace the regulator cover as quickly as possible and cycle the generator. CAUTION: *Final adjustment should always be made by increasing spring tension to assure contact between the screw head and spring support (Fig. 12-11).* Sometimes the spring support does not follow the screw head as spring tension is decreased, and it will be necessary to bend the spring support up to insure contact between the screw head and spring support. Failure of the voltage regulator unit to "hold" its setting usually results from (1) setting or checking the voltage regulator at other than operating temperature, and (2) the screw head not touching the spring support after final adjustment is completed.

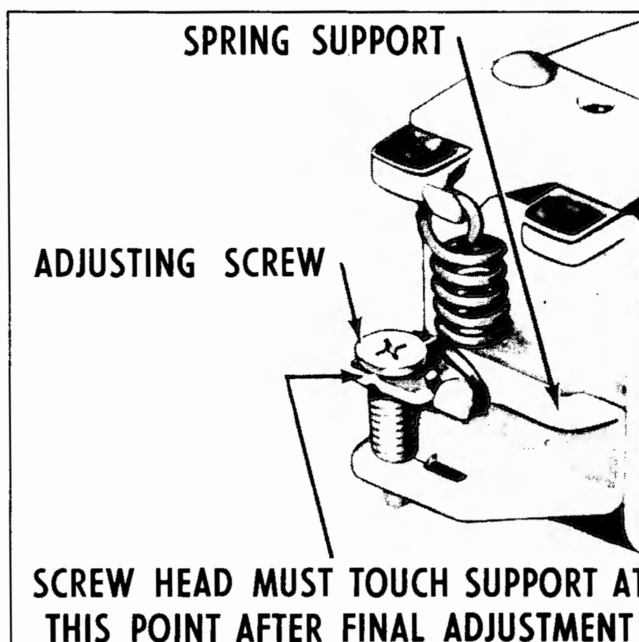


Fig. 12-11 Proper Relationship of Spring Support and Adjusting Screw

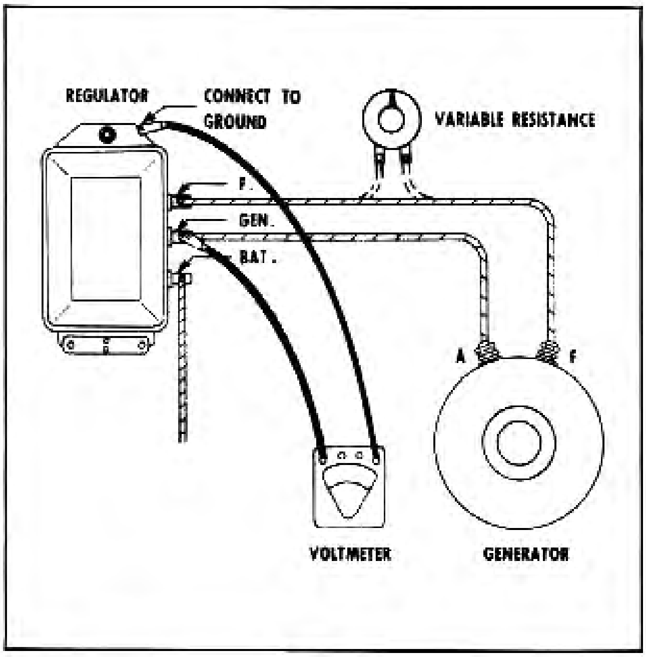


Fig. 12-12 Connections for Checking Closing Voltage

CUT-OUT RELAY CLOSING VOLTAGE—TEST AND ADJUST

NOTE: It is seldom necessary to check the closing voltage of the cut-out relay as long as the relay functions to close and open the charging circuit. Any setting that falls within the specified range is satisfactory as long as the setting is at least 0.5 volt below the voltage regulator setting.

1. Connect a voltmeter between the regulator "GEN" terminal and ground (Fig. 12-12).

2. Check cut-out relay closing voltage by *either* of the following methods.

a. Slowly increase generator speed and note the voltage at which the relay closes. Decrease generator speed and make sure the cut-out relay contact points open.

b. Connect a 25-ohm, 25-watt variable resistor in the field circuit. Operate the generator at medium speed at maximum resistance (with all the resistance of the variable resistor turned in the circuit). Slowly decrease (turn out) the resistance, and note the voltage at which the contact points close. Slowly increase the resistance and make sure that the contact points open.

3. Adjust the closing voltage by turning the adjusting screw (Fig. 12-13). Turn the screw clockwise to increase the setting and counterclockwise to decrease the setting.

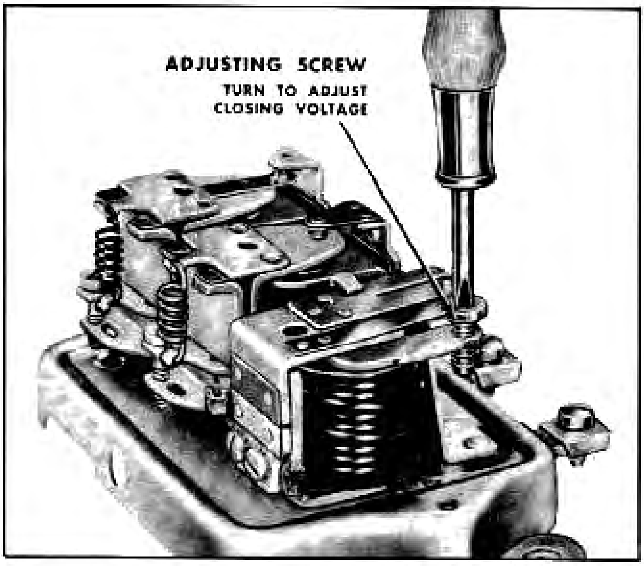


Fig. 12-13 Adjusting Closing Voltage

CURRENT REGULATOR—TEST AND ADJUST

It is seldom necessary to check the setting of the current regulator unless the generator armature shows signs of overheating. Any setting that falls within the specified range is satisfactory.

1. Connect an ammeter into the charging circuit and connect voltmeter from "BAT" to ground (Fig. 12-14).

2. Turn on all accessory load (lights, radio, etc.) and connect any additional load such as carbon pile or bank of lights across the battery to drop system voltage to 12.5-13 volts.

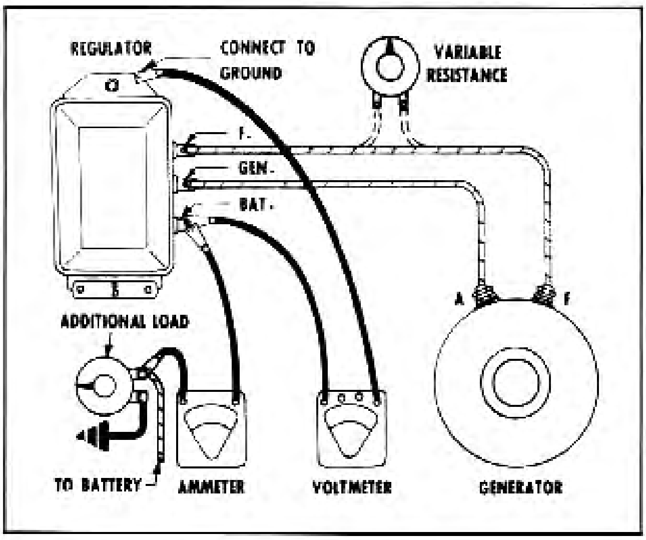


Fig. 12-14 Connections for Checking Current Regulator

3. Operate the generator at 1600 engine r.p.m. for at least 15 minutes to establish operating temperature. The regulator cover must be in place.

4. Cycle the generator by stopping engine, re-starting and returning to 1000 engine r.p.m. and note the current regulator setting.

5. Adjust the current setting in the same manner as that used for adjusting the voltage regulator setting.

CHECK FOR OXIDIZED REGULATOR CONTACT POINTS

1. Turn on the headlights.

2. Operate the generator at a speed which will produce a charge rate of 5 amperes.

3. Ground the "F" terminal of the regulator.

4. If generator output increases more than 2 amperes, oxidized regulator contact points are indicated and the regulator should be removed from the car and the contact points should be cleaned as outlined under REGULATOR INSPECTION AND ADJUSTMENT, Page 12-18.

TESTING AND ADJUSTING HEAVY DUTY VOLTAGE REGULATOR

The cut-out relay and current regulator on the heavy duty regulator are tested and adjusted in the same manner as with the standard regulator.

The double contact voltage regulator must be tested and adjusted using the following method.

CHECKING AND ADJUSTING PROCEDURE

1. To properly adjust voltage regulator, battery must be fully charged to limit the charge rate to 1 to 10 amperes. If above 10 amps. insert a ¼ ohm resistor in series with the battery.

2. Connect a voltmeter from regulator "BAT" terminal to ground (Fig. 12-15).

3. Connect a 25-ohm (25-watt) variable resistance (which has an "open" position) between the regulator "F" (field) terminal and the field lead from the generator. (Connections to the variable resistance should be made so that all the resistance can be inserted into the circuit before opening the circuit.)

4. With variable resistance turned out, operate generator at medium speed so that the voltage regulator is operating on the lower set of contacts. Continue to operate for 15 minutes to establish operating temperature of voltage regulator.

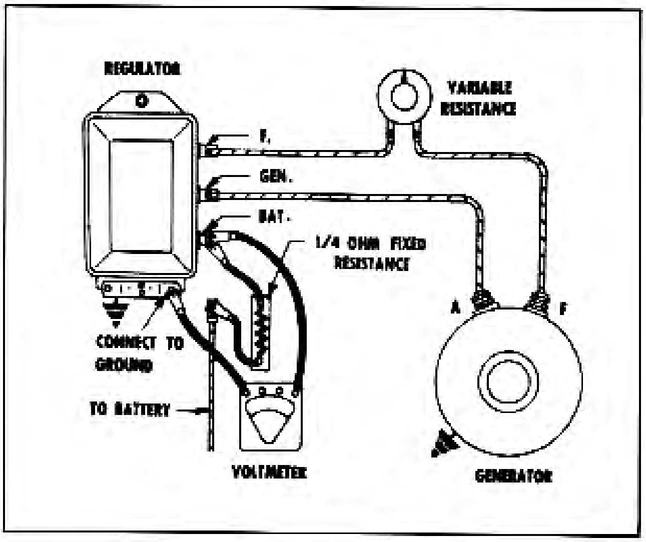


Fig. 12-15 Connections for Checking Double Contact Voltage Regulator

5. Cycle the generator by turning the variable resistance to the "open" position momentarily, then slowly cut all the resistance out. Regulator should be operating on lower contacts between 14.0 and 14.6 volts. This is the voltage setting of the regulator and may be adjusted in the conventional manner by turning the double slotted screw to adjust spring tension (Fig. 12-16).

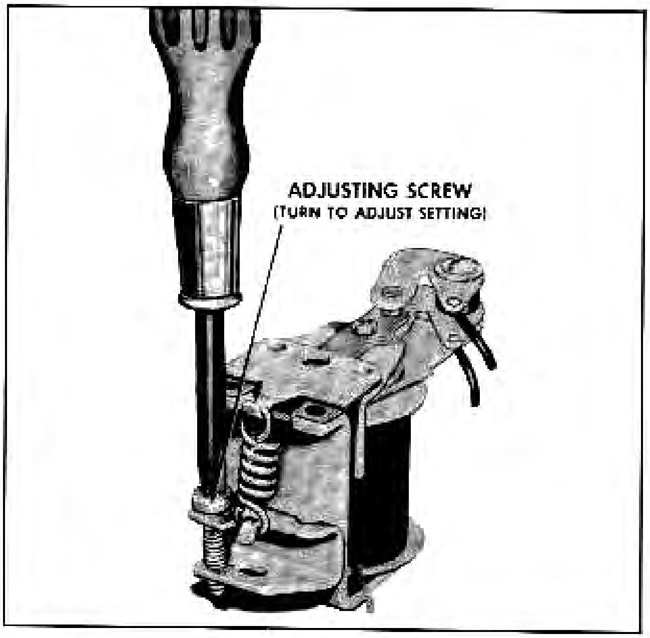


Fig. 12-16 Adjusting Voltage Regulator Setting (Lower Contacts)

6. Increase resistance slowly until regulator begins to operate on the upper contacts. The voltmeter should indicate a slight drop in voltage of .3 to .5 volts. This differential voltage may be increased by turning the air gap adjusting screw (located on the armature) (Fig. 12-17) in a clockwise direction and decreased by turning it counterclockwise. Air gap adjustment should seldom be necessary on this regulator. However, if the adjustment screw is turned, it will also affect the setting of the regulator, so that the voltage adjustment procedure must be repeated. The regulator must be cycled each time before taking voltmeter readings, as previously described.

7. If the condition ever exists where the voltage setting of the upper contacts is higher than that of the lower contacts, turn the air gap adjusting screw in a clockwise direction. If adjustment is taken up, it is necessary to reset the nominal air gap by bending the contact supports (Page 12-20).

CAUTION: *Never ground the generator field with this regulator connected to the generator. This will burn up the lower set of contact points of the voltage regulator.*

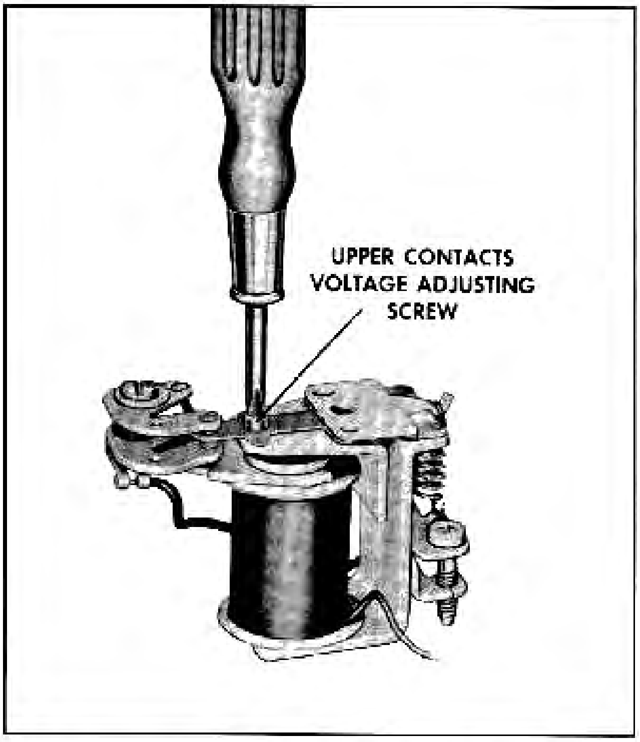


Fig. 12-17 Adjusting Voltage Setting of Upper Contacts

CHARGING CIRCUIT—MINOR REPAIRS

BATTERY CABLE REPLACEMENT

When replacing battery ground cable be sure to connect the cable to the battery support as well as to the engine. This is necessary to insure a good ground circuit through the battery support and fender skirt to the regulator.

The battery-to-starter cable is difficult to remove at the starting motor solenoid. For this reason the cable should be removed and replaced as an assembly with the starting motor as outlined on pages 12-23 and 12-27 respectively. Before fastening cables to battery, clean battery post and lightly coat battery post and cable terminals with petrolatum.

BATTERY SUPPORT REPLACEMENT

When replacing the battery support, it is very important that the outer edges of the battery bear firmly and evenly against the support. To provide even support, install shims as necessary between the corners of the support and the support bracket. Battery hold down clamp should be tightened to 22-27 lb. ins. torque.

BATTERY CHARGING

Batteries removed from the car for charging should be charged continuously at a low rate until fully charged. Batteries may be safely slow-charged at a rate in amperes equal to 7% of the battery's ampere-hour capacity. Example: 7% of 60 A.H. = 4.2 amperes. This is called the "normal" charge rate. The battery is fully charged when specific gravity readings taken at hourly intervals with battery on charge show no increase during three consecutive readings. Although the slow-charge method is recommended for charging all batteries, discharged batteries in otherwise good condition may be given a "boost" with a fast charger if time does not permit complete slow-charging. When using a quick charger, it must be remembered that the battery is only receiving a *partial* charge and that the battery electrolyte temperature must not be allowed to exceed 120° F. If the battery heats excessively, quick charging must be discontinued. NOTE: Do not load-test batteries having specific gravity readings less than 1.215 @ 80° F. Batteries removed from the car for further checking in order to determine whether or not the unit should be replaced, first should be brought to a fully-charged condition by slow-charging. Badly sulfated batteries may require a continuous slow charge for 48 hours or more before a rise in gravity reading occurs. If the specific gravity reading of any cell fails to reach 1.250 (corrected to 80° F) or if there is a variation of more than 25 points between cells after thorough slow charging, replace the battery. If the specific gravity of each cell is 1.250 or more and variation between cells is less than 25 points the battery may be given a high-rate discharge test as follows:

HIGH-RATE DISCHARGE TEST

Place an ampere load equal to three times the ampere-hour rating (Example: 3 × 60 A.H. = 180 amperes) across the battery and measure the terminal voltage. If terminal voltage is less than 9.0 volts under load, replace the battery. (If no equipment is available for placing a high-rate discharge load across the battery, measure the open circuit voltage of each cell with an open circuit cell tester. If the open circuit cell voltages vary more than .05 volt, replace the battery).

GENERATOR REMOVAL

1. Disconnect field and output wires from generator.
2. Remove adjusting strap screw and remove fan belt from generator pulley.
3. Remove generator from mounting bracket.

GENERATOR DISASSEMBLY

1. Place generator in bench vise; use vise as holding fixture only and be careful not to distort generator frame: NOTE: Check brush spring tension before disassembling generator to determine if spring is weak or brush holder is gummy (Fig. 12-18). Proper spring tension is approximately 28 ounces.

Fig. 12-18 Checking Brush Spring Tension

2. Remove two through bolts and remove commutator end frame assembly (Fig. 12-19).
3. Remove brushes.
4. Remove drive end frame assembly, with armature and pulley, from generator frame.
5. Remove drive pulley. A fan belt held tightly in the pulley groove will aid in holding the armature while removing the nut.
6. Remove drive pulley and key from armature shaft.
7. Remove spacer collar from armature shaft and then slide drive end frame from armature shaft. Bearing-assembly-spacer-inside washer will remain on armature shaft and may be lifted off after removing end frame from armature.
8. Remove bearing retainer plate and gasket from end frame.
9. Push ball bearing out of end frame and put in a clean place where grit or dirt will not enter.
10. Remove bearing felt washer and bearing felt from drive end frame.

CLEANING AND INSPECTION OF GENERATOR

1. With the generator completely disassembled, wash all metal parts except the armature and fields in cleaning solvent. Fields and armature must never be cleaned with any degreasing solvents since this may damage the insulation. NOTE: Armature and field coils may be cleaned by brushing with oleum spirits.
2. After it has been given a thorough cleaning in solvent, inspect generator ball bearing for roughness, scored races, and deformed balls.
3. Check brush holders to see that they are not deformed or bent so as to interfere with holding brushes properly against commutator.
4. Check fit of armature shaft in bushing in commutator end frame. If bushing is excessively worn it should be replaced.
5. Inspect armature commutator; if rough it must be turned down and insulation undercut. Inspect solder at points where armature wires fasten to ends of commutator riser bars to make sure solder is in place so as to assure a good connection.

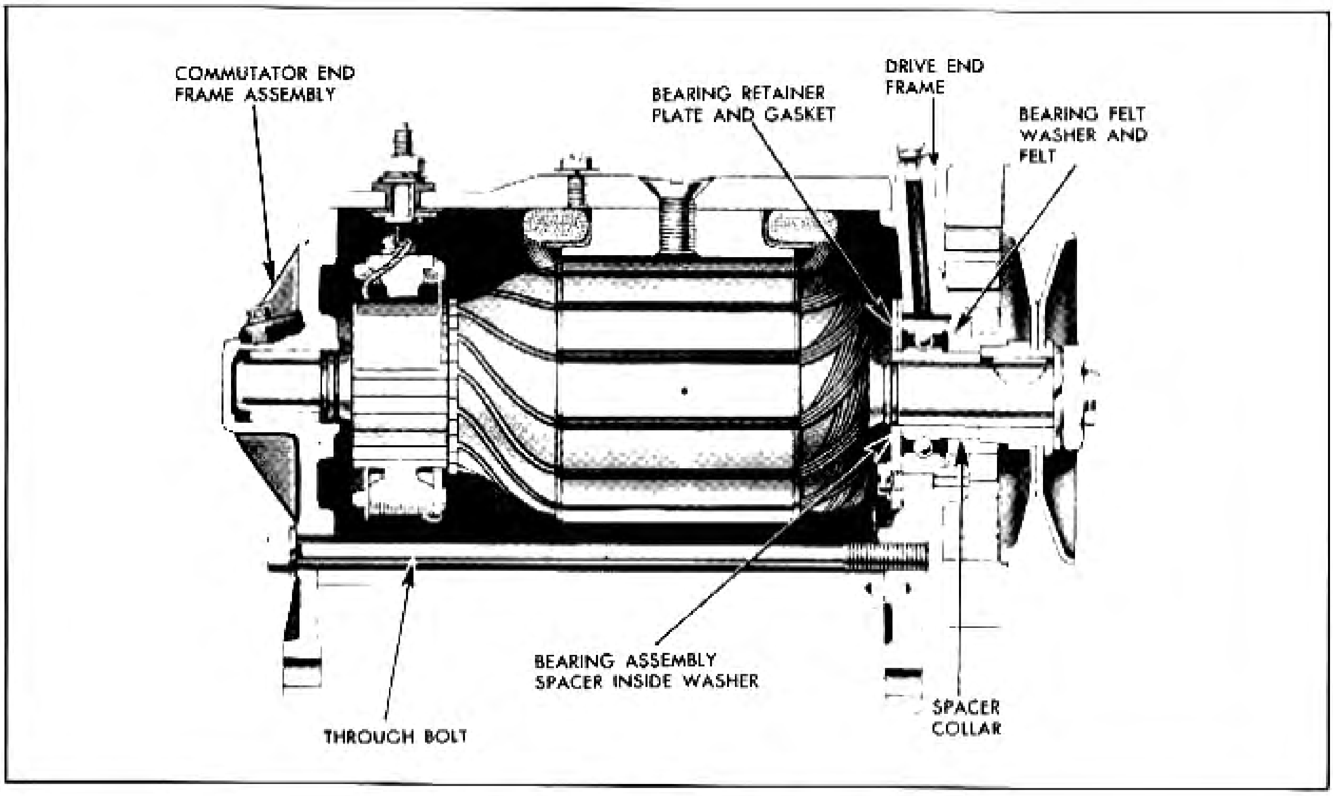


Fig. 12-19 Standard Generator—Cross Section

6. If test equipment is available:

a. Check armature for shorts by placing on growler and with hack saw blade over armature core, rotate armature (Fig. 12-20). If saw blade vibrates, armature or cummutator is shorted. Recheck after cleaning between the commutator bars and if saw blade still vibrates, armature is shorted and must be replaced.

b. Check armature for open circuit by making bar-to-bar check as shown in Fig. 12-21. Inconsistent variation in readings indicates an open armature.

Fig. 12-20 Testing Armature for Shorts

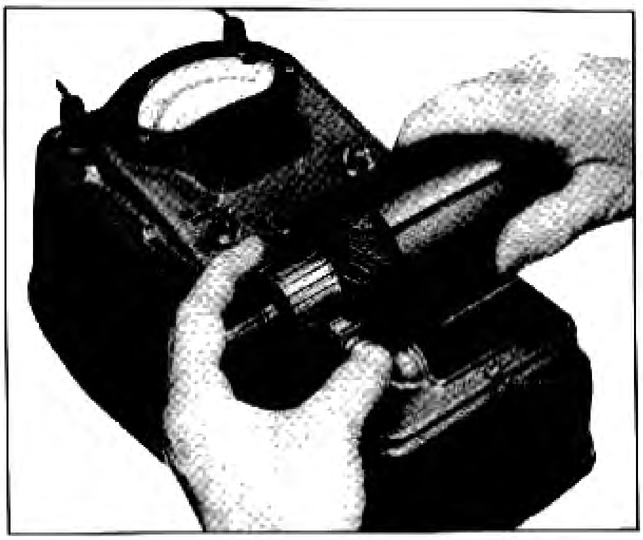


Fig. 12-21 Bar-to-Bar Test for Open Armature

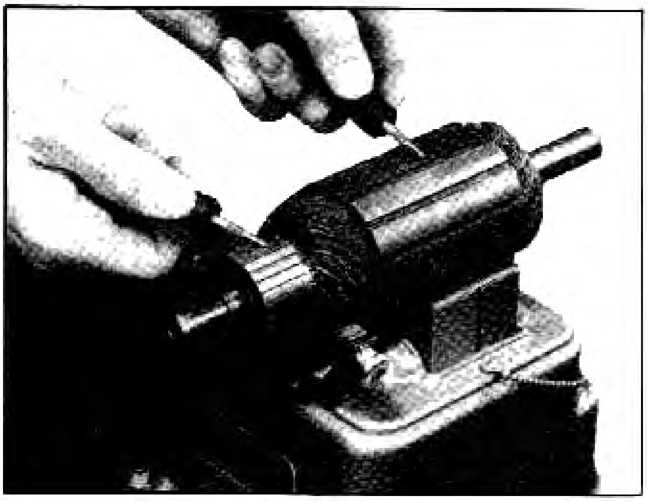


Fig. 12-22 Testing Armature for Ground

c. Using a 110-volt test lamp, place one lead on armature core and other on commutator. If lamp lights, armature is grounded and must be replaced (Fig. 12-22).

d. Using a 110-volt test lamp, place one lead on field terminal on generator frame and the other lead on armature terminal (Fig. 12-23). If lamp does not light, the field coils are open and must be replaced (unless a loose connection is found which can be soldered).

Fig. 12-23 Testing Field Coils for Open Circuit

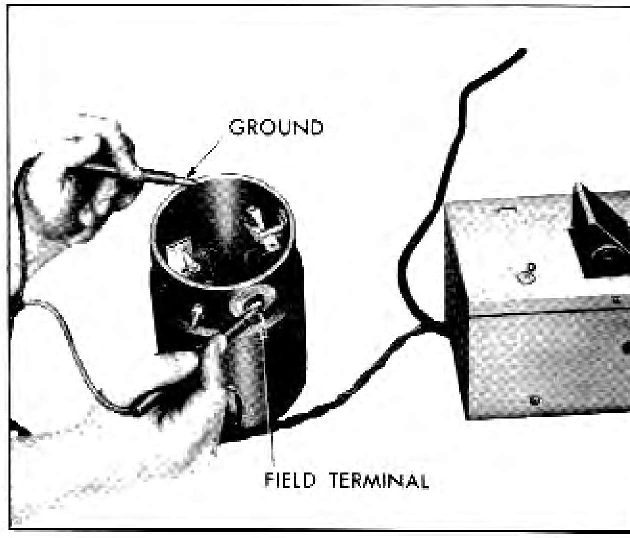


Fig. 12-24 Testing Field Coils for Ground

e. Using a 110-volt test lamp, place one lead on ground (touch to generator frame) and other lead on field terminal on generator frame (be sure free end of field wire is not touching ground and field terminal insulation is not broken) (Fig. 12-24). If lamp lights, the field coils are grounded. If ground in field coils cannot be located or repaired, coils must be replaced.

f. Using a 110-volt test lamp, place one lead on generator positive (or output) terminal on generator frame, and place other lead on ground (touch to generator frame) (Fig. 12-25). (Be sure loose end of terminal lead is not touching ground.) If lamp lights,

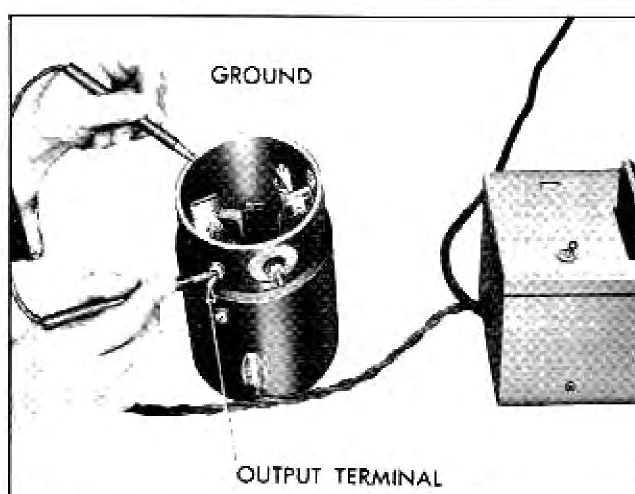


Fig. 12-25 Testing Positive Terminal for Ground

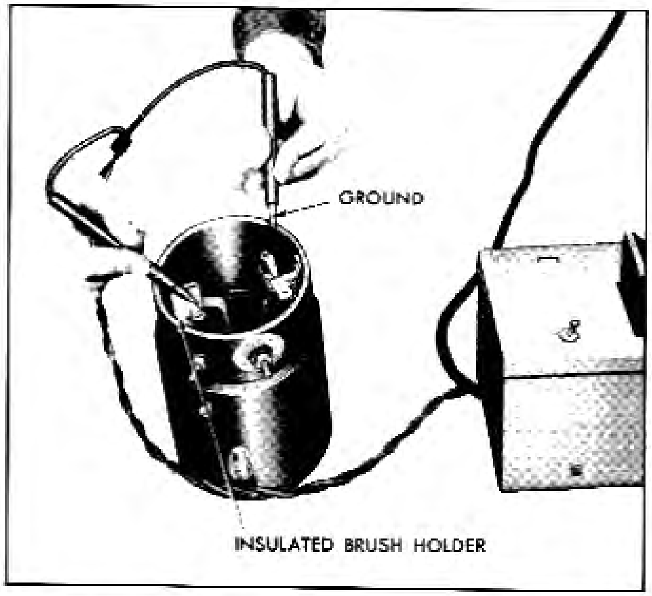


Fig. 12-26 Testing Positive Brush Holder for Ground

positive terminal insulation through generator frame is broken down and must be replaced.

g. Using a 110-volt test lamp, place one lead on the positive or insulated brush holder and the other lead on ground. If lamp lights the brush holder is grounded due to defective insulation at the frame (Fig. 12-26).

GENERATOR REPAIR

LOOSE ELECTRICAL CONNECTIONS

When an open soldered connection is found during inspection, it may be resoldered provided rosin flux is used for soldering. CAUTION: *Acid flux must never be used on electrical connections.*

TURNING COMMUTATOR

When inspection shows commutator roughness, it should be cleaned as follows:

1. Turn down commutator in a lathe until it is thoroughly cleaned. CAUTION: *Width of cut should not be beyond section previously turned.*

2. Undercut insulation between commutator bars $\frac{1}{32}$". This undercut must be the full width of insulation and flat at the bottom; a triangular groove will not be satisfactory. After undercutting, the slots should be cleaned out carefully to remove any dirt and copper dust.

3. Sand the commutator lightly with No. 00 sandpaper to remove any slight burrs left from undercutting.

4. Recheck armature on growler for short circuits.

ASSEMBLY OF GENERATOR

1. Repack ball bearing with a good grade of ball bearing grease working the grease well into the bearing.

2. Install felt washer and then steel washer in drive end frame.

3. Install ball bearing in drive end frame and then position gasket and bearing retainer on frame and install three retaining screws.

4. Place steel washer on drive end of armature shaft and then slip drive end frame assembly onto armature shaft.

5. Install spacer washer on armature shaft and slide it down into place in end frame against bearing inner race.

6. Position drive pulley key in armature shaft and install drive pulley on shaft.

7. Install drive pulley lockwasher and nut and tighten.

8. Place armature and end frame assembly in field frame, aligning dowel pins with holes.

9. Install commutator end frame on field frame, aligning dowel pins with holes.

10. Install and tighten two generator through-bolts.

11. Install new brushes in brush holders by pulling back on brush arm and inserting brush in each holder making sure that chamfered end of brush seats correctly on commutator. Brushes will be seated, if necessary after installing generator in car.

12. Connect brush and field leads to brushes.

13. Fill reservoirs with engine oil. In order to completely fill the oil reservoir at the commutator end, it will be necessary to make three consecutive fillings, allowing time between fillings for oil to saturate the wick.

GENERATOR INSTALLATION

1. Place generator in position on mounting bracket and install bracket bolts. Tighten snugly.

2. Place fan belt over generator drive pulley and fasten adjusting strap screw to generator, but do not tighten brace bolt.

3. Force generator away from engine until fan belt has ¼" deflection when forced downward from normal position with a force of about 8 lbs. (14 lbs. with Air Conditioning) applied midway between the generator and fan. Tighten adjusting strap screw with generator in this position and tighten bracket bolts securely.

4. Connect positive generator lead and field lead to terminals on generator frame. CAUTION: *On radio equipped cars do not connect radio by-pass condenser to generator field terminal. It should be connected to generator output (A) terminal.*

5. Polarize the generator by momentarily touching a jumper wire to the "BAT" and "GEN" terminals on regulator.

6. Start engine. If brushes squeak, seat them by placing brush seating paste on the commutator. The soft abrasive material of the paste will be carried under the brushes and wear the brush faces to the commutator contour in a few seconds.

REGULATOR REMOVAL

While electrical adjustments are made with the regulator on the car as outlined under CHECKS AND ADJUSTMENTS ON CAR, Page 12-7, it is necessary to remove the regulator for cleaning contact points and adjusting air gaps on the three regulator units.

To remove the regulator it is merely necessary to disconnect the leads from the regulator and remove the regulator to fender skirt mounting screws.

REGULATOR INSPECTION AND ADJUSTMENT (REMOVED FROM CAR)

CONTACT POINTS

The regulator contact points will not operate indefinitely without some attention. Eventually they will oxidize and cause lower generator output which may contribute to a discharged battery. A large majority of replaced regulators could be returned to service by cleaning the contact points and adjusting the electrical settings.

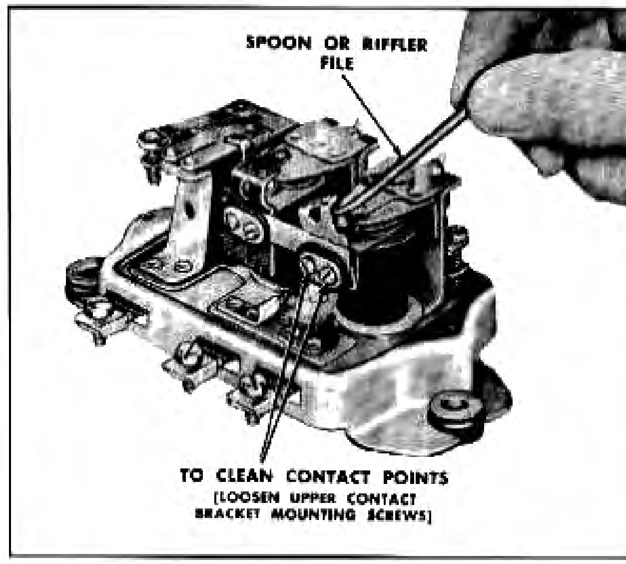


Fig. 12-27 Cleaning Regulator Contact Points

The large flat contact point located on the armature of the voltage regulator (Fig. 12-27), and on the upper contact support of the current regulator will usually require the most attention. It is not necessary to have a flat surface on this contact point but all oxides should be removed with a riffler file so that pure metal is exposed.

The small soft-alloy contact point, located on the upper contact support of voltage regulator and on the armature of current regulator for negative grounded regulator units, does not oxidize. This contact point may be cleaned with crocus cloth or other fine abrasive material followed by a thorough wash with clear carbon tetrachloride to remove any foreign material remaining on the contact surface. CAUTION: *Do not file contact points excessively. Never use sandpaper or emery cloth.*

The contact points of the double contact regulator are all of soft-alloy material and should be cleaned by the method given above for the soft point of the standard voltage and current regulator.

If it is desirable to replace the upper contact points of the regulator, reassemble regulator as shown in Figs. 12-28 and 12-29.

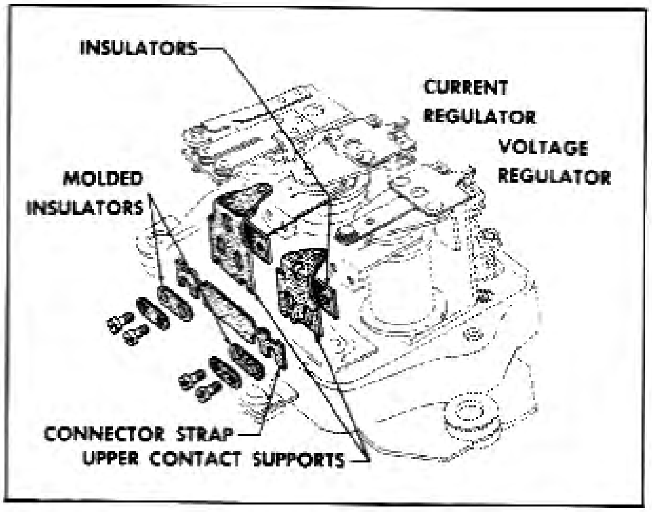


Fig. 12-28 Regulator Contact Mounting—Standard and Air Conditioning Regulator

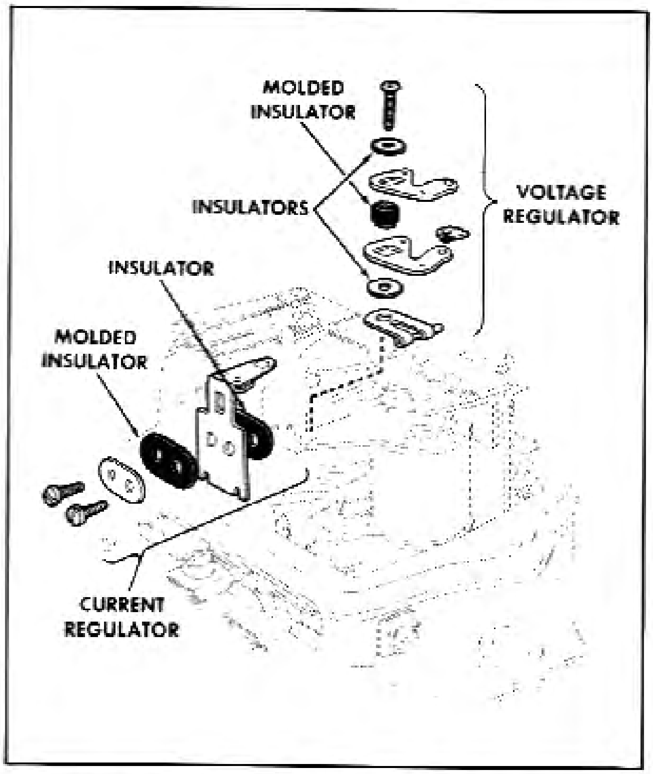


Fig. 12-29 Regulator Contact Mounting—Dual Contact Heavy Duty Voltage Regulator

CUT-OUT RELAY INSPECTION AND GAP ADJUSTMENT

1. Place fingers on armature directly above core and move armature directly down until points just close and then measure air gap between armature and center of core. Air gap should be .020".

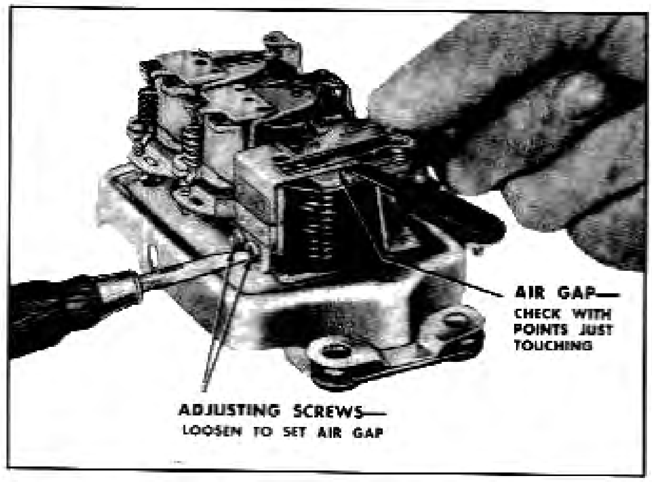


Fig. 12-30 Adjusting Cut-Out Relay

Check to see that both points close simultaneously; if not, bend spring finger so that they do. To adjust air gap, loosen two screws at back of relay and raise or lower armature as required. Tighten screws securely after adjustment (Fig. 12-30).

2. Check point opening and adjust to .020" by bending upper armature stop (Fig. 12-31).

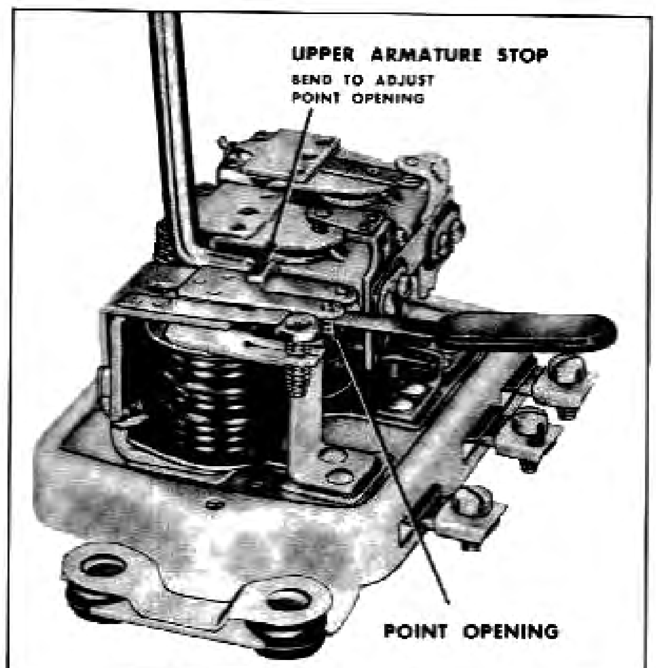


Fig. 12-31 Adjusting Cut-Out Relay Point Opening

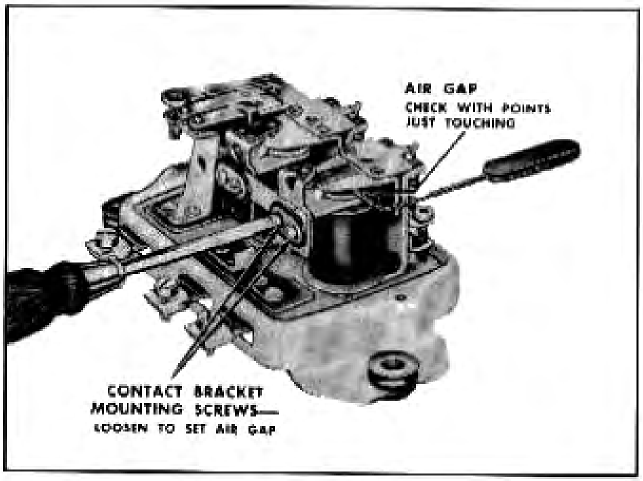


Fig. 12-32 Adjusting Voltage Regulator Air Gap—Standard and Air Conditioning Regulator

VOLTAGE REGULATOR INSPECTION AND GAP ADJUSTMENT—STANDARD AND AIR CONDITIONING REGULATORS

Push armature down to core and release it until contact points just touch and then measure air gap between armature and center of core. Air gap should be .075". NOTE: Do not push against bi-metal strip to which points are attached when making this check. This would affect the tension of the bi-metal strip resulting in improper air gap.

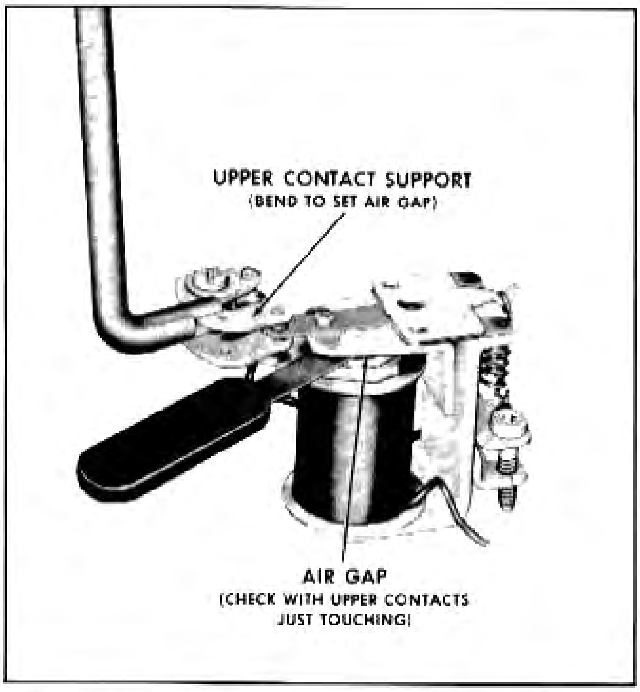


Fig. 12-33 Dual Contact Voltage Regulator Air Gap Check and Adjustment

Adjust gap by loosening contact mounting screws and raising or lowering contact brackets as required (Fig. 12-32). Check to see that points are lined up and tighten screws after adjustment.

CURRENT REGULATOR INSPECTION AND GAP ADJUSTMENT

Check and adjust current regulator air gap in exactly the same manner as voltage regulator (Fig. 12-32). Air gap should be .075".

Be sure rubber gasket is in place on regulator base before installing regulator cover.

DUAL CONTACT VOLTAGE REGULATOR AIR GAP

Make sure the air gap adjusting screw on top of armature is turned all the way in a clockwise direction before checking air gap (Fig. 12-17).

1. With upper contact points just touching, measure air gap between armature and winding core as shown in Fig. 12-33. Gap should be .080".

2. Adjust by bending upper contact support.

DUAL CONTACT VOLTAGE REGULATOR POINT OPENING

1. Push armature down until the lower set of contacts are just touching, measure point opening between upper set of contacts (Fig. 12-34). Point opening should be .016".

2. Adjust by bending the lower contact support.

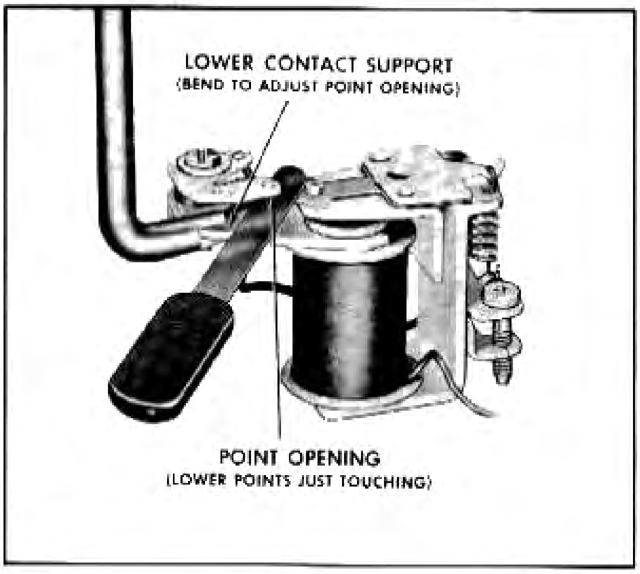


Fig. 12-34 Dual Contact Voltage Regulator Point Opening and Adjustment

INSTALLATION OF REGULATOR

1. Install regulator and tighten mounting screws to approximately 15 lb. in. torque. CAUTION: *Do not tighten the mounting screws excessively as this will destroy the cushioning effect of rubber grommets in the mounting.*

2. Attach "BAT", "GEN", and "FIELD" leads to regulator and polarize generator by momentarily touching a jumper wire to the "BAT" and "GEN" terminals on the regulator before starting the engine.

3. Check and adjust the electrical settings of the regulator on the car as outlined under CHECKS AND ADJUSTMENTS ON CAR, page 12-7.

CHARGING CIRCUIT TROUBLE DIAGNOSIS

BATTERY

1. Measure the specific gravity of the electrolyte. If it is below 1.215 (corrected to 80° F) recharge with a slow rate charger. If variation between cells exceeds 25 points (.025), remove the battery from service for further checking.

2. Measure the terminal voltage of the battery during cranking. Disconnect distributor to coil primary wire during this check to prevent engine firing. If the terminal voltage is less than 9.0 volts, remove the battery from service for further checking.

3. If the battery remains undercharged, check for loose generator belt, defective generator, high resistance in the charging circuit, oxidized regulator contact points, or a low voltage setting. (See CHECKS AND ADJUSTMENTS ON CAR.)

4. If the battery uses too much water, lower the voltage regulator setting. (See CHECKS AND ADJUSTMENTS ON CAR.)

GENERATOR

1. Check belt tension and adjust as required.

2. Inspect commutator and, if dirty, clean by holding No. 00 sandpaper or a cleaning stone against it while generator is operating at idle speed. CAUTION: Do not use emery cloth for cleaning armature.

3. With the engine operating at medium speed, momentarily ground the "F" terminal of the generator. Generator output should increase. If it doesn't, make a complete check of the generator.

4. If output is high and is not affected by grounding the "F" terminal of the generator, disconnect the lead from the "F" terminal of the generator. Generator output should fall off. If it does not, remove the generator and check it for a grounded field.

GENERATOR BRUSH NOISE

Generator brush noises can usually be eliminated by seating the brushes with the generator on the car. While brush seating compound will frequently provide satisfactory seating, the use of a brush seating stone as follows has been found to provide a more positive cure:

1. Start engine and run until it reaches normal operating temperature. (Brush noise may be more pronounced when generator is hot.)

2. Determine engine speed at which brush noise is loudest.

3. While running engine at speed where noise is loudest, very carefully stone commutator until noise disappears.

4. In rare instances, stoning may not eliminate the noise. In this case, remove the armature from the generator, turn down the commutator and undercut the mica as outlined on page 12-17. When reassembling generator, install new brushes.

REGULATOR

Measure the voltage between the "BAT" terminal of the regulator and ground at (1) idle speed, and (2) medium engine speed. The voltage should be higher at a medium engine speed than it is at idle speed. If it is not and the generator passes its tests above, make a complete check of the regulator. If it is, the voltage regulator setting still may require adjustments as discussed under points 3 and 4 of "BATTERY" if the battery remains undercharged or uses too much water.

STARTING CIRCUIT DESCRIPTION

The starting circuit includes the cranking motor, solenoid, and battery. (For a complete discussion of the battery see CHARGING CIRCUIT.) The "Enclosed Shift Lever" cranking motor (Fig. 12-35) is a 12-volt extruded frame type unit. The drive end housing is extended to enclose the entire shift lever mechanism and plunger protecting them from exposure to road dirt, icing conditions, and splash. The

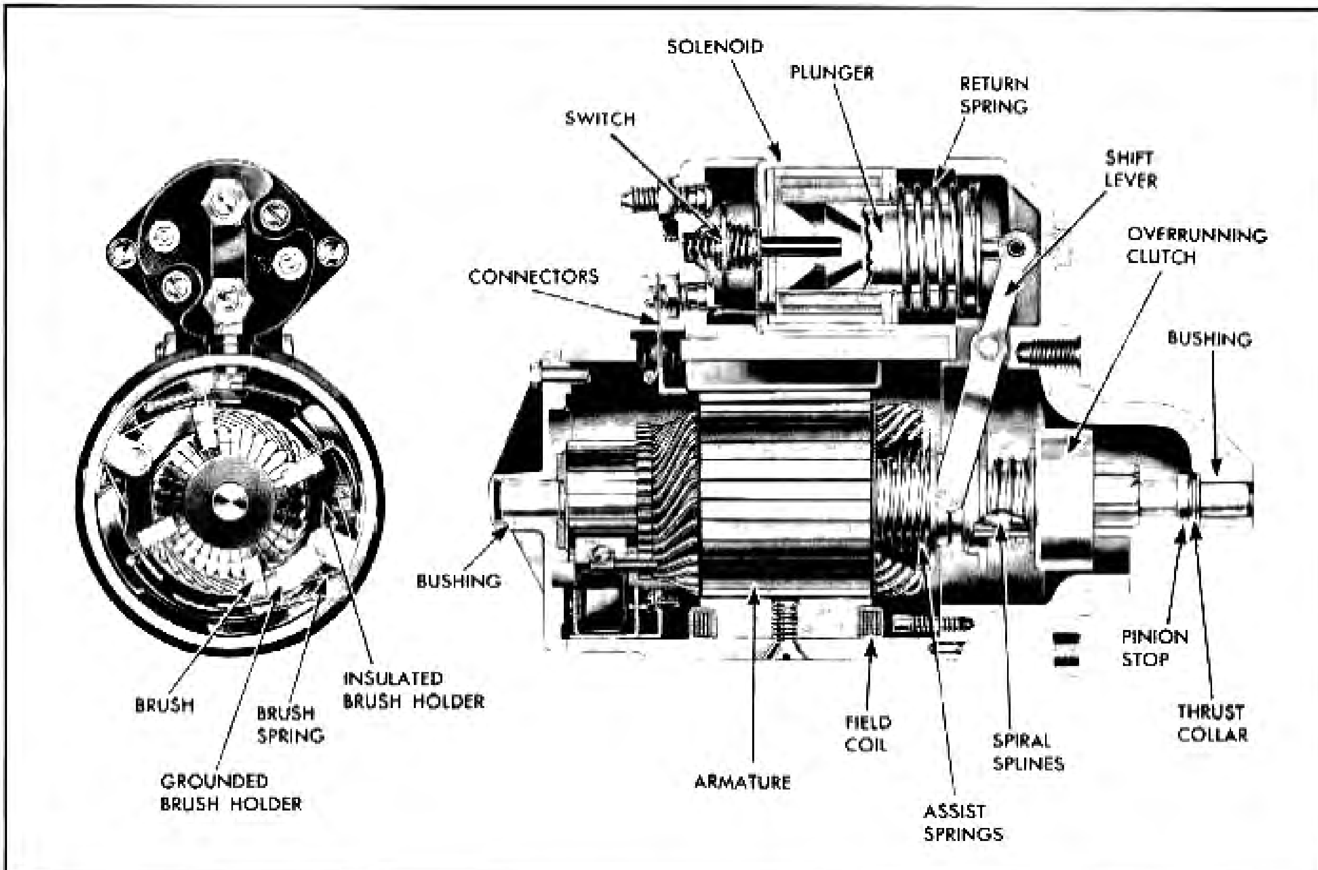


Fig. 12-35 Starting Motor and Solenoid Assembly—Cross Section

solenoid is flange mounted onto the drive end housing and is sealed to the drive housing by a sealing compound. The shift lever return spring is a compression type and is located inside the solenoid case. Shunt coil and series fields are connected directly to the solenoid terminal. A rubber grommet assembled in frame around the coil leads insulates the bar from ground and also prevents dirt, water, and oil from entering the motor. The motor has four pole shoes and a compound field—three field coils connected in series from the solenoid to the insulated brushes, and one shunt coil connected from the solenoid to ground. A small diameter overrunning clutch type of drive is used to engage the cranking motor pinion with the flywheel. The overruning action of the clutch protects the cranking motor armature from excessive speed when the engine fires. The flange mounted solenoid switch operates the overrunning clutch drive by means of a linkage to shift lever. When the control switch is closed, the solenoid is energized, shifting the cranking motor pinion into mesh with the flywheel. The main contacts of the solenoid are then closed so that battery current is delivered to the cranking motor.

The armature shaft and clutch have mating spiral splines which prevent transmission of full cranking power until the clutch pinion is fully engaged in the flywheel ring gear. A special "assist" spring is located around the armature shaft between the end fiber of the armature and the collar of the clutch drive. This "assist" spring aids the solenoid in overcoming the return spring force in the first movement of the clutch along the armature shaft. A pinion stop, consisting of a snap ring and retainer, and a thrust collar assembled on the armature shaft, takes all the end thrust.

The brush rigging has brush arm supports attached directly to the extruded section of the field frame. One ground brush and one insulated brush are pivoted from the same brush holder support; thus only two brush holder supports are required. A single ribbon type spring applies tension to each pair of brushes.

PERIODIC SERVICE

No periodic lubrication of the starting motor or solenoid is required. The motor and brushes cannot be inspected without disassembling the unit so no service is required on the motor or solenoid between overhaul periods.

CHECKS AND ADJUSTMENTS ON CAR

Although the starting motor cannot be checked against specifications on the car, a check can be made for excessive resistance in the cranking circuit. To check for excessive resistance in the cranking circuit, measure:

(1) The voltage drop, during cranking, between the insulated battery post and the "BATTERY" terminal of the solenoid.

(2) The voltage drop, during cranking, between the "BATTERY" terminal of the solenoid and the "MOTOR" terminal of the solenoid.

(3) The voltage drop, during cranking, between the grounded battery post and the starting motor frame.

CAUTION: *To prevent the engine from firing during the above checks, disconnect the primary lead to the distributor, either at the distributor or at the coil.*

If the voltage drop for any one of the above three checks exceeds 0.2 volt, excessive resistance is indicated in that portion of the cranking circuit being checked. Locate and eliminate the cause for any excessive voltage drop in these circuits in order to obtain maximum efficiency of the cranking system.

When the solenoid fails to pull in, the trouble may be due to excessive voltage drop in the solenoid control circuit. To check for this condition, close the starting switch and measure the voltage drop between the "BATTERY" terminal of the solenoid and the "SWITCH" terminal of the solenoid. Excessive resistance in the solenoid control circuit is indicated and should be corrected if this voltage drop exceeds 3.5 volts.

If the voltage drop does not exceed 3.5 volts and the solenoid does not pull in, measure the voltage available at the "SWITCH" terminal of the solenoid. If the solenoid does not feel warm, it should pull in whenever the voltage available at the "SWITCH" terminal is 7.7 volts or more (when the solenoid feels warm, it will require a somewhat higher voltage to pull in).

STARTING MOTOR REMOVAL

1. Disconnect battery to starting motor cable from battery post.

2. Remove rubber cover from junction block on left fender skirt by pulling straight off.

3. Disconnect junction block to solenoid wires from junction block noting which terminal each wire is removed from.

4. Remove battery cable from clip on junction block.

5. Raise front of car and place car stand under front suspension.

6. Remove engine side apron from below starting motor.

7. Pull battery cable and solenoid wire loom down so they hang free of surrounding parts.

8. Remove starting motor mounting screws and remove starting motor with cable and solenoid wire loom.

9. Remove wires from solenoid and cable from clamp on solenoid bracket.

STARTING MOTOR DISASSEMBLY

1. Disconnect the field straps from terminal on solenoid.

2. Remove through bolts.

3. Remove commutator end frame, field frame assembly and armature assembly from drive housing.

4. Remove overrunning clutch from armature shaft as follows:

a. Slide thrust collar (Fig. 12-36) off end of armature shaft.

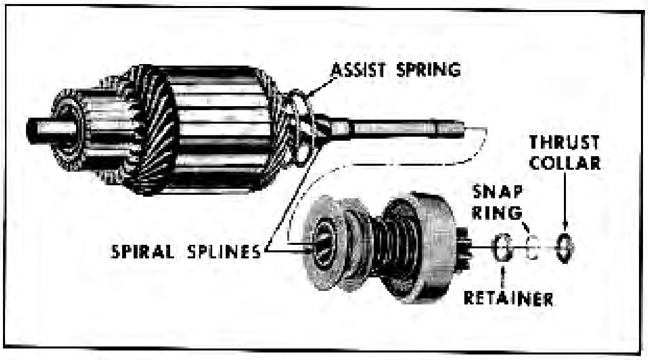


Fig. 12-36 Armature and Overrunning Clutch Assembly—Exploded

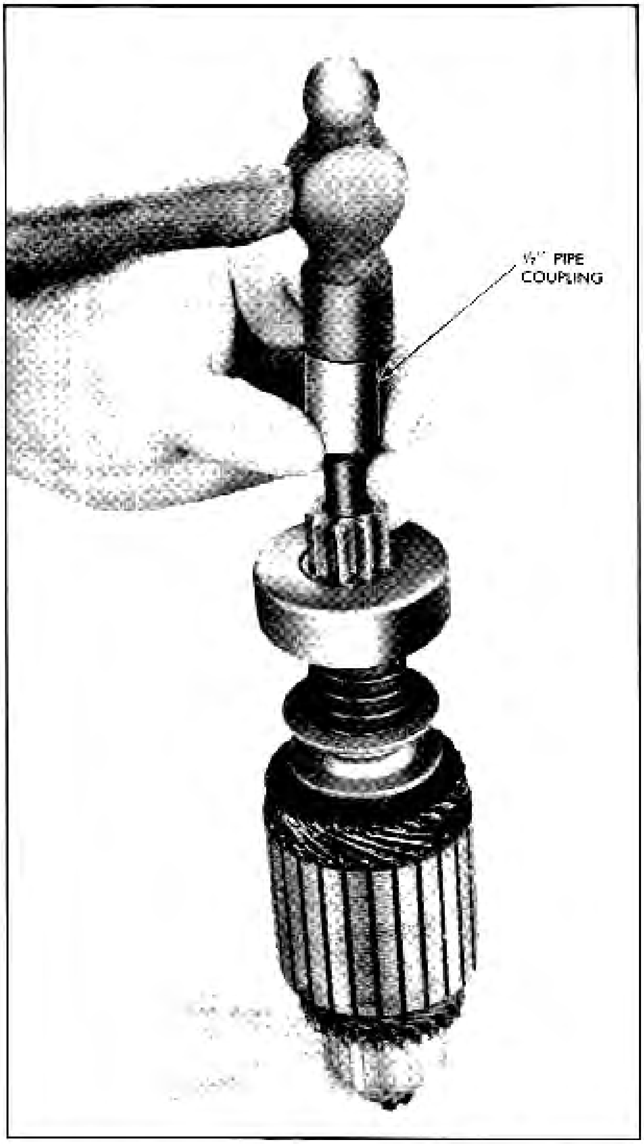


Fig. 12-37 Driving Retainer Off Snap Ring

b. Slide a standard half inch pipe coupling or other metal cylinder of suitable size (an old pinion of suitable size can be used if available) onto shaft so end of coupling or cylinder butts against edge of retainer (Fig. 12-37). Tap end of coupling with hammer, driving retainer towards armature and off snap ring.

c. Remove snap ring from groove in shaft using pliers or other suitable tool. If snap ring is too badly distorted during removal it may be necessary to use a new one when reassembling clutch.

d. Slide retainer and clutch from armature shaft.

CLEANING, INSPECTION AND TESTING OF STARTING MOTOR

1. Clean all starting motor parts, but *do not use grease dissolving solvents for cleaning the overrunning clutch, armature, and field coils* since such a solvent would dissolve the grease packed in the clutch mechanism and would damage armature and field coil insulation.

2. To check condition of solenoid contacts care must be taken in removing the cover from the solenoid.

a. Remove *only* nuts from the "MOTOR" solenoid terminal and switch "S" terminal and the two attaching screws, then remove cover. CAUTION: These terminal studs have welded lead connections—do not twist during removal of nuts.

b. If the contacts are slightly burned or dirty, the contacts should be cleaned. When the contacts are badly burned, the burned parts should be replaced.

c. When reassembling the cover on the solenoid make sure the terminal studs are properly positioned in cover before installing the nuts. The cover gasket must be centered under the cover to insure proper sealing.

3. Test overrunning clutch action. The pinion should turn freely in the overrunning direction. Check pinion teeth to see that they have not been chipped, cracked, or excessively worn. Replace assembly if necessary.

4. Check brush holders to see that they are not deformed or bent, but will properly hold brushes against the commutator.

5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly in the bushing. If the bushing is worn, it should be replaced.

6. Inspect armature commutator. If commutator is rough or out of round, it should be turned down and undercut. Inspect the points where the armature conductors join the commutator bars to make sure that it is a good firm connection. A burned commutator bar is usually evidence of a poor connection.

7. If test equipment is available,

a. Check the armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated (Fig. 12-20). If saw blade vibrates, armature is shorted. Recheck after cleaning between the commutator bars. If saw blade still vibrates, replace the armature.

b. Using a 110-volt test lamp, place one lead on the armature core or shaft and the other on the commutator (Fig. 12-22). If the lamp lights, the armature is grounded and must be replaced.

c. Using a 110-volt test lamp, place one lead on each end of the three field coils connected in series (Fig. 12-38). If the lamp does not light, the field coils are open and will require repair or replacement.

d. Using a 110-volt test lamp, place one lead on the connector strap and the other on the field frame (Fig. 12-39). Disconnect the shunt coil ground before this check is made. If the lamp lights, the field coils are grounded and the defective coils will require repair or replacement.

e. Using a 110-volt test lamp, place one lead on each end of the shunt coil (Fig. 12-40). Disconnect the shunt coil ground before this check is made. If the lamp does not light, the shunt coil is open and will require replacement.

f. Check the current draw of the solenoid windings. To check the current draw of the hold-in winding, connect a variable source of voltage (in series with an ammeter) to the switch terminal of the solenoid and ground. To check the current draw of both windings, ground the solenoid motor terminal, and connect a source of voltage (in series with an ammeter) to the switch terminal of the solenoid and ground. CAUTION: *Either of the above checks must be completed in a minimum length of time to prevent heating of the solenoid windings. Heating will cause the current draw readings to be below the specifications which are based on a temperature of 80° F. (See SPECIFICATIONS, Page 12-52.)*

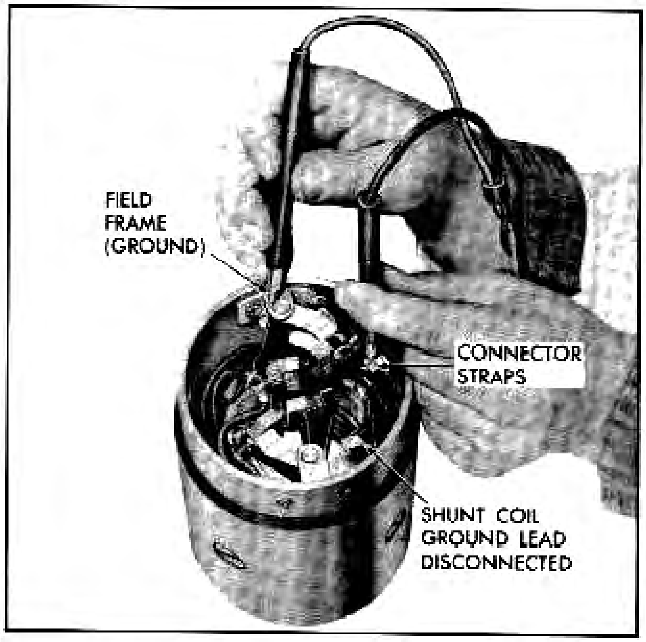


Fig. 12-39 Testing Field Coils for Ground

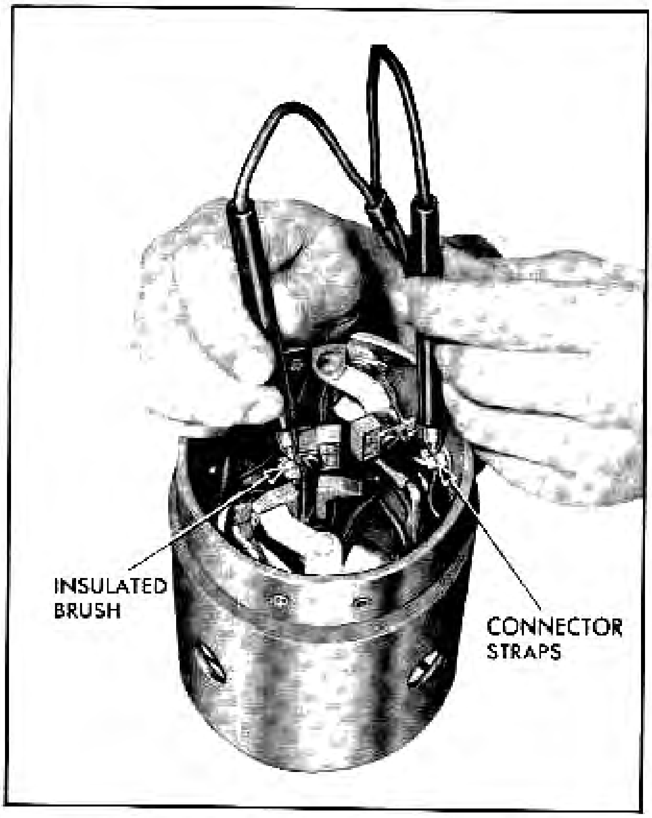


Fig. 12-38 Testing Field Coils for Open Circuit

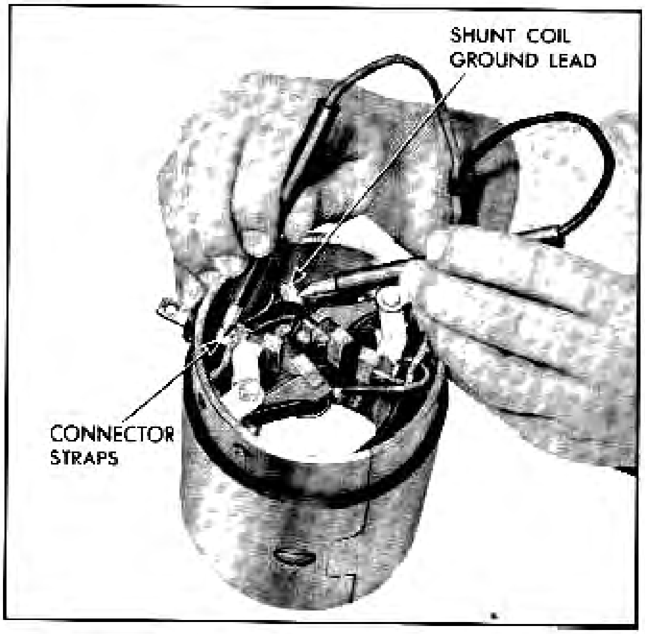


Fig. 12-40 Testing Shunt Coil for Open Circuit

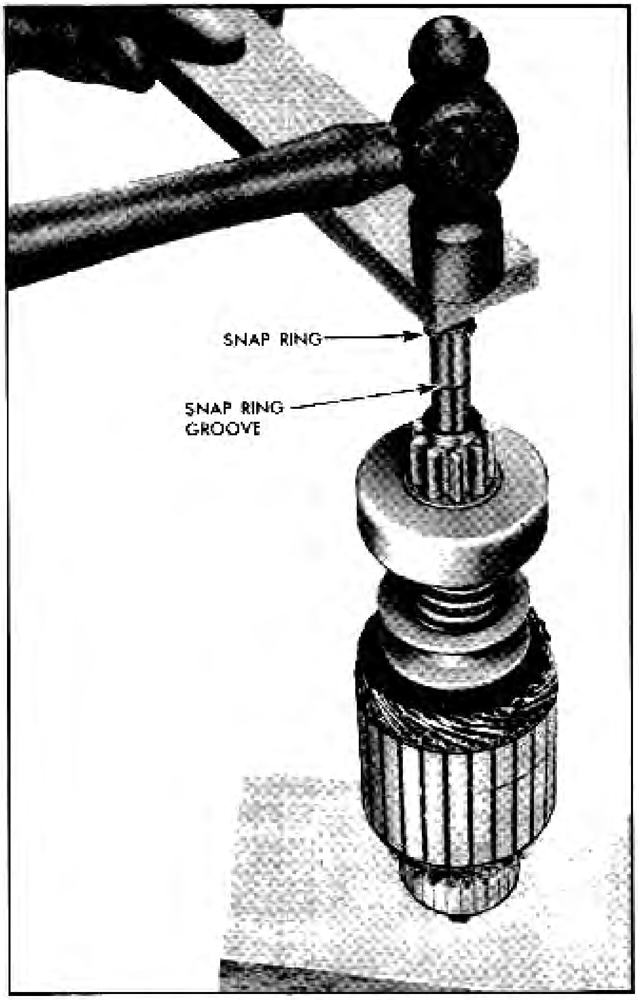


Fig. 12-41 Forcing Snap Ring Onto Armature Shaft

ASSEMBLY OF STARTING MOTOR

1. Assemble overruning clutch to armature shaft as follows:

a. Lubricate drive end of armature shaft with light engine oil.

b. Slide clutch assembly onto armature shaft with pinion outward (Fig. 12-36).

c. Slide retainer onto shaft with cupped surface facing end of shaft (Fig. 12-36).

d. Stand armature on end on wood surface with commutator down. Position snap ring on upper end of shaft and hold in place with a block of wood. Hit wood block a blow with hammer forcing snap ring over end of shaft. Slide snap ring down into groove (Fig. 12-41).

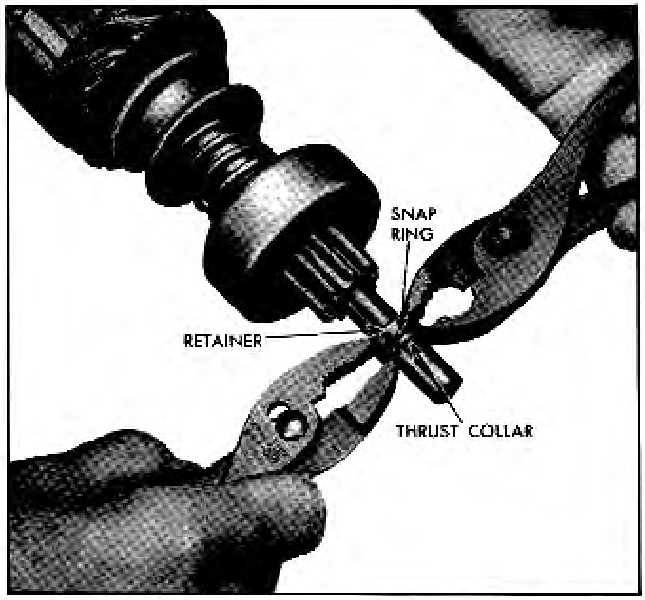


Fig. 12-42 Forcing Retainer Over Snap Ring

e. Assemble thrust collar on shaft with shoulder next to snap ring (Fig. 12-36).

f. Place armature flat on work bench, and position retainer and thrust collar next to snap ring. Then, using two pairs of pliers at same time (one pair on either side of shaft), grip retainer and thrust collar and squeeze until retainer is forced over snap ring (Fig. 12-42).

2. Place 4 or 5 drops of light engine oil in drive housing bushing. Make sure thrust collar is in place against snap ring and retainer and slide armature and clutch assembly into place in drive housing, engaging shift lever with clutch.

3. Position field frame over armature, apply sealing compound between frame and solenoid case. Position frame against drive housing using care to prevent damage to brushes.

4. Place 4 or 5 drops of light engine oil in bushing in commutator end frame. Place leather thrust washer on armature shaft and slide commutator end frame onto shaft.

5. Install through bolts and tighten securely.

6. Reconnect the field coil leads to the "MOTOR" solenoid terminal.

7. Check pinion clearance as follows:

Connect a voltage source of approximately 6 volts (three battery cells in series or 6-volt battery) be-

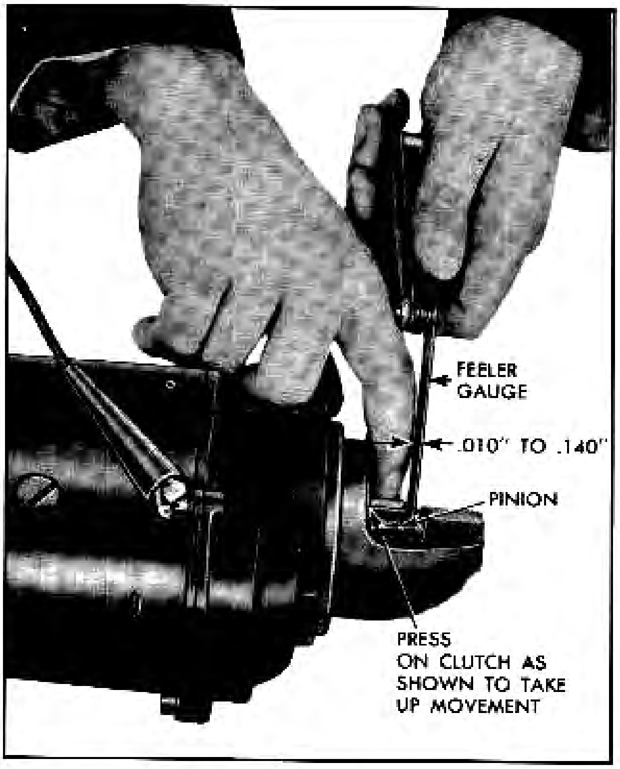


Fig. 12-43 Measuring Pinion Clearance

tween the solenoid switch terminal and ground. CAUTION: Do not connect the voltage source to the ignition coil terminal of the solenoid. Do not use a 12-volt battery instead of the 6 volts specified, as this will cause the motor to operate. As a further precaution to prevent motoring, connect a heavy jumper lead from the solenoid motor terminal to ground. After energizing the solenoid with the clutch shifted forward, push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge (Fig. 12-43).

The clearance between the end of the pinion and the pinion stop, with the pinion in cranking position, should be .010-.140". When the clearance is out of these limits it may indicate excessive wear of solenoid linkage, shift lever yoke buttons, or improper assembly of the shift lever mechanism. When shift lever mechanism is correctly assembled, the pinion clearance will fall within the specified limits.

8. Test the free speed of the starting motor. To make this test, connect a battery in series with an ammeter to the starting motor terminal and ground. Use an r.p.m. indicator to determine the speed reached by the starting motor (see SPECIFICATIONS, page 12-52). Failure of the starting motor to perform according to specifications may be due to tight or dirty bearings, or high resistance connections.

STARTING MOTOR INSTALLATION

1. Connect battery cable and solenoid wires to solenoid as shown in Fig. 12-44. NOTE: Connect yellow wire to battery cable terminal of solenoid and purple (or violet) wire to terminal marked "S".

2. Install starting motor on engine and tighten mounting screws securely.

3. Push cables up where they can be reached from above car, then lower car.

4. Route solenoid-to-junction-block wire loom around cable guide on cover of power brake unit (if so equipped), beneath steering column and connect wires to junction block. Connect wires to terminals which have matching wires on opposite side. Replace rubber cover on junction block by pressing firmly onto terminal studs.

5. Route battery cable around cable guide on cover of power brake unit (if so equipped), beneath steering column and through clamp on fender skirt junction block. Bend clamp over cable securely and connect cable to battery post.

Fig. 12-44 Wires and Cable Connected to Solenoid

STARTING MOTOR CIRCUIT TROUBLE DIAGNOSIS

STARTING MOTOR AND SOLENOID

CAUTION: *Specific gravity of battery must be 1.215 or higher before making the following tests.*

1. If the solenoid does not pull in, measure the voltage between the switch "S" terminal of the solenoid and ground with the starting switch closed. (CAUTION: *If the solenoid feels warm, allow to cool before checking.*) If the voltage is less than 7.7 volts, check for excessive resistance in the solenoid control circuit. If the voltage exceeds 7.7 volts, remove the starting motor and check (1) solenoid current draw, (2) starting motor pinion clearance, and (3) freedom of shift lever linkage.

2. If the solenoid "chatters" but does not hold in, check the solenoid for an open "hold-in" winding.

3. If motor engages but does not crank or cranks slowly, check for excessive resistance in the external cranking circuit or within the starting motor.

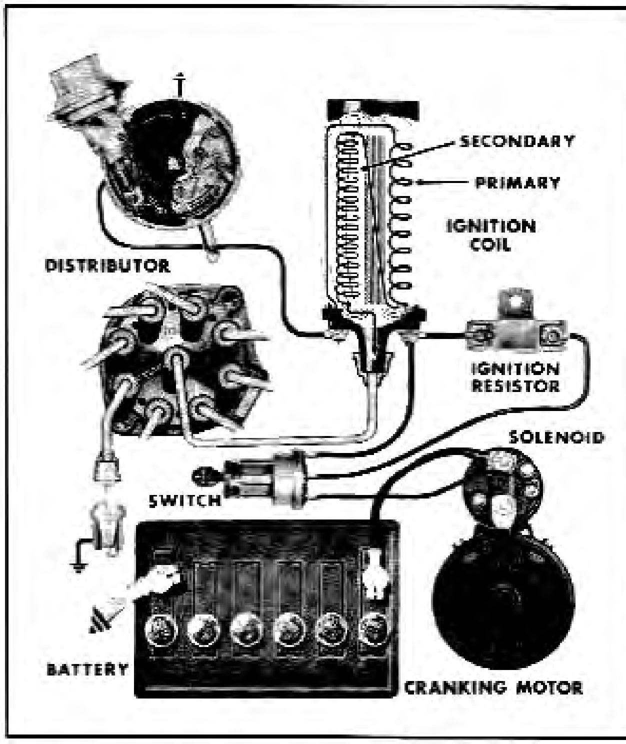


Fig. 12-45 Ignition Circuit—Schematic

IGNITION CIRCUIT DESCRIPTION

The ignition circuit (Fig. 12-45) includes the distributor, ignition coil, ignition resistor, ignition switch, spark plugs, battery, and the resistance type secondary cables. (For a complete discussion of the battery, see CHARGING CIRCUIT DESCRIPTION, page 12-4.)

DISTRIBUTOR

The new external adjustment type distributor is shown in Figs. 12-46 and 12-47. The cap has a window for adjusting dwell angle with the cap in place. Adjustment of dwell can be made on the car while the engine is operating or while the distributor is being operated on a distributor tester. The centrifugal advance components have been relocated above the breaker plate and cam. This arrangement allows the cam and the breaker lever to be located directly adjacent to the upper bearing for increased stability. The breaker plate is of one piece construction and rotates on the outer diameter of the upper bearing. The plate is held in position by a retainer clip in the upper shaft bushing. The molded rotor serves as a cover for the centrifugal advance mechanism. The vacuum control unit is mounted under the movable breaker plate to the distributor housing. The contact set is attached to the movable breaker plate. The service replacement contact set has the breaker lever

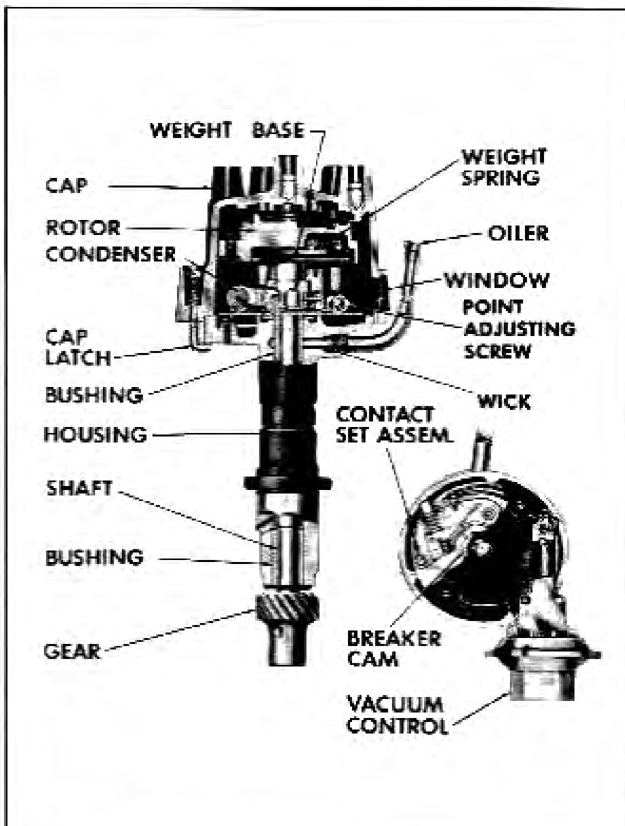


Fig. 12-46 Cross Section of Distributor

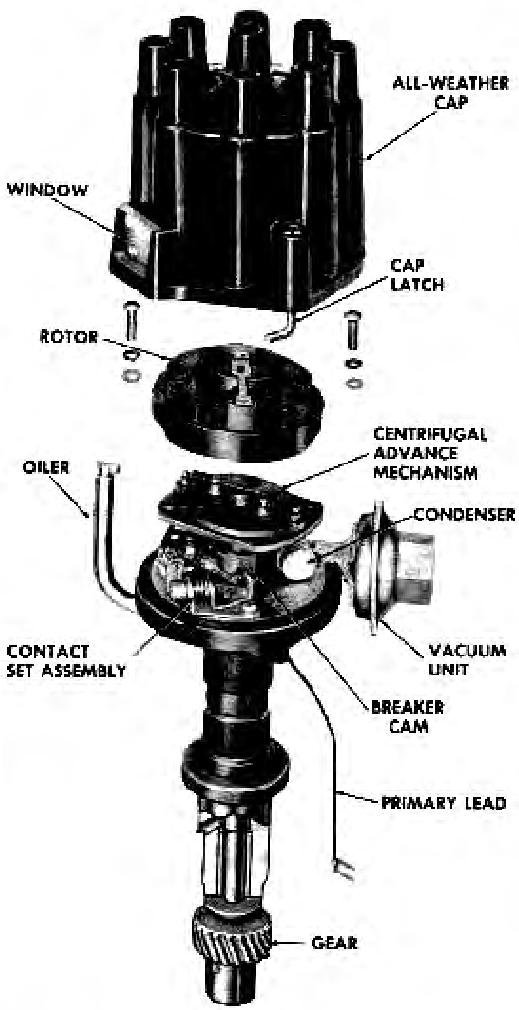


Fig. 12-47 Distributor—Partially Exploded

spring tension and point alignment pre-adjusted at the factory and is serviced as one complete assembly. Only the point opening (dwell angle) requires adjustment after replacement.

Under part throttle operation the intake manifold vacuum is sufficient to actuate the vacuum control diaphragm and cause the movable plate to move, thus advancing the spark and increasing fuel economy. During acceleration or when the engine is pulling heavy, the vacuum is not sufficient to actuate the diaphragm and the movable plate is held in the retarded position by a calibrated return spring which bears against the vacuum diaphragm.

The centrifugal advance mechanism consists of a centrifugal advance cam actuated by two centrifugal weights controlled by springs. As the speed of the distributor shaft increases with engine speed, the weights are thrown outward against the pull of the springs. This advances the breaker cam causing the contact points to open earlier and thus advancing the spark.

IGNITION COIL AND IGNITION RESISTOR

The ignition coil is an oil-filled, hermetically-sealed unit designed specifically for use with an external resistor in the 12-volt system. The combined action of the resistor and the primary windings of the coil provides a very rapid coil build-up. Rapid build-up assures maximum available voltage even at extremely high engine speeds. The resistor also prevents excessive primary current at all temperatures and thus reduces the tendency of the points to oxidize.

To obtain maximum starting performance at low temperatures, the resistor is by-passed during cranking, thereby connecting the ignition coil directly to the battery. This makes full battery voltage available to the coil and thus keeps ignition voltage as high as possible during cranking. The by-passing of the resistor during cranking is accomplished by means of a special terminal on the ignition switch which is connected directly to the coil.

SECONDARY IGNITION CABLES

All ignition cables in the secondary or high tension system (coil to distributor and distributor to plugs) are neoprene jacketed. This cable is resistant to the action of oil, grease, battery acid and road salt, and also offers resistance to corona breakdown. Ignition cables have a multiple, cloth thread core impregnated with a graphite solution to give the correct conductivity. These cables give proper resistance for suppression of radio and television interference.

No external suppressors should be used on the ignition system on car radio installation.

IGNITION AND STARTING SWITCH

The ignition and starting switch is key-operated to close the ignition primary circuit and to energize the starting motor solenoid for cranking.

The ignition switch has four positions, "OFF" when the key is straight up and down, "ACCESSORY" when turned to the left, "ON" when turned to the right until spring pressure is felt, and "START" when turned fully to the right against spring pressure.

With the switch in either the "ACCESSORY" or "ON" positions the following electrical circuits are activated; stop lights, air conditioning, direction signals, parking brake warning light, radio, back-up lights, heater and defroster, electric windshield wiper, instrument, and rear window defroster. In the "ON" position the ignition primary circuit is also activated through the resistor.

These circuits are all cut off when the ignition switch is in the "OFF" or "START" positions.

When the ignition switch is turned to the start position, the ignition primary circuit is activated directly, by-passing the resistor, and the starting motor circuit is activated to crank the engine.

Two ignition terminals, marked "IGN-1" and "IGN-2", will be found on the back of the switch. The IGN-1 terminal is energized when the ignition switch is in the normal operating position. It directs current to the ignition coil through the resistor. The IGN-2 position is energized when the ignition switch is turned to the starting position. It directs current to the coil around the resistor to provide full battery voltage to the coil when starting.

SPARK PLUGS

AC type 45 spark plugs are used in all engines. These spark plugs provide optimum performance for all normal service.

Normal or average service is assumed to be a mixture of idling, slow speed, and high speed operation with some of each making up the daily total driving. Occasional or intermittent high speed driving is essential to good spark plug performance as it provides increased and sustained combustion heat that burns away any excess deposits of carbon or oxide that may have accumulated from frequent idling or continual stop-and-go or slow-speed driving.

Spark plugs in Pontiac engines are protected by an insulating nipple made of special heat resistant material which covers the spark plug terminal and extends downward over a portion of the plug insulator. These nipples prevent "flash-over", with resulting missing of the engine, even though a film is allowed to accumulate on the exposed portion of the plug porcelains. *IMPORTANT: Do not mistake "Corona" discharge for "flash-over" or a shorted insulator. Corona is a steady blue light appearing around the insulator, just above the shell crimp. It is the visible evidence of a high tension field, and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between shell and insulator.*

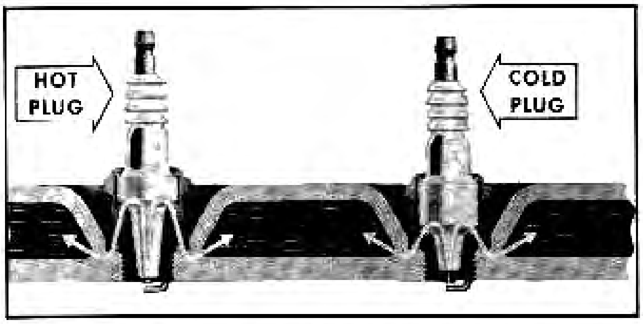


Fig. 12-48 Spark Plug Heat Range

All AC Spark Plugs have a type number on the insulator which designates the thread size as well as relative position of the plug in the "Heat Range." Type numbers starting with "4" are 14 mm. thread size.

The last digit of the type number indicates the "Heat Range" position of the plug in the AC Heat Range System (Fig. 12-48). Read these numbers as you would a thermometer—the higher the last digit, the "hotter" the plug will operate in the engine; the lower the last digit, the "cooler" the plug.

PERIODIC SERVICE

The distributor and spark plugs are the only ignition system components that require periodic service. The remainder of the ignition system requires only periodic inspection to check operation of the units, tightness of the electrical connections, and condition of the wiring. When checking the coil, test with a reputable tester.

DISTRIBUTOR

The hinge cap oiler should be filled with SAE 20 oil at each vehicle lubrication period. When replacing the contact set assembly apply a trace of Delco-Remy Cam and Ball Bearing Lubricant to the breaker cam (see Gp. 2.364 of Master Parts Catalog for lubricant). No other lubrication is required. The movable breaker plate is lubricated by oil from the upper shaft bushing.

This distributor also requires periodic inspection of cap and rotor, wiring, and point condition, and a check for correct spark timing. This should be done at each tune-up and at least every spring and fall.

SPARK PLUGS

Periodically (the actual time depending on operating conditions) the plugs should be removed for cleaning, inspection and regapping as outlined on page 12-32.

ADJUSTMENTS ON CAR

ADJUSTMENT OF DWELL ANGLE ON THE CAR

1. With the engine operating, raise the window provided in the cap.

2. Insert a "Hex" type wrench into the head of the adjusting screw as shown in Fig. 12-49.

3. Turn screw to adjust point opening by one of the following methods:

PREFERRED METHOD

Turn the adjusting screw until the specified dwell is obtained as measured by a dwell meter. (When using dwell meter be sure to test distributor resistance before testing dwell angle). **NOTE:** Providing the dwell meter is accurate and is used correctly, points can be set very accurately with a dwell meter. Several design features such as the use of the upper shaft bushing as a bearing for the breaker plate, and the construction of the advance mechanism have made this possible.

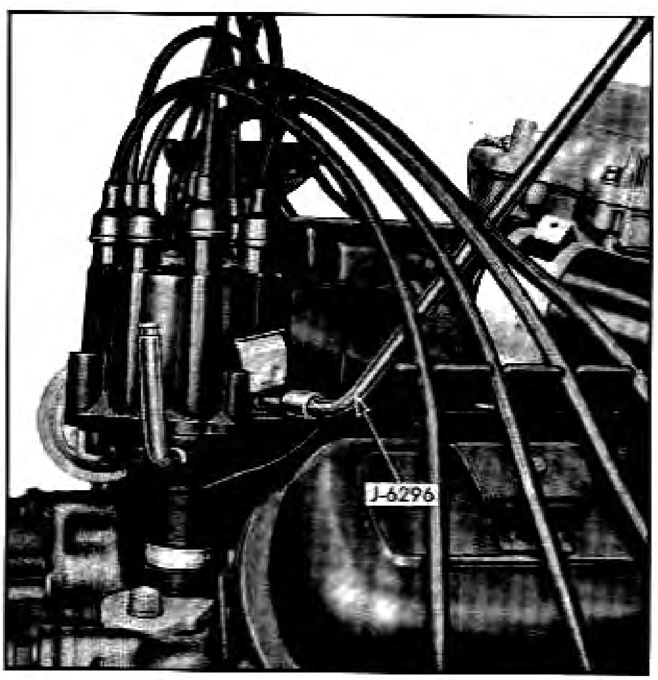


Fig. 12-49 Adjusting Dwell Angle

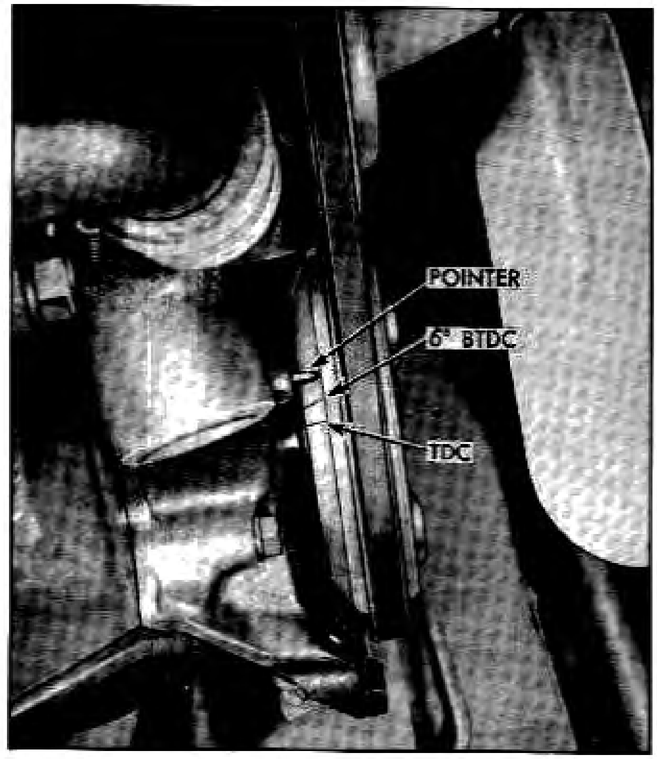


Fig. 12-50 Timing Marks and Pointer

ALTERNATE METHOD

Turn the adjusting screw (clockwise) until the engine begins to misfire. Then turn the screw one-half turn in the opposite direction (counter-clockwise). This will give the proper dwell angle.

IGNITION TIMING

Correct timing of the spark, with relation to engine piston position, is made in the shop by use of a power timing light and timing marks on the harmonic balancer (Fig. 12-50).

At the time the spark is adjusted, the general appearance of the breaker points should be observed. If a smudge line appears on the point support and breaker plate just beneath the points, burned points (from oil or crankcase vapor between the points) are very probable. Points which have gone several thousand miles will have a rough surface, but this does not mean the points are worn out. The roughness between points matches so that a large contact area is maintained and the points will continue to provide satisfactory service. If dirt or scale are present the points should be cleaned with a few strokes of a clean, fine-cut, contact file. Do not attempt to remove all roughness or dress the point surfaces down smooth. Never use emery cloth or sandpaper to clean points.

If points are burned or badly pitted they should be replaced and the cause of this condition found and corrected. If this is not done the new points will also burn and pit in a short time.

Adjust ignition timing as follows:

1. Adjust breaker point gap as outlined under "Adjustment of Dwell Angle on the Car" above.

2. Connect power timing light.

3. Loosen distributor clamp screw and rotate distributor until power timing light shows that pointer is at 6° BTDC mark on harmonic balancer (see SPECIFICATIONS, page 12-52). Tighten distributor clamp screw to 12-15 lb. ft. torque.

MINOR REPAIRS

SPARK PLUGS—INSPECT, CLEAN AND ADJUST

When checking the condition of removed spark plugs, there are five principal points to observe:

1. Dirty—The lower end of the spark plug insulator becomes coated under operation with an oxide deposit. This deposit is a conductor of electricity (especially when heated), and when occurring in sufficient quantity, will cause missing. The deposit may occur at various mileages depending on operating conditions and is usually brown in color, although sometimes it is yellow or white. Plugs with this oxide coating on the lower end are not defective and replacing them is needless. Fouled and dirty or oxide coated plugs can be thoroughly cleaned without injuring the insulator by use of the AC model "A" Spark Plug Cleaner and Indicator (Fig. 12-51) or similar equipment. NOTE: Excessive cleaning of spark plugs to remove heavy deposits, will erode the insulator tip, and lower the heat range of the plug. Heavily coated plugs should be replaced.

Spark plugs should be cleaned following the instructions furnished with the cleaner. After cleaning, file the center electrode flat (to reduce the voltage required to fire the plug) and set the gap to .033"-.038" using a round wire gauge (Fig. 12-52). Test the spark plugs following the instructions furnished with the Model "A" Spark Plug Cleaner and Indicator or similar unit before installing them in engine.

2. Worn-Out—Normal wear, electrodes consumed from long service. Replace plugs.

3. Wide Gap—Resulting from normal wear or rapid wear, requiring regapping of electrodes. When adjusting gap always make adjustment on the outer electrode, never on the center one, as this will break or crack the insulator. It is good practice to use new gaskets under the plugs when reinstalling them in the engine. Spark plugs should be tightened to not more than 25 lb. ft. torque. If a plug is installed in a location where a torque wrench cannot be used, turn the plug finger tight on a new gasket then tighten ¾ of a turn with a wrench.

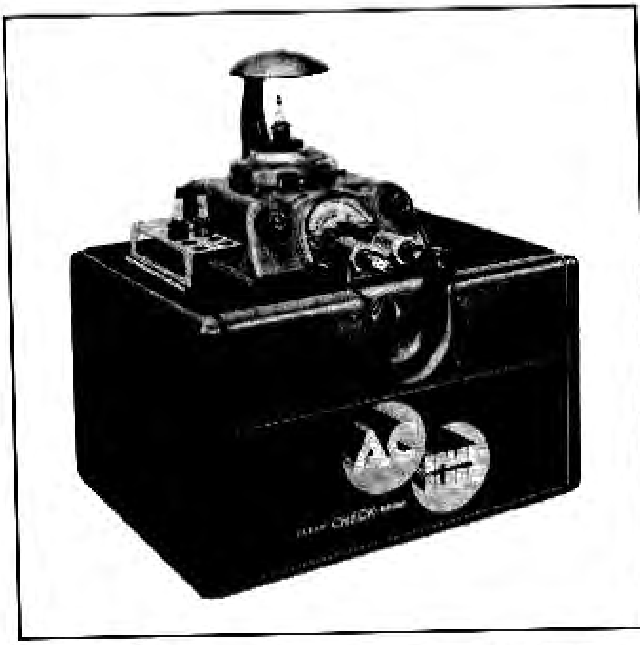


Fig. 12-51 Spark Plug Cleaner and Indicator

4. Broken Insulator—Breakage of the upper end by mechanical damage such as careless use of wrenches, or cracked insulator tips due to the plug having operated too hot. Replace plug.

5. Damaged Shell—Threads stretched or broken, or shell cracked due to mishandling or excessive tightening. Replace plug.

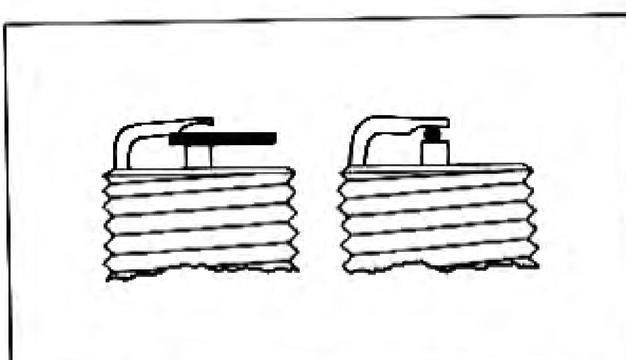


Fig. 12-52 Flat Feeler Versus Round Wire Gauge for Measuring Spark Plug Gap

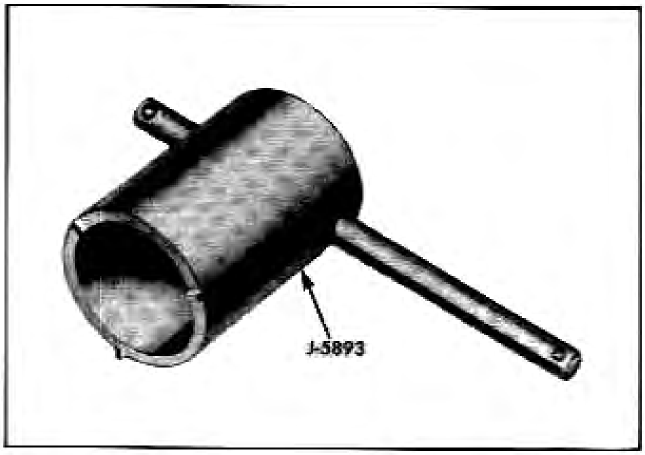


Fig. 12-53 Ignition Switch Ferrule Spanner

IGNITION AND STARTER SWITCH ASSEMBLY—REMOVE AND REPLACE

1. Remove positive cable from battery to protect against short circuit.

2. Remove ignition switch ferrule by unscrewing with special spanner J-5893 (Fig. 12-53).

3. Remove ignition switch lamp housing brace screw from bottom flange of instrument panel.

4. Remove switch from back of instrument panel and disconnect wires.

5. Replace switch by reversing above steps.

IGNITION SWITCH LOCK CYLINDER—REMOVE AND REPLACE

1. Place ignition key in lock and depress lock plunger by inserting small pin through hole in lock cap.

2. While holding plunger in, turn key approximately 20° counterclockwise to release lock cylinder and remove cylinder from switch.

3. To install lock cylinder, insert key in cylinder. Then, with key and cylinder turned about 20° counterclockwise, insert cylinder in lock and rotate clockwise to lock in place.

FREEING UP STICKING IGNITION LOCK

Occasionally an ignition lock may stick, making it difficult to insert key and turn lock. In such case blow a very small quantity of powdered graphite into the lock key hole and operate lock several times to free up.

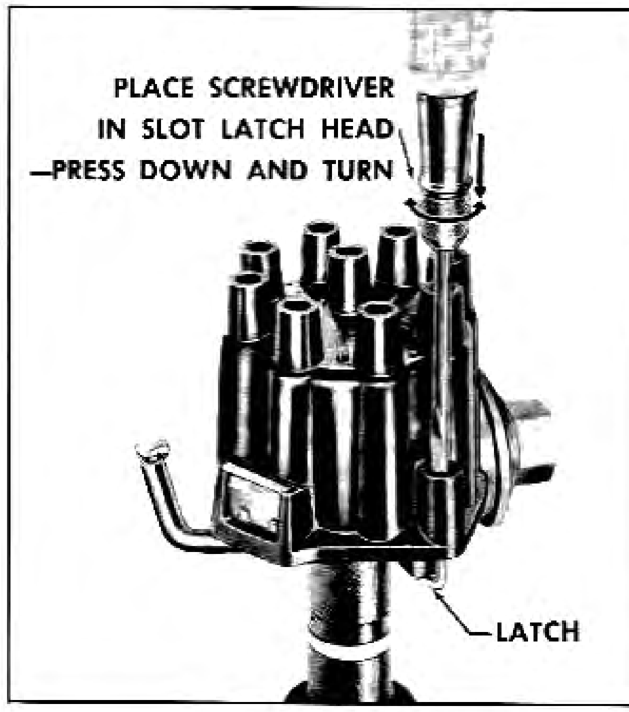


Fig. 12-54 Removing Distributor Cap

REMOVAL OF DISTRIBUTOR

1. Disconnect distributor-to-coil primary wire.

2. Remove distributor cap. NOTE: Unlatch cap by using screwdriver to disengage latches as shown in Fig. 12-54.

3. Crank engine so rotor is in position to fire No. 1 cylinder and timing mark on harmonic balancer is indexed with pointer.

4. Remove vacuum line from distributor.

5. Remove distributor clamping screw and hold-down clamp.

6. Remove distributor and distributor to block gasket. It will be noted that the rotor will rotate as the distributor is pulled out of the block. Note the relationship of the rotor and the distributor housing after removal so that the rotor can be set in the same position when the distributor is being installed. NOTE: Always set distributor in upright position so oil from distributor shaft will not run out onto breaker plate and points.

7. If distributor cap requires removal for purpose of cleaning and inspection, mark position on cap tower for lead to No. 1 cylinder. This will aid in rapid re-installation of leads on cap in right order.

DISTRIBUTOR INSPECTION AND CHECKING

With the distributor removed from the vehicle it is advisable to place the distributor in a distributor testing machine or synchroscope. When mounting distributor in tester, first secure the gear in the drive mechanism, then push distributor housing down toward the gear to take up end play between the gear and housing, and finally secure the housing in the tester. Test the distributor for variation of spark, correct centrifugal and vacuum advance, and condition of contacts. This test will give valuable information on the distributor condition and indicate parts replacement which may be necessary.

When checking the distributor condenser it should be checked with a reliable make of condenser tester. The condenser should be checked for the following properties: (1) Insulation Resistance (or Leakage), (2) Series Resistance, (3) Breakdown Test, (4) Capacity (mfd.).

REPLACING DISTRIBUTOR CONTACT SET

The contact point set is replaced as one complete assembly. The breaker lever spring tension and point alignment of the service contact set have been pre-adjusted at the factory. Only the point opening requires adjusting after replacement.

Replace contact set as follows:

1. Remove two attaching screws (Fig. 12-55) which hold base of contact set assembly in place.

2. Remove condenser lead and primary lead from nylon insulated connection by turning screw (Fig. 12-55) in contact set.

3. Replacement is the reverse of removal. CAUTION: Make sure the condenser lead and primary lead are located as in Fig. 12-56. Leads must be properly located to eliminate interference between leads and cap, weight base, or breaker plate.

4. Apply a trace of Delco-Remy Cam and Ball Bearing Lubricant to the breaker cam. (See Gp. 2.364 of the Master Parts Catalog for lubricant.)

ADJUSTING DISTRIBUTOR DWELL ANGLE

The following method can be used to adjust the dwell angle to the proper setting with the distributor removed from the car. NOTE: Dwell should always be re-checked after the distributor is installed in the car.

1. With distributor mounted in distributor testing machine, connect the dwell meter to the distributor primary lead.

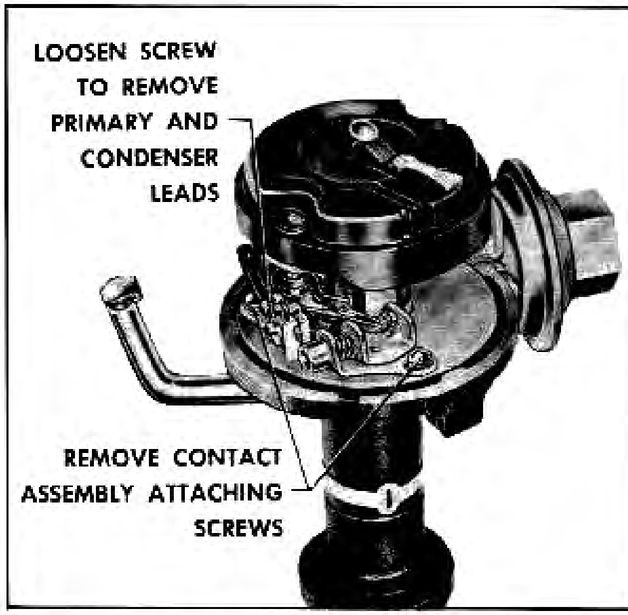


Fig. 12-55 Distributor Contact Details

2. With the distributor operating turn the adjusting screw (Fig. 12-46) until the proper dwell angle is obtained.

DISASSEMBLY OF DISTRIBUTOR

1. Remove the rotor by removing the two attaching screws, lockwashers, and flat washers (Fig. 12-57). NOTE: It will be observed that the rotor is doweled to the weight base so that it can be installed in only one position.

2. Remove both the weight springs and both the advance weights.

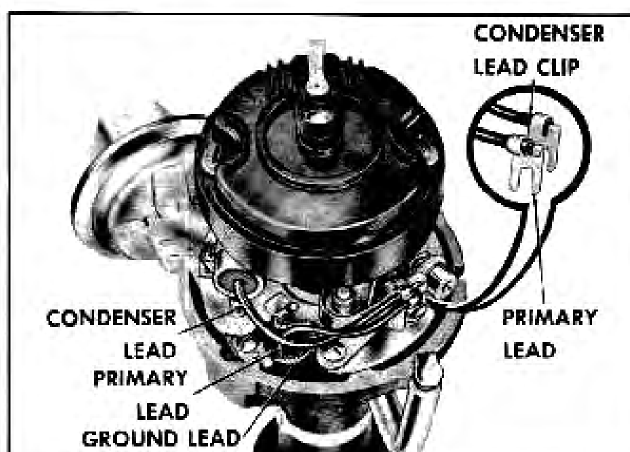


Fig. 12-56 Arrangement of Condenser and Primary Leads

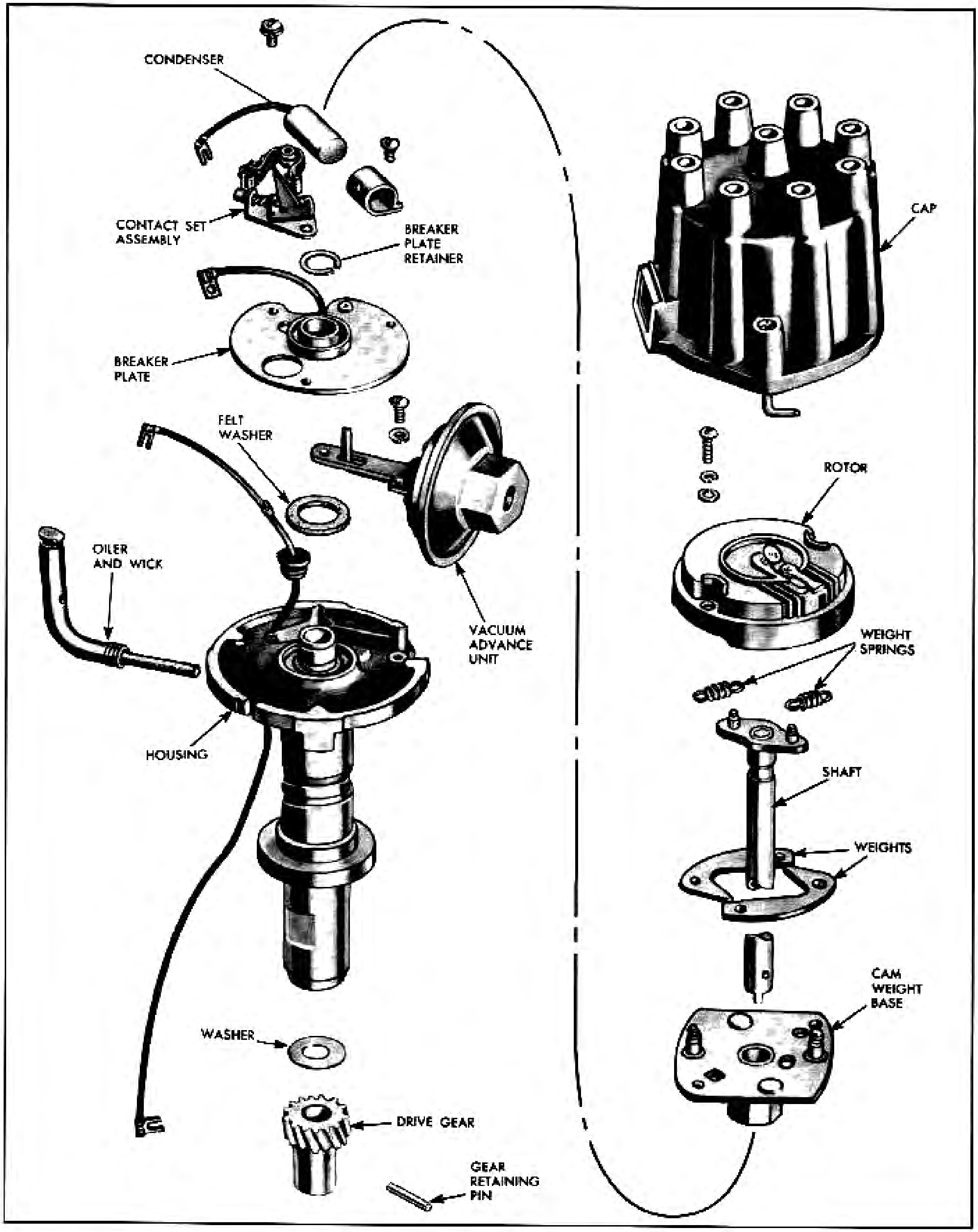


Fig. 12-57 Exploded View of Distributor

3. Remove retaining pin from the gear by filing off staking and driving it out of the gear with a drift and hammer. CAUTION: Distributor should be supported in such a way that the distributor shaft will not be damaged when driving the pin out.

4. Slide gear off the shaft.

5. Pull shaft and cam-weight base assembly from the housing.

6. Remove contact set assembly.

7. Remove condenser hold-down screw, condenser and bracket from the breaker plate.

8. Remove spring retainer and raise plate from the housing.

9. Remove two attaching screws and lockwashers and plate ground lead, and remove the vacuum advance unit.

10. Remove felt washer from around bushing in the housing.

NOTE: No attempt should be made to service the shaft bushings in the housing, as the housing and bushings are serviced as a complete assembly.

ASSEMBLY OF DISTRIBUTOR

Assembly of the distributor is the reverse of the disassembly procedure outlined above. When installing the gear on the shaft use a new retaining pin. Support the gear and shaft assembly and stake the pin securely. The pin must be tight in the hole to prevent any movement between the gear and the shaft.

Note that the rotor can be installed in only one position. It will be broken if an attempt is made to install it backwards.

DISTRIBUTOR INSTALLATION

1. Check to see that engine is at firing position for No. 1 cylinder (No. 1 piston at top of compression stroke) and timing mark on harmonic balancer is indexed with pointer.

2. Position new distributor to block gasket on block.

3. Install distributor in block so that vacuum diaphragm faces the left side of the engine and rotor points toward contact in cap for No. 1 cylinder. Before installing distributor, index rotor with housing as noted when distributor was removed. This will simplify indexing the distributor shaft and gear with the oil pump drive shaft and the drive gear on the camshaft. Distributor and rotor will be positioned as shown in Fig. 12-58 when properly installed with No. 1 piston in firing position.

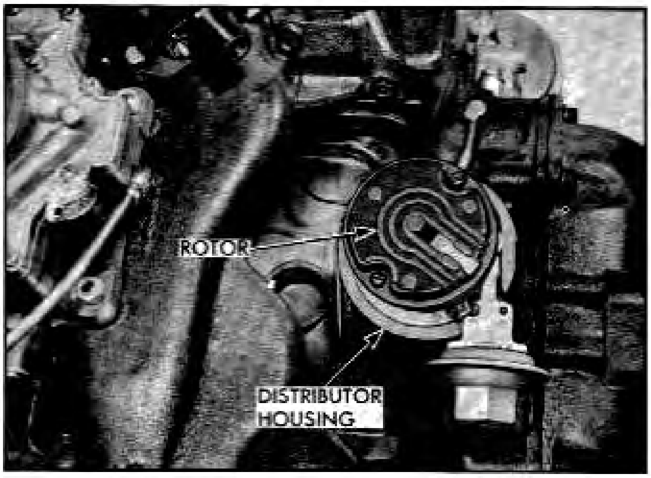


Fig. 12-58 Relationship of Distributor Housing and Rotor in Firing Position for No. 1 Cylinder

4. Replace distributor clamp leaving screw loose enough to allow distributor to be turned for adjustment.

5. Attach vacuum line to distributor.

6. Install spark plug wires in distributor cap. Place wire for No. 1 cylinder in tower shown in Fig. 12-59 (marked on old cap during disassembly) then install remaining wires counterclockwise around the cap according to the firing order (1-8-4-3-6-5-7-2).

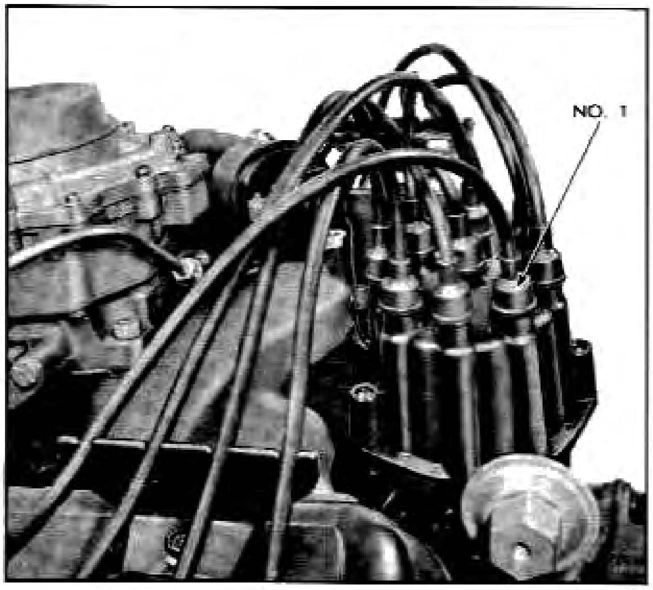


Fig. 12-59 Location of No. 1 Spark Plug Cable Terminal

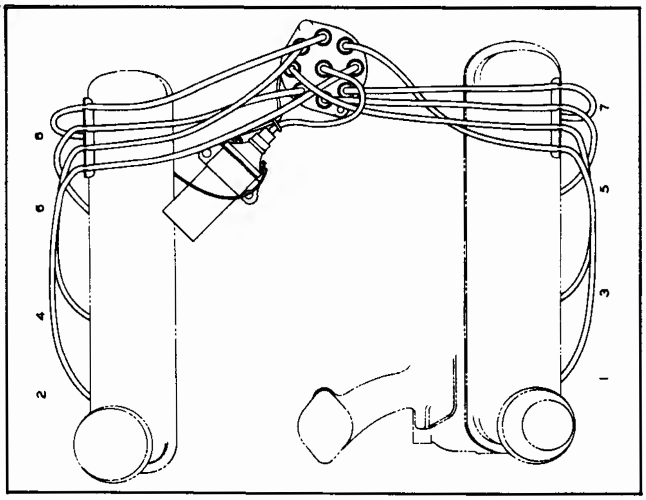


Fig. 12-60 Arrangement of Spark Plug Wires in Supports

When installing new wires, they should be located in wire supports as shown in Fig. 12-60.

7. Attach distributor to coil primary wire.
8. Replace distributor cap.
9. Adjust dwell and timing.

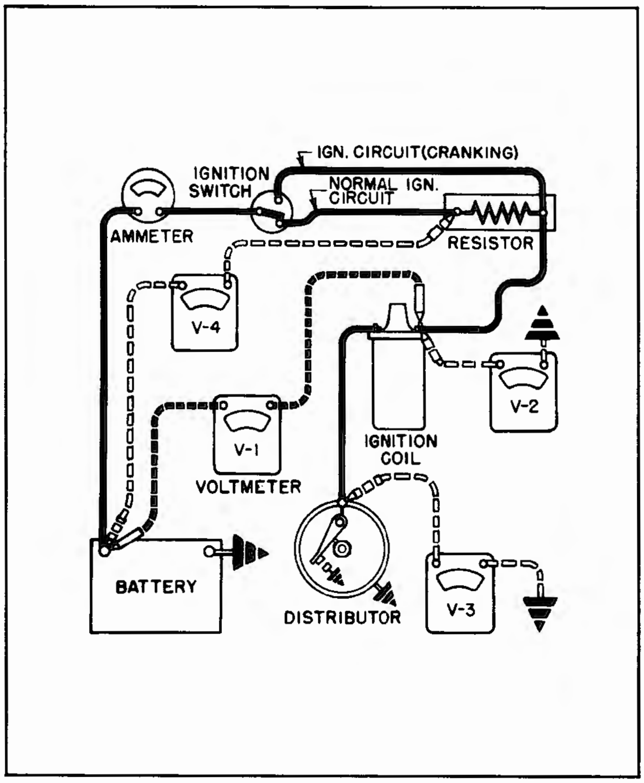


Fig. 12-61 Testing Diagram for Ignition Circuit

IGNITION SYSTEM TROUBLE DIAGNOSIS

NOTE: See page 00-6 for information concerning detonation.

QUICK CHECKS

If the engine does not run, the ignition system may be at fault if:

1. There is no spark, during cranking, when a spark plug wire is held ¼ inch from the engine.

2. The engine starts but immediately stops when the ignition switch is released from the "START" position.

If these checks indicate trouble in the ignition system, follow the procedure outlined below. This procedure may also be helpful in locating trouble in the ignition system if the car runs but not satisfactorily.

DIAGNOSIS PROCEDURE

If the checks outlined above indicate that the ignition system is at fault, the following checks may be made to help locate the difficulty. All checks are to be made with the lights and accessories off and in the sequence shown. Voltage readings referred to are indicated in Fig. 12-61.

OPERATION	SPECIFICATION	POSSIBLE TROUBLE
Check all connections in Primary and Secondary circuit.		
Remove secondary coil lead from distributor cap. Hold ¼ inch from engine while cranking, and observe if spark occurs.		*If spark occurs:* Distributor Cap. Rotor. Spark Plug Wiring.

IGINITION SYSTEM TROUBLE DIAGNOSIS (CONT.)

OPERATION	SPECIFICATION	POSSIBLE TROUBLE
Check Voltage V_1 while cranking.	1 Volt Max.	Open circuit from battery side of coil to solenoid switch. Solenoid switch not closing ignition circuit. Ground in circuit from coil terminal to solenoid switch. Ground in coil.
Check Voltage V_2 ignition switch "On", points open.	Normal Battery Voltage	Low Battery. Points not open. Ground in circuit from coil to distributor. Ground in distributor. Ground in coil. Ground in circuit from coil to solenoid switch or to resistor.
Check Voltage V_2 ignition switch "On", points closed.	5 to 7 Volts	*If over 7 volts check following:* Contacts not closed. Loose connection in distributor. Distributor not grounded to engine. Faulty contacts. Loose connection between coil and distributor. Resistor out of circuit due to shorted or incorrect wiring. Solenoid switch contacts stay closed. Resistor has too little resistance. Coil primary is open. *If under 5 volts, check following:* Loose connections between battery and resistor. Loose connections between resistor and coil. Resistor open or has excessive resistance.
Check Voltage V_3 ignition switch "On", points closed.	0.2 Volts Max.	Contacts not closed. Loose connection in distributor. Distributor not grounded to engine. Faulty contacts—if faulty, recheck voltage V_2, ignition switch on, points closed.
Check Voltage V_4 ignition switch "On", points closed.	0.7 Volts Max.	Loose connection from resistor through ignition switch circuit to battery.

If these checks fail to find cause of trouble —remove distributor, coil, and resistor from engine and check to specifications. Also check wiring harness.

LIGHTING, HORN, AND ACCESSORY POWER CIRCUITS—

GENERAL DESCRIPTION

FUSES AND CIRCUIT BREAKER

Fuses for all circuits are located in one fuse block. The fuse block is located in the inside of the dash, above and to the left of the steering column. The circuits supplied by each fuse are shown in the wiring diagram (Fig. 12-1) and one the fuse block (Fig. 12-62).

All fuses in the fuse block are 7½ ampere capacity except the 4 ampere fuse for instrument panel lamp rheostat. A spare 7½ ampere fuse is located in a clip at the bottom of the fuse block.

The headlamp, parking lamp, and tail lamp circuits are protected by a circuit breaker on the main lighting switch. The breaker is set to remain closed as long as the current flow does not exceed 22 amperes. If excessive current should flow, the circuit breaker will become heated causing the points to separate. It is calibrated so that a current of 37 amperes for a period of ½ minute to 1 minute will cause the circuit breaker to open. A current of 22 amps. should not open breaker.

Separate fuses are used for the electric antenna and air conditioner on cars so equipped. The electric antenna circuit uses a 14 ampere fuse mounted in a line holder above the fuse block. The air conditioner uses the stop light fuse and a 30 ampere fuse mounted in a line holder in the wire between the voltage regulator and the relay.

A circuit breaker is used in the electric window lift circuit. It is located inside the left cowl, above the kick pad.

LIGHTING

Lighting is controlled by two switches. First, the instrument panel main lighting switch which has two "On" positions or notches, the first for parking, tail and license lamps, and the extreme out position for the headlamps, tail, and license lamps. Rotating the lighting switch knob operates a rheostat for dimming the instrument panel lamps; with the rheostat in the extreme position the instrument panel lamps are completely off. Second, the headlamp beam switch (foot operated) which determines if the headlamp country (bright) beam or traffic (dim) beam is on when the

Fig. 12-62 Fuse Block

main lighting switch is pulled out. A red indicator lamp on the speedometer shows when the headlamp country beam is on. NOTE: Advise owner to always see that the red indicator light is out, indicating that the traffic beam is on, when meeting cars.

Parking lamps use a two filament bulb. One filament is for the direction signal and the other is for the parking lamp.

Headlamps are of sealed beam construction so that the light source, reflector, lens, and lens gasket are all assembled in one sealed unit. When the filament burns out or the lens is cracked or broken, the entire unit is readily replaceable with a new unit.

The filaments used in twelve volt headlamps are very fragile. These headlamp units must be handled carefully, therefore, to prevent breakage.

HORNS

The two horns used on the car are designed to give a blended tone when operated together. Each of these horns uses a solenoid actuated diaphragm to develop a resonating air column in the horn projector.

A relay is used in the horn circuit because of the high current required to operate horns. The relay reduces the length of heavy gauge wire required and makes a more direct connection between the horns and the battery. Consequently, higher voltage is available at the horns and better performance is obtained by eliminating the voltage drop which otherwise would be in the horn button wiring circuit.

CIGAR LIGHTERS

Two different makes of cigar lighters are used. All B.O.P. plants install Casco lighters while the Pontiac plant installs Rochester lighters.

The chief functional difference between the two lighters is that the Rochester lighter is protected by a manual reset circuit breaker while the Casco lighter is protected by a replaceable fuse.

The lighters release automatically (usual time for release is 10 to 14 seconds) which means that if the plug assembly for some reason is held in by the operator's hand a sufficient length of time (60 to 90 seconds) the fuse will blow or circuit breaker contact button will release. This may in some cases account for a blown fuse or released circuit breaker contact button where none of the other parts of the lighters are defective.

If temperature of the element shows indications of incorrect timing (too hot or too cold), the socket assembly containing the bi-metal hold-in fingers must be replaced.

The lighters have a safety feature in the form of two retaining fingers which prevent the knob and element assembly from falling out or popping out of the socket onto the floor. If these fingers do not keep the knob and element assembly from falling out onto floor the socket assembly should be replaced.

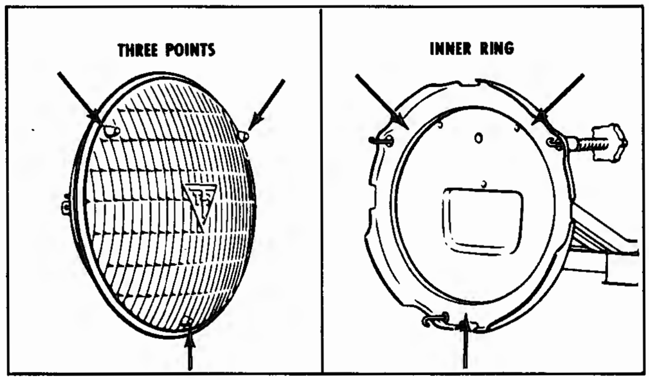


Fig. 12-63 Setting Up T-3 Aimer

ADJUSTMENTS ON CAR

AIMING HEADLAMPS WITH T-3 AIMER

1. Place car on level floor. NOTE: Aimers can be used to select a level floor or they can be calibrated for an unlevel floor (see below).

2. Remove headlamp door.

3. Using spring-loaded hooks of Safety-Aimer to engage headlamp retaining ring, fasten T-3 Safety-Aimer on each headlamp with inner ring against points on lens and cross arms horizontal (Fig. 12-63). (Aimer with the string should be fastened to left headlamp.)

4. Fasten spring loaded string from left aimer across slots to far side of right hand aimer (Fig. 12-64). Rotate aimers so string is level with slots on inner end of each cross arm.

5. Rock car gently from side to side to equalize springs.

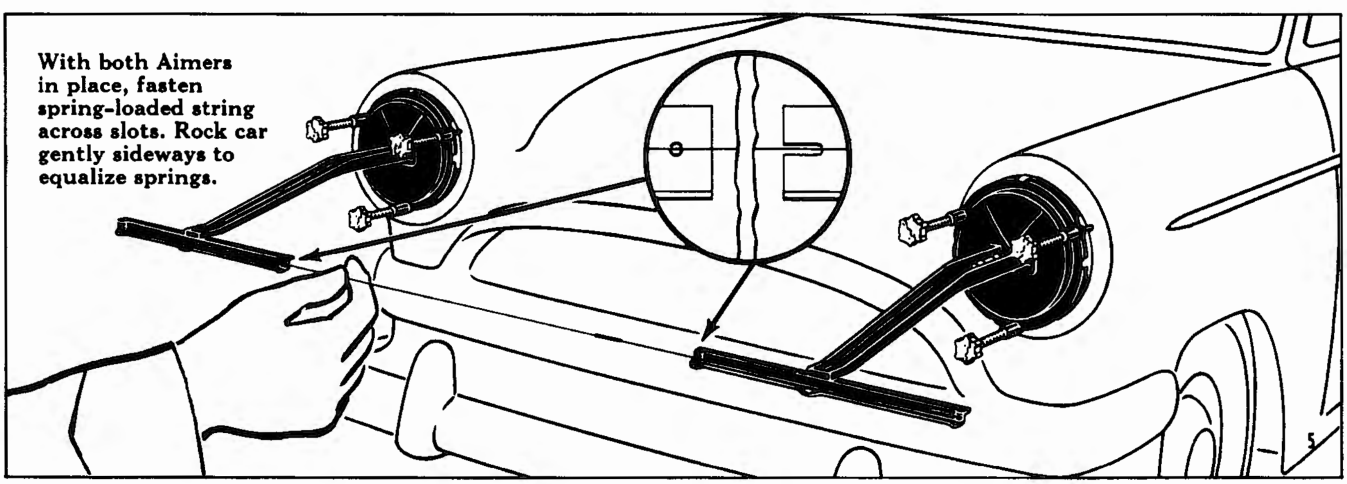


Fig 12-64 Safety-Aim Headlamp and Aimer

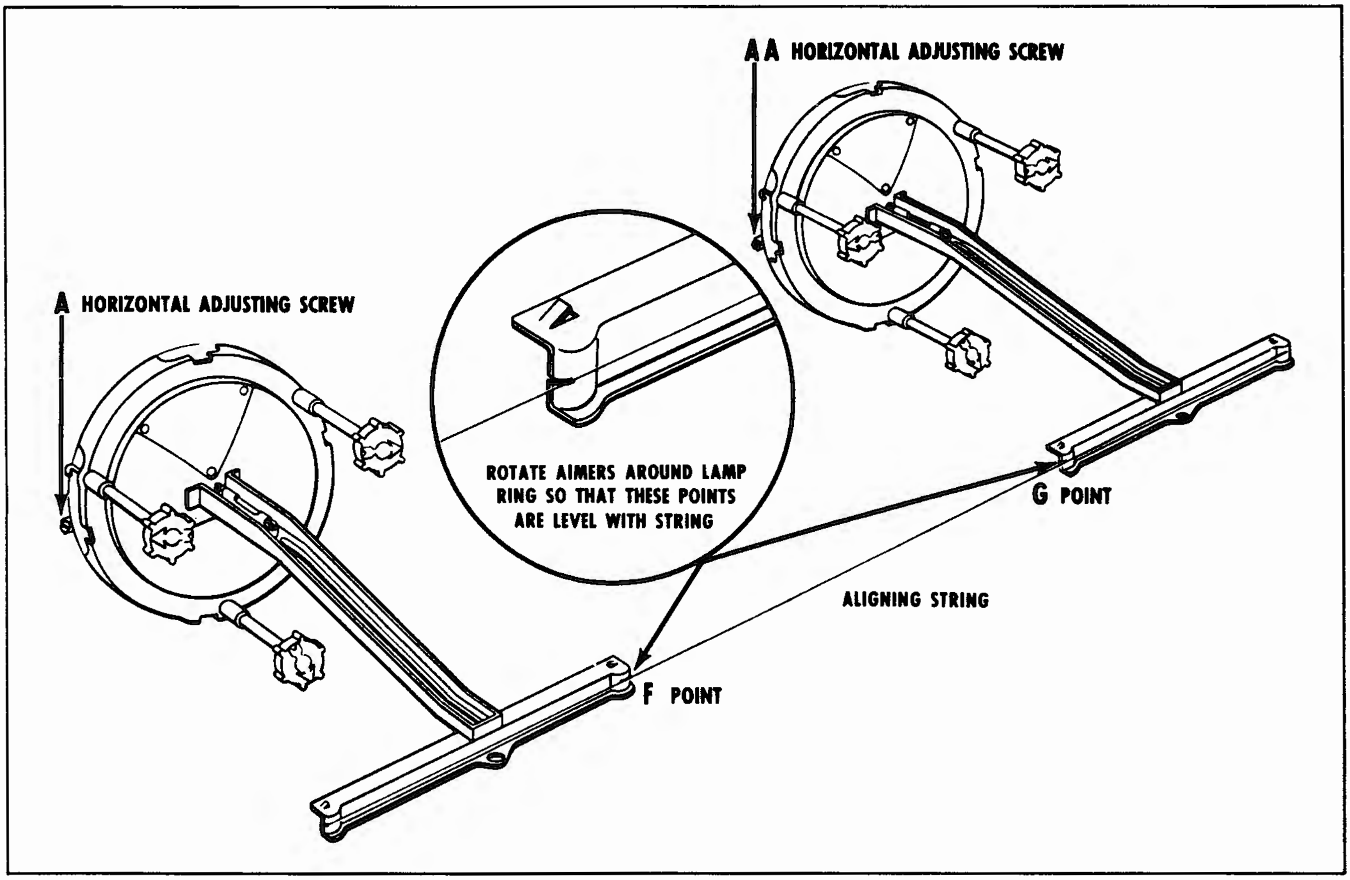


Fig. 12-65 Horizontal Adjustment

6. Adjust horizontal aim as follows:

a. Adjust left headlamp by turning horizontal adjusting screw AA in or out to make string first touch point G (Fig. 12-65). Final adjustment of screw should be in clockwise direction.

b. Repeat the operation on the other headlamp by moving horizontal adjusting screw in or out to make string touch point F.

c. Recheck points F and G. If necessary, make slight adjustments to have string barely touch points F and G.

7. Adjust vertical aim as follows:

a. Center bubble by turning vertical adjusting screw B (Fig. 12-66). (To insure proper location, back screw out until bubble is at end of vial. Then turn screw clockwise to center bubble.)

b. Repeat the same operation on the other headlamp.

c. Recheck the string at points F and G, and be sure bubbles are centered.

d. Remove aimers by releasing upper two hooks first and bottom hook last.

e. Replace headlamp doors.

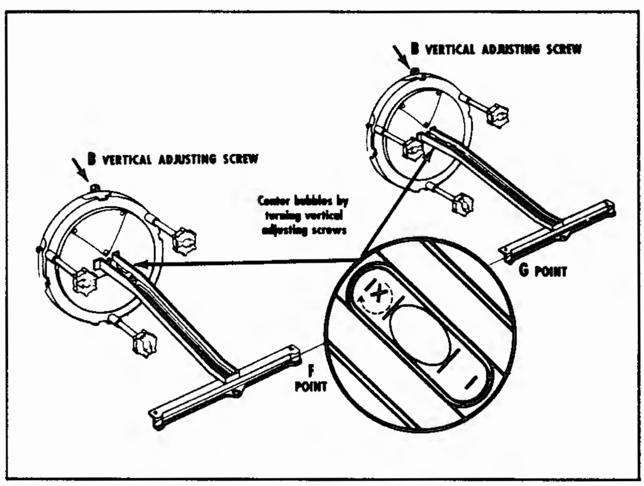


Fig. 12-66 Vertical Adjustment

SELECTING A LEVEL AIMING AREA

If you have a wheel-alignment ramp or any other level floor area, your problem is solved. If not, select an area which you believe to be level. Drive a car onto the selected surface and install the T-3 Aimer on both headlamps. Then turn headlamp vertical adjusting screw to center level bubbles.

Once you have both bubbles in the level posititon, turn the car end for end. Make sure that the wheels rest on the same spots and recheck the bubbles. If the bubbles are still within the two outside black marks on the vial, the floor is level enough to use the T-3 Aimer as it comes from the factory.

You can also make a quick check by using the T-3 Safety-Aimer as level. Use it with a true eight to ten-foot two-by-four as an extension. Place the board where you expect the car wheels to be and take readings as outlined above.

If either bubble moves beyond the outside black marks on the vial, there is too much slant to the floor. In this event a level position may be found by driving the car onto the aiming area at different angles.

Once you have determined a level aiming area, mark it so that cars of every wheelbase will be on a level surface. (Wheelbases range from 108" to 150".)

COMPENSATING FOR UNLEVEL FLOOR

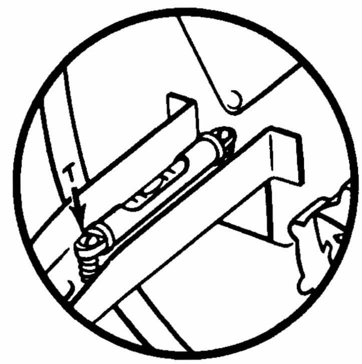
Drive car onto a surface you know to be level, such as a wheel-alignment ramp. Install T-3 Aimers on both lamps and level bubble by adjusting headlamp vertical adjusting screws.

Remove the T-3 Aimers from the headlamps (leaving the bezels off) and return the car to the aiming area which will be used. Reinstall T-3 Aimers on headlamps but do not touch headlamp vertical adjusting screws! Rock car sideways to equalize the springs. The bubbles will not be centered.

Center the bubbles on each Aimer by turning screw T (Fig. 12-67). The T-3 Aimer is now calibrated for the unlevel floor area. Therefore, all future aimings must be made with cars placed in the same area and faced in the same direction.

RECHECKING BUBBLES ON T-3 AIMER

Once the aimer is set up for use, whether on a level floor or compensated for an unlevel floor, the following will provide a quick check of the bubble accuracy at any time.



Center bubbles on each Aimer by adjusting screw T only!

Fig. 12-67 Bubble Adjusting Screw

Find a spot on the wall for each aimer where the bubble will be centered without making any adjustment of the aimer. Carefully mark these spots, identifying which is for right aimer and which for left. Then, any time the accuracy may be questioned, it can immediately be rechecked by placing the aimers on the same spots to see that the bubbles are still centered. If not centered, they can quickly be adjusted while holding them in position against the wall.

MINOR REPAIRS

DIRECTION SIGNAL SWITCH

The direction signal actuator mechanism is located in a housing just below the steering wheel (Fig. 12-68). The electrical switch is mounted on the steering column jacket just below the steering column to instrument panel bracket (Fig. 12-69). It is actuated by a rod inside the steering column jacket.

SERVICING DIRECTION SIGNAL SWITCH

The electrical switch can be removed from the steering column jacket without disturbing the actuator mechanism. After removing the two screws which retain the switch and control rod bearing plate to the jacket, the switch can be disengaged from its actuating lever. Servicing is simplified by the use of "push-on" type connectors.

The actuator mechanism can be removed as follows after removing the steering wheel.

1. Remove direction signal switch from steering column jacket and actuating lever.

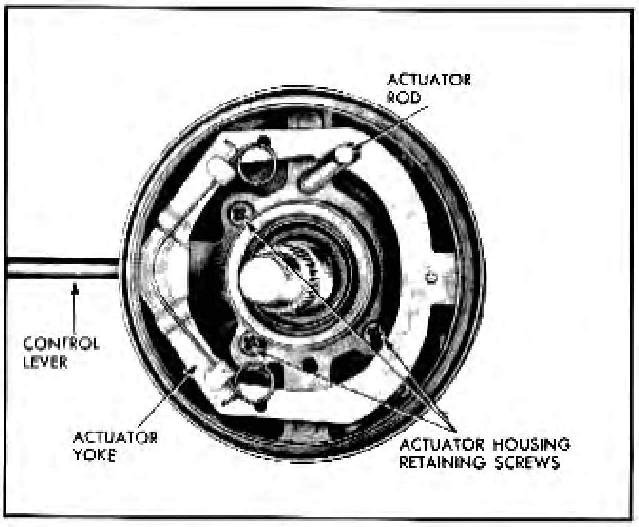


Fig. 12-68 Direction Signal Control

2. Hold actuator rod anti-rattle coil spring and bearing plate and remove hair spring type actuator lever from rod (Fig. 12-70). NOTE: A rag or steering column insulator felt stuffed into the opening below the actuator rod will prevent loss of the spring.

3. Remove anti-rattle spring and bearing plate.

4. Pull actuator rod out from top of steering column.

5. Remove three screws which retain actuator housing and remove housing.

6. Actuator yoke can be removed from housing by pressing out shield (Fig. 12-71).

Replace rod by reversing the above steps. Fasten horn wire retainer on top of direction signal switch bracket.

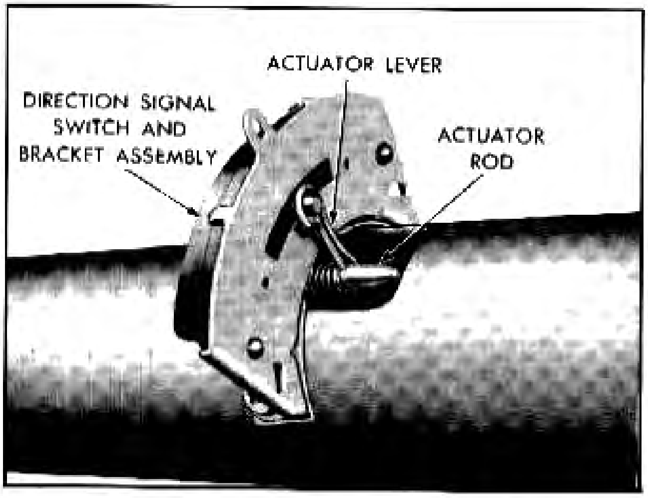


Fig. 12-69 Direction Signal Switch

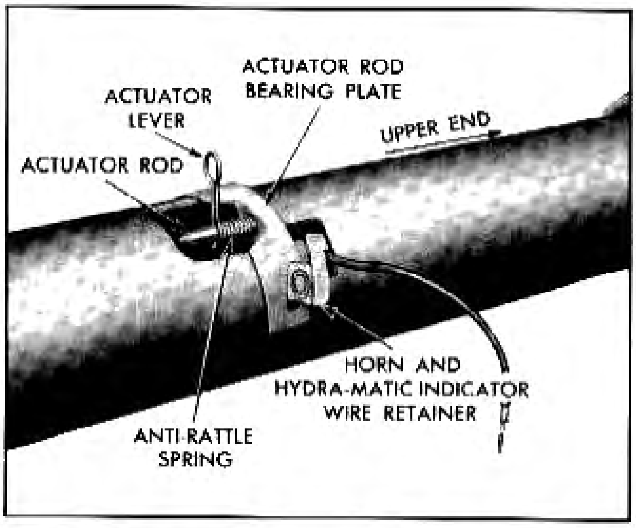


Fig. 12-70 Details at Lower End of Actuator Rod

DIRECTION SIGNAL WIRING

Direction signal schematic wiring diagram is shown in Fig. 12-1.

HEADLAMP SEALED BEAM UNIT—REMOVE AND REPLACE

1. Remove headlamp door.

2. Remove spring holding sealed beam unit retaining ring in place and remove retaining ring and sealed beam unit from mounting.

3. Pull connector from rear of beam unit and separate sealed beam unit from retaining ring and mounting ring.

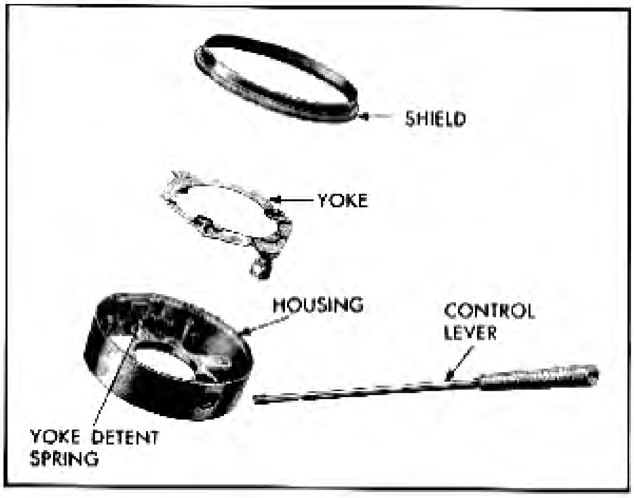


Fig. 12-71 Direction Signal Control—Exploded

4. Assemble new sealed beam unit into mounting ring and retaining ring and plug sealed beam unit into connector.

5. Install beam unit and retaining ring.

6. Check headlamp aiming and readjust if necessary.

7. If headlamp door rubber seal is defective, remove seal and cement new seal securely to door.

8. Replace headlamp door.

LIGHTING SWITCH—REMOVE AND REPLACE

1. Remove one battery cable from battery post.

2. Pull switch knob to headlight "On" position, push latch button on side of switch assembly and pull out switch knob assembly.

3. Unscrew bushing from switch assembly and remove switch assembly.

4. Remove "push-on" connector with leads from light switch and connect to new switch.

5. Position new switch in instrument panel, and start bushing through ferrule into switch assembly. Tighten bushing securely.

6. Insert knob assembly into switch assembly until end of rod engages catch.

7. Install cable on battery post.

REPLACEMENT OF CIGAR LIGHTER PARTS

FUSE—CASCO

1. Turn wire connector at rear of lighter base slightly to disengage it and then pull it to rear off lighter base assembly.

2. Unscrew fuse from lighter base assembly.

3. Screw on new lighter fuse or circuit breaker.

4. Reconnect connector to lighter base.

ELEMENT—CASCO

Remove knob and metal knob flange from element assembly and install knob and flange on new heating element assembly.

ELEMENT—ROCHESTER

Replace complete plug assembly.

LIGHTER SOCKET OR WELL

1. Remove wire connector from rear of lighter socket.

2. Unscrew clamping shell from lighter socket and remove socket from instrument panel.

3. To install, reverse above procedure, seeing that clamping shell is turned up ONLY FINGER TIGHT on lighter socket.

RESETTING CIRCUIT BREAKER—ROCHESTER

1. Remove connector and contact from back of lighter base.

2. Push circuit breaker reset button back into socket assembly.

3. Replace connector on lighter base.

INSPECTION AND ADJUSTMENT OF HORN

CURRENT ADJUSTMENT

The only adjustment on the horn is the current adjustment. Both horns should have a current draw of 8.0-11.0 amperes at 12.5 volts. Adjustment is made by turning the adjusting screw (Fig. 12-72) clockwise to decrease current or counterclockwise to increase the current. NOTE: Adjusting screws are preset at the factory to obtain the specified current draw and should not be readjusted unless current draw is found to be outside the limits specified.

No other checks or adjustments can be made or are required.

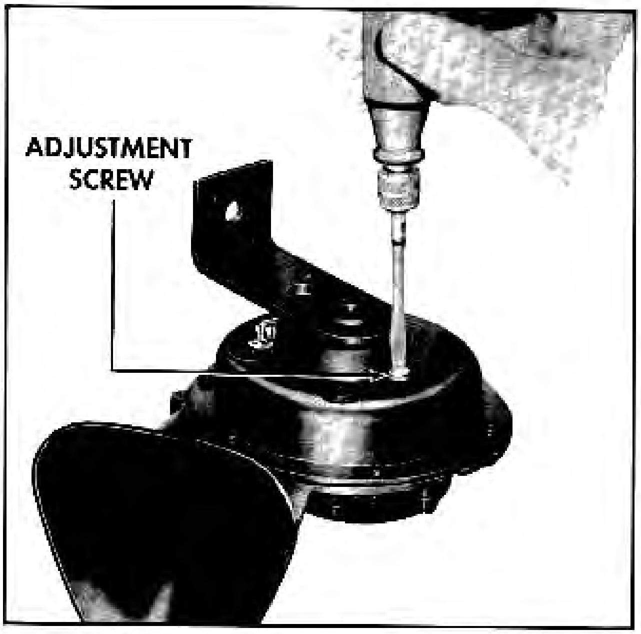


Fig. 12-72 Adjusting Current Draw of Horn

LIGHTING AND ACCESSORY POWER CIRCUITS— TROUBLE DIAGNOSIS AND TESTING

Troubles in the lighting and accessory power circuits are caused by loose connections, open or shorted wiring, or blown fuses. In each case trouble diagnosis requires following through the circuit until the source of difficulty is found. To aid in making an orderly point-to-point check, refer to the schematic wiring diagram (Figs. 12-1 and 12-2).

HORN CIRCUIT—TROUBLE DIAGNOSIS

HORNS WILL NOT OPERATE

NOTE: To locate the trouble, connect a jumper lead to the No. 1 and No. 3 terminals of the relay. (NOTE: Terminal numbers are stamped on the relay base.) If the horn blows, the trouble is in the relay, horn button, or wiring. (To determine whether the relay, horn button, or wiring is at fault, ground the No. 2 terminal of the relay. If the horn blows, the horn button or wiring is at fault.) If the horn does not blow and the wiring between the battery and relay is not defective, connect a voltmeter between the horn terminal and the horn mounting nut. Again connect the jumper lead to the No. 1 and No. 3 terminals of the relay and note the voltmeter reading.

If no voltmeter reading is obtained, the wiring between the relay and horn is open or the horn is not grounded. If the voltmeter reading is less thn 7.0 volts, the trouble is due to high resistance connections in the wiring or a faulty horn. If the voltmeter reading is above 7.0 volts, the trouble is due to a faulty horn which should be removed for a bench check.

CAUSE	REMEDY
Loose connections in circuit.	Check and tighten connections. Be sure to check ground strip in power steering coupling.
Defective horn switch.	Replace defective parts.
Defective horn relay.	Replace relay.
Defects within horn.	Adjust horn current draw or replace horn.

HORN CIRCUIT—TROUBLE DIAGNOSIS (CONT.)

POOR TONE

CAUSE	REMEDY
Low available voltage at horn.	Check battery and charging circuit.
Defects within horn.	Although the horn should blow at any voltage above 7.0 volts, a weak or poor tone may occur at operating voltages below 11.00 volts. If the horn has a weak or poor tone at an operating voltage of 11.00 volts or higher, remove the horn for inspection and adjustment (page 12–44).

HORNS OPERATE INTERMITTENTLY

CAUSE	REMEDY
Loose or intermittent connections in horn relay or horn circuit.	Check and tighten connections.
Defective horn switch.	Remove button or ring and replace defective parts.
Defective relay.	Replace relay.
Defects within horn.	Inspect and adjust horn (page 12-44).

DIRECTION SIGNAL—TROUBLE DIAGNOSIS

DIRECTION SIGNAL FAILS TO OPERATE

CAUSE	REMEDY
Blown fuse.	Replace fuse.
Defective flasher unit.	Replace flasher unit.
Loose connection in circuit.	Check and tighten connections.
Failure of direction signal in left or right parking lamp or stop lamp.	Replace lamp.

INDICATOR LAMP REMAINS ON CONSTANTLY OR FLASHES EXTREMELY FAST

CAUSE	REMEDY
Loose connections in circuit.	Check and tighten connections.

CAUSE	REMEDY
Failure of parking lamp.	Replace parking lamp.
Failure of stop lamp.	Replace stop lamp.

INSTRUMENTS— GENERAL DESCRIPTION

Instruments consist of a fuel gauge, temperature gauge (thermo-gauge), charge indicator, oil pressure gauge, and speedometer. Authorized service on the instruments can be obtained through branches of United Motors Service Division and AC Service Stations. However, a knowledge of instrument circuit checks must be had to determine if operating difficulties lie in the instrument itself or in its allied circuit.

FUEL GAUGE

An electric fuel gauge is used on all models. The fuel gauge indicates the quantity of gasoline in the tank only when the ignition switch is turned on or to the accessory position. When the ignition is turned off or to start the pointer drops back beyond the empty mark. The letters "E" and "F" on the fuel gauge are used to point out direction of indicator travel only. Gauge readings are made from five markings on the gauge face. The left hand dot indicates empty, the center dot half-full and the right hand dot full. The dash unit of this instrument consists principally of two coils spaced 90° apart, with an armature and pointer assembly mounted at the intersection of the center lines of the two coil end pieces (Fig. 12-73). Silicone liquid in the armature bearing prevents vibration of the pointer on rough roads. One end of the left coil is connected to the left gauge terminal which is connected directly to the battery (through the ignition switch). The other end of the left coil and one end of the right coil are connected to the right gauge terminal which is connected directly to a rheostat which is the fuel gauge tank unit. The other end of the right coil and the tank unit are grounded. The resistance allows more current to flow through the right hand coil as the tank fills up, causing the right hand coil to balance the constant magnetism of the left hand coil, bringing the pointer and armature assembly to rest somewhere between the two coils, the exact position depending on the relative magnetic strength between the two coils.

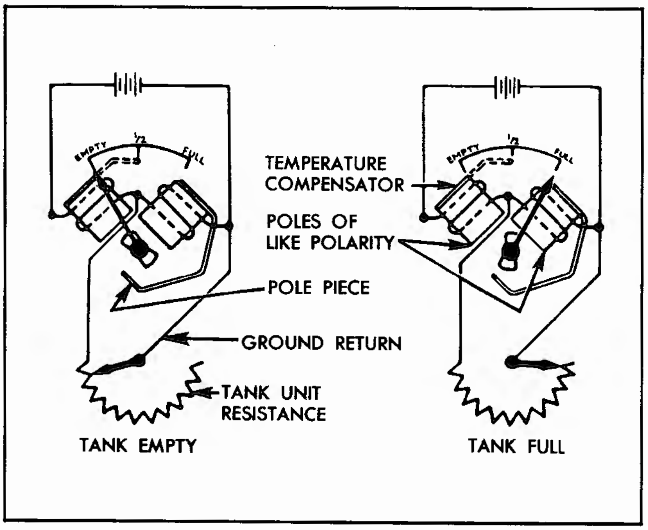


Fig. 12-73 Fuel Gauge Diagram

The fuel gauge tank unit consists of a float, with linkage connecting to a movable contact arm and a rheostat. As the float rises, due to filling the tank, the contact arm moves over the rheostat cutting in resistance and allowing more current to flow through the right-hand ("full") coil of the panel unit.

THERMO-GAUGE

The electric thermo-gauge consists of a dash unit and an engine unit connected by a single wire. Gauge readings are made from three markings on the gauge face. The left hand dot indicates Cold (100°F) and the right dot Hot (240° F). One end of each coil is connected to the left gauge terminal which is connected directly to the battery (through the ignition switch). The other end of the left coil is grounded back to the battery. The other end of the right coil is connected to the engine unit which is grounded. The resistance of the engine unit, which is high when the engine is cold, decreases the current in the right coil allowing the left coil to attract the armature and thus, causing the pointer to indicate "Cold." As the engine warms up, the engine unit resistance decreases, increasing the current in the right coil, causing the right coil to balance the constant magnetism of the left coil, bringing the pointer and armature assembly to rest somewhere between the two coils, the exact position depending on the temperature of the engine coolant water.

The engine unit consists of a thermistor housed in a suitable unit for insertion into the engine coolant. Like all thermistors this unit has a very high resistance when cold and a relatively low resistance when hot. Being in series with the right dash unit coil, the unit determines the magnitude of the current in the right coil.

CHARGE INDICATOR

The charge indicator (sometimes referred to as ammeter) consists of a frame to which is attached a soft iron pole piece. The frame also supports a permanent magnet armature and pointer assembly. When no current flows through the charge indicator, the magnet holds the pointer armature and pointer so it indicates 0. When current passes in either direction through the indicator the resulting magnetic field attracts the armature opposing the effect of the permanent magnet and giving a reading proportional to the current flow. NOTE: The charge indicator is marked "DIS" on one side of "O" and "CHG" on the other since it only indicates flow of current and does not show how much current is flowing. No attempt should be made to interpret the reading in amperes current flow.

OIL PRESSURE GAUGE

The oil pressure gauge indicates the pressure in the engine's full pressure lubrication system. The gauge is read in the same manner as the fuel gauge with the dots indicating "0", "40" and "80" respectively. The gauge shows the oil pump is working, but does not indicate how much oil there is in the crankcase. At average driving speeds the gauge should read approximately "40". When oil gauge reads approximately "40" at average driving speed, it may read near the "0" mark at hot idle.

The oil pressure gauge consists of a dial, frame and mechanism assembly. Oil pressure is transmitted through a small oil line to the threaded frame socket and into a bourdon (partially flattened curved) tube which has one end fastened to the frame. The free closed end of the bourdon tube is connected to the gauge pointer by a linkage. Oil pressure has a tendency to straighten the bourdon tube causing its free end to move outward in proportion to the pressure. This, by means of the linkage moves the pointer to give an indication of pounds per square inch pressure on the dial.

SPEEDOMETER

The speedometer incorporates a speed indicating mechanism and an odometer to record total mileage. A flexible cable, which enters the speedometer driven gear in the transmission on one end and the speedometer head at the other, rotates both mechanisms whenever the transmission main shaft, propeller shaft and wheels rotate. The speed indicating portion of the speedometer operates on the magnetic principle. In the speedometer head is a permanent magnet which rotates at the same speed as the cable. This magnet exerts a pull on a speed cup causing it to move in direct ratio to the revolving magnet speed. A speed drum is attached to the speed cup spindle to indicate speed on the speedometer dial. A finely calibrated hair spring (also part of the speed cup assembly) opposes the magnetic pull on the speed cup so the drum indicates true speed; it also pulls the cup and drum to zero when the car stops.

A bright orange speed line painted on the drum in the form of a spiral, progresses across the dial as speed increases. Speed is indicated by the leading edge of the orange area. The odometer is driven by a series of gears from a worm gear cut on the magnet shaft. The odometer discs are so geared that as any one disc finishes a complete revolution, the next disc to the left is turned one-tenth of a revolution.

PERIODIC SERVICE

No periodic service or lubrication of instruments (except for the speedometer cable) is required. In fact it must never be attempted on the panel instruments as it will interfere with their satisfactory operation. Never attempt to lubricate the fuel gauge tank unit; adequate lubrication of this unit is provided by splash of the gasoline.

In some cases the speedometer cable becomes noisy or the speed indicator wavers or jerks. This may be due to a dry cable which should be lubricated using special AC speedometer grease as outlined in the General Lubrication Section. When the cable is removed for lubrication, it should be checked for kinks. To do this, take the two ends of the cable (after removing it from casing) one end in each hand, and with the hands about a foot apart (Fig. 12-74). slowly turn the cable. If it is kinked, the loop will "flop"; in such a case replace the cable.

MINOR REPAIRS

REMOVAL OF GAUGE CLUSTERS

NOTE: Before condemning the instrument panel unit, test it as outlined on page 12-51.

To remove either the charge indicator-thermo-gauge cluster or the fuel-oil pressure gauge cluster it is merely necessary to disconnect the leads and remove the three attaching nuts from the back.

REMOVAL AND REPLACEMENT OF SPEEDOMETER HEAD

1. Remove gauge clusters.

2. Remove radio knobs and radio to trim plate attaching nuts.

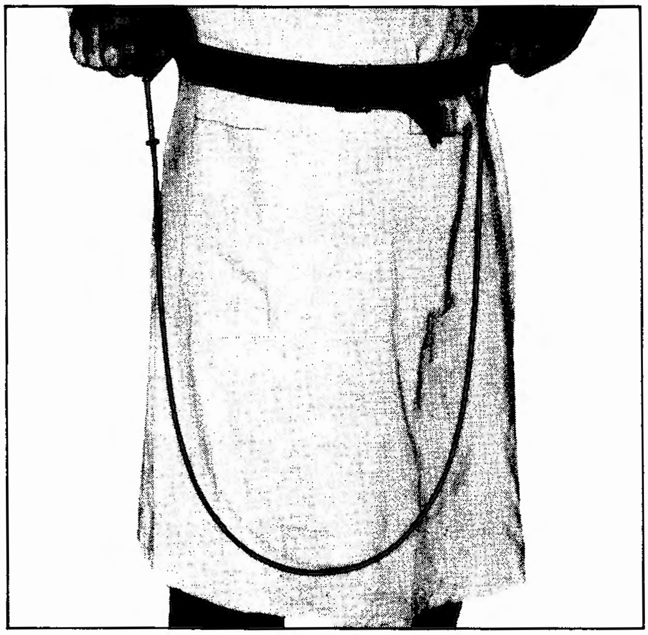


Fig. 12-74 Testing Speedometer Cable for Kinks

3. Remove six attaching screws and remove instrument panel trim plate. NOTE: Clock will remain with trim plate.

4. Disconnect speedometer cable, wiring and oil pressure gauge line.

5. From face of the instrument panel, remove two screws (one on each side) which retain speedometer head to instrument panel.

6. Pull speedometer head out of instrument panel.

7. Detach light sockets from speedometer head and remove speedometer head.

8. Reverse the above steps to install speedometer head.

FUEL GAUGE TANK UNIT—REMOVE AND REPLACE

NOTE: Before removing tank unit be sure it is actually defective; see testing section, page 12-51.

1. Clean away any dirt that has collected around tank unit and tank unit terminal so it will not enter tank and also because dirt, particularly if calcium chloride, causes an electrical leak that will cause error in gauge reading.

2. Disconnect lead from terminal on tank unit, disconnect fuel line, remove five screws holding unit to tank and remove unit from tank.

3. Install new tank unit, first checking for float arm freedom of movement by raising it to various positions and seeing if it will always fall to "empty" position.

4. Install attaching screws and tighten securely.

5. Securely install wire to terminal or tank unit and see that boot on wire connection is properly installed so as to seal connection.

6. Reconnect fuel pipe.

SPEEDOMETER CABLE—REMOVE AND REPLACE

1. Disconnect speedometer cable casing from speedometer case.

2. Slide old cable from upper end of casing, or if broken from both ends of casing.

3. Take a short piece of speedometer cable with a tip to fit the speedometer and insert it in the speedometer socket. Spin the short cable between the fingers in the direction that higher speed is indicated on the speedometer dial and note if there is any tendency to bind. If binding is noted, there is trouble inside the head and the speedometer should be repaired.

4. Inspect cable casing, especially at transmission end, for sharp bends and breaks. If breaks are noted, replace casing. NOTE: Cable casing has a daub of red paint at the point where it enters the body through the dash. This daub of red paint should be just outside the body, next to the clamp.

5. Spread a generous coating of special AC Speedometer Cable Grease over the lower two-thirds of new cable and a thin coating over the upper one-third of the cable.

6. Insert cable into upper end of casing, lower end first.

7. Seat upper cable tip in speedometer and tighten casing connector to speedometer case as tightly as possible with fingers. NOTE: Insufficient tightening of connector will result in connector loosening, causing speedometer indicator to waver.

8. See that there are no sharp bends in casing.

INSTRUMENTS—TROUBLE DIAGNOSIS AND TESTING

GASOLINE GAUGE DOES NOT SHOW "FULL" WITH FULL TANK

CAUSE	REMEDY
Gauge tank unit defective.	Repair or replace gauge tank unit.

GASOLINE GAUGE DOES NOT REGISTER WITH IGNITION ON

CAUSE	REMEDY
Break in line between instrument panel unit and ignition switch.	Check line and connections to switch and panel unit.
Defective panel unit.	Check (see page 12-51) and replace.

GASOLINE GAUGE SHOWS FULL UNDER ALL CONDITIONS

CAUSE	REMEDY
Break in line between tank and instrument panel unit.	Check (see page 12-51) and repair.
Defective tank unit.	Check (see page 12-51) and replace.
Tank unit improperly grounded.	Remove paint under tank unit mounting screws and tighten screws. Ground tank to chassis and check gauge operation.

GASOLINE GAUGE SHOWS EMPTY UNDER ALL CONDITIONS

CAUSE	REMEDY
Lead to tank unit grounded.	Make necessary repair.
Defective tank unit.	Check (see below) and replace.
Defective panel unit.	Check (see below) and replace.

THERMO-GAUGE SHOWS INCORRECT TEMPERATURE

Test thermo-gauge as outlined on page 12-51.

SPEEDOMETER NOISE AND/OR INDICATOR OSCILLATING

CAUSE	REMEDY
Cable dry.	Lubricate according to page 12-49.
Kinked cable.	Replace cable. Re-route casing so that bends have no less than 6" radius.
Defective speedometer head.	Replace or have repaired at authorized service station.
Casing connector loose on speedometer case.	Tighten connector.

TESTING FUEL GAUGE TANK AND INSTRUMENT PANEL UNITS

In order to isolate trouble in the fuel tank or instrument panel unit, use either an extra tank unit, which is known to be good, or an AC Gas Gauge Tester AC No. 1516000 which can be procured from AC Service Stations. CAUTION: In process of testing fuel gauge panel unit NEVER place full battery current on terminal to which wire to tank unit is normally attached. To do so will burn out resistance coil in tank unit even though the terminal is touched only momentarily.

To test, remove lead to tank unit from instrument panel unit and then use one of the following methods:

TESTING WITH EXTRA TANK UNIT

1. Attach a wire lead from the terminal on the extra tank unit to the tank unit terminal on the panel unit and connect a second wire from body of extra tank unit to car chassis.

2. Turn on ignition and move float on extra tank unit to full and empty positions. If panel unit indicates corresponding reading, it is satisfactory and trouble is in tank unit or wire lead from panel unit to tank unit.

3. Check wiring to tank unit by disconnecting lead from tank unit in car and connecting to test unit. With test unit grounded to chassis move float to full and empty positions and see that instrument panel unit reads correctly. Incorrect reading indicates defect in wiring.

4. Check tank unit by removing from tank, reconnecting the lead and operating unit in same manner as the test unit (tank unit must be grounded while testing). If instrument panel shows correct reading, trouble was caused by poor connection of lead to tank unit or poor ground. If instrument panel does not give correct reading, install a new tank unit.

TESTING WITH AC TESTER

1. Remove lead to tank unit from instrument panel unit. Attach red wire of AC tester to the tank unit terminal on panel unit and ground the tester by connecting the black wire to a good ground.

2. Turn on ignition switch and move lever on tester through its full travel. If panel unit reads "empty" and "full", it is satisfactory and trouble is in tank unit or possibly wire lead from instrument panel unit to tank unit.

3. Check wiring to tank by disconnecting lead from tank unit in car and connecting to AC tester. Ground tester and move lever on tester through its full travel. If instrument panel unit shows "empty" and "full", tank unit is probably defective and should be checked as in step 4 above.

TESTING THERMO-GAUGE BLOCK AND INSTRUMENT PANEL UNITS

When the thermo-gauge does not register properly it can be tested as follows:

1. With ignition off, disconnect lead from block unit and connect to known good block unit.

2. Immerse end of the new block unit in water which has been heated to 180° F. CAUTION: Do not immerse electrical terminal.

3. Turn ignition switch on and observe temperature indicated by instrument panel unit. If approximately at center mark (180° F) instrument panel unit and wiring are satisfactory and trouble is in block unit.

4. If instrument panel unit reads improperly, trouble is indicated in wiring or instrument panel unit. Turn ignition off and disconnect leads from instrument panel unit.

5. Connect leads to known good instrument panel unit.

6. Make sure water in which new block unit is immersed is still 180° F, turn on ignition switch and observe temperature indicated on instrument panel unit. If needle is approximately at center mark it confirms that trouble is in instrument panel unit. If gauge still does not read correctly the trouble is in the wire between the instrument panel unit and the block unit.

SPECIFICATIONS

DISTRIBUTOR—STANDARD

Standard Model		1110871
Rotation (viewed from top)		Counterclockwise
Ignition Timing		6° BUDC
Cam Angle, set to		30°
range		28°-32°
Breaker Lever Tension, oz.		19-23 oz.
Condenser Capacity		.18-.23 (Mfd.)
Centrifugal Advance	ENGINE R.P.M.	ENGINE DEGREES
Start	650	0-2
Intermediate		
Intermediate	2000	15.0-19.0
Maximum	4250	24-28
Vacuum Control Model		1116126
Vacuum Advance		
Inches of Mercury to Start Advance		6-8
Inches of Mercury for Full Advance		14-15 ¾
Max. Advance (engine degrees)		22°±2°

IGNITION COIL—STANDARD

Model Number	1115085

IGNITION RESISTOR

Model	1935134
Resistance at 80°F, ohms	1.40-1.62

SPARK PLUGS

Make	AC
Size	14 mm
Type	45
Gap	.035"
Torque	25 lb. ft.

HIGH TENSION WIRE RESISTANCE

Coil Wire	Replace if open circuited, or if resistance exceeds 10,000 ohms.
All Secondary Wires	Replace if open circuited, or if resistance exceeds 20,000 ohms.

CRANKING MOTOR

Model	1107661
Brush Spring Tension	35 oz. (min.)
Free Speed	
Volts	10.6
Amperes	65-100
RPM	3600-5100

SOLENOID SWITCH

Model	1119798
Hold-in Winding	10-12 Amp at 10 V.
Both Windings	40-45 Amp at 10 V.

GENERATOR (STANDARD)

Model Number	1100304
Brush Tension	28 oz.
Cold Output	25 amperes at 14 volts, 2780 RPM
Field Current Draw	1.5-1.62 amp. at 12 volt (80°F.)

GENERATOR (AIR CONDITIONING OR HEAVY DUTY 35 AMP.)

Model No.	
Air Conditioning	1102073
Heavy Duty	1102070
Brush Tension	28 oz.
Cold Output	35 amperes at 14 volts, 2510 RPM
Field Current Draw	1.69-1.79 amp at 12 volt (80°F.)

GENERATOR (HEAVY DUTY 40 AMP.)

Model Number	1102074
Brush Spring Tension	28 oz.
Cold Output	40 amperes at 14 volts, 2320 RPM
Field Current Draw	2.66-2.86 amp. at 12 volts (80°F.)

REGULATOR (STANDARD)

Model Number	1119000
Cutout Relay Air Gap	.020"
Cutout Relay Point Opening	.020"
Cutout Relay Closing Voltage	11.8-13.5 volts
Voltage Regulator Air Gap	.075
Voltage Regulator Normal Range	13.8-14.8 volts
Current Regulator Air Gap	.075
Current Regulator Setting	23-27 amps.

REGULATOR (WITH AIR CONDITIONING AND HEAVY DUTY 35 AMP.)

Model Number	1119002
Cutout Relay Air Gap	.020
Cutout Relay Point Opening	.020
Cutout Relay Closing Voltage	11.8-13.5
Voltage Regulator Air Gap	.075
Voltage Regulator Normal Range	13.8.-14.8
Current Regulator Air Gap	.075
Current Regulator Setting	32-37

REGULATOR (HEAVY DUTY 40 AMP.)

Model Number	1119163
Cutout Relay Air Gap	.020
Cutout Relay Point Opening	.020
Cutout Relay Closing Voltage	11.8-13.5
Voltage Regulator Air Gap	.080

REGULATOR (HEAVY DUTY 40 AMP.)—CONT.

Voltage Regulator Lower Contact Opening	.016
Voltage Regulator Normal Range	14.0-14.6 volts stabilized and operating on lower contacts
Voltage Regulator Upper Contact Point Setting	.3-.5 volts lower on upper contacts
Current Regulator Air Gap	.075
Current Regulator Setting	37-42

HORN RELAY

Model Number	1116920

ANTENNA RELAY

Model Number	1116928
Air Gap	.011
Point Opening	.025
Closing Voltage	8.3-10.2 volts

AIR CONDITIONING RELAY

Model Number	1116895
Air Gap	.015
Point Opening	.020
Closing Voltage	7-9 volts

HORN (LOW NOTE)

Model Number	9000317
Ampere Draw at 12.5 volts	8-11

HORN (HIGH NOTE)

Model Number	9000318
Ampere Draw at 12.5 volts	8-11

BATTERY (HYDRA-MATIC)

Model Number	558
Number of Plates	9
20 Hr. Rating	60 amp hrs.
Separators	Microporous rubber
Case	Hard rubber

BATTERY (SYNCHRO-MESH)

Model Number	2SMR53
Number of Plates	9
20 Hr. Rating	53
Separators	Microporous rubber
Case	Hard rubber

BATTERY (HEAVY DUTY)

Model Number	3SMR 72
Number of Plates	11
20 Hr. Rating	72
Separators	Microporous rubber
Case	Hard rubber

LAMP SPECIFICATIONS (12 VOLT)

STANDARD EQUIPMENT	Bulb Number	Candle Power
Bright Lights Indicator	57	2
Dome-Convertible	90	6
Dome-Exc. Convertible	1004	15
Headlamp Unit	Sealed Beam	40W 50W
Ignition Key	53	1
Instruments	57	2
License	67	4
Parking and Direction Signal	1034	4-32
Rear Quarter (Cust. Cat.)	90	6
Tail and Stop	1034	4-32
Direction Signal Indicator	57	2

SPECIAL EQUIPMENT	Bulb Number	Candle Power
Air Conditioning Control	57	2
Ash Tray	53	1
Back Up	1073	32
Clock	57	2
Compass	53	1
Courtesy (Entrance)	89	6
Glove Compartment	57	2
Hand Brake Warning	57	2
Heater Control	57	2
Front Fender Ornament	53	1
Hydra-Matic Indicator	57	2
Luggage Compartment	1003	15
Portable Spot Lamp	4416	30W
Radio Dial	57	2
Safety Lamp (Spotlamp)	Sealed Beam	30W
Underhood	93	15

FUSE AND CIRCUIT BREAKER DATA

STANDARD EQUIPMENT	
Direction Signal	7.5 Amp.
Dome Light and Stop Light	7.5 Amp.
Tail Lamp	7.5 Amp.
Lighting Switch Rheostat	4 Amp.

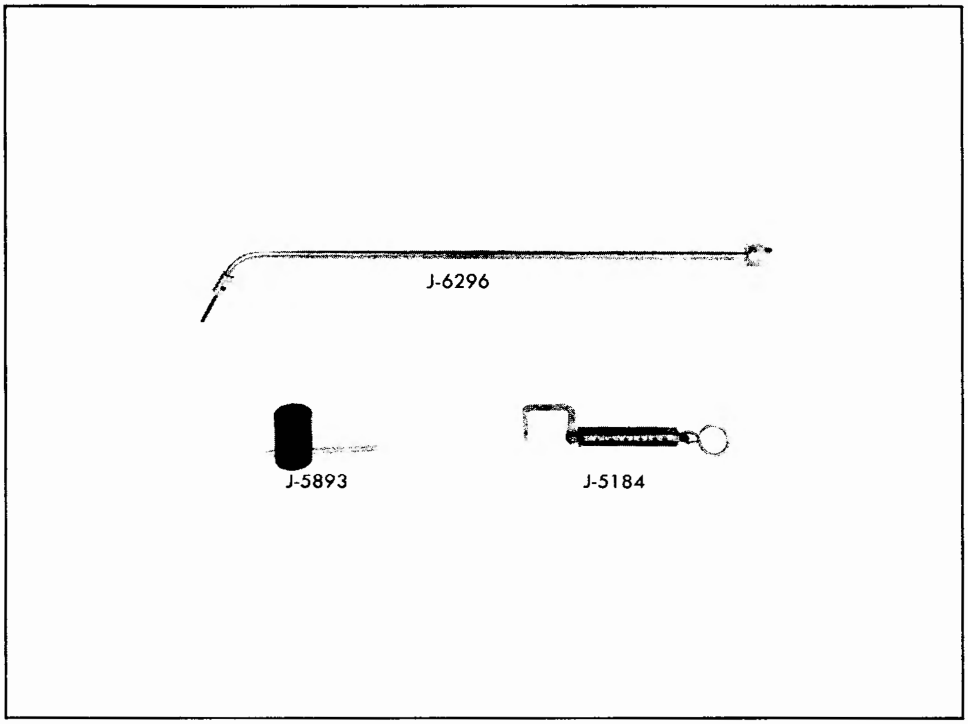
SPECIAL EQUIPMENT	
Air Conditioning	30 Amp.
Electric Antenna	14 Amp.
Electric Clock	7.5 Amp.
Ash Tray	7.5 Amp.
Back-Up Light	7.5 Amp.
Courtesy (Entrance)	7.5 Amp.

SPECIAL EQUIPMENT FUSES (CONT.)

Glove Compartment	7.5 Amp.
Hand Brake Warning	7.5 Amp.
Heater Control	7.5 Amp.
Front Fender Ornament	7.5 Amp.
Luggage Compartment	7.5 Amp.
Safety Lamp (Spot Lamp)	7.5 Amp.
Under Hood	7.5 Amp.
Cigar Lighter (Casco)	Special
Electric Windshield Wiper	30 Amp.

CIRCUIT BREAKERS

Cigar Lighter (Rochester)	Reset Type
Power Seats and Power Windows	40 Amp.



SPECIAL TOOLS

J-5184	Armature Brush Tension Checking Scale
J-5893	Ignition Switch Spanner Wrench
J-6296	Distributor Point Adjusting Tool