Generator

General

The generator supplies power to the electrical system and keeps the battery charged. It is driven by a V-belt from the crankshaft. Its output which varies with load and change in speed is governed by a voltage and current regulator.

Operation

The voltage of the DC shunt wound generator is held nearly constant despite changes in engine speed and electrical load by an electro-magnetic vibrating regulator which also prevents overcharging the battery. A cut-out relay automatically prevents the back flow of current and subsequent discharge of the battery when the engine is stopped.

In order to prevent generator damage from overload when the battery is discharged and accessories are in use, a system of regulators is used.

Regulator

The regulator system is composed of a voltage and current regulator which protects the generator from excessive current while keeping the voltage nearly constant up to the maximum load, at which point the voltage drops sharply. This system employs the generator more efficiently and charges the battery more quickly.

Generator construction

The main assemblies are:

housing, pole shoes, field coil,

armature winding and commutator,

brushes and brush holders,

armature bearing and end frames,

and the regulator.

The housing is a magnetically permeable steel walled cylinder inside which the pole shoes and field coils are attached with counter sunk screws.

The field coils, consisting of many turns of insulated copper wire, are wound around the two pole shoes and are connected in series.

The armature, an iron core in which the armature windings are imbedded and on which the commutator is located, turns between the two pole shoes. The current induced in the armature windings is taken from the commutator by the brushes.

The iron core is made of numerous stamped sheet metal laminations whose surfaces are insulated to reduce eddy currents. The armature coils, consisting of insulated copper wire, are placed in the grooves of the armature and are secured against centrifugal forces. This system of coils is called the armature winding and consists of as many coils as there are commutator sections. The end of each coil is soldered to a commutator section to provide a path to the brushes where the generator power is collected.

The commutator consists of copper sections which are insulated from each other and from the armature shaft. To prevent the carbon brushes from coming into contact with the insulation between sections after prolonged use, the insulation is trimmed back below the commutator surface.

The carbon brushes are held by spring pressure against the commutator from which they collect the current induced in the armature coils. The brushes are laterally secured by box channels in which they can move up and down.

The armature is supported by ball bearings which are held in the end frames that cover both ends of the generator. A band around one end of the generator housing covers openings through which the commutator and brushes can be inspected.

Bearings are only lubricated in conjunction with a general overhaul. Never use chassis grease.

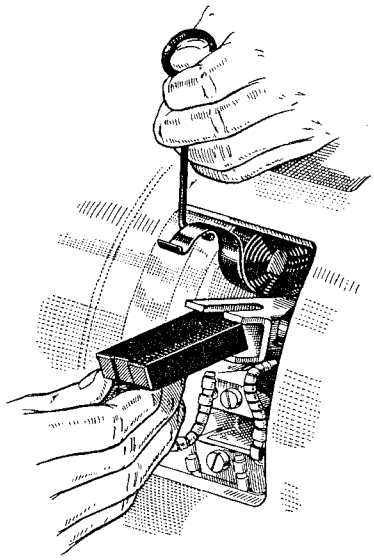


Fig. 4

Maintenance

The ball bearings of the generator are lubricated with heat resistant grease and require no attention under normal conditions.

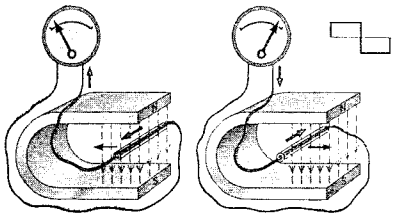
The brushes should be inspected every 6000 miles (10,000 km). Worn brushes should be replaced to prevent commutator damage.

Never oil brushes.

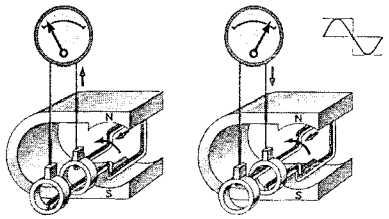
Bosch Generator

Principles of Operation

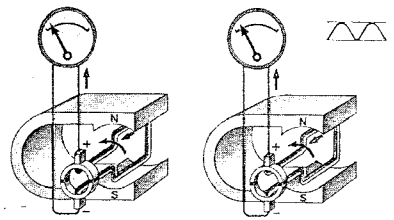
Parallel movement of Conductor in a magnetic field



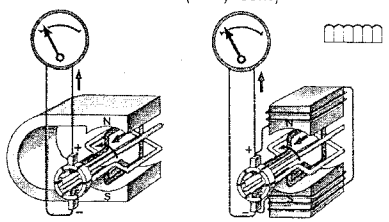
Rotating Coil in a magnetic field Alternating Current

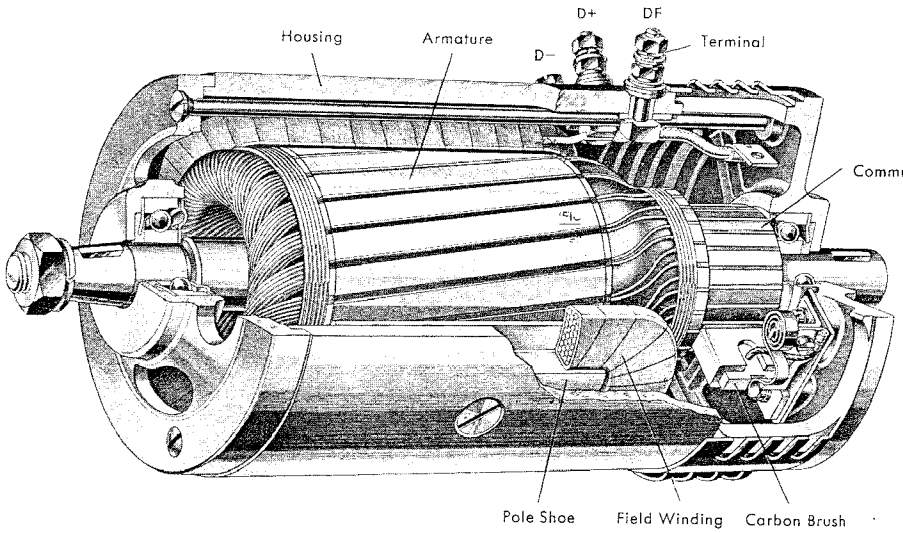


Rectified Current

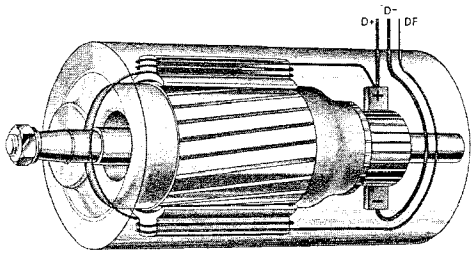


Direct Current (many Coils)

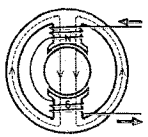




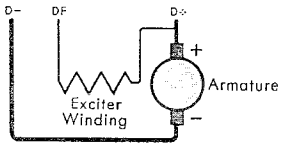
To Regulator



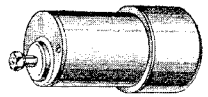
Two-pole Electromagnet



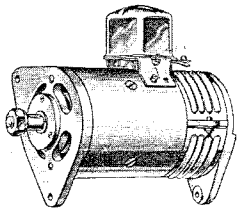
To Regulator



Generator with built-in Regulator



Generator with mounted Regulator



Generator with separate Regulator

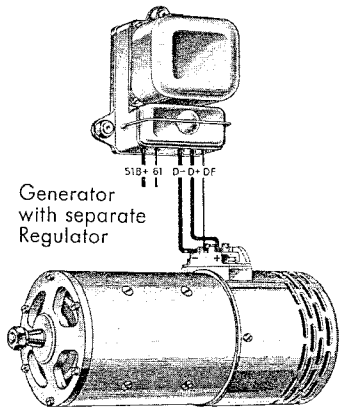
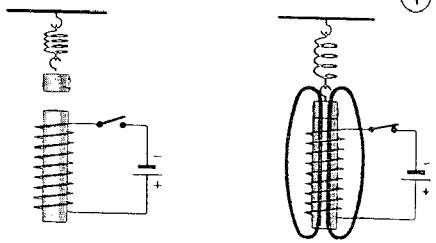


Fig. 5

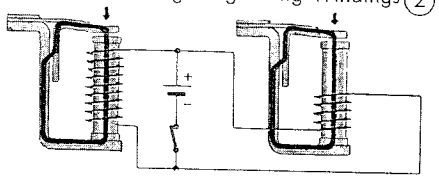
Bosch Regulator

Type RS/UA (with separate Current Regulator)

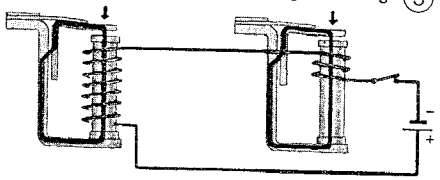
Action of Electromagnet ①



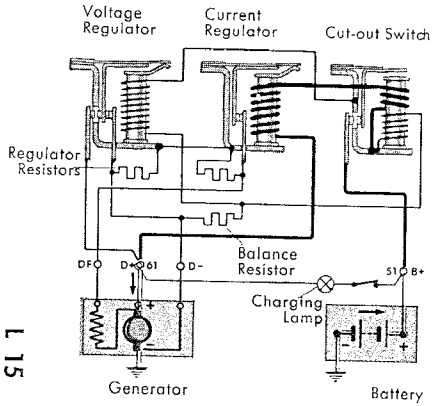
Action of the Voltage Regulating Windings ②

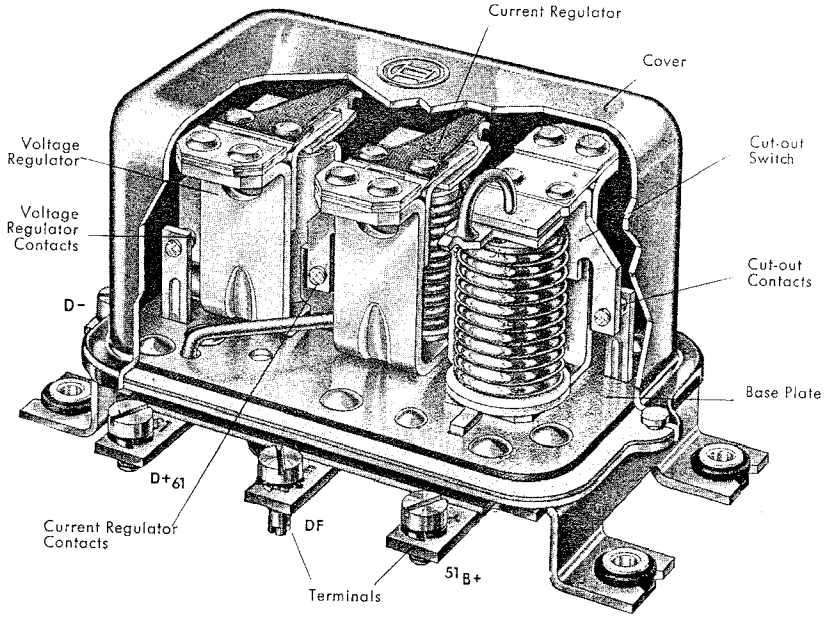


Action of the Current Regulating Windings ③

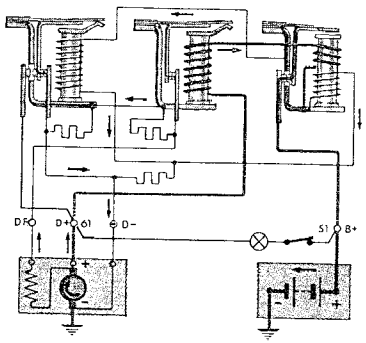


Generator at Rest ④

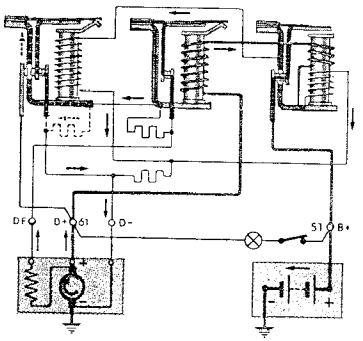




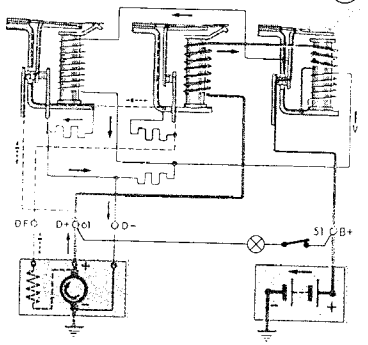
Close Cut-out Contacts ⑤



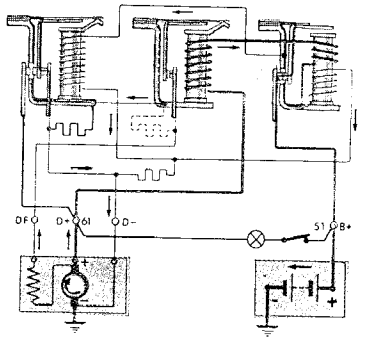
Voltage Regulation: Lower Contacts operating ⑥



Voltage Regulation: Upper Contacts Operating ⑦



Current Regulation: Current Regulator Contacts Operating ⑧



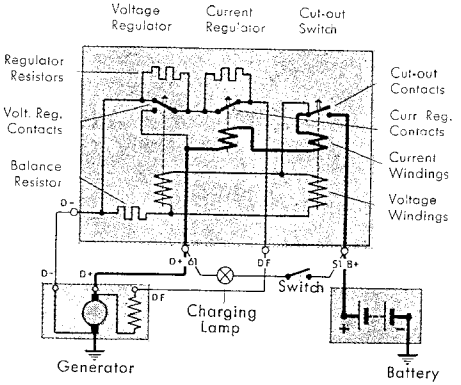


Fig. 6

Replacing Generator Indicator Bulb

1 LI

General

A generator voltage light (red) connected through the ignition switch to terminals 51 and 61 of the regulator, lights when the ignition is on. It remains lit as long as the engine is running slowly and goes out when the generator voltage exceeds the battery voltage. The lamp also provides a warning signal in case of V-belt failure and consequent stopping of the generator and cooling blower.

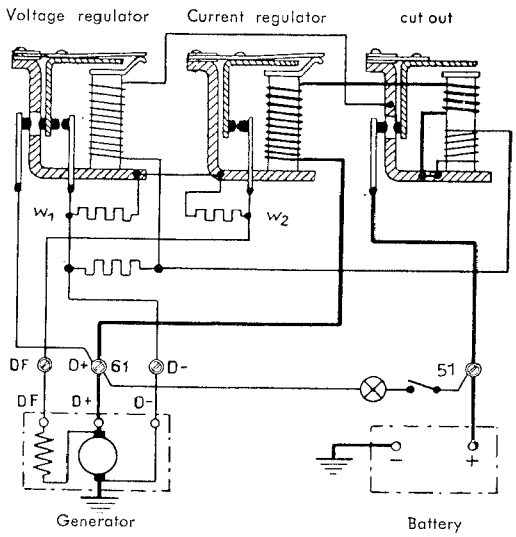


Fig. 7

Bulb Replacement

1. Pull out socket and bulb.
2. Push in, turn to the left, and pull the bulb from the socket.
3. Install new bulb in reverse manner.

Note:

For testing electrical circuits a tester with the following instruments is required:

1. Voltmeter 0 to 15 volt range.
2. Ammeter 10 to 0 to 60 amp. range and 100 to 600 range (shunt).
3. Variable resistor 0 to 5 Ohm, 300 watt rating.

Testing Current

2 LI

Warning

When performing this test do not start the engine until the ammeter is set on the 600 amp. capacity and properly connected with heavy leads.

1. Disconnect the ground strap from the battery terminal, connect the negative lead of the ammeter to the battery and the positive lead to the ground strap (series connection).
2. With all accessories switched off the ammeter should read zero. Any current reading indicates leakage in the circuit of the car to ground which must be found and repaired.
3. Switch on ignition. Ammeter should show not more than 3 amp. (with breaker points closed), going through the coil, generator and oil pressure light. A greater reading indicates faulty ignition or ignition switch.

Note:

All accessories can be tested similarly by switching them on individually. Their permissible currents are given by dividing their wattage by the circuit voltage (6 V). The total current through all accessories should not exceed the generator current rating.

3 LI

Testing Generator and No-Load Voltage

Note:

Although the generator indicator lamp may go out with increased engine speed, it is not certain that the battery is being charged adequately. If the wiring is in good condition (see 2 LI) indications of improper charging may be: weak starting effort, dim headlights when starting, or frequent battery water loss caused by excessive charging rates. The cause may be found through simple preliminary tests without removing the generator or regulator cover.

Before making any tests check the condition and tension of the V-belt.

Test:

1. Switch on ignition. Generator indicator lamp on the instrument panel must light. Disconnect generator lead from terminal "61 D+" at regulator. Lamp should go out. If the lamp does not go out the generator lead is grounded and must be repaired. Reconnect generator lead to terminal "61 D+".

2. Disconnect battery lead from terminal "51 B+" at the regulator and insulate end with tape. Connect the positive lead of the voltmeter to terminal "61 D+" and the negative lead to ground on the regulator base plate (Fig. 8).

3. Start the engine and increase speed gradually to the nominal voltage rpm (see page L 85). The voltmeter should indicate 6 V. If no reading is obtained the generator is not charging and must be overhauled.

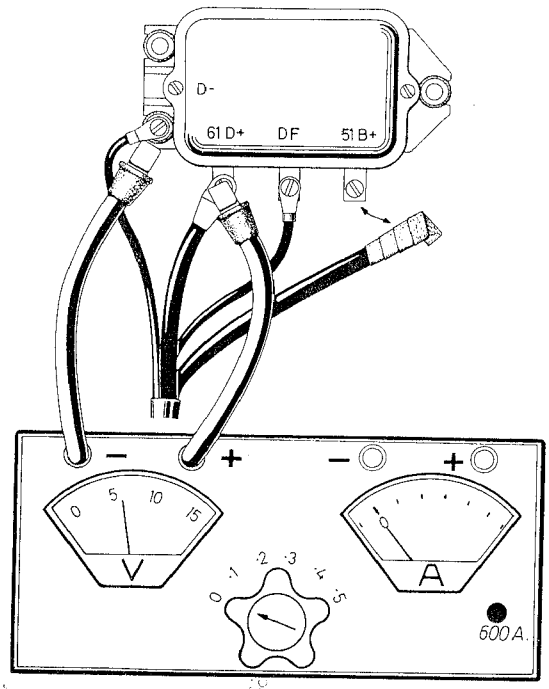


Fig. 8

If a replacement regulator is to be used for a quick check, it is important to check the field winding of the generator first to prevent damaging the regulator.

To test field windings (regulator fully connected) connect an ammeter to terminals "51 B+" and "DF" of the regulator. A reading considerably greater than 5 amp. indicates a short in the field windings or a short to ground.

Testing Voltage

4 LI

Note:

The regulator cover must remain on during the tests since the regulator elements are temperature sensitive.

a) **Regulator voltage under no load**

1. Connect leads as in Fig. 8.

2. Start engine and increase generator speed to 3500–4000 rpm, at which time the voltmeter should register the correct no-load voltage.

b) **Regulator voltage under load**

1. Connect leads as in Fig. 8 and connect ammeter to terminal "51 B+" and ground as in Fig. 9.

2. Start engine and increase speed to generator test rpm and hold constant. Increase resistance load until the ammeter indicates the correct test current. At this setting the voltmeter must indicate at least 6 volts for a generator in good working order. If the generator has become warm during the test an increase of 100 rpm is permissible to obtain rated output.

3. If the generator fails to produce current during this test the generator must be removed and checked for internal shorts in the armature and field windings. If the current does not reach the required values the regulator is at fault and must be adjusted by an auto electric shop or be replaced.

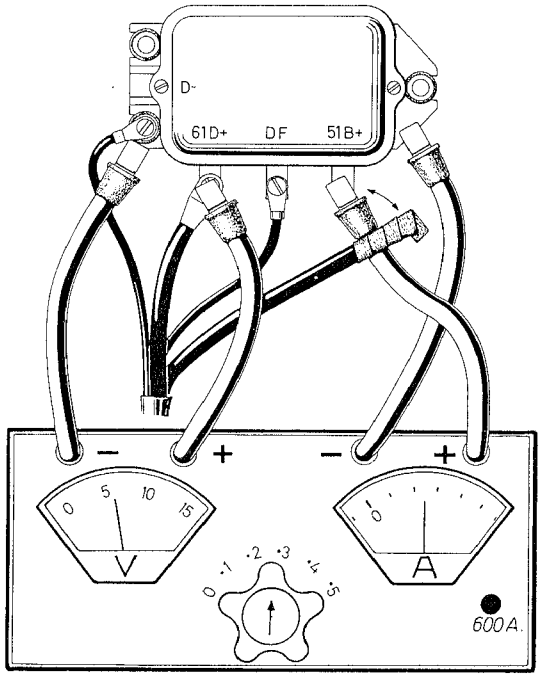


Fig. 9

c) **Current Regulator Test**

1. Connection as in Fig. 9, generator running at test rpm.

2. Gradually reduce the circuit resistance at the variable resistance, the reading on the ammeter will increase correspondingly until the current regulator starts to operate. Further reduction in the resistance will cause the voltage to fall sharply without affecting the current reading. For maximum permissible current values see page L 85.

3. If the current does not remain within the prescribed limits the regulator must be adjusted by an auto electric shop or be replaced.

5 LI

Testing Regulator Cut-Out Switch

Note:

Before making this test the battery must be in good condition and at least half-charged (Specific gravity 1.230).

a) **Cut-Out Closing**

1. Connections as for previous test. If necessary reset variable resistor to nominal output and check setting with ammeter as in 4 LI, Fig. 9.
2. Start engine and slowly increase speed. Voltage should increase but no current should flow, indicating that the cut-out switch is open. When the cut-out switch closes, the indicated voltage drops slightly and the ammeter begins to register. Leave the engine running at idle speed. The maximum voltmeter reading before the hand jumps back indicates the closing voltage. The value should be within the limits shown on page L 85. If it does not, the cut-out switch should be adjusted.

b) **Cut-Out Opening**

1. Set regulator to zero. Connect battery lead "51 B+" (insulated until now) to negative lead of ammeter. Connect positive lead of ammeter to terminal "B 51+" of the regulator (Fig. 10).
2. Increase engine speed until ammeter shows a charging current. Gradually reduce engine speed; the ammeter will pass the zero mark and indicate a negative reading before finally returning to zero. The maximum reading of the ammeter shows the opening current required to disconnect the battery from the generator. This value should lie in the range specified on page L 85. If the contacts open while ammeter shows a positive reading, the relay windings are shorted and the regulator must be replaced. The engine idle speed should preferably be set so that the ammeter rests on zero at normal engine temperatures. The ammeter must in any event indicate zero before the engine finally stops. If this does not occur the cut out switch must be adjusted by an auto electric shop or be replaced (sticking contacts).

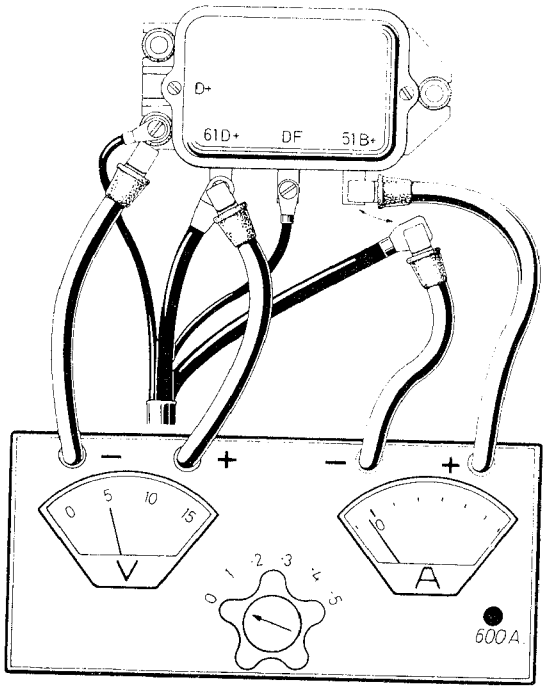


Fig. 10

6 LI

Removing and Installing Regulator

Removal

1. Disconnect all cables from regulator.
2. Remove mounting screws and remove regulator.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. When replacing a regulator, first check that the field coils of the generator are not grounded.
2. Connect cables according to wiring diagram on regulator box.
3. Polarize generator (see 8 LI Note).
4. If incorrect readings are again obtained after installing a new regulator, the generator or the wiring may be at fault and an auto electric specialist should be consulted.

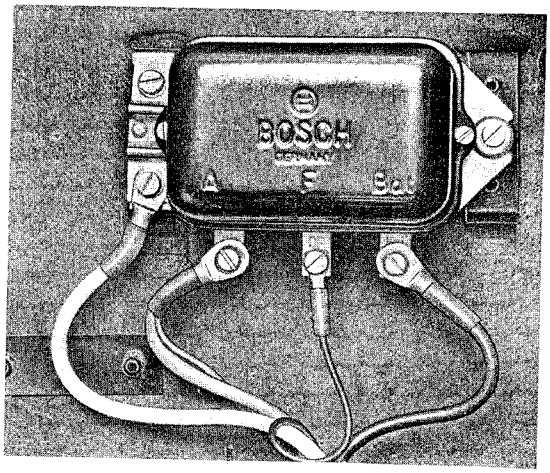


Fig. 11

Checking Brushes and Commutator

7 LI

1. Remove generator cover band.
2. Examine brushes for wear and insure that brushes move freely in their guides. Oil soaked brushes must be replaced by new ones of the same type and size.
   When installing new brushes, adjust the contact faces to the curvature of the commutator by placing a strip of emery paper (not emery cloth) 00 grade between the installed brush and commutator. Remove the emery paper when it has made full contact with the brush and blow away the carbon dust.
3. A dirty or oily commutator can be cleaned using a clean solvent soaked rag or a stick. Care must be exercised to prevent dirt from entering the bearing.
4. Test brush spring tension (Page L 85). Replace weak springs.
5. If the commutator surface is rough or worn the generator should be removed and overhauled.

Note:

Remove all solvent and allow parts to dry completely before operating the generator to prevent a possible fire.

Removing and Installing Generator

8 LI

Removal

1. Disconnect generator leads.
2. Remove V-Belt (remove outer pulley half).
3. Remove generator mounting strap.

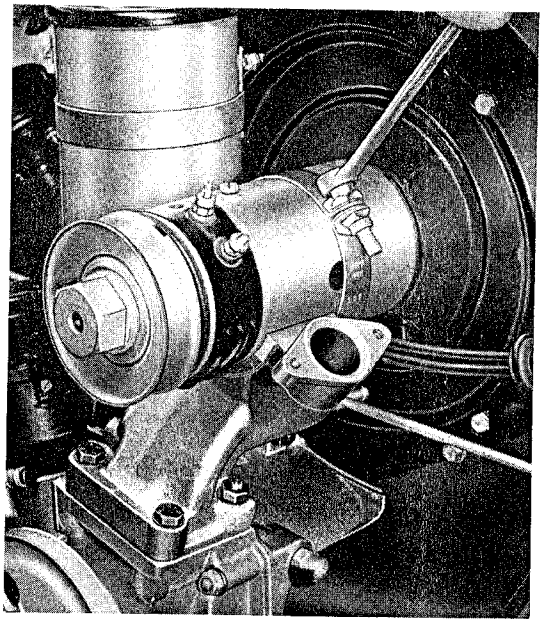


Fig. 12

4. Remove the two cap screws and two nuts at the base of the generator bracket.
5. Remove the four screws on the face of the fan housing cover and remove the generator.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Inspect the paper gasket and install a new gasket if necessary.
2. Connect cables according to the wiring diagram.

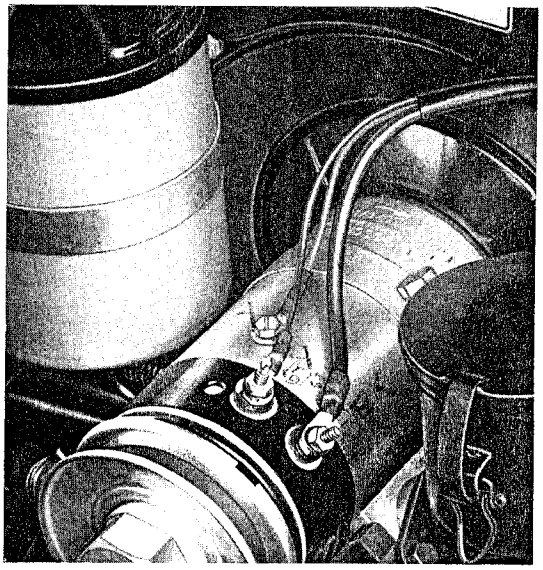


Fig. 13

Note:

Before installing the V-belt polarize the generator in order to prevent damage to the regulator and to insure proper charging. For this purpose connect the heavy red battery cable to terminal "61 D+" of the regulator. The generator should now run as a motor in the direction of engine rotation.

9 LI

Disassembling and Assembling Generator

Disassembly

1. Remove V-belt pulley and blower.
2. Disconnect field coil terminal from brush holder of positive brush.
3. Remove nuts from generator through bolts.
4. Disassemble generator and remove armature.
5. Remove ball bearing. After disassembling the generator thoroughly wash all components with clean solvent and dry with compressed air.

Assembly

The assembly is accomplished in the reverse order of disassembly observing the following points:

1. Test armature, field coils, cable connections and brushes.
2. Examine ball bearings for wear and damage. Replace if necessary. Rinse bearings in clean solvent and lubricate with high temperature grease.
3. Check end play: Too little play may cause bearing damage while too much play will permit the armature to touch the field coils.
4. Insure that cables are correctly connected to brush holders.

10 LI

Testing Armature

Armature failures cannot be found through visual inspection in most cases. The armature must therefore be tested for open circuits, short circuits, and internal ground.

Testing:

1. Open circuits in the armature usually cause arcing between segments and are therefore easily visible. Open circuits may also be found by using a potentiometer which, however, is not always available.
2. A short in the armature windings can only be tested using a growler (A.C.-Test magnet). Place the armature on the growler and turn the armature slowly, holding a thin steel strip or hacksaw blade over the core segments. Short circuits in the armature cause the hacksaw blade to vibrate against the core when held above the slot containing the short. A similar device uses a feeler containing a coil instead of a hacksaw blade. The feeler coil is connected to ear phones which make a growling noise due to the alternating current induced in the feeler coil by the short circuit (Fig. 15).

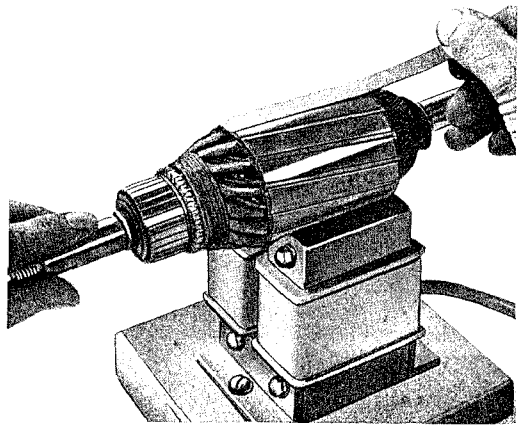


Fig. 14

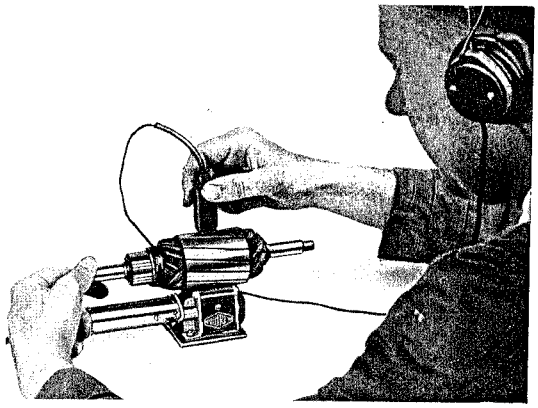


Fig. 15

3. An internal ground occurs when the armature core makes contact with the windings or when carbon dust enters the windings. The test is made using a 40 volt source and 40 volt test lamp holding the test prods on the commutator and armature core. The test lamp should not light.

4. If the commutator is out of round, burned, or scored, it should be turned and reconditioned. Such damage can only be properly corrected by turning and polishing.

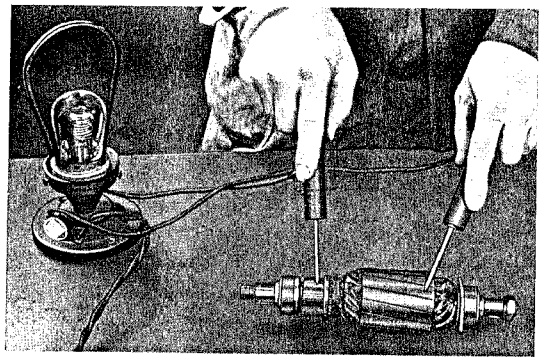


Fig. 16

The insulation between the segments should be cut down 0.3 to 0.5 mm (.012 to .020 in.) below commutator surface using a commutator saw.

Testing Field Coils

11 LI

Test field coils for open circuits, short circuits, and grounds.

1. Test each field coil separately for open circuits by connecting the coil in series with a 6 volt test lamp and a 6 volt battery. If the test lamp does not light the field coil is faulty.

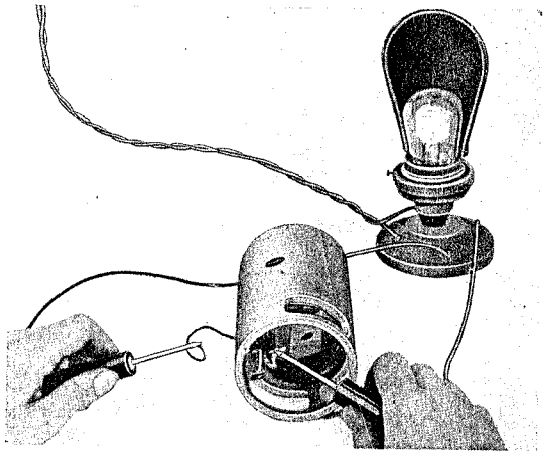


Fig. 17

2. Test each field coil for short circuity by connecting an ohmmeter to the ends of the coil and comparing the readings to the standard values (page 85). If an ohmmeter is not available, an ammeter and 6 volt battery may be connected in series to each coil to compare the current flow. If the current flow of the coils differs by more than 5 amp. the coil with the higher reading is faulty.
3. Test for grounds while field coils are installed in the generator housing by connecting a 40 volt test lamp (using 40 volt source) connecting one prod to the field winding connector and the other to the generator housing. The lamp should not light.

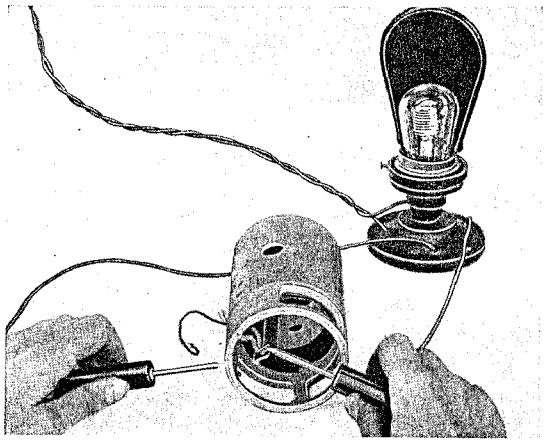


Fig. 18

4. Test the assembled field coils for continuity and solid connections in the housing (use 6 volt test lamp).

Service Diagnosis

The red generator indicator lamp lights when the ignition is switched on and should go out when the engine has been started and the speed increases.

Trouble	Cause	Repair
Generator indicator lamp does not light with ignition switched on	a. Battery discharged	a. Charge battery
	b. Battery defective	b. Replace battery
	c. Bulb burned out	c. Replace bulb
	d. Corroded or loose battery terminals	d. Clean or tighten terminals
	e. Loose connections or broken cables	e. Tighten or replace cables
	f. Ignition switch defective	f. Replace ignition switch
	g. Generator brushes do not make contact with commutator	g. Reseat brushes, or replace, or replace tension springs Do not oil brushes!
Generator lamp does not go out with increased engine speed or flashes intermittently	a. V-belt loose or faulty	a. Adjust belt tension or replace belt
	b. Regulator defective	b. Replace regulator
	c. Charging cables loose or broken (open circuit)	c. Check cables and connections
	d. Generator defective	d. Check generator
Generator lamp goes out only at high r.p.m.	a. Generator defective	a. Check generator
	b. Regulator defective (improperly set)	b. Reset or replace regulator
Generator lamp continues to light with the ignition switched off	a. Regulator contact points sticking (burned)	a. Replace regulator