

Section 3

**ELECTRICAL SYSTEM
AND
INSTRUMENTS**

INDEX

| | | | |
|---|------|--|------|
| Group 30. General | 3:1 | Group 35. Lights | |
| Group 31. Battery | | General Information | 3:46 |
| General Information | 3:1 | Service Procedures | |
| Service Procedures | 3:1 | Headlights | 3:46 |
| Group 32. Alternator S.E.V.-Marshall 35A | | Tail Lights | 3:48 |
| General Information | 3:2 | License Plate Light, Parking Lights, Side | |
| Service Procedures | 3:3 | Marker Lights | 3:49 |
| Voltage Regulator (S.E.V.-Marshall) | 3:8 | Group 36. Other Electrical Standard Equipment | |
| Testing Alternator and Voltage Regulator .. | 3:9 | General Information | |
| Service Diagnosis | 3:11 | Ignition Switch | 3:50 |
| Alternator S.E.V.-Marshall 55A | | Horns, Fuses, Windshield Wiper | 3:51 |
| General Information | 3:13 | Tail Gate Window Wiper (145), Switches | 3:52 |
| Service Procedures | 3:14 | Tail Gate Window Washer (145) | 3:53 |
| Voltage Regulator (S.E.V.-Marshall) | 3:19 | Seat/Ignition Interlock System | 3:54 |
| Testing Alternator and Voltage Regulator .. | 3:20 | Bulb Integrity Sensor | 3:55 |
| Service Diagnosis | 3:22 | Service Procedures | |
| Alternator Bosch 35A | | Switches for Turn Signal and Windshield | |
| General Information | 3:29 | Wipers | 3:56 |
| Service Procedures | 3:29 | Horn Contact Bar | 3:57 |
| Voltage Regulator | 3:29 | Wipers | 3:57 |
| Testing | 3:30 | Tail Gate Window Wiper (145) | 3:60 |
| Service Diagnosis | 3:32 | Switches | 3:62 |
| Group 33. Starter Motor | | Bulb Integrity Sensor, Interlock Control | |
| Tools | 3:33 | Unit | 3:63 |
| General Information | 3:33 | Group 38. Instruments | |
| Service Procedures | 3:34 | General Information | 3:67 |
| Group 34. Ignition System | | Speedometer, Odometer, Tachometer | 3:68 |
| Tools | 3:40 | Gauges | 3:68 |
| General Information | | Voltage Stabilizer, Warning Lights, Control | |
| Ignition Coil | 3:40 | Lights | 3:70 |
| Distributor | 3:41 | Service Procedures | |
| Service Procedures | | Combined Instrument | 3:71 |
| Distributor | 3:42 | Warning Lights, Tachometer, Speedo- | |
| Ignition Timing | 3:45 | meter, Gauges, Sensors and Senders | 3:72 |
| Group 35. Lights | | Testing Speedometer, Temperature Gauge, | |
| General Information | 3:46 | Fuel Gauge Sender, Voltage Stabilizer .. | 3:73 |
| Service Procedures | | Wiring Diagrams | |
| Headlights | 3:46 | | |
| Tail Lights | 3:48 | | |
| License Plate Light, Parking Lights, Side | | | |
| Marker Lights | 3:49 | | |

GROUP 30

GENERAL

The electrical system is designed for 12 V. The equipment is made up of the following main parts: Battery, alternator and voltage regulator, starter,

ignition system, lighting, other electrical standard equipment and instruments.

GROUP 31

BATTERY

GENERAL INFORMATION

(Replace Battery=Volvo Standard Times Op. No. 31115)

The battery, Fig 3-1, is placed on a shelf to the left of the radiator. It is a 12 V lead battery with a capacity of 60 ampèrehours and negative ground.

SERVICE PROCEDURES

REMOVAL

1. Remove the cable terminals on the battery terminal studs. Use a puller if the cable terminals are stuck to the terminal studs.
2. Remove the securing bar and lift up the battery.
3. Clean the battery with a brush and rinse it down with clean, lukewarm water.
4. Clean the battery shelf and the cable terminals. Use a special steel brush or pliers for the cable terminals.

INSTALLATION

1. Place the battery in position.
2. Re-install the securing bar and secure the battery.
3. Tighten the cable terminals to the battery terminal studs. Coat the cable terminals and battery studs with vaseline.

SERVICE

If the battery is to function satisfactorily, the acid must be maintained at the specified level above the

plates. Ensure that the acid level is about 5 mm (3/16") above the plates. If the level is too low, fill with distilled water to the extent necessary. Also make sure that the battery is securely fixed and that the cable terminals are well tightened.

The cable terminals and battery terminal studs should be coated with a light layer of vaseline to prevent oxidation.

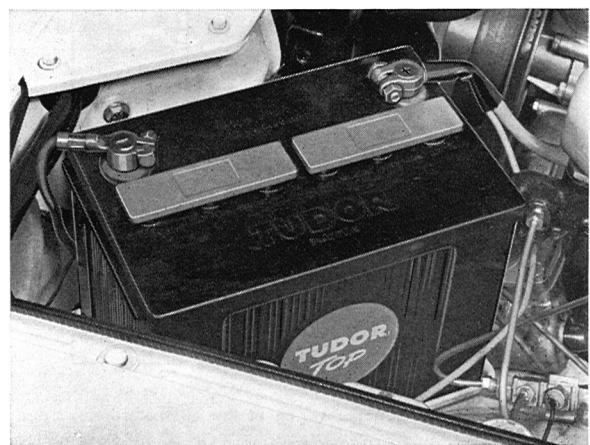


Fig. 3-1. Battery

VOLVO
105211

GROUP 32

ALTERNATOR

S.E.V. MARSHALL 14 V — 71270202

GENERAL INFORMATION

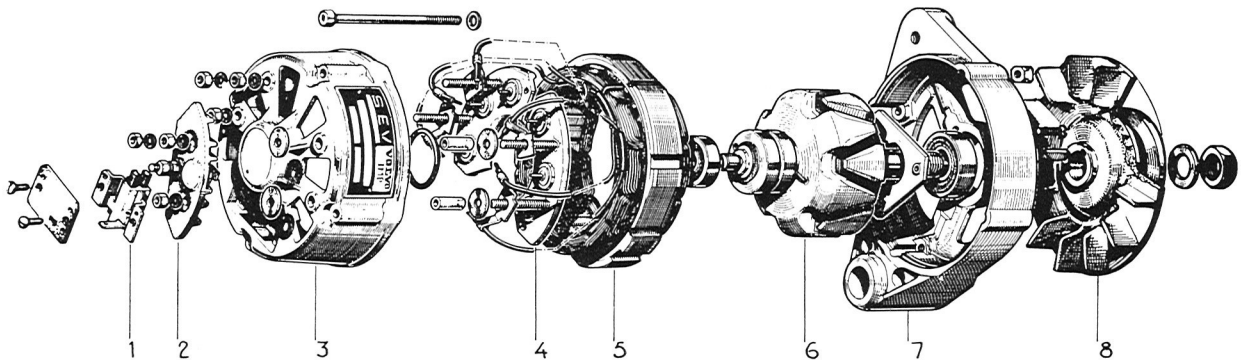


Fig. 3-2. S.E.V. Marshall alternator disassembled

- | | | |
|---------------------------------|-------------------------------|---------------------|
| 1. Brush holder | 3. Slip ring end shield | 6. Rotor |
| 2. Insulation diode with holder | 4. Rectifier (silicon diodes) | 7. Drive end shield |
| | 5. Stator | 8. Pulley with fan |

VOLVO
103 000

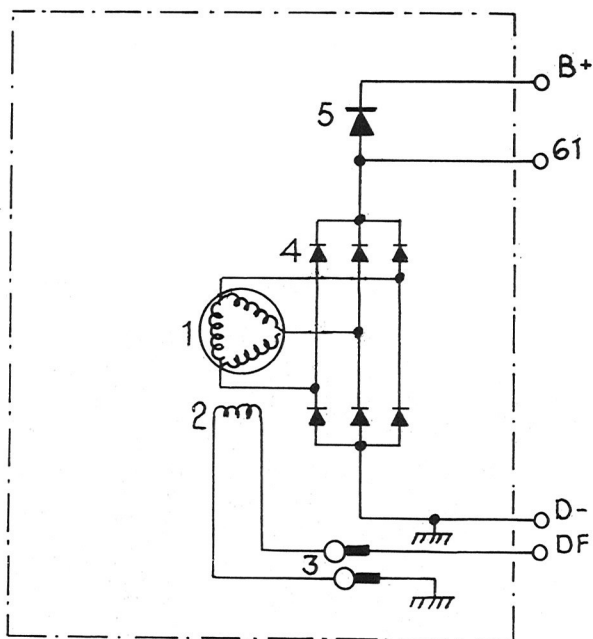


Fig. 3-3. Inner wiring of the alternator

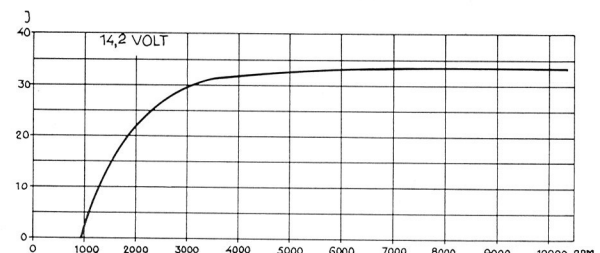
- | | |
|--------------------------------|---------------------|
| 1. Stator | 4. Rectifier diodes |
| 2. Rotor (field winding) | 5. Insulation diode |
| 3. Slip rings and brush holder | |

VOLVO
103 170

(Replace alternator=Volvo Standard Times Op. No. 32102)

The alternator is a three-phase, delta-connected alternating unit which is belt-driven from a pulley on the crankshaft.

The alternator has a built-in rectifier in the slip ring end shield. This rectifier consists of six silicon diodes. The rotor is a claw-pole type with the field winding fed across two slip rings. The rotor is designed to permit a maximum alternator speed of 250 r/s (15000 r/m).



VOLVO
103 002

Fig. 3-4. Output curve for alternator

The insulation diode (2, Fig. 3-2) placed on the outside of the alternator has two functions: it acts as an extra cut-out current protection for the alternator should any of the six rectifiers stop functioning; and it makes simple connection of the warning charging lamp possible.

The alternator is self-limiting (max. 35 amps) and for this reason a simple voltage regulator can be used with only voltage control.

SERVICE PROCEDURES

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or installing battery, make sure that the new battery is connected with the correct polarity.
2. Never run the alternator with the main circuit broken. Battery and/or alternator and regulator leads must never be disconnected while the engine is running.
3. No attempt should be made to polarize the alternator since this is not necessary.
4. When charging the battery while installed in the vehicle, the ground cable should be disconnected.
5. A fast charger should not be used as a starting aid.
6. When using an extra battery as a starting aid, always connect it in parallel.
7. When carrying out any electric welding on the vehicle, disconnect the negative battery lead as well as all the alternator leads. The welding unit should always be connected as near as

possible to where the welding is to be carried out.

ALTERNATOR REMOVAL

Re-build alternator=Volvo Standard Times Op. No. 32104

1. Disconnect the battery ground cable.
2. Disconnect the leads to the alternator.
3. Remove the bolt for the adjustment arm.
4. Remove the bolt holding the alternator to the engine block.
5. Remove the fan belt and lift the alternator forwards.

ALTERNATOR DISASSEMBLY

1. Release the two screws holding the brush holder and remove the insulation plate. Pull out the brush holder.
2. Fix the pulley with belt in a vise with soft jaws, see Fig. 3-6.

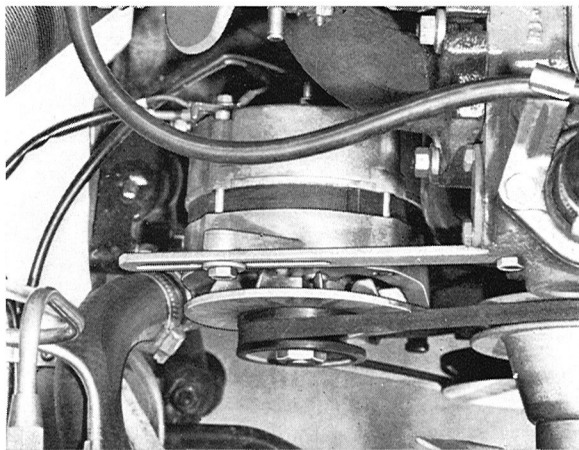


Fig. 3-5. Alternator

VOLVO
103194

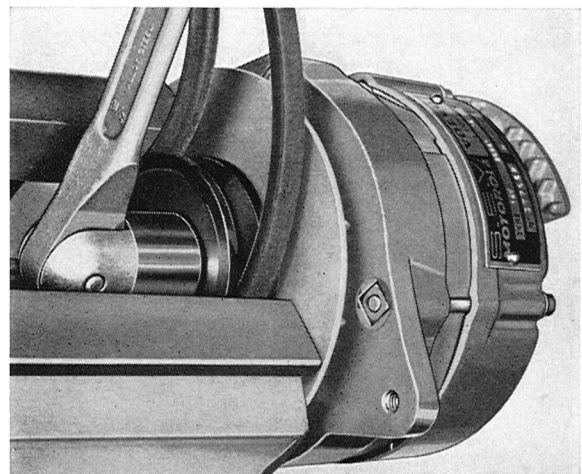
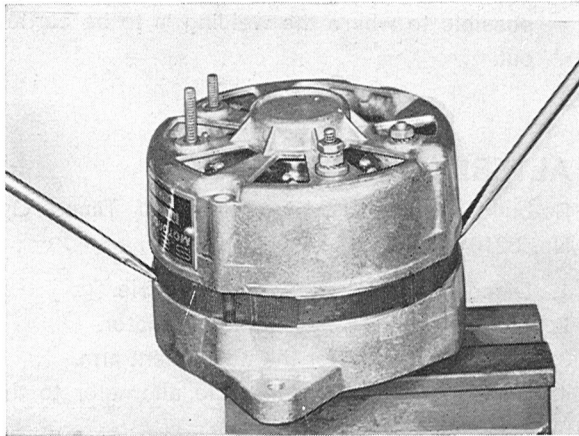


Fig. 3-6. Pulley nut removal

VOLVO
103007

3. Remove nut and washer. Lift off pulley, fan, key and spacer washer.
4. Remove nuts and washers on terminal 61 and the corresponding on the other side of the insulation diode. Lift off the insulation diode holder.
5. Mark drive end shield, stator and slip ring end shield to avoid confusion when assembling. Remove the four attaching screws.
6. Remove rotor and drive end shield with two screwdrivers, which are inserted in two of the slots between stator and drive end shield, see Fig. 3-7.

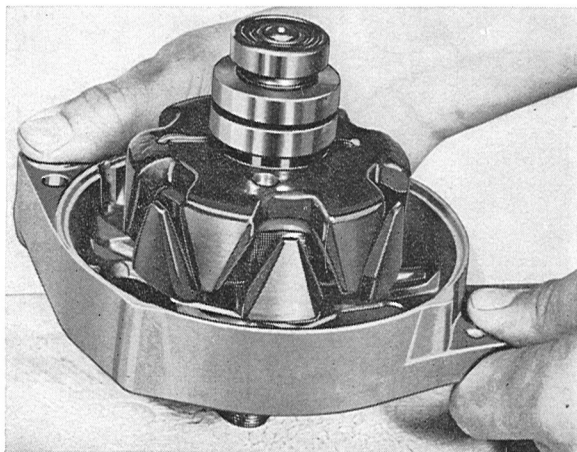


VOLVO
103 009

Fig. 3-7. Alternator disassembly

NOTE. The screwdrivers must not be inserted deeper than 2 mm (just over 1/16"), otherwise the stator may be damaged.

7. Release the three screws holding the support plate of the drive end bearing. Release the bearing by knocking the end of the shaft against a piece of wood, see Fig. 3-8.



VOLVO
103 010

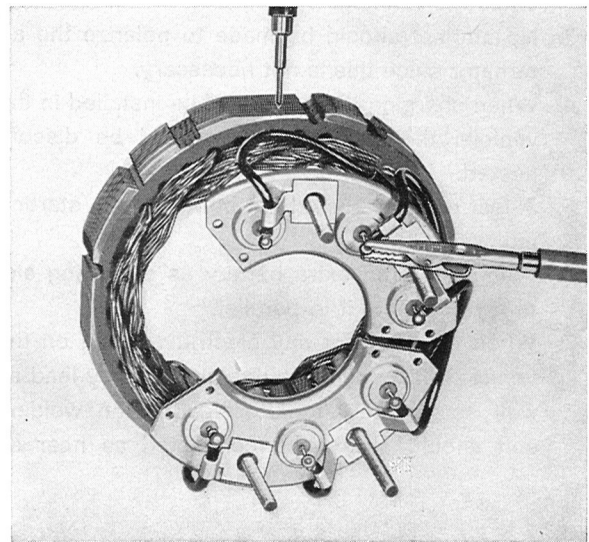
Fig. 3-8. Drive end shield removal

8. Remove nuts and washers for the diode holder for the negative diodes.
9. Remove stator and diode holders for the slip ring end shield.

CHECKING DISASSEMBLED ALTERNATOR

STATOR

Check the stator for short circuits. If one or several of the coils are burned, there must be a short-circuit in the stator. Connect a test lamp (12 V, 2-5 W) between the stator plates and a terminal on the stator, see Fig. 3-9.

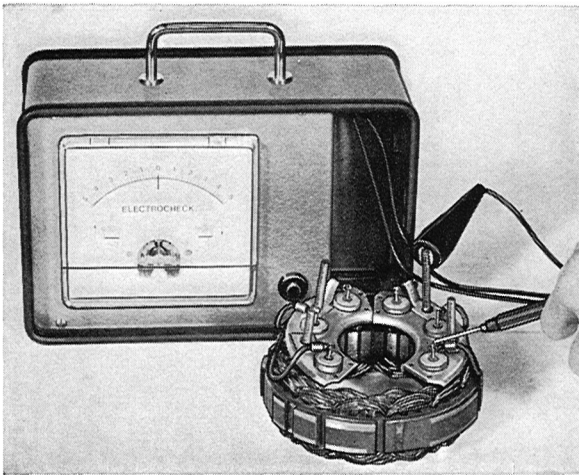


VOLVO
103 011

Fig. 3-9. Stator test

If the lamp lights, the insulation between the stator winding and the stator plates must be burned out, in which case the stator should be replaced.

NOTE: Only a 12 V, 2—5 W test lamp may be used; 110 or 220 V, D.C. or A.C. lamps must NOT be used. This applies to all the alternator components.

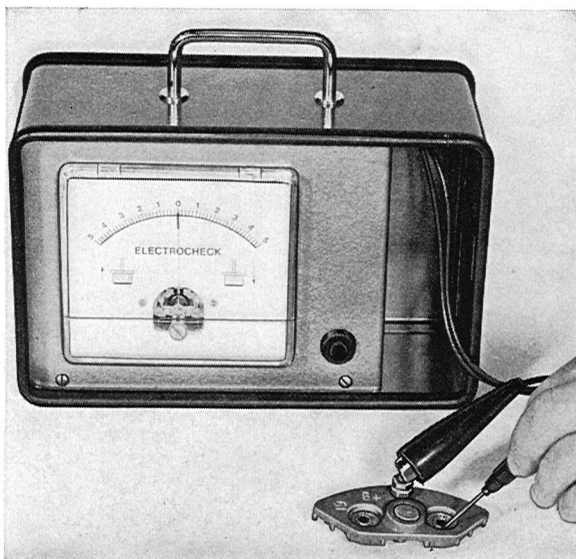


VOLVO
103012

Fig. 3-10. Diode test

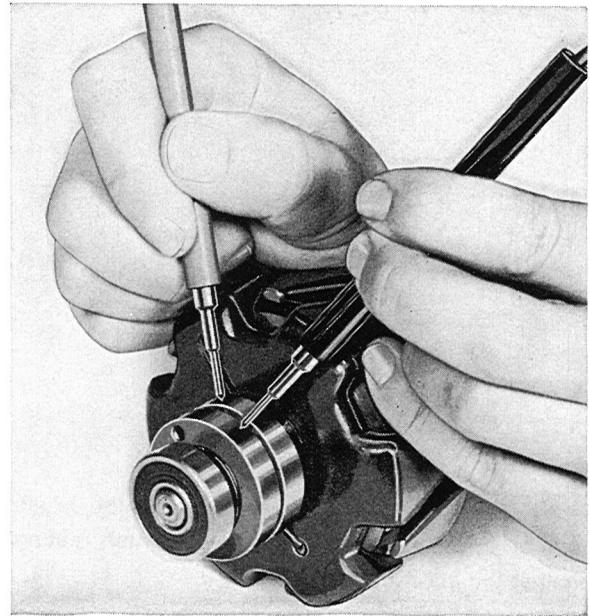
Check the diodes with a diode tester, see Fig. 3-10. If any of the rectifiers is defective, the entire diode holder (with three diodes) must be replaced. If the insulation diode is defective, replace the holder, complete with insulation diode.

If a diode tester is not available, the diodes should be soldered loose (see page 3:6) and tested with an ohmmeter. The diodes should have high resistance in reverse direction and low resistance in the flow direction.



VOLVO
103013

Fig. 3-11. Diode insulation test



VOLVO
103014

Fig. 3-12. Check-measuring rotor

ROTOR

Check to make sure that the slip rings are not dirty or burned.

Check the winding for breakage or damaged insulation. Measure the resistance between the slip rings, see Fig. 3-12. At 25°C (77°F) the resistance should be $5.2 \pm .2$ ohms.

If the slip rings are dirty, clean them carefully with a cloth moistened in trichloroethylene. The slip rings can also be polished with fine sand paper.

If the winding is defective the entire rotor must be replaced.

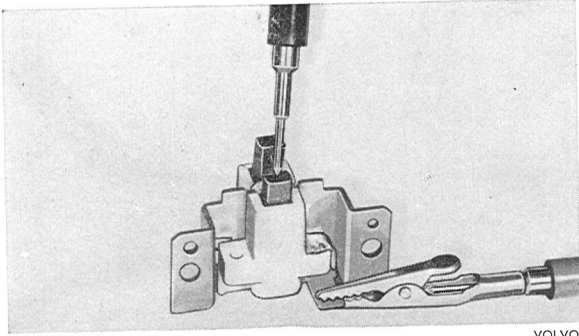
Check the bearings. (New bearings should always be installed when the alternator has been disassembled.)

BRUSH HOLDER

Connect a test lamp between the brushes. The lamp must not light.

Connect the test lamp between the DF-terminal and "+" brush. The lamp should give a steady light even if the brush or the terminal cable is moved, see Fig. 3-13. Connect the test lamp between the brush holder frame "-" brush. The lamp should give a steady light even if the brush or the terminal lead is moved.

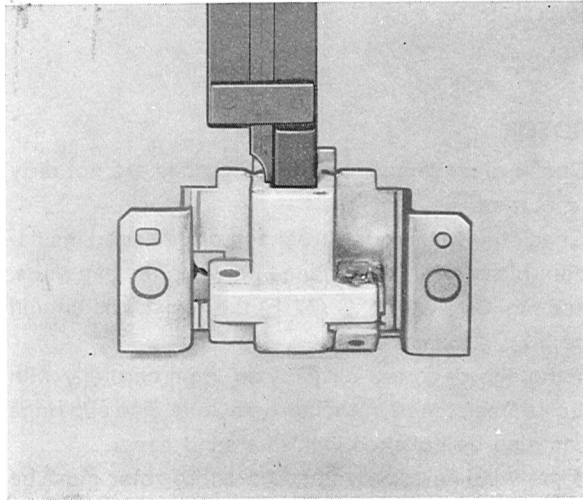
If the brush holder does not meet the above requirements, or if the brush length is less than 5 mm (approx. 3/16"), then replace the brush holder.



VOLVO
103015

Fig. 3-13. Brush holder test

The brush length is measured between the brush contact surface and holder, with the brush resting against the spring, see Fig. 3-14.



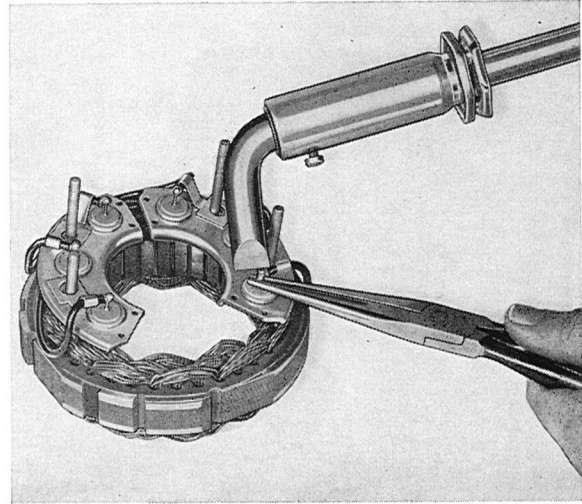
VOLVO
103940

Fig. 3-14. Measuring brush length

REPLACEMENT OF RECTIFIERS

1. Mark the leads connecting the stator to the rectifiers. Solder loose the leads.
 2. Place the new rectifier holder in exactly the same position occupied by the old one. Hold the outgoing rectifier lead with a pair of flat pliers. (This is to conduct the heat from the soldering points so as not to damage the new rectifier).
 3. Solder on the diodes, see Fig. 3-15.
- NOTE: The complete "+" or "-" rectifier holder must be replaced even if only one rectifier is faulty.

Use a well-heated soldering iron, minimum 100 W for the soldering.



VOLVO
103016

Fig. 3-15. Soldering diodes

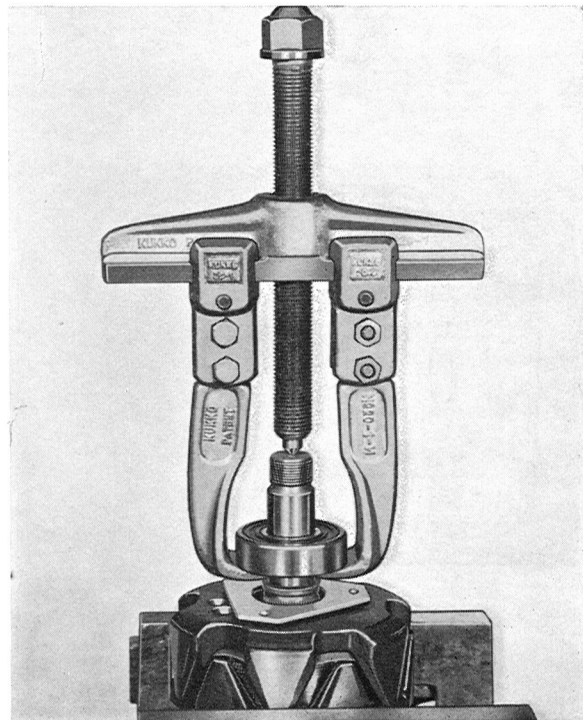
Never change places for the two rectifier holders. **The positive rectifier holder** is insulated from the frame by insulation washers and sleeves and its rectifiers are marked **red**. **The negative diode holder** is not insulated and its rectifiers are marked **black**.

BEARING REPLACEMENT

DRIVE END SHIELD BEARINGS

Removal

1. Place the rotor in a vise with soft jaws.
2. Pull the bearings off with a claw puller, see Fig. 3-16.



VOLVO
103017

Fig. 3-16. Bearing removal

Installation

1. Place the support plate on the rotor shaft with the three elevations facing the rotor winding.
2. Press the bearing in with the help of a tubular sleeve which presses on the bearing inner ring, see Fig. 3-17.

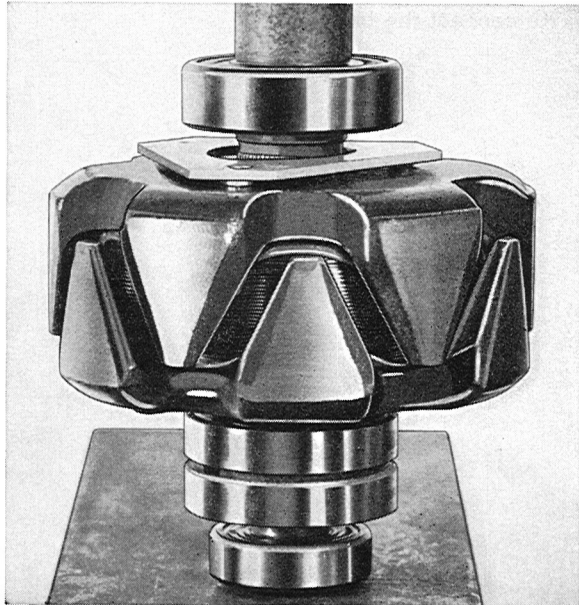


Fig. 3-17. Bearing installation

SLIP RING END BEARING

Removal

1. Place the rotor in a vise with soft jaws.
2. Pull the bearing off with a claw puller.

Installation

1. Press the bearing on with a tubular sleeve which presses on the bearing inner ring.

REPLACEMENT OF SLIP RING END SHIELD O-RING

1. Remove the O-ring with a steel blade with rounded edges (for example, a feeler gauge), see Fig. 3-18.

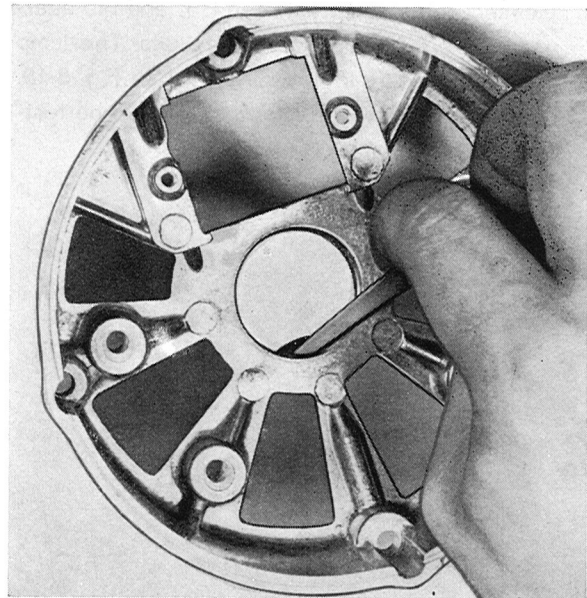


Fig. 3-18. O-ring removal

2. Wash the groove clean.
Check that the hole in the bearing shield is not blocked.
3. Install a new O-ring.
Lubricate the O-ring and the hole with mineral oil or similar.
The O-ring should be replaced each time the alternator has been disassembled.

ALTERNATOR ASSEMBLY

1. Install the stator and the diode holders in the slip ring end shield. (Do not forget the insulation washers for the positive diode holder). Install the nuts and washers on the negative diode holder screws.
2. Press the rotor into the drive end shield. Install the three screws for the drive bearing support plate.
3. Connect the rotor and stator sections.
4. Install the attaching screws. Tightening torque 2.8—3.0 Nm (2.0—2.2 lbf).
5. Install the plastic tube and insulation washers on the screws on which the insulation diode is to be mounted.
Install insulation diode, put on nuts and washers. Install brush holder.
6. Install spacer washer, key, fan, pulley, washer and nut. Tightening torque 40 Nm (29.0 lbf).

7. Connect a test lamp between B+ and the alternator frame. Switch the connections. The lamp should light only in one direction, see Fig. 3-19. After any repairs, the alternator should be test-run in a test bench.

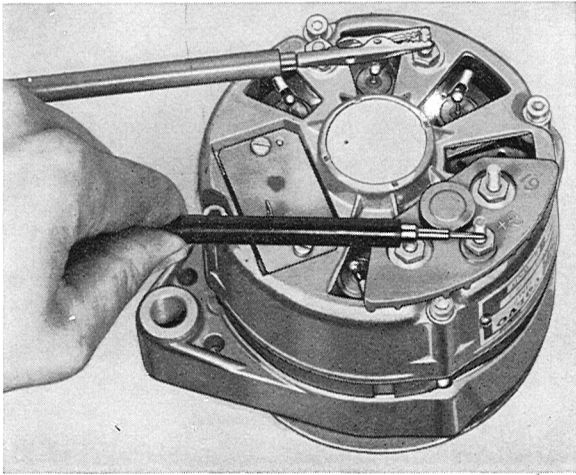


Fig. 3-19. Alternator test

VOLVO
103 020

ALTERNATOR INSTALLATION

1. Place the alternator in position and install the fan belt at the same time.
2. Install the attaching bolts and tensioning bracket without tightening the bolts. Adjust the belt tension (see Section 2, Engine, Group 26) and secure the alternator. NOTE: Force may only be applied to the front end of the alternator when adjusting the belt tension.
3. Install the leads to the alternator.
4. Re-connect the battery.

VOLTAGE REGULATOR

S.E.V. MARSHALL

GENERAL INFORMATION



Fig. 3-20. Voltage regulator installed

VOLVO
105 195

(Replace voltage regulator=Volvo Standard Times Op. No. 32205)

The regulator, Fig. 3-20, is a twin contact regulator with one upper movable contact and a lower one. The movable contact is secured to an armature which is actuated by a voltage coil. The regulator also contains three resistors and one thermistor.

FUNCTION

When the ignition key is switched on, current flows through the charging warning lamp to D+ on the regulator. It is then conducted via the regulator through the field winding to ground.

When the alternator starts rotating, alternating current is formed in the stator. This alternating current

is rectified by the rectifiers (silicon diodes) and the direct current produced is re-fed via the regulator to the field winding until the regulator voltage has been reached. When the regulating voltage has been reached, the armature is attracted by the coil. This causes the contacts to open and the field current must pass resistor R1, Fig. 3-21.

If, in spite of this, the voltage rises, the armature is drawn further down and the movable contact meets the lower contact so that the field winding is grounded at both ends, this causing the voltage to drop rapidly. The cycle is repeated continuously so that the voltage is maintained constant.

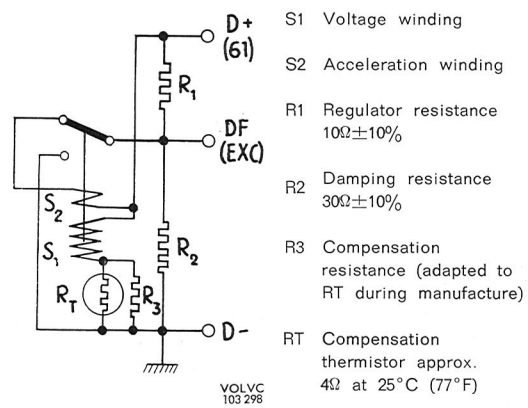


Fig. 3-21. Inner wiring of regulator

TEST OF ALTERNATOR AND VOLTAGE REGULATOR

GENERAL

Fixed clamps should be used for all testing of the alternator equipment. So-called crocodile clamps should not be used as they have a certain tendency to loosen. A loose lead can result in the alternator and regulator being damaged. When about to connect up instruments, disconnect the battery first.

ALTERNATOR CIRCUIT TEST

Before testing alternator or regulator in the vehicle, check battery and vehicle wiring system for damaged leads or insulation, loose or corroded lead terminals and poor grounding.

Check the fan belt. Any of the above faults must be remedied before the electrical checks can be started.

BATTERY TEST

Test the battery with a hydrometer and battery tester. If the battery is not fully charged, remove it from the car and charge it or replace it with a new one if necessary. A fully charged battery which is

otherwise in good condition should always be used when testing.

VOLTAGE DROP TEST

This test is made to check the leads between the alternator and the battery and also the battery ground cable. The test should be carried out with a fully charged battery in good condition. The battery terminals should be well cleaned and tightened. Load the alternator with about 10 amps. Suitable load: headlights switched on. With the engine running and the alternator supplying 10 amps., measure with a suitable voltmeter the voltage between the positive pole of the battery and B+ on the alternator. If the voltage at this test exceeds .3 volt, there is a fault in the lead or contact, which must be remedied immediately. After repairing the leads or contacts, measure once again. With the same load as above, measure the voltage drop between the negative pole of the battery and the alternator terminal D—. Here the voltage drop must not exceed .2 volt. If the voltage drop exceeds .2 volt, check battery ground, lead, alternator contact with the engine and engine contact with chassis. After making necessary repairs, measure again.

ALTERNATOR TEST

(On a test bench or on the vehicle)

Connect the alternator as shown in Fig. 3-22.

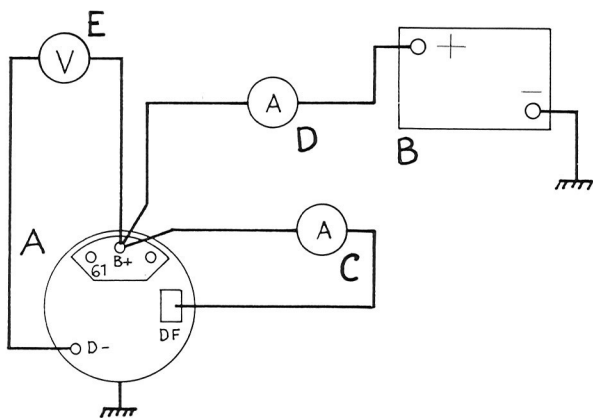


Fig. 3-22. Wiring diagram for alternator test

- | | |
|----------------------|-------------------------|
| A. Alternator | D. Ammeter 0—50 amps. |
| B. Battery 60 Ah | E. Voltmeter 0—20 volts |
| C. Ammeter 0—10 amps | |

VOLVO
103054

Check that the current through the field winding (ammeter C) is 2—2.5 amps. (If the current is not correct, then check the brush holder and field winding.) Run the alternator to a speed of 50 r/s (3000 r/m). (Engine speed 25 r/s=1500 r/m). The alternator should then produce at least 30 amps at about 13 volts. (A further load may be applied in order to maintain the voltage at about 13 volts.) Measure the voltage at B+ and 61 when the alternator charges.

The voltage should be .8—.9 volt higher at terminal 61, otherwise the insulation diode is faulty and should be replaced.

VOLTAGE REGULATOR TEST

(In a test bench or in the vehicle)

Test of charging system in vehicle=Volvo Standard Times Op. No. 32174

Connect the alternator and regulator as shown in Fig. 3-23. Run the alternator at a speed of approx. 83.5 r/s (5000 r/m) (engine speed 42 r/s=2500 r/m) for 15 seconds. Then read the voltage on the voltmeter. With no load on the alternator, the voltmeter should read 13.1—14.4 volts with the regulator ambient temperature at 25°C (77°F).

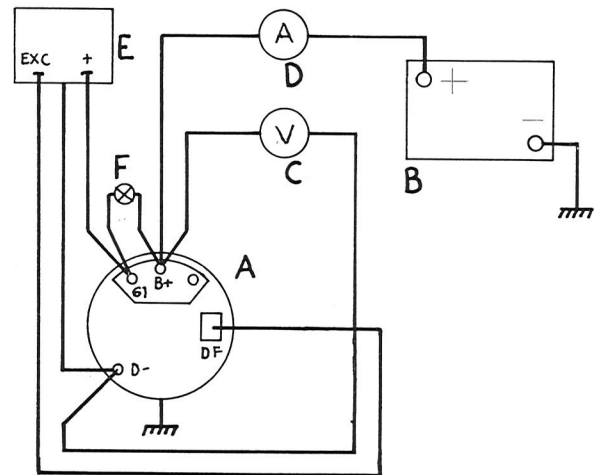


Fig. 3-23. Wiring diagram for voltage regulator test

- | | |
|-------------------------|--------------------------------------|
| A. Alternator | E. Voltage regulator |
| B. Battery 60 Ah | F. Warning lamp 12 volts, 2 watts |
| C. Voltmeter 0—20 amps. | |
| D. Ammeter 0—50 amps. | |

VOLVO
103039

Load the alternator with 10—15 amps, for example headlights, and read the voltage. The voltage should also lie on this occasion between 13.1—14.4 volts. For ambient temperatures other than 25°C (77°F), see the diagram in Fig. 3-24.

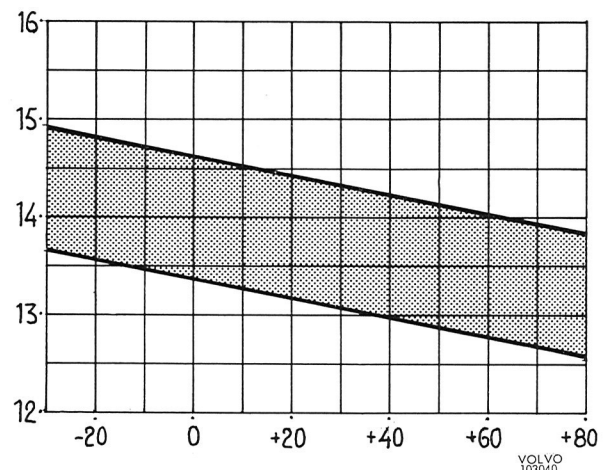


Fig. 3-24. Voltage-temperature diagram for cold voltage regulator

If the voltage is outside the tolerance limits, the regulator should be replaced.

If the voltage regulator is to be tested more accurately, install it in the vehicle which should then be driven for about 45 minutes at a speed above 50 kmph (30 mph).

The reason for the driving is to enable the regulator to obtain the correct working temperature.

NOTE: The vehicle **must** be driven. It is not sufficient just to have the engine idling.

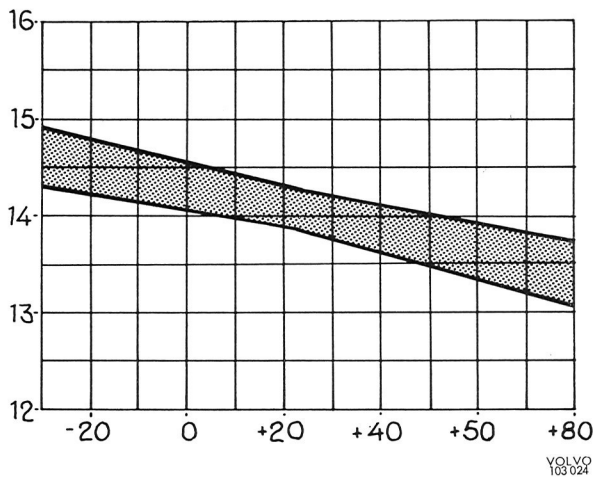


Fig. 3-25. Voltage-temperature diagram for warm voltage regulator

Immediately after, or preferably during driving, measure the voltage between B+ and D— on the alternator. The engine should run at about 42 r/s (2500 r/m) when the test is being made. When the regulator ambient temperature is about 25°C (77°F), the voltage should be 13.85—14.25 volts. For other ambient temperatures, see Fig. 3-25.

SERVICE DIAGNOSIS

CONDITION

POSSIBLE CAUSE

Alternator does not charge.

Worn or insufficiently tensioned fan belt.
 Breakage in charging circuit.
 Worn brushes.
 Breakage in rotor winding.
 Breakage in insulation diode.
 Defective regulator.

Charging weak or irregular.

Worn or insufficiently tensioned fan belt.
 Intermittent breakage in charging circuit.
 Worn brushes.
 One or several rectifier diodes broken or shorted. (Breakage in a rectifier diode reduces the charging current about 5 amps. A shorted rectifier diode limits the alternator charging current to 7—8 amps and causes a rumbling sound in the alternator.)
 Rotor partly shorted.
 Stator broken or shorted.
 Defective regulator.

Too high charging.

Defective regulator.
 Defective terminal on regulator or alternator.
 Insulation diode shorted.

Noise in alternator.

Worn fan belt.

Loose pulley.

Worn bearings

One or several rectifier diodes shorted.

Alternator pulley incorrectly aligned in relation to the crankshaft pulley.

Charging warning lamp glows.

Voltage drop in fuse box.

ALTERNATOR

S.E.V. MARSHALL 14 V—34833

GENERAL INFORMATION

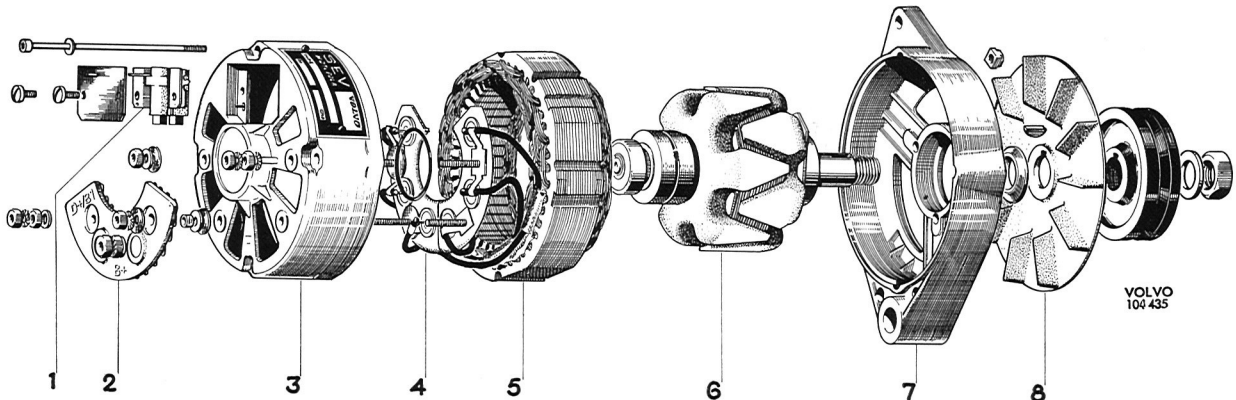


Fig. 3-26. Exploded view of alternator

- | | |
|----------------------------------|---------------------|
| 1. Brush holder | 5. Stator |
| 2. Insulation diodes with holder | 6. Rotor |
| 3. Slip ring end shield | 7. Drive end shield |
| 4. Rectifier (silicon diodes) | 8. Fan |

The alternator is a three-phase, star-connected alternator unit which is located on the right-hand side of the engine and is driven by a V-belt from a pulley on the crankshaft.

The alternator has a rectifier built into the slip ring end shield. This rectifier consists of six silicon diodes.

The alternator has a rotating field (rotor) and stationary generating windings (stator).

The rotor is of the claw-pole type with the field windings fed over the slip rings. The construction of the rotor has made it possible for the alternator to have a max. speed of 250 r/s (15 000 r/m.) The insulation diodes (2, Fig. 3-26), which are located on the outside of the alternator, have two functions: They prevent the battery from discharging through the regulator and alternator field, and they provide a simple means of operating the charging warning lamp.

The alternator is self-limiting (max. 55 amps.) and for this reason a simple voltage regulator can be used with only voltage control.

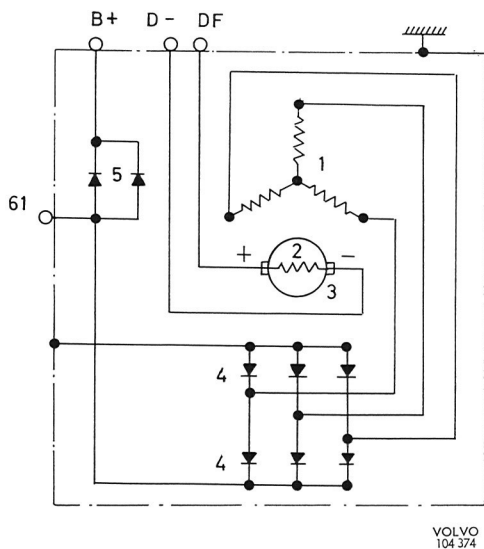


Fig. 3-27. Alternator inner circuit

- | | |
|-------------------------------|----------------------|
| 1. Stator | 4. Rectifier diodes |
| 2. Rotor (field winding) | 5. Insulation diodes |
| 3. Slip ring and brush holder | |

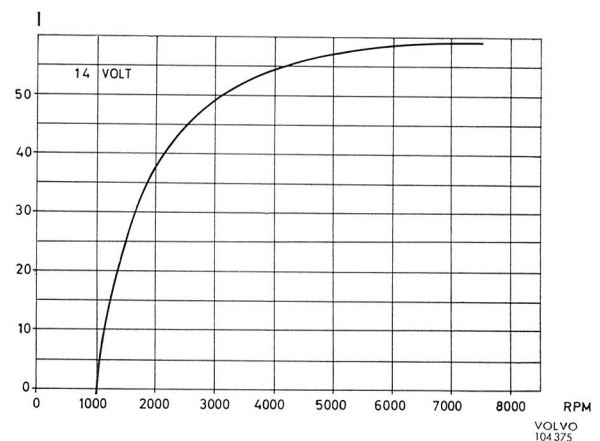


Fig. 3-28. Alternator output curve

SERVICE PROCEDURES

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or installing the battery, make sure that the new battery is connected with the correct polarity.
2. Never run the alternator with the main circuit broken. The battery and/or alternator and regulator leads must never be disconnected while the engine is running.
3. No attempt should be made to polarize the alternator since this is not necessary.
4. When charging the battery while installed in the vehicle, the battery ground cable should be disconnected.
5. A fast charger should not be used as a help in starting.
6. When using an extra battery as a starting aid, always connect it in parallel.
7. When carrying out any electric welding on the vehicle, disconnect the negative battery lead as well as all the alternator leads. The welding unit should always be connected as near as possible to where the welding is to be made.

ALTERNATOR REMOVAL

Replace alternator=Volvo Standard Times Op. No. 32102

Re-build alternator=Volvo Standard Times Op. No. 32104

1. Disconnect the battery ground cable.
2. Disconnect the leads to the alternator.
3. Remove the bolt for the adjusting bar.
4. Remove the bolt holding the alternator to the engine block.
5. Remove the belt and lift the alternator forwards.

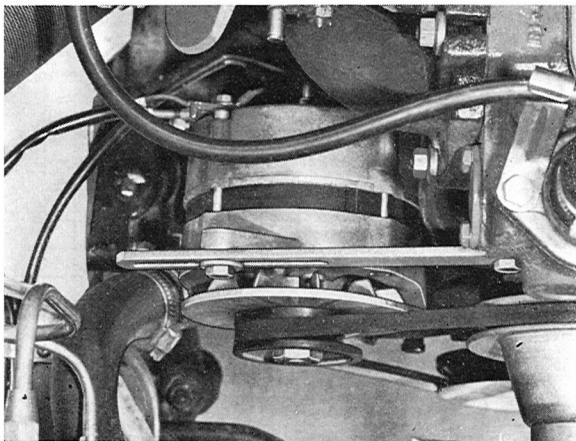


Fig. 3-29. Alternator

VOLVO
105194

ALTERNATOR DISASSEMBLY

1. Release the two screws holding the brush holder and remove the insulation plate. Pull out the brush holder.
2. Remove nut and washer. Lift off pulley, fan, key and spacer washer.
3. Remove nuts and washers on terminal 61 and the corresponding on the other side of the insulation diode. Lift off insulation diode holder, see Fig. 3-30.

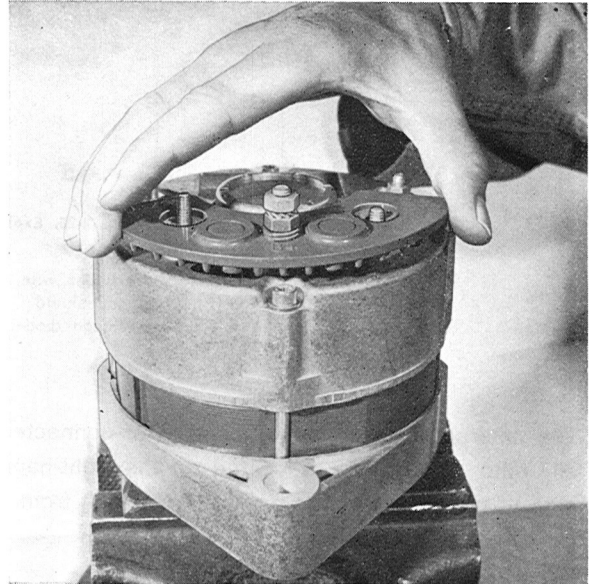


Fig. 3-30. Removal of insulation diodes

VOLVO
104470

4. Mark drive end shield, stator and slip ring end shield to avoid confusion when assembling. Remove the four attaching screws.
5. Remove stator and slip ring end shield with the help of two screwdrivers, which are inserted in two of the sockets between the stator and drive end shield, see Fig. 3-31.

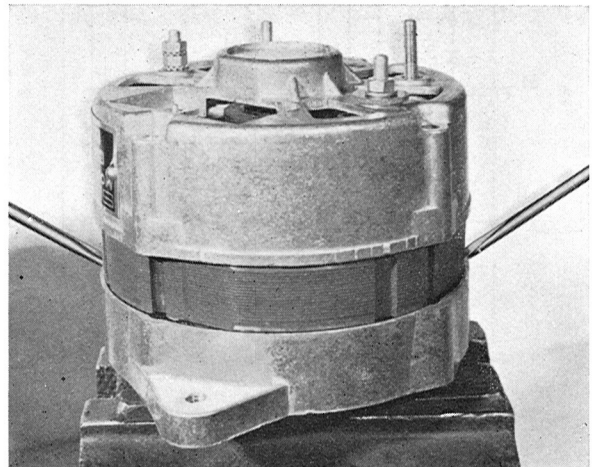


Fig. 3-31. Alternator disassembly

VOLVO
104471

NOTE: The screwdrivers may not be inserted deeper than 2 mm (just over 1/16"), otherwise the stator may be damaged.

6. Release the three screws holding the support plate of the drive end bearing. Release the bearing by knocking the end of the shaft against a piece of wood, see Fig. 3-32.
7. Remove nuts and washers for the diode holders.
8. Remove stator and diode holders for the slip ring end shield.

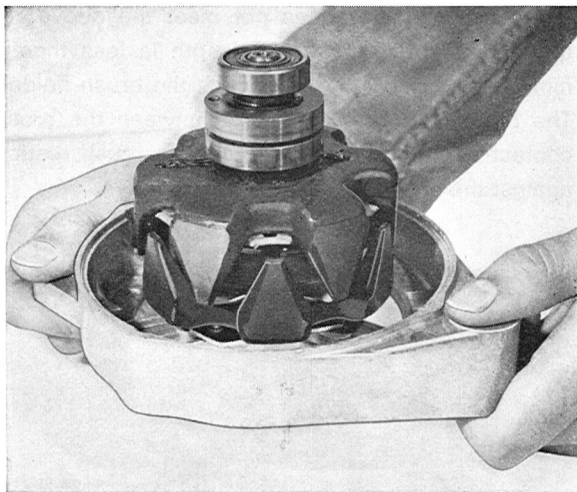


Fig. 3-32. Shield removal

VOLVO
104472

TEST OF DISASSEMBLED ALTERNATOR

STATOR

Check the stator for short circuits. If one or several of the coils are burned, there must be a short-circuit in the stator. Connect a test lamp (12 V, 2—5 W) between the stator plates and a terminal on the stator, see Fig. 3-33.

If the lamp lights, the installation between the stator winding and the stator plates must be defective and the stator should be replaced.

NOTE: Only a 12 V, 2—5 W test lamp may be used; 110 or 220 V, D.C. or A.C. lamps must NOT be used. This applies to all the alternator components. Check the diodes with a diode tester, see Fig. 3-34. If any of the rectifier diodes is defective, the entire

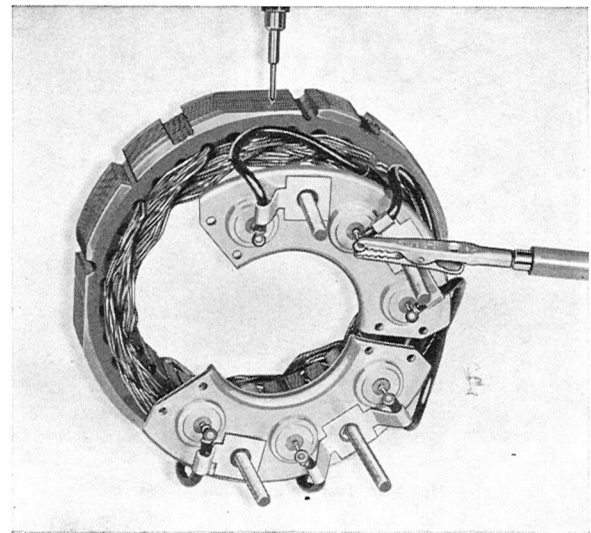


Fig. 3-33. Test of stator

VOLVO
103011

diode holder (with three diodes) must be replaced. If any of the insulation diodes is defective, replace the holder, complete with insulation diodes. If a diode tester is not available, the diodes should be soldered loose (see page 3-17) and tested with an ohmmeter. The diodes should have high resistance in reverse direction and low resistance in the flow direction.

ROTOR

Check to make sure that the slip rings are not dirty or burned.

Check the winding for breakage or damaged insulation. Measure the resistance between the slip rings, see Fig. 3-36. At 25°C (77°F) the resistance should be 3.7 ohms.

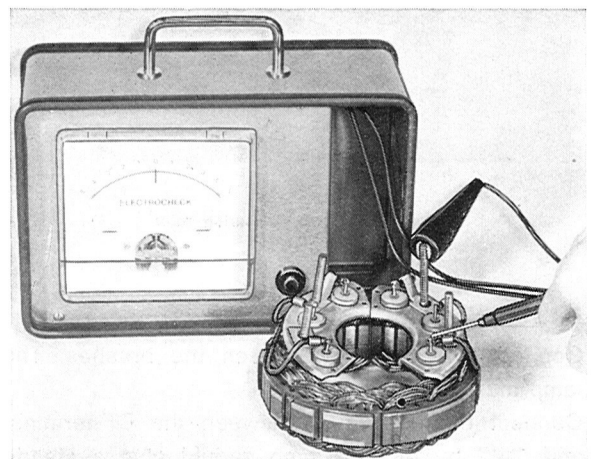


Fig. 3-34. Test of diodes

VOLVO
103012

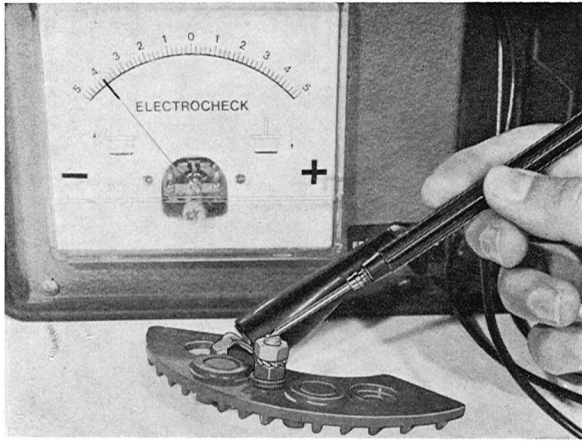


Fig. 3-35. Test of insulation diodes

If the slip rings are dirty, clean them carefully with a cloth moistened in trichloroethylene. The slip rings can also be polished with fine sand paper.

If the winding is defective, the entire rotor must be replaced.

Check the bearings. (The bearings should always be replaced when the alternator has been disassembled.)

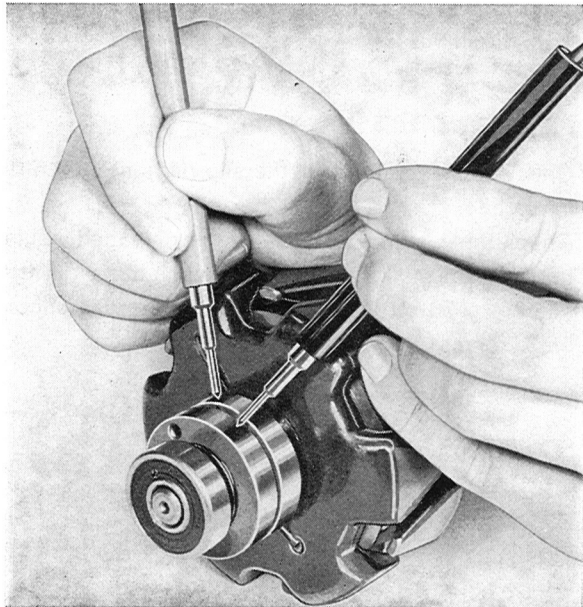


Fig. 3-36. Check-measuring rotor

BRUSH HOLDER

Connect a test lamp between the brushes. The lamp must not light.

Connect the test lamp between the DF-terminal and "+" brush. The lamp should give a steady light even if the brush or the terminal cable is moved, see Fig. 3-37.

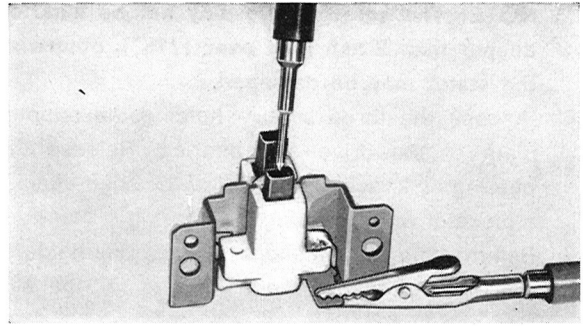


Fig. 3-37. Test of brush holder

Connect the test lamp between the brush holder frame "-" brush. The lamp should give a steady light even if the brush or the terminal lead is moved. If the brush holder does not meet the above requirements, or if the brush length is less than 5 mm (approx. 3/16"), then replace the brush holder. The brush length is measured between the brush contact surface and holder, with the brush resting against the spring, see Fig. 3-38.

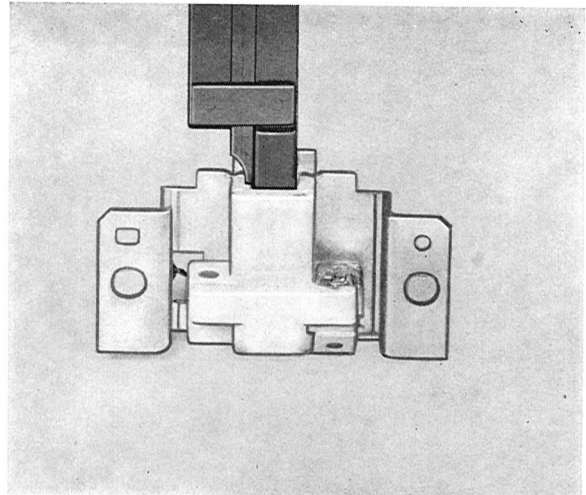
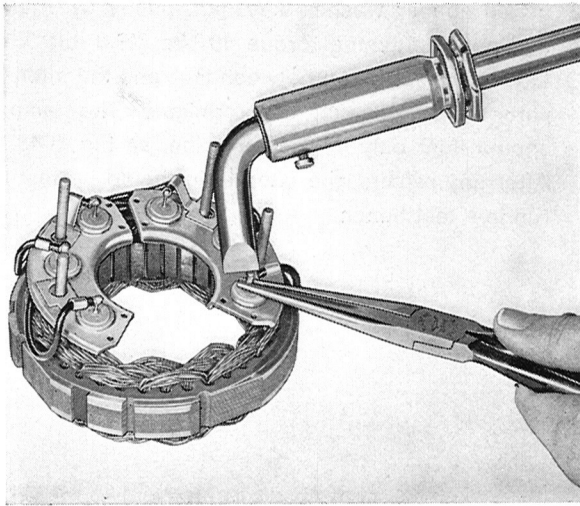


Fig. 3-38. Measuring brush length

REPLACEMENT OF RECTIFIER DIODES

1. Mark the leads connecting the stator to the rectifier diodes. Solder loose the leads.
2. Place the new diode holder in exactly the same position occupied by the old one. Hold outgoing diode lead with a pair of flat pliers. (This is to conduct the heat from the soldering point so as not to damage the new diode.)
3. Solder on the diodes, see Fig. 3-39.

NOTE: The complete "+" or "-" diode holder must be replaced even if only one diode is defective.



VOLVO
103016

Fig. 3-39. Soldering on diodes

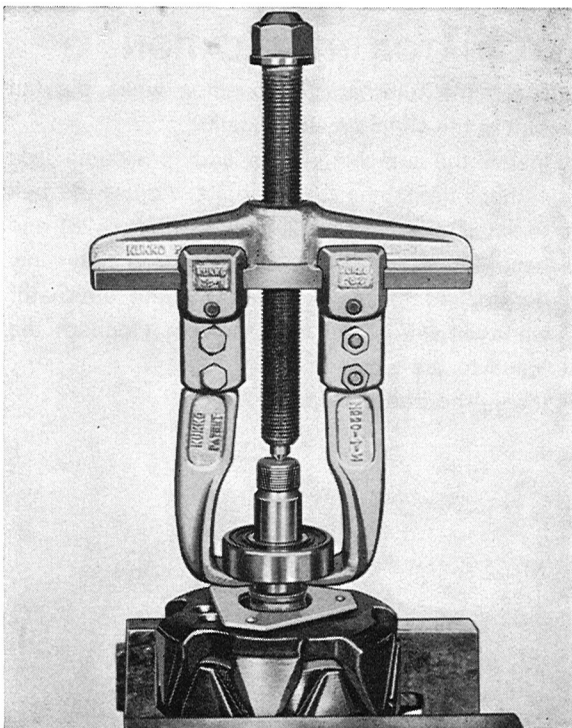
Use a well-heated soldering iron, minimum 100 W for the soldering.

Never change place for the two diode holders. The **positive diode holder** is insulated from the frame by insulation washers and sleeves and its diodes are marked **red**.

The **negative diode holder** is not insulated and its diodes are marked **black**.

BEARING REPLACEMENT

DRIVE END SHIELD BEARING



VOLVO
103017

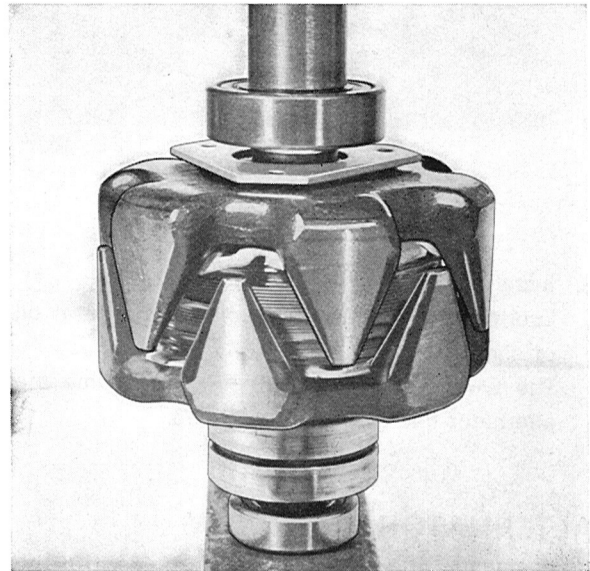
Fig. 3-40. Bearing removal

Removing

1. Place the rotor in a vise with soft jaws.
2. Pull the bearing with a claw puller, see Fig. 3-40.

Installation

1. Place the support plate on the rotor shaft with the three elevations facing the rotor winding.
2. Press the bearing in with the help of a tubular sleeve which presses on the bearing inner ring, see Fig. 3-41.



VOLVO
103018

Fig. 3-41. Bearing installation

SLIP RING END BEARING

Removal

1. Place the rotor in a vise with soft jaws.
2. Pull the bearing with a claw puller.

Installation

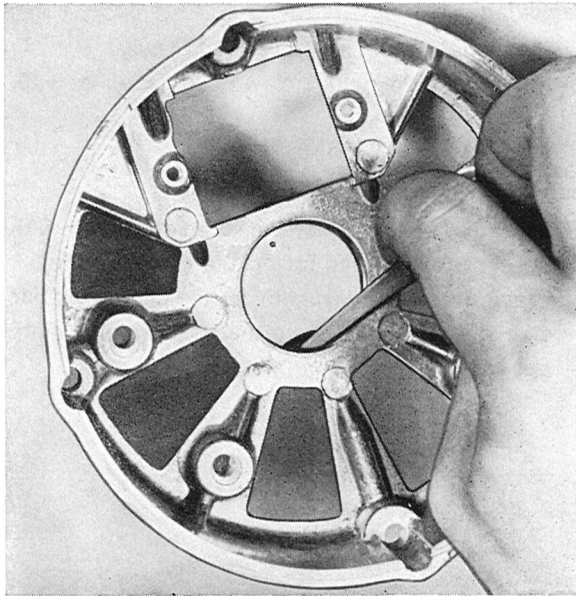
1. Press the bearing on with a tubular sleeve which presses on the bearing inner ring.

REPLACEMENT OF SLIP RING END SHIELD O-RING

1. Remove the O-ring with a steel blade with rounded edges (for example, a feeler gauge), see Fig. 3-42.

2. Wash the groove clean.

Check that the hole in the bearing shield is not blocked.



VOLVO
103 019

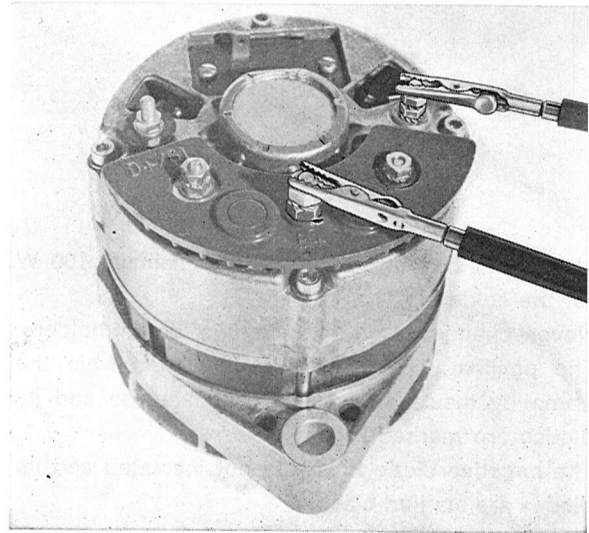
Fig. 3-42. O-ring removal

3. Install a new O-ring.
Lubricate O-ring and the hole with mineral oil or similar.
The O-ring should be replaced each time the alternator has been disassembled.

ALTERNATOR ASSEMBLY

1. Install the stator and the diode holders in the slip ring end shield. (Do not forget the insulation washers for the positive diode holder.) Install the nuts and washers on the negative diode holder screw.
2. Press the rotor into the drive end shield. Install the three screws for the drive bearing support plate.
3. Connect rotor and stator sections.
4. Install the attaching screws. Tightening torque 2.8—3.0 Nm (2.0—2.2 lbft.)
5. Install the plastic tube and insulation washers on the screws on which the insulation diode is to be installed. Install insulation diode, put on nuts and washers. Install the brush holder.

6. Install spacer washer, key, fan, pulley, washer and nut. Tightening torque 40 Nm (29.0 lbft).
7. Connect a test lamp between B+ and the alternator frame. Switch the terminals. The lamp should light only in one direction, see Fig. 3-43. After any repairs, the alternator should be test-run in a test bench.



VOLVO
104 475

Fig. 3-43. Test of alternator

ALTERNATOR INSTALLATION

1. Place the alternator in position while the fan belt at the same time is installed.
2. Install the attaching bolts and tensioning iron without tightening up the bolts. Adjust the belt tension (see Section 2, Engine, Group 25) and secure the alternator. NOTE: Force may only be applied to the front end of the alternator when adjusting the belt tension. Connect the leads to the alternator.
4. Install the battery lead.

VOLTAGE REGULATOR

GENERAL INFORMATION



Fig. 3-44. Voltage regulator

(Replace voltage regulator=Volvo Standard Times Op. No. 32205)

The regulator, Fig. 3-44, is a twin contact regulator with a fixed upper contact, a movable contact and a fixed lower one. The movable contact is attached to an armature which is actuated by a voltage coil. The regulator also houses four resistors and one thermistor.

FUNCTION

When the ignition key is switched on, current flows through the charging warning lamp to +(61) on the regulator. It is then conducted via the regulator through the field winding to ground.

When the alternator starts rotating, alternating current is formed in the stator. This alternating current is rectified by the silicon diodes and the direct current produced is re-fed via the regulator to the field winding until the regulating voltage has been

reached. When the regulating voltage has been reached, the armature is attracted by the coil. This causes the contacts to open and the field current must pass the resistances R1, Fig. 3-45.

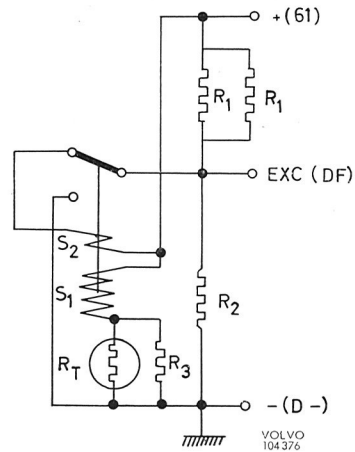


Fig. 3-45. Inner wiring of regulator

- S1 Voltage winding
- S2 Acceleration winding
- R1 Regulator resistances (2)
 $10\Omega \pm 10\%$
- R2 Damping resistance
 $300\Omega \pm 10\%$
- R3 Compensation
resistance (adapted to
RT during manufacture)
- RT Compensation
thermistor approx.
 4Ω at 25°C (77°F)

If in spite of this, the voltage rises, the armature is drawn further down and the movable contact meets the lower contact so that the field winding is grounded at both ends, this causing the voltage to drop rapidly. The cycle is repeated continuously so that the voltage is maintained constant.

TEST OF ALTERNATOR AND VOLTAGE REGULATOR

GENERAL

Fixed clamps should be used for all testing of the alternator equipment. So-called crocodile clamps should not be used as they have a certain tendency to loosen. A loose lead can result in the alternator and regulator being damaged. When about to connect up instruments, disconnect the battery first.

ALTERNATOR CIRCUIT TEST

Before carrying out any tests on the alternator or regulator in the vehicle, check the battery and vehicle wiring system for damaged leads or insulation, loose or corroded lead terminals and poor ground. **Check the fan belt** (see Section 2, Engine, Group 25). Any of the above faults must be remedied before the electrical checks can be started.

BATTERY TEST

Test the battery with a hydrometer and battery tester. If the battery is not fully charged, remove it from the car and charge it or replace it with a new one if necessary. A fully charged battery which is otherwise in good condition should always be used when testing.

TEST OF VOLTAGE DROP

This test is made to check the leads between the alternator and the battery and also the battery ground. The test should be carried out with a fully charged battery in good condition. The battery terminals should be well cleaned and tightened. Load the alternator with about 10 amps. Suitable load: headlights switched on. With the engine running and the alternator supplying 10 amps., measure with a suitable voltmeter the voltage between the positive pole of the battery and B+ on the alternator. If the voltage at this test exceeds .3 volt, there is a fault in the lead or contact, which must be remedied immediately. After repairing the leads or contacts, measure once again. With the same load as above, measure the voltage drop between the negative pole of the battery and the alternator terminal D—. Here the voltage drop must not exceed .2 volt. If the voltage drop exceeds .2 volt, check the battery ground, the alternator contact with the engine and the engine contact with the chassis. After making the necessary repairs measure again.

ALTERNATOR TEST

(In a test bench or in the vehicle)

Connect the alternator as shown in Fig. 3-46.

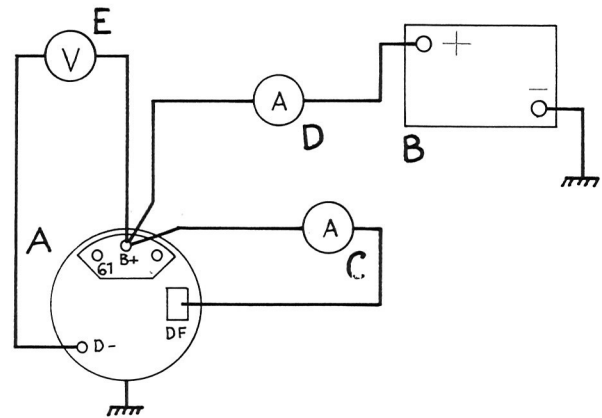


Fig. 3-46. Wiring diagram for testing alternator

A Alternator
B Battery 60 Ah
C Ammeter 0—10 amps.
D Ammeter 0—50 amps.
E Voltmeter 0—20 volts

VOLVO
103 054

Check that the current through the field winding (ammeter C) is 3—3.5 amps. (If the current is not correct, check the brush holder and field winding.) Run the alternator to a speed of approx. 50 r/s (3000 r/m). (Engine speed 25 r/s (1500 r/m). The alternator should then produce at least 48 amps at 14 volts. (A further load may be applied in order to maintain the voltage at 14 volts.) This applies to a warm alternator and an ambient temperature of 25°C (77°F).

Measure the voltage at B+ and 61 when the alternator charges.

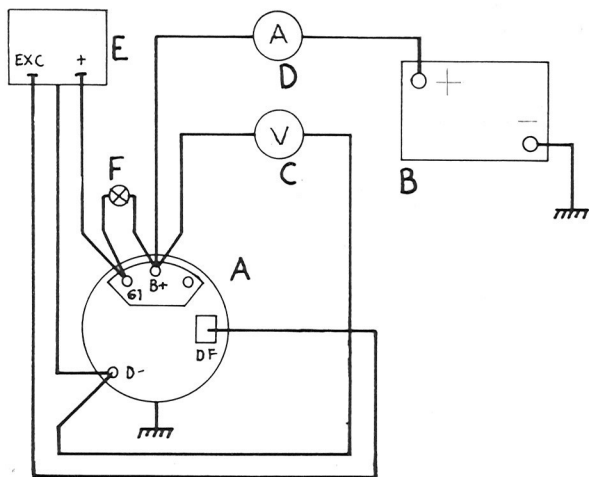
The voltage should be .8—.9 volt more than at terminal 61, otherwise the insulation diode is defective and should be replaced.

VOLTAGE REGULATOR TEST

(In a test bench or in the vehicle)

Test of charging system in vehicle = Volvo Standard Times Op. No. 32174

Connect the alternator and regulator as shown in Fig. 3-47. Run the alternator at a speed of approx. 83.5 r/s (5000 r/m) (engine speed 42 r/s = 2500 r/s) for 15 seconds. Then read the voltage on the voltmeter. With no load on the alternator, the voltmeter should read 13.1—14.3 volts with the regulator ambient temperature at 25°C (77°F).

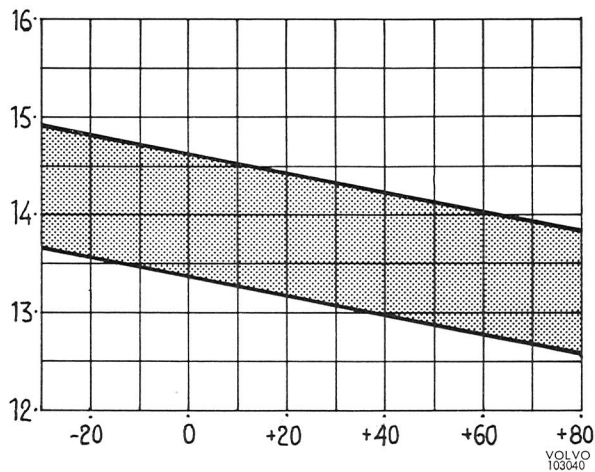


VOLVO
103039

Fig. 3-47. Wiring diagram for testing voltage regulator

- | | |
|------------------------|-------------------------------------|
| A Alternator | E Voltage regulator |
| B Battery 60 Ah | F Warning lamp 12 volts. 2 watts |
| C Voltmeter 0—20 amps. | |
| D Ammeter 0—50 amps. | |

Load the alternator with 10—15 amps, for example, headlights, and read the voltage. The voltage should also lie on this occasion between 13.1—14.4 volts. For ambient temperatures other than 25°C (77°F), see the diagram in Fig. 3-48.



VOLVO
103040

Fig. 3-48. Voltage-temperature diagram for cold voltage regulator

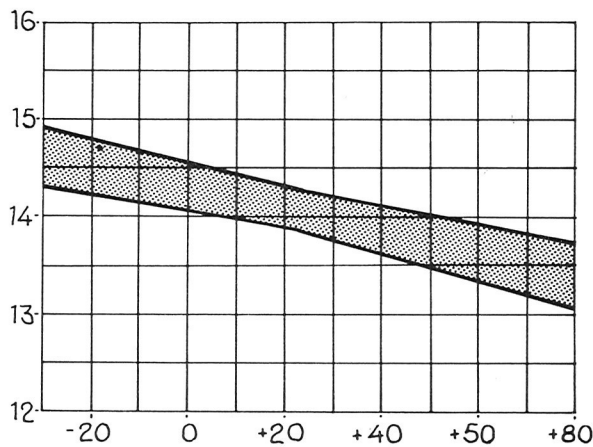
If the voltage is outside the tolerance limits, the regulator should be replaced.

If the voltage regulator is to be tested more accurately, install it in the vehicle which should then be driven for about 45 minutes at a speed above 50 kmph (30 mph).

The reason for the driving is to enable the regulator to obtain the correct working temperature.

NOTE: The vehicle must be driven. It is not sufficient just to have the engine idling.

Immediately after, or preferably during driving, measure the voltage between B+ and D— on the alternator. The engine should run at about 25 r/s (1500 r/m) 50 r/s (3000 alternator r/m) when the measuring is being carried out. When the regulator ambient temperature is about 25°C (77°F) the voltage should be 13.85—14.25 volts. For other ambient temperatures, see Fig. 3-49.



VOLVO
103024

Fig. 3-49. Voltage-temperature diagram for warm voltage regulator

SERVICE DIAGNOSIS

CONDITION

POSSIBLE CAUSE

Alternator does not charge.

Worn or insufficiently tensioned fan belt.
Breakage in charging circuit.
Worn brushes.
Breakage in rotor winding.
Breakage in insulation diode.
Detective regulator.

Charging weak or irregular.

Worn or insufficiently tensioned fan belt.
Intermittent breakage in charging circuit.
Worn brushes.
One or several rectifier diodes broken or shorted.
(Breakage in a rectifier diode reduces the charging current about 5 amps. A shorted rectifier diode limits the alternator charging current to 7—8 amps and causes a rumbling sound in the alternator.)
Rotor partly shorted.
Stator broken or shorted.
Defective regulator.

Too high charging.

Defective regulator.
Defective terminals on regulator or alternator.

Noise in alternator.

Worn fan belt.
Loose pulley.
Worn bearings.
One or several rectifier diodes shorted.
Alternator pulley incorrectly aligned in relation to the crankshaft pulley.

Charging warning lamp glows.

Voltage drop in fuse box.

ALTERNATOR

BOSCH

GENERAL INFORMATION

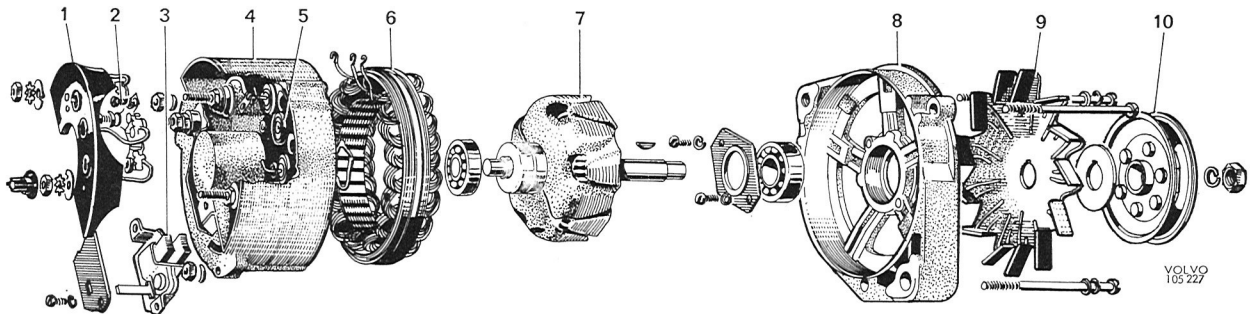


Fig. 3-50. Bosch alternator dismantled

- | | | |
|---------------------------------|--------------------------------|---------------------|
| 1. Rectifier (plus diode plate) | 4. Slip ring end shield | 7. Rotor |
| 2. Magnetizing rectifier | 5. Rectifier (negative diodes) | 8. Drive end shield |
| 3. Brush holder | 6. Stator | 9. Fan |
| | | 10. Pulley |

The alternator is a three-phase, star connected alternating unit. The rectifier, which is built into the slip ring end shield, consists of six silicon diodes. Also housed in the slip ring end shield are three so-called magnetizing diodes, which feed the field winding via the voltage regulator. This type of generator differs from a D.C. generator in that it has a rotating field winding (rotor) and a stationary main winding (stator). The rotor is a 12-pole claw-type with the field winding fed across two slip rings.

Since the alternator output is self-limited (max. 35 amps), a simple mechanical voltage regulator is used with only voltage control as its function.

FUNCTION, ALTERNATOR—VOLTAGE REGULATOR

When the ignition is switched on, current flows through the charging warning lamp to terminal D+ on the voltage regulator. Via the regulator, the current is conducted through the field winding to ground.

When the rotor starts rotating, alternating current is formed in the stator. Most of the current is rectified by the positive and negative diodes and is conducted via B+ on the alternator to the battery. A small part of the current is rectified by the magnetizing diodes and is led via 61/D+ to the voltage regulator and from there to the field winding. This cycle is repeated until the regulating voltage has

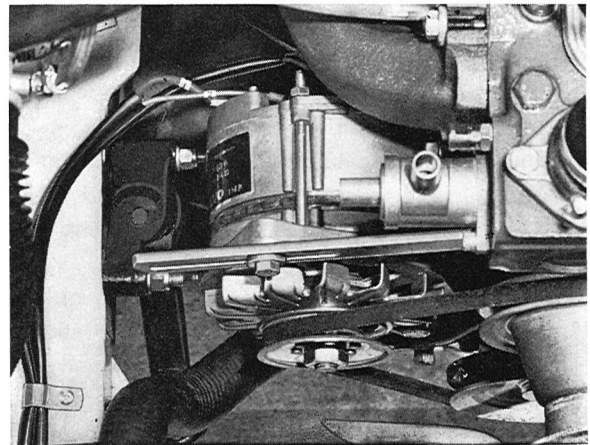


Fig. 3-51. Alternator

VOLVO
105 212

been reached, at which point the lower contacts (1, Fig. 3-72) on the voltage regulator open and field current must pass a control resistance. If the voltage rises in spite of this, the armature on the voltage coil is pulled further down so that the upper

contacts (2, Fig. 3-72) close, whereby the field winding is grounded at both ends, this causing the voltage to drop rapidly. The cycle is repeated continuously so that the voltage is maintained constant.

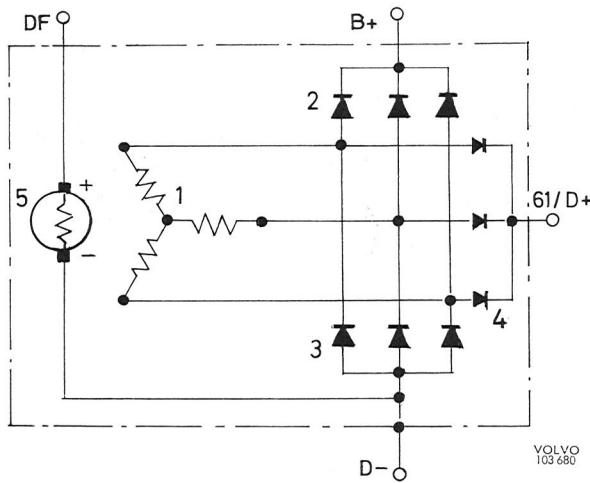


Fig. 3-52. Inner wiring of alternator

- | | |
|--------------------|-----------------------|
| 1. Stator | 4. Magnetizing diodes |
| 2. Positive diodes | 5. Rotor |
| 3. Negative diodes | |

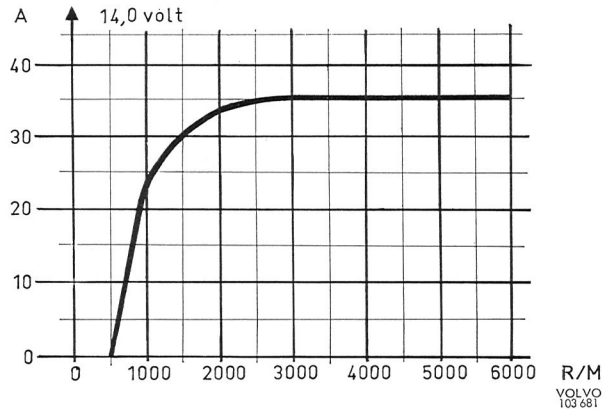


Fig. 3-53. Alternator output curve
A=amps. RM=alternator speed/minute

SERVICE PROCEDURES

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

- When replacing or installing the battery, make sure that the proper polarity is observed when connecting the new battery.
- Never run the alternator with the main circuit broken. The battery and/or alternator and regulator leads must never be disconnected while the engine is running.
- No attempt should be made to polarize the alternator since this is not necessary.
- When about to charge the battery installed in the vehicle, disconnect the battery ground cable.
- When using an extra battery as a starting aid, always connect it in parallel.
- When carrying out any electric welding on the vehicle, disconnect the negative battery lead as well as the B+ lead on the alternator and pull the two-pin plug out of the voltage regulator. The welding unit should always be connected as near as possible to where the welding is to be carried out.

ALTERNATOR REMOVAL

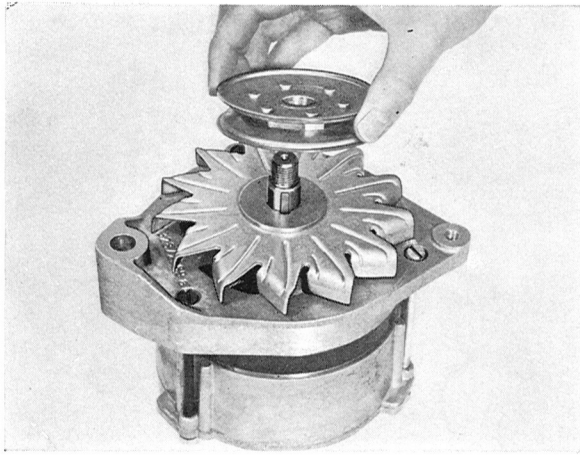
Replace alternator=Volvo Standard Times Op. No. 32102

Re-build alternator=Volvo Standard Times Op. No. 32104

- Disconnect the battery ground cable.
- Disconnect the leads to the alternator.
- Remove the bolt for the adjusting arm.
- Remove the bolt securing the alternator to the engine block.
- Remove the fan belt and lift out the alternator.

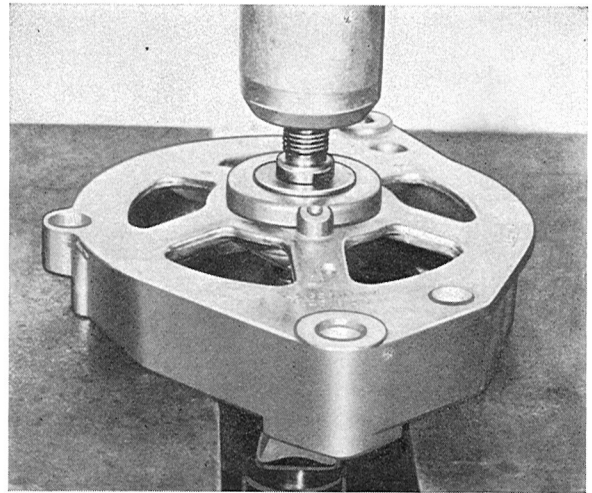
ALTERNATOR DISASSEMBLY

- Remove the nut and washer for the pulley and take off the pulley, the spacer washer and fan. Remove the key.



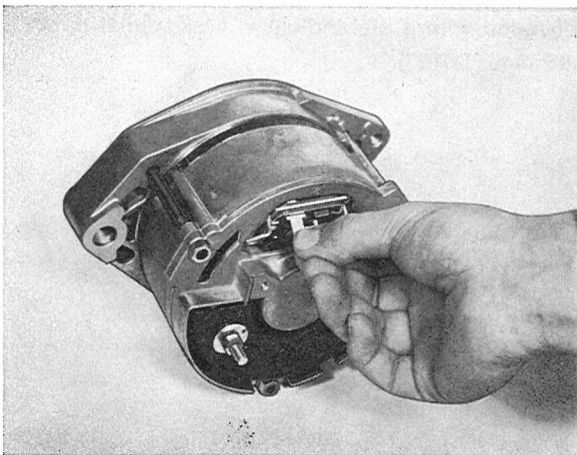
VOLVO
103 213

Fig. 3-54. Pulley removal



VOLVO
103 806

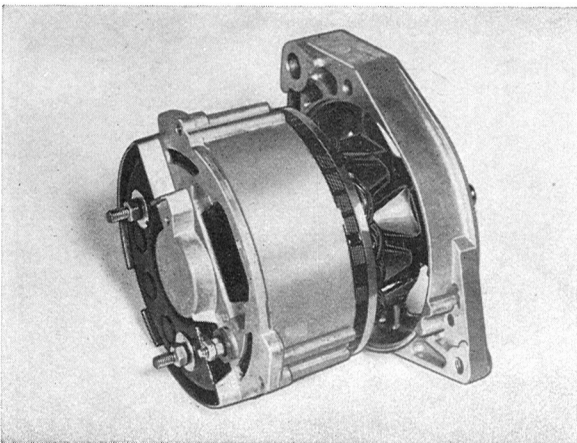
Fig. 3-57. Rotor removal



VOLVO
103 804

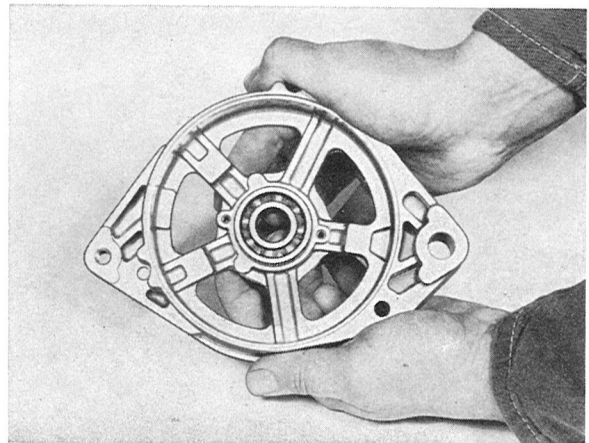
Fig. 3-55. Removal of brush holder

2. Remove the screws holding the brush holder and then the holder, se Fig. 3-55.
3. Remove nuts, washers and screws holding together the alternator and remove drive end shield and rotor from the stator and then the slip ring end shield. Fig. 3-56.
4. Press the rotor out of the drive end shield. Fig. 3-57.
5. Remove the screws for the washer which holds the drive end shield bearing and press out the bearing. Fig. 3-58.
6. Remove the nuts for the positive diode plate and lift up and bend aside the plate, see Fig. 3-59.
7. Solder loose the stator connections from the terminal points and lift off the stator.



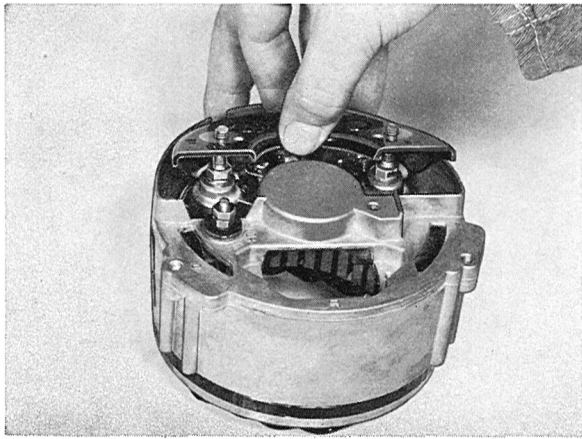
VOLVO
103 805

Fig. 3-56. Removal of rotor and drive end shield



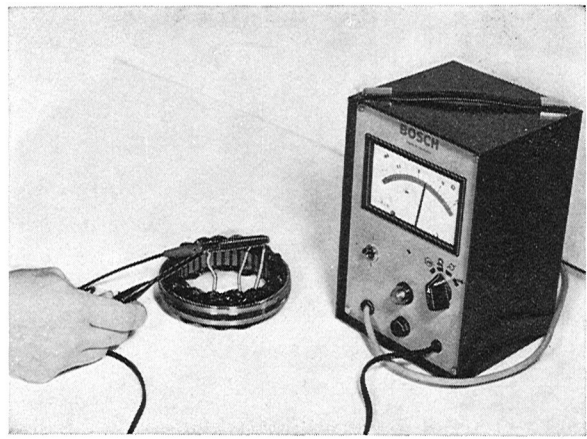
VOLVO
103 807

Fig. 3-58. Removal of drive end shield bearing



VOLVO
103 808

Fig. 3-59. Removal of positive diode plate



VOLVO
103 810

Fig. 3-61. Test of stator resistance

TEST OF DISASSEMBLED ALTERNATOR

STATOR

Check the stator insulation by connecting a 40 V alternating current between the body and a phase lead. Check the stator for breakdown by measuring the resistance between the phase leads, see Fig. 3-61.

The resistance should be .26 ohm + 10%.

ROTOR

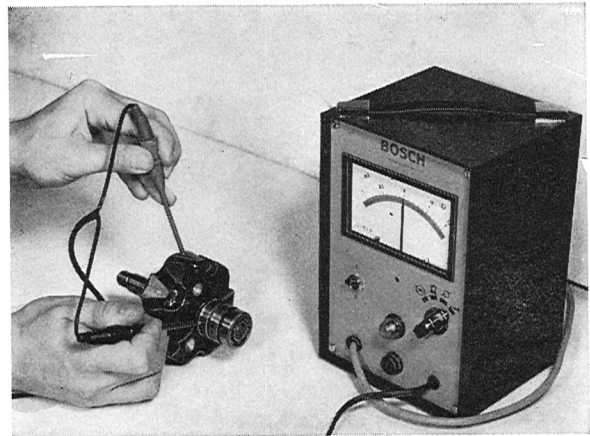
Check the rotor insulation by connecting a 40 V alternating current between the rotor frame and a slip ring, see Fig. 3-62.

Measure the resistance between the slip rings.

The resistance should be 4 ohms + 10%.

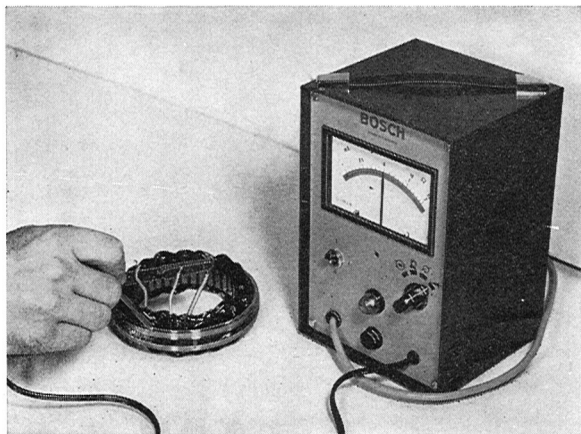
If the slip rings are burned or damaged in any other

way, they can be turned. For the turning, a tail-stock chuck should be used. The diameter of the slip rings may not be less than 31.5 mm (1.3"). After the turning, check the slip rings for possible out-of-round with a dial indicator. Max. radial throw is .03 mm (.0012").



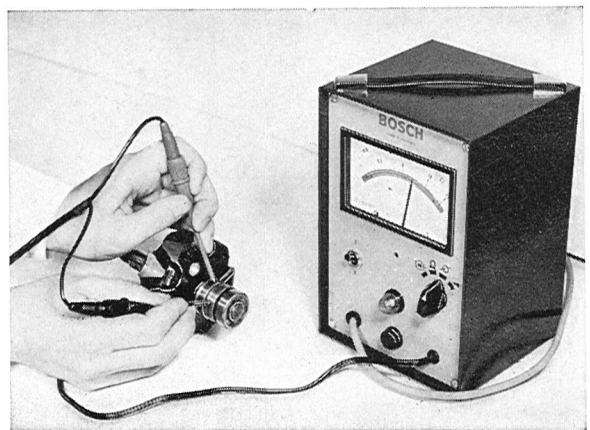
VOLVO
103 811

Fig. 3-62. Test of rotor insulation



VOLVO
103 809

Fig. 3-60. Test of stator insulation



VOLVO
103 812

Fig. 3-63. Test of rotor resistance

BRUSH HOLDER

Check the brush holder with a 40 V alternating current. Measure the length of the brush as shown in Fig. 3-64. Minimum length is 8 mm (.32").

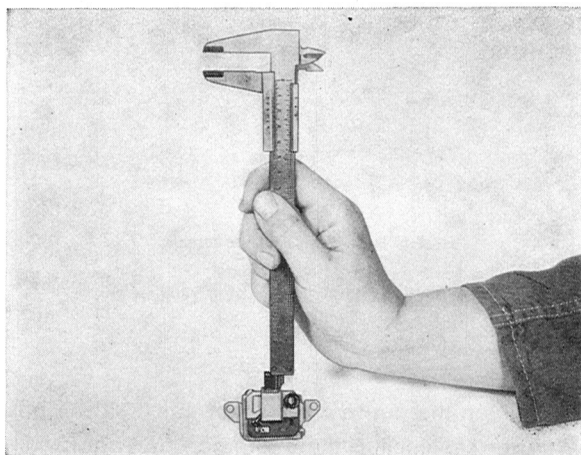


Fig. 3-64. Checking brush length

VOLVO
103813

DIODES

Check the diodes with a diode tester. If a diode is defective, replace as follows:

REPLACEMENT OF DIODES

POSITIVE DIODES

1. Solder loose the positive diode plate from the terminal points. Press out the defective diode with a suitable drift.

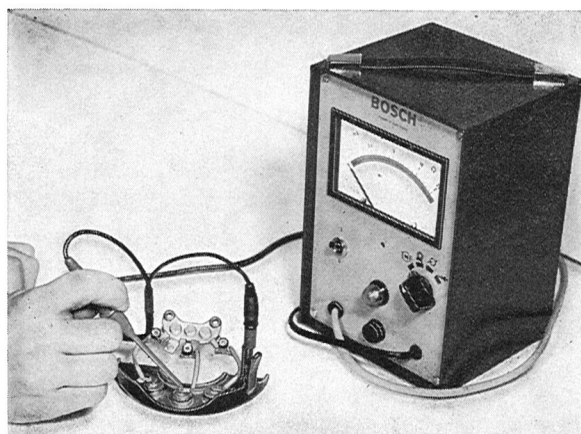


Fig. 3-65. Diode test

VOLVO
103814

2. Calibrate the hole in the positive diode plate with a suitable tool (for example, Bosch EFLJ 57/0/3 and 57/0/5).
3. Press the new diode in with a suitable tool. Before installation of the new diode, oil it with silicon oil (for example, Bosch OI 63 V 2).
4. Paint the new diode and any bare spots on the outside of the heat sink with black chlorinated rubber enamel (Bosch Ft 87 V 1 or corresponding) to prevent corrosion.
5. Solder the heat sink to its original position. Check with the diode tester.

NEGATIVE DIODES

1. Solder loose the negative diodes from the terminal points and remove the positive diode plate with the magnetizing diodes.
2. Press out the defective diode with a suitable tool.
3. Oil the new diode with silicon oil (for example, Bosch OI 63 V 2) and install it in the end shield.
4. Solder the negative diodes to the terminal points and check with the diode tester.

MAGNETIZING DIODES

1. If a magnetizing diode should be defective, replace the entire plate with all three diodes.

ASSEMBLING ALTERNATOR

1. Install the stator in the slip ring end shield and solder the stator leads to the terminal point. Install the positive diode plate.
2. Grease the drive end bearing (use Bosch Ft 1 V 4 or corresponding) and install the bearing and washer in the drive end bearing shield.

3. Press the drive end bearing shield and spacing ring on the rotor, see Fig. 3-66.

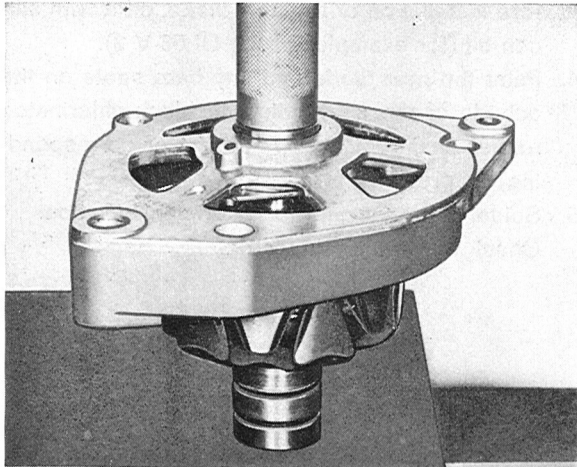


Fig. 3-66. Assembly of rotor and drive end shield

4. Grease the slip ring end shield bearing (Bosch Ft 1 V 35 or corresponding). Coat the slip ring end shield bearing seat with a light layer of Molykote paste and assemble the alternator. (Do not forget the spring ring on the slip ring end shield bearing seat.) Assemble the alternator components together with the screws and nuts. The screws should be tightened to a torque of 5.0—6.0 Nm (3.6—4.3 lbft) and the nuts to 4.5—6.0 Nm (3.3—4.3 lbft).
5. Install the brush holder.
6. Install the key, fan, spacer washer and pulley. Place the washer in position and tighten the pulley with the nut.

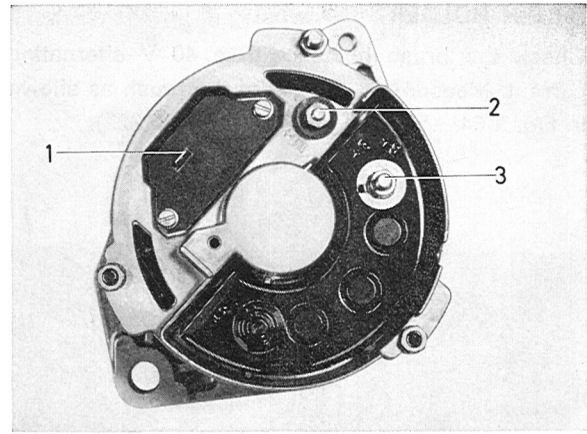


Fig. 3-67. Alternator terminals

- | | |
|----------|----------------------------|
| 1. DF | To field winding |
| 2. 61/D+ | From magnetizing rectifier |
| 3. B+ | To battery |

7. Tighten the nut to a torque of 40 Nm (29.0 lbft). After assembling the alternator, test-run it on a test bench before installation in the vehicle.

ALTERNATOR INSTALLATION

1. Install the alternator and the fan belt at the same time.
2. Install the attaching bolts and tensioning iron without tightening it.
3. Adjust the belt tension (see Section 2, Engine, Group 26) and secure the alternator.
NOTE: Force may only be applied to the front end of the alternator when adjusting the belt tension.
4. Re-install the leads to the alternator.
5. Re-install the negative lead to the battery.