

Section 3

**ELECTRICAL SYSTEM
AND
INSTRUMENTS**

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Wiring Diagrams

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 amperehours 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.

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.

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

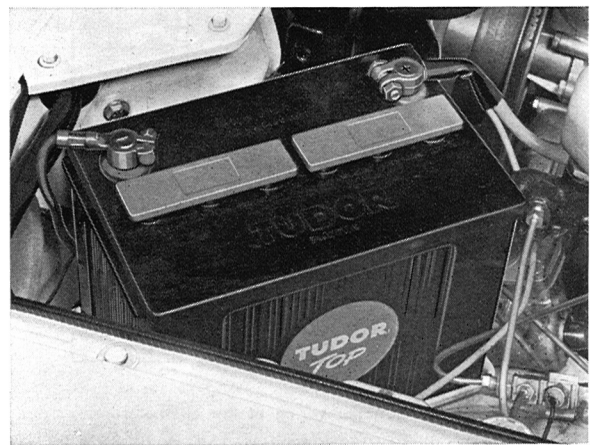


Fig. 3-1. Battery

VOLVO
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GROUP 32

ALTERNATOR

S.E.V. MARSHALL 14 V — 71270202

GENERAL INFORMATION

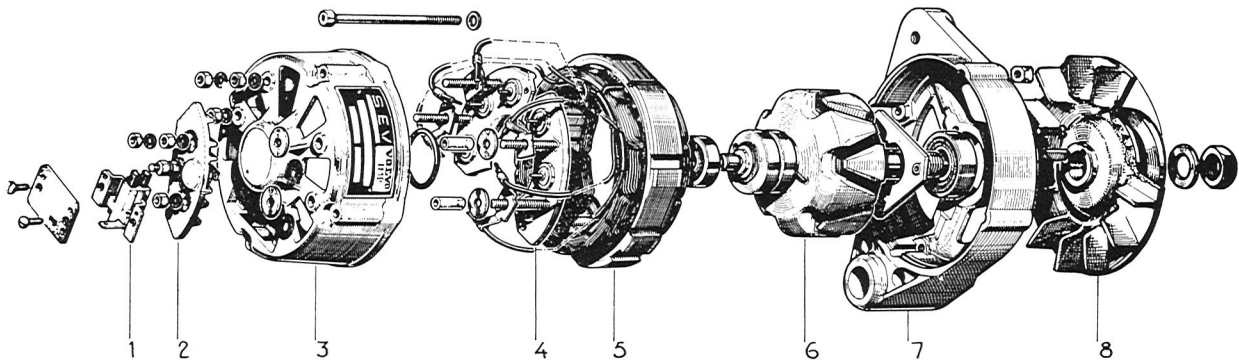


Fig. 3-2. S.E.V. Marshall alternator disassembled

- | | | |
|---------------------------------|-------------------------------|---------------------|
| 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
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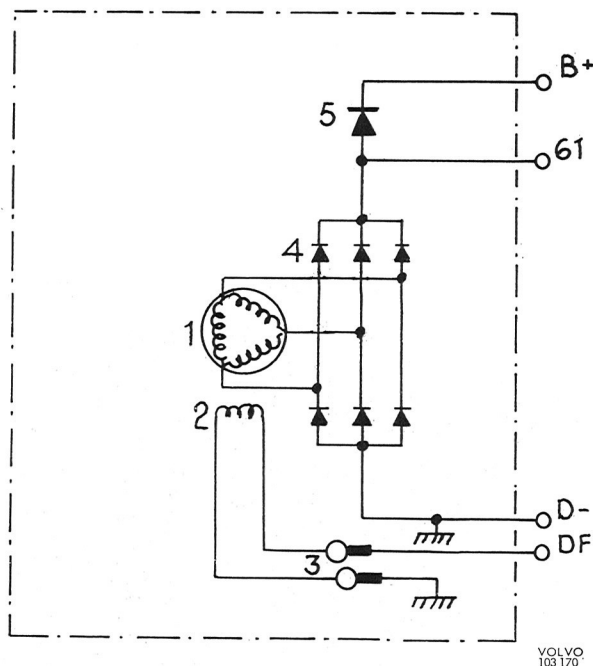


Fig. 3-3. Inner wiring of the alternator

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

VOLVO
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(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).

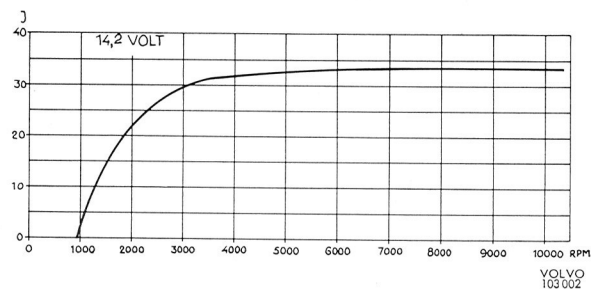


Fig. 3-4. Output curve for alternator

VOLVO
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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.

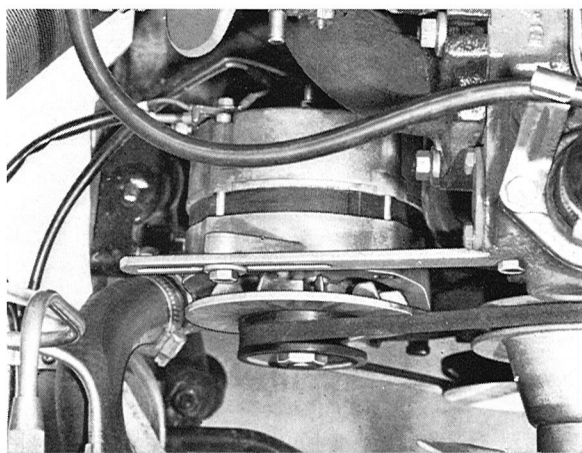


Fig. 3-5. Alternator

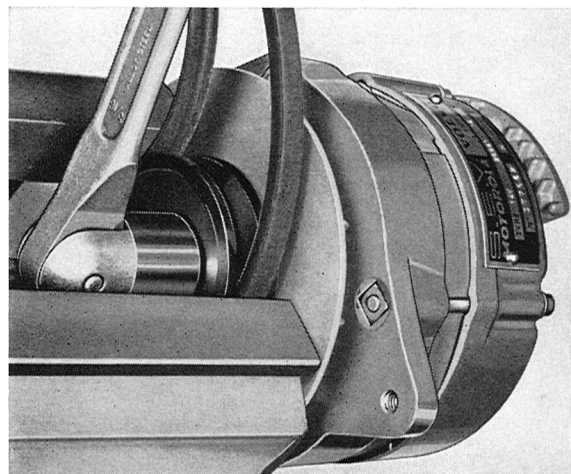
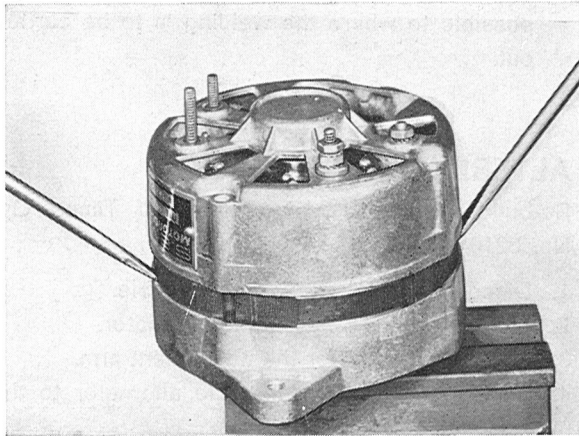


Fig. 3-6. Pulley nut removal

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.

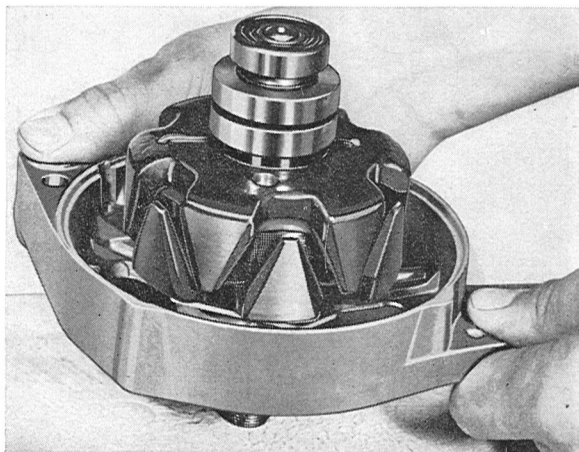


VOLVO
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Fig. 3-7. Alternator disassembly

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
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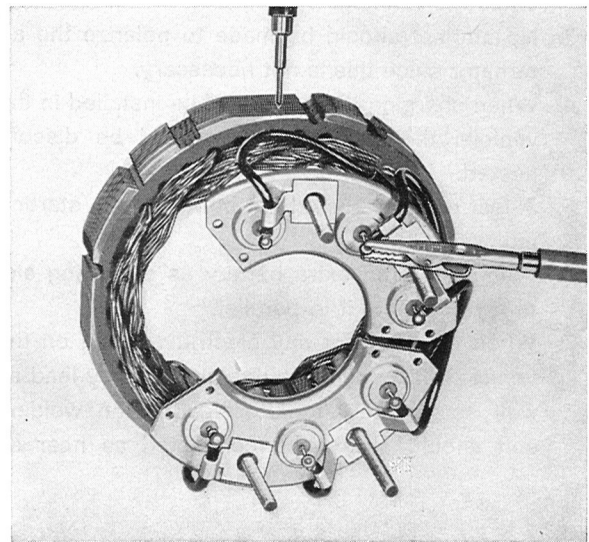
Fig. 3-8. Drive end shield removal

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.

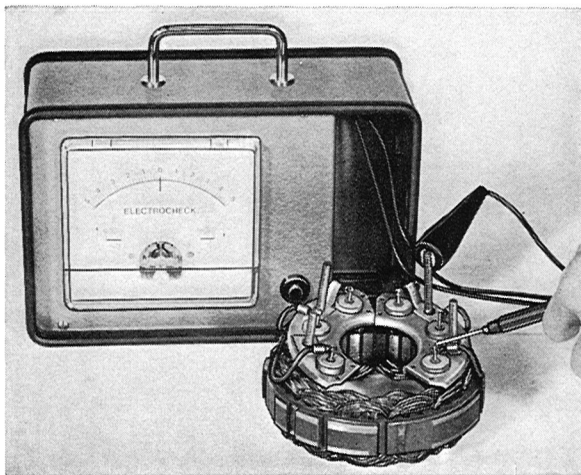


VOLVO
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Fig. 3-9. Stator test

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.

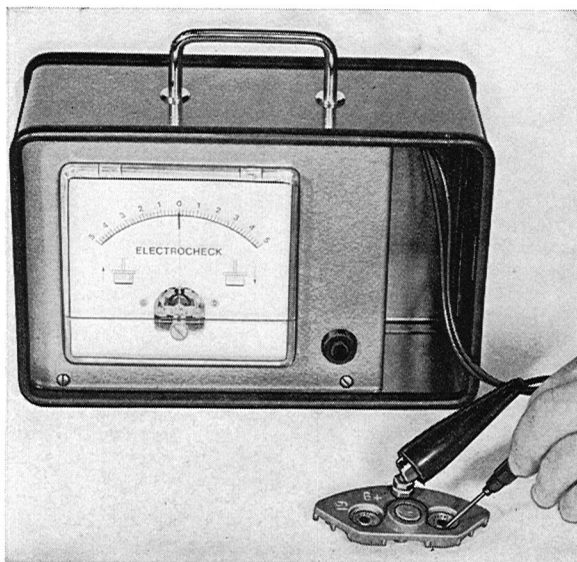


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Fig. 3-10. Diode test

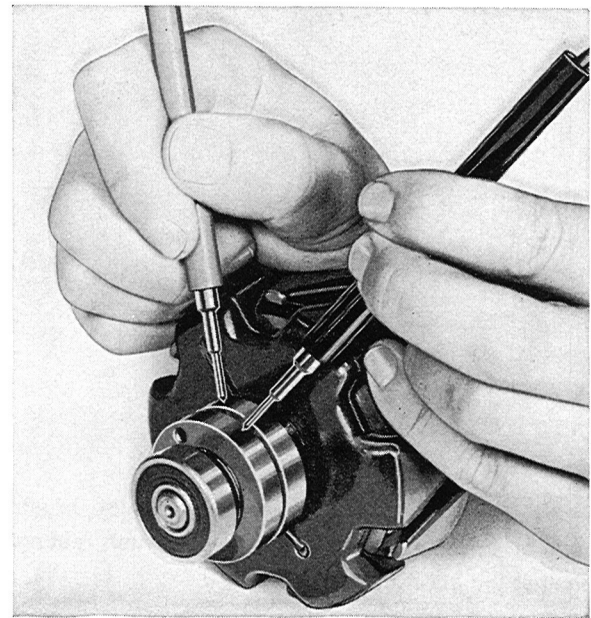
Check the diodes with a diode tester, see Fig. 3-10. If any of the rectifiers is defective, the entire diode holder (with three diodes) must be replaced. If the insulation diode is defective, replace the holder, complete with insulation diode.

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
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Fig. 3-11. Diode insulation test



VOLVO
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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.

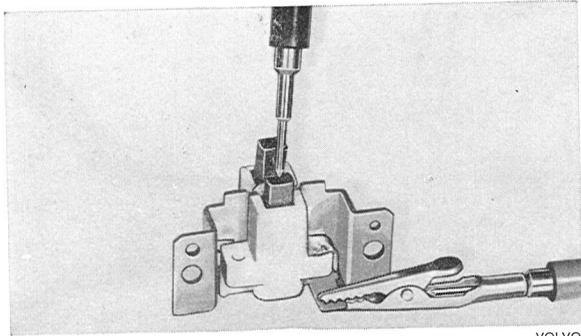


Fig. 3-13. Brush holder test

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

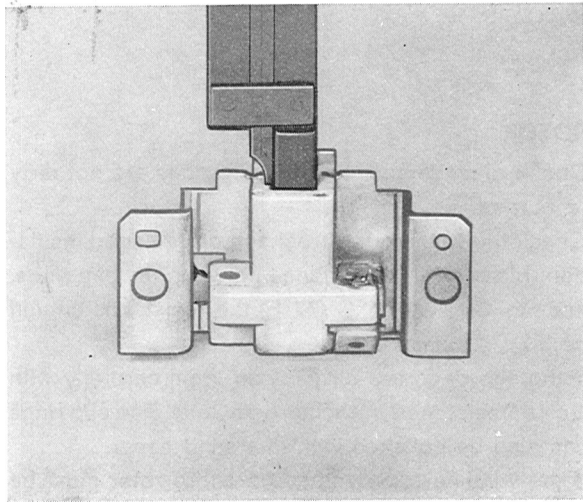


Fig. 3-14. Measuring brush length

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.

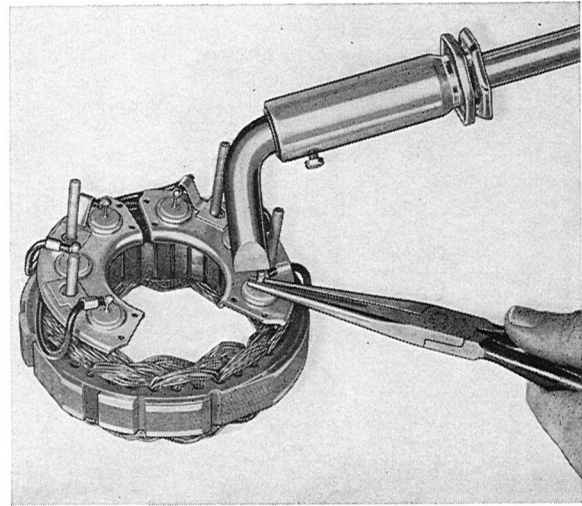


Fig. 3-15. Soldering diodes

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.

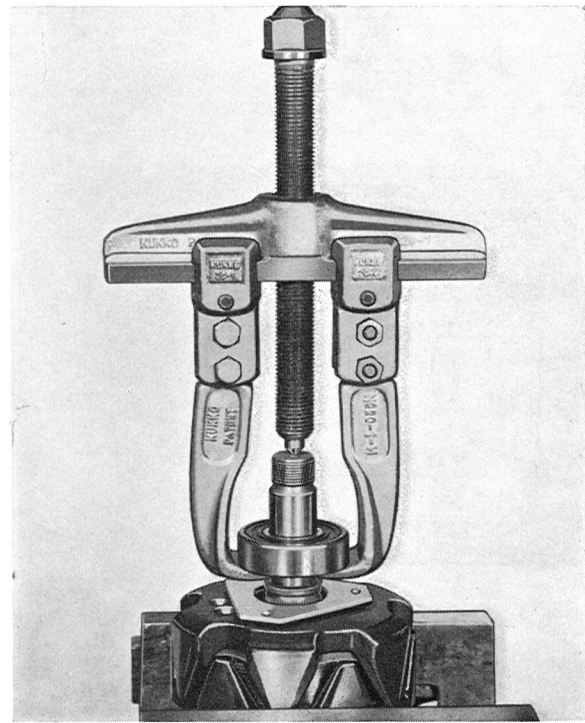


Fig. 3-16. Bearing removal

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.

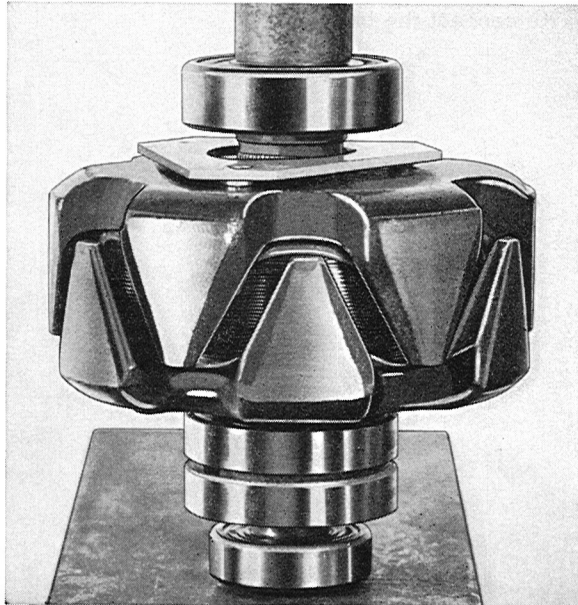


Fig. 3-17. Bearing installation

SLIP RING END BEARING

Removal

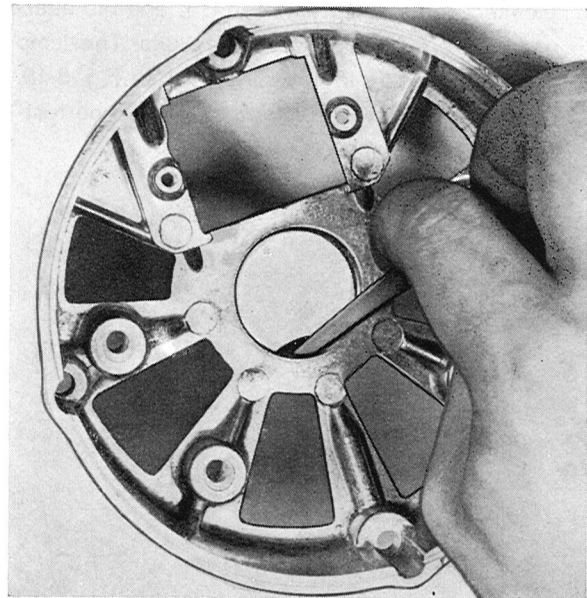
1. Place the rotor in a vise with soft jaws.
2. Pull the bearing off with a claw puller.

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.



VOLVO
103019

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.

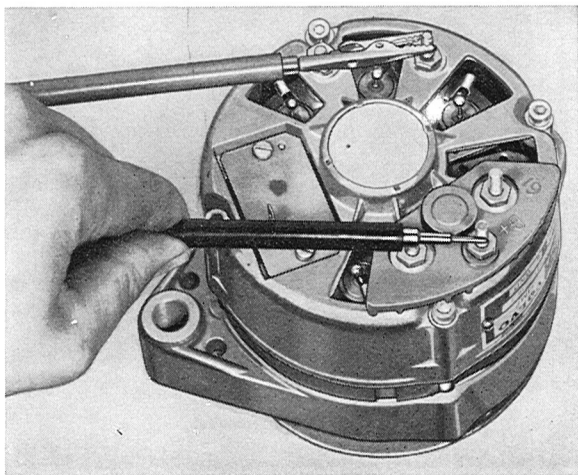


Fig. 3-19. Alternator test

VOLVO
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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

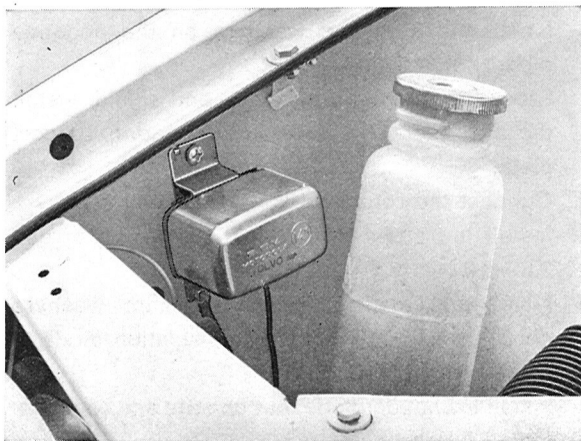


Fig. 3-20. Voltage regulator installed

VOLVO
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(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.

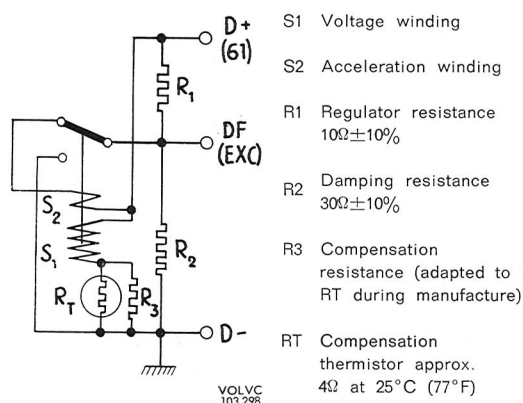


Fig. 3-21. Inner wiring of regulator

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.

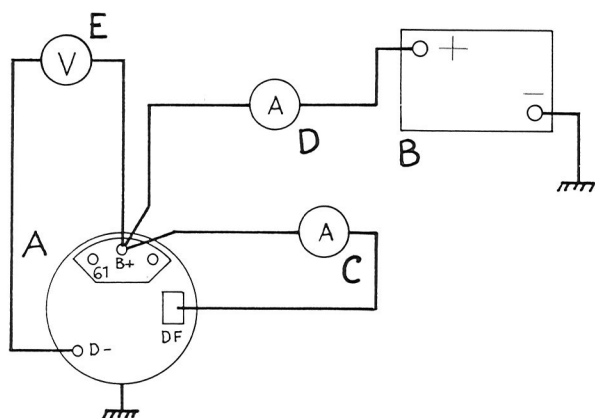


Fig. 3-22. Wiring diagram for alternator test

- | | |
|----------------------|-------------------------|
| 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.

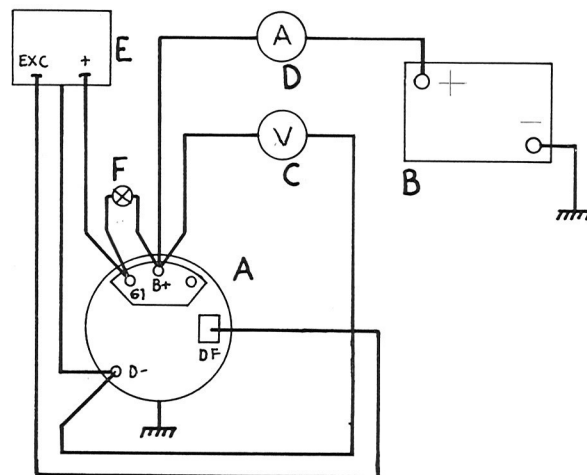
The voltage should be .8—.9 volt higher at terminal 61, otherwise the insulation diode is faulty and should be replaced.

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).



VOLVO
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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. | |

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.

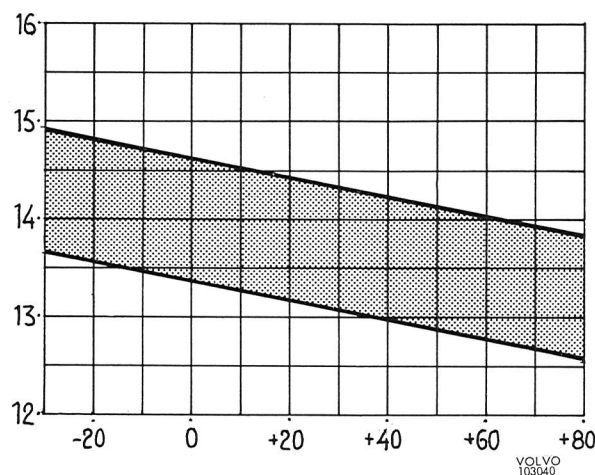


Fig. 3-24. Voltage-temperature diagram for cold voltage regulator

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.

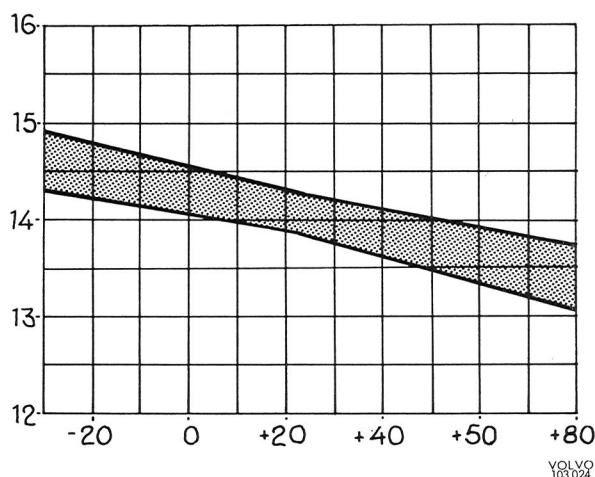


Fig. 3-25. Voltage-temperature diagram for warm voltage regulator

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

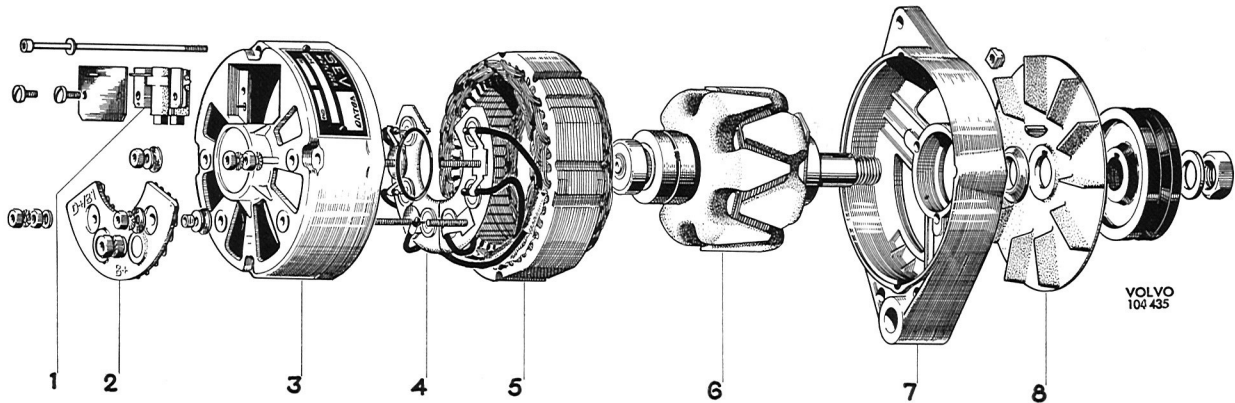


Fig. 3-26. Exploded view of alternator

- | | |
|----------------------------------|---------------------|
| 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.

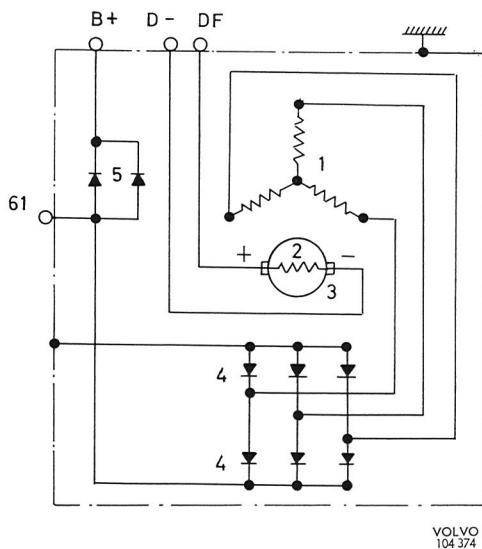


Fig. 3-27. Alternator inner circuit

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

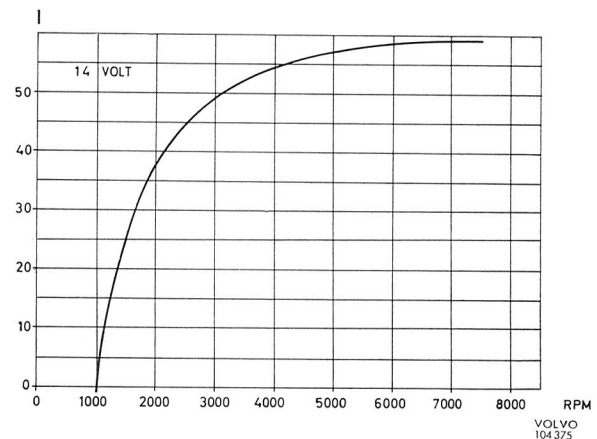


Fig. 3-28. Alternator output curve

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.

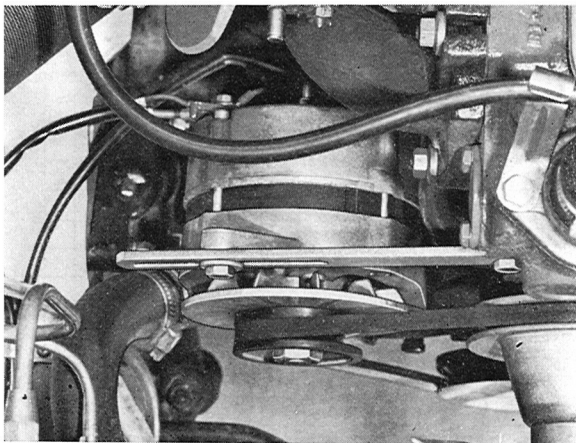


Fig. 3-29. Alternator

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.

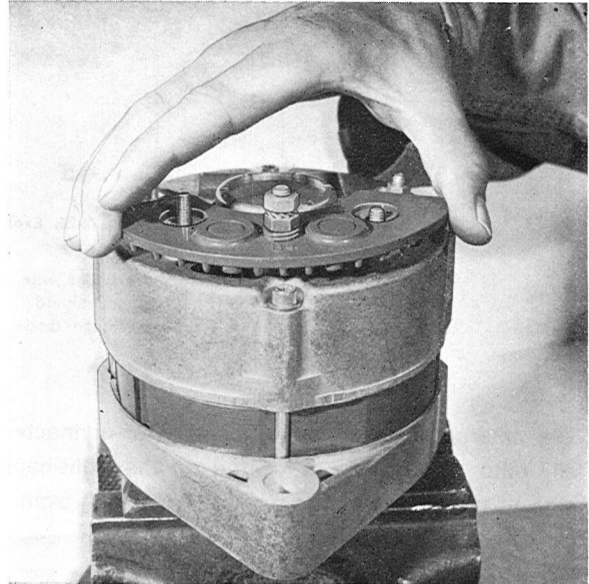


Fig. 3-30. Removal of insulation diodes

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.

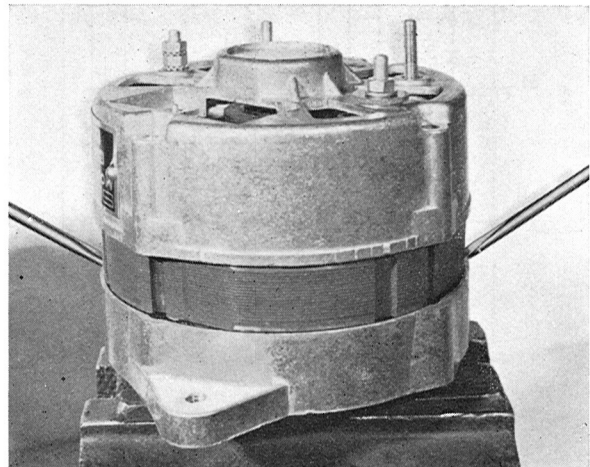


Fig. 3-31. Alternator disassembly

VOLVO
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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.

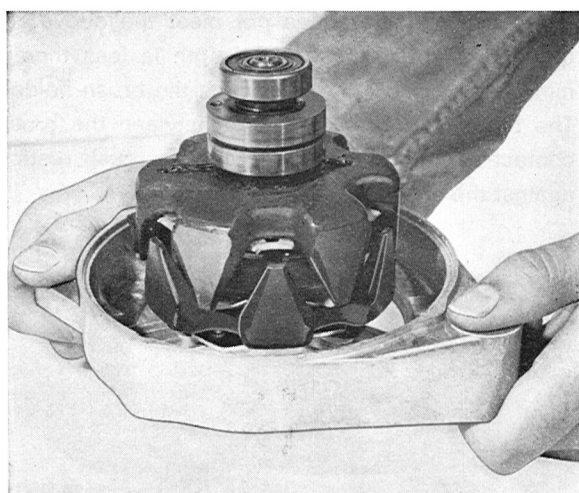


Fig. 3-32. Shield removal

VOLVO
104472

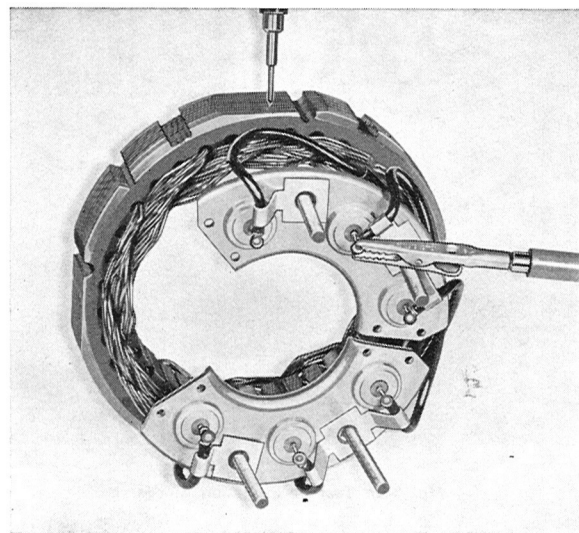
TEST OF DISASSEMBLED ALTERNATOR

STATOR

Check the stator for chort 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, se Fig. 3-34. If any of the rectifier diodes is defective, the entire



VOLVO
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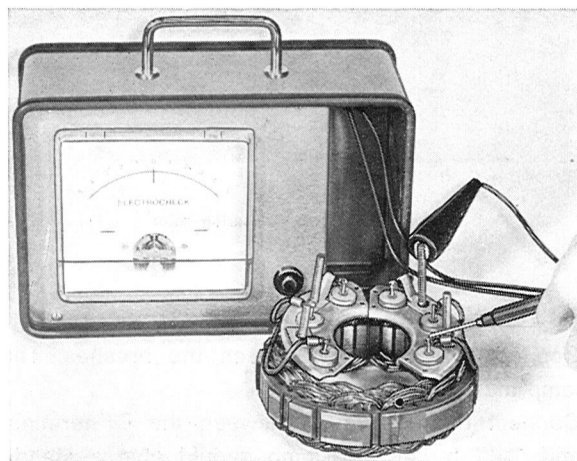
Fig. 3-33. Test of stator

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.



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Fig. 3-34. Test of diodes

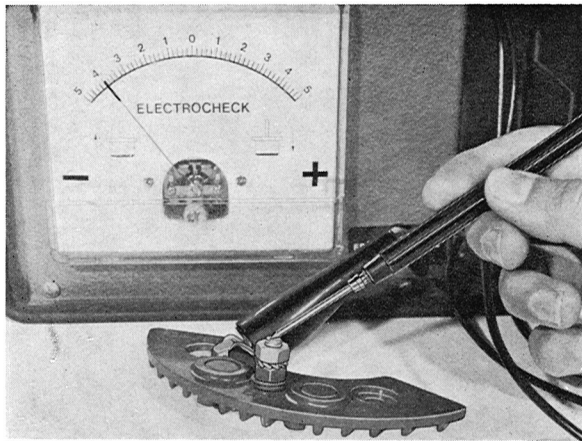


Fig. 3-35. Test of insulation diodes

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.)

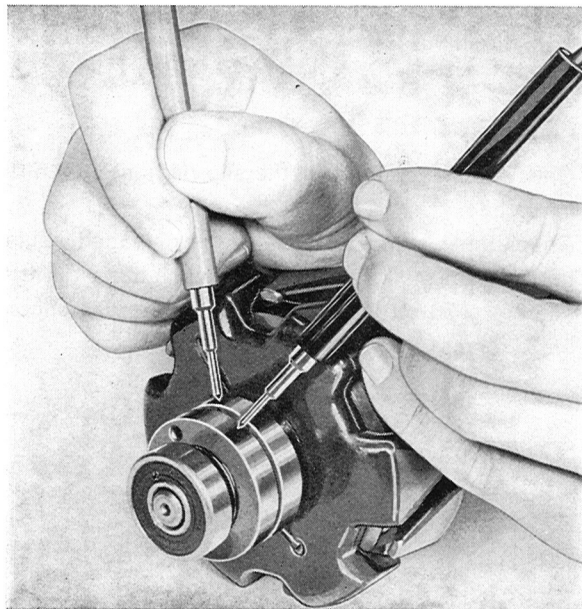


Fig. 3-36. Check-measuring rotor

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.

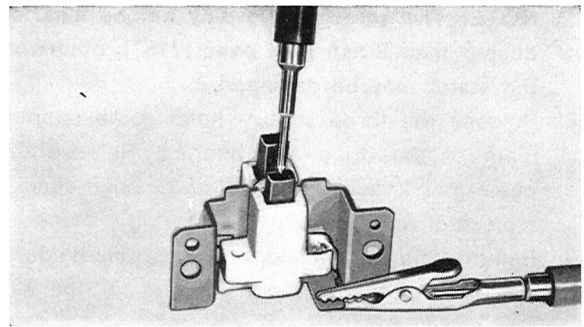


Fig. 3-37. Test of brush holder

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.

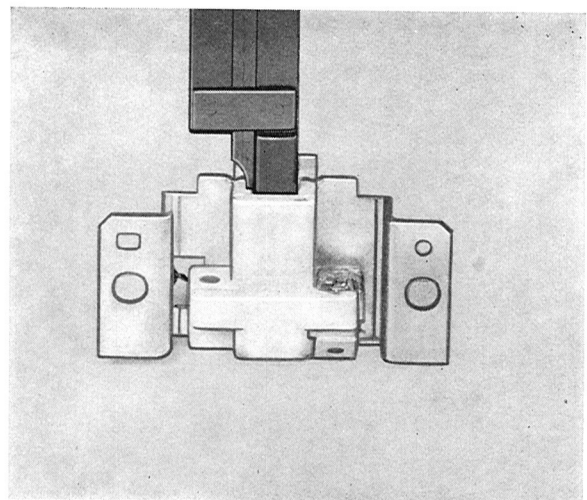


Fig. 3-38. Measuring brush length

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.

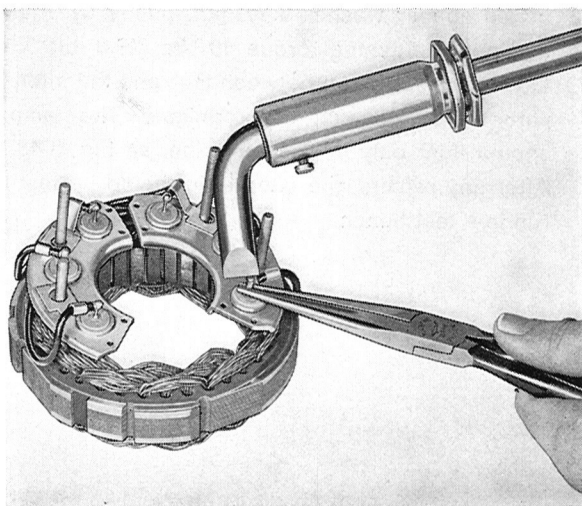


Fig. 3-39. Soldering on diodes

VOLVO
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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

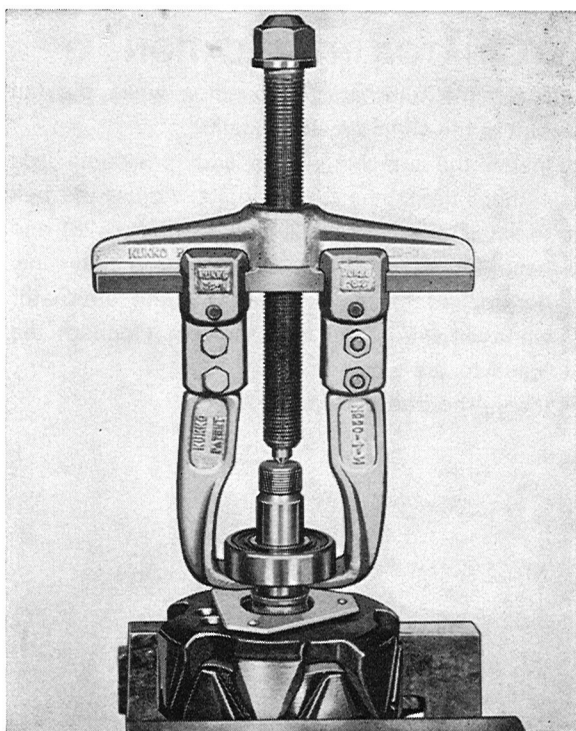


Fig. 3-40. Bearing removal

VOLVO
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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.

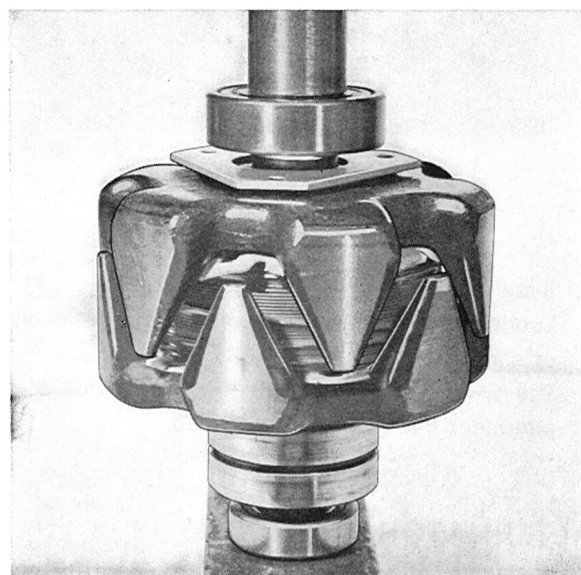


Fig. 3-41. Bearing installation

VOLVO
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SLIP RING END BEARING

Removal

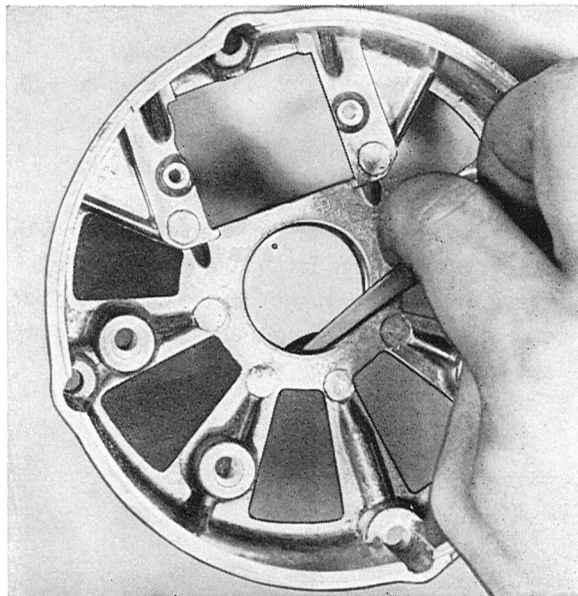
1. Place the rotor in a vise with soft jaws.
2. Pull the bearing with a claw puller.

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.



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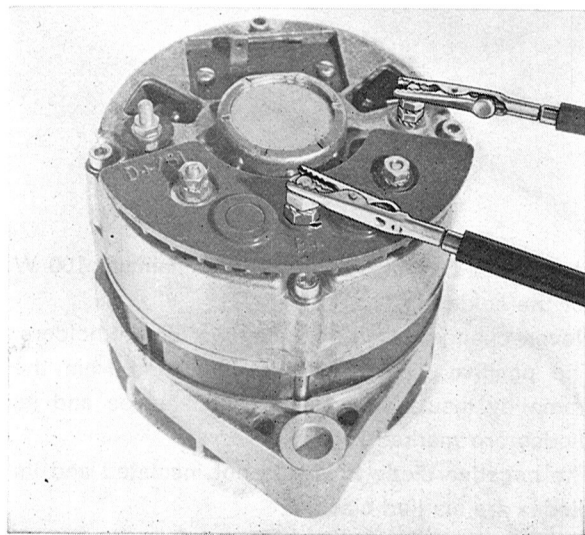
Fig. 3-42. O-ring removal

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.



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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.

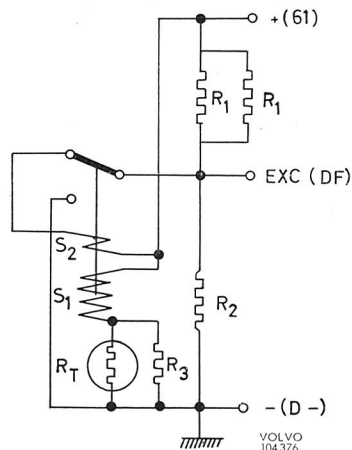


Fig. 3-45. Inner wiring of regulator

- S1 Voltage winding
- S2 Acceleration winding
- R1 Regulator resistances (2)
 $10\Omega \pm 10\%$
- R2 Damping resistance
 $3000\Omega \pm 10\%$
- 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.

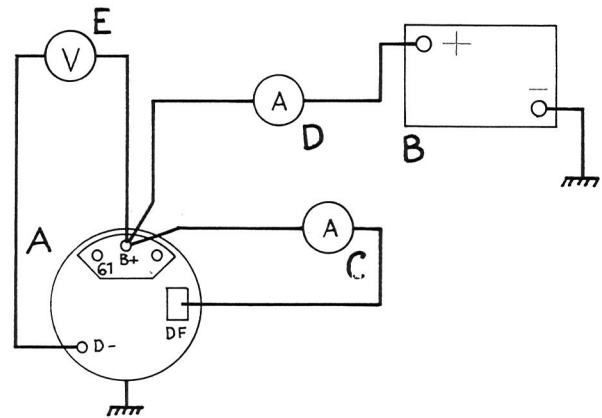
TEST OF VOLTAGE DROP

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.



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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

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.

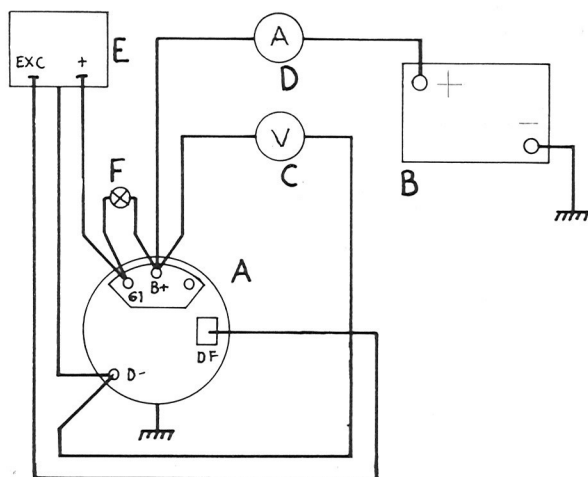
The voltage should be .8—.9 volt more than at terminal 61, otherwise the insulation diode is defective and should be replaced.

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).

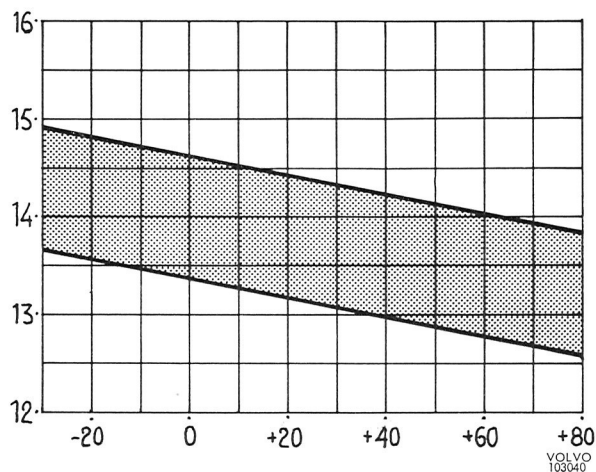


VOLVO
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Fig. 3-47. Wiring diagram for testing voltage regulator

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

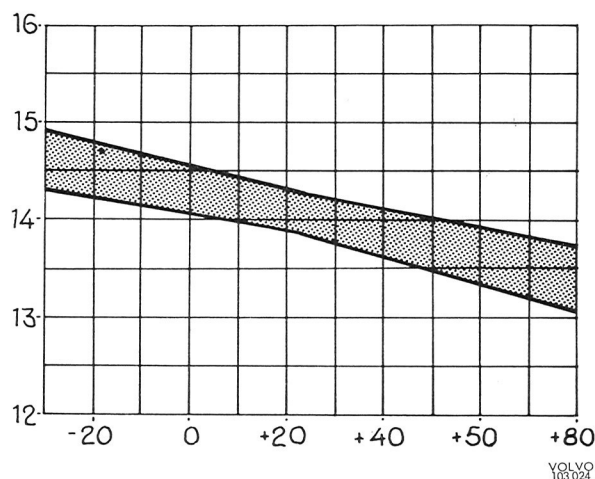
If the voltage is outside the tolerance limits, the regulator should be replaced.

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
103 024

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

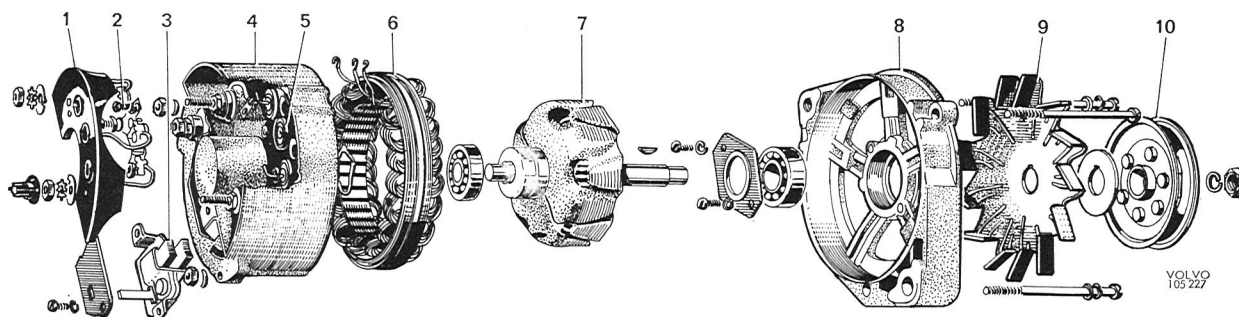


Fig. 3-50. Bosch alternator dismantled

- | | | |
|---------------------------------|--------------------------------|---------------------|
| 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.

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

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.

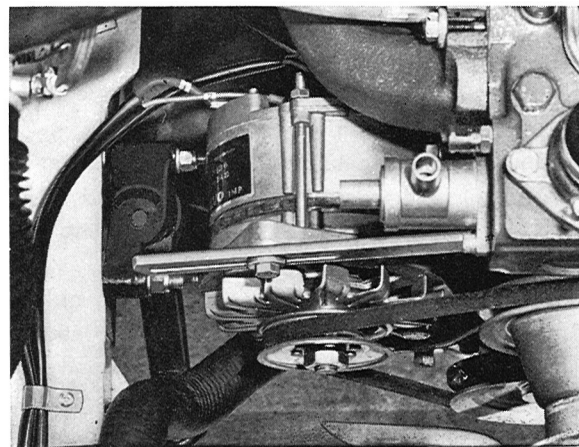


Fig. 3-51. Alternator

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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

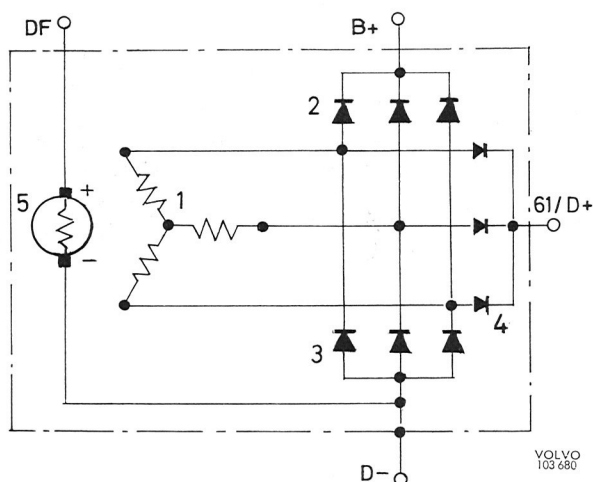


Fig. 3-52. Inner wiring of alternator

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

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.

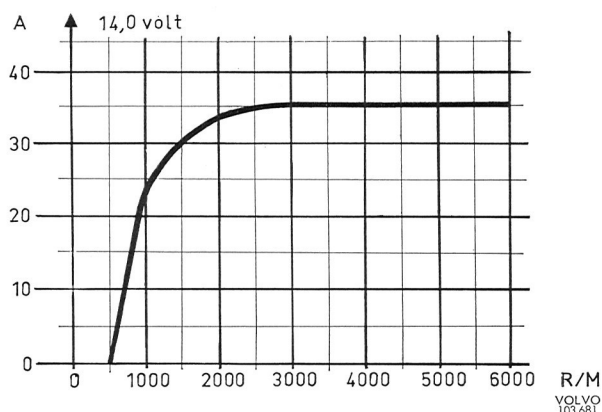


Fig. 3-53. Alternator output curve

A=amps. RM=alternator speed/minute

SERVICE PROCEDURES

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or installing the battery, make sure that the proper polarity is observed when connecting the new battery.
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 about to charge the battery installed in the vehicle, disconnect the battery ground cable.
5. When using an extra battery as a starting aid, always connect it in parallel.
6. 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

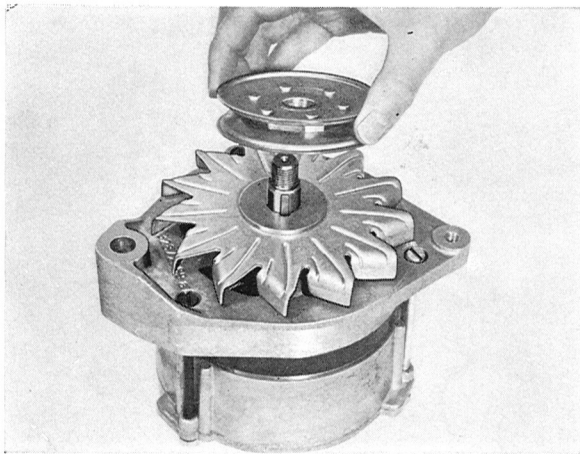
Replace alternator=Volvo Standard Times Op. No. 32102

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

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

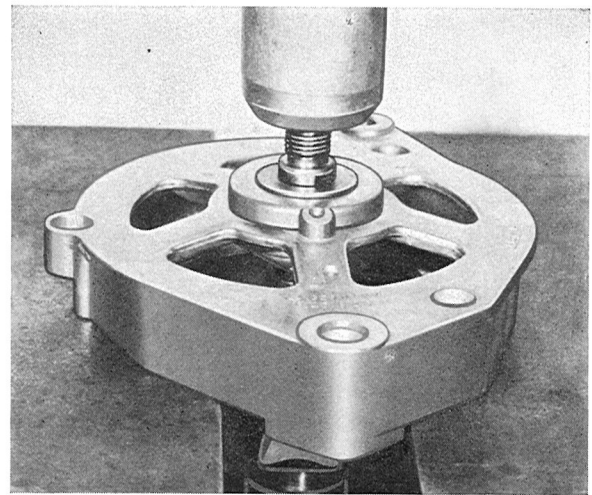
ALTERNATOR DISASSEMBLY

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



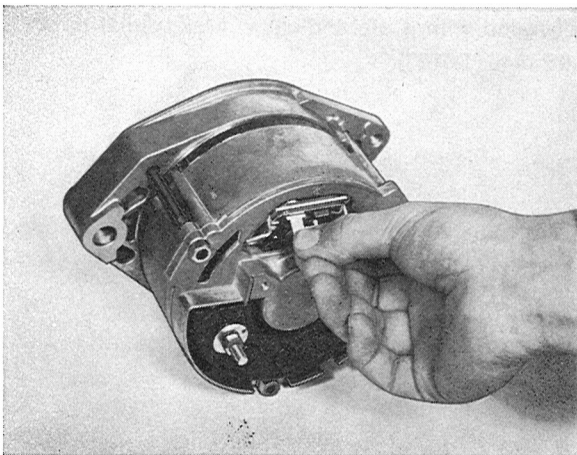
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Fig. 3-54. Pulley removal



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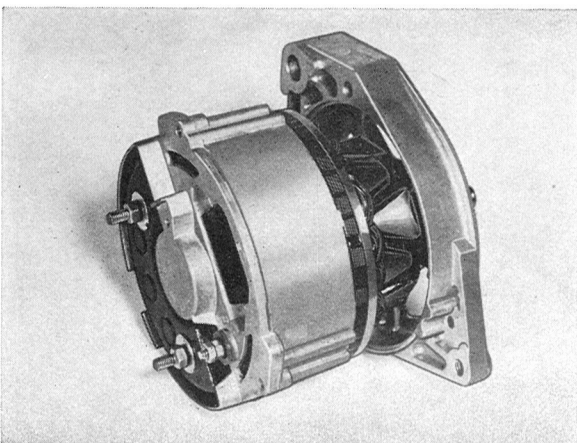
Fig. 3-57. Rotor removal



VOLVO
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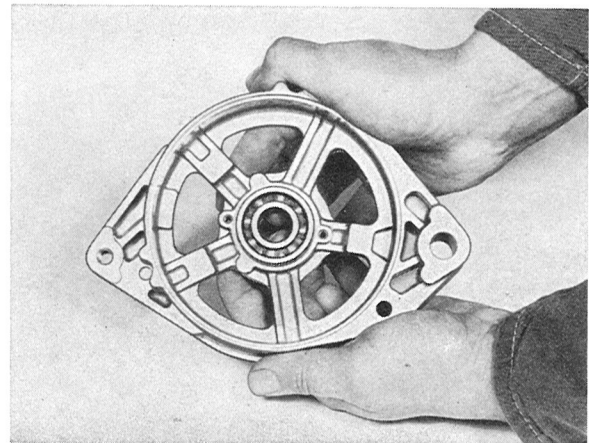
Fig. 3-55. Removal of brush holder

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

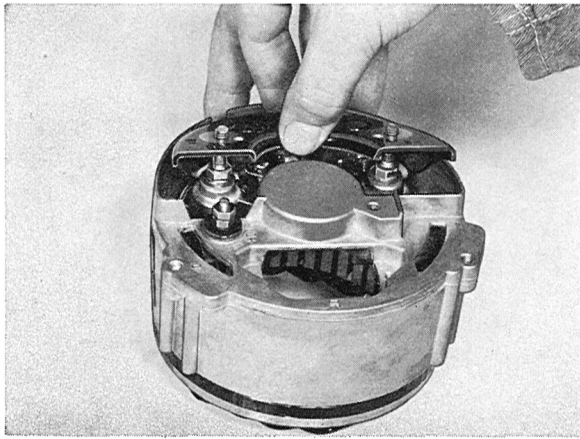


Fig. 3-59. Removal of positive diode plate

VOLVO
103 808

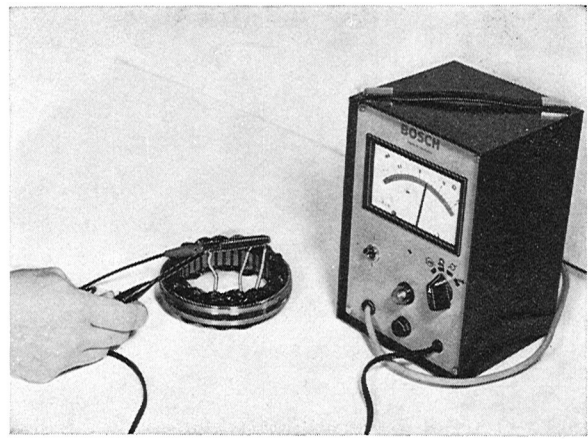


Fig. 3-61. Test of stator resistance

VOLVO
103 810

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 $.26 \text{ ohm} + 10\%$.

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 $4 \text{ ohms} + 10\%$.

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").

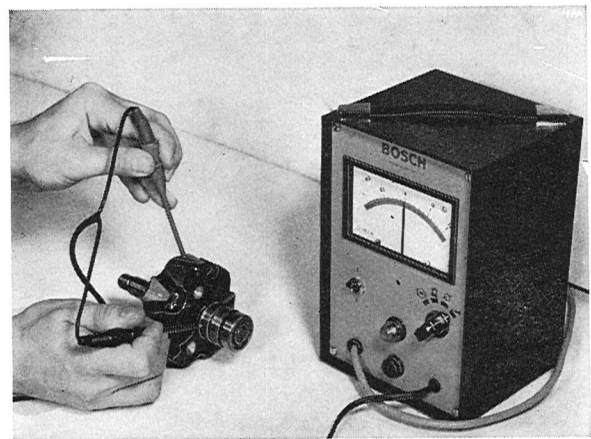


Fig. 3-62. Test of rotor insulation

VOLVO
103 811

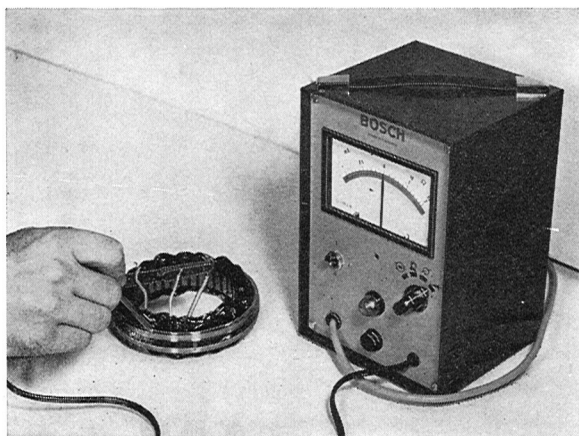


Fig. 3-60. Test of stator insulation

VOLVO
103 809

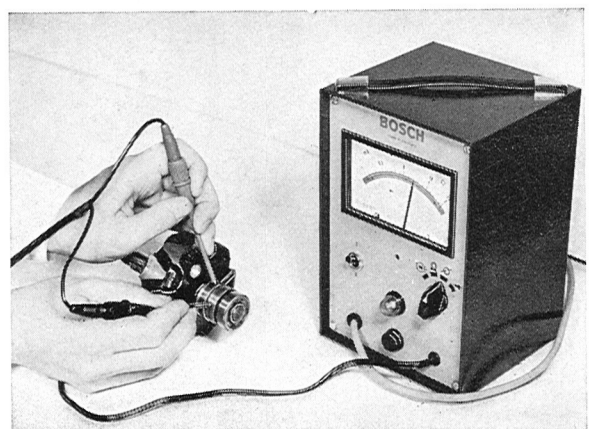


Fig. 3-63. Test of rotor resistance

VOLVO
103 812

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").

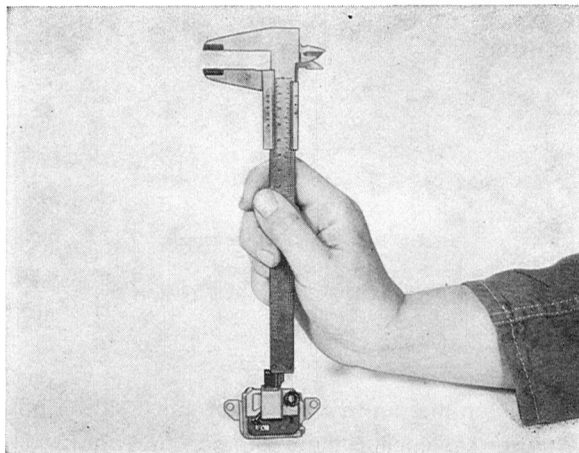


Fig. 3-64. Checking brush length

VOLVO
103 913

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.

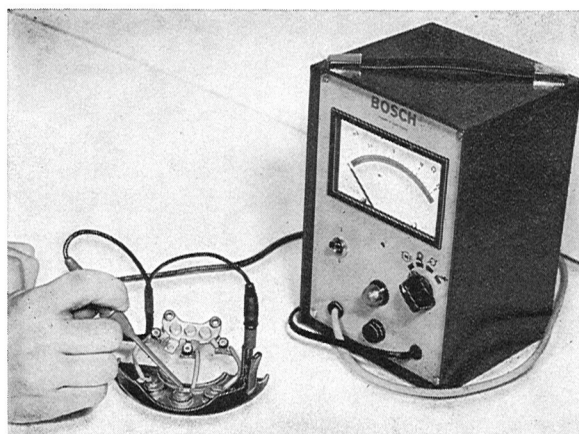


Fig. 3-65. Diode test

VOLVO
103 914

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.

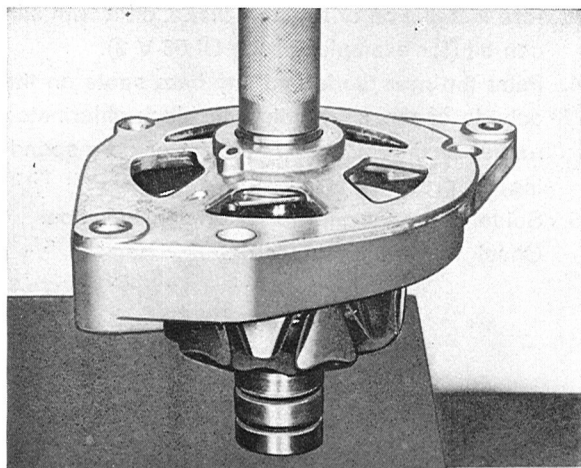
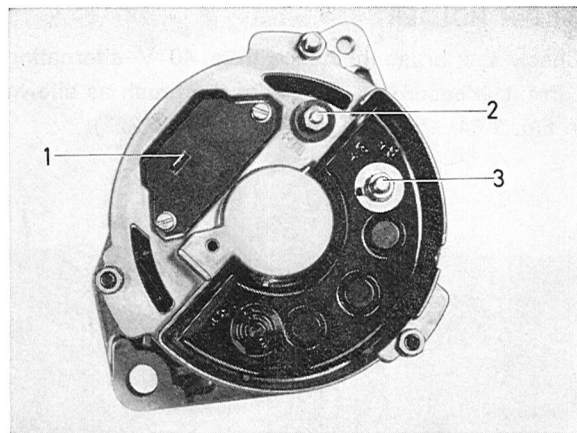


Fig. 3-66. Assembly of rotor and drive end shield

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.



VOLVO
103 816

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.

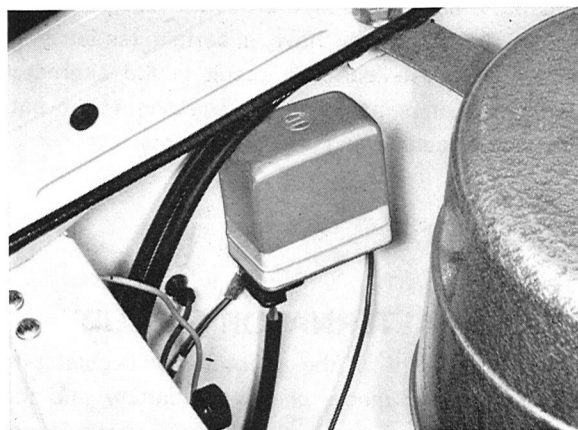
VOLTAGE REGULATOR

BOSCH

GENERAL INFORMATION

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

The voltage regulator is located on the wheel housing at a bracket behind the headlamp, see Fig. 3-68. It is a mechanical, single-pole voltage regulator with a lower contact, a movable contact and an upper contact, see Fig. 3-72. It is connected to the charging circuit by a three-pole plug. The regulator resistance is placed under a plate underneath the regulator. Temperature compensation is operated by a bimetallic spring which influences the spring tension so that the regulator receives lower regulating voltage at higher temperatures.



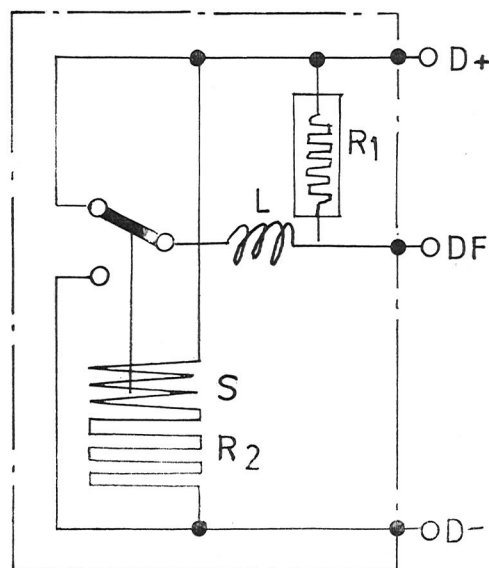
VOLVO
105 196

Fig. 3-68. Voltage regulator

SERVICE PROCEDURES

VOLTAGE REGULATOR REPLACEMENT

1. Disconnect the battery ground cable.
 2. Pull the plug out of the voltage regulator.
 3. Remove the screws and change the regulator.
 4. Install the new regulator and insert the plug.
 5. Reconnect the battery ground cable.
- Concerning regulator adjustment, see under "Test the voltage regulator".



VOLVO
103 682

Fig. 3-69. Inner wiring of voltage regulator

- S Voltage coil 35 Ω
R¹ Regulator resistance 2.45 Ω
R² Compensation resistance 50 Ω
L Contact impedance coil

TEST OF ALTERNATOR AND VOLTAGE REGULATOR

For all tests of alternator equipment, fixed clamps should be used. 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. Disconnect the battery before connecting any instruments.

TEST OF ALTERNATOR CIRCUIT

Before any tests on the alternator or regulator in the vehicle are made, check the battery and the vehicle wiring for fault in the leads or insulation, loose or corroded lead terminals and poor ground. **Check the fan belt.** Any of the fault just mentioned must be repaired before the electrical checks are 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 made with a fully charged battery in good condition. The battery connections 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 cable or contact, which must be remedied immediately. After repairing defective leads or contacts, measure 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)

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

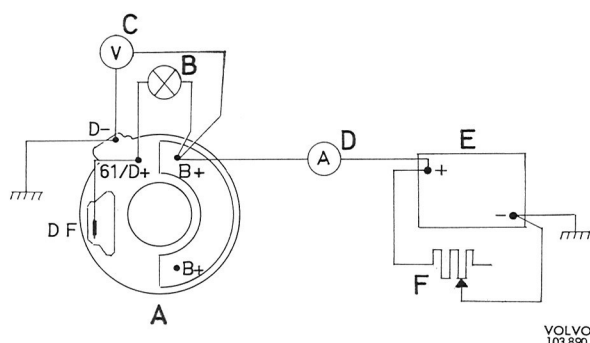


Fig. 3-70 Wiring diagram for testing alternator

- | | |
|-----------------------------------|---------------------------|
| A. Alternator | D. Ammeter 0—50 amps. |
| B. Control lamp 12 volts, 2 watts | E. Battery 60 amperehours |
| C. Voltmeter 0—20 volt | F. Load resistance |

Connect the alternator as shown in Fig. 3-70. Run it to a speed of 100 r/s (6000 r/m). Regulate the voltage to about 14 volts by means of the load resistance F. The alternator should produce 35 amps at 100 r/s (6000 r/m) and a voltage of 14 volts.

At the same time check to make sure that the charging warning lamp does not light or glow. If the alternator does not meet the above requirements, first check the brushes and diodes.

TEST AND ADJUSTMENT OF VOLTAGE REGULATOR

(In a test bench or in the vehicle)

Connect up the regulator to an alternator in good condition as shown in Fig. 3-71.

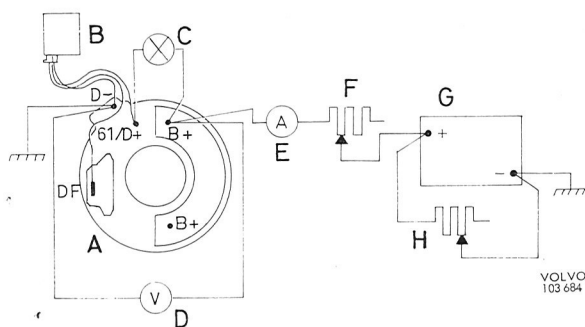


Fig. 3-71. Wiring diagram for testing voltage regulator

- | | |
|--------------------------------------|---------------------------|
| A. Alternator | E. Ammeter 0—50 amps. |
| B. Voltage lamp 12 volts | F. Regulator resistance |
| C. Control lamp 12 volts,
2 watts | G. Battery 60 amperehours |
| D. Voltmeter 0—20 volts | H. Load resistance |

Run the alternator to a speed of 67 r/s (4000 r/m) (engine speed 33.5 r/s (2000 r/m). Load the alternator with approx. 28—30 amps.

Rapidly lower the alternator speed to about 16.9 r/s (1000 r/m) (in vehicle, idling speed), raise the speed again to 67 r/s (4000 r/m) engine speed 33.5 r/s (2000 r/m) and adjust the load to approx. 28—30 amps. Read the voltmeter. The voltage should be 14.0—15.0 volts and the regulator should be regulated on the left (lower) contact (1, Fig. 3-72).

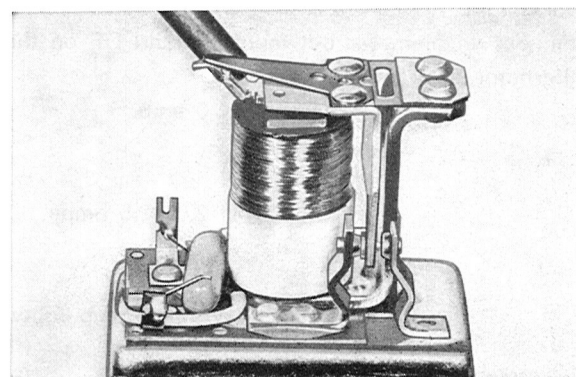


Fig. 3-73. Adjustment of voltage regulator

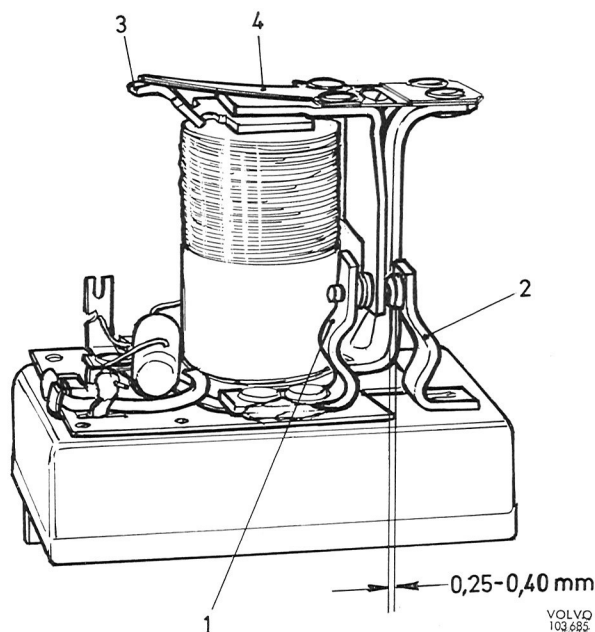


Fig. 3-72. Voltage regulator

- | | |
|--|---|
| 1. Regulator contact for
lower control range
(lower contact) | 3. Spring tensioner |
| 2. Regulator contact for
upper control range
(upper contact) | 4. Spring upper section:
Steel spring
Lower section:
Bi-metal spring |

If the tensioner is bent downwards, the regulating voltage should drop, if bent upwards the opposite should be the effect. If the regulating voltage in the upper regulating range is too high or too low in relation to the lower regulating range (0 volt to minus .3 volt) this is adjusted by bending the holder for the left (lower) contact and correcting at the same time the gap between the right (upper) contact and the movable contact according to Fig. 3-72.

If the holder is bent towards the right (upper) contact, the regulating voltage in the upper regulating range will drop. To avoid faulty adjustments due to residual magnetism in the regulator core, it is necessary to reduce the alternator speed down towards 0 after each adjustment and then increase the speed and make a new reading.

(If the adjusting is comprehensive and the regulator is warm, it can be suitably cooled to ambient temperature by means of compressed air before the final reading is made.)

SERVICE DIAGNOSIS

CONDITION

ACTION

POSSIBLE CAUSE

Warning lamp does not light with engine off.

Test lamp (12 volts 2 watts) between B+ and 61/D+ on alternator lights.

Warning lamp burned out or open circuit to D+ on regulator.

Test lamp between B+ and 61/D+ does not light.
Test lamp between 61/D+ and ground lights.

A positive diode shorted.

Test lamp between 61/D+ and ground gives a weak light. Remove the plug at the regulator and connect an ammeter between B+ and DF on the alternator. The ammeter shows:

0 amp.

Worn brushes, oxide on slip rings or breakage in rotor winding.

2.0—2.5 amps.

Open circuit in regulator or in lead DF from regulator to DF on alternator.

Warning lamp lights with engine off or running.

Disconnect the plug at the regulator:
Control lamp still lights.

Circuit shorted between D+ on the regulator and 61/D on the alternator.

Warning lamp goes out. Re-install the plug in the regulator and connect an ammeter between B+ and D+ on the alternator.

Read off the value on the ammeter:

Less than 2.0—2.5 amps.

Defective regulator (breakage).

Greater than 2.0—2.5 amps.

Circuit shorted between DF on the regulator and DF on the alternator.
Coil shorted.

Warning lamp lights with engine off but starts to give a weak light when engine is running.

Test lamp between B+ and 61/D+ on the alternator with the engine running:

Does not light.

Transition resistance in the charging circuit or in the lead to the warning lamp.

Gives a weak light.

Defective regulator (overcharging of the battery) or defective alternator (insufficient charging of the battery).

Install new regulator.

Test lamp between B+ and 61/D+ :

Does not light.

Removed regulator defective.

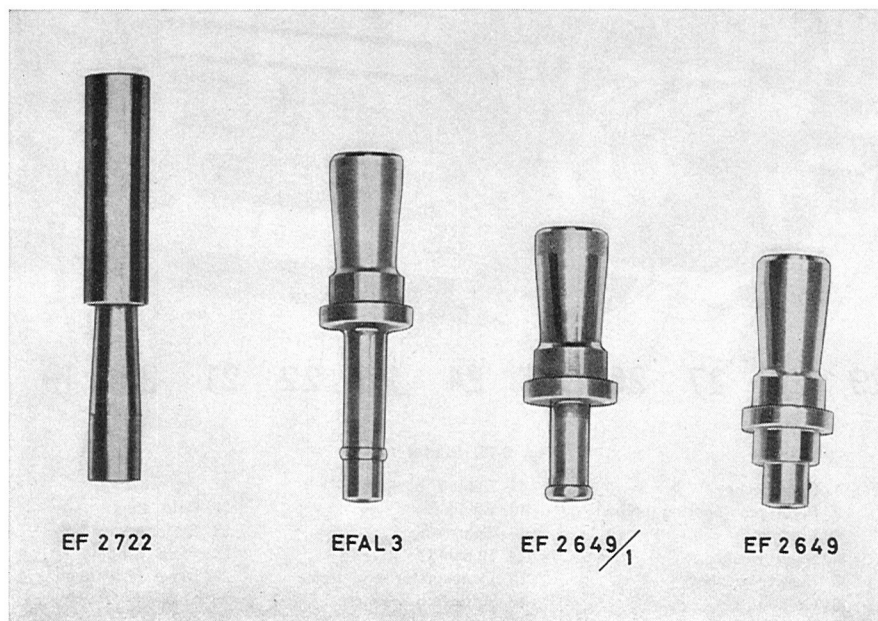
Gives a weak light.

Defective alternator.

GROUP 33

STARTER MOTOR

TOOLS



VOLVO
103 299

Fig. 3-74. Bosch special tools

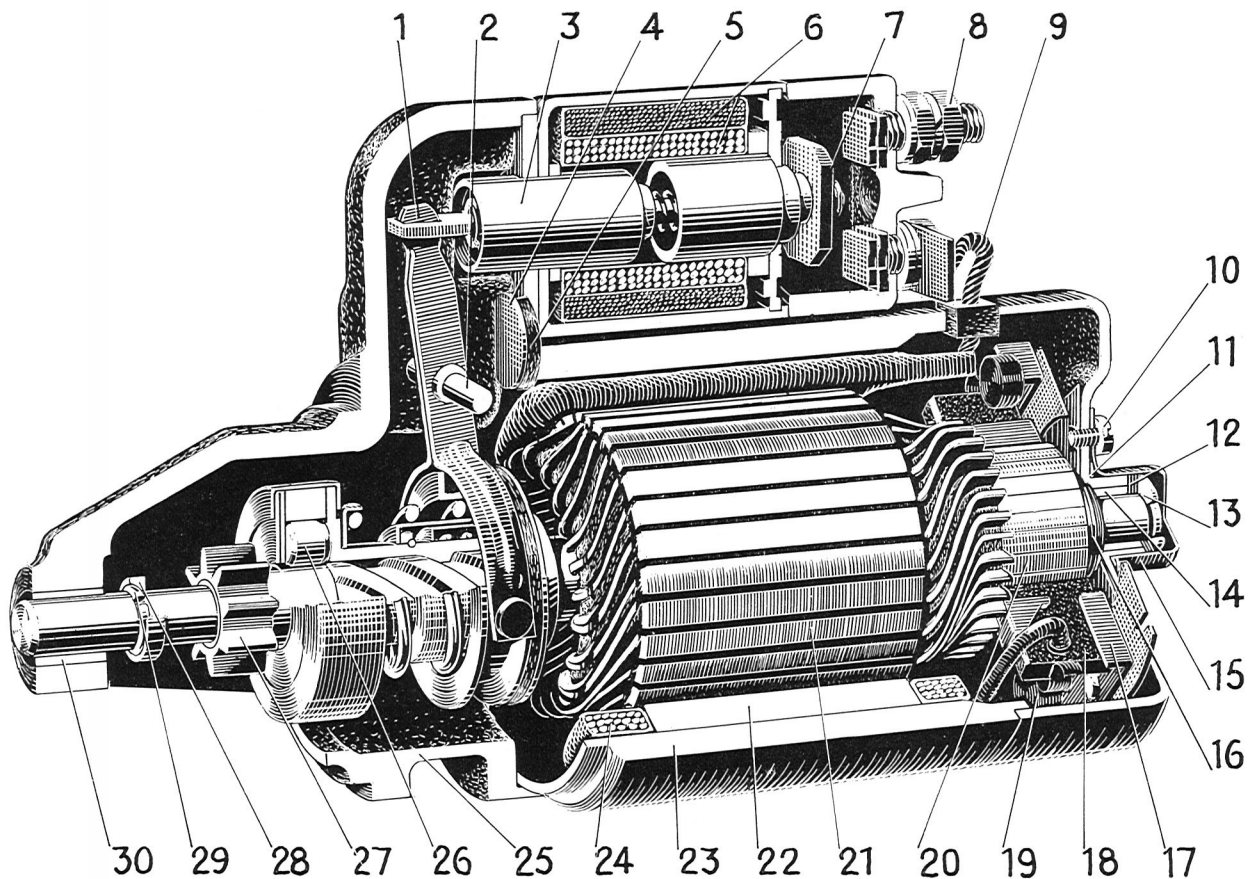
- EF 2722 Sleeve and drift for installing circlip
- EFAL 3 Smoothing drift
- EF 2649/1 Smoothing drift
- EF 2649 Drift for installing bushing

GENERAL INFORMATION

The starter motor, Fig. 3-75, is mounted on the flywheel housing on the left-hand side of the engine. It consists of a 4-pole series-wound motor. The pinion on the starter motor rotor shaft moves axially to engage with the flywheel ring gear. The pinion is controlled by a solenoid.

Turning the ignition key to the starting position cuts

in the solenoid, causing the armature in the solenoid to be drawn in and the starter pinion to engage the ring gear on the engine flywheel. When the armature has moved a certain distance, the contacts for the main current close and the starter motor starts running.



VOLVO
101 139

Fig. 3-75. Starter motor

- | | | |
|------------------------------|--------------------------|---------------------|
| 1. Shift lever | 11. Rubber gasket | 21. Armature |
| 2. Pivot pin (bearing screw) | 12. Shims | 22. Pole shoe |
| 3. Plunger | 13. Snap ring | 23. Stator |
| 4. Steel washer | 14. Bushing | 24. Field winding |
| 5. Rubber washer | 15. Commutator end frame | 25. Drive end frame |
| 6. Coil | 16. Adjusting washers | 26. One-way clutch |
| 7. Contact plate | 17. Brush holder | 27. Pinion |
| 8. Terminal for battery lead | 18. Brush | 28. Stop ring |
| 9. Connection lead to field | 19. Brush spring | 29. Snap ring |
| 10. Screw | 20. Commutator | 30. Bushing |

SERVICE PROCEDURES

Replace starter=Volvo Standard Times Op No.
33118

Re-build starter=Volvo Standard Times Op. No.
33102

REMOVAL

1. Disconnect the battery ground cable.
2. Disconnect the leads from the starter motor.
3. Remove the bolts which hold the starter motor to the timing gear housing and remove the starter.

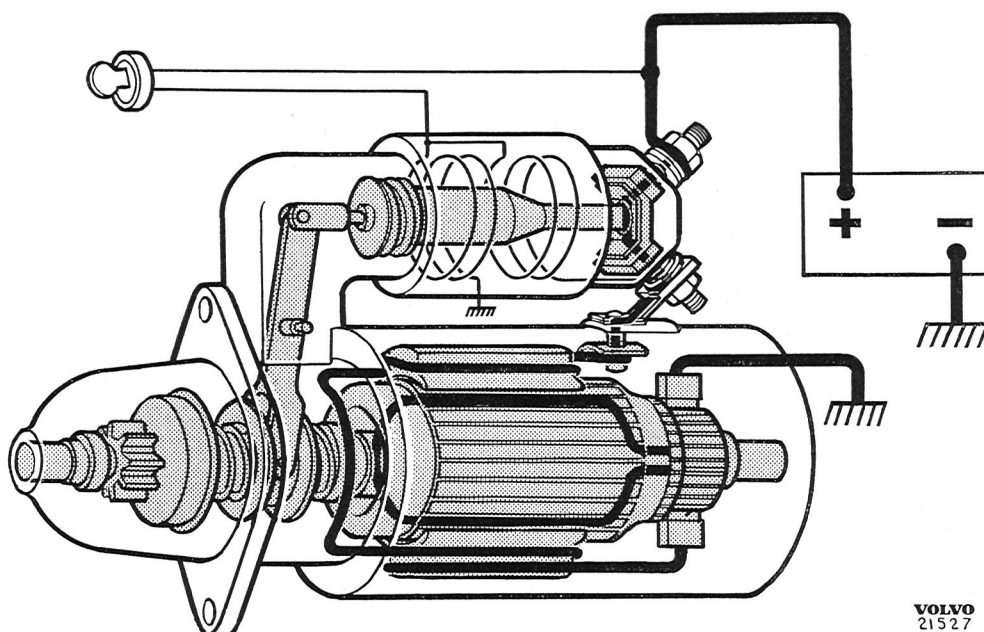


Fig. 3-76. Starter motor, general arrangement

STARTER MOTOR DISASSEMBLY

1. Remove the small cover on the front end of the shaft.
2. Lift off the lock washer and adjusting washers as shown in Figs. 3-79 and 3-80.
3. Remove the two bolts holding the commutator end frame and remove the frame.
4. Lift up the brushes and holders.
5. Remove the brush bridge from the rotor shaft. NOTE: The washers are as shown in Fig. 3-80. When the bridge is removed, the negative brushes also follow, but the positive brushes will remain in the field winding.
6. Remove the nut which holds the field terminal connection to the control solenoid.
7. Remove the attaching screws for the control solenoid. Remove the solenoid.

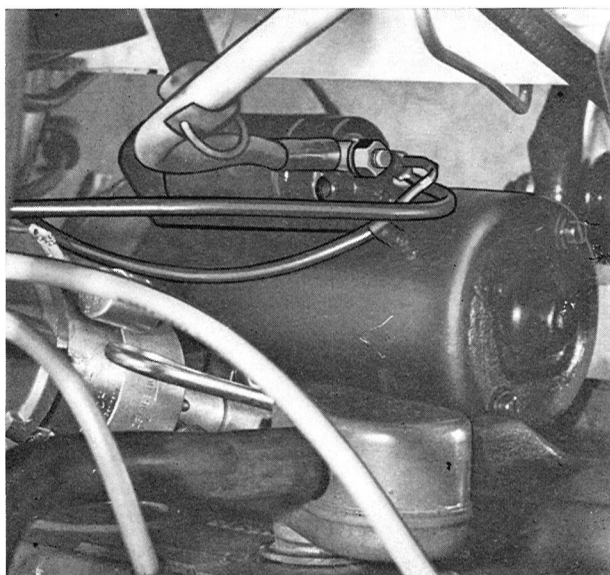
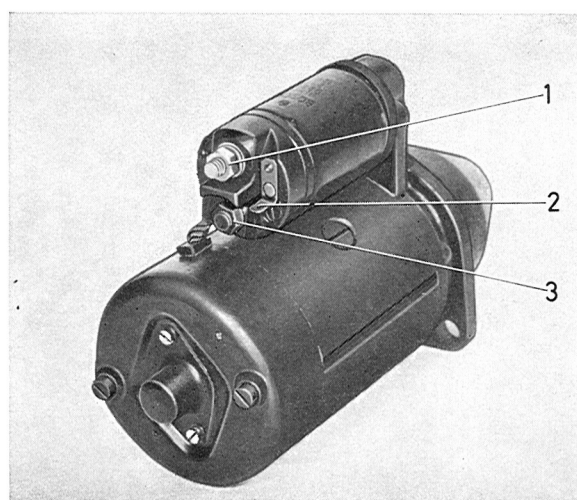


Fig. 3-77. Starter motor installed



VOLVO
103 875

Fig. 3-78. Starter motor terminals

1. From battery 2. From ignition switch 3. To field winding

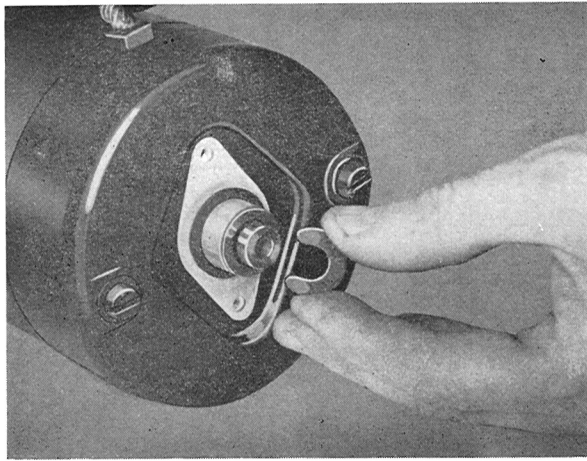


Fig. 3-79. Removing lock washer

8. Remove the drive end frame and armature from the stator.
9. Remove the rubber washer and metal washer, see Fig. 3-84.
10. Remove the screw on which the shift lever is carried.
11. Lift the armature with pinion and lever out of the drive end frame.
12. Knock back the stop washer and remove the snap ring on the armature shaft.
13. Remove the stop washer and pull off the starter pinion.

INSPECTION

Examine the armature for mechanical damage such as a bent or worn shaft, scored commutator and damaged windings.

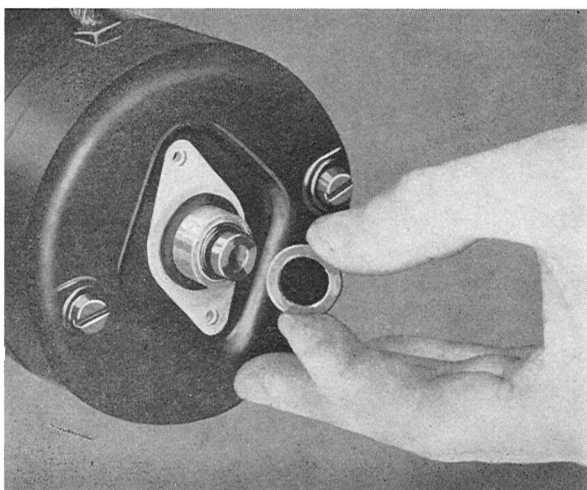


Fig. 3-80. Removing adjusting washers

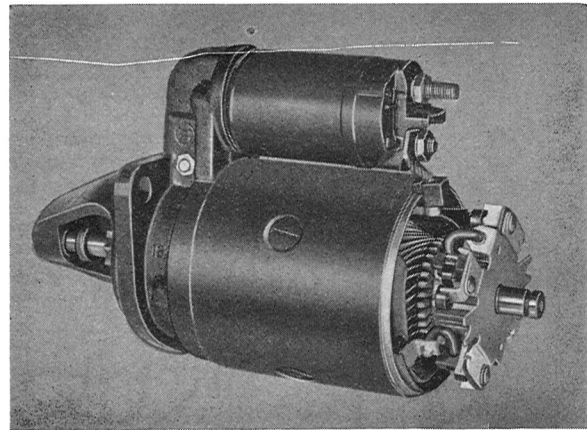


Fig. 3-81. Starter motor with bearing shield removed

If the armature shaft is bent or worn, the armature should be replaced.

If the commutator is scored or unevenly worn, it should be turned. The commutator diameter must not be less than 33 mm (1.3").

The commutator should be checked with a micrometer after turning. A radial throw of .08 mm (.003") may be considered permissible. The insulation between the laminations should be milled down to .4 mm (.016") below the surface of the laminations, see Fig. 3-86 and 3-87. This work is carried out in a special apparatus, or if such is not available, with a ground-off hacksaw blade.

Examine the armature for shorts by placing it in a growler. Switch on and hold a hacksaw blade a few mm from the armature, see Fig. 3-88. If the blade vibrates in any position when the armature is rotated, one of the following faults can be the reason: shorting through the armature frame, short-

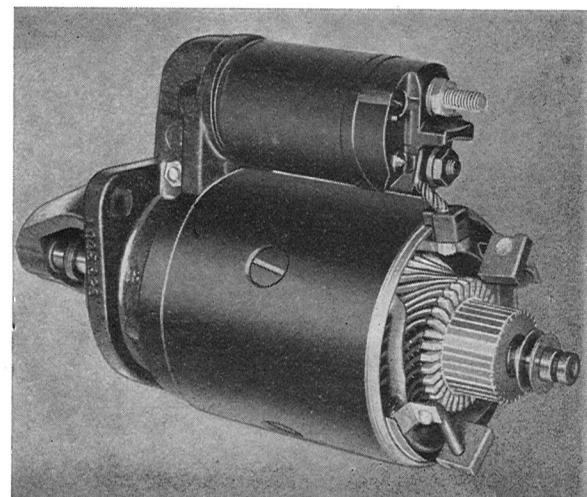


Fig. 3-82. Starter motor with brush bridge removed

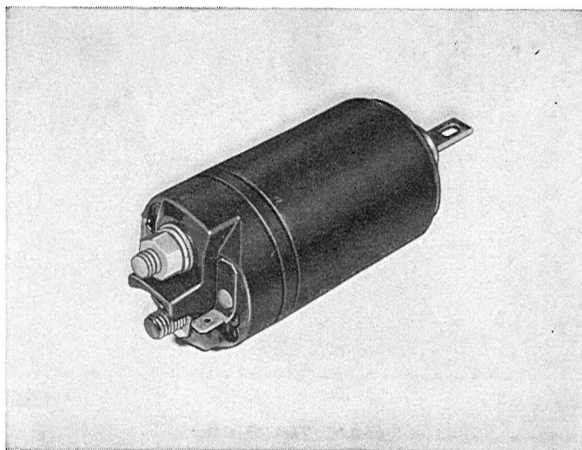


Fig. 3-83. Control solenoid

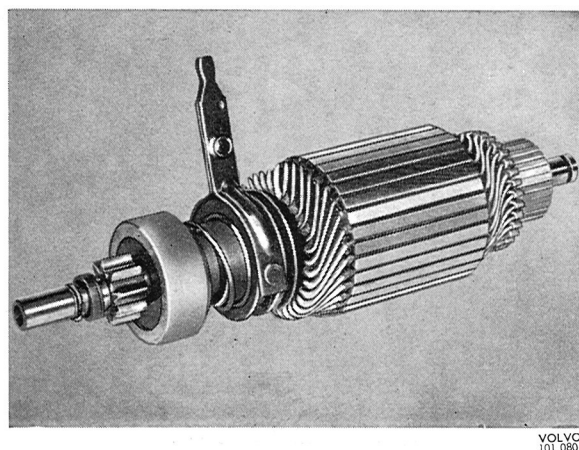


Fig. 3-85. Armature with pinion

ing in the commutator or between the windings. Check the stator with 40 volts A.C., see Fig. 3-89. Examine the drive end frame with brush holders. If any of these parts are damaged or excessively worn, they must be replaced. A bearing clearance of up to .12 mm (.005") may be considered permissible.

Inspect the other parts and replace any that are damaged or worn. The snap ring should always be replaced with a new one, since when being removed it may have been damaged or lost its tension.

SOLENOID TEST

If the solenoid does not function, first check that the battery is in good condition.

Then connect a lead between the battery positive

terminal and the solenoid contact screw for the control lead. If the solenoid still does not engage the starter pinion and main current, it should be removed from the starter motor. If, on the other hand, it engages satisfactorily, examine the starter switch and leads. When the solenoid has been removed, it should be wiped clean. Then press the armature in several times and test again by connecting it to a battery. If the solenoid still does not function, replace it with a new one.

REPLACEMENT OF BRUSHES

When replacing the brushes, the starter motor is removed and disassembled. The brushes are soldered loose from their attachments in the brush

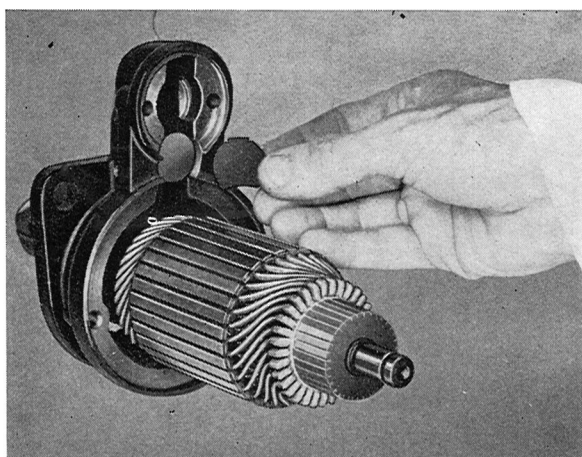


Fig. 3-84. Removing sealing washer

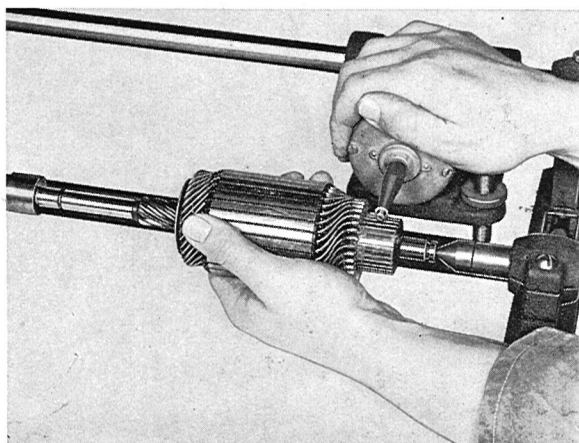


Fig. 3-86. Milling commutator

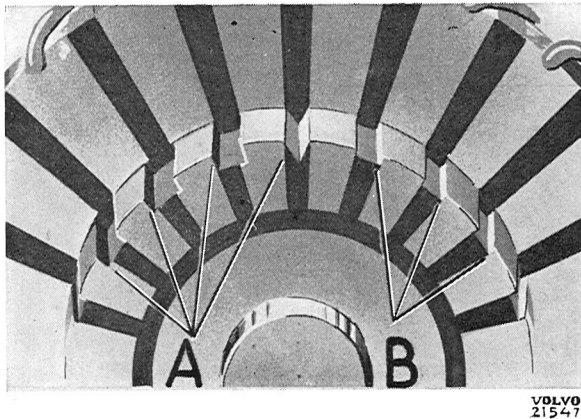


Fig. 3-87. Commutator milling
A. Incorrect milling B. Correct milling

holder and field respectively. The new brushes should be soldered on quickly and with sufficient heat. Solder must not be allowed to run down into the brush leads as this will prevent the movement of the brushes in the brush holders and may reduce the brush spring pressure. Brushes which have worn down less than 14 mm (approx 1/2") should be replaced with new ones.

INSTALLATION OF SELF-LUBRICATING BUSHINGS

The self-lubricating bushings are only worn insignificantly during operation if they are lubricated in the correct manner. If lubrication is neglected, the bushings dry out, with the result that they wear quickly. For replacement purposes bushings are supplied ready-machined to suitable dimensions. The bushings should not be machined internally or externally since the pores can then be partially blocked up, resulting in reduced lubricating capacity.

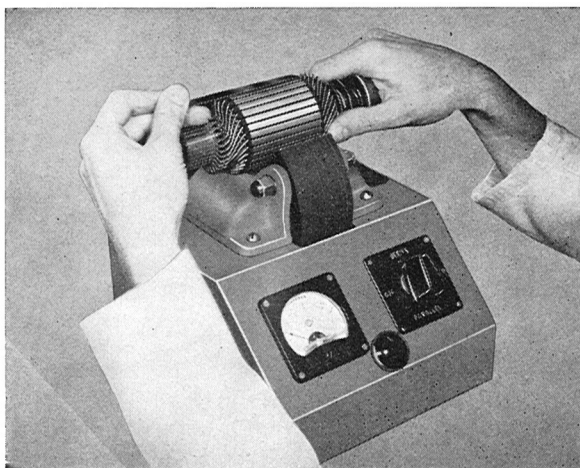


Fig. 3-88. Testing armature

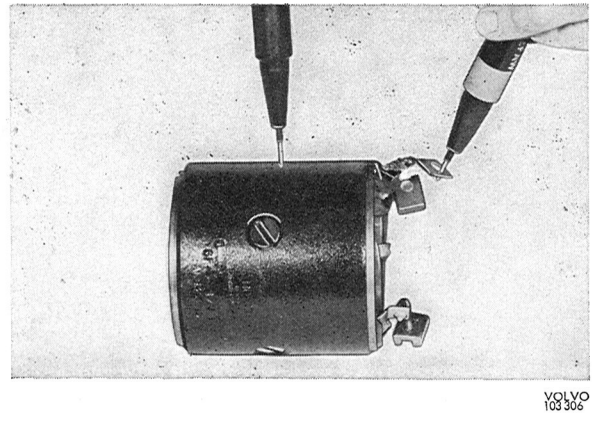


Fig. 3-89. Test of stator

Replace the bushings as follows:

1. Drive out the worn bushings with a suitable tool.
 2. Clean the hole for the bushings and cut away any burr.
 3. Press in the new bushings with a suitable drift.
- NOTE: Before a self-lubricating bushing is installed, it should lie in light oil for at least a 1/2 hour.

REPLACEMENT OF FIELD COILS

1. If the starter motor has not been disassembled, this must be done. Follow the instructions under the heading "Disassembly".

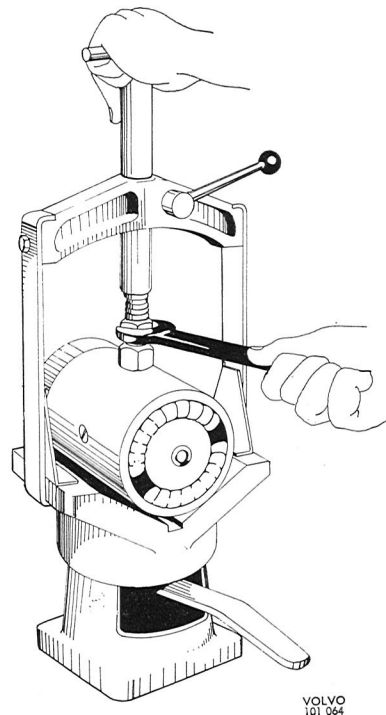


Fig. 3-90. Rotating clamping block for removal and installation of field coils

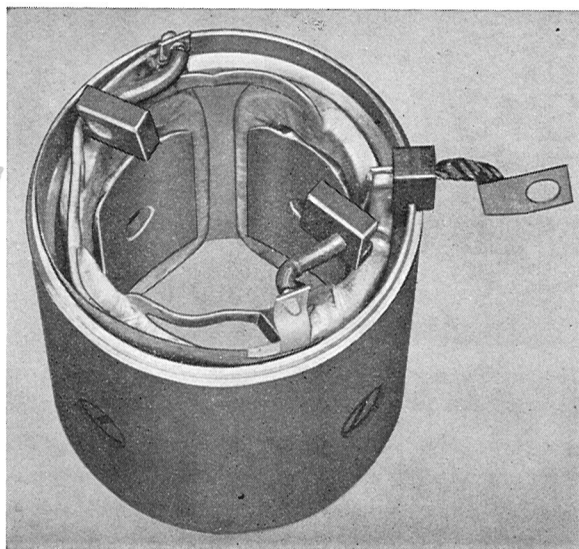


Fig. 3-91. Stator with soldered brushes

2. Mark poles and pole housing in a suitable manner so that they come in the same position when assembling.
3. Then place the stator in the rotating clamping block (Bosch EF AW 9 or similar) and remove the pole screws as shown in Fig. 3-90.
4. Before installing field coils, warm them slightly. Then place the poles in position in the field coils and slide them into the stator. Tighten the pole screws lightly. Press in a suitable drift. Set up the stator in the rotating clamping block and tighten the poles firmly.
5. Force out the press drift with a press tool. Check the installed field coils for breakage and shorts.

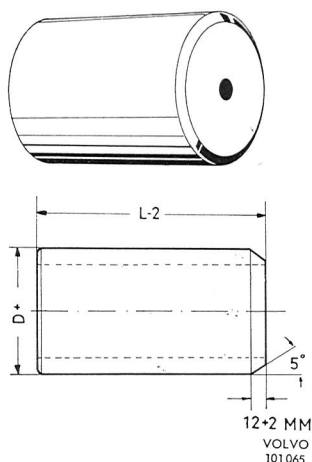


Fig. 3-92. Press drift for installation of field coils
D=66.4—66.09 mm (2.599—2.602") L=85 mm (3.346")

STARTER MOTOR ASSEMBLY

1. Lubricate the parts of the starter motor according to Fig. 3-93.

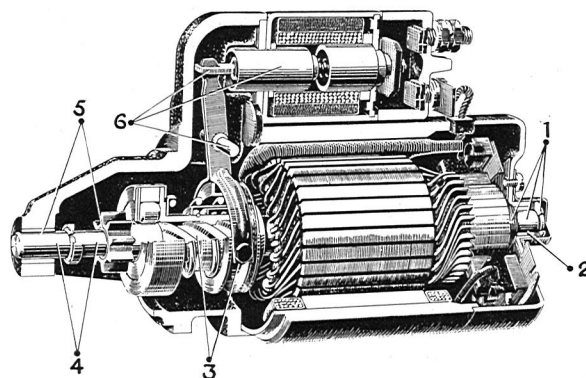


Fig. 3-93. Lubricating scheme for starter motor

Use Bosch lubricant (or equivalent) in accordance with the following directions:

1. Ft 2 V 3. Place a thin layer of grease on the insulation washers, the shaft end, the adjusting washers and lock washer.
 2. Ol 1 V 13. Place the bushing in oil for 1 hour before installation.
 3. Ft 2 V 3. Apply plenty of grease in the armature thread and the engaging lever groove.
 4. Ft 2 V 3. Place a thin layer of grease on the armature shaft.
 5. Ol 1 V 13. Place the bushings in oil for a 1/2 hour before installation.
 6. Ft 2 V 3. Lubricate the engaging lever joints and the iron core of the solenoid with a thin layer of grease.
2. Install the starter pinion on the armature shaft, and the wear washer as well as the snap ring. Secure the wear washer in position.
 3. Install the engaging arm on the pinion. Install the armature in the drive end frame.
 4. Install screw for the shift lever.
 5. Install the metal washer and rubber washer in the drive end frame.
 6. Install the stator on the armature and the drive end frame.
 7. Secure the solenoid in the shift lever. Screw tight the solenoid.
 8. Install the washers on the armature shaft as shown in Fig. 3-82.
 9. Place the brush bridge in position. Install the brushes.
 10. Install the commutator bearing frame. Screw the starter motor together with the two long bolts.
 11. Install the adjusting washers and the snap ring on the shaft end. Check the axial clearance of the armature. If necessary, adjust with the washers until the play agrees with the values in the "Specifications".
 12. Screw on securely the small casting over the shaft end.

INSTALLATION

1. Place the starter motor in position and secure it.
2. Connect the electric cables.
3. Install the lead terminal on the negative pole stud if the battery.

GROUP 34

IGNITION SYSTEM

GENERAL INFORMATION

The ignition system is of the battery ignition type. It consists of the following main parts: Ignition coil, distributor, ignition lead and spark plugs.

IGNITION COIL

The ignition coil is on the firewall, see Fig. 3-94. The function of the ignition coil is to transform the battery voltage to high tension voltage for the spark plugs. It consists of a core of laminated metal around which is a winding of heavy copper wire, the primary winding, and a winding of fine copper wire, the secondary winding. The primary winding operates at battery voltage from the distributor contact breakers. The other winding, the high-tension winding, is connected to the center terminal on the distributor cap, from where the high-tension current is distributed to the engine spark plugs.

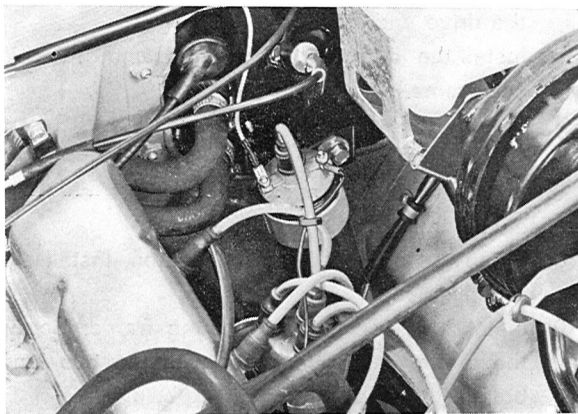


Fig. 3-94. Ignition coil installed

DISTRIBUTOR

The distributor, Fig. 3-95 and 3-96, is located on the left side of the engine, and it is driven by the camshaft. The centrifugal governor located under the breaker plate regulates the spark timing according to the engine speed. The vacuum unit governs the spark timing according to the load. (B20F engines do not have a vacuum unit.)

The B20A and B20E engines vacuum units advance the timing when the load decreases.

The B20B engine vacuum unit retards the timing at idle and engine retard. This is part of the emission control and prevents the engine from emitting excessive amount of pollutants at idle and retard.

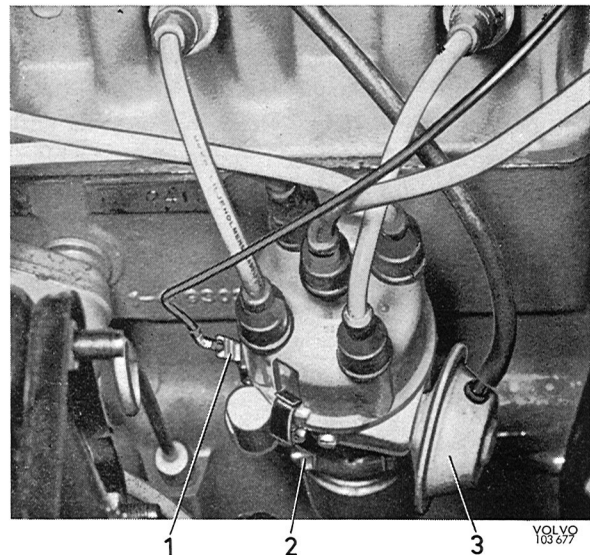
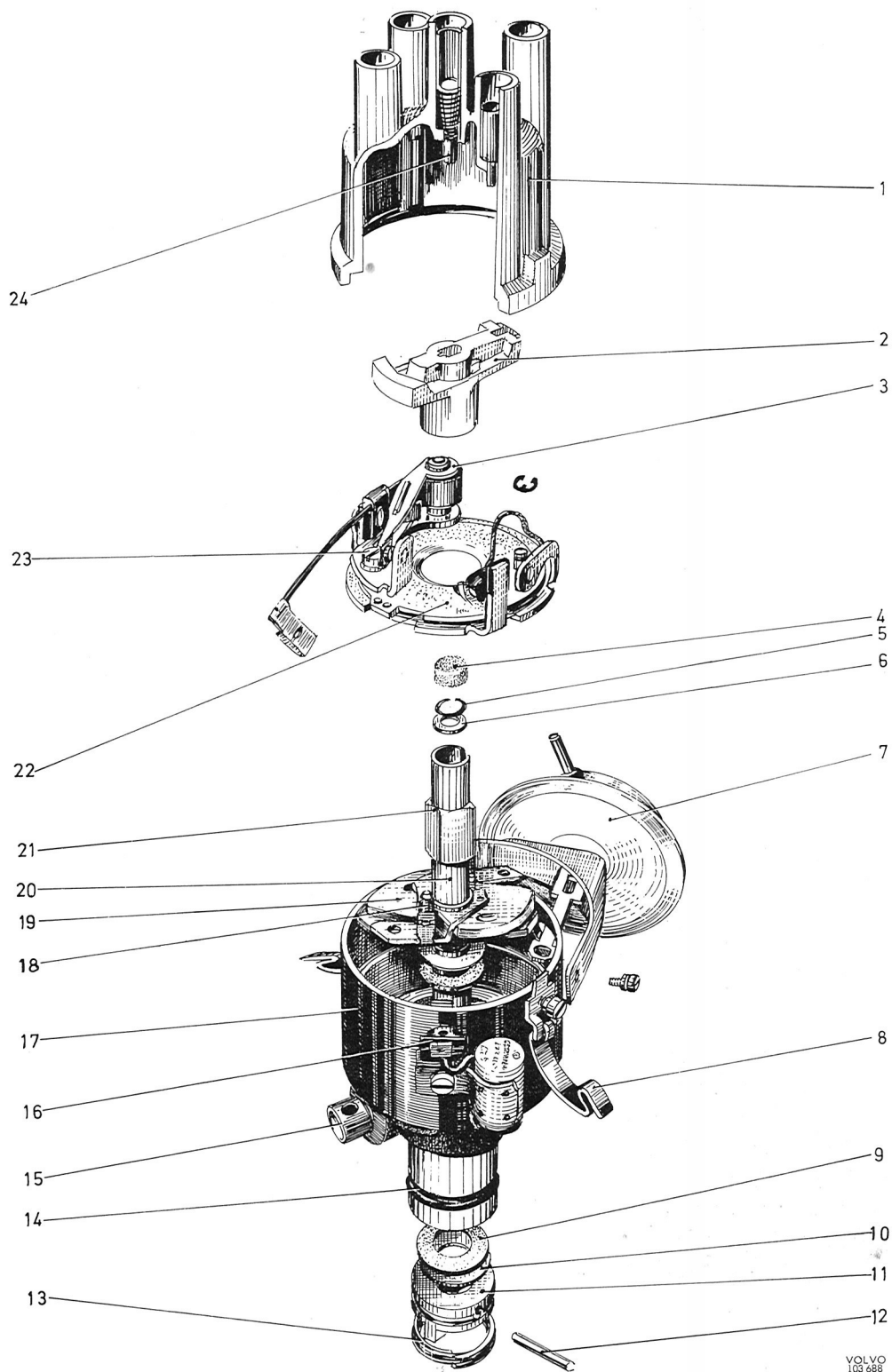


Fig. 3-95. Distributor B 20 B

1. Primary connection
2. Attaching screw
3. Vacuum regulator



VOLVO
103 688

Fig. 3-96. Distributor, B 20 B

- | | | | |
|---------------------|--------------------|---------------------------------|-------------------------------------|
| 1. Distributor cap | 7. Vacuum unit | 13. Resilient ring | 19. Centrifugal weight |
| 2. Distributor arm | 8. Cap clasp | 14. Rubber seal | 20. Breaker camshaft |
| 3. Contact | 9. Fiber washer | 15. Lubricator | 21. Breaker cam |
| 4. Lubricating felt | 10. Steel washer | 16. Primary connection | 22. Breaker plate |
| 5. Circlip | 11. Driving collar | 17. Distributor housing | 23. Lock screw for breaker contacts |
| 6. Washer | 12. Lock pin | 18. Centrifugal governor spring | 24. Rod brush (carbon) |

SERVICE PROCEDURES

DISTRIBUTOR

Replace distributor=Volvo Standard Times Op. No. 34206

REMOVAL

1. Release the lock clasps for the distributor cap and lift off the cap.
2. Remove the primary lead from the primary connection (1, Fig. 3-95).
3. Remove the vacuum hose from the vacuum unit. (When removing the hose from the bakelite connection, observe great care not to break the connection.)
4. Slacken the screw (2, Fig. 3-95) and pull up the distributor.

Re-build removed distributor=Volvo Standard Times Op. No. 34271

Clean and adjust removed distributor=Volvo Standard Times Op. No. 34285

DISASSEMBLY

1. Pull off the distributor arm.
Remove the circlip for the pull rod from the vacuum regulator.
Remove the vacuum unit according to Fig. 3-97. (Not B20F distributor.)

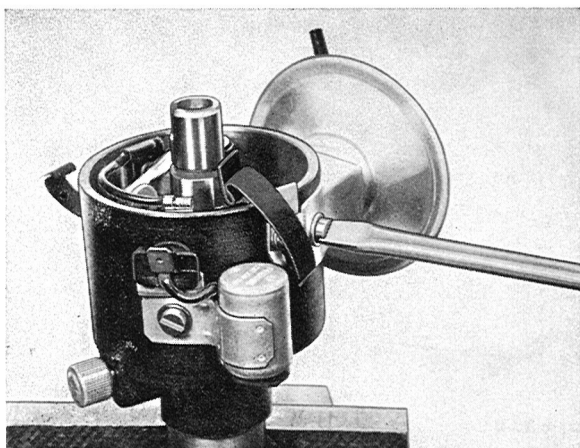


Fig. 3-97. Removing vacuum regulator

2. Mark how the lock clasps for the cap are located and remove them.
Disconnect the lead from the breaker contacts and remove the primary connection, Fig. 3-98. Lift up the breaker plate.

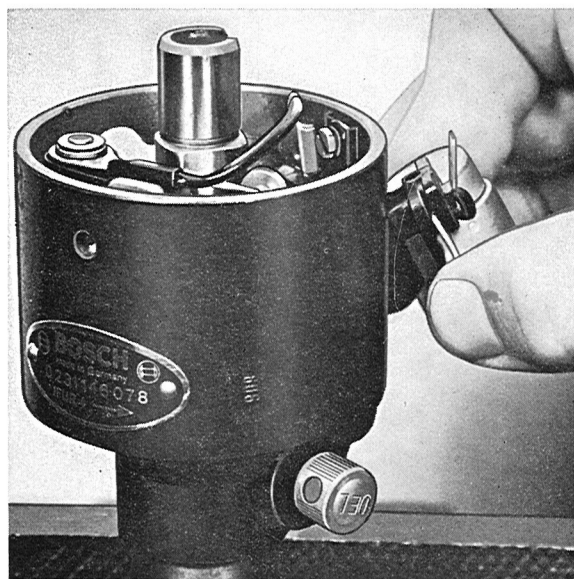


Fig. 3-98. Removing primary connection

3. Disconnect the springs for the centrifugal governor and mark how the breaker cam is located in relation to the distributor shaft. Secure the breaker cam in a vise with soft jaws. Carefully knock on the distributor housing with a plastic mallet (Fig. 3-99) until the circlip (5, Fig. 3-96) has released and lift off the breaker cam.

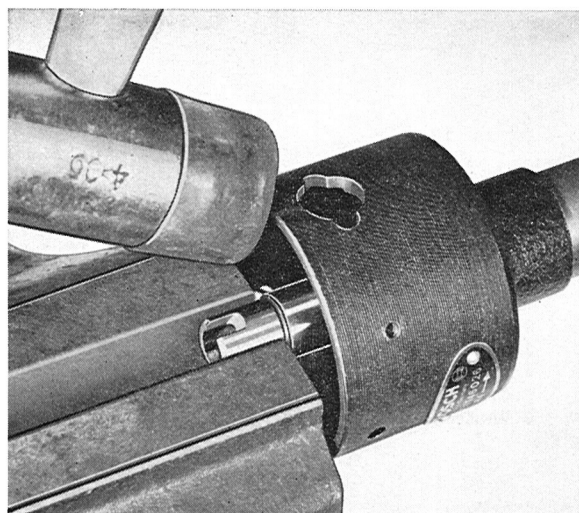


Fig. 3-99. Removing circlip

4. Remove the resilient ring (13, Fig. 3-96) and mark how the driving collar (11, Fig. 3-96) is located in relation to the distributor shaft. Tap out the pin (Fig. 3-100), lift off the driving collar and pull up the distributor shaft. Check that no washers have been lost.

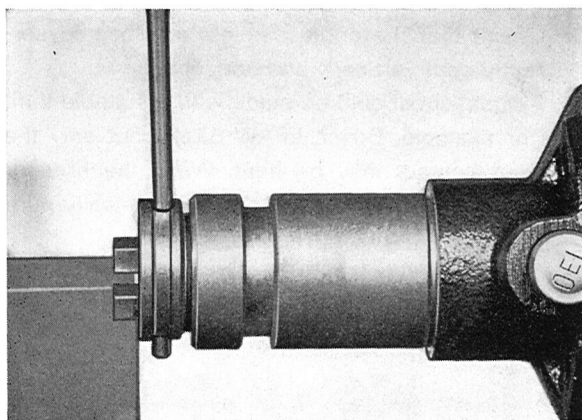


Fig. 3-100. Removing driving collar

5. Remove the lock springs for the centrifugal weights and lift up the weights.

INSPECTION

Distributor plate

The surface of the contact points should be flat and smooth. The color of the contacts should be gray. Oxidized or burned contacts must be replaced. After a long period of use, the contact lip can be worn and the spring fatigued, so that the contacts should be replaced if the distributor for any reason is disassembled.

The contact plate must not be loose, worn or have burr.

Distributor shaft

The play between the distributor shaft and the breaker camshaft must not exceed .1 mm (.004"). The cams on the breaker camshaft must not be scored or worn so that the dwell angle is altered. The holes in the centrifugal weights must not be oval or deformed in any other way. The centrifugal weight springs must not be deformed or damaged.

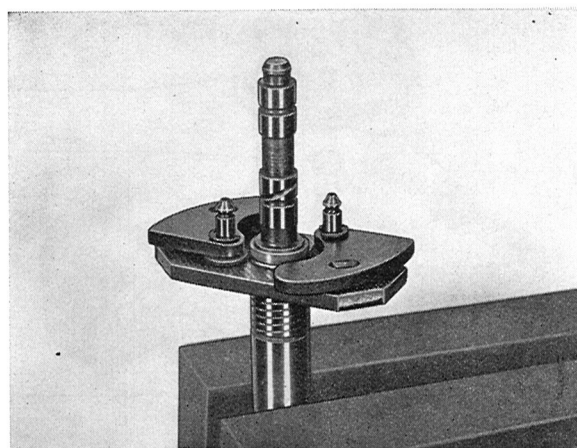


Fig. 3-101. Distributor shaft with centrifugal weights

Distributor housing

The play between the distributor housing and the shaft should not exceed .2 mm (.008"). If the play is excessive, replace the bushings and, if this is insufficient, also the shaft.

ASSEMBLY

1. Lubricate the distributor parts according to the instructions in Fig. 3-102.
2. Install the centrifugal weights and also the lock springs on to the weights. Install the breaker camshaft on to the distributor shaft. Hook on the springs for the centrifugal governor. Install the washer and circlip for the breaker camshaft. The circlip is placed into position by means of a suitable sleeve. Install the lubricating felt.
3. Install the distributor shaft in the distributor housing and install the driving collar on the distributor shaft. Make sure that the fiber washers come against the distributor housing. Install the pin in the collar and check the axial clearance on the distributor shaft. The clearance should be .10—.25 mm (.004—.010"). Any adjustment can be done by altering the number of adjusting washers on the distributor shaft.
4. Install the breaker plate. Fit the lock clasps for the cap. Fit the primary connection and connect the lead from the breaker contacts.
5. Install the vacuum regulator.

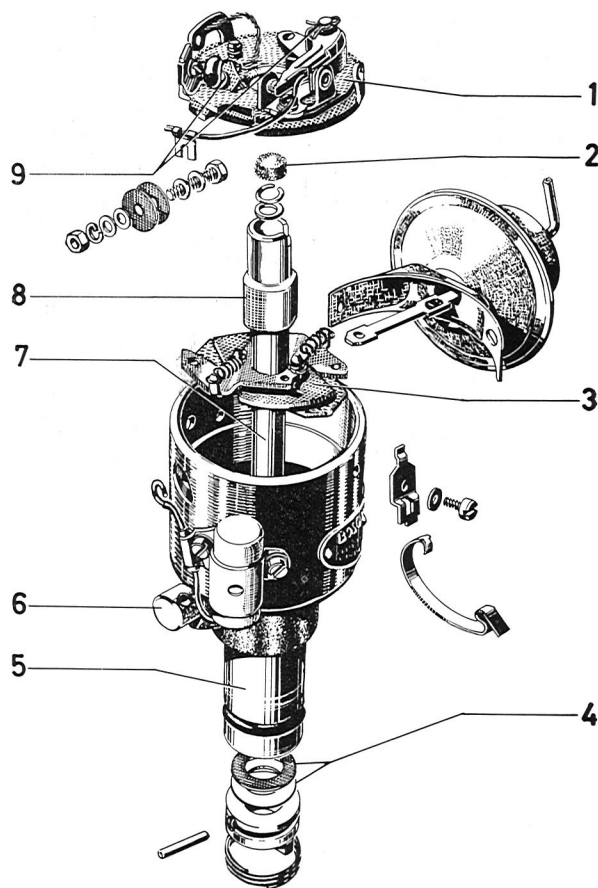


Fig. 3-102. Distributor lubrication

Use Bosch lubricants, or similar, see below:

- | | |
|--------------|--|
| 1. 01 1 V 2 | Rub the breaker plate with oil |
| 2. 01 1 V 13 | Drench the lubricating felt in oil |
| 3. Ft 2 V 3 | Lubricate the centrifugal weights sparingly |
| 4. Ft 2 V 3 | Grease the washers |
| 5. 01 1 V 13 | Immerse the bushings in oil at least 1/2 hour before installation. |
| 6. 01 1 V 13 | Fill the lubricator with oil |
| 7. 01 1 V 13 | Oil the cam before installation |
| 8. Ft 1 V 4 | Cover the cam with a thin layer |
| 9. Ft 1 V 26 | Grease the bushing for the moving contact |

VOLVO
102970

- Check that the contact points are mounted correctly both horizontally and vertically. Adjustment should be made with a suitable tool (for example, Bosch EFAW 57 A), but only the fixed contact may be bent. Wash the contacts with trichloroethylene or chemically pure gasoline.

Run the distributor on a test bench and check according to the "Specifications".

Install the distributor arm.

REPLACING CONTACT POINTS

Volvo Standard Times:

Replace Contact Points:

In vehicle	Op. No. 34202
Distributor removed	Op. No. 34281

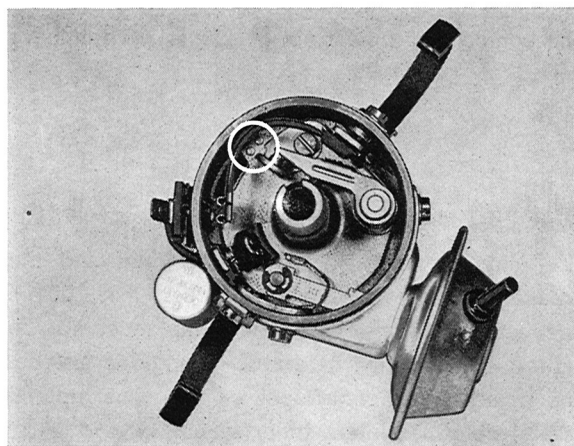
The contact points can be replaced with the distributor fitted, but it **should** be done with the distributor disassembled.

- Remove the distributor rotor arm.
- Disconnect the electric lead at the primary connection.
- Remove the screw for the contact points and lift up the old contacts.
- Lubricate the distributor according to the instructions in Fig. 3-102.
- Fit the new contact breaker.
- Connect the electric cable at the primary connection.
- Check that the contact points are located correctly both vertically and horizontally. Adjustment should be made with a suitable tool, (for example, Bosch EFAW 57 A), but only the fixed contact may be bent. Wash the breaker points with trichloroethylene or chemically pure gasoline.

Run the distributor on a test bench and check according to the "Specifications".

TESTING DISTRIBUTOR IN TEST BENCH

- Run the distributor at 8.4 r/s (500 rpm) in its ordinary direction of rotation (counter-clockwise) and adjust the dwell angle according to the "Specifications".
- Adjustment is made by slackening the screw for the contact points and then inserting a screwdriver in the recess. Fig. 3-103, and turning the screwdriver until the dwell angle is the correct one. Then tighten the screw for the contact points.
- Run the distributor and set the protractor on the test bench so that a marking comes opposite



VOLVO
103719

Fig. 3-103. Recess for adjusting the contact breaker

0° at such a low speed (below 5 distr. r/s=300 distributor r/m) that the centrifugal governor does not function. Increase the speed slowly and read the values at the prescribed graduations. A newly lubricated distributor should first be run up to maximum speed several times. Permissible tolerance for the centrifugal governor is $\pm 1^\circ$.

4. Run the distributor at low speed and adjust the protractor so that a marking is obtained at 0°. Connect the vacuum hose from the test bench to the vacuum regulator. Increase the vacuum gradually and read the values at the prescribed graduations. (Not B20F engines.)

INSTALLING

1. Position the distributor.
2. Press the distributor downwards while turning the distributor arm at the same time. When the distributor goes down about 5 mm (3/16") and it is no longer possible to turn the distributor arm, the driving collar of the distributor is then in the slot on the distributor drive.
3. Turn the distributor housing so that it takes up the same position it had before removal.
4. Connect the primary lead. Install the distributor cap.
5. Start the engine and set the ignition. (If the engine does not start, turn the distributor housing until it does so.)

IGNITION TIMING

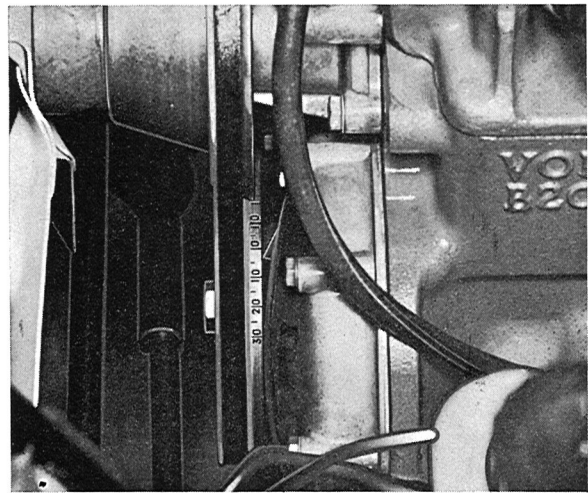
Set dwell angle and timing = Volvo Standard Times Op. No. 34276

Ignition setting should always be made with the engine running and with a timing light (Stroboscope) and a tachometer.

B 20 A AND B 20 B

1. Clean the pulley so that the graduation marks can be seen, see Fig. 3-104.
2. Disconnect the hose from the vacuum regulator. (On the B 20 B the hose should be pinched or plugged to prevent the engine taking in unwanted air.)

NOTE: On the B 20 F with exhaust gas recirculation, the vacuum hose to the EGR valve should be disconnected at the valve.



VOLVO
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Fig. 3-104. Graduation for ignition timing

3. Connect the timing light to the No. 1 cyl. spark plug and the battery. Connect a tachometer.
4. Start the engine and run it at the speed given in the "Specifications". Point the timing light at the graduations on the pulley. Slacken the attaching screw (2, Fig. 3-95) and turn it until the firing position agrees with the figure given in the "Specifications". Fix the distributor and check that the firing position and speed have not altered.
5. Remove timing light and tachometer and fit the hose to the vacuum regulator.

B 20 E, B 20 F

1. Clean the pulley so that the graduation marks can be seen, see Fig. 3-104.
2. Remove the hose connected to the distributor's vacuum regulator at the inlet duct.
3. Connect the timing light to the No. 1 cyl. spark plug and the battery. Connect a tachometer.
4. Start the engine. Adjust the engine speed to 11.6—13.4 r/s (600—800 rpm).
5. Point the timing light at the graduations on the pulley. Remove the distributor and turn it until the firing position agrees with the figure given in the "Specifications". Fix the distributor and check that the firing position and speed have not altered.
6. Remove timing light, and tachometer. Fit the hose the vacuum regulator.

GROUP 35

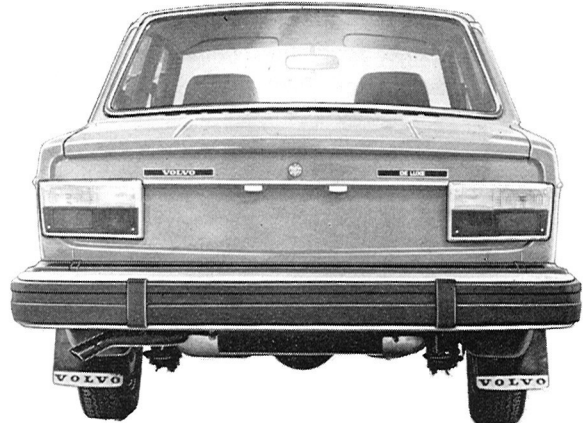
LIGHTING

GENERAL INFORMATION



VOLVO
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Fig. 3-105. Headlights



VOLVO
108625

Fig. 3-106. Rear and license plate lights

The lighting consists of two upper and lower beam headlights with quartz-iodine bulbs, H-4 bulbs (Sealed Beam inserts for the US market), parking lights, tail lights, license plate lights and, US market, side marker lights.

The headlights are installed in the grille. They are switched on and off by the light switch on the instru-

ment panel. Switching between upper and lower beams is done by moving the turn signal switch lever towards the steering wheel. A relay then makes the switching.

The tail lights have separate bulbs for rear lights, stop lights, back-up lights and turn signals.

SERVICE PROCEDURES

HEADLIGHTS

Sealed Beam, replace each, in addition to adjust headlights=Volvo Standard Times Op. No. 35121

REPLACING HEADLIGHT INSERT

1. Disconnect by pulling the connection contact backwards. (The battery must first be removed when replacing the insert for the left-hand headlights.) When replacing the insert for the right-hand headlight on vehicles with a B 20 A

or B 20 B engine, first lift the expansion tank for the radiator out of the way (for the B 20 E, F engine, remove the upper part of the air cleaner and the air filter.)

2. Remove the three plastic holders securing the insert in the case by releasing the screws. Press the insert backwards and lift it out.
3. Place the new insert in position. Re-fit the three plastic holders. Check to make sure that the holders fit in the lugs on the insert. Secure the insert.
4. Re-connect and check the light.

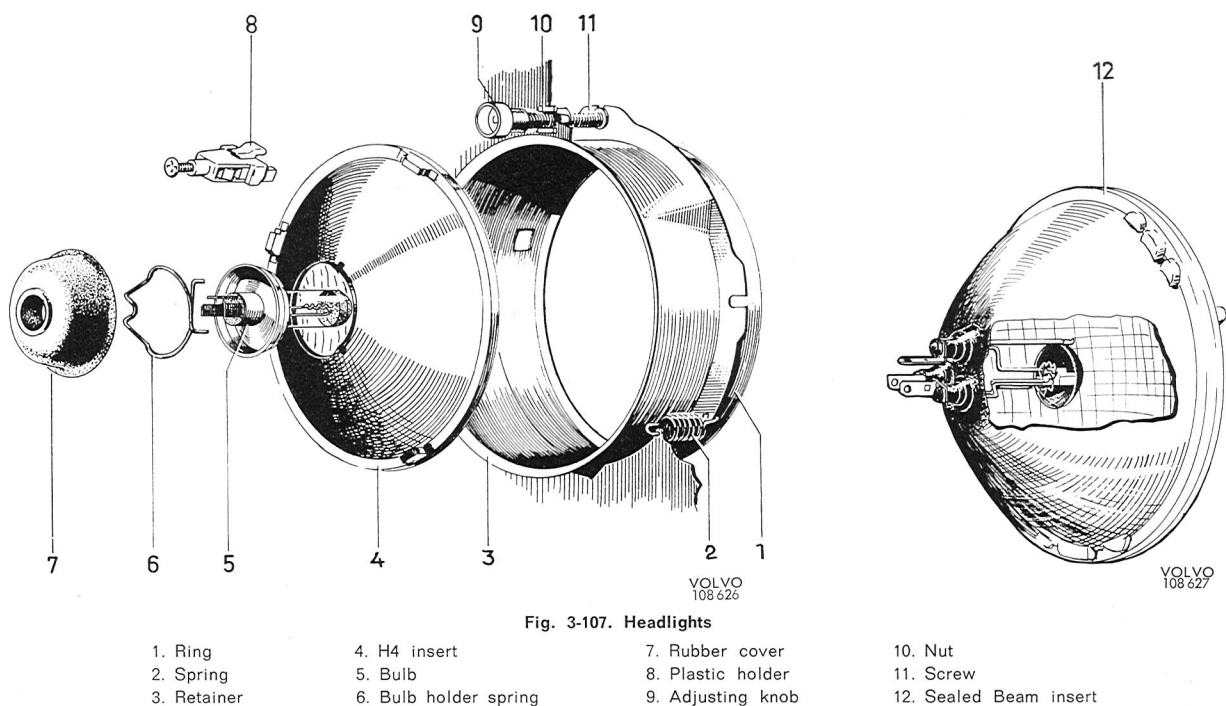


Fig. 3-107. Headlights

- | | | | |
|-------------|-----------------------|-------------------|------------------------|
| 1. Ring | 4. H4 insert | 7. Rubber cover | 10. Nut |
| 2. Spring | 5. Bulb | 8. Plastic holder | 11. Screw |
| 3. Retainer | 6. Bulb holder spring | 9. Adjusting knob | 12. Sealed Beam insert |

REPLACING HEADLIGHT BULB

1. Disconnect the cables by pulling out the connector (1, Fig. 3-108), and remove the rubber cover underneath.
2. Compress and remove the spring (1, Fig. 3-109) holding the bulb to the insert and take out the bulb.
3. Install a new bulb. (Do not touch the globe with your fingers.) Make sure it is fitted correctly. The small nibs on the bulb collar should fit in the insert recesses.
4. Install the spring and the rubber cover.
5. Connect the connection contact and check the lighting.

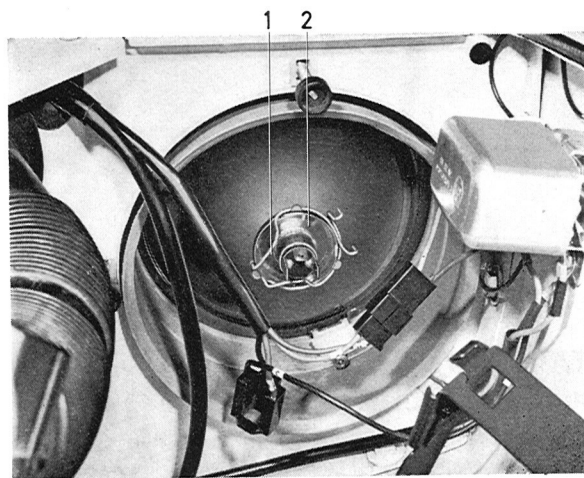


Fig. 3-109. Headlight, rear side

1. Spring 2. Bulb

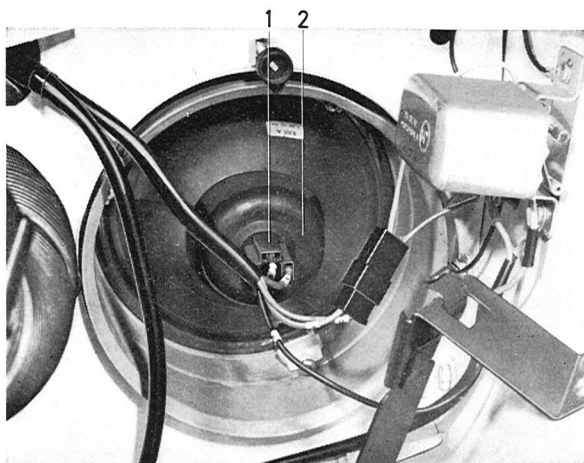


Fig. 3-108. Headlight, rear side

1. Connector 2. Rubber cover

CHECKING AND ADJUSTING

Adjust headlights=Volvo Standard Times Op. No. 35102

The headlights should be examined to check the condition of glass, reflector and bulb. If the glass is damaged by flying gravel or cracked or defective in any other way, the insert should be replaced. Glass which has become "sand-blasted" by flying gravel, etc, will considerably reduce the lighting effect and can give rise to dazzling, irregular beams, etc.

If the reflector is dull, buckled or damaged in any other way, the insert should be replaced. The inside of the bulb must not be oxidized to a black or brown color. The lighting effect normally deteriorates to such an extent that the bulbs should be replaced after 100—200 hours of operation.

The voltage at the bulb with the headlights switched on and the engine running, at charging speed, should be at least 12.5 volts if sufficient lighting power is to be produced.

The headlights should be adjusted in accordance with current legislation. Approved equipment should be used.

Adjustment is made by varying the two adjusting screws behind the headlight, see Fig. 3-110. The upper screw adjusts the headlight vertically and the screw at the side adjusts the headlight laterally.

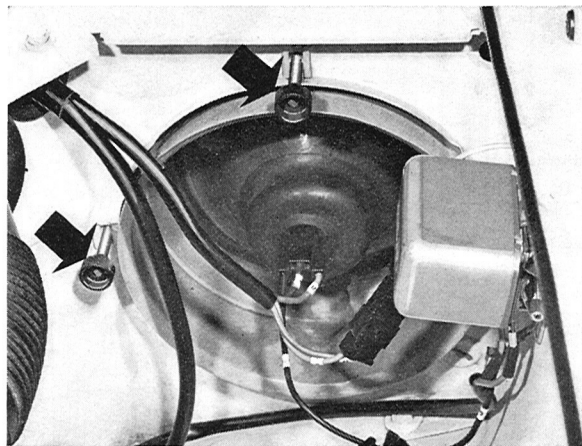


Fig. 3-110. Adjusting screws

TAIL LIGHTS

REPLACING BULBS

Replace rear light bulb or lens=Volvo Standard Times Op. No. 35118

1. Screw loose the four screws holding the glass, see Fig. 3-111 and lift off the glass.
2. Replace the bulb, see 3-112.
3. Re-install the glass.

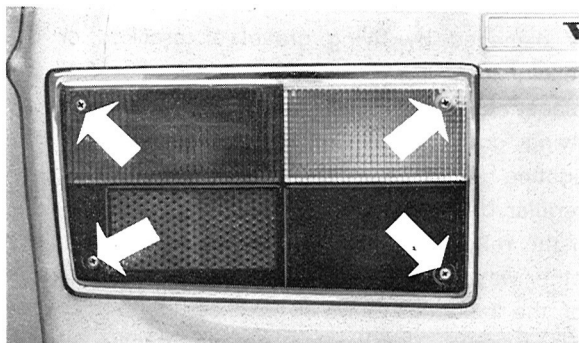


Fig. 3-111. Removing glass, rear tail light lens

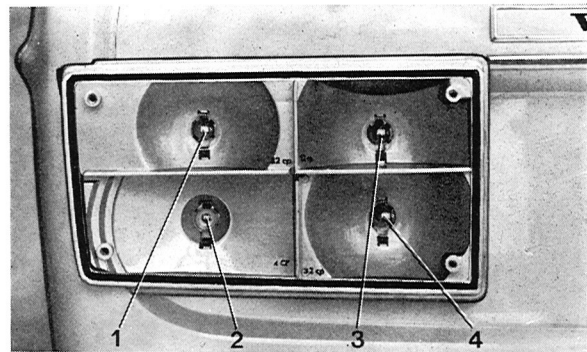


Fig. 3-112. Bulb location

- | | |
|----------------------|------------------|
| 1. Turn signal light | 3. Back-up light |
| 2. Rear light | 4. Brake light |

REPLACING TAIL LIGHT

The rear light is replaced as a complete unit.

1. Remove the spare wheel (left-hand side).
2. Remove the protective cardboard.
3. Mark up the cables and disconnect them.
4. Remove the attaching screws. A suitable tool for this is an 8 mm (5/16") screwdriver.
5. Lift off the rear light.
6. Installing is in reverse order to removal.
7. Check to make sure that the rear light functions properly.

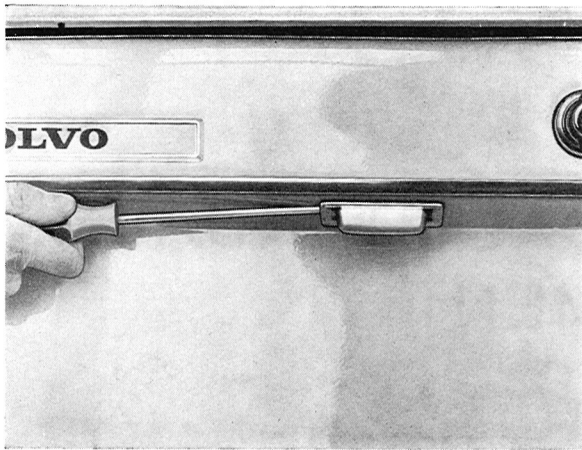


Fig. 3-113. Removing license plate light

VOLVO
107325

REPLACING LICENSE PLATE LIGHT

1. Remove the license plate light with a Phillips screwdriver according to Fig. 3-113.
2. Disconnect the electric wire from the plate.
3. Disassemble the plate according to Fig. 3-114.
4. Replace the bulb.
5. Re-connect the electric wire to the plate.
6. Install the plate by pressing it firmly into its recess.

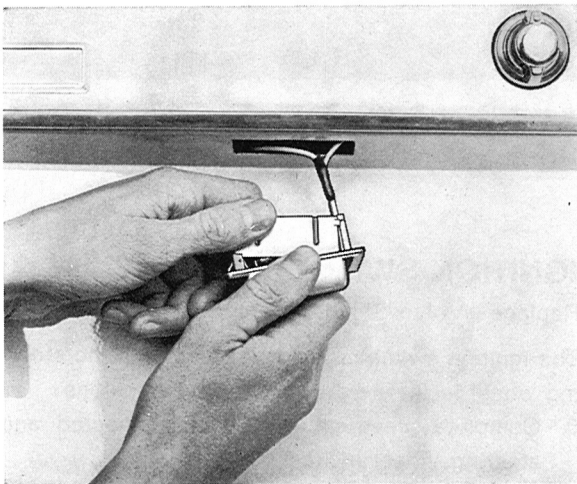


Fig. 3-114. Disassembling license plate light

VOLVO
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PARKING LIGHTS

The parking lights are located on the outside of the headlights. When removing the light to change the bulb etc., remove the two screws, Fig. 3-115, holding the lens to the grille and this will allow all the parts belonging to the light to be accessible for removal.

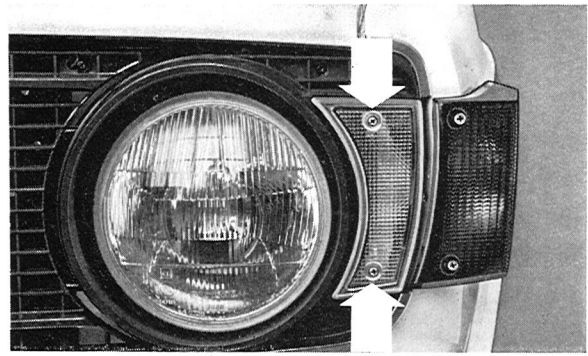


Fig. 3-115. Parking light, screws holding the lens

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SIDE MARKER LIGHTS

Two side marker lights are located on each side of the vehicle, one in front and one in rear.

The front turn signal light also serves as side marker light. It has a bulb with two functions, one for turn signal and one for side marker. To replace the bulb, remove the lens, see Fig. 3-137. To replace the bulb in the rear side marker light, remove the lens which is attached to the body by two screws, see Fig. 3-116.

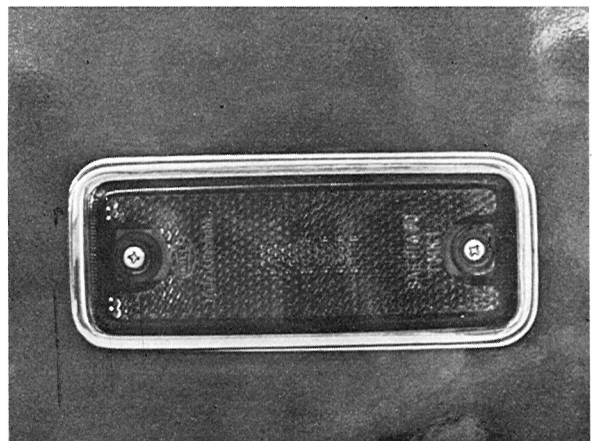


Fig. 3-116. Rear side marker light

VOLVO
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OTHER ELECTRICAL STANDARD EQUIPMENT

GENERAL INFORMATION

TURN SIGNALS

The turn signal system consists of an electronic flasher relay, turn signal switch, flash lamps on the front mudguards and bulbs in the rear lights. The turn signal switch is located under the plastic casing on the left-hand side of the steering column, see Fig. 3-118. It switches on right or left signal in two stages. Stage one is used when changing a lane and stage two when changing direction. The switch has automatic return to neutral. The control lamp is wired in parallel across the switch.

The turn signals can also be used as emergency warning flashers, which are switched on by the emergency warning flasher switch on the control panel. The flasher function is governed by the flasher on the reverse side of the control panel see Fig. 3-117.

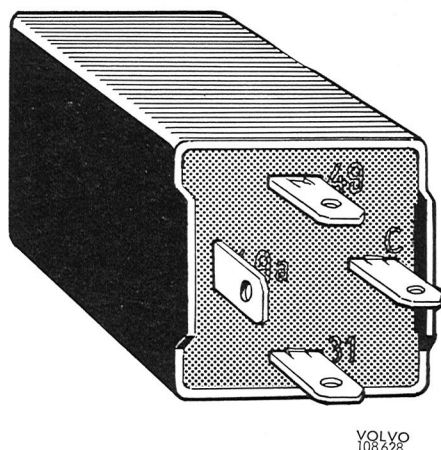
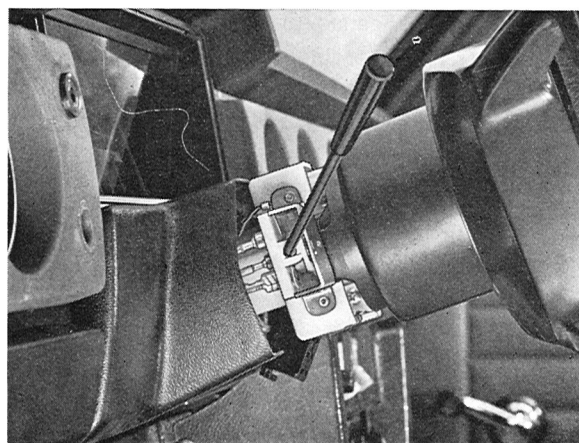


Fig. 3-117. Flasher



VOLVO
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Fig. 3-118. Turn signal switch

IGNITION SWITCH

Replace=Volvo Standard Times Op. No. 34002

The ignition switch is integrally built with the steering wheel lock. The switch has four positions:

0. Complete electrical system disconnected and steering wheel locked.
1. Current to fuse box (Intermediate position).
2. Same as position 1 but also current to ignition coil (Driving position).
3. Same as position 2 but also current to starter motor solenoid (Starting position). When the ignition key is released in position 3, it returns automatically to position 2.

Vehicles intended for U.S.A. are equipped with a special steering wheel lock with a reminder buzzer which buzzes when the driver's door is open and the ignition key is in the ignition switch, in other words, if the steering wheel is not locked.

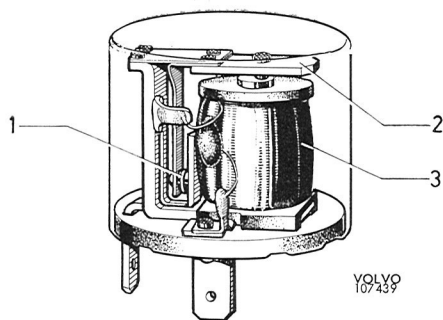


Fig. 3-119. Buzzer

1. Contacts
2. Armature
3. Coil

The buzzer is placed under the dashboard on the left-hand side and is connected to the fuse box (via the ignition) and the door switch on the driver's side. The buzzer consists of a pair of contacts and a coil. When current passes across the contacts and through the coil, the armature is drawn down towards the core of the coil. While the armature is being drawn down towards the core, the contacts cut out the current and the armature springs back, etc. This cycle is repeated continuously as long as current is switched on, that is, as long as the driver's door is open and the ignition key is in the ignition.

HORNS

Replace horn=Volvo Standard Times Op. No. 36202

The horns are located to the left of the radiator behind the grille.

One of the horns has a low frequency and the other a high frequency.

The horn pad mounted in the steering wheel operates the horns.

FUSES

The fuses are in a fuse box, which is located next to the left fresh air vent. The fuses are accessible after the cover has been removed.

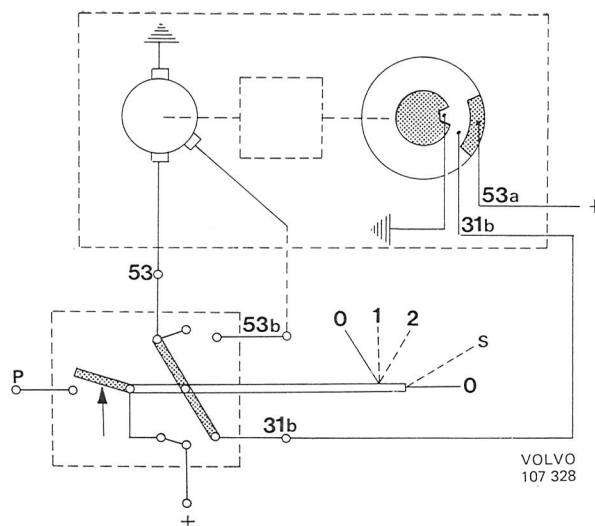


Fig. 3-120. Wiring diagram for windshield wiper motor, Electrolux

WINDSHIELD WIPERS

Volvo Standard Times	Op. No.
Replace wiper motor	36302
Replace wiper pivot assy	36318
Replace wiper motor drive wire	36356

The windshield wipers are driven by an electric motor. The motor is connected to the wipers by a combined cable and linkage system. It has a permanently magnetized field and three brushes, one a minus brush and the other two plus brushes. The plus brushes are connected one at a time so that the engine has two different speeds, 0.57 ± 0.07 r/s (34 ± 4 r/m) and $.92 \pm .8$ r/s (55 ± 5 r/m). The function of the parking switch, which is built into the gear housing, is to return the wiper blades to a suitable, predetermined, parking position, see Figs. 3-120 and 3-121, irrespective of where the wiper is switched off.

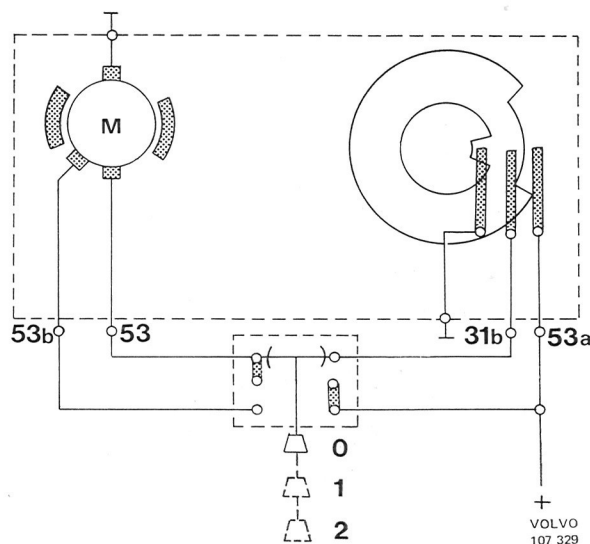


Fig. 3-121. Wiring diagram for windshield wiper motor, SWF

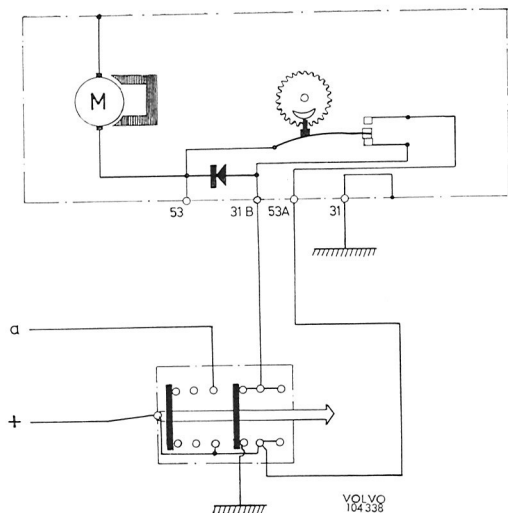


Fig. 3-122. Wiring diagram for tail gate window wiper
a. To tail gate window washer

TAIL GATE WINDOW WIPER, 145

The tail gate window wiper is operated by an electric, single-speed motor with a permanently magnetized field. It is connected to the wiper blade by a link arm. A parking switch, see Fig. 3-122, is built into the wiper motor. The function of this switch is to park the wiper blade irrespective of its position when switched off. The location of the tail gate window wiper can be seen in Fig. 3-123.

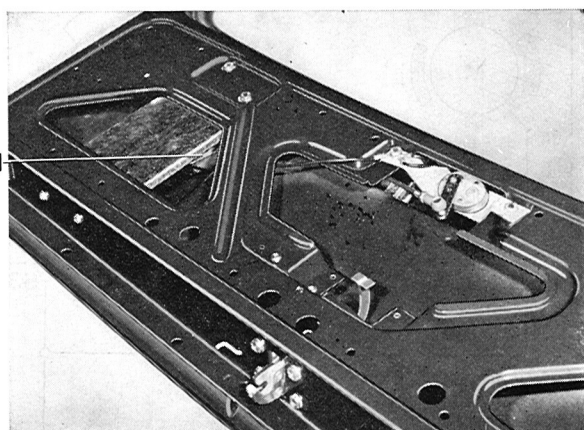


Fig. 3-123. Tail gate window wiper
1. Wiper motor

WINDSHIELD WASHER

Replace washer motor=Volvo Standard Times Op. No. 36324

The windshield washer is located on the left wheel housing. It is a gear type pump, driven by an electric motor. See Fig. 3-124.

Wipers and washers are operated by the same switch lever, located on the steering column.

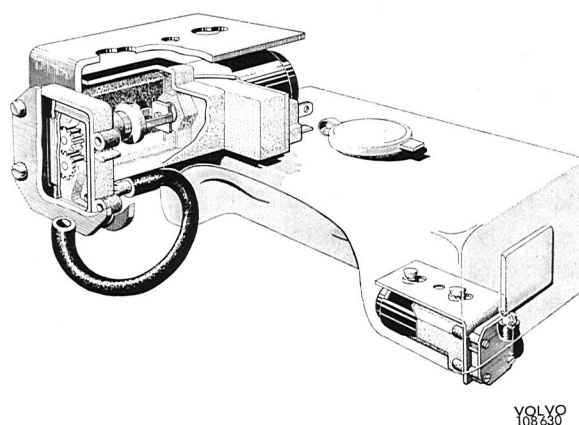


Fig. 3-124. Windshield washer

SWITCHES

The switches for the warning flashers, electrically heated rear window, are of the toggle type and are located on the control panel. Also located on the control panel is a rheostat for the instrument panel light.

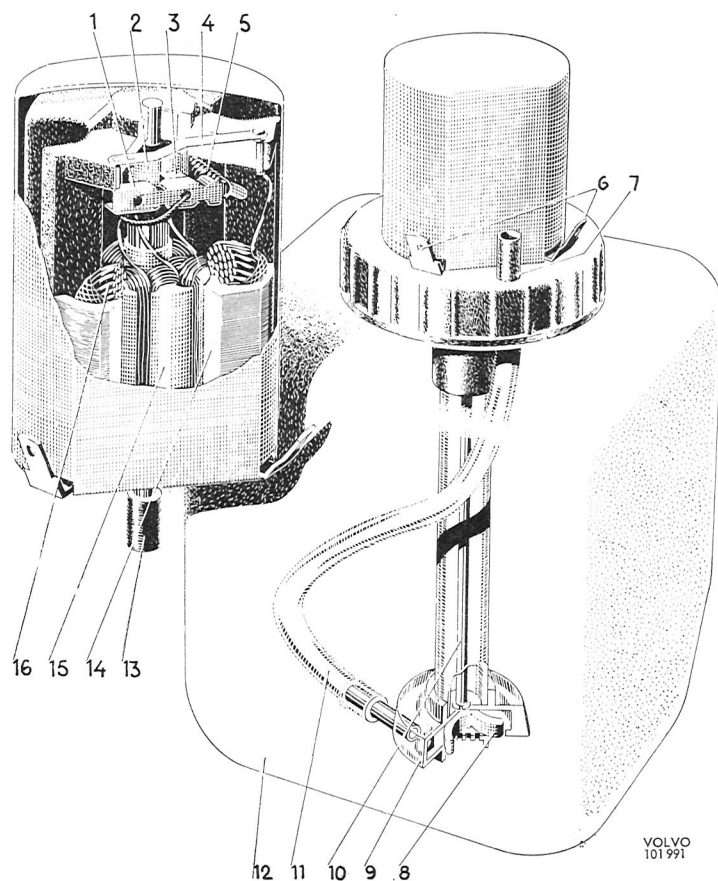


Fig. 3-125. Tail gate window washer, 145

1. Brush holder
2. Commutator
3. Brush
4. Thermal fusing
5. Spring
6. Terminal pins
7. Water outlet
8. Pump impeller
9. Pump housing
10. Shaft
11. Hose
12. Container
13. Flange
14. Stator
15. Rotor
16. Field coil

TAIL GATE WINDOW WASHER, 145

The tail gate window washer for the 145 model is driven by an electric motor, see Fig. 3-125. The pump is located at the bottom of the fluid container and is linked to the motor by a shaft. The pump is of the centrifugal type.

It is located in a cavity to the right under the floor of the cargo space, see Fig. 3-126.

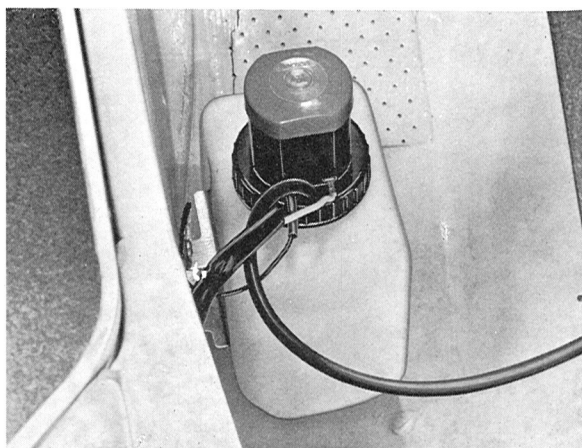


Fig. 3-126. Tail gate window washer

INTERIOR LIGHT

The interior light consists of a lamp located in the middle of the roof. The light is switched on by a switch built into the light. The switch has three positions. In its first position, the light is switched off completely, in the second position the light is on when any of the front doors is opened, and in the third position the light is on continuously.

The 145 model has an extra light in the roof over the cargo space. Opening the tail gate switches on this light.

SEAT/IGNITION INTERLOCK SYSTEM GENERAL

The purpose of the Seat/Ignition Interlock System is to prevent start of the engine if the driver's seat or the passenger's seat is occupied but the appropriate seat belt is not fastened.

The Ignition Interlock Device consists of:

SEAT CONTACTS, one for each seat, which indicate if the seat is occupied (the seat is loaded). The circuit is closed when the seat is occupied.

BELT CONTACTS, which indicate if the belt is connected. The circuit is opened when the belt is fastened.

INTERLOCK CONTROL UNIT (Logic Unit. See 1 fig. 3-128), which switches on or off the Starter Cut-out Relay, according to the indications of the above switches.

STARTER CUT-OUT RELAY, which is governed from the Interlock Control Unit and consequently opens or closes the circuit from the ignition switch to the starter.

The Interlock Control Unit incorporates also:

buzzer and **"fasten seat belt" control light** and the warning function "Ignition key left in the lock".

FUNCTION

The driver's seat and the passenger's seat have each one set of seat contacts and belt contacts. These sets are independent.

A relay in the Interlock Control Unit is governed by the indications from the driver's side and the passenger's side. When the seat belt is used correctly, the relay closes the circuit from "C" to "1" (relay rest position), and the engine can be started. See Fig. 3-127, pos. 1.

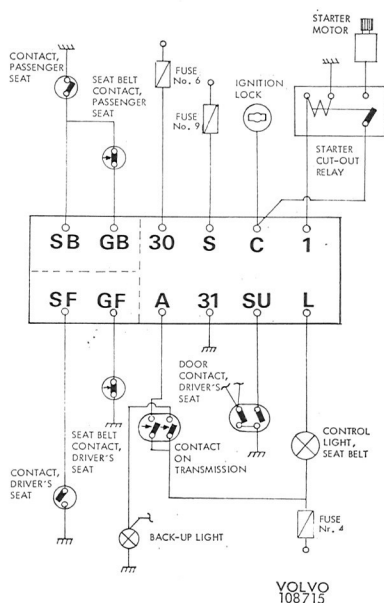


Fig. 3-127. Interlock Control System, wiring diagram

If the starter circuit has been cut out (seat and belt contacts incorrectly sequenced or misconnected) the driver is warned by the buzzer and the "Fasten Seat Belt" warning light when the ignition key is turned to the "Starting" position or the gear shift is in a forward position.

In order to prevent the cut-out and warning system to function if the seat intermittently is un-occupied (for instance at a road bump), there is a delay mechanism which cuts in the function only when the seat has been occupied for more than 20 seconds.

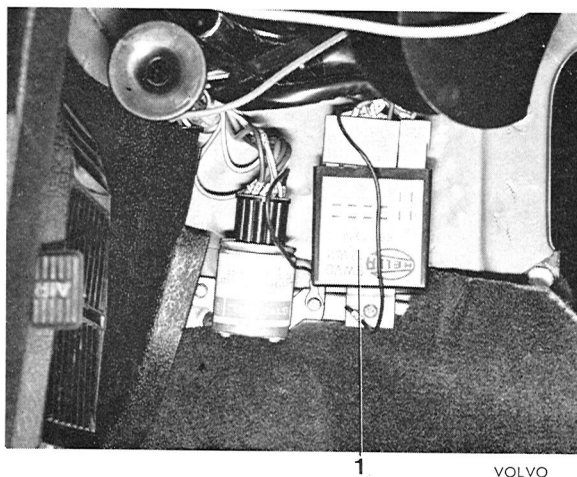


Fig. 3-128. Interlock Control Unit

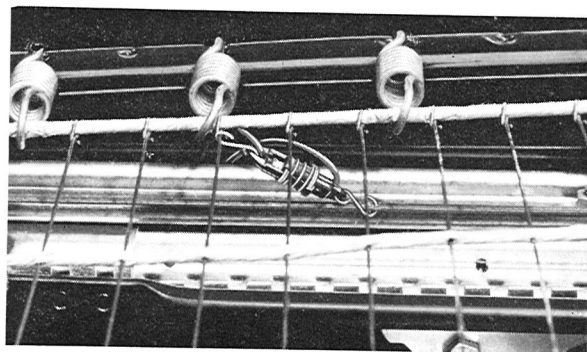


Fig. 3-129. Seat contact

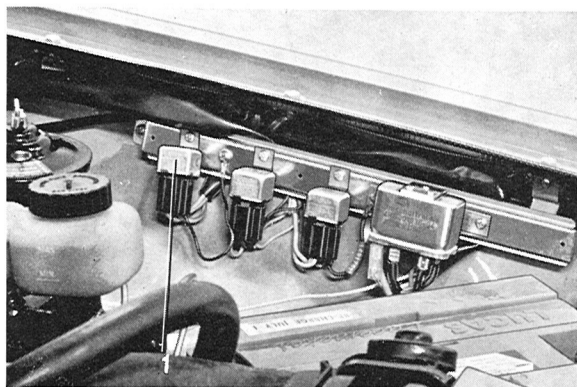


Fig. 3-130. Starter Cut-Out Relay

If the relay has functioned, the seat belt has to be disconnected and re-fastened.

The engine can be started:

1. If the seat is not occupied (loaded)
2. If the seat first is occupied and the seat belt thereafter fastened.

BRAKE LIGHT SWITCH

The brake light switch is located on the pedal carrier under the dashboard. It is operated mechanically by the brake pedal.

CONTROL RELAYS

The cars in the 140-series are as standard equipped with three control relays:

one for switching between upper and lower beams

one for the back-up lights

one for the rear window defroster.

Vehicles with automatic transmission are equipped with a start relay instead of a control relay for the back-up lights.

BULB INTEGRITY SENSOR

The Bulb Integrity Sensor system consists of a Reed relay and a warning light. It indicates if any of the bulbs for lower beam, tail light or stop light is out of order.

The indication is that the warning light comes on. The Reed relay is located to the left under the dashboard, see 1, Fig. 3-131, and the warning light is located in the combination instrument.

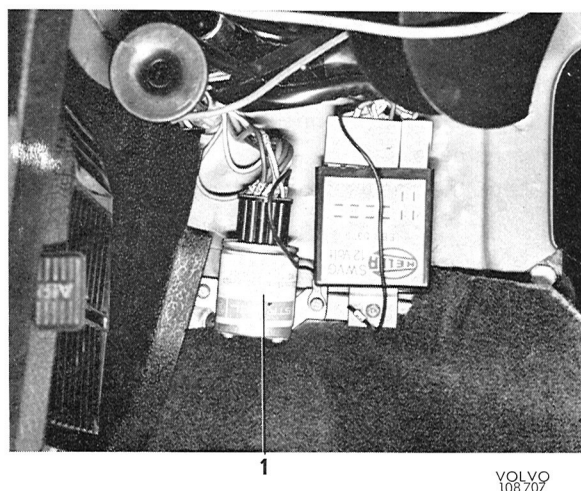


Fig. 3-131. Reed Relay

The Reed relay consists of a contact set, surrounded by three coil sets (one for lower beams, one for tail lights, one for stop lights).

Each coil set has two coils, one for left bulb, one for right bulb. The two coils are counteracting each other.

FUNCTION

When current flows through both coils in the coil set, that means that the bulbs on both sides are functioning, the two coils are counteracting each other and there is no actuation of the contacts, see Fig. 3-132. But if the current flow through one of the coils ceases (the bulb is not functioning), the contacts are actuated and the warning light comes on, see II in Fig. 3-132.

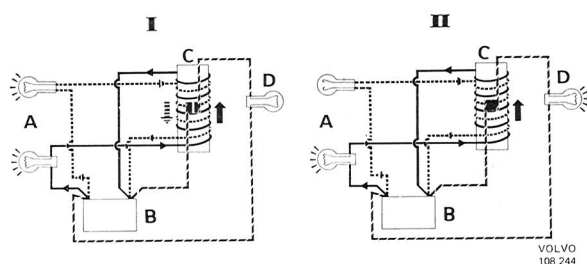


Fig. 3-132a. Bulb Integrity Sensor, function

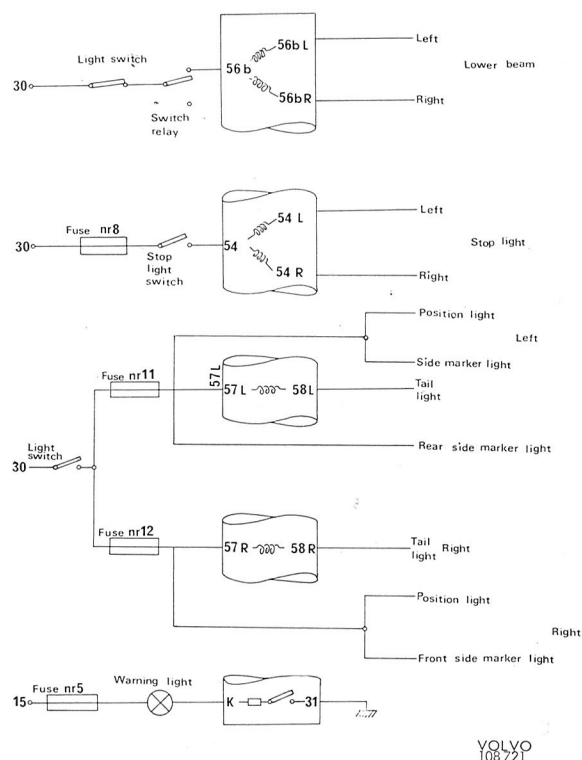


Fig. 3-132b. Bulb Integrity Sensor, wiring diagram

SERVICE PROCEDURES

REPLACING SWITCHES FOR TURN SIGNALS AND WINDSHIELD WIPERS

Replace turn signal switch=Volvo Standard Times Op. No. 36108

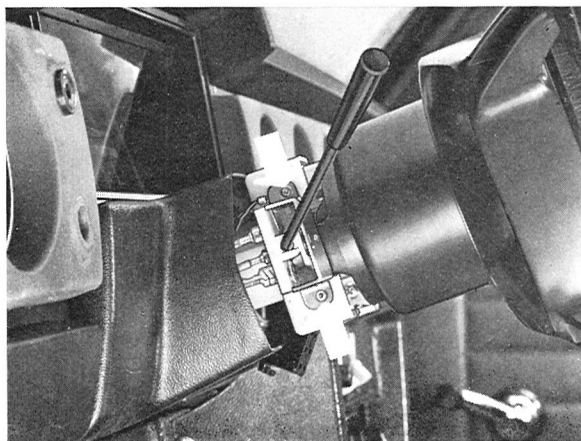


Fig. 3-133. Switch for flashers

1. Remove the casings over the steering column.
2. Remove the screws for the switch.
3. Connect the electric wires to the new switch.
4. Install the new switch and check its function.
5. Restore.

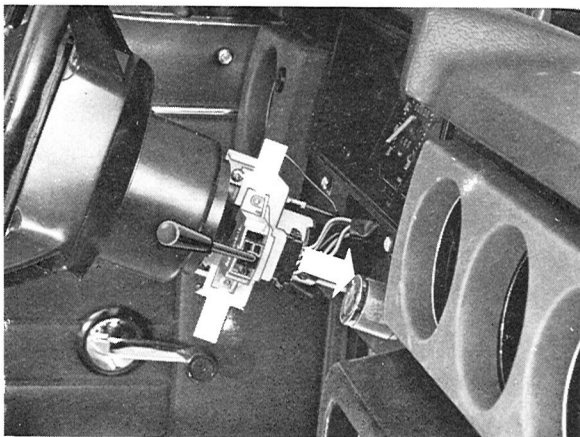


Fig. 3-134. Switch for windshield wipers

REPLACING TURN SIGNAL LIGHT

Replace turn signal light lens or bulb=Volvo Standard Times Op. No. 36106

Replace complete light=Op. No. 36124

1. Remove the electric cable from the the wiring harness in engine compartment.

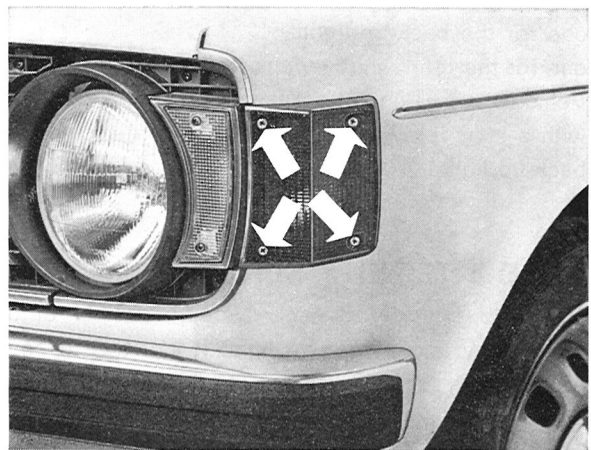


Fig. 3-135. Removing light glass

2. Remove the light lens, see Fig. 3-135.
3. Remove the housing from the fender. Pull out the electric cable with its grommet.
4. Install the new electric cable with grommet and install the housing.
5. Install the bulb, connect the electric cable to the harness.
6. Check the flasher function and install the lens.

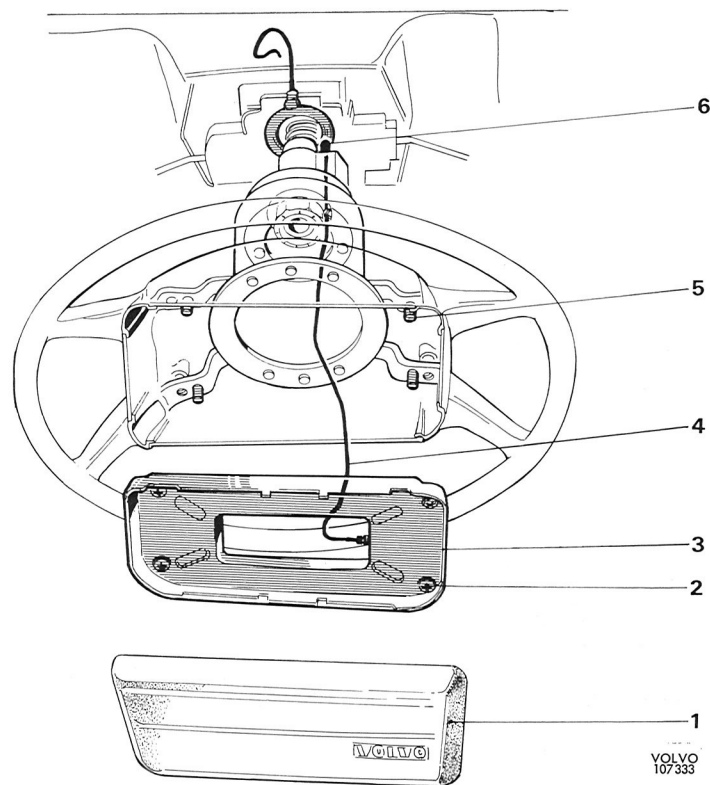


Fig. 3-136. Contact bar

- | | |
|--------------------|------------------|
| 1. Impact guard | 4. Electric wire |
| 2. Attaching screw | 5. Contact pin |
| 3. Contact bar | 6. Slip contact |

REMOVING HORN CONTACT BAR

Replace = Volvo Standard Times Op. No. 36214

1. Remove the impact guard (1, Fig. 3-136). (Carefully lever it loose with the help of a screwdriver.)
2. Disconnect the electric wire (4, Fig. 3-136) from the contact bar (3, Fig. 3-136).
3. Remove the four attaching screws (2, Fig. 3-136) for the contact bar and lift off the bar. Installation of the contact bar is in reverse order to removal. After installation, check the flasher function.

WINDSHIELD WIPERS

Volvo Standard Times, see page 3:51

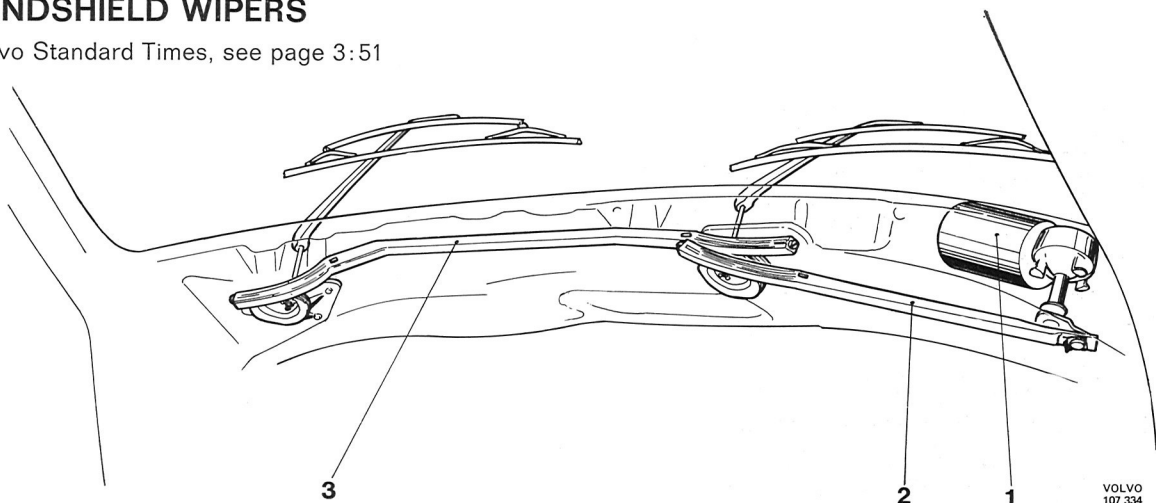


Fig. 3-137. Windshield wiper unit

1. Wiper motor
2. Drive link
3. Parallel drive link

REMOVING WIPER MOTOR

1. Remove the drive link from the output arm on the wiper motor after having first removed the lock device, see Fig. 3-138.

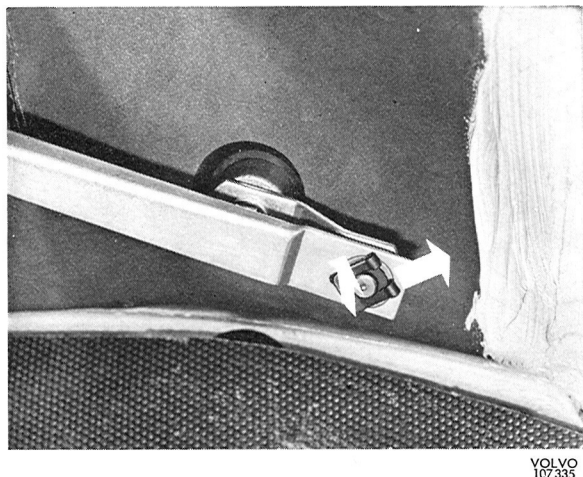


Fig. 3-138. Removing lock

2. Remove the contact from the wiper motor.
3. Remove the three attaching screws (Fig. 3-139).
Lift out the wiper motor.

When replacing a wiper motor, transfer the output arm, rubber seal, damper rubber and spacer sleeves to the new wiper motor.

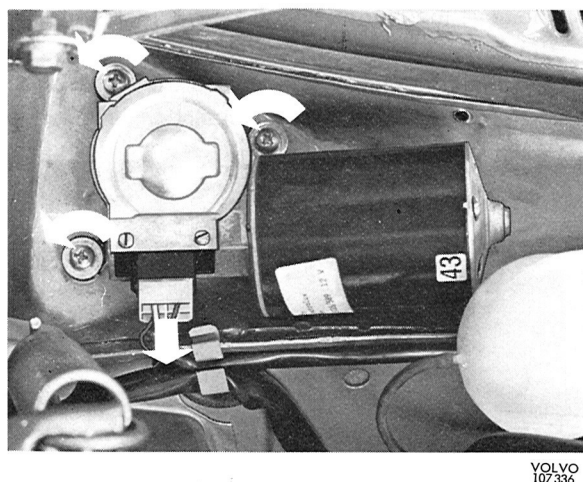


Fig. 3-139. Removing windshield wiper motor

INSTALLING WIPER MOTOR

1. Place the wiper motor in position and install the attaching screws, see Fig. 3-139.
2. Connect the contact to the wiper motor.
3. Install the drive link to the output arm on the wiper motor.
4. Check the wiper function.

REMOVING DRIVE LINK

(vehicles with standard heating system)

1. Remove the right-hand side panel and the defroster hoses.
2. Remove the drive link for the wiper motor lever and unscrew the nut for the cable stretcher. Lift off the drive link.

REMOVING DRIVE LINK

(vehicles with combined heating system)

1. Remove the glove locker.
 2. Remove the right defroster nozzle.
- Otherwise see "Removing drive link" (vehicles with standard type air conditioner).

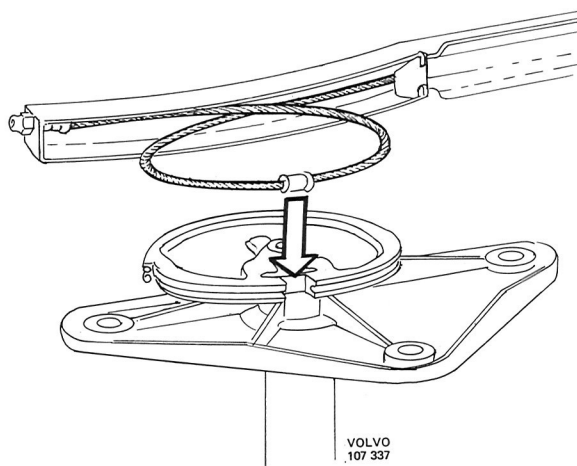


Fig. 3-140. Installing cable for drive link and parallel drive link, left-hand side

INSTALLING DRIVE LINK

(vehicles with standard heating system)

1. Place the cable's flange nipple in the segment recess and then lever the cable over the segment, see Fig. 3-140. This work should be done with the greatest care in order not to score the segment or damage it in any other way, as this would lead to disturbance in operation.
2. Install the connecting rod for the wiper motor lever. Thereafter tension the cable.
3. Check to make sure the wipers are functioning properly.
4. Install the defroster hoses and side panel.

INSTALLING DRIVE LINK

(vehicles with combined heating system)

- See points 1—3 under "Installing drive link" (vehicles with standard heating system).
4. Install the defroster nozzle and glove locker.

REPLACING CABLE

1. Remove the drive link and the parallel drive link.
2. Bend up the lock washer with the help of a screwdriver, and remove the washer. Remove the old cable.
3. Install the new cable in position and also a new lock washer.
4. Re-install the cable stretcher in the drive link. The nut should be screwed on only a couple of threads.
5. Install the drive link and parallel drive link.

REMOVING PARALLEL DRIVE LINK

Left-hand side

1. Remove the defroster hose.
(On vehicles with combined heating system, remove the air duct between the defroster nozzle and the air vent in the dashboard.)
2. Remove the nut for the cable stretcher and disconnect the cable from the segment.

Right-hand side

1. Remove the side panel and defroster hose.
(On vehicles with air conditioning of combined type, remove glove locker and right-hand defroster nozzle.)
2. Disconnect the drive link and remove it.
3. Remove the nut for the cable stretcher and disconnect the cable from the segment.
4. Lift forward the parallel drive link.

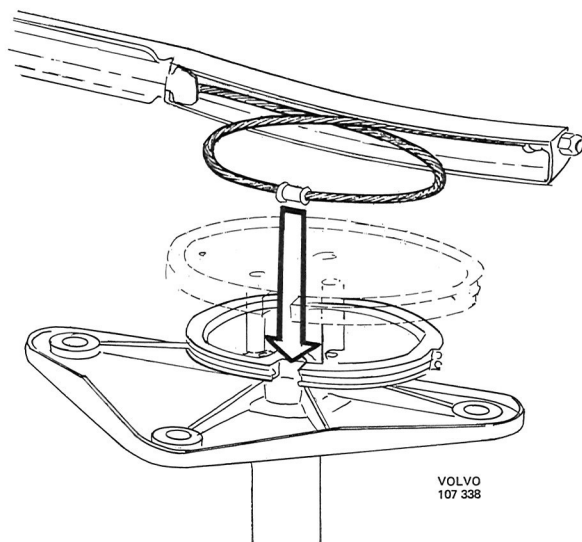


Fig. 3-141. Installing cable for parallel drive link, right-hand side

INSTALLING PARALLEL DRIVE LINK

Left-hand side

1. Place the cable's flange nipple in the large segment recess and thereafter prise the cable over the segment, see Fig. 3-140. Great care should be observed when doing this in order not to score the segment or damage it in any other way, otherwise this might lead to disturbance in operation.

Right-hand side

1. Place the cable's flange nipple in the small segment recess and thereafter prise the cable over the inner segment, see Fig. 3-141. Great care should be observed when doing this work so as not to score the segment or damage it in any other way, as this could lead to disturbance in operation. Tension the cable.
2. Place the drive link cable's flange nipple in the front segment recess and thereafter prise the cable over the segment, see Fig. 3-140. Attach the drive link to the lever on the wiper motor. Tension the cable.
3. Check the wiper function.
4. Install the defroster hoses and the side panel.
(On vehicles with combined heating system, install the defroster nozzle and the glove locker.)

REPLACING WIPER ARM BEARING

1. Remove the wiper arm.
2. Remove the drive link and parallel drive link.
3. Remove the attaching screws and lift off the wiper arm bearing.
4. Transfer the seal to the new wiper arm bearing. A worn or deformed seal should be replaced by a new one.
5. Install the wiper arm.
6. Check the wiper function.

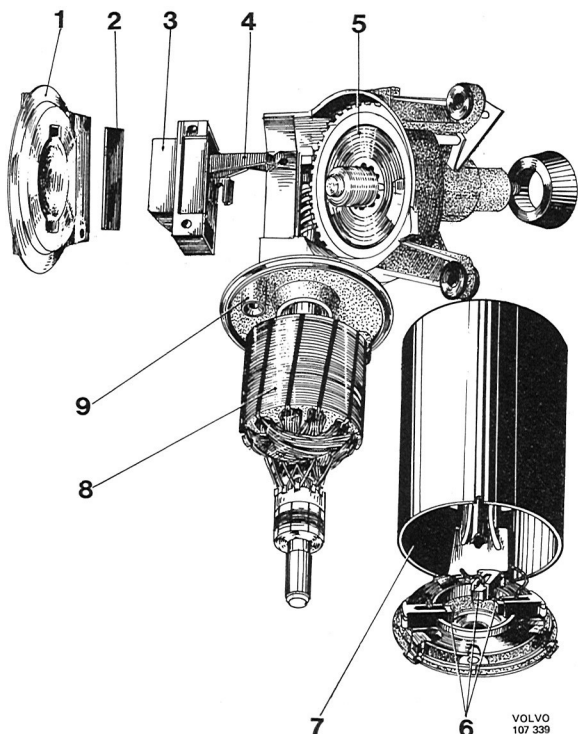


Fig. 3-142. Windshield wiper motor, Electrolux

- | | |
|--------------------------|---------------------|
| 1. Cover | 6. Electric brushes |
| 2. Packing | 7. Stator |
| 3. Connection contact | 8. Rotor |
| 4. Contacts | 9. End |
| 5. Gear with contact bar | |

TAIL GATE WINDOW WIPER, 145 REMOVING

1. Remove the negative (ground) battery lead from the battery.
2. Remove the panel on the inside of the tail gate.
3. Remove the screws securing the reinforcing plate under the wiper motor.
4. Disconnect the link arm and bend the reinforcing plate to the side and take down the wiper motor.
5. Mark and disconnect the electric wires from the motor.

EXAMINING PARKING SWITCH

If the wiper blade does not park in the proper position when the wiper is switched off, the fault can be sought in the switch or in the wiper motor parking switch, provided that the wiper blade arms are correctly fitted on the output shaft. If there is current up to connection 53a on the wiper motor and if connection 31b is grounded, the switch and cables are functioning properly and the fault will lie in the parking switch in the wiper motor, see Fig. 3-144.

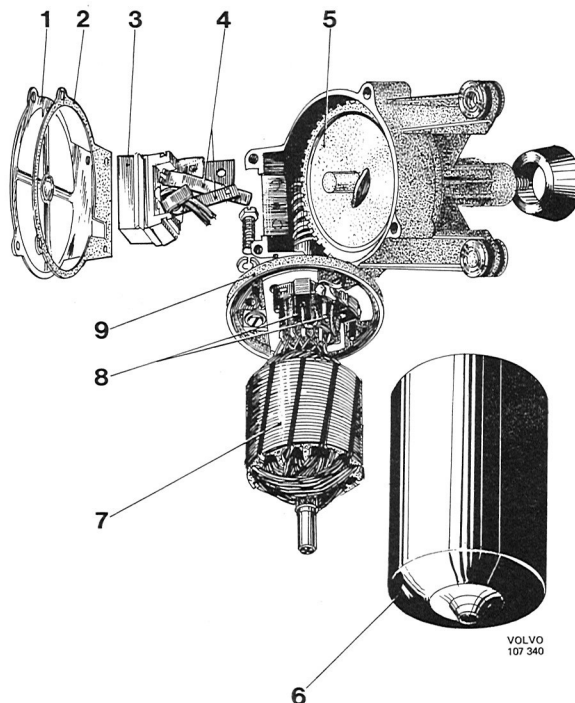


Fig. 3-143. Windshield wiper motor, SWF

- | | |
|-----------------------|---------------------|
| 1. Cover | 6. Stator |
| 2. Packing | 7. Rotor |
| 3. Connection contact | 8. Electric brushes |
| 4. Contacts | 9. End |
| 5. Gear with breakers | |

Check that the parking switch is functioning as follows:

With the lift tab in the inner position, the spring with contact 53 (6, Fig. 3-144) should lie against contact 53a (5, Fig. 3-144). When the wiper blade is in the parking position, the lift tab is lifted by an eccentric in the drive housing. This causes contact 53 (6, Fig. 3-144), to be pressed against contact 31b (7, Fig. 3-144).

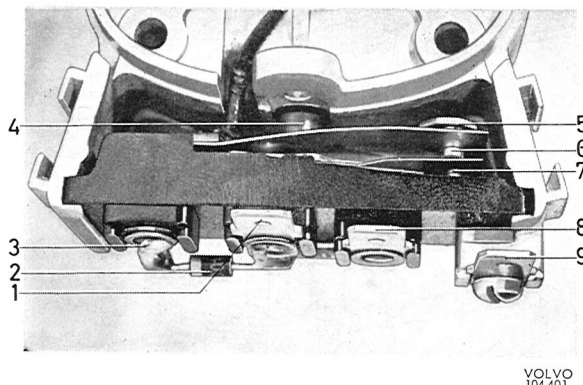


Fig. 3-144. Parking switch

- | | |
|-------------------|--------------------|
| 1. Connection 31b | 6. Contacts (2) 53 |
| 2. Riode | 7. Contact 31b |
| 3. Connection 53 | 8. Connection 53a |
| 4. Lift tab | 9. Connection 31 |
| 5. Contact 53a | |

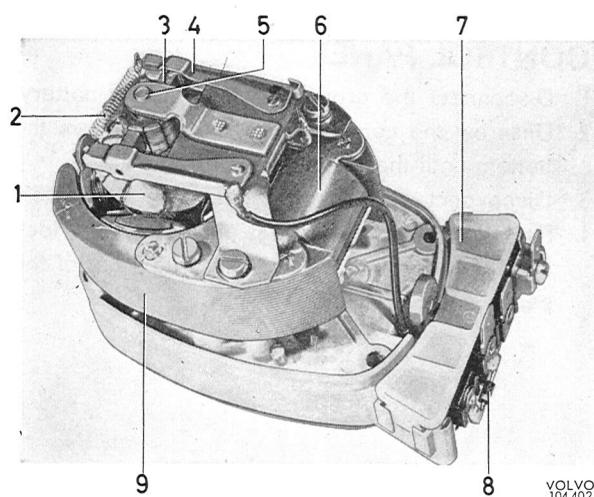


Fig. 3-145. Tail gate window wiper motor

- | | |
|-----------------------|---------------------|
| 1. Rotor | 6. Permanent magnet |
| 2. Brush spring | 7. Parking switch |
| 3. Brush | 8. Diode |
| 4. Brush holder | 9. Pole shoe |
| 5. Stop tab for rotor | |

DISASSEMBLING TAIL GATE WINDOW WIPER MOTOR

1. Remove the cover.
2. Unhook the brush spring.
3. Disconnect the two screws holding the brush holder plate and bend the plate out of the way.
4. Pull the rotor straight up. Note the small ball on the lower shaft end.
5. Disconnect the two screws holding the pole shoe and lift off the shoe.
6. Remove the drive housing cover by unscrewing the four small screws.
7. Pull the intermediate drive and drive on the output shaft straight out, see Fig. 3-146. Note the washer on the top side of the output shaft drive and flat washer underneath.

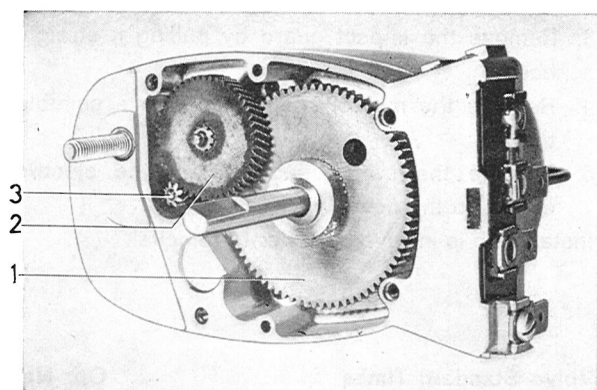


Fig. 3-146. Drive housing

1. Gear on output shaft
2. Intermediate drive, fiber
3. Rotor shaft drive

INSPECTING

Clean all the parts and check them for wear and mechanical damage. Check the rotor for short-circuiting between commutator and rotor frame and also for short-circuiting between and breakage in the winding coils. Short-circuiting between the commutator and rotor frame is tested by connecting a 40 V test lamp (alternating current) between them. The lamp must not light. Short-circuiting between the coils is tested with a small type of growler or with Bosch coil tester EFAW 90 or 95 with armature tester EFAW 96 or corresponding. Total disconnection to any commutator disc is checked with a 12 V test lamp (direct current). One of the measuring leads of the test lamp is placed on a commutator disc and the other is wound round the commutator. The lamp should light. If one of the wires to any commutator disc is broken, this is noticed by considerable burning damage on one or several of the diametrically placed discs.

Check with a test lamp or voltmeter that the diode is in circuit from connection 31b to connection 53 (+ to 31b and — to 53) and that it checks current flow in the opposite direction.

ASSEMBLING TAIL GATE WINDOW WIPER MOTOR

1. Apply plenty of grease to the drive housing, Bosch Ft 1 V 35 or corresponding.
2. Place the large drive with the output shaft and intermediate drive in position in the drive housing, see Fig. 3-146 (do not forget the two washers) and install the cover.
3. Place the pole shoe in position and secure it firmly with the two screws.
4. Apply a light oil film to the rotor shaft and its bushing.
5. Install the rotor. Make sure that the ball on the end of the rotor shaft is in position.
6. Screw the brush holder bridge firmly into position and hook on the brush spring.
7. Test-run the motor and install the cover.

INSTALLING

1. Connect the electric cables to the motor.
2. Attach the link arm at the motor and place the motor and reinforcing plate in position.
3. Install and screw tightly the screws securing the motor and reinforcing plate.
4. Connect the link arm to the output shaft and install the panel on the inside of the tail gate.
5. Connect the ground lead to the battery.

REPLACING INTERIOR LIGHT BULB

Replace interior light=Volvo Standard Times Op. No. 35154

Replace bulb=Op. No. 35153

Pull down the glass at the short side opposite the switch. Pull out the bulb. The glass is re-fitted by hooking it securely at the side where the switch is situated and then pressing in the glass firmly.

REPLACING BRAKE LIGHT SWITCH

Volvo Standard Times Op. No. 36408

When replacing the brake light switch, make sure that the new switch is adjusted correctly so that it functions satisfactorily. The distance between the brake pedal released and the threaded bronze hub on the switch should be 4 ± 2 mm ($.16 \pm .08$ ") (A, Fig. 3-147). If the distance must be adjusted, release the attaching screw for the bracket and move the bracket until the correct distance is obtained.

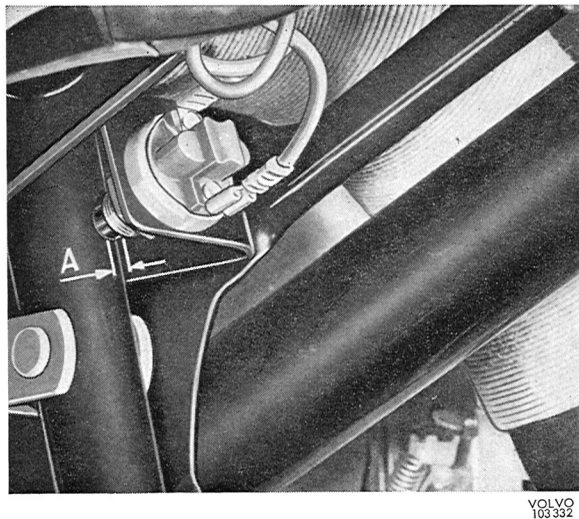


Fig. 3-147. Brake light switch

REPLACING IGNITION SWITCH

Volvo Standard Times Op. No. 34002

1. Remove the contact by pulling it straight forward.
2. Remove both the attaching screws with a screwdriver.
3. Lift out the ignition switch.

Installation of the ignition switch is in reverse order to removal.

REPLACING SWITCHES ON CONTROL PANEL

1. Disconnect the ground cable from the battery.
2. Unscrew the control panel and lift up from the bottom until the contacts are accessible.
3. Disconnect the contact harness from the switch.
4. Remove the switch by first pressing in the lock springs and then pressing the switch out of the panel, see Fig. 3-148.

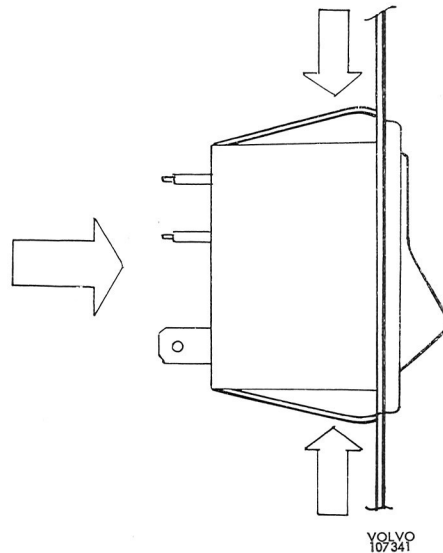


Fig. 3-148. Removing headlight switch

REPLACING HEADLIGHT SWITCH

1. Remove the switch knob.
2. Pull out the choke. (Does not apply to injection engines.)
3. Remove the impact guard by pulling it straight back.
4. Remove the nut for the switch with a suitable tool.
5. Remove the switch and transfer the electric cables to the new switch.

Installation is in reverse order to removal.

Volvo Standard Times

Replace toggle switch
Replace push-pull switch
Replace back-up light switch
Replace stop light switch

Op. No.

36412
36404
36421
36408

BULB INTEGRITY SENSOR, CHECK

NOTE: The Bulb Integrity Sensor warning light may come on if the connected bulbs current draw is distorted. A short indication may sometimes occur, when the headlight is switched on, depending on variations in "starting" time for the bulbs.

1. Switch on the ignition.

The warning light should come on.

If the warning light does not come on, it is defective.

2. Start the engine.

The warning light should go out.

The Bulb Integrity warning light and the charging control light light simultaneously: the alternator does not function.

The Bulb Integrity warning light is on after the charging control light has gone out: the Bulb Integrity Sensor is defective.

NOTE: the light switch should be pushed in and the brake pedal not actuated during the test.

3. Switch on the headlight lower beam.

The warning light should be out.

The Bulb Integrity warning light is on, but all bulbs for lower beam, parking light, tail light etc are functioning: the Bulb Integrity Sensor is defective.

4. Switch off the headlight lower beam.

5. Remove fuse No. 11 or 12.

The warning light should come on. If not, the Bulb Integrity Sensor is defective.

Re-connect the fuse.

6. Switch off the light.

7. Depress the brake pedal.

The warning light should be out. If it comes on and both brake lights function, it is defective.

8. Switch off the ignition.

BULB INTEGRITY SENSOR UNIT, REPLACEMENT

Volvo Standard Times Op. No. 36504

1. Disconnect the connector at the Sensor Unit.
2. Remove the Sensor Unit.
3. Install the replacement Sensor Unit.
4. Re-connect the connector to the Sensor Unit.
5. Check the function of the replacement unit.

INTERLOCK CONTROL UNIT, REPLACEMENT

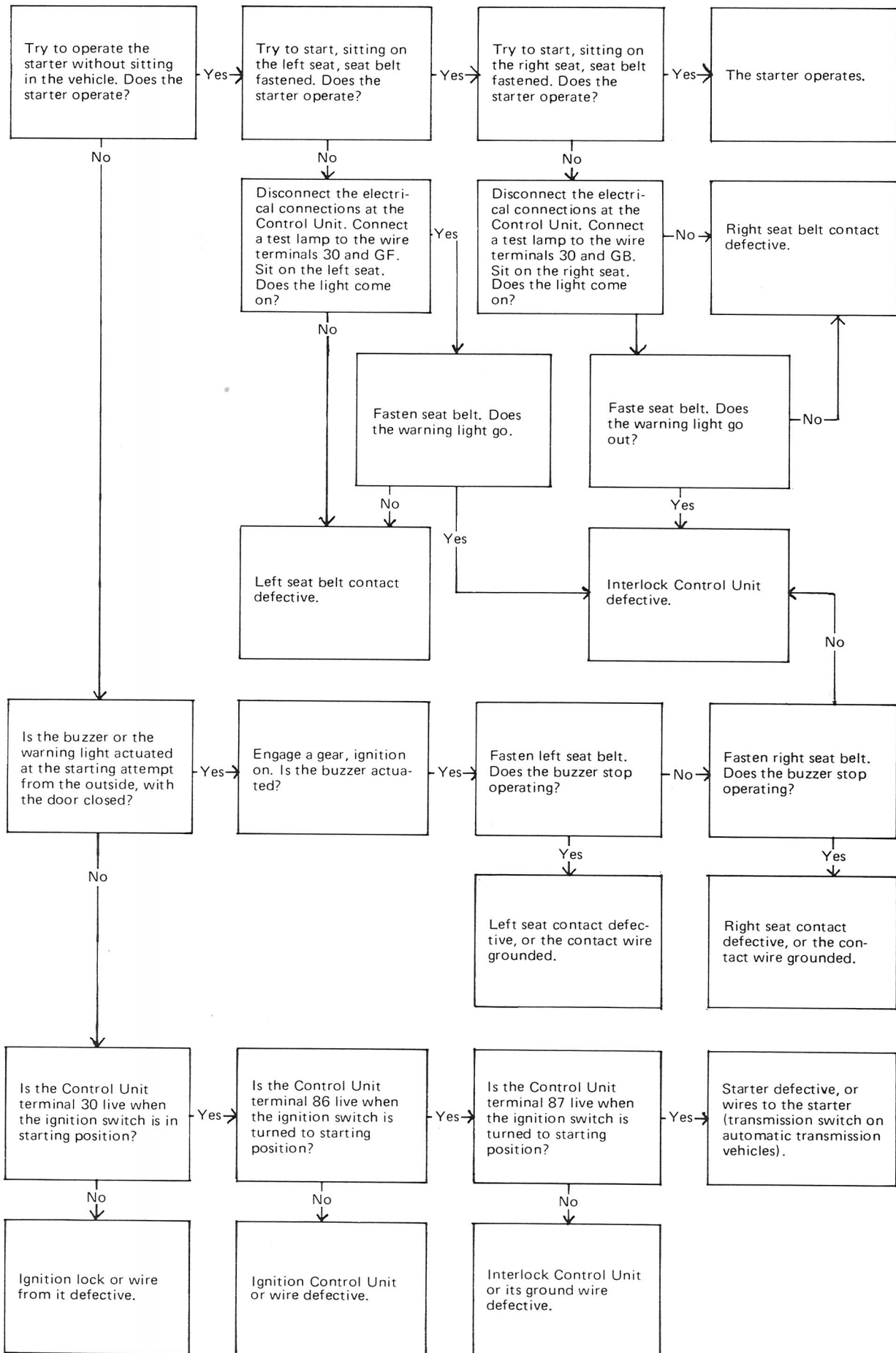
Volvo Standard Times Op. No. 36506

1. Disconnect the electrical connections at the unit.
2. Remove the control unit.
3. Install the replacement unit.
4. Test the unit, as follows:
 - a. Get seated
Move the gear lever to "Neutral" position.
Turn the ignition switch to starting position.
The starter should fail to operate.
 - b. Fasten the seat belt.
Turn the ignition switch to starting position.
The starter should operate.
Switch off the ignition.
Disconnect the seat belt and leave the vehicle.

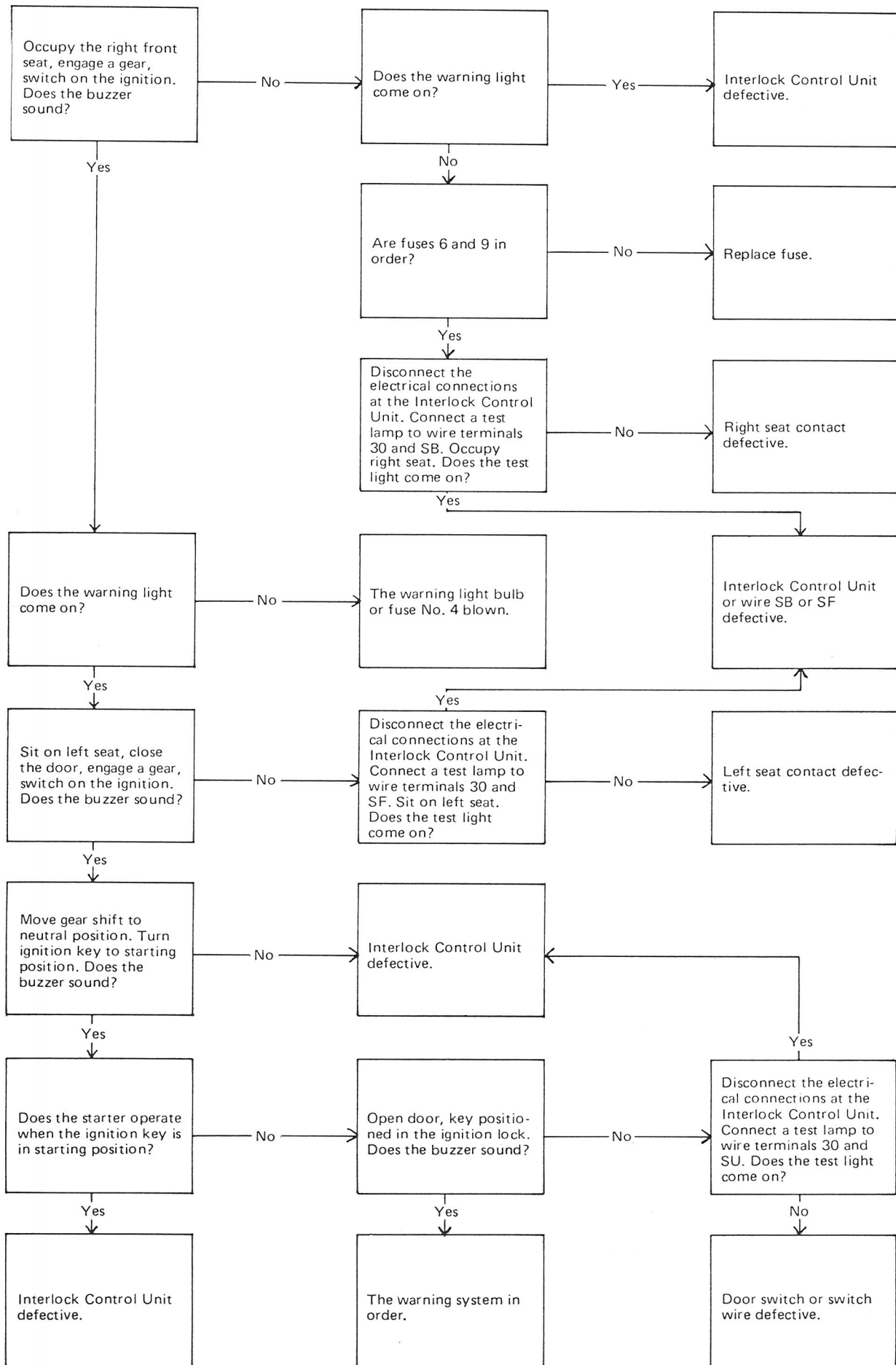
SERVICE DIAGNOSIS

For Service Diagnosis, Ignition Interlock System, see pages 3:64 through 3:66.

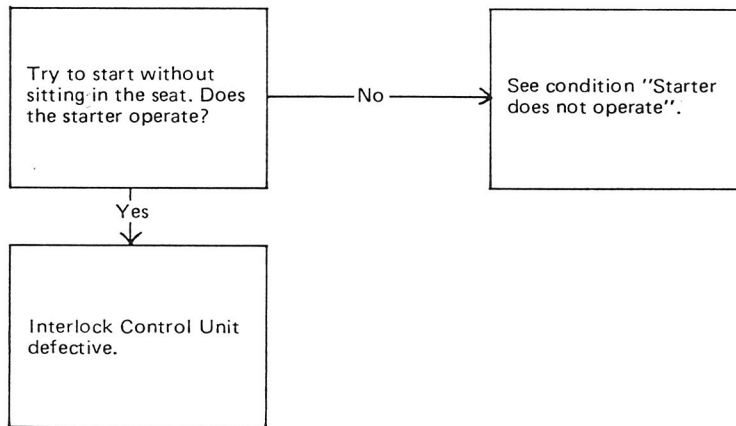
THE STARTER DOES NOT OPERATE



WARNING SYSTEM DOES NOT FUNCTION



WARNING SYSTEM OPERATES CONTINUOUSLY



GROUP 38

INSTRUMENTS

TOOLS

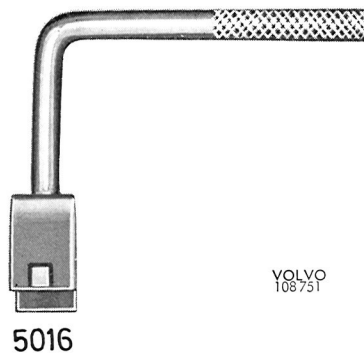


Fig. 3-149. Special tool for removing and installing tank fittings

Special tools may now be preceded by SVO or 999, e.g., SVO 1801 or 999 1801.

GENERAL INFORMATION

The instrumentation consists of a combined instrument, see Figs. 3-150 and 3-151. It comprises a speedometer and trip meter, tachometer (certain models), temperature gauge, fuel gauge, warning lamps for parking brake, brake circuit failure, oil

pressure, battery charging, choke, bulb failure warning and overdrive.

Also connected to the combined instrument is a voltage regulator which maintains the feed voltage constant for the instrumentation.



Fig. 3-150. Combined instrument, front side

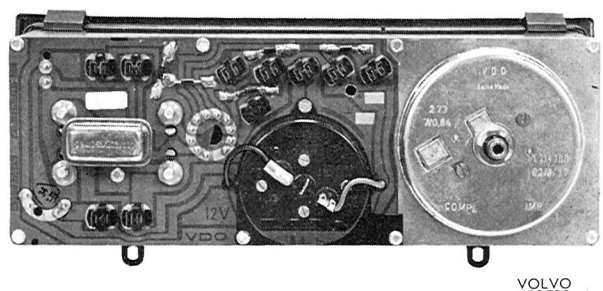


Fig. 3-151. Combined instrument, reverse side

SPEEDOMETER AND ODOMETER

The speedometer and odometer are integrally built and are driven by a drive line from a worm on the transmission output shaft.

The speedometer is of the eddy current type and mainly consists of a permanent magnet, a mounting disc and a rotor drum. The rotor drum is linked by a shaft to the gauge pointer. The shaft is also provided with a balance spring.

The odometer has a number of gears and registers up to 1 million km (600 000 miles). It is also provided with a trip meter. The ratio of the mileometer is so chosen that the drive line should rotate 640 times in order for the gauge to register 1 km.

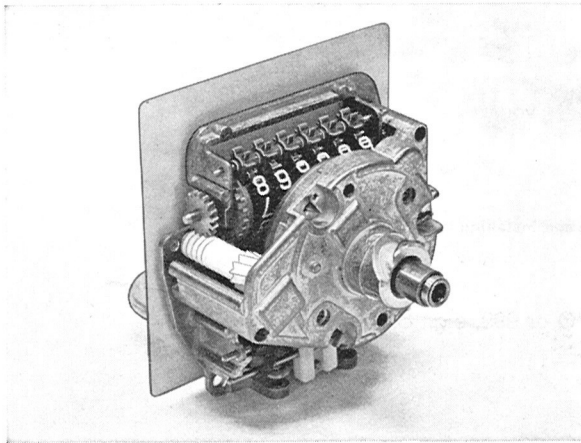


Fig. 3-152. Speedometer and mileometer

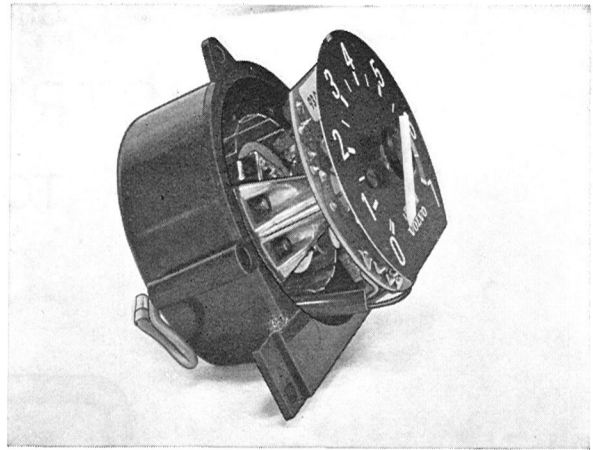
When the vehicle starts running, the drive line and the permanent magnet connected to the drive line rotate. This generates a rotating magnetic field, which gives rise to eddy currents in the rotor drum. The rotating effect which the magnetic field as well as the induced eddy currents have on the rotor drum increase with increased speed on the permanent magnet. The rotation of the rotor drum is counteracted by the balance spring, this giving a proportional reading of the pointer to the magnetic rotation.

TACHOMETER

The tachometer consists partly of a transistorized registration and amplifier unit and partly of a rotational coil system.

The registration part senses, through a sender line, the pulse frequency of the ignition coil. The amplifier part amplifies and conducts the pulses to the rotational coil system.

The rotational coil system consists of an annular shaped permanent magnet round which a coil is fitted. The coil is movable the length of the magnet



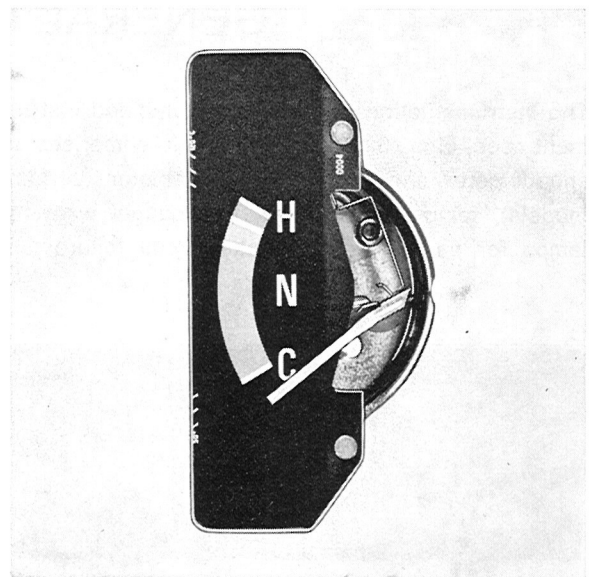
VOLVO
107345

Fig. 3-153. Tachometer

and is linked to a shaft to which the tachometer gauge pointer is attached. When pulses from the amplifier are conducted through the coil, this forms a magnetic flow which coils the length of the permanent magnet. The rotational force is proportional to the current flow through the coil.

TEMPERATURE GAUGE, COOLANT

The temperature gauge is of the bimetal type and consists of a sensor and a registering instrument. The sensor is mounted on the engine and senses the coolant temperature. The registering instrument is included in the combined instrument.



VOLVO
108709

Fig. 3-154. Temperature gauge

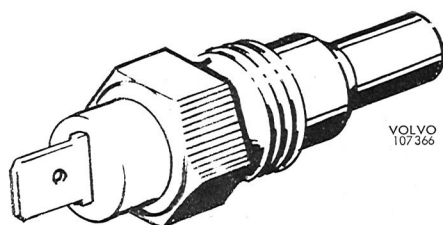


Fig. 3-155. Sensor for temperature gauge

The sensor, which is of the semi-conductive type, has a negative temperature coefficient, which means that its resistance drops in proportion to increased temperature.

The registering instrument consists of a bimetal spring connected to a pointer. A resistance wire, connected in series with the voltage stabilizer and sensor, is wound round the bimetal spring.

When the ignition is switched on, current flows from the voltage stabilizer through the resistance wire and the sensor to ground. When current passes the resistance wire, it heats up the metal spring and this causes the pointer to indicate on the gauge. The volume of the current passing through the resistance wire is in inverse proportion to the resistance of the sensor, and for this reason the gauge reading increases with increased engine temperature.

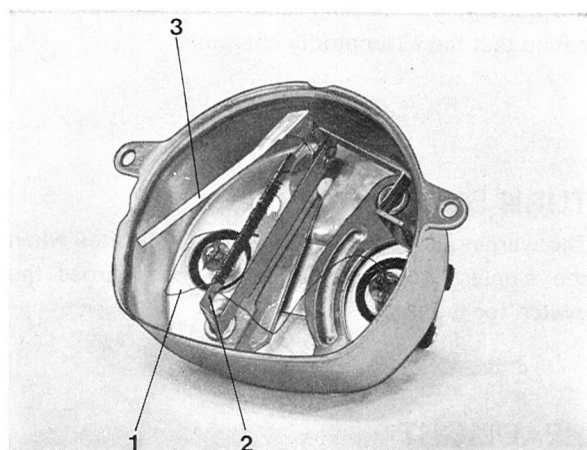


Fig. 3-156. Registering instrument, disassembled

1. Resistance wire
2. Bimetal spring
3. Pointer

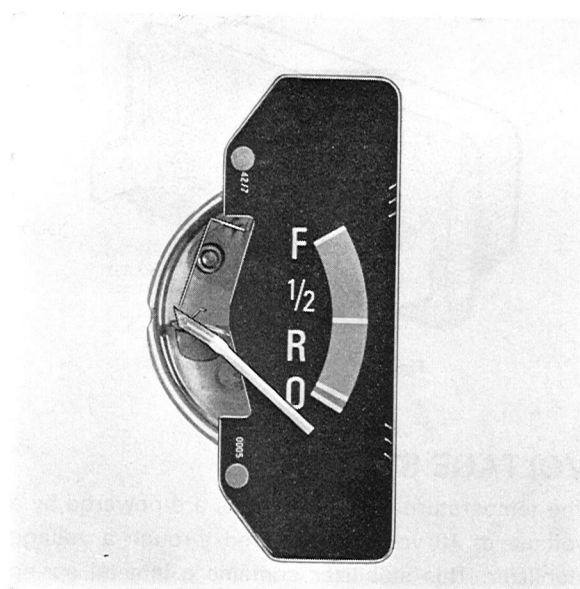


Fig. 3-157. Fuel gauge

FUEL GAUGE

The fuel gauge consists of a sender and indicating instrument. The sender in the fuel tank consists of a moving resistance, a lever and a float. The indicating instrument is of the same type as for the temperature gauge.

The function is exactly the same as for the temperature gauge, apart from the fact that the sender is mechanical. The amount of sender resistance engaged will depend on the amount of fuel in the tank and thereby the location of the float. In other words, an empty tank results in large sender resistance while a full tank produces minimum sender resistance. This has a corresponding effect on the indicating instrument.

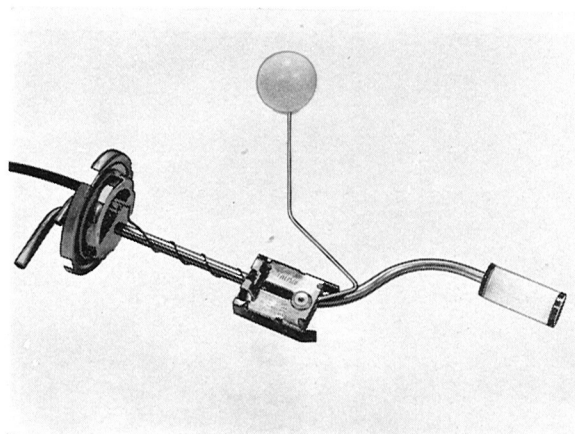


Fig. 3-158. Sender for fuel gauge

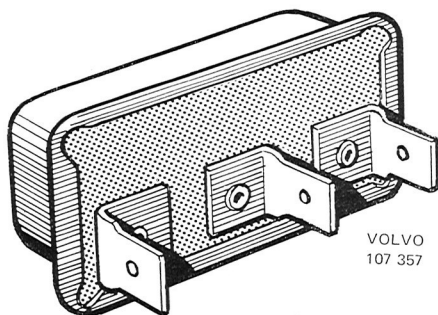


Fig. 3-159. Voltage stabilizer

VOLTAGE STABILIZER

The temperature and fuel gauges are powered by a voltage of 10 volts and are fed through a voltage stabilizer. This stabilizer contains a bimetal spring and a contact breaker. When the ignition is switched on, current flows through the stabilizer and out to the instruments. This heats the stabilizer bimetal spring which bends and thus breaks the circuit. As the spring cools down, it returns to its original position and the circuit is closed again. This cycle is repeated continuously. A regulated effect corresponding to a constant voltage of approx. 10 volts is thereby obtained. The breaking and making of the circuit is not visible on the instruments due to their inertia. The stabilizer is mounted on the reverse side of the combined instrument.

BRAKES

PARKING BRAKE

The parking brake warning lamp receives current via the ignition switch. When the parking brake is applied, the warning lamp is grounded by the switch, Fig. 3-160, and this switches on the warning lamp which remains lighted as long as the parking brake is on.

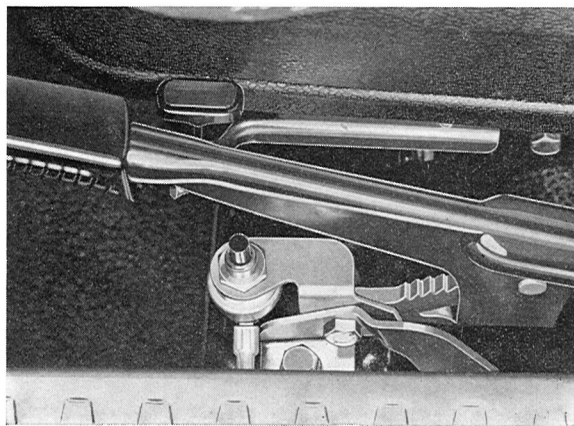


Fig. 3-160. Switch for parking brake control

BRAKE CIRCUIT FAILURE

Should a fault arise in any of the two circuits of the hydraulic brake system, so that there is a pressure difference between the circuits of more than 8—10 kp/cm² (114—142 psi) when the brakes are applied, this actuates the warning valve, Fig. 3-161 and the warning lamp goes on. The warning lamp remains lighted until the fault in the brake system has been corrected and the warning valve re-set. Re. re-setting the warning valve, see Section 5, Brake, Group 52.

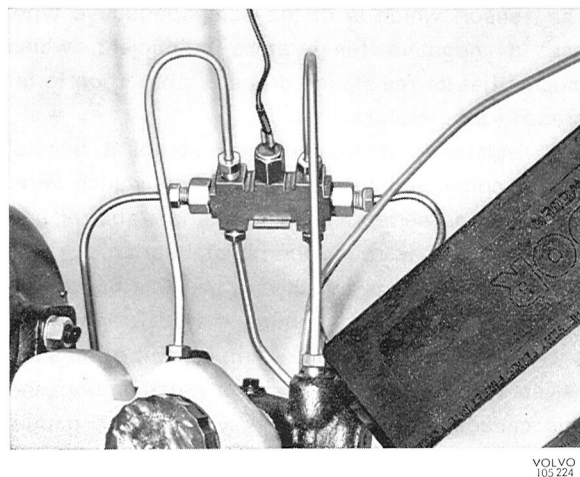


Fig. 3-161. Warning valve

BATTERY CHARGING

The battery charging warning lamp is connected to the alternator. It lights up when the alternator voltage is lower than the battery voltage. As the alternator voltage rises and commences to charge the battery, the warning lamp goes out, thus indicating that the alternator is charging.

TURN SIGNALS

The warning lamp for the turn signals flashes when the signals are engaged. It is wired across the switch for the signals.

HEADLIGHT

The control light for the headlight upper beams comes on simultaneously with the full-beam headlights. It is wired parallel with the headlights at the relay.

OIL PRESSURE

The warning lamp for the oil pressure receives current via the ignition switch and is grounded through a pressure sensitive valve on the engine. With the engine running and at normal pressure, the connection between this lamp and ground (through the engine) is open. When the oil pressure drops below a pre-determined value, the pressure sensitive valve closes the circuit and the warning lamp lights.

CONTROL PANEL

The control panel contains a rheostat for the instrument panel lighting, cigarette lighter and switch with built-in control light for the electrically heated rear window and emergency warning flashers. The control panel also contains the controls for the heating unit as well as a reminder light for the seat belts.

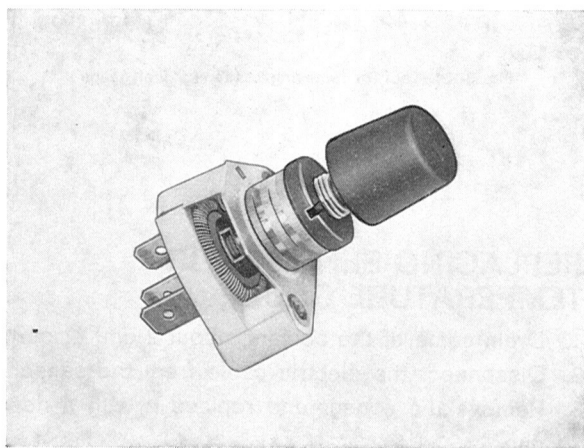


Fig. 3-162. Rheostat for instrument light

OVERDRIVE

The control light for the overdrive is connected between the switch for the overdrive and ground, and thus lights when the overdrive is engaged.

CHOKE

When the engine is choked, a contact in the choke control cuts in the circuit and this grounds the control light, which lights.

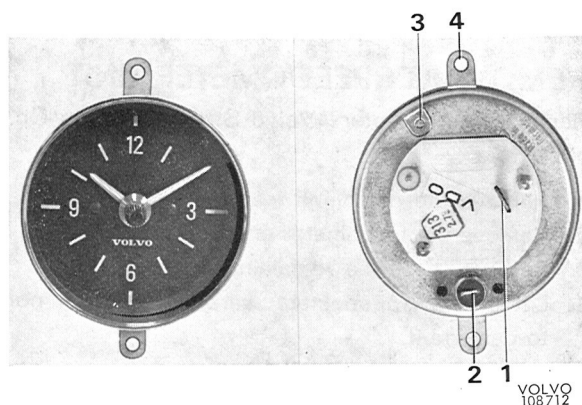


Fig. 3-163. Electric clock, front and reverse

1. Battery connection
2. Bulb
3. Battery connection
4. Attaching screws

CLOCK

The clock, Fig. 3-163, is electrically driven and above the control panel.

SERVICE PROCEDURES

For all work under the dashboard, the battery ground cable should be disconnected to avoid any short-circuiting.

REMOVING COMBINED INSTRUMENT

1. Remove the casings over the steering column.
2. Remove the attaching screw for the bracket and allow it to drop down towards the steering

column. The combined instrument's attaching screws can now be removed.

3. Disconnect the speedometer cable from the instrument.
4. Take hold of the reverse side of the speedometer gauge with the hand and press the instrument upwards — inwards until the snap lock in the upper edge of the instrument releases.
5. Lift forward the instrument and disconnect the connection from its reverse side. (On vehicles with tachometer, the tachometer cable should also be disconnected.)

REMOVING WARNING LIGHTS

1. The lights are mounted in holders which are removed by pushing in their attaching hooks and then pulling the holder straight out.
2. The bulbs are released from their sockets by pulling them straight out.

REMOVING TACHOMETER OR GUARD COVER

1. Remove the combined instrument.
2. Remove the three screws.
3. Lift off the tachometer or the guard cover carefully in order not to damage the pole connections.

REMOVING SPEEDOMETER UNIT

Replace speedometer=Volvo Standard Times Op. No. 38171

1. Remove the combined instrument.
2. Remove the tachometer or guard cover.
3. Remove the three remaining screws.
4. Lift off the speedometer carefully in order not to damage it.

REMOVING VOLTAGE STABILIZER

The voltage stabilizer is removed by pulling it straight up so that the three connection pins release from their retainers.

REMOVING CABLE PLATE

1. Remove the combined instrument.
2. Remove the tachometer or guard cover.
3. Remove the speedometer.
4. Remove the three remaining screws.
5. Carefully lift up the cable plate so that the temperature gauge or fuel gauge is not damaged.

REMOVING TEMPERATURE GAUGE AND FUEL GAUGE

Replace gauge=Volvo Standard Times Op. No. 38114

1. Remove the tachometer or guard cover.
2. Remove the speedometer.
3. Remove the contact device.
4. Remove both nuts on the reverse side of the contact device.
5. Lift out the gauge.

The components in the combined instrument are installed in reverse order to removal.

REMOVING SENDER FOR FUEL GAUGE

Replace sender or gasket=Volvo Standard Times Op. No. 23418

The sender, which is located in the fuel tank, is held in position with a bayonet fixture. When removing, use tool 5016 see Fig. 3-164.

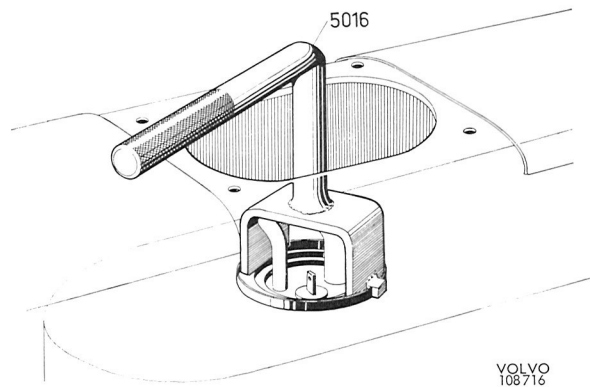


Fig. 3-164. Tool for removing sender for fuel gauge

REPLACING SENSOR FOR TEMPERATURE GAUGE

1. Drain some of the coolant, about 2 dm³ (2 qts).
2. Disconnect the electric cable from the sensor.
3. Remove the sensor and replace it with a new one.
4. Install the new sensor and connect the electric wire.
5. Fill coolant.

REMOVING CLOCK

Replace clock=Volvo Standard Times Op. No. 38124

1. Remove the impact pad.
2. Remove the control panel attaching screws.
3. Lift forward the panel sufficiently to get at the reverse side of the clock.
4. Disconnect the electric cable from the clock.
5. Remove the clock's two attaching screws and lift forward the clock.

Installation is in reverse order to removal.

TESTING SPEEDOMETER WITH MILEOMETER

If the speedometer or mileometer is not functioning, the reason may be due to a fault in the instrument or speedometer cable or the worm gear, which is located on the transmission for driving the cable. In order to decide which component is faulty, check following:

If the speedometer functions while the odometer does not, or vice-versa, then the instrument is defective and should be replaced. No attempt should be made to repair the instrument.

When both the speedometer and odometer stop functioning, the fault is probably in the speedometer cable or the worm gear. Disconnect the speedometer cable from the instrument and see if it can be rotated. If it can, this means that it has broken from the worm gear. Check the cable and the drive at the transmission.

Check to see whether the drive couplings can rotate easily. If it jams, the instrument should also be replaced.

The speedometer can be checked by running it at different speeds. The following values should then apply:

Speed of drive couplings

8.35	16.70	29.20	r/s
(500)	(1000)	(1750)	(r/m)

Speedometer reading

31.5±2.5	60.5±2.5	104.5±2.5	Mph
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TESTING SPEEDOMETER CABLE

It is most important that the speedometer cable is correctly fitted if the speedometer is to function without trouble. It is vitally important that the cable is not bent too sharply. At no point must the radius of a bend be less than 100 mm (4"). If it is less than this, vibration and noise can occur in the instrument. The drive couplings must run true in the outer casing of the cable. This is checked with the cable rotating.

TESTING TEMPERATURE GAUGE

If the temperature gauge is faulty, the faulty component (sensor, indicating instrument or voltage regulator) must first be traced and then the fault remedied. In order to trace the faulty component, two or possibly three resistors are required, one or two at 40 ohms and one at 282 ohms.

Trouble shoot as follows:

First disconnect the electric cable from the temperature sensor and then connect up the 282 ohm resistor between cable and ground.

With the ignition switched on, the pointer on the indicating instrument should be at the beginning of the green field (50° C=122° F). Instead of the 282 ohm resistor, then connect the 40 ohm resistor. The pointer on the indicating instrument should be at the beginning of the red field (120° C=248° F). With correct indicating instrument function, the sensor is defective and should be replaced by a new one.

NOTE: The sensor cable must **never** be wired directly to ground since it would overheat and ruin the instrument.

If the instrument gives incorrect reading, the fault is either in the indicating instrument or the voltage regulator.

In order to decide where the fault lies, disconnect the fuel gauge sender wire from the sender and connect a resistance of 40 ohms between wire and ground.

If the fuel gauge now shows a full tank, the fault must be in the indicating instrument of the temperature gauge, which must be replaced. If, on the other hand, the temperature gauge and fuel gauge give the same, but incorrect, reading, then the voltage regulator must be defective and should be replaced.

TESTING REMOVED TEMPERATURE SENSOR

The sensor is checked by heating it up and then reading resistance and temperature. The following values should be obtained if the sensor is in order: (NOTE: The resistances may deviate ±10 %.)

Temperature	50	100	120	°C
	(122)	(212)	(248)	°F
Resistance	282	60	40	ohms

TESTING FUEL GAUGE

The fuel gauge is checked in the same way as the temperature gauge.

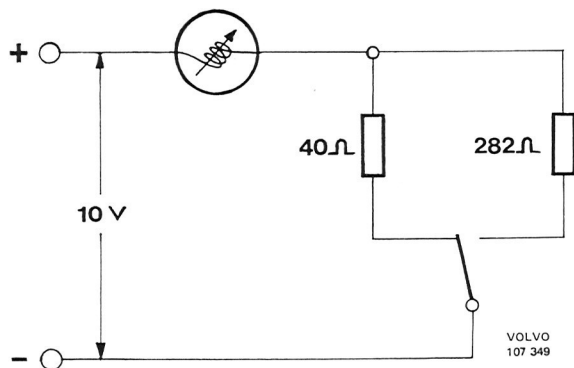


Fig. 3-165. Wiring diagram for checking temperature gauge or fuel gauge indicating instrument

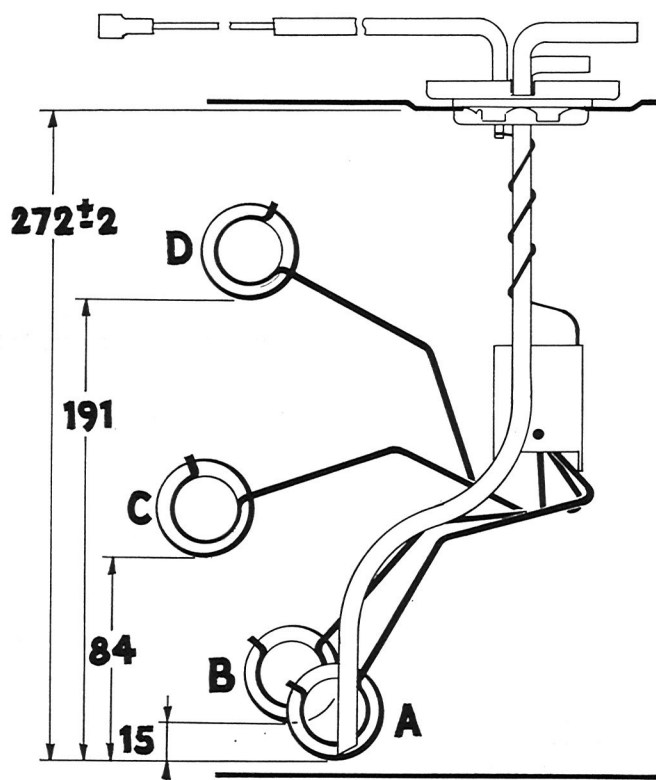
TESTING REMOVED FUEL GAUGE SENDER

The sender is checked with an ohmmeter which is wired between the contact unit for the electric cable and ground. The following resistance values should be obtained if the sender is functioning correctly:

Regarding various positions of the float, see Fig. 3-166. Its measurement indications indicate the number of mm the float should be lifted from its bottom position.

TESTING REMOVED VOLTAGE STABILIZER

The function of the voltage stabilizer can be checked with an adjustable bimetal instrument. The instrument is wired in series with a resistance of about 60 ohms and a constant D.C. voltage of 10 volts. The indicating instrument should be read off. The constant D.C. voltage is thereafter replaced by a 12 volt battery (check that the voltage is really 12 volts) and the voltage stabilizer. The indicating instrument should give a similar reading. During the test, the stabilizer should have the same position as it had in the vehicle. A damaged stabilizer is replaced by a new one, although it can of course be repaired, but this is pointless both from an economic and reliability point of view.



Position	Resistance in ohms		
A	282 ± 48	C	98 ± 14
B	$223 \pm 26,5$	D	40 ± 5

Fig. 3-166. Checking fuel gauge sender

- Pos. Unit
- Battery
 - Connection box
 - Ignition switch
 - Ignition coil
 - Distributor, firing order 1-3-4-2
 - Spark plugs
 - Starter motor
 - Alternator
 - Voltage regulator
 - Fuse box
 - Light switch
 - Bulb Integrity Sensor
 - Switch relay, upper and lower beams
 - Upper beams
 - Lower beams
 - Position light
 - Tail light
 - Side marker light
 - License plate light
 - Stop light switch
 - Stop light
 - Contact on transmission, M40—M41
 - Contact on transmission, BW 35
 - Back-up light
 - Flasher
 - Turn signal switch
 - Hazard warning light switch
 - Front turn signal
 - Rear turn signal
 - Connection at instrument
 - Brake warning light
 - Connection at instrument
 - Tachometer
 - Temperature gauge
 - Fuel gauge
 - Voltage stabilizer
 - Turn signal control light
 - Diode
 - Upper beam control light
 - Bulb Integrity Sensor warning light
 - Charging warning light
 - Parking brake control light
 - Choke control light
 - Oil pressure warning light
 - Contact, passenger's seat
 - Contact, driver's seat
 - Contact, parking brake
 - Contact, choke
 - Temperature sensor
 - Oil pressur sender
 - Contact, brake warning
 - Starter cut-out relay
 - Fuel gauge sender
 - Horn
 - Horn ring
 - Switch, wiper/washer
 - Wiper
 - Washer
 - Blower switch
 - Blower
 - Switch, electrically heated rear window
 - Electrically heated rear window
 - Clock
 - Cigarette lighter
 - Instrument light rheostat
 - Instrument light
 - Control panel light
 - Gear shift panel light
 - Contact, glove locker
 - Light, glove locker
 - Interior light
 - Door contact, driver's side
 - Door contact, passenger's side
 - Relay, headlight wiper
 - Interlock Control Unit
 - Buzzer, seat belt
 - Warning light, seat belt
 - Seat belt contact, passenger's side
 - Seat belt contact, driver's side
 - Connection
 - Switch, overdrive M 41
 - Switch for overdrive, on transmission M 41
 - Solenoid for overdrive, on transmission M 41
 - Overdrive control light
 - Headlight wiper
 - Heater pad with rheostat, drivers's seat
 - Heater pad, driver's seat
 - Light reminder buzzer.
 - Cold start injector
 - Thermal time switch
 - Control pressure regulator
 - Fuel pump
 - Air flow sensor
 - Auxiliary air valve

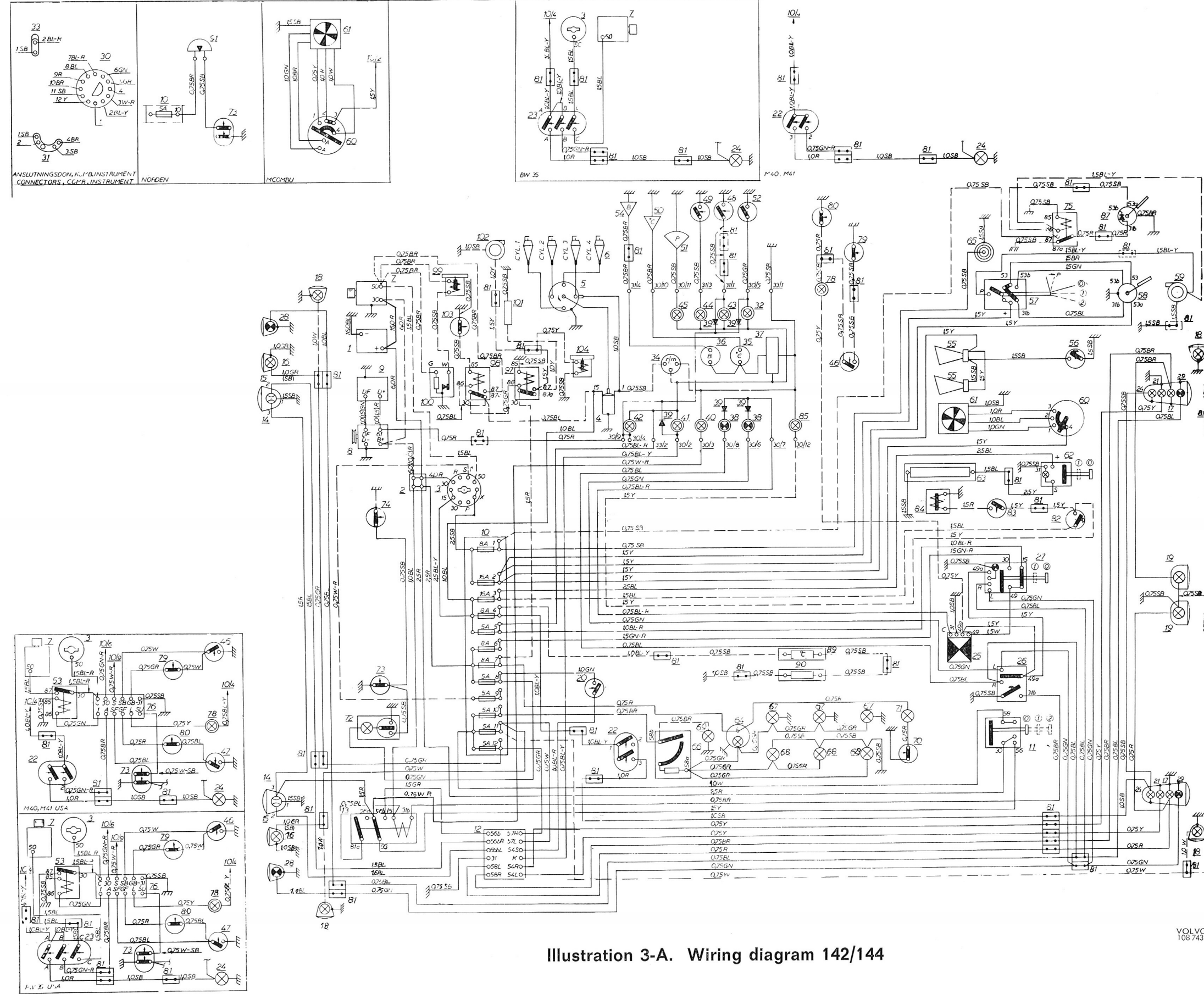


Illustration 3-A. Wiring diagram 142/144

- Pos. Unit
1. Battery
 2. Connection box
 3. Ignition switch
 4. Ignition coil
 5. Distributor, firing order 1-3-4-2
 6. Spark plugs
 7. Starter motor
 8. Alternator
 9. Voltage regulator
 10. Fuse box
 11. Light switch
 12. Bulb Integrity Sensor
 13. Switch relay, upper and lower beams
 14. Upper beams
 15. Lower beams
 16. Position light
 17. Tail light
 18. Side marker light
 19. License plate light
 20. Stop light switch
 21. Stop light
 22. Contact on transmission, M40—M41
 23. Contact on transmission, BW 35
 24. Back-up light
 25. Flasher
 26. Turn signal switch
 27. Hazard warning light switch
 28. Front turn signal
 29. Rear turn signal
 30. Connection at instrument
 31. Connection at instrument
 32. Brake warning light
 33. Connection at instrument
 34. Tachometer
 35. Temperature gauge
 36. Fuel gauge
 37. Voltage stabilizer
 38. Turn signal control light
 39. Diode
 40. Upper beam control light
 41. Bulb Integrity Sensor warning light
 42. Charging warning light
 43. Parking brake control light
 44. Choke control light
 45. Oil pressure warning light
 46. Contact, passenger's seat
 47. Contact, driver's seat
 48. Contact, parking brake
 49. Contact, choke
 50. Temperature sensor
 51. Oil pressure sender
 52. Contact, brake warning
 53. Starter cut-out relay
 54. Fuel gauge sender
 55. Horn
 56. Horn ring
 57. Switch, wiper/washer
 58. Wiper
 59. Washer
 60. Blower switch
 61. Blower
 62. Switch, electrically heated rear window
 63. Electrically heated rear window
 64. Clock
 65. Cigarette lighter
 66. Instrument light rheostat
 67. Instrument light
 68. Control panel light
 69. Gear shift panel light
 70. Contact, glove locker
 71. Light, glove locker
 72. Interior light
 73. Door contact, driver's side
 74. Door contact, passenger's side
 75. Relay, headlight wiper
 76. Interlock Control Unit
 77. Buzzer, seat belt
 78. Warning light, seat belt
 79. Seat belt contact, passenger's side
 80. Seat belt contact, driver's side
 81. Connection
 82. Switch, overdrive M41
 83. Switch for overdrive, on transmission M 41
 84. Solenoid for overdrive, on transmission M 41
 85. Overdrive control light
 87. Headlight wiper
 89. Heater pad with rheostat drivers's seat
 90. Heater pad, driver's seat
 91. Light reminder buzzer
 97. Relay, fuel pump
 98. Main relay, fuel injection
 99. Cold start injector
 100. Thermal time switch
 101. Control pressure regulator
 102. Fuel pump
 103. Air flow sensor
 104. Rear interior lamp
 105. Rear door contact
 106. Rear window wiper
 107. Rear window washer
 108. Rear window wipe/wash switch
 109. Auxiliary air valve

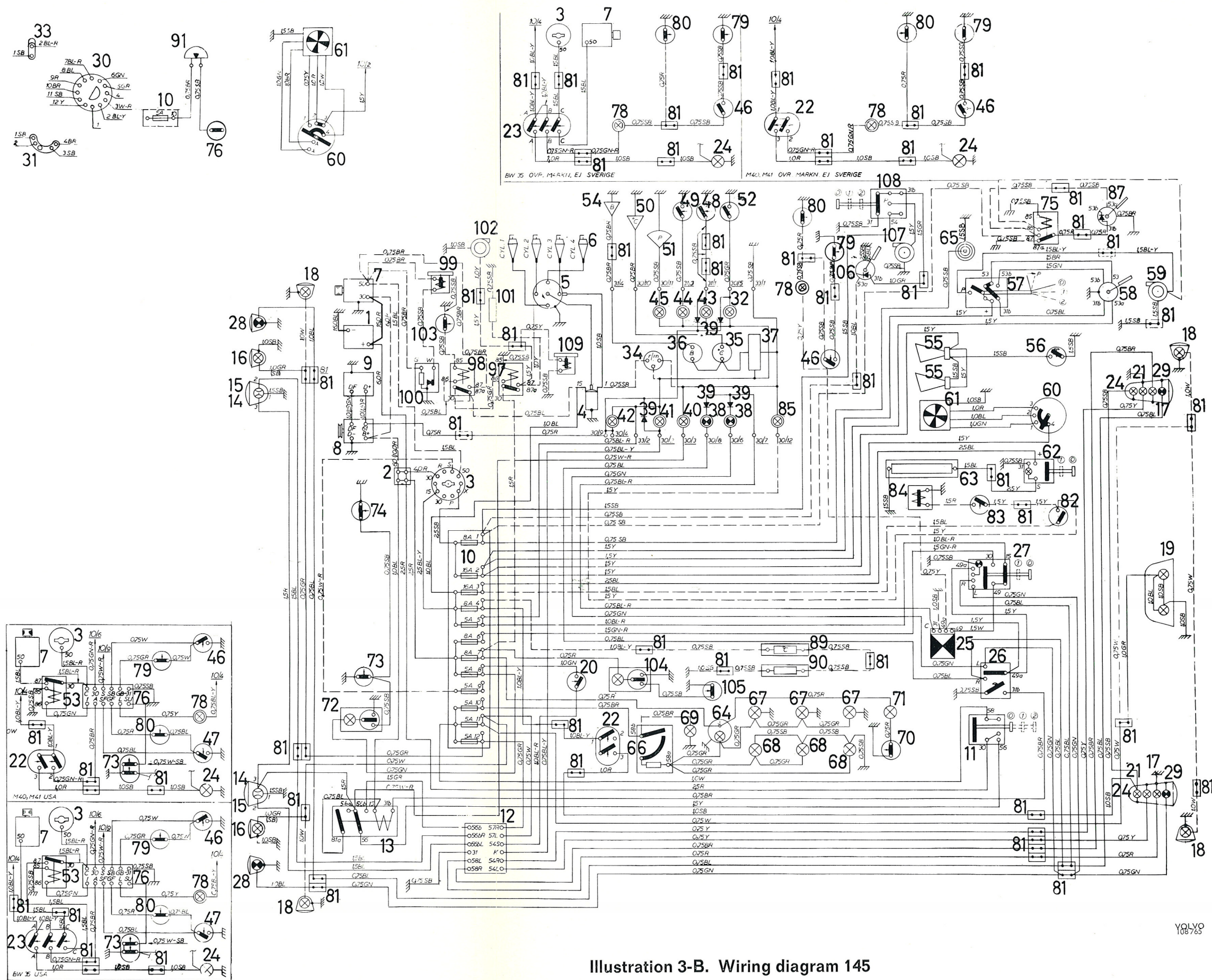


Illustration 3-B. Wiring diagram 145