GROUP 30

GENERAL

The electrical system is designed for a voltage of 12 V. The equipment is made up of the following main parts: Battery, alternator and voltage regulator, starter motor, ignition system, lighting, other electrical standard equipment and instruments.

GROUP 31

BATTERY

DESCRIPTION

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

REPAIR INSTRUCTIONS

REMOVING

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.

FITTING

1. Place the battery in position.
2. Re-fit 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.

SERVICING

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

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

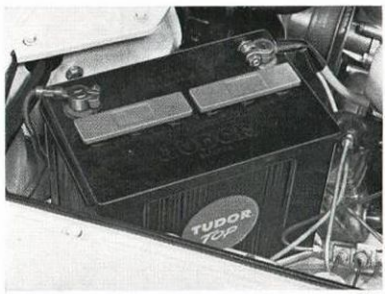


Fig. 3-1. Battery

ALTERNATOR

S.E.V. MARSHALL 14 V—71270202

DESCRIPTION

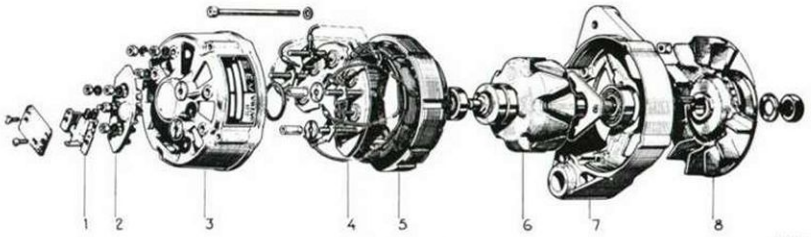


Fig. 3-2. S.E.V. Marshall alternator dismantled

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

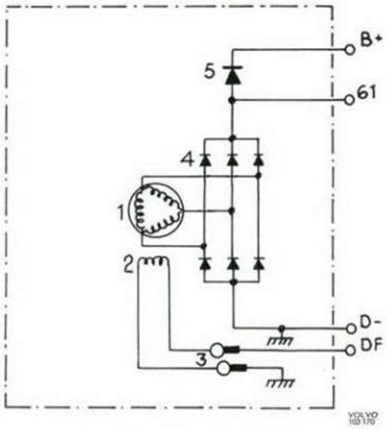


Fig. 3-3. Inner wiring of the alternator

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

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 so designed as to permit a maximum alternator speed of 250 r/s (15000 r/m).

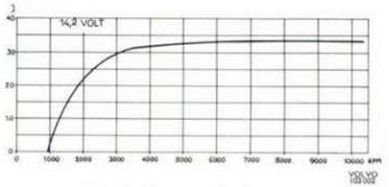


Fig. 3-4. Output curve for alternator

The isolation 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 rectifier diodes stop functioning; and it makes simple connecting up 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.

REPAIR INSTRUCTIONS

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or fitting 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 negative battery lead should be disconnected.
5. A rapid charger should not be used as an aid in starting.
6. When using an extra battery as an aid in starting, 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.

REMOVING ALTERNATOR

1. Disconnect the negative lead to the battery.
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.

DISASSEMBLING ALTERNATOR

1. Release the two screws holding the brush holder and remove the isolation plate. Pull out the brush holder.
2. Fix the pulley with belt in a vice with soft jaws, see Fig. 3-6.
3. Remove the nut and washer. Lift off the pulley, fan, key and spacer washer.
4. Remove the nuts and washers on terminal 61 and the corresponding on the other side of the isolation diode. Lift off the isolation diode holder.
5. Mark the drive end shield, stator and slip ring end shield to avoid confusion when assembling. Remove the four attaching screws.

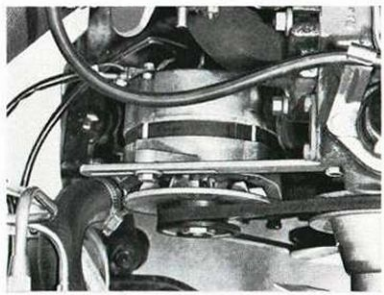


Fig. 3-5. Alternator fitted

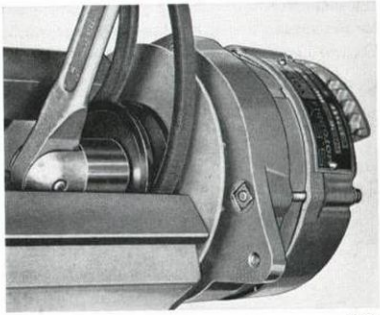


Fig. 3-6. Removing pulley nut

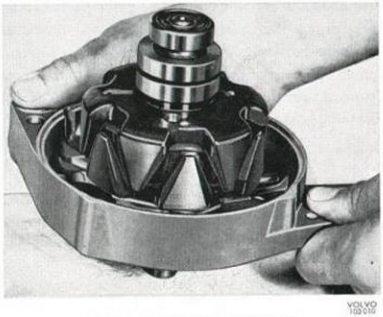


Fig. 3-8. Removing drive end shield

6. Remove the rotor and drive end shield with the help of two screwdrivers, which are inserted in two of the slots between the stator and drive end shield, see Fig. 3-7.
   NOTE. The screwdrivers may 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.
8. Remove the nuts and washers for the diode holder for the negative diodes.
9. Remove the stator and diode holders for the slip ring end shield.

CHECKING DISASSEMBLED ALTERNATOR

STATOR

Check the stator for any short-circuiting. If one or several of the coils are burnt, 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.

If the lamp lights, the isolation between the stator winding and the stator plates must be burnt 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 may NOT be used. This applies to all the alternator components.

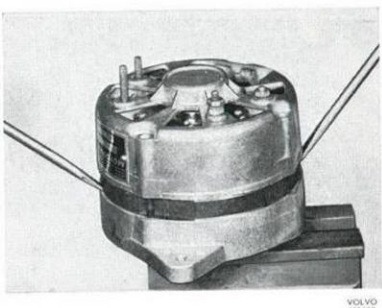


Fig. 3-7. Disassembling alternator

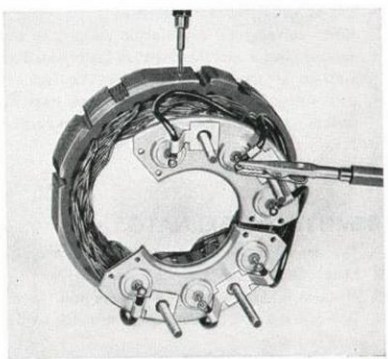


Fig. 3-9. Checking stator

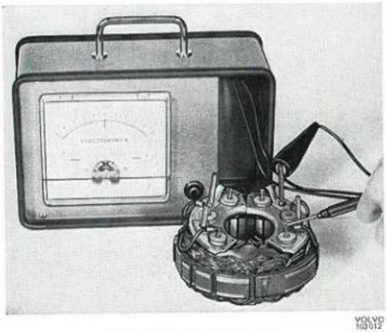


Fig. 3-10. Checking diodes

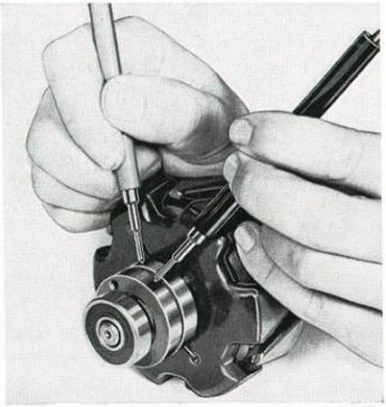


Fig. 3-12. Check-measuring rotor

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

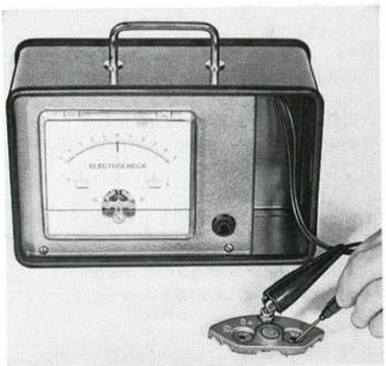


Fig. 3-11. Checking isolation diode

ROTOR

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

Check the winding for breakage or damaged isolation. Measure the resistance between the slip rings, see Fig. 3-12. At 25°C (77°F) the resistance should be 5.2±0.2 ohms.

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

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

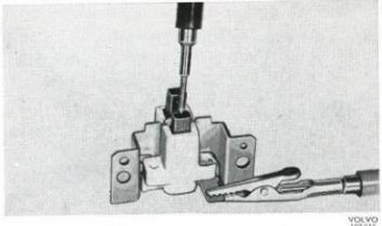
Check the bearings. (New bearings should always be fitted when the alternator has been dismantled.)

BRUSH HOLDER

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

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

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



VOLVO 103 015

Fig. 3-13. Checking brush holder

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

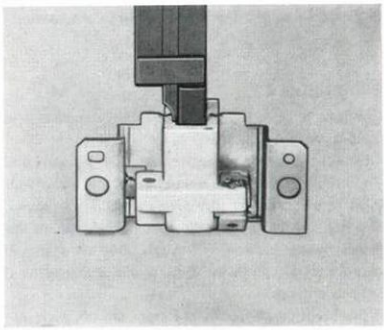
REPLACING RECTIFIER DIODES

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

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

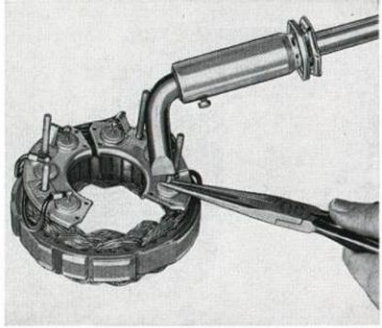
Never change places for the two diode holders. **The positive diode holder** is isolated from the frame by means of isolation washers and sleeves and its diodes are marked in **red.**

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



VOLVO 103 940

Fig. 3-14. Measuring brush length



VOLVO 103 016

Fig. 3-15. Soldering diodes

REPLACING BEARINGS

DRIVE END SHIELD BEARINGS

Removing

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

Fitting

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.

SLIP RING END BEARING

Removing

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

Fitting

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

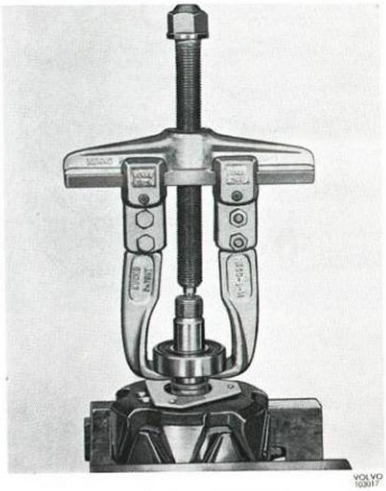


Fig. 3-16. Removing bearings

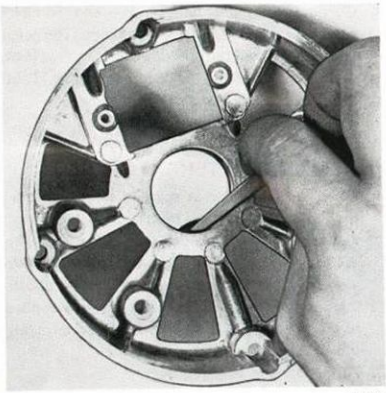


Fig. 3-18. Removing O-ring

REPLACING 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.
2. Wash the groove clean.
   Check that the hole in the bearing shield is not blocked.
3. Fit 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 dismantled.

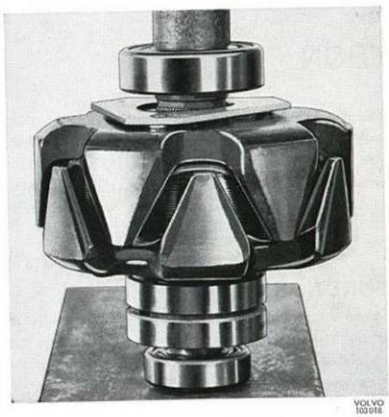


Fig. 3-17. Fitting bearings

ASSEMBLING ALTERNATOR

1. Fit the stator and the diode holders in the slip ring end shield. (Do not forget the isolation washers for the positive diode holder). Fit the nuts and washers on the negative diode holder screws.
2. Press the rotor into the drive end shield. Fit the three screws for the drive bearing support plate.
3. Fit together the rotor and stator sections.
4. Fit the attaching screws. Tightening torque 2.8—3.0 Nm (2.0—2.2 lbft).
5. Fit the plastic tube and isolation washers on the screws on which the isolation diode is to be mounted.
   Fit the isolation diode, put on the nuts and washers. Fit the brush holder.
6. Fit the 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 connections. The lamp should light only in one direction, se Fig. 3-19. After any repairs, the alternator should be test-run in a test bench.

INSTALLING ALTERNATOR

1. Place the alternator in position while fitting on the fan belt at the same time.
2. Fit the attaching bolts and tensioning iron without tightening up the bolts. Adjust the belt tension (see Part 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. Fit the leads to the alternator.
4. Fit the battery lead.

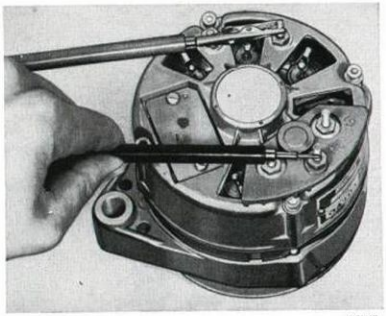


Fig. 3-19. Checking alternator

VOLTAGE REGULATOR

S.E.V. MARSHALL

DESCRIPTION

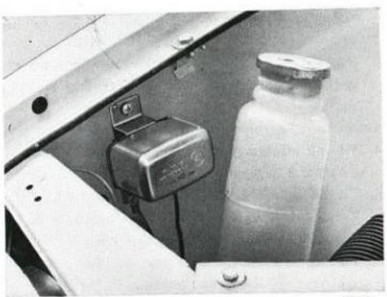


Fig. 3-20. Voltage regulator fitted

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 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 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.

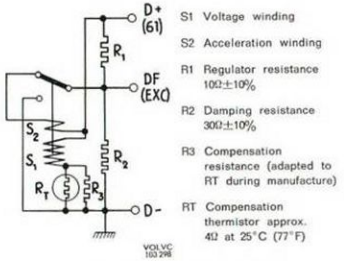


Fig. 3-21. Inner wiring of regulator

TESTING 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.

CHECKING ALTERNATOR CIRCUIT

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 grounding.

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

TESTING BATTERY

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.

CHECKING VOLTAGE DROP

This test is made to check the leads between the alternator and the battery and also the battery earth lead. 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: Mainbeam lights switched on. With the engine running and the alternator supplying 10 amps., measure with a suitable voltmeter the voltage between the pasitive pole of the battery and B+ on the alternator. If the voltage at this test exceeds 0.3 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 0.2 volt. If the voltage drop exceeds 0.2 volt, check the battery ground, lead, the alternator contact with the engine and the engine contact with the chassis. After making the necessary repairs, measure again.

CHECKING ALTERNATOR

(In a test bench or in the vehicle)

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

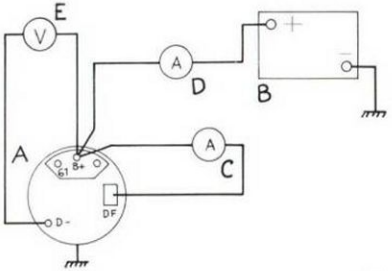


Fig. 3-22. Wiring diagram for testing alternator

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

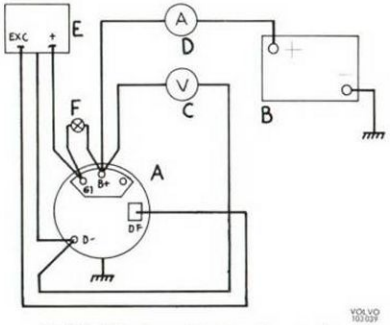


Fig. 3-23. Wiring diagram for testing voltage regulator

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

Check that the current through the field winding (ammeter C) is 2—2.5 amps. (If the current is not the correct one, 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 conncted up 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 08.—0.9 volt higher at terminal 61, otherwise the isolation diode is faulty and should be replaced.

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

If the voltage regulator is to be tested more accuretely, 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.

CHECKING VOLTAGE REGULATOR

(In a test bench or in the vehicle)

Connect up the alternator and regulator as shown in Fig. 3-23. Run the alternator at about a speed of 83.5 r/s (5000 r/m) (engine speed 42 r/s = 2500 r/m) for 15 seconds. Then read off 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).

Load the alternator with 10—15 amps, for example, full-beam headlights, and read off 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.

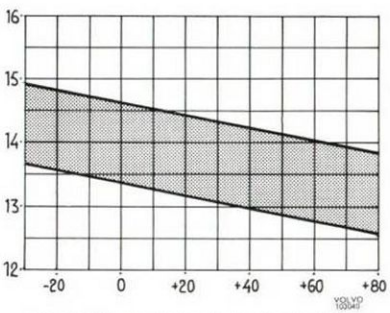


Fig. 3-24. Voltage-temperature diagram for cold voltage regulator

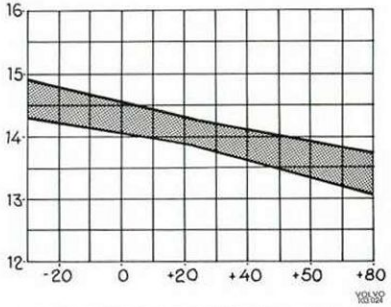


Fig. 3-25. Voltage-temperature diagram for warm voltage regulator

Immediately after, or preferably during driving, measure the voltage between B+ and D— on the alternator. The engine should be turning over at about 42 r/s (2500 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. 3-25.

FAULT TRACING

FAULT	REASON
Alternator does not charge.	**Worn or insufficiently tensioned fan belt.** Breakage in charging circuit. Worn brushes. Breakage in rotor winding. Breakage in isolation diode. Faulty regulator.
Charging weak or irregular.	**Worn or insufficiently tensioned fan belt.** Intermittent breakage in charging circuit. Worn brushes. Breakage or short-circuiting in one or several rectifier diodes. (Breakage in a diode reduces the charging current about 5 amps. Short-circuiting in a diode limits the alternator charging current to 7—8 amps and causes a rumbling sound in the alternator.) Partial short-circuiting in the rotor. Breakage or short-circuiting in the stator. Faulty regulator.
Too high charging.	Faulty regulator. Faulty terminal on regulator or alternator. Short-circuiting in isolation diode.

Noise in alternator.	Worn fan belt. Loose pulley. Worn bearings Short-circuiting in one or several rectifier diodes. Alternator pulley incorrectly aligned in relation to the crankshaft pulley.
Charging warning lamp glows.	Voltage drop in fusebox.

ALTERNATOR

S.E.V. MARSHALL 14 V—34833

DESCRIPTION

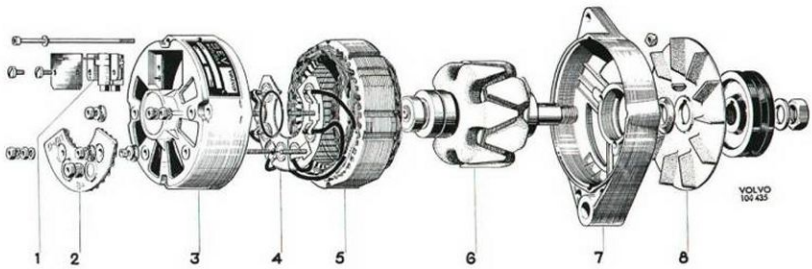


Fig. 3-26. Exploded view of alternator

1. Brush holder
2. Isolation diodes with holder
3. Slip ring end shield
4. Rectifier (silicon diodes)
5. Stator
6. Rotor
7. Drive end shield
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.

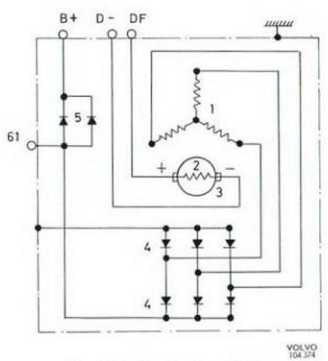


Fig. 3-27. Alternator inner circuit

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

The alternator has a roating 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 isolation diodes (2, Fig. 3-26), which are placed 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.

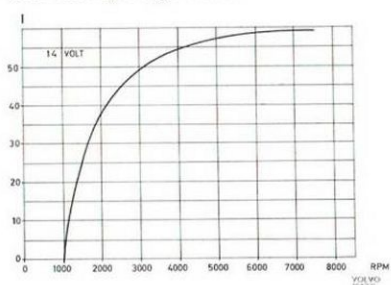


Fig. 3-28. Alternator output curve

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or fitting 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 negative battery lead should be disconnected.
5. A rapid charger should not be used as a help in starting.
6. When using an extra battery as an aid in starting, 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.

REMOVING ALTERNATOR

1. Disconnect the negative lead to the battery.
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.

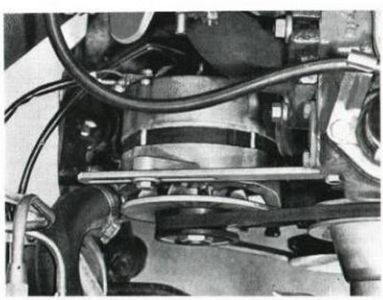


Fig. 3-29. Alternator fitted

DISASSEMBLING ALTERNATOR

1. Release the two screws holding the brush holder and remove the isolation plate. Pull out the brush holder.
2. Remove the nut and washer. Lift off the pulley, fan, key and spacer washer.
3. Remove the nuts and washers on terminal 61 and the corresponding on the other side of the isolation diode. Lift off the isolation diode holder, see Fig. 3-30.
4. Mark the drive end shield, stator and slip ring end shield to avoid confusion when assembling. Remove the four attaching screws.
5. Remove the 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.
   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 the nuts and washers for the diode holders.
8. Remove the stator and diode holders for the slip ring end shield.

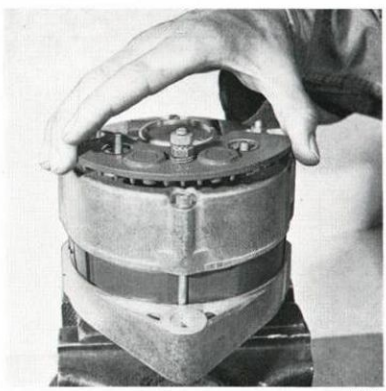
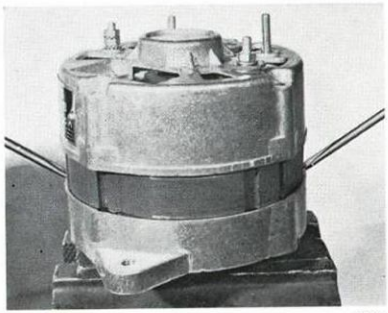
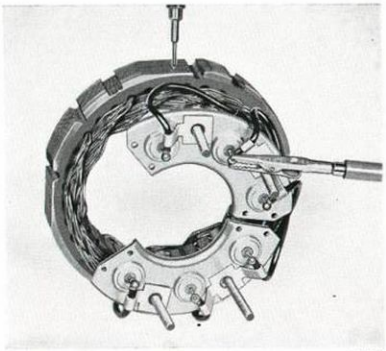


Fig. 3-30. Removing isolation diodes



VOLVO 104 471

Fig. 3-31. Disassembling alternator



VOLVO 103 011

Fig. 3-33. Checking stator

CHECKING DISASSEMBLED ALTERNATOR

STATOR

Check the stator for any short-ciruiting. If one or several of the coils are burnt, 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 isolation between the stator winding and the stator plates must be burnt 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 may NOT be used. This applies to all the alternator components.

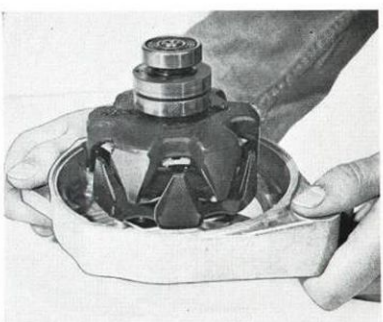
Check the diodes with a diode tester, see Fig. 3-34. If any of the rectifier diodes is faulty, the entire diode holder (with three diodes) must be replaced. If any of the isolation diodes is faulty, replace the holder, complete with isolation diodes.

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

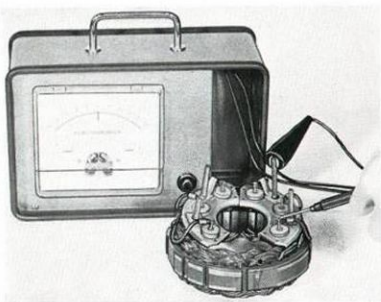
Check to make sure that the slip rings are not dirty or burnt.

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



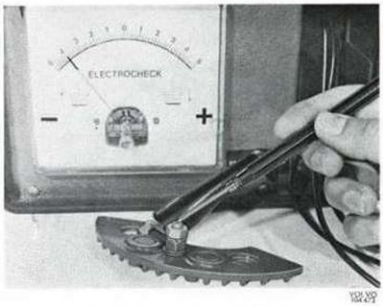
VOLVO 104 472

Fig. 3-32. Removing drive end shield



VOLVO 103 012

Fig. 3-34. Checking diodes



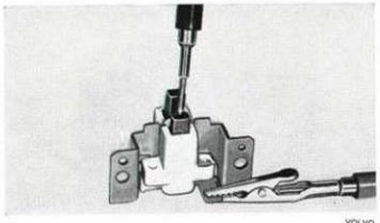
VOLVO 104 472

Fig. 3-35. Checking isolation diodes

If the slip rings are dirty, clean them carefully with a cloth moistened in trichlorethylene. The slip rings can also be polished with fine sand paper.
If the winding is faulty, the entire rotor must be replaced.
Check the bearings. (The bearings should always be replaced when the alternator has been dismantled.)

BRUSH HOLDER

Connect a test lamp betwen 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. 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.



VOLVO 103 013

Fig. 3-37. Checking brush holder

REPLACING RECTIFIER DIODES

1. Mark the leads connecting the stator to the diodes. Solder loose the leads.
2. Place the new diode holder in exactly the same position occupied by the old one. Hold the 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 faulty.

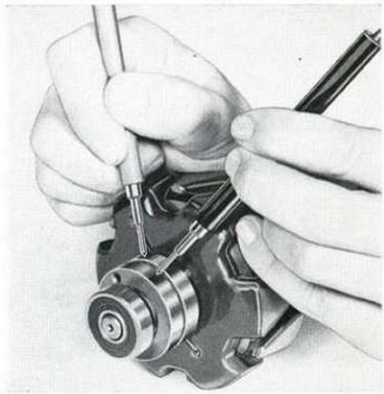


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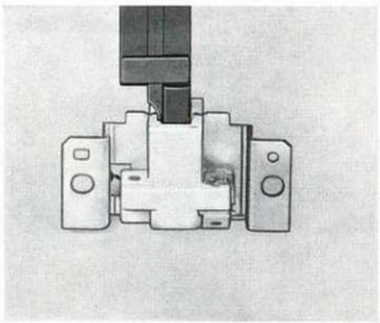
Fig. 3-36. Check-measuring rotor



VOLVO 103 940

Fig. 3-38. Measuring brush length

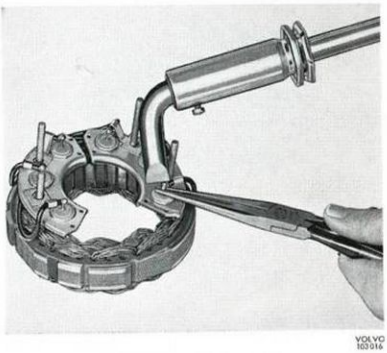


Fig. 3-39. Soldering on diodes

Use a well-heated soldering iron, minimum 100 W for the soldering.
Never change places for the two diode holders. The **positive diode holder** is isolated from the frame by means of isolation washers and sleeves and its diodes are marked in **red.**
The **negative diode holder** is not isolated and its diodes are marked in **black.**

REPLACING BEARINGS

DRIVE END SHIELD BEARING

Removing

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

Installing

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.

SLIP RING END BEARING

Removing

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

Installing

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

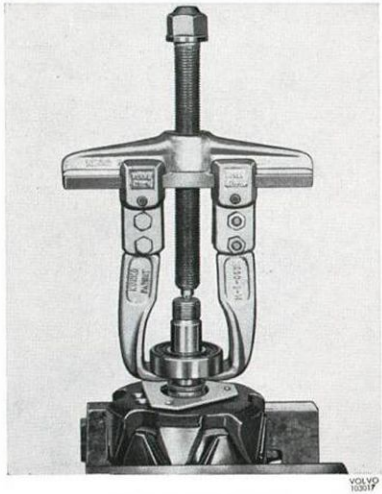


Fig. 3-40. Removing bearing

REPLACING 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.

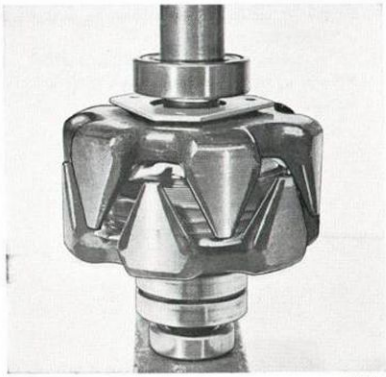


Fig. 3-41. Fitting bearing

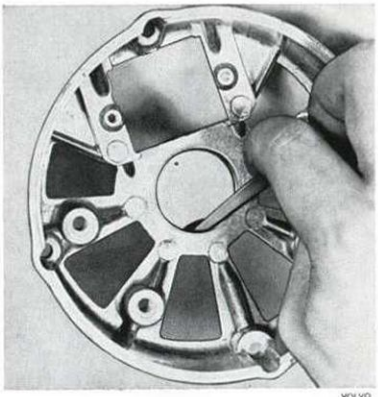


Fig. 3-42. Removing O-ring

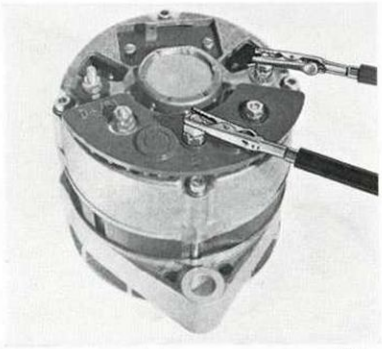


Fig. 3-43. Checking alternator

3. Fit 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 dismantld.

ASSEMBLING ALTERNATOR

1. Fit the stator and the diode holders in the slip ring end shield. (Do not forget the isolation washers for the positive diode holder.) Fit the nuts and washers on the negative diode holder screw.
2. Press the rotor into the drive end shield. Fit the three screws for the drive bearing support plate.
3. Fit together the rotor and stator sections.
4. Fit the attaching screws. Tightening torque 2.8—3.0 Nm (2.0—2.2 lbft.)
5. Fit the plastic tube and isolation washers on the screws on which the isolation diode is to be mounted.
   Fit the isolation diode, put on the nuts and washers. Fit the brush holder.
6. Fit the 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 shoul dbe test-run in a test bench.

INSTALLING ALTERNATOR

1. Place the alternator in position while fitting on the fan belt at the same time.
2. Fit the attaching bolts and tensioning iron without tightening up the bolts. Adjust the belt tension (se Part 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. Fit the leads to the alternator.
4. Fit the battery lead.

VOLTAGE REGULATOR

DESCRIPTION

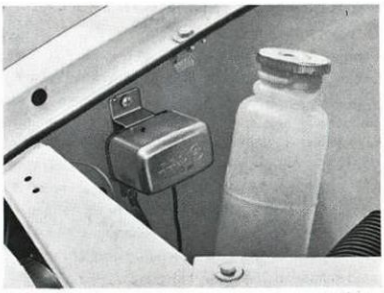


Fig. 3-44. Voltage regulator fitted

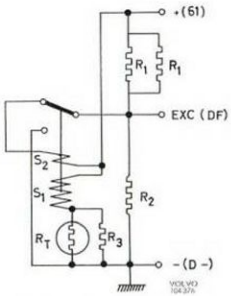


Fig. 3-45. Inner wiring of regulator

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

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 ane thermistor.

FUNCTION

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

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.

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 earthed at both ends, this causing the voltage to drop rapidly. The cycle is repeated continuously so that the voltage is maintained constant.

TESTING 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.

CHECKING ALTERNATOR CIRCUIT

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 earthing. **Check the fan belt** (see Part 2, Engine, Grup 25). Any of the above faults must be remedied before the electrical checks can be started.

TESTING BATTERY

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.

CHECKING VOLTAGE DROP

This test is made to check the leads between the alternator and the battery and also the battery earth lead. 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: Mainbeam lights 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 0.3 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 0.2 volt. If the voltage drop exceeds 0.2 volt, check the battery earth lead, the alternator contact with the engine and the engine contact with the chassis. After making the necessary repairs measure again.

CHECKING ALTERNATOR

(In a test bench or in the vehicle)

Connect up the alternator as shown in Fig. 3-46. Check that the current through the field winding (ammeter C) is 3—3.5 amps. (If the current is not the correct one, 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 48 amps at 14 volts. (A further load may be connected up in order to maintain the voltage at 14 volts.) This applies to a warm alternator and an ambient temperature of 25°C (77°F).

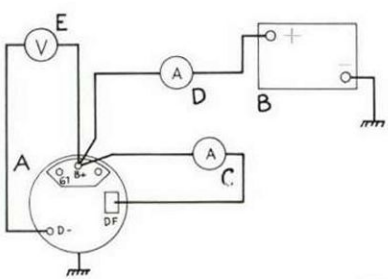
Measure the voltage at B+ and 61 when the alternator charges.

The voltage should be 0.8—0.9 volt more than at terminal 61, otherwise the isolation diode is faulty and should be replaced.

CHECKING VOLTAGE REGULATOR

(In a test bench or in the vehicle)

Connect up the alternator and regulator as shown in Fig. 3-47. Run the alternator at about a speed of 83.5 r/s (5000 r/m) (engine speed 42 r/s = 2 500 r/s) for 15 seconds. Then read off 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 1021034

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

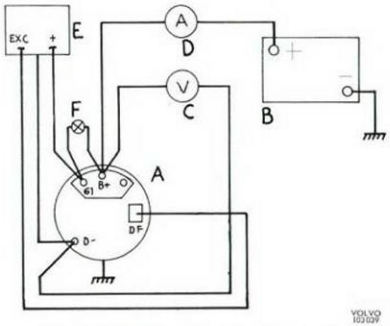


Fig. 3-47. Wiring diagram for testing voltage regulator

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

Load the alternator with 10—15 amps, for example, full-beam headlights, and read off 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.

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

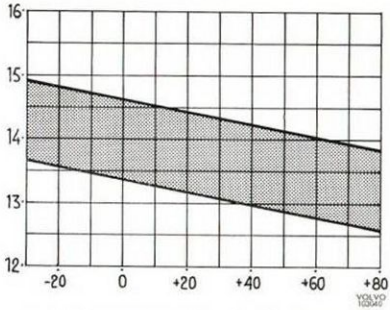


Fig. 3-48. Voltage-temperature diagram for cold voltage regulator

alternator. The engine should be turning over 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.

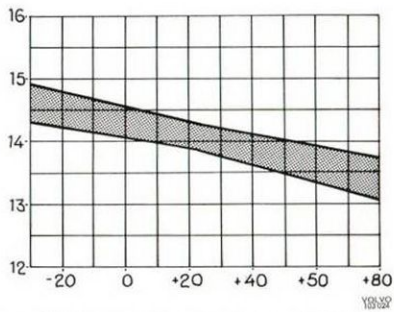


Fig. 3-49. Voltage-temperature diagram for warm voltage regulator

FAULT TRACING

FAULT	REASON
Alternator does not charge.	Worn or insufficiently tensioned fan belt. Breakage in charging circuit. Worn brushes. Breakage in rotor winding. Breakage in isolation diodes. Faulty regulator.
Charging weak or irregular.	Worn or insufficiently tensioned fan belt. Intermittent breakage in charging circuit. Worn brushes. Breakage or short-circuiting in one or several rectifier diodes. (Breakage in a diode reduces the charging current about 5 amps. Short-circuiting in a diode limits the alternator charging current to 7—8 amps and causes a rumbling sound in the alternator.) Partial short- circuiting in the rotor. Breakage or short-circuiting in the stator. Faulty regulator.
Too high charging.	Faulty regulator. Faulty terminals on regulator or alternator. Short-circuiting in isolation diodes.
Noise in alternator.	Worn fan belt. Loose pulley. Worn bearings. Short-circuiting in one or several rectifier diodes. Alternator pulley incorrectly aligned in relation to the crankshaft pulley.
Charging warning lamp glows.	Voltage drop in fusebox.

ALTERNATOR

BOSCH

DESCRIPTION

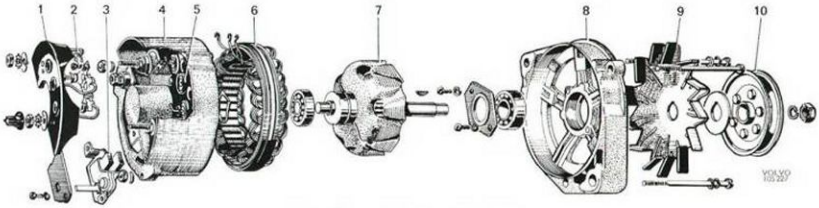


Fig. 3-50. Bosch alternator dismantled

1. Rectifier (plus diode plate)
2. Magnetizing rectifier
3. Brush holder
4. Slip ring end shield
5. Rectifier (negative diodes)
6. Stator
7. Rotor
8. Drive end shield
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 is self-limiting concerning the current (max. 35 amps), a simple mechanical voltage regulator is used with only voltage control as its function.

FUNCTION, ALTERNATOR—VOLTAGE REGULATOR

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

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

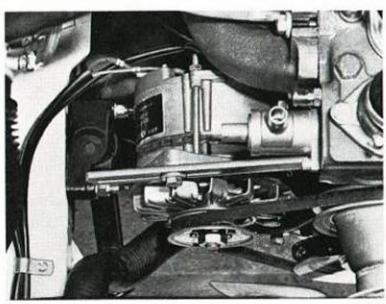


Fig. 3-51. Alternator fitted

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

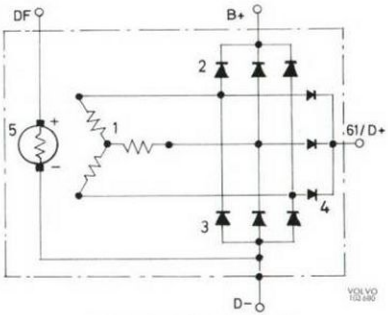


Fig. 3-52. Inner wiring of alternator

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

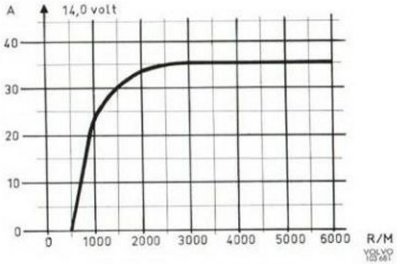


Fig. 3-53. Alternator output curve

A = amps. RM = alternator speed/minute

REPAIR INSTRUCTIONS

SPECIAL INSTRUCTIONS FOR WORK ON ALTERNATOR EQUIPMENT

1. When replacing or fitting the battery make sure that the proper polarity is observed when connecting up 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 negative battery lead.
5. When using an extra battery as an aid in starting, 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.

REMOVING ALTERNATOR

1. Disconnect the negative lead to the battery.
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.

DISASSEMBLING ALTERNATOR

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

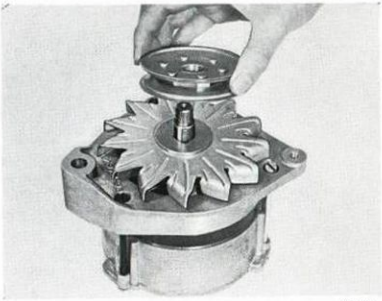


Fig. 3-54. Removing pulley

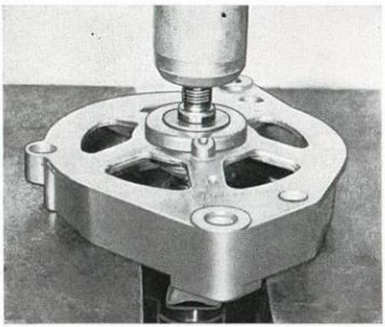


Fig. 3-57. Removing rotor

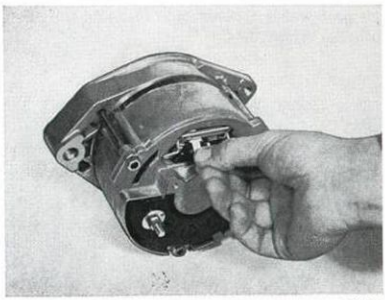


Fig. 3-55. Removing brush holder

2. Remove the screws holding the brush holder and then take off the holder, se Fig. 3-55.
3. Remove nuts, washers and screws holding together the alternator and take off the drive end shield and rotor from the stator and then the slip ring end shield.
4. Press the rotor out of the drive end shield.
5. Remove the screws for the washer which holds the drive end shield bearing and press out the bearing.
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.

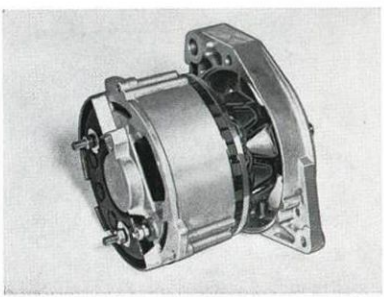


Fig. 3-56. Removing rotor and drive end shield

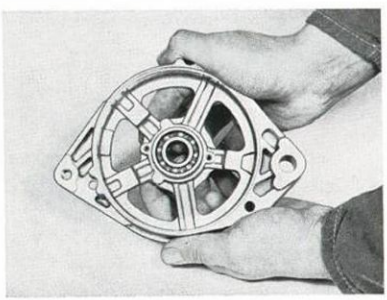


Fig. 3-58. Removing drive end shield bearing

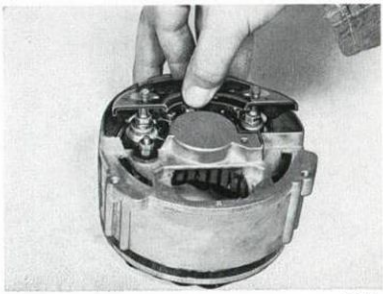


Fig. 3-59. Removing positive diode plate

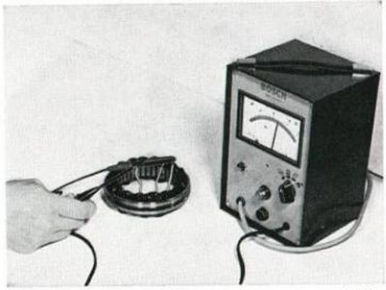


Fig. 3-61. Checking stator resistance

CHECKING DISASSEMBLED ALTERNATOR

STATOR

Cneck the stator isolation 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 0.26 ohm + 10 %.

ROTOR

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

Measure the resistance between the slip rings.

The resistance should be 4 ohms + 10 %.

If the slip rings are burnt or damaged in any other way, they can be lathed. For the lathing, a tailstock chuck should be used. The diameter of the slip rings may be less than 31.5 mm (1.3"). After the lathing, check the slip rings for possible out-of-round with a dial indicator. Max. radial throw is 0.03 mm (0.0012").

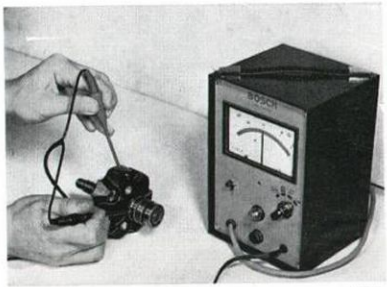


Fig. 3-62. Checking rotor isolation

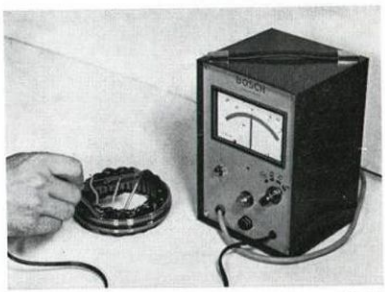


Fig. 3-60. Checking stator isolation

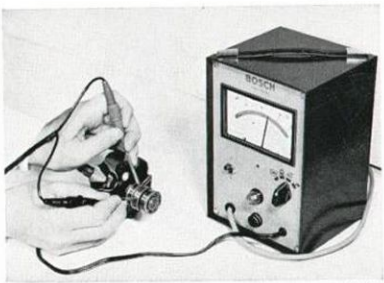


Fig. 3-63. Checking rotor resistance

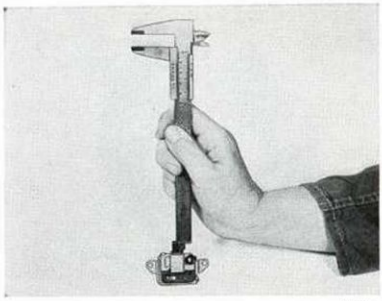


Fig. 3-64. Checking brush length

BRUSH HOLDER

Check the brush holder isolation with a 40 V alternating current. Measure the length of the brush as shown in Fig. 3-64. Minimum length is 8 mm (0.32").

DIODES

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

REPLACING DIODES

POSITIVE DIODES

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

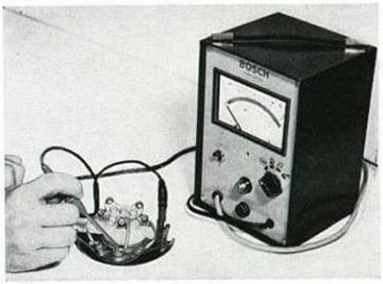


Fig. 3-65. Checking diodes

2. Calibrate the hole in the positive diode plate with a suitable tool (for example, Bosch EFLJ 57/0/3 ond 57/0/).
3. Press the new diode in with a suitable tool. Before fitting 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 Ft87V1 or corresponding) to prevent corrosion.
5. Solder the heat sink to its original position. Check with the diode tester.

NEGATIVE DIODES

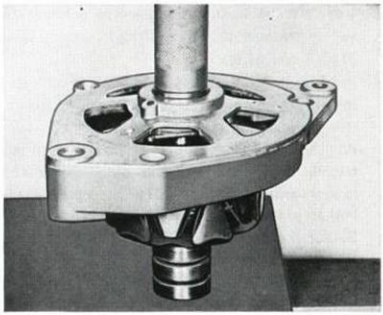
1. Solder loose the negative diodes from the terminal points and lift off the positive diode plate with the magnetizing diodes.
2. Press out the faulty diode with a suitable tool.
3. Oil the new diode with silicon oil (for example, Bosch OI 64 V 2) and install it in the end shield.
4. Solder the negative diodes to the terminal points and check with the diode tester.

MAGNETIZING DIODES

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

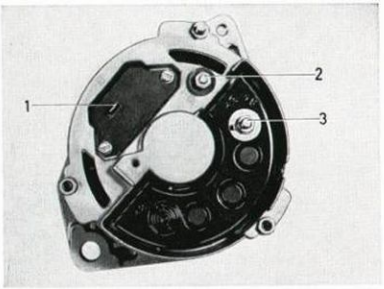
ASSEMBLING ALTERNATOR

1. Fit the stator in the slip ring end shield and solder the stator leads to the terminal point. Fit the positive diode plate.
2. Grease the drive end bearing (use Bosch Ft 1 V 34 or corresponding) and fit 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.
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 screw 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. Fit the brush holder.



VOLVO 103 815

Fig. 3-66. Assembling the rotor and drive end shield



VOLVO 103 816

Fig. 3-67. Alternator terminals

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

6. Fix the key, fan, spacer washer and pulley. Place the washer in position and tighten up the pulley with the nut.
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 installing it in the vehicle.

INSTALLING ALTERNATOR

1. Install the alternator and fit the fan belt at the same time.
2. Fit the attaching bolts and tensioning iron without tightening it.
3. Adjust the belt tension (see Part 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-fit the leads to the alternator.
5. Re fit the negative lead to the battery.

VOLTAGE REGULATOR

BOSCH

DESCRIPTION

The voltage regulator is located on the wheel housing at an angle 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 means of a three-pole plug. The regulator resistance is placed under a plate underneath the regulator. Temperature compensation is operated by a bimetal spring which influences the spring tension so that the regulator receives lower regulating voltage at higher temperatures.

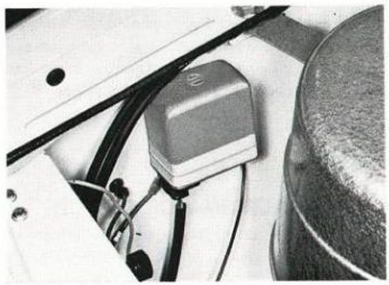


Fig. 3-68. Voltage regulator fitted

REPAIR INSTRUCTIONS

REPLACING VOLTAGE REGULATOR

1. Remove the negative battery lead.
2. Pull the plug out of the voltage regulator.
3. Remove the screws and change the regulator.
4. Fit on the new regulator and insert the plug.
5. Re-fit the negative battery lead.

Concerning regulator adjustmet, see under "Testing and adjusting the voltage regulator".

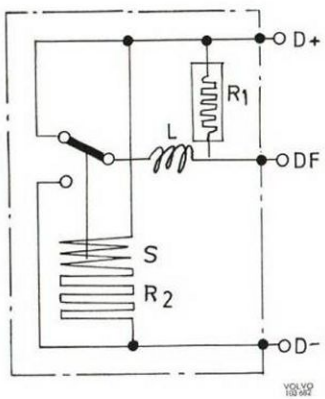


Fig. 3-69. Inner wiring of voltage regulator

S Voltage winding 35 Ω
R^1 Regulator resistance 2.45 Ω
R^2 Compensation resistance 50 Ω
L Contact impedance coil

TESTING ALTERNATOR AND VOLTAGE REGULATOR

For all testing of the 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 up any instruments.

TESTING ALTERNATOR CIRCUIT

Before carrying out any tests on the alternator or regulator in the vehicle, check the battery and the vehicle wiring for fault in the leads or isolation, loose or corroded lead terminals and poor earthing. **Check the fan belt.** Any of the faults just mentioned must be repaired before the electrical checks are started.

TESTING BATTERY

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.

CHECKING VOLTAGE DROP

This test is made to check the leads between the alternator and the battery and also the battery earth lead. The test should be carried out 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: Mainbeam lights 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 0.3 volt, there is a fault in the cable or contact, which must be remedied immediately. After repairing the faulty leads or contacts, measure once agarin. With the same load as above, measure the voltage drop between th negative pole of the battery and the alternator terminal D—. Here the voltage drop must not exceed 0.2 volt. If the voltage drop exceeds 0.2 volt, check the battery earth lead, the alternator contact with the engine and the engine contact with the chassis. After making the necessary repairs, mesaure again.

TESTING ALTERNATOR

(In a test bench or in the vehicle)

Connect up 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.

TESTING AND ADJUSTING 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.

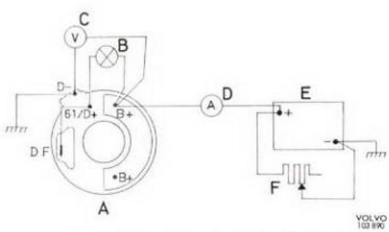


Fig. 3-70. Wiring diagram for testing alternator

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

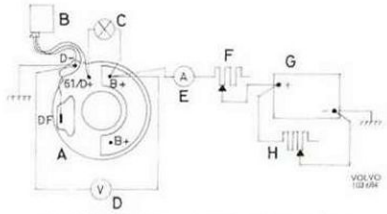


Fig. 3-71. Wiring diagram for testing voltage regulator

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

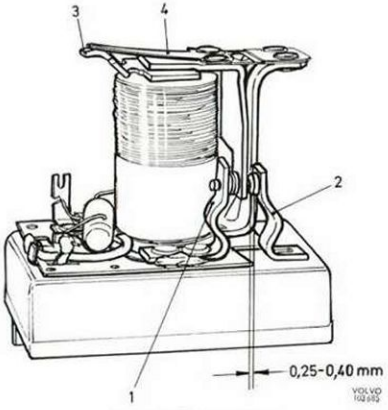


Fig. 3-72. Voltage regulator

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

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 about 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 about 28—30 amps. Read off 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). The reading should be made within 30 seconds after the test has begun. Reduce the load on the alternator to 3—8 amps and read off the regulating voltage. This voltage should now lie within the tolerance 0 volt to minus 0.3 volt in relation to the first reading. The regulator should now be regulated on the right (upper) contact (2, Fig. 3-72).

The regulating voltage in the lower regulating range is adjusted by bending the tensioner for the bimetal spring, see Fig. 3-73.

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 mins 0.3 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.)

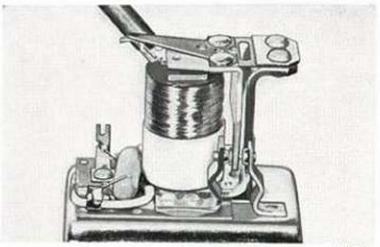


Fig. 3-73. Adjusting control voltage

FAULT TRACING

SYMPTOM

FAULT TRACING METHOD	FAULT
Warning lamp does not light with engine off.	
Test lamp (12 volts 2 watts) between B+ and 61/D+ on alternator lights.	Warning lamp burnt out or break in its circuit to D+ on regulator.
Test lamp between B+ and 61/D+ does not light. Test lamp between 61/D+ and earth lights.	Short-circuiting in a positive diode.
Test lamp between 61/D+ and earth 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.	Breakage 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.	Short-circuiting in the circuit between D+ on regulator and 61/D+ on alternator.
Warning lamp goes out. Re-fit 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.	Short-circuiting in the circuit between DF on the regulator and DF on the alternator. Short-circuiting in the winding.
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).
Fit new regulator. Test lamp between B+ and 61/D+: Does not light.	Removed regulator defective.
Gives a weak light.	Defective alternator.

STARTER MOTOR

TOOLS

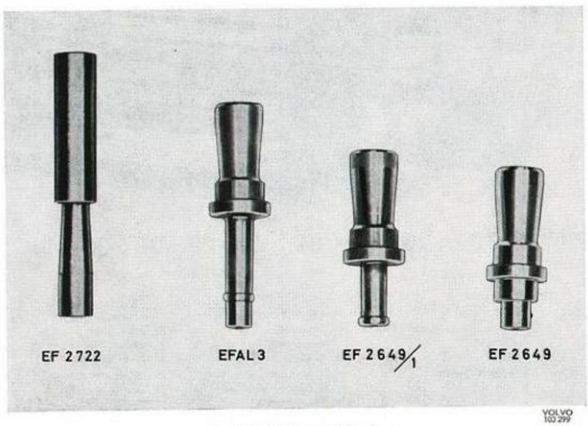


Fig. 3-74. Bosch special tools

EF 2722 Sleeve and drift for fitting circlip
EFAL 3 Smoothing drift
EF 2649/1 Smoothing drift
EF 2649 Drift for fitting bush

DESCRIPTION

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.

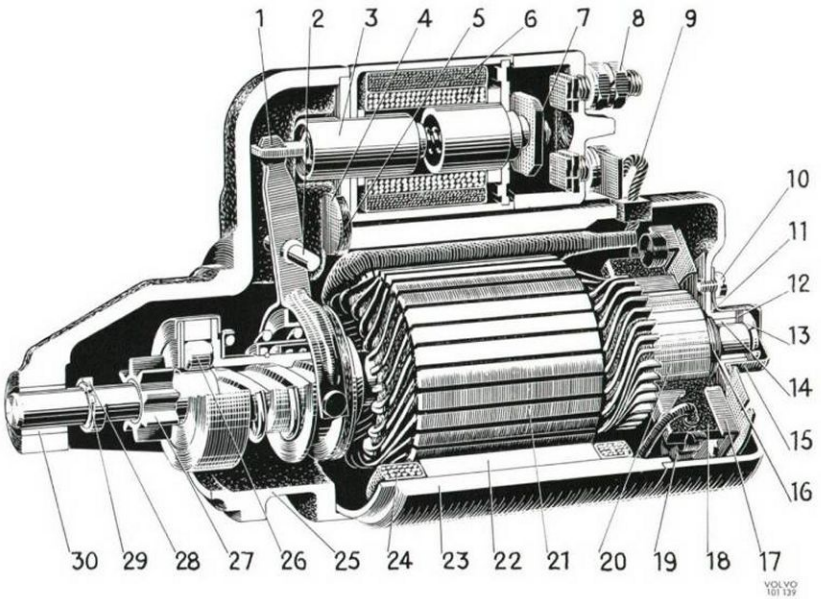


Fig. 3-75. Starter motor

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

REPAIR INSTRUCTIONS

REMOVING

1. Remove the cable terminal from the battery negative terminal studs.
2. Disconnect the leads from the starter motor.
3. Unscrew the bolts which hold the starter motor to the timing gear casing and lift it off.

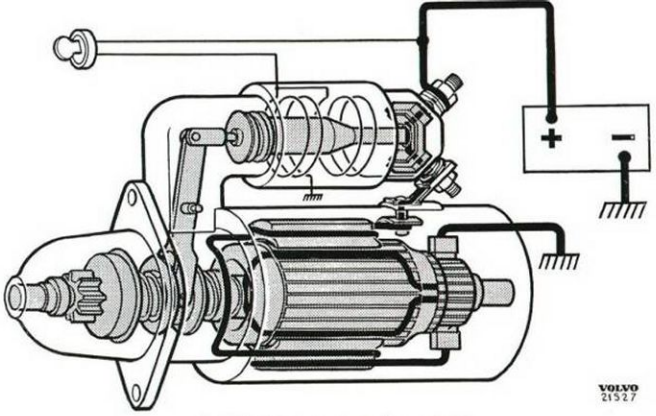


Fig. 3-76. Starter motor, general arrangement

DISASSEMBLING STARTER MOTOR

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 fram 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 follow also, but the positive brushes will remain in the field winding.
6. Unscrew the nut which holds the field terminal connection to the control solenoid.
7. Unscrew the attaching screws for the control solenoid. Remove the solenoid.

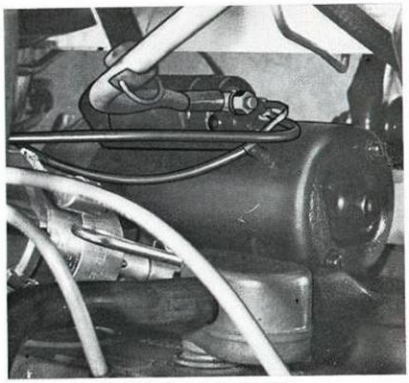


Fig. 3-77. Starter motor installed

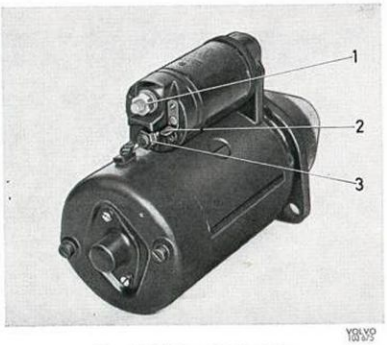


Fig. 3-78. Starter motor terminals

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

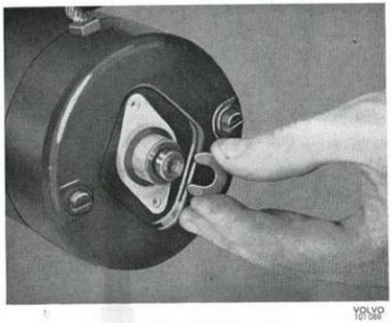


Fig. 3-79. Removing lock washer

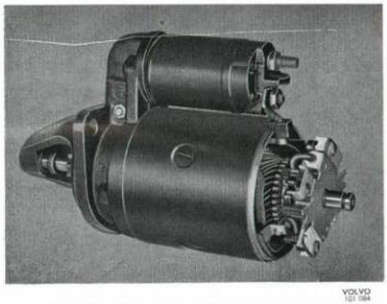


Fig. 3-81. Starter motor with bearing shield removed

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.

INSPECTING

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

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 commuator shuld be checked with a micrometer after turning. A radial throw of 0.08 mm (0.003″) may be considered permissible. The isolation between the laminations should be milled down to 0.4 mm (0.016″) 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 shorting by placing it in a growler machine. 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 armatures is rotated, one of the following faults can be the reason: shorting through the armature frame,

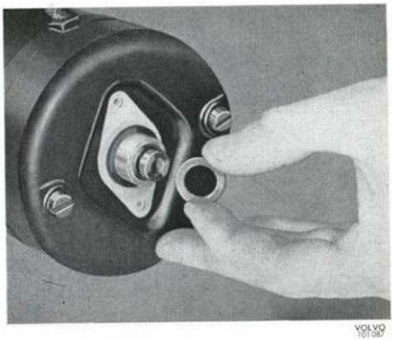


Fig. 3-80. Removing adjusting washers

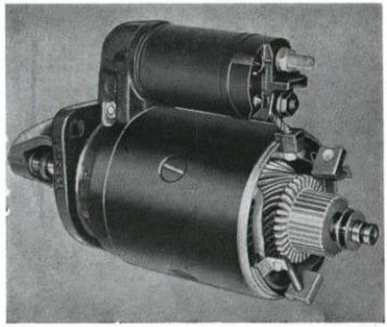


Fig. 3-82. Starter motor with brush bridge removed

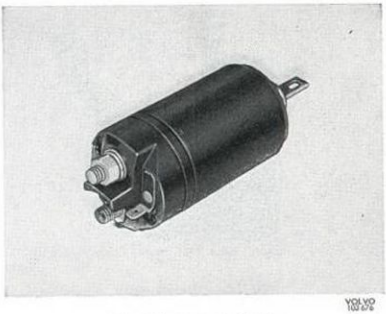


Fig. 3-83. Control solenoid

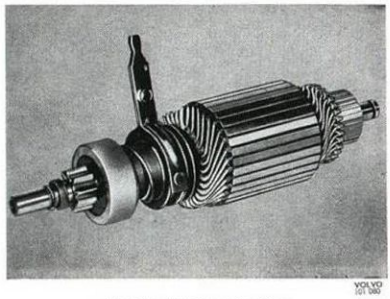


Fig. 3-85. Armature with pinion

shorting in the sommutator 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 0.12 mm (0.005") 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.

CHECKING CONTROL SOLENOID

If the control solenoid does not function, first check that the battery is in good condition. If there is no fault in the battery, connect a lead between the battery positive terminal and the control solenoid contact screw for the control lead. If the control 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 control 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 control solenoid does not function after the above measures, replace it with a new one.

REPLACING BRUSHES

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

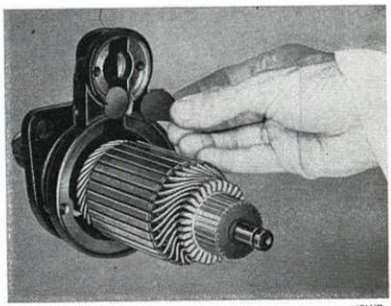


Fig. 3-84. Removing sealing washer

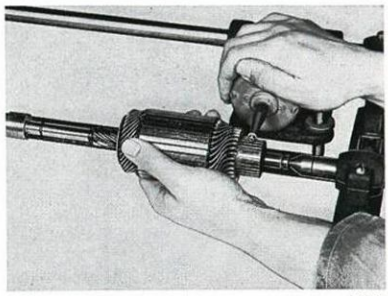


Fig. 3-86. Milling commutator

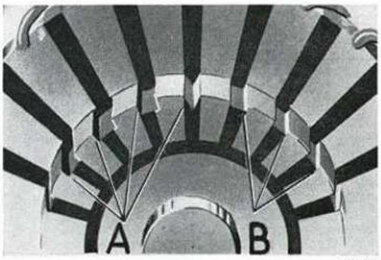


Fig. 3-87. Commutator milling
A. Incorrect milling B. Correct milling

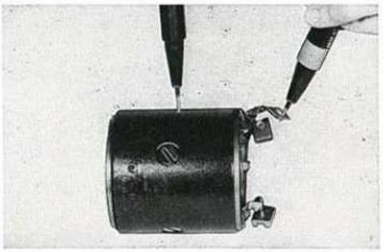


Fig. 3-89. Checking stator

holder and field winding 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.

INSTALLING SELF-LUBRICATING BUSHES

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

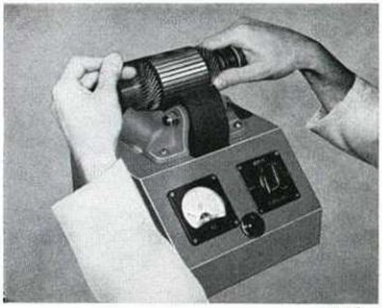


Fig. 3-88. Testing armature

Replace the bushes as follows:

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

REPLACING FIELD WINDING

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

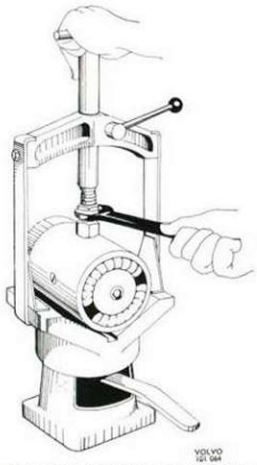


Fig. 3-90. Rotating clamping block for removing field winding

Fig. 3-91. Stator with soldered brushes

2. Mark the pole shoes 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 unscrew the pole screws as shown in Fig. 3-90.
4. Before fitting new field coils, warm them sligtly. Then place the pole shoes 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 pole shoes firmly.
5. Force out the press drift with a press tool. Check the fitted field windings for breakage and short-circuiting.

ASSEMBLING STARTER MOTOR

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

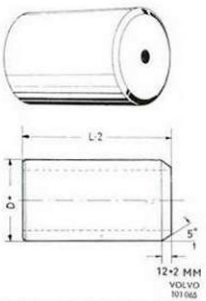


Fig. 3-92. Press drift for fitting field winding
D=66.4—66.09 mm (2.599—2.602") L=85 mm (3.346")

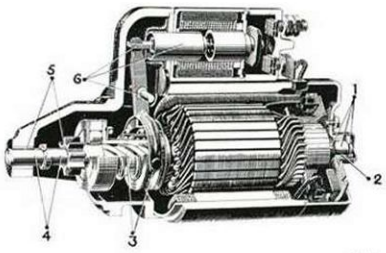


Fig. 3-93. Lubricating scheme for starter motor

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

1. Ft 2 V 3. Place a thin layer of grease on the isolation washers, the shaft end, the adjusting washers and lock washer.
2. Ol 1 V 13. Place the bush in oil for 1 hour before fitting
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 bushes in oil for a 1/2 hour before fitting.
6. Ft 2 V 3. Lubricate the engaging lever joints and the iron core of the solenoid with a thin layer of grease.

2. Fit the starter pinion on the armature shaft, and the wear washer as well as the snap ring. Seure the wear washer in position.
3. Fit the engaging arm on the pinion. Fit the armature in the drive end frame.
4. Fit the screw for the shift lever.
5. Fit the metal washer and rubber washer in the drive end frame.
6. Fit the stator on the armature and the drive end frame.
7. Secure the solenoid in the shift lever. Screw tight the solenoid.
8. Fit the washers on the armature shaft as shown in Fig. 3-82.
9. Place the brush bridge in position. Fit the brushes.
10. Fit the commutator bearing frame. Screw the starter motor together with the two through bolts.
11. Fit 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.

INSTALLING

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

IGNITION SYSTEM

TOOLS

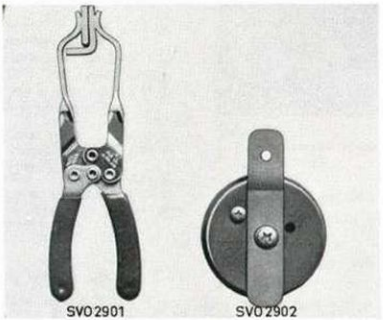


Fig. 3-94. Special tools for ignition setting, B 20 E
SVO 2901 Pinchers SVO 2902 Cover

The designation SVO before the tool number is to be replaced by the number 999. This applies also to new production of older tools.

DESCRIPTION

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 fitted on the firewall, see Fig. 3-95. 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

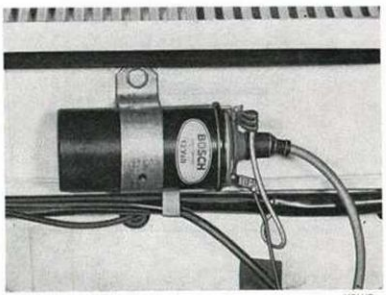


Fig. 3-95. Ignition coil installed

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.

DISTRIBUTOR

The distributor, Figs. 3-96 and 3-97, is fitted on the left-hand side of the engine and is driven from the camshaft. The adjustment of the distributor in relation to engine speed is regulated by a centrifugal governor fitted under the breaker plate. The adjustment in relation to loading is controlled by a vacuum regulator.

The vacuum regulator on the B 20 A engine raises the firing when the load on the engine reduces. On the B 20 B and B 20 E, F engines the vacuum regulator lowers the firing below the basic setting during idling and engine braking. Reducing the firing is part of exhaust emission control and prevents the engine from emitting excessive, noxious exahust gases at idling and engine braking.

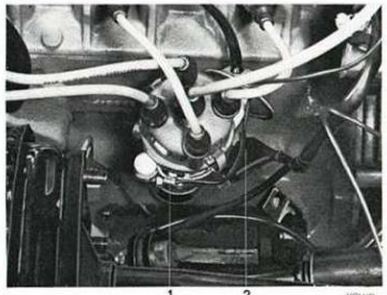


Fig. 3-97. Distributor B 20 E, F installed

1. Primary connection 2. Plug control for triggering contacts, fuel injection system

B 20 B-engines with automatic transmission (early prod., intended for U.S.A.) are fitted with a plastic holder on the hose between the carburettor and the vacuum regulator in the distributor, see Fig. 3-98.

The function of the plastic holder is to delay the resetting of the vacuum regulator about 6 seconds. Two triggering contacts for the fuel injection system are located under the centrifugal governor in the distributor of the B 20 E, F-engines. The contacts are mounted on a contact device and cannot be adjusted. With fault in these contacts, replace the entire device.

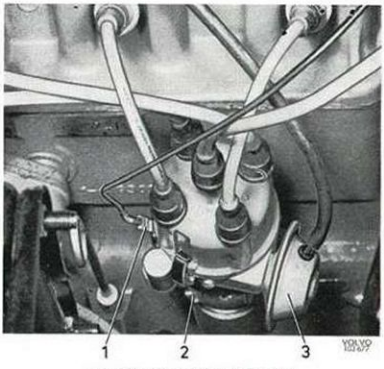


Fig. 3-96. Distributor B 20 B fitted

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

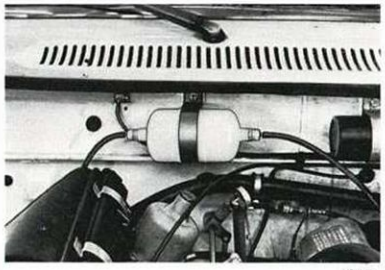


Fig. 3-98. Installing plastic holder, early prod.

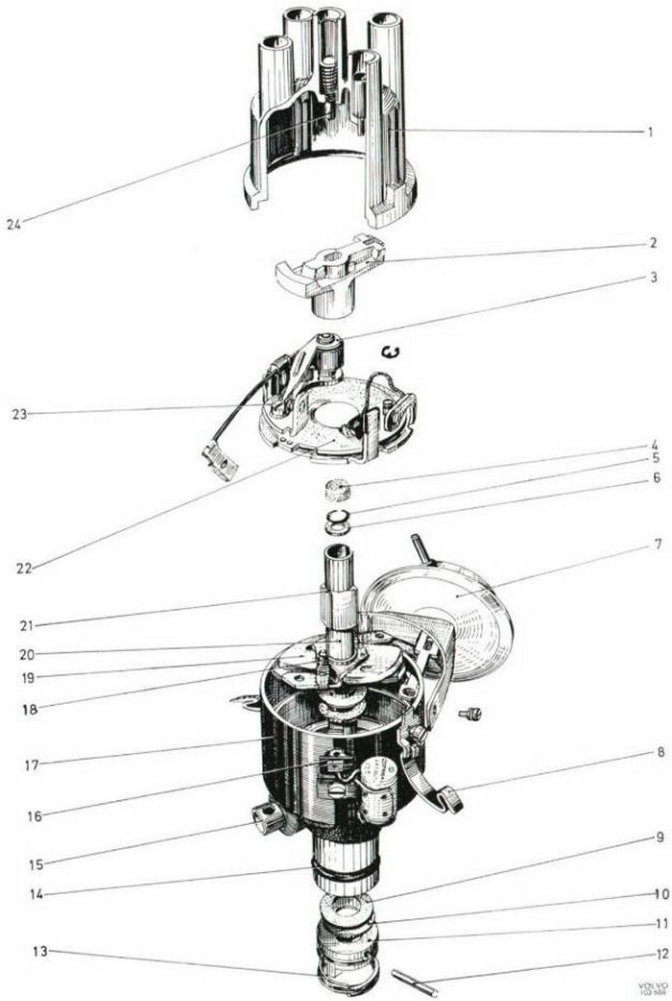


Fig. 3-99. Distributor, B 20 B

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

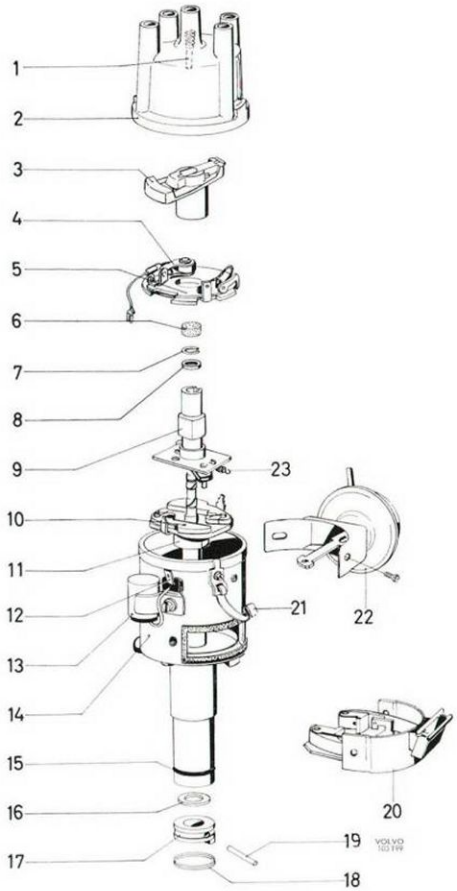


Fig. 3-100. Distributor, B 20 E, B 20 F

1. Rod brush (carbon)
2. Distributor cap
3. Distributor arm
4. Contact breaker
5. Breaker plate
6. Lubricating felt
7. Circlip
8. Washer
9. Breaker cam
10. Centrifugal weight
11. Cam for triggering contacts
12. Primary terminal
13. Capacitor
14. Distributor body
15. Rubber real
16. Washers
17. Driving collar
18. Resilient ring
19. Lock pin
20. Contact device
21. Lock clasp for distr. cap
22. Vacuum regulator
23. Centrifugal governor spring

DISTRIBUTOR

REMOVING

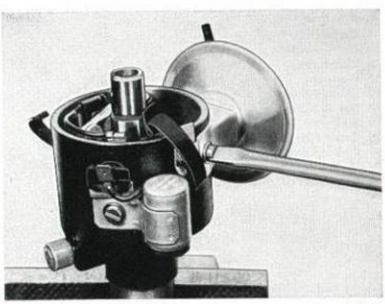
1. Release the lock clasps for the distributor cap and lift off the cap.
2. Remove the primary lead from the primary connection (1, Fig. 3-96).
3. Remove the vacuum hose from the vacuum regulator. (When removing the hose from the bakelite connection, observe great care not to break the connection.)
4. Pull out the plug contact for the triggering contacts (concerns B 20 E, B 20 F).
5. Slacken the screw (2, Fig. 3-96) and pull up the distributor.

VOLVO 103720

Fig. 3-102. Removing primary connection

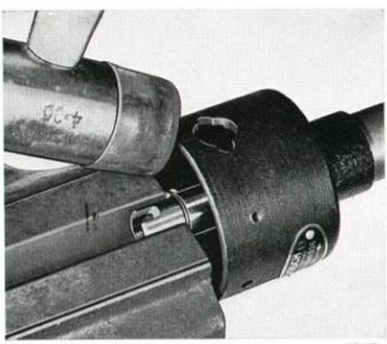
DISASSEMBLING

1. Pull off the distributor arm.
   Remove the circlip for the pull rod from the vacuum regulator.
   Remove the vacuum regulator according to Fig. 3-101.
2. Mark up 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. 3-102.
   Lift up the breaker plate.
3. Disconnect the springs for the centrifugal governor and mark up how the breaker cam is located in relation to the distributor shaft. Secure the breaker cam in a vice with soft jaws. Carefully knock on the distributor housing with a plastic mallet (Fig. 3-103) until the circlip (5, Fig. 3-99) has released and lift off the breaker cam.



VOLVO 103717

Fig. 3-101. Removing vacuum regulator



VOLVO 102977

Fig. 3-103. Removing circlip

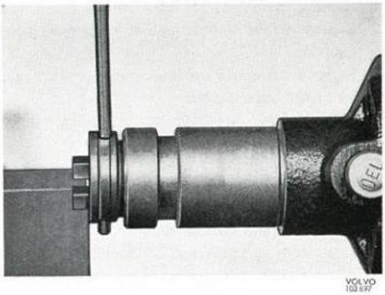


Fig. 3-104. Removing driving collar

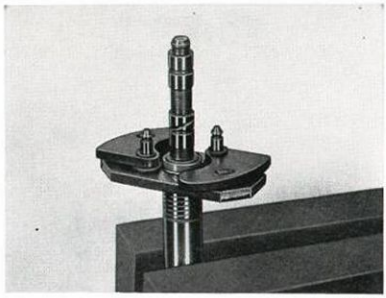


Fig. 3-105. Distributor shaft with centrifugal weights

4. Unscrew the screws holding the contact device and remove the device (concerns B 20 E, B 20 F).
5. Remove the resilient ring (13, Fig. 3-99) and mark up how the driving collar (11. Fig. 3-99) is located in relation to the distributor shaft.
   Tap out the pin (Fig. 3-104), lift off the driving collar and pull up the distributor shaft.
   Check that no washers have been lost.
6. Remove the lock springs for the centrifugal weights and lift up the weights.

INSPECTING

Distributor plate

The surface of the contact breaker points should be flat and smooth. The colour of the contacts should be grey. Oxidized or burnt 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 on.

Distributor shaft

The play between the distributor shaft and the breaker camshaft must not exceed 0.1 mm (0.004″). The cams on the breaker camshaft must not be scored or worn down 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.

Distributor housing

The play between the distributor housing and the shaft should not exceed 0.2 mm (0.008″). If the play is excessive, replace the bushes and, if this is insufficient, also the shaft.

ASSEMBLING

1. Lubricate the distributor parts according to the instructions given in Fig. 3-106.
2. Fit the centrifugal weights and also the lock springs on to the weights. Fit the breaker camshaft on to the distributor shaft. Hook on the springs for the centrifugal governor. Fit the washer and circlip for the breaker camshaft. The circlip is placed into position by means of a suitable sleeve. Fit the lubricating felt.
3. Fit 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. Fit the pin in the collar and check the axial clearance on the distributor shaft. The clearance should be 0.1—0.25 mm (0.004—0.010″). Any adjustment can be done by altering the number of adjusting washers on the distributor shaft.
   Fit the resilient ring on the driving collar.
4. Fit the contact device (concerns B 20 E, B 20 F). Check the packing, replace if necessary.
5. Fit the breaker plate. Fit the lock clasps for the cap. Fit the primary connection and connect the lead from the breaker contacts.
6. Fit the vacuum regulator.

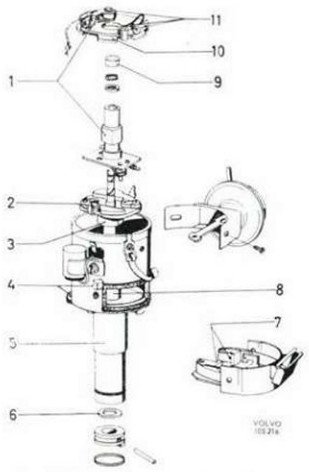


Fig. 3-106. Lubricating scheme for distributor

Use Bosch lubricant (or equivalent) according to below

1. Ft 1 v 4. Place a little grease on the fiber tab and a light layer on the breaker cam.
2. Ft 2 v 3. Grease the weights.
3. Ft 1 v 4. Place a light layer on the breaker cam.
4. Ol 1 v 13. Fill the lubricator with oil and drench the felts in oil.
5. Ol 1 v 13. Place the brushes in oil for a least 1/2 hour before use Soak the lubr. felt in oil.
6. Ft 2 v 3. Grease the washers.
7. Ft 1 v 4. Place a little grease on the fiber tabs.
8. Ol 1 v 13. Oil the shaft before fitting.
9. Ol 1 v 13. Drench the lubr. felt in oil.
10. Ol 1 v 2. Oil the breaker plate.
11. Ft 1 v 26. Grease the bush for the movable contacts, the pin for the vacuum regulator and the ball.

7. Check that the breaker contacts 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 trichlorethylene or chemically pure gasoline.

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

Fit the distributor arm.

REPLACING CONTACT BREAKER

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

1. Remove the distributor rotor arm.
2. Disconnect the electric lead at the primary connection.
3. Remove the screw for the contact breaker and lift up the old contacts.
4. Lubricate the distributor according to the instructions given in Fig. 3-106.
5. Fit the new contact breaker.
6. Connect the electric cable at the primary connection.
7. Check that the contact breaker is 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 contacts with trichlorethylene or chemically pure gasoline.

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

TESTING DISTRIBUTOR IN TEST BENCH

1. Run the distributor at 8.4 r/s (500 r/m) in its ordinary direction of rotation (anti-clockwise) and adjust the contact breaker dwell angle according to the "Specifications".
2. Adjustment is made by slackening a little the screw for the breaker contacts and then inserting a screwdriver in the recess, Fig. 3-107, and turning the screwdriver until the dwell angle is the correct one.
   Then tighten the screw for the contact breaker.
3. Run the distributor and set the protactor on the test bench so that a marking comes opposite 0°

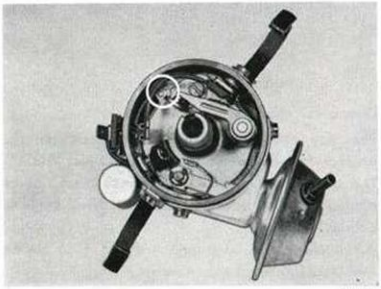


Fig. 3-107. Recess for adjusting the contact breaker

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 off 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 ±1°.

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 off the values at the prescribed graduations.

INSTALLING

1. Place the distributor in position.
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 plug contact to the triggering contacts (concerns B 20 E, F).
5. Connect the primary lead. Fit on the distributor cap.
6. Start the engine and set the ignition. (If the engine does not start, turn the distributor housing until it does so.)

IGNITION DISTRIBUTOR TRIGGERING CONTACTS, B 20 E, B 20 F

REPLACING

1. Remove the ignition distributor.
2. Undo the two screws securing the holder and pull out the holder.
3. Apply a little grease (Bosch Ft 1 V 4 or corresponding) to the fiber deflecting pieces of the contact breaker lever on the new holder.
4. Check to see if the rubber ring is not damaged, replace if necessary.
5. Fit the new holder in the distributor and secure it.
   (It is not possible to adjust the contacts.)
6. Fit the distributor and adjust the ignition.
7. Check the contacts with test instrument EFAW 228 in accordance with the test chart.

IGNITION SETTING

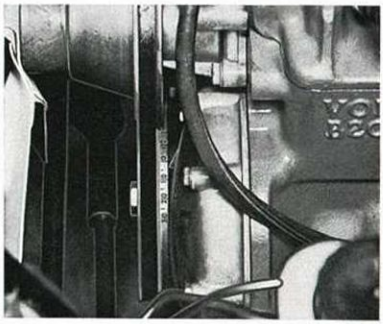
Ignition setting should always be carried out with the engine running and with the help of an ignition-setting lamp (Stroboscope) and rev. counter.

B 20 A AND B 20 B

1. Clean the pulley so that the graduation marks can be seen, see Fig. 3-108.
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.
3. Connect the timing light to the No. 1 cyl. spark plug and the battery. Connect a rev. counter.
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. 3-96) 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 the timing light and rev. counter and fit the hose to the vacuum regulator.
   Connect the vacuum hose to the EGR valve (B 20 F with EGR).

B 20 E, B 20 F

1. Clean the pulley so that the graduation marks can be seen, see Fig. 3-108.
2. Remove the hose connected to the distributor's vacuum regulator at the inlet duct. Also discon-



VOLVO 103721

Fig. 3-108. Graduation for ignition setting

nect the hose between the air cleaner and inlet duct, at the duct.

3. Connect the timing light to the No. 1 cyl. spark plug and the battery. Connect a rev. counter.
4. Start the engine. Fit the plastic cover, SVO 2902, on the inlet duct, see Fig. 3-109, and adjust down the engine speed to 11.6—13.4 r/s (700—800 r/m) by moving the bar over the hole in the plastic cover.
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 the timing light, rev. counter, plastic cover and pinchers. Fit the hose to the vacuum regulator as well as the hose between the air cleaner and inlet duct.

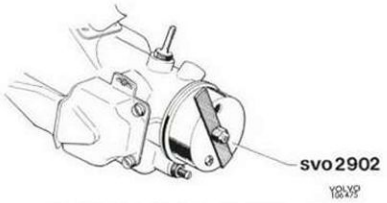


Fig. 3-109. Tools for adjusting engine speed during ignition setting, B 20 E, B 20 F

LIGHTING

DESCRIPTION

Fig. 3-110. Headlights

Fig. 3-111. Rear and license plate lights

The lighting consists of two full- and dipped-beam headlights, parking lamps, rear lamps, license plate light and side marker lights.

The headlights are fitted in the grille. They are switched on and off by the lighting switch on the instrument panel. Switching between full- and dipped-beam positions is done by moving the directional indicator lever switch towards the steering wheel. The relay (1, Fig. 3-132) then connects up the lighting. 140 GL is equipped with halogen lights, H-4 lamps, for both fullbeam and dipped headlights (does not apply to USA).

The rear lamps have separate bulbs for rear lights, stop lights, reversing lights and directional indicators.

REPAIR INSTRUCTIONS

HEADLIGHTS

REPLACING HEADLIGHT INSERT

1. Disconnect the cables by pulling the connection contact backwards. (The battery must first be removed when about to replace the insert for the left-hand headlights. When about to replace 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 air cleaner.)
2. Remove the three plastic holders securing the insert in the case by undoing 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. Fit the connection contact and check the lighting.

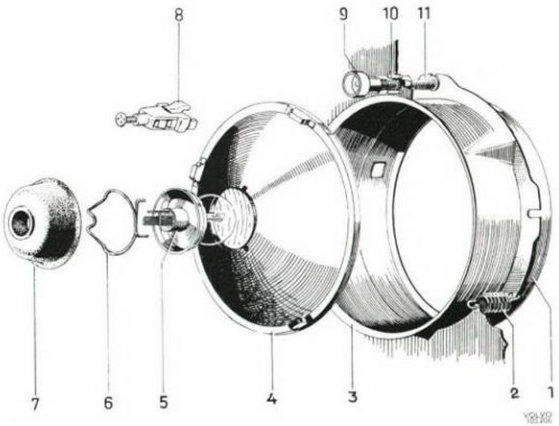


Fig. 3-112. Headlights

1. Ring
2. Spring
3. Retainer
4. Insert
5. Bulb
6. Bulb holder spring
7. Rubber cover
8. Plastic holder
9. Adjusting knob
10. Nut
11. Screw

REPLACING HEADLIGHT BULB

1. Disconnect the cables by pulling out the connection contact (1, Fig. 3-113), and remove the rubber cover underneath.
2. Compress and remove the spring (1, Fig. 3-114), holding the bulb to the insert and take out the bulb.
3. Fit 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. Fit the spring and the rubber cover.
5. Connect the connection contact and check the lighting.

CHECKING AND ADJUSTING

The headlights should be examined to check the condition of the 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 colour. The lighting effect normally deteriorates to such an extent that the bulbs should be replaced after 100—200 hours of operation.

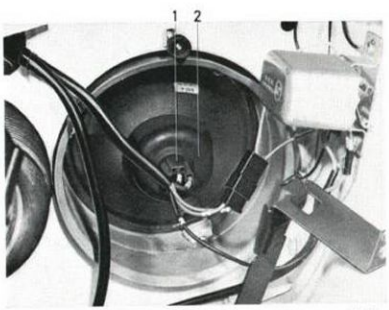


Fig. 3-113. Headlight, rear side

1. Connection contact 2. Rubber cover

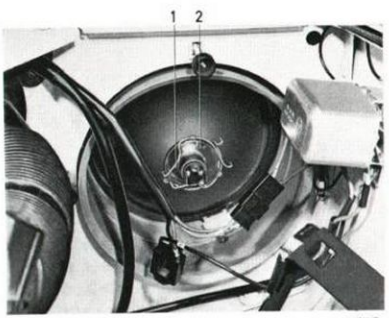


Fig. 3-114. Headlight, rear side

1. Spring 2. Bulb

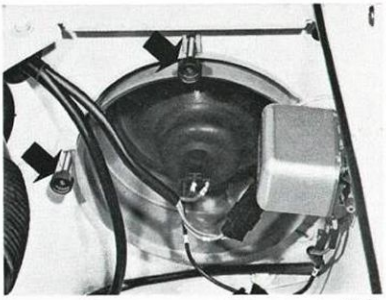


Fig. 3-115. Adjusting screws

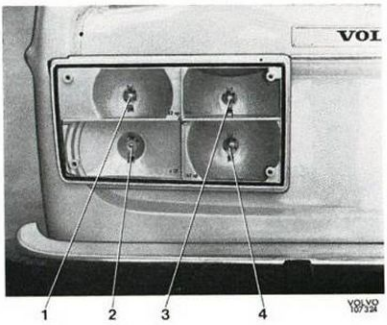


Fig. 3-117. Bulb location

1. Directional indicator light
2. Rear light
3. Reversing light
4. Brake light

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 strength 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. 3-115. The upper screw adjusts the headlight vertically and the screw at the side adjusts the headlight laterally.

REAR LIGHTS

REPLACING BULBS

1. Screw loose the four screws holding the glass, see Fig. 3-116, and lift off the glass.
2. Replace the bulb.
3. Re-fit the glass.

REPLACING REAR LIGHT

The rear light is replaced as a complete unit.

1. Remove the spare wheel (right-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.

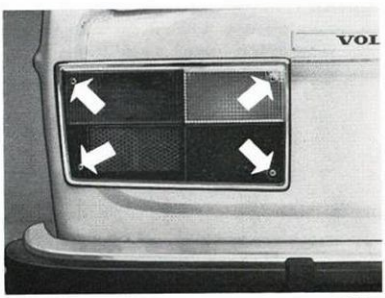


Fig. 3-116. Removing glass, rear light lens

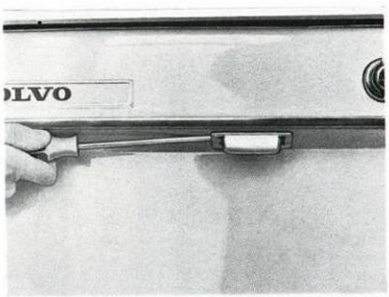


Fig. 3-118. Removing license plate light

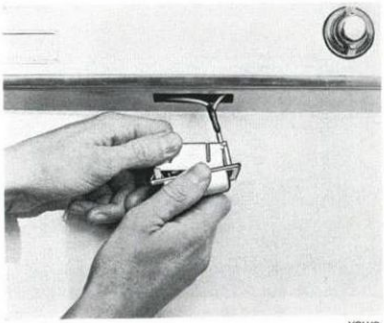


Fig. 3-119. Disassembling license plate light

REPLACING LICENSE PLATE LIGHT

1. Remove the license plate light with the help of a crosshead screwdriver according to Fig. 3-118.
2. Disconnect the electric cable from the plate.
3. Disassemble the plate according to Fig. 3-119.
4. Replace the bulb.
5. Re-connect the electric cable to the plate.
6. Install the plate by pressing it firmly into its recess.

145:

The license plate light consists of two bulb housings secured to the tailgate. The bulbs are changed as follows:

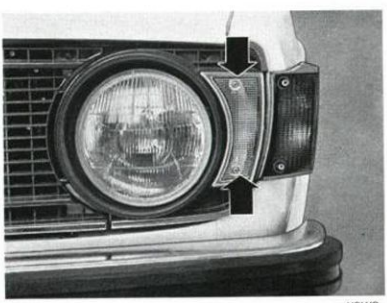


Fig. 3-120. Parking light, screws holding the lens

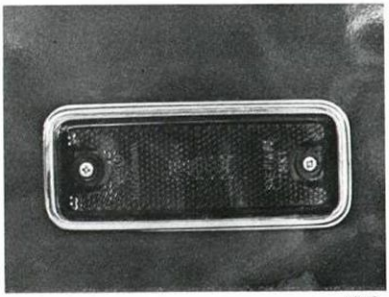


Fig. 3-121. Side marker light

Press in the catches in the bulb housing by inserting a screwdriver in the opening on the left-hand side of the housing, see Fig. 3-118. Pull the housing out of its attachment.

Pull out the cover end not provided with a pin.

The bulb is now accessible for replacement.

When installing, fit first the guide pins in the recesses and then press on the cover. Check that the rubber liner is correctly in position and push the bulb housing securely into the attachment.

PARKING LIGHTS

The parking lights are mounted on the outside of the headlights. When removing the light to change the bulb etc., unscrew the two screws, Fig. 3-120, holding the lens to the grille and this will allow all the parts belonging to the light to be accessible for removal.

SIDE MARKER LIGHTS

Two flasher marker lights are placed on each side of the car.

To replace the bulb, take off the lens, which is fitted to the body by means of two screws.

OTHER ELECTRICAL STANDARD EQUIPMENT

DESCRIPTION

DIRECTIONAL INDICATOR SYSTEM

The directional indicator system consists of a thermal-type flasher relay (electronic flasher relay for USA), directional indicator switch, flash lamps on the front mudguards and bulbs in the rear lights. The directional indicator lever switch is located under the plastic casing on the left-hand side of the steering column, see Fig. 3-123. It switches on the right or left indicators 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 for the directional indicator is wired in parallel across the switch.

The directional indicator signals can also be used as emergency warning flashers, which are switched on by the emergency warning flasher switch mounted on the control panel. The flasher function is then looked after by the flasher relay placed on the reverse side of the control panel, see Fig. 3-122.

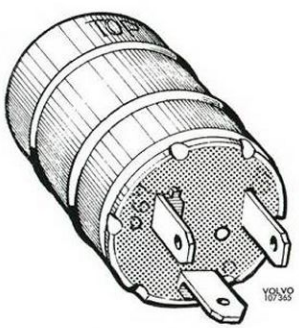


Fig. 3-122. Flasher relay

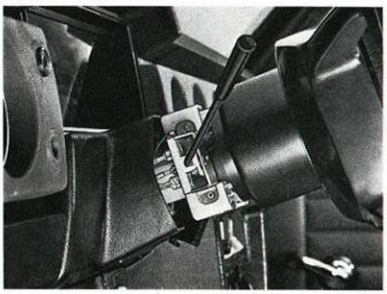


Fig. 3-123. Directional indicator lever switch

IGNITION SWITCH

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 fusebox (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 fitted 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.

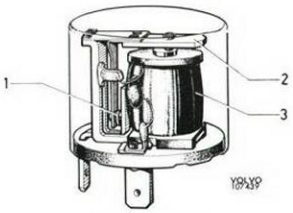


Fig. 3-124. Buzzer
1. Contacts
2. Armature
3. Coil

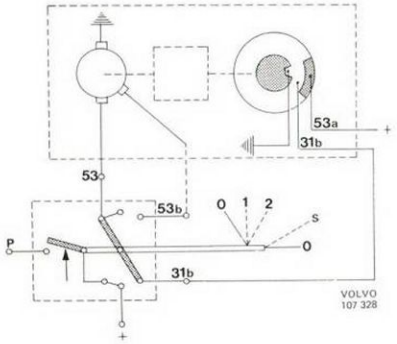


Fig. 3-125. Wiring diagram for windshield wiper motor, Electrolux

The buzzer is placed under the dashboard on the left-hand side and is connected between 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.

WINDSHIELD WIPERS

The windshield wipers are driven by an electric motor. The motor is connected to the wipers by means of a combined cable and linkage system. It has a permanently magnetized field and three brushes, one of which is a minus brush and the other two being plus brushes. Both 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 0.92±0.8 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. 3-125 and 3-126, irrespective of where the wiper is switched off.

HORNS

The horns are mounted 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.

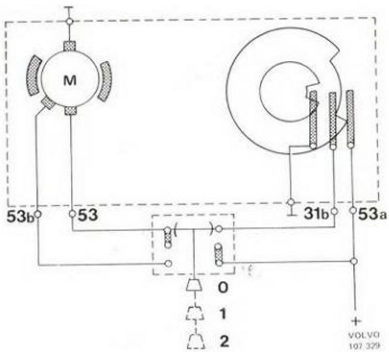


Fig. 3-126. Wiring diagram for windshield wiper motor, SWF

FUSES

The fuses are collected in a fusebox, which is placed next to the left fresh air vent. The fuses are accessible when the cover is taken off.

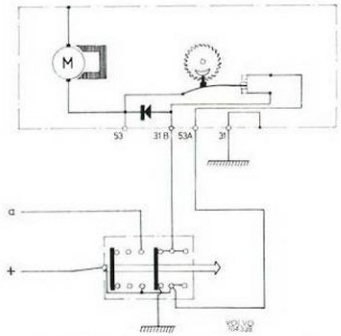


Fig. 3-127. Wiring diagram for tailgate window wiper
a. To tailgate window washer

WINDSHIELD WASHER

The windshield washer, which is located on the left-hand side of the dashboard, is driven by an electric motor, see Fig. 3-129. The pump is placed at the bottom of the water container and is linked with the motor by a shaft. The pump is of the centrifugal type, and there are two versions, see Figs. 3-129 and 3-130.

Both wipers and washers are operated by a lever mounted on the steering column, see Fig. 3-134.

SWITCHES

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

TAILGATE WINDOW WIPER, 145

The tailgate window wiper is operated by an electric, single-speed motor with a permanently magnetized field. It is connected to the wiper blade by means of a link arm. A parking switch, see Fig. 3-127, 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 tailgate window wiper can be seen from Fig. 3-128.

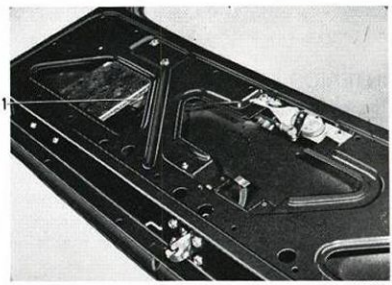


Fig. 3-128. Tailgate window wiper, fitted
1. Wiper motor

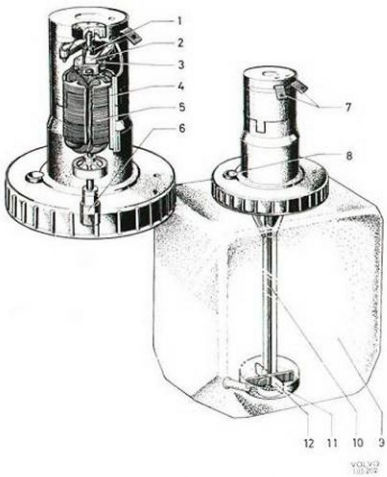


Fig. 3-129. Windshield washer

1. Commutator
2. Brush
3. Spring
4. Permanent magnet
5. Rotor
6. Flange
7. Connecting lips
8. Wiper fluid hose hole
9. Container
10. Shaft
11. Pump housing
12. Pump impeller

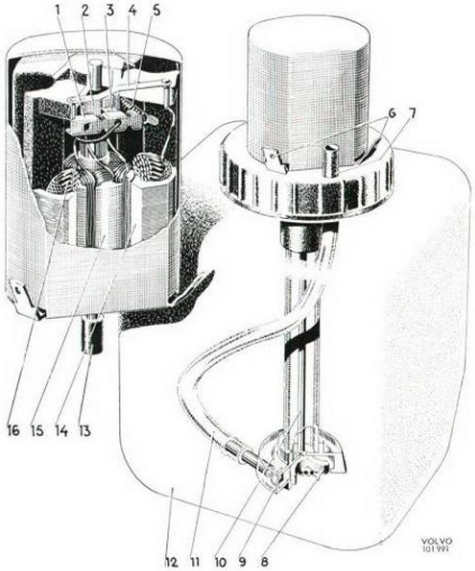


Fig. 3-130. Windshield washer

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 winding

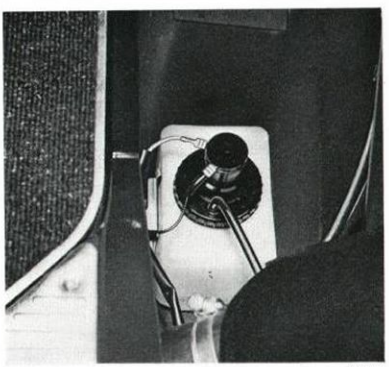


Fig. 3-131. Tailgate window washer, fitted

TAILGATE WINDOW WASHER, 145

The tailgate window washer for the 145 model is of the same type as the windshield washer. It is placed in a cavity to the right under the floor of the cargo space, see Fig. 3-131.

INTERIOR LIGHTING

The interior lighting consists of a lamp located in the middle of the roof. The lamp is switched on by means of 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 tailgate switches on this light.

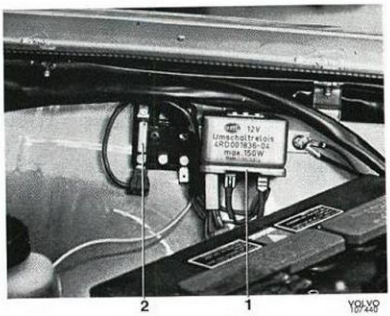


Fig. 3-132. Control relays

1. Step relay for dipped, full-beams switching
2. Fuse for fuel injection system (140 GL)

BRAKE LIGHT SWITCH

The brake light switch is placed on the pedal carrier beneath the dashboard. It is operated mechanically by the brake pedal.

CONTROL RELAYS

As standard the cars in the 140-series are fitted with three control relays, a step relay for the full-beam and dipped lights, a control relay for the back-up lights and a control relay for the rear window defroster. Vehicles with automatic transmission are fitted with a start relay instead of a control relay for the back-up lights.

REPAIR INSTRUCTIONS

REPLACING SWITCHES FOR FLASHERS AND WINDSHIELD WIPERS

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

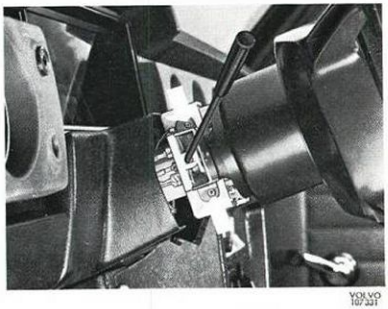


Fig. 3-133. Switch for flashers

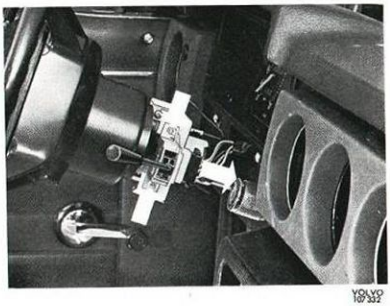


Fig. 3-134. Switch for windshield wipers

Fig. 3-135. Removing flasher light glass

REPLACING FLASHER LIGHTS

1. Remove the electric cable from the the cable harness in engine compartment.
2. Remove the light glass, see Fig. 3-135.
3. Remove the housing from the fender. Pull out the electric cable with its grommet.
4. Fit the new electric cable with grommet and install the housing.
5. Fit the bulb and connect the electric cable to the harness.
6. Check the flasher function and fit the glass.

REMOVING CONTACT BAR

1. Remove the impact guard (1, Fig. 3-136). (Carefully lever it loose with the help of a screwdriver.)
2. Disconnect the electric cable (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.

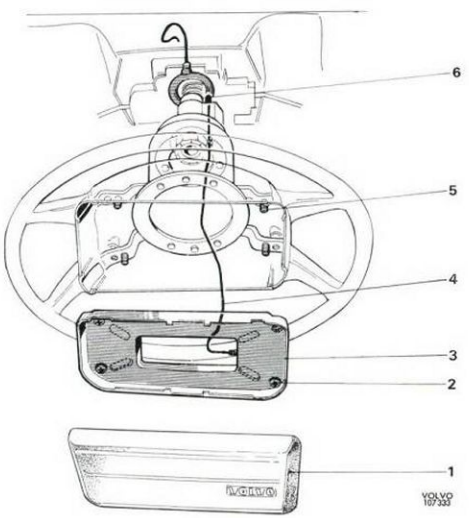


Fig. 3-136. Contact bar

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

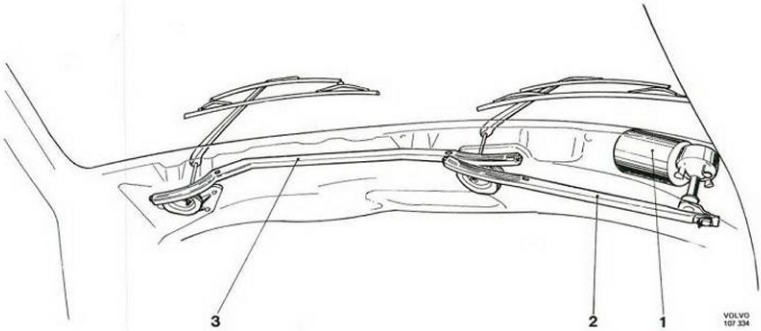


Fig. 3-137. Windshield wiper unit
1. Wiper motor
2. Drive link
3. Parallel drive link

REMOVING WIPER MOTOR

1. Remove the drive link from the lever on the wiper motor after having first removed the lock device, see Fig. 3-138.
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 lever, rubber seal, damper rubber and spacer sleeves to the new wiper motor.

INSTALLING WIPER MOTOR

1. Place the wiper motor in position and fit the attaching screws, see Fig. 3-139.
2. Connect up the contact to the wiper motor.
3. Fit the drive link to the lever on the wiper motor.
4. Check the wiper function.

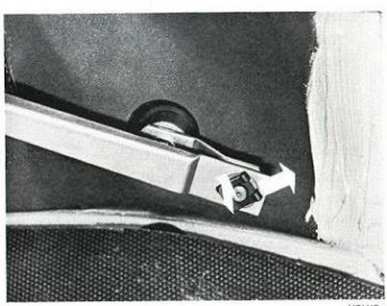


Fig. 3-138. Removing locking for drive link

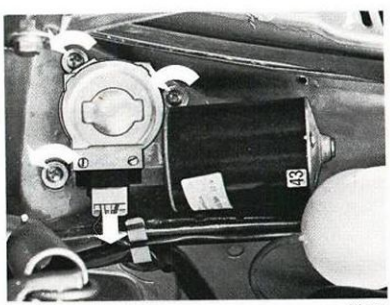


Fig. 3-139. Removing windshield wiper motor

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).

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. Fit the connecting rod for the wiper motor lever. Thereafter tension the cable.
3. Check to make sure the wipers are functioning properly.
4. Fit 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. Fit the defroster nozzle and glove locker.

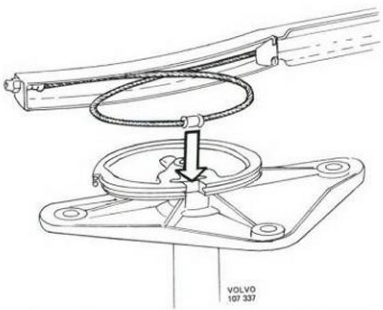


Fig. 3-140. Installing cable for drive link and parallel drive link, left-hand side

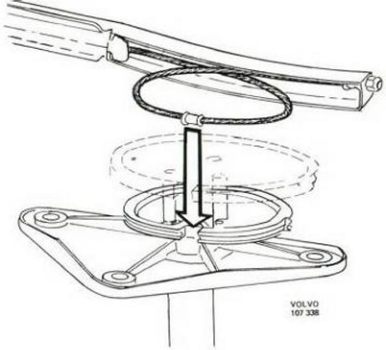


Fig. 3-141. Installing cable for parallel drive link, right-hand side

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. Fit 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. Fit 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.

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.
   Fit the drive link to the lever on the wiper motor. Tension the cable.
3. Check the wiper function.

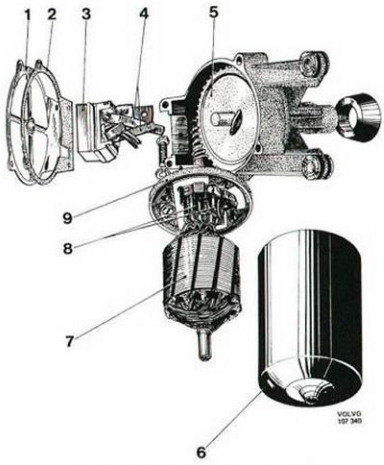


Fig. 3-143. Windshield wiper motor, SWF

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

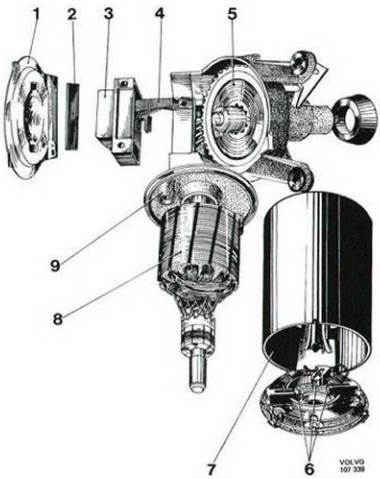


Fig. 3-142. Windshield wiper motor, Electrolux

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

4. Fit the defroster hoses and the side panel. (On vehicles with combined heating system, fit 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.

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.

REPLACING IGNITION SWITCH

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

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

TAILGATE WINDOW WIPER, 145

REMOVING

1. Remove the negative (ground) battery lead from the battery.
2. Take off the panel on the inside of the tailgate.
3. Unscrew 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 up and disconnect the electric cables from the motor.

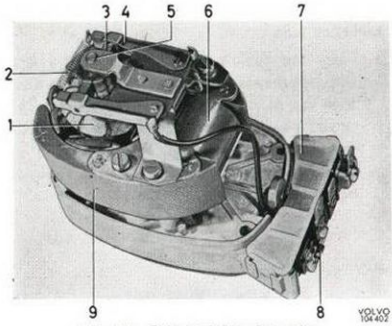


Fig. 3-145. Tailgate window wiper motor

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

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 outgoing 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.

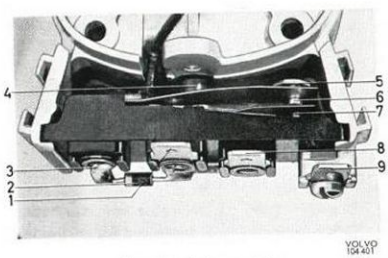


Fig. 3-144. Parking switch

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

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).

DISASSEMBLING TAILGATE WINDOW WIPER MOTOR

1. Remove the casing.
2. Unhook the brush spring.
3. Disconnect the two screws holding the brush holder bridge and bend the bridge 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.

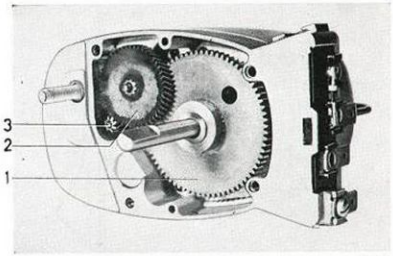


Fig. 3-146. Drive housing

1. Drive 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 commutor 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 TAILGATE 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 fit 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 bush.
5. Fit 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 fit the casing.

INSTALLING

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

REPLACING INTERIOR LIGHT BULB

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

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 (0.16±0.008") (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.

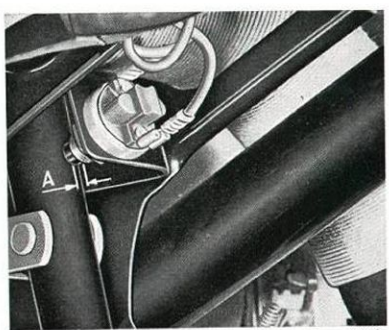


Fig. 3-147. Brake light switch

REPLACING HEADLIGHT SWITCH

1. Unscrew 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. Undo 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.

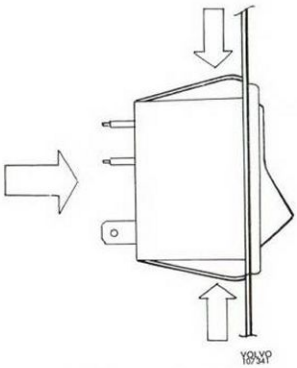


Fig. 3-148. Removing switch

GROUP 38

INSTRUMENTS

TOOLS

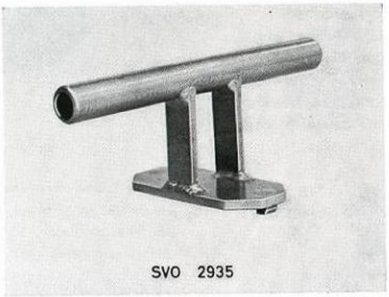


Fig. 3-149. Special tool for removing and installing tank fittings

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

DESCRIPTION

The instrumentation consists of a combined instrument, see Figs. 3-150 and 3-151. It comprises a speedometer, mileometer and trip meter, rev counter (only on certain models), temperature gauge, fuel gauge, warning lamps for parking brake, fullbeams, brake circuit failure, oil pressure, battery charging, choke and overdrive (for vehicles fitted with such). Also connected to the combined instrument is a voltage regulator which maintains the feed voltage constant for the instrumentation.

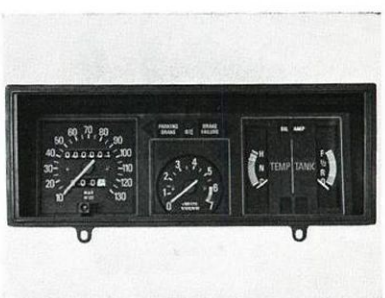


Fig. 3-150. Combined instrument, front side

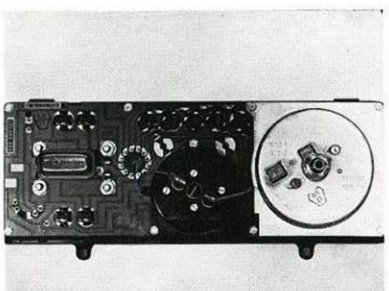


Fig. 3-151. Combined instrument, reverse side

SPEEDOMETER AND MILEOMETER

The speedometer and mileometer are integrally built and are driven by a drive line from a worm on the output shaft of the gearbox.

The speedometer is of the eddy current type and more or less 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 mileometer is made up of 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 revs in order for the gauge to register 1 km.

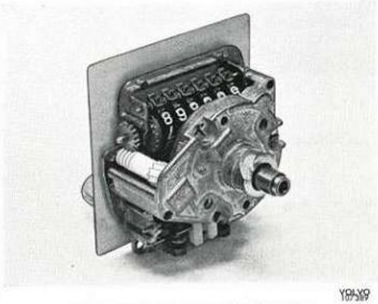


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Fig. 3-152. Speedometer and mileometer

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.

REV COUNTER

The rev counter 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

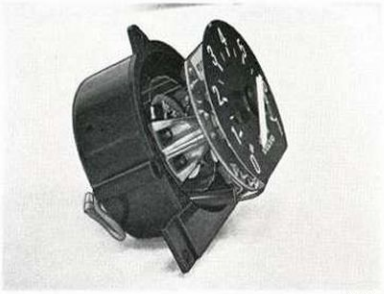

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Fig. 3-153. Rev counter

and is linked to a shaft to which the rev counter gauge pointer is fitted. 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.

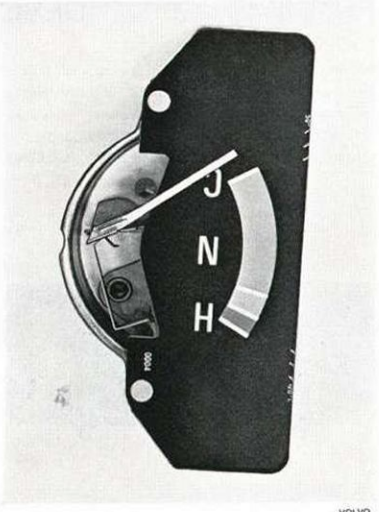

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Fig. 3-154. Registering instrument for temperature gauge

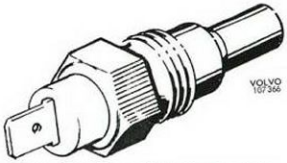


Fig. 3-155. Sensor for temperature gauge

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.

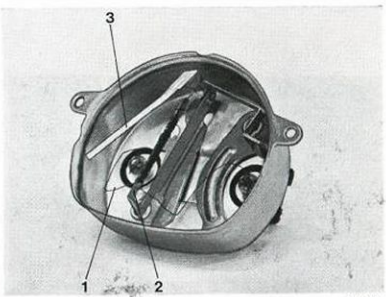


Fig. 3-156. Registering instrument, disassembled

1. Resistance wire
2. Bimetal spring
3. Pointer

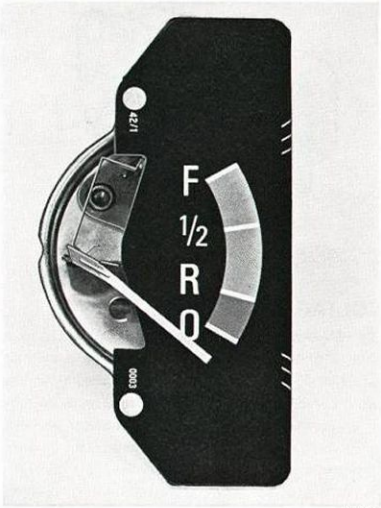


Fig. 3-157. Registering instrument, fuel

FUEL GAUGE

The fuel gauge consists of a sender and indicating instrument. The sender, fitted 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.

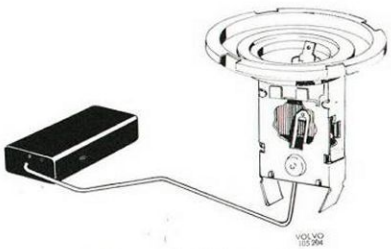


Fig. 3-158. Sender for fuel gauge

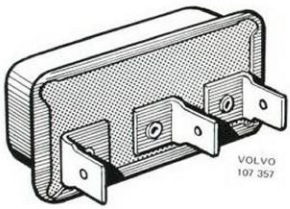


Fig. 3-159. Voltage stabilizer

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 af 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.

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.

DIRECTIONAL INDICATORS

The warning lamp for the directional indicators flashes when the indicators are engaged. It is wired across the switch for the indicators.

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. 3-161, and this switches on the warning lamp which remains lighted as long as the parking brake is on.

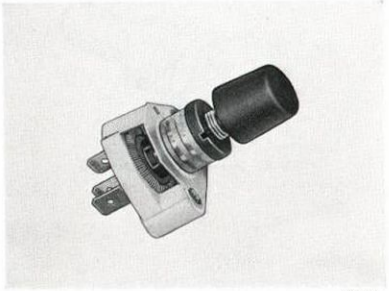


Fig. 3-160. Rheostat for instrument lighting

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. 3-162, and the warning lamp goes on. The warning lamp remains lighted until the fault in the brake system has been put right and the warning valve re-set. Concerning re-setting the warning valve, see Part 5 Brakes, Group 52.

FULL-BEAM HEADLIGHTS

The warning lamp for the full-beam headlights flashes simultanously with the full-beam headlights. It is wired parallel with the headlights at the step relay.

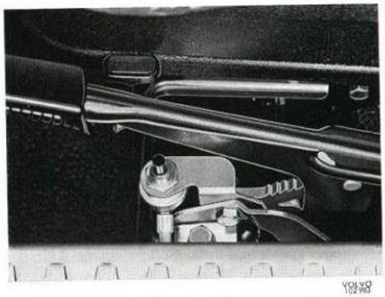


Fig. 3-161. Switch for parking brake control

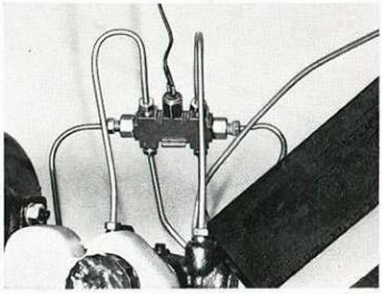


Fig. 3-162. Warning valve

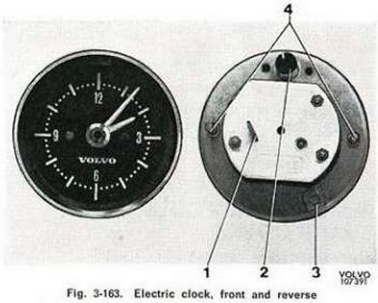


Fig. 3-163. Electric clock, front and reverse
1. Battery connection
2. Bulb
3. Battery connection
4. Attaching screws

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 warning lamp 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 lamp for the seat belts.

OVERDRIVE

The warning lamp 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 warning lamp which lights.

CLOCK

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

REPAIR INSTRUCTIONS

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

REMOVING COMBINED INSTRUMENT

1. Remove the casings over the steering column.
2. Unscrew 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 rev counter, the rev counter sender cable should also be disconnected.)

REMOVING WARNING LAMPS

1. The lamps 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 REV COUNTER OR GUARD COVER

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

REMOVING SPEEDOMETER WITH MILEOMETER

1. Remove the combined instrument.
2. Remove the rev counter or guard cover.
3. Unscrew 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 rev counter or guard cover.
3. Remove the speedometer.
4. Unscrew 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

1. Remove the rev counter or guard cover.
2. Remove the speedometer.
3. Remove the contact device.
4. Unscrew both the 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.

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

REMOVING SENDER FOR FUEL GAUGE

The sender, which is located in the fuel tank, is held in position with a bayonet fixture. When removing, use tool 2738, see Fig. 3-164.

REPLACING SENSOR FOR TEMPERATURE GAUGE

1. Drain some of the coolant, about 2 dm^3 (2 qts).
2. Disconnect the electric cable from the sensor.
3. Unscrew the sensor and replace it with a new one.
4. Screw tight the new sensor and connect up the electric cable.
5. Fill with coolant.

REMOVING CLOCK

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.

CHECKING 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, which is located on the gearbox, for driving the cable.

In order to decide which component is faulty, carry out the following:

If the speedometer functions while the mileometer 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 mileometer stop functioning, the fault is probably in the speedometer cable or the worm. Disconnect the speedometer cable from the instrument and see whether it rotates. If it does, this means that it has broken from the worm, in which case replace the cable and check the drive at the same time at the gearbox. 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

CHECKING 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.

CHECKING 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.

The fault tracing is 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 up 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 faulty 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 a faulty 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 line from the sender and connect up a resistance of 40 ohms between cable and ground.

If the fuel gauge now shows a full tank, the fault must be in the indicating instrument of the temperature gauge, which is then to 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.

CHECKING REMOVED TEMPERATURE SENSOR

The sensor is checked by heating it up and then reading off its resistance and temperature. The following values should be obtained if the sensor is without fault:

(NOTE. The resistances may deviate ±10 %.)

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

CHECKING FUEL GAUGE

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

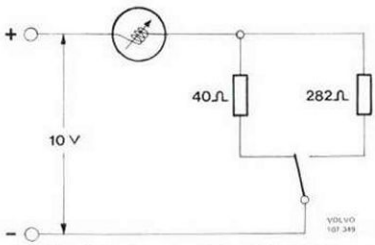


Fig. 3-165. Wiring diagram for checking temperature gauge or fuel gauge indicating instrument

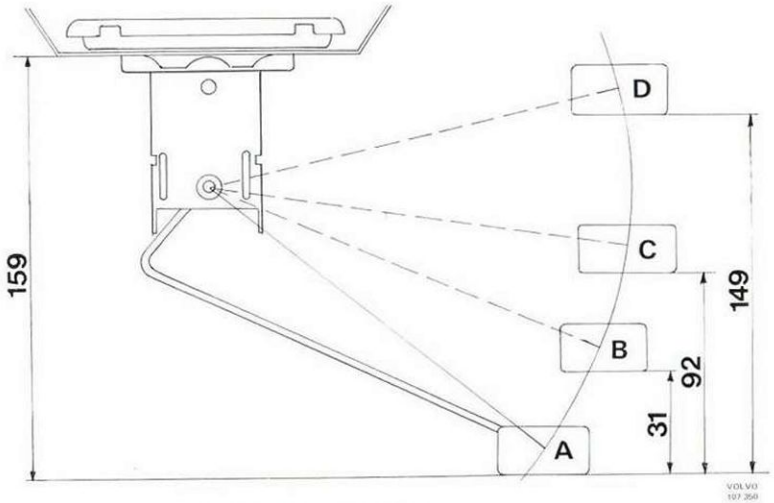
CHECKING REMOVED FUEL SENDER

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:

With regard to the 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.

CHECKING 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.

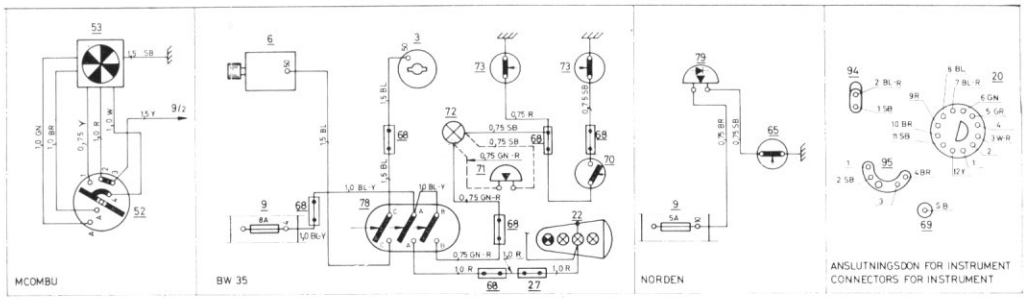


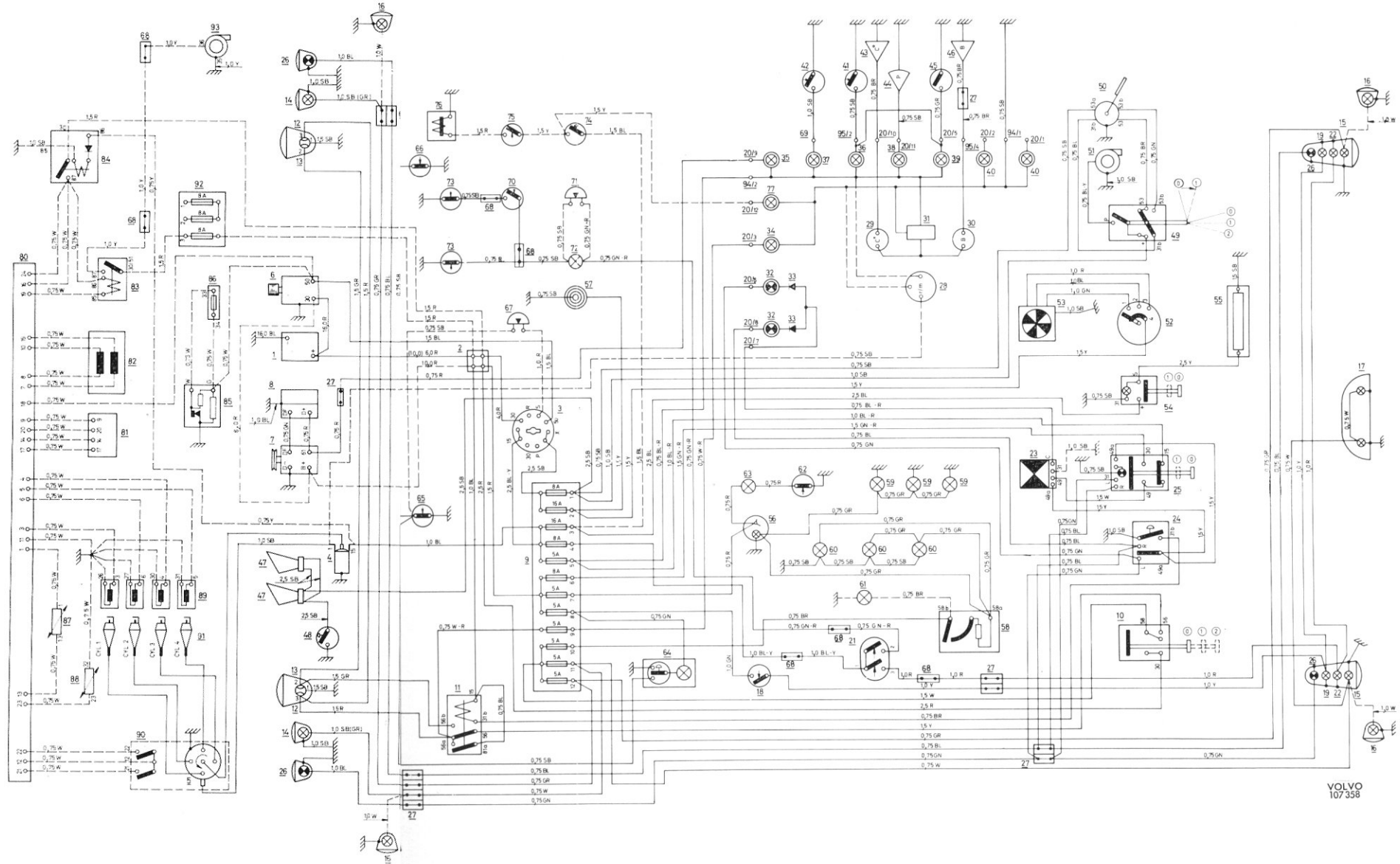
Position	Resistance in ohms		
A	282±48	C	75±11.5
B	146±19	D	40± 5

Fig. 3-166. Checking fuel sender

A=Empty tank
B=Reserve (8 dm³=1.8 galls.)
C=Half tank (29 dm³=6.5 galls.)
D=Full tank (58 dm³=13 galls.)

Pos.	Title	Data
1.	Battery	12 V 60 Ah
2.	Connection box	
3.	Ignition switch	
4.	Ignition coil	
5.	Distributor, firing sequence	1-3-4-2
6.	Starter motor	
7.	Alternator	
8.	Changing regulator	
9.	Fusebox	
10.	Light switch	
11.	Dip relay for main and dipped beams	
12.	Headlights	45 W
13.	Dipped beams	40 W
14.	Position light	5 W
15.	Rear light	5 W
16.	Side marking lights	5 W
17.	Plate light	2×5 W
18.	Brake stop light contact	
19.	Brake stop lights	32 cp
20.	Connection at instrument	
21.	Contact on gearbox M 40, M 41	
22.	Reverse lights	32 cp
23.	Flasher unit	
24.	Dir. ind. switch	
25.	Switch, emergency warning flashers	
26.	Flasher lights	32 cp
27.	Part of 6-pole connection block	
28.	Rev counter	
29.	Thermometer	
30.	Fuel gauge	
31.	Voltage stabilizer	
32.	Flasher light warning lamp	1.2 W
33.	Diode	
34.	Warning lamp for main beams	1.2 W
35.	Warning lamp for battery charging	1.2 W
36.	Parking brake warning lamp	1.2 W
37.	Choke warning lamp	1.2 W
38.	Oil pressure warning lamp	1.2 W
39.	Brake warning lamp	1.2 W
40.	Vacant warning lamp	
41.	Parking brake contact	
42.	Choke control contact	
43.	Temperature sensor	
44.	Oil pressure sensor	
45.	Brake warning contact	
46.	Brake level sender	
47.	Horn	
48.	Horn ring	
49.	Switch, windshield wipers/washer	
50.	Windshield wipers	
51.	Windshield washer	
52.	Switch, fan	
53.	Fan	
54.	Switch, elec. heated rear window	
55.	Elec. heated rear window	
56.	Clock	
57.	Cigarette lighter	
58.	Rheostat for instrument panel lighting	
59.	Instrument panel lighting	3×2 W
60.	Lighting for controls	3×1.2 W
61.	Shift positions light, aut. trans.	1.2 W
62.	Glove locker contact	
63.	Glove locker lamp	
64.	Interior lamp	
65.	Door switch on left side	
66.	Door switch on right side	
67.	Reminder buzzer for ignition key	
68.	Joint	
69.	Connection at instrument	
70.	Passenger seat contact	
71.	Reminder buzzer for seat belt	
72.	Seat belt warning lamp	1.2 W
73.	Contact for seat belt	
74.	Switch for overdrive M 41	
75.	Contact for overdrive on gearbox M 41	
76.	Solenoid for overdrive on gearbox M 41	
77.	Overdrive warning lamp	1.2 W
78.	Contact on automatic transmission BW 35	
79.	Reminder buzzer for lights	
80.	Control unit	
81.	Throttle valve switch	
82.	Pressure sensor	
83.	Relay for fuel pump	





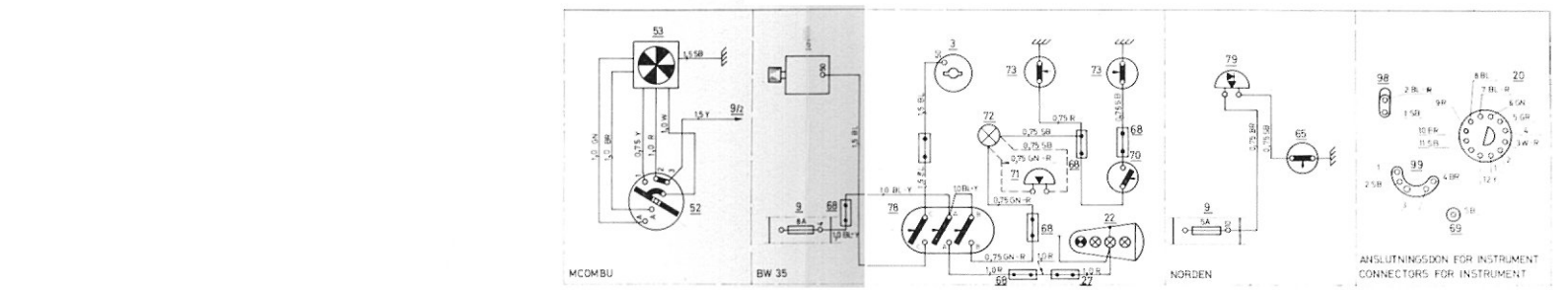
Pos.	Title	Data
84.	Main relay for fuel injection	
85.	Thermal timer contact	
86.	Start valve	
87.	Temperature sensor I	
88.	Temperature sensor II	
89.	Injection valves	
90.	Cut-in contact	
91.	Spark plug	
92.	Fusebox	
93.	Fuel pump	
94.	Connection at instrument	
95.	Connection at instrument	

Colour code

SB	Black
Y	Yellow
Bl	Blue
Bl-Y	Blue-Yellow
Bl-R	Blue-Red
Gn-R	Green-Red
R	Red
Gn	Green
W-R	White-Red
W	White
Br	Brown
Gr	Grey

ILLUSTRATION 3-A.
WIRING DIAGRAM 142/144

Pos.	Title	Data
1.	Battery	12 V 60 Ah
2.	Connection box	
3.	Ignition switch	
4.	Ignition coil	
5.	Distributor, firing sequence	1-3-4-2
6.	Starter motor	
7.	Alternator	
8.	Charging regulator	
9.	Fusebox	
10.	Light switch	
11.	Dip relay for main and dipped beams	
12.	Headlights	45 W
13.	Dipped beams	40 W
14.	Position light	5 W
15.	Rear lights	5 W
16.	Side marking lights	5 W
17.	Plate light	2×5 W
18.	Brake stop light contact	
19.	Brake stop lights	32 cp
20.	Connection at instrument	
21.	Contact on gearbox M 40, M 41	
22.	Reverse lights	32 cp
23.	Flasher unit	
24.	Dir. ind. switch	
25.	Switch, emergency warning flashers	
26.	Flasher lights	32 cp
27.	Part of 6-pole connection block	
28.	Rev counter	
29.	Thermometer	
30.	Fuel gauge	
31.	Voltage stabilizer	
32.	Flasher light warning lamp	1.2 W
33.	Diode	
34.	Warning lamp for main beams	1.2 W
35.	Warning lamp for battery charging	1.2 W
36.	Parking brake warning lamp	1.2 W
37.	Choke warning lamp	1.2 W
38.	Oil pressure warning lamp	1.2 W
39.	Brake warning lamp	1.2 W
40.	Vacant warning lamp	
41.	Parking brake contact	
42.	Choke control contact	
43.	Temperature sensor	
44.	Oil pressure sensor	
45.	Brake warning contact	
46.	Brake level sender	
47.	Horn	
48.	Horn ring	
49.	Switch, windshield wipers/washer	
50.	Windshield wipers	
51.	Windshield washer	
52.	Switch, fan	
53.	Fan	
54.	Switch, elec. heated rear window	
55.	Elec. heated rear window	
56.	Clock	
57.	Cigarette lighter	
58.	Rheostat for instrument panel lighting	
59.	Instrument panel lighting	3×2 W
60.	Lighting for control panel	3×1.2 W
61.	Shift positions light, aut. trans.	1.2 W
62.	Glove locker contact	
63.	Glove locker lamp	
64.	Interior lamp	
65.	Door switch on left side	
66.	Door switch on right side	
67.	Reminder buzzer for ignition key	
68.	Joint	
69.	Connection at instrument	
70.	Passenger seat contact	
71.	Reminder buzzer for seat belt	
72.	Seat belt warning lamp	1.2 W
73.	Contact for seat belt	
74.	Switch for overdrive M 41	
75.	Contact for overdrive on gearbox M 41	
76.	Solenoid for overdrive on gearbox M 41	
77.	Overdrive warning lamp	1.2 W
78.	Contact on automatic transmission BW 35	
79.	Reminder buzzer for lights	
80.	Switch for elec. heated tailgate window	
81.	Tailgate window wiper	
82.	Tailgate window washer	
83.	Rear roof light	10 W
84.	Control unit	
85.	Throttle valve switch	



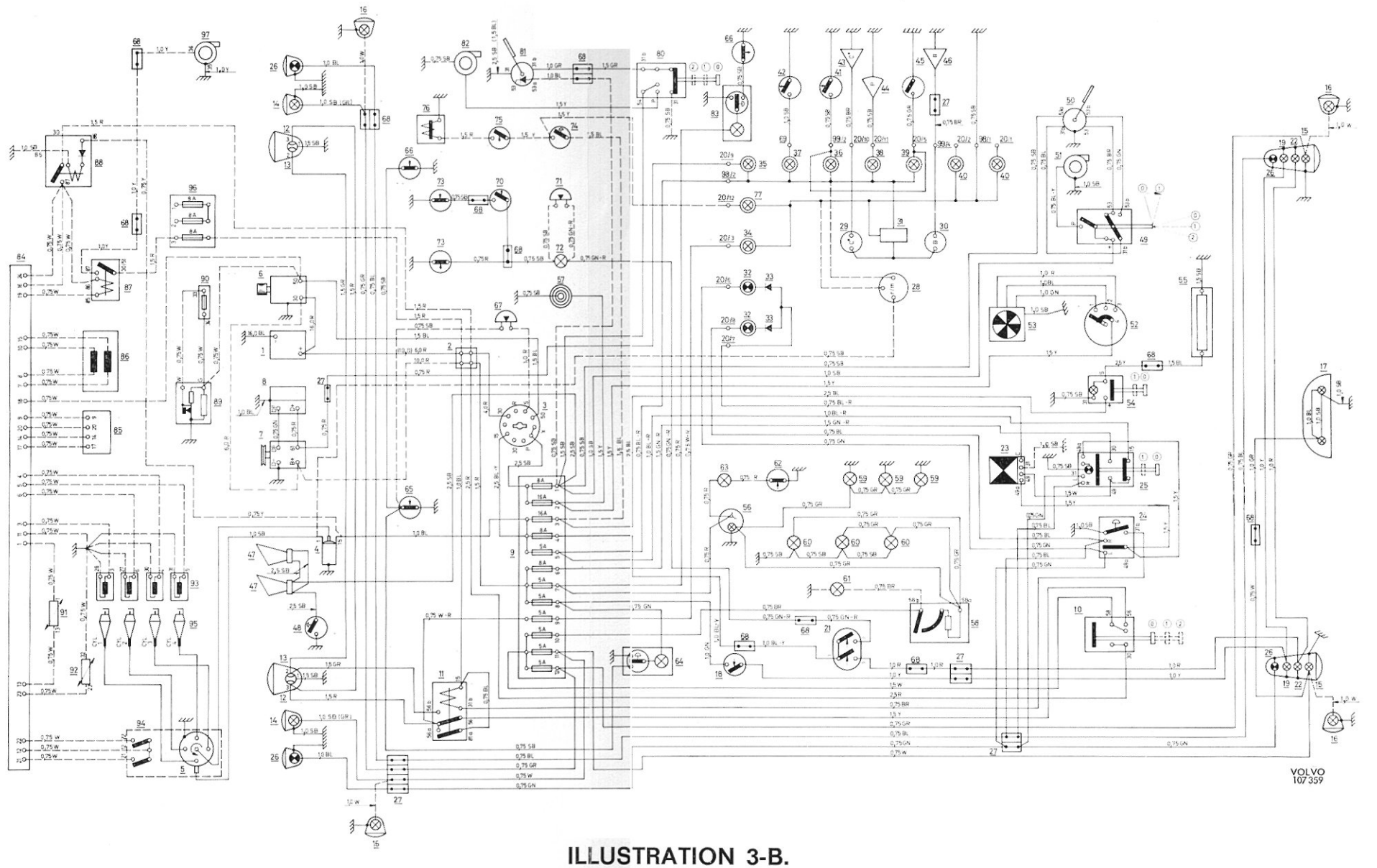


ILLUSTRATION 3-B.
WIRING DIAGRAM 145

Pos.	Title
86.	Pressure sensor
87.	Relay for fuel pump
88.	Main relay for fuel injection
89.	Thermal timer contact
90.	Start valve
91.	Temperature sensor I
92.	Temperature sensor II
93.	Injection valves
94.	Trip contact
95.	Spark plug
96.	Fusebox
97.	Fuel pump
98.	Connection at instrument
99.	Connection at instrument

Colour code	
SB	Black
Y	Yellow
Bl	Blue
Bl-Y	Blue-Yellow
Bl-R	Blue-Red
Gn-R	Green-Red
R	Red
Gn	Green
W-R	White-Red
W	White
Br	Brown
Gr	Grey