

# SERVICE MANUAL

**VOLVO**  
**P 1800**

*Export Service Department*

AKTIEBOLAGET

**VOLVO**

GÖTEBORG · SWEDEN

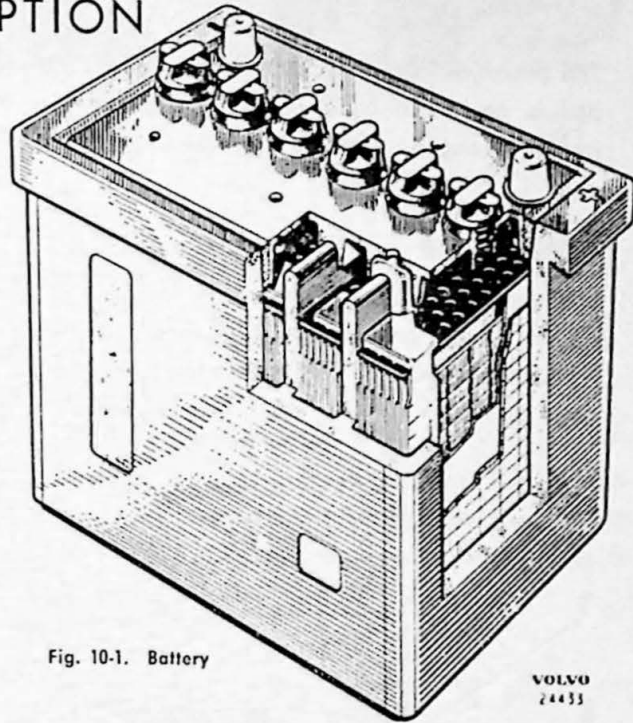
# ELECTRICAL SYSTEM

## DESCRIPTION

The electrical system of the Volvo P 1800 is a 12-volt system. The equipment can be grouped into the following main parts: battery, generator, charging control, starter motor, ignition system, lighting and signals devices and instruments.

### BATTERY

The battery is located on a shelf to the right on the front side of the bulkhead. It is a 12-volt lead battery consisting of 6 cells. The battery has a capacity of 57 ampere hours.



### STARTER MOTOR

The starter motor, Fig. 10-2, is fitted on the flywheel housing on the left side of the engine. It consists of a 4-pole series motor.

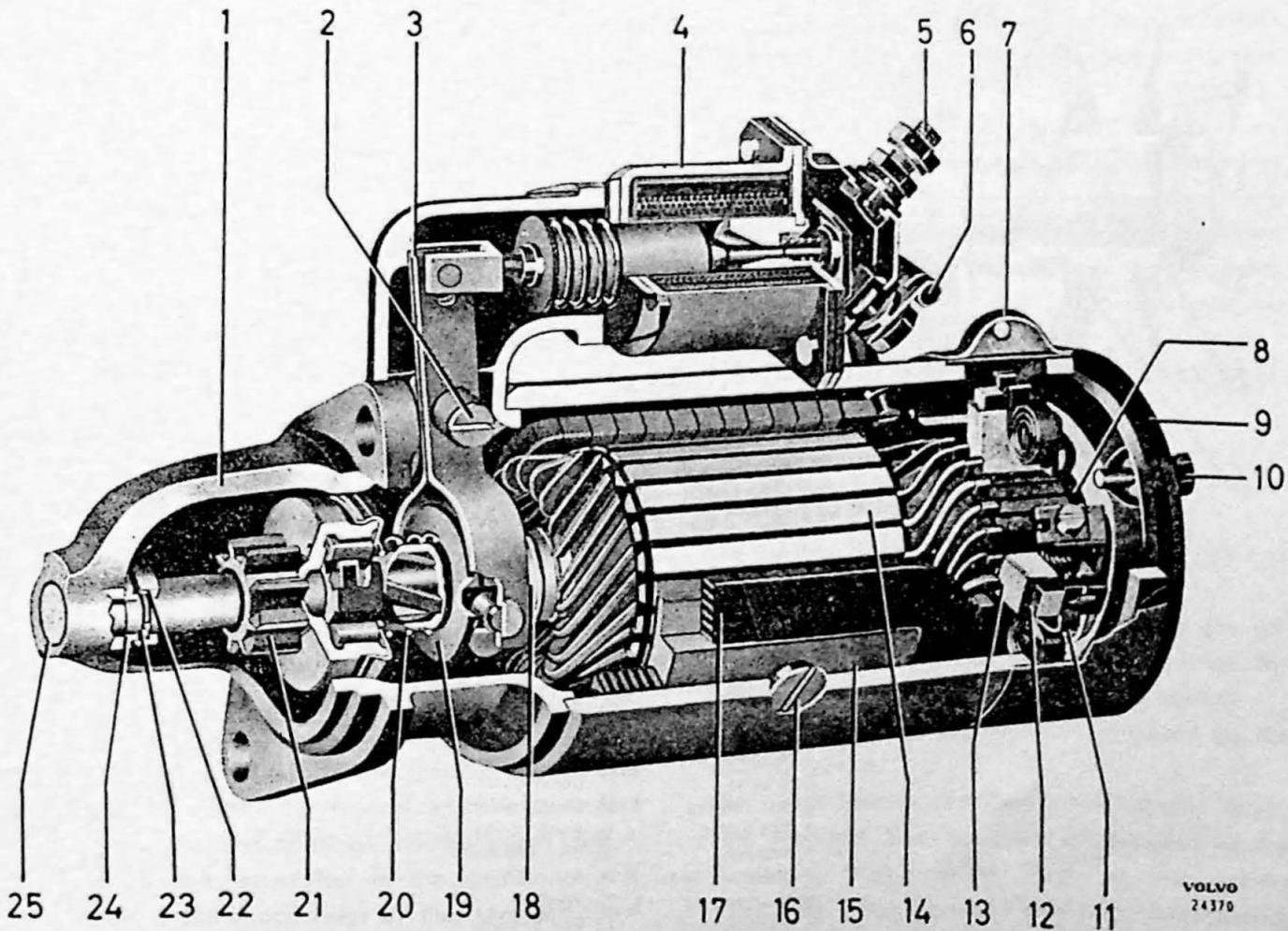


Fig. 10-2. Starter motor



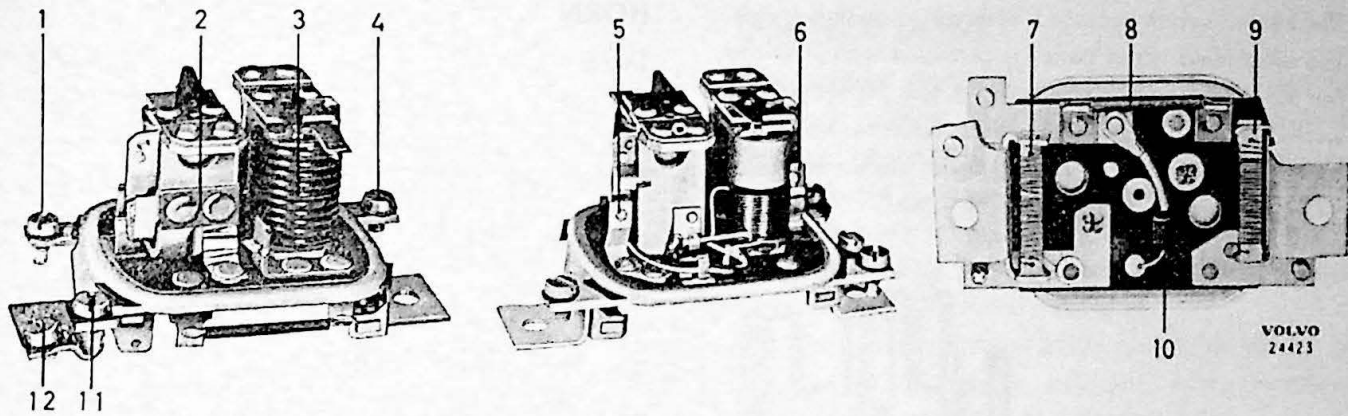


Fig. 10-4. Charging control

- |                    |                          |
|--------------------|--------------------------|
| 1. Terminal, DF    | 7. Resistance w R        |
| 2. Voltage control | 8. Variometer resistance |
| 3. Cut-in relay    | 9. Resistance a R        |
| 4. Terminal, B+    | 10. Variometer           |
| 5. Cut-in contact  | 11. Terminal D+, 61      |
| 6. Control contact | 12. Ground connection    |

## IGNITION SYSTEM

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

### Ignition coil

The ignition coil is fitted on the left side of the bulk-head.

The purpose of the ignition coil is to transform battery voltage to high-tension voltage for the spark plugs. It consists of a core of laminated plate around which is coiled a winding of heavy copper wire, the primary winding, and a winding of fine copper wire, the secondary winding. The first-mentioned winding, the primary winding, operates at battery voltage from the contact breakers in the distributor. The secondary winding, the high-tension winding, is connected to the center terminal on the distributor cover. From here the high-tension is distributed to the engine spark plugs.

### The distributor

The distributor, Fig. 10-5, is placed on the left side of the engine and driven from the camshaft.

The distributor has two separate electrical circuits, low-tension and high-tension. Low-tension (battery voltage) is distributed to the ignition coil by the contact breakers, the function of which is controlled by a distributor cam fitted on the distributor shaft.

The high-tension generated in the ignition coils is distributed to the spark plugs by the rotor arm fitted on the distributor camshaft. The adjustment of the

distributor in relation to the engine speed is controlled by a centrifugal governor located under the contact breaker plate. Adjustment in relation to loading is controlled by the vacuum governor.

## LIGHTING

Lighting consists of headlights giving full and dimmed beams, directional flashers and parking lights, rear lights and number plate lighting.

The headlights are fitted in the front fenders. They are operated by a light switch fitted on the instrument panel. Full and dimmed headlight beams are controlled by a foot dimmer switch fitted in the floor. The parking lights are placed under the headlights and contain bulbs for parking and directional indicators.

The rear lights have two bulbs for rear light, directional indicators and stop light.

## SWITCHES AND CONTROLS

The lighting control consists of a combined pull and turn switch.

The pulling function is used for switching the car lighting on and off and the turning function for controlling the strength of the instrument lighting.

The directional indicator switch is placed on the steering column.

The switch lever is provided with automatic return. The headlight flashing signal is controlled by the directional flasher switch lever on the steering column. By lifting the switch lever towards the steering wheel, full headlight beams are engaged.

The heater switch is placed beside the ignition switch. The windshield wiper switch is provided with positions for full speed and half speed and also for windshield washing. The windshield wipers operate when the button is pulled out. The windshield washer functions when the button is turned to the right.

## HORN

There are three horns fitted in two groups. One of the groups is provided with two horns, one with a low note and one with a high note. This group is operated by a horn button in the center of the steering wheel. The other group consisting of a loud-tone horn is operated by a spring-loaded switch lever on the steering column. When the horn button is pressed in, the winding in a horn relay (fitted on the left wheel housing) is grounded so that the windings in both the loud-tone horn and the two other horns are grounded. Current is fed to the horns over a fuse.

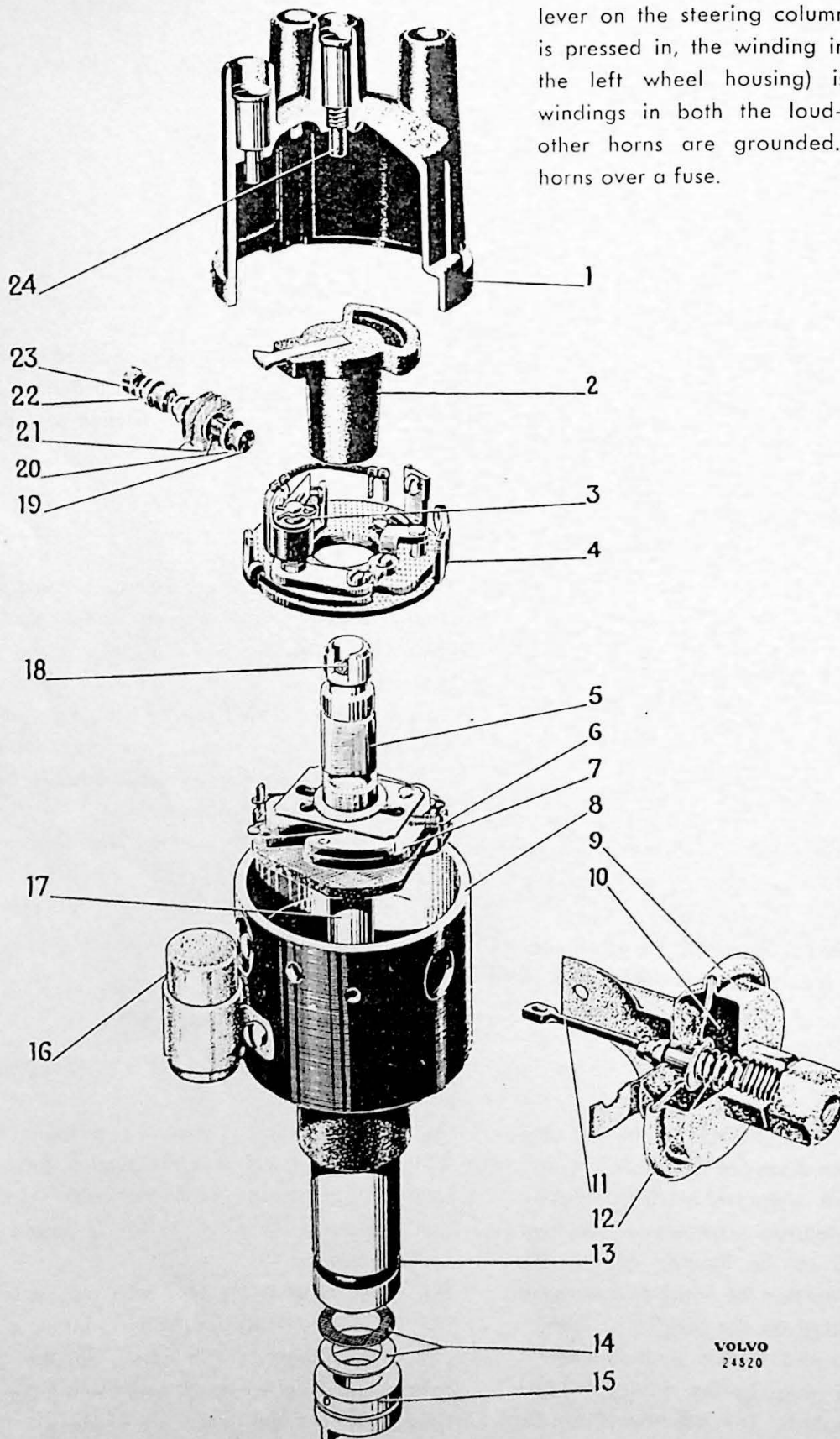


Fig. 10-5. Distributor

1. Cover
2. Rotor arm
3. Contact breaker points
4. Contact breaker plate
5. Contact breaker cam
6. Spring
7. Governor weight
8. Distributor housing
9. Vacuum regulator
10. Diaphragm
11. Link rod
12. Spring
13. Rubber seal
14. Washers
15. Collar
16. Condenser
17. Distributor shaft
18. Felt packing
19. Screw
20. Flat washer
21. Insulating washers
22. Spring washer
23. Nut
24. Brush

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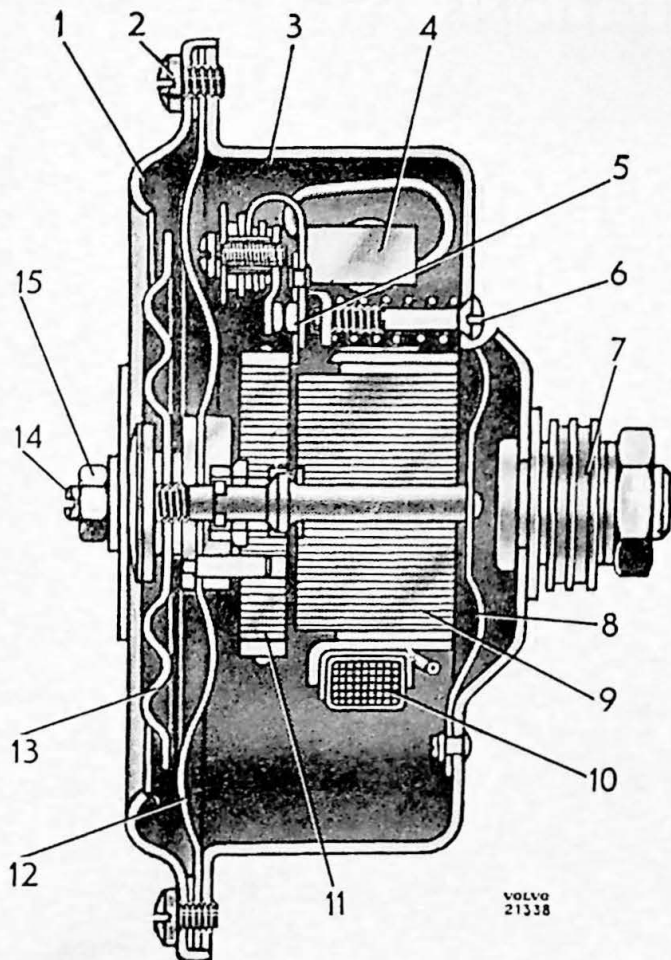


Fig. 10-6. Horn

1. Cover
2. Screw
3. Housing
4. Condenser
5. Cut-out
6. Adjusting screw for cut-out
7. Attachment
8. Leaf spring
9. Iron core
10. Magnetic winding
11. Armature plate
12. Diaphragm
13. Vibrating plate
14. Adjusting screw
15. Lock nut

## CONTROL LAMPS

The charging control lamp should be out when the engine is running. This shows that the generator is charging the battery. If the lamp lights, this indicates a fault in the generator. At low engine speed (idling speed) it is normal for the lamp to light.

The control lamp for the directional flashers blinks when one of the flashers is engaged.

The control lamp for full-beam headlights comes on when full headlights are engaged. When switching to dimmed headlights, the lamp goes out.

## WINDSHIELD WIPER

The windshield wipers are driven by an electric motor. The motor operates the wiper blades through a gear housing and linkage system. The motor has two speeds.

## FUSES

The fuses are placed beside the charging control on the left wheel housing.

The fuses consist of melt-wires fitted in glass tubes. The wiring diagram shows how the fuses are connected and what leads and components they protect.

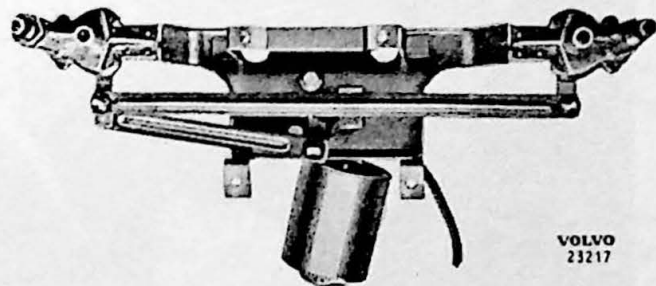


Fig. 10-7. Windshield wiper

# REPAIR INSTRUCTIONS

## BATTERY

### Removing

1. Remove the cable terminals from the battery terminal studs.  
Use a puller if the terminals are stuck on the studs.
2. Slacken the nuts on the attaching bar and lift out the battery.
3. Brush off the battery with a brush and wash it with clean lukewarm water.
4. Clean the battery shelf and cable terminals. Use a special steel brush for the cable terminals.

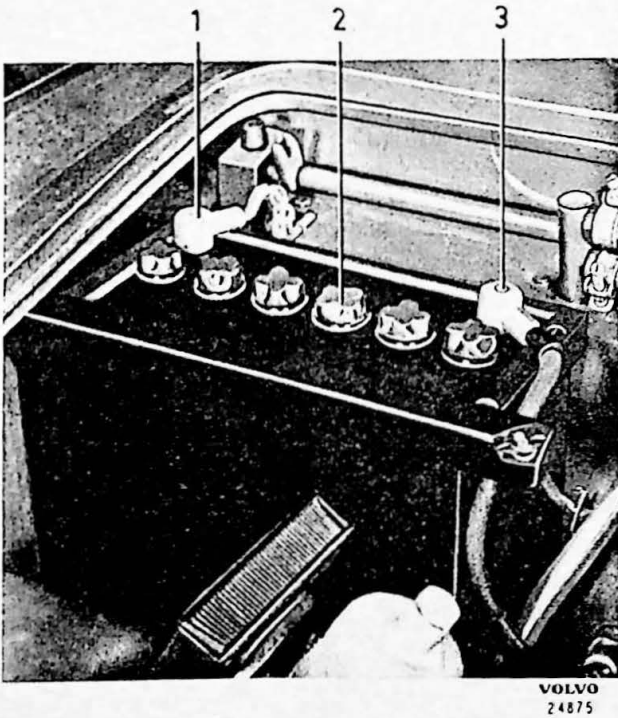


Fig. 10-8. Battery

1. Ground lead    2. Filling plug    3. Lead to starter motor

### Fitting

1. Place the battery in position. See that it is fitted the right way. Fix the battery with the attaching bar and nuts.
2. Tighten the cable terminals onto the terminal studs. The battery negative terminal stud should be grounded.
3. Coat the cable terminals and terminal studs with vaseline.

### Maintenance and charging instructions

In order for the battery to function properly it must be in good condition. The first condition for this is that the fluid level is maintained at the correct height above the plates. If the fluid level is allowed to fall below the upper edge of the plates, the full capacity of the battery cannot be obtained since only that part of the plates surrounded by fluid can be used for charging and discharging. Therefore ensure that the level comes up to the plate A shown in Fig. 10-9. If the level is too low, top up with **distilled water** as necessary.

Use a filling flask as shown in Fig. 10-9.

NOTE. On no account must battery acid be used for this topping up.

If the battery is in a discharged condition or if the specific gravity of the fluid has fallen to 1.23, the battery must be taken out and charged at a charging station.

If the battery has to be charged for the reasons given above, it should be lifted out of the car and washed externally with clean water.

Only direct-current must be used for charging. Alternating-current will destroy the battery.

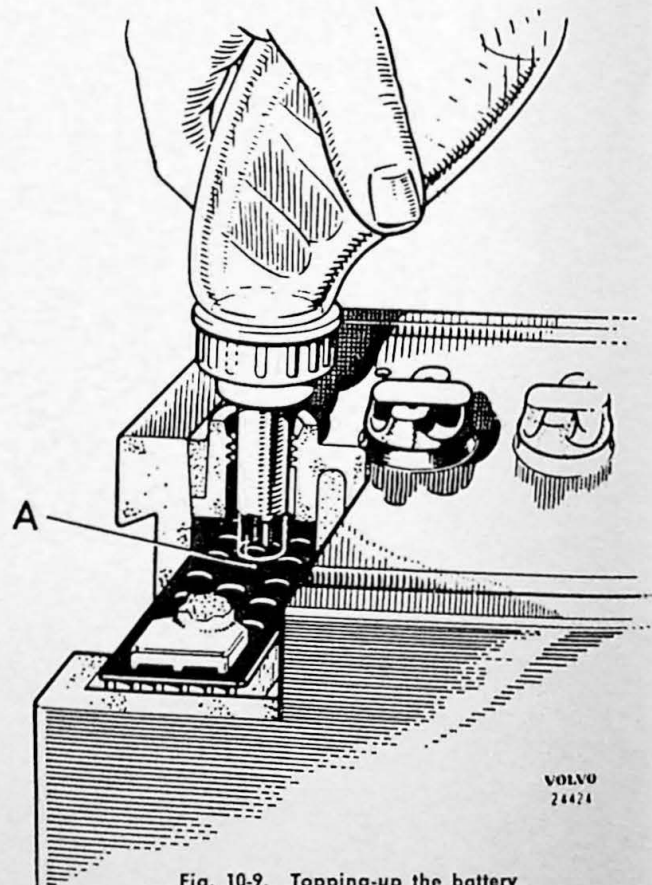


Fig. 10-9. Topping-up the battery

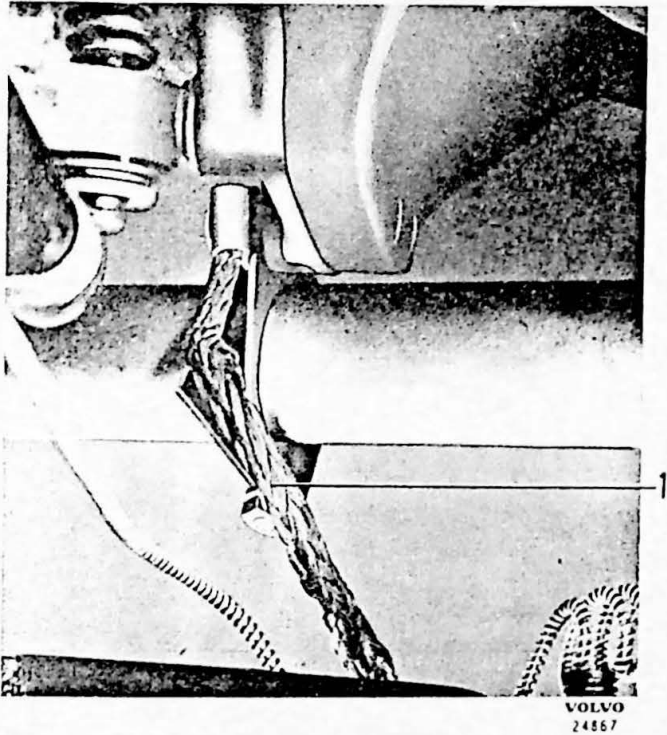


Fig. 10-10. Placing ground lead between engine and body  
1. Ground lead

## STARTER MOTOR

### Removing

1. Remove the cable terminal from the negative terminal stud of the battery.
2. Remove the leads from the starter motor solenoid.
3. Remove the bolts that hold the starter motor to the flywheel housing and remove same.
4. Wipe off the starter motor externally with a piece of cloth moistened in gasoline.

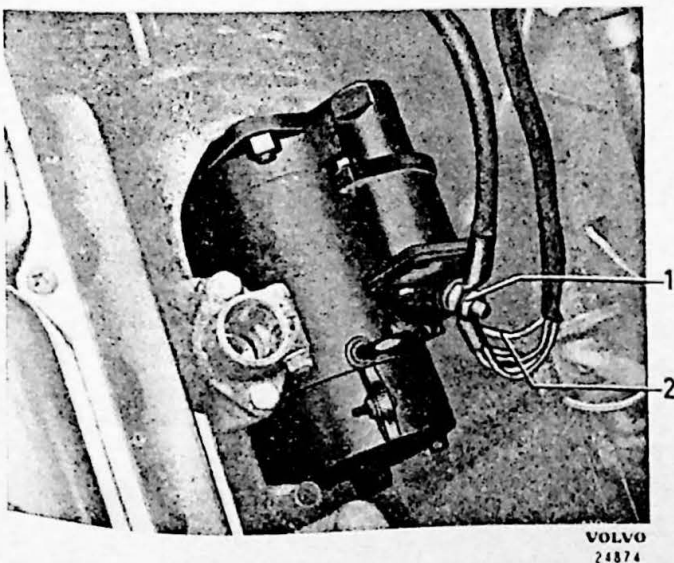


Fig. 10-11. Starter motor fitted  
1. Battery lead 2. Control lead

### Fitting

Fitting is carried out in the reverse order to removing. Tighten the bolts evenly but not too tightly. Connect the leads carefully.

### Measures before disassembling

If the starter motor shows signs of not functioning satisfactorily or perhaps not working at all, make sure first that it is not the battery, lead, starter contact or solenoid causing the trouble. If the fault is localised to the starter motor, remove same.

Before disassembling begins, we would point out the importance of carrying out tests correctly. In addition, reliable instruments must be available if the test results are to be of any value.

Testing is carried out as follows:

Place the starter motor on the test bench and remove the protecting band.

Connect the starter motor to the correct voltage. The starter motor housing is connected with the negative terminal. If the starter motor functions without any sign of short-circuiting or stiffness when current is connected, continue testing. Connect in a voltmeter and ammeter to a shunt of 500 amps. Hold a revolution counter against the shaft end of the rotor. Connect current and read off voltage, current value and speed. In addition, watch the brushes and commutator. Note the values and observations. Compare the values with those given in the specifications for an unloaded starter motor. The following reasons can now be established:

- |   |  |
|---|--|
| 1. Low speed and low current strength.  | Excessive resistance caused by dirty commutator, worn brushes or insufficient spring pressure.   |
| 2. Low speed and high current strength. | Short-circuiting in the field windings. The rotor drags against the pole shoes because of worn bearings or bent rotor shaft.           |
| 3. Excessive sparking, low rotation.    | Insufficient spring pressure because of worn brushes or fatigued brush springs. Short-circuiting or partial breakage in rotor winding. |
| 4. Excessive movement of brushes        | Insufficient spring pressure or out-of-round commutator.   |

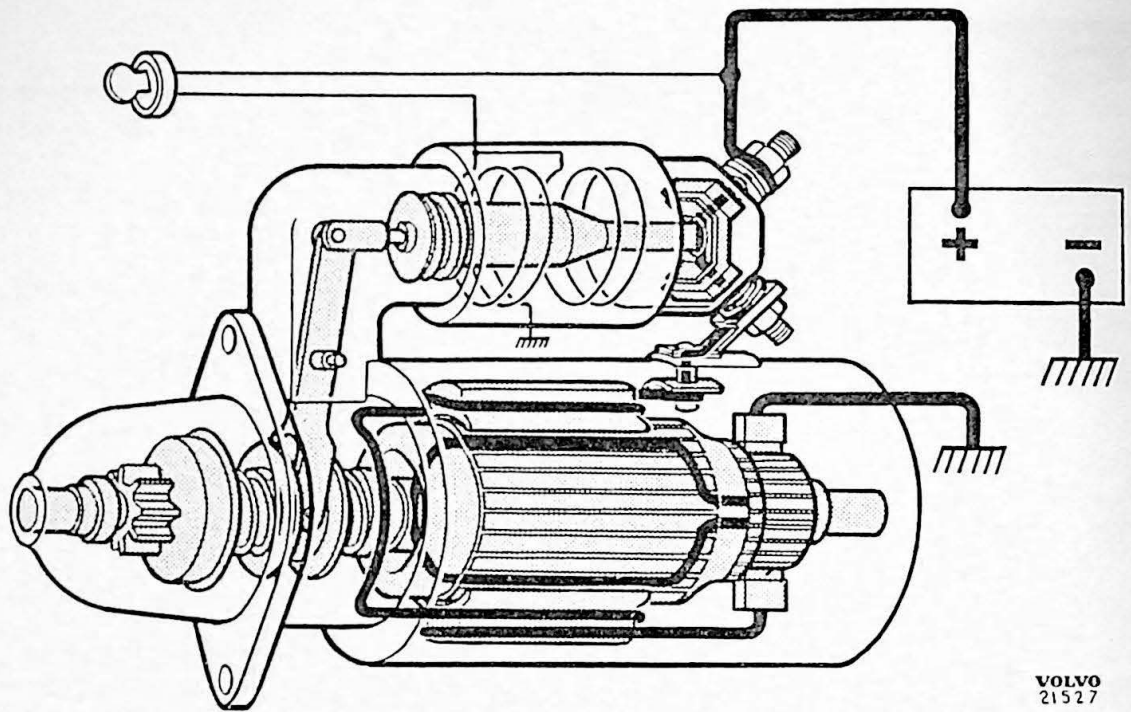


Fig. 10-12. Starter motor. Arrangement diagram

### Disassembling the starter motor

Disassembling the starter motor for overhaul (cleaning and lubricating) or repair is done as follows:

1. Remove the protecting band.
2. Lift the brush springs and pull up the brushes, Fig. 10-13.
3. Mark the position of the front and rear end heads in relation to the housing.
4. Remove the bolts which hold the 3 above-mentioned main parts of the starter together. Lift off the rear end head with rotor brake together with housing after the lead between the solenoid and housing has been disconnected.
5. Lift out the rotor with pinion housing, Fig. 10-14. This can be done after the pivot bolt for the solenoid engaging fork has been unscrewed.
6. Remove the stop washers on the rotor shaft. The thin washers (axial adjusting washers) and washer (3, Fig. 10-15) are removed by being pulled straight off the shaft. The thick washer (1, Fig. 10-15) should first be knocked in  $3/16$ — $5/16$ " (5—8 mm) on the shaft so that the lock ring (2, Fig. 10-15) can be removed, after which the washer is pulled off the shaft.
7. Remove the rotor brake from the rear end head.
8. Blow all dust and dirt from the starter motor housing with field winding and rotor. Clean off with a piece of cloth moistened with gasoline. Note. Blended gasoline, such as, for example, bentyl, must not be used since this can dissolve the insulation.

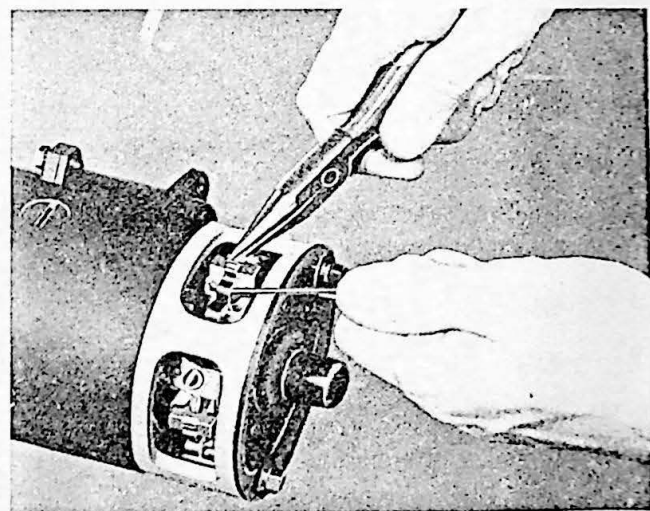


Fig. 10-13. Removing the brushes

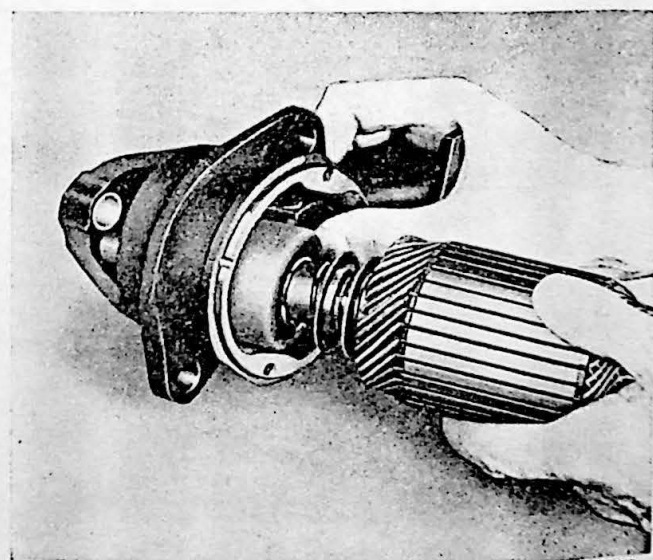


Fig. 10-14. Removing the pinion and rotor

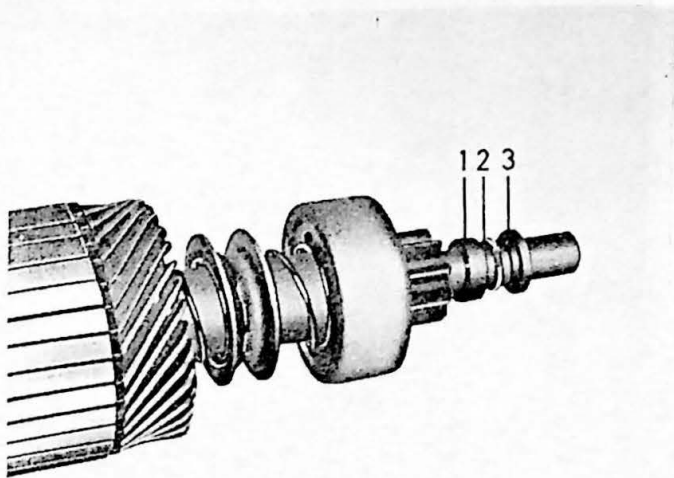


Fig. 10-15. Pinion, locking ring and nut

1. Stop ring, inner 2. Locking ring 3. Stop ring, outer

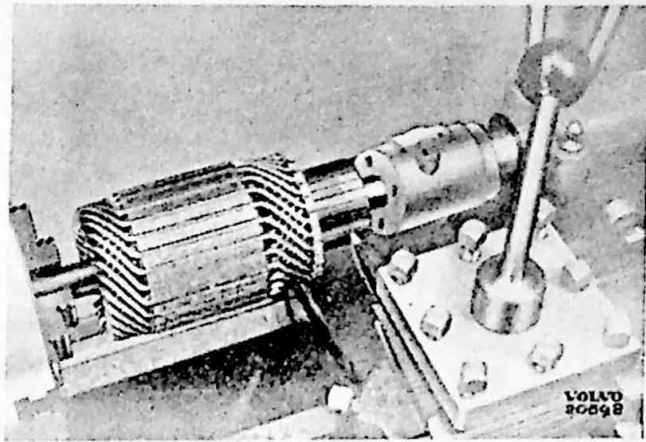


Fig. 10-17. Lathe-turning the commutator

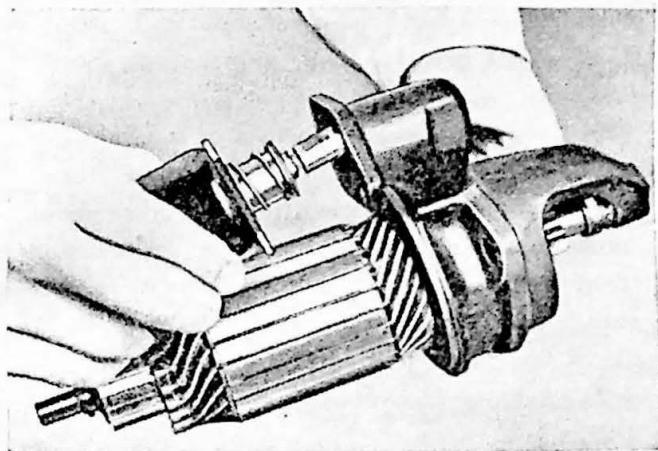


Fig. 10-16. Removing the solenoid

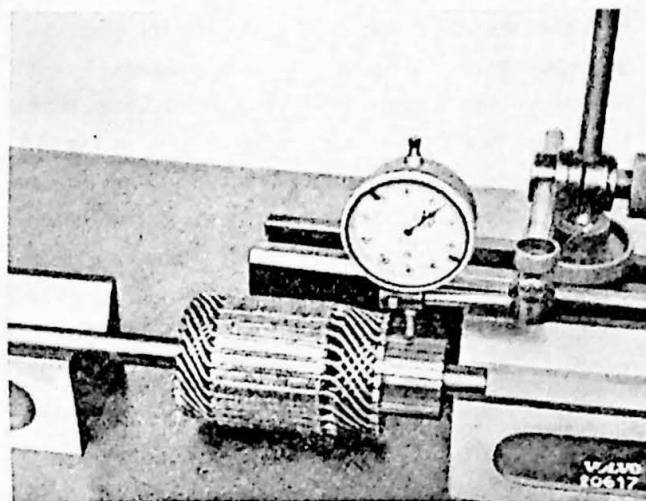


Fig. 10-18. Dial-indicating the rotor

## Inspection

Examine the rotor for mechanical damage. This can consist of a bent or worn shaft, scratched commutator and damaged winding.

If the rotor shaft is bent or worn, the rotor should be replaced. The shaft should only be straightened in exceptional circumstances. This should be done in a press.

If the commutator is scratched or unevenly worn, it should be turned, see Fig. 10-17. When doing this a special chuck should be used, see Fig. Take small cuts each time so that no more material is removed than is absolutely necessary. Large cuts can cause damage to the insulation and disks.

The commutator should be checked with a dial indicator gauge after turning as shown in Fig. 10-18. Radial throw must not exceed 0.003" (0.08 mm). The

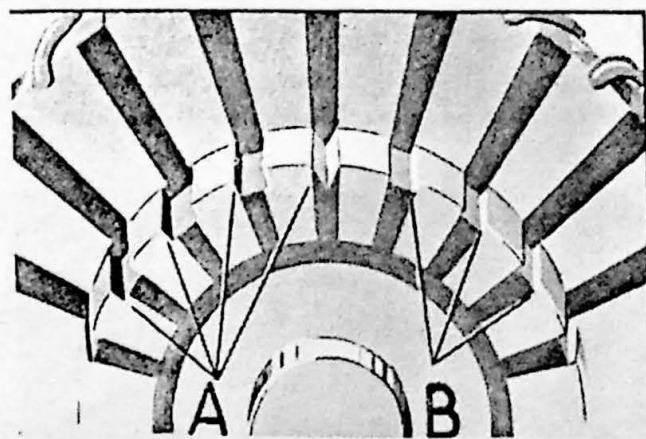


Fig. 10-19. A. Incorrect milling B. Correct milling

insulation between the disks should be milled down 1/64" (0.4 mm) under the disk surface. See Figs 10-19 and 10-20. This work should be carried out in a special apparatus or if one of these is not available, with a ground-off hacksaw blade.

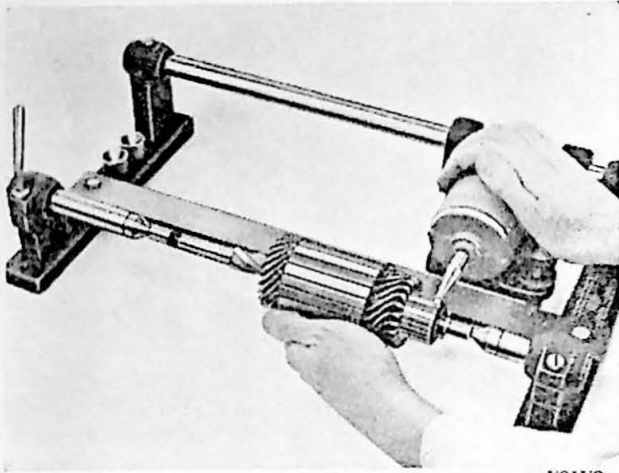


Fig. 10-20. Milling grooves

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Examine the rotor for short-circuiting by placing it in an apparatus intended for this purpose (growler). Switch on the current and hold a hacksaw blade a short distance from the rotor as shown in Fig. 10-21. If the blade vibrates in any position when the rotor is turned, this can depend on one of the following reasons: shorting to the rotor frame, shorting in the commutator or between the windings.

Shorting to the rotor frame is tested with the help of probes and test lamp.

Examine the housing and field winding for damage caused by the rotor. Check that the field winding is not shorted to ground by connecting the contact points to the housing and field winding as shown in Fig. 10-22. If the lamp lights, the winding or inlet in the housing is damaged. Ensure that the brushes do not lie against the housing. Remove the inlet in the housing and check again. If the lamp still lights this shows that the field is grounded. The winding must be removed. See under "Replacing the field winding".

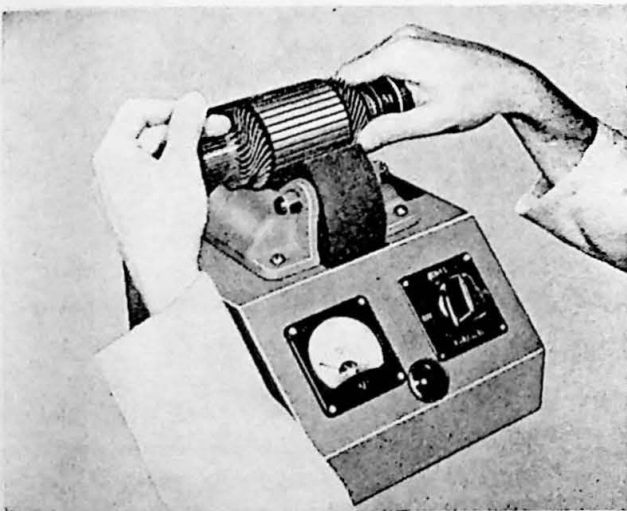


Fig. 10-21. Testing the rotor

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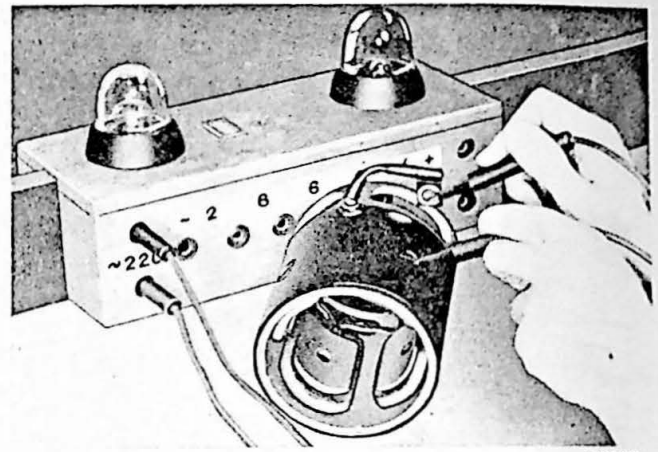


Fig. 10-22. Testing the field winding

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Check the bearing end head with brush retainer. If any parts are damaged or excessively worn, they must be replaced. Bearing clearance must not exceed 0.005" (0.12 mm). Check that both positive brush holders do not touch the end head, Fig. 10-23.

Brushes that are damaged, scratched or more than half-worn must be replaced.

Check spring pressure by means of a spring balance inserted in the spring, see Fig. 10-24. The force necessary to lift the spring from the brush should be between the values given in the specifications. If there is any deviation from the values, replace the springs concerned.

Check the pinion housing. Check the bearing on the shaft. Bearing clearance must not exceed 0.005" (0.12 mm).

Inspect the other parts and replace any which are damaged or worn. Locking rings should always be replaced with new ones since they may have been damaged or lost their tension when being removed.

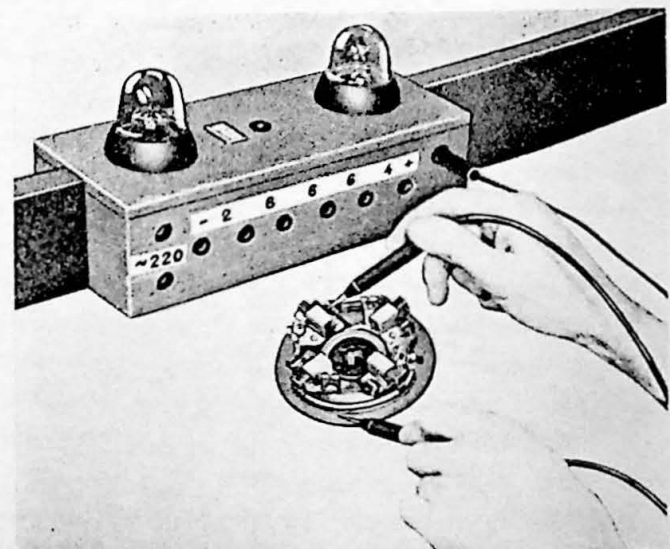


Fig. 10-23. Testing the brush retainer

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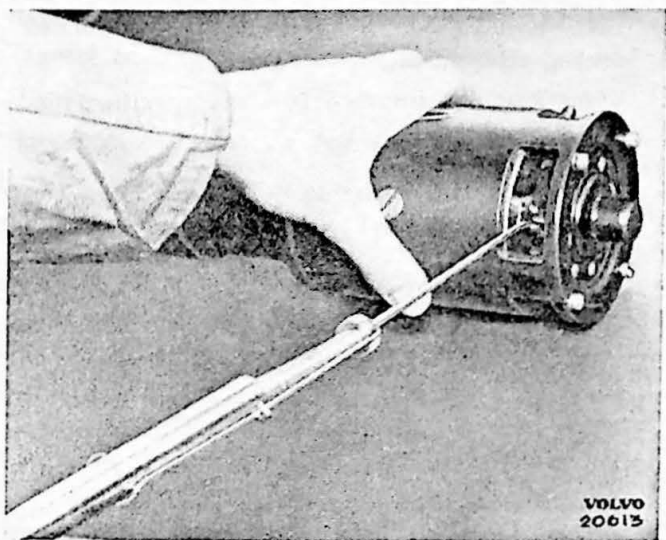


Fig. 10-24. Checking brush spring tension

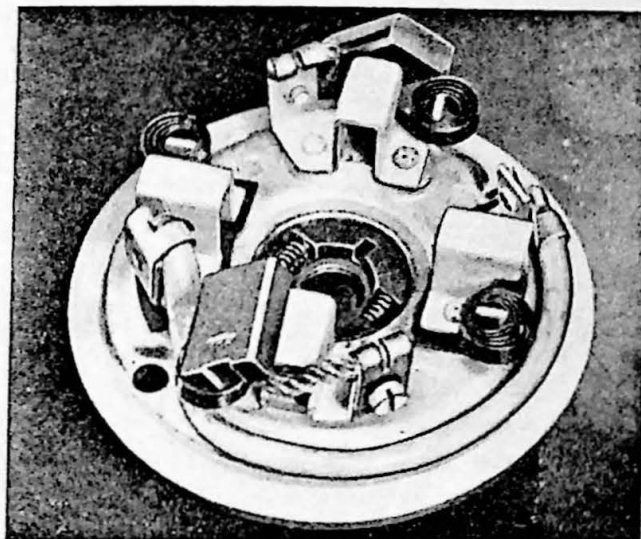


Fig. 10-26. End head

### Assembling the starter motor

1. Fit the rotor brake in the rear end head, see Fig. 10-25, and the lead between the positive brushes as shown in Fig. 10-26.
2. Fit the starter pinion on the rotor shaft, then put on washers and locking ring as shown in the Fig. Lubricate the rotor shaft as shown in the instructions in Fig. 10-31.
3. Assemble the rotor and pinion housing and place the engaging arm in position round the starter pinion. Then fit the solenoid lever on the pinion housing and place in the pivot bolt. Lubricate the starter pinion and engaging arm with heat-resisting ball bearing grease.
5. Place the housing on the rotor fit it into the end head following guide pins or marking. Place the rear end head on the rear shaft end of the rotor and bolt it in the correct position with the through-running bolts. Turn the rotor and check that it

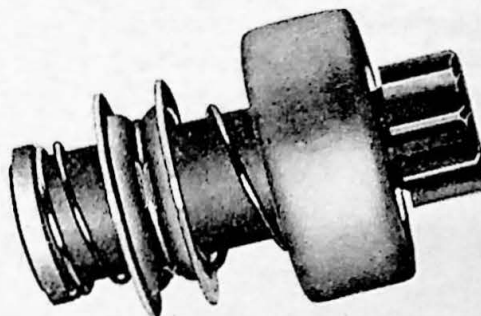


Fig. 10-27. Starter pinion

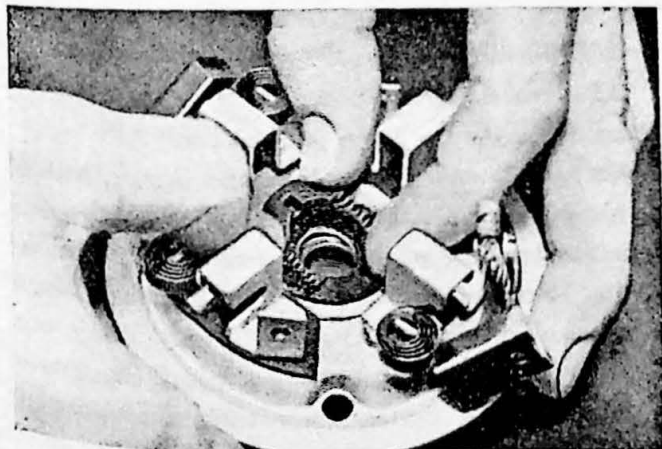


Fig. 10-25. Fitting the rotor brake

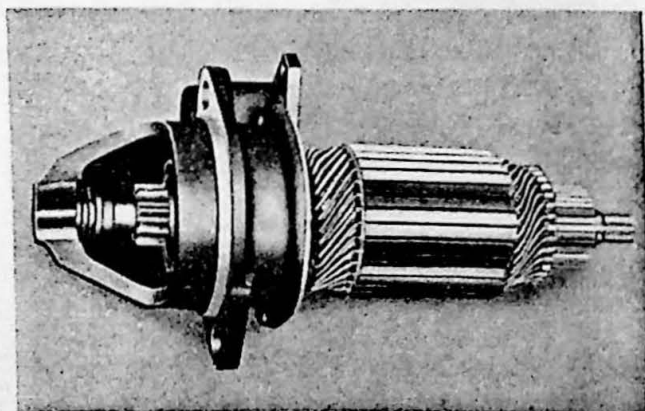


Fig. 10-28. Rotor and starter pinion fitted

runs easily. Measure the axial clearance and compare with the specifications. Lubricate the shaft end and bushing.

6. Fit the brushes.

## Solenoid

If the solenoid does not work, first check that the battery is in good condition. If there is no fault with the battery, connect a lead between the battery positive terminal and the contact screw of the solenoid control lead. If the solenoid still does not connect in the starter pinion and main current, remove it from the starter motor. If it engages, on the other hand, examine the ignition switch and leads.

When the solenoid has been removed it should be cleaned. Then press in its armature several times and test again by connecting it to a battery. If it still does not function, check the coil when the values in the specifications should apply. A faulty solenoid should be replaced with a new one.

Before refitting the solenoid, the distance "a" between the center line through the stud in the solenoid fork and solenoid lever attaching flange should be checked when the iron core is fully withdrawn, see Fig. 10-30. After adjusting this distance and tightening the lock nut, recheck the distance "a".

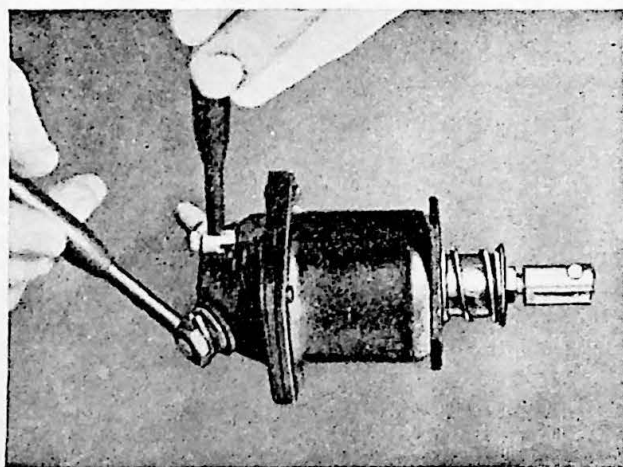


Fig. 10-29. Testing the solenoid

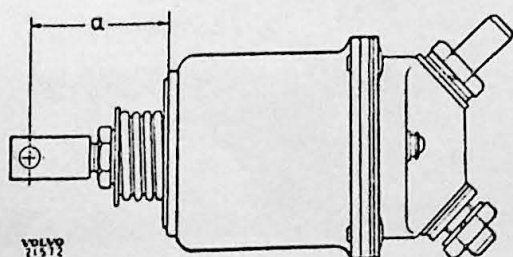


Fig. 10-30. Adjusting distance for the solenoid fork

The nut and fork stud should then be locked with sealing compound.

Concerning the distance "a", see specifications.

## Replacing the brushes

If the brushes are damaged or more than half-worn, they must be replaced.

When replacing the brushes the starter motor must be removed from the car and cleaned externally. Brushes should be changed with the starter motor assembled. The lead from the brush is unscrewed, the brush spring lifted with a hook and the brush then lifted up from its retainer. The new brush is slid into the retainer and screwed in.

## Replacing the field winding

1. If the starter motor is not disassembled, do so. Follow the instructions under the heading "Disassembling".
2. Lay the housing in a V-block as shown in Fig. 10-45. Place a screwdriver in the drill chuck. Press down with the handle at the same time as turning the screwdriver. The screws are usually very tight. Therefore make sure that the screwdriver fits well into the screw slot and is sufficiently wide.
3. When the screws have been removed, lift off the housing. Screw out the screws with an ordinary screwdriver. Remove the field coil inlet in the housing and then lift out the winding and pole shoes.
4. Place the pole shoes in the new field winding and screw them on to the housing. Use the same method as when removing them.
5. Solder the field coil at the inlet in the housing.
6. Fit together the other parts of the starter motor. See under "Assembling".

## Testing the starter motor

After the starter motor has been assembled it should be tested before fitting into the car.

Carry out the mechanical tests first. Measure the friction torque of the rotor brake, the free-wheel moment of the pinion, the brush spring tension and the rotor axial clearance if these have not been checked previously. After these tests, carry out the electrical tests.

First test the starter motor unloaded according to the values given in the specifications. After this test, lock the starter motor pinion by connecting it to a

lever which is locked. Read off the voltage and current according to the specifications.

### Lubricating scheme for starter motor

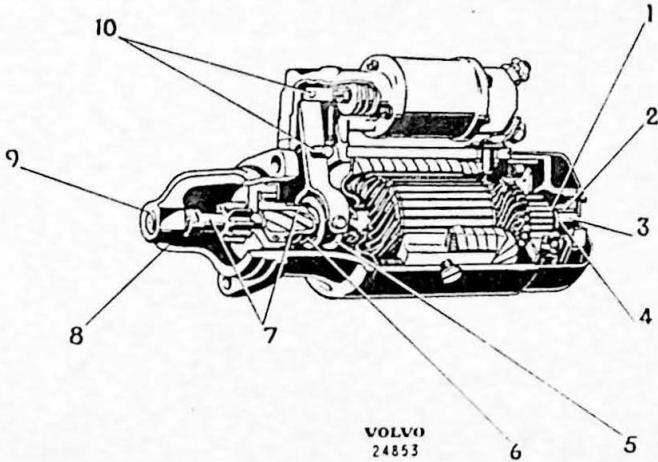


Fig. 10-31. Lubricating the starter motor

Use Bosch lubricant (or corresponding) as shown by the designations given below

1. Ft 1 v 8. Lubricate the rotor springs lightly
2. Ol 1 v 13. Lay the bushing in oil for 2 hours before fitting
3. Ft 1 v 8. Lubricate the adjusting washers and shaft ends lightly
4. Ft 1 v 8. Coat the rotor brake liberally with grease
5. Ft 1 v 8. Coat the groove liberally with grease
6. Ft 1 v 8. Lubricate the flange sleeve and coil spring lightly
7. Ft 1 v 8. Lubricate the shaft end guides lightly
8. Ft 1 v 8. Lubricate the adjusting washers lightly
9. Ol 1 v 13. Lay the bushing in oil 2 hours before fitting
10. Ft 1 v 8. Lubricate the studs and their positions lightly

## GENERATOR

### Removing

1. Remove the cable terminal from the battery negative terminal.
2. Remove the leads from the generator.
3. Disconnect the tensioning stay for the V-belt and lift off the V-belt.
4. Remove the two bolts holding the generator to the engine and remove it.
5. Clean off the generator externally with a piece of cloth moistened in gasoline.

### Fitting

Fitting is carried out in the reverse order to removing. The attaching bolts should be secured with tab washers or castle nuts and split pins.

### Measures before removing and disassembling

If the generator does not charge or if there is reason to believe that it does not generate a sufficient

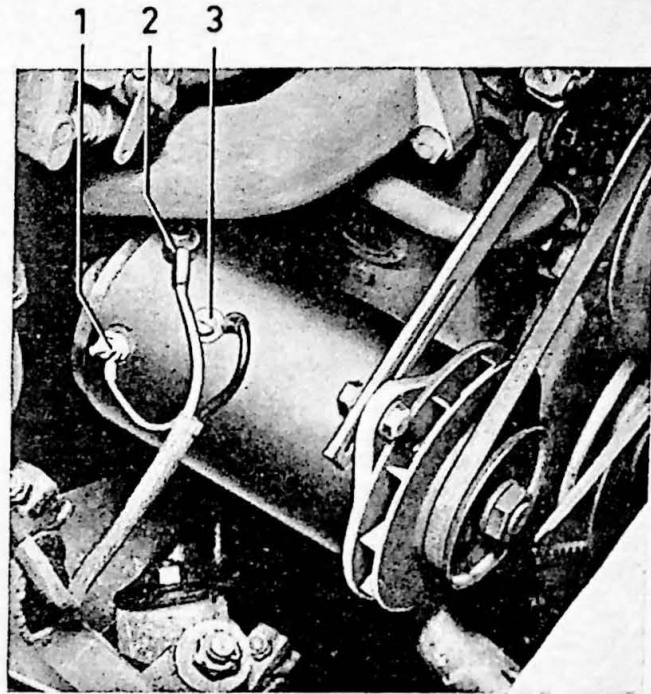


Fig. 10-32. Generator connections  
1. Generator, DF 2. Generator, D+ 3. Ground leads

quantity of current or gives too high an output or voltage, it must be ascertained whether the fault is in the generator itself or if the charging control and cables are faulty.

First check that the connection from the battery to the relay terminal marked 51 B+ is intact. This is done with a voltmeter. The voltmeter is connected between the relay terminal B (51 B+) and the chassis. The voltage must not be less than battery voltage. If the voltmeter gives a poor reading, leads and contact points must be examined. If the voltmeter gives no reading at all, this indicates a breakage in the system.

If there is no fault, the following test should be done on the generator. Disconnect the leads on the generator. The field terminal (small screw) is connected with a lead to the generator frame, voltmeter connected in between the generator current terminal (large screw) and generator frame. The engine is started and run from idling speed up to about 2000 r.p.m. while the voltmeter is being watched. The voltage should increase in step with the engine speed. Then return to idling speed and disconnect the ground connection of the field. The voltmeter should then return to zero. If it does not do so, the field is grounded inside the generator so that the control organ of the charging control will not function with the result that the generator will burn out.

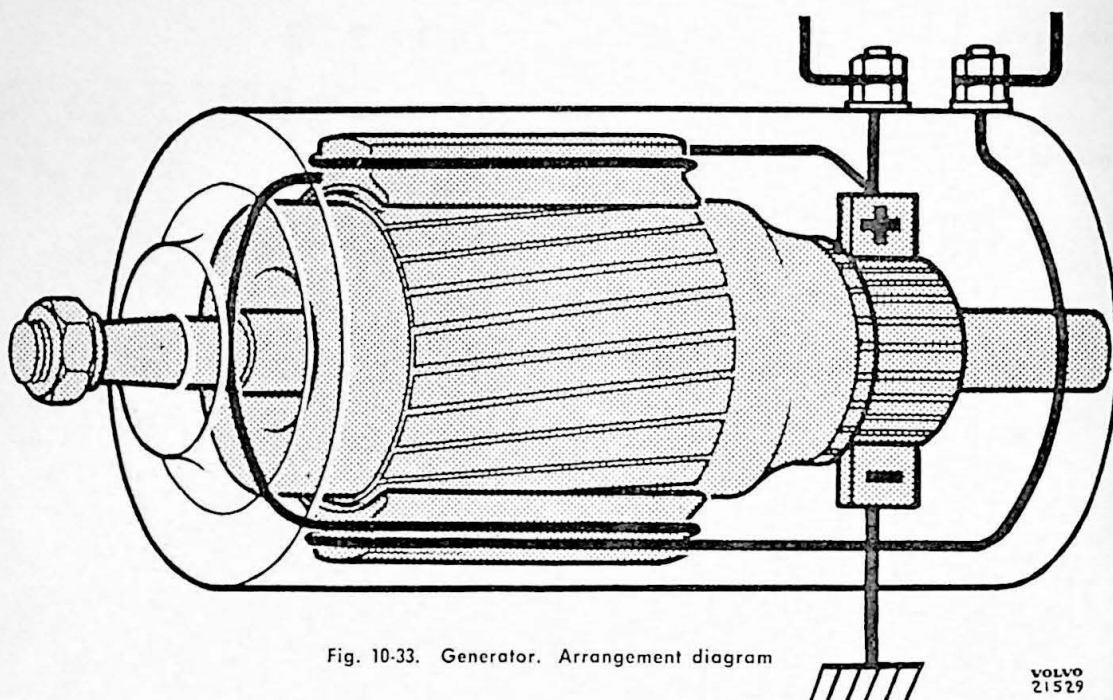


Fig. 10-33. Generator. Arrangement diagram

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The test can also be carried out as follows: Disconnect the generator leads at the charging control. Ground the field lead, increase engine speed gradually at the same time bringing the other lead from the generator in contact a few times with the charging control frame. Heavy sparking should occur when contact is made between the leads and charging control frame.

If no sparks are seen or if the voltmeter does not give a reading, the generator is faulty and must be removed.

Then break connection between the charging control frame and field lead, bring the main lead in contact again with the charging control frame and no sparks must now be seen. If sparking occurs, the field is grounded inside the generator.

### Inspecting the generator

After removing, the generator should be cleaned externally with gasoline or similar. The protecting band for the brushes should be removed and the generator placed on a test bench. The testing to be carried out is designed to establish the type of fault in the generator and it is very important that the testing should be done correctly and with reliable instruments.

The generator field terminal is connected to the generator frame and this is connected to the battery negative terminal. The battery positive terminal is connected in series with an ammeter to the generator output terminal.

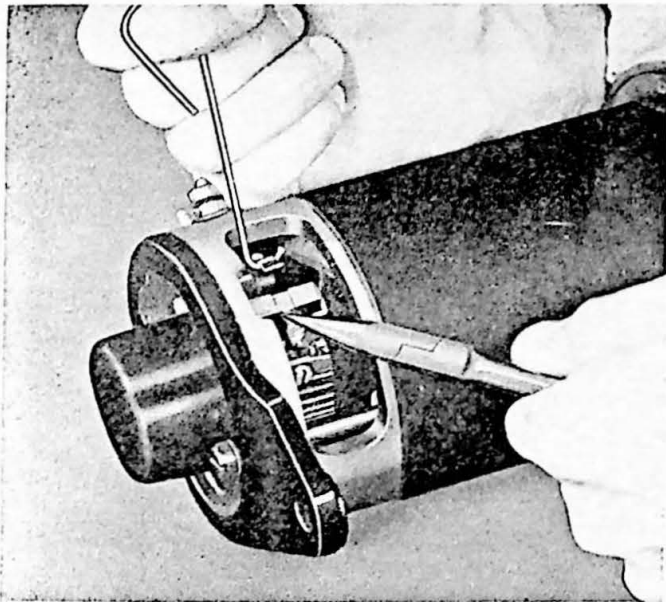
The generator should now run as motor at a low and even speed. If not, see the following fault tracing scheme.

Current low, rotor stationary.	Brushes worn or stuck in retainer and do not reach down to the commutator.
Current low, rotor rotating slowly.	Poor contact between brushes and commutator. Breakage in rotor winding.
Current high, rotor stationary.	Short-circuit in rotor. Breakage or short-circuit in field. A bearing has seized.
Current high, rotor rotating.	Scratched or burnt commutator. Bearings binding. Excessive brush spring pressure.
Excessive movement of brushes and heavy sparking.	Out-of-round or burnt commutator. Damaged brushes.

### Disassembling

Disassembling the generator for overhaul (cleaning and lubricating) is done as follows:

1. Remove the protecting band if this has been fitted again after testing.
2. Disconnect the brush leads. Lift up the pressure arms or springs for the brushes with a hook and pull up the brushes, see Fig. 10-34.
3. Remove the bolts which hold the generator housing and end heads together. When doing

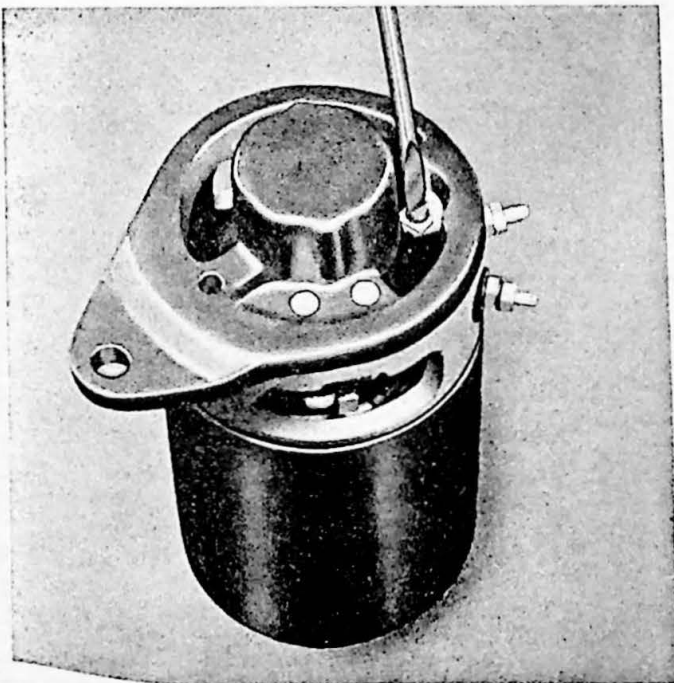


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Fig. 10-34. Removing the brushes

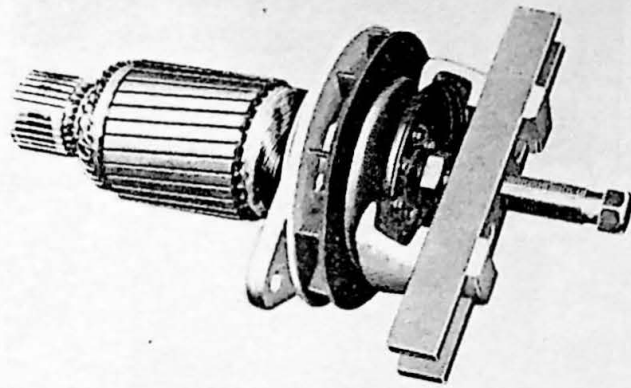
so, first release the connecting bar as shown in Fig. 10-35.

4. Take off the rear end head with brush retainer.
5. Lift the rotor from the housing.
6. Place the rotor in a vice but do not grip too tightly (use copper jaws). Undo the nut for the belt pulley and pull off same. Use a tool as shown in Fig. 10-36. Remove the Woodruffe key.
7. Remove the front end head from the rotor.
8. Pull off the ball bearings with a standard puller.
9. Blow the generator housing and field winding



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Fig. 10-35. Removing the connecting bar



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Fig. 10-36. Removing the belt pulley

together with rotor free from dust and dirt. Clean with a linen rag moistened in gasoline.

Note. Blended gasoline, for example, bentyl, must not be used since it dissolves the shellac. Wash the other parts, except the brushes, in clean gasoline.

### Inspection

Examine the rotor for mechanical damage. This can consist of a bent or worn shaft, scratched commutator and damaged or loose rotor winding.

A shaft which is only slightly bent can be straightened in a press but it is not recommended. Preferably replace the whole rotor.

If the commutator is scratched or unevenly worn, it should be lathe-turned. When turning, a special chuck should be used. In addition the greatest care must be observed. Take small cuts every time so that no more material than is absolutely necessary is removed. If too large cuts are taken, this can damage the

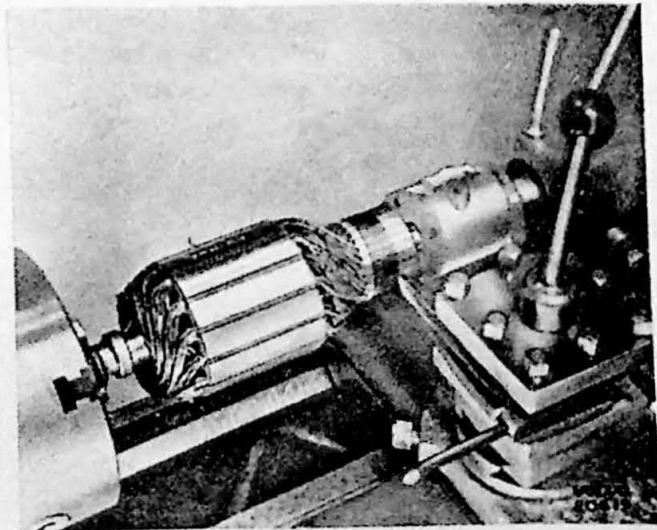


Fig. 10-37. Turning the commutator

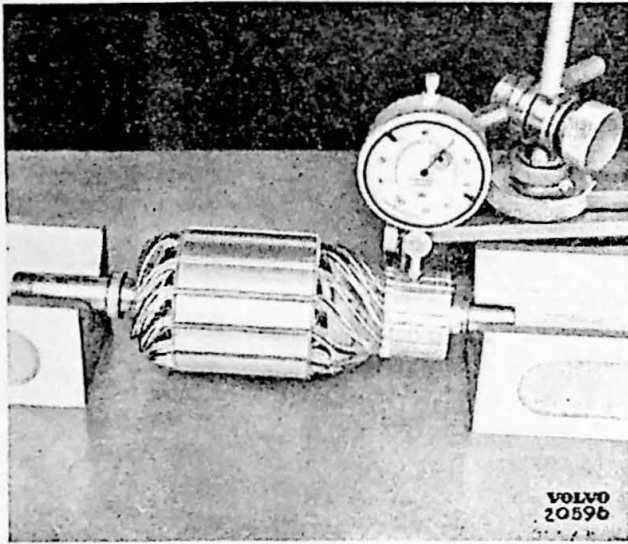


Fig. 10-38. Dial indicating the commutator

insulation and disks. Ensure that no object comes in contact with the rotor or winding during turning.

After turning, the commutator should be measured with a dial indicator gauge as shown in Fig. 10-38. Out-of-roundness must not exceed 0.0005" (0.013 mm). The insulation between the disks should be milled down 1/32" (0.8—1.0 mm) under the disk surface, see Fig. 10-39. This should be done in a special apparatus but if one of these is not available, with a ground-off hacksaw blade.

Examine the rotor both before and after turning by placing it in a special test apparatus (growler). Switch on and hold a hacksaw blade a short distance from the rotor, see Fig. 10-40. If the blade vibrates in any position when the rotor is turned round, one of the following faults can be the reason: short-circuiting to the rotor frame, short-circuit in the commutator or windings.

Short-circuiting between the windings can be measured by holding the resistance fork against the

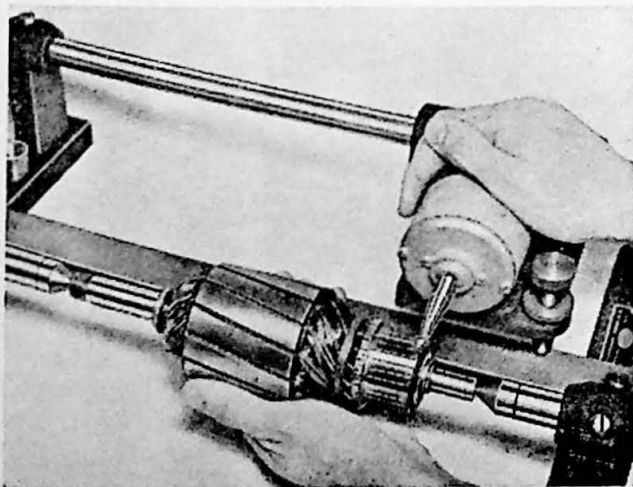


Fig. 10-39. Milling the grooves

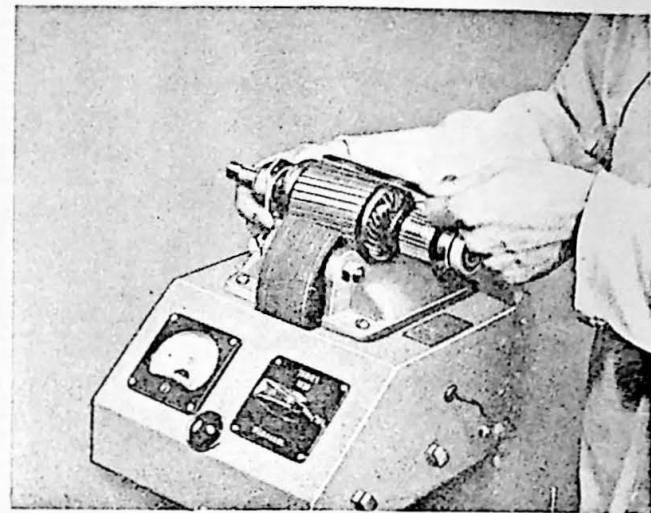


Fig. 10-40. Testing the rotor

commutator as shown in Fig. 10-41. Switch on and adjust the rheostat while turning the rotor backwards and forwards until the highest reading is obtained on the meter. Turn the rotor (the fork must be held still) so that the next pair of disks comes opposite the forks and hold it against these. If there is no fault, the reading should be the same and also for the other disks. A rotor winding with short-circuiting between the winding coils shows a low reading and a broken winding, no reading at all.

Short-circuiting to the rotor body is checked with the help of test probes and test lamps. See Fig. 10-42. Examine the housing and field winding for damage that could have been caused by the rotor. Test that the field winding is not grounded by connecting the

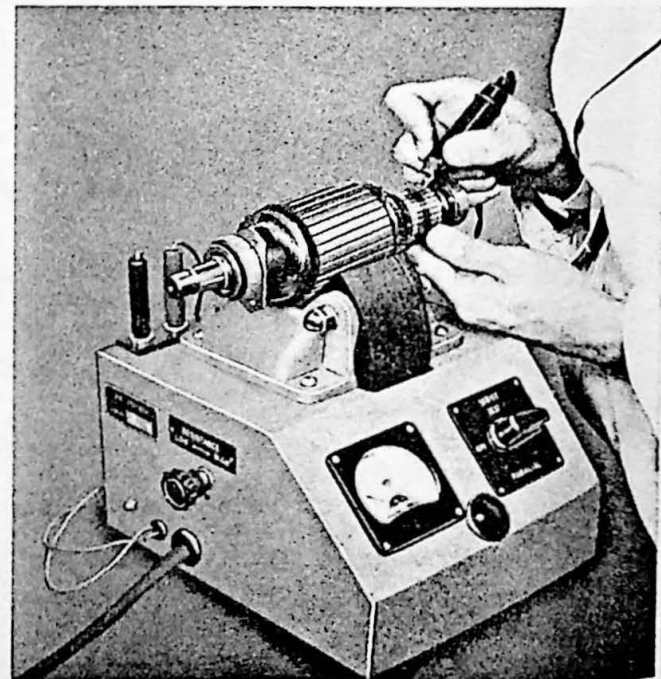
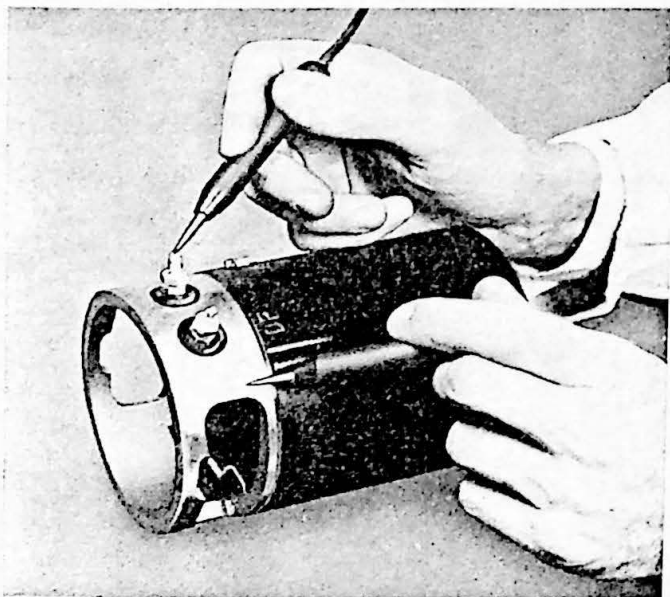


Fig. 10-41. Measuring the rotor



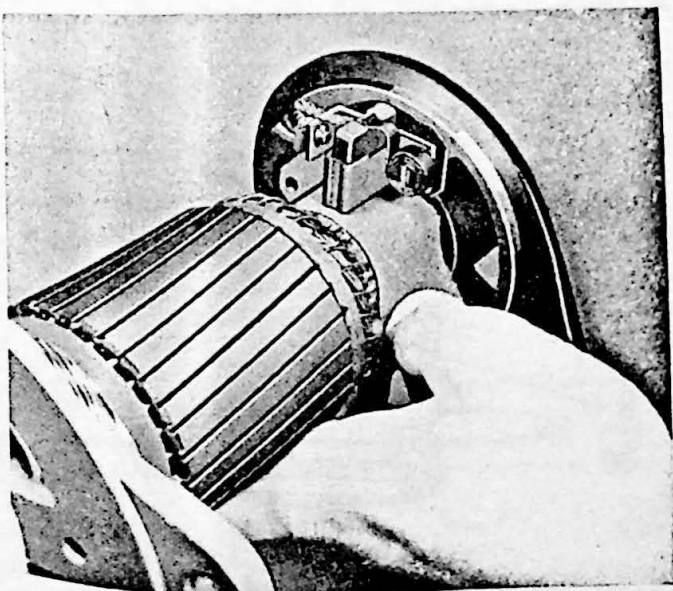
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Fig. 10-42. Testing the stator

contact points to field terminal and housing. If the lamp lights, there is leakage between the field winding and housing.

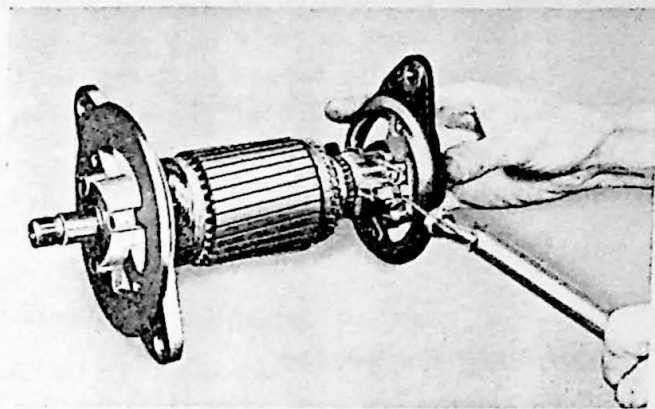
Ensure that the cable from the field winding to the positive brush holder does not touch the housing. Screw out the field inlet and test again. If the lamp still lights, the field winding is in contact with the housing. If so, the winding must be removed. See under "Replacing the field winding".

Internal faults in the field coils are determined by measuring the current consumption of the coils. This is done with an ohmmeter or volt-ammeter. If a volt-ammeter is used, convert according to Ohms law. Examine the rear end head brush retainer.



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Fig. 10-43. Cleaning the brushes



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Fig. 10-44. Measuring brush pressure

If any parts are damaged, they should be replaced with new ones. Check that there is no leakage between the positive brush holder (insulated) and end head.

Brushes that are damaged or worn down more than half should be replaced. Brushes which are scratched or make bad contact with the commutator can be cleaned with sandpaper grade 00 or 000. See Fig. 10-43.

Check brush spring tension by fitting the end head on the rotor and connecting a spring balance to the flexible arm or spring, see Fig. 10-44. The force necessary to lift the arm or spring should agree with that given in the specifications. If there are deviations from these values, the spring must be replaced.

Check the bearings. The ball bearings should rotate freely without any noticeable play. Damaged or worn bearings should be replaced.

### Assembling

1. Fit the stop ring and sleeve, where these exist, on the shaft.
2. Place the inner cover with any felt ring on the shaft. Lubricate the bearing with heat-resisting ball bearing grease and then fit it.
3. Place the front end head on the shaft and bearing. Place any outer cover with felt ring beside the end head and bolt the end head and cover together.
4. Drive in the key and press on the belt pulley. Place the rotor in a vice. Do not tighten too hard otherwise the rotor may be deformed. Fit spring washer and nut.
5. Insert the rotor into the housing and ensure that the guide pin locates correctly.

- Place the end head on the shaft, fit in the guide pin and screw in the 2 bolts which hold the generator housing and end heads together. Check that the rotor turns easily. Fit the brushes into the holders in the rear end head.
- Connect the terminal tab for output current to the positive brush, see Fig. 10-35.

### Replacing the brushes

If the brushes are worn down more than half-way or damaged, they must be replaced. A symptom of this is that the generator ceases to charge. Remove the protecting band and examine the brushes and commutator. If it can be seen that the above fault is the reason for charging not taking place, the generator must be removed.

Wash carefully and wipe the generator externally with a piece of rag moistened in gasoline.

Remove the brushes by undoing the connections on the brush holders, lifting up the brush springs and pulling up the brush with a pair of pliers, see Fig. 10-34. If the commutator is scratched or unevenly worn, the generator must be disassembled and the commutator lathe-turned. See further under "Disassembling, inspection and assembling". Place in the correct type brushes and fit the protecting band. If there are test devices available, it is wise to test the generator before refitting it in the car. See further under "Testing the generator".

### Replacing the field winding

- If the generator is not disassembled, proceed in accordance with points 1 to 5 under the heading "Disassembling".
- Place the generator housing in a V-block as shown in Fig. 10-45. Press downwards at the same time as turning the screwdriver. The screws are usually very tight. Therefore ensure that the screwdriver fits properly into the groove in the head of the screw and is sufficiently wide. When both screws have been removed, lift the housing out of the way. Screw out the screws with a screwdriver. Remove the cable inlet in the housing and lift out the windings and pole shoes.
- Fit the new field winding into the housing. Follow the same procedure as when removing the screws.
- Connect the cables at the inlet in the housing. Check for grounding.

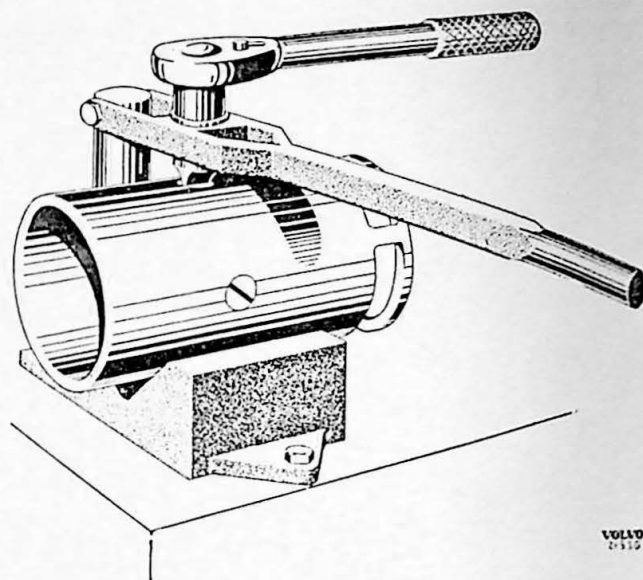


Fig. 10-45. Removing the field winding

- Assemble the other parts of the generator. See under the heading "Assembling".

### Testing the generator

Before the generator is refitted into the car it should be tested. Place the generator on a test bench and connect a volt-ammeter.

Run the generator as motor for a short while. Ensure that the generator has the right polarity, negative to ground. Check that current consumption for the generator is normal and that it runs evenly and silently, etc. Then start the drive motor, check its direction of rotation, and check that the generator gives the necessary voltage at the speeds stated in the specifications. Check that there is no sparking on the commutator and that the brushes do not jump.

### Lubricating scheme for generator

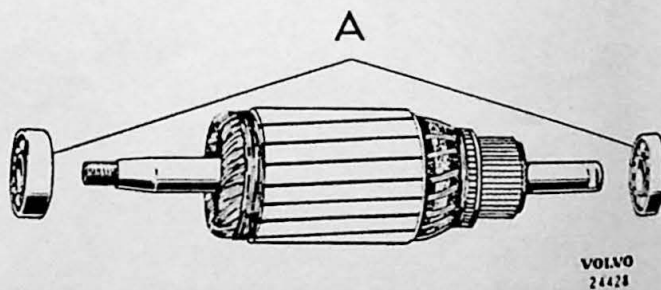


Fig. 10-46. Lubricating scheme for generator  
A. Bearing lubricated with grease, Bosch FT 1 v 22 or corresponding

## CHARGING CONTROL

### Removing

1. Disconnect the lead on the charging control.
2. Remove the charging control from the plate on the wheel housing.
3. Clean the charging control externally.

### Fitting

1. If the charging control has been replaced, check that the new one is of the right type.

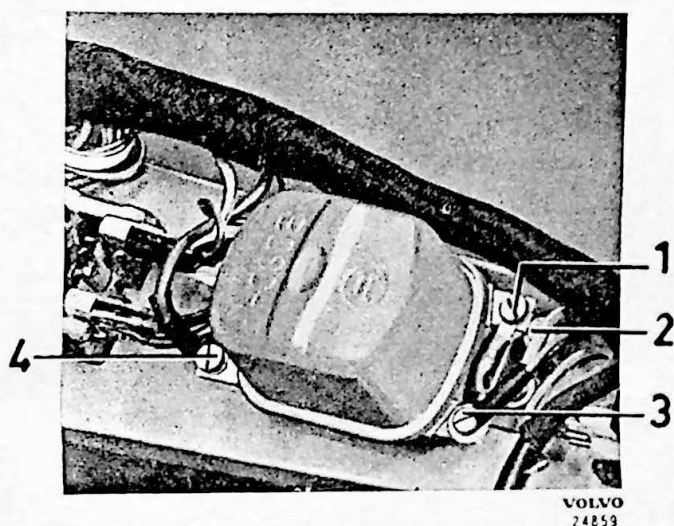


Fig. 10-47. Charging control terminals

1. Generator D+, 61
2. Ground lead
3. Generator field, DF
4. Battery, B+

2. Screw the charging control onto the plate on the wheel housing.
3. Connect the leads. The leads are connected as shown in the Fig. 10-47 or according to the wiring diagram, illustration 10-1.

### Adjusting the charging control

#### Reverse current relay

##### Cut-in voltage

Connect a voltmeter over D+ on the control and generator frame. Start the engine and increase speed gradually while watching the voltmeter. The reading should at first increase and then fall to 0.1—0.2 volts when the reverse current relay cuts in and thereafter remain stationary. The voltage which the voltmeter comes up to before this happens is the cut-in voltage. This is checked with the specifications after which any necessary adjustments are made.

Adjusting is carried out by increasing or decreasing the spring pressure influencing the relay armature. If the spring pressure is decreased, cut-in voltage decreases and vice versa.

Preliminary adjusting is shown in Fig. 10-49 and final adjusting in Fig. 10-50.

#### Reverse current

An ammeter is connected in series with B+ on the charging control and lead to the battery. The

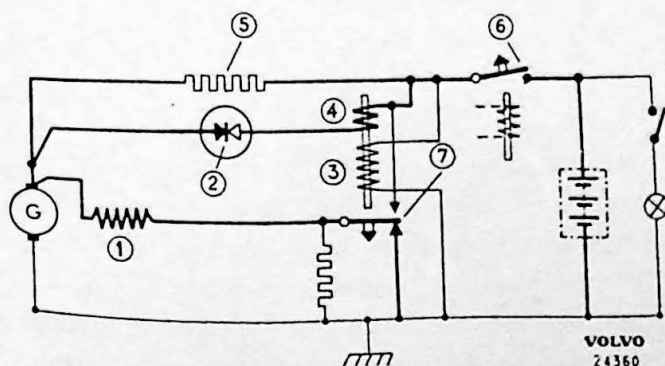


Fig. 10-48. Wiring diagram for charging control

1. Field winding
2. Variometer
3. Voltage winding
4. Current winding
5. Variometer resistance
6. Cut-in contacts
7. Control contacts

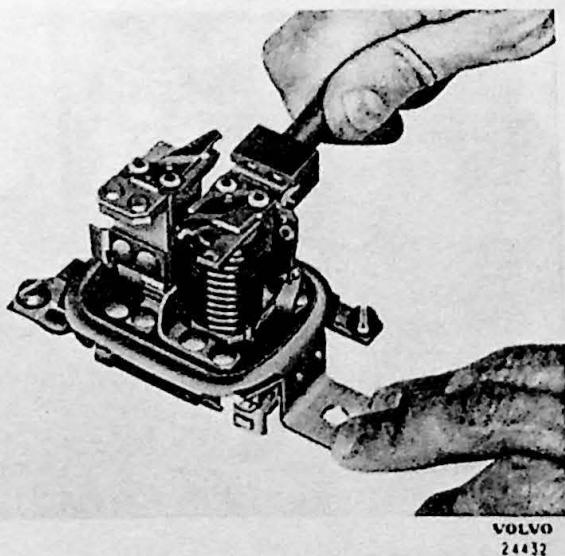


Fig. 10-49. Adjusting cut-in voltage

generator speed is increased until the ammeter shows charging. The speed is then decreased slowly. The ammeter needle goes to zero and then over to discharge. It then returns suddenly to zero. The reverse current is read off at the turning point before the needle returns to zero. The relay has cut out when the needle returns to the zero position. The reverse current should be between the values given in the specifications.

If the reverse current is too low, the curve in the contact spring should be lessened by bending the contact yoke for the cut-in contact. It may be necessary to file off the pole pin slightly. If the reverse current is too high, the curve of the contact spring must be increased. Check the cut-in contact gap and adjust it if necessary. After adjustment, re-check the cut-in voltage.

### Voltage control

Break the connection B+ on the voltage control. Connect a voltmeter between B+ and the voltage control frame and increase the generator speed gradually.

As soon as voltage control has begun, that is to say, when the voltage does not rise any more, the control voltage should be read off. Adjustment of the voltage control is done by bending the support tab for the spring tongue as shown in Fig. 10-50 so that the spring tongue is completely relieved. Preliminary adjustment is then done by bending the relay elbow as shown in Fig. 10-51. If the elbow is bent downwards, voltage is increased and vice versa.

Preliminary adjustment should be about 1—2 volts

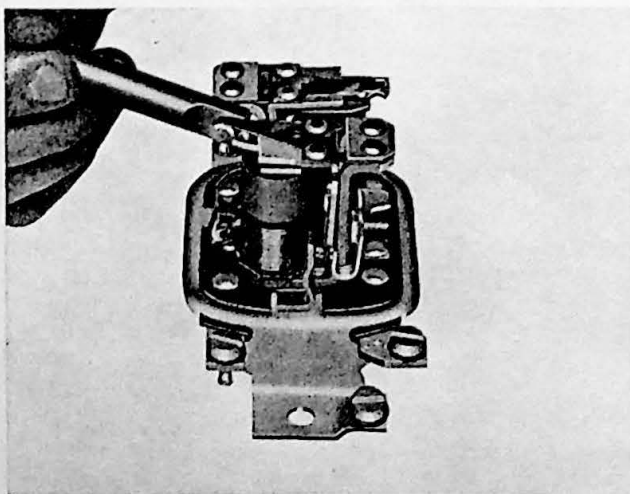
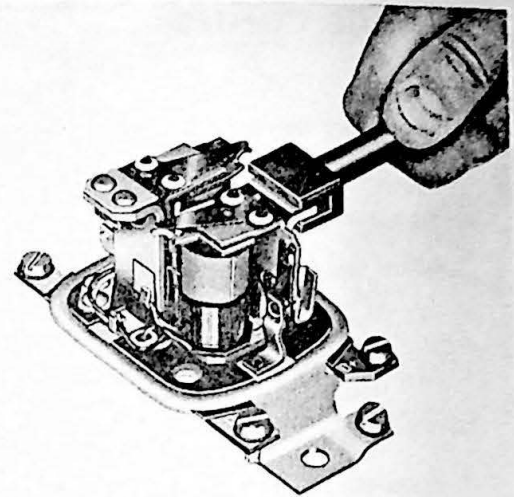


Fig. 10-50. Final adjustment of voltage control

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Fig. 10-51. Preliminary adjustment of voltage control

lower than final adjustment. This is done by bending the support tab upwards so that the spring tongue is tensioned, see Fig. 10-50. Special Bosch tool V 397.

Increase and decrease the speed a few times and check that the voltage control is correctly adjusted. NOTE. This adjustment must be carried out when the generator has attained full operating temperature, that is to say, at least 12 minutes after the engine has been started from cold.

### Adjusting the voltage control with loading applied

Connect an ammeter between B+ and the live lead and connect an adjustable loading resistance of suitable size between the ammeter battery side and ground. In addition, connect a voltmeter between B+ and ground.

Increase speed and check the meter readings. Adjust the loading resistance so that a loading current twice as great as rated output is obtained. Check the control voltage under load.

Run the engine at the above loading. After about 12 minutes, that is to say, when the generator has attained operating temperature, the current value must not be greater than 2/3rds of the maximum current stamped on the generator (1 max.). If the loading has not fallen, this indicates a fault in the variometer so that the control must be replaced.

Since the generator output is very high, this puts great demands on the condition and tension of the drive belt. Before starting work on the charging control and generator, therefore, always check that the belt is correctly tensioned.

## DISTRIBUTOR

### Removing

1. Lift off the distributor cap.
2. Mark the rotor arm position on the distributor housing.
3. Disconnect the primary lead 1, Fig. 10-52.
4. Disconnect the vacuum pipe on the vacuum regulator.
5. Unscrew the screw (4, Fig. 10-52) on the control arm and lift up the distributor.

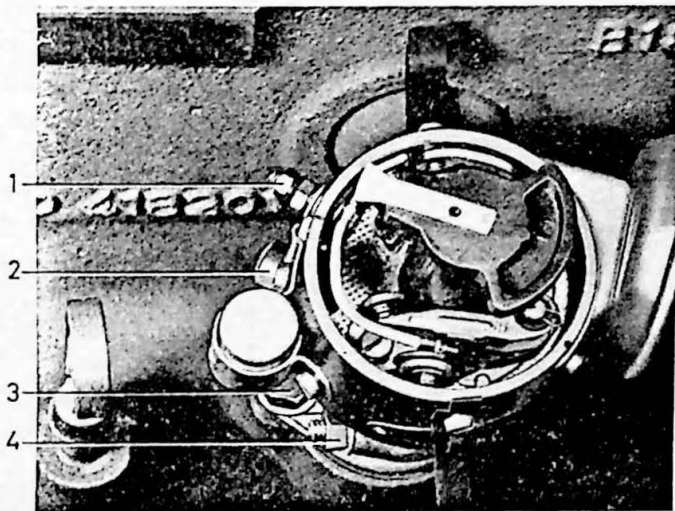


Fig. 10-52. Distributor, fitted

- |                           |                                    |
|---------------------------|------------------------------------|
| 1. Lead for ignition coil | 3. Screw for attaching distributor |
| 2. Lubricating cup        | 4. Adjusting screw                 |

### Fitting

Fitting is done in the reverse order to removing. If the engine has not been turned while the distributor

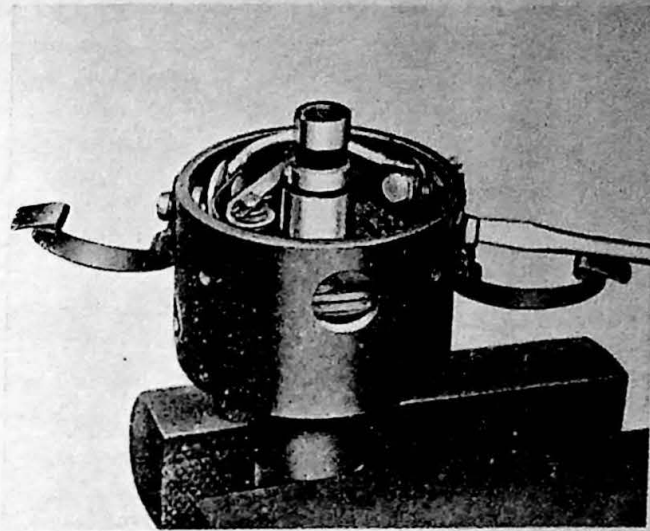


Fig. 10-54. Removing the contact breaker plate

has been removed, fit it in accordance with the marking under point 2 above.

### Adjusting the ignition

Concerning adjusting the ignition, see Part 1, Engine.

### Disassembling the distributor

1. Pull off the rotor arm.
2. Disconnect the vacuum regulator by unscrewing the screws as shown in Fig. 10-53 and then lifting it off.
3. Remove the primary terminal screw with washers.
4. Remove the contact breaker plate. This is done by unscrewing the two screws which hold the distributor cap retainers, Fig. 10-54.

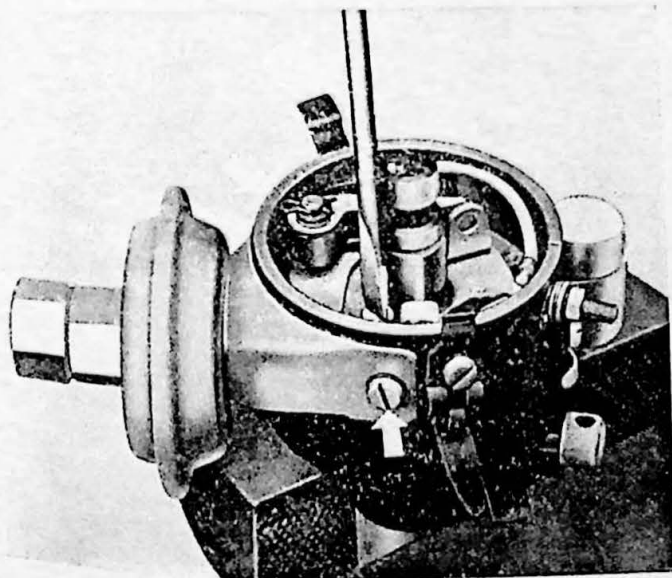


Fig. 10-53. Removing the vacuum regulator

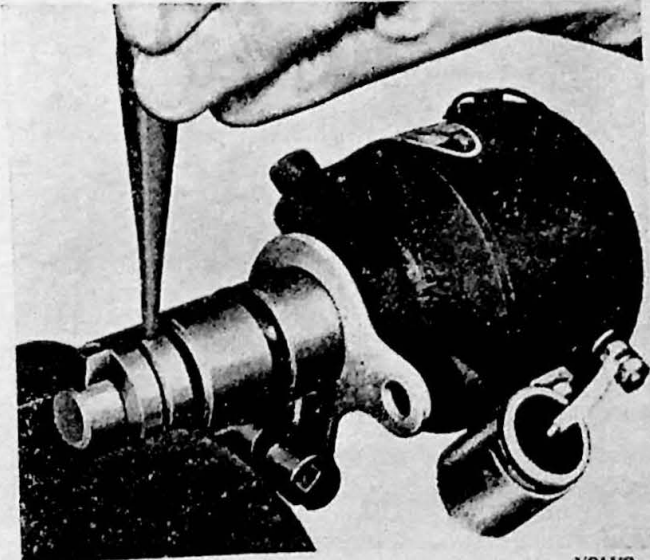


Fig. 10-55. Removing the collar

5. Lift the stop spring (locking spring) and knock out the pin for the collar and pull it off. Mark the position of the collar in relation to the shaft. Fig. 10-55.
6. Lift up the distributor shaft.
7. Release the locking springs and springs between the centrifugal regulator and breaker camshaft and lift up same.
8. Wash all parts in gasoline and lay them out for inspection.

## Inspection

### Distributor plate

1. The contact breaker points should be smooth and even at the contact surfaces. They should be of a grey color. Replace oxidised or burnt contacts. After a long period of running the points can become worn and the springs fatigued so that the contacts should be replaced.
2. There must be no play or wear on the contact plate causing loose particles.

### Distributor shaft

1. The clearance between the distributor shaft and breaker camshaft must not exceed 0.004" (0.1 mm).
2. The cams on the breaker camshaft must not be scored or worn as this will cause alteration in the closing angle.
3. The holes in the centrifugal regulator weights

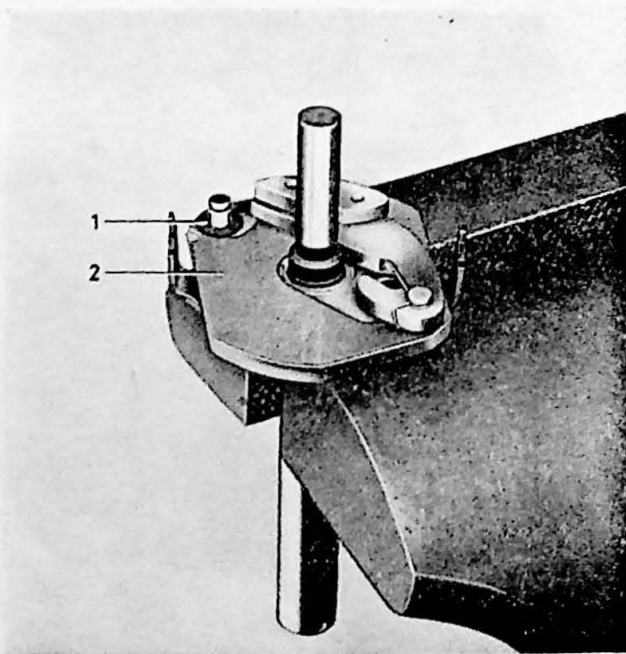


Fig. 10-56. Plate with fiber washers  
1. Fiber washer 2. Resitex plate

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- must not be oval or otherwise deformed. The fiber washers, Fig. 10-56, must be intact.
4. The springs for the above-mentioned regulator must not be deformed or damaged.

### Distributor housing

1. The clearance between the distributor housing and shaft should not exceed 0.008" (0.2 mm). If the clearance is greater than this, replace the bushings, and if this is not sufficient, replace the shaft.
2. The insulation washers for the primary terminal must not be cracked or soaked with oil as this can cause current leakage.
3. The capacitor should be checked with a direct-current glow-lamp or with a capacitor bridge. When testing with glow-lamp at room temperature, there should be no discharging and when testing with the capacitor warmed to 140–160° F (60–70° C), a maximum of 15 discharges per minute can be accepted.

### Assembling

1. Place the Resitex washer on the distributor shaft and the fiber washers over this, see Fig. 10-56. Lubricate and place the centrifugal regulator weights in position. Place on the locking springs. Concerning lubricating, see Fig. 10-60.
2. Lubricate and fit the breaker camshaft and put on the springs, see Fig. 10-57.
3. Lubricate the distributor shaft and place it in the distributor housing. Check that the axial adjusting

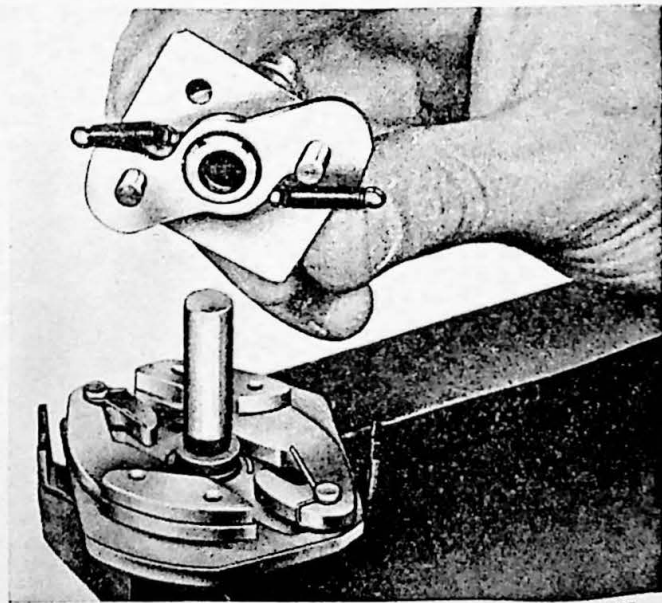
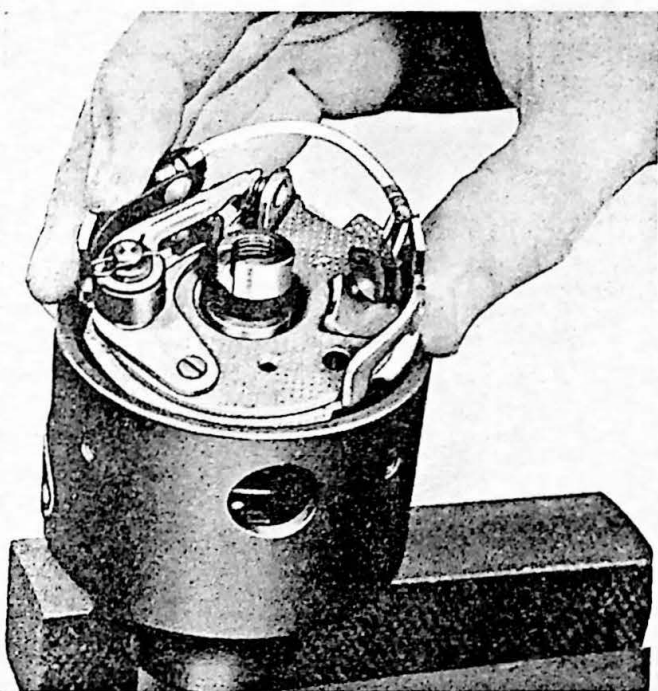


Fig. 10-57. Fitting the contact breaker camshaft

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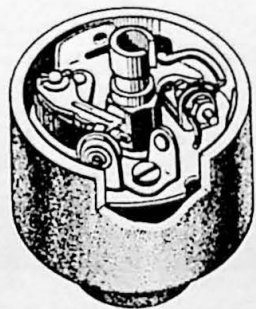
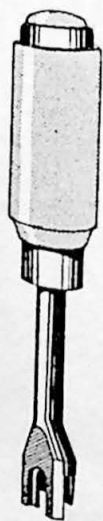
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Fig. 10-58. Fitting the contact breaker plate

washers are located correctly. The fiber washer should contact the inside of the distributor. The steel washers should contact the collar.

Fit the contact breaker plate and springs, see Fig. 10-58.

4. Fit the primary terminal and connect this to the contact breakers and capacitor.
5. If the contact breakers have been replaced, ensure that the new ones come at the correct height and that they are level with each other. Levelling adjustment is done with a contracting tool (for example, Bosch EFAW 57 or similar). Only the fixed contact may be bent as shown in Fig. 10-59. Adjust the gap and check contact pressure.



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Fig. 10-59. Adjusting contact gap

6. Fit the vacuum regulator.
7. Fit the collar, check axial clearance. The fiber washer should lie against the distributor housing and the steel washer (steel washers) against the collar. The axial clearance should be min. 0.004" (0.1 mm), max. 0.008" (0.2 mm).

### Testing the distributor

The distributor should be tested in a distributor testbench (synchrograph) or in an electrical testbench with necessary accessories.

1. Set up the distributor according to the instructions applying for the distributor testbench concerned.
2. Run the distributor in the normal direction of rotation and adjust the closing angle of the contact breakers in accordance with the specifications.
3. Run the distributor and adjust the setting disk so that the spark comes opposite 0° at a speed when the centrifugal regulator has not begun to take effect. Increase the speed gradually and read off the values at the prescribed revolutions. Newly lubricated distributors should first be run at maximum speed a few times. Permissible tolerance for the centrifugal regulator is  $\pm 1^\circ$ .
4. Run the distributor at low speed (about 200 r.p.m.) and set the adjusting disk so that the spark occurs at 0°. Increase the vacuum and read off the ignition setting. Increase the vacuum successively and check that the whole range of adjustment agrees. Then test vacuum control in a decreasing direction by lowering the vacuum and reading off the values. The difference between increasing and decreasing values must not exceed 1.5°. If so, there is a fault in the contact breaker plate, pull-rod or vacuum regulator.

### Adjusting the ignition curve

#### (Centrifugal regulator)

The curve is adjusted by tensioning the centrifugal regulator springs. To do this the shaft must be lifted up from the distributor housing and the screws on the underside of the collar loosened. If the collar is turned against the direction of rotation, the springs are tensioned, that is to say, ignition is retarded and optimum control is reached later.

NOTE. The curve must not be adjusted by bending the spring yoke.

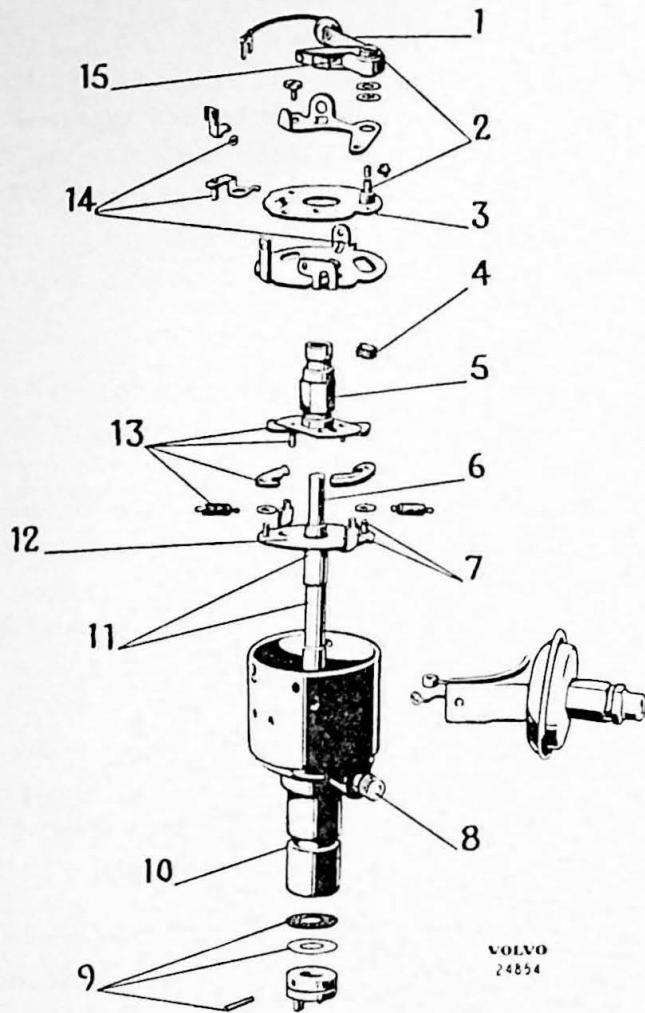


Fig. 10-60. Lubricating scheme for distributor  
(Bosch lubricant or corresponding)

1. Lubricate the spring sparingly with Ft 1 v 4
2. Lubricate the bushing and studs with Ft 1 v 22
3. Oil the sliding surfaces of the contact breaker plate with OI 1 v 2
4. Soak the lubricating felt with OI 1 v 2 oil
5. Lubricate the cam with a thin layer Ft 1 v 4 grease
6. Lubricate the shaft stud lightly and oil it in with Ft 1 v 8 and OI 1 v 2
7. Lubricate bearing studs and spring attachments with Ft 1 v 8
8. Fill the oil cup while turning the shaft. Use OI 1 v 13
9. Lubricate washers and pins before filling with OI 1 v 13
10. Soak the lubricating felt between the bushings with OI 1 v 13 oil
11. Lubricate the shaft and fiber washers with grease and oil Ft 1 v 22 and OI 1 v 13
12. Lubricate the regulator plate with OI 1 v 22
13. Lubricate contact surfaces, plate studs, etc., with Ft 1 v 8
14. Lubricate the bearing studs, ball, guide lip and their contact surfaces with plenty of grease Ft 1 v 22
15. Put a small quantity of grease on the rivet side of the lifting lip Ft 1 v 4

## HEADLIGHTS

### Replacing the headlights

The following section describes how the headlights should be removed from the car and disassembled. For partial disassembly, follow the instructions given in the appropriate points.

1. Remove the headlight rim as shown in Fig. 10-61.

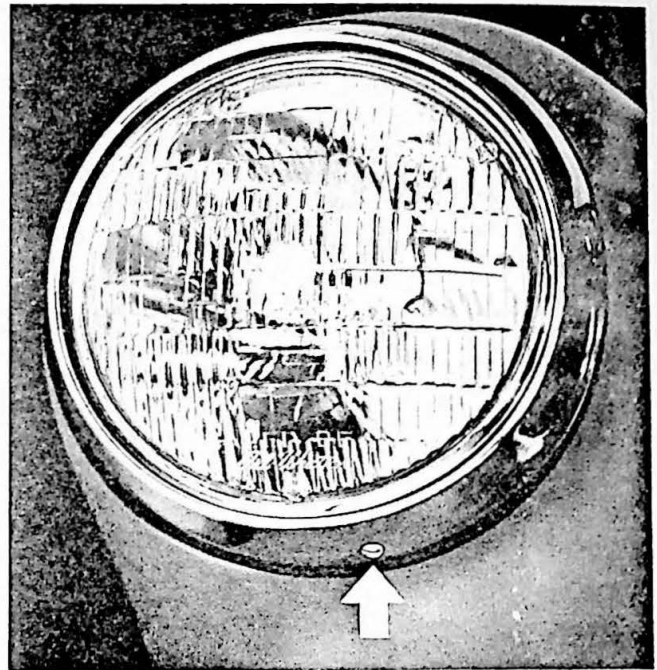


Fig. 10-61. Removing the headlight rim

2. Unscrew the screws indicated by the arrows and turn the headlight ring to the left and remove same, see Fig. 10-62.
3. Lift out the insert.
4. Pull off the coupling contact from the bulb or headlight insert, see Fig. 10-63.
5. Unhook the spring and lift out the bowl.
6. Unscrew the four screws which hold the casing to the mudguard and remove same.

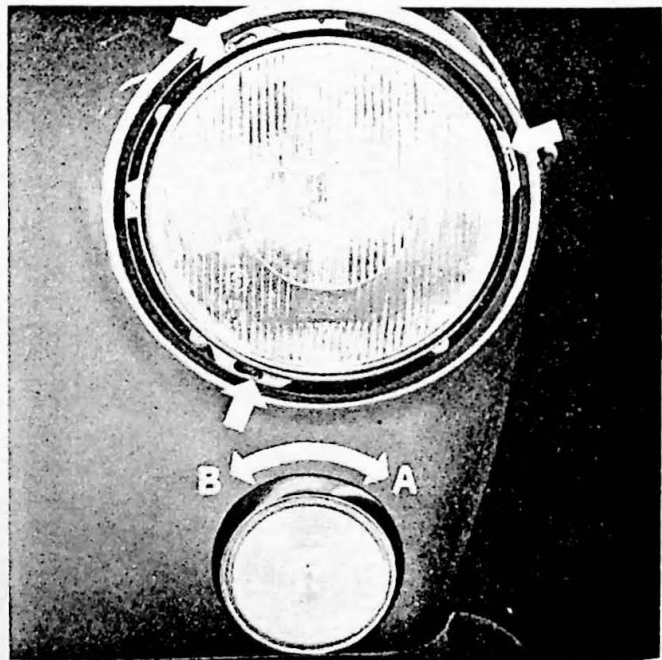
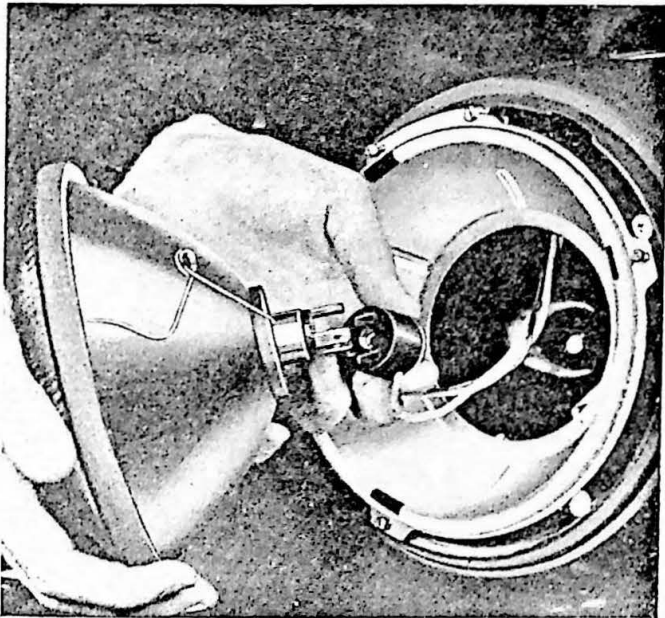
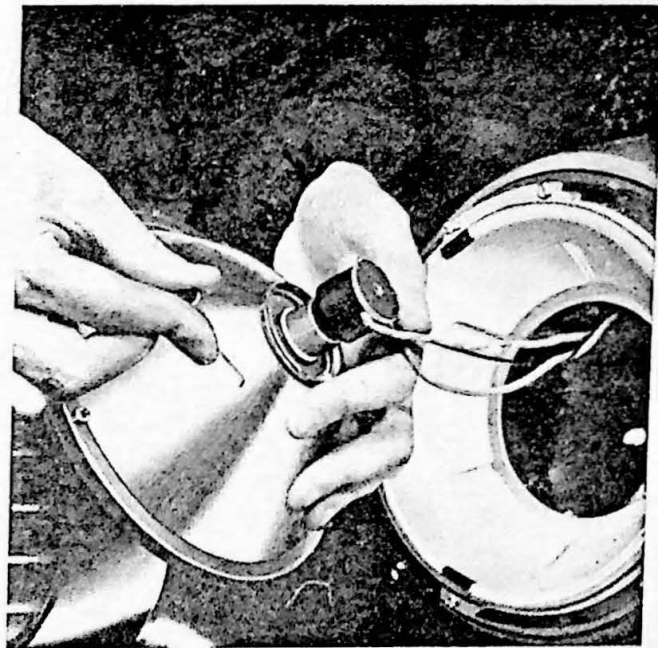


Fig. 10-62. Removing the headlight inner ring  
A. Removing the glass B. Fitting the glass



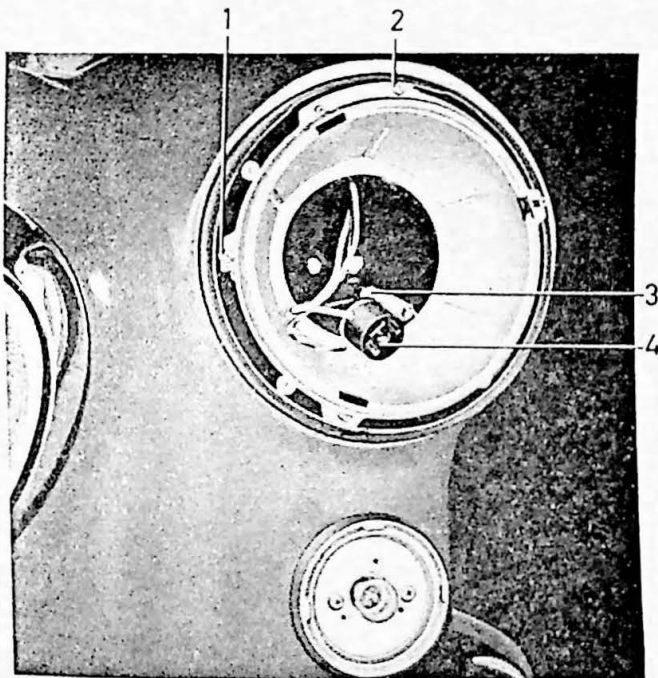
VOLVO  
24881

Fig. 10-63. Fitting the coupling contacts



VOLVO  
24879

Fig. 10-65. Removing the bulb holder



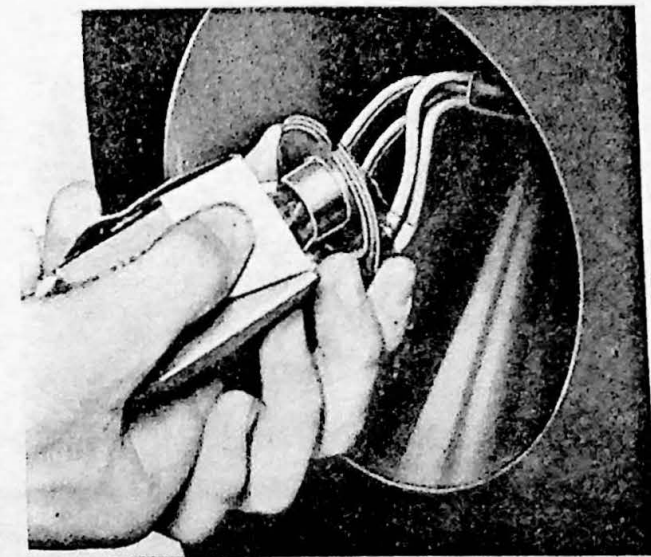
VOLVO  
24880

Fig. 10-64. Headlight bowl

1. Adjusting screw
2. Adjusting screw
3. Spring
4. Coupling contact

### Replacing the bulbs

1. Carry out points 1—4 under the heading "Replacing the headlights".
2. Remove the spring which holds the bulb holder to the inset and lift out the bulb holder, Fig. 10-65, then remove the old bulb.
3. Fit the new bulb. This should be done as shown in Fig. 10-66. Do not touch the bulb itself with the fingers but only pull out the bulbs socket from



VOLVO  
23165

Fig. 10-66. Fitting the bulb

the carton far enough for the bulb to be fitted.  
4. Fitting is done in the reverse order to removing.

### Adjusting the headlights

From a traffic safety point of view it is of great importance that the headlights are adjusted in accordance with existing regulations.

This is done by turning the two screws as shown in Fig. 10-64.

### FLASHER AND PARKING LIGHT

The glass is removed by turning to the left. The lamp is removed by unscrewing the two screws beside the bulb, see Fig. 10-64.

## NUMBER PLATE LIGHT

The number plate light can be replaced from the inside of the luggage compartment. To do this, unscrew the nuts as shown in Fig. 10-67. The bulb can be replaced by removing the bulb holder as shown in Fig. 10-67.



Fig. 10-67. Number plate light, removing the bulb

## REAR LIGHT

### Replacing the rear light

1. Unscrew the four screws which hold the glass, see Fig. 10-68.
2. Unscrew the two screws which hold the rear light housing to the body, see Fig. 10-69. The nuts are accessible from inside the luggage compartment.
3. Disconnect the leads at the connecting pieces, see Fig. 10-70.

Fitting is done in the reverse order. When fitting, ensure that good sealing is obtained between the body and the rear light and that good grounding is obtained.

## INSTRUMENTS AND INTERIOR LIGHTING

The instrument lighting consists of six bulbs attached to the instruments and accessible from the backside of the instrument panel.

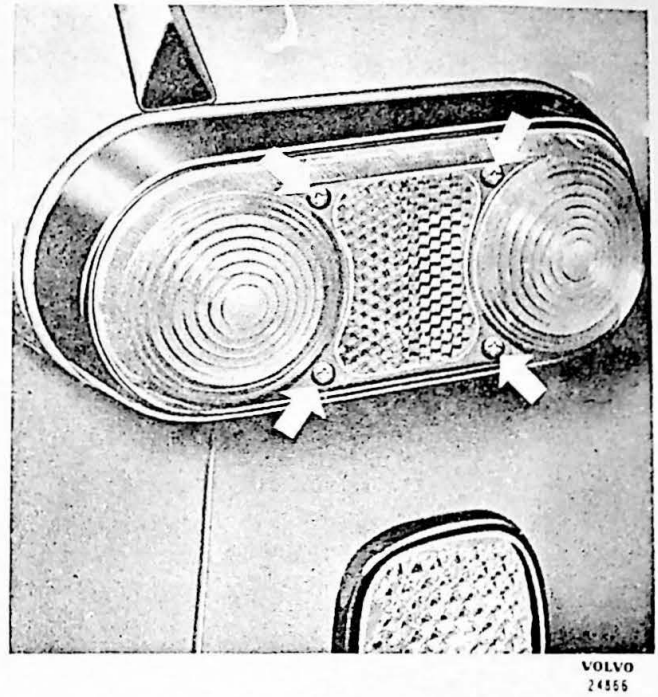


Fig. 10-68. Rear light

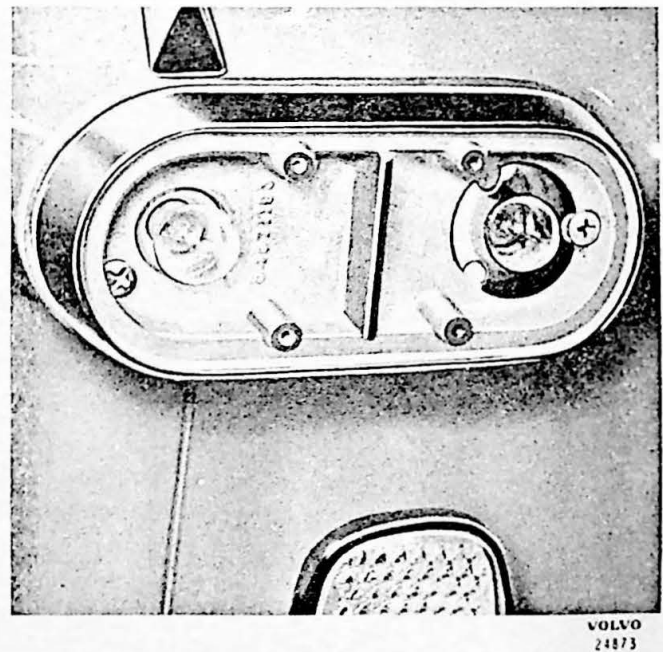


Fig. 10-69. Rear light, glass removed

The control lamps are also fitted in the instrument panel. All control lamps are accessible for replacement from the backside of the instrument panel. Interior lighting consists of two lamps placed at the rear next to the rear window. The bulbs are accessible after the glasses have been removed. These are removed by pulling straight out.

## LIGHTING SWITCH

The pull switch for lighting has three positions: off, parking and full and dimmed headlights.

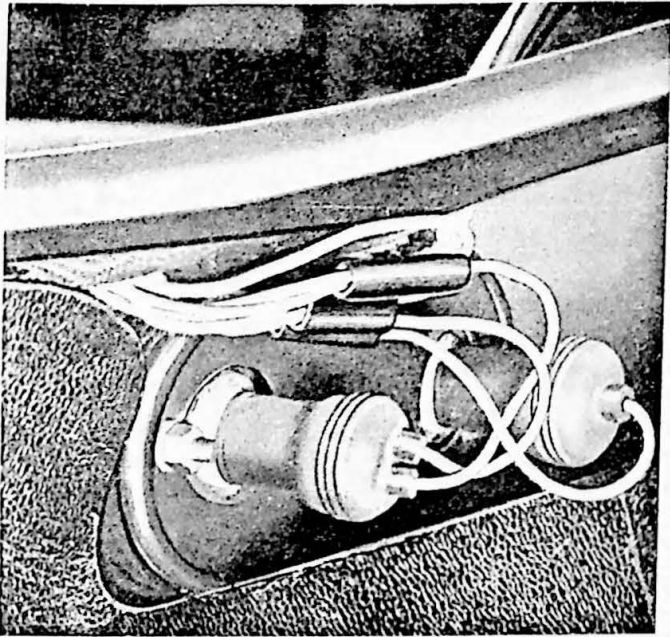


Fig. 10-70. Rear light coupling contacts

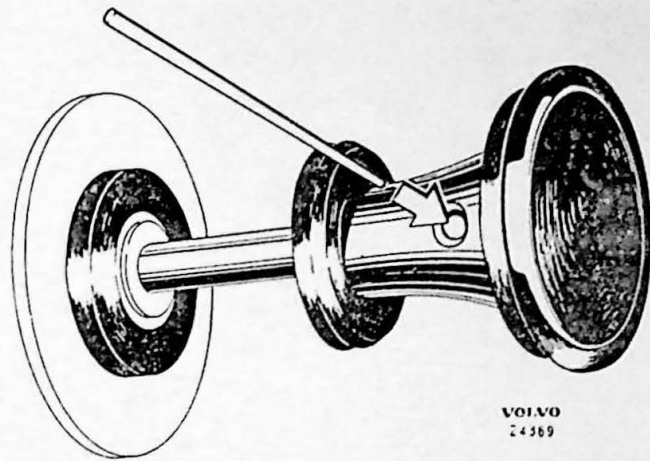


Fig. 10-71. Removing the pull button

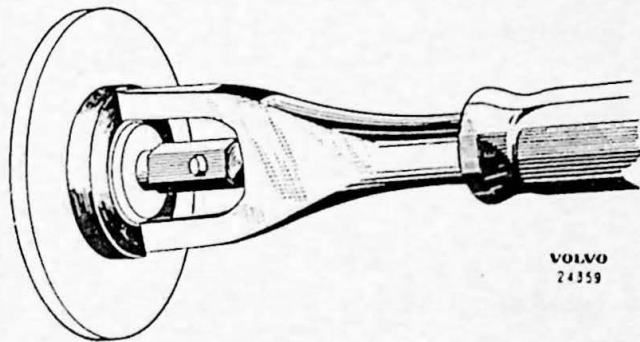


Fig. 10-72. Removing the switch

The switch can be removed from the instrument panel as follows:

1. Disconnect the ground lead from the battery.
2. The pull button is removed by pressing in the locking pin with a suitable tool after which the button can be pulled out. Fig. 10-71.
3. The switch is removed by unscrewing the nut with a suitable tool as shown in Fig. 10-72.
4. The switch can then be removed rearwards and downwards.
5. Mark the leads and disconnect them.

## DIRECTIONAL INDICATOR SWITCH

1. Remove the steering wheel in accordance with the instructions in Part 6.
2. Unscrew the screws which hold the switch casing, see Fig. 10-73.
3. Unscrew the jacket tube screws and pull this up so that the switch screws are accessible.
4. Unscrew the two screws which hold the switch to the jacket tube.  
The position of the switch is adjusted by turning the jacket tube. Concerning the attachment of this, see Part 6.

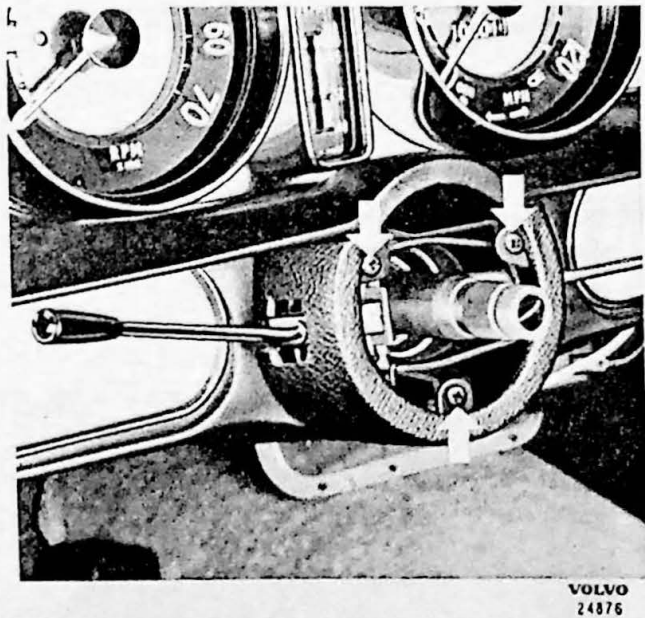


Fig. 10-73. Removing the switch casing

## WINDSHIELD WIPER

### Removing and fitting

1. Pull off the wiper arms.
2. Unscrew the two nuts and remove the washer and seal. Disconnect the leads.

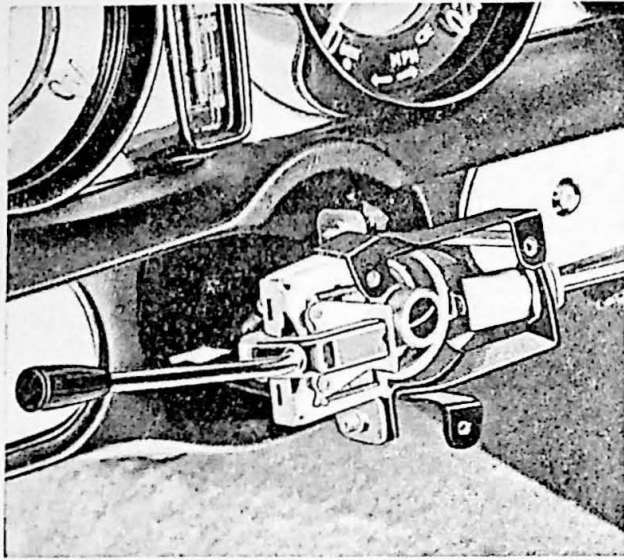


Fig. 10-74. Directional indicator switch, casing removed

3. Unscrew the two screws which hold the wiper to the body and remove same.

Fitting is done in the reverse order.

### Lubricating the windshield wiper

The bushings and tooth segments in the wiper linkage system are lubricated during assembly. It is not necessary to lubricate the link arms or gearing after a certain time and this need only be done in connection with reconditioning.

### FUSES

The fuses are placed as shown in Fig. 10-75. Concerning the position of the fuses in the wiring circuit, see the wiring diagram. When replacing fuse boxes and

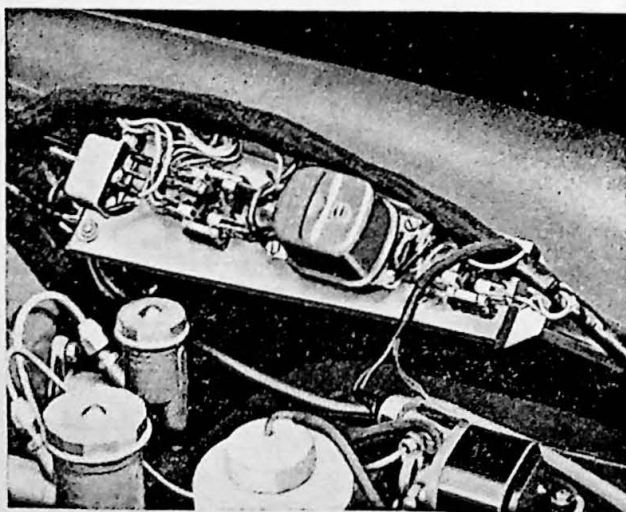


Fig. 10-75. Location of fuses

similar, the whole plate with fuse boxes, charging control and overdrive relay can be removed from the car as shown in Fig. 10-75. The melt-fuses in the fuse boxes should be replaced when damaged. Fuses must never be repaired or replaced with nails, pieces of wire or similar.

### ELECTRICAL LEADS

The wiring diagram shows how the electrical leads connect the various components and also shows the marking and cross-sectional area of the leads. The leads are of different colors to facilitate fitting and fault tracing. When fault tracing, it is important to carry this out following the wiring diagram. If there should be a breakage or grounding in a lead, it should be replaced. When doing so it is important to ensure that the new lead has at least the same cross-sectional area as the old one. Too small an area can lead to overloading and dangerous heating up of the lead.

### HORN

There are three horn units which are spring-suspended and attached to the front cross-member. When removing, the hood must first be taken off. When replacing the horn lead through the jacket tube, attach a piece of wire or similar to facilitate pulling down the new lead.

The horn switch on the side of the jacket tube is accessible after the steering wheel has been removed, the jacket tube screws removed and the tube pulled up as shown in Fig. 10-74. The steering shaft is divided and fitted with a rubber coupling disk in the middle. A ground connection is fitted over the coupling disk. When repairing and adjusting, ensure that this fits securely and gives good contact.

### INSTRUMENTS

All instruments are fitted to the instrument panel with clips and screws.

Before carrying out work on the instruments, one of the battery leads should be disconnected from the battery.

### Speedometer

If the speedometer does not give a reading but the mileometer functions and vice versa that is to say, the mileometer does not function but the speedometer

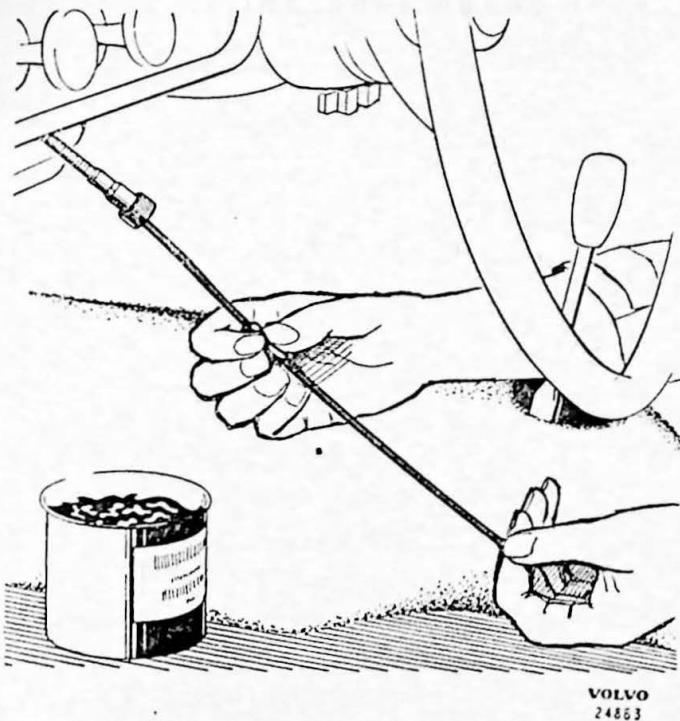


Fig. 10-76. Lubricating the speedometer cable

gives a reading, the fault is in the instrument so that it should be removed and sent to an instrument repair shop. If the instrument gives neither a speed nor mileage reading or if the needle is unsteady, the driving cable should be removed since this is probably broken or binding in the outer casing.

## Speedometer cable

### Lubricating

It is important that the cable must not be lubricated in such a manner that oil can penetrate up into

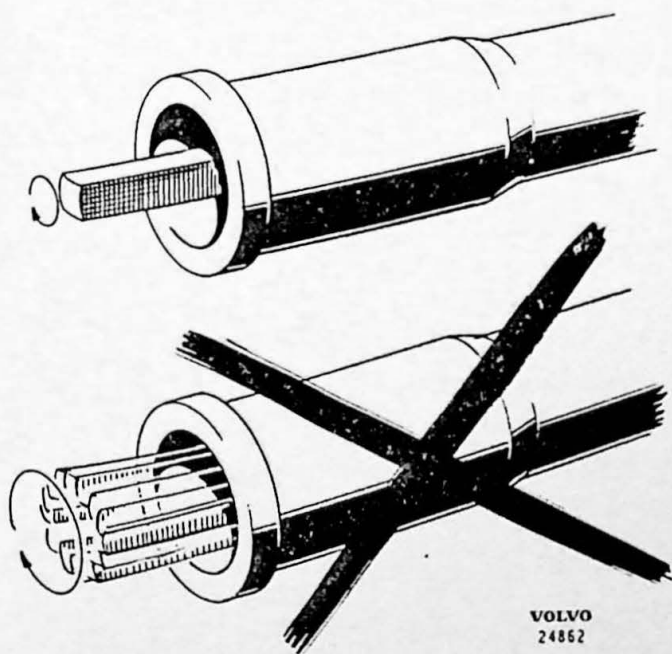


Fig. 10-77. Checking the rotation of the cable

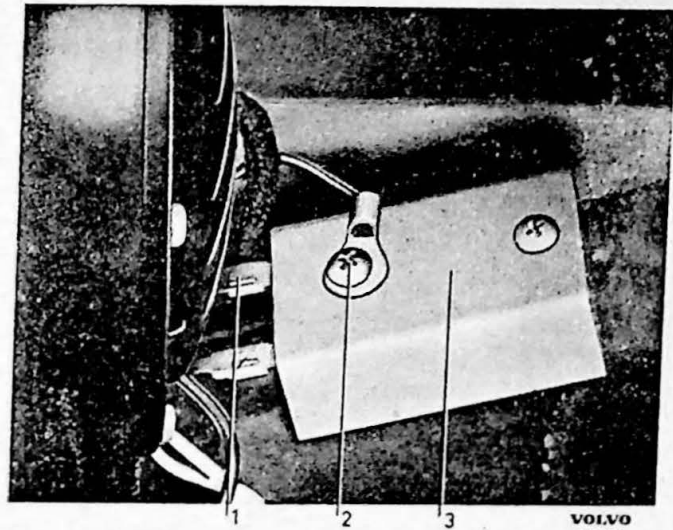


Fig. 10-78. Revolution counter sender  
1. Terminals 2. Ground lead 3. Sender unit

the instrument and damage it. During servicing, therefore, it is unsuitable to lubricate the cable with oil. Instead the cable should be lubricated as follows: Remove the cable from the speedometer. Pull the cable from the outer casing about 8" (20 cm) and wipe it clean. Lubricate the cable with Castrol LM grease or corresponding and slide it back into the outer casing again, see Fig. 10-76.

### Checking the cable

If the cable has been replaced, the bending radii must be checked. There must be no bend in the cable for at least 2" (50 mm) from the connection at the transmission and instrument respectively. The minimum permissible bending radius of the cable must not be less than 6" (15 cm). If any bending radius is less than 6" (15 cm) this may cause the needle to vibrate. The cable should run concentrically in the outer casing and checking is carried out by rotating the cable as shown in Fig. 10-77.

### Revolution counter

The revolution counter on the instrument panel is fed from a transistorised sender type Scinenta VM-1 A which, by means of the breaker impulses in the ignition coil, produces current proportional to the engine speed. The sender is molded in synthetic resin and is therefore almost entirely insensitive to mechanical stresses and reasonable temperature variations. The sender unit is placed in the air intake in front of the radiator, see Fig. 10-78.

Because of the sensitivity of the transistors for battery polarity, faulty connection of the sender will result in it being destroyed immediately.

When connecting the sender, therefore, great care must be taken to ensure that the terminals are connected correctly. This applies particularly to the terminal pin marked "M".

In the event of a fault in the revolution counter, the function of the instrument dial can be checked by connecting an ammeter for 10 milliamps or more (max. 100 milliamps) between the chassis (negative) and the terminal pin "M", (positive). At 2800 r.p.m. the meter should show 10 milliamps. The internal resistance of the ammeter must be less than 70 ohms at the measuring range concerned.

If the meter gives no reading, the sender unit must be replaced after having ascertained that there is no fault in the leads.

Concerning data, see the specifications.

Connecting:

"M" to positive terminal of instrument.

"+" to ignition switch

"B" to breaker contact

The short lead is grounded.

### Fuel gauge

The fuel gauge is removed as follows:

1. Disconnect one of the battery leads.
2. Remove the bulb holders for the instrument lighting.
3. Undo the clamps which hold the instrument and lift it down.
4. Disconnect the leads from the instrument. Mark the leads since any confusion when fitting can ruin the instrument.

### Fuel gauge tank unit

#### Removing

1. Make sure that the ignition key is in the neutral position.
2. Remove the cover over the unit.
3. Blow well clean round the unit.
4. Disconnect the lead and screws which hold the unit and lift it off.

Fitting is done in the reverse order. When fitting, use a new gasket which should be coated with sealing compound.

### Oil pressure gauge

1. Disconnect one of the battery leads. Although the oil pressure gauge is not of the electrical type, this recommendation is given to avoid short-circuits which can be caused by working with tools under the instrument panel. These short-circuits can be both severe and expensive to repair.
2. Disconnect the pipe on the oil pressure gauge.
3. Release the clamps which hold the instrument and lift it down.

Fitting is done in the reverse order. Do not forget to connect the oil pipe before starting the engine.

### Water and oil temperature gauges

The fuel levels must be lowered before the respective sensitive heads can be removed. As in the case above, disconnect one of the battery leads before starting work under the instrument panel. The pipe leads to the sensitive heads must be handled with care and sharp bends, etc. must be avoided.

# FAULT TRACING

It is of great importance to carry out fault tracing systematically. This applies particularly to the electrical system. If any part of the electrical system does not function satisfactorily, the reason must first be established before any measures are taken for repair or replacement. It is thus not sufficient merely to replace the faulty part (instrument) without first testing that this is where the real trouble lies. It is possible

that the fault may be due to outside elements. The procedure for fault-tracing should therefore be:

1. Establish which part is faulty.
2. Establish the reason for the occurrence of the fault.
3. Repair or replace the part concerned.

	FAULT	
Reason		Remedy

## BATTERY

### The battery is discharged or does not maintain charging

Insufficient charging from generator.  
 Fluid level in battery too low.  
 Loose or corroded connections.  
 Short-circuit in brake contact.  
 Internal short-circuit in battery.

Adjust the charging control.  
 Top-up with distilled water.  
 Clean the cable terminals and tighten them carefully.  
 Replace the brake contact.  
 Indicated by the fact that the specific gravity of the acid does not rise during continued charging. Replace the battery.

### Battery gets abnormally warm or gases excessively

Excessive charging from generator.  
 Fluid level too low.  
 Battery has been badly charged.  
 Internal short-circuit.

Adjust the charging control.  
 Top-up with distilled water.  
 Have the battery charged.  
 Replace the battery.

## STARTER MOTOR

### The starter motor does not work

Battery discharged.  
 Bad connections and/or grounding to chassis.  
 Faulty solenoid or starter contact.

Examine the battery. Charge or replace battery.  
 Check the connections at the battery, starter motor and starter relay or solenoid.  
 Press the starter contact and check that the solenoid engages. If it does not do so, check that current is received from the starter contact when this is in the starting position. See also under "Faulty starter motor". A faulty solenoid or starter contact should be replaced.  
 Test by disconnecting the battery lead from the solenoid and holding it against the terminal on the starter motor itself. If the starter motor does not function, remove it for testing and repair. Do not hold the lead in place for more than a few seconds if the starter motor does not work.

Faulty starter motor.

### Test values

Reverse current relay:	
Adjusted for cutting-in at .....	12.4—13.1 volts
at reverse current .....	2.0—7.5 amp.
Voltage control:	
control voltage, idling, adjusted to .....	14.1—14.8 volts
loaded .....	13.0—14.0 volts
Load current:	
Cold generator and regulator .....	45 amp
Warm generator and regulator .....	30 amp

### STARTER MOTOR

Type .....	Bosch EGD 1/12 AR 37
System voltage .....	12 volts
Grounded .....	Negative terminal
Direction of rotation .....	Clockwise
Output .....	approx. 0.9 h.p. at 15° F (−10° C)
	approx. 1.2 h.p. at 70° F (+20° C)
Number of teeth on pinion .....	9
Brushes, designation .....	DSK 35/5
number .....	4

### Test values

Mechanical:	
Axial clearance of rotor .....	0.004—0.012" (0.1—0.3 mm)
Brush spring tension .....	1.76—1.98 lb (800—900 grammes)
Distance from pinion to ring gear .....	0.098—0.118" (2.5—3 mm)
Friction torque of rotor brake .....	2.6—4.34 lb.in. (3—5 kg/cm)
Pinion free-wheel torque .....	1.13—1.56 (1.3—1.8 kg/cm)
Tooth flank clearance .....	0.014—0.023" (0.35—0.6 mm)
Electrical:	
Starter motor unloaded:	
11.5 volt and 40—60 amp. ....	5500—7500 r.p.m.
Starter motor loaded:	
10 volts and 200 amp. ....	1100—1300 r.p.m.
Starter motor locked:	
(r.p.m. = 0) .....	400—450 amp. 8 volt
Solenoid:	
Cut-in voltage .....	Max. 7 volt
Setting measurement "a" (see Fig. 10-29) .....	1.268±0.004" (32.2±0.1 mm)

### FUSES

Fuse boxes under hood on left wheel housing, 3 fuses rated 35 amp.

### REVOLUTION COUNTER

Range .....	0—7000 r.p.m.
Corresponding current in instrument dial .....	0—25.0 milliamps.
Internal resistance in instrument dial .....	75 ohms, max.
Maximum operating temperature for sender .....	160° F (70° C)

### BULBS

	Strength	Number
Headlight bulbs .....	45/40 W	2
Lamp for number plate lighting .....	6 W	2
Rear lights/flashers .....	20/5 W	2
Stop lights .....	20 W	2
Instrument lighting .....	2.4 W	6
Flashers and parking lights .....	20/5 W	2
Map-reading light .....	6 W	1
Roof light .....	5 W	2
Control light for directional flashers .....	2.4 W	1
Control light for headlights .....	2.4 W	1
Control light for charging .....	2.4 W	1
Control light for overdrive .....	2.4 W	1

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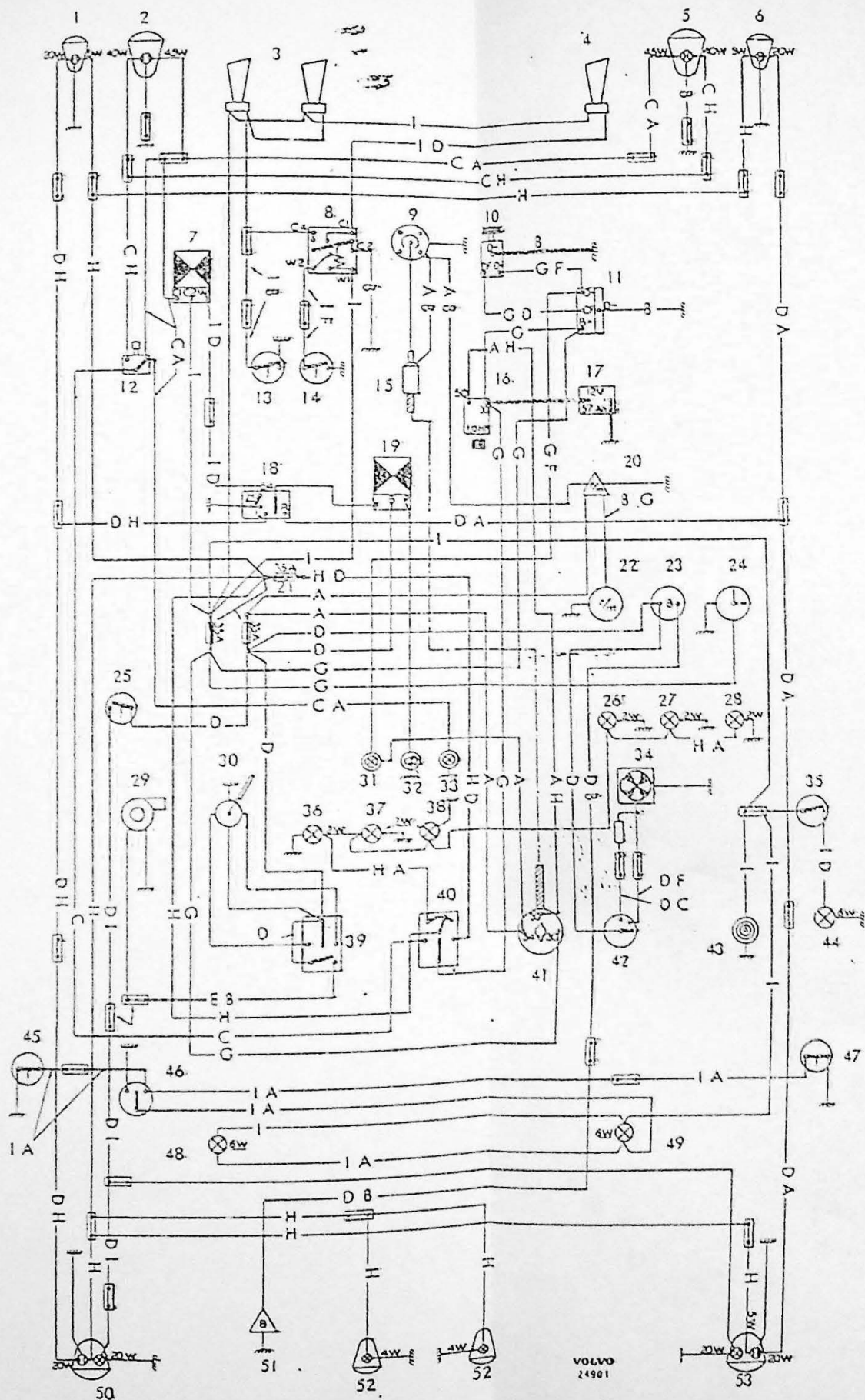


Illustration X. Wiring Diagram

1. Flasher and parking light, left
2. Headlight, left
3. Horn
4. Loud tone horn
5. Headlight, right
6. Flasher and parking light, right
7. Relay for headlight flasher
8. Horn relay
9. Distributor
10. Generator
11. Charging control
12. Foot dimmer switch
13. Horn button
14. Lever for loud tone horn
15. Ignition coil
16. Starter motor
17. Battery
18. Directional indicator switch
19. Flasher impulse unit, directional indicators
20. Revolution counter sender
21. Fuses
22. Revolution counter
23. Fuel gauge
24. Clock
25. Brake contact
26. Instrument lighting
27. Instrument lighting
28. Instrument lighting
29. Windshield wather
30. Windshield wipers
31. Warning lamp, charging
32. Warning lamp, directional indicators
33. Warning lamp, full headlights
34. Heater
35. Switch, map-reading light
36. Instrument lighting
37. Instrument lighting
38. Instrument lighting
39. Controls for windshield wipers and windshield washers
40. Lighting controls
41. Ignition switch
42. Heater controls
43. Cigarette lighter
44. Map-reading light
45. Door contact
46. Switch for roof light
47. Door contact
48. Roof light
49. Roof light
50. Rear light, left
51. Fuel gauge sender
52. License plate lighting
53. Rear light, right

A = White  
 B = Black  
 C = Blue  
 D = Green  
 E = Light green  
 F = Yellow  
 G = Brown  
 H = Red  
 I = Purple