

# CONTENTS 50

Description .....	1
Repair instructions .....	4
Battery .....	4
Dynamo .....	6
Charging relay .....	13
Starter motor .....	18
Ammeter .....	27
Fuel gauge .....	27
Headlights .....	28
Horns .....	28
Switches .....	28
Cables .....	28
Tracing faults .....	30
Specifications (Sec Part 10 for the vehicle concerned)	

## DESCRIPTION

This book concerns repair instructions for the battery, dynamo, charging control, starter motor

and other electrical equipment common to all types of Volvo cars and vans.

### Battery

All cars and vans are fitted with lead batteries (lead accumulators). A lead battery is a battery where the positive and negative plates (electrodes) are immersed in a solution composed of sulphuric acid and distilled water.

The construction of the battery is shown in Fig. 1. The positive and negative plates in each cell are each connected to a positive or negative terminal on the top of the battery. A battery consists of two or more cells depending on the voltage required. Each cell has a voltage of two volts so that a 6-volt battery is composed of three cells.

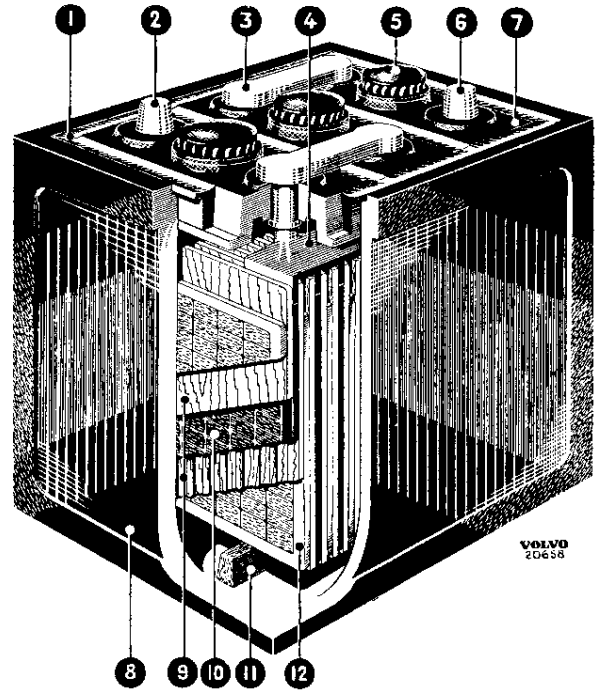


Fig. 1.

- |                       |                    |
|-----------------------|--------------------|
| 1. Sealing compound   | 7. Cover for cell  |
| 2. Terminal, negative | 8. Container       |
| 3. Cell connector     | 9. Wooden spacer   |
| 4. Terminal bridge    | 10. Positive plate |
| 5. Cell plug          | 11. Support        |
| 6. Terminal, positive | 12. Negative plate |

### Dynamo

The dynamo is of the shunt type i.e. its field winding is connected in parallel (shunt) with the rotor winding. The principle of a shunt connected dynamo is shown in Fig. 2. The dynamo charging capacity is governed by a charging relay.

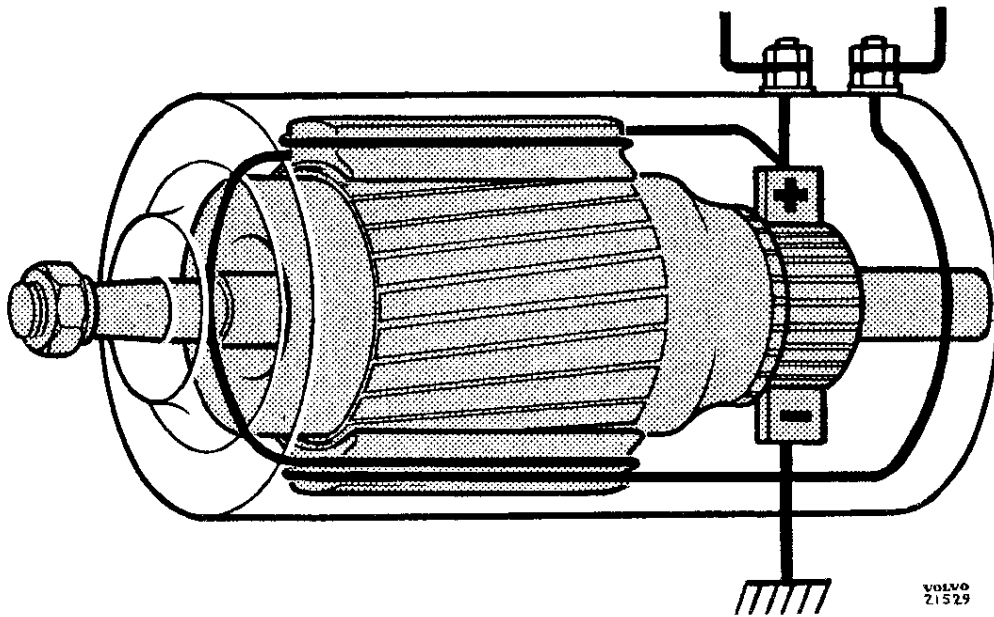


Fig. 2.

## Charging relay

The charging relay is a contact control of the vibrator type, e.g. a continually and rapidly operating contact system. It consists of a voltage control, a current control and a cutout relay.

The principle of a charging relay is shown in Fig. 3.

The voltage control regulates the dynamo voltage according to the battery charging condition and other loading. Should the charge become so powerful that it reaches the maximum permissible charging current strength for the dynamo, the current control comes into action and limits the strength of current to its maximum value.

The return cutout current relay is to prevent the battery from discharging. It is "cut in" when the dynamo is not operating or is operating at such a low speed that dynamo voltage does not exceed battery voltage.

The cutout relay, current and voltage controls are adjustable to facilitate settings to the correct values.

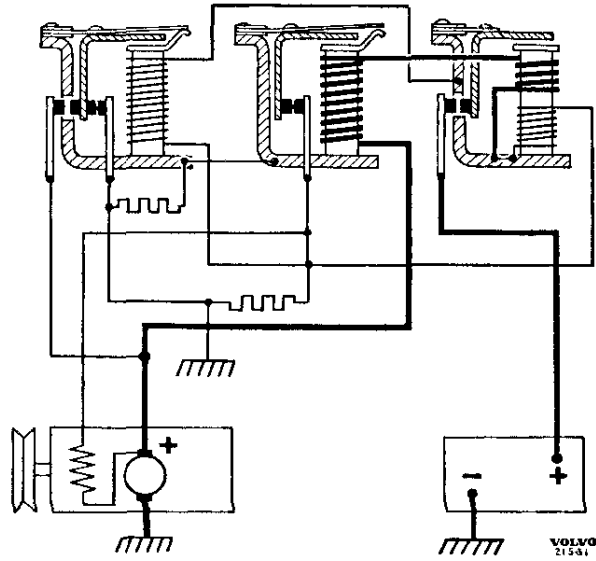


Fig. 3.

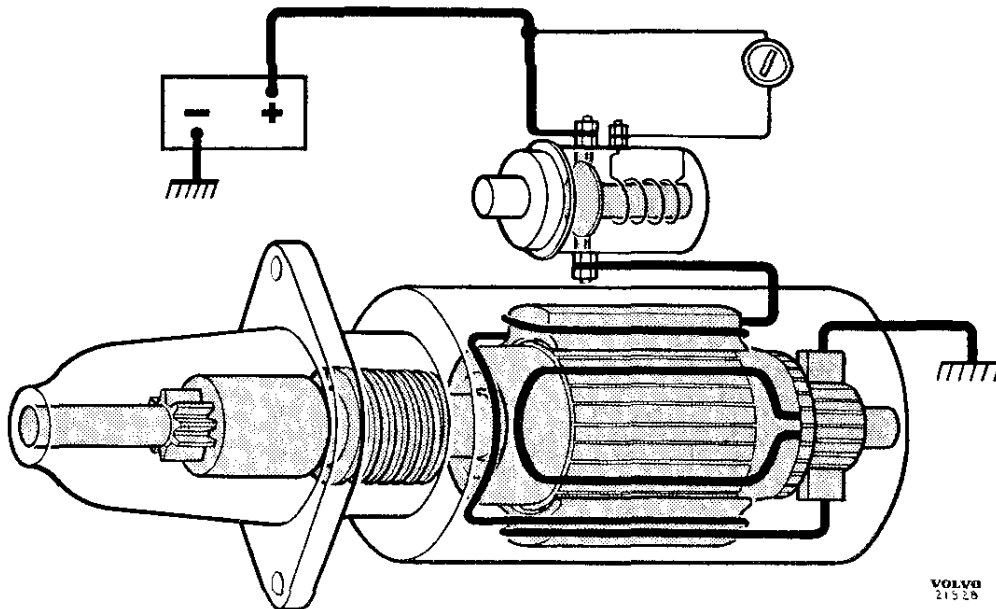


Fig. 4.

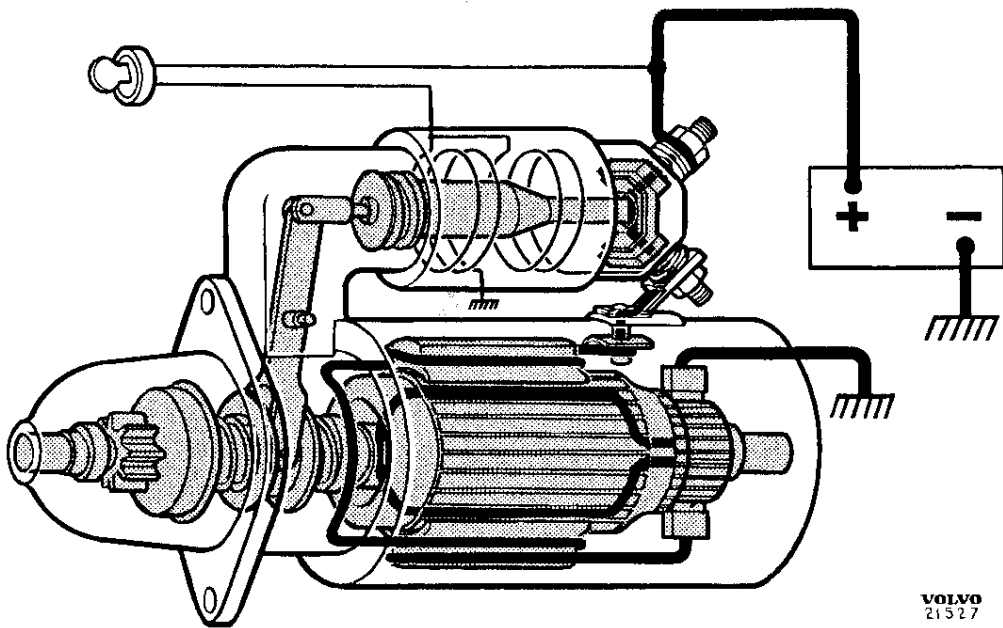


Fig. 5.

VOLVO  
21527

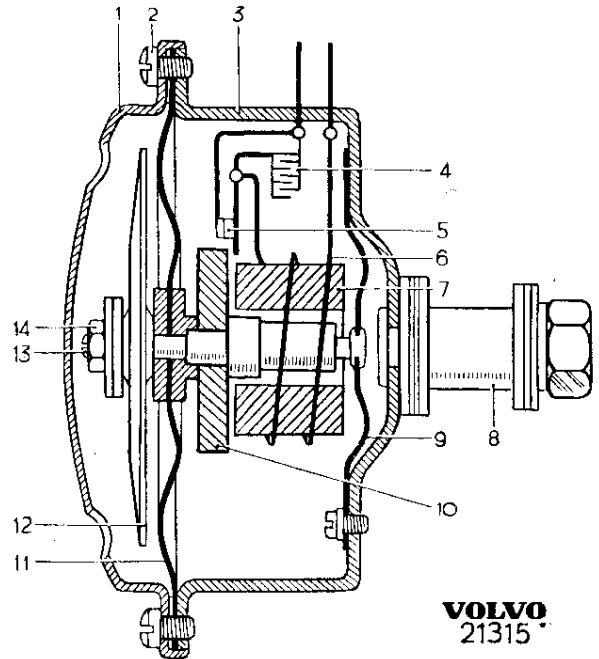
### Starter motor

The starter motor is of the series type which means that the rotor and field windings are connected in series. Concerning the connection of the gear drive, there are two different types; one with a start relay and Bendix drive and the other with a solenoid.

On the model with the start relay and Bendix drive, which is schematically shown in Fig. 4, the control current influences a relay which connects the main current to the starter motor field and rotor windings. When the rotor begins to rotate it meshes the Bendix drive to the flywheel and turns it.

In the case of the model with the solenoid, the control current influences the core through a coil. When the core is influenced it connects the starter gear through a mechanical device, thus connecting the circuit to the field and rotor windings. This type of starter motor is shown schematically in Fig. 5.

double horns. This consists of a relay which, when the horn button is depressed, connects the main current between the battery and the signal horn.



VOLVO  
21315

Fig. 6.

- |                   |                    |
|-------------------|--------------------|
| 1. Cover          | 8. Attachment      |
| 2. Screw          | 9. Leaf spring     |
| 3. Housing        | 10. Armature plate |
| 4. Condenser      | 11. Diaphragm      |
| 5. Breaker        | 12. Vibrator plate |
| 6. Magnet winding | 13. Set screw      |
| 7. Electro-magnet | 14. Lock nut       |

### Horn

The horn is composed of a diaphragm, fitted in a cover, which vibrates rapidly through the influence of an electro-magnet with a breaker. The principle of the horn is shown in Fig. 6. There is a horn relay fitted in vehicles with

## REPAIR INSTRUCTIONS

## Battery Maintenance and charging instructions

The battery must be kept in first-class condition if it is to operate properly. One of the most important things to observe is that the electrolyte is kept at the prescribed level above the plates. Should the electrolyte be allowed to sink lower than the upper edges of the plates, the full capacity of the battery will not be employed as only the part of the plates which are submerged in the electrolyte can influence the charging and discharging. Check that the electrolyte is 5—10 mm ( $1/4$ "— $1/2$ " ) over the top of the spacer. Check the level with a glass tube. If the level is too low, top-up with *distilled* water. Use a filler flask as shown in Fig. 7.

N. B. Battery acid must never be used when topping-up as described above.

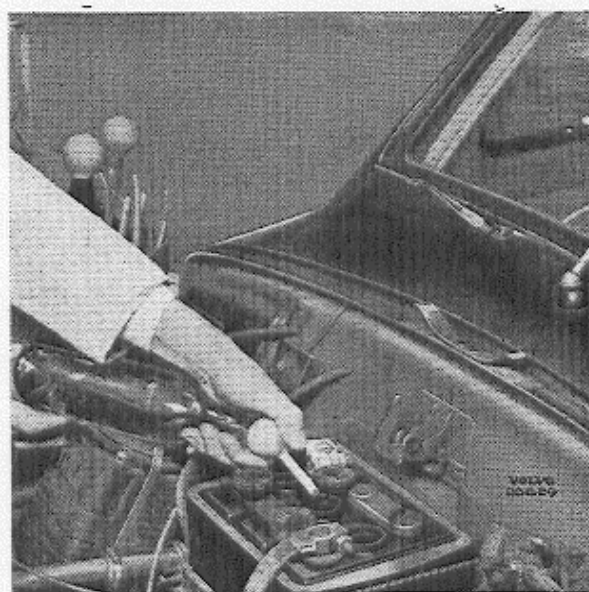


Fig. 7.

Check that the battery sits firmly in place. Cell plugs, connections and terminals must be well tightened.

Check that the impregnated felt rings are undamaged to prevent the cable and positive and negative terminals from corroding. The positive and negative felt rings are red and green respectively. Cable terminals should be coated with vaseline.

If the battery should be completely discharged or if the electrolyte specific gravity has sunk below 1.23, the battery must be lifted out and charged at a charging station. The electrolyte specific gravity should be measured with a hydrometer as shown in Fig. 8.

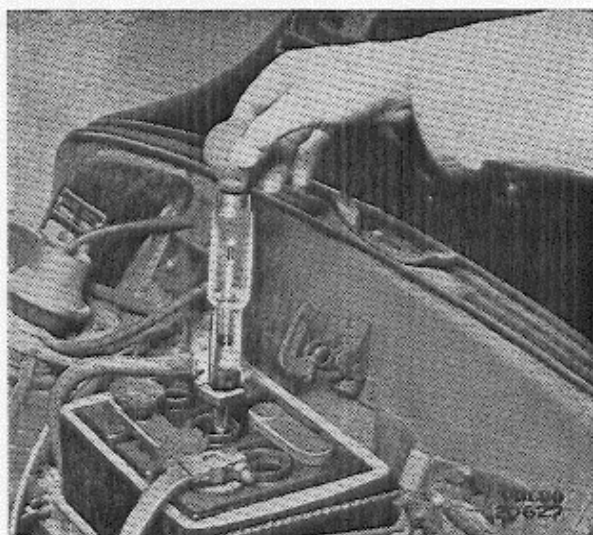


Fig. 8.

If the battery is to be recharged for the above-mentioned reason; lift the battery out of the vehicle and at the same time wash and rinse it externally with clean water. Pull off the battery terminals with a puller supplied for that reason if they are tight on the terminals, Fig. 9.

Use only direct current for charging. Alternating current can ruin the battery.

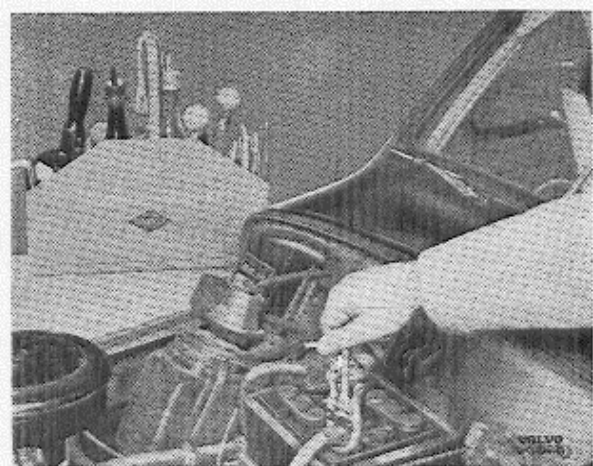


Fig. 9.

Connect the charging unit positive cable to the battery positive terminal and the negative cable to the negative terminal and check that they make good contact.

Screw out the plugs and check the electrolyte level. If the level is too low, top-up, with *distilled water*.

**N. B.** Battery acid must never be used.

The plugs must not be screwed in during charging as this can cause considerable damage to the battery (the battery can explode). Turn on the charging unit and adjust the charging rate to the current stated in the specifications.

Do not smoke or allow any naked flame in the charging room or in the vicinity of the battery. The fumes which are generated are highly inflammable and can cause an explosion.

When the electrolyte specific gravity has reached 1.28 and has not risen further, despite continuous charging during the last two hours, the battery is fully charged. When charging is completed the cell voltage should be about 2.6 volts.

If the above-mentioned specific gravity is not reached but remains constant at a lower value, despite several hours charging at the prescribed current, the electrolyte specific gravity must be adjusted to 1.28. This is carried out by drawing off a certain amount of electrolyte and replacing it with battery acid with a specific gravity of 1.36. Carry on charging for a further half hour so that the electrolyte and acid mix.

If the electrolyte specific gravity is above 1.28 when charging is complete, draw off some of the electrolyte and replace it with distilled water. After filling always check that the level is correct.

Disconnect the battery when it is fully charged. Screw in the cell plugs and rinse the battery externally with clean water.

When the battery is fitted in the vehicle, check that it is properly attached, that the cable terminals are cleaned and well tightened and they are coated with vaseline. The cable terminals are most effectively cleaned with pliers specially made for that purpose, see Fig. 10.

To determine the battery condition when charging it can be tested with a cell tester. The voltage should not be lower than 1.6 volts and should not vary more than 0.2 volts during a 10—15 second period.

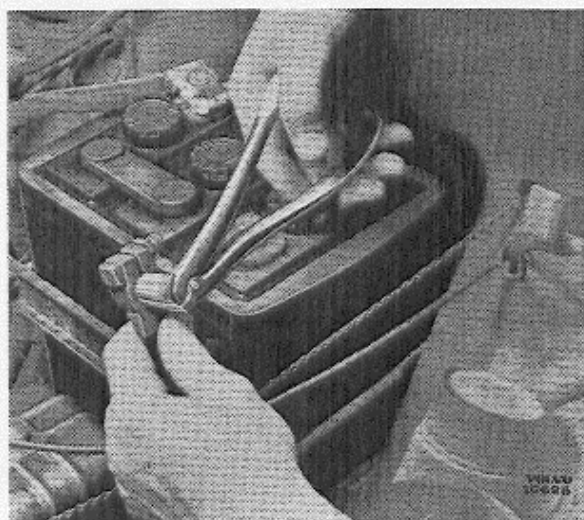


Fig. 10.

Electrolyte specific gravity at  $+15^{\circ}\text{C}$  ( $59^{\circ}\text{F}$ ) and various battery charge conditions:

Charge condition		Electrolyte specific gravity
Full charge	(1/1)	1.28
Three-quarter charge	(3/4)	1.24
Half charge	(1/2)	1.21
Quarter charge	(1/4)	1.16
Discharged	(0)	1.12

### Storing the battery

The vehicle battery should be stored in a dry dust-free place. The temperature should be kept between  $0^{\circ}$  and  $20^{\circ}\text{C}$  ( $32^{\circ}$  and  $68^{\circ}\text{F}$ ).

#### Storing an uncharged battery with wooden spacers (without acid)

The spacers, which are moist when fitted, gradually dry and eventually split when in storage over a considerable period of time. Due to the moisture the plates suffer from sulphation fairly quickly. By reason of this fact, uncharged batteries fitted with wooden spacers should not be stored for a longer period than a maximum of six months.

There are special instructions concerning the charging of batteries for the first time. These instructions are supplied with every new battery.

#### Storing an uncharged battery with dry spacers (without acid)

Uncharged batteries with dry spacers, e.g. rubber, can normally be stored for several years.

The plugs are well sealed with special washers when delivered from the factory and must not be unsealed during the storage period.

Instructions concerning the first charging accompany the battery on delivery and should be carefully followed.

### Storing of charged batteries (with acid)

The capacity of the electrolyte specific gravity sinks successively as the plates suffer from sulphation and thus harden.

For this reason all batteries must be recharged about once a month. Charge for a few hours with the specified current. Check that the electrolyte specific gravity rises to its correct value, about 1.28.

The electrolyte should be about 5—10 mm ( $\frac{1}{4}$ — $\frac{1}{2}$ " ) above the separators and should it be necessary to top-up, this should be done with *distilled water*.

Sulphuric acid should only be added under special circumstances. See under the heading "Maintenance and charging instructions".

When storing over an extensive period of time, the charged batteries should be discharged about every third month with the current with applies for the following charges, to a lower limit of 1.75 volts per cell. Recharging should then be carried out according to the above instructions.

### Removal of lead sulphate from the plates

Provided that any sulphate deposits have not taken too great a hold, the plates can regain first-class condition if the following instructions are carried out.

Remove all electrolyte from the battery and replace it completely with distilled water. Charge the battery to about  $\frac{1}{4}$  of the specified value, until the voltage has reached a minimum of 2.55 volts per cell.

Remove the distilled water and replace it with diluted sulphuric acid with a specific gravity of 1.28. Charge the battery for a short time so that the newly added electrolyte mixes with the electrolyte which was left in the plates and separators.

In the case of excessive sulphation the batteries should be charged and discharged several times when filled with distilled water before refilling with electrolyte.

### Fitting check

Before fitting new batteries the following instructions should be observed:

1. The electrolyte specific gravity should be checked with a hydrometer, batteries with electrolyte specific weight less than 1.27 should be charged.
2. The cell voltage should be checked with a cell tester.
3. The container should be examined and cleaned.
4. Terminals and connections should be brushed with a steel brush.

### Examining the battery

The level of electrolyte in the battery should be checked once a fortnight in the summer and once a months in the winter. If necessary top-up with distilled water so that the electrolyte is about 5—10 mm ( $\frac{1}{4}$ — $\frac{1}{2}$ " ) above the separators.

The electrolyte specific weight should be checked at the same time. Should it show a value of less than 1.23 the battery should be charged immediately. Suitable charging currents are shown in the specifications.

### Charging a battery for the first time

When a battery is charged for the first time the instructions which the manufacturer delivers with the battery should be carefully followed.

### "Quick-charging" units

In exceptional situations a "quick-charge" can be used instead of the usual rectifier of the slow-charging type and provided it concerns the recharging of a previously charged battery which has more or less discharged. The first charging should never be carried out with a "quick-charging" unit. It is imperative that the temperature never exceeds + 40° C (104° F). Should this happen charging must cease immediately and then continue when the temperature has sunk.

### Dynamo

#### Procedure to be carried out before removal and disassembly

Should the dynamo not charge or there be any reason to suspect that it does not generate current in sufficient quantities, or should it produce excessive current or voltage, make sure that the

fault lies in the dynamo itself and not in the ammeter, charging relay or cables.

First check that the connection from the battery to the relay connection marked B (51 B+ on Bosch control) is complete. This is carried out with a voltmeter. The voltmeter is connected between the relay connection B (51 B+) and the chassis. The voltage should not be noticeably less than the battery voltage. Should the voltmeter give a poor reading, the cables and contact points must be examined. Should there be no reading whatsoever on the voltmeter there is a breakdown in the system.

Should no faults be discovered carry out the following test on the dynamo. Unscrew the cables on the dynamo. Connect the sealed take-off (a small screw) with a cable to the dynamo frame, connect a voltmeter between the dynamo current take-off (thick screw) and the dynamo frame. Start the engine and increase from idling up to about 2000 r.p.m. watching the voltmeter reading at the same time. The voltage should increase as the engine speed increases. Return to idling and disconnect the field frame connection. The voltmeter should then return to zero. Should it not do this the field is connected to the frame inside the dynamo whereupon the charging cutout device is put out of action which can result in the dynamo burning out. The test can also be carried out in the following way: Release the dynamo cables on the charging relay. Connect the field

cable to the frame, increase the engine speed slowly at the same time bringing the other dynamo cable into contact with the charging relay frame several times. Powerful sparks will appear when contact between the cables and the charging relay frame is broken.

Break the contact between the charging relay frame and the field cable, bring the main cable into contact with the charging relay frame again and should there be no sparks, the field is earthed inside the dynamo.

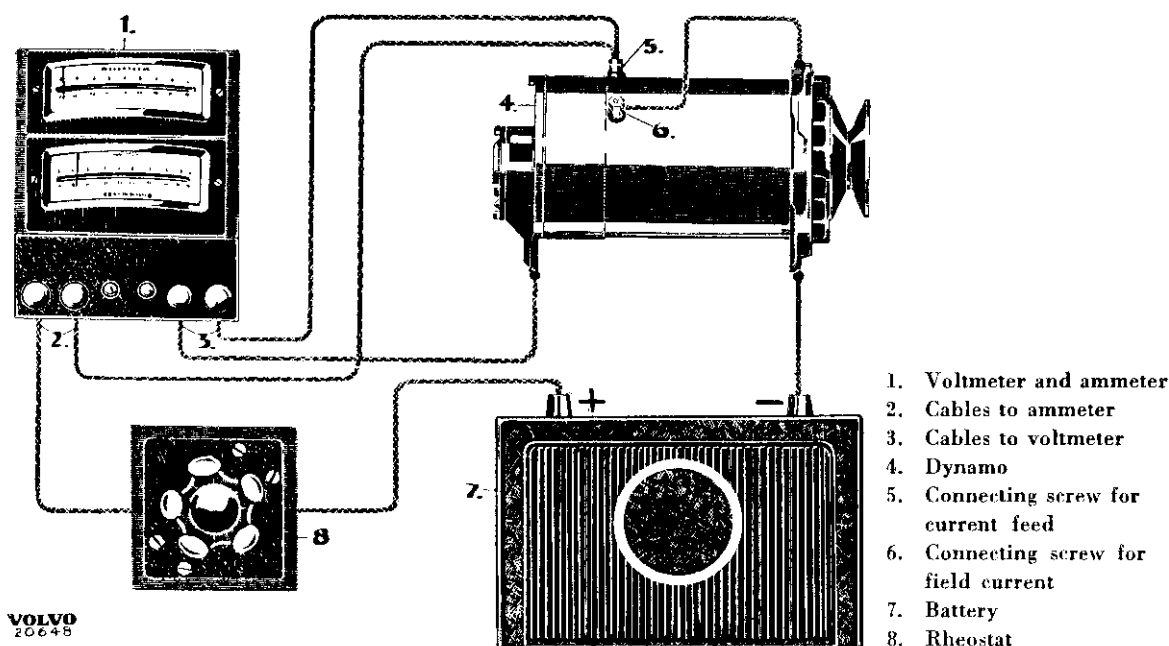
If no sparks are seen or if the voltmeter gives no reading, the dynamo is faulty and must be removed.

## Removing and examining the dynamo

For instructions concerning the removal of the dynamo, see under the heading "Dynamo" in part 10 (Electrical system) for the vehicle concerned.

After removal clean the dynamo externally with petrol or something similar. The protector strip for the carbon brushes should be removed and the dynamo fitted in a test bench. The test which is now to be carried out is to ascertain the type of fault in the dynamo and it is imperative that the test is carried out correctly and with the correct instruments.

The dynamo field feed is connected to the dynamo frame which is connected to the battery



VOLVO  
20648

Fig. 11. Testing the dynamo (dynamo as motor).

negative terminal. The positive terminal on the battery is connected in series with an ammeter to the dynamo current feed.

The dynamo should now act as a motor with a low, even speed: should this not be the case see the following fault tracing table.

This test can also be carried out as follows: Connect a rheostat between the battery and the ammeter. A voltmeter should be connected over the dynamo current feed and dynamo frame, see Fig. 11. The rheostat should be adjusted according to the specification. The dynamo current consumption should now correspond with the given specification. Should it not correspond with one of the given values, one of the following faults can be to blame.

Low amperage, rotor standing still.	Carbon brushes worn or have stuck in their holders and cannot contact the commutator.
Low current, rotor rotates slowly.	Poor contact between the carbon brushes and the commutator. Breakage in the rotor winding.
High current, rotor standing still.	Short circuit in rotor. Breakage or short circuit in field. One of the bearings has seized.
High current, rotor rotates.	Damaged or burnt commutator. Seized bearings. Excessive brush spring pressure.
Excessive carbon brush movement and intensive sparking.	Out-of-round or burnt commutator. Damaged carbon brushes.

### Disassembly

The dynamo should be disassembled for overhaul (cleaning and lubricating) in the following manner:

1. Remove the protector strip if this has been refitted after testing.
2. Unscrew the carbon brush connecting cable. Lift up the pressure arms or the carbon brush springs with the hook and pull up the carbon brushes, see Fig. 12.
3. Remove the screws which hold the dynamo housing and the commutator end heads together.

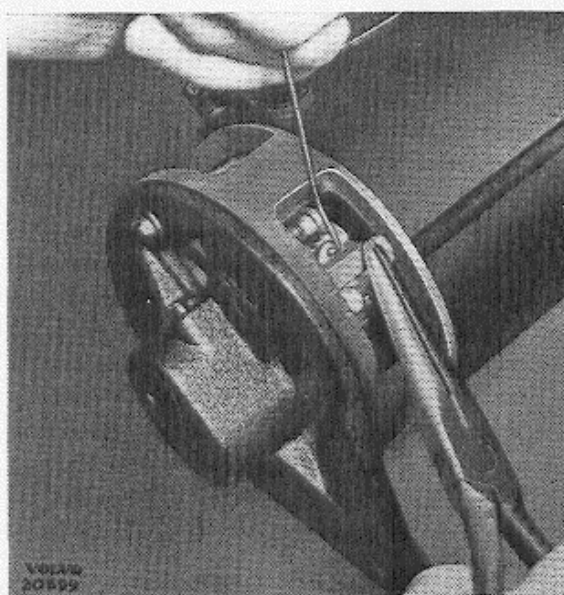


Fig. 12.

4. Lift out the rear commutator end head with the carbon brush holders.
5. Lift the rotor out of the housing.
6. Fit the rotor in a vice, but do not tighten excessively (use copper jaws). Loosen the nut for the pulley and pull off the pulley. Use tool SVO 2002, Fig. 13. Remove the Woodruff key.
7. Remove the commutator end head from the rotor.
8. Pull off the ball bearing with a standard puller.

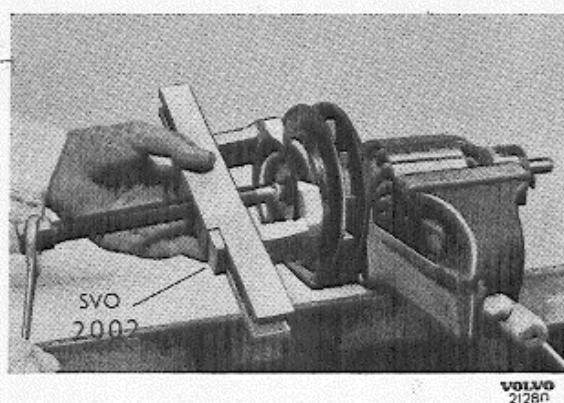


Fig. 13.

9. Blow the generator, field winding and rotor clean from dust with a blast of compressed air. Wipe with a piece of rag moistened with petrol. N.B. Alcoholic petrol, e.g. bentyl, should not be used as this will dissolve the

shellac. Clean the remaining components, except the carbon brushes, with clean petrol.

### Inspection

Examine the rotor concerning mechanical faults. It can happen that the rotor is bent, has a worn shaft, damaged commutator or damaged or loose rotor winding.

A slightly bent shaft can be aligned in a press but this is not to be recommended. It is preferable to replace the rotor.

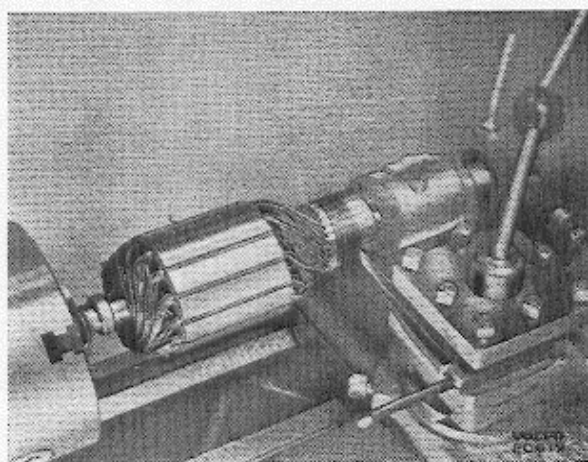


Fig. 14.

If the commutator is scratched or unevenly worn it should be lathe-turned. When turning, a chuck specially made for this purpose should be used, see Fig. 14. Great care must be taken. Take small cuts each time so as not to remove more material than is absolutely necessary. If too large

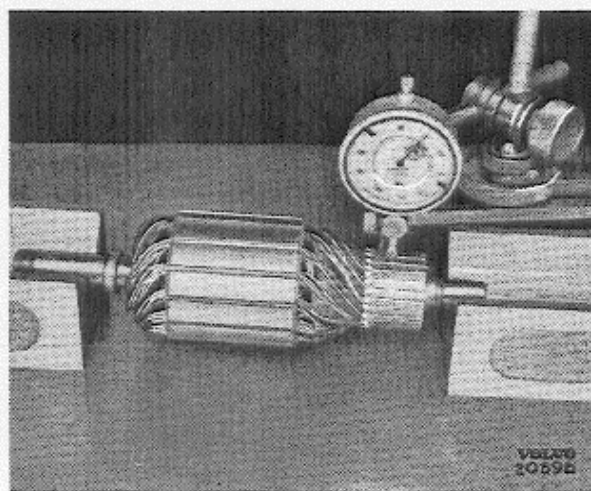


Fig. 15.

a cut is taken the insulation and segments can be damaged. Make sure that no shavings come into contact with the rotor or the windings during turning.

After turning the commutator should be checked as shown in Fig. 15. An out-of-roundness of 0.013 mm (0.0005") is permissible. The insulation between the segments should be cut back 0.8—1.0 mm (0.03"—0.04") under the segment surface, Fig. 16. This is done with a special apparatus or should such apparatus not be available, with a ground hacksaw blade.

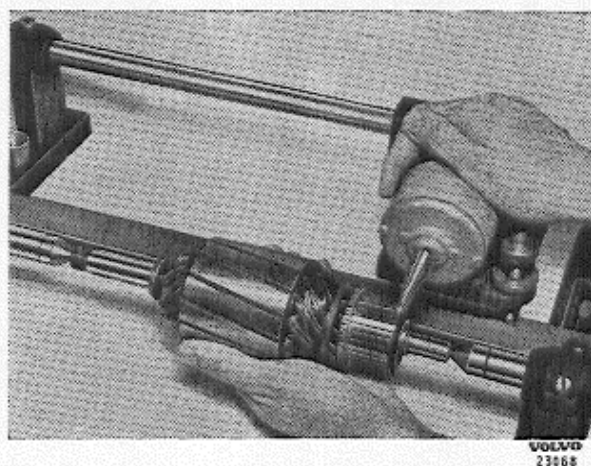


Fig. 16.

Examine the rotor before and after turning by fitting it in a growler. Throw over the switch and hold a hacksaw blade a few mm from the rotor, Fig. 17. Should the blade vibrate in any position when the rotor revolves, it can be caused by one

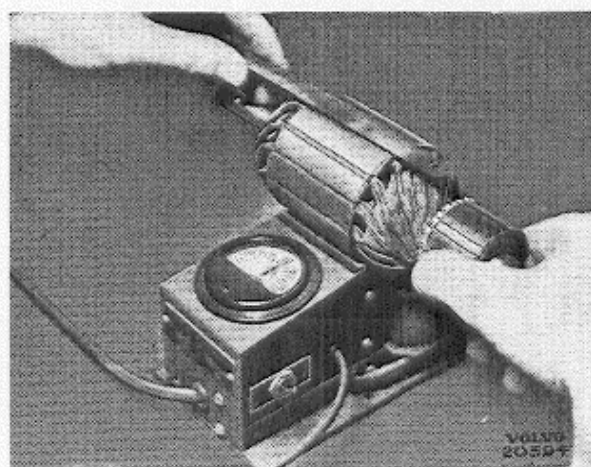


Fig. 17.

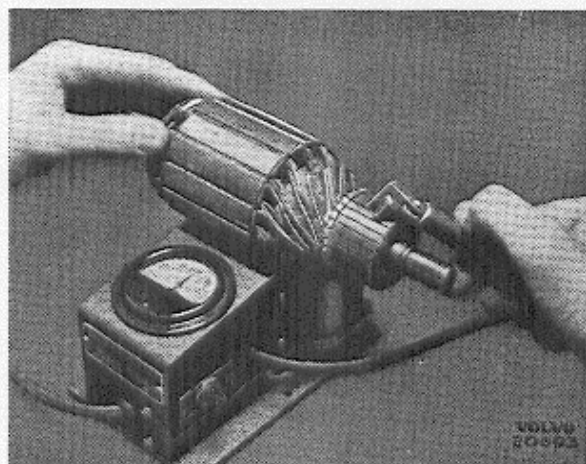


Fig. 18.

of the following faults: leakage to the rotor frame, leakage in the commutator or windings.

Leakage between the windings can be measured by holding a resistor fork against the commutator, as shown in Fig. 18. Switch on and adjust the rheostat while the rotor is turned to and fro until the highest reading is obtained on the gauge. Turn the rotor (holding the fork still) so that the next pair of plates come immediately opposite. Hold the fork against these. If there is no fault the reading should be the same and so on with the other plates. A rotor with a leak between the winding rotations shows a low reading and a rotor with a breakage shows no reading at all.

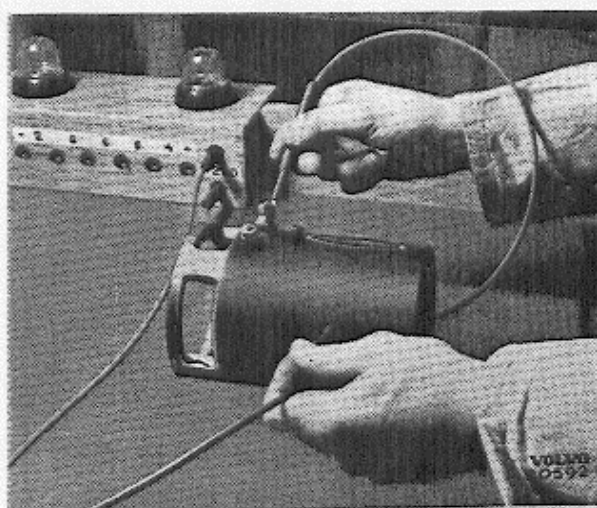


Fig. 19.

A leakage to the rotor can be ascertained with the aid of tester pins and a test lamp.

Examine the housing and field winding concerning damage which could have been caused by the rotor. Check that the field winding is not earthed to the frame by connecting contact points to the field and the housing as shown in Fig. 19. If the lamp lights, a short circuit has occurred between the field winding and the housing. Check that the cable from the field winding to the positive brush holder does not lie against the housing. Unscrew the field connection and test again. If the lamp lights again the field winding is in contact with the housing.

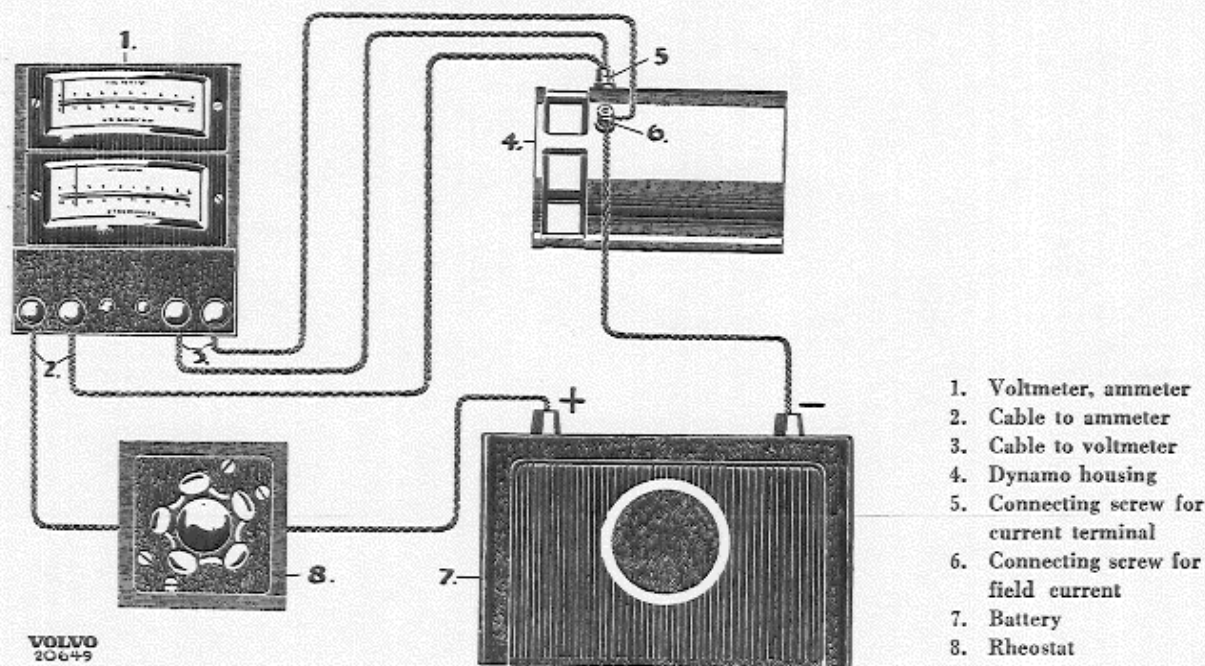


Fig. 20. Measuring the dynamo field winding.

The winding must then be removed. See under the heading "Replacing the field winding".

Internal faults in the field coil can be checked by measuring the coil current consumption. This is carried out with a voltmeter and ammeter. Our specifications give the coil current consumption at 5 volts. To be able to check with this voltage requires a rheostat. Connect as shown in Fig. 20. The rheostat must be set so that the voltmeter shows 5 volts. The value on the ammeter should correspond with the specifications. Otherwise the field winding must be replaced. Examine the rear commutator end head and brush holders. Should any components be damaged they must be replaced with new. Check that there is no short-circuiting between the positive brush holder (insulated) and the commutator end head.

Carbon brushes which are damaged or worn down more than half way must be replaced. Carbon brushes which are damaged or have poor contact against the collector can be ground with sand paper, size 00 or 000. See Fig. 21.

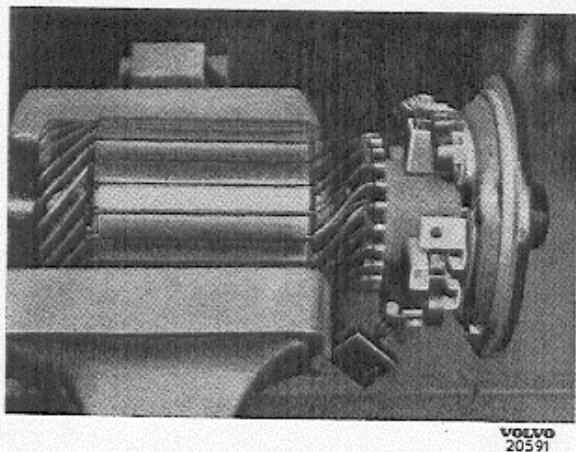


Fig. 21.

Test the carbon brush pressure by mounting the commutator end head on the rotor and connecting a spring balance to the flexible arm or spring, Fig. 22. The power which is required to lift the arm or the spring should correspond with the specifications. Should the values not correspond, the spring must be replaced.

Check the bearing. The ball bearing should run easily without any looseness when rotating. Damaged or worn bearings must be replaced. Bushings should be replaced if necessary.

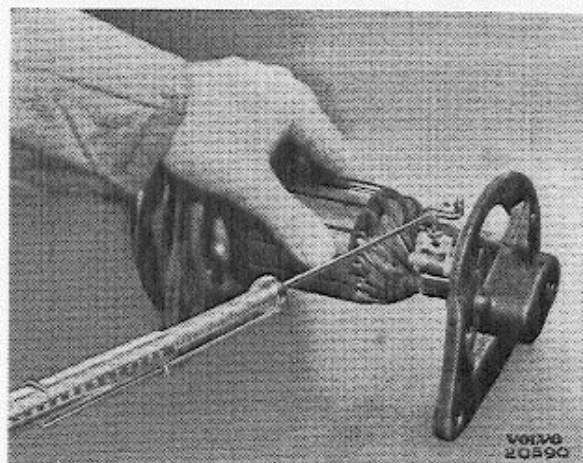


Fig. 22.

### Assembly

1. Fit the stop ring and sleeve, if there is one, on the shaft.
2. Place on the inner cover and felt ring of the shaft. Lubricate the bearing with heat-resistant ball-bearing grease and then fit it into place.
3. Fit the forward commutator end head on the shaft and bearing. Fit the outer lock with felt ring next to the commutator end head and screw the commutator end head and cover together.
4. Drive in the cross key and press on the pulley. Fit the rotor in a vice. Do not tighten excessively as it can deform the rotor. Fit the spring washer and nut.
5. Push the rotor into the housing and check that the guide pin comes into the correct position.
6. Fit the commutator end head onto the shaft, match the guide pin and screw in the two screws which hold the dynamo housing and commutator end heads together. Check that the rotor runs easily. Fit the carbon brushes in the holders in the rear commutator end head.
7. Connect the cable for the main current on the positive brush.
8. Fit the lubricating felt after it has been dipped in engine oil.
9. The dynamo is now ready for testing. Regarding that, see page 13.

### Replacing a carbon brush

If the carbon brushes have worn down more than half way or are damaged, they must be

replaced. This is normally indicated by the fact that the dynamo stops charging. Loosen the protector strip and inspect the carbon brushes and commutators. If the above-mentioned fault is the cause of the trouble, remove the dynamo.

Clean the outside of the dynamo carefully or wipe it with a rag which has been moistened with petrol.

Remove the carbon brushes by loosening the contact on the brush holders, lift up the brush spring and pull up the carbon brush with pliers, see Fig. 12.

If the commutator is scratched or unevenly worn the dynamo must be disassembled and the commutator turned. See under the heading "Disassembly, inspection and assembly".

Fit the carbon brushes into place, check that the right type are used, and refit the protector strip. If there should be a dynamo testing device in the vicinity it is wise to test the dynamo before it is refitted into the vehicle. See under the heading "Testing the dynamo".

### Replacing the field winding

1. If the dynamo is not already disassembled, this must be done according to points 1—5 under the heading "Disassembly".
2. Fit the dynamo housing in a V-block as shown in Fig. 23. Fit a driver in the drill chuck. Press downwards at the same time

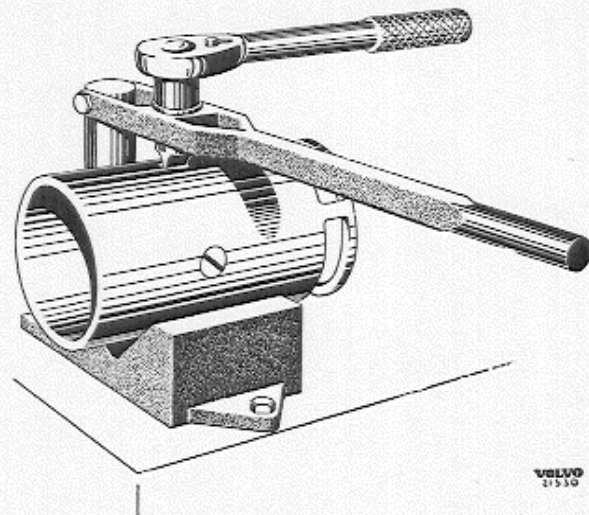
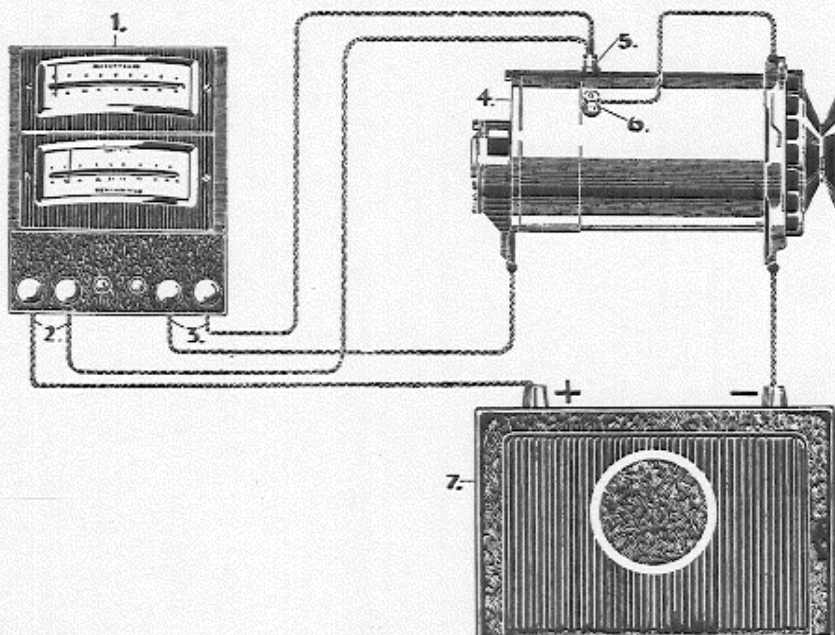


Fig. 23.

as the driver is rotated. The screws normally sit very tightly. Check that the driver fits into the groove on the screws and is wide enough.

3. When both of the screws have been released, lift the housing out of the way. Screw out the screws with the screwdriver. Release the cables which pass through the housing and lift out the windings and cable terminals.
4. Fit the new field winding in the housing. Use the same device as used when releasing the screw.



1. Voltmeter, ammeter
2. Cables to ammeter
3. Cables to voltmeter
4. Dynamo
5. Connecting screw for current terminal
6. Connecting screw for field winding
7. Battery

Fig. 24. Connections for bench testing.

5. Connect the cables to the through way in the housing. Test for earthing.
6. Assemble the rest of the dynamo component parts. See under the heading "Assembly".

### Testing the dynamo

Before the dynamo is refitted in the vehicle it should be tested. Fit the dynamo into the test-bench and connect the voltmeter and ammeter. See Fig. 24.

First run the dynamo as a motor for a short while. Check that the dynamo has the correct polarization, earthed to frame. Make sure that the dynamo current consumption is normal and that it runs quietly and smoothly etc. Then start the drive motor, check the direction of rotation, make sure that the dynamo gives the specified voltage. Check that there is no sparking on the commutator and that the carbon brushes do not "jump".

Fig. 25 shows the type of apparatus used for testing the dynamo.

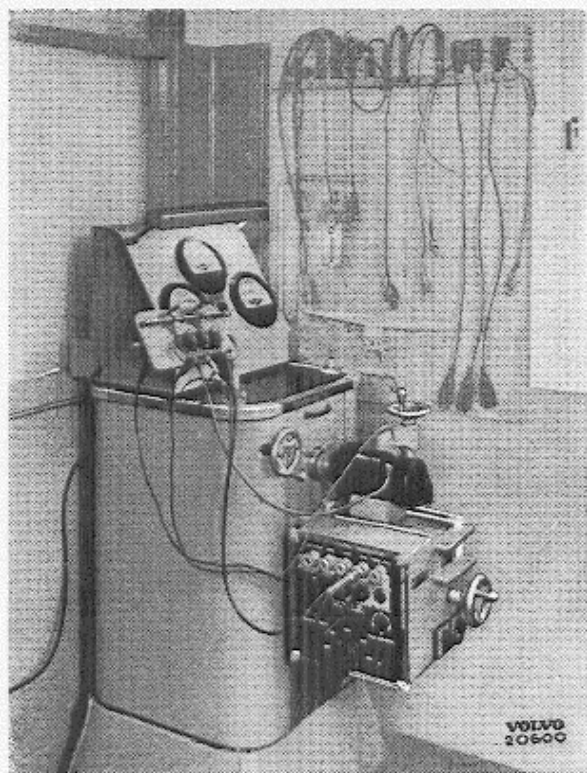


Fig. 25.

### Charging relay Testing and adjusting

The work on the charging relay which is described here applies only for testing and adjusting. Other types of work which can be classified as repairs, e.g. the replacement of coils or burned contacts, damaged insulation or burned resistance, should be carried out by the local Bosch or Auto-Lite representatives.

When working on the charging relay you should have accurate measuring instruments at your disposal. Fig. 26 and 27 show two of the normal instruments of American manufacture.

All measurements should be carried out when the charging relay has reached operating tempe-

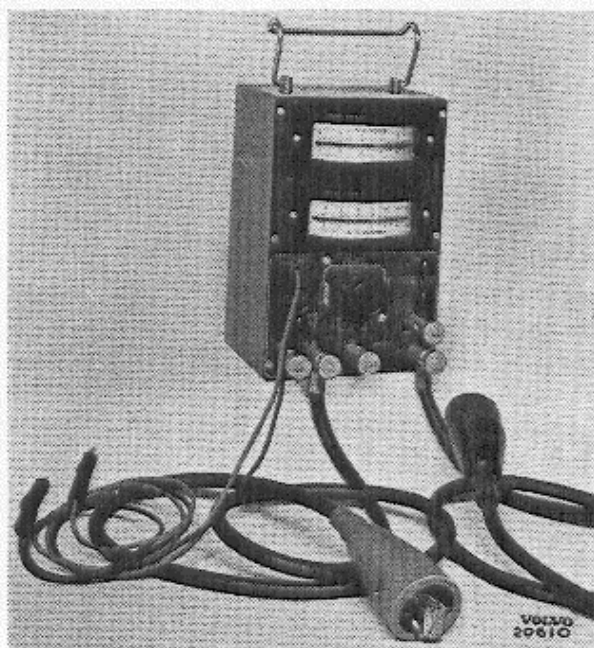


Fig. 26.

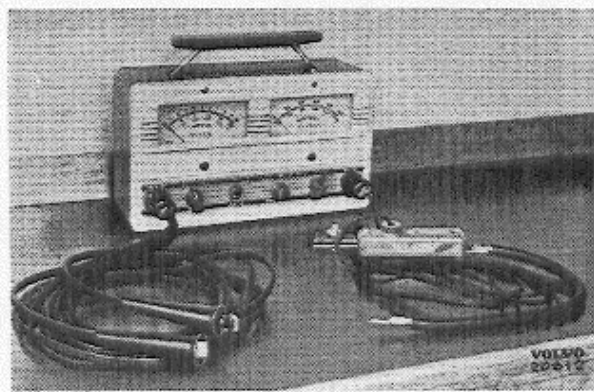


Fig. 27.

ratures. This is done by letting the relay operate with normal charging current for 15—20 minutes.

Always have the relay cover fitted when taking readings as it has a very strong influence on the function of the control.

The charging relay consists of a cut-out, current control and voltage control, which are fitted on the same frame.

*N. B.* The current and voltage controls never operate simultaneously.

### Testing and adjusting in the vehicle

The work which can be carried out on the charging relay when it is fitted in the vehicle is limited to minor adjustments of the cut-out, voltage control and current control. We recommend that for major adjustments and accurate check the charging control should be fitted in a test bench.

### Adjusting the cut-out

Connect an ammeter in series with the connection B (51 B+) on the relay and the thick cable from the battery. A voltmeter should be connected to A (D+61) on the relay and to the dynamo frame. Start the engine and increase the engine speed slowly while watching the voltmeter. This increases first until the cut-out closes and then sinks about 0.1 volts and remains steady. The value reached by the voltmeter at that instant before the cut-out closes is called the "cut-out" voltage. This should be compared with the specifications whereupon any necessary

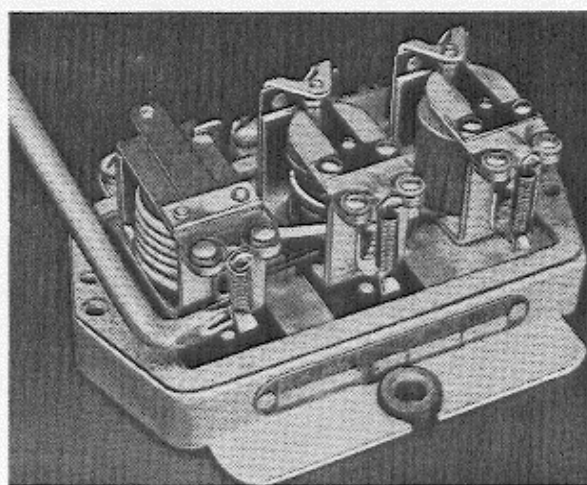


Fig. 28.

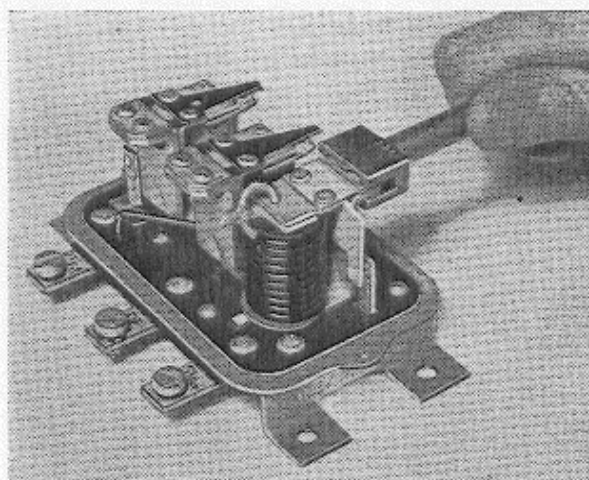


Fig. 29.

adjustments can be carried out (instructions concerning this come later).

The "cut-out" voltage is checked by first increasing the dynamo speed to about half charge and then letting the speed decrease slowly at the same time watching the ammeter. This will first recede to zero and then go over to show discharge. The current value when the relay opens is called the reverse current. This value should be compared with the specifications.

The closing voltage is adjusted by increasing or decreasing the spring pressure which influences the relay armature. Decrease the spring pressure and the cut-in voltage decreases and increase the spring pressure and the cut-in voltage will then increase.

Auto-Lite charging relays are adjusted with a tool as shown in Fig. 28.

Bosch charging relays are adjusted with Robo tool No. V 397. Mode of operation is shown in Fig. 29.

*N. B.* Pliers and screwdrivers are very unsuitable for use as adjusting tools — do not use them.

The reverse current is adjusted by altering the air gap between the armature and the solenoid core. See under disassembled control.

Each time the cut-in voltage is adjusted the reverse current must be checked and vice versa.

### Adjusting the voltage control

#### Auto-Lite

Connect the ammeter as when adjusting the cut-out relay, connect the voltmeter between connection B and the relay frame. Turn on the

vehicle lighting. Run the engine at about 2000 r.p.m. Watch the voltmeter reading and adjust the voltage control as specified.

### Bosch

Connect the voltmeter between 51 B+ and the relay frame. Run the engine at about 2000 r.p.m. Read off the voltmeter and adjust the voltage control as specified.

*N. B.* The cover should be in place when the instruments are read.

The Auto-Lite charging relay is adjusted by increasing or decreasing the spring pressure

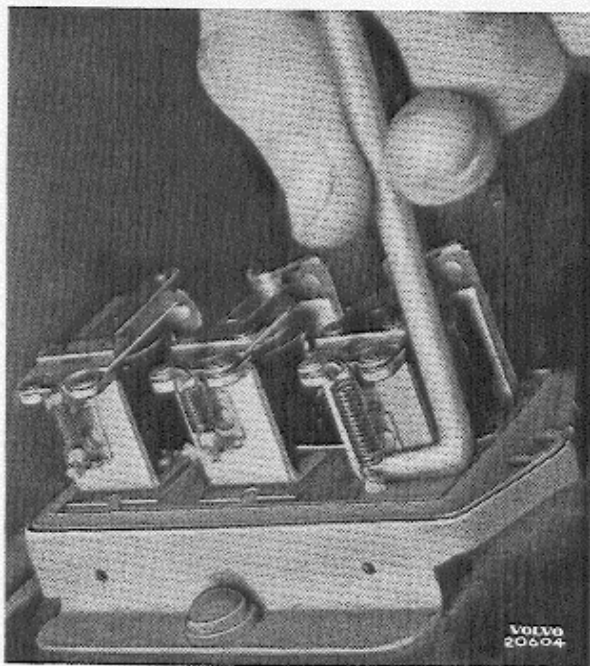


Fig. 30.

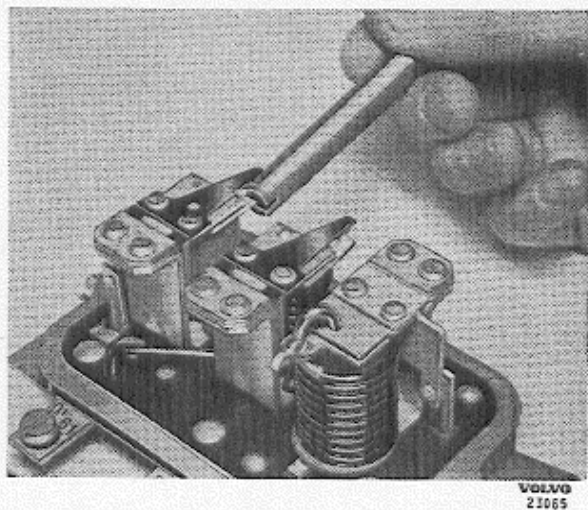


Fig. 31.

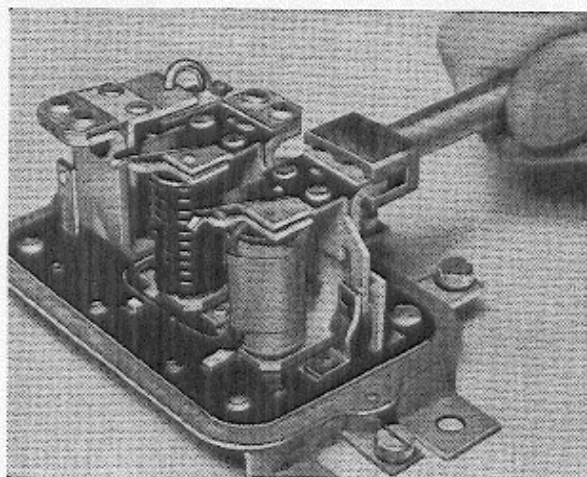


Fig. 32.

which influences the armature. Decrease the spring pressure and the voltage decreases and vice versa. See Fig. 30.

The Bosch unit is adjusted by bending the support projection for the spring tongue down so this is free, see Fig. 31. Then carry out any large adjustments by bending the adjuster arm as shown in Fig. 32. Bend the arm down and the voltage increases and vice versa. Major adjustments should lie about 0.3—0.5 volts lower than final adjustment. Final adjustment is carried out by bending the support projection up so that the spring tongue is tensioned. Increase and decrease speed several times and check that the setting is correct.

### Adjusting the current control

Couple the instruments in the same way as when adjusting the voltage control. Connect a loading resistor (carbon disc resistor, 1000 watt) in parallel with the battery. Fig. 33. Start the engine and run it at about 2000 r.p.m. Couple in sufficient resistance so that the battery voltage sinks to 6.5—6.8 volts. Read off the ammeter and adjust the current as specified. Disconnect the resistor. Never have the loading resistor connected longer than is absolutely necessary.

The current control is adjusted in the same way as the voltage control. The major adjustment of the Bosch control should lie about 10% lower than the final adjustment.

*N. B.* The control cover should be fitted in position when the instruments are read.

Increase and decrease the speed several times and check that the control is correctly set.

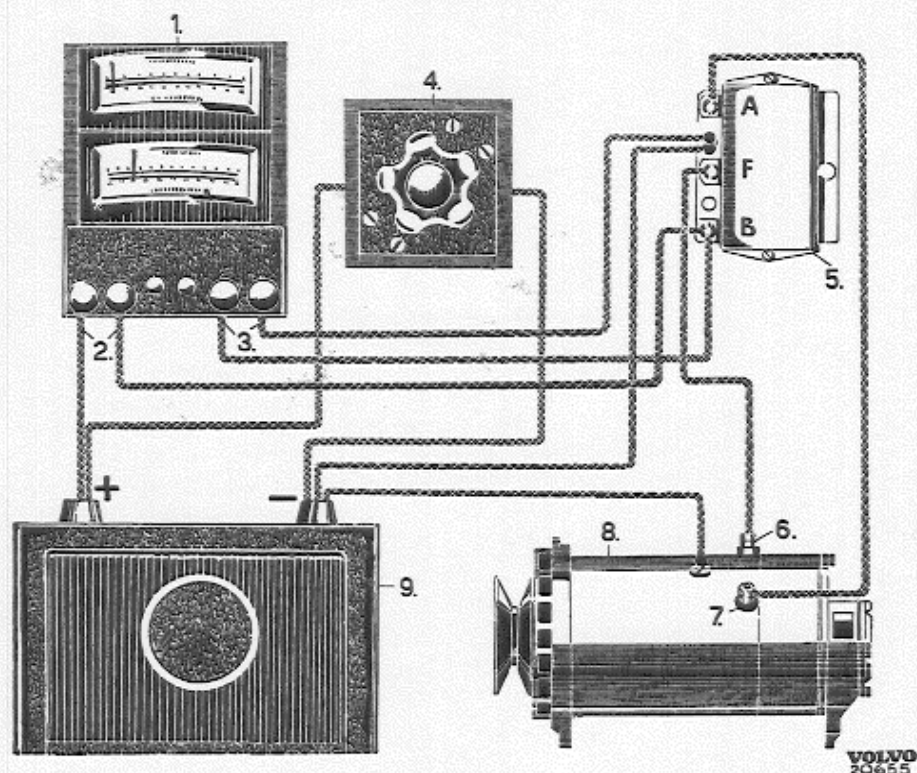


Fig. 33. Connection for current control test.

1. Voltmeter, ammeter
2. Cables to ammeter
3. Cables to voltmeter
4. Rheostat
5. Charging control
6. Connecting screw for field winding
7. Connecting screw for current terminal
8. Dynamo
9. Battery
- A. Connecting screw for cable from dynamo terminal
- F. Connecting screw for cable to dynamo field winding
- B. Connecting screw for battery cable

### Check and adjustment of a charging relay which has been removed from the vehicle

If the control does not operate satisfactorily after the previously described adjustments have been carried out, it should be removed from the vehicle. Inspect carefully concerning burned contacts, burned coils, mechanical damage, stretched springs, burned or damaged insulation. At the same time check that all rivets are firm and that all soldered points contact properly.

If the contacts are burned or uneven they should be polished with a contact file. The file should be fine, one side to be flat and it should be thin enough to operate easily between the contacts. See Fig. 34. Always file in only one direction, not to and fro. After polishing with the file, clean the contacts with a linen rag moistened with trichlorethylene or carbon tetrachloride, see Fig. 35. Never polish with sand paper or emery cloth.

The air gap is checked with a step gauge and a testing lamp. When working on an Auto-Lite

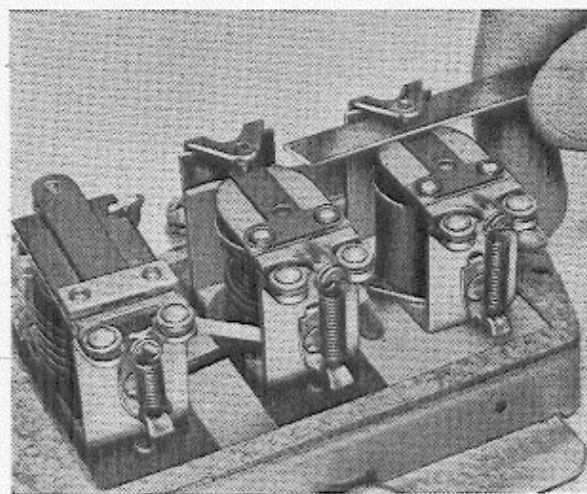


Fig. 34.

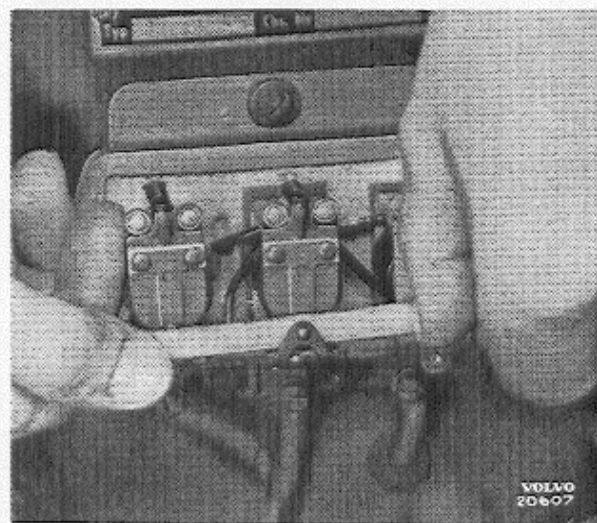


Fig. 35.

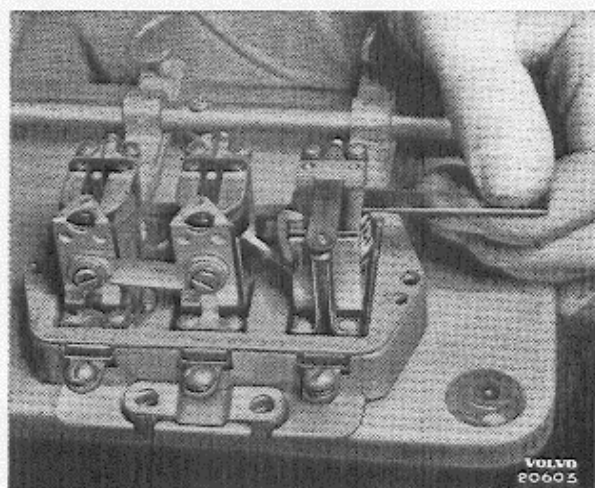


Fig. 36.

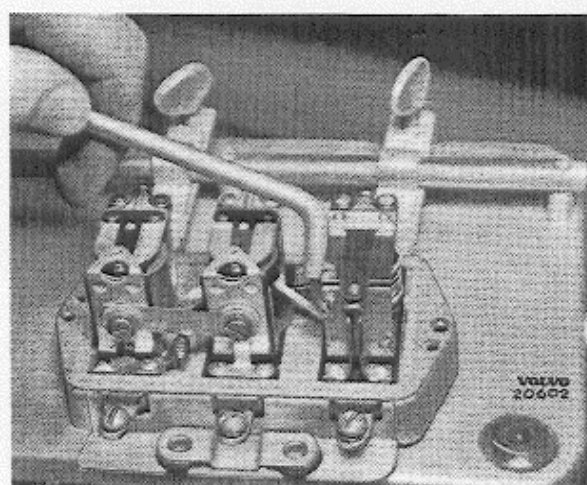


Fig. 37.

charging relay special care must be taken concerning the air gap setting whereupon a step gauge with maximum and minimum points must be used. See below.

The value which is given for the Bosch relay has, as is seen on the specifications, rather large tolerances. When adjusting the air gap for this control it is sufficient if it lies between the specified measurements.

The air gap on the cut-out is checked between the solenoid core and the armature. Use the step gauge as shown in Fig. 36. See the specifications concerning the value. If the gap is faulty, bend the projection on the top of armature, Fig. 37. The clearance between the contacts is controlled by fitting the step gauge between these, adjust the contact clearance as shown in Fig. 38. The contact tongue on the relay armature must not be bent.

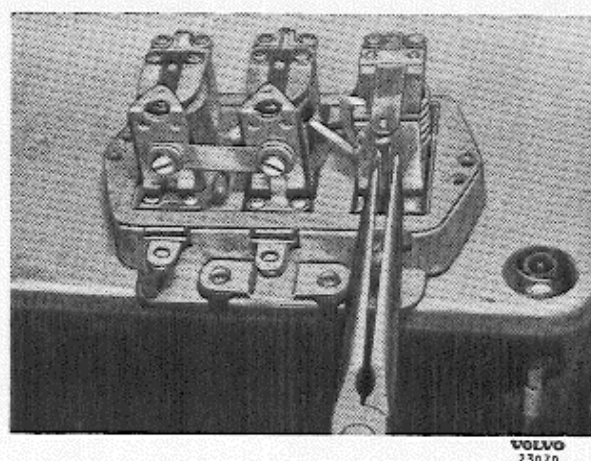


Fig. 38.

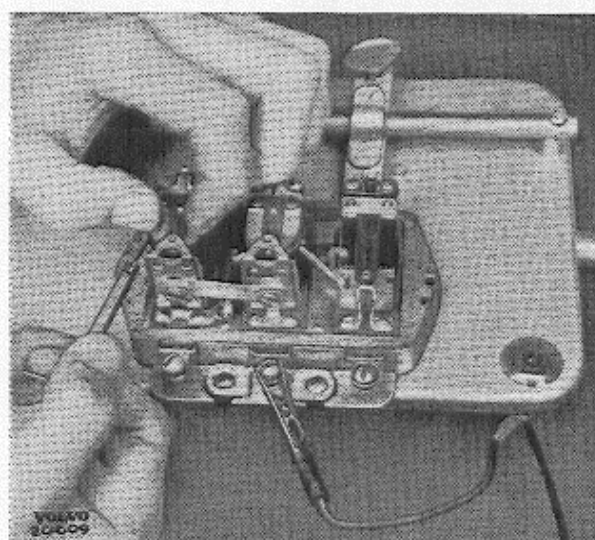


Fig. 39.

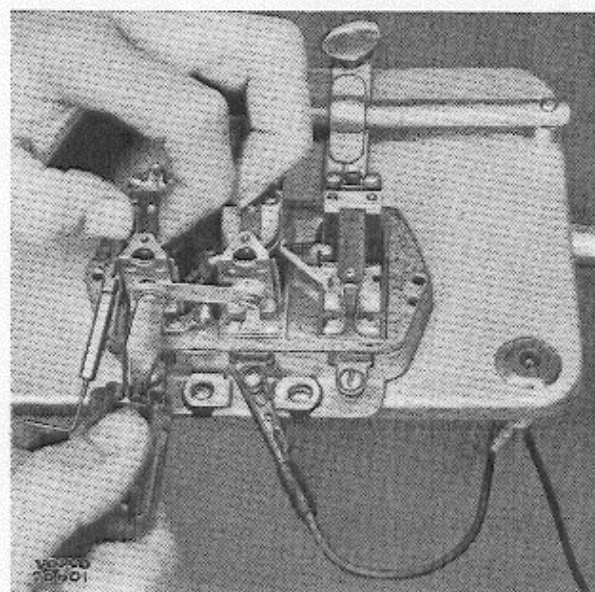


Fig. 40.

The voltage control air gap is checked between the solenoid core and the armature. Measuring is carried out with a wire gauge of a thickness specified in the specifications. See that the wire gauge comes immediately opposite the rivet which is attached to the armature. The air gap is thus not measured between the solenoid core and the rivet head. So that the check should be accurate, connect a test lamp in series with the source of current and the field connection, see Fig. 39. The lamp should then light up weakly.

To obtain maximum measurement the lamp glow strength should not vary, the contacts should not be separated. For minimum measurements the lamp glow strength should decrease when the armature is depressed. N. B. The armature should be depressed with one finger on each side of the contact tongue, see Fig. 39. If it is necessary to adjust the air gap, move the upper contact up or down after the attaching screw has been released. See Fig. 40.

The current control is checked with the wire gauge as specified. The wire gauge should be fitted in front of the rivet which is attached to the armature. Necessary adjustment are carried out by moving the upper contact up or down after the attaching screw has been released.

After these adjustments have been carried out the charging relay must be tested again, the contact spring pressure must be adjusted, together with the dynamo. The dynamo should be of the same type and manufacture so that the control works in the same way as when fitted in the vehicle.

Adjusting should be carried out in the same way as has been described earlier when the control was fitted in the vehicle. If the test-bench has a built-in loading resistor, use this in the same way as was recommended for the separate resistor. If there is no built-in resistor, use a loose resistor in the same way as when carrying out adjustments in the vehicle.

Should the charging relay, despite the precautions carried out, still not operate satisfactorily, replace it or else send it to the factory representative for repair.

## Starter motor

### Precautions prior to removal and disassembly

Should the starter motor show signs of not functioning correctly or, perhaps, not function at all, first make sure that it is not the battery, cables, starter switch, starter relay or control solenoid which are at fault. If the fault is localized in the starter motor, it must be removed. Before starting disassembly we would like to point out the importance of correct testing. Furthermore a suitable testing apparatus must be available if the test results are to be of any value.

Test as follows:

Fit the starter motor in a V-block on the test-bench and remove the protector strip.

Connect the starter motor to the correct voltage. The starter motor housing must be

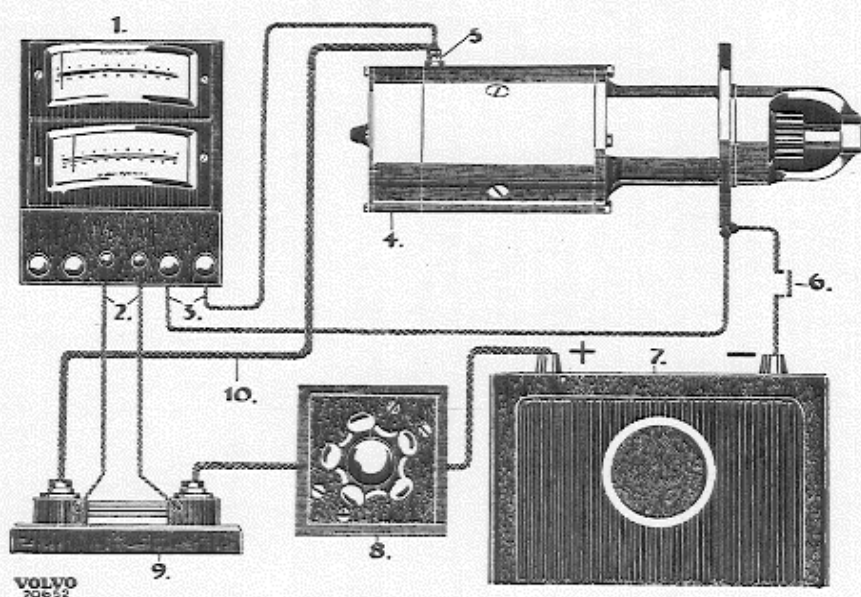


Fig. 41. Starter motor test.

1. Voltmeter, ammeter
2. Cables to ammeter
3. Cables to voltmeter
4. Starter motor
5. Connecting screw
6. Circuit closer
7. Battery
8. Resistance
9. 500-amp. shunt
10. Battery cable (min. 35 sq.mm)

connected with the negative connection, If the starter motor functions without any signs of short-circuiting or stiffness when the current ceases, continue testing. Connect a voltmeter and an ammeter to a 500-amp. shunt as shown in Fig. 41. Hold a revolution counter against the shaft end of the rotor. Cut the current and read off the voltage, amperage and speed. At the same time look at the carbon brushes and commutator. Note the values and points concerning the brushes and commutator. Compare the values with those given in the specifications for an unloaded starter motor. The following faults can now be ascertained:

- |                                     |   |
|-------------------------------------|---|
| 1. Low speed and low current.       | Excessive resistance caused by dirty commutator, worn carbon brushes or poor spring pressure.   |
| 2. Low speed and high current.      | Short-circuiting in field windings. The rotor slips against the terminals by reason of worn bearing or buckled rotor shaft.             |
| 3. Powerful sparking, low rotation. | Low spring pressure by reason of worn carbon brushes or loose brush springs. Short circuiting or partial breakage in the rotor winding. |
| 4. Excessive carbon brush movement. | Poor spring pressure or out-of-round commutator.  |

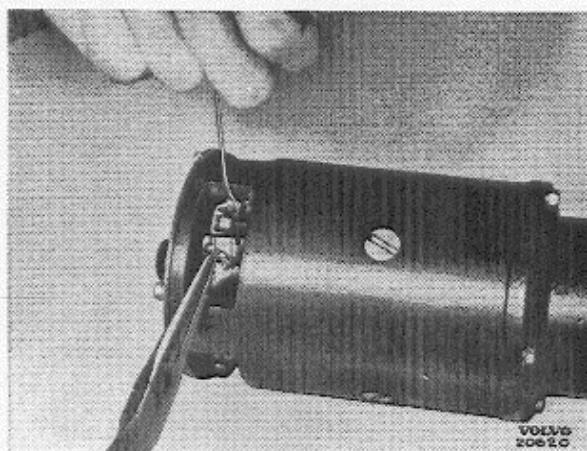


Fig. 42.

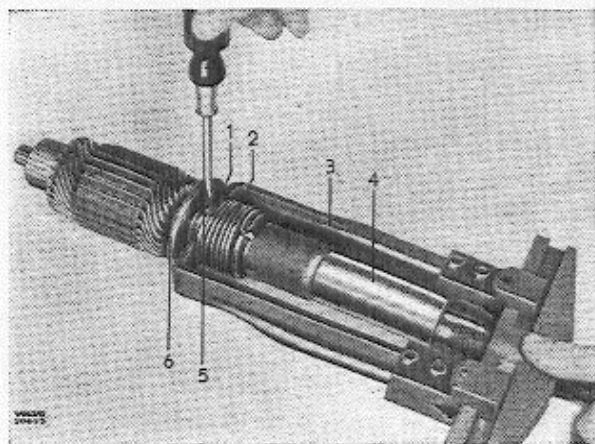


Fig. 43.

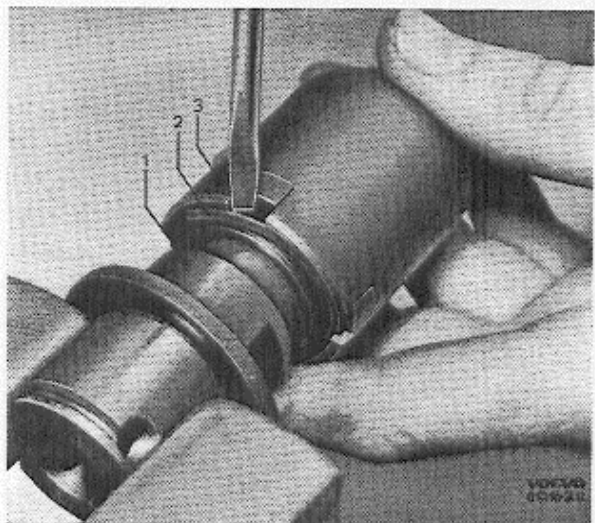


Fig. 44.

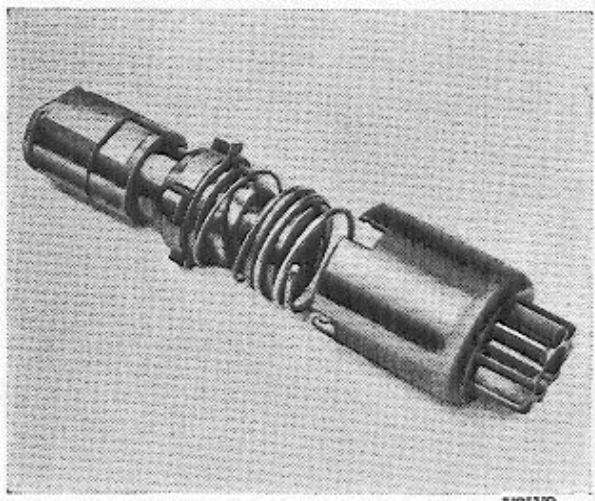


Fig. 45.

### Disassembling the starter motor and starter relay

The disassembly of the starter motor in conjunction with overhaul (cleaning and lubricating) or repair should be carried out as follows:

1. Remove the starter relay.
2. Remove the protector strip.
3. Lift the carbon brush springs and then pull them up, Fig. 42.
4. Mark how the Bendix cover and rear commutator end head with brush holders are situated in relation to the housing in cases where there is no guide pin.
5. Remove the rear commutator end head, brush holders and if necessary adjuster and thrust washers.
6. Release the Bendix cover from the housing and lift up the rotor. Separate the rotor and cover.
7. Press the inner holder (1) for the Bendix spring (2) with the help of the puller (3, Fig. 43) and tubular driver (4) as far forward so that the screw (5) can be removed. Then lift the Bendix device from the shaft.
8. Remove the drive ring key, centre bearing and thrust washer from the shaft.
9. Remove the lock ring. Release the puller and tubular driver and then lift off the inner holder and Bendix spring.
10. Remove the lock ring (2, Fig. 44) which holds the drive (3) for the sleeve (1) and lift off the sleeve. The location of the various components is shown in Fig. 45.
11. Blow the starter motor housing, field winding and rotor clean from dust. If necessary wipe with a bit of rag moistened

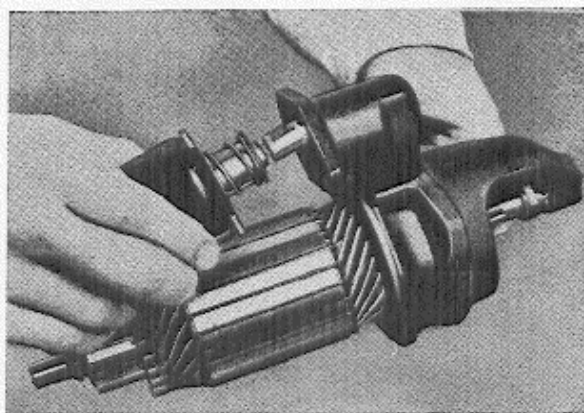


Fig. 46.

VOLVO  
21279

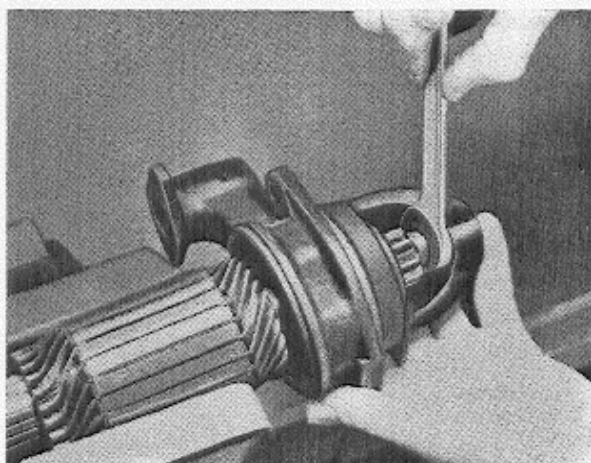


Fig. 47.

VOLVO  
21270

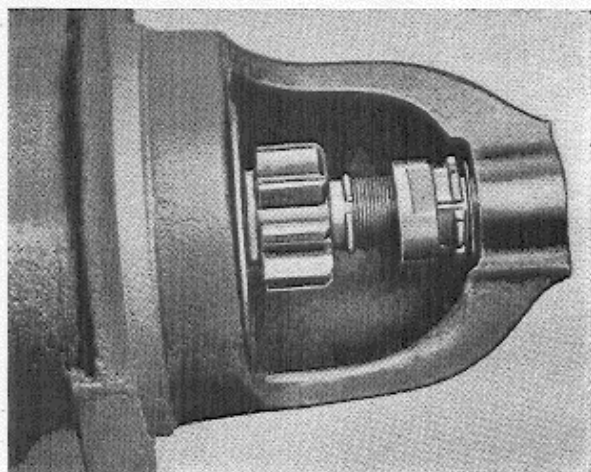


Fig. 48.

VOLVO  
21277

with petrol. N. B. Alcoholic petrol, e.g. hentyl, should not be used as this will dissolve the insulation. Clean the rest of the components, with the exception of the carbon brushes, with clean petrol.

### Disassembling the starter motor and control solenoid

The disassembly of the starter motor for overhaul (cleaning and lubricating) or repair should be carried out as follows:

1. Remove the protector strip.
2. Lift the carbon brush springs and pull them up, compare with Fig. 42.
3. Mark the positions of the forward and rear end heads in relation to the housing if there is no guide pin.

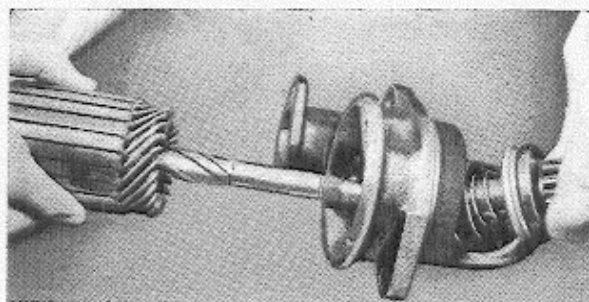


Fig. 49.

4. Remove the screws which hold the three main components of the starter motor together. Lift away the rear commutator end head and rotor brake as well as the housing, when cables between the control solenoid and housing have been loosened.
5. Release the control solenoid from the end head by removing the two attaching screws and then lifting the control solenoid upwards and out, Fig. 46.

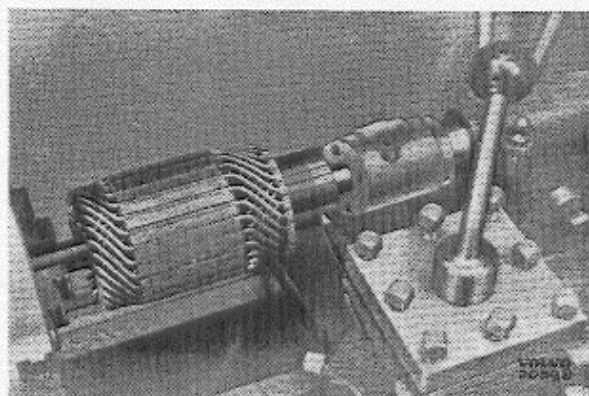


Fig. 50.

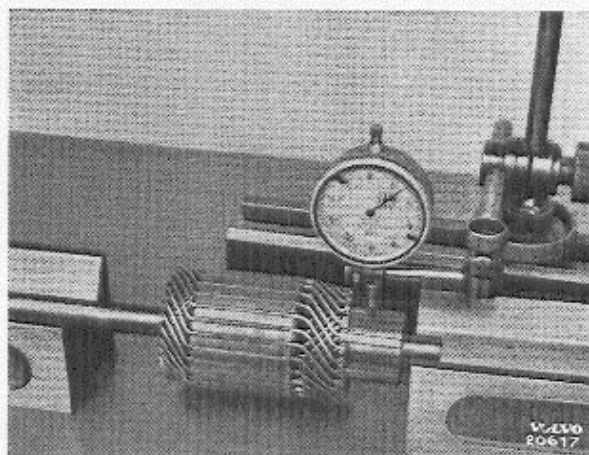


Fig. 51.

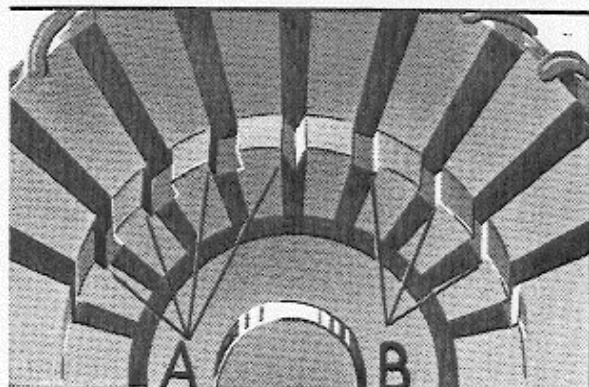


Fig. 52.

6. Remove the cotter pin and loosen the nut on the rotor shaft. Remove the lock ring, see Figs. 47 and 48. Polish the edge of the shaft at the lock ring with a file so that any burr is removed.
7. Lift the rotor out from the commutator end head and starter gear and then lift out the starter gear from the end head, see Fig. 49.
8. Remove the rotor brake from the rear commutator end head.
9. Blow the starter motor housing, field windings and rotor clean of dust. If necessary wipe with a bit of rag moistened with petrol. N. B. Do not use petrol with a high spirit content, e.g. bentyl, as this can dissolve the insulation.

Clean the rest of the components, with the exception of the control solenoid, in clean petrol.

### Inspection

Examine the rotor for mechanical damage. It can have a bent or worn shaft, scratched commutator or damaged windings.

If the rotor shaft is bent or worn the rotor must be replaced. The axle should only be aligned in certain circumstances. In this case it is aligned in a press.

If the commutator is scratched or unevenly worn it should be turned, Fig. 50. When turning, a chuck specially made for this purpose should be used, see Fig. 50. Only take a small cut each time so that no excessive material is cut away. If you cut excessively, the insulation and the segments can be damaged. Check that no other objects come in contact with the rotor during turning.

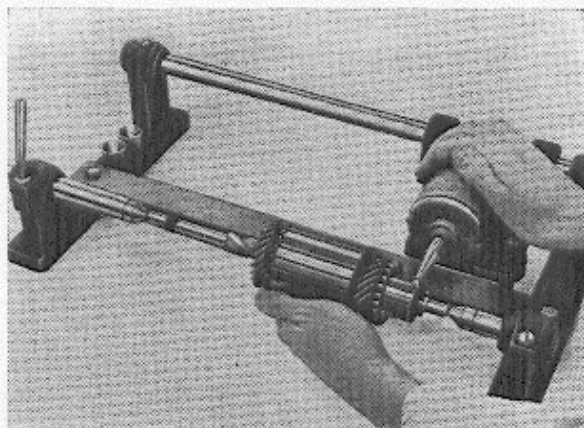


Fig. 53.

The commutator should be checked after turning as shown in Fig. 51. A radial throw of 0.003" (0.08 mm) is permissible. The insulation between the segments should be cut back 0.4 mm (1/64") under the segment surface, Figs. 52 and 53. This should be carried out with a special apparatus or should there not be one available, a ground hack saw blade.

Examine the rotor for short-circuiting by fitting it in a growler. Switch on and hold a hack saw blade a few millimeters from the rotor, Fig. 54. Should the blade vibrate in any position when the rotor rotates, one of the following faults can be the cause: leakage to the rotor frame, leakage in the commutator or between the windings.

Leakage to the rotor frame can be tested with the aid tester pins and a testing lamp.

Examine the housing and field windings for damage caused by the rotor. Check that the field windings are not earthed by connecting the contact points to the housing and field windings as shown in Fig. 55. Should the lamp light up the windings or the connection through the housing are damaged. Check that the carbon brushes do not lie against the housing. Loosen the connection through the housing and test again. If the lamp still lights up, the field windings are earthed and must be removed. See under the heading "Replacing the field winding", page 26.

Examine the commutator end head and brush holders. Should any of the components be damaged or badly worn they must be replaced. Bearing clearance of up to 0.12 mm (3/64") is permissible. Check that neither of the positive brush holders are connected to the end head, Fig. 56.

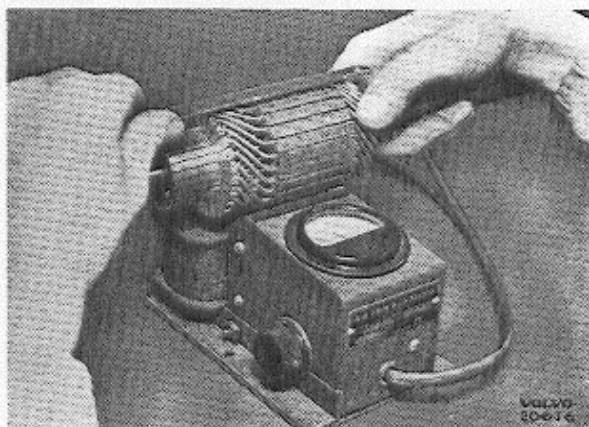


Fig. 54.

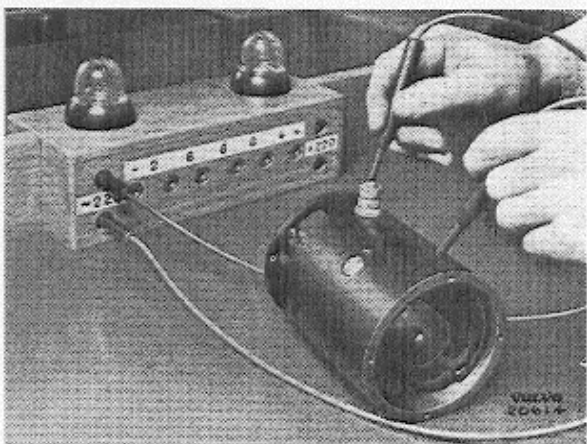


Fig. 55.

Carbon brushes which are damaged, scratched or more than half worn should be replaced.

Check the spring pressure with a spring balance which is hooked in the spring, see Fig. 57. The power required to lift the spring from the carbon brush should compare with the values given in the specifications. Should they not compare favourably, the spring concerned must be replaced.

Examine the drive housing. Test the bearing on the shaft. A clearance of up to 0.12 mm (3/64") should be considered as maximum.

Inspect the remaining components and replace any of them which are damaged or worn. Always replace the lock rings as they will have become damaged or will have lost their tension when removed.

### Assembling the starter motor and starter relay

1. Fit the thrust washer and centre bearing on the shaft and drive in the key for the Ben-

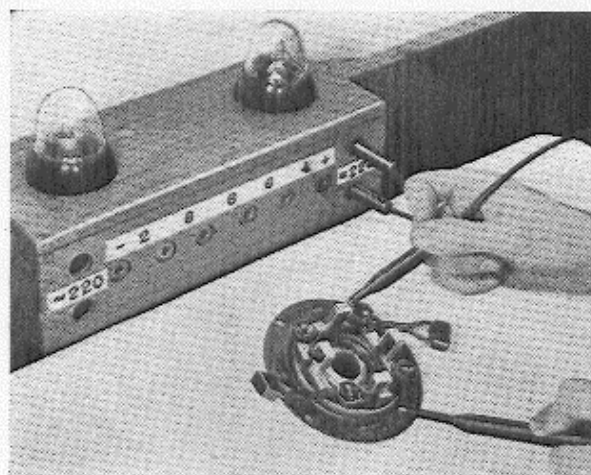


Fig. 56.

- dix device. Lubricate the bearing with a couple of drops of engine oil.
- Fit a new drive lock ring. The lock ring is fitted on the shaft in front of the outer Bendix spring holder.
  - Oil-in all the Bendix device components with thin oil.
  - Place the shorter spring in the drive. If the longer spring has been removed or replaced it must be fitted on the sleeve. Fit the gear on the shaft with the sleeve and fit the lock ring.
  - Fit the Bendix spring and holder on the Bendix device shaft and depress the spring with the aid of the puller and tubular driver, until the aperture is free, see Fig. 58. Fit the lock ring. The lock ring opening should lie immediately opposite the lock screw aperture.
  - Fit the Bendix device on the rotor shaft and fit the lock screw, see Fig. 44. Take away the puller and tubular driver.
  - Place the Bendix cover on the rotor shaft and match the guide pin in the centre bearing projection.
  - Fit the rotor in the housing and screw the Bendix cover to the housing as shown by the markings in the guide pin.
  - Fit the adjuster washer and thrust washer on the shaft at the commutator and fit the rear end head to the housing. N.B. Position of the marks.
  - Turn the rotor. This should go easily and should not chafe in any position. Measure the rotor axial play with a gauge against the

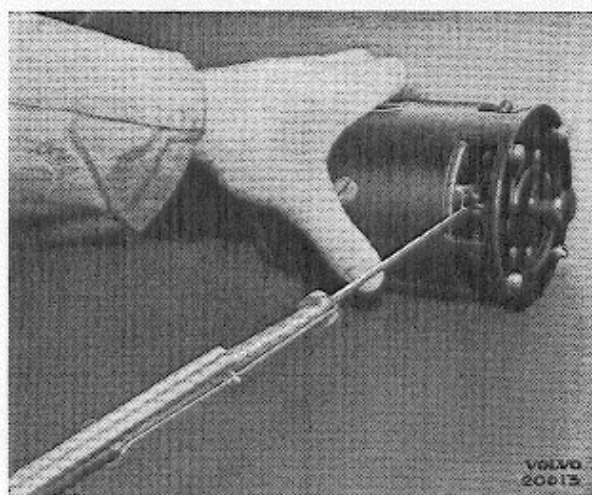


Fig. 57.

end of the shaft. Adjustments are carried out by replacing thrust washers. Measure the distance from the Bendix cover to the forward edge of the drive when it leaves the coil. The measurements should correspond with the specifications.

- Fit the carbon brushes.
- Lubricate the bearing with thin engine oil whereupon the starter motor is ready for testing. Regarding this, see page 26.

### Starter relay

If the starter relay does not connect in the main current to the starter motor, it is tested as follows:

The relay should be tested for cut-in with the starter motor operating voltage as shown in Fig. 59. Check that the relay does not chafe by removing the little cover on the front end of the relay and then pushing in the iron core. The iron

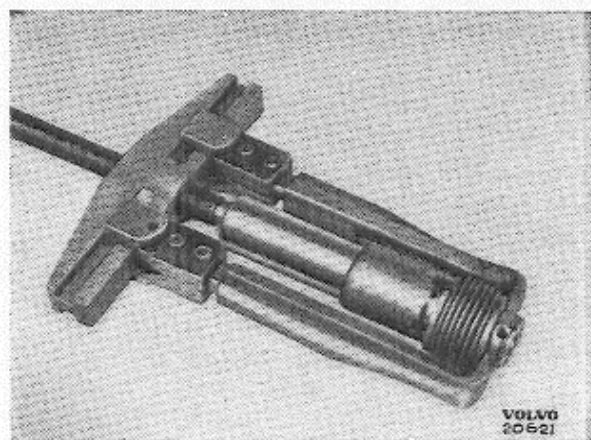


Fig. 58.

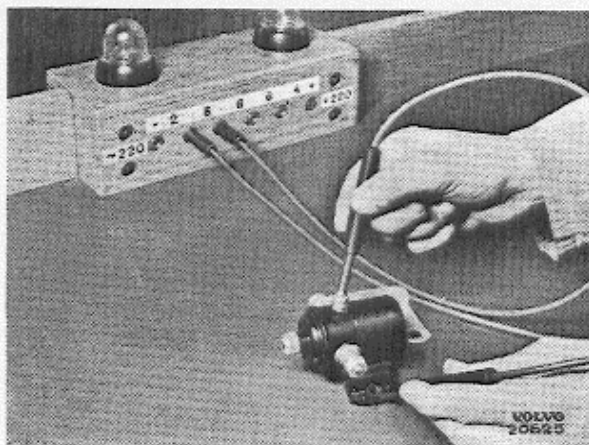


Fig. 59.

core should move easily and the return spring should not be stiff. Make sure that the relay contacts are free of fault by fitting it to a fault-free starter motor, which is then driven on a fully charged battery. The starter motor should be driven partly with the starter relay connected and partly direct from the battery. No alteration in speed should occur.

### Assembling the starter motor and control solenoid

1. Fit the rotor brakes in the rear commutator end head, see Fig. 60, as will as the cables between the positive carbon brushes, as shown in Fig. 61.
2. Fit the springs and the guide sleeve on the starter drive, see Fig. 62, as well as the coupling arm in the end head if it has been disassembled. Lubricate the starter drive and coupling arm with heat-resistant ball bearing grease.

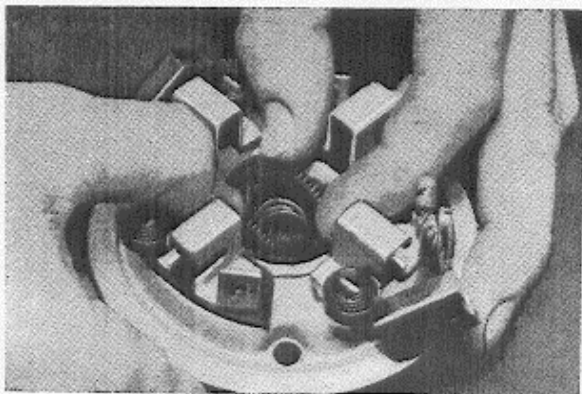


Fig. 60.

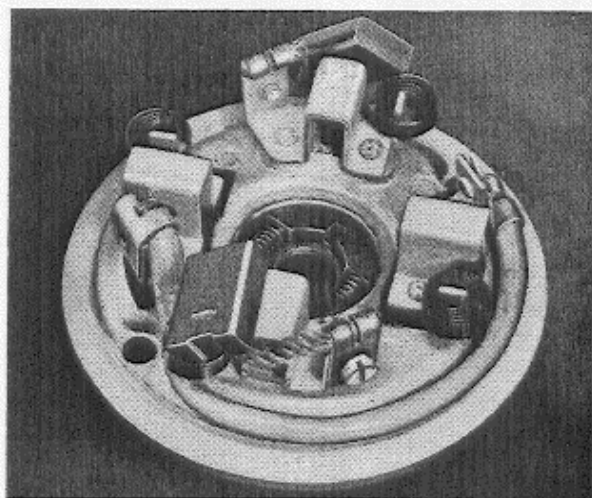


Fig. 61.

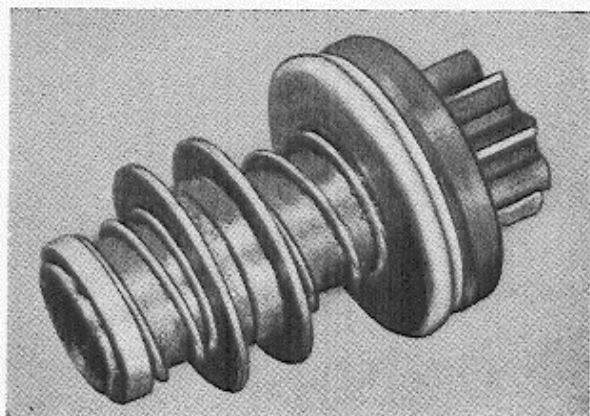


Fig. 62.

3. Fit the starter drive in the commutator end head with the guide sleeve in the coupling arm pins, Fig. 63. Fit the rotor shaft in the starter drive and fit on the lock ring (1, Fig. 64), nut (2) and washer (3). Tighten the nut and lock with a cotter pin.
4. Fit the control solenoid to the end head.
5. Fit the housing on the rotor and match it with the end head (guide pin or mark). Fit on the rear commutator end head to the rear end of the rotor shaft and bolt it into the correct position with the bolts. Turn the rotor and check that it moves easily. Measure the axial clearance and compare with the specifications.
6. Fit the carbon brushes.
7. Lubricate the forward and rear bearings with thin engine oil. The starter motor is now ready for testing. See page 26.

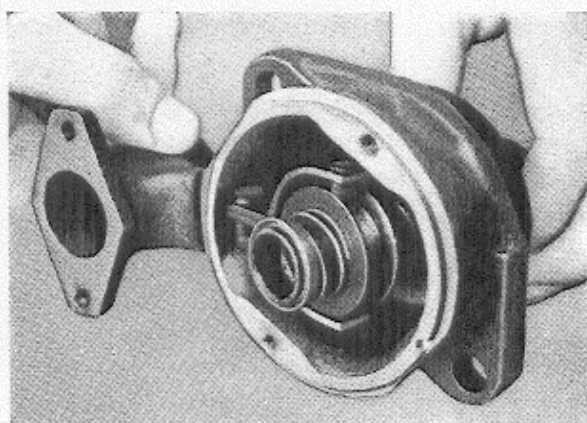


Fig. 63.

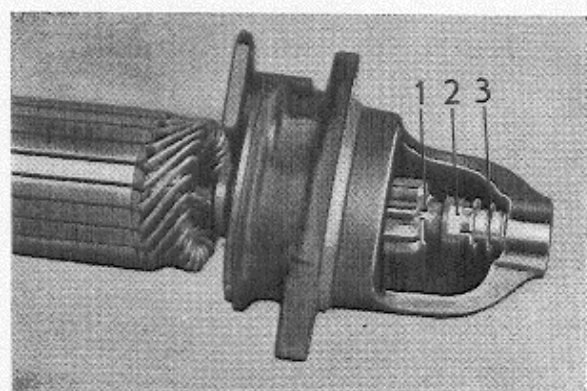


Fig. 64.

### Control solenoid

If the control solenoid does not function, check that the battery is in good condition. When this has been done, connect a cable between the positive terminal on the battery and the operating cable contact screw on the control solenoid.

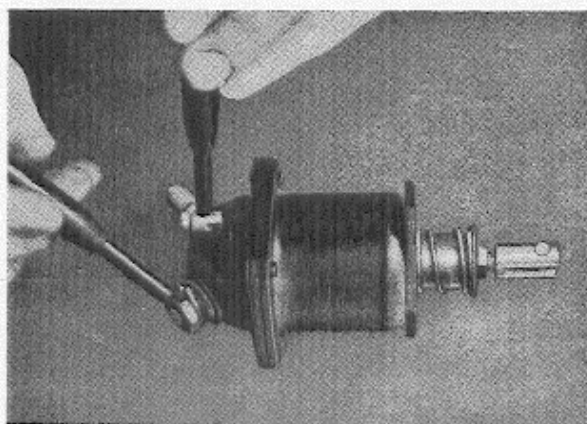


Fig. 65.

If the solenoid still does not function and connect the main current as well as meshing the starter gear, it should be removed from the starter motor. If, on the other hand, it does function, then the ignition and cables should be checked.

When the control solenoid has been removed it should be cleaned. Then push in the core several times and then test again by connecting it to a battery. If it still does not function, carry out measurements on the coil and compare with the test values to be found in the specifications. If the control solenoid is faulty, it should be replaced.

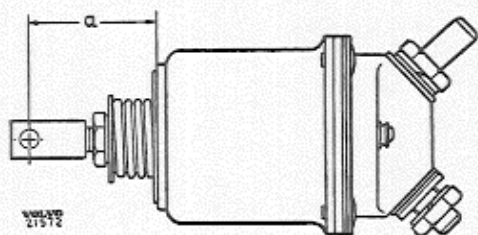


Fig. 66.

Before the control solenoid is refitted, the distance "a" between the centre line through the pin in the fork and the solenoid attaching flange should be checked when the iron core is completely retracted. See fig. 66. When this distance has been set and the lock nut has been tightened, the distance "a" should again be checked. Then lock the nut and the yoke and seal them.

See the specifications for the vehicle concerned for distance "a".

### Replacement of carbon brushes

If the carbon brushes are damaged or worn down to less than half their size, they must be replaced. Loosen the protector band and check.

When the carbon brushes are replaced, the starter motor is removed from the vehicle and is cleaned thoroughly externally.

On Bosch starter motors, the carbon brushes can be replaced without disassembling the starter motor. The cable from the brush in question is loosened and a hook is used to lift up the brush spring after which the brush itself can be removed from its retainer. The new carbon brush is placed into the retainer and screwed into position.

Auto-Lite starter motors, however, must be disassembled. Follow the directions given under the heading "Disassembly". A soldering iron is used to remove the brush cables. The new brushes should be fitted and soldered carefully. Make sure that too much solder is not used since this can run into the brush cable. The result of this will be that the cable becomes so stiff that the brush spring cannot push down the carbon brush with sufficient pressure against the commutator.

The negative carbon brushes are often fitted with terminals which are to be riveted in position under the carbon retainer. The working procedure then is to drill out the rivets holding the brush retainer in the end head, remove the brush and terminal, fit the new brush in position and rivet the end head, the terminal and the carbon brush retainer. Use steel rivets, not brake lining rivets or aluminium rivets.

Examine the commutator. If it shows any signs of damage or is worn unevenly, it should be lathe turned. See under the heading "Inspection" on page 21.

Assemble the starter motor in accordance with the directions given under the heading "Assembly".

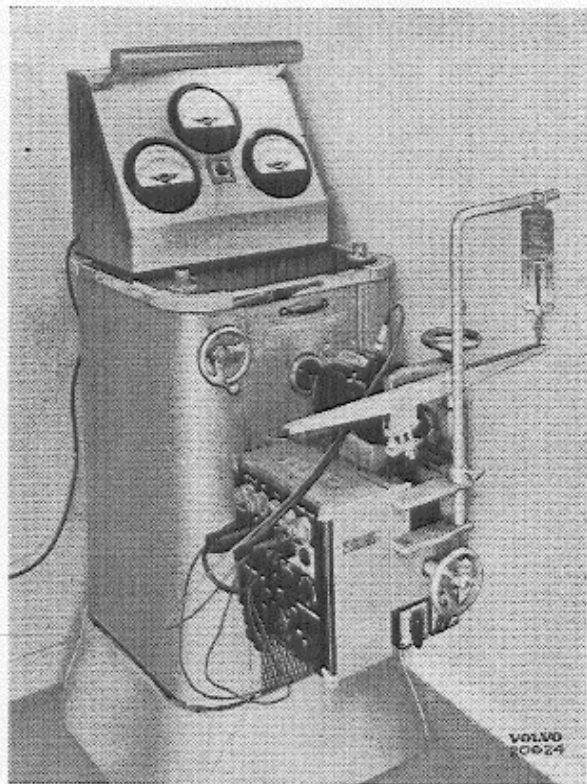


Fig. 67.

## Replacement of field winding

1. If the starter motor is not disassembled, this must be carried out. Follow the directions given under the heading "Disassembly".
2. Place the housing in a V-block as shown in Fig. 23. Fit a driver in the drill chuck. Press downwards with the handle at the same time as the driver is turned. The pole shoes are usually very tightly in position. Make sure that the driver used fits well and is sufficiently wide.
3. When the screws have been loosened the housing is lifted out. Then remove the screws with a normal screwdriver. Loosen the field coil connection through the housing and then lift out the coil and pole shoes.
4. Fit the pole shoes in the new field winding and tighten them in the housing. Use the same device as when loosening the screws. Fit new carbon brushes if the old brushes are damaged or worn down more than half.
5. Solder the field coil connection in position where it passes through the housing.
6. Assemble the other parts of the starter motor. See under the heading "Assembly".

## Testing the starter motor

When the starter motor has been assembled, it should be tested before being fitted in the vehicle.

Carry out the mechanical tests first. Measure the rotor brake friction torque and the drive idling torque, carbon brush spring tension and rotor end play if these values have not been checked earlier. After completing the mechanical tests, continue with the electrical tests.

Before this is done the starter motor is connected as shown on Fig. 41. First test the starter motor with no load and compare with the values shown in the specifications. After this test has been carried out, the starter motor drive is locked by connecting it to a lever of known length. The outer end of the lever is connected with a spring balance and shown in Fig. 67. Adjust the current and voltage according to the specifications and read off the value on the spring balance. Multiply the length of the lever in metres by the figures shown on the spring balance in kg and compare with the figures shown in the specifications.

## Ammeter

If the ammeter shows no reading or there is reason to suspect that it is indicating an excessively high charging current, the following procedure should be carried out.

Check that all connections are properly tightened on their respective terminals and that the cables are in good condition.

Loosen the battery cables at the charging relay and connect in an ammeter in series at this point. Start the engine and read off both ammeters. If the figure shown by the ammeter in the car is about 5 amps. lower than the other ammeter which has been connected in circuit, then there is no fault. The degree of accuracy of the ammeter fitted in the car is not great since its main function is to show whether the battery is being charged or is discharging.

If the ammeter does not show any reading at all or moves in jerks, check that the indicator needle is not in contact with the glass. Disconnect all cables from the ammeter and make sure that the indicator needle remains zero.

An indicator needle which does not show zero when the engine is switched off or which is in contact with the glass, can usually be adjusted by being carefully bent in the desired direction.

If the ammeter shows no reading at all, the above procedure is carried out. Check cables and terminals and check the charging current. If the extra ammeter used indicates normal charging current, there is something wrong with the ammeter fitted in the vehicle. It should be removed and replaced.

## Fuel gauge

The fuel gauge consists of two units; one of these is the instrument fitted in the instrument panel while the other one is the fuel gauge tank unit which is fitted in the top of the fuel tank. These two units are connected by means of a cable.

If the fuel gauge shows faulty readings or no reading at all, the fault can lie in the instrument, the tank unit or the cables.

First of all check that the connections on the instrument and the tank unit are properly tightened and that good contact has been obtained at these connections and at the earth connections.

Use a test lamp to ensure that there is current on the feed side of the instrument.

If poor contact is not the reason of the fault, the two following procedures are adopted depending on the indications given by the instrument.

### The instrument indicates "Empty" ("T")

1. Disconnect the cable on the instrument which goes to the tank unit.
2. Switch on the ignition switch. If the fuel gauge now indicates "Full" ("F") then there is nothing wrong with the instrument.
3. Switch off the ignition and reconnect the cable in the instrument.
4. Disconnect the cable at the tank unit and insulate it from earth.
5. Switch on the ignition switch. If the fuel gauge now indicates "Full", then there is nothing wrong with the cable, i.e. it is not earthing.

The fault must then be in the tank unit which should be disassembled and tested. See "Replacement of fuel gauge" in Part 10 for the vehicle concerned.

### The instrument shows "Full" ("F"), all the time

1. Disconnect the cable at the tank unit.
2. Switch on the ignition switch.
3. Hold the cable in contact with a point on the body or the fuel line that has been scraped clean. If the fuel gauge then indicates "Empty" ("T"), then there is nothing wrong with the cable or the instrument so that the fault lies in the tank unit.
4. If the fuel gauge, however, does not indicate "Empty" when this is done, the cable is disconnected at the instrument. Short-circuit the contact screw to the body by using a screwdriver. If there is nothing wrong with the instrument, the indicator needle should then go over to "Empty" ("T"). Otherwise the fault can lie in poor contact on the connection between the instrument and the cable to the tank unit or a breakage in this cable.

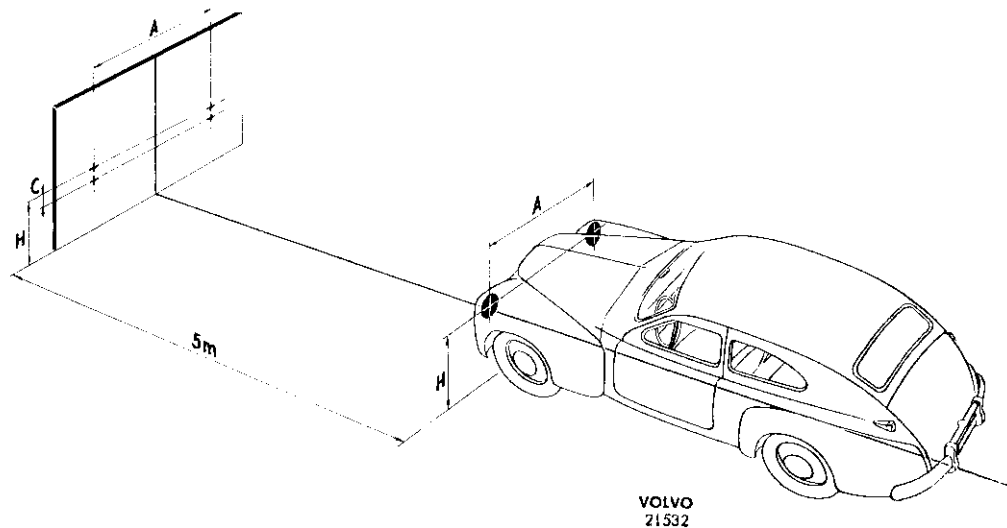


Fig. 68.

A better way of testing the instrument and the cable is to use an "AC Gas Gauge Tester" or a new fuel gauge unit and connecting this to the cable or the instrument.

A faulty fuel gauge instrument or tank unit should be replaced with a new one.

## Headlights

### Adjustment

From the point of view of traffic safety, it is of the greatest importance that the headlights are adjusted in accordance with regulations. Since these regulations vary from country to country no figures can be quoted but, in general, headlight setting adjustment is carried out as shown in Fig. 68.

## Horns

If there is no sound from the horn when the horn ring is depressed, check that the current is reaching the horn connection. If this should not be the case, check the fuse and the feed cable. If there is current, earth the other horn terminal screw whereupon the horn should sound if there is nothing wrong with it. Should it sound, examine the cable to the horn ring on the steering wheel and the contacts there. Faulty parts are removed and either adjusted or replaced. Damaged cables should also be replaced.

If the tone of the horn is not as it should be, adjustment can be carried out by means of the screw for this purpose. The tone of the horn is very dependent upon this mounting (rubber or

spring) and this mounting should therefore be carefully checked.

If there are any other faults on the horn, it should be sent in to an electrical workshop or should be replaced.

Examination along the same lines as indicated above should be carried out on vehicles fitted with two horns and a horn relay.

## Switches

Switches which do not function in a satisfactory way should usually be replaced since, in most cases, the contacts cannot be repaired or polished. Before carrying out replacements, always check to make sure that cables and fuses are in good condition. Due to great resistance in switches resulting from burned or damaged contact surfaces, voltage drop can be so considerable that it effects the function of other units in the same circuit. Voltage drop through a switch should not exceed 0.1 volts.

## Cables

The cables connecting the battery with the various electrical units are shown by the wiring diagram for the vehicle concerned.

There should be no difficulty when replacing cables if the wiring diagram is carefully followed. When replacing a cable, make sure that the cross section of the new cable used is at least as great as that shown in the wiring diagram. The best way of joining cables is by using connector units.

Cable faults can consist of breakage or short circuiting to the chassis. The indication of this is that the unit being fed by the cable in question does not function. The damage must be localized systematically since, in many cases, there is no outward sign of damage on the cable at all. Make sure, with the help of the wiring diagram and a test lamp, that there is voltage at the feed point, for example the fuse, if the unit in question is connected through a fuse. Check on both sides of the fuse. Then follow the cable outwards towards the unit in question and determine in this way where the damage is located. One of the test lamp leads should be fitted with a crocodile clip and the other with a sharp point. The crocodile clip should be connected to the frame while the point is held in contact with terminal screws or is pushed into the cable itself.

Where there is short-circuiting to the chassis it is not possible to check directly since the fuse will blow immediately. Instead connect in the test lamp in place of the fuse and then examine the cable in question by disconnecting it at the points where it is clamped on the chassis. Carry out careful examination at places where the cable passes through holes in plating, members etc. When the test lamp goes out or only shows

a very feeble light, then the damaged point in the cable has been located.

Cables are fitted in cable harnesses so that cable replacement is rather difficult. The simplest way to carry out repair is to fit a completely new cable and disconnect the old one.

## Fuses

The fuses intended for use on cars and vans are rated at 8 and 25 amps.

Data concerning the fuses is given below.

Rating . . . . .	8 amps.	25 amps.
Current rating under continuous loading . . . . .	8 amps.	25 amps.
Current for which the fuses should hold for at least one hour . . . . .	12 amps.	35 amps.
Current for which the fuses should melt inside one minute . . . . .	20 amps.	62.5 amps.

The fuses are fitted in a fuse box which is attached to the bulkhead under the bonnet. There is a printed card under the fuses showing the circuit in which the various fuses are connected.

## TRACING FAULTS

It is extremely important that faults are traced systematically and this applies particularly to the electrical system. If there is some unit in the electrical system which is not functioning correctly, the reason for this must always be determined before any repair or replacement can be carried out. It is useless merely to replace the faulty unit (instrument) without first carrying out tests to determine that the fault was actually in the unit or instrument. Testing must also be carried out to determine whether the

fault is caused by other units. If the ammeter, for example, shows an excessively high (or low) charging current, it is possible that the fault can be in the ammeter itself. Most often, however, the fault is in the charging relay which is faultily adjusted or in need of overhaul.

**Procedure when tracing faults:**

1. Locate the faulty unit.
2. Determine the cause of the fault.
3. Repair or replace the parts concerned.

FAULT	
CAUSE	REMEDY

### Battery

#### The battery is discharged or will not hold the charge

<p>The dynamo is not charging sufficiently.</p> <p>Low electrolyte level in battery.</p> <p>Excessively low electrolyte specific gravity.</p> <p>Loose or corroded terminal clamps.</p> <p>Short-circuit in brake contact.</p> <p>Internal short-circuit in battery.</p>	<p>Adjust the charging relay.</p> <p>Top-up with distilled water.</p> <p>See under heading "Battery".</p> <p>Clean the terminal and tighten carefully.</p> <p>Replace brake contact.</p> <p>Recognized by the fact that battery electrolyte specific gravity does not increase with continued charging. Replace the battery.</p>
--	--

#### The battery becomes abnormally warm or much gas is produced

<p>The dynamo is charging excessively.</p> <p>Low electrolyte level.</p> <p>The battery has been insufficiently charged.</p> <p>Internal short-circuit.</p> <p>Sulphation of battery plates.</p>	<p>Adjust the charging relay.</p> <p>Top-up with distilled water.</p> <p>Charge the battery.</p> <p>Replace the battery.</p> <p>See under the heading "Removal of lead sulphate" on page 6.</p>
--	---

## Dynamo and charging relay

### Excessively low or no charging when battery is discharged

Poor contact or damaged cables.

Inspect all cables between the dynamo, the charging relay, the ammeter and the battery for loose contacts, broken cables, poor insulation, corrosion and earthing.

Worn or insufficiently tensioned fan belt.  
Faulty dynamo.

Replace or adjust the tension on the fan belt.

Loosen the cable for the commutator current and the cable to the battery from the charging relay and connect an ammeter in series with these. Start the engine and let it idle. Connect the take-off for field current to the dynamo housing. If the ammeter shows little or no reading at this engine speed or slightly higher engine speed the dynamo should be removed for examination and repair.

Note. Never run the dynamo when connected as described above at such a high speed that the maximum current of 35 amps. is exceeded.

Test and adjust the charging relay. See under the heading "Charging relay".

Faulty charging relay.

### Excessively high charging when battery is fully charged

Faulty dynamo.

Let the dynamo run at about half charge. Disconnect the field cable from the charging relay. If the degree of charge does not decrease to zero, loosen the field cable also from the dynamo. If the charge then sinks to zero examine the cable. If this is in good condition then the dynamo is faulty and should be removed for repair.

High resistance at chassis connection points.

Examine chassis connection points at the dynamo, the charging relay and the battery.

Faulty charging relay.

Test and adjust the charging relay. Carry out the procedure described under the heading "Charging relay".

## Starter motor

### The starter motor does not function

Discharged battery.

Examine the battery. Charge or replace the battery.

Poor connections and (or) chassis connection.

Check connections to the battery, the starter motor and starter relay or the control solenoid. Operate the starter switch and check that the starter relay and the control solenoid operate. If this is not the case make sure that the current is actually passing through the starter switch when this is in the starting position. See under the heading "Faulty starter motor". Replace any faulty control solenoid, starter relay or starter switch.

Faulty control solenoid, starter relay or starter switch.

## PV

Faulty starter motor.

Test by disconnecting the battery cable from the starter relay or the control solenoid and hold it against the connection on the starter motor itself. If the starter motor does not function (do not keep the cable in contact more than a few seconds if the starter motor does not function) it should be removed for testing and repair.

### The starter motor operates weakly

Poor battery.

Test and charge if necessary.

High resistance in starter motor circuit.

Examine all connections on the cables to the starter motor and the cables between the motor and the chassis. Make sure that all contact surfaces are clean, that all cable terminals are well soldered and all connections are thoroughly tightened.

Poor contact in starter relay or control solenoid.

Compare the starter motor output with and without the starter relay (control solenoid) by disconnecting the cable at the starter relay (control solenoid) and holding it directly in contact with the starter motor connection bolt. Replace a faulty starter relay or control solenoid.

Faulty starter motor.

Remove and test the starter motor.

### The starter motor runs at high speed without meshing in the flywheel ring gear

Damaged flywheel ring gear.

Remove the casing under the flywheel. See Part I. Replace the damaged ring gear.

Damaged drive and/or Bendix spring.

Remove starter motor and replace damaged parts.

Damaged drive and/or meshing device.

Remove starter motor and replace damaged parts.

## Ammeter

### Faulty indication

The indicator needle is chafing on the glass of the dial.

Remove the ammeter and carefully bend the needle in the desired direction. Test the ammeter.

The needle refuses to indicate zero.

Remove the ammeter. Carefully bend the pointer until it indicates zero and then test the ammeter.

The needle has an uneven and jerky movement.

Remove the ammeter and examine to see if the needle is chafing in its bearing. Adjust and then test the ammeter.

Damaged ammeter calibration.

Replace the ammeter.

### No indication

Loose connections.

Check all connections.

Faulty ammeter.

Replace the ammeter.

## Fuel gauge

### The instrument indicates empty

Poor contact between ignition switch and fuel gauge.	Check connections.	} See under the heading "Fuel gauge" on page 27.
Short circuit to earth.	Check the instrument chassis connection.	
Faulty instrument.	Replace the instrument.	

### The instrument indicates full all the time

The fuel gauge tank unit has a poor chassis connection.	Check the chassis connection of the fuel gauge tank unit.	} See under heading "Fuel gauge" on page 27.
Loose connections or cable breakage between the instrument and the tank unit.	Check the connections and the cable.	
Faulty tank unit.	Replace tank unit.	

### The instrument indicates an excessively high value

Loose connections or poor chassis connection of tank unit.	Check connections.
Faulty instrument.	Replace instrument.
Faulty tank unit.	Replace tank unit.

### The instrument indicates excessively low values

Earthing of the cable between the instrument and the tank unit.	Examine. Replace faulty cable.
Faulty instrument.	Replace instruments.
Faulty tank unit.	Replace tank unit.

## Headlights

### The headlights do not function

Burned out fuses.	Replace fuses.
Burned out bulbs.	Replace bulbs.
Loose connections.	Check all connections.
Poor earth connection.	Check earth connection between bulb—bulb holder—headlight insert—chassis.
Faulty switch or foot dipper switch.	Replace.
Breakage in cables.	Replace damaged cable.

### The headlight burns too weakly

Glass and/or reflector dirty.

Excessively high resistance in switch and/or foot dipper switch. Poor contact at fuse.

Poor chassis connection at headlight.

The bulbs fitted are intended for a higher voltage.

Examine. The glass and the reflector cannot be separated so that both must be replaced in this case.

Carry out check measurements of voltage drop in switch and foot dipper switch.

Examine chassis connection.

Replace the bulbs.

### The bulbs burn out quickly

The charging relay is faultily adjusted or damaged so that the dynamo is charging excessively.

The electrolyte level in the battery is too low or the plates are short circuiting.

The battery terminal clamps are corroded.

Test and adjust the charging relay in accordance with the directions given under the heading "Charging relay". If the bulbs become black when they burn out this means that there is excessively high voltage in the circuit.

Examine the battery.

Clean and tighten the terminals and connections. Replace damaged terminals and/or cables.

## Direction indicator (semaphore type)

### Both the direction indicators out of function

Burned out fuse.

Faulty direction indicator switch.

Loose connections at starting switch, fuse box or switch.

The direction indicator arms are chafing or are damaged.

Breakage on the cable between the starter switch and the direction indicator switch.

Replace.

Replace.

Examine all connections.

Lubricate the direction indicator arms, test and replace if necessary.

Check the circuit. Replace damaged cables. If the starter switch does not work either, the fault can lie in the starter switch or the cable to the starter switch.

### One of the direction indicators is out of function

Faulty direction indicator switch.

Loose connections on direction indicator switch or direction indicator arm. Poor chassis connection.

Breakage on the cable between the direction indicator switch and then direction indicator.

The direction indicator chafes or is damaged.

Replace.

Tighten connections and check that a good chassis connection is obtained.

Replace cable.

Lubricate the direction indicator, test and replace if necessary.

## Direction indicators (flasher type)

### Both direction indicators out of function

Burned out fuse.	Replace fuse.
Loose connections at fuse box, connector or direction indicator switch.	Check for loose contact at the points mentioned. The fault can also be in the ignition switch or the cable to the fuse box.
Faulty direction indicator switch.	Replace.
Faulty flasher impulse unit.	Replace.
Breakage on the cable, direction indicator switch — flasher impulse unit — direction indicator.	Replace faulty cable.
Burned out bulbs.	Replace.

### One direction indicator out of function

Burned out bulb.	Replace.
Faulty switch.	Replace switch.
Loose connection or damaged cable.	Check. Replace damaged cable.

## Horn

### The horn does not function

Burned out fuse.	Replace fuse.
Breakage in the cable from the horn button to the horn, or in the cable between the fuse box and the horn.	Examine the cables. The fault can be in the cable between the ignition switch and the fuse box or in the ignition switch itself. Another possibility is the cable between the ammeter and the fuse box. The last two alternatives depend upon how connections are carried out.
Faulty horn button.	Replace faulty horn button.
Faulty horn.	Disassemble, test and adjust.
Faulty horn relay on vehicles fitted with two horns.	Disassemble and test. Replace faulty relay.

### The horn only functions occasionally

Loose connections.	Check all connections and tighten those which appear to have poor contact.
Poor contact in horn button (and relay).	Disassemble horn button and replace faulty or damaged parts.

### The horn has not the correct tone

Faulty adjustment.	Readjust.
Loose connections or corroded contacts causing excessive resistance.	Check the voltage fall over connections and switches. Replace corroded contacts.

## List of contents 51

Description .....	1
Repair instructions .....	7
Battery .....	7
Starter motor .....	9
Dynamo .....	17
Charging control .....	23
Distributor .....	25
Headlights .....	28
Flashers and parking lights .....	32
Rear lights .....	32
Number plate lighting .....	32
Instrument and interior lighting .....	33
Lighting switch .....	33
Direction indicator switch .....	34
Horn .....	34
Windscreen wiper .....	35
Electrical leads .....	37
Leads for extra equipment .....	37
Fuses .....	37
Heater .....	38
Windscreen washer .....	38
Fault tracing .....	40
Specifications .....	43