

# Service Manual

## Trucks

Section 3

Electrical System

C303

CIVIL

# VOLVO



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### Group 39 Wiring Diagram

Wiring Diagram .....	Fold-out
----------------------	----------





Distance from pinion to ring gear .....	1.2-4.4 mm (0.048-0.173")
Rotor brake frictional torque .....	0.22-0.40 Nm 2.2-4.0 kgf m (16-30 lbf ft)
Pinion idling torque .....	0.13-0.18 Nm 1.3-1.8 kgf m (9.5-13.0 lbf ft)
Backlash .....	0.35-0.50 mm (0.014-0.020")
Minimum diameter of commutator .....	33 mm (1.3")
Minimum length of brushes .....	13 mm (0.5)
Test values, electrical (with a battery capacity of 135 Ah)	
Unloaded starter motor 11.5 V and 30-50 A .....	96.7-130.0 r/s (5800-7800 r/min)
Locked starter motor (rotor) 6 V and 330-420 A .....	0 r/s
Control solenoid cut-in voltage .....	Min. 7.5 V

## Ignition system

Firing sequence .....	1-5-3-6-2-4
Ignition timing (vacuum governor disconnected) .....	10° at 13.3 r/s (800 r/min)
Basic firing position (engine switched off) .....	10° B.T.D.C.
Spark plugs .....	W 200 T 35 or corresponding
Spark plugs, electrode gap .....	0.7-0.8 mm
Spark plugs, tightening torque .....	35-40 Nm 3.5-4.0 kgf m (26-30 lbf ft)
Ignition coil, condenser .....	0.45 $\mu$ F
Spark plug cables, damper resistance at 20°C (68°F) .....	1000 $\Omega$ at distributor 5000 $\Omega$ at spark plug

## Distributor

Type .....	PFU 6
Direction of rotation .....	Anti-clockwise
Cam angle (dwell angle) .....	39°-45°
Breaker contacts, gap .....	Min. 0.25 mm (0.010")
contact pressure .....	5.0-6.3 N (0.5-0.63 kgf = 1-1.4 lbf)

## Centrifugal governor

Advance, total .....	11.5-13.5 distr. degrees
Advance begins at .....	10.2-12.1 distr. r/s (610-725 distr. r/min)
Values, 5° .....	14.3-16.7 distr. r/s (860-1000 distr. r/min)
10° .....	26.3-32.9 distr. r/s (1575-1975 distr. r/min)
Advance, maximum, at .....	37.5 distr. r/s (2250 distr. r/min)

## Vacuum governor (positive)

Advance, total .....	4-6 distr. degrees
Advance begins at .....	10.7-16.0 kPa (80-120 mm Hg) (3-5")
Values at 2.5 distr. degrees .....	15.3-21.3 kPa (115-160 mm Hg) (4.5-6.3")
Advance, maximum, at .....	23.3-25.3 kPa (175-190 mm Hg) (7-7.5")

## Lighting

### Bulbs

	Qty	Output	Socket	Type
Headlamps .....	2	60/55 W		H 4
Direction indicators .....	4	23 W	Ba 15 s	
Parking lights .....	2	4 W	Ba 9 s	
Stop lights .....	2	23 W	Ba 15 s	
Tail lights .....	2	10 W	Ba 15 s	
Interior lighting .....	2	10 W	S 8.5	

### Indicator and warning lights

Fullbeams .....	1	2 W	Ba 9 s
Direction indicators .....	2	2 W	Ba 9 s
Diff. locks .....	2	2 W	Ba 9 s
Front-wheel drive .....	1	2 W	Ba 9 s
Battery charging .....	1	2 W	Ba 9 s
Oil pressure .....	1	2 W	Ba 9 s
Brakes .....	1	2 W	Ba 9 s

### Instruments

Speedometer .....	1	2 W	Ba 9 s
Coolant temperature gauge .....	1	2 W	Ba 9 s
Fuel gauge .....	1	2 W	Ba 9 s

### Switches

Lights .....	1	2 W	Ba 7 s
Windscreen wipers .....	2	2 W	Ba 7 s
Washers .....	1	2 W	Ba 7 s
Hazard warning lights .....	1	2 W	Ba 7 s
Headlamp wipers .....	1	2 W	Ba 7 s

### Fuses

Qty	Rated current
18	8 A

## General Service Procedures

Before carrying out any repairs, disconnect the negative lead from the battery.

Wiring cables have been coloured in order to facilitate identification.

The following cable colours are used:

Light	Blue BL	Green GN	Black SB
White	Brown BN	Yellow Y	Grey GR

When about to do any electrical welding work on the vehicle, disconnect both battery cables and the cables to the charging alternator. The welding machine should be connected as near as possible to where the welding is to take place and on the same main component. For example, if the frame is to be welded, the welding machine should be earthed to the frame.

A layout wiring diagram has been made for the following conditions:

Condition	Group Illustration
Lighting, instruments and switches	35
Windscreen headlamp washers (hose routing)	36
Direction indicators with hazard warning flashers	36
Windscreen wipers with relay	36
Windscreen wiper parking	36
Headlamp wipers	36
Coolant temperature gauge with sender	38
Fuel gauge with sender	38
Engaging front-wheel drive	38
Engaging vacuum contacts	38
Warning devices for warning lamp marked "Brake"	38

### Connection designations on various components

The listing below is to show the association between wire connection and the component terminal designation.

From

To

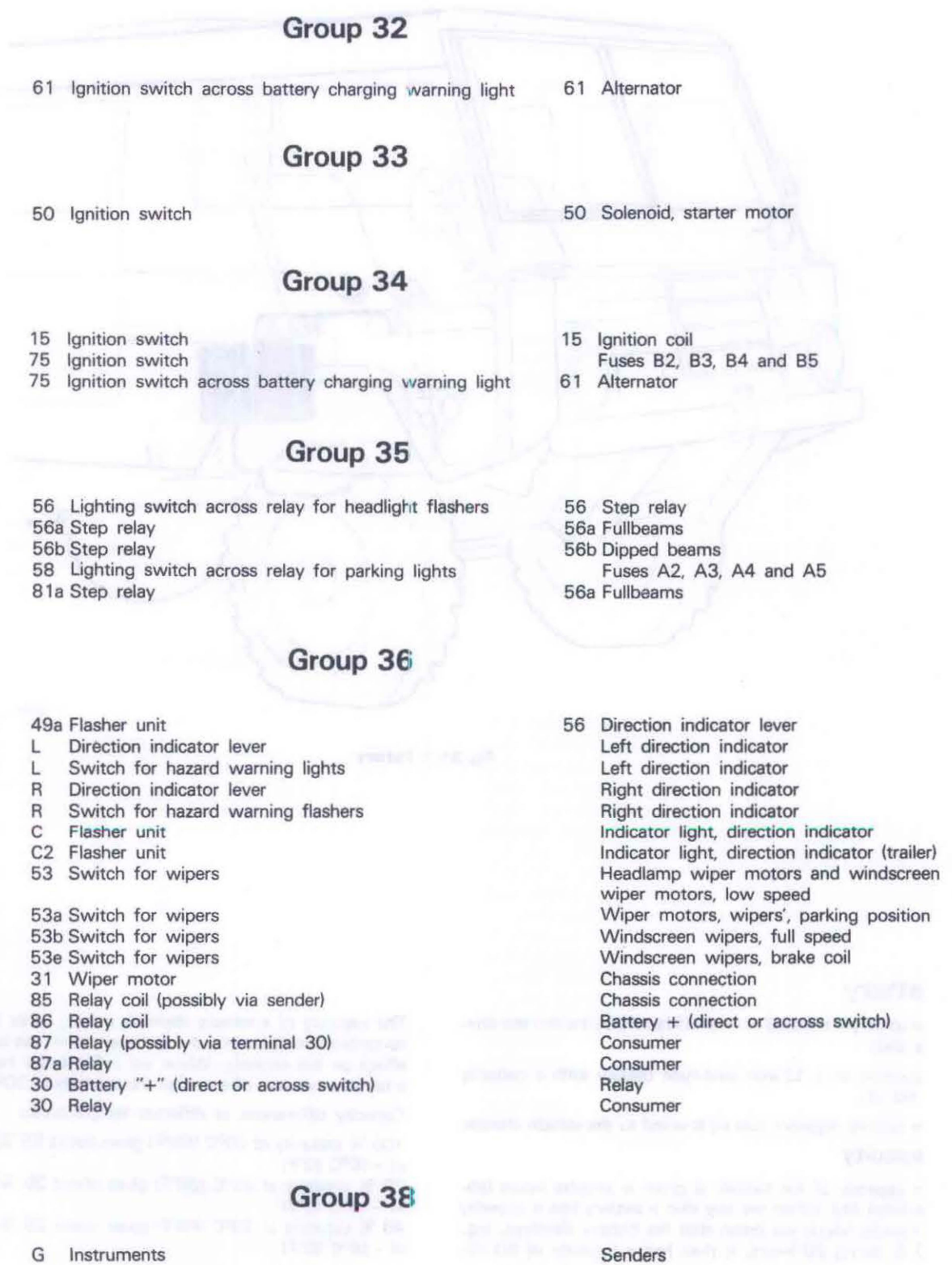
### Group 31

Battery  
Starter motor  
Starter motor

30 Starter motor  
B+ Alternator  
30 Ignition switch

From

To



## Group 31. Battery

### Construction and Function

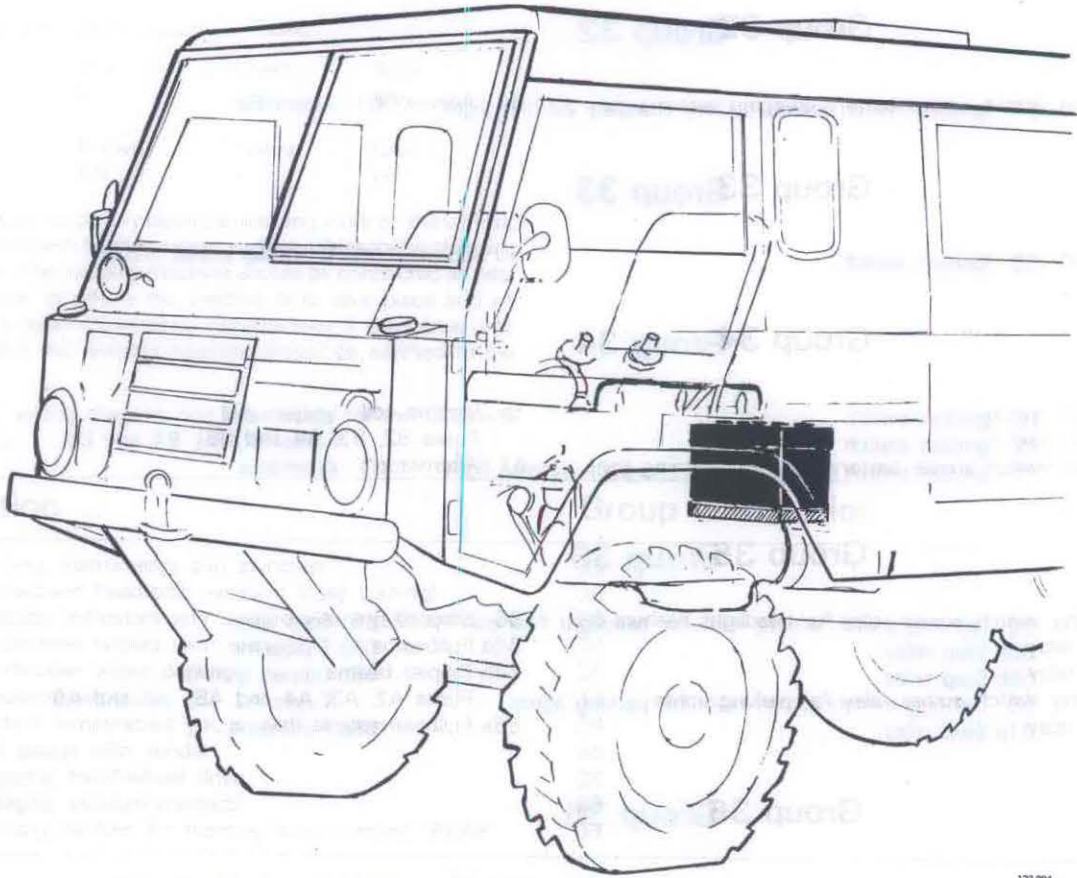


Fig. 31-1. Battery

#### attery

The battery is situated on the left-hand side, behind the driver's seat.

The battery consists of a 12-volt lead-type battery with a capacity of 60 Ah.

The battery negative pole (-) is wired to the vehicle chassis.

#### Capacity

The capacity of the battery is given in ampère hours (abbreviated Ah). When we say that a battery has a capacity of twenty hours, we mean that the battery develops, e.g., 3 A during 20 hours. It then has a capacity of 60 Ah.

The capacity of a battery depends among other things on its ambient temperature. A low temperature has a negative effect on the capacity. When we indicate the capacity of a battery, we very often mean the capacity at 20°C (68°F).

Capacity differences at different temperatures:

100 % capacity at 20°C (68°F) gives about 55 % capacity at -18°C (0°F)

70 % capacity at 20°C (68°F) gives about 35 % capacity at -18°C (0°F)

40 % capacity at 20°C (68°F) gives about 25 % capacity at -18°C (0°F).

## Service Procedures

### Battery

When replacing the battery, make sure that the new one is connected up with the correct polarity (minus to vehicle chassis).

The battery cables must not be disconnected when the engine is running.

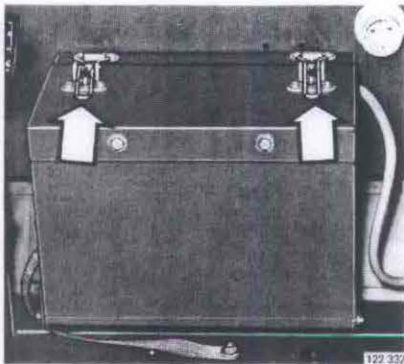
To ensure that the battery operates without any trouble, always maintain the fluid at the prescribed level. Make sure that it is about 5 mm (3/16") above the cell plates. Top-up if necessary with sufficient distilled water. Also make sure that the battery cable shoes are fixed securely. The cable shoes and pole studs should be coated with a light layer of grease, e.g., Bosch Ft 40 V 1 or corresponding.

### 31102-3

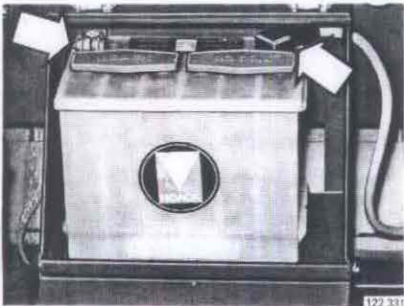
#### Changing the battery

##### Removal

1. Unclasp the lock clasps and fold down the cover.



2. Remove the insulation across B+.
3. Disconnect the battery cables from the battery.
4. Remove the battery.

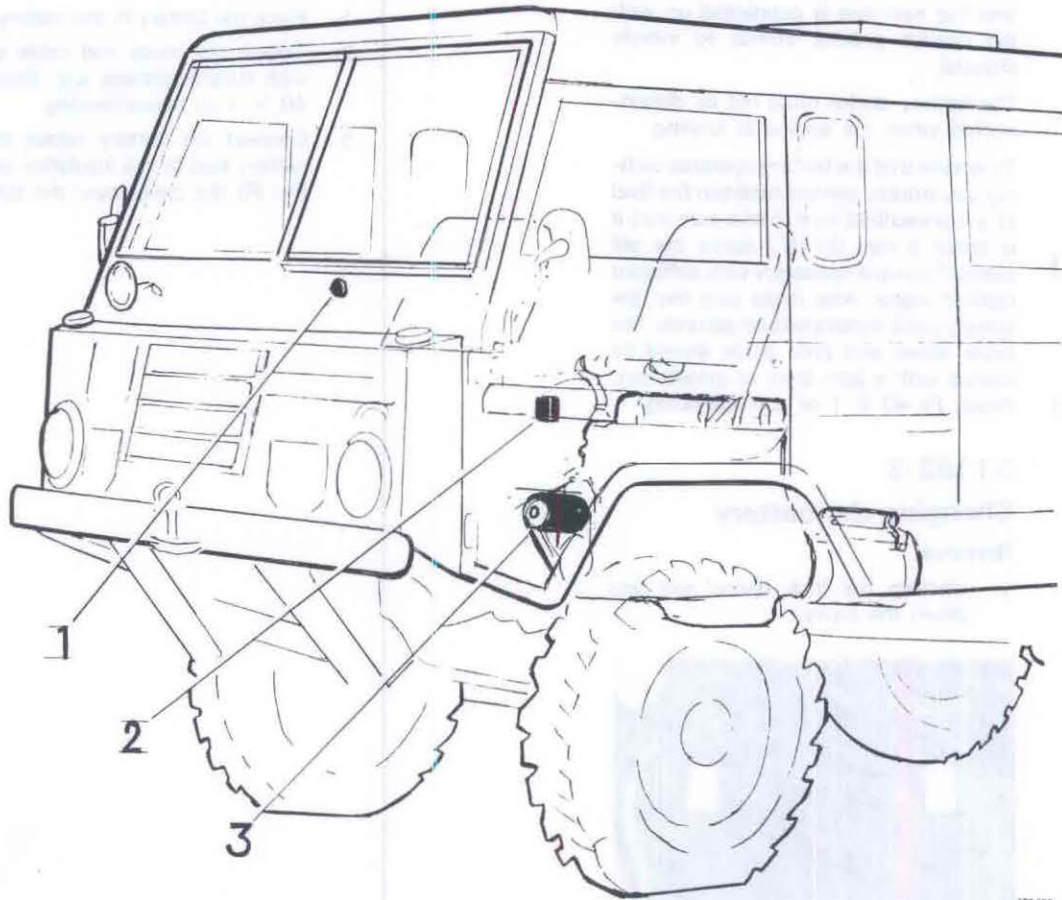


##### Installation

1. Place the battery in the battery box.
2. Grease the studs and cable shoes with suitable grease, e.g., Bosch Ft 40 V 1 or corresponding.
3. Connect the battery cables to the battery and fit the insulation across B+. Fit the cover over the battery.

## Group 32. Alternator

### Construction and Function



122 096

Fig. 32-1. Alternator

- 1 Battery charging warning light
- 2 Charging regulator
- 3 Alternator

#### alternator

alternator is situated on the right-hand side of the engine is driven by two belts from the crankshaft pulley. The alternator develops an output of max. 770 W.

The charging regulator is mounted on the right-hand side of the rear engine casing lock device. The battery charging warning light is on the instrument panel.

The alternator is a three-phase, delta-connected alternator unit, of make Bosch 14V/55A. The rectifier, which is built into the slip ring end shield, consists of six silicon diodes. The drive end shield houses three magnetizing diodes which feed the rotor winding via the charging regulator.

An alternator differs from a dynamo in that it has a rotating field coil (rotor) and stationary generating winding (stator).

The rotor is of the claw-pole type with the field windings fed across two slip rings. Since the alternator is self-limiting with regard to current (max. 55A), a simple, mechanical charging regulator can be used with only voltage control.

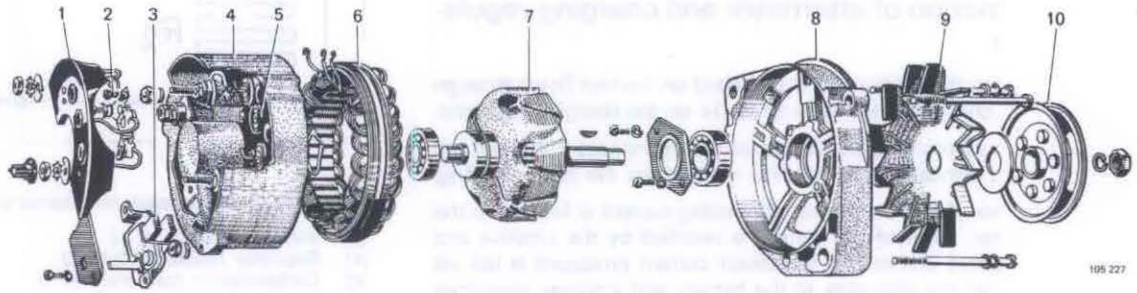


Fig. 32-2. Exploded view of alternator

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

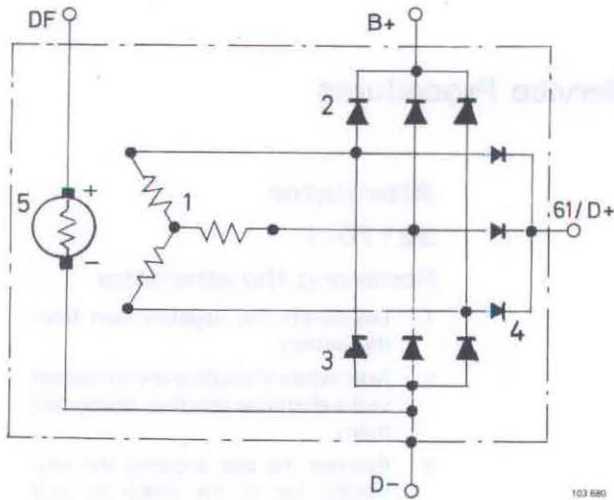


Fig. 32-3. Alternator internal wiring

- 1 Stator windings
- 2 Positive rectifier diodes
- 3 Negative rectifier diodes
- 4 Magnetizing diodes
- 5 Rotor winding

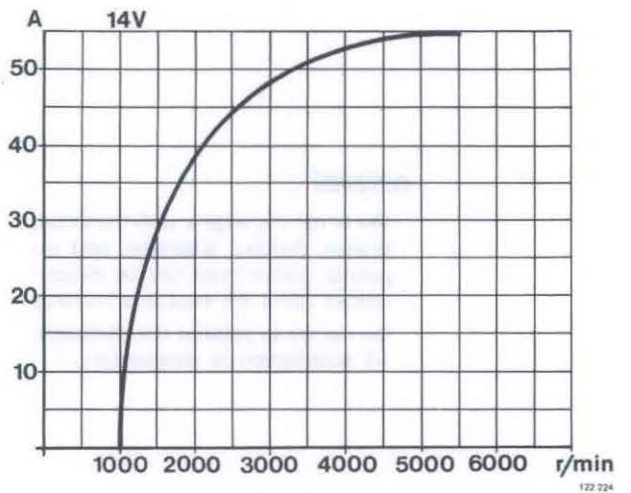


Fig. 32-4. Output curve  
The above speed applies to alternator

## Charging regulator Bosch AD 14 V

A charging regulator is a mechanical, single-pole voltage regulator.

It consists of a contact system which consists of 1, a movable contact, 2, a lower contact, 3, an upper contact, see Fig. 32-5.

A regulator resistor is placed under a plate underneath the regulator. Temperature compensation is operated by a metal spring which influences the spring tension so that the regulator receives lower regulating voltage at higher temperatures.

## Function of alternator and charging regulator

When the ignition key is switched on, current flows through the charging warning lamp to D+ on the charging regulator.

Current is then conducted via the regulator through the field winding to earth. This magnetizes the rotor winding.

When the rotor rotates, alternating current is formed in the rotor. Most of the current is rectified by the positive and negative diodes and the direct current produced is led via 61/D+ on the alternator to the battery and a power consumer (consumers) if switched on. A small part of the current is rectified by the magnetizing diodes and is led via 61/D+ to the charging regulator and then onto the rotor winding. The cycle is repeated until the regulating voltage has been reached. When this has been reached, contact is broken between 1 and 2 on Fig. 32-5. This forces the magnetizing current to the rotor winding to pass resistance  $R_1$ , Fig. 32-5. The voltage rises in spite of this, the armature is drawn further down in the voltage coil and the movable contact meets the upper contact (3), Fig. 32-5. This earths the field winding at both ends and the voltage drops. The cycle is repeated continuously so that voltage is maintained constant.

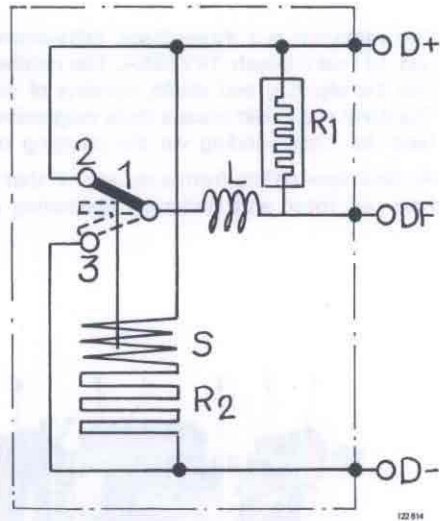


Fig. 32-5. Charging regulator internal wiring

S	Voltage winding $35 \Omega$
R1	Regulator resistance $2.45 \Omega$
R2	Compensation resistance $50 \Omega$
L	Contact impedance coil

- 1 Movable contact
- 2 Lower contact
- 3 Upper contact

## Service Procedures

### General

Never run the engine with the circuit broken. Battery, alternator and regulator cables must not be disconnected while the engine is running.

Do not try to polarize the alternator. All polarization is unnecessary.

### Alternator

#### 32170-1

#### Removing the alternator

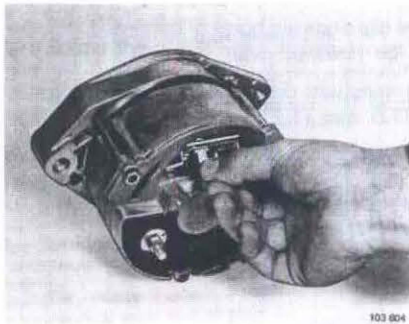
1. Disconnect the negative lead from the battery.
2. Note where the cables are connected to the alternator and then disconnect them.
3. Remove the bolt securing the tensioning bar to the alternator and slacken a couple of turns the bolt securing the tensioning bar to the cylinder head.
4. Remove the alternator retaining bolt and its spacer washer. Remove the drive belts and the alternator.

## Alternator (removed)

### Overhauling

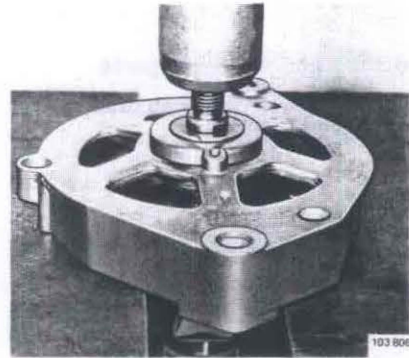
#### Disassembling

1. Fit the alternator pulley and pulley belt in a vice with soft jaws. Remove the nut, washer, pulley, fan and key.
2. Remove the screws securing the brush holder. Pull out the holder.

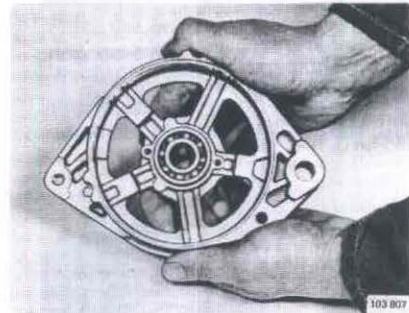


3. Mark the drive end shields and stator to ensure they are re-fitted correctly when assembling.
4. Remove the three screws holding the alternator together. Separate the drive end shield and rotor from the slip ring end shield and stator.

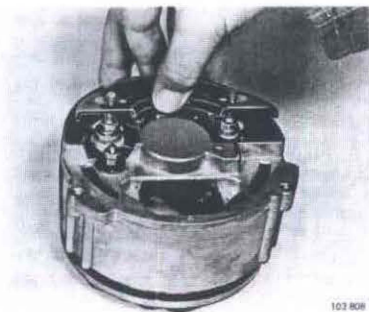
5. Press the rotor out of the drive end shield.



6. Remove the screws for the cover washer which holds the drive end bearing and press out the bearing.



7. Remove the nuts for the positive diode plate and lift up and bend the plate aside.



Solder loose the stator connections from the terminals and remove the stator.

Pull the slip ring bearing from the rotor.

### Checking and replacing parts

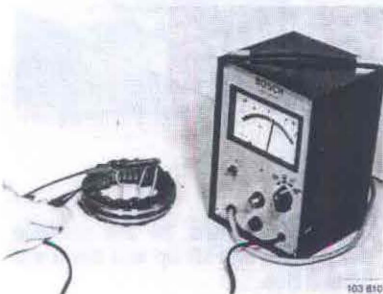
Clean the removed parts with white spirit before checking them.

#### Stator

Check the stator insulation by connecting 40 V alternating current between the stator body and a phase winding.



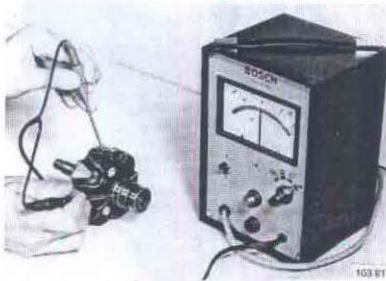
Check the stator for any short-circuiting by measuring the resistance between the stator windings (three measurements). The resistance should be 0.14–0.15 ohm.



0,14–0,15  $\Omega$

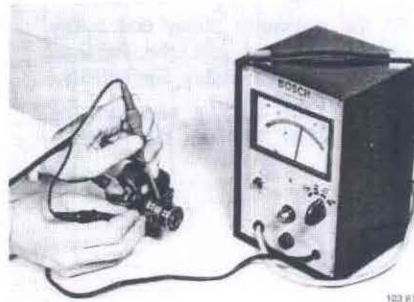
#### Rotor

Check the rotor insulation by connecting 40 V alternating current between the rotor body and a slip ring.



Measure the resistance between the slip rings with the help of an ohmmeter.

The resistance should be 4.0–4.4 ohms.



4,0–4,4  $\Omega$

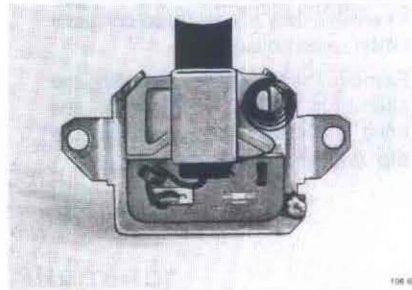
If the slip rings are burnt or damaged, they can be polished with, e.g., pinol chuck.

The minimum diameter for the slip rings is 31.5 mm (1.2").

After polishing, check the roundness on the slip rings with a dial indicator. Max. permissible radial throw is 0.03 mm (0.0012").

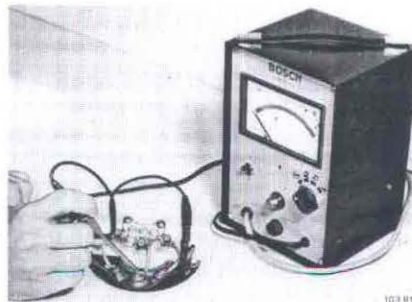
#### Brush holder

Check the brush holder insulation with a 40 V alternating current. Measure the brush length which should be minimum 14 mm (0.5").



#### Diodes

Check the diodes with a diode tester. Faulty diodes must be replaced as follows.



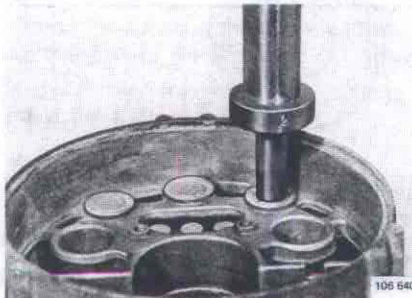
## Replacing the diodes

### Positive diodes

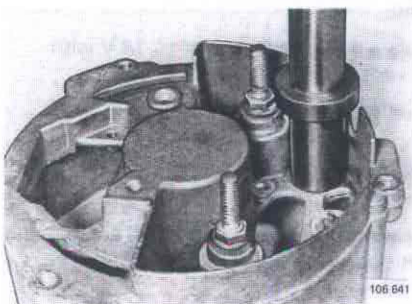
1. Solder loose the positive diode plate from the connections. Press out the faulty diode with a suitable drift.
2. Calibrate the hole in the positive diode plate with a suitable tool (e.g. Bosch EFLJ 57/0/3 and 57/05).
3. Oil the new diode with silicon oil (e.g. Bosch OI 63V2) and press it in with a suitable drift.
4. Paint the new diode and any bare spots on the outside of the positive diode plate with black paint (Bosch F 1 87 V 1 corresponding) to prevent corrosion.
5. Solder the positive diode plate to the connections. Check with a diode tester.

### Negative diodes

1. Solder loose the negative diodes from the connections. Screw loose the plate holding the magnetizing diodes and lift off the plate together with the positive diode plate.
2. Press out the faulty diode with a suitable tool.



3. Oil the new diode with silicon oil (e.g. Bosch OI 63V2) and fit it in the bearing shield.



4. Solder on the negative diodes to the connections and check with a diode tester.

### Magnetizing diodes

1. If any of the magnetizing diodes is faulty, replace the entire plate and all three diodes.

### Bearings

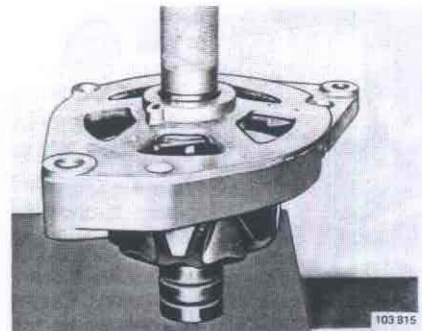
Check to make sure the bearings are not damaged or worn.

Grease the old bearings (or new ones if fitted) with Bosch special grease Ft 1 V 34 or corresponding.

Fit the bearing on the rotor. Fit the bearing in the drive end shield and fix the washer over the bearing.

### Assembling

1. Fix the stator in the slip ring end shield and solder the stator windings to the connections. Fit the positive diode plate.
2. Press the bearing shield and spacer ring onto the rotor.



3. Smear the bearing rear seat with a light layer of Molykote paste and assemble the alternator. (Do not forget the spring ring on the bearing rear seat.) Assemble the alternator by means of the screws and nuts (check the marking).
4. Fit the brush holder.
5. Fit the key, fan, pulley, washer and nut.
6. Tighten the nut to a torque of 40 Nm (4 kgf m = 29 lbf ft). After assembling the alternator, test it on a test bench before installing it in the vehicle, see under "Charging Test" (on test bench or in vehicle), page 14.

40 Nm

## 172-1

### Installing the alternator

Place the alternator in position and fit the retaining bolt and spacer washer. (Do not tighten up the bolt.)

Fit the drive belts.

Fit the bolt securing the tensioning bar. (Do not tighten up the bolt.)

Tension the drive belts by levering with a suitable tool on the alternator drive bearing end and then tighten up the bolt securing the tensioning bar.

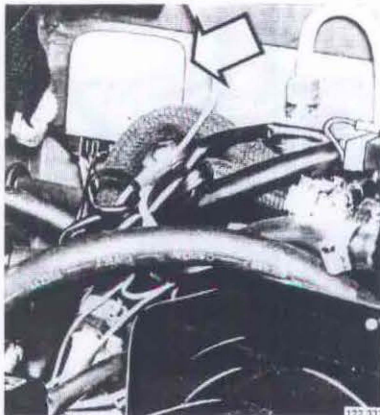
Tighten up the alternator retaining bolt.

Tighten up the bolt on the cylinder head and connect the cables to their terminals.

Fit the front engine cover. Connect the negative cable to the battery and fit the cover over the battery.

## 205-3

### Replacing the charging regulator



Pull the insert plug out of the charging regulator.

Remove the bolts securing the regulator.

Check that the number on the new regulator is the same as that on the old one.

Mount and secure the regulator and connect the insert plug.

## Testing the alternator and regulator

Before testing the alternator or regulator in the vehicle, check the battery and test the electrical circuit for faulty cables or insulation, loose or corroded cable shoes and poor earthing. **Check the drive belts.** Any faults discovered must be put right before doing any electrical checks.

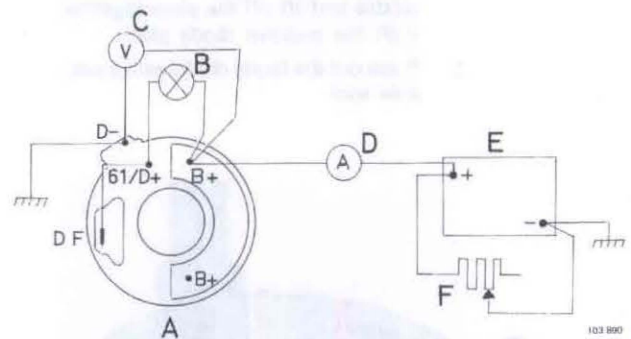
Always make sure that the circuit is not broken when checking the alternator equipment. A disconnected cable can ruin both alternator and regulator.

## 32183-4, 32174-2

### Charging test (on test bench or in vehicle)

#### Alternator

Wire the alternator according to the diagram below.



- |   |                       |   |                 |
|---|-----------------------|---|-----------------|
| A | Alternator            | D | Ammeter 0-60 A  |
| B | Check lamp (12 V 2 W) | E | Battery         |
| C | Voltmeter 0-20 V      | F | Load resistance |

Run the alternator at 100 r/s (6000 r/min) (engine speed 58 r/s = 3500 r/min).

Regulate the voltage to approx. 14 V with load resistance F.

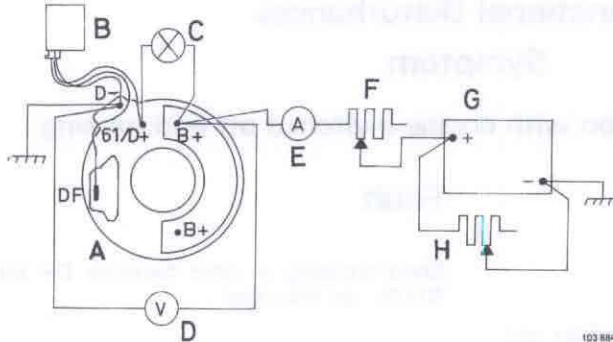
The alternator should now generate 55 A.

If it does not, first check the brushes and the diodes.

If speeds differing from the above are obtained, compare with the output curve in Fig. 32-4.

### Testing and adjusting the regulator (in the vehicle or on test bench)

Connect the regulator to a fault-free alternator according to the wiring diagram below.



- |   |                         |   |                    |
|---|-------------------------|---|--------------------|
| A | Alternator              | E | Ammeter 0-60 A     |
| B | Regulator               | F | Control resistance |
| C | Control lamp (12 V 2 W) | G | Battery            |
| D | Voltmeter 0-20 V        | H | Load resistance    |

Run the alternator at 67 r/s (4000 r/min) (engine speed 39 r/s = 2300 r/min). Load the alternator to 44-46 A. Lower the alternator speed to approx. 16.7 r/s (1000 r/min) (engine idling speed). Again increase the speed to the above and adjust the load to 44-46 A.

Read off the voltmeter. The voltage should be 13.9-14.8 volts.

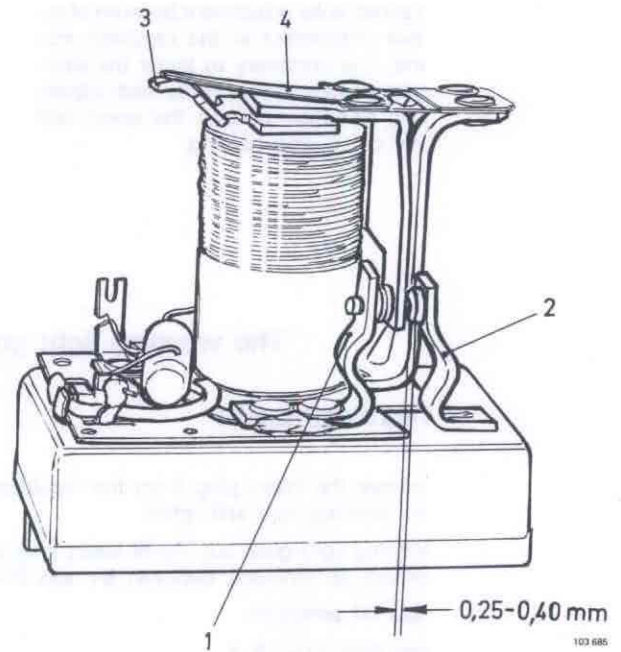
13,9-14,8 V

The regulator should regulate on the left (lower) contact. Read-off within 30 seconds after starting the test.

Reduce the alternator load to 3-8 A and read off the control voltage. 3-8 A

The control voltage should now be within the tolerance 0 V to minus 0.4 V in relation to the first reading.

The regulator should now regulate on the right (upper) contact.

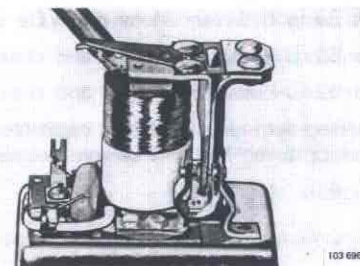


- 1 Regulator contact for lower control range (lower contact)
- 2 Regulator contact for upper control range (upper contact)
- 3 Stop bracket
- 4 Spring upper section: Steel spring  
lower section: Bimetal spring

If the control voltage in the upper control range is high or low in relation to the lower control range 0 V to minus 0.4 V, adjust by bending the retainer for the left (lower) contact while correcting the gap between the right (upper) contact and the movable contact according to the Fig. above.

If the holder is bent towards the right (upper) contact, this lowers the control voltage in the upper control range.

The control voltage in the lower control range is adjusted by bending the stop bracket for the bimetal spring.



If the stop bracket is bent downwards, this lowers the control voltage, if it is bent upwards, this increases the voltage.

To avoid faulty adjustment because of residual magnetism in the regulator iron parts, it is necessary to lower the alternator speed towards 0 after each adjustment, and then increase the speed and carry out a new reading.

(If the adjusting work is going to take some time and the regulator is warm, it can be suitably cooled to room temperature with compressed air before carrying out the final reading.)

## Functional Disturbances

### Symptom

#### The warning light goes on with engine switched off and running

##### Test measure

Remove the insert plug from the regulator: the warning light still lights.

Warning light goes out. Re-fit insert plug in regulator and connect an ammeter between B+ and D+ on alternator.

Read-off ammeter:

Less than 2.0–2.5 A

Greater than 2.0–2.5 A.

##### Fault

Short-circuiting in cable between D+ on regulator and 61/D+ on alternator.

Defective regulator (breakage).

Short-circuiting in cable between DF on regulator to DF on alternator. Short-circuiting in rotor winding.

#### Warning light goes on with engine switched off but starts to glint when engine is running

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

Lamp does not light

Lamp glints

Fit new regulator.

Test lamp between B+ and 61/D+:

Lamp does not light

Lamp glints

Transit resistance in charging circuit or in cable to warning light.

Regulator defective (battery overcharges) or alternator defective (insufficient charging of battery).

Removed regulator defective

Alternator defective

#### Warning lamp does not light with engine switched off

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

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

Test lamp between 61/D+ and chassis lights.

Test lamp between 61/D+ and chassis glints.

Warning light glints. Remove insert plug from regulator and connect an ammeter between B+ and DF on alternator.

Ammeter shows: 0 A

2.0–2.5 A

Burnt-out warning light or breakage in its circuit to D+ on regulator.

Short-circuiting in a positive diode.

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

Breakage in regulator or in cable DF from regulator to DF on alternator.

## Group 33 Starter Motor

### Construction and Function

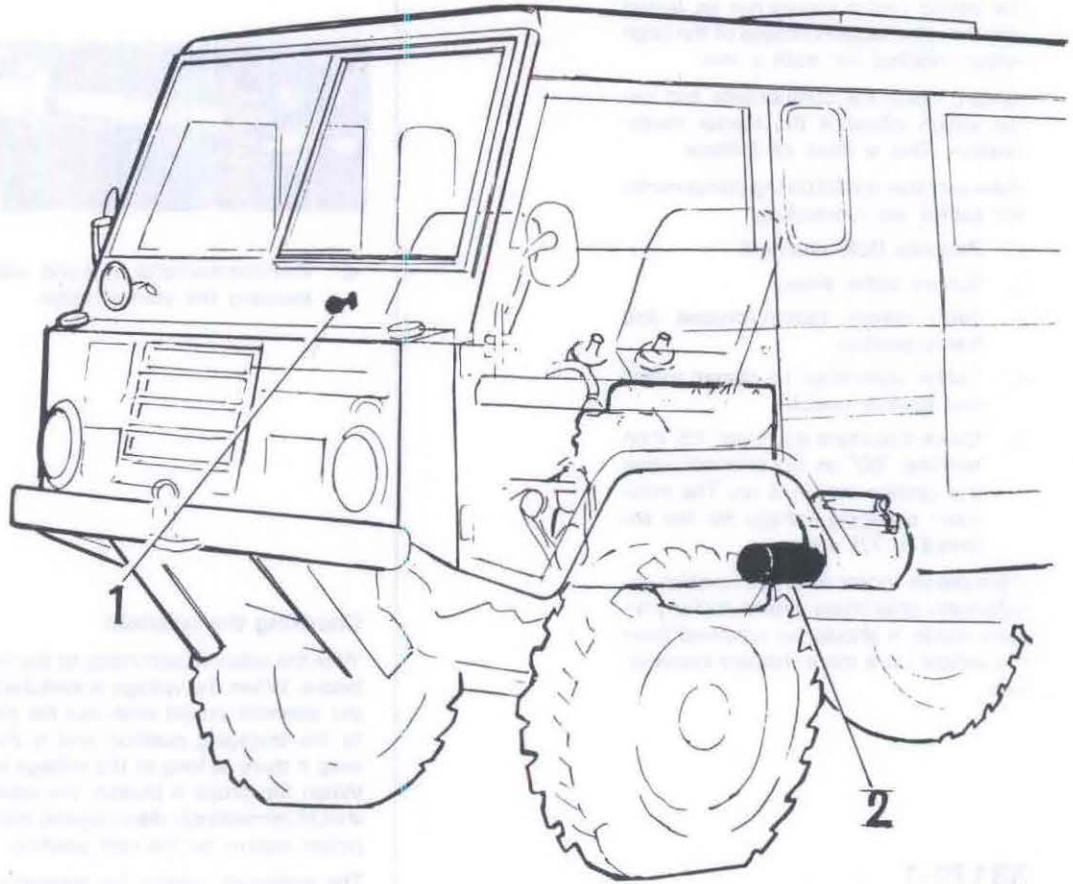


Fig. 33-1. Starter motor

- 1 Ignition switch
- 2 Starter motor

### Starter motor

The starter motor is a four-pole, series-wound motor and has an output of approx. 815 W (1.1 h.p.). It is situated on the left-hand side of the engine. The starter motor rotor shaft pinion moves axially to engage with the flywheel ring gear. The pinion is controlled by a solenoid. Turning the ignition key to the starting position cuts in the solenoid, this causing the armature in the solenoid to be drawn in and

the starter pinion to engage the ring gear on the engine flywheel.

When the armature has moved a certain distance, the contacts for the main current close and the starter motor starts running.

## Service Procedures

### Starter Motor

#### Testing in vehicle

The starter motor should not be tested with the rotor locked because of the large output required for such a test.

Instead, check the components and cables which influence the starter motor function. This is done as follows:

Make sure that the following components and cables are functioning.

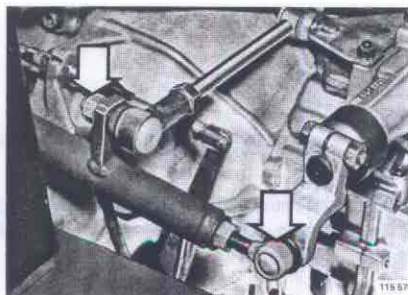
1. Batteries (fully charged)
2. Battery cable shoes.
3. Earth cables, battery-chassis and frame-gearbox.
4. Cables connected to starter motor and ignition switch.
5. Check that there is at least 7.5 V on terminal "50" on the solenoid when the ignition switch is on. The minimum engaging voltage for the solenoid is 7.5 volts.

If the starter motor does not function satisfactorily after these checks and any repairs made, it should be removed from the vehicle for a more detailed examination.

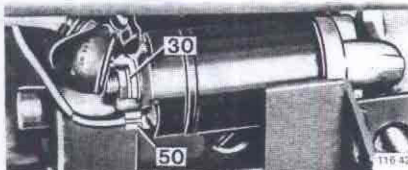
### 33170-1

#### Removing the starter motor

1. Disconnect the negative cable from the battery.
2. Remove the rear engine casing. Remove the gear lever control ball joints from the gearbox and lift up the control pipe.



3. Disconnect the cables from the starter motor.

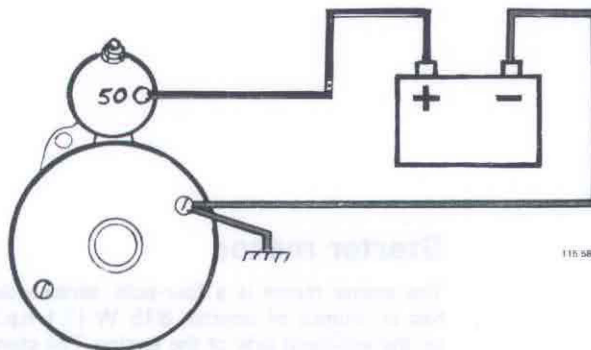


4. Remove the bolts, nuts and washers securing the starter motor.

#### Checking the solenoid

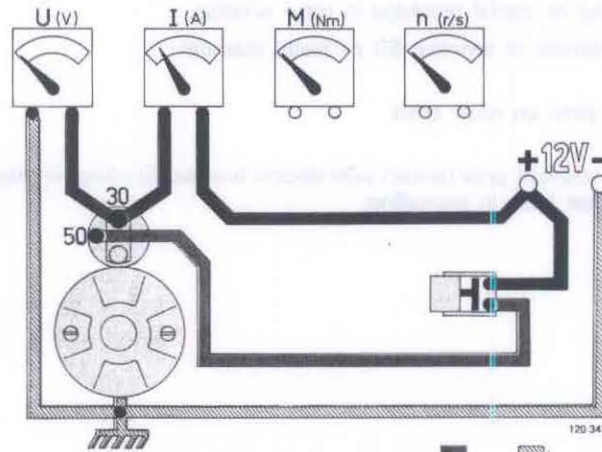
Wire the solenoid according to the figure below. When the voltage is switched on, the solenoid should push out the pinion to the engaging position and it should keep it there as long as the voltage is on. When the circuit is broken, the solenoid should immediately disengage so that the pinion returns to the rest position.

The minimum voltage for engaging the solenoid is 8 volts.



### Testing the starter motor on test bench

Wipe the outside of the starter motor with a damp cloth and then secure it on a test bench. Connect the measuring instruments according to the diagram below. NOTE! The test bench must be provided with a shunt for minimum 500 A.



The following values should be obtained:

1. Starter motor unloaded  
Power consumption 40–50 A  
Voltage 12 V  
Speed 115–135 r/s (6900–8100 r/min)
2. Starter motor loaded  
Power consumption 185–200 A  
Voltage 9 V  
Speed 17.6–22.5 r/s (1050–1350 r/min)
3. Starter motor locked  
Power consumption 300–350 A  
Voltage 6 V  
Speed 0 r/s

If the values deviate from the guide values of the maker, this may be due to the fact that the battery capacity of the test bench differs slightly from the capacity available when the guide values were drawn up.

In order to check whether the measured values agree, they should be re-calculated according to the following formula:

$$I = \frac{I_x \cdot U}{U_x}$$

$I$  = Maker's guide value (300–350 A according to Test 3)  
 $I_x$  = The current measured by you on test bench  
 $U$  = Maker's guide value (6 V according to Test 3)  
 $U_x$  = The voltage measured by you on test bench

### Example: Starter motor locked

$$I = \frac{I_x \cdot U}{U_x}$$

Measured values  $I_x = 270 \text{ A}$   $U_x = 5 \text{ V}$   
 Makers' guide values  $I = 300\text{--}350 \text{ A}$   $U = 6 \text{ V}$

Calculate what  $I$  will be and compare this with the maker's guide value ( $I$ ).

$$I = \frac{I_x \cdot U}{U_x} = \frac{270 \cdot 6}{5} = \frac{1620}{5} = \underline{324 \text{ A}}$$

The calculated value, 324 A, is within the maker's guide value, which was 300–350 A.

### Comments

The measured value, 270 A, has thus been re-calculated to 324 A, which is an approved value.

Concerning functional disturbances, see overleaf.

## Operational Disturbances

### Symptoms

- Low speed and low current.
- Low speed and high current.
- Powerful sparking, low rotation.
- Pinion goes back to rest position before voltage cuts-out.
- Pinion does not go back to rest position when voltage cuts-out.
- Solenoid cuts in, but starter motor does not start.

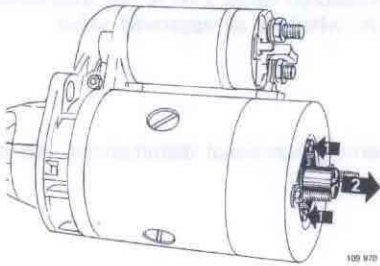
### Reason

- Large resistance because of dirty commutator, worn brushes or low brush spring pressure (poor batteries).
- Short-circuiting in magnetic windings. Rotor slips round against pole shoes because of worn bearings or bent rotor shaft.
- Low spring pressure because of worn brushes or displaced brush springs. Short-circuiting or partial breakage in rotor winding.
- Poor contact at terminal 50 or faulty solenoid.
- Pinion jams on rotor shaft.
- Faulty solenoid, poor contact with electric brushes. Breakage in magnetic winding. Rotor jams in journaling.

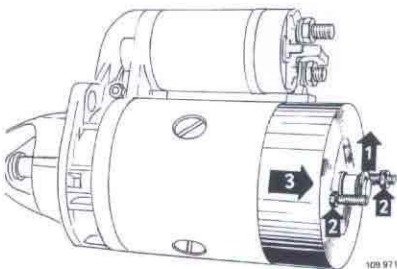
## Overhauling the starter motor

### Disassembling the starter motor

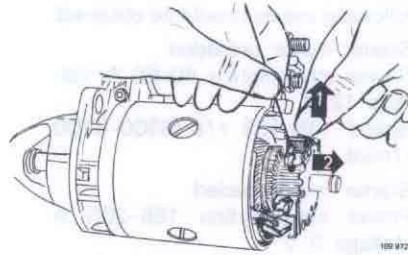
Remove the cover from the commutator frame.



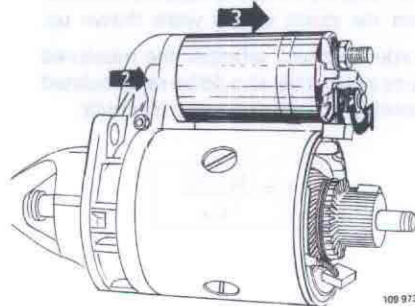
Remove the lock washers and adjusting screws as well as the two nuts. Remove the frame.



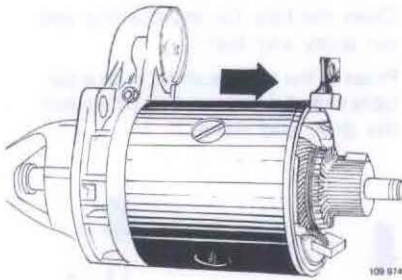
Remove the negative brushes and the brush holder.



Remove the nut securing the magnetic winding terminal from the solenoid. Remove the screws holding the solenoid.



Remove the pole housing from the armature and drive end frame.



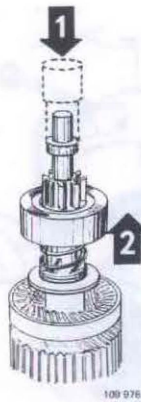
Remove the rubber washer and metal washer.

Remove the screw on which the shift lever is carried.

Remove the armature and shift lever.

Knock back the stop washer with the help of a suitable sleeve.

Remove the snap ring, stop washer and pinion.

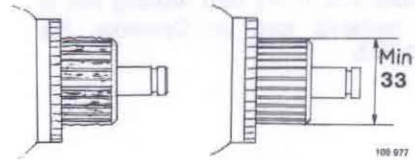


### Checking and replacing parts

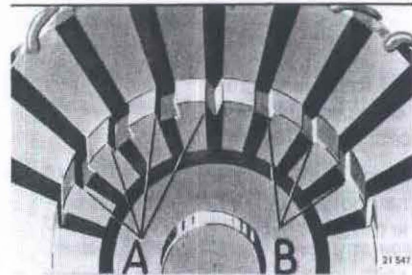
#### Armature

Examine the armature for mechanical damage. A bent or worn armature shaft must be replaced.

If the commutator is scored or unevenly worn, it should be turned. The minimum diameter is 33 mm (1.3").



After turning the commutator, check it with a micrometer. A radial throw of up to 0.08 mm (0.003") is permitted. The insulation between the laminations should be milled down to 0.4 mm (0.016") below the surface. This work is to be carried out in a special apparatus intended for this purpose, or if such is not available, with a ground-off hacksaw blade.

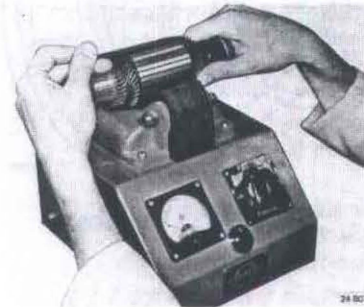


(max. 0.4 mm = 0.016" milling)

A = incorrectly milled  
B = correctly milled

Examine the armature for shorts by placing it in a growler.

Switch on and hold a hacksaw blade a few mm from the armature. If the blade



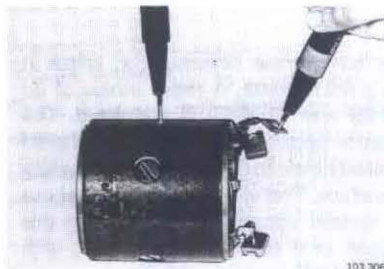
vibrates in any position when the armature is rotated, one of the following faults can be the reason.

Shorting through the armature frame, shorting in the commutator or between the windings.

### the housing

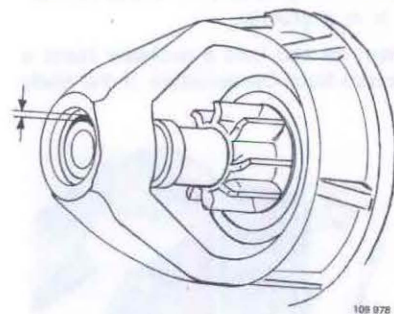
Check the field winding for shorting. Test with 40 volts A.C.

Also test the winding for breakage with 40 volts A.C. If the field winding has to be replaced, look up Operation No. 33175-5.



Examine the drive end frame and brush holders. If damaged or excessively worn, they must be replaced.

The clearance between the armature shaft and bushings may not exceed 0.12 mm (0.005"). Examine the other parts and replace any that are damaged or worn. The snap ring should always be replaced with a new one, since it may have been damaged or lost its tension when being removed.



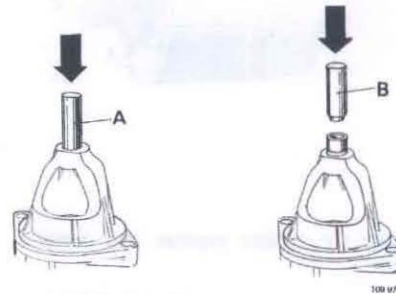
A = max. 0.12 mm (0.005")

### Replacing the self-lubricating bushings

The self-lubricating bushings, so-called "compo-bushings" should wear insignificantly during operation if lubricated correctly.

The bushings should be immersed in oil for at least 1/2 hour (use e.g. Bosch 01 1V 13 or corresponding) before being fitted.

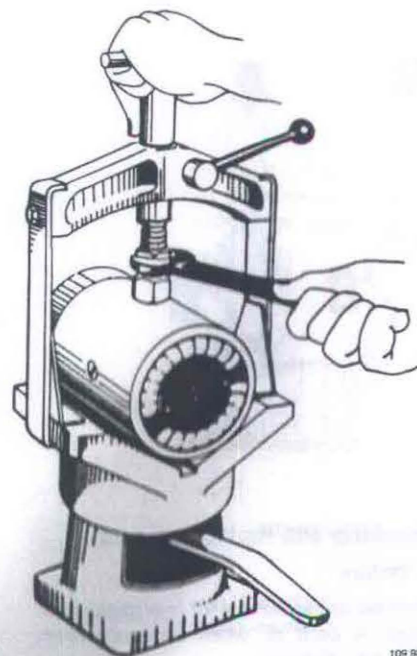
1. Drive out the worn bushing with the help of a suitable tool. Use a counterhold against the drive end frame.
2. Clean the hole for the bushing and cut away any burr.
3. Press in the new bushing with a suitable drift. Use a counterhold against the drive end frame.



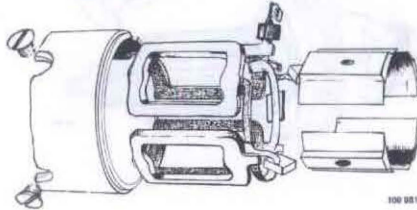
### 33175-5

#### Replacing the field coils

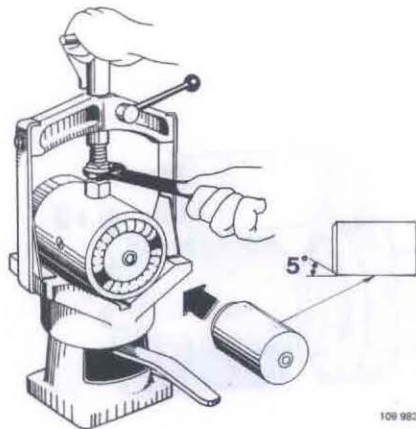
1. Mark the pole shoes and pole housing in a suitable manner so that they are re-fitted in their initial position.
2. Place the pole housing in a rotating clamping block (Bosch EFAW 9) and remove the pole shoes.



- Remove the pole shoes and magnetic winding from the pole housing.
- Fix the new magnetic windings loosely in the housing together with the pole shoes. Make sure the pole shoes are located according to the marks.



- Press in a suitable drift in the housing and tighten up the pole shoes.

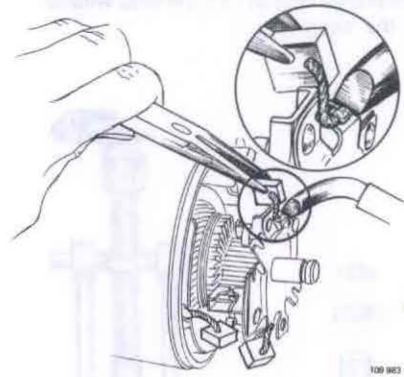


- Remove the press drift. Remove the housing from the clamping block.
- Check the installed field coils for breakage and shorts (with 40 volts A.C.).

#### Replacing the brushes

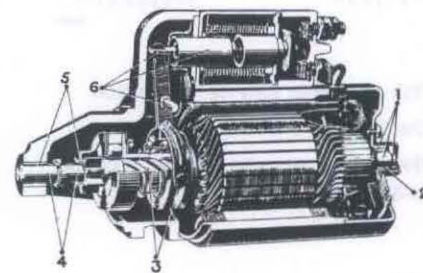
Brushes shorter than 14 mm (approx. 1/2") must be replaced with new ones.

- Solder loose the brushes from their respective attachments.
- Solder well the new brushes. This must be done rapidly and with sufficient heat. The solder must not run down onto the brush wires, since this will impede the movement of the brushes in the holder and thereby reduce the brush spring pressure.



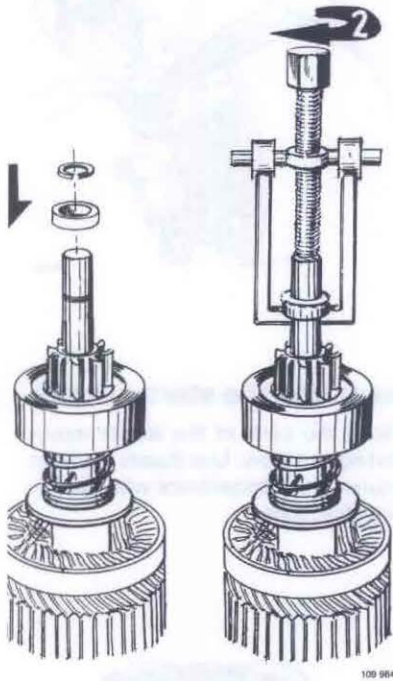
#### Assembling the starter motor

Lubricate the parts of the starter motor according to below. Use Bosch lubricant (or equivalent) in accordance with the following directions:

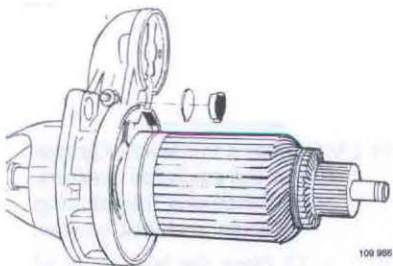


- Ft 2 V 3 Place a thin layer of grease on the insulation washers, the shaft end, the adjusting washers and lock washer.
- Oil 1 V 13 Place the bushing in oil for 1/2 hour before installation.
- Ft 2 V 3 Apply plenty of grease to the armature thread and the engaging lever groove.
- Ft 2 V 3 Place a thin layer of grease on the armature shaft.
- Oil 1 V 13 Place the bushings in oil for 1/2 hour before installation.
- Ft 2 V 3 Lubricate the engaging lever joints and the iron core of the solenoid with a thin layer of grease.

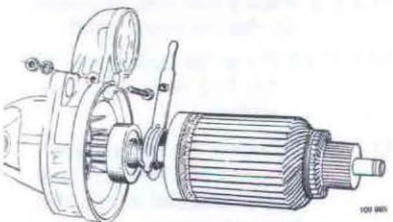
the pinion, stop washer and snap ring the armature shaft. Fit the stop washer or the snap ring.



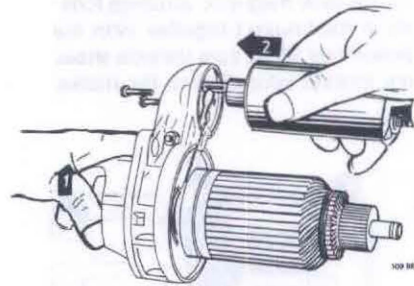
Fit the engaging arm on the pinion.  
Fit the armature in the drive frame.  
Fit the screw, nut and washer securing the engaging arm.



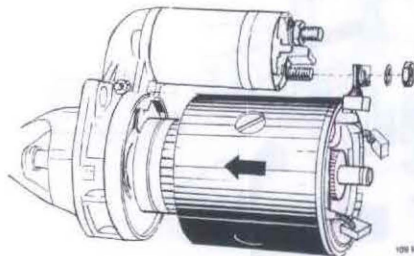
Fit the metal washer and rubber washer.



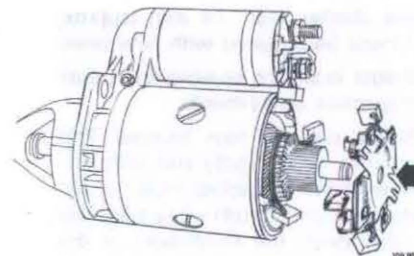
Fit the solenoid.



Fit the starter motor housing.  
Connect the cable to the solenoid.

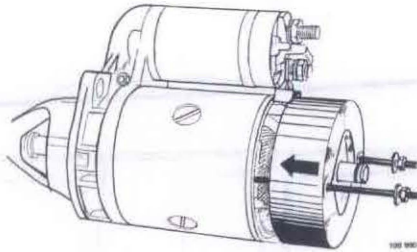


Fit the brush holder in position. Fit the brushes.



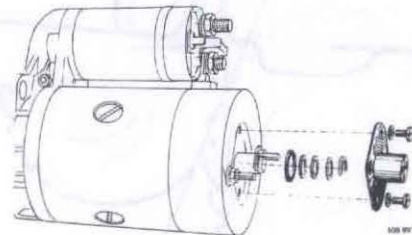
Fit the commutator bearing frame.

Screw the starter motor together with the two long bolts.



Fit the adjusting washers and snap ring on the shaft end. Check the armature axial clearance.

This should be 0.05–0.030 mm (0.002–0.012"). If necessary, adjust with a suitable number of washers until the clearance is correct. Screw tight the small casing of the shaft end.



Before installing the starter motor, run it on a test bench. Compare Figs. from page 19.

## 33172-1

### Installing the starter motor

1. Screw the starter motor into position on the flywheel casing.
2. Connect the cables to the starter motor.
3. Fit the gear lever control ball joints on the gearbox.
4. Fit the rear engine casing.
5. Connect the negative cable to the battery.

## Group 34 Ignition System

### Construction and Function

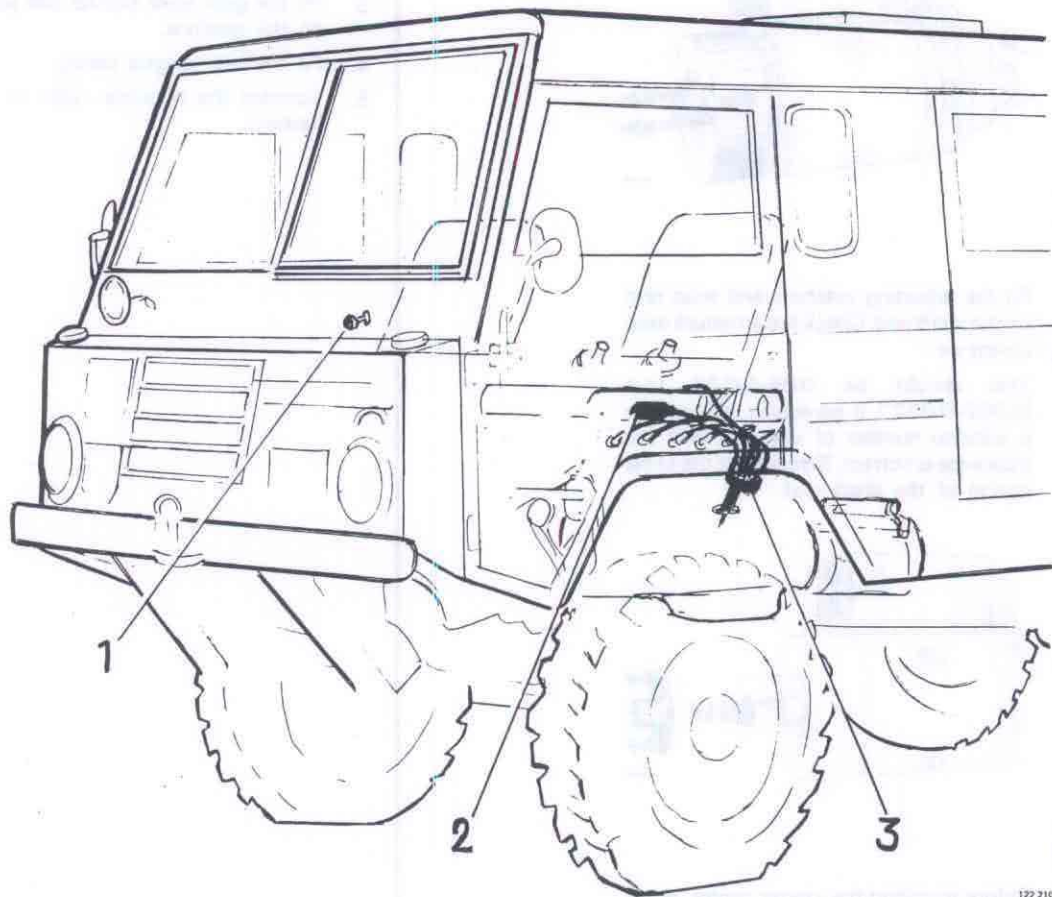


Fig. 34-1. Ignition components

1. Ignition
2. Ignition coil
3. Distributor

The ignition system is of the battery-ignition type. It consists of the following main components: ignition coil, ignition switch, distributor, ignition cables and spark plugs.

## Ignition coil

The ignition coil is situated in the engine compartment on the left-hand side, see Fig. 34-2.

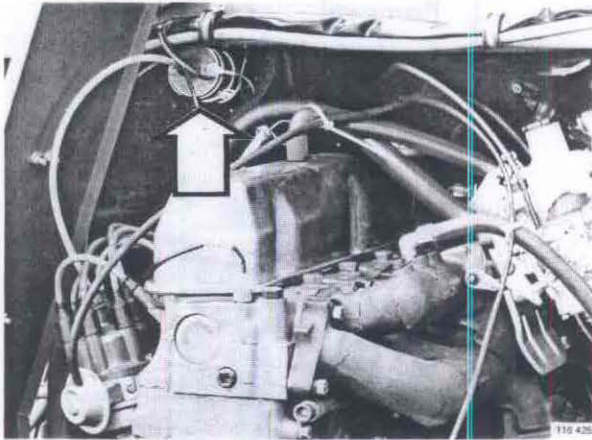


Fig. 34-2. Ignition coil

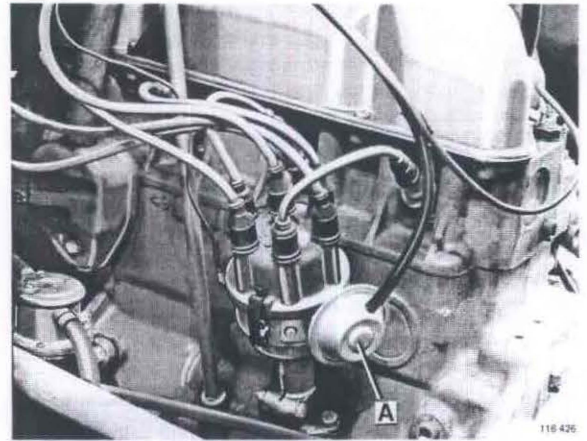


Fig 34-4. Distributor with ignition cables

Firing order: 1-5-3-6-2-4

Its setting in relation to engine speed is regulated by the centrifugal governor located under the breaker plate (see 8, Fig. 34-5).

## Ignition

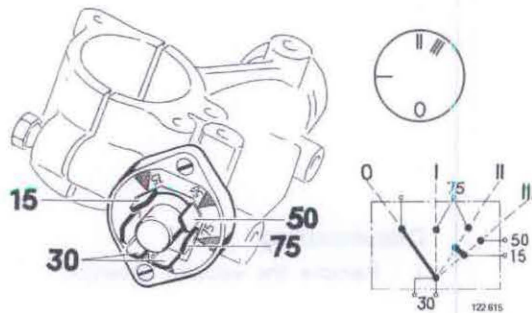


Fig. 34-3. Ignition

## Distributor

The distributor is situated on the left-hand side of the engine, see Fig. 34-4, and is driven from the camshaft.

Its setting in relation to engine speed is regulated by the vacuum governor mounted on top of the distributor (see A, Fig. 34-4).

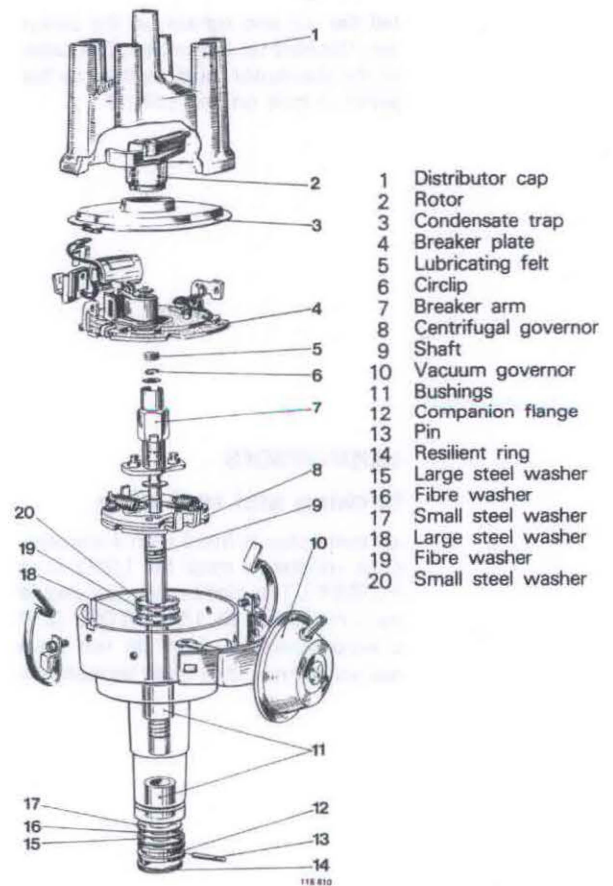


Fig. 34-5. Exploded view of distributor

## Service Procedures

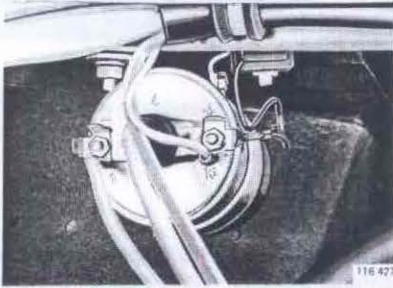
### Ignition coil

#### Removal

Disconnect the cables from the ignition coil.

Release the screw securing the ignition coil.

Remove the ignition coil.



#### Installation

Install the coil and tighten up the clamp screw. Connect up the cables. The cable from the distributor must be fixed to the negative output on the coil (1).

### Suppressors

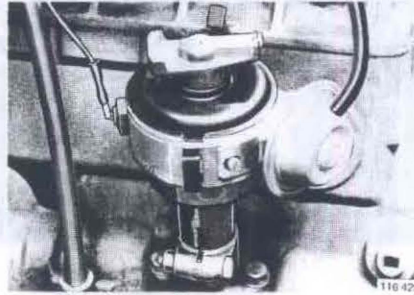
#### Checking and replacing

Each spark plug is fitted with a suppressor. Its resistance must be  $1,000 \Omega$  at  $20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ). The distributor rotor should give a resistance of  $4,500\text{--}6,000 \Omega$ . If the suppressors or rotor do not have these resistances, they must be replaced.

### Distributor

#### Removal

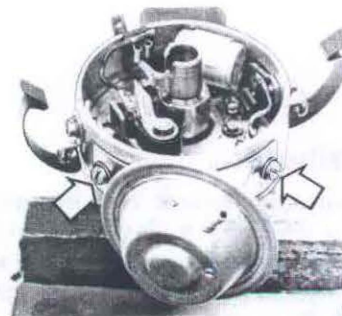
1. Unclasp the lock clasps for the distributor cap and lift off the cap.



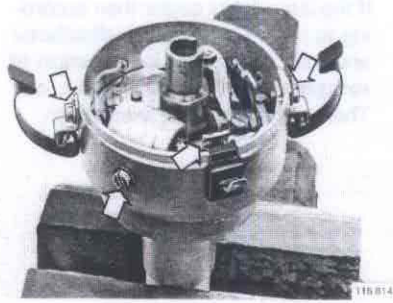
2. Disconnect the low-voltage cable at the distributor. Remove the vacuum hose from the vacuum governor. Lift off the distributor rotor and remove the condensate trap. Release the retaining screw and pull up the distributor.

#### Disassembling

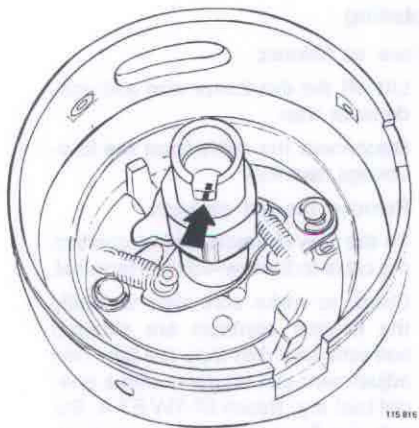
1. Remove the vacuum governor.



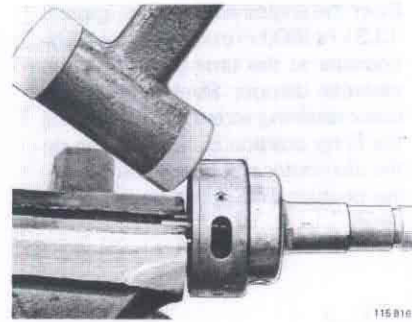
2. Unclasp the lock clasps for the cap. Disconnect the cable from the breaker contacts and remove the condenser with its low-voltage terminal.



3. Mark the location of the breaker plate in relation to the distributor housing and lift up the plate.
4. Release the springs for the centrifugal governor. Remove the lubricating felt and line-up mark to ensure that the breaker cam is re-fitted in the right place in relation to the distributor shaft.

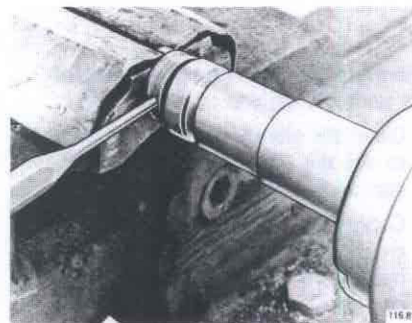


5. Fix the breaker cam in a vice with soft jaws. Carefully tap on the distributor housing with a plastic mallet until the circlip loosens. Take care of the circlip and the washers.



6. Remove the resilient ring and line-up mark the flange to ensure that it is refitted in the proper place in relation to the distributor shaft.

Tap out the pin. Lift off the flange and pull up the distributor shaft. Take care of the washers.



7. Remove the lock pins for the centrifugal weights and lift off the weights.

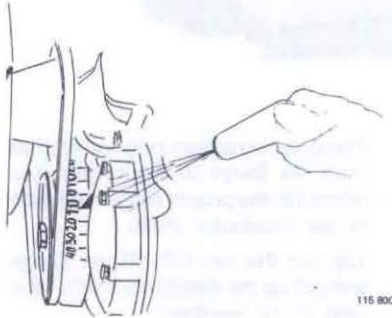
## Checking and replacing parts

### Breaker plate

The contacts should be smooth and even on the contact surfaces. The colour of the contacts should be grey.

Replace oxidized or burnt contacts. The breakers can get worn after being used for some time and the spring can become fatigued, so that the contacts should be replaced if the distributor is disassembled for some reason or other.

Start the engine and run it at approx. 13.3 r/s (800 r/min). Aim the Stroboscope at the timing mark on the vibration damper. Slacken the distributor retaining screw and turn it until the firing position is 10°. Tighten up the distributor and check that the firing position and speed have not altered.



115 800

Remove the Stroboscope and connect the hose to the vacuum governor.

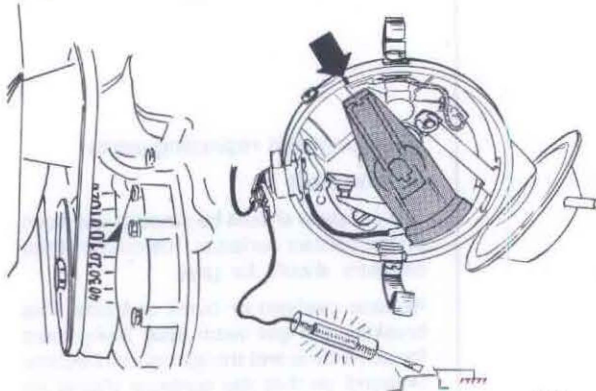
*The firing setting can be adjusted as follows with the engine switched off:*

Clean the vibration damper in order to see the firing mark. Remove the cap and condensate trap.

Connect a 24 V lamp between the engine body and the low-voltage terminal on the distributor. Do not disconnect the cable.

Turn the ignition key to the firing position.

Slowly rotate the crankshaft (by hand) in the rotational direction of the engine until the 10° timing mark on the vibration damper is opposite the firing mark. The distributor rotor should then point to the line-up mark on the edge of the distributor housing. The test lamp should light.



115 812

5. If the lamp does not light, slacken the distributor and turn it slowly **opposite to its direction of rotation** until the lamp does light. When the lamp lights, tighten up the distributor.
6. If the lamp lights earlier than according to point 4, slacken the distributor and turn it slowly **in its direction of rotation** until the lamp goes out. Then tighten up the distributor.

## 34202-2

### Breaker contacts

#### Replacing

Replace as follows:

1. Lift off the distributor arm and condensate trap.
2. Disconnect the cable from the low-voltage terminal.
3. Remove the old contacts.
4. Fit the new contacts and re-connect the cable to the low-voltage terminal.
5. Check to make sure that vertically the breaker contacts are situated correctly and that they are flat. This adjustment can be done with a special tool, e.g., Bosch EFAW 57 A. But only the fixed contact may be bent. Cover the breaker cam and fibre tab with a light layer of grease.
6. Clean the breaker contacts with trichloroethylene or chemically pure petrol.
7. Run the distributor on a test bench and adjust according to the distributor data. See under: "Test-running a distributor on a test bench".
8. Fit the condensate trap and the distributor rotor.

## Group 35 Lighting

### Construction and Function

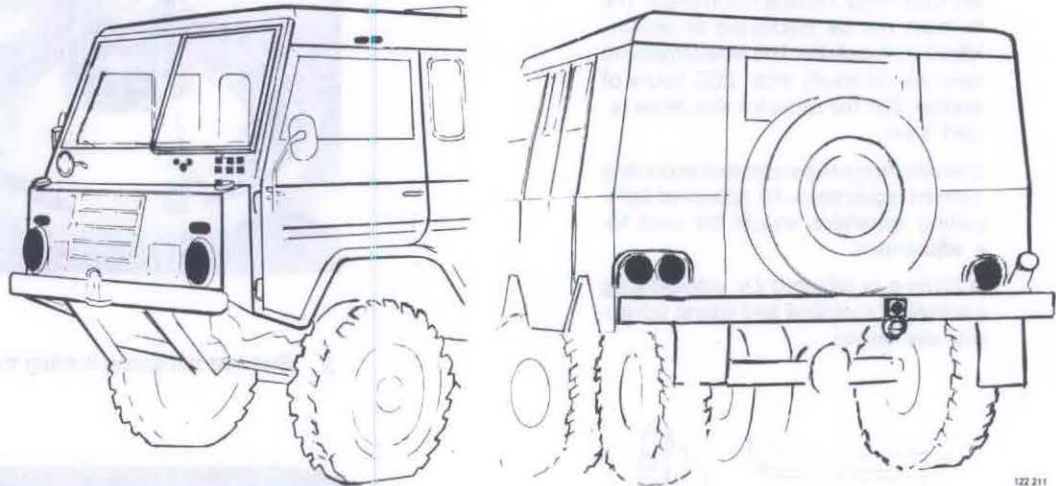


Fig. 35-1. Vehicle lighting

The lighting system comprises the following:

Headlamps, parking and direction indicator lights, instrument panel lighting, switch lighting, interior lighting, tail lights, reversing lights and a 7-pole output for trailer lighting.

Switching between fullbeams and dipped beams is done by moving the direction indicator lever towards the steering wheel. This causes the step relay, see Fig. 36-1, to switch on the beams.

The tail lights are provided with separate bulbs for the tail light, stop lights and direction indicators.

## Service Procedures

### Headlamps

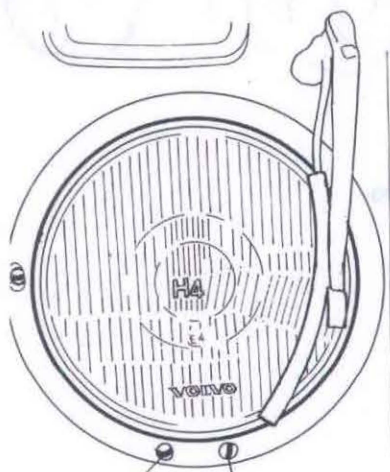
#### Checking and adjusting

Check the headlamp glass, reflector and bulb. If the glass has been damaged by gravel, or cracked or defective in any other way, replace the insert. The lighting from a headlamp with cracked glass will have deteriorated and give rise to irritating split beams.

If the reflector is mat, buckled or damaged in any other way, replace it complete. The bulb must not be blackened or browned on the globe. The headlamps can deteriorate so much after 200 hours of operation that the reflector should be replaced then.

The headlamps can be adjusted according to current regulations. An approved light-adjusting apparatus should be used for the adjustment.

If the lighting is adjusted by manipulating the screws for vertical and lateral adjustment, see below.



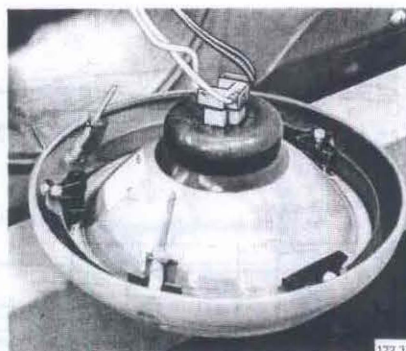
- 1 Lateral adjustment
- 2 Retaining screw
- 3 Vertical adjustment

#### Replacing the headlamp insert

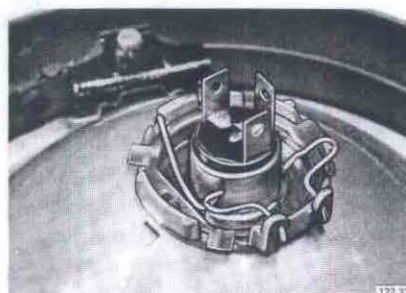
To replace the bulb carry out points 1-3 and 6-9 below.

Remove the retaining screw in the headlamp rim, see above.

2. Lift forwards the rim and insert. Disconnect the connector from the bulb. Remove the rubber dust cover from the bulb base.



3. Remove the spring holding the bulb.



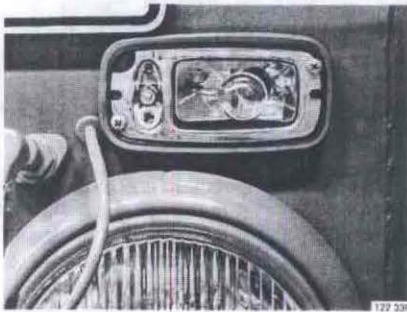
4. Remove the three screws securing the insert.
5. Fit the new insert and secure it with the three screws.
6. Fit the new bulb in the insert.  
**NOTE!** Do not touch the globe with your fingers. Grease, etc., on the globe causes a vapour to be emitted when the globe is heated and this can damage the reflector.
7. Fit the rubber dust cover over the bulb base, etc., and connect the connector to the bulb.
8. Restore the rim and insert.
9. Adjust the lighting.

## Parking and direction indicator lights

36130-2

### Replacing the bulbs

1. Remove the screws securing the lens.
2. Remove the faulty bulb by pressing it inwards and then turning it (bayonet fitting).



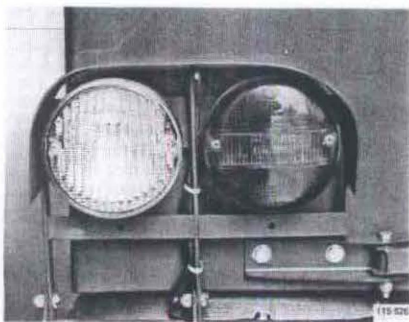
3. Fit the new bulb. (Do not touch the bulb globe with your fingers.)
4. Wipe the lens with a moist cloth and re-fit it and tighten up with the two screws.

## Tail and reversing lights

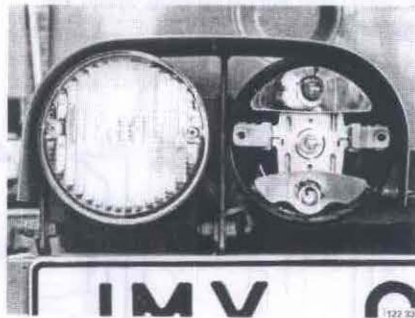
36132-2

### Replacing the bulbs

1. Remove the screws securing the lens over the bulb to be replaced.



2. Remove the faulty bulb by pressing it in and turning it.



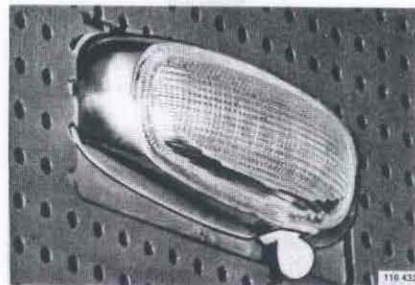
3. Fit the new bulb but do not touch the globe with your fingers. Wipe the lens with a moist cloth and re-fit it.

## Interior light

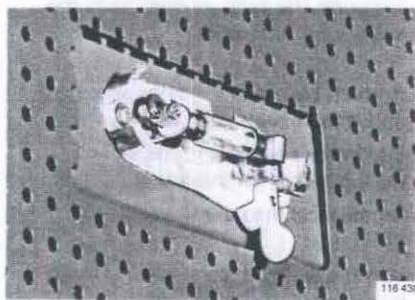
35303-3

### Replacing the bulb

1. Remove the glass by pulling it rearwards.



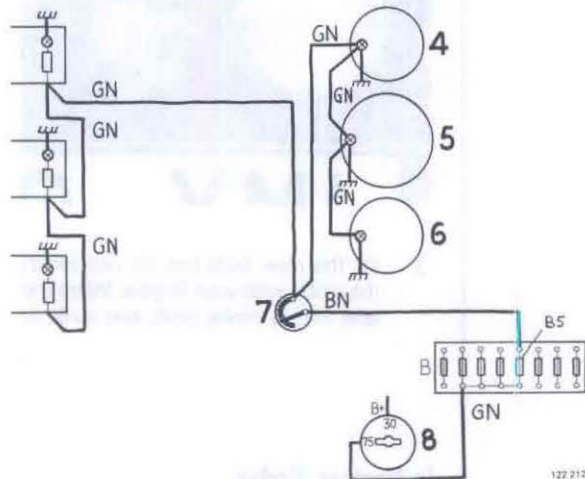
2. Remove the bulb and fit a new one.



3. Place the glass in position and push it straight in.

## Instrument panel and switch lighting

The illustration below shows the instrument panel and switch lighting circuit via a rheostat.



Wiring diagram

- 1 Switch, windscreen washer
- 2 Switch, windscreen wiper
- 3 Switch, windscreen wiper
- 4 Fuel gauge
- 5 Speedometer
- 6 Temperature gauge
- 7 Rheostat
- 8 Ignition
- B Fuse holder (B)

## Replacing the bulbs in switches and instruments

Remove the cover from the batteries and disconnect the negative cable from the battery.

Separate the bulb retainer from the switch and instrument by pulling it straight out.

Remove the faulty bulb by pressing it in and turning it. Fit the new bulb.

Fit the bulb retainer in the switch or instrument by pushing it straight in.

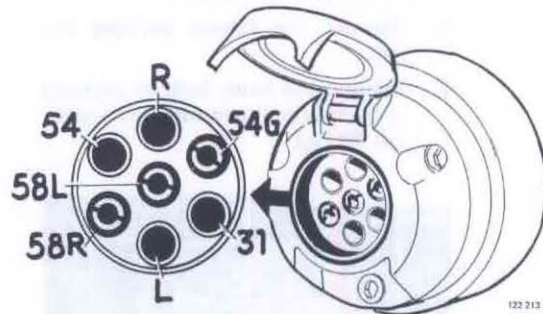
Re-connect the negative cable to the battery.

Note! The cables to the switch bulb holders are earth cables.

The cables to the instrument bulb holders are feed cables, which go directly from the rheostat.

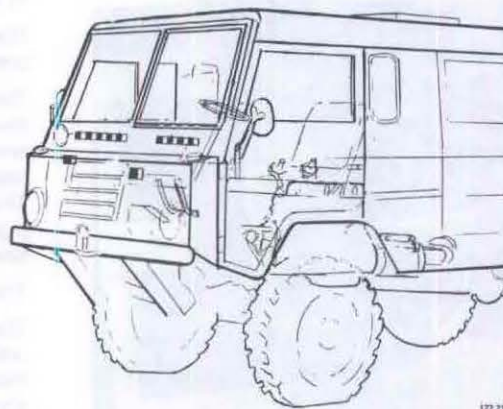
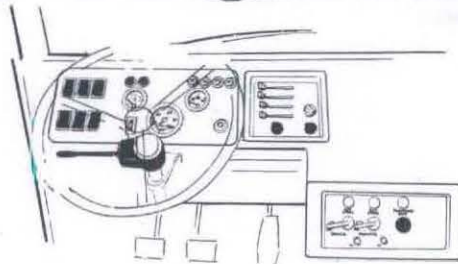
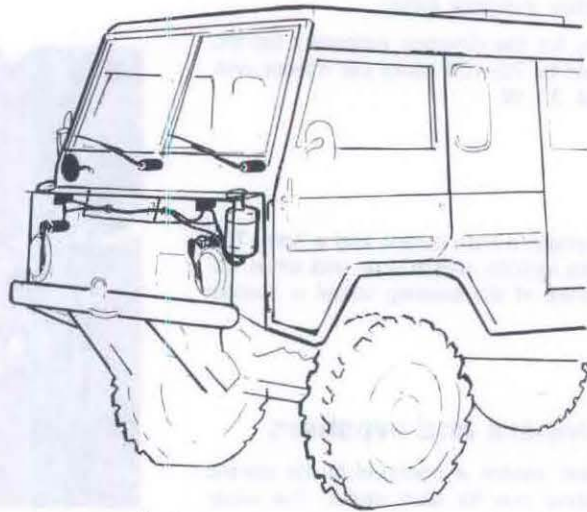
## Trailer socket output

The vehicle is equipped with a 7-pole trailer socket output.



- |     |                            |    |                           |
|-----|----------------------------|----|---------------------------|
| 54G | Not used                   | L  | Direction indicator, left |
| 58L | Tail light                 | 54 | Stop light                |
| 58R | Tail light                 | 31 | Chassis                   |
| R   | Direction indicator, right |    |                           |

## Group 36 Direction indicators and hazard warning flashers, horn, windscreen wipers and washers, switches and relays



122 214

Fig. 36-1. Wipers, direction indicators, switches and relays

## Construction and Function

### Direction indicators and hazard warning flashers

The direction indicator system includes an electronically operated flasher device, switches, indicator lights (for vehicle and trailer) as well as indicator lights front and rear.

The hazard warning flasher system includes a switch with tilt-in blinker, flasher device and lights (front and rear) which so function as direction indicator lights.

The blinking frequency for the direction indicators (hazard warning flashers) should be 75–105 blinks per minute with bulbs with wattage of 21 W.

### Horn system

The horn system comprises a horn button and a horn. The horn operates when the ignition switch is on and when the horn button in the centre of the steering wheel is pushed.

### Windscreen wipers and washers

Each of the windscreen wipers is operated by its electric motor and two switches, one for each motor. The wiper motors are two-speed.

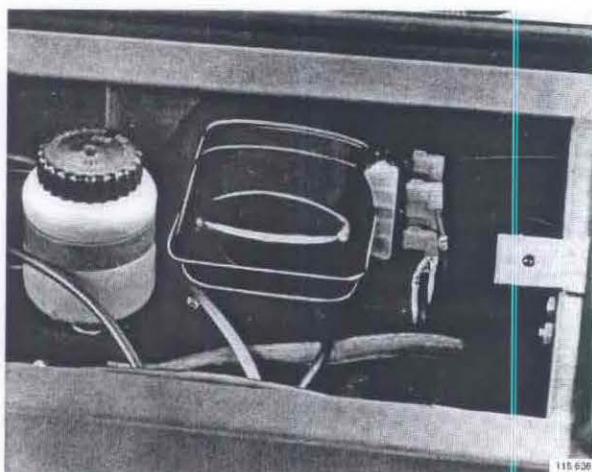


Fig. 36-2. Windscreen wiper motor, R/H side

Each of the headlamp wipers is operated by its electric motor and a switch, which automatically returns to the shut-off position.

The headlamp wiper motors can be engaged when the parking lights at least are on.

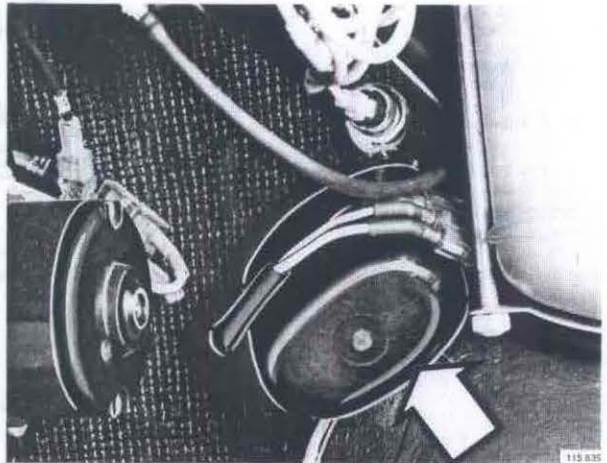


Fig. 36-3. Headlamp wiper motor, R/H side

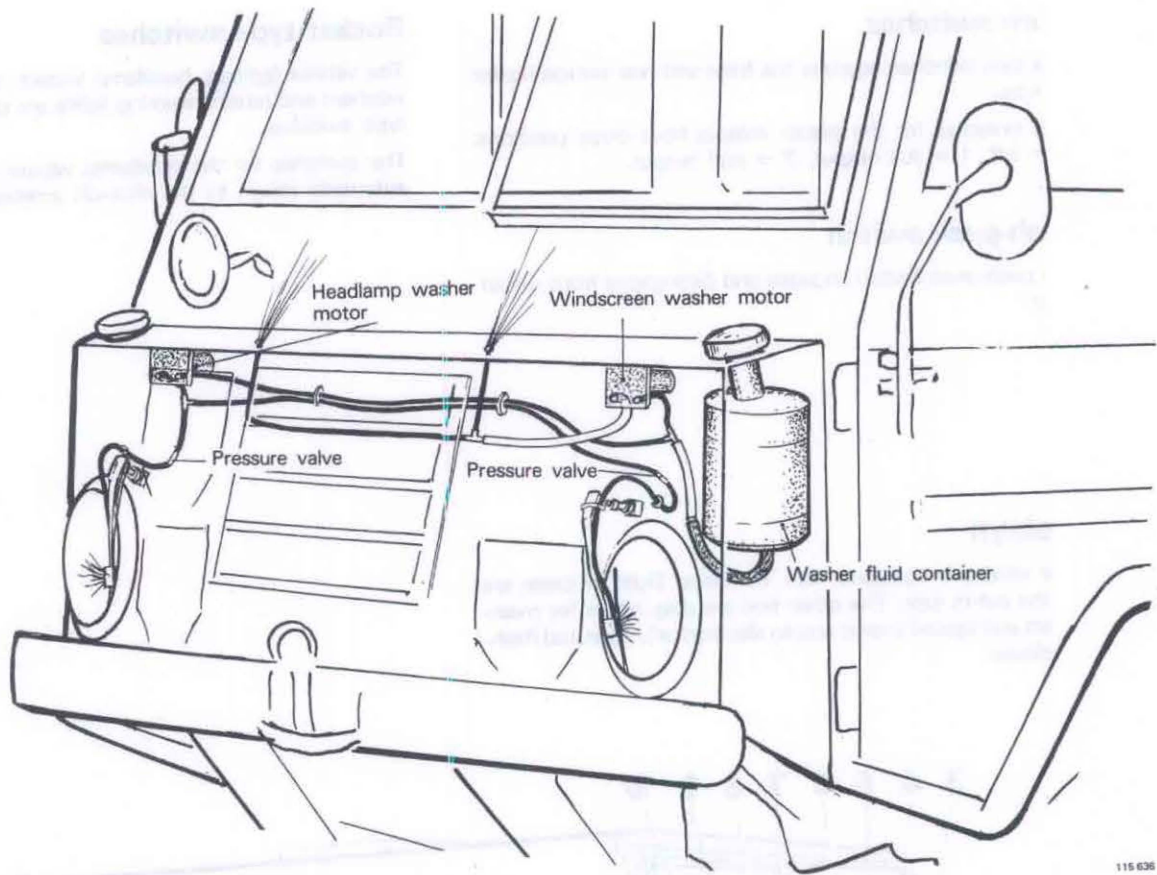
The windscreen and headlamp wipers automatically return to the parking position as long as the ignition switch is on. The windscreen and headlamp wiper motors are radio-suppressed.

The vehicle is equipped with two different washer motors, the one on the left-hand side which is responsible for the windscreens, and the one on the right-hand side which is responsible for the right-hand headlamps and washer fluid. The windscreen and headlamp washer system consists of a gear-driven pump, electric motor, hoses, valves and nozzles. See the layout diagram on Fig. 36-4.

The washer motors are radio-suppressed.

The pump and the electric motor are integrally built as a unit. The washer fluid container is the same for both washer motors and holds about 3 dm<sup>3</sup> (3 litres/3 qts.). The windscreen washer motor is operated by means of a switch, which automatically returns to the shut-off position.

The headlamp washer motor functions only when the headlamp wipers are engaged.



115 636

Fig. 36-4. Layout diagram, washers

## Switches

The vehicle is equipped with three types of switches: rocker, turn and push-push switches.

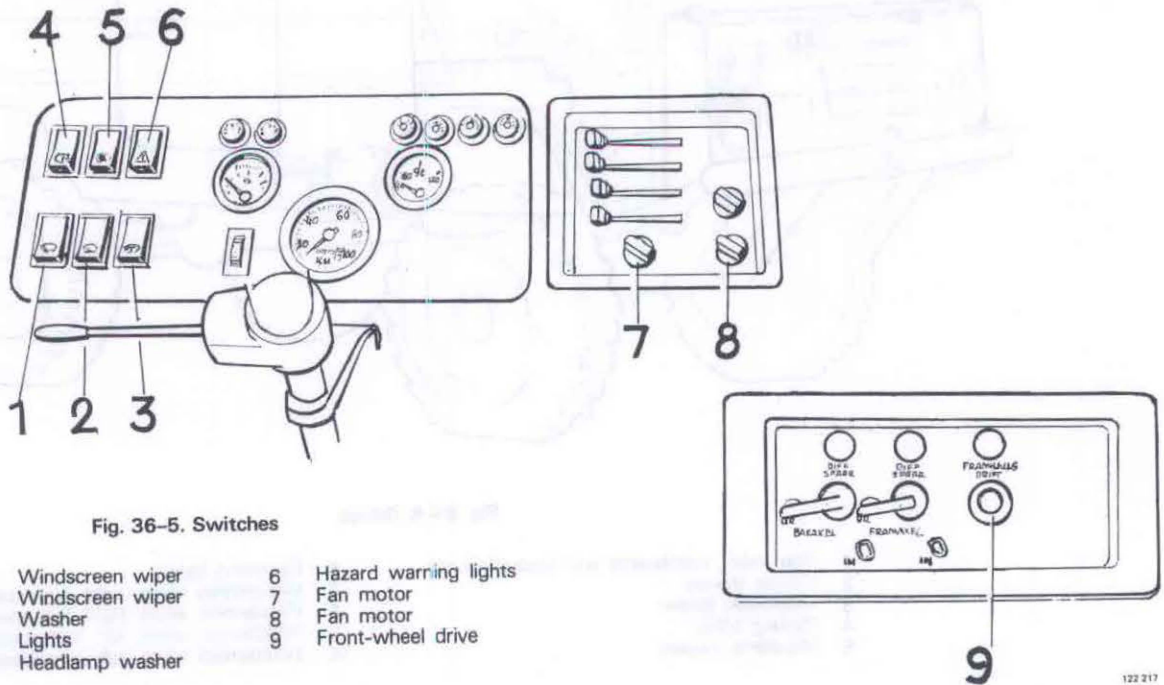


Fig. 36-5. Switches

- |   |                  |   |                       |
|---|------------------|---|-----------------------|
| 1 | Windscreen wiper | 6 | Hazard warning lights |
| 2 | Windscreen wiper | 7 | Fan motor             |
| 3 | Washer           | 8 | Fan motor             |
| 4 | Lights           | 9 | Front-wheel drive     |
| 5 | Headlamp washer  |   |                       |

122 217

### Turn switches

The turn switches regulate the front and rear vehicle heater motors.

The switches for the heater motors have three positions: 0 = off, 1 = full output, 2 = half output.

### Push-push switch

The push-push switch engages and disengages front-wheel drive.

### Rocker-type switches

The vehicle lighting, headlamp wipers, windscreen wipers, washers and hazard warning lights are operated by rocker-type switches.

The switches for the headlamp wipers and washers have automatic return to the shut-off position.

### Relays

The vehicle is equipped with 10 relays. Eight of these are the cut-in type. The other two are step-relays for mainbeam and dipped beams and an electronically operated flash-device.

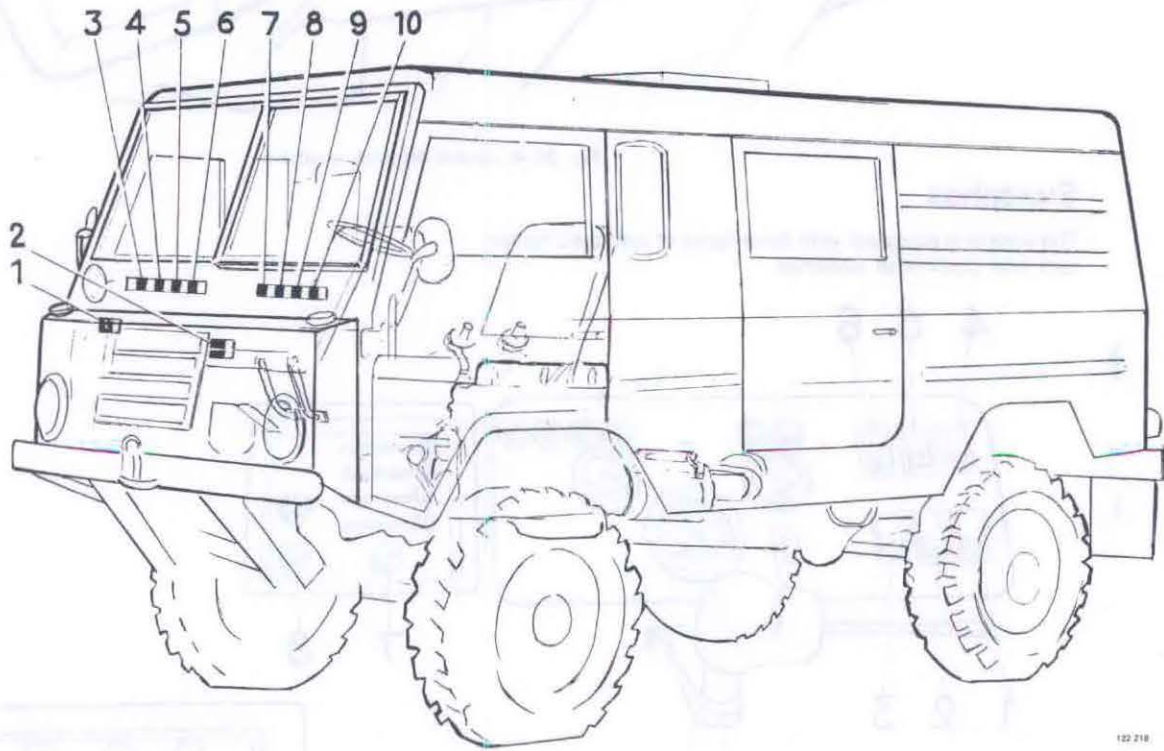
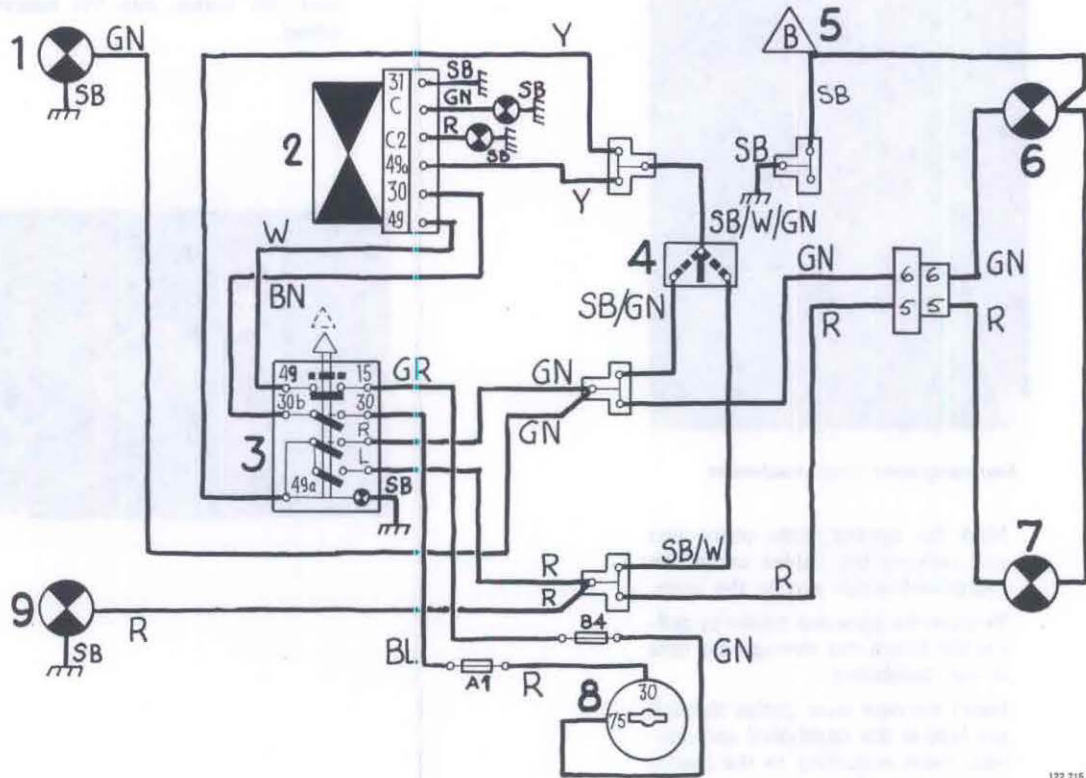


Fig. 36-6. Relays

- |  |                                       |
|--|---------------------------------------|
| 1 Step relay, mainbeams and dipped beams | 6 Reversing lights                    |
| 2 Flasher device                         | 7 Windscreen wiper, right, high-speed |
| 3 Mainbeam flasher                       | 8 Windscreen wiper, right, low-speed  |
| 4 Parking lights                         | 9 Windscreen wiper, left, high-speed  |
| 5 Headlamp wipers                        | 10 Windscreen wiper, left, low-speed  |

Direction indicators and hazard warning flashers



122 215

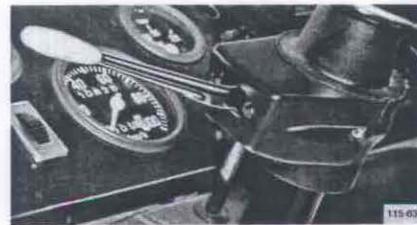
Wiring diagram for direction indicators and hazard warning flashers

- |   |                               |   |                                  |
|---|-------------------------------|---|----------------------------------|
| 1 | Bulb, dir. indicator, front   | 6 | Bulb, dir. indicator, left-rear  |
| 2 | Flasher device                | 7 | Bulb, dir. indicator, right-rear |
| 3 | Switch, hazard warning lights | 8 | Ignition                         |
| 4 | Dir. indicator lever          | 9 | Bulb, dir. indicator, left-front |
| 5 | Fuel gauge sender             |   |                                  |

36108-2

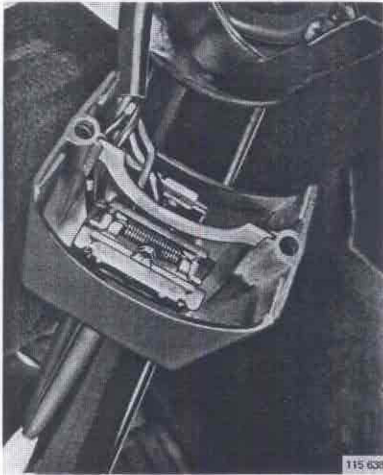
Replacing the direction indicator lever

1. Remove the screws securing the switch to the steering column.



Removing the screws securing dir. ind. lever

Remove the U-shaped washer and the two screws securing the lever to the attachment.



Removing lever from attachment

Mark for correct cable connection and remove the cables under the dashboard which run to the lever.

Remove the lever and cables by pulling the levers out through the hole in the dashboard.

Insert the new lever cables through the hole in the dashboard and connect them according to the marks.

Fix the lever to the attachment and fit the U-shaped washer.

Secure the lever and attachment to the steering column.

horn

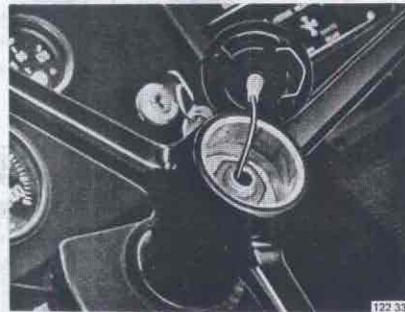
## 6202-2 Replacing

Disconnect the cables and the nut which secures the horn.

Fit the new horn and connect up the cables.

## Replacing the horn button

1. Remove the horn button by levering it up with a small screwdriver or similar tool.
2. Disconnect the cable from the button.
3. Fit the cable to the new button and push the button into the steering wheel.

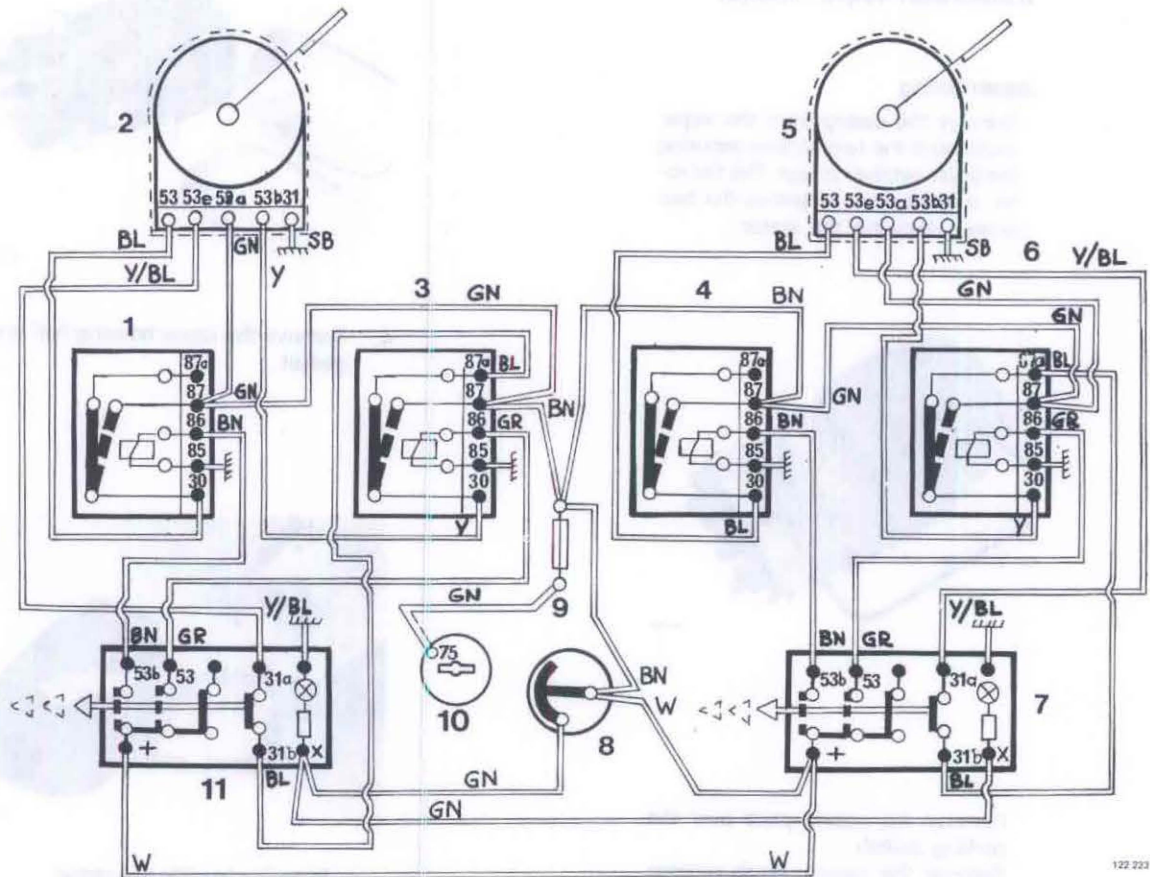


## Windscreen wipers and washers

### Windscreen wiper

#### Checking

If the windscreen wipers do not function (ignition switched on) either at high or low speed, check to make sure fuse B5 is in good condition. If it is not, probably the reason is a short-circuit to the vehicle chassis at the wiper motors, switches, relays, rheostat or on the cables to these components. Use the wiring diagram overleaf as an aid when fault-tracing and connecting up replaced parts.



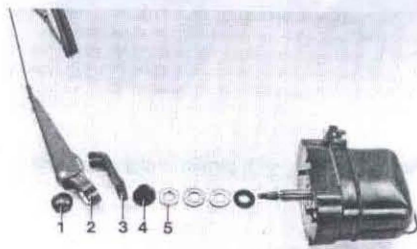
122 223

- |                          |                     |
|--------------------------|---------------------|
| 1 Relay, low-speed       | 6 Relay, high-speed |
| 2 Windscreen wiper motor | 7 Switch            |
| 3 Relay, high-speed      | 8 Rheostat          |
| 4 Relay, low-speed       | 9 Fuse B5           |
| 5 Windscreen wiper motor | 10 Switch           |

## Windscreen wipers

### Removing

1. Remove the cover from the batteries and disconnect the negative cable from the battery.
2. Remove the protective cap and wiper arm.
3. Remove the flange, dust cover, nut, washer and seal.



- |                   |               |
|-------------------|---------------|
| 1. Protective cap | 4. Dust cover |
| 2. Wiper arm      | 5. Nut        |
| 3. Flange         |               |

4. Lift forwards the wiper motor, mark for correct re-installation and disconnect the cables.

### Installing

1. Connect up the cables according to the marking and fit the wiper motor with seal, washers and nut.
2. Fit the dust cover. Adjust and fit the flange so that the wiper arm is located properly.
3. Secure the wiper arm to the wiper shaft with the protective cap.
4. Connect up the negative cable to the battery and fit the cover over the battery.

115 642

## Indscreen wiper motor

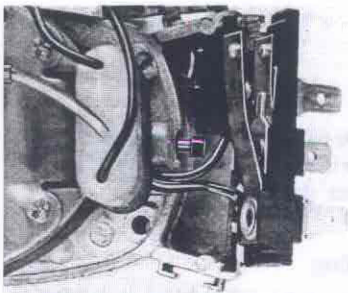
### Disassembling

Remove the casing from the wiper motor and the two screws securing the brush retainer bridge. Pull the rotor straight up and remove the two screws securing the stator.



115 844

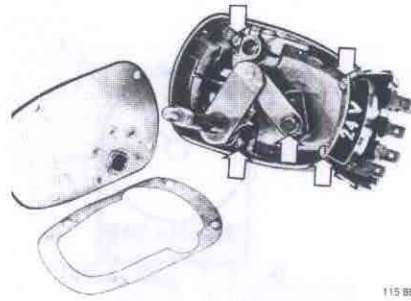
Remove the plastic plate over the parking switch. Remove the switch, brush retainer bridge and radio suppressor from the housing.



115 851

### Removing the parking switch

Remove the end and gasket from the output shaft. Remove the output shaft and tooth segment. Remove the four screws securing the lower housing half.



115 852

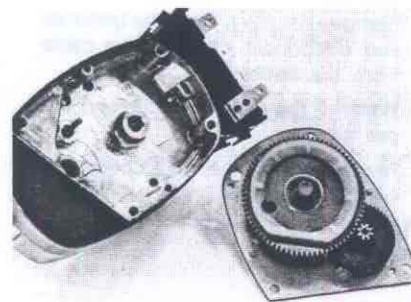
4. Remove the lower housing half and gasket.



115 853

### Removing housing and gasket

5. Lift off the plate, gasket, gear wheel and pinion from the pinion housing.



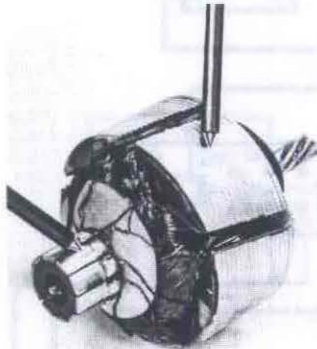
115 854

### Pinion housing with pinion and gear wheel

### Checking and replacing parts

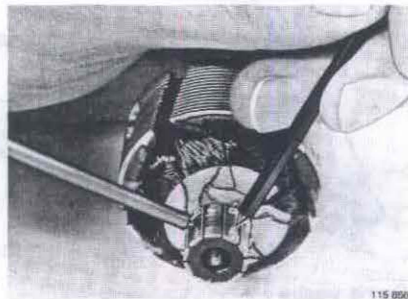
Clean all the parts and check for wear or any other defect. Check also the rotor for flash-over between commutator and rotor body as well as flash-over between, and breakage in, the winding coils.

Test for flash-over between commutator and rotor body by connecting a test lamp (40 V A.C.) between them. The lamp must not light.



Insulation test, rotor

Test for flash-over between the winding coils with a smaller type of growler or with a Bosch coil tester EFAW 90 or 95 with ancillary test probe EFAW 96 or corresponding. Total breakage in any of the commutator discs can be checked with a test lamp (12 V D.C.). One of the measuring points of the test lamp is placed on a commutator disc and the other measuring point is moved round the commutator. The lamp should light.

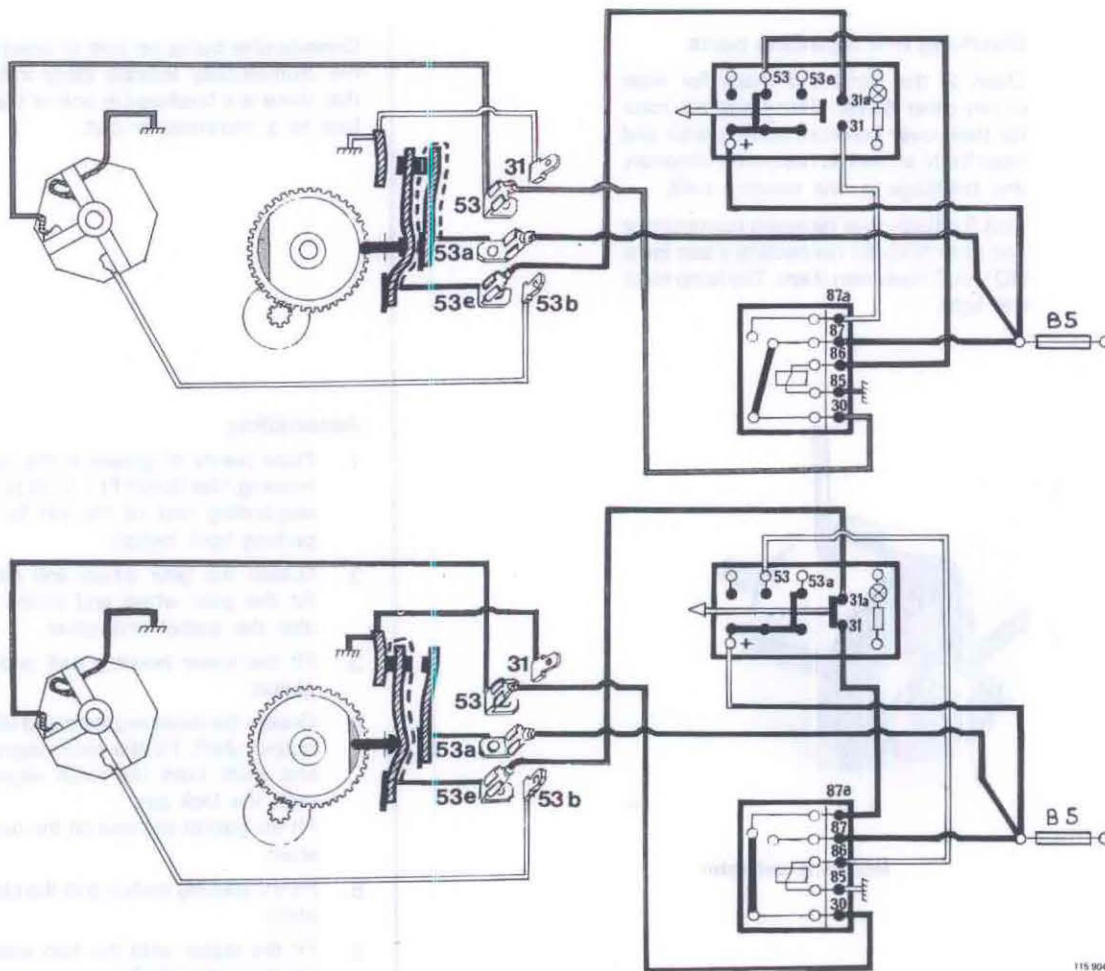


Breakage test, rotor

Considerable burns on one or several of the diametrically located discs indicate that there is a breakage in one of the cables to a commutator disc.

### Assembling

1. Place plenty of grease in the pinion housing. Use Bosch Ft 1 V 35 or corresponding and oil the pin for the parking light switch.
2. Grease the gear wheel and pinion. Fit the gear wheel and pinion and also the gasket and cover.
3. Fit the lower housing half and the gasket.
4. Grease the tooth segment and oil the output shaft. Fit the tooth segment and shaft. Lock the tooth segment with the lock pin. Fit the gasket and end on the output shaft.
5. Fit the parking switch and the plastic plate.
6. Fit the stator with the two screws. Oil the rotor shaft. Fit the rotor and secure the suppressor.
7. Fit the brush retainer bridge on the stator.
8. Fit the protective casing and test-run the windscreen wiper motor. Check the parking function. See the layout diagram on the next page.



Layout diagram for parking function

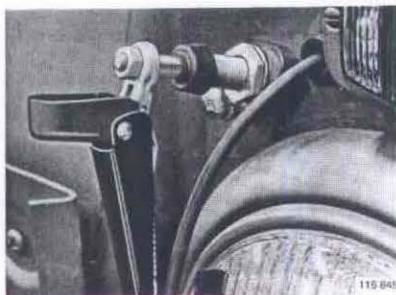
115 904

## Headlamp wiper motor

### moving

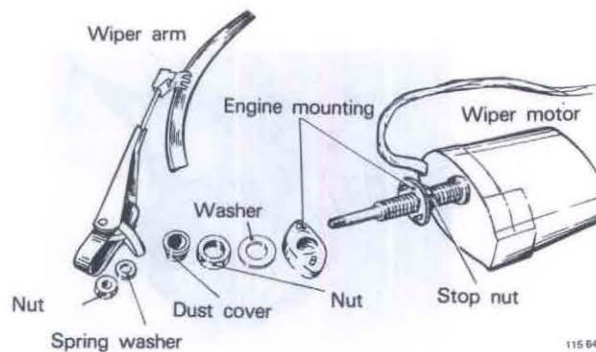
Remove the clamp and washer hose from the wiper arm.

Bend up the cover and remove the nut as well as the wiper arm from the shaft.



Removing the wiper arm

3. Remove the dust cover, nut, washer and spacer, and lift forwards the wiper motor.
4. Mark where the cables are connected and disconnect them.

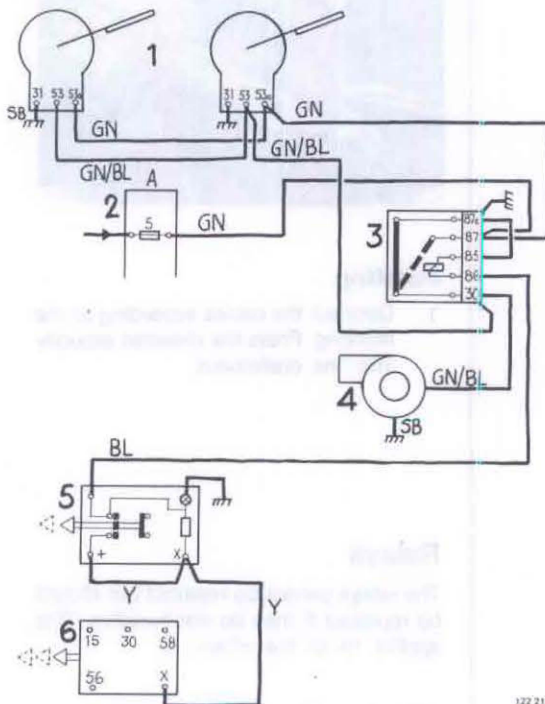


Headlamp wiper assembly complete

115 646

## Installing

1. Connect up the cables according to the marking.
2. Fit the wiper motor and wiper mounts (make sure that the guide pins fit in the guide holes), also the washer, nut and dust cover.
3. Switch on the ignition and the parking lights. Start the wiper motor and allow it to take up the parking position by manipulating with the switch button. The parking position is taken up automatically.
4. Fit the wiper arm and nut and connect the washer hose to the nozzle.
5. Clamp the hose to the wiper arm with the clamps.



Layout diagram for headlamp wipers and washers

- 1 Headlamp wiper
- 2 Fusebox (A5)
- 3 Relay, headlamp wiper
- 4 Headlamp washer
- 5 Switch
- 6 Switch, lighting

## Washer motor

### Removing

1. Remove the screws securing the motor.
2. Mark-up for correct re-installation and disconnect the hoses and cables from the washer motor.

### Installing

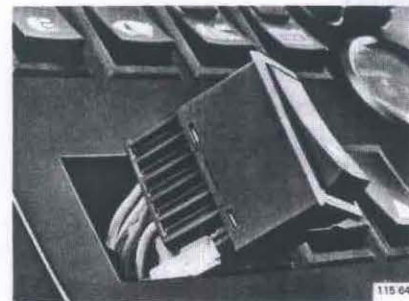
1. Connect up the hoses and cables according to the markings. See Fig. 36-4.
2. Screw tight the motor to the body.

## Switches

### Rocker-type switches

#### Removing

1. Remove the cover over the batteries and disconnect the negative cable from the battery.
2. Push out from the reverse side of the instrument panel the switch complete with connector and bulb holder.



3. Separate the connector and bulb holder from the switch.

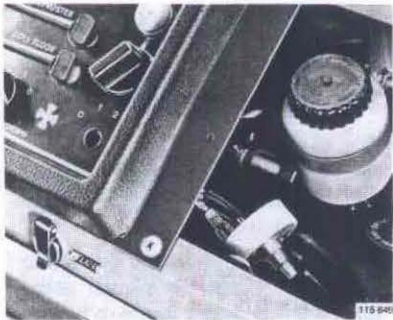
#### Installing

1. Fit the bulb holder and connector to the new switch.
2. Push in and secure the switch on the instrument panel.
3. Connect-up the negative cable to the battery. Fit the cover over the batteries.

## Turn switch (car heater)

### Removing

1. Remove the cover over the batteries and disconnect the negative cable from the battery.
2. Remove the cover to the right of the switches.
3. Remove the knob from the switch by pulling it straight out and unscrewing the nut.
4. Lift forwards the switch. Mark how the cables are connected and then disconnect them.



### Installing

1. Connect-up the cables according to the marking and fit the switch.
2. Fit the nut, knob and cover.
3. Connect the negative cable to the battery and fit the cover over the batteries.

## Push-push switches

### Removing

1. Lift out the switch from the panel.



2. Mark-up for correct re-installation and disconnect the cables from the switch.

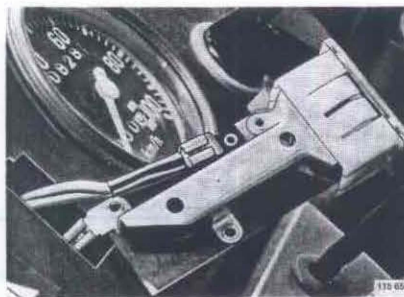
### Installing

1. Connect-up the cables according to the marking.
2. Secure the switch to the panel.

## Rheostat

### Removing

1. Make sure that the ignition is switched off. Mark-up for correct re-installation and disconnect the cables from the rheostat.
2. Push out the rheostat from the reverse side of the dashboard.



### Installing

1. Connect the cables according to the marking. Press the rheostat securely into the dashboard.

## Relays

The relays cannot be repaired but should be replaced if they do not function. This applies to all the relays.

### Cut-in relays (type mini)

#### Replacing

1. Pull the relay straight out from the relay socket.
2. Check that the new relay is of the correct rating before fitting it. Push the new relay securely into the socket.

## Flasher device

### Removing

1. Remove the screws securing the flasher device clamp.



2. Remove the flasher device from the clamp and separate it from the connector.

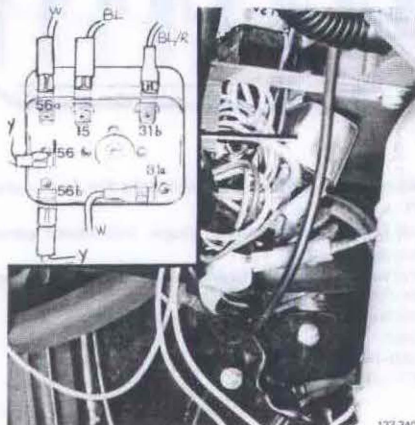
### Installing

1. Wire the connector to the new flasher device.
2. Place the device in position behind the clamp and tighten up the screws.

## Step relay for main-beams/dipped beams

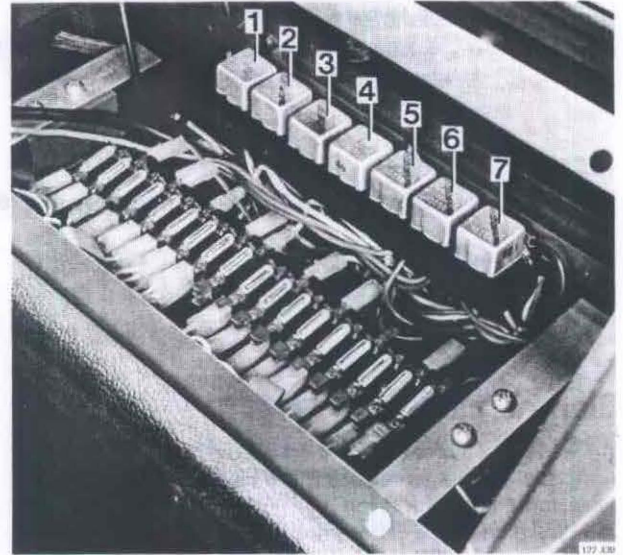
### Removing

1. Remove the cover from over the batteries and disconnect the negative cable from the battery.
2. Mark-up and disconnect the cables from the step relay.
3. Remove the screws securing the relay.



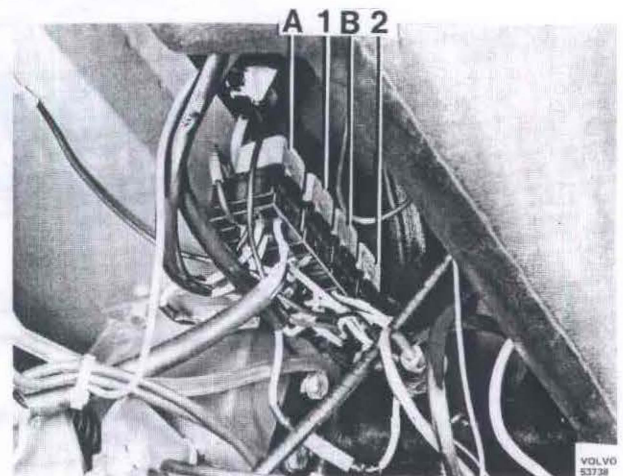
## Installing

1. Fit the relay.
2. Connect the cables according to the markings.
3. Connect the negative cable of the battery and fit the cover over the batteries.



Relays underneath oddments locker

- |   |                 |    |                      |
|---|-----------------|----|----------------------|
| 1 | Reversing light | 5* | Motor and cab heater |
| 2 | Headlamp wiper  | 6* | Motor and cab heater |
| 3 | Parking light   | 7* | Motor and cab heater |
| 4 | Headlamp        | *  | Not standard         |



Relays under dashboard

- |   |                                  |
|---|----------------------------------|
| A | L/H windscreen wiper, low-speed  |
| 1 | L/H windscreen wiper, high-speed |
| B | R/H windscreen wiper, low-speed  |
| 2 | R/H windscreen wiper, high-speed |

# Group 37 Cables and Fuses

## Construction and Function

### Cables

The cables installed in the vehicle have different colours. These have been abbreviated in the fold-out diagram and the layout diagrams as follows:

B = blue, GN = green, R = red, Y = yellow, SB = black, G = grey, W = white and BN = brown.

### Fuses

The vehicle is fitted with two fuseboxes, each of which has

9 fuses. The fuseboxes are located under the oddments locker in the dashboard, right-hand side. Each fuse is rated for a current of 8 A.

### Connectors

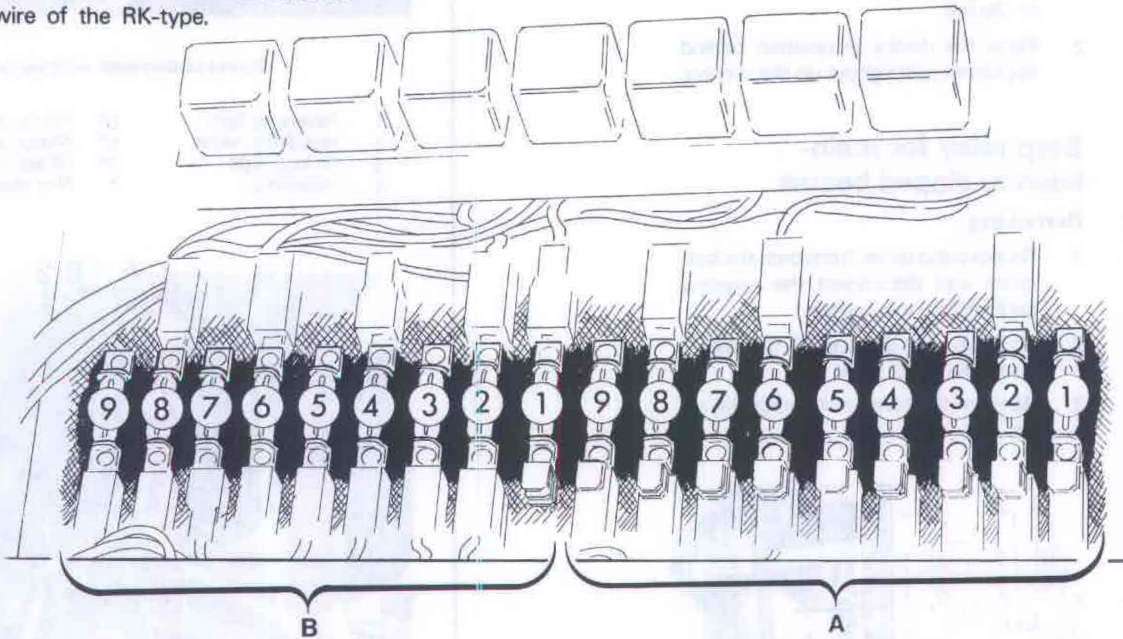
The vehicle is equipped with two connectors: a 6-pole and an 8-pole connector. They are located at the right-hand side of the rear engine cover.

## Service Procedures

### Electric cables

In the event of a breakage or short-circuit in a cable, it must be replaced. The new cable must have the same area, colour and insulation as the old one and also be of the RK-type.

### Fuses



- A1 Interior lighting, socket, warning light
- A2 Left-hand parking light
- A3 Left-hand tail light
- A4 Right-hand tail light
- A5 Right-hand parking light, headlamp wiper
- A6 Left-hand dipped beam
- A7 Right-hand dipped beam
- A8 Left-hand fullbeam
- A9 Right-hand fullbeam, fullbeam indicator light
- B1 Spare

- B2 Fan motor, solenoid, indicator light for front-wheel drive and diff. lock
- B3 Fuel gauge, temperature gauge, instrument panel light, horn, reversing lights
- B4 Direction indicators, brake warning light, lighting
- B5 Windscreen wipers, oil pressure
- B6 Headlamp flasher, brake light contact
- B7 Spare
- B8 Right-hand stop light
- B9 Left-hand stop light

# Group 38 Instruments, Contacts and Indicator/Warning Lights

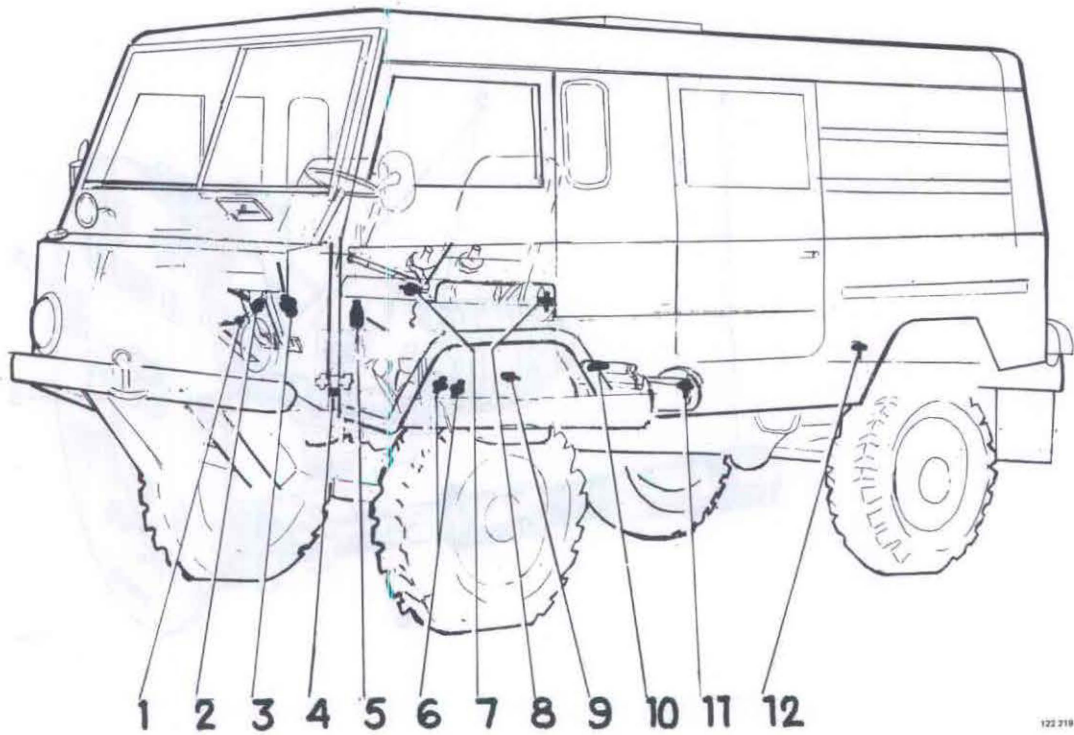
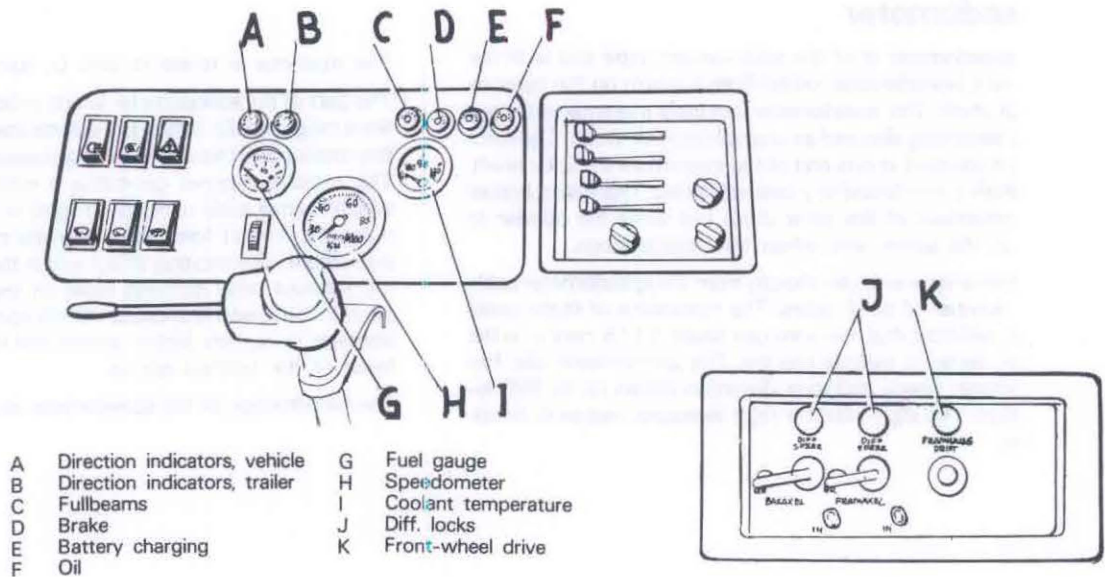


Fig. 38-1. Instruments, contacts and indicator/warning lights

- |   |                             |    |                     |
|---|-----------------------------|----|---------------------|
| 1 | Pedal movement              | 7  | Parking brake       |
| 2 | Stop lights                 | 8  | Coolant temperature |
| 3 | Front-wheel drive           | 9  | Oil pressure        |
| 4 | Brake-circuit failure       | 10 | Reversing light     |
| 5 | Solenoid, front-wheel drive | 11 | Front-wheel drive   |
| 6 | Diff. locks                 | 12 | Fuel level          |

## Construction and Function

### Speedometer

The speedometer is of the eddy-current type and is driven by a cable (speedometer cable) from a worm on the gearbox output shaft. The speedometer contains a permanent magnet mounting disc and an aluminium rotor drum. The rotor drum is situated at one end of the instrument's pointer shaft. This shaft is also linked to a balance spring. This spring brakes movement of the rotor drum and turns the pointer to rest at the same time when the vehicle stops.

The odometer is driven directly from the speedometer cable through a number of small gears. The reductions of these gears are so selected that the wire can rotate 617.5 revs in order for the meter to register one km. The speedometer also has a counter which indicates distances driven up to 999 kilometers. The digit extreme right indicates metres in hundreds.

The tripmeter is re-set to zero by turning the small knob.

The part of the speedometer which indicates the speed functions magnetically. When the vehicle starts moving, the drive line rotates and this causes the permanent magnet to rotate. The rotating magnet generates a rotating magnetic field, which causes eddy currents to form in the rotor drum. The magnet's lines of force flow over the mounting disc of the instrument. The rotating effect which the magnetic field and the induced eddy currents have on the rotor drum is dependent on speed (increased vehicle speed causes the speedometer to register higher speed) and on the counteracting force of the balance spring.

The construction of the speedometer is shown in Fig. 38-2.

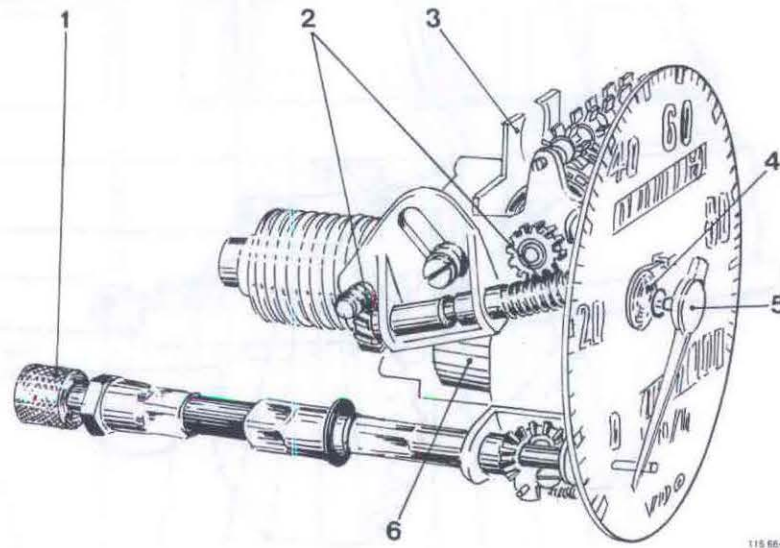


Fig. 38-2. Speedometer layout

- |                             |                                    |
|-----------------------------|------------------------------------|
| 1 Re-set knob for tripmeter | 4 Balance spring                   |
| 2 Worm                      | 5 Speedometer pointer              |
| 3 Mounting disc             | 6 Rotor drum with permanent magnet |

## Engine temperature gauge

The engine temperature gauge system has two main parts: a temperature gauge on the dashboard and a temperature sender in the engine block.

The temperature sender consists of a temperature-sensitive semi-conductor. The resistance through the sender reduces as the temperature of the engine rises.

The temperature gauge has three coils which function as electromagnets. One is connected in series to the sender, the other two are wired to the vehicle chassis via a fixed resistor, see Fig. 38-3.

When the engine coolant is cold (high resistance in the sender), most of the current goes through the two coils connected in series and through the fixed resistor to the vehicle chassis.

The magnetic force which arises at these coils attracts the armature plate so that the pointer points to 40°C (104°F) or less.

When the engine coolant temperature starts rising (the resistance in the sender reduces), more and more current passes through the coil connected in series to the sender. The magnetic force which arises attracts the gauge pointer armature plate in the opposite direction to previously. The gauge pointer moves on the dial, and thus indicates the temperature, in relation to the amount of current flowing through the coils. The amount of current flowing through the coils is determined by the temperature of the coolant.

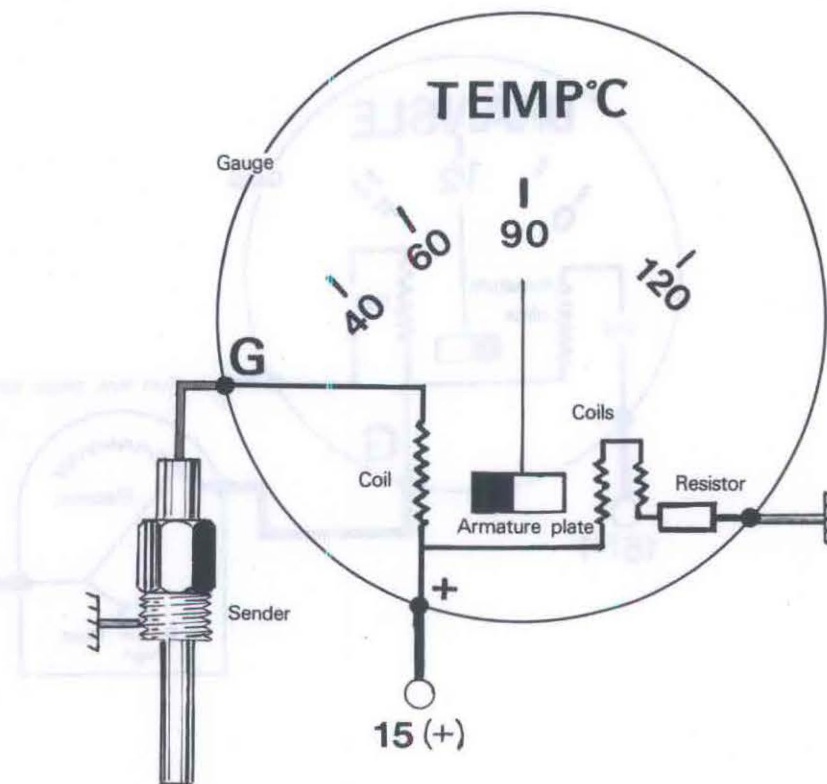


Fig. 38-3. Temperature gauge with sender, layout diagram

## Fuel gauge

The fuel gauge system, see Fig. 38-4, has two main parts: the fuel gauge on the dashboard and a tank gauge sending unit in the fuel tank.

The tank gauge sending unit consists of a float which is in contact with a contact plate via a lever. The contact plate slides over a rheostat. When there is more or less fuel in the tank (the fuel level rises or drops) more or less of the rheostat coils are in circuit.

The fuel gauge has two coils, which function as solenoids. The gauge needle armature plate is attracted to whichever of the two coils has the greatest magnetic force, and this in its turn will depend on how much current is flowing through either of these coils, see Fig. 38-4. If, for example, the magnetic force is the same in each coil, then the gauge pointer indicates that the tank is 1/2 full. The fuel tank indicator unit determines how much current will flow through the coil.

Ex: When the float is at the bottom position (the tank is empty), then there is little resistance in the rheostat. Most of the current will then flow through the coil which is connected in series to the rheostat, and only a little part of the current flows through the oil which is connected to the vehicle chassis.

When the float is at its top position, then there is great resistance in the rheostat. Most of the current will then flow through the coil which is connected to the vehicle chassis.

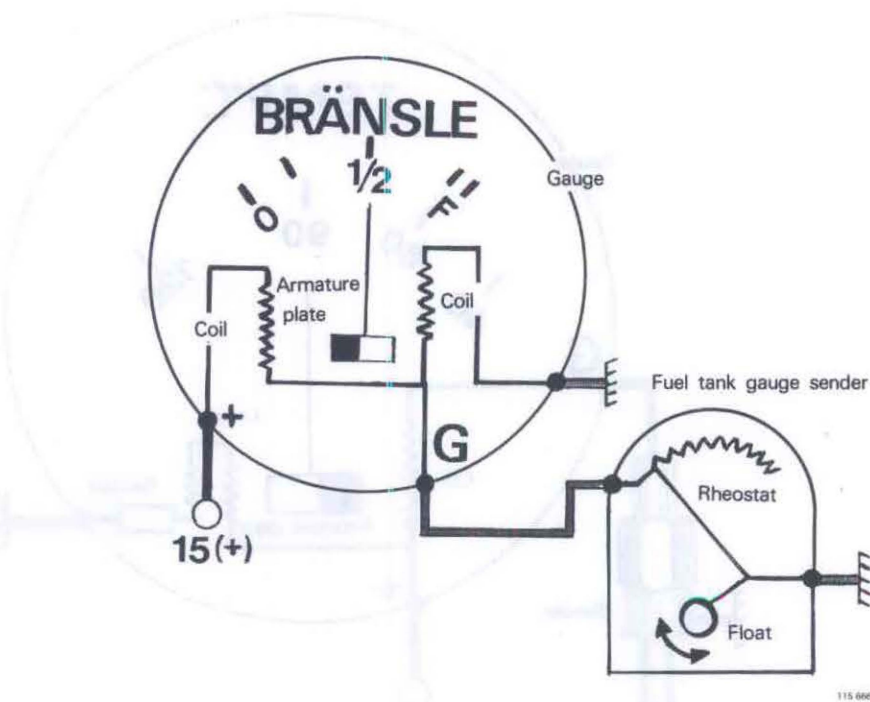


Fig. 38-4. Layout diagram of fuel gauge and fuel tank sending unit

- 1 Coil
- 2 Armature plate
- 3 Coil
- 4 Gauge
- 5 Fuel tank gauge sender

## Solenoid, front-wheel drive

The electrical system which operates the mechanical engagement of the front-wheel drive comprises the following components: solenoid, switch, contacts and indicator light, see layout diagram, Fig. 38-5.

When the ignition is switched on, current flows through the solenoid winding, the pressure contact in the transfer box, the push-push switch on the instrument panel and then to the push contact on the brake line to the vehicle chassis. The current circuit is closed and the armature in the solenoid has been pulled to its top position. When the current circuit is opened, the armature in the solenoid goes to its lowest position and this engages the front-wheel drive.

As the above shows, this engaging and disengaging the front-wheel drive will depend on whether there is current through the solenoid winding or not. The front-wheel drive can thus be operated with:

- A. Ignition. With the ignition key in neutral, the current is broken and front-wheel drive is engaged. When the key is turned, the front-wheel drive is disengaged, providing that the contacts and switches are in the position shown in Fig. 38-5.
- B. Gear lever. When a low gear is engaged, the contact breaks the auxiliary gearbox current and the front-wheel drive engages.
- C. Panel switch. Pushing in the switch breaks the current circuit and engages the front-wheel drive.
- D. Brake pedal. When the brake pedal is depressed and the hydraulic pressure in the pressure switch exceeds 0.8–1.0 MPa (8–10 kgf/cm<sup>2</sup> = 11–14 lbf/in<sup>2</sup>), the current circuit is broken and the front-wheel drive is engaged.

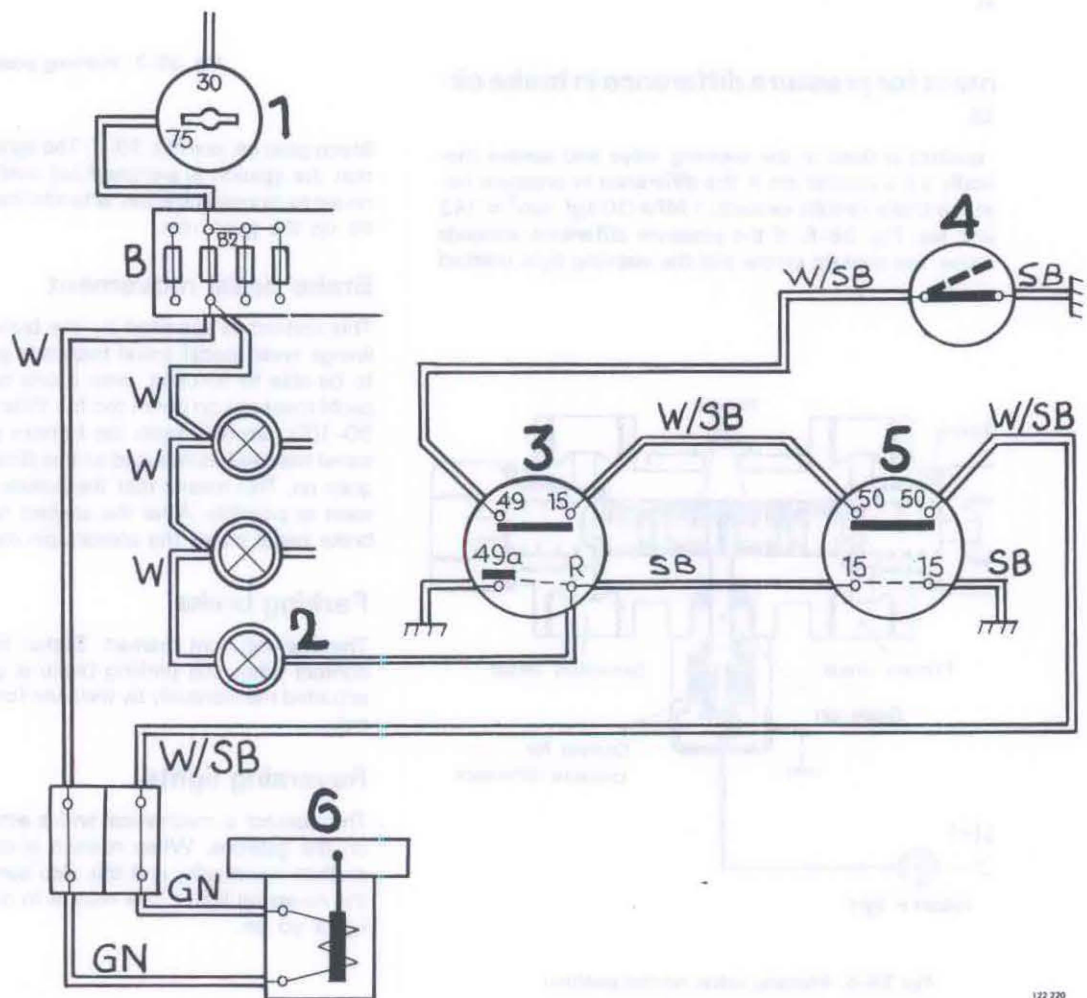


Fig. 38-5. Wiring diagram for front-wheel drive

- |   |                                    |   |                              |
|---|------------------------------------|---|------------------------------|
| 1 | Ignition                           | 4 | Pressure contact, brake line |
| 2 | Fusebox (B)                        | 5 | Contact, transfer box        |
| 2 | Indicator light, front-wheel drive | 6 | Solenoid                     |
| 3 | Switch, instrument panel           |   |                              |

## Under contacts

### Pressure

When the ignition is switched on, current flows through the pressure warning light and further through the oil pressure sender to the vehicle chassis. When the engine starts and oil pressure exceeds 40–70 kPa (0.4–0.7 kgf/cm<sup>2</sup> = 0.3 lbf/in<sup>2</sup>), this actuates a diaphragm which breaks the electrical circuit between the sender and chassis. Warning light goes out.

### Contacts

#### Stop lights

The contact for the stop lights is mechanical and is actuated by the brake pedal. When the pedal is not depressed, the contact circuit is broken. When the pedal is depressed, the contact circuit to the stop lights is closed so that the lights go on.

#### Contact for pressure difference in brake circuits

This contact is fixed in the warning valve and senses mechanically via a control pin if the difference in pressure between the brake circuits exceeds 1 MPa (10 kgf/cm<sup>2</sup> = 142 in<sup>2</sup>), see Fig. 38-6. If the pressure difference exceeds this value, the contact earths and the warning light marked

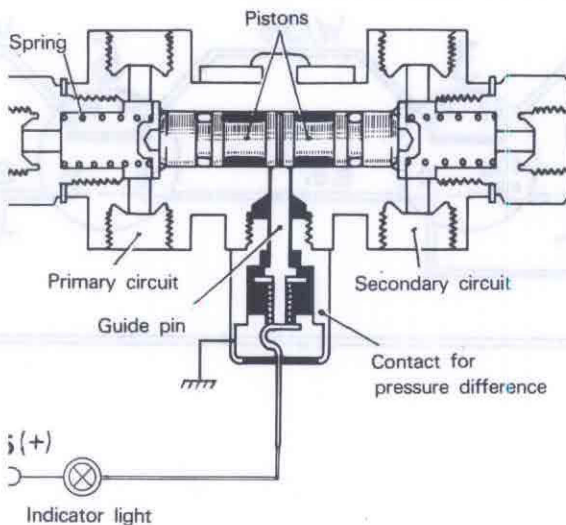


Fig. 38-6. Warning valve, normal position

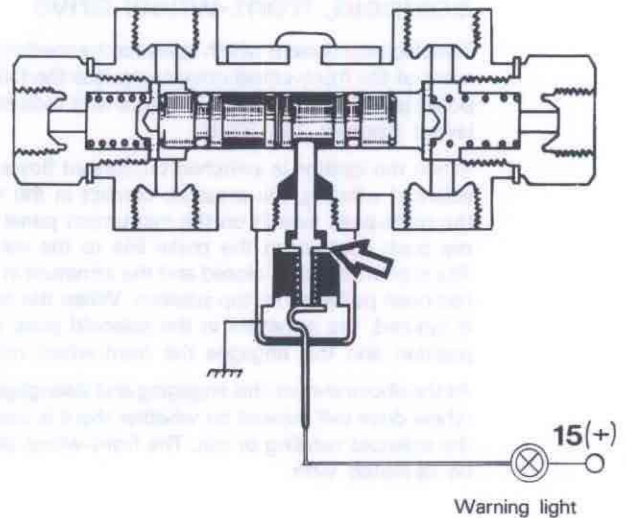


Fig. 38-7. Warning position

Brake goes on, see Fig. 38-7. The light remains on (providing that the ignition is switched on) until the contact has been re-set to its initial position, whereby the warning valve pistons lift up the guide pin.

### Brake pedal movement

This contact is actuated by the brake pedal. As the brake linings wear, pedal travel becomes greater. For the brakes to be able to function, even if one of the circuits fails, the pedal must not go down too far. When the pedal goes down 90–100 mm (4"), from the bottom position, that is, pedal travel reserve has reduced to this distance, the warning light goes on. This means that the brakes should be adjusted as soon as possible. After the contact has indicated excessive brake pedal travel, the contact pin must be re-set by hand.

### Parking brake

The warning light marked "Brake" lights by means of this contact when the parking brake is applied. The contact is actuated mechanically by the lever for the parking brake control.

### Reversing lights

This contact is mechanical and is actuated by the shift gear on the gearbox. When reverse is engaged, the contact is earthed electrically, and this also earths the cut-in relay for the reversing lights. The relay is in circuit and the reversing lights go on.

### Differential locks

The contacts are connected on the vacuum lines which run to the front and rear control cylinders, see Fig. 38-8.

The function of the contacts is to switch on the indicator lights marked "Diff.lock" when vacuum exceeds 39.5–40.5 kPa (0.395–0.405 kgf/cm<sup>2</sup> = 5–6 lbf/in<sup>2</sup>).

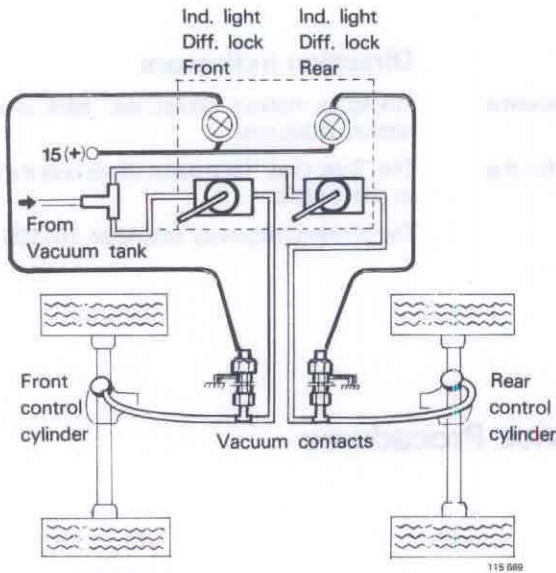


Fig. 38-8. Layout diagram for link-up of vacuum contacts

## Warning/indicator lights

### Battery charging

This light is marked "Charging". It is connected between the ignition terminal 61 and the alternator terminal 61. When the alternator voltage is lower than the battery voltage, the light goes on. When the voltage rises and the alternator starts charging the battery, the light goes out. This indicates that the alternator is charging.

### Oil pressure

The light marked "Oil" should go on when the lubricating oil pressure in the engine goes below 40–70 kPa (0.4–0.7 kgf/cm<sup>2</sup> = 6–10 lbf/in<sup>2</sup>).

### Brake

The light marked "Brake" should go on; when the parking brake is applied, or when the brake pedal travel exceeds a certain distance, see Fig. 38-9.

### Diff. lock

The lights marked "Diff. lock" go on when the vacuum in the lines to the control cylinders for the front and rear differential locks exceeds 39.5–40.5 kPa (0.395–0.405 kgf/cm<sup>2</sup> = 5–6 lbf/in<sup>2</sup>).

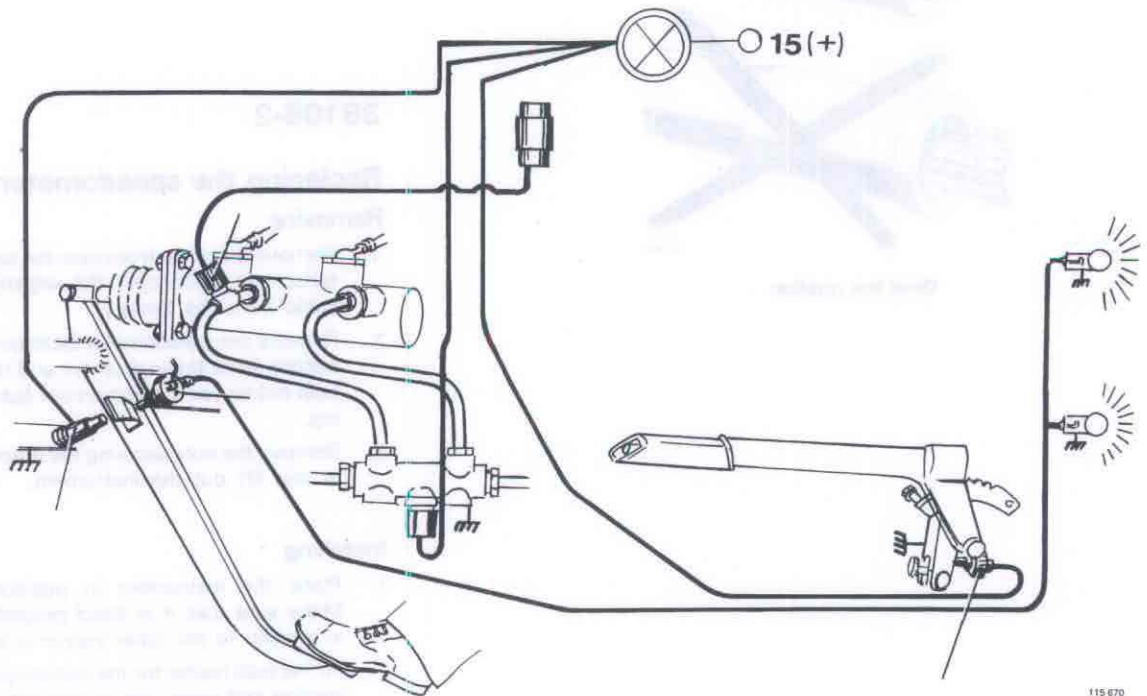


Fig. 38-9. Warning system for warning light marked "Brake"

## Mainbeams

The light marked "Mainbeam" goes on when the mainbeams are on.

The light is connected in parallel with the mainbeam for the right-hand side at the fuse (A9).

## Direction indicators

The lights marked "Direct. ind." blink in unison with the direction indicators.

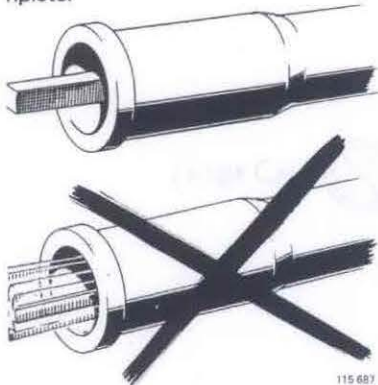
The "Direct ind." for a trailer blinks only if a trailer is connected to the vehicle.

The blinking frequency should be 75-105 blinks per minute.

## Service Procedures

### Speedometer

If the speedometer does not give a reading but the mileometer is functioning or if the speedometer is functioning but not the mileometer, then the fault is in the speedometer. If the instrument is not working at all, or if the speedometer needle swings, probably the drive line is broken or is jamming in its sleeve. If this is the case, replace the speedometer cable completely.



Drive line rotation



Speedometer

### 38108-2

#### Replacing the speedometer

##### Removing

1. Remove the cover from over the batteries and disconnect the negative cable from the battery.
2. Remove the speedometer cable connection from the instrument and the bulb holder for the instrument lighting.
3. Remove the nuts securing the bracket and lift out the instrument.

##### Installing

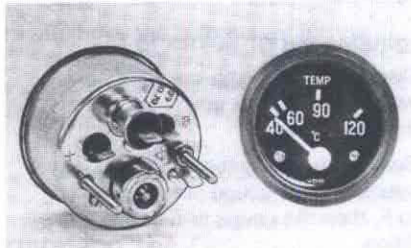
1. Place the instrument in position. Make sure that it is fitted properly in relation to the other instruments.
2. Fit the bulb holder for the instrument lighting and screw the speedometer cable nut on the instrument.
3. Connect up the negative cable to the battery and fit the battery cover.

## Engine temperature gauge

### Testing

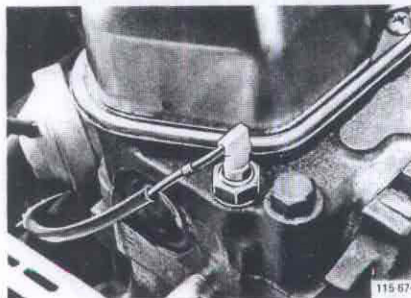
If the engine temperature gauge gives incorrect temperature or no temperature at all, then the fault may lie in the instrument, its sender or in the cables. The first thing to check is that there is good contact between the various instruments and sender connections and that the instrument is properly wired to the vehicle chassis.

Examine with a voltmeter or test lamp to make sure there is voltage on the instrument feed side. If the cables and contacts are without fault, carry out the following tests:



115 672

Engine temperature gauge



115 674

Sender for engine temperature gauge

### Temperature gauge indicates 40°C (100°F)

1. Disconnect the cable at the sender.
2. Switch on the ignition.
3. Hold the cable end against a scraped clean part on the engine in order to get an earth connection. If the gauge pointer goes over to 120°C (250°F), then the cable and instrument are in good condition so that the fault must be looked for in the sender. See under "Checking the sender".

4. If the gauge pointer does not swing to 120°C (250°F), disconnect the cable also at the instrument. Connect contact pin "G" to the chassis. If the instrument is functioning properly, the indicator should swing over to 120°C (250°F). And if the instrument is without fault, there must be a breakage in the cable to the sender. If this is the case, repair or replace the cable.

### Temperature gauge shows 120°C (250°F)

1. Disconnect the cable running from the instrument to the sender, the blue-coloured cable.
2. Switch on the ignition. If the gauge pointer swings to 40°C (100°F), then the gauge is in good condition.
3. Switch off the ignition and connect up the cable between instrument and sender.
4. Disconnect the cable at the sender and insulate it from the vehicle chassis.
5. Switch on the ignition. If the gauge pointer also swings to 40°C (100°F) now, then the cable is in good condition. The fault must be looked for in the sender. See under "Checking the sender".

### Checking the sender

Check the sender with an ohmmeter, which is connected between the connection terminal and the vehicle chassis. The following temperatures apply (the sender body should be lowered into the coolant as far as to where the threads start):

Temperature	Resistance in sender
60°C (140°F)	120.5–147.5 $\Omega$
90°C (194°F)	46.9–55.5 $\Omega$
100°C (212°F)	35.5–41.5 $\Omega$

Replace sender if faulty.

### 38230-2

### Replacing the temperature sender

1. Remove the rear engine cover and disconnect the cable from the temperature sender.
2. If necessary, drain a little coolant from the cooling system.
3. Remove the sender and its gasket.
4. Fit a new sender and gasket and connect up the cable.
5. If necessary, top-up the cooling system with coolant and re-fit the engine cover.

### Checking the temperature gauge

The temperature gauge is checked with the floatless sender connected up. Lower the sender body into the coolant as far as possible where the threads start. Heat the engine in a suitable way and check the temperature with the help of a mercury thermometer.

### Moving the temperature gauge

Remove the cover from over the batteries and disconnect the negative cable from the battery.

Remove the bulb holder for the instrument lighting and disconnect the cables to the instrument.

Remove the nuts securing the bracket and the earth cable. Remove the bracket and lift out the temperature gauge.

### Installing the temperature gauge

Place the temperature gauge in position and make sure that it is fitted properly in relation to the other instruments.

Fit the bracket and tighten up the gauge with the two nuts.

Fit the bulb holder for the instrument lighting and connect the cable connections to the gauge. The blue coloured cable is connected to "G", and the two yellow ones to "+".

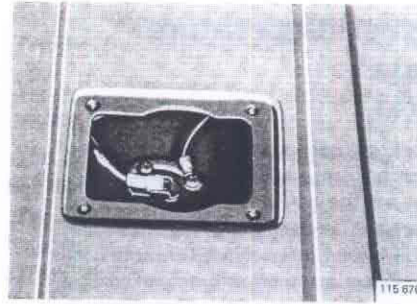
Connect up the negative cable to the battery and fit the cover over the batteries.

### Fuel gauge

If the gauge gives a wrong reading or nothing at all, then the fault may be in the instrument, the fuel gauge sending unit or in the cables. Before starting the check that the connections at the instrument and sending unit are in good condition. Also check the earth to the fuel gauge sending unit. With a voltmeter or



Fuel gauge



Gauge sender unit

test lamp find out if there is voltage on the feed side of the instrument (when the ignition is switched on). If the cables and contacts are in good condition, continue testing as follows:

#### Fuel gauge pointer points to 0

1. Disconnect the green-coloured cable which runs to the gauge sender at the instrument.
2. Switch on the ignition to the firing position. If the gauge pointer swings to F, then the gauge is in good condition.
3. Switch off with the ignition key and re-connect the cable at the instrument.
4. Disconnect the cable at the gauge sending unit and keep it insulated from the vehicle chassis. Turn the ignition key to firing. If the gauge pointer swings to F, then the cable is also in good condition. The fault is probably in the gauge sending unit, which should be removed and tested with an ohmmeter.
5. The resistance with an empty tank (the float is at its lowest position) should be 0-6  $\Omega$ .  
With a full tank (the float is at its top position) the resistance should be 178-192  $\Omega$ .

Move the gauge sending unit float up and down. The ohmmeter pointer should follow the movement of the float without jerking or without interruption.

#### Fuel gauge pointer points to F

1. Disconnect the green-coloured cable at the gauge level sending unit.
2. Switch on the ignition.
3. Hold the end of the disconnected cable against the chassis. If the pointer swings over to 0, then the cable and gauge are without fault, so the fault is probably in the gauge sending unit. See point 5 under the above previous test.

4. If, when doing the test described above, the gauge pointer does not swing to 0, disconnect the cable at the gauge. Connect the contact washer to the chassis with a piece of cable or corresponding. If the gauge is in good condition, the pointer will swing to 0. And if the instrument is without fault, then the fault is probably a poor contact at the connections to the instrument or in the cables to the gauge level sending unit.

### Removing the fuel gauge

1. Remove the cover from over the batteries and disconnect the negative cable from the battery.
2. Remove the bulb holder for the instrument lighting and the cable connections at the instrument.
3. Remove the nuts securing the bracket and disconnect the earth cables. Remove the bracket and lift out the instrument.

### Installing the fuel gauge

1. Place the fuel gauge in position. Make sure that it is located properly in relation to the other instruments.
2. Fit the bracket and connect up the earth cables. Tighten up the gauge with the two nuts.
3. Fit the bulb holder for the instrument lighting and connect the flat-pin sleeves as follows: the green-coloured cable is connected to the terminal marked "G". The yellow-coloured cables are connected to the terminal marked "+".
4. Connect up the negative cable to the battery and fit the cover over the batteries.

### Removing the fuel gauge level sending unit

1. Remove the four screws securing the cover over the unit.
2. Disconnect the cables from the unit. Make a line-up mark (with, e.g., a screw-driver) on the unit and the tank.
3. Remove the screws securing the unit and then take out the unit. Remove the unit gasket.

### Installing the fuel gauge level sending unit

1. Fit a new gasket and restore the sending unit back in position.
2. If necessary replace the rubber washer for the screws. Screw tight

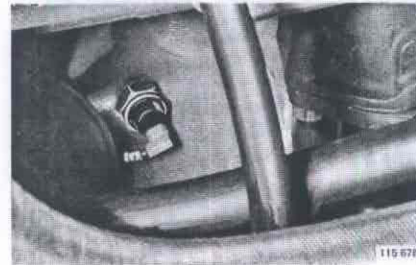
the sending unit and connect up the cables.

3. Fit and secure the cover over the sending unit.

## 38202-2

### Replacing the contact for oil pressure gauge sender

1. Remove the rear engine cover.
2. Disconnect the cable from the oil pressure gauge contact.

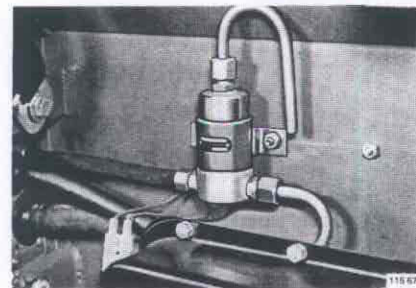


3. Have the new sender ready and fit it as soon as the old one has been removed.
4. Connect up the cable and re-fit the engine cover.

### Solenoid for front-wheel drive

#### Removing

1. Make sure that the ignition is switched off. Then disconnect the cables at the connector.
2. Slacken pipe and hose connections at the solenoid several turns.



Solenoid for front-wheel drive

3. Remove the screws securing the solenoid as well as the pipe and hose connections.

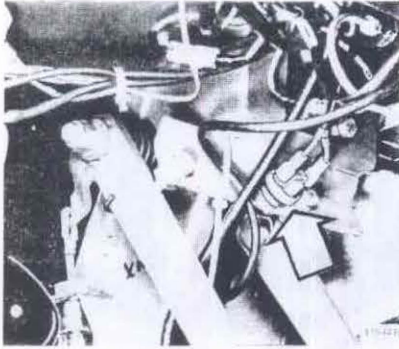
#### Installing

1. Fit the pipe and hose connections to the solenoid without tightening up.
2. Fit the solenoid.
3. Screw tight the pipe and hose connections and connect the cables to the connector.

## Contact for stop lights

### 3408-2 Replacing

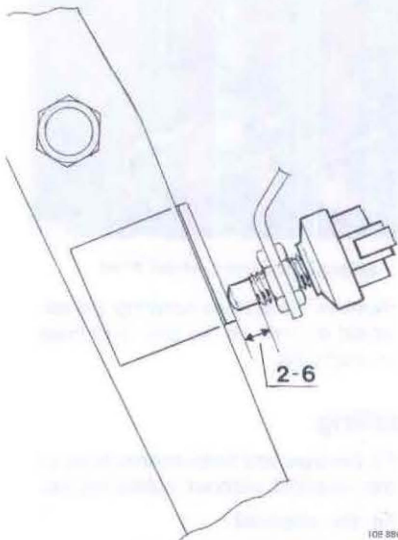
Disconnect the cables and remove the nut securing the contact to the bracket.



Fit the contact to the bracket and connect up the cables.

### Adjusting

For the contact to function correctly and prevent it from being damaged, it must have a certain position in relation to the brake pedal. The distance between the pedal in the rest position and the brass sleeve on the contact should be 2–6 mm (1/16"). With a different distance, slacken the nuts and move the contact in order to obtain the correct distance. Thereafter tighten up the nuts.

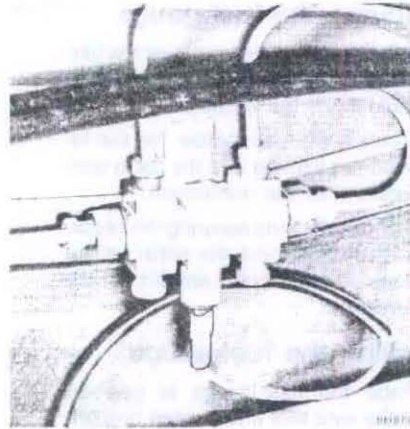


Contact for stop lights, adjustment measurement

## Contact for pressure difference in brake circuits

### Replacing

1. Disconnect the cable and unscrew the old contact.
2. Carefully screw the new contact into the warning valve. The tightening torque is approx. 15 Nm (1.5 kgf m = 22 lbf ft). Connect up the cable.



## Contact for brake pedal travel

### 36424-2

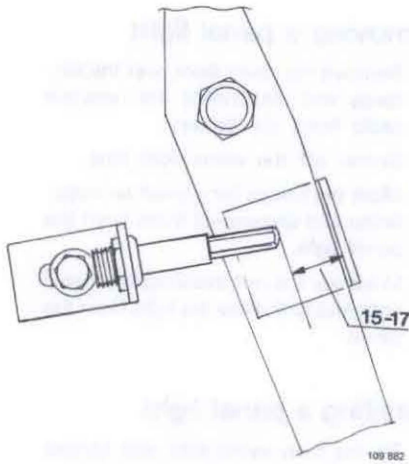
### Replacing

1. Disconnect the cable and remove the nut securing the contact to the bracket.
2. Fit and tighten up the new contact to the bracket and connect up the cable.

### Adjusting

The contact should give warning when there is about 90–100 mm (4") left of pedal travel, measured at the centre of the footplate. Since normally this can only be checked by means of bleeding, check the position of the contact by measuring the distance between the brake pedal bracket and the contact pin, with the brake pedal in the rest position. This distance should be 15–17 mm (5/8"). If the distance is otherwise, slacken the nut and move the contact in order to obtain the correct distance. Thereafter tighten up the nut.

The contact is re-set from the warning position by pushing back the contact pin to the rest position.



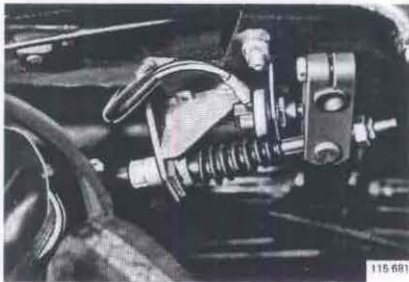
Contact for brake pedal travel, adjustment measurement

### Contact for parking brake

**36422-2**

#### Replacing

1. Remove the inspection cover.

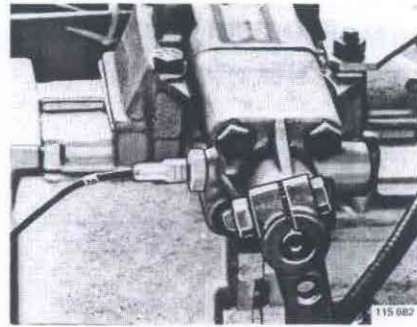


2. Disconnect the cable and remove the nut securing the contact to the bracket.
3. Fit and tighten up the new contact to the bracket and connect the cable. The contact should cut in the circuit to the warning light marked "Brake" at the second or third ratchet notch. Put back the inspection cover.

### Contact for reversing lights

#### Replacing

1. Remove the cover from over the gearbox.
2. Disconnect the cable and remove the contact.
3. Fit the new contact and connect up the cable.



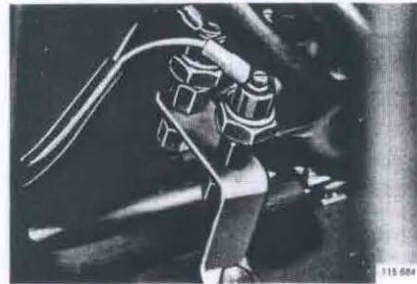
4. Put back the cover over the gearbox.

### Vacuum contact for diff. locks

**38240-2**

#### Replacing

1. Disconnect the cable from the contact.
2. Remove the contact.
3. Fit the new contact and connect up the cable.

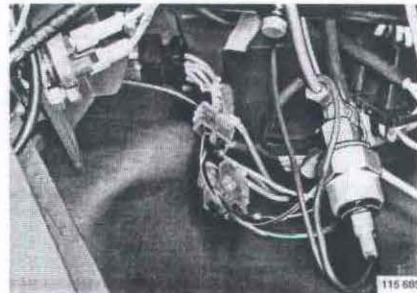


### Contact for front-wheel drive (underneath instrument panel)

**36452-2**

#### Replacing

Have a new contact and gasket ready for fitting. Disconnect the cable and unscrew the contact. Quickly fit the new contact and gasket. Connect up the cable. Check the level in the brake fluid containers and test the brakes.



## Contact for front-wheel drive (at transfer box)

### Removing

Remove the cover from over the gearbox.

Mark for correct re-installation and disconnect the cables from the contact.

Remove the contact and copper washer.

### Installing

Screw in the contact together with a new copper washer.

Connect up the cables according to the marking.

Put back the cover over the gearbox.

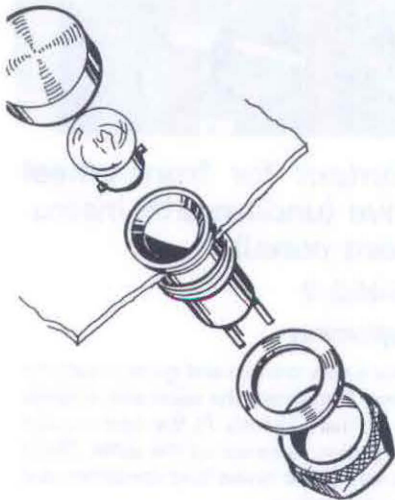
## Panel lights

### 8161-3

#### Replacing a bulb

Unscrew the panel light lens and remove the bulb.

Fit the new bulb and screw on the lens.



## Removing a panel light

1. Remove the cover from over the batteries and disconnect the negative cable from the battery.
2. Screw off the panel light lens.
3. Mark the cables for correct re-installation and disconnect them from the panel light.
4. Unscrew the nut securing the panel light and withdraw the light from the panel.

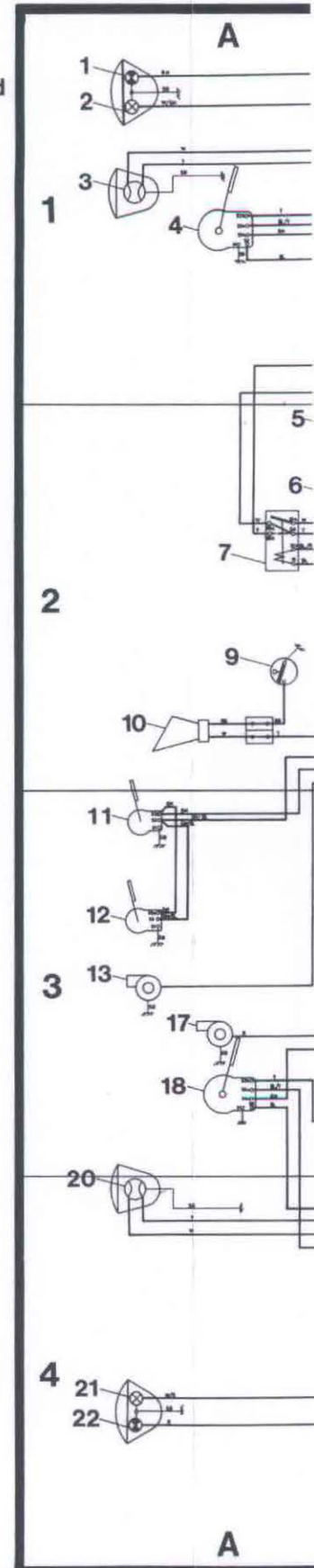
## Installing a panel light

1. Fit the new panel light and tighten it to the panel with the nut.
2. Connect up the cables according to the marking.
3. Fit a new bulb if necessary and screw on the lens.
4. Connect up the negative cable to the battery and re-fit the cover over the batteries.

## List of electrical components

letter and figure within brackets indicat the square in which the component is placed

ilb, direction indicators	(A1)	64 Reversing light contact	(D2)
ilb, parking lights	(A1)	65 Contact, parking brake	(D2)
ilb, fullbeams and dipped beams	(A1)	66 Starter motor	(D2)
indscreen wipers	(A1)	67 Battery	(D2)
lay, headlight flasher	(A2)	68 Distributor	(D3)
lay, parking lights	(A2)	69 Capacitor	(D3)
ep relay, fullbeams and dipped beams	(A2)	70 Ignition coil	(D3)
lay, headlamp ipers	(A2)	71 Charging regulator	(D3)
orn button	(A2)	72 Alternator	(D3)
orn	(A2)	73 Contact, oil pressure	(D3)
adlamp wiper	(A3)	74 Contact, front-wheel drive	(D4)
adlamp wiper	(A3)	75 Contact, front-wheel drive	(D4)
adlamp washers	(A3)	76 Solenoid valve	(D4)
lay, windscreen wiper	(A3)	77 Switch, interior lighting	(D4)
lay, windscreen wiper	(A3)	78 Bulb, interior light	(D4)
lay, windscreen wiper	(A3)	79 Bulb, tail light	(E1)
indscreen washers	(A3)	80 Bulb, direction indicator	(E1)
indscreen wiper	(A3)	81 Bulb, stop lights	(E1)
lay, windscreen wipers	(A3)	82 Trailer contact	(E3)
lb, fullbeams and dipped beams	(A4)	83 Bulb, reversing lights	(E4)
lb, parking light	(A4)	84 Bulb, tail light	(E4)
lb, direction indicator	(A4)	85 Bulb, direction indicator	(E4)
n motor, extra	(B2)	86 Bulb, stop light	(E4)
ritch, fan motor	(B2)		
n motor	(B2)		
ntact, front-wheel drive	(B2)		
ntact, brake pedal movement	(B2)		
arning light, battery charging	(B3)		
arning light, oil pressure	(B3)		
arning light, brakes	(B3)		
ostat	(B3)		
licator light, fullbeams	(B3)		
olant temperature gauge	(B3)		
licator light, direction indicator	(B3)		
sher device	(B3)		
licator light, direction indicator	(B3)		
eedometer	(B3)		
el gauge	(B4)		
ritch, windscreen wash	(B4)		
ritch, hazard warning lights	(B4)		
ritch, headlamp wipers	(B4)		
ritch, windscreen wiper	(B4)		
ritch, windscreen wiper	(B4)		
ritch, lights	(B4)		
g socket	(C1)		
ike light contact	(C2)		
ection indicator stalk	(C2)		
ay, reversing lights	(D2)		
ntact, brake circuit	(D2)		
ark plugs	(D2)		
mper resistance	(D2)		
ntact, differential lock	(C3)		
ntact, differential lock	(C3)		
icator light, differential lock	(C4)		
nder, coolant temperature gauge	(C4)		
icator light, differential lock	(C4)		
icator light, front-wheel drive	(C4)		
ition switch	(C4)		
al level sender	(D1)		
ole, connector	(D1)		
ole, connector	(D1)		





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2 Bulb, parking lights	(A1)	65 Contact, parking brake	(D2)
3 Bulb, fullbeams and dipped beams	(A1)	66 Starter motor	(D2)
4 Windscreen wipers	(A1)	67 Battery	(D2)
5 Relay, headlight flasher	(A2)	68 Distributor	(D3)
6 Relay, parking lights	(A2)	69 Capacitor	(D3)
7 Relay, fullbeams and dipped beams	(A2)	70 Ignition coil	(D3)
8 Relay, headlamp wipers	(A2)	71 Charging regulator	(D3)
9 Horn button	(A2)	72 Alternator	(D3)
10 Horn	(A2)	73 Contact, oil pressure	(D3)
11 Headlamp wiper	(A3)	74 Contact, front-wheel drive	(D4)
12 Headlamp wiper	(A3)	75 Contact, front-wheel drive	(D4)
13 Headlamp washers	(A3)	76 Solenoid valve	(D4)
14 Relay, windscreen wiper	(A3)	77 Switch, interior lighting	(D4)
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18 Windscreen wiper	(A3)	81 Bulb, stop lights	(E1)
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21 Bulb, parking light	(A4)	84 Bulb, tail light	(E4)
22 Bulb, direction indicator	(A4)	85 Bulb, direction indicator	(E4)
23 Fan motor, extra	(B2)	86 Bulb, stop light	(E4)
24 Switch, fan motor	(B2)		
27 Fan motor	(B2)		
28 Contact, front-wheel drive	(B2)		
29 Contact, brake pedal movement	(B2)		
30 Warning light, battery charging	(B3)		
31 Warning light, oil pressure	(B3)		
32 Warning light, brakes	(B3)		
33 Rheostat	(B3)		
34 Indicator light, fullbeams	(B3)		
35 Coolant temperature gauge	(B3)		
36 Indicator light, direction indicator	(B3)		
37 Flasher device	(B3)		
38 Indicator light, direction indicator	(B3)		
39 Speedometer	(B3)		
40 Fuel gauge	(B4)		
41 Switch, windscreen wash	(B4)		
42 Switch, hazard warning lights	(B4)		
43 Switch, headlamp wipers	(B4)		
44 Switch, windscreen wiper	(B4)		
45 Switch, windscreen wiper	(B4)		
46 Switch, lights	(B4)		
47 Light socket	(C1)		
48 Brake light contact	(C2)		
49 Direction indicator stalk	(C2)		
50 Relay, reversing lights	(D2)		
51 Contact, brake circuit	(D2)		
52 Spark plugs	(D2)		
53 Limper resistance	(D2)		
54 Contact, differential lock	(C3)		
55 Contact, differential lock	(C3)		
56 Indicator light, differential lock	(C4)		
57 Sender, coolant temperature gauge	(C4)		
58 Indicator light, differential lock	(C4)		
59 Indicator light, front-wheel drive	(C4)		
60 Ignition switch	(C4)		
61 Fuel level sender	(D1)		
62 Console, connector	(D1)		
63 Console, connector	(D1)		

25 Fuse Block (B1)  
26 Fuse Block (B2)

