

CHAPTER 12

THE ELECTRICAL SYSTEM

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12:1 Description

All models covered by this manual have 12-volt electrical systems in which the negative terminal of the battery is earthed to the car bodywork.

There are wiring diagrams in **Technical Data** at the end of this manual which will enable those with electrical experience to trace and correct faults.

Instructions for servicing the items of electrical equipment are given in this chapter, but it must be pointed out that it is not sensible to try to repair units which are seriously defective, electrically or mechanically. Such faulty equipment should be replaced by new or reconditioned units.

12:2 The battery

To maintain the performance of the battery, it is essential to carry out the following operations, particularly in winter when heavy current demands must be met.

Keep the top and surrounding parts of the battery clean and dry, as dampness can cause current leakage. Clean off corrosion from the metal parts of the battery mounting with diluted ammonia and coat them with anti-sulphuric paint. Clean the terminal posts and smear them with petroleum jelly, tightening the terminal clamps securely. Check the battery earth lead connection to the car body

for looseness or corrosion. High electrical resistance due to corrosion at the battery terminals can be responsible for a lack of sufficient current to operate the starter motor.

Regularly remove the screw caps from the battery and check the electrolyte level in each cell, topping up with distilled water if necessary to just cover the separator plates.

If a battery fault is suspected, test the condition of the cells with a hydrometer. **Never add neat acid to the battery. If it is necessary to prepare new electrolyte due to loss or spillage, add sulphuric acid to distilled water. It is highly dangerous to add water to acid.** It is safest to have the battery refilled with electrolyte if it is necessary by a service station.

The indications from the hydrometer readings of the specific gravity are as follows:

<i>For climates below 27°C or 80°F</i>			<i>Specific gravity</i>
Cell fully charged	..	..	1.270 to 1.290
Cell half discharged	..	..	1.190 to 1.210
Cell discharged	..	..	1.110 to 1.130
<i>For climates above 27°C or 80°F</i>			
Cell fully charged	..	..	1.210 to 1.230
Cell half discharged	..	..	1.130 to 1.150
Cell discharged	..	..	1.050 to 1.070

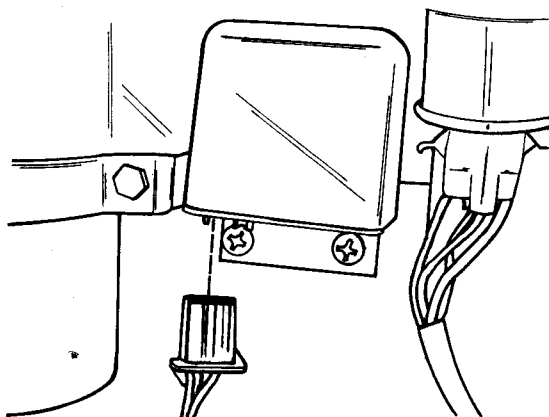


FIG 12:1 Regulator plug connection and mounting screws

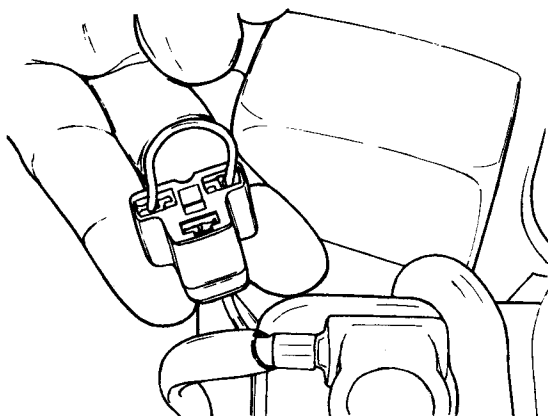


FIG 12:2 Shorting plug connectors for test purposes

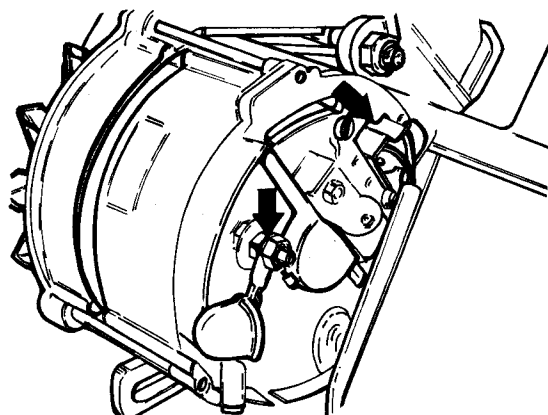


FIG 12:3 Alternator wiring connections

These figures assume electrolyte temperature of 60°F or 16°C. If the temperature of the electrolyte exceeds this, add 0.002 to the readings for each 5°F or 3°C rise. Subtract 0.002 for any corresponding drop below 60°F or 16°C.

If the battery is in a low state of charge, take the car for a long daylight run or put the battery on a charger at 5amps, with the vents in place, until it gases freely. Do not use a naked light near the battery as the gas is inflammable. If the battery is to stand unused for long periods give a refreshing charge every month. It will be ruined if it is left uncharged.

12:3 The alternator

The alternator provides current for the various items of electrical equipment and to charge the battery, the unit operating at all engine speeds. The current produced is alternate, this being rectified to direct current supply by diodes mounted in the alternator casing. Alternator drive is by belt from the crankshaft pulley. Very little maintenance is needed, apart from the occasional check on belt tension as described in **Chapter 4, Section 4:4**, and on the condition and tightness of the wiring connections. Keep the outside of the unit free from dirt, particularly around the ventilation holes in the cover.

The alternator must never be run with the battery disconnected, nor must the battery cables be reversed at any time. Test connections must be carefully made, and the battery and alternator must be completely disconnected before any electric welding is carried out on any part of the car. The engine must never be started with a battery charger still connected to the battery. These warnings must be observed, otherwise extensive damage to the alternator components, particularly the diodes, will result.

The alternator is designed and constructed to give many years of trouble-free service. If, however, a fault should develop in the unit, it should be checked and serviced by a fully equipped service station or a reconditioned unit obtained and fitted.

Alternator testing:

A simple check on alternator charging can be carried out after dark by switching on the headlamps and starting the engine. If the alternator is charging, the headlamps will brighten considerably as the system voltage rises from the nominal battery voltage to the higher figure produced by the alternator.

If the alternator is not charging, check the wiring and connections in the charging circuit. If these are in order, the alternator should be checked and repaired by a service station.

If the ignition warning light stays on when the engine is running, a simple electrical test is possible. Switch off the engine and pull the multiple plug from the regulator unit as shown in **FIG 12:1**. Use a suitable piece of wire to join the connectors for the blue wire and black wire as shown in **FIG 12:2**. Start the engine and run it at approximately 1000rev/min. If the ignition warning light goes out immediately, the regulator is defective and a new regulator should be fitted. If the ignition warning light glows or continues to burn brightly, there is a fault in the alternator, which should be checked and repaired by a service station.

Alternator removal:

Disconnect the battery negative cable, then refer to **FIG 12:3** and disconnect the multiple plug and the single cable from the rear of the alternator. Note that the brown wire goes to earth and the red wire to the B+ terminal. Slacken the alternator mounting bolts, swing the unit towards the engine to slacken the drive belt, then remove the belt. Unbolt and remove the alternator.

Refitting is a reversal of the removal procedure, adjusting the belt tension as described in **Chapter 4, Section 4:4**.

12:4 The starter motor

The starter is a brush type series wound motor equipped with an overrunning clutch and operated by a solenoid. The armature shaft is supported in metal bushes which require no routine servicing.

When the starter is operated from the switch, the engagement lever moves the pinion into mesh with the engine ring gear. When the pinion meshes with the ring gear teeth, the solenoid contact closes the circuit and the starter motor operates to turn the engine. When the engine starts, the speed of the rotating ring gear causes the pinion to overrun the clutch and armature. The pinion continues in engagement until the switch is released when the engagement lever returns it to the rest position under spring pressure.

Tests for a starter which does not operate:

Check that the battery is in good condition and fully charged and that its connections are clean and tight. Switch on the headlamps and operate the starter switch. Current is reaching the starter if the lights dim when the starter is operated, in which case it will be necessary to remove the starter for servicing. If the lights do not dim significantly, switch them off and operate the starter switch while listening for a clicking sound at the starter motor, which will indicate that the starter solenoid is operating.

If no sound can be heard at the starter when the switch is operated, check the wiring and connections between the battery and the starter switch and between the switch and the solenoid. If the solenoid can be heard operating when the starter switch is operated, check the wiring and connections between the battery and the main starter motor terminal, taking care not to accidentally earth the main battery to starter motor lead which is live at all times. If the wiring is not the cause of the trouble, the fault is internal and the starter motor must be removed and serviced.

Removing the starter:

Disconnect the battery earth cable, then disconnect the wiring from the starter motor as indicated by the arrows in **FIG 12:4**. Remove the fixing bolts then lift the starter motor from the engine.

Starter dismantling:

Disconnect the cable from the solenoid connection. Remove the fixing screws and detach the solenoid, unhooking the plunger from the engagement lever as shown in **FIG 12:5**. Refer to **FIG 12:6** and detach the

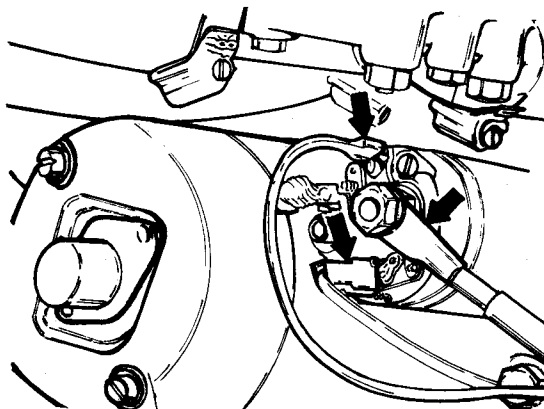


FIG 12:4 Starter motor wiring connections

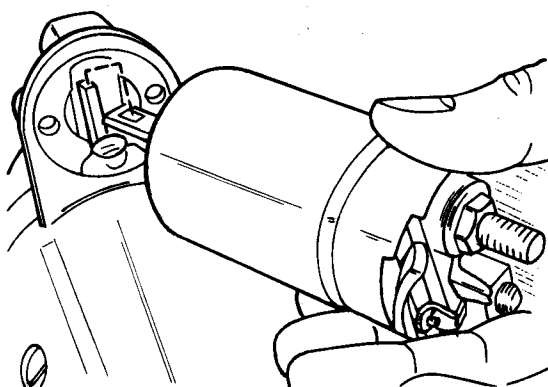


FIG 12:5 Solenoid removal

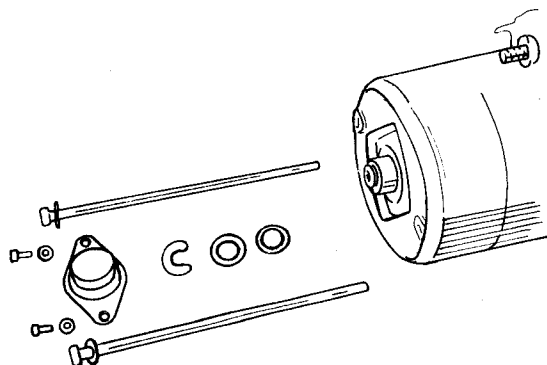


FIG 12:6 Removing end cap and through bolts

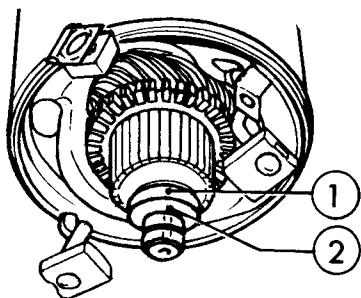


FIG 12:7 Removing brush holder assembly

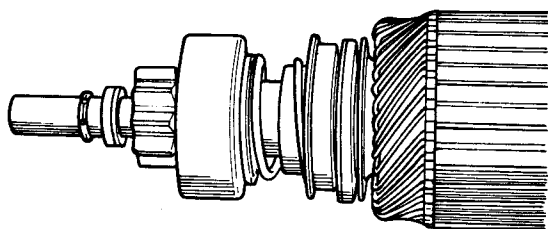
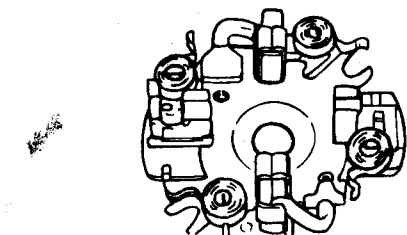


FIG 12:8 Drive pinion removal

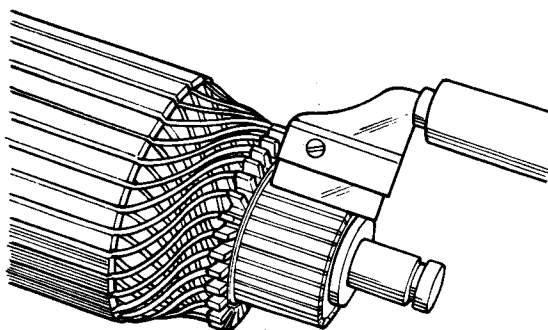


FIG 12:9 Undercutting commutator insulation

end cap. Remove the securing plate, shim and seal. Note that shim thickness should be modified if necessary during reassembly, to ensure an armature end play of 0.1 to 0.15mm (0.0039 to 0.0059in). Remove the two through bolts.

Pull back the springs and lift out the positive brushes, then detach the brush holder assembly as shown in FIG 12:7, noting washer 1 and insulating washer 2. Detach the starter body from the armature and drive end bracket assembly. Remove the engagement lever pivot bolt, then pull the armature and engagement lever from the drive end bracket.

To remove the drive pinion, refer to FIG 12:8 and use a suitable piece of tube to drive the stop collar towards the gear, then remove the stop ring from the groove and pull off the collar and pinion assembly.

Starter motor servicing:

Cleaning:

Blow away all loose dust and dirt with an air line. Use a small brush to clean out crevices. Petrol or methylated spirits may be used to help in cleaning the metal parts, but the field coils, armature and drive pinion assembly must under no circumstances be soaked with solvent.

Brush gear:

Check the brushes for wear or contamination and renew if necessary. The old brushes should be unsoldered one at a time, then the new brushes soldered carefully into place. Grip the end of the flexible lead near to the joint when soldering to prevent solder from running down the lead.

Clean the brushes and brush holder assembly with a petrol moistened cloth and check that the brushes move freely in their holders. If a brush sticks in position, remove it and carefully ease the sides against a fine file. When installing the brushes to their holders, lift each brush and retain in the top of the holder by engaging the spring against the side of the brush. When the holder assembly has been refitted, push the brushes down into place and locate the springs correctly on top of each brush.

The commutator:

The commutator on which the carbon brushes operate should have a smooth polished surface which is dark in appearance. Wiping over with a piece of cloth moistened with methylated spirits or petrol is usually sufficient to clean the surface. Light burn marks or scores can be polished off with fine grade glasspaper (do not use emerycloth as this leaves particles embedded in the copper). Deeper damage may be skimmed off in a lathe, at high speed and using a very sharp tool. A diamond-tipped tool should be used for a light final cut. Note that the commutator must not be reduced below the minimum diameter of 33mm (1.3in). On completion, undercut the insulation between commutator segments as shown in FIG 12:9, using a special tool as illustrated or a suitable hacksaw blade ground to the thickness of the insulation. Undercut the insulation to a depth of 0.5mm (0.0197in) below the level of the segments. Finally, clean away all dust from the commutator.

The armature:

Check the armature for charred insulation, loose segments or laminations and for scored laminations. Shortcircuited windings may be suspected if individual commutator segments are badly burnt. If the armature is damaged in any way it should be renewed. If an electrical fault in the armature is suspected, have it tested on special equipment at a service station.

Field coils:

Test for insulation breakdown by connecting a 12-volt supply and test lamp between the terminal and starter body as shown in FIG 12:10. If the lamp lights it indicates a shortcircuit between the field coils and earth. Use the test lamp to check continuity by connecting the leads so that the coil windings are in series. If the lamp does not light there is a break in the field coil windings. Renewal of field coils should be carried out at a service station.

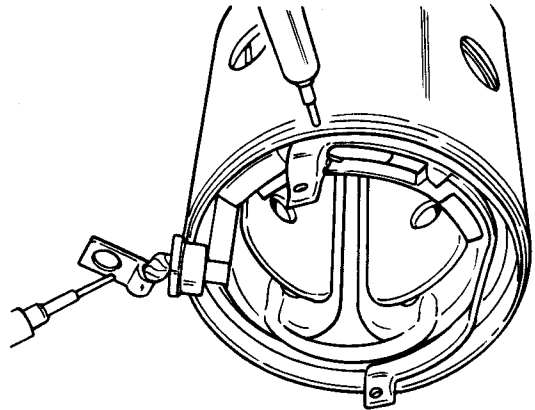


FIG 12:10 Field coil insulation test

Drive pinion assembly:

The starter drive pinion and clutch assembly must not be washed in solvents as this would wash away the internal lubricant. Cleaning should be confined to wiping away dirt with a cloth. Light damage to the pinion teeth which engage the engine ring gear can be cleaned off with a fine file or oilstone, but deeper damage necessitates the renewal of the complete drive assembly. Check that the clutch takes up the drive instantaneously but slips freely in the opposite direction. The complete pinion and clutch assembly must be renewed if the clutch is defective.

Bearings:

The bearings in the drive end and commutator end brackets should be renewed if worn or damaged. If suitable mandrels and press equipment are not available, have the work carried out at a service station. Before installing a new bush, soak it for at least half-an-hour in engine oil, then shake off excess oil and press into position until flush with the housing. If the original bushes are in serviceable condition, lubricate them lightly with engine oil when reassembling the starter.

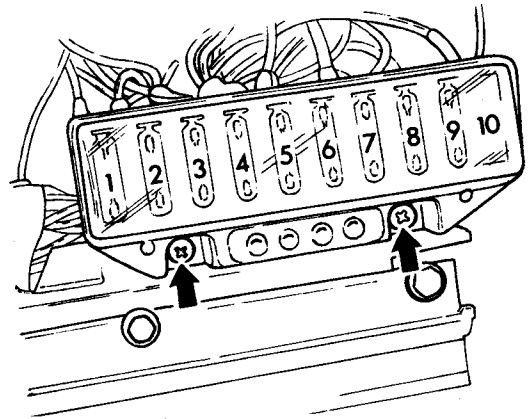


FIG 12:11 The fuse box

Solenoid:

No attempt should be made to service a faulty solenoid unit. Any mechanical or electrical faults will dictate renewal of the assembly. Check the engagement lever which moves the pinion into mesh with the engine ring gear and renew if worn or damaged.

Reassembly:

This is a reversal of the dismantling procedure. Lightly lubricate the engagement lever pivot bolt using an approved grade of grease. When reassembling the drive pinion assembly, tap the stop collar down the shaft past the groove, install the stop ring firmly in the groove, then force the stop collar over the stop ring to secure.

12:5 Fuses

The fuses which protect the main electrical circuits are mounted in a fuse box provided with a snap-on cover as shown in FIG 12:11.

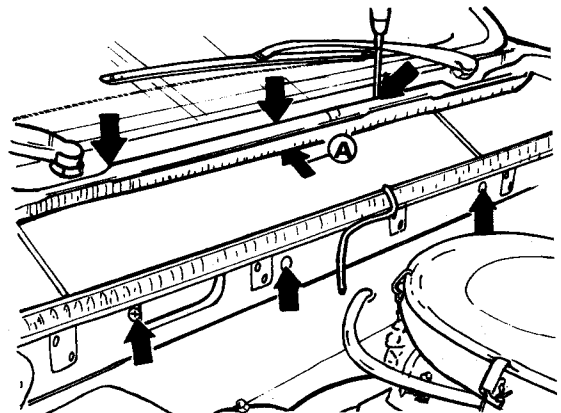


FIG 12:12 Heater coverplate removal

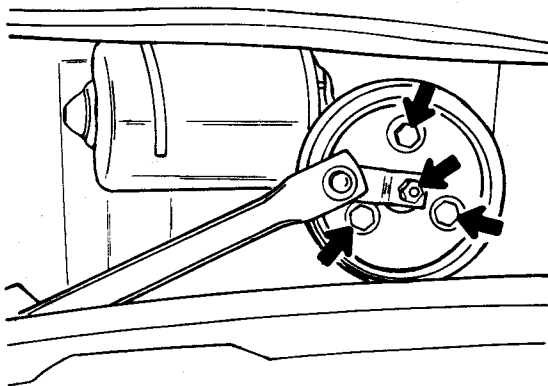


FIG 12:13 Wiper motor removal

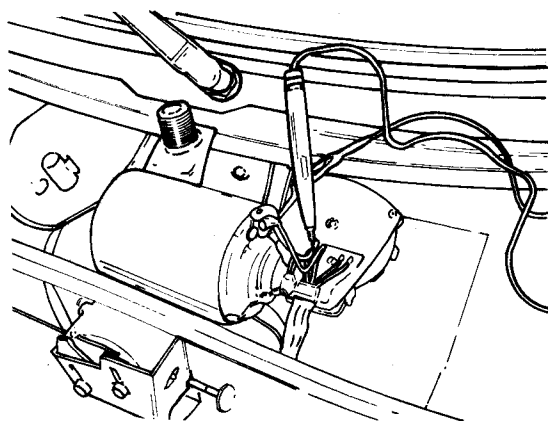


FIG 12:14 Checking current supply to wiper motor

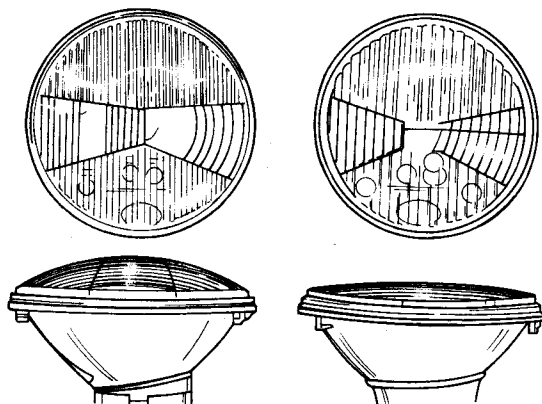


FIG 12:15 Early (left), and later (right), headlamp units

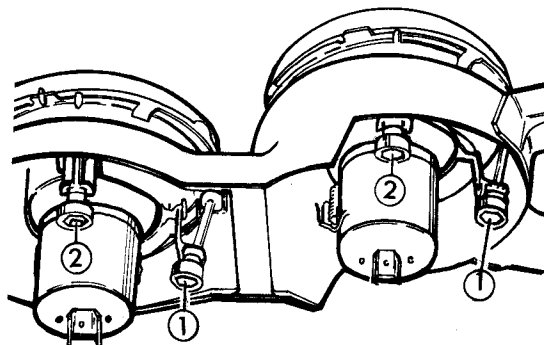


FIG 12:16 Headlamp beam setting screws

If a fuse blows, briefly check the circuit that it protects and install a new fuse. Check each circuit in turn and if the new fuse does not blow, it is possible that the old one had weakened with age. If the new fuse blows, carefully check the circuit that was live at the time and do not fit another fuse until the fault has been found and repaired. A fuse that blows intermittently will make it more difficult to correct the fault, but try shaking the wiring loom as the fault is likely to be caused by chafed insulation making intermittent contact.

Never fit a fuse of higher rating than that specified, and never use anything as a substitute for a fuse of the correct type. The fuse is designed to be the weak link in the circuit and if a higher rated fuse or an incorrect substitute is installed the wiring may fail instead, possibly causing a fire.

12:6 Windscreen wipers

Wiper motor removal:

Refer to FIG 12:12 and remove the heater unit cover plate, noting the position of the special sealing strip **A** between cover plate and water drain gutter. Make sure that the wiper linkage is in the parked position. If the motor has failed with the wipers in any other position, move to the parked position by turning the motor crank. Refer to FIG 12:13. Remove the nut to detach the crank and remove the three screws to release the wiper motor from its mountings. Pull off the multiple plug and remove the wiper by tilting downwards.

If the motor is inoperative, check the current supply as shown in FIG 12:14. Reconnect the multiple plug to the motor, then switch on the ignition and wiper switches. Use a test lamp or voltmeter at terminal 53 (black/yellow and green cables) or 53b (black/white and red cables) to check if current is reaching the wiper motor. If the cables are live, the wiper motor must be internally defective.

Refit the wiper motor in the reverse order of removal. To ensure that the motor is in the parked position, temporarily connect the multiple plug then switch on the ignition and wiper switches. Allow the motor to run for a few seconds, then switch off at the wiper switch. The motor will then stop automatically in the parked position.

Wiper linkage removal:

To remove the wiper linkage and motor complete, first remove the heater unit cover plate as described

previously. Remove the wiper arms by pulling the bosses from the splined shafts. If removal proves difficult, carefully lever the arms from the shafts by twisting the blade of a large screwdriver between the boss and the nut. Remove the nuts and washers securing the wiper arm shafts in position, then push the shafts through the mounting holes and detach the linkage assembly complete. Pull the multiple plug from the plug board and remove complete with rubber grommet. If necessary, press off the connecting link and drive rod and unscrew the wiper pivot bearings.

Refitting is a reversal of the removal procedure. Make sure that the motor and linkage are in the parked position, as described previously. Push the wiper arms on to the shafts so that the blades are approximately 1 to 2cm (0.4 to 0.8in) from the edge of the screen in the parked position.

12:7 Headlamps

Lamp unit removal:

The lamp units are of the sealed beam type and must be renewed complete if either of the filaments should fail. Remove the fixing screws and detach the ornamental grill from the front of the car. Remove the fixing screws and lift the headlamp unit from the housing, then disconnect the multiple plug from the rear of the unit. When installing, make sure that the headlamp unit is correctly located in the recesses provided in the housing frame.

Modifications:

Later models are fitted with an improved type of headlamp unit, having a flat lens instead of the earlier type of rounded lens, as shown in FIG 12:15. It is recommended that earlier models be fitted with this later type of headlamp unit, as it provides a beam of greater intensity and range.

Headlamp beam setting:

The headlamp main beams should be set so that, when the car is loaded with a weight of 70kg (155lb), or the weight of one person, in the centre of the rear seat, the main beams are parallel to each other and to the road. The dipped beams should provide a good spread of light to the front and nearside of the car without dazzling oncoming drivers. The tyres must be correctly inflated when checking beam settings.

The knurled headlamp beam adjustment screws are shown in FIG 12:16, horizontal adjustment being carried out at screws 1 and vertical adjustment at screws 2. The screws are accessible from the inside of the engine compartment. It is recommended that headlamp beam setting be carried out at a service station having special optical equipment, this method giving the most accurate results.

12:8 Fault diagnosis

(a) Battery discharged

- 1 Terminal connections loose or dirty
- 2 Shorts in lighting circuits
- 3 Alternator not charging
- 4 Regulator faulty
- 5 Battery internally defective

(b) Insufficient charge rate

- 1 Check 1 and 4 in (a)
- 2 Drive belt slipping
- 3 Alternator defective

(c) Battery will not hold charge

- 1 Low electrolyte level
- 2 Battery plates sulphated
- 3 Electrolyte leakage from cracked case
- 4 Battery internally defective

(d) Battery overcharged

- 1 Regulator faulty

(e) Alternator output low or nil

- 1 Drive belt broken or slipping
- 2 Regulator faulty
- 3 Brushes sticking, springs weak or broken
- 4 Faulty internal windings
- 5 Defective diode(s)

(f) Starter motor lacks power or will not turn

- 1 Battery discharged, loose cable connections
- 2 Starter switch or solenoid faulty
- 3 Brushes worn or sticking, leads detached or shorting
- 4 Commutator dirty or worn
- 5 Starter shaft bent
- 6 Engine abnormally stiff

(g) Starter runs but does not turn engine

- 1 Pinion engagement mechanism faulty
- 2 Broken teeth on pinion or engine ring gear

(h) Starter motor rough or noisy

- 1 Mounting bolts loose
- 2 Pinion engagement mechanism faulty
- 3 Damaged pinion or engine ring gear teeth

(j) Noisy starter when engine is running

- 1 Pinion return mechanism faulty
- 2 Mounting bolts loose

(k) Starter motor inoperative

- 1 Check 1 and 3 in (f)
- 2 Armature or field coils faulty

(l) Lamps inoperative or erratic

- 1 Battery low, bulbs burned out
- 2 Faulty earthing of lamps or battery
- 3 Lighting switch faulty, loose or broken connections

(m) Wiper motor sluggish, taking high current

- 1 Wiper motor internally defective
- 2 Wiper motor fixings loose
- 3 Linkage worn or binding

NOTES