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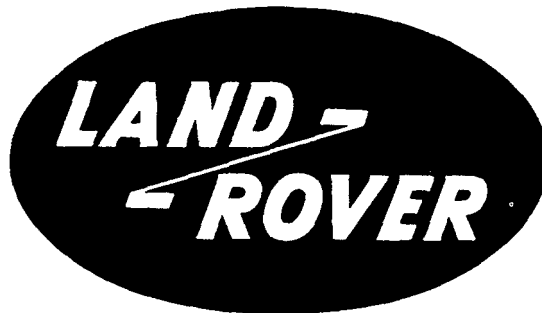
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# Special Service Tools

The use of approved special service tools is important. They are essential if service operations are to be carried out efficiently, and safely. The amount of time which they save can be considerable.

Every special tool is designed with the close co-operation of Land Rover Ltd., and no tool is put into production which has not been tested and approved by us. New tools are only introduced where an operation cannot be satisfactorily carried out using existing tools or standard equipment. The user is therefore assured that the tool is necessary and that it will perform accurately, efficiently and safely.

Special tools bulletins will be issued periodically giving details of new tools as they are introduced.

All orders and enquiries from the United Kingdom should be sent direct to V. L. Churchill. Overseas orders should be placed with the local V. L. Churchill distributor, where one **exists**. Countries where there is no distributor may order direct from V. L. Churchill Limited, PO Box 3 Daventry, Northants, England NN11 4NF.

The tools recommended in this Workshop Manual are listed in a multi-language, illustrated catalogue obtainable from Messers. V. L. Churchill at the above address under publication number 2217/2/84 or from Land Rover Ltd., under part number LSM0052TC from the following address, Land Rover Merchandising Service, P.O. Box 534, Erdington, Birmingham B24 0QS.



## INTRODUCTION

This Workshop Manual covers the Land Rover Ninety and One Ten range of vehicles. It is primarily designed to assist skilled technicians in the efficient repair and maintenance of Land Rover vehicles.

Using the appropriate service tools and carrying out the procedures as detailed will enable the operations to be completed within the time stated in the 'Repair Operation Times'.

The Manual has been produced in separate books; this allows the information to be distributed throughout the specialist areas of the modern service facility.

A table of contents in Book 1 lists the major components and systems together with the section and book numbers. The cover of each book details the sections contained within that book.

The title page of each book carries the part numbers required to order replacement books, binders or complete Service Manuals. This can be done through the normal channels.

## REFERENCES

References to the left- or right-hand side in the manual are made when viewing the vehicle from the rear. With the engine and gearbox assembly removed, the water pump end of the engine is referred to as the front.

To reduce repetition, operations covered in this manual do not include reference to testing the vehicle after repair. It is essential that work is inspected and tested after completion and if necessary a road test of the vehicle is carried out particularly where safety related items are concerned.

## DIMENSIONS

The dimensions quoted are to design engineering specification. Alternative unit equivalents, shown in brackets following the dimensions, have been converted from the original specification.

During the period of running-in from new, certain adjustments may vary from the specification figures given in this Manual. These adjustments will be re-set by the Distributor or Dealer at the After Sales Service, and thereafter should be maintained at the figures specified in the Manual.

## REPAIRS AND REPLACEMENTS

When replacement parts are required it is essential that only Land Rover parts are used.

Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories:

Safety features embodied in the vehicle may be impaired if other than Land Rover parts are fitted. In certain territories, legislation prohibits the fitting of parts not to the vehicle manufacturer's specification. Torque wrench setting figures given in the Repair Operation Manual must be strictly adhered to. Locking devices, where specified, must be fitted. If the efficiency of a locking device is impaired during removal it must be renewed. Owners purchasing accessories while travelling abroad should ensure that the accessory and its fitted location on the vehicle conform to mandatory requirements existing in their country of origin. The terms of the Owners Service Statement may be invalidated by the fitting of other than Land Rover parts.

**All** Land Rover parts have the full backing of the Owners Service Statement.

Land Rover Distributors and Dealers are obliged to supply only Land Rover service parts.

## POISONOUS SUBSTANCES

Many liquids and other substances used in motor vehicles are poisonous and should under no circumstances be consumed and should as far as possible be kept away from open wounds. These substances among others include antifreeze, brake fluid, fuel, windscreen washer additives, lubricants and various adhesives.

## FUEL HANDLING PRECAUTIONS

The following information provides basic precautions which must be observed if petrol (gasoline) is to be handled safely. It also outlines the other areas of risk which must not be ignored.

This information is issued for basic guidance only, and in any case of doubt appropriate enquiries should be made of your local Fire Officer.

## GENERAL

Petrol/gasoline vapour is highly flammable and in confined spaces is also very explosive and toxic.

When petrol/gasoline evaporates it produces 150 times its own volume in vapour, which when diluted with air becomes a readily ignitable mixture. The vapour is heavier than air and will always fall to the lowest level. It can readily be distributed throughout a workshop by air current, consequently, even a small spillage of petrol/gasoline is potentially very dangerous.

Always have a fire extinguisher containing FOAM CO<sub>2</sub> GAS, or POWDER close at hand when handling or draining fuel, or when dismantling fuel systems and in areas where fuel containers are stored.

Always disconnect the vehicle battery BEFORE carrying out dismantling or draining work on a fuel system.

Whenever petrol/gasoline is being handled, drained or stored, or when fuel systems are being dismantled all forms of ignition must be extinguished or removed, any head-lamps used must be flameproof and kept clear of spillage.

**NO ONE SHOULD BE PERMITTED TO REPAIR COMPONENTS ASSOCIATED WITH PETROL/GASOLINE WITHOUT FIRST HAVING HAD SPECIALIST TRAINING.**

## FUEL TANK DRAINING

**WARNING: PETROL/GASOLINE MUST NOT BE EXTRACTED OR DRAINED FROM ANY VEHICLE WHILST IT IS STANDING OVER A PIT.**

Draining or extracting petrol/gasoline from vehicle fuel tank must be carried out in a well ventilated area.

The receptacle used to contain the petrol/gasoline must be more than adequate for the full amount of fuel to be extracted or drained. The receptacle should be clearly marked with its contents, and placed in a safe storage area which meets the requirements of local authority regulations.

**WHEN PETROL/GASOLINE HAS BEEN EXTRACTED OR DRAINED FROM A FUEL TANK THE PRECAUTIONS GOVERNING NAKED LIGHTS AND IGNITION SOURCES SHOULD BE MAINTAINED.**

## FUEL TANK REMOVAL

On vehicles where the fuel line is secured to the fuel tank outlet by a spring steel clip, it is recommended that such clips are released before the fuel line is disconnected or the fuel tank unit is removed. This procedure will avoid the possibility of residual petrol fumes in the fuel tank being ignited when the clips are released.

As an added precaution fuel tanks should have a PETROL/GASOLINE VAPOUR warning label attached to them as soon as they are removed from the vehicle.

## FUEL TANK REPAIR

Under no circumstances should a repair to any tank involving heat treatment be carried out without first rendering the tank SAFE, by using one of the following methods:

**STEAMING:** With the filler cap and tank unit removed, empty the tank. Steam the tank for at least two hours with low pressure steam. Position the tank so that condensation can drain away freely, ensuring that any sediment and sludge not volatilised by the steam, is washed out during the steaming process.

**BOILING:** With the filler cap and tank unit removed, empty the tank. Immerse the tank completely in boiling water containing an effective alkaline degreasing agent or a detergent, with the water filling and also surrounding the tank for at least two hours.

After steaming or boiling a signed and dated label to this effect should be attached to the tank.

## SPECIFICATION

Purchasers are advised that the specification details set out in this Manual apply to a range of vehicles and not to any one. For the specification of a particular vehicle, purchasers should consult their Distributor or Dealer.

The Manufacturers reserve the right to vary their specifications with or without notice, and at such times and in such manner as they think fit. Major as well as minor changes may be involved in accordance with the Manufacturer's policy of constant product improvement.

Whilst every effort is made to ensure the accuracy of the particulars contained in this Manual, neither the Manufacturer nor the Distributor or Dealer, by whom this Manual is supplied, shall in any circumstances be held liable for any inaccuracy or the consequences thereof.

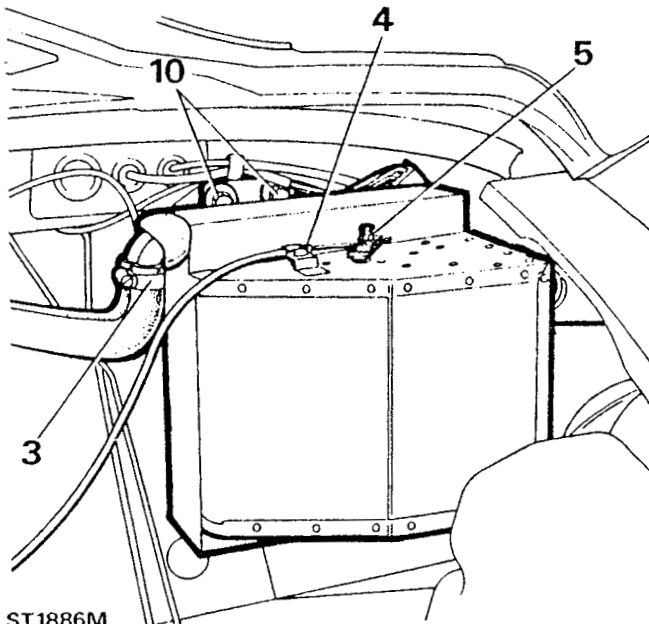
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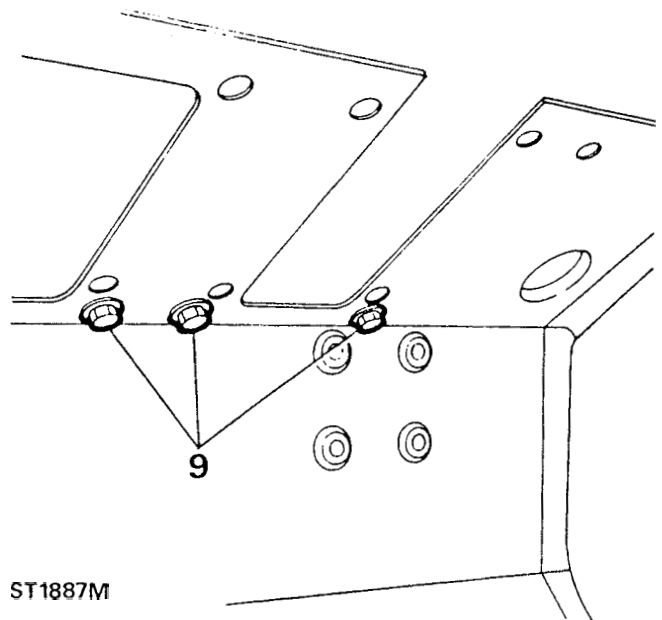
**REMOVE FROM VEHICLE**

1. Remove bonnet and disconnect battery.
2. Remove radiator bottom hose at radiator union and drain cooling system.
3. Slacken and remove the heater hoses at heater box unions.
4. Remove outer cable securing clips.
5. Slacken and remove control cables at the heater box.
6. Remove heater wiring harness securing loop.
7. Disconnect harness multi-plug.
8. Remove interior bulkhead trim.



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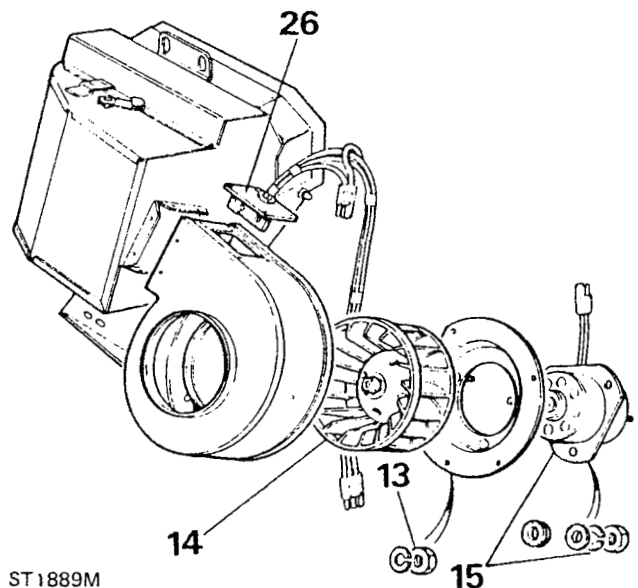
9. Remove lower nuts and bolts securing the heater unit to the bulkhead.
10. Slacken heater unit upper retaining bolts.
11. Manoeuvre heater unit clear of engine bay.



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**OVERHAUL****Fan Motor Assembly**

12. Remove the nuts securing the angled bracket to the heater unit, and remove the bracket.
13. Remove the five nuts securing the fan assembly to the heater unit. Unplug the connector and remove the fan assembly from the heater unit.
14. Remove circlip holding the impeller to the drive shaft and remove the impeller.
15. Remove the three nuts securing the fan motor to the mounting plate and release the motor from the plate.

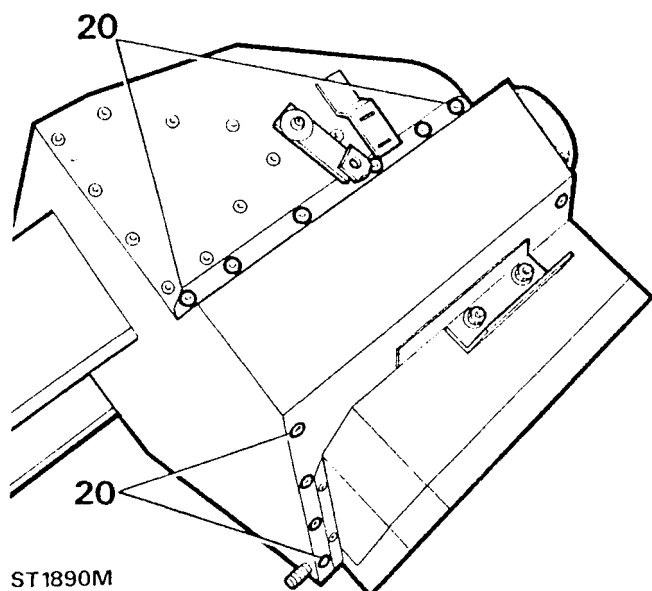


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16. Fit fan motor into mounting plate, apply Rostik 1261 adhesive to mating faces, and secure with the three nuts.
17. Refit impeller to fan drive shaft and fit circlip.
18. Refit fan assembly to casing and secure with the five nuts.
19. Plug in connector to resistor harness and refit angled bracket.

#### Heater Matrix

20. Drill out rivets holding the air duct and top cover to the casing. (Three of the rivets are concealed by the rubber seal).



ST1890M

21. Lift off cover, air duct and seal.
22. Lift heater matrix out of casing.
23. Fit foam rubber to heater matrix casing and position matrix in casing.
24. Check that flap valves operate correctly and without sticking.
25. Refit top cover and rivet into place.

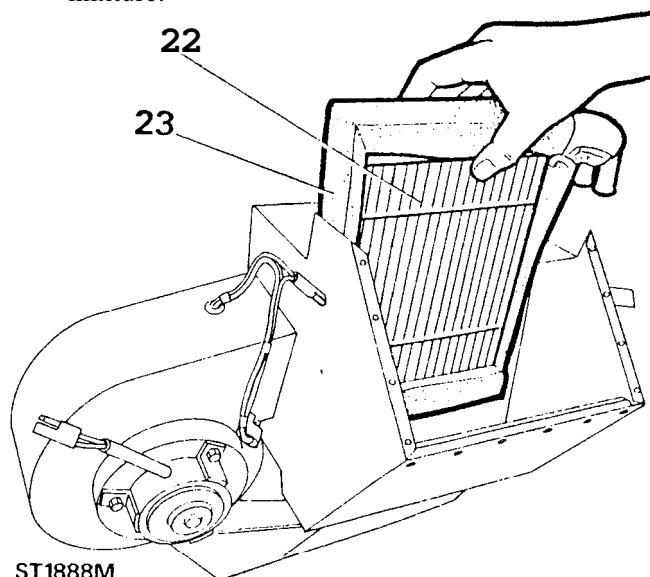
#### Resistor Unit

26. Drill out the four rivets retaining the resistor mounting plate, and lift out plate with resistor.
27. Apply Bostik adhesive to resistor plate and secure in position with rivets.

#### REFIT TO VEHICLE

28. Smear heater unit sealing rubber with a suitable impact adhesive, and locate to heater.
29. Place heater unit into engine bay and manoeuvre into position on bulkhead.
30. Loosely fit lower heater unit nuts and bolts.
31. Tighten heater unit upper securing bolts.
32. Tighten lower nuts and bolts.
33. Refit interior bulkhead trim.
34. Locate heater wiring harness into securing loop, and tighten nut.

35. Connect harness multi-plug.
36. Refit control cable outer clip and inner cable pinch bolts.
37. If necessary, prime heater matrix with coolant mixture.



ST1888M

38. Connect hoses to heater unit and tighten hose clips.
39. Refit radiator bottom hose and refill cooling system with the required anti-freeze concentration or corrosion inhibitor.
40. Refit bonnet.
41. Connect battery, start engine, and check for leaks.
42. After engine has cooled check coolant level in the expansion tank and radiator. Top up if necessary.



## General Service Information

### INTRODUCTION

Before any component of the air conditioning system is removed, the system must be depressurised. When the component is replaced, the system must be evacuated to remove all traces of old refrigerant and moisture. Then the system must be recharged with new refrigerant.

Any service operation that requires the loosening of a refrigerant line connection should be performed only by qualified service personnel. Refrigerant and/or oil will escape whenever a hose or pipe is disconnected.

All work involving the handling of refrigerant requires special equipment, a knowledge of its proper use and attention to safety measures.

### Servicing equipment

The following equipment is required for full servicing of the air conditioning system.

Charging trolley  
Leak detector  
Tachometer  
Safety goggles  
Refrigerant charging line gaskets  
Thermometer  $-20^{\circ}\text{C}$  to  $-60^{\circ}\text{C}$   
Valve Core Removers

### SERVICING MATERIALS

Refrigerant: Refrigerant 2, which includes Freon 2 or Arcton 2.

**CAUTION: Methychloride refrigerants must not be used.**

Nominal charge weight: 1,25 kg (2.75 lbs).

Compressor oil: *See* Recommended Lubricants.

### PRECAUTIONS IN HANDLING REFRIGERANT

The refrigerant used in the air conditioning system is Refrigerant 2, and is transparent and colourless in both the gaseous and liquid state. It has a boiling point of  $-29.8^{\circ}\text{C}$  ( $-21.7^{\circ}\text{F}$ ) at atmospheric pressure and at all normal pressures and temperatures it becomes a vapour. The vapour is heavier than air, non-flammable, and non-explosive. It is non-poisonous except when in contact with an open flame, and non-corrosive until it comes in contact with water.

The following precautions in handling Refrigerant 12 should be observed at all times.

- DO NOT** — leave refrigerant drum without its heavy cap fitted.  
— carry refrigerant drum inside a vehicle.  
— subject refrigerant drums to high temperature.  
— weld or steam clean near an air conditioning system.  
— expose eyes to liquid refrigerant, ALWAYS wear goggles.  
— discharge refrigerant vapour into an area with an exposed flame or into an engine intake. Heavy concentrations of refrigerant in contact with naked flame produces a toxic gas.  
— allow liquid refrigerant to contact bright metal, it will tarnish metal and chrome surfaces, and combined with moisture can seriously corrode all metal surfaces.

### PRECAUTIONS IN HANDLING REFRIGERANT LINES

**WARNING: Always wear safety goggles when opening refrigerant connections.**

- When disconnecting any pipe or flexible connection the system must be discharged of all pressure. Proceed cautiously, regardless of gauge readings. Open connections slowly, keeping hands and face well clear, so that no injury occurs if there is liquid in the line. If pressure is noticed, allow it to bleed off slowly.
- Lines, flexible end connections and components must be capped immediately they are opened to prevent the entrance of moisture and dirt.
- Any dirt or grease on fittings must be wiped off with a clean alcohol dampened cloth. Do not use chlorinated solvents such as trichloroethylene. If dirt, grease or moisture cannot be removed from inside the pipes, they must be replaced with new pipes.
- All replacement components and flexible end connections are sealed, and should only be opened immediately prior to making the connection.
- Ensure the components are at room temperature before uncapping, to prevent condensation of moisture from the air that enters.
- Components must not remain uncapped for longer than fifteen minutes. In the event of delay, the caps must be replaced.
- Receiver/driers must never be left uncapped as they contain Silica Gel crystals which will absorb moisture from the atmosphere. A receiver/drier left uncapped must be replaced, and not used.
- The compressor shaft must not be rotated until the system is entirely assembled and contains a charge of refrigerant.

- (j) A new compressor contains an initial charge of 312,5 ml (11 UK fluid ozs) of oil when received, part of which is distributed throughout the system when it has been run. The compressor contains a holding charge of gas when received which should be retained until the hoses are connected.
- (k) The receiver/drier should be the last component connected to the system to ensure optimum dehydration and maximum moisture protection of the system.
- (l) All precautions must be taken to prevent damage to fittings and connections. Slight damage could cause a leak with the high pressures used in the system.
- (m) Always use two spanners of the correct size, one on each hexagon, when releasing and tightening refrigeration unions.
- (n) Joints and 'O' rings should be coated with refrigeration oil to aid correct seating. Fittings which are not lubricated with refrigerant oil are almost certain to leak.
- (o) All lines must be free of kinks. The efficiency of the system is reduced by a single kink or restriction.
- (p) Flexible hoses should not be bent to a radius less than ten times the diameter of the hoses.
- (q) Flexible connections should not be within 50 mm (2 ins) of the exhaust manifold.
- (r) Completed assemblies must be checked for refrigeration lines touching sheet metal panels. Any direct contact of lines and sheet transmits noise and must be eliminated.

## PERIODIC MAINTENANCE

Routine servicing apart from visual checks, is not necessary. The visual inspections are as follows:

### Condenser

With a hose pipe or air line, clean the face of the condenser to remove flies, leaves etc. Check the pipe connections for signs of oil leakage.

### Compressor

Check hose connections for signs of oil leakage. Check flexible hoses for swelling. Examine the compressor belt for tightness and condition. Checking the compressor oil level and topping-up is only necessary after charging the system or in the event of a malfunction of the system.

### Receiver/Drier

Examine the sight glass for bubbles with the system operating. Check connections for leakage.

### Evaporator

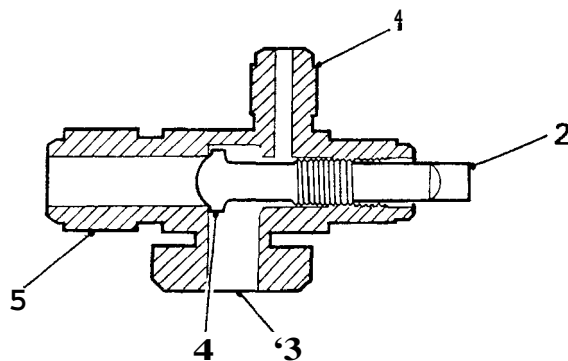
Examine the refrigeration connections at the unit. If the system should develop a fault, or if erratic operation is noticed, refer to the fault diagnosis chart.

### Service valves

There are two types of service valves in operation: 'Stem' and 'Schrader'. To identify where the different operations occur, stem type will be boxed.

#### Stem type

Stem type service valves allow for the isolation of the compressor from other parts of the system. When these valves are used in conjunction with the liquid line quick-disconnect fittings, the three major assemblies of the system can be removed from the vehicle with a minimal loss of refrigerant. In addition, it is possible to remove major assemblies for repair of components which are not part of the refrigeration system, or provide access to parts of the vehicle which are obstructed by the air conditioning system, without fully discharging the system. A thorough understanding of the stem type service valve is necessary before undertaking servicing or repair involving the air conditioning system.



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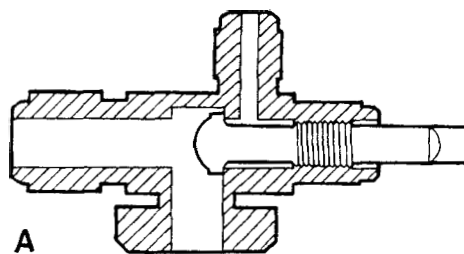
#### Stem type service valve

- 1 Serviceport
- 2 Valve stem
- 3 Compressor port
- 4 Valve seat
- 5 Hose connector

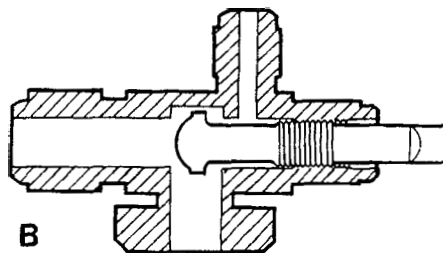
**NOTE:** A special wrench should be used to adjust the valve to prevent damage to the stem.

The stem type service valve has three positions, the operation of which is explained as follows.

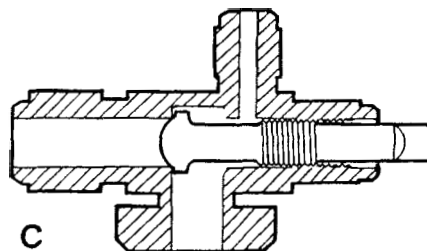
A. **ON: FULLY ANTICLOCKWISE** - Normal operating position, and the position which is used for connecting and disconnecting the manifold gauge set, is the on position. The stem is turned fully anticlockwise. This seals the service gauge port from receiving any refrigerant flow.



B. **MID (Test) POSITION** - After the service gauge manifold has been installed (the valve stem is in the on position), turn the valve stem the required number of turns clockwise. This will put the valve stem seat midway in the service valve and allow full system operation while permitting refrigerant pressure to reach the gauges.



C. **OFF: FULLY CLOCKWISE** - With the service valve stem turned fully clockwise, the valve will block passage of refrigerant flow through the system. As illustrated, the refrigerant flow to or from the compressor (depending on whether it is high side or low side) is blocked.



ST1386M

**WARNING:** NEVER operate the air conditioning system with the service valves in the OFF POSITION, it will cause severe damage to the compressor.

### Schrader Type

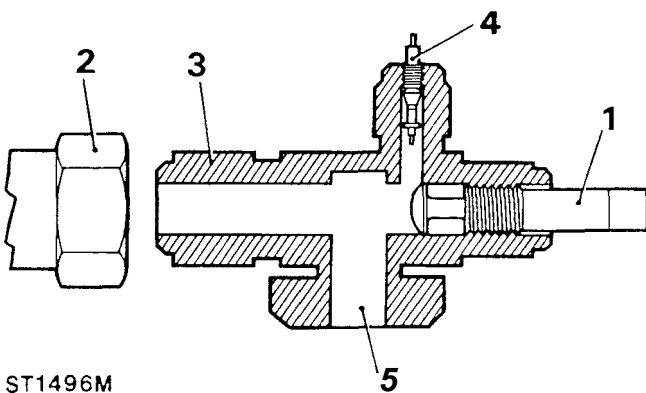
These are secured to the head of the compressor, and the suction and discharge flexible end connections are secured to them by unions.

The service valves are identified as suction or low pressure, and discharge or high pressure. Whilst they are identical in operation they are not interchangeable, as the connections are of different sizes.

The valve with the larger connections fits the suction side.

As the name suggests, these valves are for service purposes, providing connections to external pressure/vacuum gauges for test purposes. In combination with charging and testing equipment they are used to charge the system with refrigerant.

### Schrader service valve



ST1496M

1. Valve stem
2. Hose connection
3. Service valve
4. Schrader valve core
5. Compressor port

**NOTE:** A special wrench should be used to adjust the valve to prevent damage to the stem.

The Schrader type service valve has two positions, the operation of which is explained as follows.

**A. ON: FULLY ANTICLOCKWISE** - Normal operating position, and the position which is used for connecting and disconnecting the manifold gauge set, is the on position. The stem is turned fully anticlockwise. This seals the service gauge port from receiving an, refrigerant flow.

**B. OFF: FULLY CLOCKWISE** - With the service valve stem turned fully clockwise, the valve will block passage of refrigerant flow through the system. As illustrated, the refrigerant flow to or from the compressor (depending on whether it is high side or low side) is blocked.

**WARNING: NEVER operate the air conditioning system with the service valves in the OFF POSITION, it will cause severe damage to the compressor.**

### Valve Core Remover

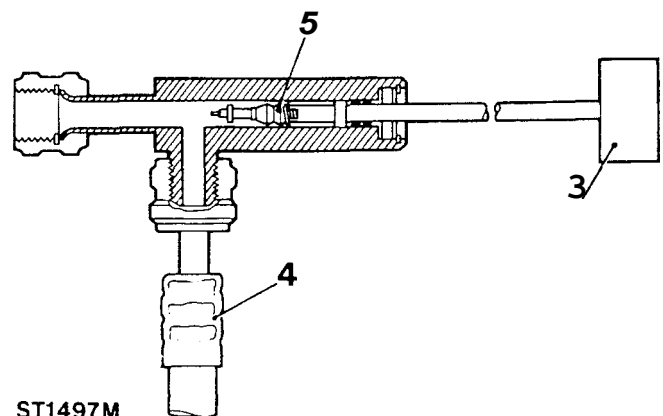
Where Schrader Valve depressors are not fitted to the Testing equipment lines Valve core removers can be used.

### Valve Core Removal

The use of valve core removers will facilitate servicing operations and should be used as follows:

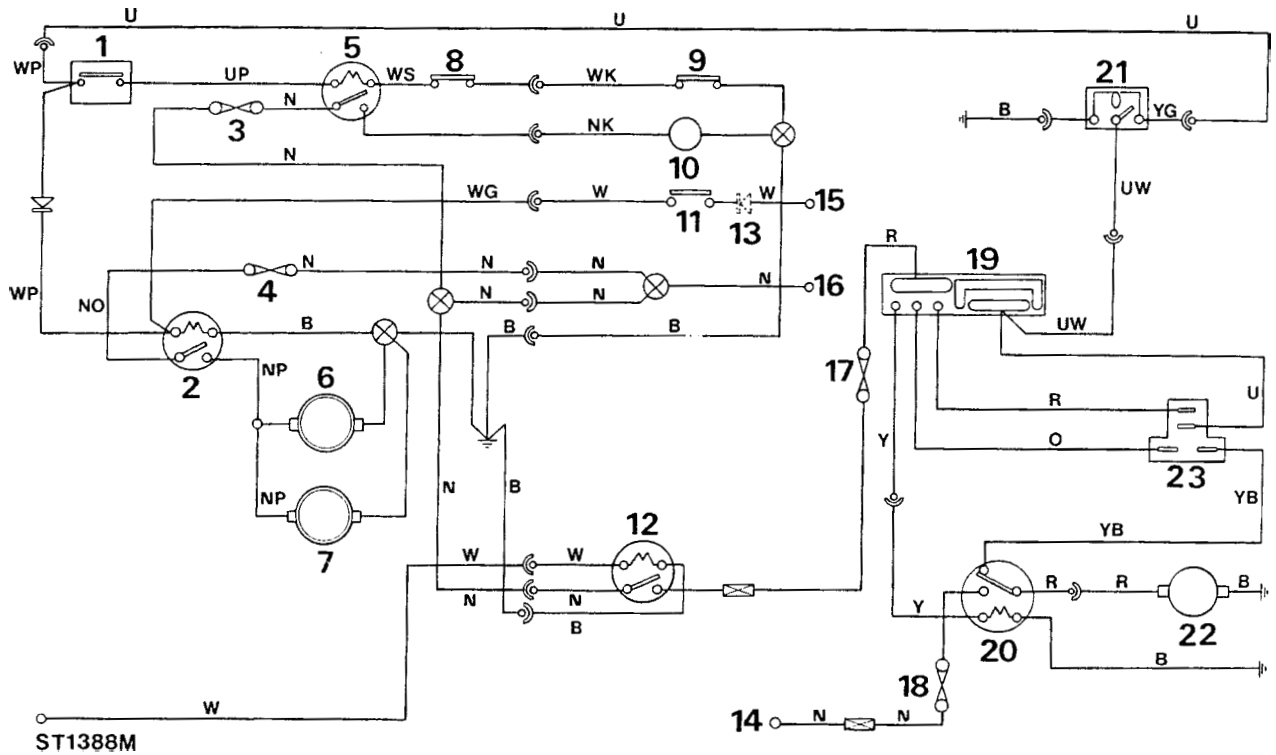
1. Close all valves on the charging trolley.
2. Remove the service valve cap and seals from the valve core remover.
3. Withdraw the plunger as far as possible and connect the core remover to the service valve.
4. Connect the hose to the core remover.
5. Depress the plunger until it contacts the valve core. Unscrew the valve until it is free. Withdraw the plunger to its full extent.

Service valve caps must be replaced when service operations are completed. Failure to replace caps could result in refrigerant loss and system failure.



ST1497M

ELECTRICAL CIRCUIT DIAGRAM



Key to Circuit Diagram

- 1. Thermostat
- 2. Condenser fan relay
- 3. 5 amp fuse
- 4. 17 amp fuse
- 5. Compressor clutch relay
- 6. L.H. fan
- 7. R.H. fan
- 8. High pressure switch
- 9. Compressor clutch temperature switch
- 10. Compressor clutch
- 11. Fan temperature switch
- 12. Blower fan relay
- 13. Diode — Diesel engines only
- 14. Termination point\*
- 15. Ignition feed pick-off point
- 16. Starter solenoid pick-off point
- 17. 30 amp fuse
- 18. 30 amp fuse
- 19. Fan speed selector switch
- Wiring U = 1st speed
- R = 2nd speed
- O = 3rd speed
- Y = 4th speed
- 20. Relay
- 21. Air conditioning on/off switch
- 22. Evaporator motor
- 23. Resistor block

**NOTE: R.H. steering models have only three fan speeds**

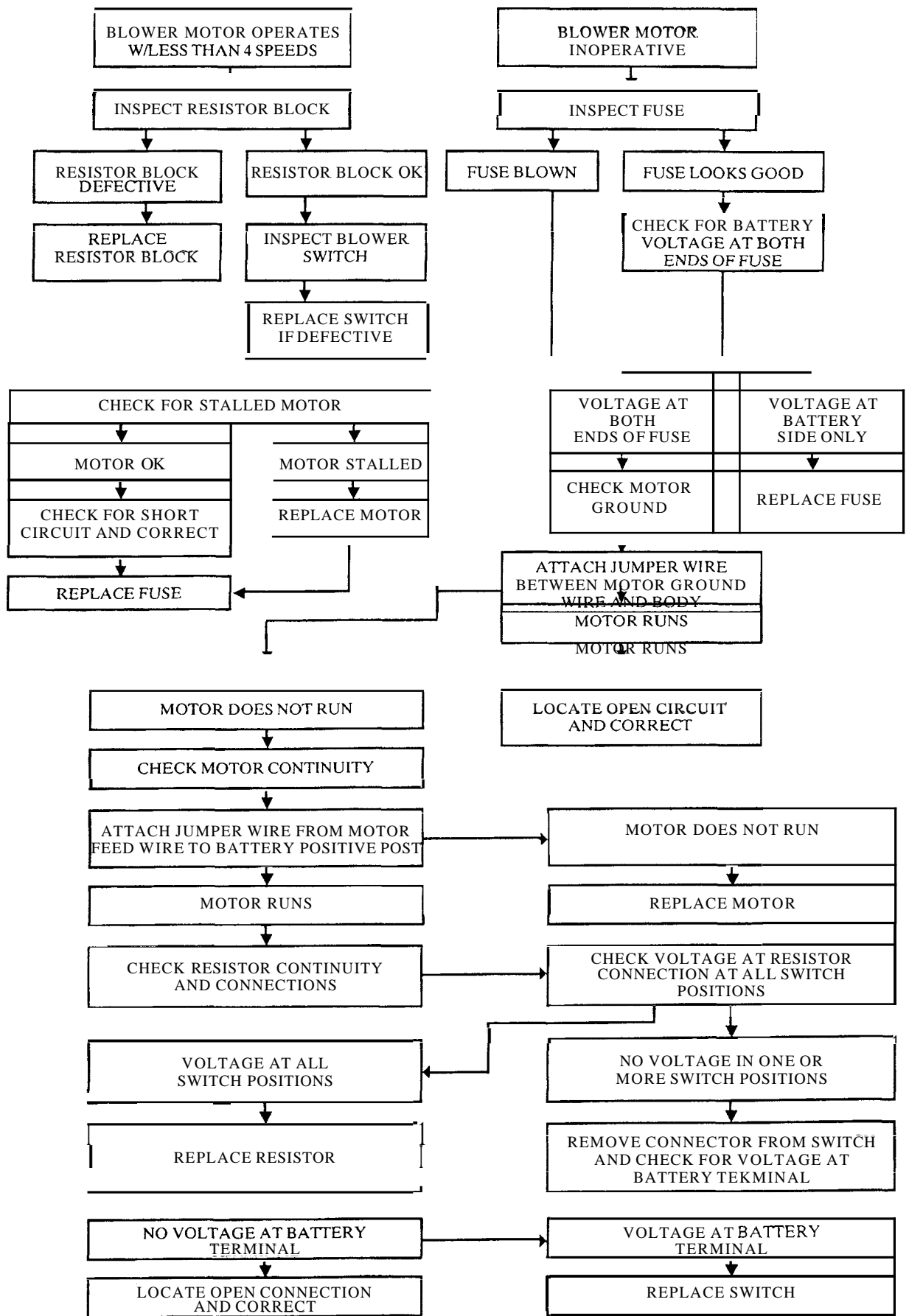
\* denotes: L.H. petrol, L.H./R.H. diesel models, termination at starter solenoid.  
 R.H. petrol models, termination via link lead to ignition switch.

Key to cable colours

B Black G Green K Pink L Light N Brown O Orange P Purple R Red S Slate U Blue W White Y Yellow

The last letter of a colour code denotes the tracer colour

**ELECTRICAL**  
**AIR CONDITIONER BLOWER MOTOR AND CONTROL SYSTEM DIAGNOSIS**



**Refrigeration System Fault Diagnosis**

For any refrigeration system to function properly all components must be in good working order. The unit cooling cycle and the relationship between air discharge temperature and ambient temperature and the pressures at the compressor can help to determine proper operation of the system.

The length of any cooling cycle is determined by such factors as ambient temperature and humidity, thermostat setting, compressor speed and air leakage into the cooled area, etc. With these factors constant, any sudden increase in the length of the cooling cycle would be indicative of abnormal operation of the air conditioner.

The low and high side pressures at the compressor will vary with changing ambient temperature, humidity, cab temperature and altitude.

The following conditions should be checked after operating the system for several minutes:

1. All high side lines and components should be warm to the touch.
2. All low side lines should be cool to the touch.
3. Inlet and outlet temperatures at the receiver/drier should be at the same temperature (warm). Any very noticeable temperature difference indicates a blocked receiver/drier.
4. Heavy frost on the inlet to the expansion valve may indicate a defective valve or moisture in the system.
5. With ambient humidity between 30% and 60%, compressor pressures and evaporator air discharge temperature should fall within the general limits given in the table below.

Type of Weather	Evaporator Air Temp °F (°C)	Low Side Pressure lb/in <sup>2</sup> (Kg/cm <sup>2</sup> )	High Side Pressure lb/in <sup>2</sup> (Kg/cm <sup>2</sup> )
Cool Day 70°F-80°F (21-27°C)	35-45°F (1.7-7.2°C)	15-20 (1.1-1.4)	160-200 (11.2-14)
Warm Day 80°F-90°F (27-32°C)	40-50°F (4.4-10°C)	20-25 (1.4-1.8)	190-240 (13.4-16.9)
Over 90°F (Over 32°C)	45-60°F (7.2-15.6°C)	25-30 (1.8-2.1)	220-270 (15.5-19)

**NOTE:**

1. Low and high side pressures are guides not specific limits.
2. Evap. air temperatures will be lower on dry days, higher on humid days.

FAULT	CAUSE	REMEDY
A. HIGH HEAD PRESSURE	<ol style="list-style-type: none"> <li>1. Overcharge of refrigerant.</li> <li>2. Air in system.</li> <li>3. Condenser air passage clogged with dirt or other foreign matter.</li> <li>4. Condenser fan motor defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Purge with bleed hose until bubbles start to appear in sight glass; then, add sufficient refrigerant gas to clear sight glass.</li> <li>2. Slowly blow charge to atmosphere. Install new drier; evacuate and charge system.</li> <li>3. Clean condenser of debris.</li> <li>4. Replace motor.</li> </ol>
B. LOW HEAD PRESSURE	<ol style="list-style-type: none"> <li>1. Undercharge of refrigerant; evident by bubbles in sight glass while system is operating.</li> <li>2. Split compressor gasket or leaking valves</li> <li>3. Defective compressor</li> </ol>	<ol style="list-style-type: none"> <li>1. Evacuate and recharge the system. Check for leakage.</li> <li>2. Replace gasket and install new drier, evacuate, and charge the system.</li> <li>3. Replace compressor.</li> </ol>
C. HIGH SUCTION PRESSURE	<ol style="list-style-type: none"> <li>1. Slack compressor belt.</li> <li>2. Refrigerant flooding through evaporator into suction line; evident by ice on suction line and suction service valve.</li> <li>3. Expansion valve stuck open.</li> <li>4. Compressor suction valve strainer restricted.</li> <li>5. Leaking compressor valves, valve gaskets and/or service valves.</li> <li>6. Receiver/drier stopped; evident by temperature difference between input and output lines.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust belt tension.</li> <li>2. Check thermobulb. Bulb should be securely clamped to clean horizontal section of copper suction pipe.</li> <li>3. Replace expansion valve.</li> <li>4. Replace compressor.</li> <li>5. Replace valves and/or gaskets. Install new drier, evacuate, and charge the system.</li> <li>5. Install new drier, evacuate and charge the system.</li> </ol>
D. LOW SUCTION	<ol style="list-style-type: none"> <li>1. Expansion valve thermobulb not operating.</li> <li>2. Expansion valve sticking closed</li> <li>3. Moisture freezing in expansion valve orifice. Valve outlet tube will frost while inlet hose tube will have little or no frost. System operates</li> <li>4. Dust, paper scraps, or other debris restricting evaporator blower grille.</li> <li>5. Defective evaporator blower motor, wiring, or blower switch.</li> </ol>	<ol style="list-style-type: none"> <li>1. Warm thermobulb with hand. Suction should rise rapidly to 20 lbs. or more. If not, replace expansion-valve.</li> <li>2. Check inlet side screen. Clean if clogged. Refer to C-2 and C-3.</li> <li>3. Install new drier, evacuate and charge the system. periodically.</li> <li>4. Clean grilles as required.</li> <li>5. Refer to Fault Diagnosis for Electrical System.</li> </ol>
E. NOISY EXPANSION VALVE (steady hissing)	<ol style="list-style-type: none"> <li>1. Low refrigerant charge; evident by bubbles in sight glass.</li> </ol>	<ol style="list-style-type: none"> <li>1. Leak test. Repair or replace components as required.</li> </ol>
F. INSUFFICIENT COOLING	<ol style="list-style-type: none"> <li>1. Expansion valve not operating properly.</li> <li>2. Low refrigerant charge; evident by bubbles in sight glass.</li> <li>1. Compressor not pumping.</li> </ol>	<ol style="list-style-type: none"> <li>1. Refer to C-2, C-3, D-2, D-3 and E.</li> <li>1. Refer to B-1 and E.</li> <li>1. Refer to B-2 and B-3</li> </ol>
G. COMPRESSOR BELT	<ol style="list-style-type: none"> <li>1. Belt tension</li> <li>2. Excessive head pressure.</li> <li>3. Incorrect alignment of pulleys or worn belt not riding properly.</li> <li>4. Nicked or broken pulley.</li> <li>1. Frozen compressor.</li> </ol>	<ol style="list-style-type: none"> <li>1. With tension gauge adjust to 100 lbs. (45 kg); or tighten until depression of about ½ inch (1.25 cm) occurs across longest span.</li> <li>2. Refer to A-1 through A-4 and C-6.</li> <li>1. Repair as needed.</li> <li>1. Replace pulley.</li> <li>1. Replace compressor.</li> </ol>
H. ENGINE NOISE AND/OR VIBRATION	<ol style="list-style-type: none"> <li>1. Loose or missing mounting bolts.</li> <li>2. Broken mounting bracket, idler bracket, or brace.</li> <li>1. Loose flywheel or clutch retaining bolt.</li> <li>2. Rough idler pulley bearing.</li> <li>3. Bent, loose, or improperly mounted engine drive pulley.</li> <li>1. Incorrect installation of clutch bearing seal.</li> <li>2. Insecure mountings of accessories: generator, power steering, air filter, etc.</li> <li>2. Excessive head pressure.</li> <li>2. Incorrect compressor oil.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair as necessary.</li> <li>2. Replace defective part.</li> <li>1. Repair as necessary.</li> <li>1. Replace bearing.</li> <li>1. Repair as necessary.</li> <li>1. Replace bearing.</li> <li>1. Repair as necessary</li> <li>1. Refer to A-1, A-2, A-3, A-4 and C-6.</li> <li>1. Refer to Compressor Oil Level Check.</li> </ol>



COMPRESSOR AND CLUTCH DIAGNOSIS

COMPRESSOR CLUTCH WILL NOT ENGAGE

NO VOLTAGE AT CLUTCH

OPEN FUSE

PUSH-BUTTON SWITCH DEFECTIVE

FAULTY WIRING

POOR CLUTCH GROUND

CYCLING CLUTCH SWITCH

IF CONTACT OPEN  
REPLACE SWITCH

VOLTAGE AT CLUTCH LOW

OPEN CLUTCH COIL

REPLACE COIL

COMPRESSOR WILL NOT TURN PROPERLY  
CLUTCH ENGAGES BUT SLIPS OR SMOKES

CLUTCH-SLIPPING

LOW VOLTAGE AT CLUTCH

CLUTCH COIL PARTIALLY SHORTED

REPLACE CLUTCH COIL  
REPLACE CLUTCH COIL

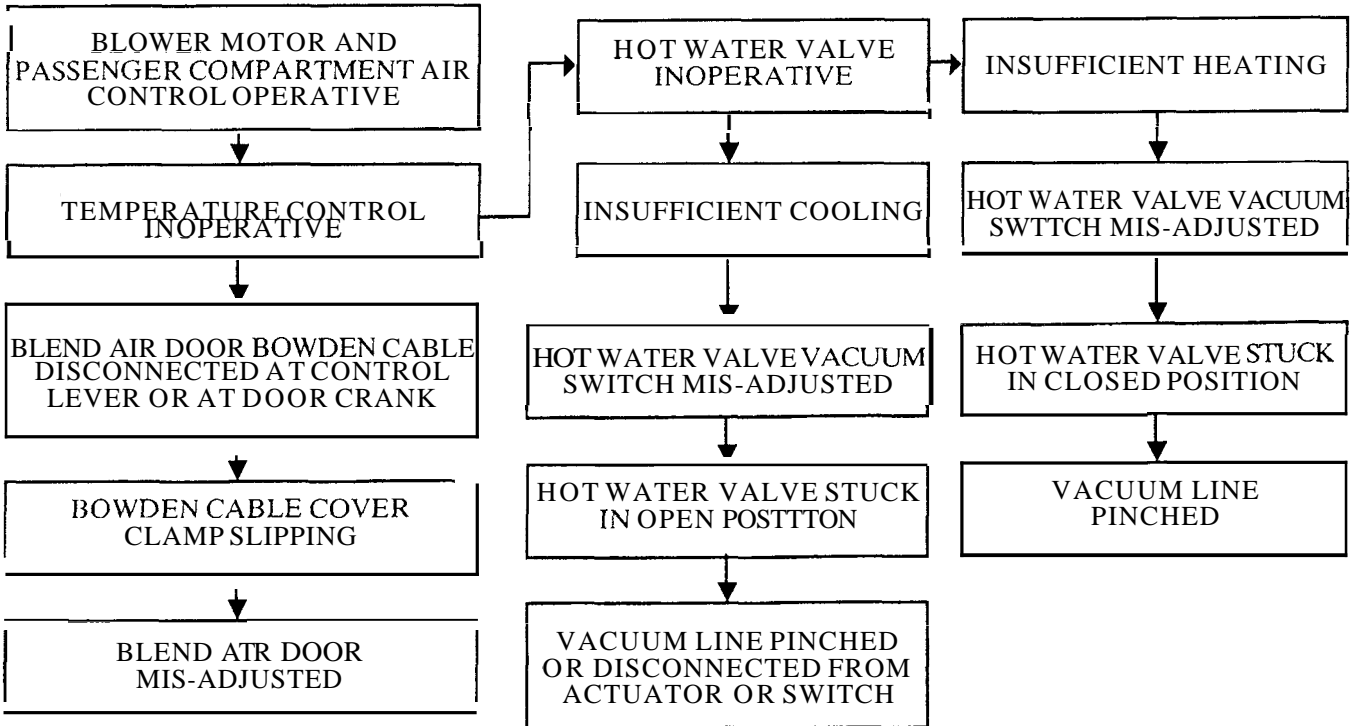
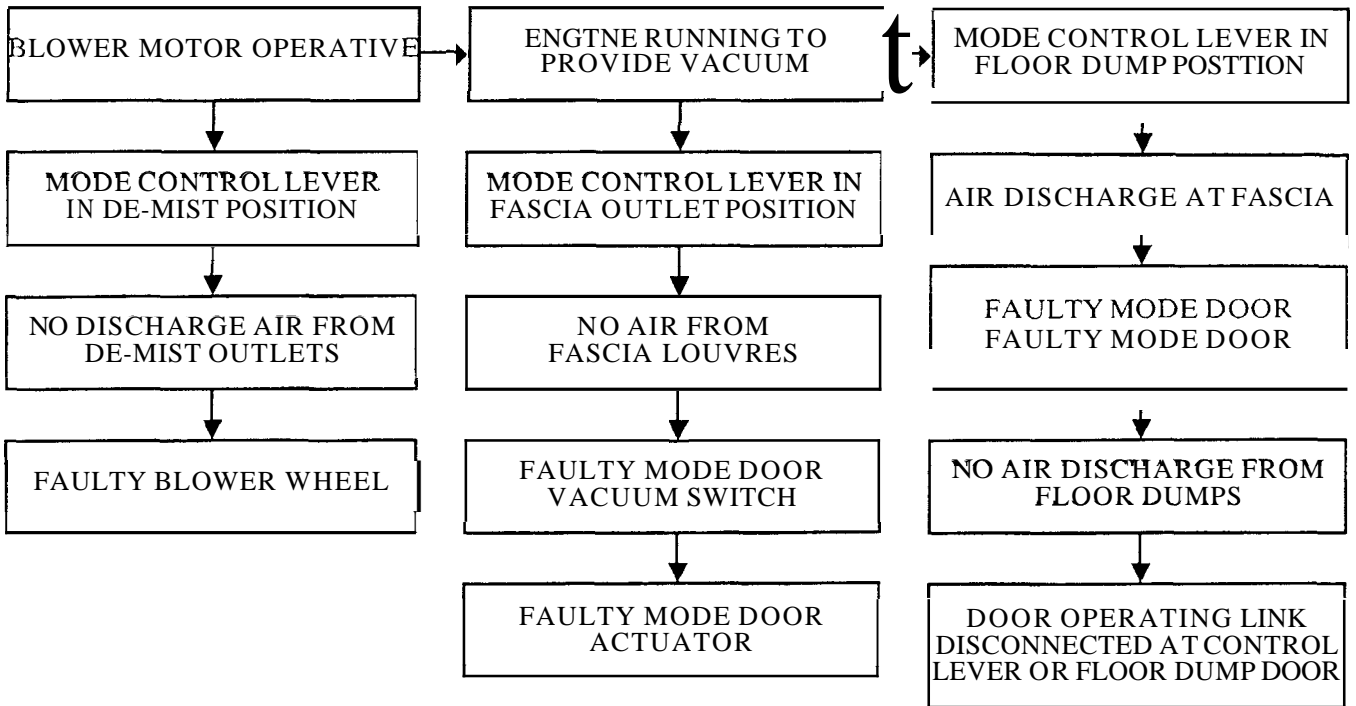
SEIZED COMPRESSOR

REPLACE COMPRESSOR AND  
CLUTCH ASSEMBLY

BELTS SLIPPING

ADJUST BELT TO PROPER TENSION

MECHANICAL  
AIR CONDITIONER BLOWER MOTOR AND CONTROL SYSTEM DIAGNOSIS



CHARGING AND TESTING EQUIPMENT

Connecting the gauge set

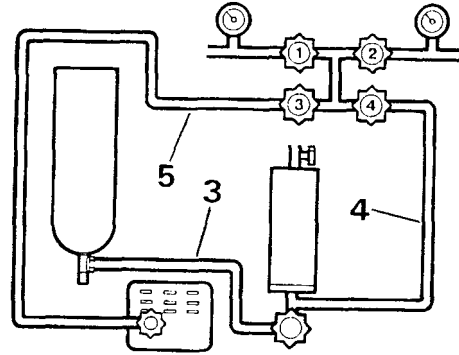
NOTE 1: There are two methods of connecting the charging and testing equipment, depending on the operation to be carried out. The method described for 'evacuating or charging with liquid refrigerant' also applies to 'pressure test' and 'compressor oil level check' operations.

NOTE 2: Various types of charge and test equipment are available depending upon the manufacturer chosen by the user. The equipment illustrated may differ slightly in layout to that possessed by the user, however, it is recommended that the user adheres to the appropriate manufacturer's instructions for the charge and test equipment used in their workshop.

-NOTE: The boxed instructions in the following procedure refer to compressors with STEM type valves. All other instructions refer to SCHRADER type valves.

Fitting

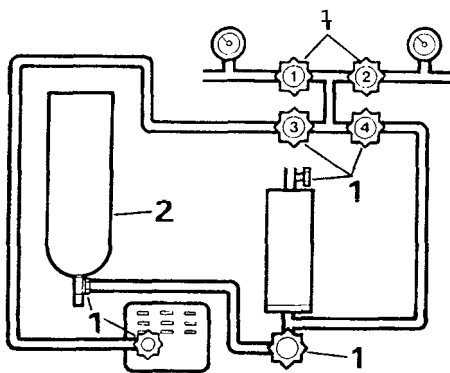
1. Ensure that all the valves on the charging and testing equipment are closed. Control valves on the particular equipment selected are numbered 1 to 4 as illustrated. The sequence may vary on other proprietary equipment.
2. Mount a 11,3 kg (25 lb) drum of refrigerant upside down on the support at the rear of the charging equipment, and secure with the strap.



ST 1393M

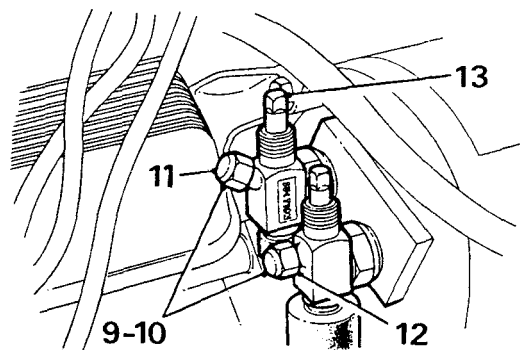
6. Place the vehicle in a ventilated area away from open flames and heat sources. Stop the engine, open and secure the bonnet.
7. Check that both service valves are fully open (turned anti-clockwise).
8. Put on the safety goggles.
9. Remove the caps from the gauge connections on the service ports.
10. Coat the threads and flares with refrigerant oil.
11. Connect the low pressure charging line (blue) from valve No. 1 to the compressor suction service port.
12. Connect the high pressure charging line (red) from valve No. 2 to the compressor discharge service port.

13. Using the service wrench, turn the suction service valve stem 'clockwise' counting the number of turns necessary to close the valve.



ST 1392M

3. Connect the hose from the bottom of the charging cylinder to the refrigerant drum valve.
4. Connect the hose between the bottom of the charging cylinder and the refrigerant control valve (No. 4).
5. Connect the hose between the vacuum pump valve and the vacuum control valve (No. 3).



ST1412M

14. After the valve is fully closed, turn the stem out (anti-clockwise) half the number of turns counted, this should position the valve seat in the mid (test) position.

15. Turn the stem on the discharge valve clockwise until the pressure rises on the discharge pressure gauge. If the system is to be evacuated, the discharge service valve seat must be in the mid (test) position.

16. The charging and testing equipment is now connected and ready for proceeding with the required operation.

#### Removing

17. If the engine has been operated, it must be stopped prior to disconnecting the charging and testing equipment.
18. Close both service ports (turn fully anti-clockwise) until fully closed.
19. Close all valves on the charging and testing equipment.
20. Disconnect the charging lines from the service ports.
21. Refit the blanking caps to the compressor valve stems and service ports, and to the charging lines.
22. Close the bonnet.

### AIR CONDITIONING SYSTEM OPERATIONS

#### Depressurising

NOTE: The air conditioning refrigeration system contains 'Refrigerant 12' under pressure, and before any component is disconnected or removed, the system **must** be discharged of all pressure.

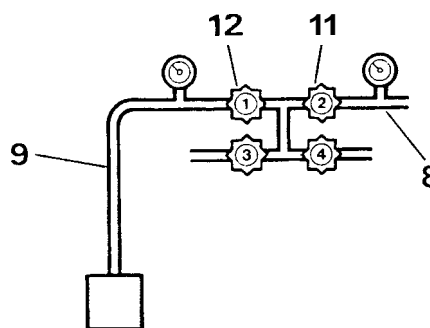
Refrigerant **12** evaporates so rapidly at normal atmospheric pressures and temperatures that it tends to freeze anything it contacts. Extreme care must be taken to prevent any liquid refrigerant from contacting the skin and especially the eyes. Should any liquid refrigerant get into the eyes, use a few drops of sterile mineral oil to wash them out and then wash the eyes with a weak solution of boric acid. Seek medical attention immediately even though the initial irritation has ceased after first aid treatment. Always wear safety goggles when opening refrigerant connections.

WARNING: Open connections slowly, keeping the

1. Place the vehicle in a ventilated area away from open flames and heat sources.
2. Stop the engine.
3. Open and secure the bonnet.
4. Remove the caps from the compressor service ports.
5. Check that both compressor service valves are fully opened (turned anti-clockwise).
6. Close all valves on the charging and testing equipment.
7. Put on safety goggles.
8. Connect the high pressure charging line (red) from valve No. 2 to the compressor discharge service port.
9. Run the (blue) hose to an open tapped container of approximately one litre capacity. Attach the hose to the container so that it will not blow out of the container. The purpose of the container is to collect any oil carried by the refrigerant.

10. Open the compressor discharge service port a quarter of a turn.

11. Open valve No. 2 fully.
12. Slowly open the valve No. 1 one turn to allow the refrigerant to escape, if necessary, adjust the refrigerant flow so that the oil captured in the container is not blown out of the container.

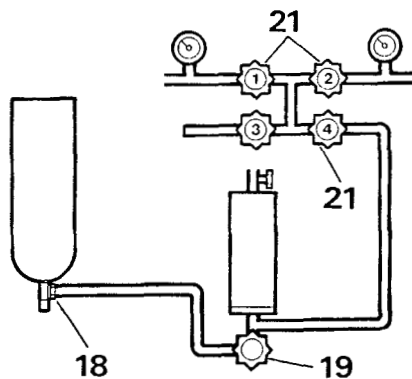


ST 1413M

13. Measure the amount of oil discharged from the system so that an equal amount of new oil can be returned to the system during the charging operation. Discard the old oil.
  14. When the gauge pressure is below 50 psi, slowly open the valve No. 1 to maintain refrigerant flow.
  15. When the pressure has been reduced, and the system has been completely discharged, close the valves Nos. 1 and 2 on the charging and testing equipment.
16. Close the compressor discharge service port (turn anti-clockwise).

**NOTE:** If it is necessary to disconnect the compressor hoses, the compressor should be sealed by fully closing the relevant service valve (turn fully clockwise). It is essential to ensure that both service valves are open before operating the compressor. Similarly any other component of the refrigeration system should be capped immediately when disconnected.

18. Open the refrigeration drum valve.
19. Open the valve at the base of the charging cylinder and allow approximately 0,25 kg (0.5 lb) of refrigerant to enter the cylinder.
20. Close the refrigeration drum valve and the valve at the base of the charging cylinder.
21. Open the refrigerant control valve (valve No. 4) and flush out the high and low pressure lines by opening valves Nos. 1 and 2 momentarily until a white stream of refrigerant is observed.



ST 1414M

22. Close all valves on the charging and testing equipment, and fit the blanking caps.
23. The air conditioning system is now depressurised.

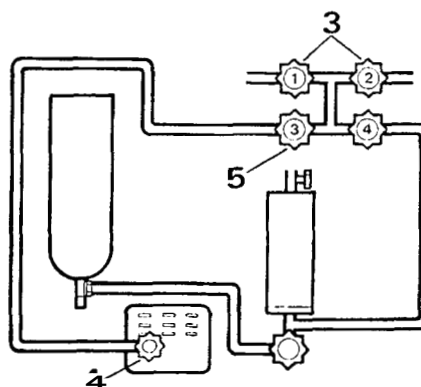
**Evacuating**

Whenever the system has been opened to the atmosphere it is necessary that the system be evacuated to remove all air and moisture. It is also an essential preliminary operation to charging the system with Refrigerant 12. The evacuate operation also provides a check for leaks due to faulty connections.

1. Depressurise the air conditioning system as previously described, then connect the gauge set as detailed under 'Charging and Testing Equipment'.

2. Adjust both service valve seats to the mid (Test) position.

3. Open the low and high pressure valves Nos. 1 and 2.
4. Start the vacuum pump and check that the vacuum pump valve is open.
5. Slowly open the vacuum control valve No. 3. If the vacuum is applied to the system too quickly, the residual oil may be drawn out.

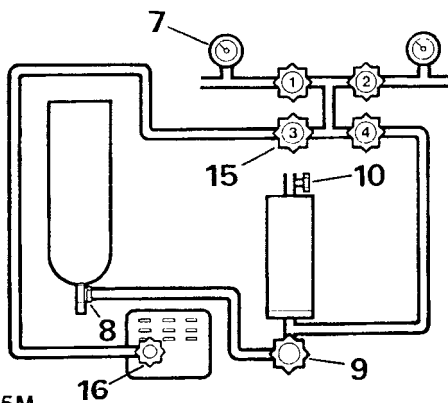


ST 1394M

6. In evacuating the system it is necessary to lower the pressure so that the boiling point of water in the system is lower than the surrounding air temperature. At an ambient temperature of 23.8°C (75°F), it is necessary to lower the system pressure to 29.5 in Hg vacuum to bring the boiling point of water to 22°C (72°F). Atmospheric pressure (and vacuum gauge readings) decrease as altitude increases by approximately 25 mm (1 in) Hg per 300 m (1000 ft). The following chart provides a guide to the various gauge readings at differing altitudes, for the same 10 mm (0.4 in) Hg absolute pressure.

Altitude, ft	m	Vacuum Reading in Hg	mm
0	0	29.5	750
1,000	300	28.5	725
2,000	600	27.4	695
3,000	900	26.4	670
4,000	1200	25.4	645
5,000	1500	24.5	622
6,000	1800	23.5	596
7,000	2100	22.6	574
8,000	2400	21.8	554
9,000	2700	20.9	530
10,000	3000	20.1	510

7. The low side gauge should indicate a vacuum of 660 mm (26 in) Hg within five minutes.
8. Whilst the system is evacuating, fill the charging cylinder by opening the refrigerant drum valve.
9. Open the valve at the base of the charging cylinder and fill the cylinder with 1,0 kg (2.2 lb) of refrigerant. Liquid refrigerant will be observed rising in the sight glass.
10. As the refrigerant stops filling the cylinder, open the valve at the top of the cylinder (behind the control panel) intermittently, to relieve the head pressure and allow the refrigerant to continue filling the cylinder.
11. When the refrigerant reaches the desired level in the sight glass, close both the valve at the base of the cylinder and the valve at the bottom of the refrigerant tank.
12. Ensure the top cylinder valve is fully closed. If bubbling is present in the sight glass, reopen the cylinder base valve momentarily to equalise the drum and cylinder pressures.
13. If 660 mm (26 in) Hg of vacuum is not achieved within five minutes, it signifies either the system has a leak or the vacuum pump is defective. Initially check the vacuum pump, if the pump proves to be functioning properly then investigate for a leak in the air conditioning system.
14. Close the vacuum control valve No. 3.
15. Stop the vacuum pump and allow the vacuum to hold for fifteen minutes, then check that there is no pressure rise (a loss of vacuum) evident on the compound gauge. Any pressure rise denotes a leak which must be rectified before proceeding further. Refer to the heading titled 'Leak Detection' later in this section.
16. With the system satisfactorily evacuated, the system is ready for charging with refrigerant.

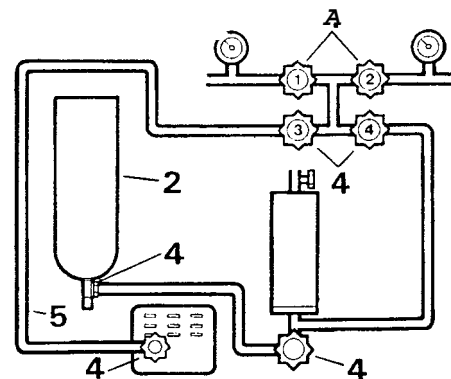


ST 1395M

### Sweeping

**NOTE: This operation is in addition to evacuating, and is to remove moisture from systems that have been open to atmosphere for a long period, or that are known to contain excessive moisture.**

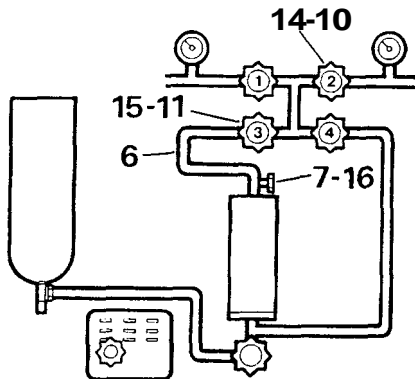
1. Fit a new liquid receiver/drier, as detailed under the heading "Receiver/Drier".
2. Ensure that a full drum of refrigerant is fitted on the charging and testing equipment.
3. Fit the charging and testing equipment as previously described for evacuating and evacuate the air conditioning system, allowing 0,25 to 0,45 kg ( $\frac{1}{2}$  to 1 lb) of refrigerant to enter the charging cylinder.
4. Close all valves on the charging and testing equipment.
5. Disconnect the intake hose from the vacuum pump.



ST 1396M

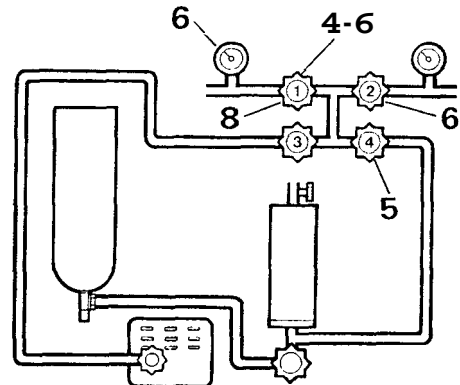
6. Connect the intake hose to the valve at the top of the charging cylinder.
7. Open the valve at the top of the charging cylinder.
8. Put on safety goggles,
9. Crack open the hose connection at valve No. 3 and allow some refrigerant to purge the hose, then close the connection.
10. Open the high pressure valve (No. 2).
11. Slowly open valve No. 3, which is now connected to the top valve of the charging cylinder, and allow gas to flow into the system until the reading on the compound gauge remains steady. Between 0,25 and 0,45 kg ( $\frac{1}{2}$  to 1 lb) of refrigerant will enter the system.
12. Allow the dry refrigerant introduced into the system to remain for 10 minutes.

13. Crack the suction valve charging line at the service port on the compressor to allow an escape of refrigerant, at the same time observing the sight glass in the charging cylinder. A slight drop in the level should be allowed before closing the connection at the compressor.
14. Close the high pressure valve (No. 2).
15. Close valve No. 3.
16. Close the valve at the top of the charging cylinder.



ST 1397M

6. If the full charge of 1,0 kg (2.2 lb) of liquid refrigerant will not enter the system, then close the high pressure valve (No. 2) and open the low pressure valve (No. 1), ensuring that the low pressure gauge does not exceed 40 psi.
7. Start and run the engine at 1,000-1,500 rev/min and allow refrigerant to be drawn through the low pressure valve (No. 1) until the full charge of 1,0 kg (2.2 lb) has been drawn into the system.
8. Close valve No. 1.



ST 1398M

17. Reconnect the charging and testing equipment, as described for evacuating and evacuate the air conditioning system.
18. Maintain the vacuum for twenty minutes. The air conditioning system is now ready for charging with refrigerant.

9. Check the air conditioning system is operating satisfactorily by carrying out a pressure test, as described later in the Section.

**CAUTION: Do not overcharge the air conditioning system as this will cause excessive head pressure.**

### Charging

**CAUTION: Do not charge liquid refrigerant into the compressor. Liquid cannot be compressed; and if liquid refrigerant enters the compressor inlet valve, severe damage is possible; in addition, the oil charge may be absorbed into the refrigerant, causing damage when the compressor is operated.**

1. Fit the charging and testing equipment as previously described for evacuating.
2. Evacuate the air conditioning system allowing 1,0 kg (2.2 lb) of refrigerant to enter the charging cylinder.
3. Put on safety goggles.
4. Close the low pressure valve (No. 1).
5. Open the refrigerant control valve (No. 4) and release liquid refrigerant into the system through the compressor discharge valve port (High pressure). The pressure in the system will eventually balance.

### Leak test

The following instructions refer to an electronic type refrigerant leak detector which is the safest, most sensitive and widely used.

1. Place the vehicle in a well ventilated area but free from draughts, as leakage from the system could be dissipated without detection.
2. Follow the instructions issued by the manufacturer of the particular leak detector being used. Certain detectors have visual and audible indicators.
3. Commence searching for leaks by passing the detector probe around all joints and components, particularly on the underside, as the refrigerant gas is heavier than air.
4. Insert the probe into an air outlet of the evaporator. Switch the air conditioning blower on and off at intervals of ten seconds. Any leaking refrigerant will be gathered in by the blower and detected.

5. Insert the probe between the magnetic clutch and compressor to check the shaft seal for leaks.
6. Check all service valve connections, valve plate, head and base plate joints and back seal plate.
7. Check the condenser for leaks at the pipe connections.
8. If any leaks are found, the system must be depressurised before attempting rectification. If repairs by brazing are necessary, the component must be removed from the vehicle and all traces of refrigerant expelled before heat is applied.
9. After repairs check the system for leaks and evacuate prior to charging.

**Pressure test**

1. Fit the charging and test equipment as previously described.
2. Start the engine.
3. Run the engine at 1,000 to 1,200 rev/min with the heat control set to cold (blue) zone, air distribution to the central position, recirculation control to recirculation and the air conditioning control 'ON' with fan speed to maximum.
4. Note the ambient air temperature control in the immediate test area in front of the vehicle, and check the high pressure gauge readings — discharge side — against table 1.

**Table I**

Ambient Temperature		Compound Gauge Readings		High Pressure Gauge Readings	
°C	°F	kgf/cm <sup>2</sup>	lbf/in <sup>2</sup>	kgf/cm <sup>2</sup>	lbf/in <sup>2</sup>
16	60	1,05-1,4	15-20	7,0-10,2	100-150
26,7	80	1,4-1,75	20-25	9,8-13,3	140-190
38	100	1,75-2,1	25-30	11,6-15,8	180-225
43,5	110	2,1-2,45	30-35	15,1-17,5	215-250

7. Close both service ports (turn fully anti-clockwise) and close all valves on the charging and test equipment. Disconnect the charging lines from the compressor. Refit the blanking caps to the compressor valve stems, port connections and charging lines.

8. Close the bonnet.

**Test**

1. Place the vehicle in a ventilated, shaded area free from excessive draught, with the doors and windows open.
2. Check that the surface of the condenser is not restricted with dirt, leaves, flies, etc. Do not neglect to check the surface between the condenser and the radiator. Clean as necessary.
3. Switch on the ignition and the air conditioner air flow control. Check that the blower is operating efficiently at low, medium and high speeds. Switch off the blower and the ignition.
4. Check that the evaporator condensate drains are open and clear.
5. Check the tension of the compressor driving belt, and adjust if necessary.
6. Inspect all connections for the presence of refrigerant oil. If oil is evident, check for leaks, and rectify as necessary.

**NOTE: The compressor oil is soluble in Refrigerant 12 and is deposited when the refrigerant evaporates from a leak.**

7. Start the engine.
8. Set the temperature control switch to maximum cooling and switch the air conditioner blower control on and off several times, checking that the magnetic clutch on the compressor engages and releases each time.
9. With the temperature control at maximum cooling and the blower control at high speed, warm up the engine and fast idle at 1,000 rev/min. Check the sight glass for bubbles or foam. The sight glass should be generally clear after five minutes running, occasional bubbles being acceptable. Continuous bubbles may appear in a serviceable system on a cool day, or if there is insufficient air flow over the condenser at a high ambient temperature.
10. Repeat at 1,800 rev/min.
11. Gradually increase the engine speed to the high range, and check the sight glass at intervals.
12. Check for frosting on the service valves and evaporator fins.
13. Check the high pressure pipes and connections by hand for varying temperature. Low temperature indicates a restriction or blockage at that point.
14. Switch off the air conditioning blower and stop the engine.
15. If the air conditioning equipment is still not satisfactory, proceed with the pressure test as previously described in this section.

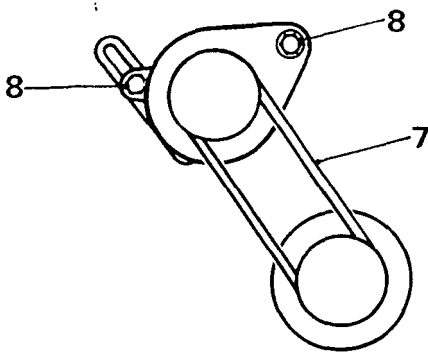


**COMPRESSOR****Removal**

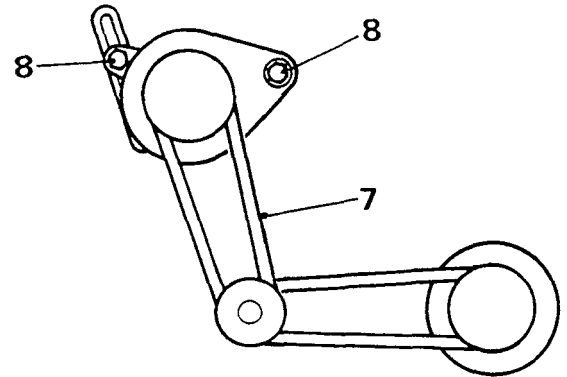
1. Place the vehicle in a ventilated area away from open flames and heat sources.
2. Stop the engine and secure the bonnet in an open position.
3. Remove the caps from the compressor service valves and connect the gauge set for evacuating.
4. Evacuate the system as previously described.
5. Open fully (turn anti-clockwise) the compressor service valves and disconnect the gauge set. Cap all pipe and valve connections to prevent dirt or moisture entering the system.
6. Remove the electrical connections to the compressor.

**4-cylinder Petrol only**

7. Slacken all the Compressor adjustment fixings and remove the drive belt from the compressor.
8. Remove the adjusting and pivot fixings and the compressor from retaining bracket.

**Diesel model**

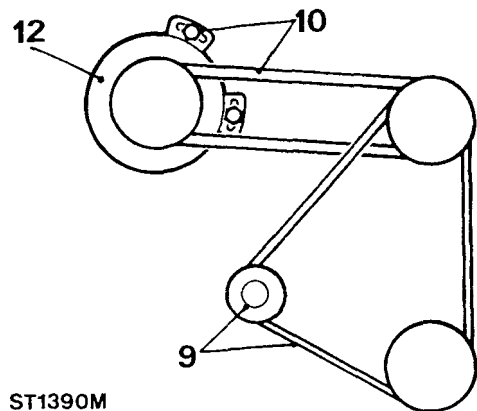
ST1418M

**Petrol model**

ST1419M

**V8 models only**

9. Release the jockey wheel adjuster to enable the front drive (fan) belt to be removed.
10. Release the tensioner on the compressor drive belt.
11. Remove the fixing bolt and swivel the compressor and bracket assembly to expose the bolt which is securing the bracket.
12. Remove the bolt and lift the compressor and bracket clear and place on a bench.
13. Whilst supporting the compressor, remove the five bolts holding the compressor to the brackets.



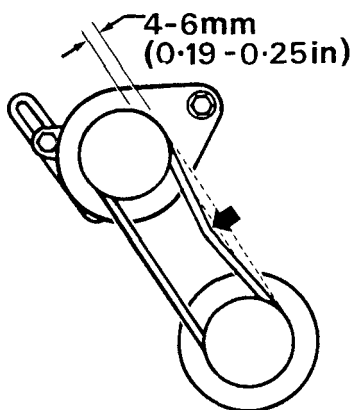
ST1390M

**All engines**

14. No servicing is recommended to the compressor, therefore a new unit must be fitted.
15. Reverse procedure as appropriate 13 to 9 and 6 to 3 for V8 models or 8 to 3 for 4-cylinder models noting the procedure for adjusting the compressor drive belts.

**Refitting****Drive belt adjustment****Diesel only**

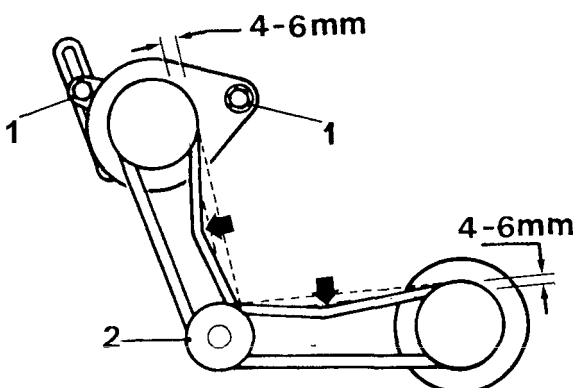
16. Ensure all adjustment bolts associated with the compressor are slack.
17. Alter the position of the compressor to provide a belt tension of 4-6 mm (0.19-0.25 in). Secure all compressor adjustment bolts and recheck the tension.



ST1408M

**4-cylinder Petrol only**

18. Ensure all adjustment bolts associated with the compressor (1) and the lower pulley pivot fixing (2) are slack.
19. Adjust the position of the lower pulley to give a belt tension of 4-6 mm (0.19-0.25 in).
20. Tighten the pivot bolt and recheck the tension.
21. Alter the position of the compressor to provide a belt tension of 4-6 mm (0.19-0.25 in).
22. Secure all compressor adjustment bolts and recheck the tension.

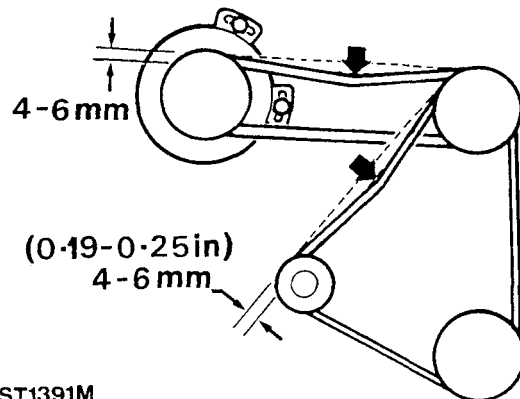


ST1409M

**V8 Petrol only**

23. Ensure all adjustment bolts associated with the compressor are slack.

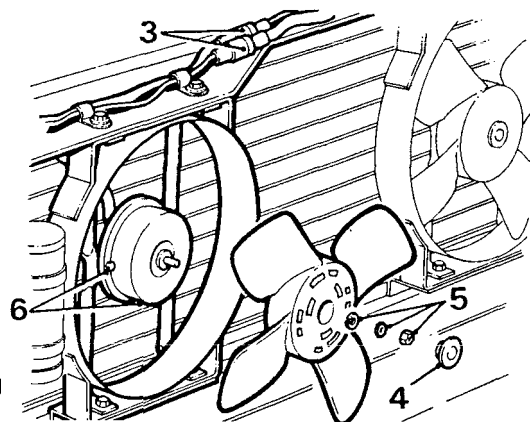
24. Alter the position of the compressor to provide a belt tension of 4-6 mm (0.19-0.25 in). Secure all compressor adjustment bolts and recheck the tension.
25. Ensure the jockey pulley adjustment bolts are slack.
26. Alter the position of the jockey pulley to give a belt tension of 4-6 mm (0.19-0.25 in). Secure the adjustment bolts and recheck tension.



ST1391M

**CONDENSER FAN MOTORS****Removal**

1. Open and secure the bonnet.
2. Release the six self tapping screws securing the front nose and grille assembly, lift clear.
3. Disconnect the electrical leads to the fans.
4. Remove the blanking caps from the fan centres.
5. Remove the 8 mm securing nuts, star and spring washers from the fan blade centres, pull blade from its respective fan motor shaft.
6. Release the two fan motor retaining bolts and remove the motor whilst feeding the fan motor through the appropriate aperture.



ST1401M

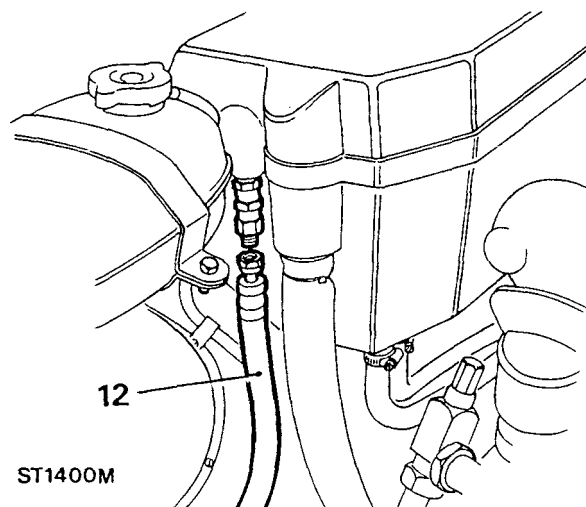
**Refitting**

7. Reverse procedures 6 to 1 ensuring the fan supply wiring is routed and securely clipped so that the wiring does not foul the fan blades.

## CONDENSER AND RECEIVER/DRIER

### Removal

1. Place the vehicle in a well ventilated area.
2. Stop the engine, open and secure the bonnet.
3. Remove the caps from the compressor service valves. Connect the gauge set for evacuation, and evacuate as detailed earlier.
4. Having evacuated the air conditioning system, open fully (turn anti-clockwise) the compressor service valves and disconnect the gauge set. Replace all caps to valve connections.
5. Release the four top and two side fixings securing the grille and nose assembly and remove.
6. Disconnect the wires at the rear of the horn, the air conditioning fan leads located across the top of the fan cowling frame and the electrical connector to the receiver/drier.
7. Release the four bolts and large packing washers securing the cowling to the wing sides.
8. Remove the four nuts securing the fan cowling to the bottom bracket and lift clear.
9. Remove the two bolts securing the bonnet striker support plate.



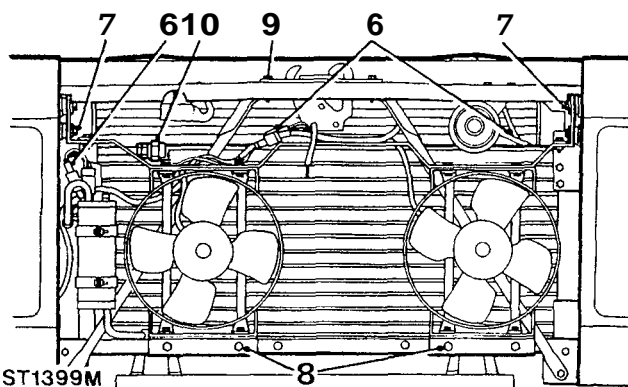
ST1400M

**NOTE: L.H. steering vehicle illustrated on R.H. steering vehicles the high pressure hose is on the side of the evaporator unit facing the engine.**

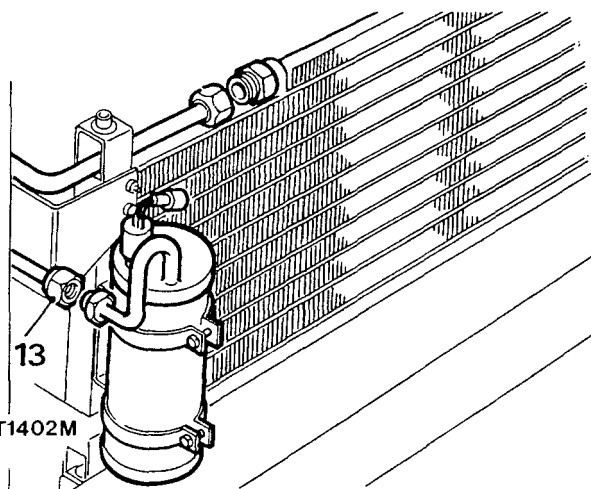
13. Release the high pressure pipe from the receiver/drier, cap the pipe end connections.

### Condenser removal only

10. Release the top air conditioning hose and cap the ends to prevent moisture and dirt entering the system.



ST1399M



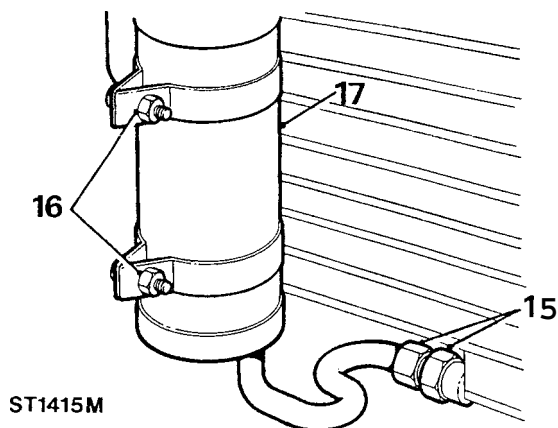
ST1402M

14. Release both air conditioning pipes from the condenser extension plate. Lift the condenser clear.

11. Lift the condenser from the bottom mounting lugs and carefully ease the condenser forwards as far as possible.
12. Release the high pressure air conditioning hose complete with the sight glass, at the evaporator connection. Cap the ends to prevent dirt or moisture entering the system.

### Receiver/drier removal

15. Whilst supporting with suitable spanners, unscrew the bottom union to the receiver/drier. Cap the pipe ends to prevent dirt or moisture entering the system.
16. Release the receiver/drier clamp bolts and allow the assembly to drop clear of the condenser.
17. Lift the receiver/drier from the condenser and discard. It is NOT recommended to refit the old unit.



### Refitting

18. Reverse procedures 17 to 15 using a new receiver/drier unit.
19. Connect the high pressure pipe to the received drier. Using two spanners on each union, tighten the union noting that the sight glass remains in the vertical position.
20. Carefully locate the condenser into position, refit the fixings securing the condenser to the extension plate. Connect and tighten the air conditioning hose to the top of the condenser. Use two spanners on each union.
21. Refit the condenser to the bottom bracket.
22. Place the bonnet striker support plate into position, do not secure at this stage.
23. Fit the fan cowling support brackets. It will be necessary to lift the bonnet striker support plate to permit the positioning of the fan cowling assembly to the condenser mounting lugs.
24. Secure the steady rods and the lower condenser mounting bracket. Do not tighten the bolts at this stage. Reconnect the top horn electrical leads.
25. Loosely fit the four bolts and distance washers which support the bonnet striker support plate and fan cowling to the wing sides.
26. Tighten the lower condenser bracket bolts.
27. Adjust the condenser position with the bonnet striker support bracket assembly to obtain an equal distance from the radiator. Tighten the four side mounting bolts.
28. Tighten the four nuts and washers which secure the fan cowling mounting.
29. Reconnect the electrical wiring for the fan assemblies, horn and receiver/drier.
30. Recheck the security of all fixings.
31. Refit the front nose and grille assembly and secure.
32. Evacuate, sweep and charge the air conditioning system as previously described.

### EVAPORATOR — LH steering models

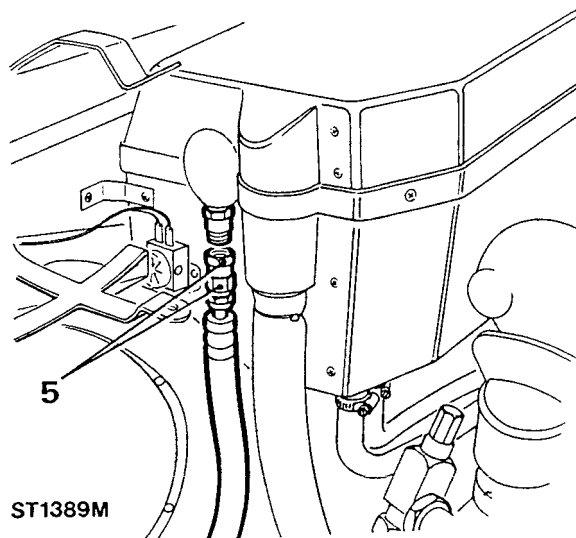
**NOTE:** It is only necessary to evacuate the air conditioning system when removing the evaporator matrix or to change the expansion valve.

### Removal

1. Place the vehicle in a ventilated area away from open flames and heat sources.
2. Stop the engine and secure the bonnet in an open position.

### Heater matrix and blower motor only

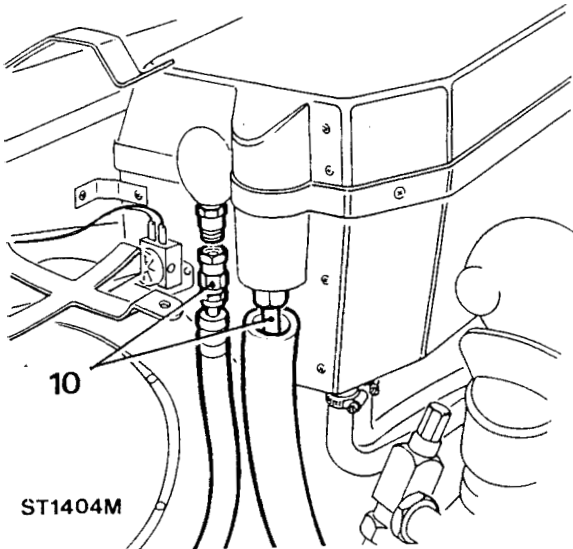
3. Remove the caps from the compressor service valves and close (turn clockwise) fully.
4. Disconnect the low pressure valve from the compressor and cap both ends to prevent dirt or moisture entering the system.
5. Using two suitable spanners remove the high pressure pipe from the evaporator side. Cap both ends to prevent dirt or moisture entering the system.



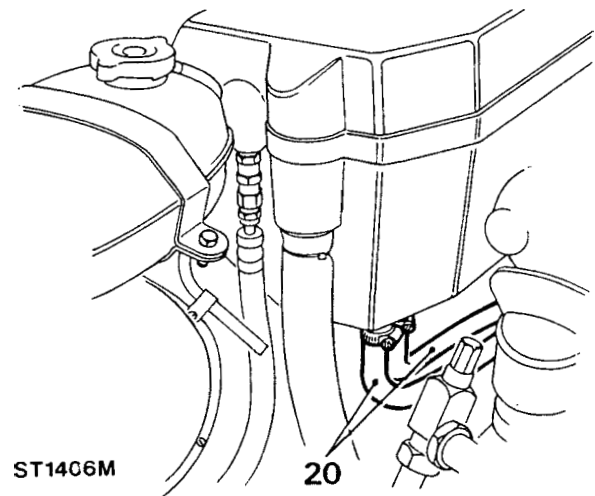
### Evaporator matrix and expansion valve only

6. Remove the caps from the Compressor service valves and connect the gauge set for evacuating.
7. Evacuate the air conditioning system as previously described.
8. Open the compressor service valves and disconnect the gauge set. Cap all pipes and gauge connections to prevent dirt or moisture entering the system.
9. Release the fixings and remove the expansion tank to provide access to the air conditioning high and low pressure pipes.

10. Whilst supporting both unions with suitable spanners unscrew the high and low pressure air conditioning pipes to the evaporator. Cap the pipe ends and evaporator inlets to prevent dirt or moisture entering the system.

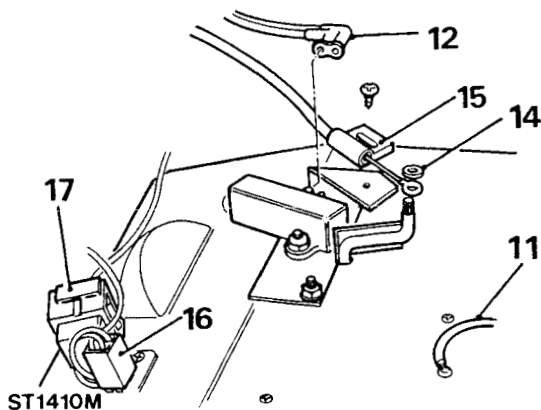


18. Remove the screw, releasing the relay connector block.
19. All wiring on the top of the evaporator is now disconnected with the exception of the earth lead, this is disconnected when the evaporator mounting block is removed.
20. Using suitable pipe clamps, clamp the inlet and outlet coolant pipes at the base of the evaporator and release the two jubilee clips and detach, or drain the radiator.

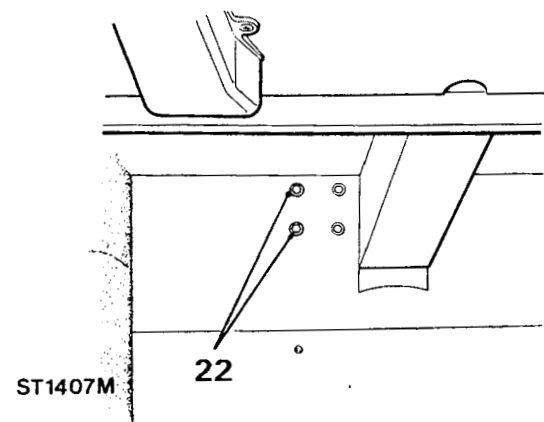


**Evaporator unit**

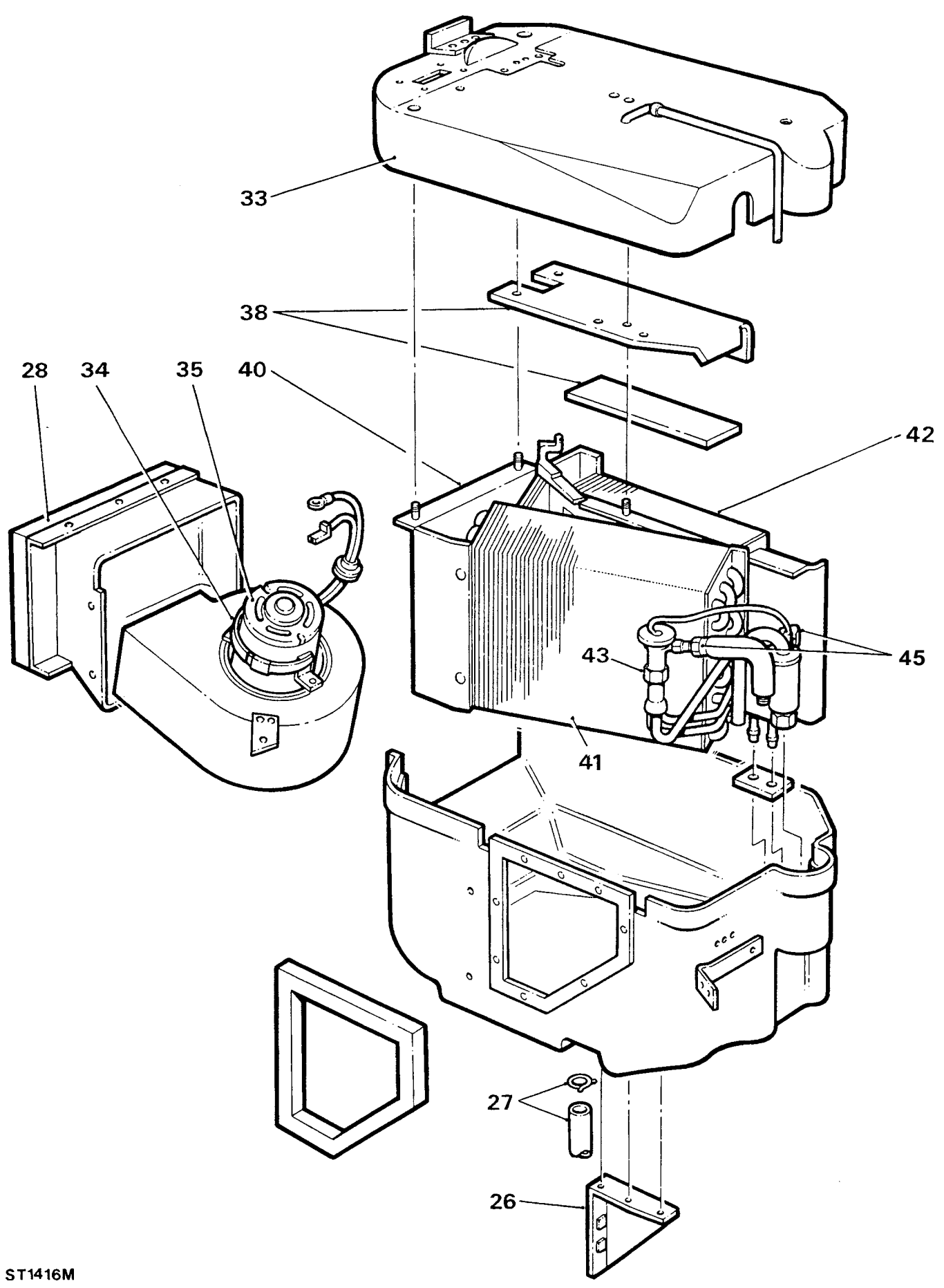
11. Disconnect the electrical leads feeding the compressor clutch cycling switch.
12. Detach the vacuum pipes from the water valve switch.
13. Remove the fixings securing the water valve switch and withdraw it.
14. Remove the clip and cable connection from the evaporator heater flap rod. Use a new clip on reassembly.
15. Release the nylon cable retainer.
16. Detach the heater electric supply lead at the connecting block.
17. Remove the relay from its connecting block revealing one self tapping screw.



21. From inside the vehicle remove the front passenger carpet and self tapping screws which retain the toe-board. Remove the toe-board.
22. Release the two bolts.



23. From inside the engine compartment remove the two upper evaporator mounting block bolts fitted to the engine bulkhead. This also releases the earthing leads.
24. Remove the bolt securing the angled bracket at the front of the evaporator casing.



ST1416M

25. Lift the evaporator clear of the vehicle and place on a bench with a suitable support underneath the case to ensure the heater pipes are not damaged.
26. Release the nuts and remove the bracket from underneath the evaporator casing.
27. Remove the wire clip and detach the dump valve located underneath.
28. Release the seven self tapping screws securing the outlet duct and carefully break the sealing compound around the edge of the duct and **pull** ducting plate away from evaporator body.
29. Remove the fifteen screws located around the cover seam, Remove the old sealing compound from the body and top cover.
30. Remove the four screws and four nuts from the top of the cover.
31. From the front of the unit remove the two screws adjacent to the low pressure pipe moulding.
32. At the side of the unit remove the two screws adjacent to the air intake aperture.
33. Lift the top cover **off** whilst feeding the blower motor wiring and air control flap rod through their respective apertures, thus exposing the blower motor, heater matrix and air conditioning evaporator matrix.

#### Blower motor unit removal only

34. Remove the screws retaining the motor unit to the casing.
35. Release the three bracket retaining screws and withdraw motor and impeller.
36. Detach the star washer, spring clip and impeller.
37. Remove the two nuts from the motor shroud and lift clear.

#### Heater/Evaporator matrices removal only

38. Lift the support plate and insulation pad from the matrix.
39. From the bottom of the casing, remove the three screws adjacent to the dump valve outlet, in addition to the screws next to the heater pipes.
40. Lift the evaporator and heater matrices together with the supporting frame containing the air direction flap clear of the casing.
41. Detach the evaporator matrix by releasing the four screws, two at both ends of the support bracket.
42. Detach the heater matrix by removing the self-tapping screw.

#### Expansion valve removal

43. Support the suction pipe union with suitable spanners and release.
44. Remove the bleed pipe retaining nut from the suction pipe.
45. Remove the spring clip retaining the expansion valve sensor pipe to the main suction pipe which now releases the expansion valve and high pressure pipe. Place valve on bench and unscrew the high pressure pipe from the expansion valve.
46. Seal and cap all apertures; discard all 'O' rings which are renewed on assembly.

#### Refitting

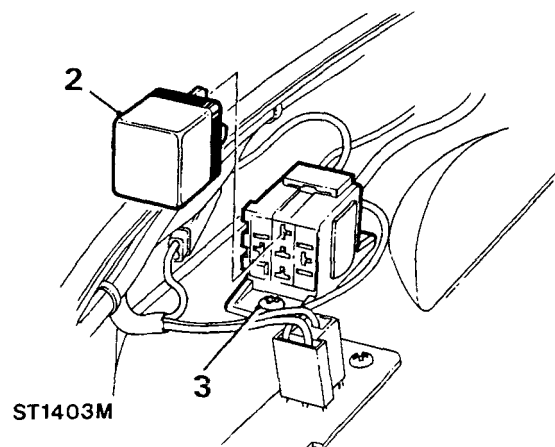
47. Reverse procedures 46 to 11 noting that all threads, unions, 'O' rings are coated with refrigerant oil prior to fitting.

**NOTE: Depending upon which unit has been refitted reverse the appropriate procedures: Heater Matrix or Blower Motor 5 to 3 Evaporator Matrix or Expansion Valve 10 to 6 and then charge the air conditioning system as previously described with Refrigerant 12.**

#### RESISTOR BLOCK

##### Removal

1. Stop the engine and secure the bonnet in an open position.
2. Detach the blower motor wiring connector.
3. Remove the self tapping screw and lift the resistor block out.



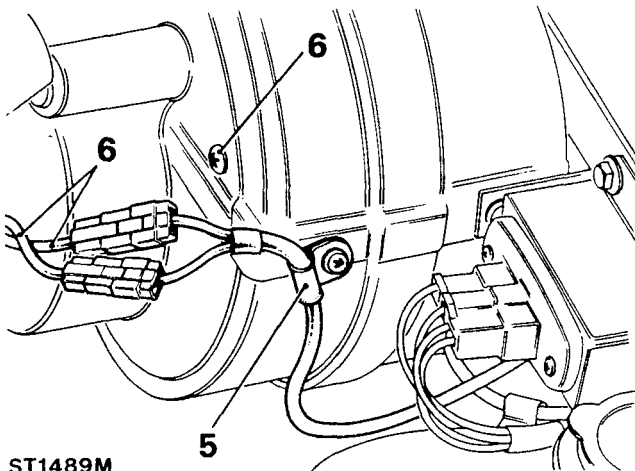
##### Refitting

4. Reverse procedures 3 to 1.

## EVAPORATOR BLOWER MOTOR — RH Steering models

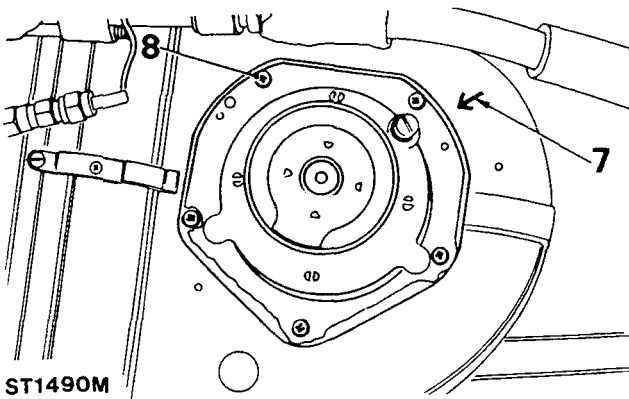
### Removal

1. Open and secure the bonnet.
2. Release the plastic tie retaining the carburettor breather pipe to the right hand air intake elbow.
3. Remove the pulsair pipe connected to the air intake elbow.
4. Remove the right hand air intake elbow.
5. Disconnect the clip and blower motor wiring.
6. Release the blower motor cover fixings and separate the casing slightly to allow the earth and Lucas connectors to be released.



ST1489M

7. Remove the cover ensuring that a mark is made on the casing to indicate the correct positioning of the blower motor when refitting.
8. Release the five self-tapping screws and withdraw the blower motor and impeller. It may be necessary to move the low pressure air conditioning pipe aside to provide sufficient clearance.



ST1490M

9. Remove the centre nut on the impeller and carefully ease the impeller from the blower motor shaft.

### Refitting

10. Reverse procedures 9 to 1 ensuring that all seals are replaced.

## Evaporator remove and refit — R.H. steering models

For removal of the blower motor only, see section "Evaporator Blower Motor".

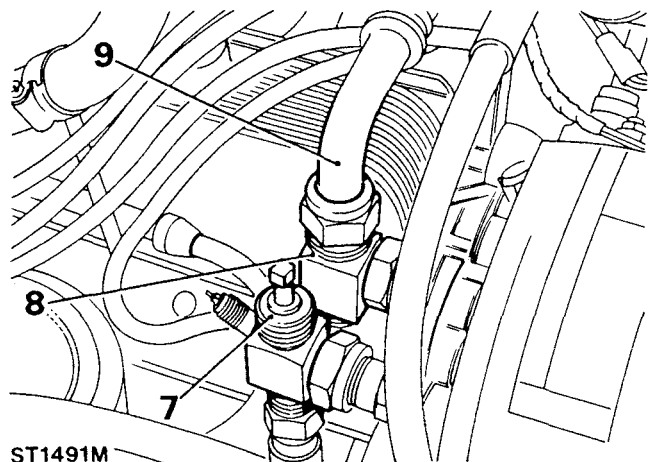
**NOTE: It is only required to evacuate the air conditioning system when removing the evaporator matrix or changing the expansion valve.**

### Removal

1. Place the vehicle in a ventilated area away from open flames and heat sources.
2. Stop the engine and secure the bonnet in an open position.
3. Disconnect the battery.
4. Unscrew the radiator drain-plug and partially drain the radiator.
5. Remove the air-cleaner.
6. Remove the caps from the compressor service valves.

### Heater matrix only

7. Fully close (turn clockwise) the high pressure valve.
8. Fully open (turn anti-clockwise) the low pressure valve.
9. Slowly disconnect the low pressure pipe from the compressor rotor lock adaptor plate.



ST1491M

10. Remove the plastic 'O' ring from the rotor lock seal. Cap and seal both unions to prevent dirt or moisture entering the system.
11. Release the plastic tie securing the low pressure pipe to the upper engine bracket.
12. Remove the two plastic ties, securing the insulation cover on the high pressure pipe and remove the cover.
13. Whilst supporting both unions with suitable spanners, unscrew the high pressure air conditioning pipe from the evaporator.



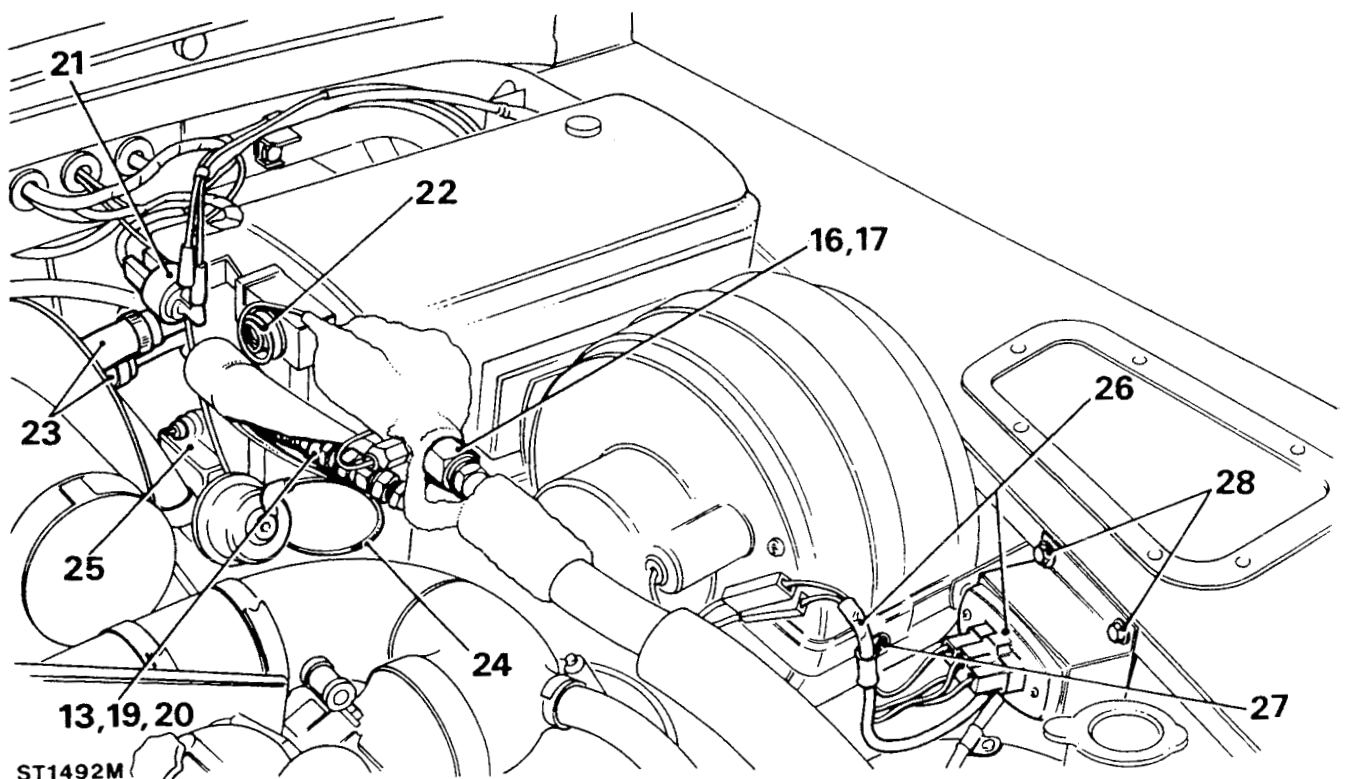
**Evaporator matrix and expansion valve only**

14. Evacuate the air conditioning system as previously described.
15. Open (turn anti-clockwise) the compressor service valves and disconnect the gauge set. Cap all pipes and gauge connections to prevent dirt or moisture entering the system.
16. Remove the insulating cover on the low pressure pipe.
17. Whilst supporting both unions with suitable spanners, unscrew the low pressure air conditioning pipe from the evaporator.
18. Cap both ends to prevent dirt or moisture entering the system.
19. Remove the two plastic ties, securing the insulation cover on the high pressure pipe and remove the cover.
20. Whilst supporting both unions with suitable spanners, unscrew the high pressure air conditioning pipe from the evaporator.

**Evaporator unit**

21. Remove the self tapping screw securing the air control flap solenoid.
22. Disconnect the two 'Ronco' thermostat wires.
23. Disconnect the two heater hoses from the side of the evaporator unit.
24. Remove the vacuum pipe from the water valve switch.
25. Remove the clip and cable connection from the evaporator air flap rod. Use a new clip on reassembly.
26. Disconnect the blower motor wiring connections.

27. Remove the screw retaining the blower motor wiring to the blower motor housing.
28. Remove the two bolts securing the blower motor resistor block to the engine compartment.
29. Remove the bolt securing the front support bracket to the blower motor housing.
30. From inside the vehicle remove the front passenger carpet and five self tapping screws which retain the toe-box cover.
31. Release the four bottom mounting bracket bolts, ensuring that the spacing washers from the two innermost bolts are retrieved from the engine bulkhead side.
32. From inside the engine compartment remove the two 13mm upper evaporator mounting bracket bolts fitted to the engine bulkhead.
33. Lift the evaporator clear of the vehicle and place on a bench with the blower motor cover facing up.
34. Turn the evaporator unit around and remove the fixings retaining the blower motor housing duct.
35. Remove the "Ranco" thermostat from the top of the unit.
36. Remove the seven self-tapping screws securing the top and bottom halves of the unit together.
37. Remove the eight screws from the right hand side of the unit.
38. Peel back the sponge pad on the outlet duct to expose the last retaining screw. Remove the screw.
39. Remove the two screws on the top of the unit.
40. Remove the joint sealant around the seam and separate the two halves of the evaporator cover assembly.
41. Remove the heater matrix from the evaporator casing.



ST1492M

**Evaporator matrix and Expansion valve only**

42. Release the screws attached to the blower motor retaining plate and remove the plate.
43. Remove the blower motor inner housing.
44. Remove the bleed-pipe retaining nut from the low pressure pipe.
45. Remove the spring clip retaining the expansion valve sensor pipe to the low pressure pipe and remove the expansion valve and high pressure pipe.
46. Unscrew the high pressure pipe from the expansion valve.
47. Seal and cap all pipes and connections to prevent dirt or moisture entering the system. Discard all 'O' rings, which are renewed on refitting.
48. Release the two nuts adjacent to the dump valve.
49. Remove the two evaporator mounting screws from each side of the casing.
50. Release the two upper evaporator mounting bracket screws and **pull** the bracket away from the evaporator.
51. Lift the evaporator matrix from the casing with the two side plates and place on a bench.

**Refitting**

52. Reverse procedures 51 to 21, ensuring that all threads, unions and 'O' rings are coated with refrigerant oil prior to fitting. Discard all old 'O' rings and renew on refitting. When reversing procedure 31, ensure that the spacing washers are fitted to the two innermost bolts.

**NOTE: Depending upon which component has been removed, reverse the appropriate procedure as follows:**

**Evaporator matrix and expansion valve 20 to 2**  
**Heater matrix 13 to 2.**

---

## ELECTRICAL PRECAUTIONS

The following guidelines are intended to ensure the safety of the operator whilst preventing damage to electrical and any electronic components fitted to the vehicle.

Before commencing any test procedure on a vehicle ensure that the test equipment is working correctly and any harness or connectors are in good condition, this particularly applies to mains leads and plugs.

**WARNING: Before commencing work on an ignition system, all high tension terminals, adaptors and diagnostic equipment for testing should be inspected to ensure that they are adequately insulated and shielded to prevent accidental personal contacts and minimize the risk of shock. Wearers of surgically implanted pacemaker devices should not be in close proximity to ignition circuits or diagnostic equipment.**

### Polarity

Never reverse connect the vehicle battery and always observe the correct polarity when connecting test equipment.

### High voltage circuits

Whenever disconnecting live high tension circuits always use insulated pliers and never allow the open end of a high tension lead to come into contact with other components particularly electronic control units. Exercise caution when measuring the voltage on the coil terminals while the engine is running, since, high voltage spikes can occur on these terminals.

### Connectors and harness

Always ensure that these items are dry and oil free before disconnecting and connecting test equipment. Never force connectors apart either by using tools or by pulling on the wiring harness. Always ensure locking tabs are disengaged before removal and note orientation to enable correct reconnection. Ensure that any protective covers and substances are replaced if disturbed. Having confirmed a component to be faulty switch-off the ignition and disconnect the battery. Remove the component and support the disconnected

harness. When replacing the component keep oily hands away from electrical connection areas and push connectors home until any locking tabs fully engage.

### Battery disconnecting

Before disconnecting the battery, switch off all electrical equipment.

### Battery charging

Recharge the battery out of the vehicle and keep the top well ventilated. While being charged or discharged, and for approximately fifteen minutes afterwards, batteries emit hydrogen gas which is flammable. Always ensure any battery charging area is well ventilated and that every precaution is taken to avoid naked flames and sparks.

## GENERAL PRECAUTIONS

Switch-off ignition prior to making any connection or disconnection in the system as electrical surge caused by disconnecting 'live' connections can damage electronic components.

Ensure hands and work surfaces are clean and free of grease, swarf, etc. as grease collects dirt which can cause tracking or high-resistance contacts.

When handling printed circuit boards, treat them as you would a hi-fi record — hold by the edges only.

Prior to commencing a test, and periodically during a test, touch a good earth, for instance, a cigar lighter socket, to discharge body static as some electronic components are vulnerable to static electricity.

## TEST EQUIPMENT

A range of 'Fast Check' testers is available to provide a means of fast effective diagnosis of faults in electronic systems currently fitted to Land Rover and Range Rover vehicles.

It is essential that operators familiarise themselves with the components of the system to be checked and the instruction for the relevant fast check test before commencing diagnosis.

**OVERHAUL V8 ENGINE DISTRIBUTOR****DISMANTLE**

1. Unclip and remove the distributor cap.
2. Withdraw the rotor arm.
3. Remove the contact breaker spring anchor nut and lift off:
  - a) the top-half of insulation bush
  - b) the low tension lead (Black)
  - c) the capacitor lead (Orange).
4. Remove the contact breaker retaining screw, plain and spring washer and remove contact set assembly.
5. Remove the complete insulation bush.
6. Remove the capacitor.
7. Remove the dwell-angle adjuster screw and spring.
8. Remove the two screws and withdraw the vacuum unit and rubber joint washer.
9. Remove the three screws and lift off the centrifugal advance cover-plate with the cover plate earth lead.
10. Punch out the drive pinion roll-pin and remove the drive pinion and tab washer.

**INSPECTION**

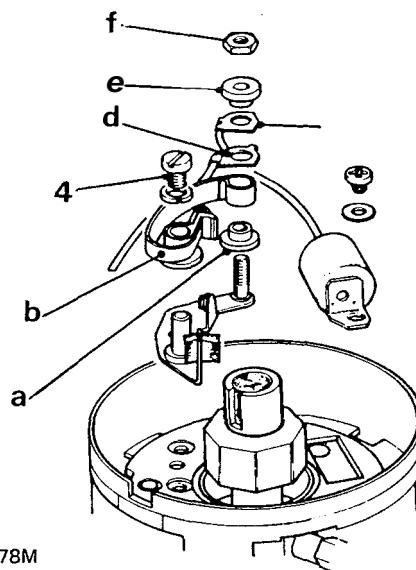
11. Examine the parts for wear and replace as necessary. Renew the capacitor and contact set. Examine the distributor cap for cracks and tracking. Renew the cap if the electrodes are worn and burned. If the cap is serviceable fit a new H.T. pick-up brush and spring. Renew the rotor arm if cracked and if the metal contact is burnt and worn. Check the low tension lead for continuity and renew if faulty. Check the vacuum unit diaphragm by withdrawing the air and placing a finger over the air pipe to determine if the vacuum is being held. Renew the unit if unsatisfactory.

**ASSEMBLE**

When assembling, smear the centrifugal cover-plate and vacuum lever with Chevron SR1 grease or equivalent.

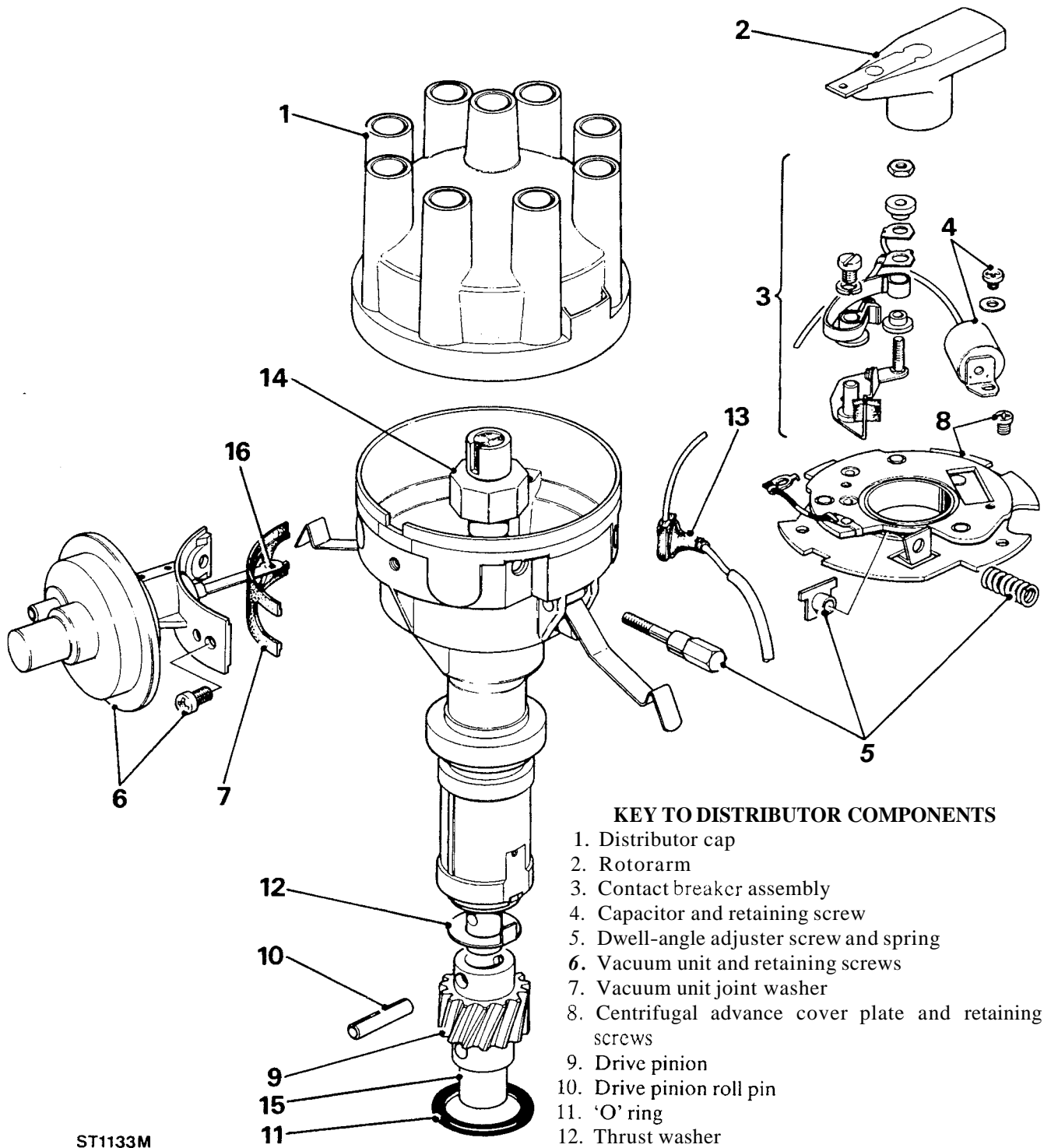
12. Fit the tab washer and drive pinion and secure with a new roll pin.
13. Fit the centrifugal advance cover-plate and secure with the three screws noting that one screw is used to retain the centrifugal advance cover plate earth lead.
14. Fit the vacuum unit and rubber joint washer and ensure that the operating lever is inserted between the two plates which make up the centrifugal cover plate assembly.

15. Fit the dwell angle adjustment screw and spring.
16. Fit the capacitor.
17. Fit the contact breaker set ensuring that the small post protruding from below the contact set locates through the hole in the cover plate into the hole in the end of the vacuum unit actuating lever. Secure with the screw, plain and spring washers.
18. Assemble the contact breaker spring insulating bushes and electrical leads, as illustrated in the following sequence:
  - a) lower bush
  - b) spring
  - c) low tension lead
  - d) capacitor lead
  - e) top bush
  - f) and secure with the anchor spring nut.
19. Apply a few drops of engine oil to the distributor cam lubrication pad.



ST1278M

20. Using a feeler gauge, and the dwell angle adjuster, set the contact breaker points to a nominal clearance of 0,35 to 0,40 mm (0.014 to 0.016 in). Once the distributor is fitted to the engine the dwell angle must be adjusted to 26° to 28° using special tuning equipment.
21. Fit the rotor arm.
22. Fit the distributor cap ensuring that the H.T. pick-up brush moves freely in its location.
23. When fitting the distributor to the engine insert a new 'O' ring seal into the body groove.



### KEY TO DISTRIBUTOR COMPONENTS

1. Distributor cap
2. Rotorarm
3. Contact breaker assembly
4. Capacitor and retaining screw
5. Dwell-angle adjuster screw and spring
6. Vacuum unit and retaining screws
7. Vacuum unit joint washer
8. Centrifugal advance cover plate and retaining screws
9. Drive pinion
10. Drive pinion roll pin
11. 'O' ring
12. Thrust washer
13. Contact breaker L.T. lead and grommet
14. Distributor cam
15. Distributor drive dog
16. vacuum unit actuating lever

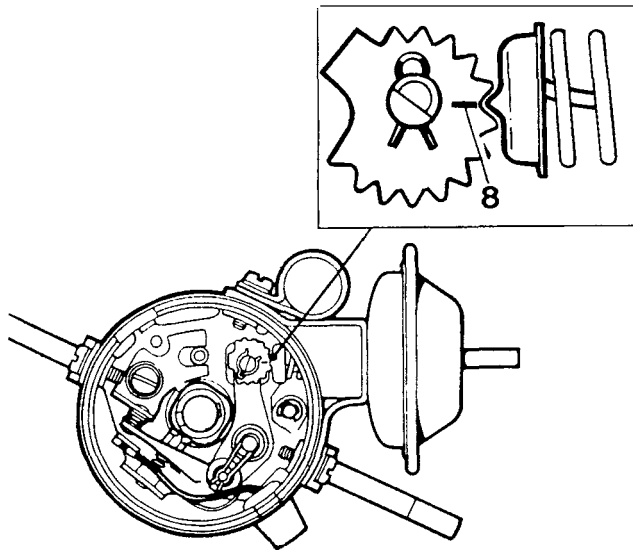
ST1133M

## OVERHAUL DUCELLIER DISTRIBUTOR — four cylinder engine

### DISMANTLE

1. Remove the distributor from the engine.
2. Remove the distributor cap.
3. Remove the rotor arm.
4. Remove the dust cover.
5. Remove the felt pad from the top of the rotor.
6. Remove the two screws retaining the condenser and vacuum unit and remove the condenser lead from the connector block.
7. Remove the retaining clip from the eccentric 'D' post.
8. Mark the position of the serrated cam in relation to the spring seat of the vacuum operating link.
9. Disengage the vacuum operating link and serrated cam from the eccentric 'D' post and remove the vacuum unit.
10. Remove the retaining screw and withdraw the fixed contact plate.
11. Remove the retaining clip and insulation washer.
12. Release the connector block from the distributor body.
13. Lift out the moving contact complete with connector block and leads.
14. Mark the relationship of the base plate to the body and remove the retaining screw. Whilst holding the pressure pad clear of the rotor, withdraw the base plate.
15. Remove the moving contact post-plate.
16. Examine the advance mechanism of the cam, check the shaft for excessive side play. If any of these parts are damaged or worn renew the complete distributor.
17. Examine all other components for damage or excessive wear and renew where necessary.
18. Check the distributor cover for signs of tracking or cracks and check that the pick-up brush moves freely in its holder.
19. Check the rotor arm for damage, electrode security, burning and tracking.

continued

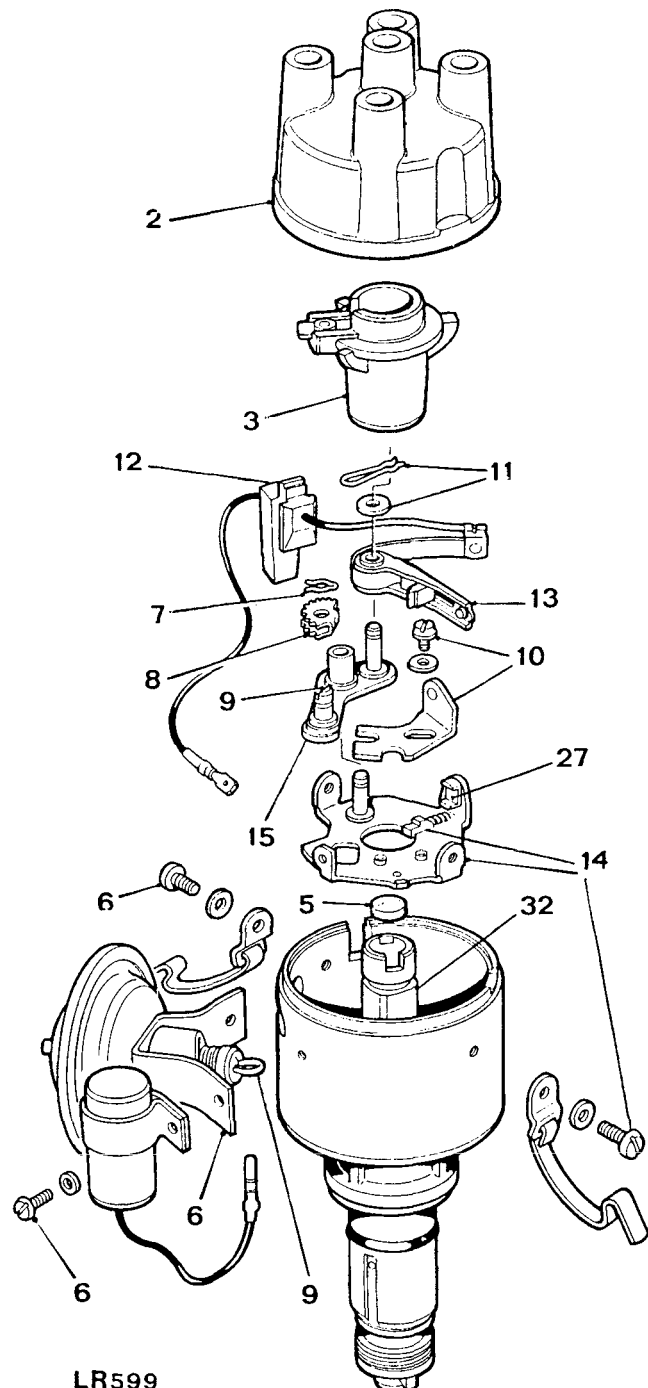


ST1279M

9. Disengage the vacuum operating link and serrated cam from the eccentric 'D' post and remove the vacuum unit.
10. Remove the retaining screw and withdraw the fixed contact plate.
11. Remove the retaining clip and insulation washer.
12. Release the connector block from the distributor body.
13. Lift out the moving contact complete with connector block and leads.
14. Mark the relationship of the base plate to the body and remove the retaining screw. Whilst holding the pressure pad clear of the rotor, withdraw the base plate.
15. Remove the moving contact post-plate.

### INSPECTION

**NOTE:** The distributor drive dog is loosely retained on the drive shaft, the 'float' allows for any misalignment.



LR599

**REASSEMBLE**

20. Using Retinax 'A' or equivalent grease lubricate the centrifugal weight pivot posts and lightly smear the cam pressure pad and contact pivot post.
21. Fit the pressure pad and spring to the base plate.
22. Fit the base plate to the body, lining up the marks, and secure with the retaining screw and clip on the opposite side to the vacuum unit.
23. Smear a little grease on the post and fit the moving contact post-plate to the base plate.
24. Offer up the vacuum unit to the body and fit the operating link and serrated cam to the 'D' post. Ensure that the identification marks line up — see instruction 8. Secure the assembly with the spring clip.
25. Secure the vacuum unit and condenser to the body with the remaining screw and clip.
26. Fit the fixed contact and loosely retain with the screw.
27. Fit the moving contact ensuring that the leaf spring locates in the nylon guide.
28. Fit the connector block to the body.
29. Fit the insulation washer and retain assembly with the spring clip.
30. Fit condenser lead to connector block.
31. Place the felt pad in the top of the rotor and add a few drops of oil.
32. Smear a small quantity of grease on the rotor cam.
33. Adjust the contact point gap to a datum setting of 0.43 mm (0.017 in) with a feeler gauge by turning the rotor spindle until a cam fully opens the points. Move the fixed contact plate to obtain the required gap and tighten the retaining screw.
34. Fit the distributor to the engine.
35. Fit the dust cover.
36. Fit the rotor arm and distributor cap.
37. Connect the H.T. leads to the appropriate spark plugs.

**OVERHAUL LUCAS 45D4 DISTRIBUTOR — Four cylinder engine****Dismantling**

1. Remove the rotor arm.
2. Extract the felt pad, if fitted, from the cam.
3. Remove the two vacuum unit retaining screws, tilt the unit to disengage the operating arm and remove the vacuum unit.
4. Push the low tension lead and grommet into the inside of the body.
5. Remove the securing screws and lift out the base plate assembly.
6. Drive out the parallel pin retaining the drive dog.
7. Remove the drive dog and thrust washer.
8. Remove the shaft complete with automatic advance mechanism and steel washer.
9. Push the moving contact spring inwards and detach the low tension connector from the spring loop.
10. Remove the screw to release the earth lead and capacitor.
11. Remove the securing screw and lift off the contact set.

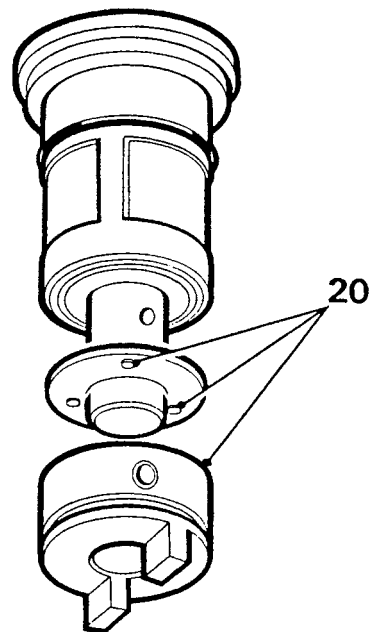
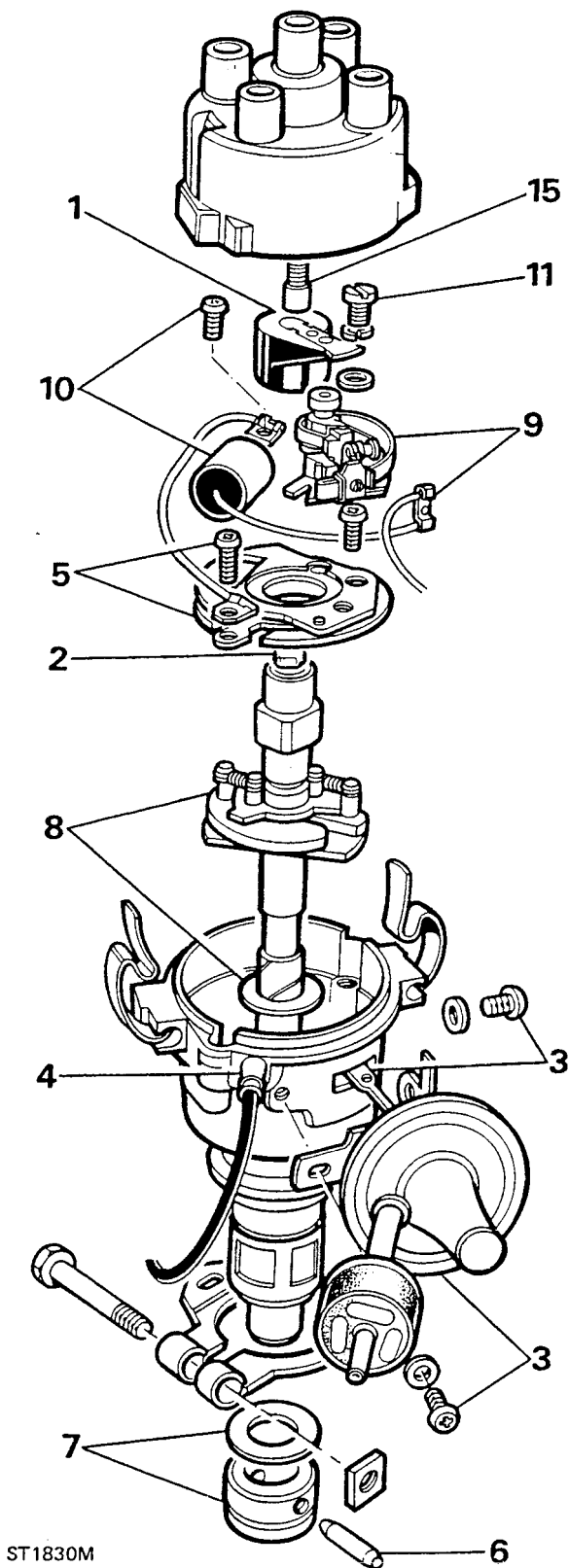
**Inspection**

12. Do not dismantle the advance mechanism beyond removing the control springs. If any of the moving parts or the cam are worn or damaged, renew the complete shaft assembly.
13. Check the fit of the shaft in its bearing: if the bearing allows excessive side play, renew the complete distributor.
14. Check the base plate assembly; if the spring between the plates is damaged or if the plates do not move freely, renew the assembly.
15. Check the distributor cap for signs of tracking or cracks and check that the pick-up brush moves freely in its holder.
16. Check the rotor arm for damage, electrode security, and burning or tracking.

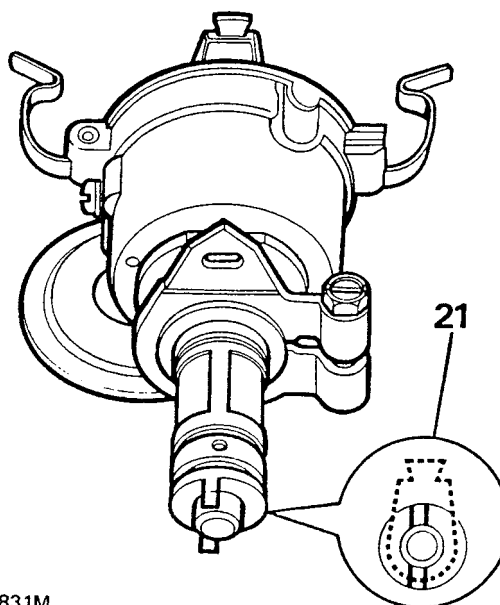
**Reassembling**

17. Reverse the procedure in 1 to 11, noting the following instructions.
18. Lubricate the contact pivot post with Retinax 'A' or equivalent grease.
19. Ensure that the steel washer is fitted on the shaft and lubricate the shaft with Rocol MP (Moly pad).
20. Fit the thrust washer with its raised lips towards the drive dog.

continued



21. Fit the drive dog so that the driving tongues are parallel with the rotor arm electrode and to the left of its centre line when the rotor arm points upwards as shown.



22. If a new shaft is fitted it must be drilled through the hole in the drive dog using a 4.76 mm ( $\frac{3}{16}$ ) drill.
23. During drilling, push the shaft from the cam end, pressing the drive dog and washer against the body shank.
24. Secure the pin in the drive dog by ring-punching the holes. If the shaft is new, tap the drive end to flatten the washer pips and ensure the correct end-float.
25. Set the contact points gap.



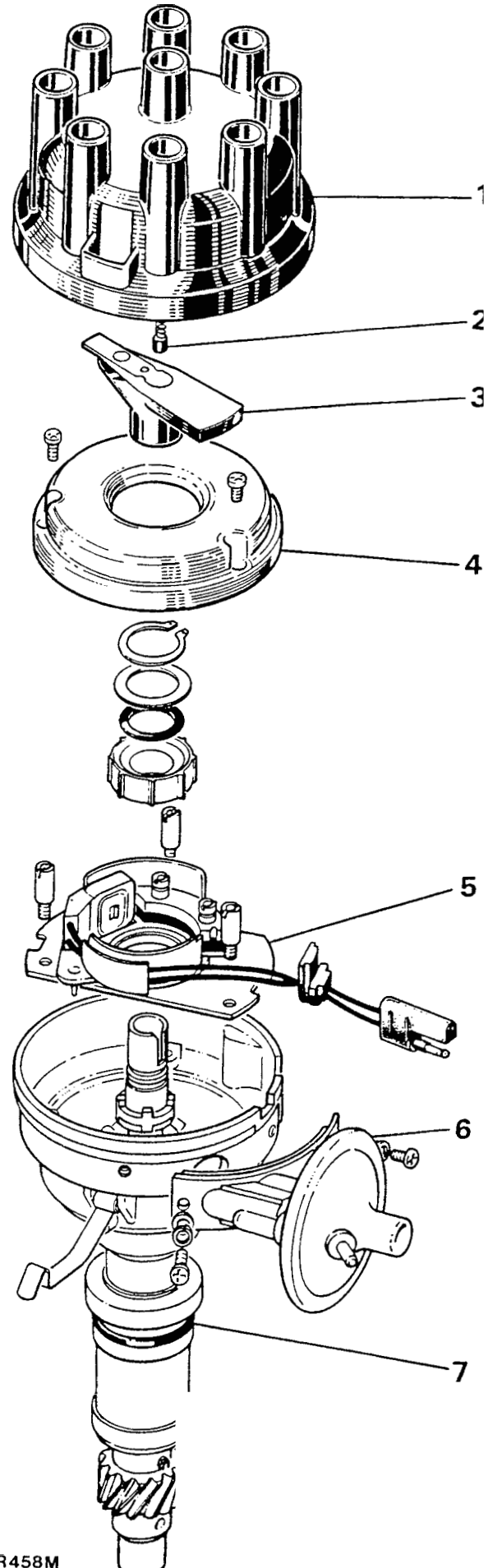
**ELECTRONIC IGNITION — WITH 35DMS DISTRIBUTOR**

The Lucas model 35DM8 distributor has a conventional advance/retard vacuum unit and centrifugal automatic advance mechanism.

A pick-up module, in conjunction with a rotating timing retractor inside the distributor body, generates timing signals. These are applied to an electronic ignition amplifier unit fitted under the ignition coil mounted on top of the left front wing valance.

**Key to illustration**

1. Cap
2. HT Brush and spring
3. Rotorarm
4. Insulation cover (Flash shield)
5. Pick-up and base plate assembly
6. Vacuum unit
7. 'O' ring oil seal



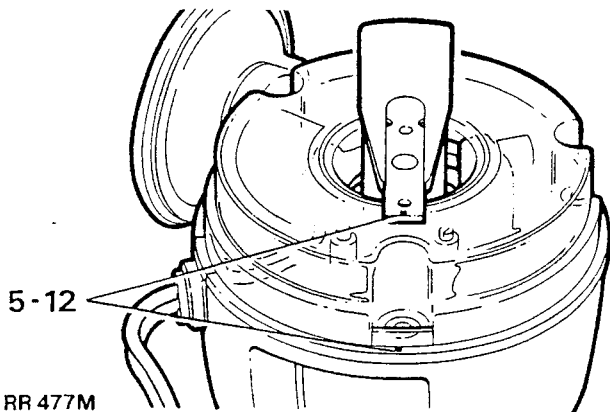
RR458M

## DISTRIBUTOR — ELECTRONIC IGNITION — V8 ENGINES 35DM8

### Remove and refit

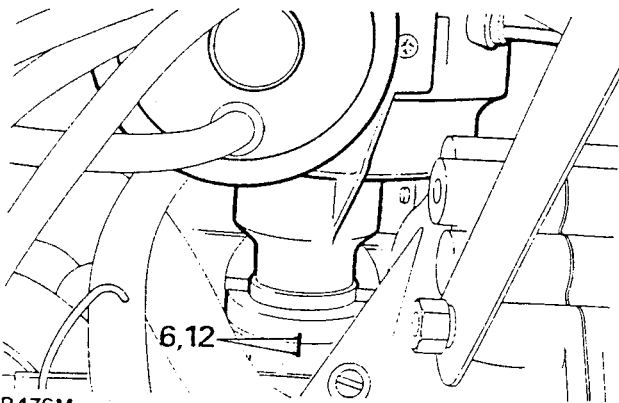
#### Removing

1. Disconnect battery.
2. Disconnect vacuum pipe(s).
3. Remove distributor cap.
4. Disconnect low tension lead from coil.
5. Mark distributor body in relation to centre line of rotor arm.



RR477M

6. Add alignment marks to distributor and front cover.



RR476M

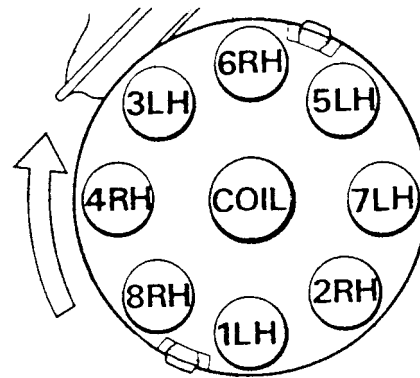
**NOTE: Marking distributor enables refitting in exact original position, but if engine is turned while distributor is removed, complete ignition timing procedure must be followed.**

7. Release the distributor clamp and remove distributor.

#### Refitting

**NOTE: If a new distributor is being fitted, mark body in same relative position as distributor removed.**

8. Leads for distributor cap should be connected as illustrated.  
Figures 1 to 8 inclusive indicate plug lead numbers.  
RH — Right hand side of engine, when viewed from the rear.  
LH Left hand side of engine, when viewed from the rear.



RR616M

9. If engine has not been turned whilst distributor has been removed, proceed as follows (items 10 to 17).
10. Fit new 'O' ring seal to distributor housing.
11. Turn distributor drive until centre line of rotor arm is 30° anti-clockwise from mark made on top edge of distributor body.
12. Fit distributor in accordance with alignment markings.

**NOTE: It may be necessary to align oil pump drive shaft to enable distributor drive shaft to engage in slot.**

13. Fit clamp and bolt. Secure distributor in exact original position.
14. Connect vacuum pipe to distributor and low tension lead to coil.
15. Fit distributor cap.
16. Reconnect battery.
17. Using suitable electronic equipment, set ignition timing as follows.
18. If, with distributor removed, engine has been turned it will be necessary to carry out the following procedure.
19. Set engine — No. 1 piston to static ignition timing figure (see section 05) on compression stroke.
20. Turn distributor drive until rotor arm is approximately 30° anti-clockwise from number one sparking plug lead position on cap.
21. Fit distributor to engine.
22. Check that centre line of rotor arm is now in line with number one sparking plug lead on cap.  
Reposition distributor if necessary.
23. If distributor does not seat correctly in front cover, oil pump drive is not engaged. Engage by lightly pressing down distributor while turning engine.
24. Fit clamp and bolt leaving both loose at this stage.
25. Set the timing statically to within 2°-3° of T.D.C.
26. Connect vacuum pipe(s) to distributor.
27. Fit low tension lead to coil.
28. Fit distributor cap.
29. Reconnect battery.
30. Using suitable electronic equipment set the ignition timing.

### Ignition timing

1. It is essential that the following procedures are adhered to. Inaccurate timing can lead to serious engine damage and additionally create failure to comply with the emission regulations applying to the country of destination. If the engine is being checked in the vehicle and is fitted with an air conditioning unit the compressor must be isolated.
2. On initial engine build, or if the distributor has been disturbed for any reason, the ignition timing must be set statically to within 2"-3" of T.D.C.  
(This sequence is to give only an approximation in order that the engine may be started) **ON NO ACCOUNT MUST THE ENGINE BE STARTED BEFORE THIS OPERATION IS CARRIED OUT.**  
Refer to 'Engine Tuning Data' for ignition timing specification.

#### Equipment required

Calibrated Tachometer  
Stroboscopic lamp

3. Couple stroboscopic timing lamp and tachometer to engine following the manufacturers instructions.
4. Disconnect the vacuum pipes from the distributor.
5. Start engine; with no load and not exceeding 3,000 rpm, run engine until normal operating temperature is reached. (Thermostat open). Check that the normal idling speed falls within the tolerance specified in table.
6. Idle speed for timing purposes must not exceed 750 rpm, and this speed should be achieved by removing a breather hose, **NOT BY ADJUSTING CARBURETTOR IDLE SETTING SCREWS.**
7. With the distributor clamping bolt slackened, turn distributor until the timing flash coincides with the timing pointer and the correct timing mark on the rim of the torsional vibration damper as shown in the table.
8. Retighten the distributor clamping bolt securely. Recheck timing in the event that retightening has disturbed the distributor position.
9. Refit vacuum pipes.
10. Disconnect stroboscopic timing lamp and tachometer from engine.

### LUCAS CONSTANT ENERGY IGNITION SYSTEM 35DM8 PRELIMINARY CHECKS

Inspect battery cables and connections to ensure they are clean and tight. Check battery state of charge if in doubt as to its condition.

Inspect all LT connections to ensure that they are clean and tight. Check the HT leads are correctly positioned and not shorting to earth against any engine components. The wiring harness and individual cables should be firmly fastened to prevent chafing.

### PICK-UP MODULE AIR GAP SETTINGS

Air gap settings vary according to vehicle application.

**NOTE:** The gap is set initially at the factory and will only require adjusting if tampered with or when the pick-up module is replaced.

#### Test Notes

- (i) The ignition must be switched on for all checks.
- (ii) Key to symbols used in charts for Tests 2.  
 Correct Reading     High Reading     Low Reading
- (iii) Use feeler gauges manufactured from a non-magnetic material when setting air gaps.

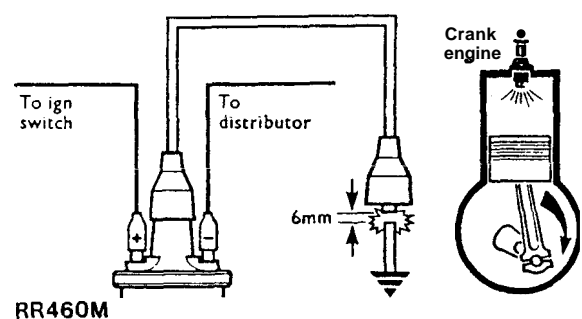
### TEST 1:

#### Check HT Sparking

Remove coil/distributor HT lead from distributor cover and hold approximately 6 mm (0.25 in) from the engine block. Switch the ignition 'on' and operate the starter.

If regular sparking occurs, proceed to Test 6. If no sparking proceed to Test 2.

#### Test 1



**TEST 2:**

**Amplifier Static Checks**

Switch the ignition 'ON'  
 (a) Connect voltmeter to points in the circuit indicated by the arrow heads and make a note of the voltage readings.

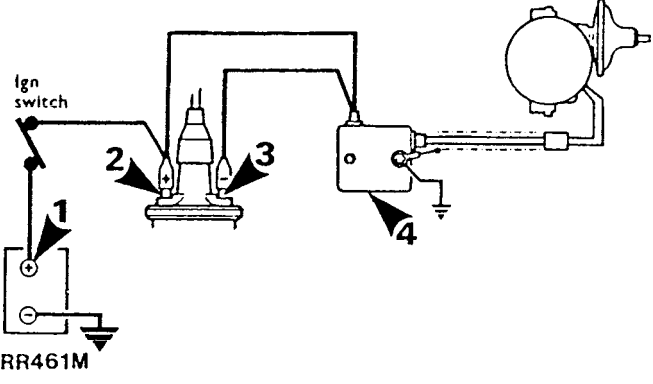
**NOTE: Only move the voltmeter positive lead during tests 2, 3 and 4.**

(b) Compare voltages obtained with the specified values listed below:—  
 EXPECTED READINGS

- 1 More than 11.5volts
- 2 1 volt max below volts at point 1 in test circuit
- 3 1 volt max below volts at point 1 in test circuit
- 4 0 volt -0.1 volt

(c) If all readings are correct proceed to Test 3.  
 (d) Check incorrect reading(s) with chart to identify area of possible faults, i.e. faults listed under heading "Suspect".

Test 2



1	2	3	4	SUSPECT
L	✓	✓	✓	Discharged battery
✓	L	L	✓	Ign. switch and/or wiring
✓	✓	L	✓	Coil or amplifier
✓	✓	✓	H	Amplifier earth

**TEST 3:**

**Check Amplifier Switching**

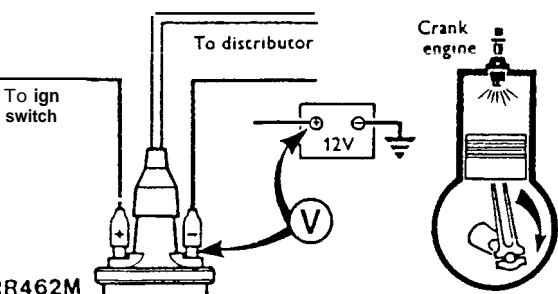
Disconnect the High Tension lead between the coil and distributor.  
 Connect the voltmeter between battery positive (+ ve) terminal and HT coil negative (- ve) terminal: the voltmeter should register zero volts. Switch the ignition 'on' and crank the engine: the voltmeter reading should increase just above zero, in which case proceed with Test 5.  
 If there is no increase in voltage during cranking proceed to Test 4.

**TEST 4:**

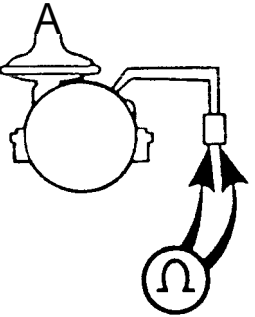
**Pick-up Coil Resistance. Applications with Separate Amplifier**

Disconnect the pick-up leads at the harness connector. Connect the ohmmeter leads to the two pick-up leads in the plug.  
 The ohmmeter should register between 2k and 5k ohms if pick-up is satisfactory. Change the amplifier if ohmmeter reading is correct. If the engine still does not start carry out Test 5.  
 Change the pick-up if ohmmeter reading is incorrect. If the engine still does not start proceed to Test 5.

Test 3



Test 4



**TEST 5:**

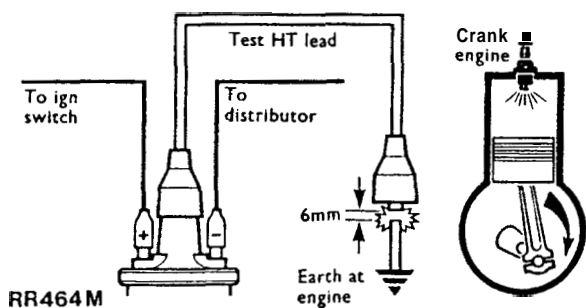
## Check HT Sparking

Remove existing coil/distributor HT lead and fit test HT lead to coil chimney. Hold free end about 6 mm (0.25 in) from the engine block and crank the engine.

HT sparking good, repeat test with original HT lead, if then no sparking, change HT lead. If sparking is good but engine will not start, proceed to Test 6.

If no sparking, replace coil.

If engine will not start carry out Test 6.

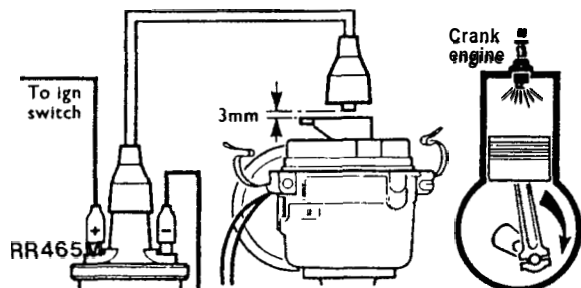
**Test 5****TEST 6:**

## Check Rotor Arm

Remove distributor cover. Disconnect coil HT lead from cover and hold about 3 mm (0.13 in) above rotor arm electrode and crank the engine. There should be no HT sparking between rotor and HT lead. If satisfactory carry out Test 7.

HT sparking, replace rotor arm.

If engine will not start carry out Test 7.

**Test 6****TEST 7:**

## Visual and HT Cable Checks

Examine:	Should be:
1. Distributor Cover	Clean, dry, no tracking marks
2. Coil Top	Clean, dry, no tracking marks
3. HT Cable Insulation	Must not be cracked chafed or perished
4. HT Cable Continuity	Must not be open circuit
5. Sparking Plugs	Clean, dry, and set to correct gap.

**NOTE:**

1. Reluctor	Must not foul pick-up or leads
2. Rotor and Flash Shield	Must not be cracked or show signs of tracking marks.

**OVERHAUL DISTRIBUTOR — LUCAS 35DM8****Distributor Cap**

1. Unclip and remove cap.
2. Renew cap if known to be faulty.
3. Clean with a nap-free cloth.

**Rotor Arm**

4. Pull rotor arm from keyed shaft.
5. Renew rotor arm if known to be faulty.

**Insulation Cover (Flash shield)**

6. Remove cover, secured by 3 screws.
7. Renew cover if known to be faulty.

**Vacuum Unit**

8. Remove 2 screws from vacuum unit securing bracket, disengage vacuum unit connecting rod from pick-up base plate connecting peg, and withdraw vacuum unit from distributor body.

**Pick-up and Base Plate Assembly**

9. Use circlip pliers to remove the circlip retaining the reluctor on rotor shaft.
10. Remove the flat washer and then the 'O' ring recessed in the top of the reluctor.
11. Insert the blade of a small screwdriver beneath the reluctor and prise it partially along the shaft, sufficient to enable it to be gripped between fingers and withdrawn from the shaft.

**NOTE: Coupling ring fitted beneath reluctor.**

12. Remove pick-up and base plate assembly, secured by 3 support pillars.

**NOTE: Do not disturb the 2 barrel nuts securing the pick-up module, otherwise the air gap will need re-adjustment.**

13. Renew pick-up and base plate assembly if module is known to be faulty, otherwise check pick-up winding resistance (2k-5k ohms).

**Re-Assembly**

14. This is mainly a reversal of the dismantling procedure, noting the following points:

**Lubrication****Apply clean engine oil:**

- (a) 3 drops to feltpad reservoir in rotor shaft.

**Apply Chevron SR1 (or equivalent) grease.**

- (b) Auto advance mechanism
- (c) Pick-up plate centre bearing
- (d) Pre tilt spring and its rubbing area (pick-up and base plate assy)
- (e) Vacuum unit connecting peg (pick-up and base assy) and
- (f) the connecting peg hole in vacuum unit connecting rod.

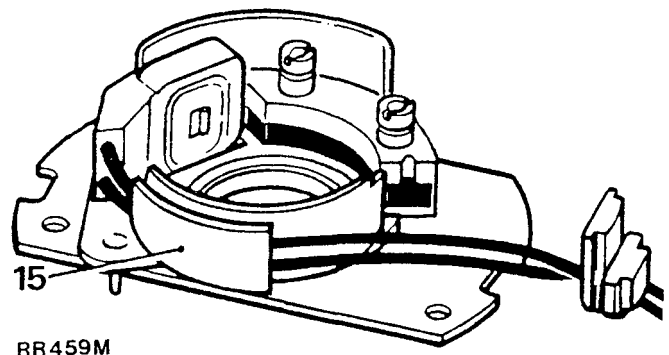
**Apply Rocal MHT (or equivalent) grease.**

- (g) Vacuum unit connecting rod seal (located in vacuum unit where connecting rod protrudes)

**NOTE: Applicable only to double acting vacuum units.**

**Fitting Pick-up and Base Plate Assembly**

15. Pick up leads must be prevented from fouling the rotating reluctor. Both leads should be located in plastic carrier as illustrated. Check during re-assembly.

**TECHNICAL DATA**

Firing angles .....	0°-45°-90° etc. ± 1°
Application .....	12V Negative earth
Pick up air gap adjustment (Pick up limb/reluctor tooth) .....	0.20 mm - 0.35 mm (0.008 in - 0.014 in)
Pick up winding resistance .....	2k - 5k ohms

### Refitting Reluctor

- Slide reluctor as far as it will go on rotor shaft, then rotate reluctor until it engages with the coupling ring beneath the pick up base plate. The distributor shaft, coupling ring and reluctor are 'keyed' and rotate together.

### Pick Up Air Gap Adjustment

- The air gap between the pick up limb and reluctor teeth must be set within the specified limits, using a non-ferrous feeler gauge.

**NOTE 1:** When the original pick up and base plate assembly has been refitted the air gap should not normally require resetting as it is pre-set at the factory. When renewing the assembly the air gap will require adjusting to within the specified limits. See technical data.

## AMPLIFIER

### Remove and Refit

#### Removing

- Disconnect the battery.
- Disconnect the electrical leads from the amplifier and coil.
- Remove the two retaining bolts with washers securing the coil to the amplifier.
- Remove the two bolts securing the amplifier to the valance.

#### Refitting

- Reverse the removal procedure, ensuring that all electrical leads are correctly reconnected.

**NOTE:** The amplifier is not serviceable, in the event of a fault a new amplifier must be fitted.

## ELECTRONIC IGNITION — with Lucas 35DLM8 Distributor

The Lucas 35DLM8 distributor has a conventional advance/retard unit and centrifugal automatic advance mechanism.

A pick-up module, in conjunction with a rotating timing reluctor inside the distributor body, generates timing signals. These are applied to an electronic ignition amplifier module mounted on the side of the distributor body.

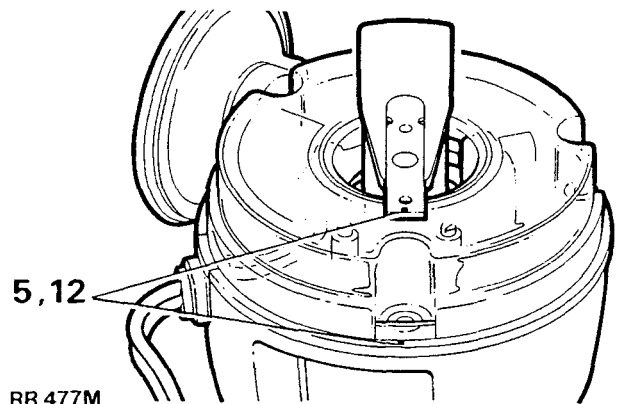
**NOTE:** The pick-up air gap is factory set. Do not adjust the gap unless the pick-up is being changed or the base plate has been moved. Use a non-ferrous feeler gauge to set the air gap.

## DISTRIBUTOR — 35DLM8

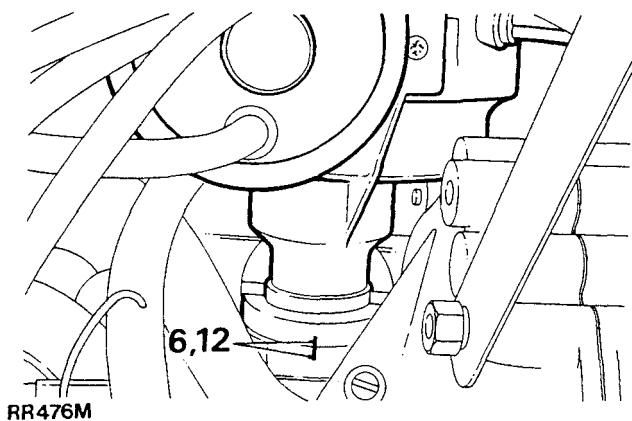
### Remove and refit

#### Removing

- Disconnect battery.
- Disconnect vacuum pipe(s).
- Remove distributor cap.
- Disconnect low tension lead from coil.
- Mark distributor body in relation to centre line of rotor arm



- Add alignment marks to distributor and front cover.



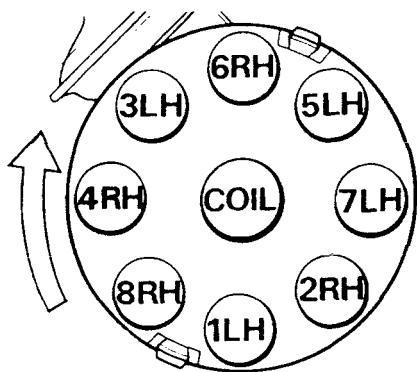
**NOTE: Marking distributor enables refitting in exact original position, but if engine is turned while distributor is removed, complete ignition timing procedure must be followed.**

7. Release the distributor clamp and remove the distributor.

**Refitting**

**NOTE: If a new distributor is being fitted, mark body in same relative position as distributor removed.**

8. Leads for distributor cap should be connected as illustrated.  
 Figures 1 to 8 inclusive indicate plug lead numbers.  
 RH — Right-hand side of engine, when viewed from the rear.  
 LH — Left-hand side of engine, when viewed from the rear.



RR616M

9. If engine has not been turned whilst distributor has been removed, proceed as follows (items 10 to 17).
10. Fit new 'O' ring seal to distributor housing.
11. Turn distributor drive until centre line of rotor arm is 30° anti-clockwise from mark made on top edge of distributor body.
12. Fit distributor in accordance with alignment markings.

**NOTE: it may be necessary to align oil pump drive shaft to enable distributor drive shaft to engage in slot.**

13. Fit clamp and bolt. Secure distributor in exact original position.
14. Connect vacuum pipe to distributor and low tension lead to coil.
15. Fit distributor cap.
16. Reconnect battery.
17. Using suitable electronic equipment, set the ignition timing, See IGNITION TIMING — Adjust.
18. If, with distributor removed, engine has been turned it will be necessary to carry out the following procedure.
19. Set engine — No. 1 piston to static ignition timing figure (see data section) on compression stroke.
20. Turn distributor drive until rotor arm is approximately 30° anti-clockwise from number one sparking plug lead position on cap.
21. Fit distributor to engine.
22. Check that centre line of rotor arm is now in line with number one sparking plug lead on cap. Reposition distributor if necessary.
23. If distributor does not seat correctly in front cover, oil pump drive is not engaged. Engage by lightly pressing down distributor while turning engine.
24. Fit clamp and bolt leaving both loose at this stage.
25. Set the ignition timing statically to within 2"-3" of T.D.C.
26. Connect the vacuum pipe to the distributor.
27. Fit low tension lead to coil.
28. Fit distributor cap.
29. Reconnect the battery.
30. Using suitable electronic equipment set the ignition timing, See IGNITION TIMING — Adjust.

**DISTRIBUTOR—LUCAS35DLM8**

**Overhaul**

**DISTRIBUTOR COVER**

1. Unclip and remove the cover.
2. Renew the cover if known to be faulty.
3. Clean the cover and HT brush with a nap free cloth.

**ROTOR ARM**

4. Pull rotor arm from keyed shaft.
5. Renew rotor arm if known to be faulty.

**INSULATION COVER (Flash shield)**

6. Remove cover, secured by three screws.
7. Renew cover if known to be faulty.

**VACUUM UNIT**

8. Remove two screws from vacuum unit securing bracket, disengage vacuum unit connecting rod from pick-up base plate connecting peg, and withdraw vacuum unit from distributor body.



## AMPLIFIER MODULE

9. Remove two screws and withdraw the module.
10. Remove the gasket.
11. Remove two screws securing the cast heatsink and remove the heatsink.

**WARNING:** The amplifier contains Beryllia. Do not open or crush.

## PICK-UP AND BASE PLATE ASSEMBLY

12. Use circlip pliers to remove the circlip retaining the reluctor on rotor shaft.
13. Remove the flat washer and then the 'O' ring recessed in the top of the reluctor.
14. Gently withdraw the reluctor from the shaft, taking care not to damage the teeth.

**NOTE:** Coupling ring fitted beneath reluctor.

15. Remove three support pillars and cable grommet. Lift out the pick-up and base plate assembly.

**NOTE:** Do not disturb the two barrel nuts securing the pick-up module, otherwise the air gap will need re-adjustment.

16. Renew pick-up and base plate assembly if module is known to be faulty, otherwise check pick-up winding resistance (2k-5k ohm).

## RE-ASSEMBLY

17. This is mainly a reversal of the dismantling procedure, noting the following points:

## LUBRICATION

Apply clean engine oil:

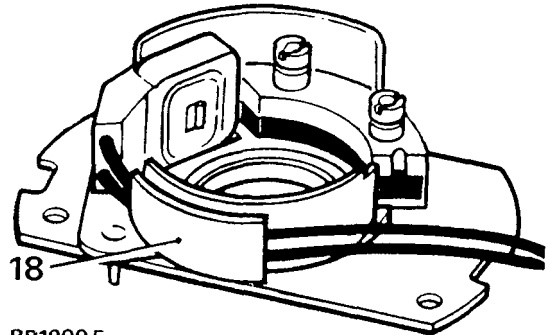
- a. Three drops to felt pad reservoir in rotor shaft.

Apply Chevron SR1 (or equivalent) grease.

- b. Auto advance mechanism.
- c. Pick-up plate centre bearing.
- d. Pre tilt spring and its rubbing area (pick-up and base plate assy).
- e. Vacuum unit connecting peg (pick-up and base plate assy) and
- f. the connecting peg hole in vacuum unit connecting rod.

## FITTING PICK-UP AND BASE PLATE ASSEMBLY

18. Pick-up leads must be prevented from fouling the rotating reluctor. Both leads should be located in plastic carrier as illustrated. Check during re-assembly.



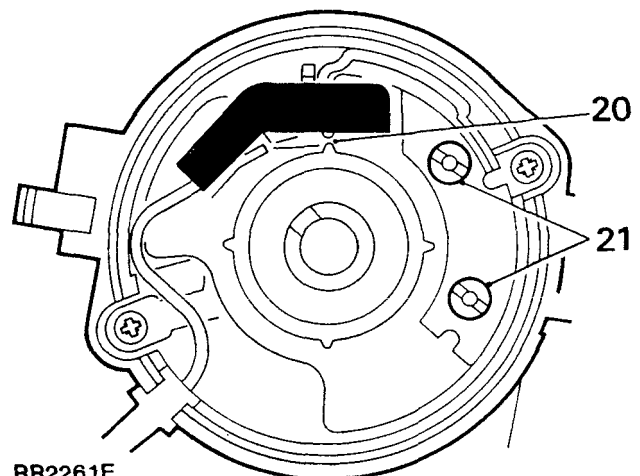
RR1900 E

## REFITTING RELUCTOR

19. Slide reluctor as far as it will go on rotor shaft, then rotate reluctor until it engages with the coupling ring beneath the pick-up base plate. The distributor shaft, coupling ring and reluctor are 'keyed' and rotate together. Fit the 'O' ring, flat washer and retaining circlip.

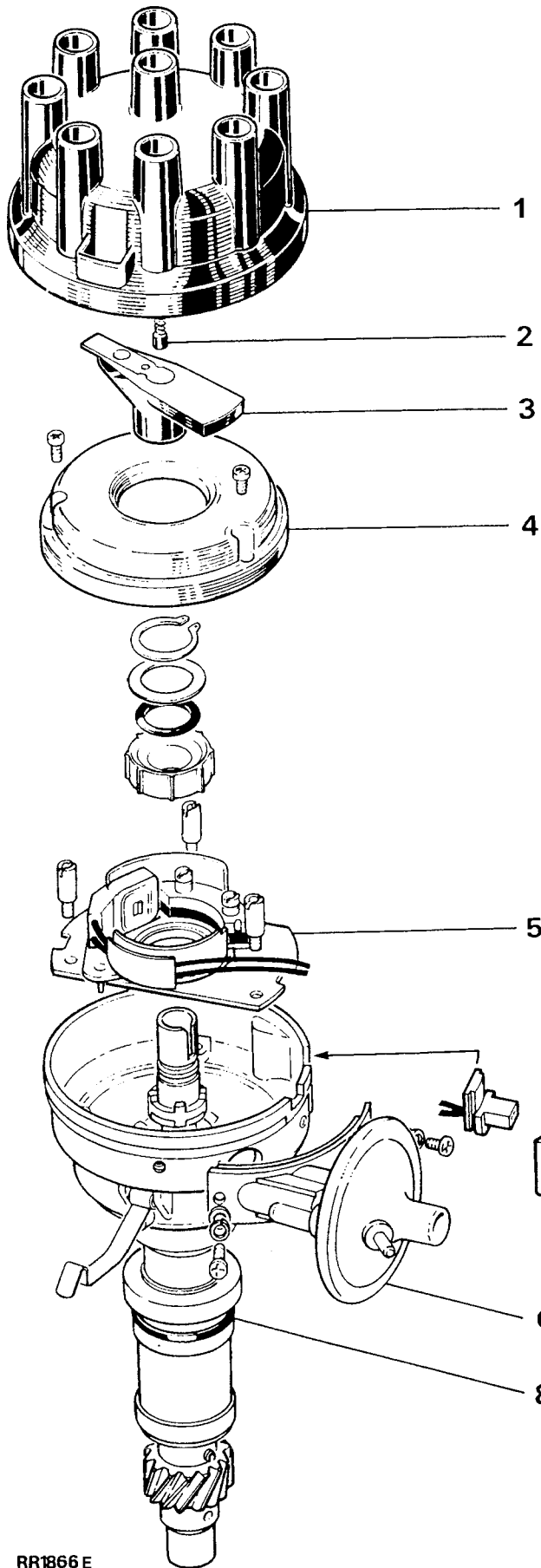
## PICK-UP AIR GAP ADJUSTMENT

20. The air gap between the pick-up limb and reluctor teeth must be set within the specified limits, using a non-ferrous feeler gauge.
21. If adjustment is necessary, slacken the two barrel nuts to set the air gap. See Engine Tuning Data.



RR2261 E

**NOTE:** When the original pick-up and base plate assembly has been refitted the air gap should be checked, **and adjusted** if necessary. When renewing the assembly the air gap will require adjusting to within the specified limits.



**Service Parts**

- 1. Cover
- 2. HT brush & spring
- 3. Rotor arm
- 4. Insul cover
- 5. **Pick-up** module and base plate assembly
- 6. Vacuum unit
- 7. Amplifier module
- 8. O-ring oil seal
- 9. Gasket

RR1866 E

## AMPLIFIER MODULE

- Before fitting the module, apply MS4 Silicone grease or equivalent heat — conducting compound to the amplifier module backplate, the seating face on distributor body and both faces of the heatsink casting.

## IGNITION TIMING

### Adjust

- It is essential that the following procedures are adhered to. Inaccurate timing can lead to serious engine damage and additionally create failure to comply with the emission regulations applying to the country of destination. If the engine is being checked in the vehicle and is fitted with an air conditioning unit the compressor must be isolated.
- On initial engine build, or if the distributor has been disturbed for any reason, the ignition timing must be set statically to 6° B.T.D.C.  
(This sequence is to give only an approximation in order that the engine may be started) **ON NO ACCOUNT MUST THE ENGINE BE STARTED BEFORE THIS OPERATION IS CARRIED OUT.**

### Equipment required

Calibrated Tachometer

Stroboscopic lamp

- Couple stroboscopic timing lamp and tachometer to engine following the manufacturers instructions.
- Disconnect the vacuum pipes from the distributor.
- Start engine, with no load and not exceeding 3,000 rpm, run engine until normal operating temperature is reached. (Thermostat open). Check that the normal idling speed falls within the tolerance specified in the data section.
- Idle speed for timing purposes must not exceed 750 rpm, and this speed should be achieved by removing a breather hose **NOT BY ADJUSTING IDLE SETTING SCREWS.**
- With the distributor clamping bolt slackened turn distributor until the timing flash coincides with the timing pointer and the correct timing mark on the rim of the torsional vibration damper as shown in the engine tuning section.
- Retighten the distributor clamping bolt securely. Recheck timing in the event that retightening has disturbed the distributor position.
- Refit vacuum pipes.
- Disconnect stroboscopic timing lamp and tachometer from engine.

## LUCAS CONSTANT ENERGY IGNITION SYSTEM 35DLM8 PRELIMINARY CHECKS

Inspect battery cables and connections to ensure they are clean and tight. Check battery state of charge if in doubt as to its condition.

Inspect all LT connections to ensure that they are clean and tight. Check the HT leads are correctly positioned and not shorting to earth against any engine components. The wiring harness and individual cables should be firmly fastened to prevent chafing.

### PICK-UP AIR GAP

Check air gap with a non-ferrous feeler gauge.

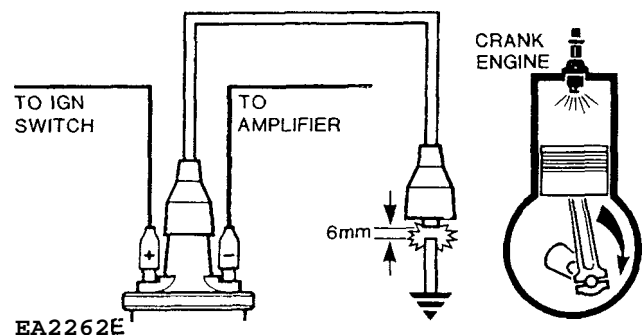
**NOTE: The gap is set initially at the factory and will only require adjusting if tampered with or when the pick-up module is replaced.**

### TEST 1:

#### Check HT Sparking

Remove coil/distributor HT lead from distributor cover and hold approximately 6 mm (0.25 in) from the engine block. Switch the ignition 'on' and operate the starter.

If regular sparking occurs, proceed to Test 6. If no sparking proceed to Test 2.



**TEST 2:**

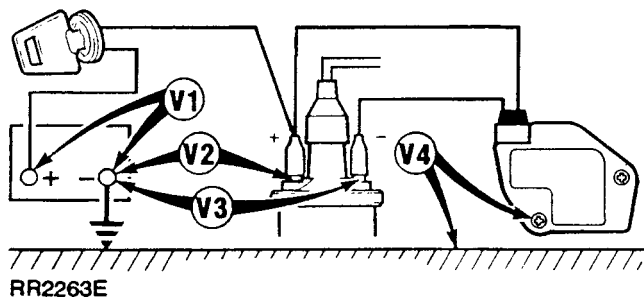
**L. T. Voltage**

Switch the ignition 'on'

- (a) Connect voltmeter to points in the circuit indicated by the arrow heads and make a note of the voltage readings.
- (b) Compare voltages obtained with the specified values listed below:

**EXPECTED READINGS**

- V1. More than 11.5 volts
- V2. 1 volt max below volts at point 1 in test circuit
- V3. 1 volt max below volts at point 1 in test circuit
- v4. 0 volt -0.1 volt



- (c) If all readings are correct proceed to Test 3.
- (d) Check incorrect reading(s) with chart to identify area of possible faults, i.e. faults listed under heading 'Suspect'.
- (e) If coil or amplifier is suspected, disconnect LT lead at coil, repeat V3. If voltage is still incorrect, fit new coil. If voltage is now correct, check LT lead, if satisfactory fit new amplifier.
- (f) If engine will not start proceed to Test 3.

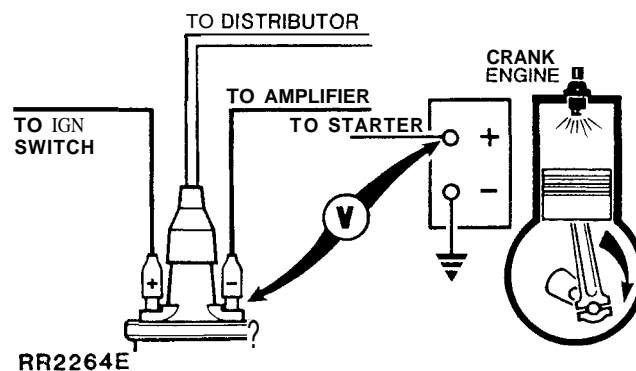
1	2	3	4	SUSPECT
L	✓	✓	✓	Discharged battery
✓	L	L	✓	Ign. switch and/or wiring
✓	✓	L	✓	Coil or amplifier
✓	✓	✓	H	Amplificrearth

✓

**TEST 3:**

**Check Amplifier Switching**

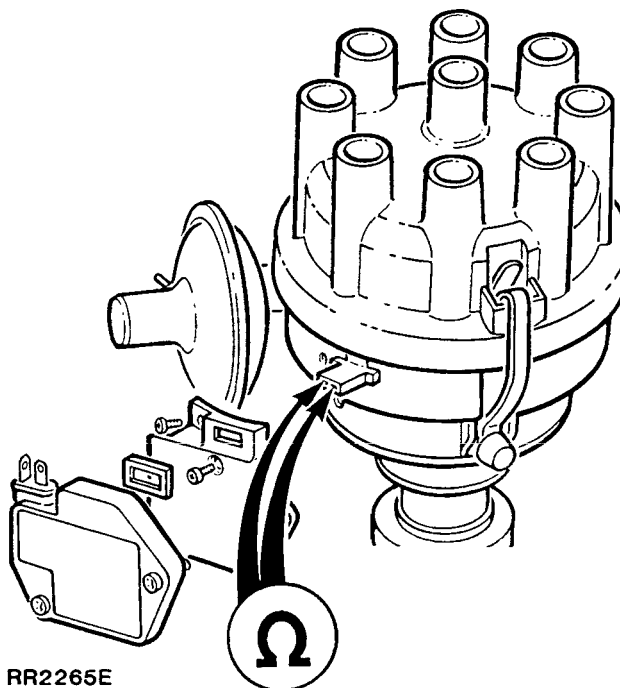
Connect the voltmeter between battery positive (+ ve) terminal and FIT coil negative (- ve) terminal: the voltmeter should register zero volts. Switch the ignition 'on' and crank the engine. The voltmeter reading should increase just above zero, in which case proceed with Test 5. If there is no increase in voltage during cranking proceed to Test 4.



**TEST 4:**

**Pick-Up Coil Resistance.**

Disconnect the pick-up leads at the harness connector. Connect the ohmmeter leads to the two pick-up leads in the plug. The ohmmeter should register between 2k and 5k ohms if pick-up is satisfactory. If the ohmmeter reading is correct, check all connections between pick-up and amplifier, if satisfactory, fit new amplifier. If the engine still does not start carry out Test 5. Change the pick-up if ohmmeter reading is incorrect. If the engine still does not start proceed to Test 5.



**TEST 5:**

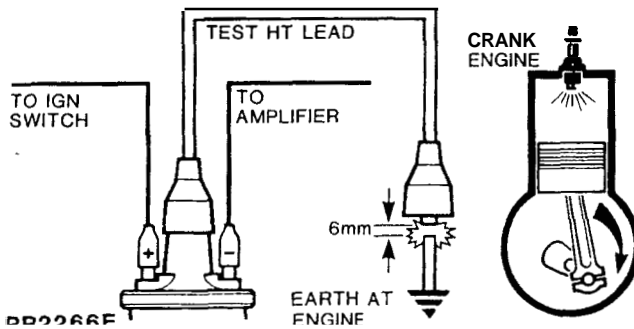
**Coil HT Sparking**

Remove existing coil/distributor HT lead and fit test HT lead to coil tower. Using suitable insulated pliers, hold free end about 6 mm (0.25 in) from the engine block and crank the engine. There should be a good HT spark.

If weak or no sparking, fit new coil, repeat test.

HT sparking good, repeat test with original HT lead. If sparking is good, carry out Test 6.

If weak or no sparking, fit new HT lead, if engine will not start carry out Test 6.



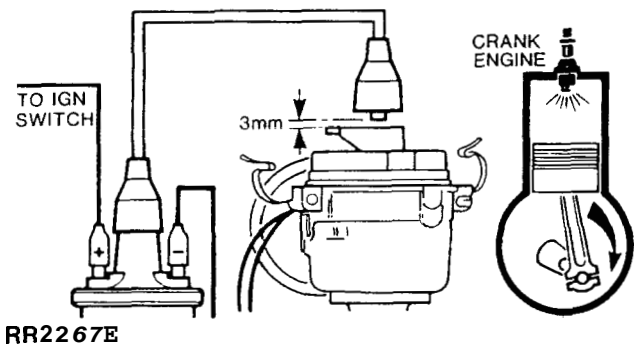
**TEST 6:**

**Rotor Arm**

Remove distributor cover. Disconnect coil HT lead from cover and using insulated pliers, hold about 3 mm (0.13 in) above rotor arm electrode and crank the engine. There should be no HT sparking between rotor and HT lead. If satisfactory carry out Test 7.

If HT sparking occurs, an earth fault on the rotor arm is indicated. Fit new rotor arm.

If engine will not start carry out Test 7.



**TEST 7:**

**Visual and HT Cable Checks**

Examine:	Should be:
1. Distributor Cover	Clean, dry, no tracking marks
2. Coil Top	Clean, dry, no tracking marks
3. HT Cable Insulation	Must not be cracked chafed or perished
4. HT Cable Continuity	Must not be open circuit
5. Sparking Plugs	Clean, dry, and set to correct gap.

**NOTE:**

- |                           |  |
|---------------------------|--|
| 1. Reluctor               | Must not foul pick-up or leads                       |
| 2. Rotor and Flash Shield | Must not be cracked or show signs of tracking marks. |

**ALTERNATOR OVERHAUL — Lucas A115-3 and A115-45****DISMANTLE**

1. Remove the alternator from the engine.
2. Remove the cover retaining screws and lift off the cover.

**Removing the surge protection diode**

3. Withdraw the screw securing the diode to the slip ring end bracket.
4. Disconnect the lead from the rectifier assembly and remove the diode.

**Removing the regulator** (Note arrangement of the brush box connections)

5. Disconnect the regulator leads.
6. Remove the screw securing the regulator to the brush box and withdraw the regulator. Note that this screw also secures the inner brush mounting plate in position.

**Removing brush box assembly**

7. Remove the screw retaining the outer brush mounting plate.
8. Withdraw both brushes.
9. Remove the two screws securing the brush box to the slip ring end bracket and lift off the brush box.

**Removing the rectifier assembly**

10. Securely clamp the alternator and release the stator winding cable ends from the rectifier by applying a hot soldering iron to the terminal tags of the rectifier. When the solder melts prise out the cable end.
11. Remove the two remaining screws securing the rectifier assembly to the slip ring end bracket and lift off the rectifier.

**NOTE: Further dismantling of the rectifier is not required.**

**Removing the slip ring end bracket**

12. Securely clamp the alternator and remove the three fixing bolts.
13. Lift off the bracket. If necessary tap under each fixing bolt with a soft mallet.

**Removing stator assembly**

14. Note the position of the stator output leads relative to the alternator fixing lugs and then lift the stator from the drive end bracket.

**Separating drive end bracket and rotor**

15. Remove the shaft nut washers from the pulley, woodruff key and spacers.
16. Use a press to remove the rotor shaft from the drive end bearing.  
Check all components as detailed under bench testing and renew any parts that are unsatisfactory. If necessary the slip rings and or the slip ring end bearing on the rotor shaft can be replaced. To renew the bearing, both slip rings must be removed as follows:
17. Unsolder outer slip ring connection and gently prise the slip ring off the shaft.
18. Unsolder inner slip ring connection and gently prise the slip ring off the shaft.

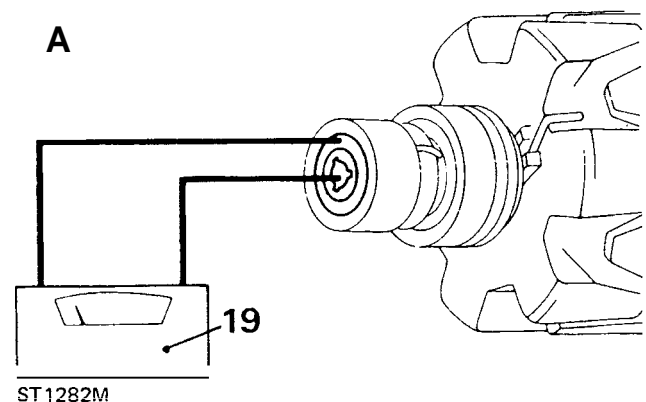
Whilst carrying out the above two instructions take care not to damage the insulation covering the winding leads.

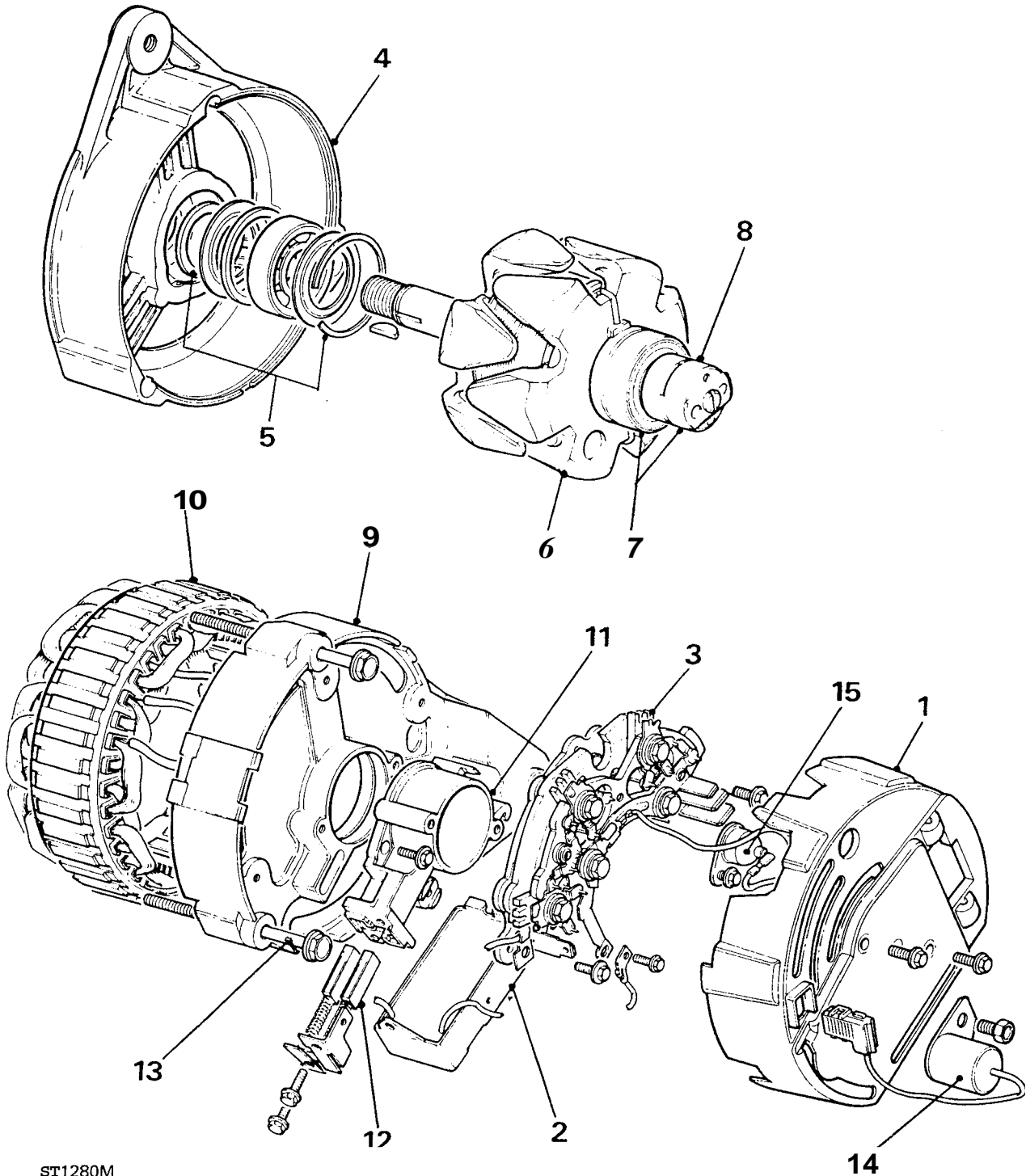
**ELECTRICAL TEST OF COMPONENTS**

The illustrations for the following tests show the Components separated from the alternator, for clarity.

**Rotor field winding**

19. Check field winding continuity and resistance simultaneously, by connecting either a battery-operated ohmmeter (illustration **A**) or a 12 volt battery and moving coil ammeter (illustration **B**) between the slip rings. The ohmmeter should indicate the appropriate resistance given in the data, or it should indicate a current approximate to the figure obtained by dividing the appropriate resistance of the rotor into the battery voltage.

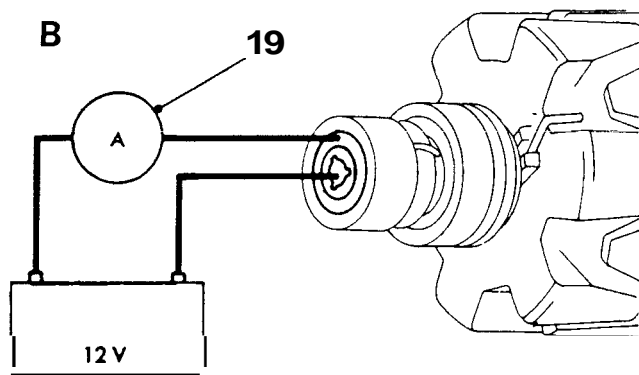




ST1280M

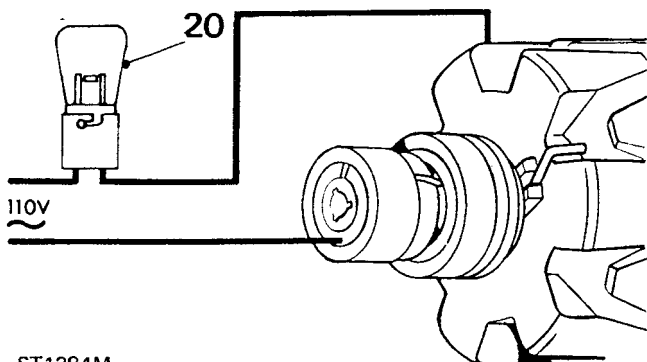
## KEY TO ALTERNATOR

- |                          |  |
|--------------------------|--|
| 1. Cover                 | 9. Slip ring end bracket                                     |
| 2. Regulator             | 10. Stator   |
| 3. Rectifier             | 11. Brush box  |
| 4. Drive-end bracket     | 12. Brush set  |
| 5. End bearing kit       | 13. Fixing bolt — slip ring end bracket to drive-end bracket |
| 6. Rotor assembly        | 14. Suppression capacitor                                    |
| 7. Slip ring end bearing | 15. Surge protection diode                                   |
| 8. Slip rings            |  |



ST1283M

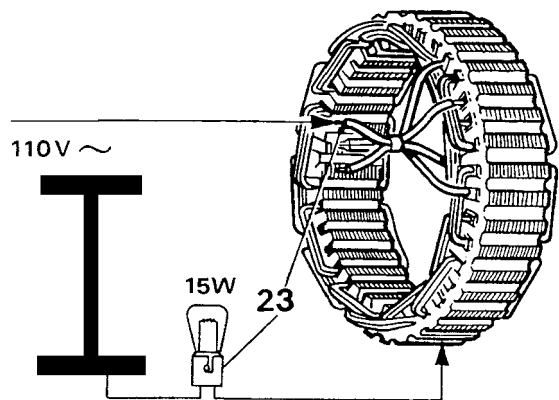
20. Check for satisfactory field winding insulation by connecting a 110 V A.C. 15-watt test lamp between either of the slip rings and the rotor body. The lamp should not light.



ST1284M

### Stator winding

21. Due to the very low resistance of the stator windings, a practical test to determine the presence of short-circuited turns cannot be carried out without the use of special instruments. However, in practice inter-winding short-circuiting is usually indicated by obvious signs of burning of the insulating varnish covering the windings. If this is the case, renew the stator assembly without the need for further testing.
22. Check continuity of stator windings, by first connecting any two of the three stator winding connecting cables in series with a 12 V battery-operated test lamp, of not less than 36 watts. The test lamp should light. If not, renew the stator assembly. Providing the first part of the test is satisfactory, transfer one of the test lamp leads to the other (third) cable. Again the test lamp should light. If so, proceed to insulation test.
23. Check insulation of stator windings, by connecting a 110 V A.C. 15-watt test lamp between the stator laminations and any one of the three connecting cables. The lamp should not light.



ST1285M

### Rectifier diodes

24. Test each of the nine diodes separately, as follows. Connect a 12 V battery and a 1.5 watt bulb in series with one of the diodes, one test lead being applied to the diode connecting pin and the other to the particular heat sink plate in which the diode undergoing test is soldered. Note whether lamp lights, then reverse the test lead connections. The lamp should light during one half of the test only. If any one diode test is unsatisfactory, renew the rectifier assembly.

### Regulator

25. Individual testing of the regulator can only be carried out with special test equipment and unless this is available the regulator must be proved by substitution.

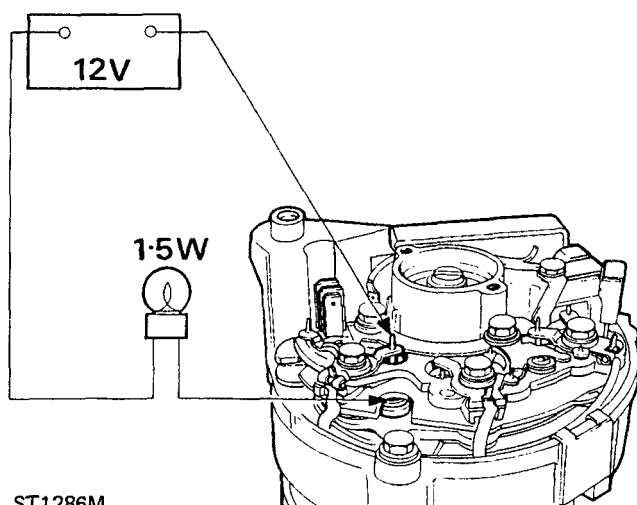
### ASSEMBLE

Reassembly of the alternator is a reversal of the dismantling procedure. However the following points should be observed.

26. Take care not to damage the insulation covering the winding leads when renewing the slip rings.
27. A build up of solder must not occur on the upper face of the inner slip ring.
28. Use resin cored solder only.
29. Pack the bearings with a suitable high melting point grease.
30. Ensure that the brushes move freely in the brush box.
31. If the slip rings are not renewed the existing ones must be clean and smooth.
32. Tighten fixings to the torque figures quoted.

continued





### TIGHTENING TORQUES

Through bolts .....	4.5 - 6.2 Nm (3.3 - 4.6 lbf ft)
Shaft nut .....	27.2 - 47.5 Nm (20.0 - 35.0 lbf ft)
Rectifier fixing bolts .....	3.4 - 3.96 Nm (2.5 - 2.9 lbf ft)
Sundry screws:	
SRE Cover .....	1.7 - 2.25 Nm (1.3 - 1.7 lbf ft)
Brush Box .....	3.4 - 3.96 Nm (2.5 - 2.9 lbf ft)
Surge Diode .....	3.4 - 3.96 Nm (2.5 - 2.9 lbf ft)
Capacitor.. .....	3.61 - 4.74 Nm (2.7 - 3.5 lbf ft)
Brush and Regulator fixing .....	1.7 - 2.25 Nm (1.3 - 1.7 lbf ft)
D/E Bearing Plate .....	4.7 - 5.7 Nm (3.5 - 4.2 lbf ft)
Reg 'IND' Lead .....	1.1 - 1.36 Nm (9.7 - 12.0 lbf in)
NUTS:	
Main output terminal.. .....	3.96 - 5.08 Nm (2.9 - 3.7 lbf ft)
'IND' terminal nuts .....	3.61 - 4.74 Nm (2.7 - 3.5 lbf ft)

**ALTERNATOR OVERHAUL — Lucas A127-65****Description**

The model A127 alternator is a three phase, field sensed unit, the rotor and stator windings generate three phase alternating current (AC) which is rectified to direct current (DC). The electronic voltage regulator unit controls the alternator output voltage by high frequency switching of the rotor field circuit.

It is essential that good electrical connections are maintained at all times. Of particular importance are those in the charging circuit (including those at the battery) which should be occasionally inspected to see that they are clean and tight. In this way any significant increase in circuit resistance can be prevented.

Do not disconnect battery cables while the engine is running or damages to the semi-conductor devices may occur. It is also inadvisable to break or make any connections in the alternator charging and control circuits while the engine is running.

The model 21TR electronic voltage regulator employs micro-circuit techniques resulting in improved performance under difficult service conditions. The whole assembly is encapsulated in silicone rubber and housed in an aluminium heat sink, ensuring complete protection against the adverse effects of temperature, dust, and moisture etc.

The brushbox assembly is incorporated in the regulator unit.

Surge protection is incorporated in the regulator unit.

The regulating voltage is set during manufacture to give the required regulating voltage range of 13.6 to 14.4 volts, and no adjustment is necessary. The only maintenance needed is the occasional check on terminal connections and wiping with a clean dry cloth.

The alternator system provides for direct connection of a charge (ignition) indicator warning light, and eliminates the need for a field switching relay or warning light control unit. As the warning lamp is connected in the charging circuit, lamp failure will cause loss of charge. Lamp should be checked regularly and a spare carried.

When using rapid charge equipment to re-charge the battery, the battery must be disconnected from the vehicle.

**NOTE: Alternator charging circuit - The ignition warning light is connected in series with the alternator field circuit. Bulb failure would prevent the alternator charging, except at very high engine speed, therefore, the bulb should be checked before suspecting an alternator failure.**

**Precautions**

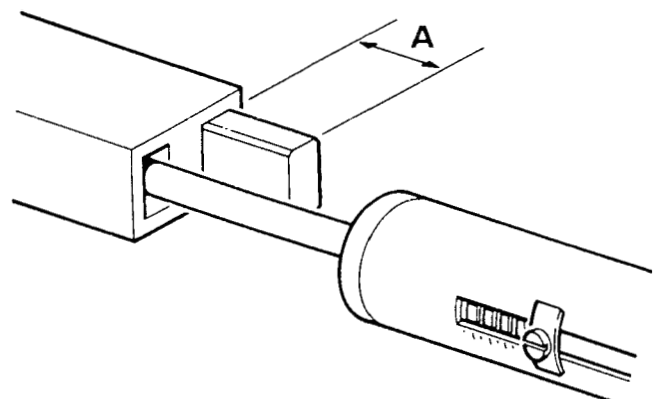
Battery polarity is **NEGATIVE EARTH**, which must be maintained at all times.

No separate control unit is fitted; instead a voltage regulator of micro-circuit construction is mounted on the slip ring end bracket.

Battery voltage is applied to the alternator output cable even when the ignition is switched off, the battery must be disconnected before commencing any work on the alternator. The battery must also be disconnected when repairs to the body structure arc being done by arc welding.

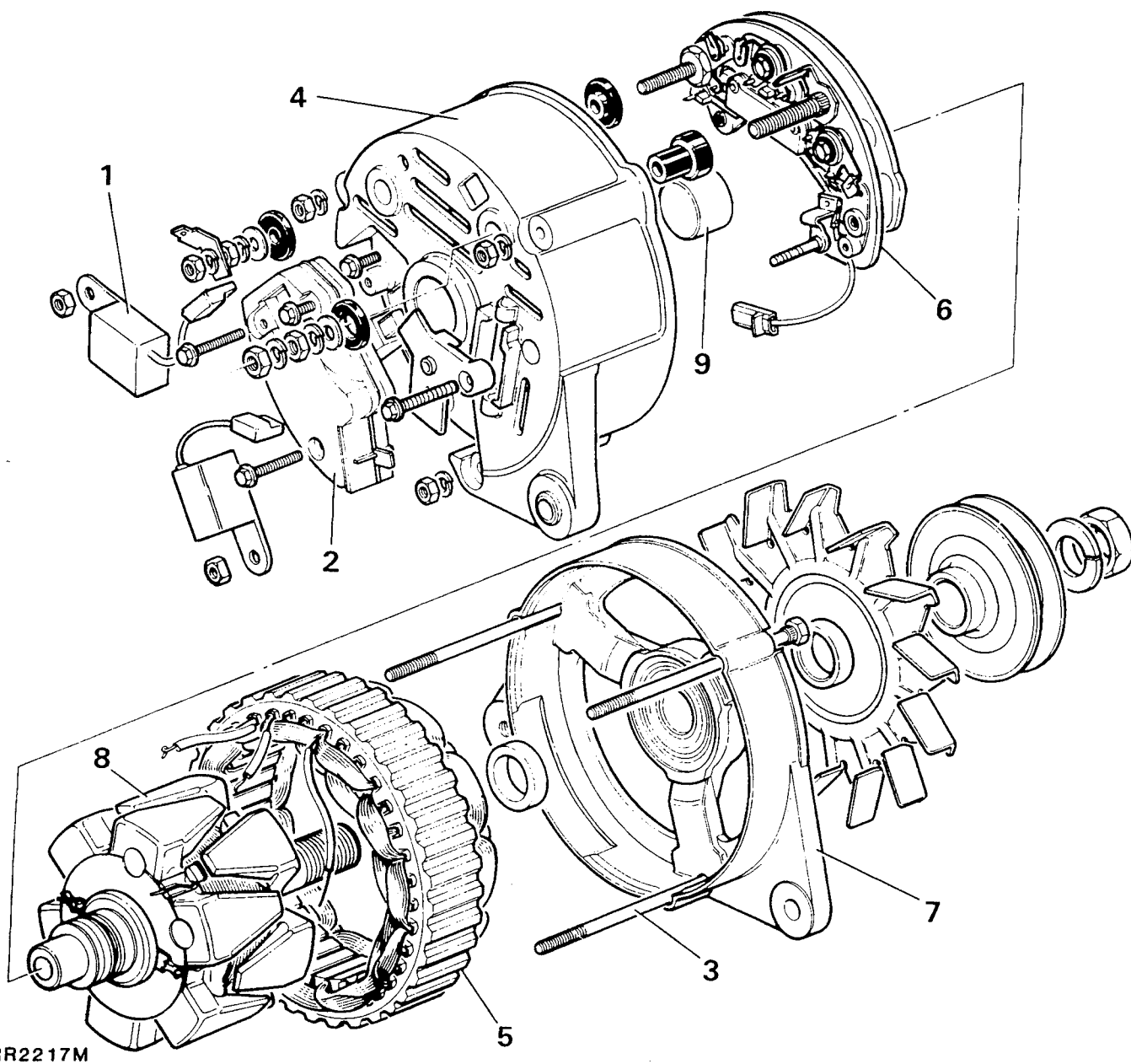
**DISMANTLE**

1. Withdraw the connectors from the alternator.
2. Remove the alternator.
3. Remove the nuts from the through bolts, disconnect the connectors and remove two suppression capacitors.
4. Remove three screws, disconnect one lead and withdraw the regulator and brushbox assembly.
5. Check the brush lengths by measuring length of protrusion from moulding. If dimension **A** is 5mm (0.20in) or less, change the assembly.



RR2218M

## ALTERNATOR — LUCAS A 127-65

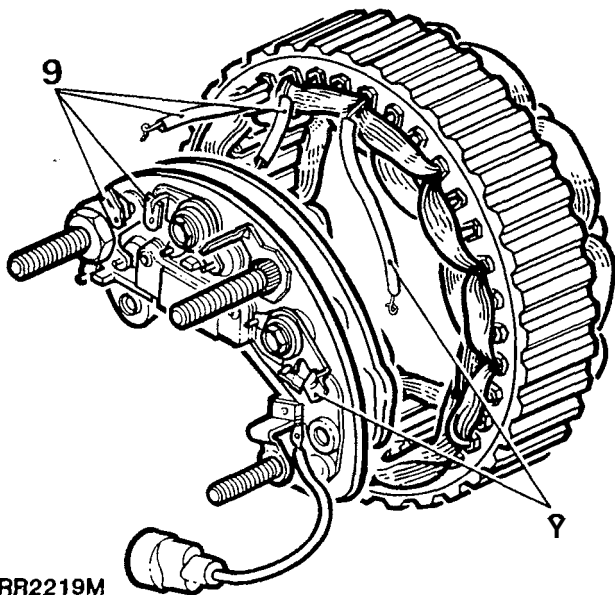


RR2217M

**Service parts**

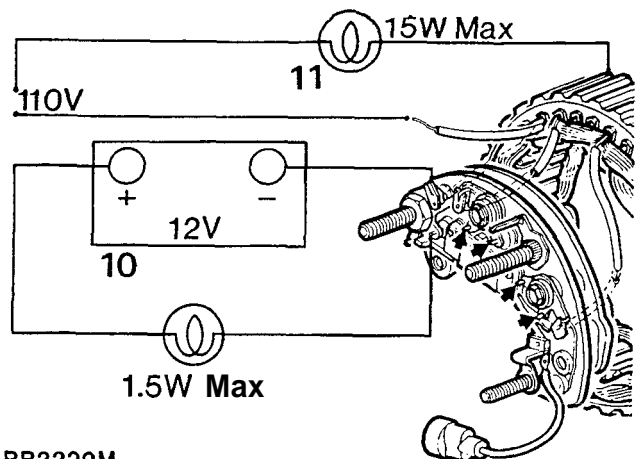
1. Suppression capacitors - 2 off
2. Regulator/Brush box assembly
3. Through bolts
4. Slip ring end (SRE) bracket
5. Stator
6. Rectifier
7. Drive end bracket (DRE)/bearing assembly
8. Rotor
9. Slip ring end bearing

6. Check brush spring pressure using a push type spring gauge. Gauge should register 136 to 279 g (5 to 10 oz) when brush is pressed until face is flush with housing. If reading is outside these limits, renew assembly.
7. Mark the relative positions of the end brackets and stator. Remove through bolts and withdraw slip ring end bracket and stator assembly. Carefully tap the mounting lugs with a mallet if necessary.
8. Remove nuts, washers and insulators from stud terminals noting their position for reassembly. Remove two screws and insulation cover and withdraw rectifier and stator from slip ring end bracket.



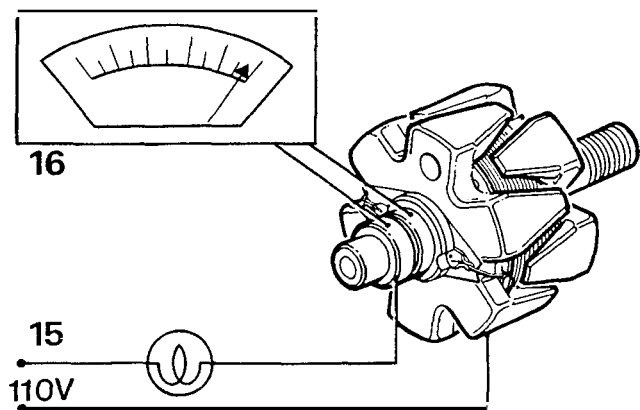
RR2219M

9. Release the stator winding cable ends from the rectifier by applying a hot soldering iron to the terminal tags of the rectifier. Prise out the cable ends when the solder melts, and separate the rectifier and stator. Further dismantling of the rectifier is not required.
10. Check the diodes. Connect the test equipment as shown and test each diode in turn, note whether lamp lights, then reverse test lead connections. The lamp should light in one direction only. Renew the rectifier assembly if a faulty diode is diagnosed.
11. Visually inspect the stator windings for signs of damage or burning. Check the stator insulation using a suitable 110 volt test lamp. Connect the test leads to the laminated yoke and to each of the three leads in turn. If test lamp lights, fit a new stator.
12. Remove the fan and pulley assembly. Push out the rotor shaft from the bearing using a suitable press and remove the spacer from the shaft.



RR2220M

13. Clean surfaces of slip rings using a solvent moistened cloth.
14. Inspect slip ring surfaces for signs of burning, remove burn marks using extra fine glasspaper. On no account should emery cloth or similar abrasives be used, or any attempt made to machine the slip rings.
15. Check the insulation of the rotor field windings, using a suitable 110 volt test lamp connected between one of the slip rings and one of the rotor poles. If the test lamp lights, the rotor must be renewed.



RR2221M

16. Check the resistance/continuity of the rotor field windings by connecting an ohmmeter to the slip rings as shown. A reading of 3.2 ohms should be obtained.
17. Check condition of bearings. If signs of rubbing between rotor poles and stator is evident, both bearings are excessively worn, and must be renewed.
18. Use a suitable press, applying pressure from the rear of the slip ring end bracket, to withdraw or refit the bearing. Note that the drive end bracket and bearing are only supplied as a unit.

**Assembling**

19. Fit the spacer and press the rotor into the drive end bracket. Insert the through bolts. Fit the spacer, fan, pulley and spring washer to the shaft. Fit and tighten the pulley nut to the correct torque.
20. Fit the stator and rectifier assembly to the drive end bracket in the position previously marked.
21. Fit the slip ring end bracket in the position previously marked, locating the regulator lead through its aperture. Fit the insulation cover and tighten two rectifier securing screws.
22. Fit and tighten the through bolt nuts evenly and to the correct torque.
23. Connect the lead to the regulator, locate the brushes on the slip rings and secure the regulator/brushbox assembly, taking care not to damage the brushes.
24. Fit both suppression capacitors.
25. Refit the alternator.

**ALTERNATOR DATA**

Manufacturer .....	Lucas
Type .....	<b>A127/65</b>
Polarity .....	Negative earth
Maximum operating speed .....	15000rev/min
Maximum DC output at 6000 rev/min .....	65 amp
Stator windings .....	3 phase
Stator winding resistance .....	0.15 ohm/phase
Regulator type .....	21TR
Regulator controlled voltage .....	13.6-14.4V
Field winding rotor poles .....	12
Rotor winding resistance .....	3.2 ohms
Brush length - new .....	17 mm (0.67 in) } From
Renew regulator/brushbox assembly at .....	5 mm (0.20 in) } moulding
Brush spring pressure - flush with brushbox moulding .....	1.3-2.7N (4.7-9.8oz)

**TORQUE WRENCH SETTING**

	<b>Nm</b>	<b>lbf ft</b>
Alternator shaft nut .....	50-70	37-52
Alternator through bolts .....	5.5	4.0
Alternator rectifier screws .....	3.5	2.5
Regulator/brushbox screws .....	2.5	2.0
Terminal nut - main output .....	4.0	3.0
Terminal nut - phase .....	4.0	3.0

### ALTERNATOR FUNCTIONAL CHECK

The alternator contains polarity sensitive components that could be permanently damaged if subjected to incorrect polarity.

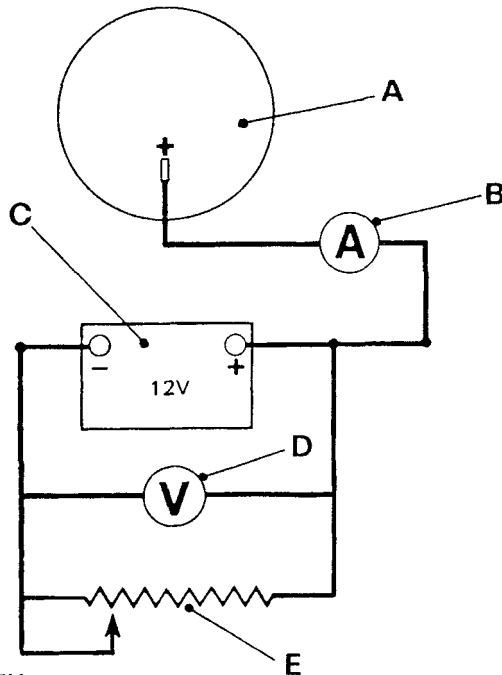
Do not connect or disconnect any part of the charging circuit — including the battery leads — while the engine is running. Run the alternator with all connections made or with the unit disconnected.

This operation must be performed in two parts. The first to prove the alternator's capacity to produce current. The second to prove the performance of the integral regulator.

#### Check capacity to produce current

**NOTE: The stated output may be exceeded slightly when the alternator is cold. To avoid misleading results, the check should be performed with the unit as near to its normal operating temperature as possible.**

1. Check drive belt adjustment.
2. Disconnect the multi-socket connector.
3. Remove the cover and provide a suitable probe and wire to enable the field winding earth brush to be earthed direct thus by-passing the regulator.
4. Provide a test circuit as shown below.
  - A. Alternator
  - B. Ammeter
  - C. 12 volt battery
  - D. Voltmeter
  - E. Variable resistance



ST12B7M

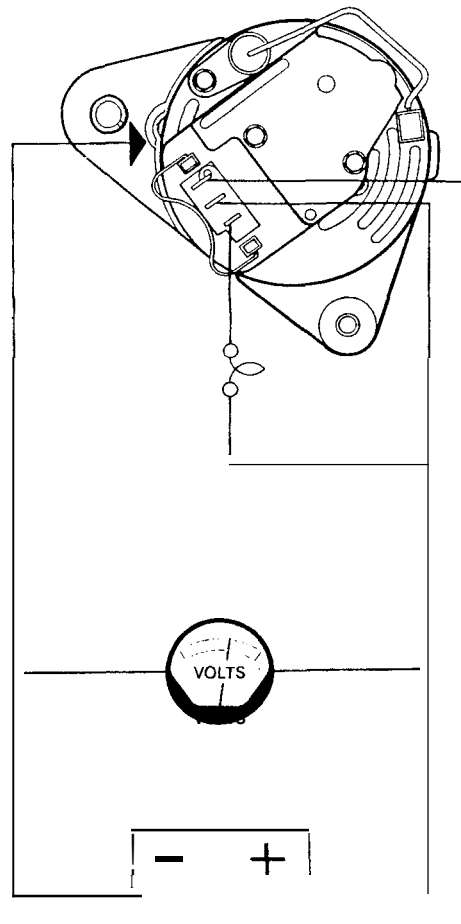
5. Do not connect the variable resistor across the battery for longer than is necessary to perform the check.
6. Run the engine.
7. Gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.

8. Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). Adjust the variable resistor so that the voltmeter reads 14 volts. The ammeter reading should now be approximately equal to the nominal output given in data.
9. If the ammeter reading is not correct the indication is that the alternator requires overhaul or replacement.

#### Check control regulator

**NOTE: The stated output may be exceeded slightly when the alternator is cold. To avoid misleading results, the check should be performed with the unit as near to its normal operating temperature as possible.**

10. Check drive belt adjustment.
11. Disconnect multi-socket connector.
12. Provide a test circuit as shown.



13. Start the engine and gradually increase the speed. At 1550 alternator rev/min (775 engine rev/min) the light should be extinguished.
14. Hold the speed at approximately 6000 alternator rev/min (3000 engine rev/min). The voltmeter reading should now be steady at 13.6 to 14.4 volts.
15. If the voltmeter reading is not steady at the above figure — and a satisfactory 'check capacity to produce current' has been performed — the indication is that the control regulator should be replaced.

## DIODE FAULT SYSTEM

Failure of one or more of the diodes will be indicated by the output of the alternator and in some instances by an abnormally high temperature and noise level. The following fault symptom chart shows how diode failure will influence alternator test results.

Warning Light	Temperature	Noise	output	Probable Fault (Associated Damage)
Illuminated at stand-still, extinguished at cut-in speed (1,500 rev/min) but at higher speeds becomes partially illuminated again and gets progressively brighter	High	Normal	Higher than normal at 6,000 rev/min. Approximately 40A	Live-side main output diode open circuit. (May damage rotor field winding and regulator, overheat, brushboxes, and fuse warning light bulb)
Not illuminated between zero at 1,500 rev/min	High	Excessive	Very low at 6,000 rev/min Approximately 10A	Live-side main output diode short circuit. (May damage associated 'field' diode)
Illuminated at stand-still, dims appreciably at cut-in speed (1,500 rev/min) and gets progressively dimmer or may be extinguished at higher speeds	Normal	Excessive	Poor at low speed Slightly below normal at 6,000 rev/min. Approximately 32A	Earth-side main output diode open circuit
Illuminated at stand-still, dims appreciably at cut-in speed (1,500 rev/min) and gets progressively dimmer or may be extinguished at higher speeds	Normal	Normal	Lower than normal at 6,000 rev/min. Approximately 29A	'Field' diode open-circuit
Illuminated at stand-still, dims at cut-in speed (1,500 rev/min) and remains dim, but may be extinguished at very high speeds	Normal	Excessive	Very low at all speeds above cut-in (1,500 rev/min).	Earth-side main output diode short-circuit, or stator winding short-circuit to earth
Illuminated at stand-still, dims at cut-in speed (1,500 rev/min) and remains dim, but may be extinguished at very high speeds	Normal	Excessive	Very low at 6,000 rev/min Approximately 7A	'Field' diode short-circuit

## ALTERNATOR FAULT AND DIAGNOSIS CHART

ALTERNATOR DOES NOT CHARGE	WORN OR SLACK BELT WORN OR DIRTY BRUSHES BROKEN OR FAULTY ROTOR WINDING BREAK IN CHARGING CIRCUIT OPEN CIRCUIT OR FAULTY FIELD DIODE FAULTY REGULATOR 2 OR 3 RECTIFIER DIODES OF SAME POLARITY FAULTY
WEAK OR IRREGULAR CHARGE	WORN OR SLACK BELT WORN OR DIRTY BRUSHES ONE OR MORE DEFECTIVE RECTIFIER DIODES OPEN OR SHORT-CIRCUITED STATOR FAULTY REGULATOR FAULTY CONNECTIONS
OVER CHARGE	FAULTY REGULATOR FAULTY CONNECTIONS BETWEEN ALTERNATOR AND REGULATOR
NOISY ALTERNATOR	WORN BELT LOOSE PULLEY LOOSE ALTERNATOR MOUNTINGS MISALIGNMENT OF PULLEYS FAULTY BEARING ONE OR SEVERAL RECTIFIER DIODES OPEN OR SHORT-CIRCUITED SHORT-CIRCUITED STATOR

CHECK EACH ITEM IN TURN AND RECTIFY IF NECESSARY BEFORE PROCEEDING TO NEXT ITEM.

**DIESEL ENGINE STARTER MOTOR (2M113)****DISMANTLE TEST AND OVERHAUL****Solenoid Unit**

1. Disconnect link from starter terminal.
2. Unscrew and remove solenoid securing screws and withdraw the solenoid body.
3. Remove plunger complete with seal and nylon block (if fitted) by lifting front end of plunger to release it from the top of the engagement lever.

**Commutator end bracket**

4. Remove the two brush plate securing screws.
5. Remove the two through bolts.
6. Withdraw the commutator end bracket and seal (if fitted). Note position of the dowel pegs in the end of commutator.

**Brush plate assembly**

7. Disengage the brushes and remove the brush plate assembly.

**Yoke assembly**

8. Withdraw the yoke assembly complete with field coils, brushes and seal (if fitted).

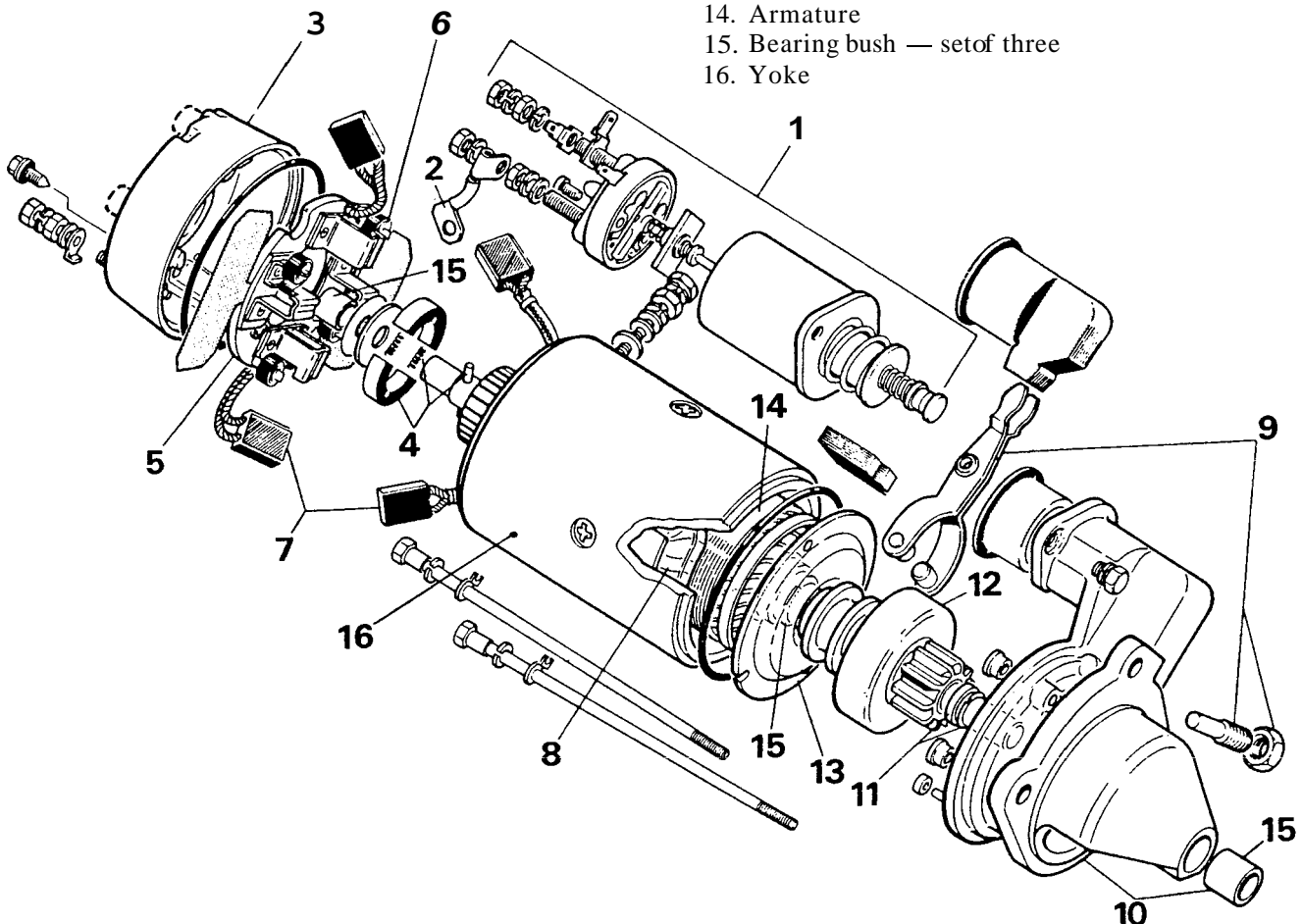
**Drive end bracket**

9. Remove the eccentric pivot pin.
10. Withdraw the drive-end bracket by releasing engagement lever from drive operating collar whilst the bracket is being removed.

continued

**KEY TO STARTER MOTOR COMPONENTS**

1. Solenoid
2. Solenoid — starterlink
3. Bracket assembly — commutator end
4. Brake assembly
5. Brush box mounting plate assembly
6. Brush springs
7. Brush set
8. Field coil assembly
9. Engaging lever assembly
10. Bracket assembly drive-end
11. Retention assembly
12. Drive
13. Bracket assembly, intermediate
14. Armature
15. Bearing bush — set of three
16. Yoke





**Drive assembly and intermediate bracket**

11. Drive the thrust collar back towards the drive pinion away from the jump ring.
12. Prise the jump ring from the groove in the drive shaft.
13. Remove the collar, drive pinion and intermediate bracket from the armature and note the position of the peg in the bracket.

**TEST AND OVERHAUL****Solenoid Windings**

14. Check the continuity and resistance value of the winding, see technical data. If unsatisfactory renew the solenoid.

**Solenoid Contacts**

15. With the solenoid plunger removed, check, with an ohmmeter, the continuity across the main contacts. The reading should be infinity.
16. Fit the plunger and operate it, by hand, to close the contacts. If satisfactory the ohmmeter should register zero.
17. If one or both of the above tests prove unsatisfactory, renew or repair the solenoid.
18. Check the operation of all springs for freedom of movement.

**Brush gear**

19. Check the brushes for damage, wear and length against the figures in the technical data. If necessary renew brushes, but see 'Field Coils' first.
20. Before renewing brushes check the field coils and brush plate assembly.
21. If necessary, clean the brushes with a petrol moistened cloth.
22. Check the brush springs and ensure that the brushes move freely in their holders.

**Drive pinion**

23. Examine the pinion for wear and damage. The pinion should rotate in one direction only, independent of the clutch body. Renew pinion if unsatisfactory.

**Field coils**

24. Inspect the coils for damage and ensure that the insulation tape is firm and not loose. Check all joints for continuity and evidence of burning which indicates an insulation fault.
25. If the brushes are being renewed cut the flexible leads leaving a sufficient length to enable the new brush leads to be joined with a soldered connection.

**Armature**

26. Clean the armature with a petrol moistened cloth.
27. If growler equipment is available check for short-circuited windings.
28. Examine the commutator and if worn or damaged it can be skimmed provided that it is not machined below the minimum diameter of 38 mm (1.5 in).
29. Finally, finish the commutator with fine emery cloth. **Do not undercut the commutator segments.**

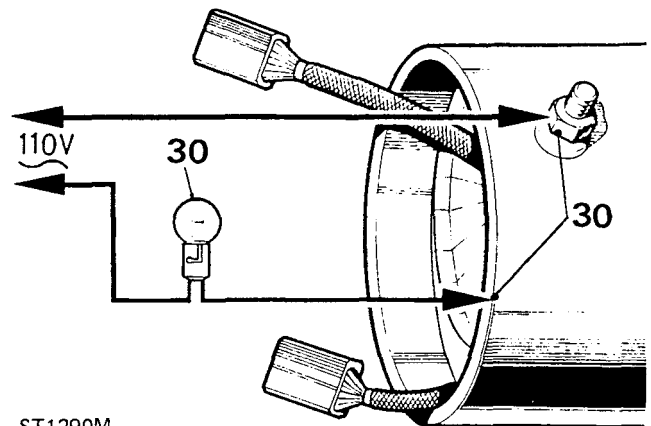
**Insulation test**

Check the insulation of the following components using a 110 V A.C. 15 watt test lamp:

Field coils, armature commutator and windings, insulated brush boxes.

**Field coil insulation**

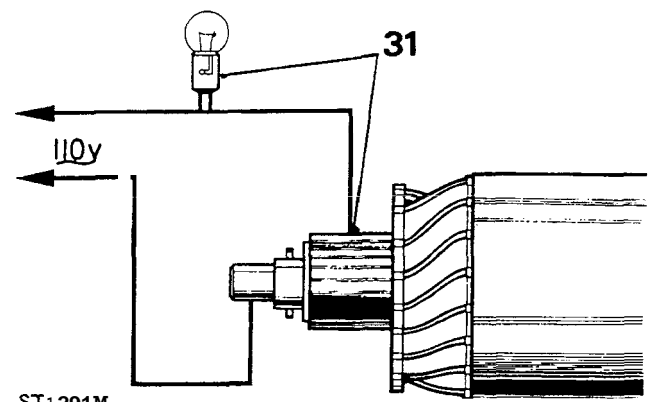
30. Connect the test lamp between the yoke terminal and the yoke. Ensure that the brushes are not touching the yoke. The lamp should **not** light if the insulation is satisfactory. If the lamp does illuminate renew the field coil assembly.



ST1290M

**Armature insulation**

31. Connect the test lamp between any one of the commutator segments and the armature shaft. The lamp should not light, if it does replace the armature.



ST1291M

**Brush box insulation**

32. Connect the test lamp between a clean part of the bracket and each of the two insulated brush boxes in turn. If the test lamp lights renew the commutator end bracket assembly.

**Bearing bushes**

33. If the armature fouls the pole shoes or side play exists between the armature shaft and bush, renew the bearing bushes using a suitable hand press mandrel.

**ASSEMBLE STARTER MOTOR**

Re-assembly is mainly a reversal of the foregoing dismantling procedure. However, the following points should be observed.

**Lubrication**

34. Smear the drive shaft splines and the drive operating collar and bearing surface of the engagement fork with Shell Retinax 'A' grease.

**Armature**

35. Ensure that the brake pin is tight and symmetrically positioned.  
36. Check that the jump ring locates properly in the drive shaft groove and is covered by the thrust collar.

**Drive-end and intermediate brackets**

37. Ensure that the dowel peg in the drive-end bracket aligns with matching location in the intermediate bracket before offering the yoke into position.

**Brush plate**

38. Wedge the earth brushes in raised position with brush springs.  
39. Offer the brush plate into position and fit the field coil brushes in the boxes.  
40. Release the earth brushes and position the springs.  
41. Ensure that the brushes move freely in the holders.

**Commutator end bracket**

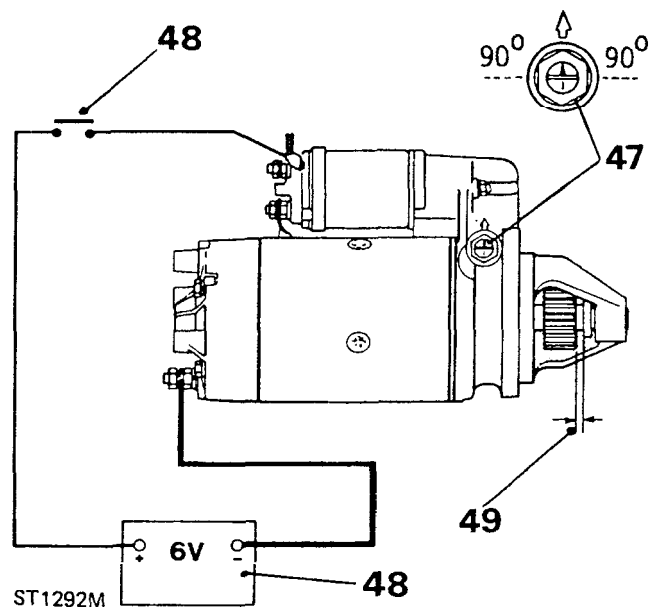
42. Check that the earth stud is fixed securely.  
43. Ensure that the armature brake pin and slots in the brake shoes align with each other.  
44. Make sure that the fixing holes in the brush plate line up with the holes in the commutator end bracket.  
45. Check that the through bolts are aligned with the threaded holes in the drive-end bracket.

**Solenoid**

46. Ensure that the plunger locates properly with the operating lever.

**Pinion setting**

47. Screw the eccentric pivot pin fully into the casing and slacken one full turn and position as illustrated with arrow on the pin in line with the arrow on casing and tighten locknut. This provides an initial setting for final adjustment.  
48. Connect up the starter, as illustrated, using a 6 volt supply and operate a starter control switch so that the pinion will move into the engaged position without rotating.  
49. Whilst maintaining this position press back the pinion towards the yoke. Insert a feeler gauge between the pinion end face and jump ring collar. The correct clearance should be 0,13 to 0,38 mm (0.005 to 0.015 in).  
50. If adjustment is required, release the locknut and turn the pivot pin as necessary to achieve the correct setting. Apply 'gold size' to the threads of the pivot pin and locknut and tighten the latter to the correct torque.



## TECHNICAL DATA

**Starter performance (2M113)**

Minimum battery requirement .....	12 V 128 Ah (20 hr rate) battery at least 70% charged.	
Lock torque .....	39.4 Nm 4.0 Kg m 29.0 lb ft	} 940 A max at 6.5 V min
Torque at 1000 rev/min .....	14.9 Nm 1.5 Kg m 11.0 lb ft	
Light running current .....	100 A max at 5,000 - 7,500 rev/min	

**Solenoid Windings Resistance**

Operating winding resistance .....	0.145 - 0.165 ohms
measured between small unmarked Lucar terminal and main terminal marked 'STA'.	
Hold-on winding resistance .....	0.46 - 0.56 ohms
measured between small unmarked Lucar terminal and earth point on solenoid body.	

**Brushgear**

New brush length .....	22.2 mm ( $\frac{7}{8}$ in) $\pm$ 0.50 mm (0.020 in)
Renew brush at .....	8 mm ( $\frac{5}{16}$ in)

**Armature end-float**

Cast aluminium intermediate bracket .....	0.03 - 1.4 mm (0.001 - 0.056 in)
Pressed steel intermediate bracket .....	0.03 - 1.55 mm (0.001 - 0.061 in)

**Commutator**

Commutator minimum diameter .....	38 mm (1.5 in)
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## TIGHTENING TORQUES

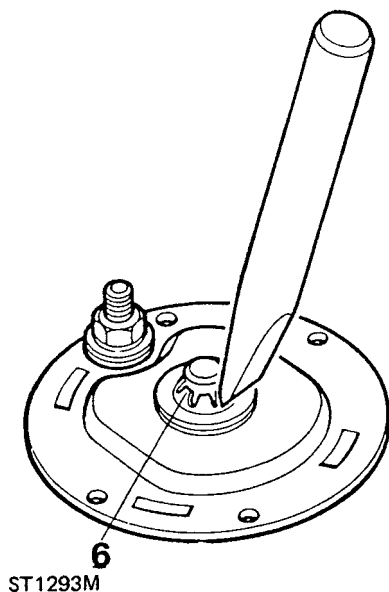
Solenoid main 'BAT' terminal cable fixing nut .....	3.9 Nm (2.9 lb ft)
Solenoid/starter link terminal fixing nuts .....	3.5 Nm (2.6 lb ft)
Solenoid end cover fixing screws .....	2.82 Nm (2.1 lb ft)
Solenoid unit fixing screws .....	6 Nm (4.5 lb ft)
Brush plate fixing screws .....	7 Nm (5.0 lb ft)
Starter earth stud, nuts .....	6 Nm (4.5 lb ft)
Pole shoe fixing screws .....	40.68 Nm (30 lb ft)
Through bolts .....	10.84 Nm (8 lb ft)
Eccentric pivot pin locknut .....	20 Nm (15.0 lb ft)

## V8 ENGINE STARTER MOTOR (3M100PE)

## DISMANTLE TEST AND OVERHAUL

## DISMANTLE

1. Remove the starter motor.
2. Remove the connecting link between the starter and the solenoid terminal 'STA'.
3. Remove the solenoid from the drive end bracket.
4. Grasp the solenoid plunger and lift the front end to release it from the top of the drive engagement lever.
5. Remove the end cap seal.
6. Using an engineer's chisel, cut through a number of the retaining ring claws until the grip on the armature shaft is sufficiently relieved to allow the retaining ring to be removed.



7. Remove the two through-bolts.
8. Partially withdraw the commutator end cover and disengage the two field coil brushes from the brush box.
9. Remove the commutator end cover.
10. Withdraw the yoke and field coil assembly.
11. Withdraw the pivot pin.
12. Withdraw the armature.
13. Using a suitable tube, remove the collar and jump ring from the armature shaft.
14. Slide the thrust collar and the roller clutch drive and lever assembly off the shaft.

## TEST AND OVERHAUL

## Clutch

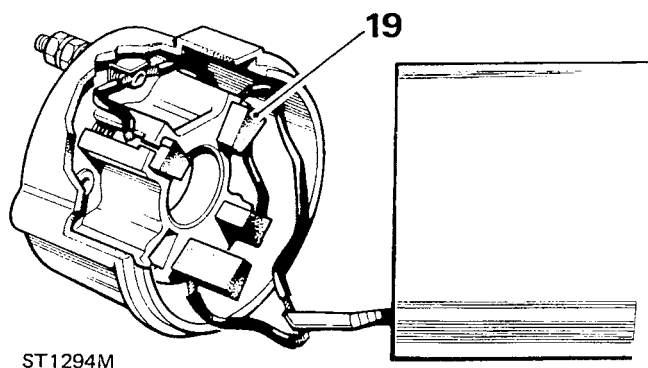
16. Check that the clutch gives instantaneous take-up of the drive in one direction and rotates easily and smoothly in the other direction.
17. Ensure that the clutch is free to move round and along the shaft splines without any tendency to bind.

**NOTE: The roller clutch drive is sealed in a rolled steel cover and cannot be dismantled.**

18. Lubricate all clutch moving parts with Shell SB 2628 grease for cold and temperate climates or Shell Retinax 'A' for hot climates.

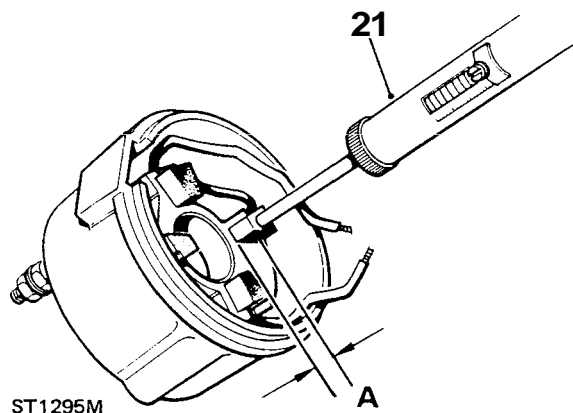
## Brushes

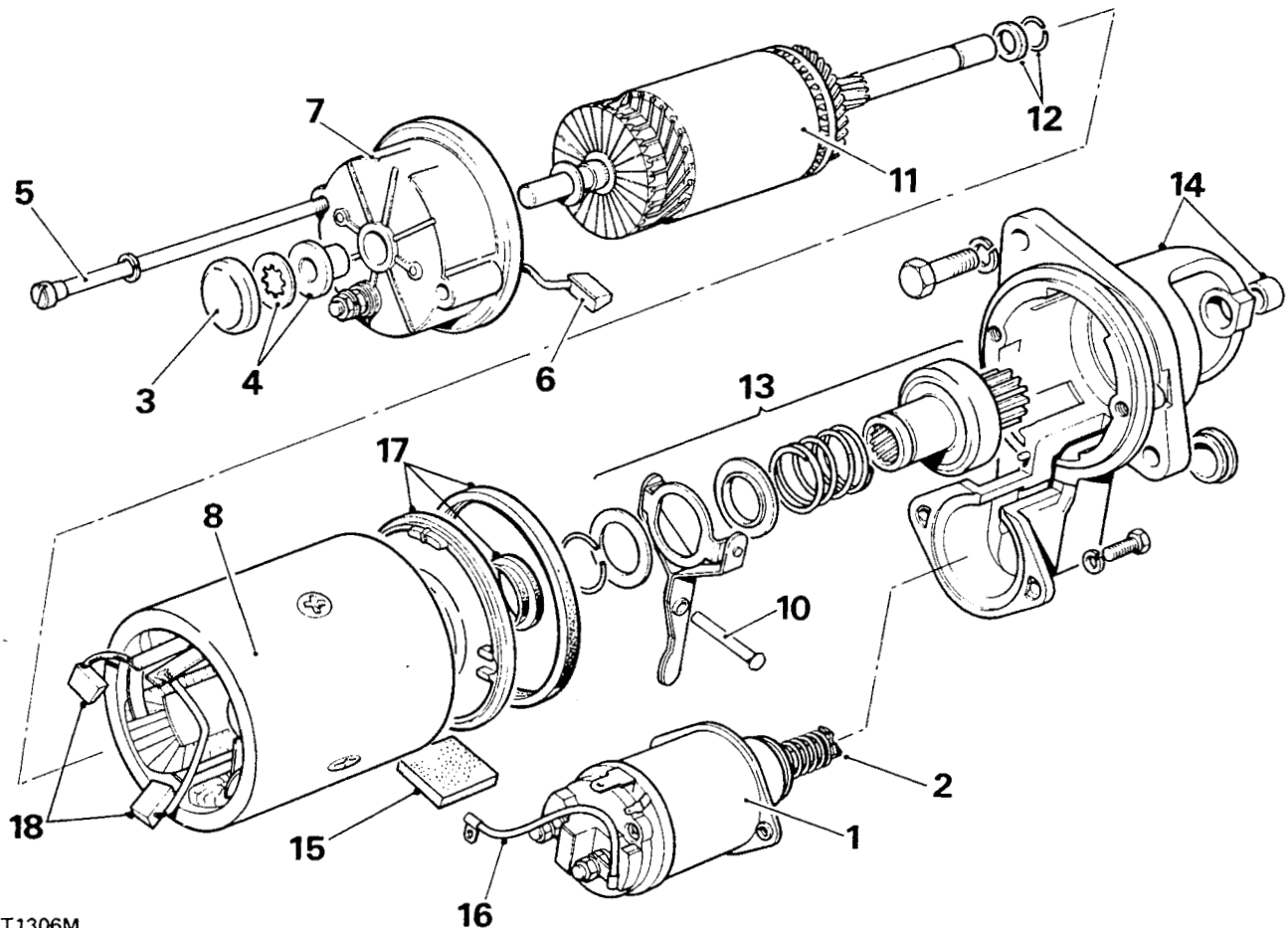
19. Check that the brushes move freely in the brush box moulding. Rectify sticking brushes by wiping with a petrol-moistened cloth.



20. Fit new brushes if they are damaged or worn to approximately 9,5 mm (0.375 in).
21. Using a push-type spring gauge, check the brush spring pressure. With new brushes pushed in until the top of the brush protrudes about 1,5 mm (0.065 in) from the brush box moulding, dimension A, the spring pressure reading should be 1,0 kgf (36 ozf).

continued





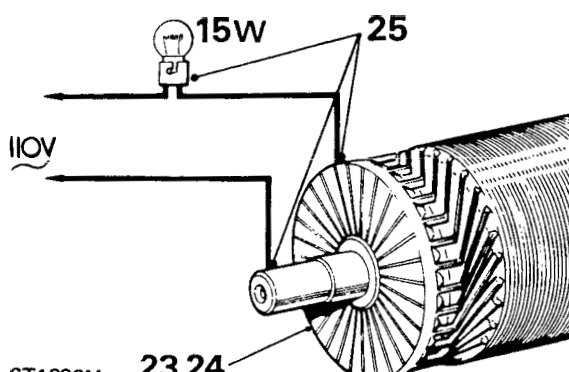
ST1306M

## KEY TO STAKTER MOTOR COMPONENTS

22. Check the insulation of the brush springs by connecting a 110 V A.C. 15W test lamp between a clean part of the commutator end cover and each of the springs in turn. The lamp should not light.

## Armature

23. Check the commutator. If cleaning only is necessary, use a flat surface of very fine glass paper, and then wipe the commutator surface with a petrol-moistened cloth.
24. If necessary, the commutator may be machined provided a finished surface can be obtained without reducing the thickness of the commutator copper below 3,5 mm (0.140 in), otherwise a new armature must be fitted. **Do not undercut the insulation slots.**

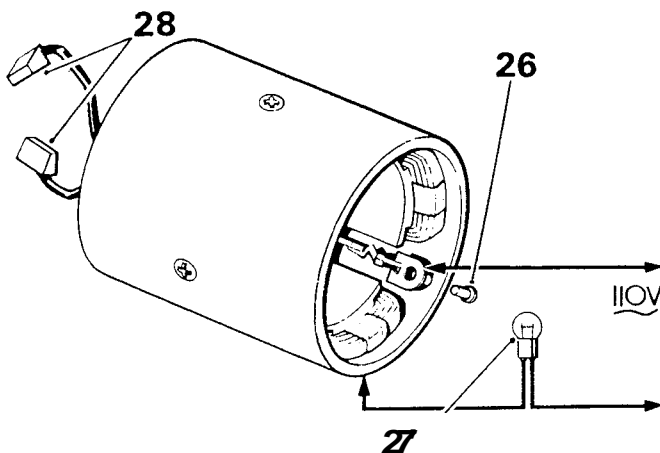


1. Solenoid
2. Solenoid plunger
3. End cap seal
4. Spire ring and bush
5. Through bolts
6. Brush plate brushes
7. Commutator end cover
8. Yoke and field coil assembly
9. Retaining ring
10. Pivotpin
11. Armature
12. Collar and jump ring
13. Thrust collar and roller clutch drive and lever assembly
14. Drive-end bracket and bush
15. Rubber block
16. Connecting link between starter and solenoid
17. Intermediate bracket and seals
18. Field coil brushes

25. Check the armature insulation by connecting a 110 V A.C. 15 W test lamp between any one of the commutator segments and the shaft. The lamp should not light; if it does light, fit a new armature.

**Field coil insulation**

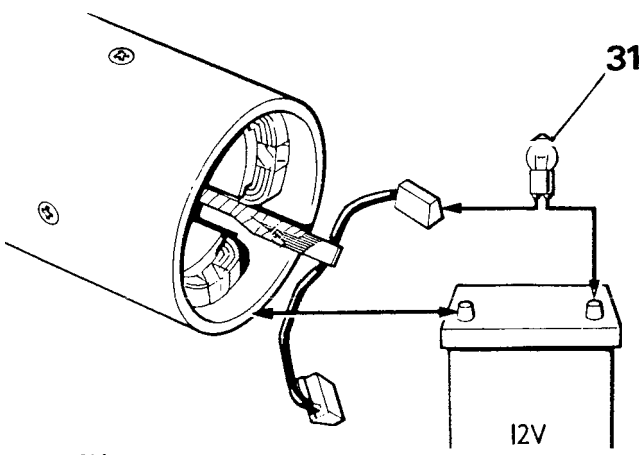
26. Disconnect the end of the field winding where it is riveted to the yoke, by filing away the riveted over end of the connecting-eyelet securing rivet, sufficient to enable the rivet to be tapped out of the yoke.
27. Connect a 110 V A.C. 15 W test lamp between the disconnected end of the winding and a clean part of the yoke.
28. Ensure that the brushes or bare parts of their flexibles arc not touching the yoke during the test.
29. The lamp should not light; if it does light, fit a new field coil assembly.
30. Re-secure the end of the field winding to the yoke.



ST1297M

**Field coil continuity**

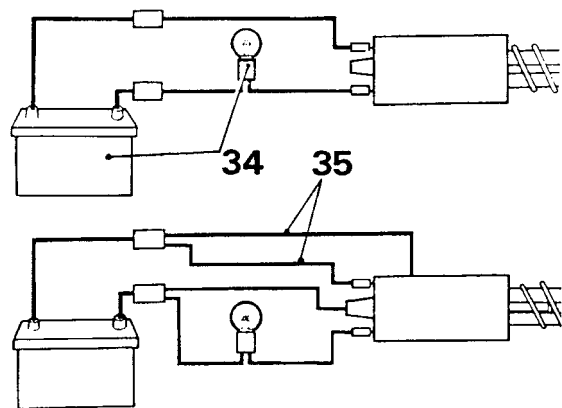
31. Connect a 12 V battery-operated test lamp between each of the brushes in turn and a clean part of the yoke.
32. The lamp should not light; if it does light, fit a new field coil assembly.



ST1298M

**Solenoid**

33. Disconnect all cables from the solenoid terminals and connectors.
34. Connect a 12 V battery and a 12 V 60 W test lamp between the solenoid main terminals. The lamp should not light; if it does light, fit new solenoid contacts or a new solenoid complete.
35. Leave the test lamp connected and, using the same 12 V battery supply, energize the solenoid by connecting 12 V between the small solenoid operating Lucar terminal blade and a good earth point on the solenoid body.
36. The solenoid should be heard to operate and the test lamp should light with **full** brilliance, otherwise fit new solenoid contacts or a new solenoid complete.



ST1299M

**ASSEMBLE**

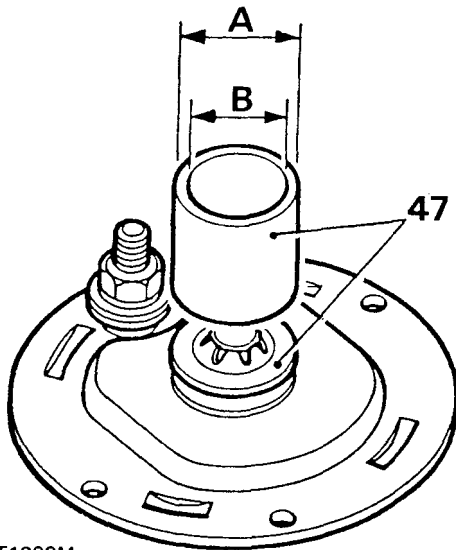
37. Fit the intermediate bracket and inner seal over the armature shaft.
38. Slide the thrust collar and the roller clutch drive and lever assembly onto the armature shaft.
39. Fit the jump ring and collar to the armature shaft.
40. Fit the armature.
41. Fit the pivot pin and splay the end.
42. Fit the yoke and field coil assembly and ensure that the dowel peg in the drive-end bracket aligns with matching location in the intermediate bracket before offering the yoke into position.
43. Fit the internal thrust washer to the shaft.
44. Engage the two field coil brushes in the brush box and fit the commutator end cover.
45. Secure the assembly with the two through bolts and tighten to the correct torque.
46. Fit the sintered bearing bush.

continued

47. Using a suitable tube, drive a new spire ring into position, as illustrated. The position of the spire ring on the armature shaft determines the armature end-float which should be 0,25 mm (0.010 in) maximum between the spire retaining ring and the sintered bearing bush shoulder. Care, therefore, must be used when fitting the spire ring.

Dimension A 25,4 mm (1.00 ins)

Dimension B 19 mm (0.75 ins)



ST1300M

48. Fit the end cap seal.  
49. Fit the solenoid to the drive-end bracket whilst locating the drive engagement lever.  
50. Fit the connecting link between the starter and solenoid terminal 'STA'.

## PETROL ENGINE 2.25 LITRE STARTER MOTOR (2M100) LUCAS.

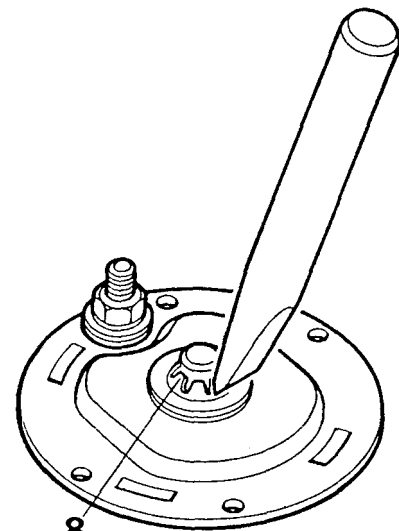
### DISMANTLE TEST AND OVERHAUL

#### DISMANTLE

1. Remove the nut securing the (solenoid-to-starter) connecting link to the solenoid 'STA' terminal.
2. Pull back the connecting link from the solenoid terminal.
3. Remove the nuts securing the solenoid to the drive-end bracket.
4. Remove the solenoid unit from the drive-end bracket.
5. Lift the solenoid plunger and return spring from the engagement lever.
6. Remove the block-shaped grommet.

**NOTE:** Before carrying out instructions 7 to 14 ensure that new retaining rings are available for the armature shaft and the engagement lever pivot pin are available for reassembly of the starter.

7. Remove the end cap seal.
8. Using an engineer's chisel, cut through a number of the retaining ring claws until the grip on the armature shaft is sufficiently relieved to allow the retaining ring to be removed.



ST1301M

9. Remove the through-bolts.
10. Detach the commutator end cover from the yoke, disengaging the field brushes from the brush box moulding, and remove the end-cover.
11. Remove the thrust washer from the armature shaft.
12. Withdraw the yoke from the armature and drive-end assembly.

13. Drive the pivot pin from the engagement lever and drive-end bracket.
14. Move the thrust collar clear of the jump ring, and remove the jump ring from the armature shaft.
15. Remove the thrust collar.
16. Remove the roller clutch drive and engagement lever assembly and intermediate bracket assembly from the armature shaft.

## INSPECTION

### Brush gear

17. Check the brush spring tension using a spring balance; renew a spring if its tension is not within the limits given.
18. Check the brushes for wear; renew any brush worn to or approaching the minimum length.
19. To renew a brush, unsolder the flexible connection, remove the brush and re-solder the flexible connection of the new brush in place. New brushes are pre-formed and do not require bedding to the commutator.

### Commutator

20. Clean the commutator with a cloth moistened with fuel and examine it for burns, pitting, and excessive wear.
21. Carry out instructions 22-24 to recondition the commutator.
22. Skim the commutator at high speed using a very sharp tool and removing the minimum amount of metal necessary to restore the surface.

23. Polish the commutator with very fine sandpaper.
24. Using an air blast, clean any copper residue from the armature.

**IMPORTANT: The commutator segment insulators must not be undercut.**

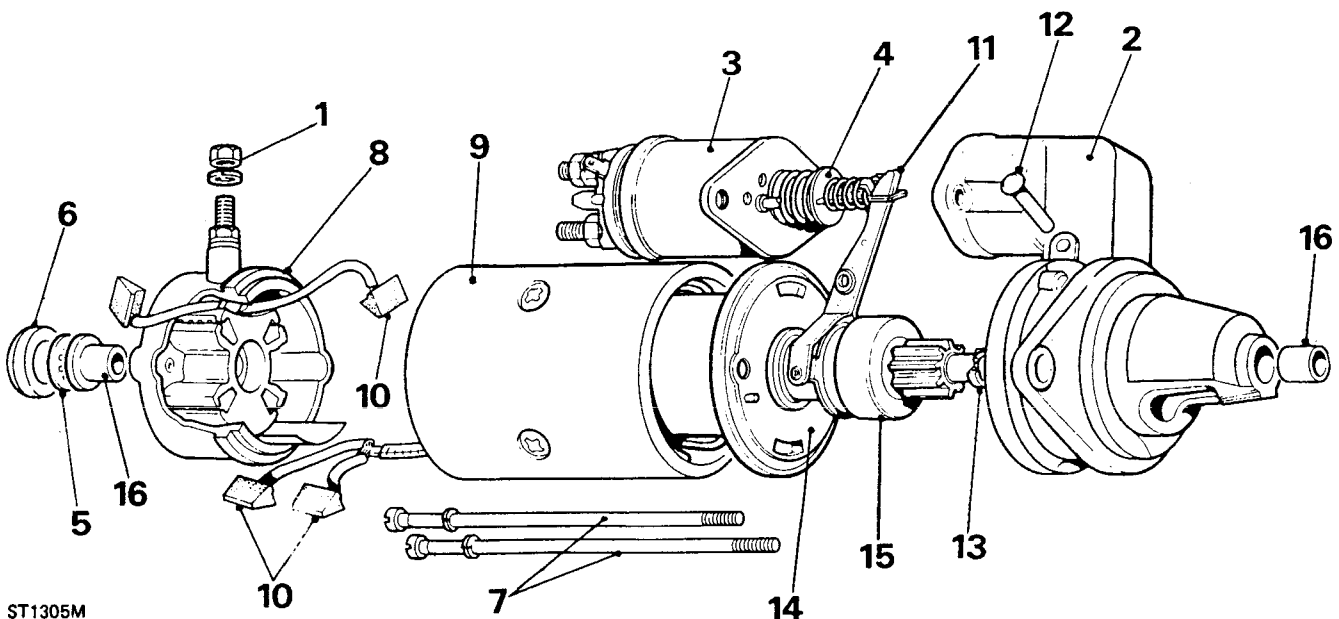
### Armature

25. Test the insulation of the armature windings with a 12-volt test lamp and battery connected between the armature shaft and the commutator; if the lamp lights the armature must be renewed.
26. Check the windings at their connections with the commutator riser for signs of melted solder or lifted conductors.

continued

## KEY TO STARTER MOTOR

1. Nut securing connecting link to STA terminal
2. Drive-end bracket
3. Solenoid
4. Solenoid plunger and return spring
5. Spire ring
6. End cap seal
7. Through bolts
8. Commutator end cover
9. Yoke
10. Field coil and brush plate brushes
11. Engagement lever
12. Pivotpin
13. Thrust collar and jump ring
14. Intermediate bracket
15. Roller clutch drive assembly
16. Bush



ST1305M



27. Check the shaft for distortion; if the shaft is bent or distorted the armature must be renewed. Do not attempt to straighten the shaft or machine the armature core laminations.

### Field windings

28. Connect a 12-volt battery-operated test lamp between each of the field brushes and a clean part of the yoke; the lamp will light if continuity is satisfactory between the brushes, windings, and yoke connection.
29. Disconnect the field windings from the riveted connection with the yoke. Using a 110-volt A.C., 15-watt test lamp connected between each of the brushes in turn and the yoke, check the insulation of the field windings, if the lamp lights the windings must be renewed. The field windings may be renewed as follows:
30. Disconnect the end of the field winding where it is riveted to the yoke.
31. Remove the four pole-shoe retaining screws using a wheel-operated screwdriver.
32. Withdraw the field coil assembly from the yoke.
33. Clean the inside of the yoke and insulating pieces which the through-bolts locate.
34. Loosely fit the new field coil assembly with the pole-shoes into the yoke.
35. Fit the pole-shoe retaining screws but do not tighten.
36. Slide the insulating pieces between the field coils and the yoke, positioned 90° each side of the field coil brush connection point.
37. Tighten the pole-shoe screws evenly using a wheel-operated screwdriver, to the correct torque.
38. Reconnect the end of the winding to the yoke.

### Commutator end bracket

39. Check the insulation of the brush springs by connecting a 110-volt A.C., 15-watt test lamp between a clean part of the commutator end cover and each of the springs in turn; the lamp will light if the insulation is not satisfactory.

### Bearings

40. If the bearings in the commutator end cover and the drive-end bracket are worn sufficiently to allow excessive side-play of the armature shaft, the bearing bush must be renewed as follows; instructions 41 and 42.
41. Support the bracket and drive out the bush using a suitable sized mandrel.
42. Using a polished, shouldered mandrel, the same diameter as the shaft bearing journal, press the new bushes into the brackets.

### Roller clutch drive

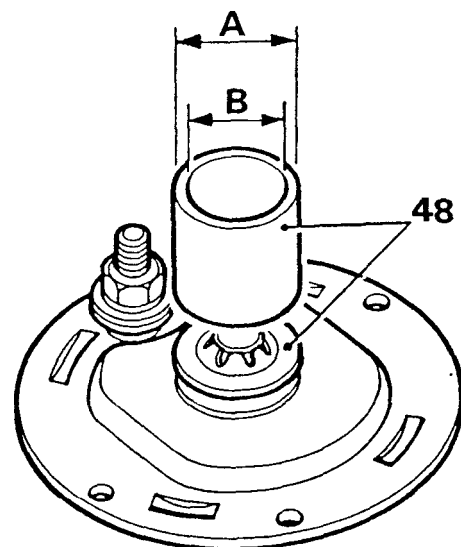
43. Check the operation of the drive clutch, it should provide instantaneous take-up of the drive in one direction and rotate easily and smoothly in the other direction.
44. Check that the drive moves freely on the armature splines without binding or sticking.

### ASSEMBLE

45. Reverse instructions 1 to 16 whilst observing the following instructions 46 to 48, also ensure that the dowel peg in the drive-end bracket aligns with matching location in the intermediate bracket before offering the yoke into position.
46. When assembling the drive-end bracket use a new engagement lever pivot pin, and splay the end.
47. Ensure that the internal thrust washer is fitted to the commutator end of the armature shaft before the armature end cover is fitted.
48. Using a suitable tube, drive a new spire ring into position, as illustrated. The position of the spire ring on the armature shaft determines the armature end-float which should be 0,25 mm (0.010 in) maximum between the spire retaining ring and the sintered bearing bush shoulder. Care, therefore, must be used when fitting the spire ring.

Dimension A 25,4 mm (1.00 in)

Dimension B (19 mm (0.75 in)



ST1302M

### BENCH TEST

#### Lock torque and current

49. Clamp the starter firmly in a vice. Connect a starter switch, a 0-600 amp ammeter and a 12-volt battery in series to the starter.
50. Connect a voltmeter between the solenoid two main terminals.
51. Secure an arm to the driving pinion, and connect a spring balance to the free end of the arm.

52. Operate the switch and note the ammeter, voltmeter, and spring balance readings. Calculate the lock torque by multiplying the reading of the spring balance in pounds by the length of the arm in feet.
53. Check the readings obtained in instruction 52 against the figures given in **DATA** for lock torque current and voltage.

**NOTE: If a constant-voltage supply is used for this test, a higher voltage may be registered on the voltmeter than the figure given. If this should occur a variable resistance must be added to the circuit and adjusted to give the required reading and the test repeated.**

#### Solenoid — Coil

54. Check the continuity of the coil windings between the terminal 'STA' and a good earth point on the solenoid body, using an ammeter (in series); a reading of 11.2 to 11.8 amps should be obtained. If **no** reading, renew the solenoid.
55. Using an ohmmeter connected between the small unmarked Lucar terminal and terminal 'STA' check the resistance of the closing (series) winding; if the reading differs considerably from the limits given the solenoid must be renewed.

56. Using an ohmmeter connected between the small unmarked Lucar terminal and a good earth on the solenoid body, check the resistance of the hold-on (shunt) winding; if the reading differs considerably from the limits given, the solenoid must be renewed.

#### Solenoid contacts

57. Check the contacts for correct opening and closing by carrying out the instructions 49 to 51 plus the following instruction 58.
58. Operate the switch and note the voltmeter reading; it should register practically zero if the solenoid is satisfactory. Alternatively the solenoid should be checked by substitution.
59. The contacts must only be renewed as a set, e.g. moving and fixed contacts. The fixed contacts are an integral part of the moulded cover. Renew a set of contacts by following instructions 60 to 66.
60. Remove the screws securing the terminal and base assembly to the solenoid.
61. Unsolder the coil connections from the cover terminals.
62. Clamp the solenoid in a vice.
63. Remove the terminal and base assembly.
64. Assemble the new terminal and base assembly.
65. Resolder the connections to the terminal and base assembly.
66. Refit the securing screws and tighten to correct torque.

#### TECHNICAL DATA

Brush spring tension .....	1,02 kg (36 oz)
Minimum brush length .....	9,5 mm (0.375 in)
Minimum commutator thickness .....	3,5 mm (0.140 in)
Lock torque .....	2,02 kgm (14.4 lb ft) with 463 amps
Torque at 1,000 r.p.m. ....	1,02 kgm (7.3 lb ft) with 300 amps
Light running current .....	40 amp at 6,000 r.p.m. (approx.)
Maximum armature end-float .....	0,25 mm (0.010 in)

#### Solenoid

Closing (series) winding resistance .....	0.25 to 0.27 ohm
Hold on (shunt) winding resistance .....	0.76 to 0.80 ohm

#### TIGHTENING TORQUES

Drive-end bracket nuts .....	6 Nm (4.5 lb ft)
Through bolts .....	10 Nm (8 lb ft)
Pole-shoe screws .....	40 Nm (30 lb ft)
Solenoid base assembly screws .....	2 Nm (1.8 lb ft)

**STARTER MOTOR — Paris Rhone — 4 cylinder Diesel****Dismantle and Test****DISMANTLE**

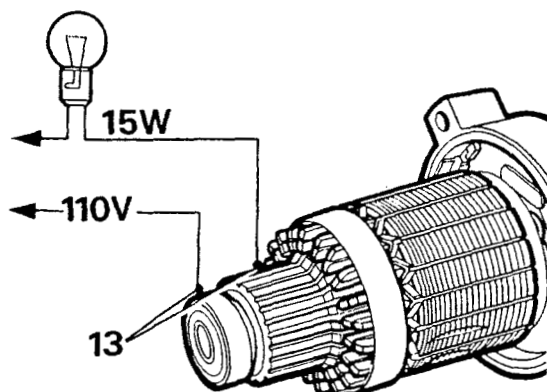
1. Remove starter motor from engine.
2. Disconnect field winding lead from the solenoid.
3. Remove the two nuts and withdraw the solenoid, plunger and spring.
4. Remove the terminal strap.
5. Remove the two through-stud nuts.
6. Remove the brush plate cover.
7. Withdraw the yoke complete with brush plate assembly whilst noting the position of the yoke location plate in the reduction gear housing.
8. Remove the single socket headed screw and withdraw the armature and reduction gear housing from the drive-end bracket.
9. Remove the clutch drive and pinion assembly.
10. Withdraw the brushes from the holders.

**Inspection and test**

11. Examine all parts for condition. Check the bearings and bushes and pinion drive assembly for wear. Examine the reduction drive pinion and drive gear internal teeth. Check the field coil and armature brushes.

**Armature**

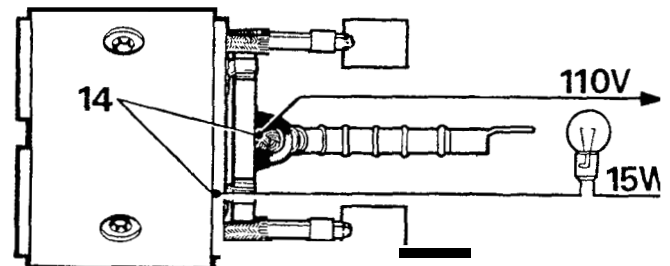
12. Using very fine glass paper, clean the commutator and wipe the surface with a petrol-moistened cloth. Do not undercut the insulation slots.
13. Check the armature insulation by connecting a 110 V.A.C. 15 W test lamp between each commutator segment in turn and the armature shaft. The lamp should not light.



ST1846M

**Field coil insulation**

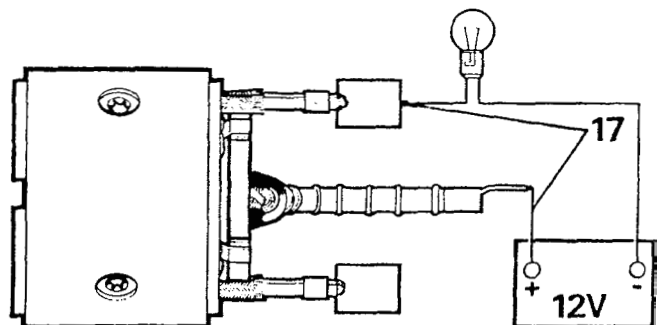
14. Connect a 110 V.A.C. 15 W test lamp between the disconnected end of the winding and a clean part of the yoke,
15. Ensure that the brushes or leads do not touch the yoke during the test.
16. The lamp should not light; if it does light, fit a new field coil assembly.



ST1847M

**Field coil continuity**

17. Connect a 12 V battery-operated test lamp between each brush in turn and a link lead.
18. The lamp should light; if it does not light, fit a new field coil assembly.

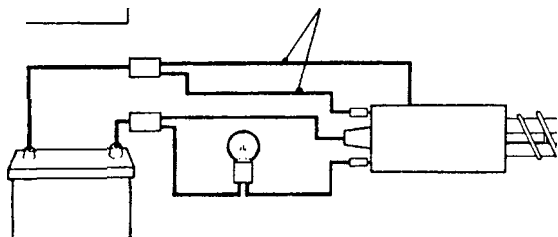


ST1848M

**Solenoid**

19. Disconnect all cables from the solenoid terminals and connectors.
20. Connect a 12 V battery and a 12 V 60 W test lamp across the solenoid main terminals. The lamp should not light; if it does light, fit a new solenoid complete.
21. Leave the test lamp connected and, using the same 12 V battery supply, energize the solenoid by connecting a 12 V supply between the small solenoid operating Lucar terminal blade and a good earth point on the solenoid body.

continued

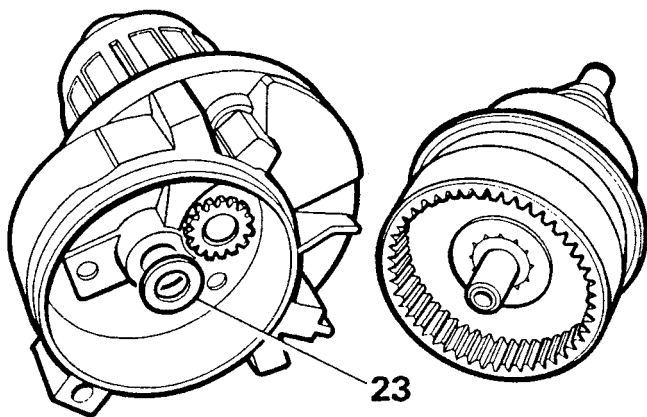


ST1853M

22. The solenoid should be heard to operate and the test lamp should light with full brilliance, otherwise fit a new solenoid complete.

#### ASSEMBLE

23. Fit the round rubber pad to the drive-end bracket.  
 24. Fit the lever to clutch drive and pinion assembly and fit to the drive-end bracket ensuring that the two washers are in position on the shaft.  
 25. Check that the fibre washer is positioned on the shaft inside the reduction gear.



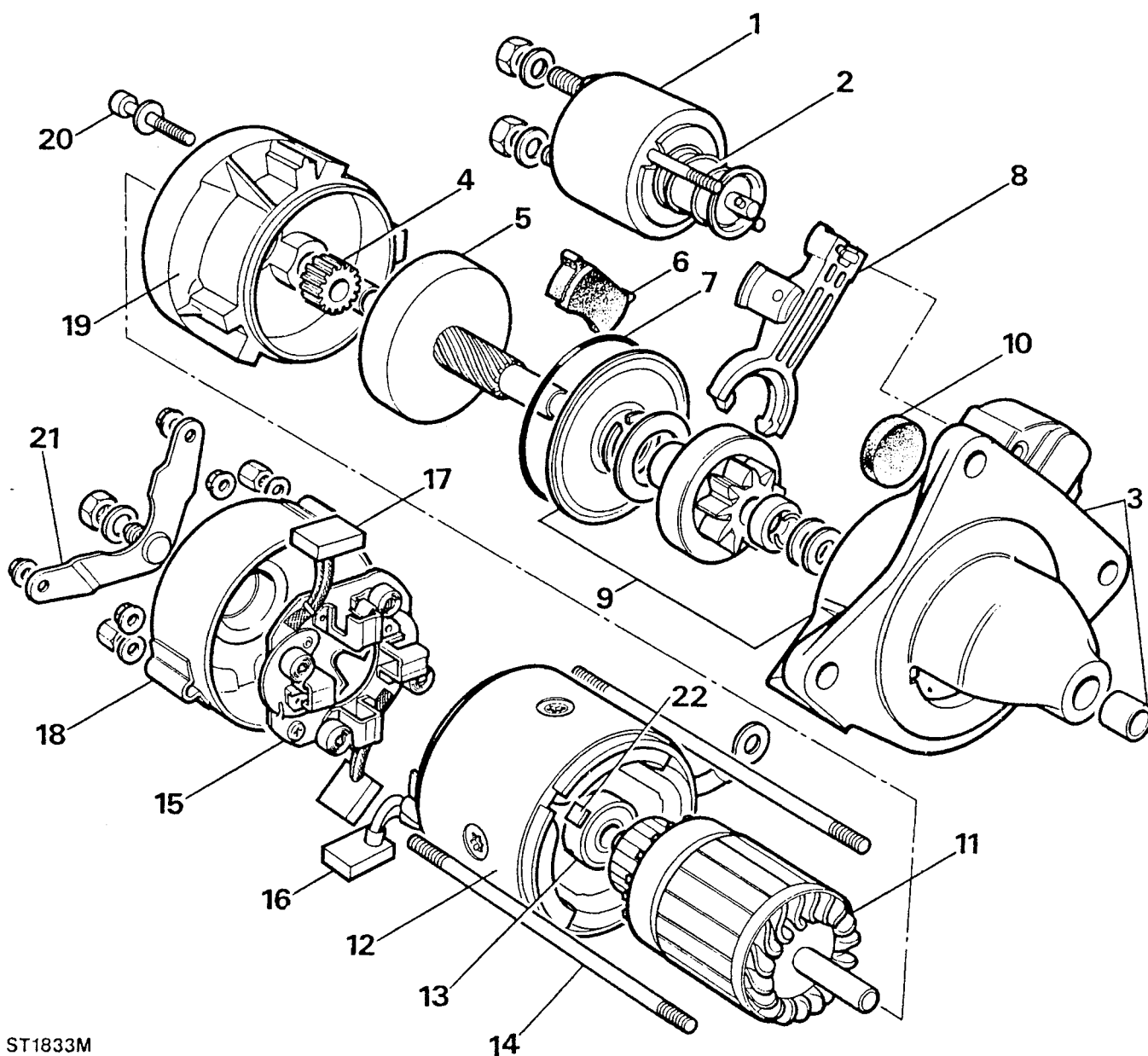
ST1849M

26. Place the rubber pad, with plain side towards the drive-end bracket fit the 'O' ring seal and assemble the reduction gear housing to the drive-end bracket and secure with the single socket-headed bolt.  
 27. Place the yoke location plate in position in the slot in the reduction gear housing and fit the yoke and brush plate to the armature.  
 28. Insert the brushes into their holders and release the retaining springs. Ensure that the brushes rest correctly on the commutator.

29. Fit the through-studs to the drive-end bracket.  
 30. Fit the brush plate cover and secure to the brush plate with the two nuts.  
 31. Secure the assembly with the through-stud nuts.  
 32. Fit the terminal strap to the through-studs and retain with the two nuts.  
 33. Fit the coil spring to the solenoid plunger and assemble the solenoid to the drive-end bracket and secure with the two nuts.  
 34. Check that the starter motor turns freely without tight spots.

#### TIGHTENING TORQUES

Battery connection	11 NM
Earth connection	11 NM
Socket headed screw	7-C 1,4 NM
Field winding to solenoid nut	$9,5 \pm 1,5$ NM
Through-stud nut	$8,5 \pm 1,5$ NM
Brush cover nuts	$4,2 \pm 0,6$ NM
Solenoid retaining nuts	$3,1 \pm 0,4$ NM



ST1833M

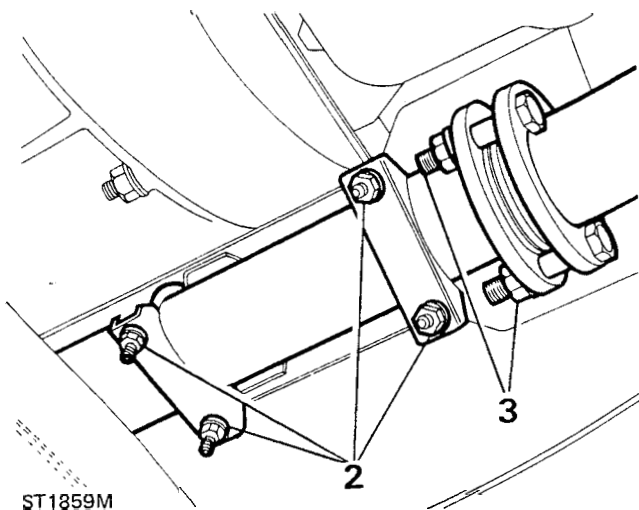
## KEY TO STARTER MOTOR

- |                                     |                            |
|-------------------------------------|----------------------------|
| 1. Solenoid                         | 12. Yoke                   |
| 2. Solenoid plunger and spring      | 13. Roller bearing         |
| 3. Drive-end bracket and bush       | 14. Through-studs          |
| 4. Reduction gear pinion            | 15. Brush plate            |
| 5. Reduction gear                   | 16. Field coil brushes     |
| 6. Rubberpad                        | 17. Armature brushes       |
| 7. 'O' ring seal                    | 18. Brush plate cover      |
| 8. Lever                            | 19. Reduction gear housing |
| 9. Clutch drive and pinion assembly | 20. Socket-headed screw    |
| 10. Rubber pad                      | 21. Terminal strap         |
| 11. Armature                        | 22. Yoke location key      |

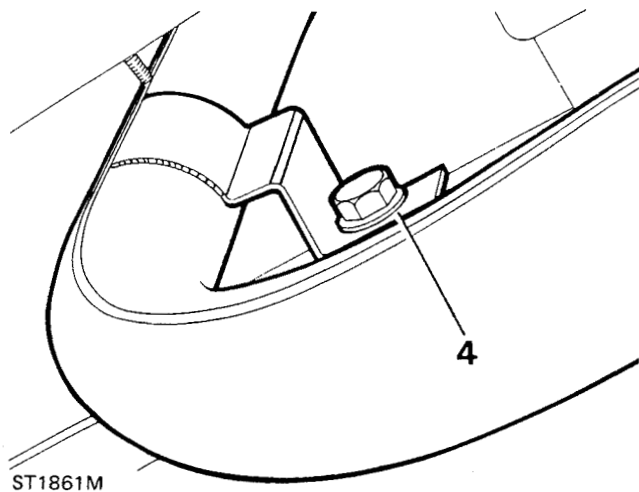
**STARTER MOTOR — Paris Rhone, Turbo charged 2.5 Diesel engine.**

**Removing**

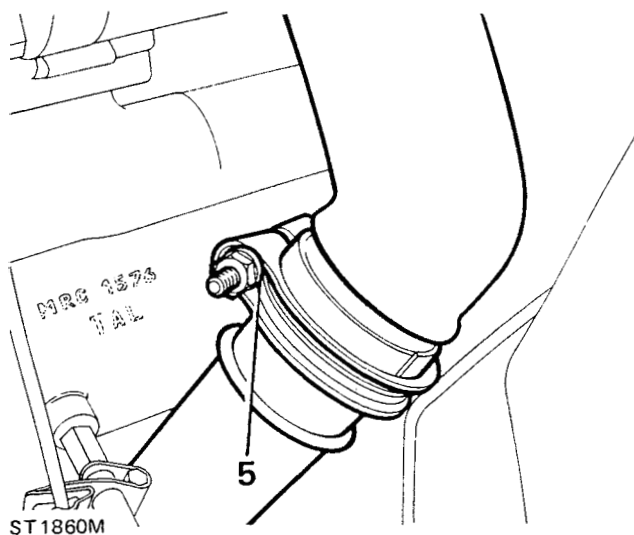
1. Disconnect the battery.
2. Slacken the four nuts securing the intermediate exhaust pipe heat shield and move the shield rearwards.
3. Remove the exhaust flange nuts and bolts.



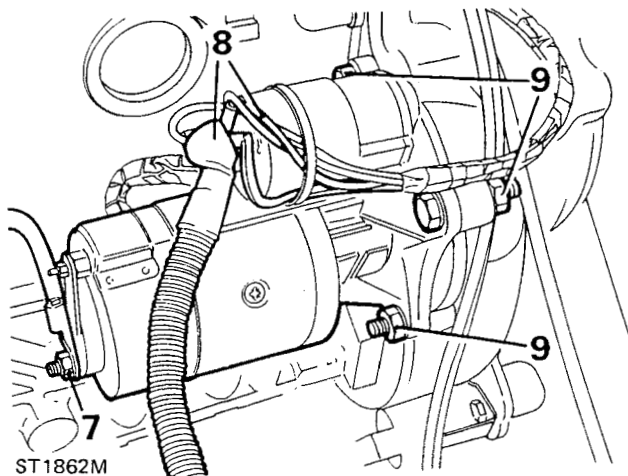
4. Remove the bolt securing the front downpipe to the cylinder block.



5. Release the clamp securing the front downpipe to the turbo-charger elbow.
6. Remove the front downpipe.
7. Disconnect the earth straps from the starter motor.
8. Disconnect the battery, alternator and ignition leads from the starter motor.

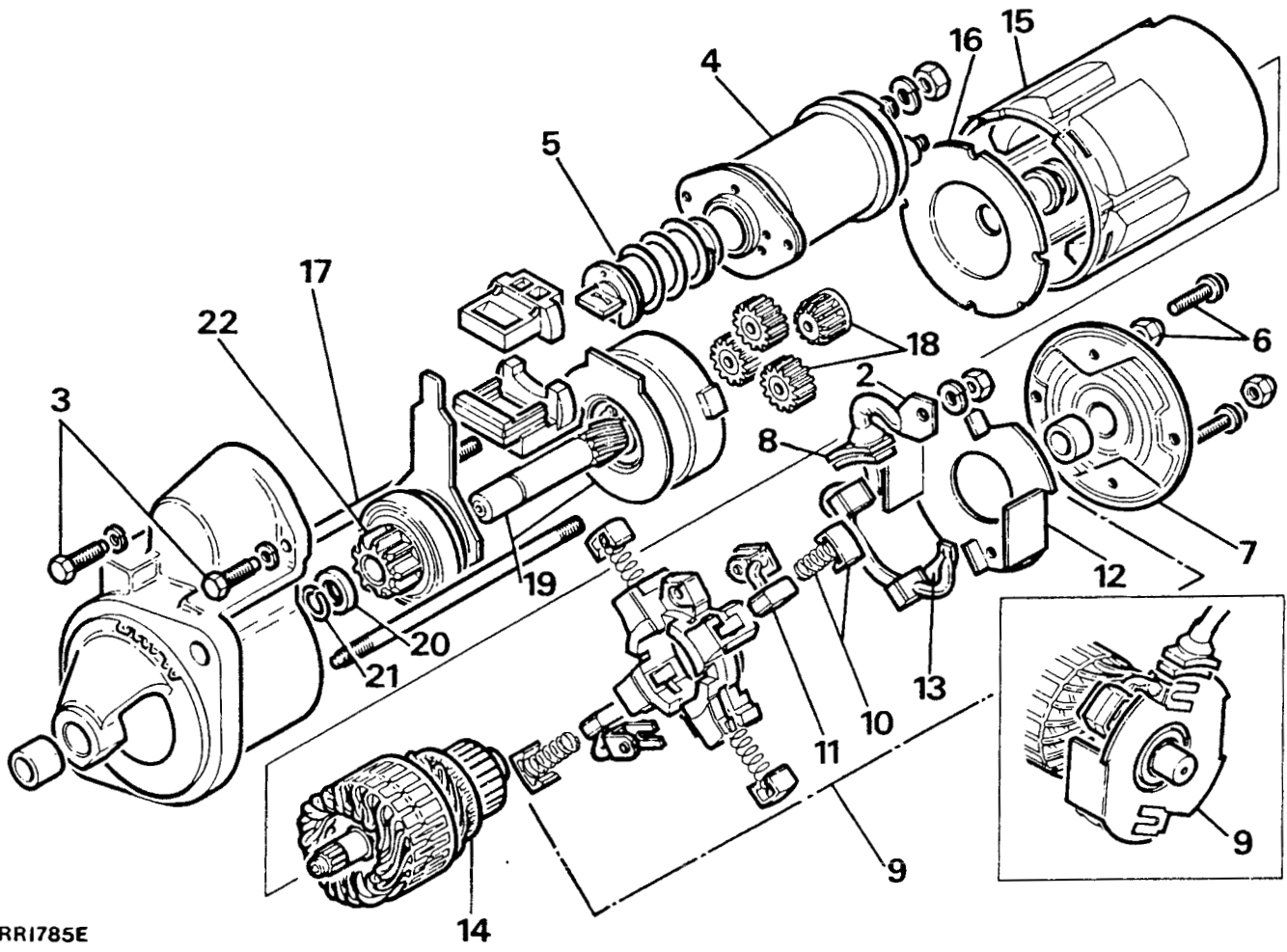


9. Remove the starter motor fixings to the engine i.e. one nut and bolt, one nut and one bolt.
10. Remove the starter motor.



**Fitting**

11. Fit starter motor to engine locating it on the single stud and secure with the remaining fixings and evenly tighten to the correct torque.
12. Connect the alternator, ignition and battery leads to the starter solenoid.
13. Connect the earth leads to the rear of the starter motor.
14. Fit the exhaust front-pipe to the intermediate system and evenly tighten the three bolts. Reposition the heatshield and tighten the four nuts.
15. Connect the front pipe to the turbo-charger elbow and secure with the clamp.
16. Secure the front pipe to the cylinder block with the single bolt.

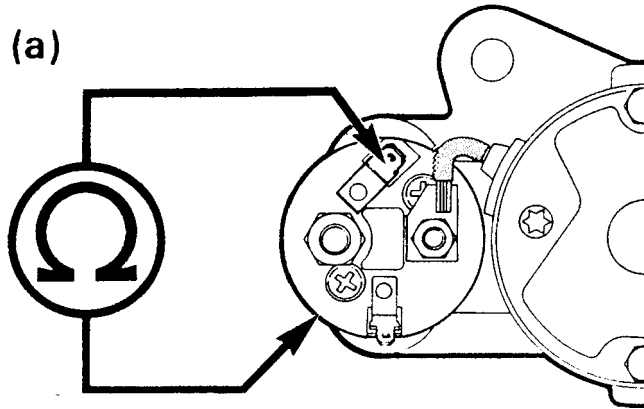


RR1785E

**Inspecting**

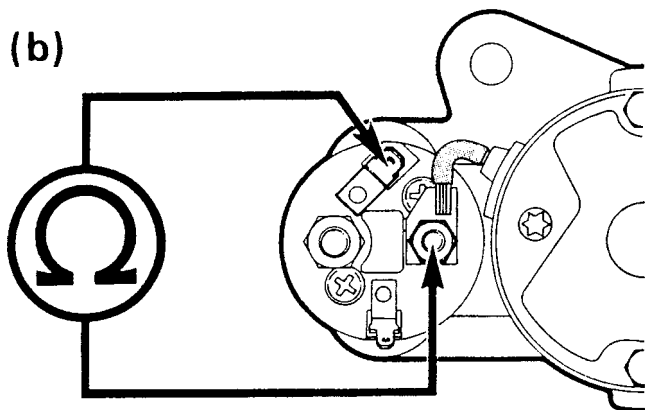
**Solenoid**

23. Check the continuity and resistance value of windings by connecting an ohmmeter as shown.



RR1812E

(a) Resistance value should be:  
 $1.074 \pm 0.035$  ohms

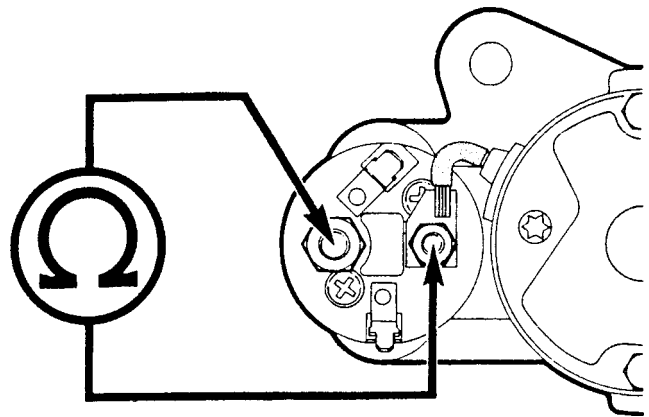


RR1813E

(b) Resistance value should be:  
 $0.298 \pm 0.015$  ohms

If test results are unsatisfactory replace the solenoid.  
 If results are correct proceed to 24.

24. Check the contacts by connecting an ohmmeter as shown.  
 Solenoid plunger removed, ohmmeter should read infinity.



RR1814E

Solenoid plunger operated by hand, ohmmeter should read zero.

If test results are unsatisfactory, replace the solenoid.

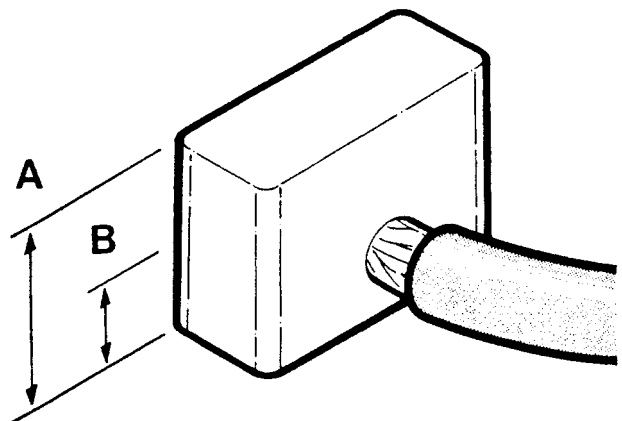
If results are correct proceed to 25.

25. Check operation of spring for freedom of movement.

**Brush gear**

26. Check brush springs and ensure that the brushes move freely in their holders.

Clean the brushes with a petrol moistened cloth, if required.



RR1815E

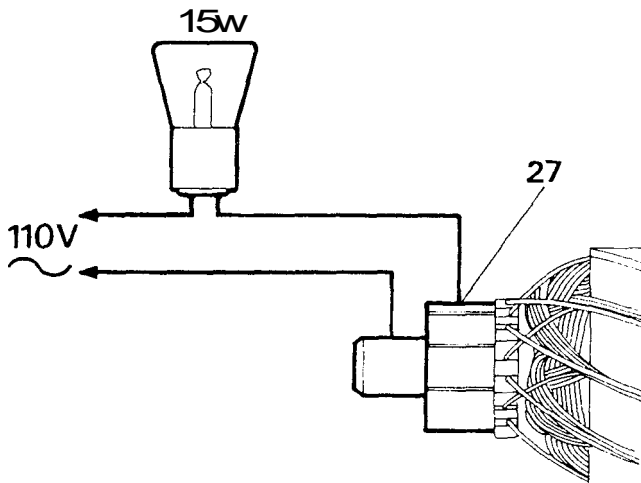
Brush length new, Dimension A is 9 mm (0.354 in).

Minimum brush length, Dimension B is 3.5 mm (0.138 in).



### Armature

27. Check the armature insulation using suitable test equipment. Connect the tester between any one commutator segment and the shaft. The method illustrated uses a 110 V, 15 W test lamp. If the lamp illuminates the armature is faulty, and a replacement component is required.



RR1927E

28. If necessary, the commutator may be machined, providing a finished surface can be obtained without reducing the diameter below 28.8 mm (1.13 in), otherwise a new commutator must be fitted. Finish the surface with fine emery cloth. Do not undercut the insulation slots.

### Drive assembly

29. Test the roller clutch. The pinion should rotate in one direction only, independent of the clutch body. Replace the unit if unsatisfactory or if teeth are damaged or worn.

### Bearings

30. Renew the bearing bushes if there is evidence of armature fouling magnets or if there is perceptible side play between the shaft and bush.
31. Drive end/intermediate end bracket: press out the bush using a suitable press and mandrel.
32. Press the new bush in, ensuring that on the drive end bracket, the bush is flush with the casting.

33. Commutator end bracket; thread a  $\frac{9}{16}$ " Whitworth or suitable similar tap firmly into the bush. Extract the bush with the tap using a power press in reverse.

**NOTE: Soak new bushes in engine oil for thirty minutes before fitting.**

### Reassembly

34. Reverse the instructions 1 to 22. Smear the teeth and operating collar of the roller clutch with Shell Retinax 'A' grease. Smear the pivot lever of the drive assembly with Mobil 22 grease. Smear the drive shaft sun and planet gears with Rocol BRB1200 grease.
35. Tighten all the fixings to the correct torque — see Torque Wrench Settings.

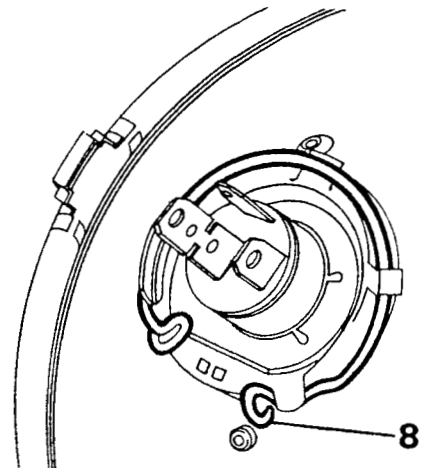
## REMOVE AND OVERHAUL HEADLAMPS

## Remove and dismantle

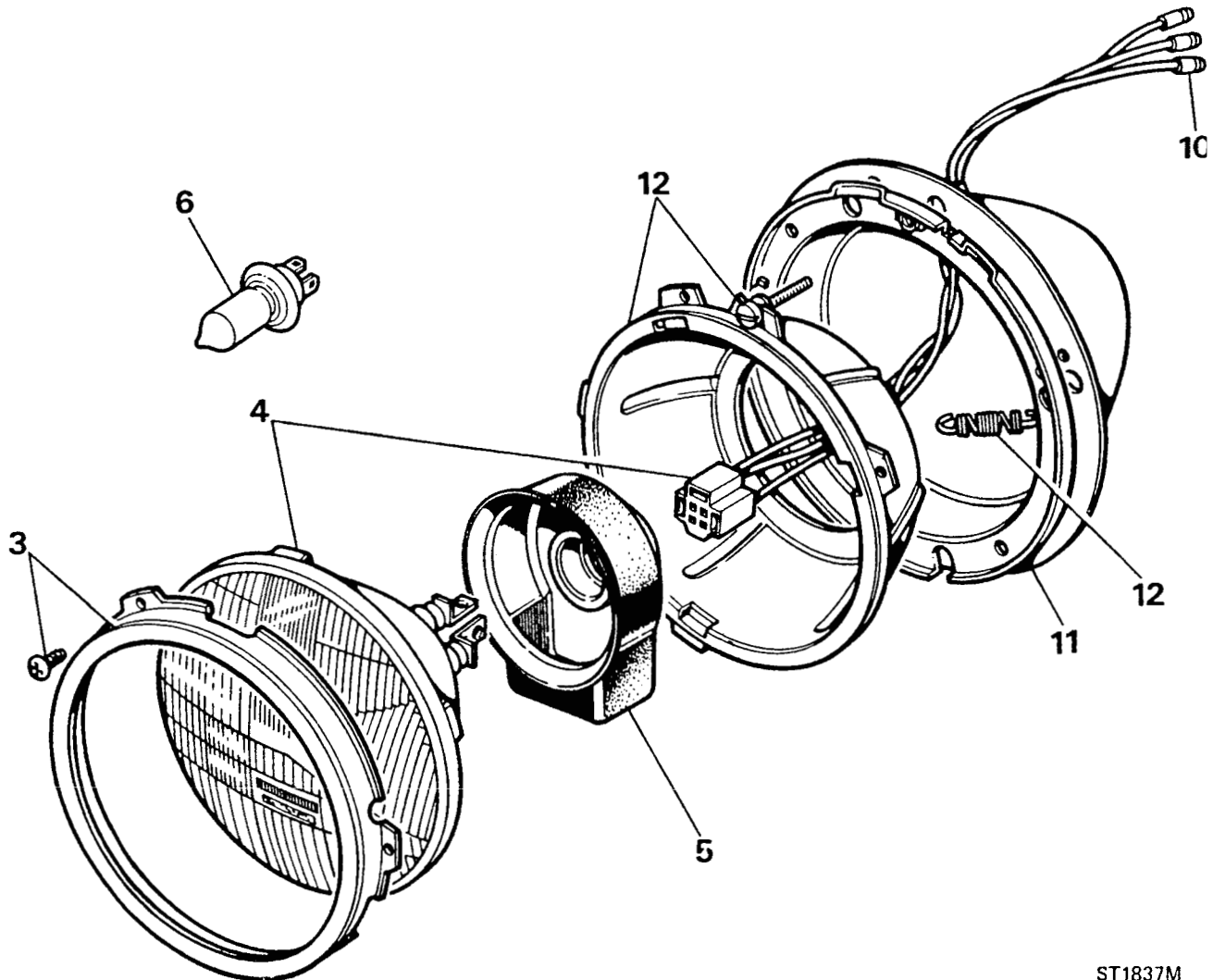
**NOTE:** Instructions 1 to 8 cover renewal of the bulb or light unit only.

1. Disconnect the battery for safety.
2. Remove the six screws and remove the plastic bezel surrounding the head, side and flasher lamps.
3. Remove the three screws retaining the rim and light unit, and remove the rim.
4. Withdraw the light unit or reflector and pull-off the electrical connector.
5. Remove the rubber grommet.
6. Discard the light unit, if faulty, or the bulb if failed.
7. Release the spring clip to remove the bulb from the reflector unit.
8. If required, fit a new bulb of the correct wattage and secure with the spring clip, as illustrated.

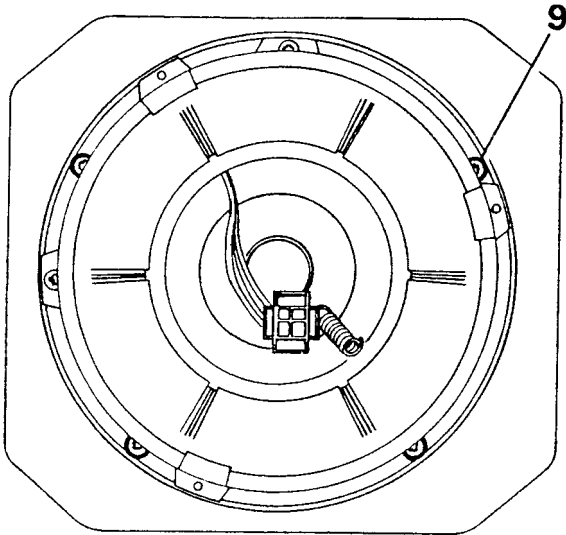
ST1839M



9. Remove the four screws and release the headlamp shell from the front wing.
10. Disconnect the electrical leads from the bullet connectors and remove the headlamp shell.
11. Remove the rubber seal.
12. Release the two trimmer screws and coil spring and detach the rim seating from the headlamp shell.



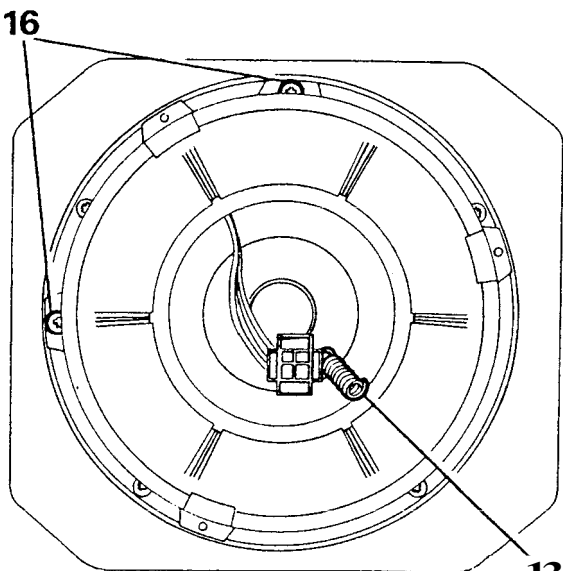
ST1837M



ST1838M

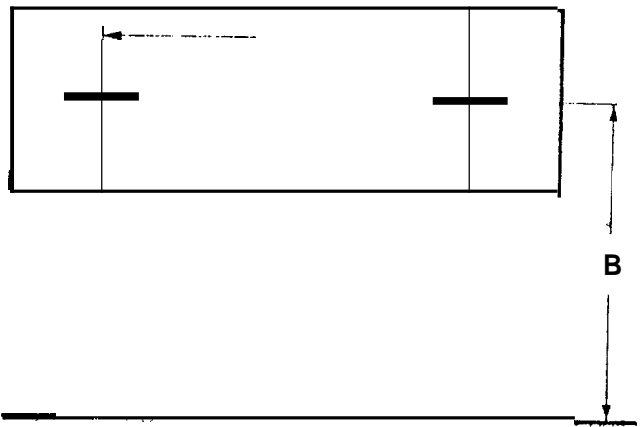
**Assemble and refit**

13. Fit the rim seating to the headlamp shell with the two trimmer screws and coil spring.
14. Fit the rubber seal to the headlamp shell.
15. Connect the leads to the bullet connectors.
16. Fit the headlamp shell into the front wing locating the trimmer screws into the two holes in the wing. Ensure that the assembly is located, as illustrated, with one trimmer screw at the 12 o'clock position and the other 90° to the left.
17. Secure the shell assembly to the wing with the four screws.
18. Offer-up the light or reflector unit to the rim seating and connect the electrical plug.



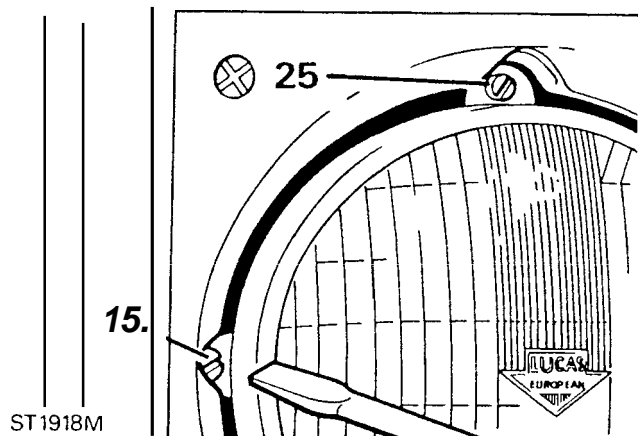
ST1840M

19. Secure the assembly with the rim and three screws.
20. Fit the plastic bezel with the six screws.
21. Connect the battery and check that the lamps function.
22. Check the main beam setting using beam setting equipment. Should this not be available the beam can be temporarily checked and adjusted in the following way:-
23. Position the vehicle on level ground with the tyres correctly inflated, approximately four meters from a wall or screen, marked as illustrated.
24. The beam centres 'A' are measured horizontally on the vehicle and the dimension 'B' vertically from the ground.



ST11719M

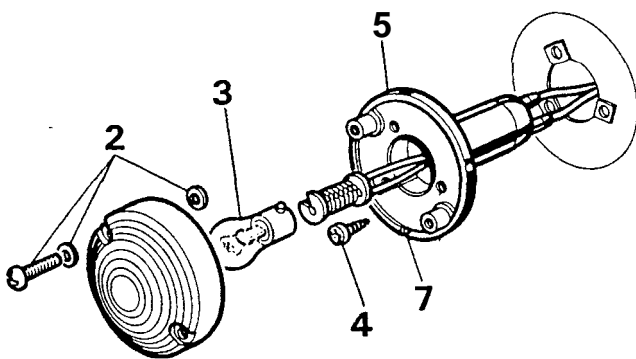
25. Switch-on the main beam and adjust the setting as necessary with the trimmer screws.



ST1918M

**SIDE, TAIL AND FLASHER LAMPS****Renew bulbs and lamps**

1. Disconnect the battery.
2. Remove the two screws and fibre washers and withdraw the lens and collect the two rubber washers inside the lens.
3. Push the bulb inwards, twist and withdraw.
4. Remove the three screws and withdraw the lamp holder complete. Disconnect the electrical leads from the bullet connectors inside the vehicle wing for the front lamps. For rear lamps remove the cover inside the body for access to the connectors.
5. If necessary remove the rubber bulb holder cover.



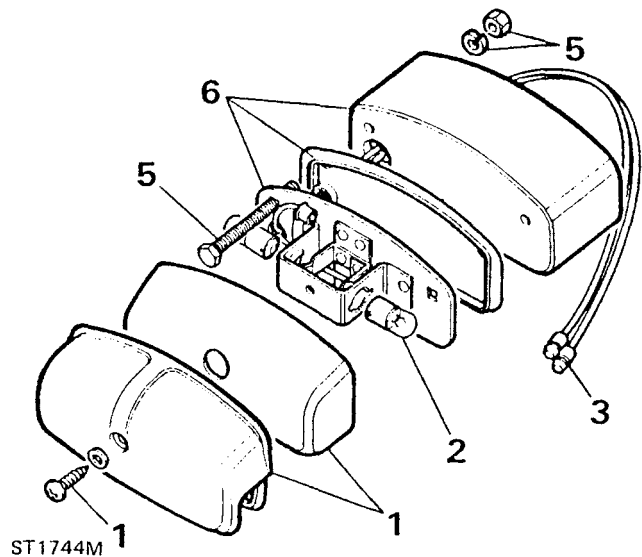
ST1841M

**Refitting lamp and bulbs**

6. Fit the rubber cover to the lamp holder.
7. Ensure that the drain gap in the cover is at the bottom.
8. Connect the electrical leads to the bullet connectors.
9. Fit the lamp to the vehicle, observing instruction 7, and secure with the three screws.
10. Fit the bulb of the same wattage, if renewed.
11. Fit the lens ensuring that the rubber and fibre washers are correctly positioned. Evenly tighten the two screws. Overtightening could crack the lens.

**REAR NUMBER PLATE LAMP****Remove and renew bulbs**

1. Disconnect the battery and remove the single screw securing the lamp cover and lens.
2. At this stage the bulbs only can be renewed.
3. Disconnect the electrical leads.
4. Remove the cover from inside the vehicle body.
5. Remove the two nuts and washers securing the lamp to the vehicle body.
6. Remove the bulb holder complete with rubber seal and mounting block.



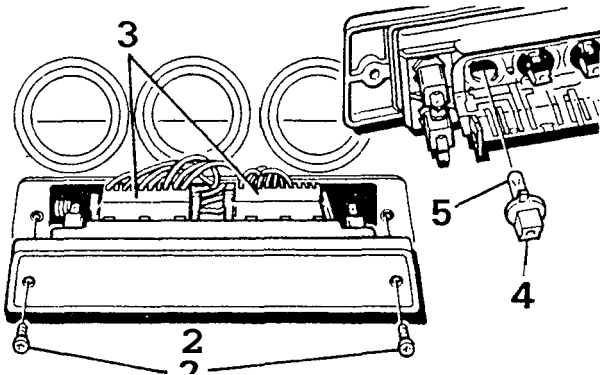
ST1744M

**Refitting lamp and bulbs**

7. Assemble the bulb holder and rubber seal to the mounting block, connect the leads and fit to the vehicle body with the two screws and nuts.
8. Fit the bulbs.
9. Fit the lens and lamp cover and secure with the single screw. Connect the battery and test the lamp.

**Renew the bulbs**

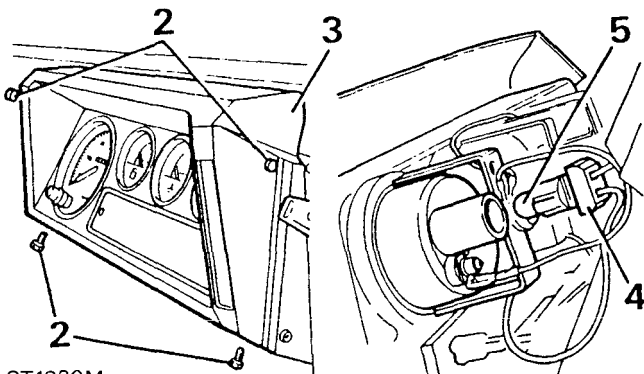
1. Disconnect the battery.
2. Remove two screws and withdraw the warning light module from the front of the instrument panel.
3. Pull off the plug connector to **give** access to warning light bulbs.
4. Twist the bulb holder and pull it from its socket.
5. Pull the bulb from the holder.
6. Fit a new bulb and refit the holder and plug connector.
7. Refit the module.
8. Connect the battery.



ST1919M

**INSTRUMENT ILLUMINATION****Renew bulbs**

1. Disconnect the battery.
2. Remove the four screws retaining the instrument panel.
3. Ease forward the panel *to* gain access to the bulbs.  
If necessary, disconnect the drive cable from the back of the speedometer.
4. Twist the bulb holder and pull it from its socket.
5. Pull the bulb from its holder.
6. Fit a new bulb and refit the holder.
7. Replace the instrument panel.
8. Connect the battery.



ST1920M

**OVERHAUL WIPER MOTOR****DISMANTLE**

1. Remove the wiper motor and drive from the vehicle.
2. Remove the wiper motor gearbox cover.
3. Remove the circlip and plain washer securing the connecting rod.
4. Withdraw the connecting rod.
5. Withdraw the flat washer.
6. Remove the circlip and washer securing the shaft and gear.
7. Clean any burrs from the gear shaft and withdraw the gear.
8. Withdraw the dished washer.
9. Add alignment marks to the yoke and gearbox for reassembly.
10. Remove the yoke securing bolts.
11. Withdraw the yoke and armature.
12. Remove the brush gear assembly.
13. Remove the limit switch.

**INSPECTION AND TEST**

14. Check the brushes for excessive wear, if they are worn to 4,8 mm (0.190 in) in length, fit a new brush gear assembly.
15. Using a push type gauge, check that the brush spring pressure is 140 to 200 g (5 to 7 oz) when the bottom of the brush is level with the bottom of the slot in the brush box. Fit a new brush gear assembly if the springs are not satisfactory.

16. Test the armature for insulation and open- or short-circuits. Use a 110 V 15 W test lamp. Fit a new armature if faulty.
17. Examine the gear wheel for damage or excessive wear.

**ASSEMBLE**

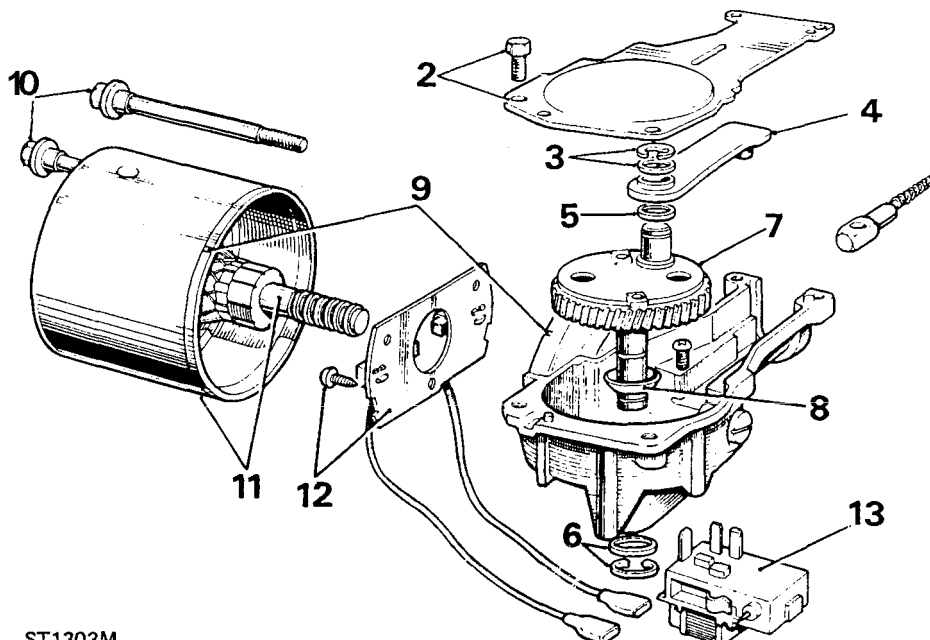
Use Ragosine Listate Grease to lubricate the gear wheel teeth, armature shaft worm gear, connecting rod and pin, cable rack and wheelbox gear wheels.

Use Shell Turbo 41 oil sparingly to lubricate the bearing bushes, armature shaft bearing journals, gear wheel shaft and wheelbox spindles. Thoroughly soak the felt washer in the yoke bearing with oil.

18. Fit the limit switch.
19. Fit the brush gear assembly.

**KEY TO WIPER MOTOR COMPONENTS**

1. Flexible drive
2. Gearbox cover
3. Connecting-rod retaining washer and circlip
4. Connecting-rod
5. Flat washer
6. Gear shaft retaining washer and circlip
7. Drivegear
8. Dished washer
9. Alignment marks — yoke to body
10. Yoke securing bolts
11. Armature and yoke
12. Brush gear assembly
13. Limit switch



ST1303M



## ELECTRICAL EQUIPMENT FAULT TRACING

## INTRODUCTION

The following information is designed to assist electricians in diagnosing faults by a process of elimination.

If the diagnosis charts are followed step by step, isolation of a fault and its rectification will be achieved logically and consistently in the minimum of time.

Basic information on the use of standard equipment and normal workshop practice is not given. If electronic diagnostic equipment is being used, the manufacturer's operating instructions must be followed.

## SYSTEMATIC DIAGNOSIS

Normally, if the tests are completed in the sequence given, it should be possible to detect the fault. If difficulty is experienced, return to the beginning and analyse the results to check that you are on the right path.

## 1. Collect Evidence

Collect as much evidence as possible, do not rely on just a few symptoms.

Use all the senses — sight, smell, sound.

## 2. Analyse Evidence

Consider all evidence collected.

## 3. Locate Fault

Narrow down the fault to a component, using test equipment and the collected evidence.

## 4. Determine and Remove Cause

Ask why the fault has occurred. Trace and rectify the cause.

## 5. Rectify Fault

Adjust, overhaul or renew the faulty component, but ensure the cause of the fault is also rectified.

## 6. Check System

Ensure the equipment operates correctly and is properly fixed.

## PRELIMINARY CHECKS AND TESTS

The checks and test procedures given must be carried out in the sequence indicated.

## Battery

State of charge and condition of the battery must be checked before circuits are tested.

## Connections

Ensure all connections are clean and secure. Earth connections must be made to clean unpainted surfaces.

## Fuses

Check for obvious signs of overload or short circuit before renewing a blown fuse or resetting an overload cut-out.

Under no circumstances must a higher rating fuse be used than that specified.

## Voltage Drop

Check a circuit with the normal load applied and the voltmeter connected in parallel. Voltage drop varies with load, cable size and current,

## Current Flow

Connect the ammeter in series with the supply cable (not starter cable).

## Resistance

Use an ohmmeter to measure the resistance in a circuit or component.

## Required Test Equipment

## Charging Tests 1 to 9

0-20 V Moving coil voltmeter

5-0-50 A Moving coil ammeter

Hydrometer

Heavy discharge voltage tester

Cadium sticks

## Ignition Tests 10 to 15

0-20 V Moving coil voltmeter

0-1 V Moving coil voltmeter

Ohmmeter

## Starter Tests 16 to 26

0-20 V Moving coil voltmeter

5-0-60 A Moving coil ammeter

Hydrometer

Lock torque clamps

Spring balance

## ABBREVIATIONS

A.	Amperes	L.T.	Low tension
Ah	Ampere-hour	mm	Millimetre
C	Centigrade (Celsius)	rev/min	revolutions per minute
d.c.	Direct current	V.	Volts
F	Fahrenheit	°	Degree temperature
H.T.	High tension	%	Percentage
in	Inch		



Test	Recitification	Clean, renew as necessary	<p><b>Battery Service</b>                  Topping-up: Use distilled or deionised water. Battery additives should never be used.                  Charging: A slow charge at normal rate is more beneficial than at a fast rate.                  Condition: If after charging, battery voltage is below 9 V, renew the battery.</p>																
	Check	1, 2, 3, 4	<p><b>1. Charging circuit:</b>                  Check continuity of leads, tightness and cleanliness of connections</p>																
Check	<p><b>HARGING SYSTEM</b>                  battery will not hold charge</p>	<p>1, 2, 3, 4</p>	<p><b>2. Check battery charge:</b>                  Using a hydrometer, check the specific gravity in each battery cell.                  Note: Readings should not be taken if the battery has only just been topped up. It should be charged for 1 - 2 hours before taking any readings.</p> <table border="1"> <tr> <td rowspan="2">Climates normally below 25°C (77°F)</td> <td rowspan="2">Climates normally above 25°C (77°F)</td> <td>(i)</td> <td>1.260 - 1.280</td> <td>Battery fully charged</td> <td>Carry out Test 3</td> </tr> <tr> <td>(ii)</td> <td>1.230 - 1.250</td> <td>Battery 70% charged</td> <td>Carry out Test 3</td> </tr> <tr> <td>(iii)</td> <td>1.110 - 1.130</td> <td>1.050 - 1.070</td> <td>Battery discharged</td> <td>Charge battery and recheck or renew</td> </tr> </table> <p>(iv) A variation of 0.040 between cells indicates a suspect battery                  For every 10°C (18°F) subtract 0.007. For every 10°C (18°F) above 15°C (60°F) add 0.007.</p>		Climates normally below 25°C (77°F)	Climates normally above 25°C (77°F)	(i)	1.260 - 1.280	Battery fully charged	Carry out Test 3	(ii)	1.230 - 1.250	Battery 70% charged	Carry out Test 3	(iii)	1.110 - 1.130	1.050 - 1.070	Battery discharged	Charge battery and recheck or renew
			Climates normally below 25°C (77°F)	Climates normally above 25°C (77°F)			(i)	1.260 - 1.280	Battery fully charged	Carry out Test 3									
					(ii)	1.230 - 1.250	Battery 70% charged	Carry out Test 3											
			(iii)	1.110 - 1.130	1.050 - 1.070	Battery discharged	Charge battery and recheck or renew												
			<p><b>3. Heavy voltage discharge check:</b>                  Using heavy discharge test equipment, set the tester to discharge the battery at three times the Ah capacity (20 hour rate) for 15 seconds.</p>		(i) Voltage reading more than 9.6 V — Battery satisfactory	(ii) Voltage reading less than 9.6 V — Battery unsatisfactory	Carry out Test 4												
			<p><b>4. Intercell voltage check:</b>                  Charge the battery for three minutes at the stated Ah capacity (20 hour rate) or at 40A, whichever is the lowest. With battery still on charge, record overall voltage and the intercell readings using the cadmium sticks. Subtract the lowest intercell reading from the highest. Intercell voltage variation more than 0.15 V — Defective battery.</p>		(i) Battery voltage below 15.5 V, intercell voltage variation less than 0.15 V — Battery satisfactory but discharged	(iii) Battery voltage above 15.5 V, intercell voltage variation less than 0.15 V — Battery discharged and may be sulphated	Charge battery and re-test												

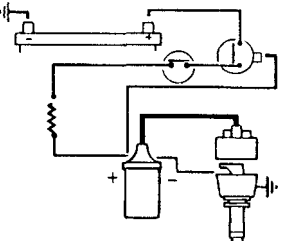
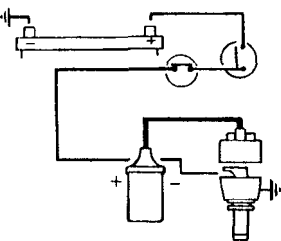
continued

fault	Check	Test	Rectification
battery not being charged <b>CAUTION:</b> The vehicle battery must never be disconnected while the engine is running Warning light stays on  Warning light does not function when ignition switched on  <b>TEST EQUIPMENT</b> Voltmeter 0 - 20 V moving coil Ammeter 5-0-60A moving coil Hydrometer	1, 2, 3, 4, 5  1, 2, 3, 4, 6, 7  1, 2, 3, 4, 8, 5	<b>5. Alternator output</b> Connect a voltmeter across the battery terminals. Connect an ammeter into the alternator battery sensing circuit either at the battery terminal or solenoid. Switch on all loads (except wipers) for one minute. Run the engine at 3,000 rev/min and wait until the ammeter reading is stable.	Overhaul alternator
		(i) Ammeter reading Zero — Faulty alternator	
		(ii) Ammeter reading below 10A, voltmeter reading between 13.6 and 14.6V and battery in low state of charge	Bench test and overhaul
		(iii) Ammeter reading below 10A, voltmeter reading below 13.6V	Renew voltage regulator
		(iv) Ammeter reading above 10A, voltmeter reading above 14.6V	Renew voltage regulator
		<b>6. Drive belt:</b> Check the drive belt is not broken or slipping	Adjust or renew
		<b>7. IND lead:</b> Disconnect the IND lead from the alternator, start engine and run above idle speed.	
		(i) Warning light stays on — Short circuit to earth between IND lead and warning light	Repair or renew
		(ii) Warning light goes out	Carry out Test 5
		<b>8. Warning light bulb:</b> Check warning lamp bulb	
		(i) Bulb faulty	Renew
		(ii) Bulb not faulty	Carry out Test 9
		<b>9. Alternator plug connections:</b> Remove plug from alternator, switch on ignition and connect a voltmeter between earth and each terminal in turn.	
(i) Voltmeter reads 12V	Carry out Test 5		
(ii) Voltmeter does not read 12V — cable circuits faulty	Check cable continuity; repair or renew		
<b>IGNITION SYSTEM</b>			
Engine will not fire	10, 11, 12, 13, 14, 1	<b>10. Engine cranking speed:</b> Too low	See STARTING SYSTEM
		<b>11. Sparking plugs:</b> Check for dirty electrodes or incorrect gaps for faulty operation on pressure test equipment	Clean. set gaps or renew contact breaker distributors carry out Test 12
		<b>12. Contact breaker points:</b> Check for incorrect gap, burning or pitting	Clean, adjust or renew
		<b>13. Distributor cap:</b> Check for 'tracking' (thin lines of burned bakelite), ensure cap is clean and dry and that the centre brush moves freely with no excessive side movement and contacts the rotor arm.	Rectify or replace. Carry out Test 14.  Rectify or replace. Carry out Test 14.

continued

fault	Check	Test	Rectification
IGNITION SYSTEM	a.	Connect 0-1 V voltmeter as in Test 15c, fit a jumper lead from earth to distributor body, with ignition on and contact breaker points closed: (i) Below 0.2V	Remake earth connections between distributor body and earth
		(ii) Above 0.2V — High resistance or open circuit in distributor	Check/repair or renew contact breaker points, base plate screws earth lead or supply lead as necessary
	b.	Connect 0-20 V voltmeter as in Test 15b, with ignition on and contact breaker points open: (i) Above 12 V — Continuity in primary windings of coil, supply line and ballast resistor if fitted	Carry out Test 15g
		(ii) Zero — open circuit feed to coil, open circuit primary windings, open circuit ballast resistor if fitted or short circuit in distributor or coil negative lead	Carry out Test 15f
		Connect 0-20 V voltage as in Test 15b, with ignition on and contact breaker points open. Remove coil negative lead from coil and recheck voltage: (i) Above 12V — Shortcircuit in coil, negative lead or distributor	Check contact breaker points correctly fitted, short circuit in condenser (or capacitor when ballast resistor fitted) or supply lead; repair or renew
		(ii) Zero — reconnect coil negative lead	Carry out Test 15g
		Connect 0-20 V voltmeter between earth and coil positive terminal, with ignition on and contact breaker points closed: (i) Above 12V — Coil primary windings open circuit	Renew coil
		(ii) 11.5V - 12V without ballast resistor      If result of Test 15f was above 12V 5V - 7V with ballast resistor                      L.T. circuit is satisfactory	Fault elsewhere
		(iii) Below 11.5V or zero without ballast resistor — Excessive resistance or open circuit supply to coil. Leaving the voltmeter connected to earth, work back through the supply circuit at the terminals on the ignition switch and solenoid until the resistance or open circuit is located	Rectify and recheck
		(iv) Below 5V or zero with ballast resistor — Excessive resistance or open circuit in supply to coil	Carry out Test 15H
		Connect 0-20 V voltmeter between earth and the lead from the ballast resistor to the coil positive terminal, with the ignition on and contact breaker points closed: (i) 5V - 7V or above 12V — Fault in the ballast resistor to coil lead	Repair or renew lead then re-test
		(ii) Below 5V or zero — Excessive resistance or open circuit between battery and coil	Carry out Test 15j
		Connect 0-20 V voltmeter between earth feed lead to ballast resistor, with ignition on and contact breaker points closed: (i) Above 12V — Fault in ballast resistor	Renew and re-test. If satisfactory fault elsewhere
		(ii) Zero or below 11.5V — Fault in supply circuit from battery. Leaving the voltmeter connected to earth, work back through the supply circuit at the terminals on the ignition switch and solenoid until the fault is located.	Rectify and re-test. If satisfactory fault elsewhere

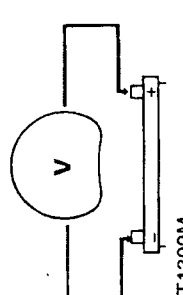
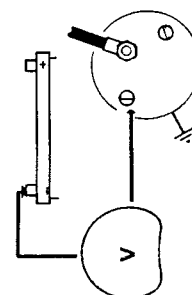
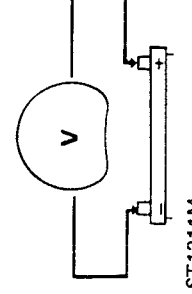
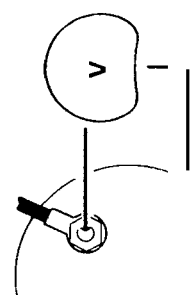
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Fault	Check	Test	Rectification		
<b>IGNITION SYSTEM</b>		<b>14. H.T. Circuit</b>			
			<p>a. Disconnect main H.T. lead from distributor cap, hold approximately 6 mm (¼ in) from a good earth, ensure contact breaker points are closed, switch on ignition and flick contact breaker points open.</p> <p>(i) Good healthy spark — Main H.T. lead, condenser and coil satisfactory</p> <p>(ii) Poor or no spark</p>	<p>Carry out Test 14e</p> <p>Carry out Test 14b</p>	
	ST1307M		<p>b. Replace main H.T. lead with a known good H.T. lead and repeat Test</p> <p>(i) Good healthy spark — Original H.T. lead faulty</p> <p>(ii) Poor or no spark</p>	<p>Renew main H.T. lead. Carry out Test 14e</p> <p>Carry out Test 14c</p>	
			<p>c. Replace condenser with a known good one and repeat Test</p> <p>(i) Good healthy spark — Original condenser faulty</p> <p>(ii) Poor or no spark</p> <p>d. Replace ignition coil with a known good coil and repeat Test</p> <p>(i) Good healthy spark — original coil faulty</p>	<p>Renew condenser. Carry out Test 14e</p> <p>Carry out Test 14d</p> <p>Renew coil, refit original H.T. lead and condenser and repeat Tests 14a and b, or carry out Test 14e</p>	
	ST1308M				
	<b>TEST EQUIPMENT</b>		<p>e. Hold loose end of main H.T. lead approximately 3 mm (⅛ in) from the rotor arm electrode. Ensure contact breaker points are closed, switch on ignition and flick points open</p> <p>(i) Good healthy spark — Rotor arm shorting to earth</p> <p>(ii) Very faint or no spark — Rotor arm insulation satisfactory</p>	<p>Renew rotor arm</p> <p>Carry out Test 15</p>	
			<b>15. L.T. circuit continuity check:</b>		
		<p>(A) Voltmeter 0 - 20V moving coil</p> <p>(B) Voltmeter 0 - 1V moving coil</p>		<p>a. Check battery voltage and state of charge</p>	<p>See STARTING SYSTEM</p>
		Ohmmeter		<p>b. Connect voltmeter 0 - 1V between earth and coil negative terminal with ignition on and contact breaker points closed:</p> <p>(i) Below 0.2V</p> <p>(ii) Above 0.2V — Resistance or open circuit</p>	<p>Carry out Test 15e</p> <p>Carry out Test 15c</p>
				<p>c. Connect 0 - 1V voltmeter between earth and distributor L.T. terminal with ignition on and contact breaker points closed:</p> <p>(i) Below 0.2V — Resistance or open circuit between coil negative and distributor L.T. terminal</p> <p>(ii) Above 0.2V — Resistance or open circuit between earth and distributor L.T. terminal</p>	<p>Renew lead</p> <p>Carry out Test 15d</p>

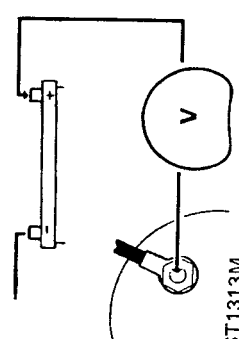
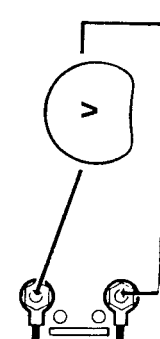
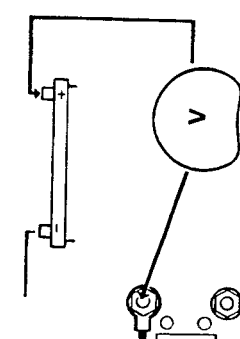
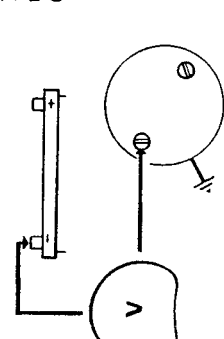
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Fault	Check	Test	Rectification
IGNITION SYSTEM (continued)	1.	Connect voltmeter (B) as in Test 15C, fit a jumper lead from earth to distributor body, with ignition on and contact breaker points closed: (i) Below 0.2V	Remake earth connections between distributor body and earth
		(ii) Above 0.2V — High resistance or open circuit in distributor	Check/repair or renew contact breaker points, base plate screws earth lead or supply lead as necessary
	2.	Connect voltmeter (A) as in Test 15b, with ignition on and contact breaker points open: (i) Above 12 V — Continuity in primary windings of coil, supply line and ballast resistor if fitted	Carry out Test 15g
		(ii) Zero — open circuit feed to coil, open circuit primary windings, open circuit ballast resistor if fitted or short circuit in distributor or coil — ve lead	Carry out Test 15f
	3.	Connect voltage (A) as in Test 15b, with ignition on and contact breaker points open. Remove coil — ve lead from coil and recheck voltage: (i) Above 12 V — Short circuit in coil, —ve lead or distributor	Check contact breaker points correctly fitted, short circuit in condenser (or capacitor when ballast resistor fitted) or supply lead; repair or renew
		(ii) Zero — reconnect coil — ve lead	Carry out Test 15g
	3.	Connect voltmeter (A) between earth and coil +ve terminal, with ignition on and contact breaker points closed: (i) Above 12V — Coil primary windings open circuit	Renew coil
		(ii) 11.5V - 12V without ballast resistor } If result of Test 15f was above 12V 5V - 7V with ballast resistor } L.T. circuit is satisfactory	Fault elsewhere
		(iii) Below 11.5V or zero without ballast resistor — Excessive resistance or open circuit supply to coil. Leaving the voltmeter connected to earth, work back through the supply circuit at the terminals on the ignition switch and solenoid until the resistance or open circuit is located	Rectify and recheck
		(iv) Below 5V or zero with ballast resistor — Excessive resistance or open circuit in supply to coil	Carry out Test 15h
	h.	Connect voltmeter (A) between earth and the lead from the ballast resistor to the coil +ve terminal, with the ignition on and contact breaker points closed: (i) 5V - 7V or above 12V — Fault in the ballast resistor to coil lead	Repair or renew lead then re-test
		(ii) Below 5V or zero — Excessive resistance or open circuit between battery and coil	Carry out Test 15j
	j.	Connect voltmeter (A) between earth feed lead to ballast resistor, with ignition on and contact breaker points closed: (i) Above 12V — Fault in ballast resistor	Renew and re-test. If satisfactory fault elsewhere
		(ii) Zero or below 11.5V — Fault in supply circuit from battery. Leaving the voltmeter connected to earth, work back through the supply circuit at the terminals on the ignition switch and solenoid until the fault is located.	Rectify and re-test. If satisfactory fault elsewhere

continued

Fault	Check	Test	Rectification
<b>STARTER SYSTEM</b> Starter will not operate	16, 17, 18, 19, 20, 21, 22	16. Battery voltage Connect voltmeter between battery terminals: Below 12V  ST1309M	Charge or renew battery
Engine cranking speed low	16, 17, 18, 19, 23, 24, 25	17. Battery charge Take hydrometer readings: Below 70% charged — 1.230 at 15°C	Charge battery, see <b>CHARGING SYSTEM</b>
Engine will not start	16, 17, 18, 19, 24, 25	18. Wiring a. Check the electrical connection of the coil b. Disconnect coil negative lead. Voltmeter between battery negative and starter end bracket bolt. Operate starter: Above 0.5V  ST1310M	a. Renew wiring and connectors b. Clean and tighten all earth connections, battery, starter engine Tighten starter through bolts Remove starter, clean motor and backplate faces
Starter operates but crankshaft stationary	23, 24, 25	19. Battery — on load  ST1311M	Disconnect coil negative lead, Voltmeter as Test 1 Operate starter a. Below 10V — starter or circuit taking too much current b. Between 10V to 12V but crankshafts turn slowly
Starter operates but crankshaft stationary	23, 24, 25	20. Battery voltage at starter — on load  ST1312M	Disconnect coil negative lead. Voltmeter starter terminal to earth on motor Operate starter a. Below 9.5V — Starter defective b. Below 9.5V c. Below 9.5V — solenoid operating

continued

Fault	Check / Test	Rectification
	<p><b>21. Starter voltage — on load</b></p>  <p>Voltmeter starter terminal to battery positive. Switch on ignition, battery voltage Disconnect coil positive lead Operate starter</p> <p>a. Below 0.5V — cable and connections satisfactory b. Above 0.5V — Resist cable between battery and starter</p> <p>ST1313M</p>	<p>a. Carry out Test 23 b. Check connections and cables</p>
	<p><b>22. Voltage drop across solenoid switch</b></p>  <p>Voltmeter between starter solenoid terminals. Switch on ignition, battery voltage Disconnect coil negative lead. Operate starter</p> <p>a. Below 0.5V b. Above 0.5V</p> <p>ST1314M</p>	<p>a. Carry out Test 23 b. Faulty switch or connections</p>
	<p><b>23. Voltage at Solenoid — on load</b></p>  <p>Disconnect coil negative lead, Voltmeter between solenoid feed terminal and battery positive Operate starter</p> <p>a. 9V to 10V — and result of Test 22 was 'b' (below 9V with ballast resistor circuit) b. above 12V — Starter does not operate (above 9V with ballast resistor circuit)</p> <p>ST1315M</p>	<p>a. Change solenoid b. Clean earth, re-test — renew solenoid</p>
	<p><b>24. Voltage drop in earth line</b></p>  <p>Disconnect coil negative lead. Voltmeter between starter through bolt and battery negative terminal Operate starter: above 0.5V</p> <p>ST1316M</p>	<p>i. Clean and tighten all earth connections, battery, starter, engine ii. Tighten starter, through bolts iii. Remove starter, clean motor and backplate faces</p>

continued

Fault	Check	Test	Rectification
STARTER SYSTEM		<p><b>25.</b> Drive faulty</p> <ul style="list-style-type: none"> <li>a. Remove starter: check condition of pinion and starter ring gear</li> <li>b. Inertia drive, check that pinion rotates freely</li> <li>c. Check that crankshaft rotates freely</li> <li>d. Lock torque, free running speed and current</li> </ul> <p><b>26.</b> Ignition circuit fault</p>	<ul style="list-style-type: none"> <li>a. Renew pinion or ring gear</li> <li>b. Renew inertia drive</li> <li>c. Check for engine fault, tight or siezed</li> <li>d. Check brushes — overhaul starter</li> </ul> <p>See IGNITION SYSTEM</p>

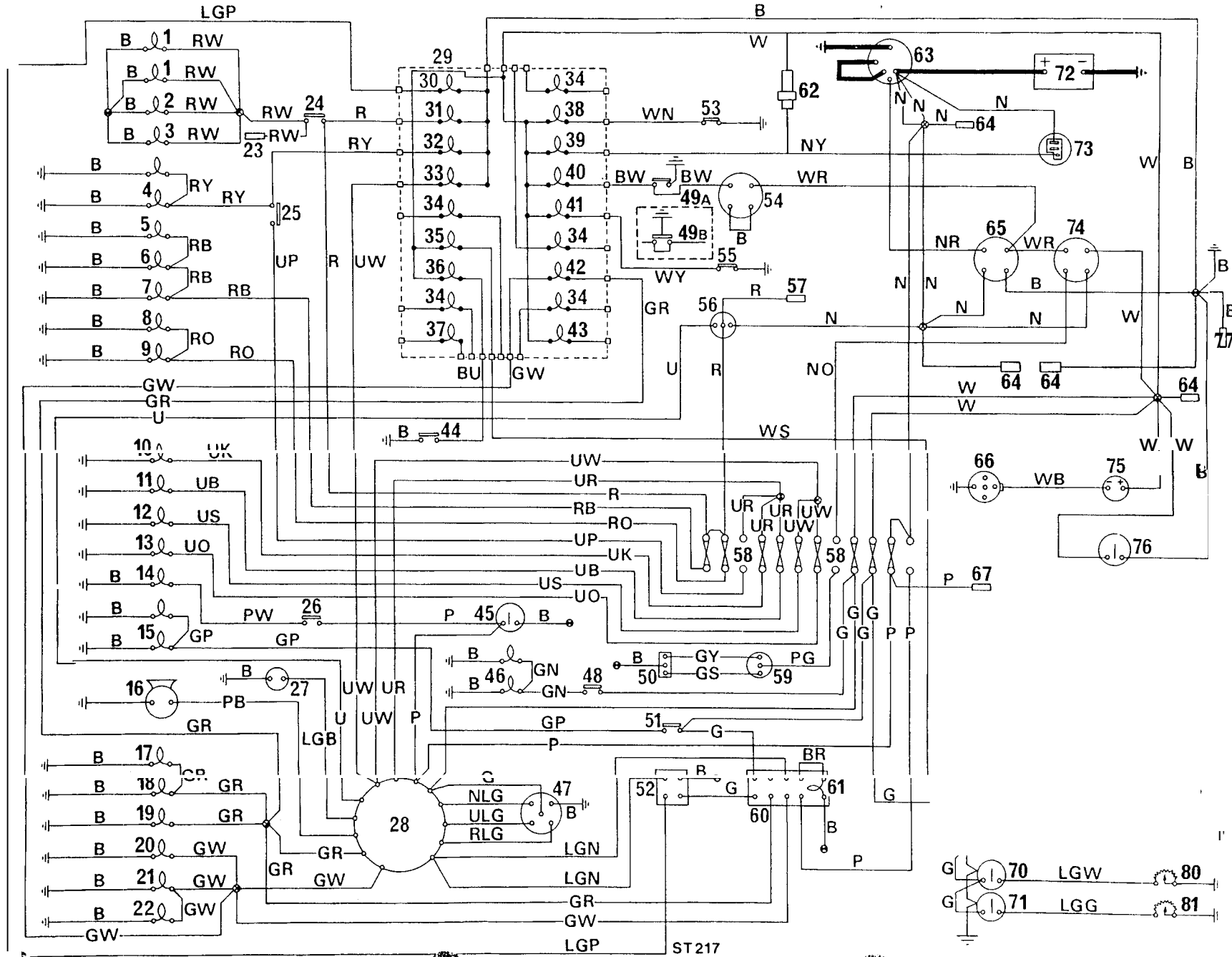




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### FOUR CYLINDER PETROL



## KEY TO FOUR CYLINDER PETROL DIAGRAM

- |   |  |   |
|---|--|---|
| <ul style="list-style-type: none"> <li>1. Speedometer illumination</li> <li>2. Fuel indicator illumination</li> <li>3. Water temperature illumination</li> <li>4. Rear log lamps</li> <li>5. Number plate lamp</li> <li>6. LH tail lamp</li> <li>7. LH side lamp</li> <li>8. RH tail lamp</li> <li>9. RH side lamp</li> <li>10. LH headlamp dip beam</li> <li>11. RH headlamp dip beam</li> <li>12. LH headlamp main beam</li> <li>13. RH headlamp main beam</li> <li>14. Interior lamp</li> <li>15. Stop lamp</li> <li>16. Horn</li> <li>17. LH side repeater</li> <li>18. LH front indicator</li> <li>19. LH rear indicator</li> <li>20. RH front indicator</li> <li>21. RH rear indicator</li> <li>22. RH side repeater</li> <li>23. Auxiliary instrument illumination</li> <li>24. Panel illumination switch</li> <li>25. Rear fog switch</li> <li>26. Interior lighting switch</li> <li>27. Washer pump</li> <li>28. Steering column switches</li> <li>29. Grouped warning lights (comprising items 30 to 43)</li> </ul> | <ul style="list-style-type: none"> <li>30. Trailer warning light</li> <li>31. Side light warning light</li> <li>32. Rear fog warning light</li> <li>33. Main beam warning light</li> <li>34. Spare position</li> <li>35. Low fuel warning light</li> <li>36. Locked four-wheel drive warning light</li> <li>37. Cold start warning light</li> <li>38. Oil warning light</li> <li>39. Charge warning light</li> <li>40. Brake warning light</li> <li>41. Park brake warning light</li> <li>42. Direction indicator warning light</li> <li>43. Seat belt warning light</li> <li>44. Locked four-wheel drive switch</li> <li>45. Clock</li> <li>46. Reversing lamps</li> <li>47. Wiper motor</li> <li>48. Reversing lamp switch</li> <li>49a Brake fluid loss switch (Ninety models only)</li> <li>49b Pressure differential warning actuator switch (One Ten models only)</li> <li>50. Heater switch</li> <li>51. Stop lamp switch</li> <li>52. Flasher unit</li> <li>53. Oil pressure switch</li> </ul> | <ul style="list-style-type: none"> <li>54. Brake check relay</li> <li>55. Park brake switch</li> <li>56. Light switch</li> <li>57. Pick-up point for front fog lamps</li> <li>58. Fuses</li> <li>59. Heater motor</li> <li>60. Hazard switch</li> <li>61. Hazard switch illumination</li> <li>62. Ignition light resistor</li> <li>63. Starter solenoid</li> <li>64. Spare pick-up point</li> <li>65. Start relay</li> <li>66. Distributor</li> <li>67. Pick-up point for auxiliary trailer</li> <li>68. Fuel indicator</li> <li>69. Water temperature indicator</li> <li>70. Oil pressure indicator</li> <li>71. Oil temperature indicator</li> <li>72. Battery</li> <li>73. Alternator</li> <li>74. Start switch</li> <li>75. Coil</li> <li>76. Battery condition indicator</li> <li>77. Pick-up point for auxiliary instrument illumination</li> <li>78. Fuel tank unit</li> <li>79. Water temperature transmitter</li> <li>80. Oil pressure transmitter</li> <li>81. Oil temperature transmitter</li> </ul> |
|---|--|---|

### Key to cable colours

B Black G Green K Pink L Light N Brown O Orange P Purple R Red S Slate U Blue W White Y Yellow

The last letter of a colour code denotes the tracer colour



Connectors via plug and socket



Snap connectors



Permanent in-line connections

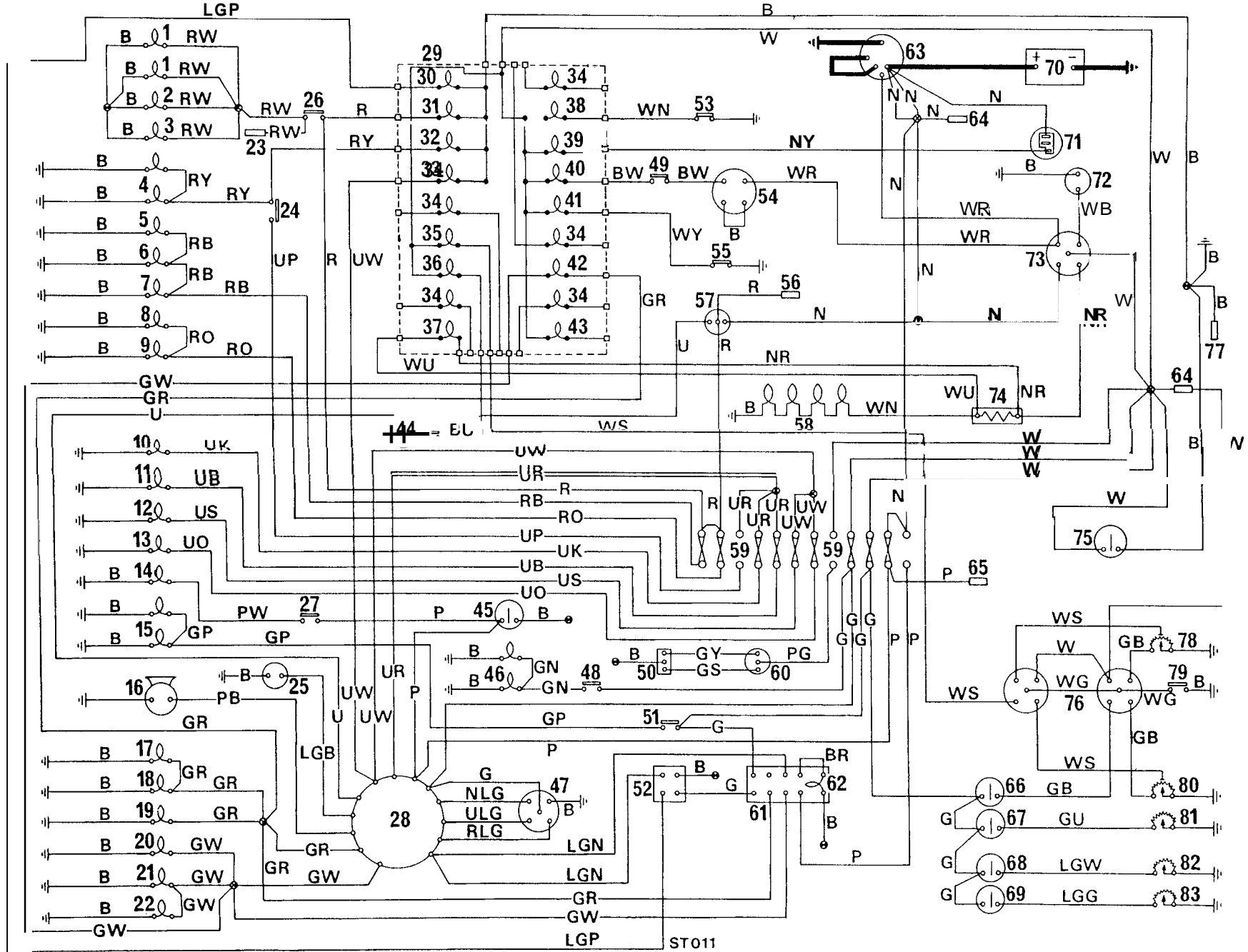


Earth connections via cables



Earth connections via fixing bolts

FOUR CYLINDER 2.25 DIESEL,





## KEY TO FOUR CYLINDER 2.25 LITRE DIESEL DIAGRAM

- |  |  |   |
|--|--|---|
| 1. Speedometer illumination  | 30. Trailer warning light                            | 57. Light switch  |
| 2. Fuel indicator illumination   | 31. Side light warning light                         | 58. Heater plugs  |
| 3. Water temperature indicator illumination                            | 32. Rear fog warning light                           | 59. Fuses   |
| 4. Rear fog lamps (when fitted)  | 33. Main beam warning light                          | 60. Heater motor (when fitted)  |
| 5. Number plate lamp   | 34. Spare  | 61. Hazard switch (when fitted)                                       |
| 6. LH tail lamp  | 35. Low fuel warning light                           | 62. Hazard switch illumination (when fitted)                          |
| 7. LH side lamp  | 36. Locked four-wheel drive warning light            | 63. Starter solenoid  |
| 8. RH tail lamp  | 37. Cold start warning light                         | 64. Spare pick-up point   |
| 9. RH side lamp  | 38. Oil warning light                                | 65. Pick-off point for auxiliary trailer                              |
| 10. LH headlamp dip beam   | 39. Charge warning light                             | 66. Fuel indicator  |
| 11. RH headlamp dip beam   | 40. Brake warning light                              | 67. Water temperature indicator                                       |
| 12. LH headlamp main beam  | 41. Park brake warning light                         | 68. Oil pressure indicator (when fitted)                              |
| 13. RH headlamp main beam  | 42. Direction indicator warning light                | 69. Oil temperature indicator (when fitted)                           |
| 14. Interior lamp  | 43. Seat belt warning light                          | 70. Battery   |
| 15. Stop lamp  | 44. Locked four-wheel drive switch                   | 71. Alternator  |
| 16. Horn   | 45. Clock (when fitted)                              | 72. Fuel shut off valve   |
| 17. LH side repeater (when fitted)                                     | 46. Reversing lamps (when fitted)                    | 73. Heat/Start switch   |
| 18. LH front indicator   | 47. Wiper motor                                      | 74. Ballast resistor  |
| 19. LH rear indicator  | 48. Reversing lamp switch (when fitted)              | 75. Battery condition indicator                                       |
| 20. RH front indicator   | 49. Pressure differential warning actuator switch    | 76. Fuel changeover relays (when fitted)                              |
| 21. RH rear indicator  | 50. Heater switch (when fitted)                      | 77. Pick-up point for auxiliary instrument illumination (when fitted) |
| 22. RH side repeater (when fitted)                                     | 51. Stop lamp switch                                 | 78. Rear tank unit  |
| 23. Pick-off point for auxiliary instrument illumination (when fitted) | 52. Flasher unit                                     | 79. Fuel cock switch (when fitted)                                    |
| 24. Rear fog switch (when fitted)                                      | 53. Oil pressure switch                              | 80. Side tank unit  |
| 25. Washer pump  | 54. Brake check relay                                | 81. Water temperature transmitter                                     |
| 26. Panel illumination switch  | 55. Park brake switch (when fitted)                  | 82. Oil pressure transmitter (when fitted)                            |
| 27. Interior light switch  | 56. Pick-off point for front fog lamps (when fitted) | 83. Oil temperature transmitter (when fitted)                         |
| 28. Steering column switches   |  |   |
| 29. Grouped warning lights (comprising items 30 to 43)                 |  |   |

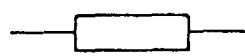
### Key to cable colours

B Black G Green K Pink L Light N Brown O Orange P Purple R Red S Slate U Blue W White Y Yellow

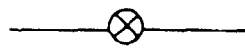
The last letter of the colour code denotes the tracer colour



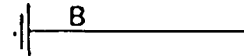
Connectors via plug and socket



Snap connectors



Permanent in-line connections

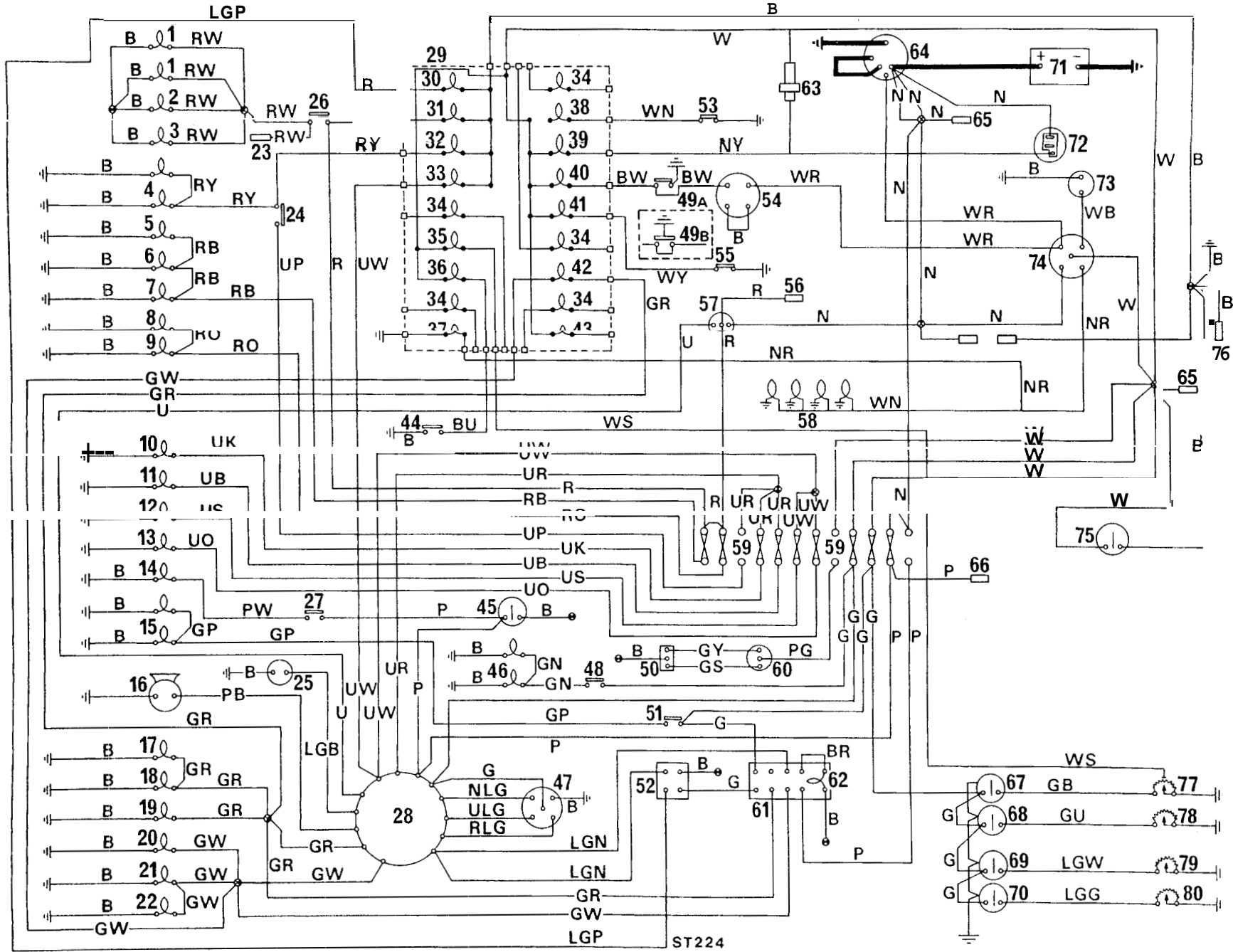


Earth connections via cables



Earth connections via fixing bolts

### FOUR CYLINDER 2.5 LITRE DIESEL



## KEY TO FOUR CYLINDER 2.5 LITRE DIESEL DIAGRAM

- |   |   |  |
|---|---|--|
| <ul style="list-style-type: none"> <li>1. Speedometer illumination</li> <li>2. Fuel indicator illumination</li> <li>3. Water temperature indicator illumination</li> <li>4. Rear fog lamps</li> <li>5. Number plate lamp</li> <li>6. LH tail lamp</li> <li>7. LH side lamp</li> <li>8. RH tail lamp</li> <li>9. RH side lamp</li> <li>10. LH headlamp dip beam</li> <li>11. RH headlamp dip beam</li> <li>12. LH headlamp main beam</li> <li>13. RH headlamp main beam</li> <li>14. Interior lamp</li> <li>15. Stoplamp</li> <li>16. Horn</li> <li>17. LH side repeater</li> <li>18. LH front indicator</li> <li>19. LH rear indicator</li> <li>20. RH front indicator</li> <li>21. RH rear indicator</li> <li>22. RH side repeater</li> <li>23. Pick-off point for auxiliary instrument illumination</li> <li>24. Rear fog switch</li> <li>25. Washer pump</li> <li>26. Panel illumination switch</li> <li>27. Interior lighting switch</li> <li>28. Steering column switches</li> <li>29. Grouped warning lights (comprising items 30 to 43)</li> </ul> | <ul style="list-style-type: none"> <li>30. Trailer warning light</li> <li>31. Side light warning light</li> <li>32. Rear fog warning light</li> <li>33. Main beam warning light</li> <li>34. Spare</li> <li>35. Low fuel warning light</li> <li>36. Locked four-wheel drive warning light</li> <li>37. Cold start warning light</li> <li>38. Oil warning light</li> <li>39. Charge warning light</li> <li>40. Brake warning light</li> <li>41. Park brake warning light</li> <li>42. Direction indicator warning light</li> <li>43. Seat belt warning light</li> <li>44. Locked four-wheel drive switch</li> <li>45. Clock</li> <li>46. Reversing lamps</li> <li>47. Wiper motor</li> <li>48. Reversing lamp switch</li> <li>49a Brake fluid loss switch (Ninety models only)</li> <li>49b Pressure differential warning actuator switch (One Ten models only)</li> <li>50. Heater switch</li> <li>51. Stop lamp switch</li> <li>52. Flasher unit</li> <li>53. Oil pressure switch</li> </ul> | <ul style="list-style-type: none"> <li>54. Brake check relay</li> <li>55. Park brake switch</li> <li>56. Pick-off point for front fog lamps (when fitted)</li> <li>57. Light switch</li> <li>58. Heater plugs</li> <li>59. Fuses</li> <li>60. Heater motor</li> <li>61. Hazard switch</li> <li>62. Hazard switch illumination</li> <li>63. Ignition light resistor</li> <li>64. Starter solenoid</li> <li>65. Spare pick-up point</li> <li>66. Pick-off point of auxiliary trailer</li> <li>67. Fuel indicator</li> <li>68. Water temperature indicator</li> <li>69. Oil pressure indicator</li> <li>70. Oil temperature indicator</li> <li>71. Battery</li> <li>72. Alternator</li> <li>73. Fuel shut off valve</li> <li>74. Heat/Start switch</li> <li>75. Battery condition indicator</li> <li>76. Pick-up point for auxiliary instrument illumination</li> <li>77. Fuel tank unit</li> <li>78. Water temperature transmitter</li> <li>79. Oil pressure transmitter</li> <li>80. Oil temperature transmitter</li> </ul> |
|---|---|--|

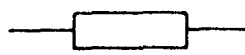
### Key to cable colours

B Black G Green K Pink L Light N Brown O Orange P Purple R Red S Slate U Blue W White Y Yellow

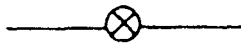
The last letter of a colour code denotes the tracer colour



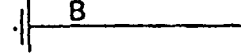
Connectors via plug and socket



Snap connectors



Permanent in-line connections

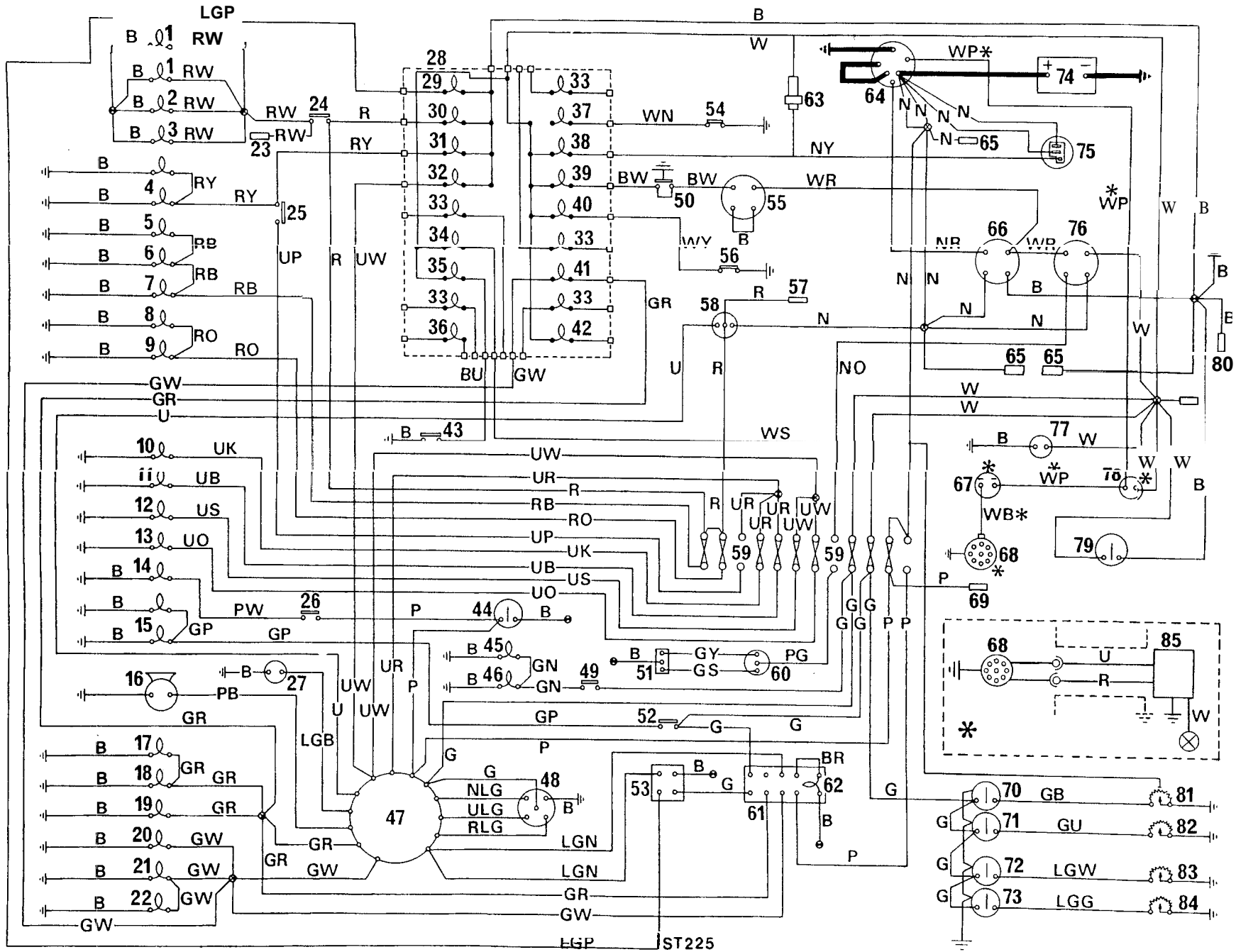


Earth connections via cables



Earth connections via fixing bolts

V8 CYLINDER PETROL





## KEY TO V8 CYLINDER PETROL DIAGRAM

- |  |  |  |
|--|--|--|
| 1. Speedometer illumination                              | 30. Side light warning light                         | 58. Light switch   |
| 2. Fuel indicator illumination                           | 31. Rear fog warning light                           | 59. Fuses  |
| 3. Water temperature illumination                        | 32. Main beam warning light                          | 60. Heater motor   |
| 4. Rear fog lamps  | 33. Spare position                                   | 61. Hazard switch  |
| 5. Number plate lamp                                     | 34. Low fuel warning light                           | 62. Hazard switch illumination                           |
| 6. LH tail lamp  | 35. Locked four-wheel drive warning light            | 63. Ignition light resistor                              |
| 7. LH side lamp  | 36. Cold start warning light                         | 64. Starter solenoid                                     |
| 8. RH tail lamp  | 37. Oil warning light                                | 65. Spare pick-off point                                 |
| 9. RH side lamp  | 38. Charge warning light                             | 66. Start relay  |
| 10. LH headlamp dip beam                                 | 39. Brake warning light                              | 67. Coil   |
| 11. RH headlamp dip beam                                 | 40. Park brake warning light                         | 68. Distributor  |
| 12. LH headlamp main beam                                | 41. Direction indicator warning light                | 69. Pick-off point for auxiliary trailer                 |
| 13. RH headlamp main beam                                | 42. Seat belt warning light                          | 70. Fuel indicator                                       |
| 14. Interior lamp  | 43. Locked four-wheel drive switch                   | 71. Water temperature indicator                          |
| 15. Stop lamp  | 44. Clock (when fitted)                              | 72. Oil pressure indicator                               |
| 16. Horn   | 45. LH Reversing lamp                                | 73. Oil temperature indicator (when fitted)              |
| 17. LH side repeater                                     | 46. RH Reversing lamp                                | 74. Battery  |
| 18. LH front indicator                                   | 47. Steering column switches                         | 75. Alternator   |
| 19. LH rear indicator                                    | 48. Wiper motor                                      | 76. Start switch   |
| 20. RH front indicator                                   | 49. Reversing lamp switch                            | 77. Fuel pump  |
| 21. RH rear indicator                                    | 50. Pressure differential warning actuator switch    | 78. Ballast resistor                                     |
| 22. RH side repeater                                     | 51. Heater switch                                    | 79. Battery condition indicator                          |
| 23. Pick-off point for auxiliary instrument illumination | 52. Stop lamp switch                                 | 80. Pick-off point for auxiliary instrument illumination |
| 24. Panel illumination switch                            | 53. Flasher unit                                     | 81. Tank unit transmitter                                |
| 25. Rear fog switch (when fitted)                        | 54. Oil pressure switch                              | 82. Water temperature transmitter                        |
| 26. Interior light switch                                | 55. Brake check relay                                | 83. Oil pressure transmitter                             |
| 27. Washer pump  | 56. Park brake switch                                | 84. Oil temperature transmitter                          |
| 28. Grouped warning lights (comprising items 29 to 42)   | 57. Pick-off point for front fog lamps (when fitted) | 85. Ignition module (when fitted)                        |
| 29. Trailer warning light                                |  |  |

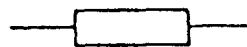
### Key to cable colours

B Black G Green K Pink L Light N Brown O Orange P Purple R Red S Slate U Blue W White Y Yellow

The last letter of a colour code denotes the tracer colour



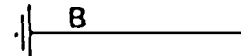
Connectors via plug and socket



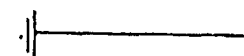
Snap connectors



Permanent in-line connections

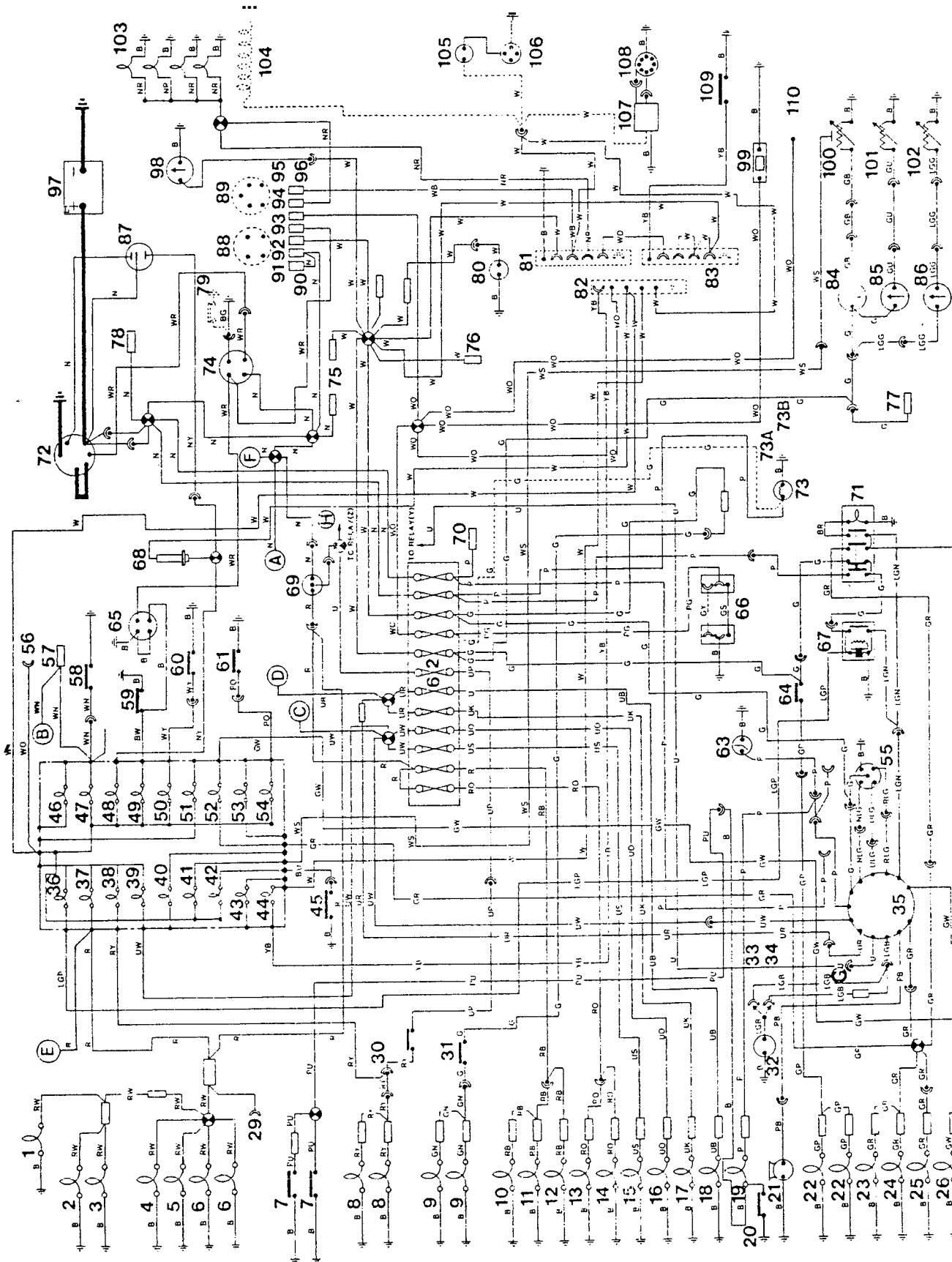


Earth connections via cables



Earth connections via fixing bolts

COFFPOSIT = CIRCUIT DIAGRAM — ALL MODELS AND MARKETS — 1986 ONWARDS



## KEY TO COMPOSITE CIRCUIT DIAGRAM

- |   |   |  |
|---|---|--|
| 1. Battery condition indicator illumination | 38. Rear fog warning light                        | 74. Start relay                                |
| 2. Cigar lighter illumination               | 39. Main beam warning light                       | 75. Spares                                     |
| 3. Oil temperature indicator illumination   | 40. Spare   | 76. Auxiliary instrument illumination          |
| 4. Water temperature indicator illumination | 41. Low fuel warning light                        | 77. Spare auxiliary instrument                 |
| 5. Fuel indicator illumination              | 42. Locked 4WD warning light                      | 78. Spare                                      |
| 6. Speedometer illumination                 | 43. Spare   | 79. Starter inhibitor switch (auto only)       |
| 7. Door switches (when fitted)              | 44. Cold start warning light                      | 80. Fuel pump (petrol only)                    |
| 8. Rear fog lamp                            | 45. Locked 4WD switch                             | 81. Connector — Diesel                         |
| 9. Reverse lamp                             | 46. Spare   | 82. Connector — common                         |
| 10. Number plate lamp                       | 47. Oil warning light                             | 83. Connector — petrol                         |
| 11. LH tail lamp                            | 48. Ignition warning light                        | 84. Fuel indicator                             |
| 12. LH side lamp                            | 49. Brakes warning light                          | 85. Water temperature indicator                |
| 13. RH tail lamp                            | 50. Park brake warning light                      | 86. Oil temperature indicator                  |
| 14. RH side lamp                            | 51. Spare   | 87. Alternator                                 |
| 15. LH headlamp main beam                   | 52. Direction indicator warning light             | 88. Petrol ignition switch                     |
| 16. RH headlamp main beam                   | 53. Spare   | 89. Diesel ignition switch                     |
| 17. LH headlamp dip beam                    | 54. Seat belt warning light                       | 90. Feed snap connector                        |
| 18. RH headlamp dip beam                    | 55. Wiper motor                                   | 91. Feed snap connector                        |
| 19. Interior lamp (when fitted)             | 56. Norwegian daytime running lights connection   | 92. Ignition snap connector                    |
| 20. Interior lamp switch                    | 57. German fuel shut off and Norway connections   | 93. Starter snap connector                     |
| 21. Horn                                    | 58. Oil pressure switch                           | 94. Auxiliary snap connector                   |
| 22. Stoplamp                                | 59. Pressure differential warning actuator switch | 95. Heater snap connector                      |
| 23. LH side repeater                        | 60. Park brake switch (when fitted)               | 96. Fuel shut-off snap connector               |
| 24. LH front indicator                      | 61. Seat belt switch (when fitted)                | 97. Battery                                    |
| 25. LH rear indicator                       | 62. Fuses   | 98. Battery condition indicator (when fitted)  |
| 26. RH side repeater                        | 63. Clock (when fitted)                           | 99. Radio (when fitted)                        |
| 27. RH front indicator                      | 64. Stop lamp switch                              | 100. Tank unit — fortwin tanks system          |
| 28. RH rear indicator                       | 65. Brake check relay                             | 101. Water temp transmitter                    |
| 29. Front fog feed                          | 66. Heater connections                            | 102. Oil temperature transmitter (when fitted) |
| 30. Rear fog switch                         | 67. Flasher unit                                  | 103. Glow plugs (Diesel only)                  |
| 31. Reverse lamp switch                     | 68. Ignition light resistor                       | 104. Fuel shut off solenoid                    |
| 32. Washer pump                             | 69. Light switch                                  | 105. (4 cylinder petrol only) coil             |
| 33. RH washer pump connection               | 70. Auxiliary                                     | 106. Distributor (4 cylinder petrol only)      |
| 34. LH washer pump connection               | 71. Hazard unit                                   | 107. 2 CE unit — V8 only                       |
| 35. Steering column switches                | 72. Starter solenoid                              | 108. Distributor — V8 only                     |
| 36. Trailer warning light                   | 73. Cigar lighter (when fitted)                   | 109. Choke switch (petrol only)                |
| 37. Side light warning light                | a) Australia                                      | 110. Air conditioning feed (when fitted)       |
|   | b) Rest of World                                  |  |

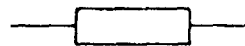
### Key to cable colours

B Black G Green K Pink L Light N Brown O Orange P Purple R Red S Slate U Blue W White Y Yellow

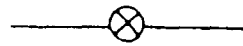
The last letter of a colour code denotes the tracer colour



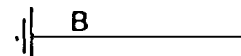
Connectors via **plug** and socket



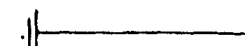
Snap connectors



Permanent in-line connections

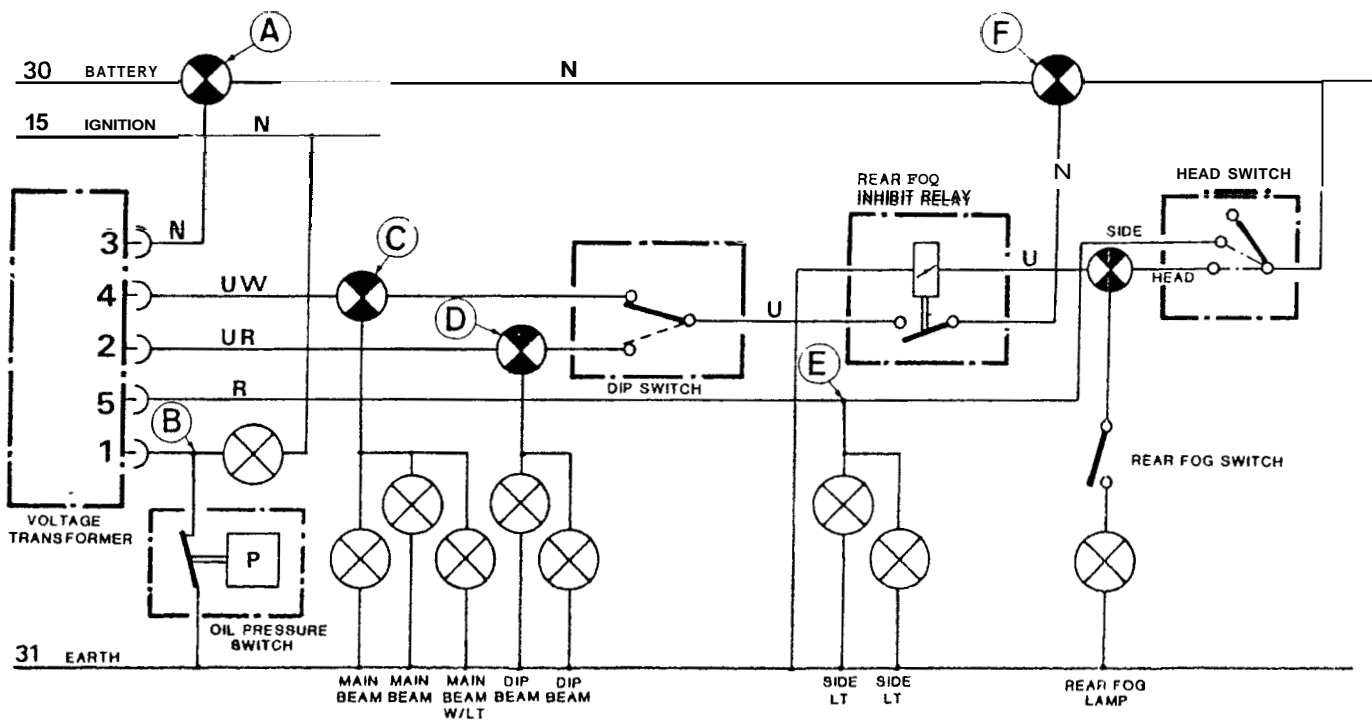


Earth connections via cables



Earth connections via fixing **bolts**

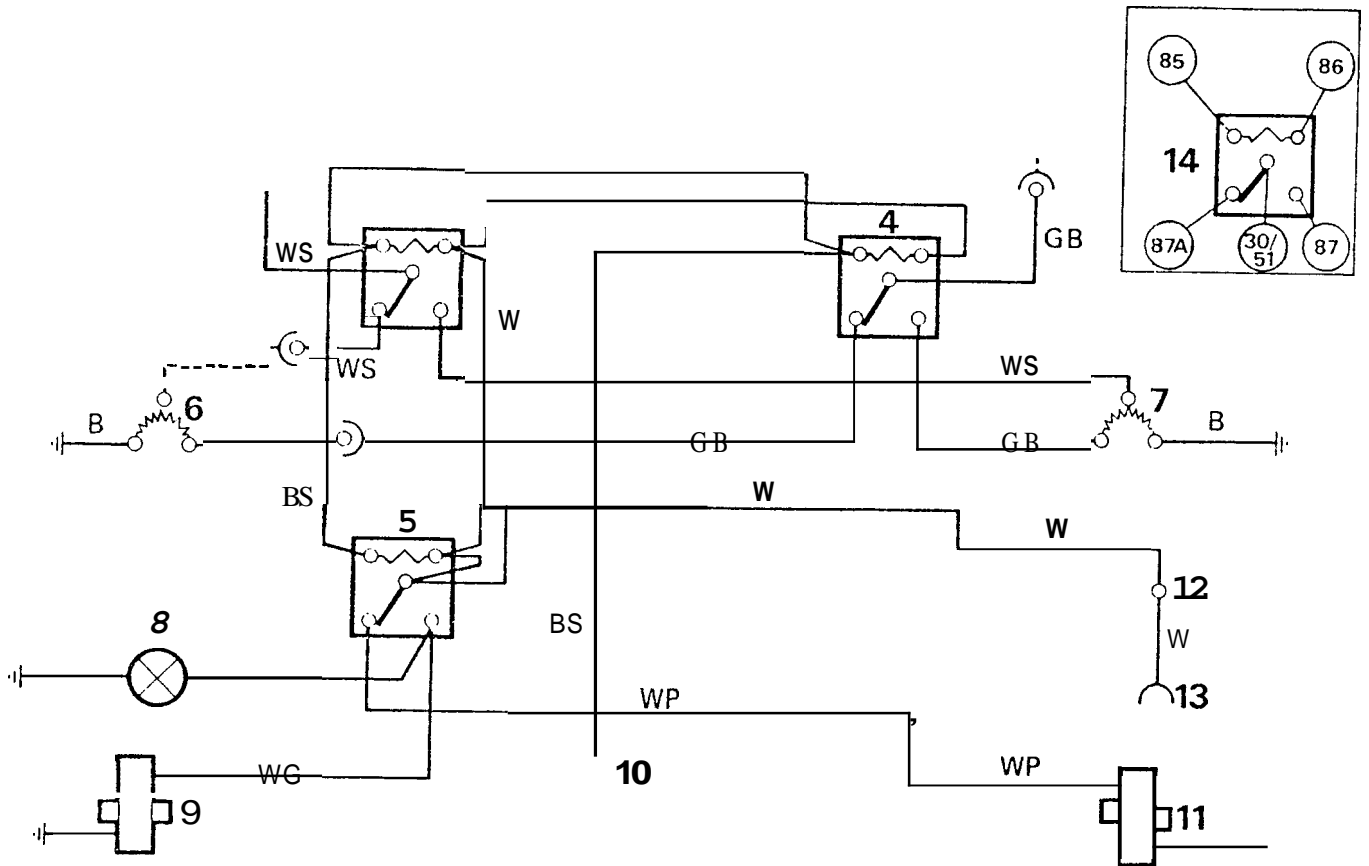
DIM-DIP CIRCUIT — UNITED KINGDOM ONLY



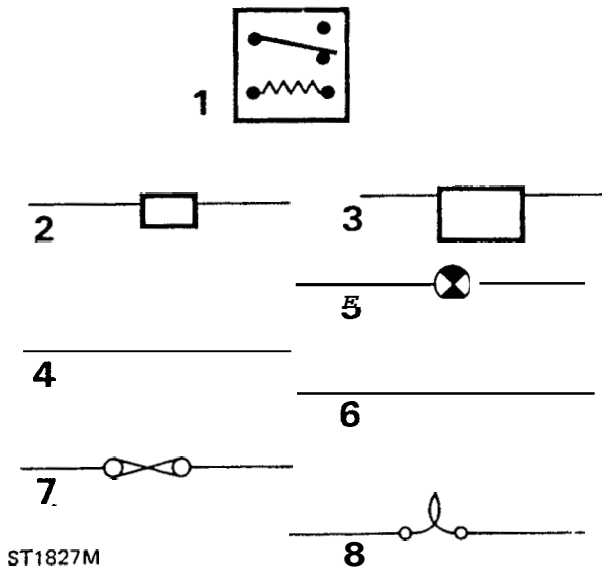
ST258

The in-line connections lettered A, B, C, D, E and F connect into the corresponding lettered connections in the main composite circuit diagram.

## CIRCUIT DIAGRAM — TWINTANK — TWINPUMPS



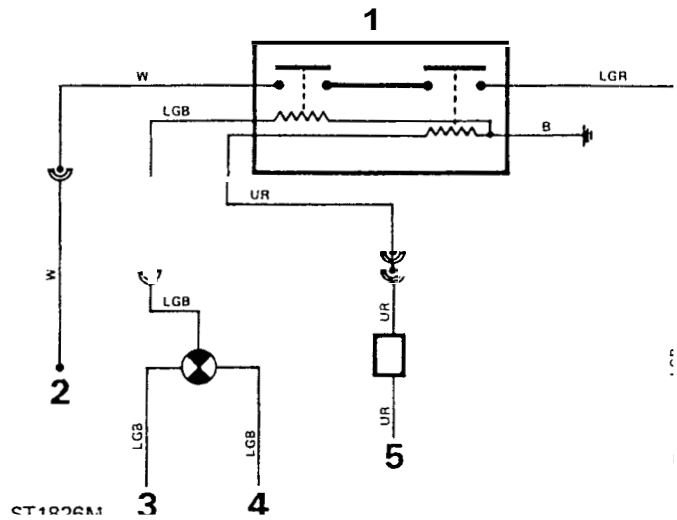
1. Low fuel warning light
2. Fuelgauge
3. Relay 28RA low level warning
4. Relay 28RA Fuel gauge
5. Relay 28RA Fuel pumps
6. Rear tank unit
7. Side tank unit



ST1827M

KEY TO TERMINATIONS

1. 28 RA Relay (normally closed position)
2. 4 way moulded connecting tube
3. 6 way moulded connecting tube
4. Pin and socket connector
5. Clinch connections
6. Earth connections via cables
7. Fuse connections
8. Bulb connections

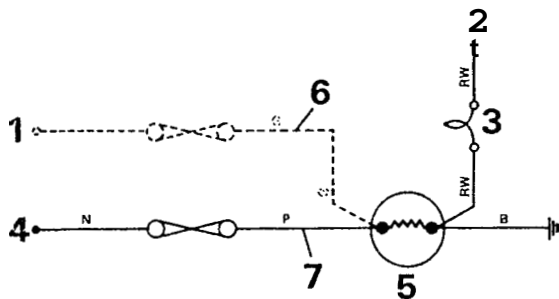


ST1826M

POWER WASH SYSTEM

1. Power wash timer
2. Ignition feed
3. Screen wash pump
4. Screen wash switch
5. Dipswitch
6. Power wash pump

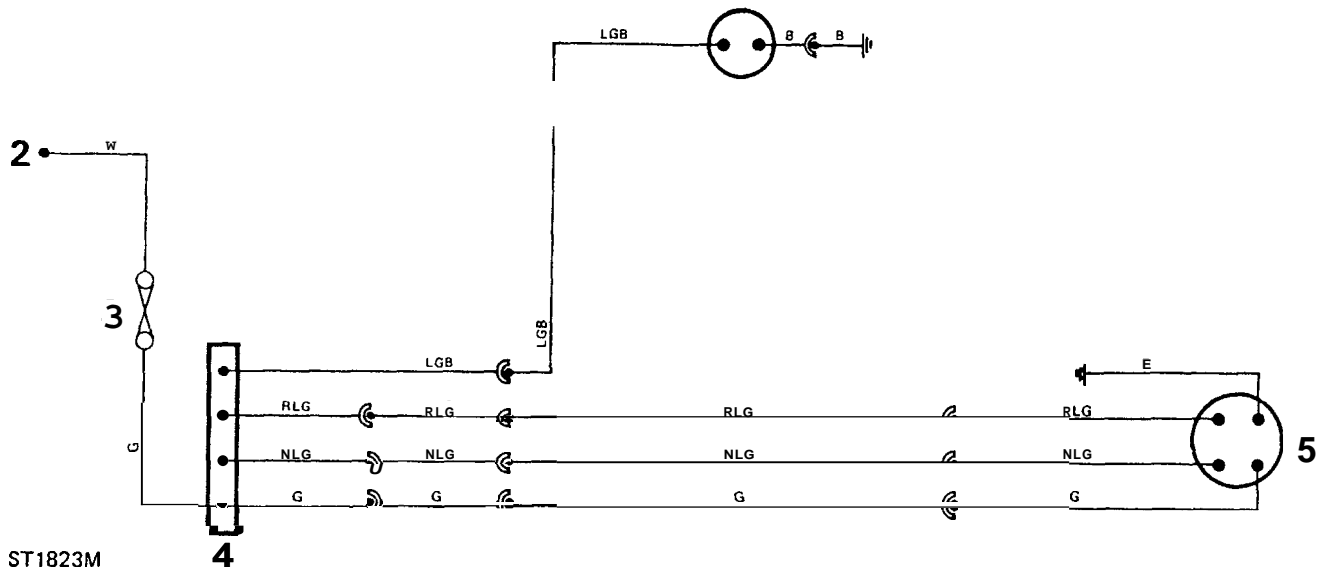
continued



ST1824M

CIGAR LIGHTER

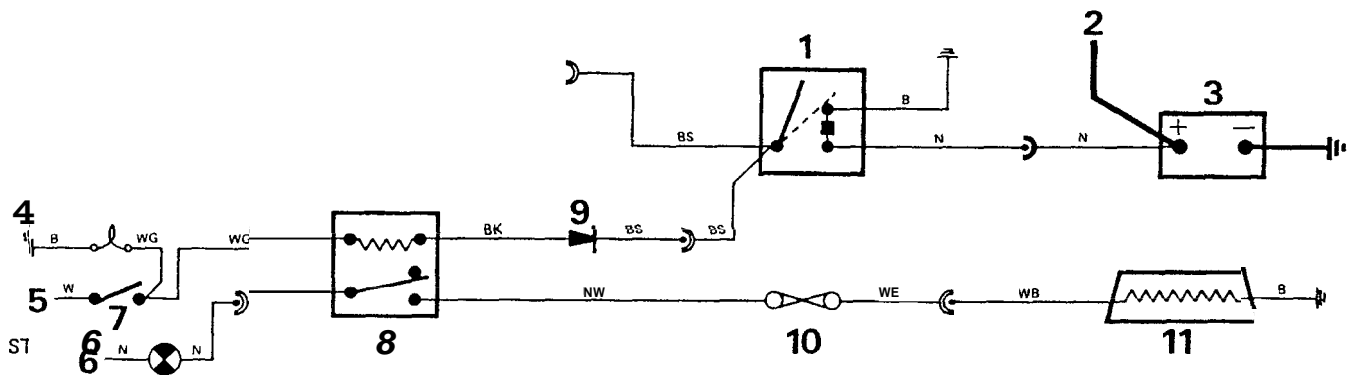
1. Ignition feed
2. Side light circuit
3. Battery positive
4. Cigar lighter
5. Australia Only (dotted line)
6. Standard Circuit (solid line)



ST1823M

**REAR WASH-WIPE SYSTEM**

- 1. Washer pump
- 2. Ignition feed
- 3. 5 amp fuse
- 4. Wiper switch
- 5. Wiper motor



**HEATED REAR WINDOW**

- 1. Voltage sensitive switch
- 2. Starter solenoid
- 3. Battery
- 4. Heated rear window warning light
- 5. Ignition feed
- 6. Battery positive
- 7. Heated rear window switch
- 8. Heated rear window relay
- 9. Diode
- 10. 10 amp fuse
- 11. Heated rear window

