AIR CONDITIONING-A.R.A. SYSTEM

Description

The A.R.A. air conditioning system comprises four major units:

1. An engine-mounted compressor.
2. A condenser mounted in front of the radiator.
3. A receiver/drier unit located in the engine compartment.
4. An evaporator unit mounted behind the dashboard.

The four units are interconnected by hoses carrying refrigerant, and the evaporator is linked into the vehicle ventilation system.

WARNING: Under no circumstances should refrigerant hoses be disconnected without first discharging the system

Refrigeration cycle

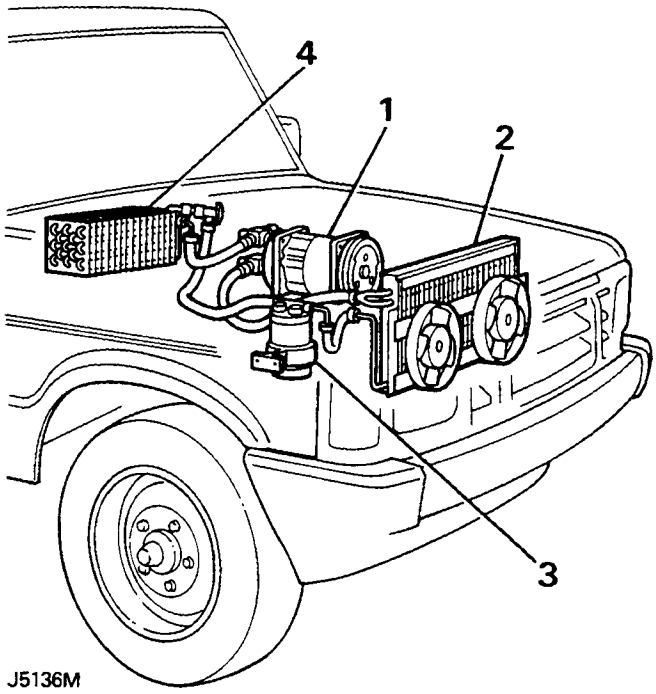
The function of the refrigeration circuit is to cool the evaporator.

1. Compressor

The compressor draws vaporized refrigerant from the evaporator. It is compressed, and thus heated, and passed on to the condenser as a hot, high pressure vapour.

2. Condenser

The condenser is mounted directly in front of the vehicle radiator. It consists of a refrigerant coil mounted in a series of thin cooling fins to provide the maximum heat transfer in a minimum amount of space. Airflow across condenser is induced by vehicle movement and is assisted by two electric condenser fans. The refrigerant enters the inlet at the top of the condenser as a heat laden high pressure vapour.



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As this vapour passes down through the condenser coils, heat will follow its natural tendency and flow from the hot refrigerant vapour into the cooler air flowing across the condenser coils and fins.
When the refrigerant vapour reaches the temperature and pressure that will induce a change of state, a large quantity of latent heat will be transferred to the outside air. The refrigerant will change from a high pressure **HOT VAPOUR** to a high pressure **WARM LIQUID.**

3. Receiver drier

This unit filters, removes moisture, and acts as a reservoir for the liquid. To prevent icing inside the system, extreme precautions are taken during servicing to exclude moisture. The receiver drier should be considered as a second stage insurance to prevent the serious consequences of ice obstructing the flow.

NOTE: A sight glass provided in the unit top enables a visual check to be made of the high pressure liquid flow.

4. Expansion valve and evaporator

High pressure liquid refrigerant is delivered to the expansion valve. A severe pressure drop occurs across the valve and as the refrigerant enters the evaporator space at a temperature of approximately −6°C(21°F) it boils and vaporizes. As this change of state occurs, a large amount of latent heat is absorbed. The evaporator is therefore cooled and as a result heat is extracted from the air flowing across the evaporator. The air flow is controlled by two evaporator fans regulated by the air conditioner fan control.

Second cycle

Low pressure vaporized refrigerant is drawn from the evaporator by the compressor and a second cycle commences.

GENERAL SERVICE INFORMATION

Introduction

Before any component of the air conditioning system is removed, the system must be discharged. When the component is replaced, the system must be evacuated to remove all traces of old refrigerant and moisture. The system must then 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 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 station
Leak detector
Safety goggles
Refrigerant charging line seals
Thermometer +20°C to -60°C (+68°F to 76°F)
Compressor dipstick

SERVICING MATERIALS

Refrigerant: Refrigerant 12, which includes Freon 12 or Arcton 12.

CAUTION: Methychloride refrigerants must not be used.

Nominal charge weight:
1.19 kg (42 oz).
Compressor oil: See Recommended Lubricants.

PRECAUTIONS IN HANDLING REFRIGERANT

Refrigerant 12 is transparent and colourless in both the gaseous and liquid state. It has a boiling point of -29.8°C (-21.7°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.

FIRST AID: If refrigerant should contact the eyes or skin, splash the eyes or affected area with cold water for several minutes. Do not rub. As soon as possible thereafter, obtain treatment from a doctor or eye specialist.

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

DO NOT:

- Leave refrigerant container open to atmosphere.
- Carry refrigerant container inside a vehicle.
- Subject refrigerant containers 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 produce a toxic gas, phosgene.
- 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.

(a) When disconnecting any hose 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.

(b) Lines, flexible end connections and components must be capped immediately they are opened to prevent the entrance oi moisture and dirt.

(c) 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 hoses, they must be replaced with new hoses.

(d) All replacement components and flexible end connections must be sealed, and only opened immediately prior to making the connection.

(e) Ensure the components are at room temperature before uncapping, to prevent condensation of moisture from the air that enters.

(f) Components must not remain uncapped for longer than fifteen minutes. In the event of delay, the caps must be fitted.

(g) 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 not be used, fit a new unit.

(h) 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 approximately 135 ml (4.6 fluid oz) 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 wrenches of the correct size, one on each fitting 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 50mm (2 in) of the exhaust manifold.

(r) Completed assemblies must be checked for refrigeration lines touching metal panels. Any direct contact of lines and panels 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 garden hose or air line, clean the fins of the condenser to remove flies, leaves, etc. Check the hose connection 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

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.

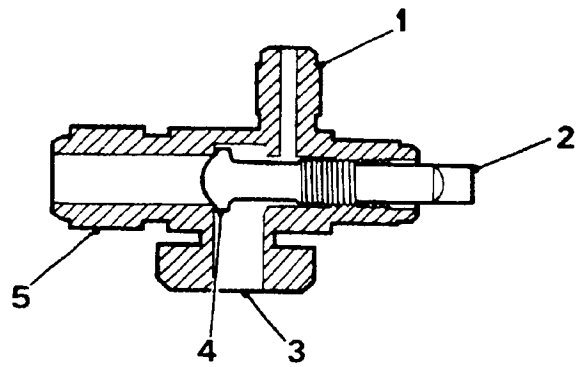
The valve with the larger connections fits the suction side. As the name suggests, these valves are for service purposes, providing connections to external pressure/vacuum gauges for test purposes. In combination with charging and testing equipment they are used to charge the system with refrigerant.

There are two types of service valves in operation: 'Stem' and 'Schrader'.

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.

NOTE: A thorough understanding of the stem type service valve is necessary before undertaking servicing or repair involving the air conditioning system.



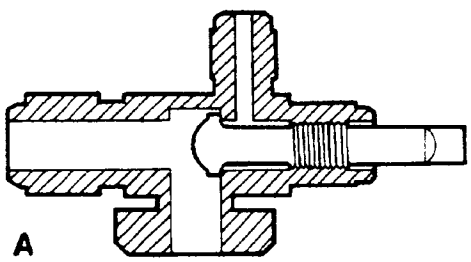
ST1387M

Stem type service valve

1. Service port.
2. Valve stem.
3. Compressor port.
4. Valve seat.
5. Hose connector.

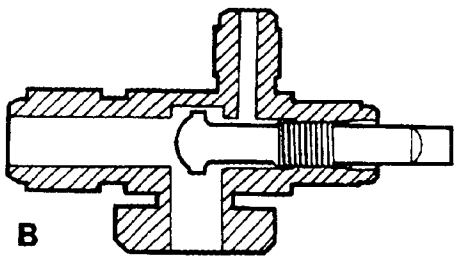
NOTE: A special wrench should be used to adjust the valve to prevent damage to the stem.

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



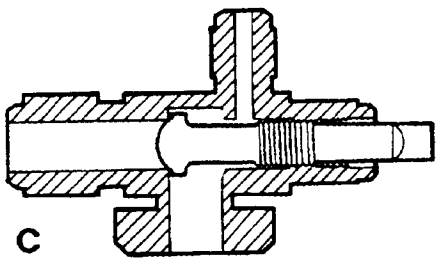
RR1734M

A. **ON: FULLY COUNTER-CLOCKWISE-** 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 counter-clockwise. This seals the service gauge port from receiving any refrigerant flow.



RR1735M

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.

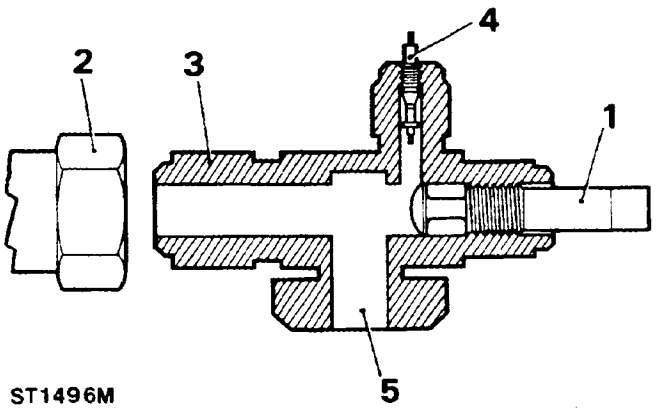


RR1736M

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.

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



ST1496M

Schrader service valve

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 COUNTER-CLOCKWISE-** 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 counter-clockwise. This seals the service gauge port from receiving any 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. 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.

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

ELECTRICAL SUPPLY SWITCHES AND FUSES

The electrical components of the air conditioning system draw current from a number of separate relays.
The air conditioning system is mastered from the starter relay and is switched **OFF** during engine cranking.
Each component in turn is energised and controlled by a series of relays and switches as indicated by the circuit diagram, and component location diagram in the Electrical Section 86.

Both condenser fans operate together when the air conditioning circuit is switched **ON**, and when the ignition is switched **ON** and the coolant temperature is high, this is sensed by the engine water temperature sensor.

The three blade type fuses are located in the fuse box mounted on the lower fascia panel. They are numbered A8, C5 and C6. It is essential to use a fuse of the same value when fitting a replacement. See Electrical Section 86 for relay and fuse details.

AIR CONDITIONING ELECTRICAL/MECHANICAL FAULT DIAGNOSIS

FAULT	CAUSE	REMEDY
A. MOTOR INOPERATIVE OR SLOW RUNNING	1. Incorrect voltage. 2. Open or defective fuse or relay. 3. Loose wire connection including ground. 4. Switch open or defective. 5. Tight, worn, or burnt motor bearings. 6. Open rotor windings. 7. Worn motor brushes. 8. Shaft binding-blade misaligned. 9. Defective resistors.	1. Check voltage. 2. Check and replace as necessary. 3. Check system wires; tighten all connections. 4. Replace switch. 5. Replace motor. 6. Replace motor. 7. Replace motor. 8. Check alignment. Repair or replace as necessary. 9. Rectify or replace.
B. CLUTCH INOPERATIVE	1. Incorrect voltage. 2. Open or defective fuse or relay. 3. Defective thermostat control or pressure switch. 4. Shorted or open field coil. 5. Bearing seized (clutch will not disengage). 6. Refrigeration circuit problem causing heavy load and excessive drive torque.	1. Check voltage. 2. Check and replace as necessary. 3. Replace thermostat or pressure switch. 4. Replace coil. 5. Replace bearing. 6. Check and rectify.
C. CLUTCH NOISY	1. Incorrect alignment. 2. Loose belt. 3. Compressor not mounted securely. 4. Bearing in clutch-pulley assembly not pressed in. 5. Low voltage to clutch. 6. Clutch will not spin freely. 7. Oil on clutch face. 8. Slipping clutch. 9. Overloaded or locked compressor. 10. Icing.	1. Check alignment; repair as necessary. 2. Adjust to proper tension. 3. Repair as necessary. 4. Remove clutch and replace bearing. 5. Check connections and voltage. 6. Refer to B5 above. 7. Check compressor seals for leaks. 8. Refer to C5 above. 9. Repair or replace compressor. 10. Check for suction line frosting. Replace expansion valve if necessary. Replace receiver/drier if necessary.
D. CONDENSER AND/OR EVAPORATOR VIBRATION	1. Motor and/or blades improperly mounted. 2. Foreign matter build-up on blades. 3. Excessive wear of motor bearings.	1. Check mountings, adjust as necessary. 2. Clean blades with a suitable non-inflammable cleaner. 3. Replace motor.

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, in-car temperature and altitude.
The following items should be checked before operating the system:

1. Compressor drive belt tension.
2. Compressor magnetic clutch operation.
3. Condenser fan operation.
4. Condenser fins, dirt will cause poor cooling and higher operating temperatures.

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

1. All high pressure lines and components should be hot to the touch.
2. All low pressure 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 p.s.i. (bar)	High Side Pressure p.s.i. (bar)
Cool day 70-80°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 80-90°F (27-32°C)	40-50°F (4.4-10°C)	20-25 (1.4-1.8)	190-240 (13.4-16.9)
Hot day 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. *Evaporator air temperatures will be lower on dry days, higher on humid days.*

FAULT	CAUSE	REMEDY
A. HIGH HEAD PRESSURE	1. Overcharge of refrigerant.	1. Purge with bleed hose until bubbles start to appear in sight glass; then, add sufficient refrigerant gas to clear sight glass.
	2. Air in system.	2. Slowly blow charge to shop exhaust system. Install new drier; evacuate and charge system.
	3. Condenser air passage clogged with dirt or other foreign matter.	3. Clean condenser of debris.
	4. Condenser fan motor defective.	4. Replace motor.
B. LOW HEAD PRESSURE	1. Undercharge of refrigerant; evident by bubbles in sight glass while system is operating.	1. Evacuate and recharge the system. Check for leakage.
	2. Split compressor gasket or leaking valves.	2. Replace gasket and/or reed valve; Install new drier, evacuate and charge the system.
	3. Defective compressor.	3. Repair or replace compressor.
C. HIGH SUCTION PRESSURE	1. Loose compressor belt.	1. Adjust belt tension.
	2. Refrigerant flooding through evaporator into suction line; evident by ice on suction line and suction service valve.	2. Check thermobulb. Bulb should be securely clamped to clean horizontal section of copper suction pipe.
	3. Expansion valve stuck open.	3. Replace expansion valve.
	4. Compressor suction valve strainer restricted.	4. Remove and clean or replace strainer.
	5. Leaking compressor valves, valve gaskets and/or service valves.	5. Replace valves and/or gaskets. Install new drier evacuate and charge the system.
	6. Receiver/drier stopped; evident by temperature difference between input and output lines.	6. Install new drier, evacuate and charge the system.
D. LOW SUCTION	1. Expansion valve thermobulb not operating.	1. Warm thermobulb with hand. Suction should rise rapidly to 20 lb or more. If not replace expansion valve.
	2. Expansion valve sticking closed.	2. Check inlet side screen. Clean if clogged. Refer To C-2 and C-3.
	3. Moisture freezing in expansion valve orifice. Valve outlet tube will frost while inlet hose tube will have little or no frost. System operates periodically.	3. Install new drier, evacuate and charge the system.
	4. Dust, paper scraps, or other debris restricting evaporator blower grille	4. Clean grilles as required.
	5. Defective evaporator blower motor, wiring, or blower switch.	5. Refer to Fault Diagnosis Chart for blower motor.

FAULT	CAUSE	REMEDY
E. NOISY EXPANSION VALVE (steady hissing)	1. Low refrigerant charge; evident by bubbles in sight glass.	1. Leak test. Repair or replace components as required.
F. INSUFFICIENT COOLING	1. Expansion valve not operating properly. 2. Low refrigerant charge-evident by bubbles in sight glass. 3. Compressor not pumping.	1. Refer to C-2, C-3, D-1 and E. 2. Refer to B-1 and E. 3. Refer to B-2 and B-3
G. COMPRESSOR BELT SLIPPING	1. Belt tension. 2. Excessive head pressure. 3. Incorrect alignment of pulleys or worn belt not riding properly. 4. Nicked or broken pulley. 5. Seized compressor.	1. Adjust belt tension. 2. Refer to A-1 through A-4 and C-6. 3. Repair as needed. 4. Replace as needed. 5. Replace compressor.
H. ENGINE NOISE AND/OR VIBRATION	1. Loose or missing mounting bolts. 2. Broken mounting bracket. 3. Loose flywheel or clutch retaining bolt. 4. Rough idler pulley bearing. 5. Bent, loose, or improperly mounted engine drive pulley. 6. Defective compressor bearing. 7. Insecure mountings of accessories; generator, power steering, air filter, etc. 8. Excessive head pressure. 9. Incorrect compressor oil level.	1. Repair as necessary. 2. Replace bracket. 3. Repair as necessary. 4. Replace bearing. 5. Repair as necessary. 6. Replace bearing. 7. Repair as necessary. 8. Refer to A-1, A-2, A-3 A-4 and C-6. 9. Refer to compressor Oil Level Check.

CHARGING AND TESTING EQUIPMENT

This is standard equipment for the servicing of automotive air conditioning systems, and is used for all testing, trouble shooting, evacuating and charging operations.
Various designs of charging and testing equipment are available depending upon the manufacturer chosen by the user. As slight variations do occur it is recommended that the operator adheres to the appropriate manufacturers' instructions for the equipment in use.

WARNING: The air conditioning system is charged with a high pressure, potentially toxic refrigerant. Repairs or servicing MUST only be carried out by an operator familiar with both the vehicle system and the charging and testing equipment.
All operations must be carried out in a well-ventilated area away from open flame and heat sources.
Always wear safety goggles and protective gloves when opening refrigerant connections.

Connecting

1. Check that both service valves are fully open (turned counter-clockwise).
2. Wearing safety goggles remove the dust caps from the gauge connections on the service ports.
3. Coat the threads and flares with compressor oil.
4. Connect the charging and testing equipment referring to the equipment manufacturer's instructions.

Removing

5. If the engine has been operated it must be stopped prior to disconnecting the equipment.
6. Close both the service ports by turning fully counter-clockwise.
7. Disconnect the charging lines from the service ports.
8. Refit the dust caps to the compressor valve stems and service ports, and to the charging lines.

AIR CONDITIONING SYSTEM

Discharging the system

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

WARNING: 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 escaping and 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 and protective gloves when opening refrigerant connections.

Discharging

Discharge the air conditioning system using suitable vapour recovery and recycling equipment following the manufacturer's instructions.

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.

Evacuate

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.

Evacuating

1. Discharge the system as previously described, and connect the charging and testing equipment referring to the manufacturer's instructions.
2. Slowly open the vacuum control valve. If the vacuum is applied to the system too quickly, the residual oil may be drawn out.
3. 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 25mm (1 in) Hg per 300m (1000 ft). The following chart provides a guide to the various gauge readings at differing altitudes, for the same 10mm (0.4 in) Hg absolute pressure.

Altitude ft	Vacuum Reading in Hg
0	29.5
1,000	28.5
2,000	27.4
3,000	26.4
4,000	25.4
5,000	24.5
6,000	23.5
7,000	22.6
8,000	21.8
9,000	20.9
10,000	20.1

4. The low side gauge should indicate a vacuum of 660mm (26 in) Hg within five minutes.
5. If 660mm (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.
6. Continue evacuating for 30 minutes to ensure the removal of all moisture.
7. 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. Moisture remaining in the system will continue to boil and cause loss of vacuum. Refer to the heading titled 'Leak Detection' later in this section. With the system satisfactorily evacuated, the system is ready for charging with refrigerant.

Quick flushing

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. Connect the charging and testing equipment and follow the equipment manufacturer's instructions for quick flushing.
3. Evacuate the system.
4. Allow a charge of refrigerant of between 0.25 and 0.45kg (0.5 to 1 lb) to enter the system.
5. Allow the refrigerant introduced into the system to remain for ten minutes.
6. Reconnect the charging and testing equipment following the equipment manufacturer's instructions for evacuating. Evacuate the system.
7. Maintain the vacuum for twenty minutes. The air conditioning system is now ready for charging with refrigerant.

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. Ensure that the air conditioning system is evacuated as previously described.
2. Follow the equipment manufacturer's instructions for charging the system with refrigerant.
3. Ensure that the full charge of refrigerant is drawn into the system. See Charge Data.
4. After completing the procedure check the air conditioning system is operating satisfactorily by carrying out a pressure test, as described in this section.

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

CAUTION: Recycled refrigerant sourced from domestic or commercial refrigerators must not be used in air conditioning systems fitted to Land Rover vehicles. Refrigerant recycled from vehicle air conditioning systems may be used.

Charge Data	Full Charge	
Left hand drive vehicle	1.19kg	42 ozs
Right hand drive vehicle	1.19kg	42 ozs
Vehicle with Wynn system rear air conditioning unit	1.54kg	53 ozs

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 or into the evaporator drain tube. 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 hose connections.
8. If any leaks are found, the system must be discharged 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. Cut off the air supply to the dash vents using the left hand lever. Move the slider levers to air conditioning '**ON**' and fan speed to maximum.
4. Note the ambient air temperature in the immediate test area in front of the vehicle, and check the high pressure gauge readings, discharge side, against Table 1.

The pressure gauge readings will vary within the range quoted with the rate of flow of air over the condenser, the higher readings resulting from a low air flow. It is recommended that a fan is used for additional air flow over the condenser if the system is to be operated for a long time. Always use a fan if temperatures are over 26.7°C (80°F), so that a consistent analysis can be made of readings.

5. If the pressure readings are outside the limits quoted, refer to the fault diagnosis chart at the beginning of this section.
6. Stop the engine.
7. Close both service ports (turn fully counter-clockwise) and close all valves on the charging and test equipment. Disconnect the charging lines from the compressor. Refit the dust caps to the compressor valve stems, port connections and charging lines.
8. Close the bonnet.

Table 1

Ambient Temperature		Compound Gauge Readings		High Pressure Gauge Readings	
°C	°F	bar	p.s.i.	bar	p.s.i.
16	60	1,03-1,4	15-20	6,9-10,3	100-150
26,7	80	1,4-1,72	20-25	9,6-13,1	140-190
38	100	1,72-2,1	25-30	12,4-15,5	180-225
43,5	110	2,1-2,4	30-35	14,8-17,2	215-250

System 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 repair as necessary.

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

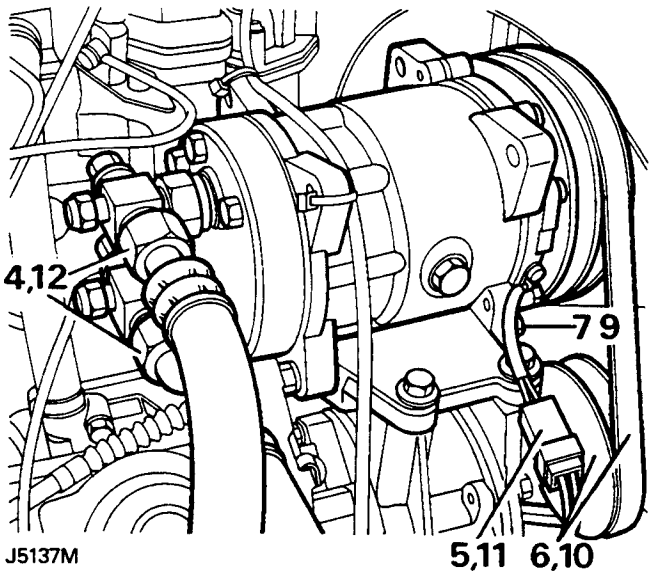
7. Start the engine.
8. Set the temperature control switch to maximum cooling and switch the air conditioner blower control on and off several times, checking that the magnetic clutch on the compressor engages and releases each time.
9. With the temperature control at maximum cooling and the blower control 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 hoses 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

Remove and refit

Removing

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. Disconnect the battery negative lead.
3. Discharge the air conditioning system.
4. Using goggles to protect the eyes, and wearing gloves, disconnect the suction and discharge unions from the back of the compressor. Cap the flexible end connections and service valves immediately.
5. Disconnect the lead to the compressor magnetic clutch at the connector.
6. Loosen the idler pulley securing bolt and release the driving belt.
7. Remove the two compressor mounting bolts and lift compressor clear.



Refit ting

8. If a new compressor is being fitted, drain the oil from the new compressor. Drain and measure the oil from the old compressor. Measure new oil equal to the amount drained from the old compressor. Add 30 ml (1 fluid oz) of new oil to this amount and refill the new compressor.
9. Locate the compressor in position, fit and tighten the mounting bolts.
10. Fit the compressor driving belt and adjust as described in Maintenance Section 10.
11. Connect the lead to the compressor magnetic clutch at the connector.
12. Refit the suction and discharge flexible end connectors to the service valves, lubricating the flares and threads of the unions with compressor oil.
13. Evacuate the air conditioning system, maintaining the vacuum for ten minutes.
14. Charge the air conditioning system.

COMPRESSOR OIL LEVEL

Sanden 709

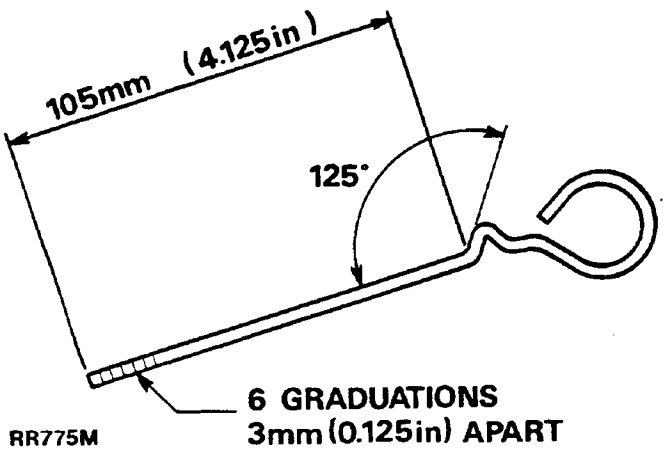
Check

It is not necessary to check the compressor oil level as part of routine maintenance.

NOTE: The compressor oil level should be checked whenever any components, including the compressor are removed and refitted, or when a pipe or hose has been removed and reconnected or, if a refrigerant leak is suspected. All compressors are factory charged with 135 ± 15 ml (4.6 ± 0.5 fl oz) of oil. When the air conditioning equipment is operated some of the oil circulates throughout the system with the refrigerant, the amount varying with engine speed. When the system is switched off the oil remains in the pipe lines and components, so the level of oil in the compressor is reduced, by approximately 30 ml (1 fl oz). the compressor oil level must finally be checked after the system has been fully charged with refrigerant and operated to obtain a refrigerated temperature of the car interior. This ensures the correct oil balance throughout the system.

NOTE: The system will require an extra 30ml of compressor oil on vehicles fitted with additional rear air conditioning unit.

The compressor is not fitted with an oil level dipstick, and a suitable dipstick must be made locally from 3mm (0.125 in) diameter soft wire in accordance with the accompanying illustration. After shaping, mark the end of the dipstick with sixteen graduations 3mm (0.125 in) apart.



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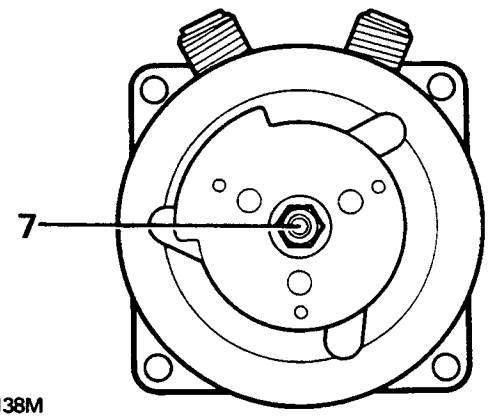
Procedure

1. Open the bonnet.
2. Fit the charging and testing equipment.
3. Start the engine and turn the temperature control to maximum cooling position, and the air flow control to **HIGH** speed. Operate the system for ten minutes at engine idle speed.

NOTE: It is important to open the valve slowly during the following item to avoid a sudden pressure reduction in the compressor crankcase that could cause a large amount of oil to leave the compressor. Refer also to SERVICE VALVES.

4. Reduce the engine speed to idling, and **SLOWLY** open the suction side valve on the test equipment until the compound gauge reads 0 or a little below.
5. Stop the engine at this point and quickly open the suction valve and discharge valve.
6. Loosen the oil filler plug and unscrew it slowly by five turns to bleed off crankcase pressure.



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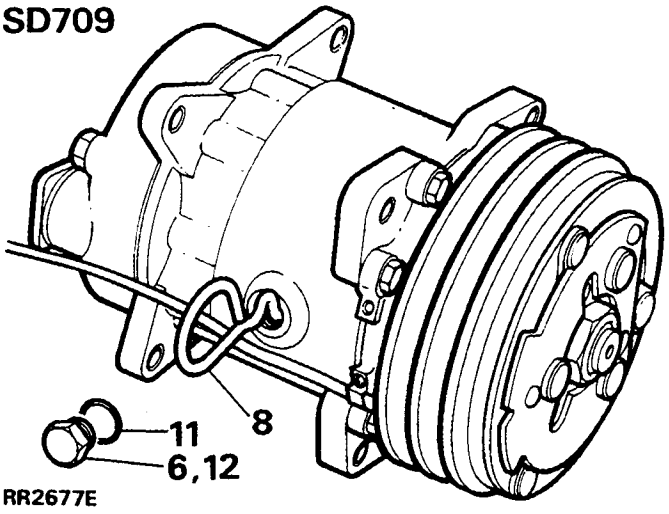
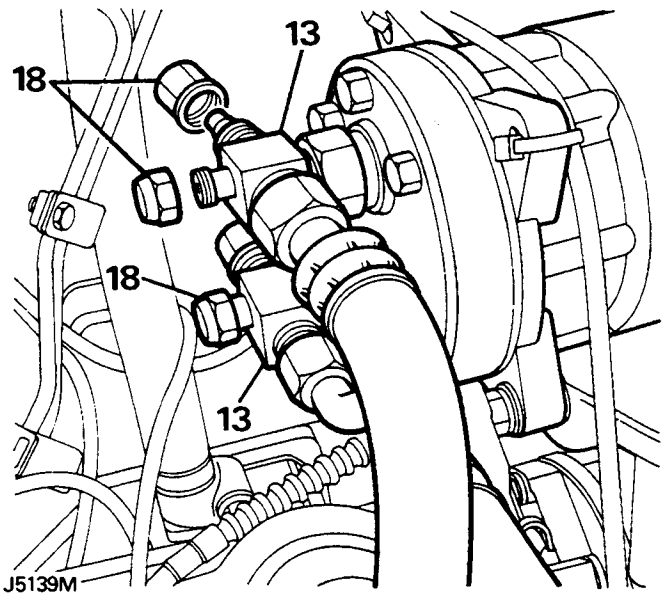
7. Remove the oil filler plug. Align the counterweight to the 9 o'clock position to enable the dipstick to be inserted to its full length.
8. Wipe the dipstick and insert to its stop position, ensuring the angle of the dipstick is flush with the surface of the filler orifice.



9. Withdraw the dipstick and count the number of graduations to determine the depth of oil.
10. **Oil level - SD 510:** two to four graduations. **SD 709:** fifteen to sixteen graduations. Add or remove oil as necessary until the mid-range figure is obtained. It is recommended that a syringe is used for adding or removing oil. Use only the correct compressor oil - see Recommended Lubricants, section 09.
11. Lubricate a new 'O' ring with compressor oil, fit it over the threads of the level plug without twisting, and install the level plug loosely.
12. Evacuate the air from the compressor using the vacuum pump on the charging and testing equipment, following the equipment manufacturer's instructions. Tighten the filler plug to the correct torque, see Torque Values.
13. Close fully the suction and discharge valves.



14. Start and run the engine at 1,200 rev/min and check for leak at the compressor level plug. Do not overtighten to correct a leak. In the event of a leak isolate the compressor as previously described in items 4 to 6, and check the 'O' ring seats for dirt, etc.
15. Stop the engine.
16. Close all valves on the charging and testing equipment.
17. Disconnect the charging lines from the compressor.
18. Refit the dust caps to the compressor valve stems and gauge connections, and to the charging lines.
19. Close the bonnet.

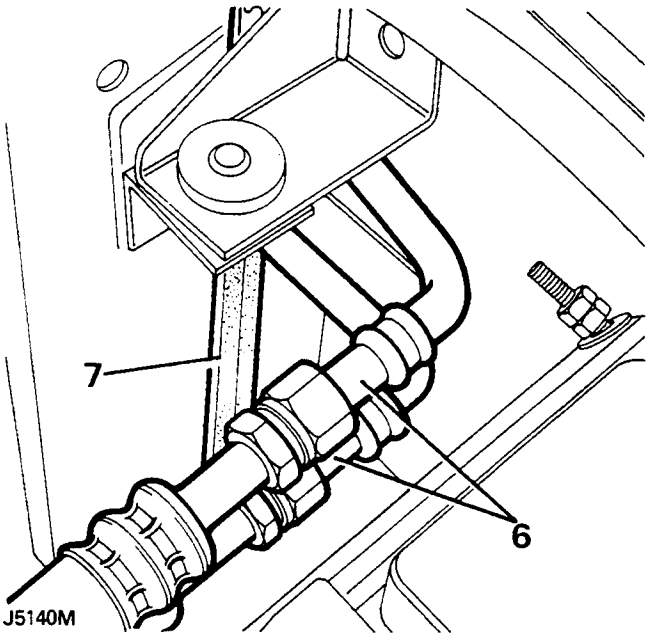
CONDENSER AND FANS ASSEMBLY

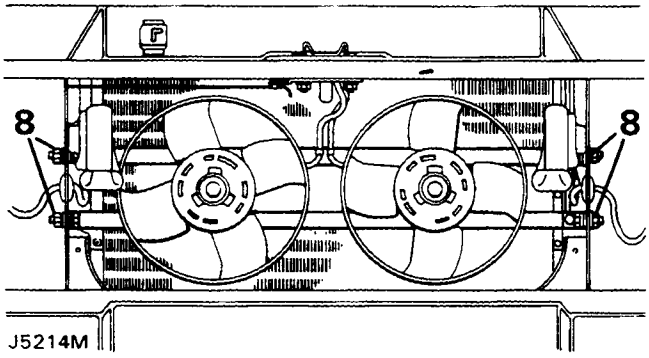
Removal

1. Disconnect the battery negative lead.
2. Discharge the air conditioning system.
3. Remove the headlamp surrounds and the grille panel.
4. Remove the radiator (Section 26).
5. Disconnect the two fan motor wiring connections at the top of the condenser unit.

CAUTION: Before carrying out instruction 6 protect the eyes with safety goggles and wear protective gloves.

6. Using two spanners on each fitting, carefully disconnect the hoses at the condenser end. Plug the exposed ends of the hoses and the fittings on the condenser with suitable plugs which will prevent moisture ingress.
7. Remove the vertical radiator seal from each side.





8. Remove the four securing bolts and withdraw the condenser, complete with fans, from the engine compartment.

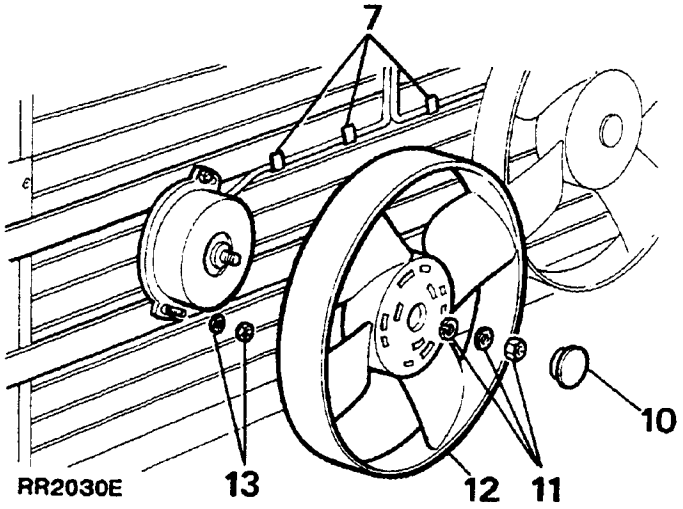
Refitting

9. To refit the condenser reverse operations 3 to 8 of the removal procedure.
10. If a new condenser has been fitted add 30 ml (1 fl oz) of the correct oil to the compressor to compensate for loss of retained oil in the replaced unit.
11. Evacuate the air conditioning system.
12. Charge the system.
13. Reconnect the battery negative lead.
14. Carry out a leak test on the disturbed joints.
15. Check for correct operation of the air conditioning by carrying out a System Test.

CONDENSER FANS AND MOTORS

Removal

1. Disconnect the battery negative lead.
2. Remove the headlamp surrounds and the grille panel.
3. Remove the dust caps from the fan centres.
4. Remove the securing nuts and washers.
5. Withdraw the fan blades from the motor shafts.
6. Disconnect the two fan motor wiring connectors at the top of the condenser unit.
7. Release the clips securing the leads.
8. Remove the nuts and washers securing each motor and detach the fan motor assemblies from the vehicle.



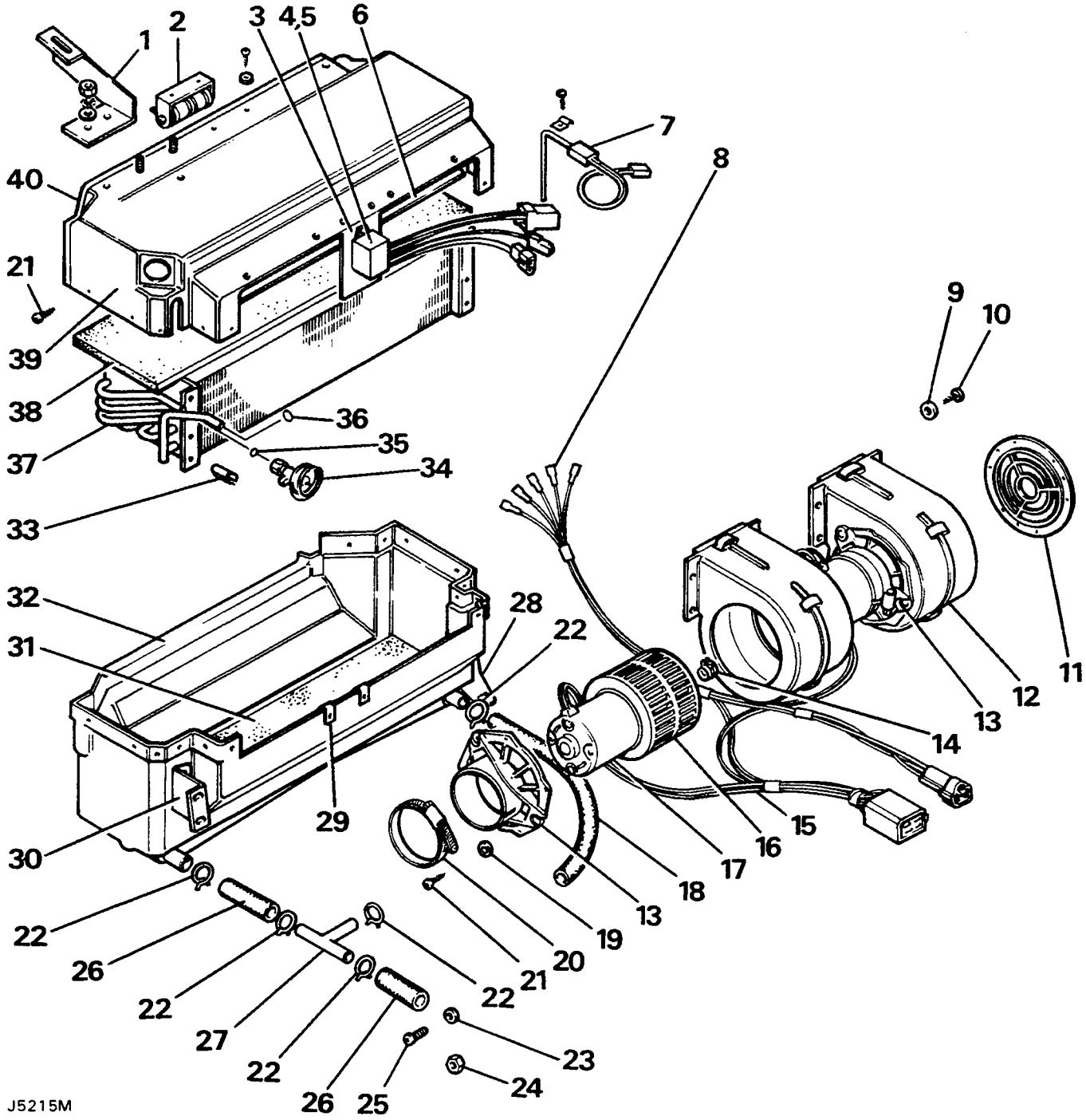
Refitting

9. Reverse the removal procedure, ensuring that the wiring is correctly clipped and no fouling of the fan blades occurs.

EVAPORATOR AND BLOWERS ASSEMBLY

Removal

1. Disconnect the negative lead from the battery.
2. Discharge the air conditioning system.
3. Remove the fascia (Section 76).
4. Remove the two securing nuts from the inboard lower side of the evaporator and the single screw from the outboard side.
5. Remove the bulkhead seal to prevent damage to the aluminium pipes when lowering the evaporator unit into the footwell.
6. Support the evaporator and blowers assembly, remove the nut and bolt securing the top bracket and lower the assembly into the vehicle footwell.
7. Remove the insulation tape from the expansion valve pipe connections and exposed suction line.
8. Using two spanners, break the pipe connections, to allow any residual pressure to discharge.
9. Complete the disconnection of the pipes and blank off pipe ends and connections immediately to prevent moisture ingress.
10. Release the retaining clips and detach the drain tubes from the bottom of the evaporator.
11. Disconnect the five electrical connectors noting their locations to assist refitting.
12. Withdraw the evaporator and blowers assembly from the vehicle.



1. Mounting bracket
2. Resistor assembly
3. Blower mounting plate
4. Thermostat assembly
5. Thermostat cover
6. Baffle
7. Thermistor
8. Resistor leads
9. Washer
10. Screw
11. Ring orifice
12. Blower housing
13. Motor mounting
14. Clip
15. Motor harness
16. Blower wheel
17. Blower motor
18. Drain hose
19. Washer
20. Clamp
21. Washer
22. Clamp
23. Washer
24. Nut
25. Screw
26. Drain hose
27. Drain tube 3 way
28. Mounting bracket
29. Nut
30. Mounting bracket
31. Insulation
32. Bottom case
33. Clamp expansion valve
34. Expansion valve
35. 'O' Ring seal
36. 'O' Ring seal
37. Evaporator coil
38. Insulation
39. Top case
40. Seal

Refitting

13. Position the evaporator and blowers assembly in the vehicle footwell.
14. Connect the drain hoses and secure with the retaining clips.
15. Remove the blanks from the pipe ends and connections.
16. Smear pipe threads with refrigerant compressor oil, to assist sealing, and connect the pipes to their respective connectors using new 'O' ring seals. Tighten the connections to the correct torque.
17. Fit the insulation tape to the expansion valve and to the pipe connections.
18. Connect the electrical connections to the locations noted during dismantling.
19. Position the assembly and secure with the nuts, bolts and single screw.
20. Tighten the nuts and bolts to the required torque.
21. Refit the bulkhead seal.
22. Evacuate the air conditioning system.
23. To compensate for loss of oil, add 45 ml (1.5 fl oz) of the correct oil to the compressor.
24. Charge the air conditioning system.
25. Carry out a leak test on any accessible disturbed joints.
26. Fit the fascia (Section 76).
27. Connect the battery negative lead.
28. Carry out a functional test on the air conditioning system.

EVAPORATOR MATRIX

Removal

1. Remove the evaporator and blowers assembly from the vehicle.
2. Unclamp the sensor coil from the evaporator outlet pipe.
3. Carefully unscrew the expansion valve from the evaporator. Blank off the exposed connections immediately to prevent the ingress of moisture.
4. Remove the mounting brackets from the casing.
5. Disconnect the electrical leads, remove the securing clip and withdraw the thermister probe from the top of the evaporator.
6. Remove the eight screws and detach the blower motor assemblies from the casing.
7. Remove the screws securing the casing halves and withdraw the casing from the evaporator matrix.

Refitting

8. Fit the casing halves to the evaporator matrix and secure with the screws.
9. Fit the blower motor assemblies to the casing and secure with the eight screws.
10. Fit the thermistor probe to its location in the top of evaporator, secure with the clip and screw and reconnect the electrical leads.
11. Fit the mounting brackets to the casing.
12. Assemble the expansion valve to the evaporator. Use refrigerant compressor oil on all mating surfaces to assist leakage prevention. Tighten the connection to the correct torque.
13. Clamp the sensor coil to the evaporator outlet pipe in its original position.
14. Refit the evaporator and blowers assembly to the vehicle.

BLOWER UNITS

Removal

1. Remove the evaporator and blowers assembly from the vehicle.
2. Remove the eight screws and detach the blower motor assemblies from the evaporator casing.

Dismantling

3. Note the position of the motor leads to assist refitting. Remove the blower motor assemblies from the evaporator casing.
3. Note the position of the motor leads to assist refitting. Remove the screws securing the motor mounting to the blower casing and withdraw the motor and wheel assembly.
4. Slacken the wormgear clamp and detach the motor mounting from the motor.
5. Remove the securing clip and detach the blower wheel from the motor shaft.
6. If a new motor is being fitted, detach the motor leads from the multi-plug, by releasing the blades from the plug.

Reassembly

7. If removed, refit the motor leads to the multi-plug.
8. Fit the blower wheel to the motor shaft, with the white paint mark on the rim of the wheel towards the motor and the flat on the shaft aligned with the flat in the bore of the wheel. Secure the wheel to the shaft with the clip.
9. Fit the motor mounting to the motor, align with the location marks on the motor body, and secure with the wormgear clamp.
10. Fit the blower casing to the motor and wheel assembly, ensuring correct location of motor leads, as noted during dismantling.

Refitting

11. Refit the blower motors to the evaporator casing in reverse order to removal.
12. Refit the evaporator and blowers assembly to the vehicle.

THERMOSTAT ASSEMBLY

Removal

1. Disconnect the battery negative lead.
2. Remove the fascia from the vehicle (Section 76).
3. Remove the bulkhead seal to prevent damage to the aluminium pipes when lowering the evaporator unit into the footwell.
4. Detach the evaporator and blowers assembly and lower into the vehicle footwell.
5. Disconnect the electrical leads at the connector blocks.
6. Remove the securing screws and withdraw the thermostat from the evaporator and blowers assembly.

Refitting

6. Refit the thermostat in reverse order to removal.

RESISTOR UNIT

Removal

1. Disconnect the battery negative lead.
2. Remove the fascia from the vehicle (Section 76).
3. Remove the bulkhead seal to prevent damage to the aluminium pipes when lowering the evaporator unit into the footwell.
4. Detach the evaporator and blowers assembly and lower into the vehicle footwell.
5. Disconnect the electrical leads at the connector block.
6. Remove the securing screws and fibre washers and withdraw the resistor unit. Note the location of the fibre washers to assist when refitting.

Refitting

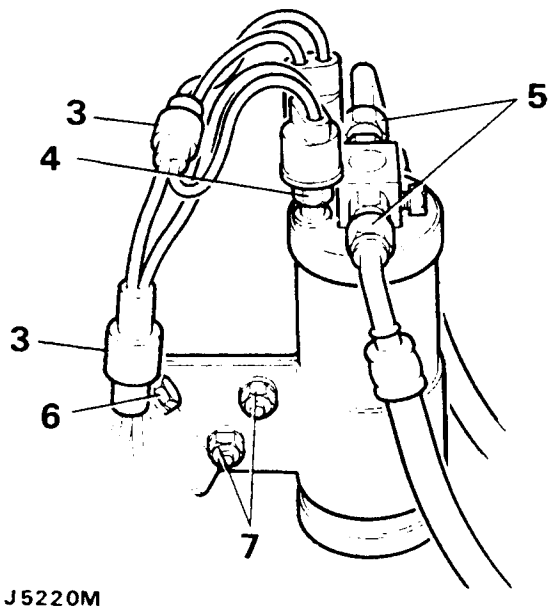
7. Refit the resistor unit in reverse order to removal ensuring that the fibre washers are correctly located.

RECEIVER DRIER

CAUTION: Immediate blanking of the receiver drier unit connections is important. The exposed life of the unit is only 15 minutes.

Removal

1. Disconnect the battery negative lead.
2. Discharge the complete system.
3. Disconnect the electrical leads at the two plug connectors.



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4. Wearing safety goggles and protective gloves, carefully unscrew the pressure switches from the receiver dryer, using the appropriate size spanner on the hexagons. Blank the exposed apertures immediately to prevent the ingress of moisture.
5. Disconnect the two hose connections using a second spanner to support the hose adaptor. Blank the exposed connections on the receiver drier and on the hoses immediately to prevent the ingress of moisture.
6. Remove one of the nuts and bolts securing the mounting bracket flange to the wing valance.
7. Remove nuts and bolts clamping the mounting bracket and withdraw the receiver drier from the bracket.

Refitting

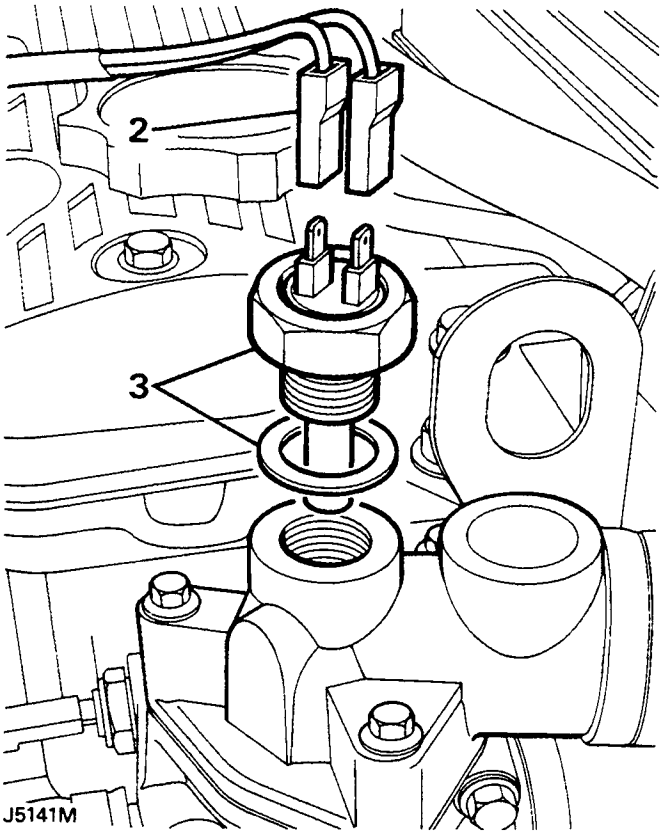
8. Insert the receiver drier into the mounting bracket with the inlet and outlet connections aligned with their respective hoses.
9. Connect the two hose connections finger tight. Use refrigerant compressor oil on all mating surfaces to assist leakage prevention.
10. Fit and tighten the clamp bolts to secure the receiver drier in the mounting bracket.
11. Fit the nut and bolt to secure the mounting bracket to the wing valance.
12. Tighten the hose connections to the correct torque, using a second spanner to support the adaptor.
13. Coat the threads of the pressure switches with refrigerant compressor oil and fit them to the receiver drier, tightening the switches to the correct torque.
14. Connect the electrical leads at the plug connectors.
15. To compensate for loss of oil, add 15 ml (1/2 fl oz) of the correct oil to the compressor.
16. Evacuate the air conditioning system.
17. Charge the air conditioning system.
18. Perform a leak test on all disturbed joints.
19. Carry out a functional check on the complete system.

COOLANT TEMPERATURE SENSOR

Remove and refit

Removing

1. Disconnect the battery negative lead.
2. Disconnect the electrical leads from the sensor.
3. Remove the sensor from the thermostat housing.



Refitting

4. Reverse the removal procedure, using a **NEW** joint washer.

AIR CONDITIONING CONTROLS/THERMOSTAT

See Heater and Air Conditioning Controls in Section 80 - Heating and Ventilation.