AIR CONDITIONING — A.R.A. SYSTEM

Description

The A.R.A. air conditioning system comprises four 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 fascia.

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 pipes be disconnected without first depressurising the system.

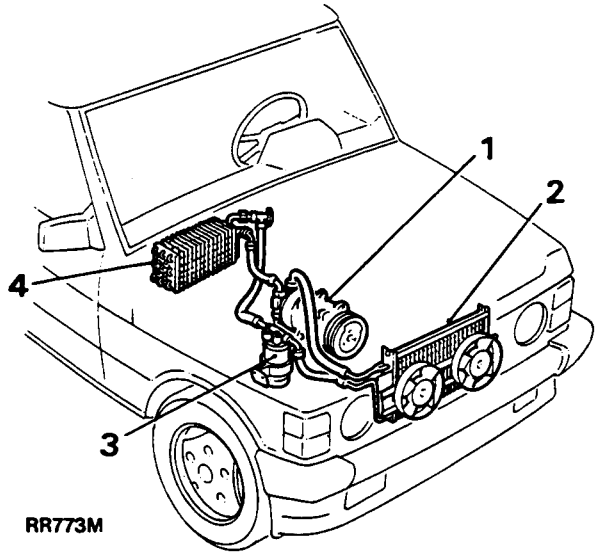
Cold refrigerant circuit

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 the 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. 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. 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 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
Vaporized refrigerant is then 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 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.

Continued

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°C to −60°C (68°F to −76°F)
Valve core removers
Compressor dipstick

SERVICING MATERIALS

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

CAUTION: Methychloride refrigerants must not be used.

Nominal charge weight:
RHD vehicles: 1.25 kg (44 oz)
LHD vehicles: 1.08 kg (38 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.

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.

(a) 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.
(b) Lines, flexible end connections and components must be capped immediately they are opened to prevent the entrance of 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 pipes, they must be replaced with new pipes.
(d) All replacement components and flexible end connections are sealed, and should only be 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 replaced.
(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 be replaced, and not used.
(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 135 ml (4.6 UK 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 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.

Continued

(q) Flexible connections should not be within 50 mm (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 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

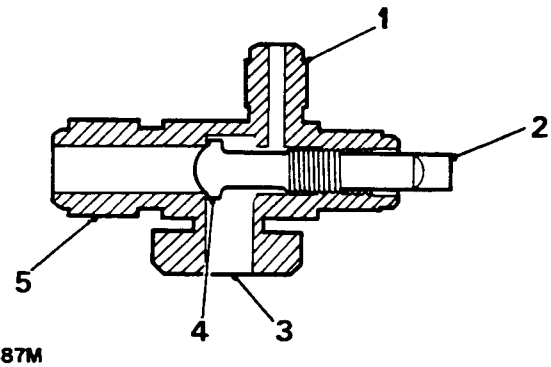
Examine the refrigeration connections at the unit. If the system should develop a fault, or if erratic operation is noticed, refer to the fault diagnosis chart.

SERVICE VALVES

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

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.

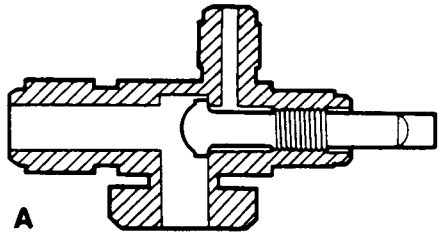


ST1387M

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 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.

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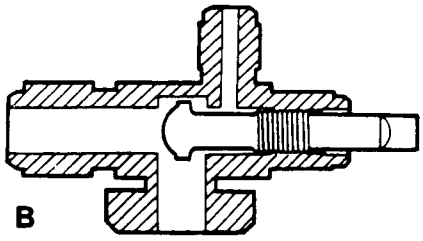
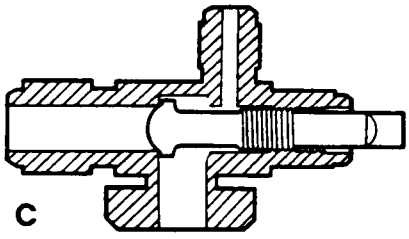


RR1735M

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

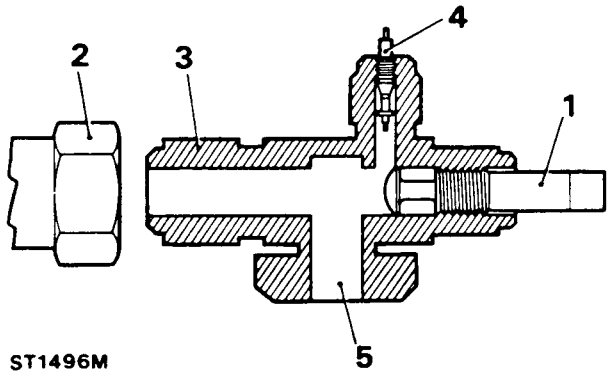
C. OFF: FULLY CLOCKWISE — With the service valve stem turned fully clockwise, the valve will block passage of refrigerant flow through the system. As illustrated, the refrigerant flow to or from the compressor (depending on whether it is high side or low side) is blocked.

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

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 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. 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.

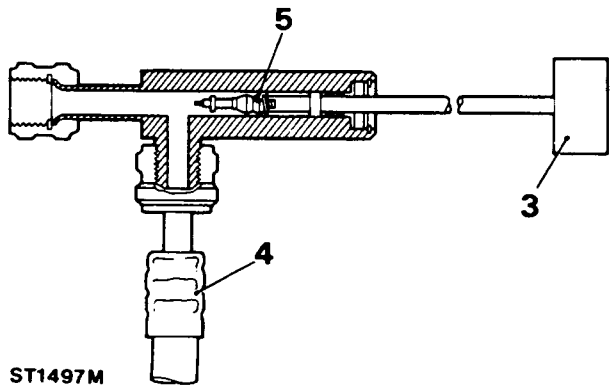
Valve core remover

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.

Electrical supply switches and fuses

The four main components of the air conditioning system draw current from their own 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 of various types as indicated by the circuit diagram.

The relays are mounted on the engine compartment closure panel. Both condenser fans operate together when the air conditioning circuit is switched 'on' or when the ignition is switched 'on' and the coolant temperature is high, on automatic vehicles only.

Electronic Fuel Injection vehicles have a solenoid operated air valve, which is activated when the compressor clutch is energized. This increases engine rev/min when the air conditioning system is operative at idle speed.

The four Autofuse type fuses are located in the fuse box mounted on the lower fascia panel. They are numbered A1 to A4. It is essential that a fuse of the same value is used when fitting a replacement.

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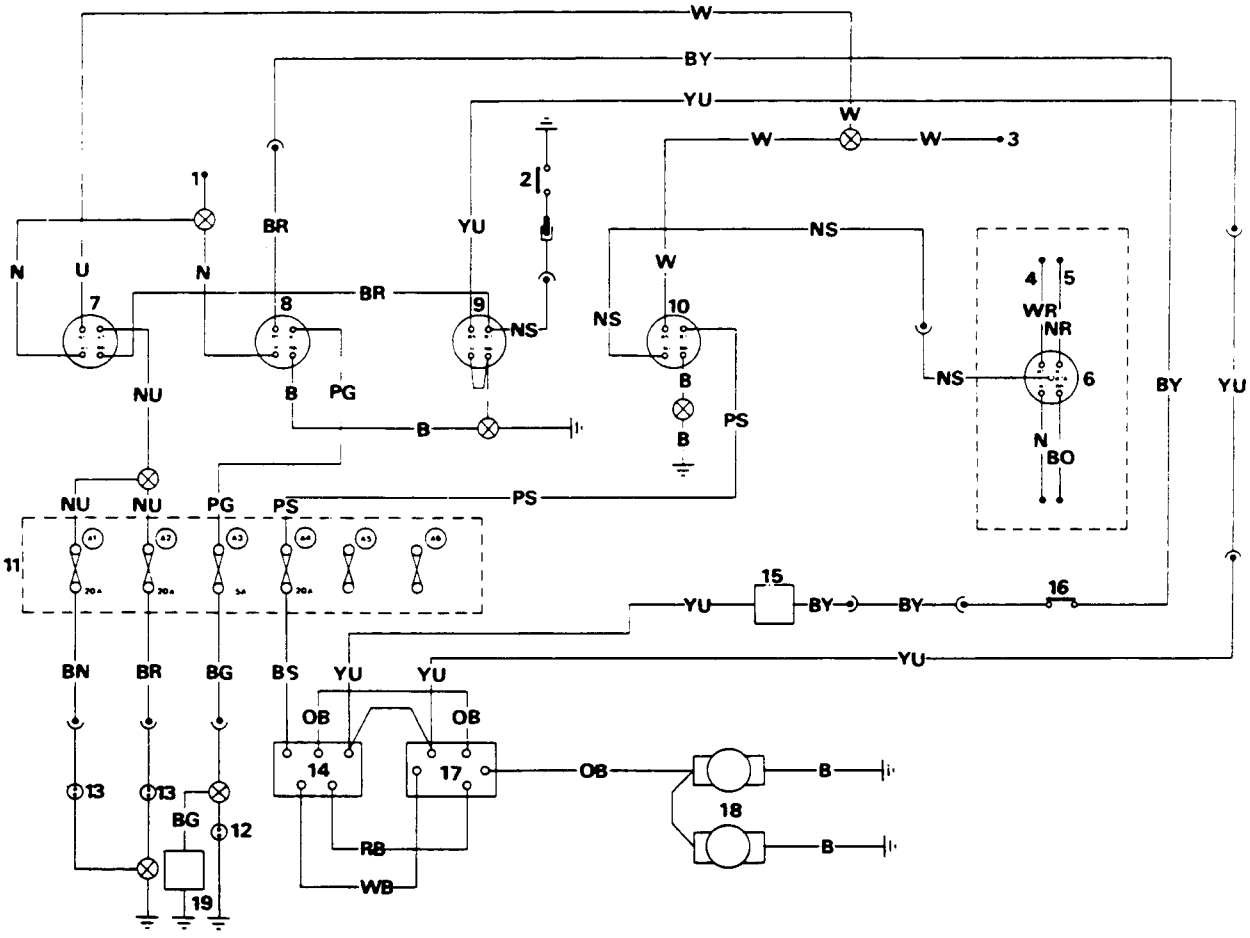
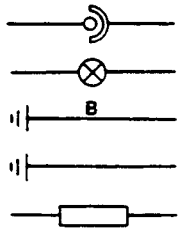


RR613M

KEY TO CIRCUIT DIAGRAM

1. Terminal post.
2. Engine water temperature switch (Automatic only).
3. Ignition feed.
4. Crank feed.
5. Starter solenoid.
6. Starter relay.
7. Fan relay.
8. Compressor clutch relay.
9. Air conditioning controlled fan relay.
10. Air conditioning relay (Ignition controlled).
11. Auxiliary fuse box.
12. Compressor clutch.
13. Fans.
14. Control switch.
15. Thermostat.
16. High pressure switch.
17. Resistor.
18. Blower motors.
19. Solenoid operated air valve.

Circuit symbols



Plug and socket
Clinch connector
Earth connection via cables
Earth connection via bolts
Snap connectors

Cable colour code

B	Black	G	Green	R	Red
U	Blue	O	Orange	W	White
N	Brown	P	Purple	Y	Yellow

The last letter of a colour code denotes the tracer.

Electrical System 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 resistor board.	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 properly. 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 Blade corrosion or foreign matter build-up. 3 Excessive wear of motor bearings.	1 Check mountings, adjust as necessary. 2 Clean blades with solvent or other 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, 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/in² (kg/cm²)	High Side Pressure lb/in² (kg/cm²)
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. Evap. 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 atmosphere. 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 Slack 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 Electrical System.
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.	1 Refer to C-2, C-3, D-1 and E.
	2 Low refrigerant charge—evident by bubbles in sight glass.	2 Refer to B-1 and E.
	3 Compressor not pumping.	3 Refer to B-2 and B-3.
G. COMPRESSOR BELT SLIPPING	1 Belt tension.	1 Adjust belt tension.
	2 Excessive head pressure.	2 Refer to A-1 through A-4 and C-6.
	3 Incorrect alignment of pulleys or worn belt not riding properly.	3 Repair as needed.
	4 Nicked or broken pulley.	4 Replace as needed.
	5 Seized compressor.	5 Replace compressor.
H. ENGINE NOISE AND/OR VIBRATION	1 Loose or missing mounting bolts.	1 Repair as necessary.
	2 Broken mounting bracket.	2 Replace bracket.
	3 Loose flywheel or clutch retaining bolt.	3 Repair as necessary.
	4 Rough idler pulley bearing.	4 Replace bearing.
	5 Bent, loose, or improperly mounted engine drive pulley.	5 Repair as necessary.
	6 Defective compressor bearing.	6 Replace bearing.
	7 Insecure mountings of accessories: generator, power steering, air filter, etc.	7 Repair as necessary.
	8 Excessive head pressure.	8 Refer to A-1, A-2, A-3, A-4 and C-6.
	9 Incorrect compressor oil level.	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 when opening refrigerant connections.

Connecting

1. Check that both service valves are fully open (turned anti-clockwise).
2. Wearing safety goggles remove the 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 anti-clockwise.
7. Disconnect the charging lines from the service ports.
8. Refit the blanking caps to the compressor valve stems and service ports, and to the charging lines.

AIR CONDITIONING SYSTEM

Depressurise

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 hands and face well clear, so that no injury occurs if there is liquid in the line. If presssure is noticed allow it to bleed off slowly.

Depressurising

1. Connect the equipment according to the manufacturer's instructions.
2. Run the blue, low pressure hose to an open-topped 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.
3. When depressurising adjust the refrigerant flow to ensure that oil is not blown out of the container.
4. Measure the amount of oil discharged from the system. Add an equal amount of new oil to the system during the charging operation. Discard the old oil.

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. Depressurise 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 25 mm (1 in) Hg per 300 m (100 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	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 660 mm (26 in) Hg within five minutes.
5. 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.
6. 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.
   With the system satisfactorily evacuated, the system is ready for charging with refrigerant.

Sweep

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.

Sweeping

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 sweeping.
3. Maintain the vacuum for twenty minutes. The air conditioning system is now ready for charging with refrigerant.

Charge

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.

Charging

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 (RHD 1.25 kg (44 oz), LHD 1.08 kg (38 oz) is drawn into the system.
4. After completing the procedure 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.

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.

Continued

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 1

Ambient Temperature		Compound Gauge Readings		High Pressure Gauge Readings	
°C	°F	kgf/cm²	lbf/in²	kgf/cm²	lbf/in²
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

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 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.

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 rectify as necessary.

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

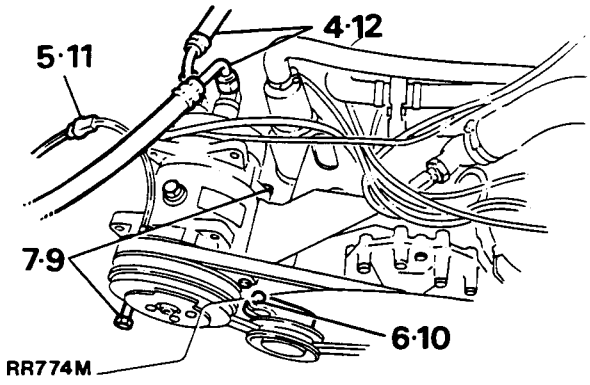
7. Start the engine.
8. Set the temperature control switch to maximum cooling and switch the air conditioner blower control on and off several times, checking that the magnetic clutch on the compressor engages and releases each time.
9. With the temperature control at maximum cooling and the blower control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

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.
3. Depressurise 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. Slacken the jockey pulley securing bolt and release the driving belt.
7. Remove the two compressor mounting bolts and lift compressor clear.



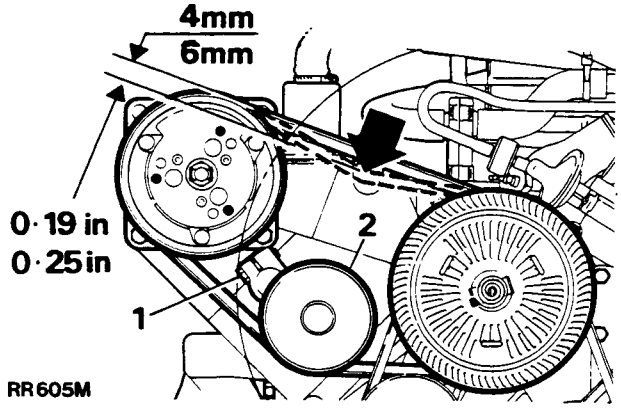
Refitting

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 UK 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 under 'Compressor drive belt—adjust'.
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 DRIVE BELT

Adjust

1. Slacken the jockey wheel securing bolt.
2. Adjust the position of the jockey wheel until the



correct tension is obtained. The belt must be tight with 4 to 6 mm (0.19 to 0.25 in) total deflection when checked by hand midway between the pulleys on the longest run.
3. Tighten the securing bolt and recheck the tension.

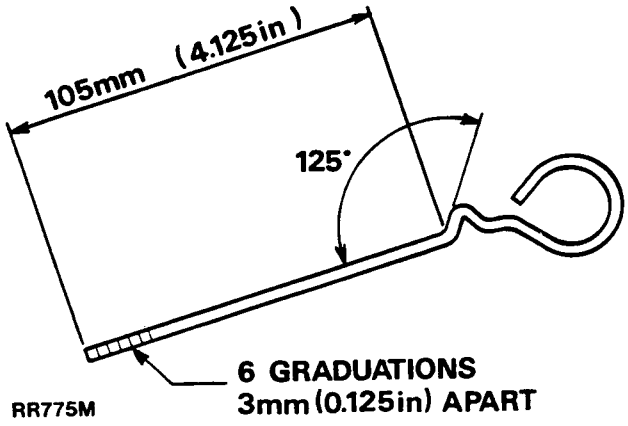
COMPRESSOR OIL LEVEL

Check

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 UK 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 UK 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.

Continued

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

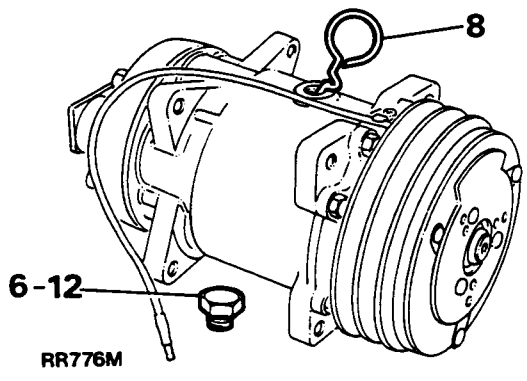


Procedure

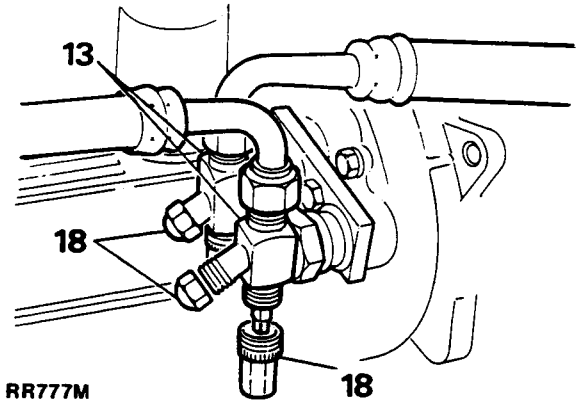
1. Open the bonnet.
2. Fit the charging and testing equipment.
3. Start the engine and turn the temperature control to maximum cooling position, and the air flow control to HIGH speed. Operate the system for five minutes at 1,200–1,500 rev/min.

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.

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.



7. Remove the oil filler plug. Looking through the oil filler orifice, centralise the internal components by slowly turning the compressor clutch plate. This will enable the dipstick to be inserted to its full depth.
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. The acceptable level is two to four graduations, if required add or remove oil until the mid-range figure is obtained. Use only the correct compression 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 Section 06.
13. Close fully the suction and discharge valves.



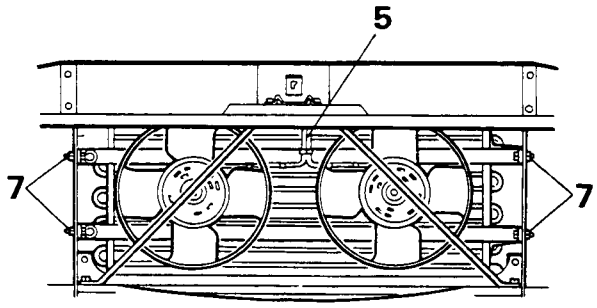
14. Start and run the engine at 1,200 rev/min and check for leak at the compressor level plug. Do not overtighten to correct a leak. In the event of a leak isolate the compressor as previously described in items 4 to 6, and check the 'O' ring seats for dirt, etc.
15. Stop the engine.
16. Close all valves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

CONDENSER

Remove and refit

Removing

1. Open the bonnet and disconnect the battery.
2. Depressurise the air conditioning system.
3. Remove six screws and withdraw the front grille panel.
4. Remove the radiator.
5. Disconnect the two fan motor wiring connections.



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

6. Using two spanners on each union, carefully disconnect the pipes at the condenser end. Fit blanks to the exposed ends of the pipes.
7. Remove four bolts securing the condenser and remove condenser complete with fan motor assemblies.

Refitting

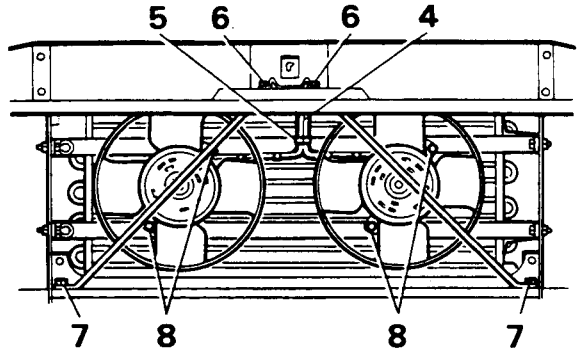
8. Reverse instructions 3 to 7 above.
9. Add 30 ml (1 UK fl oz) of the correct oil to the compressor to compensate for oil loss if a new condenser is to be fitted.
10. Evacuate the air conditioning system.
11. Charge the system.
12. Carry out a leak test on the disturbed joints.
13. Check the air conditioning operation by carrying out a System Test.

CONDENSER FANS AND MOTORS

Remove and refit

Removing

1. Open the bonnet and disconnect the battery.
2. Remove the six screws and withdraw the grille panel.
3. (**Automatic vehicles only**) remove the transmission oil cooler by disconnecting the wiring, detaching the two oil pipes and two mounting bolts each side.
4. Disconnect the two fan motor wiring connectors.
5. Release the wiring securing clips.



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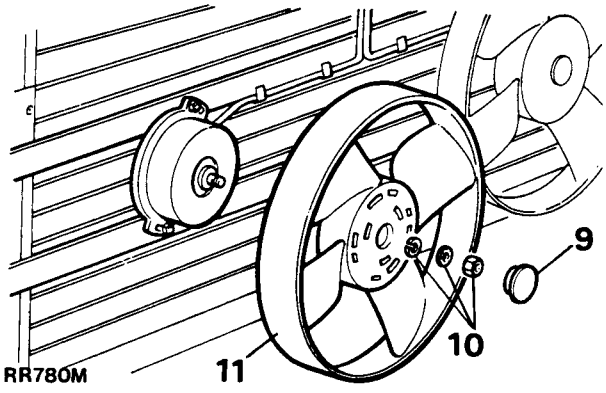
6. Slacken the two upper bolts securing the left- and right-hand bonnet striker support stays.
7. Remove the lower bolts securing the lower ends of the stays and pivot both stays forward.
8. Remove the two nuts and washers securing each motor and withdraw the fan motor assemblies from the vehicle.
9. Remove the blanking caps from the fan centres.



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10. Remove the securing nut and washers.
11. Withdraw the fan blades from the motor spindle.

Refitting

12. Reverse 1–11 above, ensuring that the wire is correctly clipped and no fouling of the fan blades occurs.
13. Automatic only: check transmission fluid level.

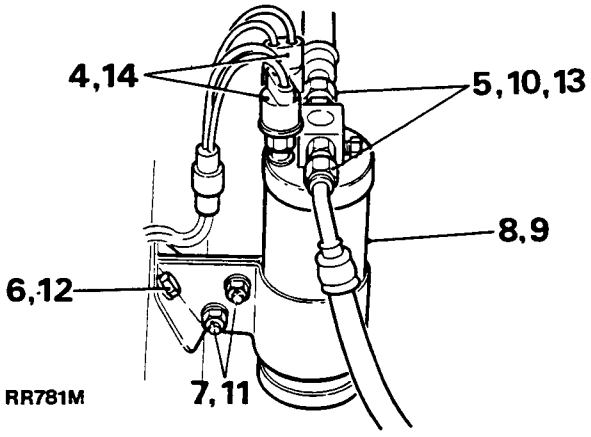
RECEIVER DRIER

Remove and refit

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

Removing

1. Connect the gauge set.
2. Discharge the complete system.
3. Protect the eyes with safety goggles and wear gloves during operations 4 and 5.
4. Disconnect the electrical leads at the snap connectors and carefully unscrew the pressure switches from the receiver drier. Blank the exposed connections immediately.



5. Carefully disconnect the two hose connections. Use a second spanner to support the hose adaptor. Blank the exposed connections immediately.
6. Remove one bolt, nut and washers securing the mounting bracket to the wing valance.
7. Remove the clamp bolts, washers and nuts.
8. Withdraw the receiver drier from the mounting bracket.

Refitting

9. Insert the receiver drier into the mounting bracket with the inlet and outlet connections correct to the refrigerant circuit as shown.
10. Connect the two hose connections finger tight. Use refrigerant compressor oil on all mating surfaces to assist leakage prevention.
11. Fit the clamp bolts, washers and nuts.
12. Secure the mounting bracket to the wing valance.
13. Tighten the two hose connections to the correct torque. Use a second spanner to support the hose adaptor.
14. Carefully refit the pressure switches to the receiver drier. Use refrigerant compressor oil on all mating surfaces to assist leakage prevention and tighten the switches to the correct torque. Reconnect the electrical leads.
15. To compensate for oil loss, add 15 ml (½ UK fl oz) of the correct oil to the compressor.
16. Evacuate the complete system.
17. Charge the complete system.
18. Perform a leak test on any disturbed joints.
19. Carry out a functional check.
20. Disconnect the gauge set.

DASHBOARD UNIT—ARA

EVAPORATOR

Remove and refit

Expansion valve
Remove and refit 1 to 22 and 34 to 56

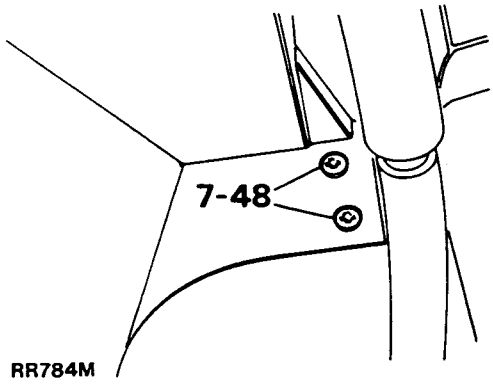
Hose—compressor to evaporator
Remove and refit 1 to 5 and 50 to 56

Hose—receiver drier to evaporator
Remove and refit 1 to 5 and 50 to 56

Blower assembly
Remove and refit 1 to 24 and 32 to 56

Removing

1. Open the bonnet and connect the gauge set.
2. Depressurise the system.
3. Isolate the battery.
4. Protect the eyes with safety goggles and wear gloves during instruction 5.
5. Disconnect the evaporator hoses from the compressor and the receiver drier. Use a second spanner to support the hose adaptors and blank all the exposed connections immediately.
6. Disconnect the dash unit electrical harness at the underbonnet relays and release the cable from the clips.
7. Working inside the vehicle, withdraw the lower fascia panel and remove the screws securing the lower edge of the centre console.



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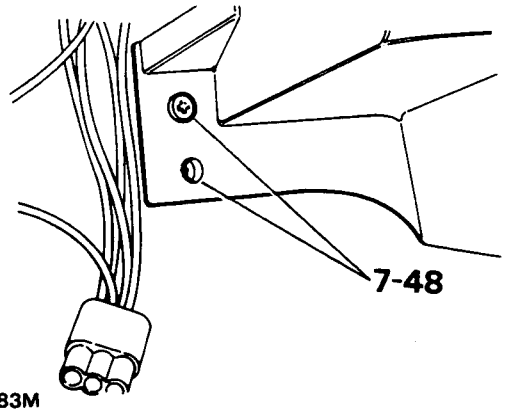

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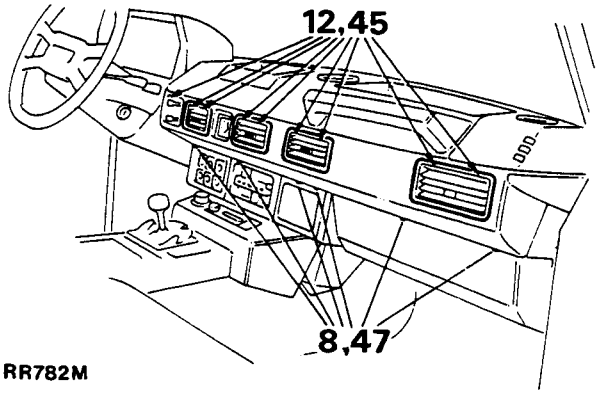
8. Remove the six screws securing the lower edge of the louvre panel to the console and evaporator case.



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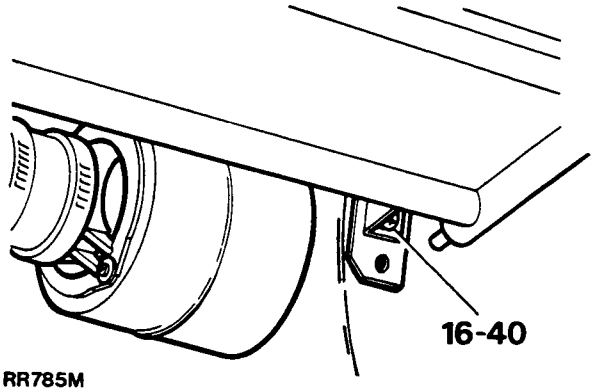
9. Remove the heater control panel and knobs from the centre console.
10. Remove the centre console.
11. Carefully prise out the four air vents.
12. Remove the screws securing the evaporator plenum and louvre panel to the dash top panel.
13. Withdraw the thermostat sensor from the evaporator.
14. Withdraw the louvre panel clear of the dash.
15. Depress the left end of the plenum and remove the air hoses from the upper panel.



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Continued

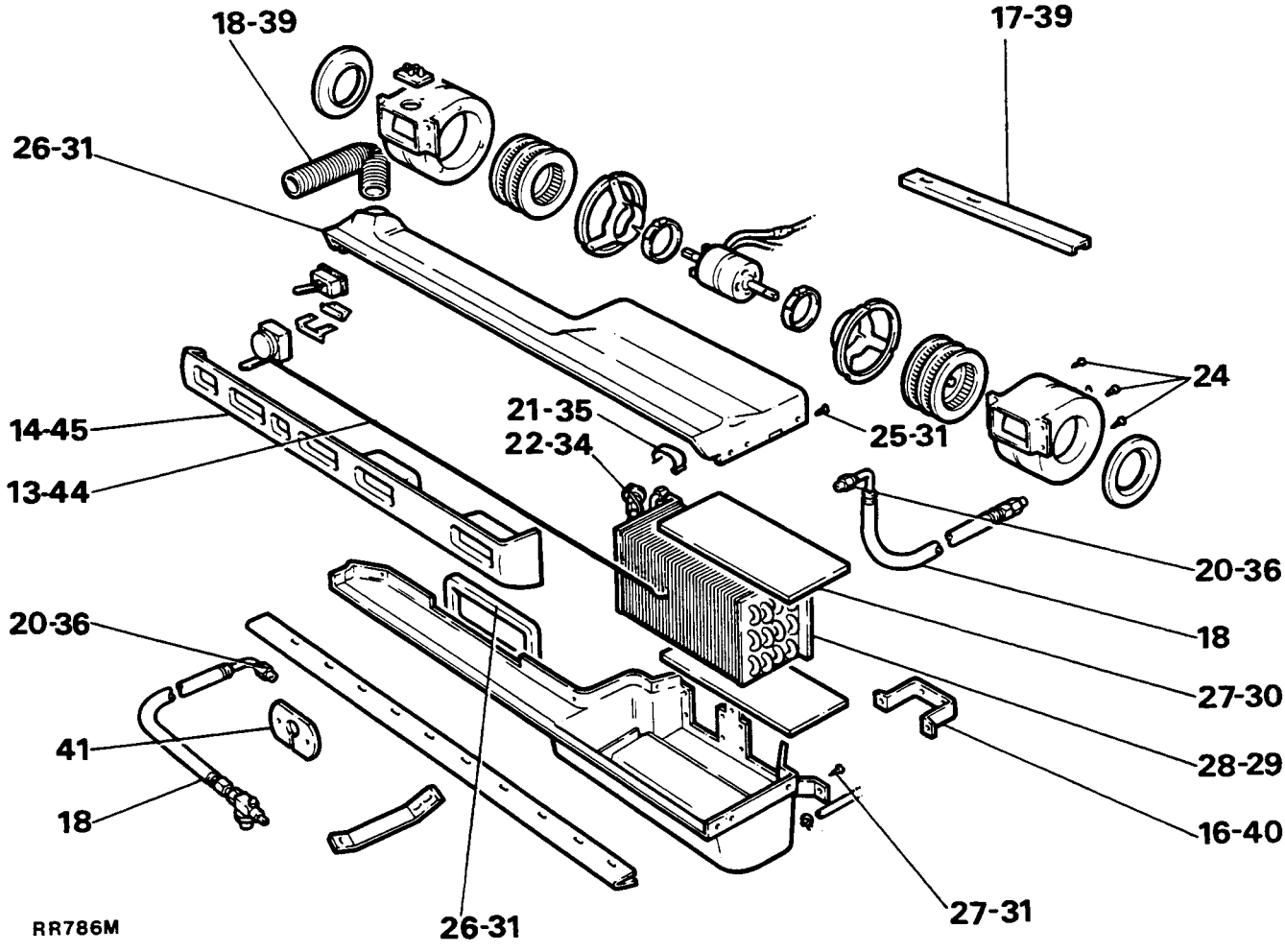
16. Remove the screws securing the lower right evaporator bracket.
17. Support the evaporator case and remove the two nuts securing the case and reinforcing strip to the upper mounting bracket.
18. Carefully withdraw the refrigerant hoses, electrical harness and evaporator condensate tubes through the bulkhead and remove the rear left-hand air hose from the plenum. Remove the evaporator and plenum assembly from the vehicle.

Dismantling

19. Remove the insulation from the evaporator and expansion valve hose connections.
20. Disconnect the hoses from the expansion valve and evaporator. Use a second spanner to support the hose adaptors and blank all the exposed connections immediately.
21. Unclip the sensor coil from the evaporator outlet pipe.
22. Carefully unscrew the expansion valve from the evaporator. Blank the exposed connections immediately.
23. Unplug the electrical harness at the connector on the left-hand blower casing.
24. Remove the eight securing screws and detach the blower units from the evaporator case.
25. Remove the screws securing the upper evaporator/plenum casing to the evaporator and lower casing.
26. Remove the heater seal and lift off the upper casing.
27. Remove the insulation pad and the two screws securing the evaporator to the lower casing.
28. Withdraw the evaporator from the casing.

Assembling

29. Secure the evaporator to the lower casing.
30. Fit the insulation pad and run the electrical leads under the evaporator outlet pipe.
31. Secure the casings together with the screws and refit the heater seal.
32. Refit and secure the blower units to the evaporator casing.
33. Connect the electrical lead to the connector on the left-hand blower casing.
34. Assemble the expansion valve to the evaporator with the inlet facing downwards. Use refrigerant compressor oil on all mating surfaces to assist leakage prevention. Tighten the connection to the correct torque.



35. Clip the sensor coil to the evaporator outlet pipe.
36. Connect the hoses to the evaporator and expansion valve. Use new 'O' rings and refrigerant compressor oil on all mating surfaces to assist leakage prevention. Tighten the connections to the correct torque.
37. Wrap all exposed metal at the hose connections with 'prestite' tape.

Refitting

38. Place the evaporator assembly on the floor of the vehicle and route the electrical harness and the refrigerant hoses through the bulkhead.
39. Lift the unit into the mounting position and connect the rear left-hand air hose. Fit the reinforcement strip and secure the casing to the upper bracket with two nuts.
40. Secure the lower right mounting bracket to the vehicle.
41. Feed the hoses, electrical harness and evaporator condensate tubes through the bulkhead. Ensure that the apertures and grommets are adequately sealed against ingress of dust and moisture.
42. Depress the left end of the plenum and connect the two upper air hoses.
43. Position the left-hand of the plenum so that the opening is centered over the fresh air outlet of the heater.
44. Carefully push the thermostat pipe into the evaporator fins.
45. Refit the louvre panel and secure the plenum casing and grille panel to the dash top panel with screws.
46. Refit the centre console.
47. Refit the six screws securing the louvre panel to the centre console and evaporator case.
48. Secure the lower edge of the console and refit the lower fascia panel.
49. Working under the bonnet, connect the dash harness to the two relays.
50. Connect the two refrigerant hoses to the compressor and receiver drier. Use refrigerant compressor oil on all mating surfaces to assist leakage prevention. Tighten the connections to the correct torque.
51. To compensate for oil loss, add 45 ml (1.5 UK fl oz) of the correct oil to the compressor.
52. Evacuate the system.
53. Charge the complete system.
54. Perform a leak test on any accessible disturbed joints.
55. Perform a functional check.
56. Disconnect the gauge set.

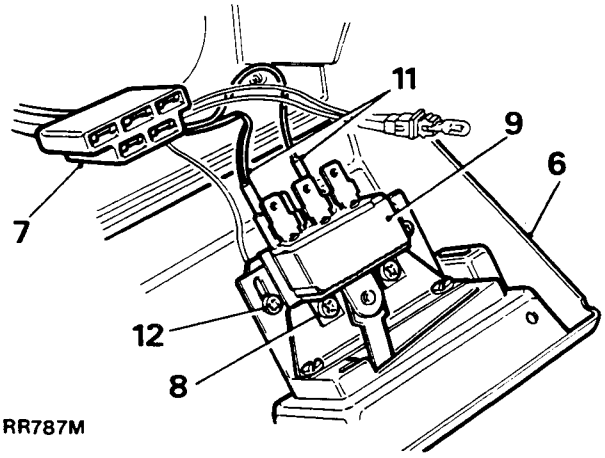
CONTROL PANEL

Thermostat
Remove and refit—1 to 6 and 10 to 14

Fan control switch
Remove and refit—1 to 9 and 14

Removing

1. Disconnect the battery.
2. Pull the finger tip control knobs off the control levers.
3. Carefully prise the four air vents out of the louvre panel.
4. Remove the nine screws securing the louvre panel to the upper panel.
5. Remove the six screws securing the louvre panel to the lower panel.
6. Withdraw the panel only as far as the electrical leads will permit.



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7. Disconnect the multi-plug from the rear of the fan control switch.
8. Remove the two securing screws.
9. Withdraw the fan control switch.
10. Withdraw the thermostat sensor from the fins of the evaporator.
11. Disconnect the electrical leads from the rear of the thermostat.
12. Remove the two securing screws.
13. Withdraw the thermostat.

Refitting

14. Reverse the removal procedure.

Notes