Group Index, Alphabetical

Section	Section Number
Climate Control Two-Piston Refrigerant Compressor	83.02
Heater and Air Conditioner, R–12 Systems	83.00
Heater and Air Conditioner, R–134a Systems	83.03
Sanden SD7 Series Refrigerant Compressor	83.04
York Swashplate Refrigerant Compressor	83.01

Heater and Air Conditioner, R–12 Systems 83.00

Contents

Subject	Subject Number
General Information, Description of Components, Definition of Terms, and Principles of Operation	050
Service Operations	
Safety Precautions	100
Heater Core Removal and Installation	110
Evaporator Coil Removal and Installation	120
Thermostatic Switch Replacement	130
Blower Motor Replacement	140
Resistor Block Replacement	150
Water Regulating Valve Replacement	160
Expansion Valve Replacement	170
Receiver-Drier Replacement	180
Binary Switch Replacement	190
Condenser Replacement	200
Control Panel Replacement	210
Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing	220
Troubleshooting	300
Specifications	400

General Information, Description of Components, Definition of Terms, and Principles of Operation

General Information

The heater and air conditioner unit uses a common blower motor and duct work to heat or cool the cab. Airflow rate is controlled by a three-speed blower switch. Air outlets are located in the instrument panel, along the bottom of the dash, at the windshield, and also at the side windows. See **Fig. 1**.

When equipped with an air conditioner, temperature can be moderated by opening or closing a water regulating valve, which controls the flow of warm engine coolant to the heater core. The temperature of the air inside the cab partly depends on how much coolant is flowing through the heater core, and how much liquid refrigerant is in the evaporator coil.

The air conditioning system also includes a cycling-clutch refrigerant compressor, a condenser, an expansion valve, an evaporator coil, a fixed-temperature thermostatic switch, and mechanically operated controls.

DESCRIPTION OF COMPONENTS

Refrigerant

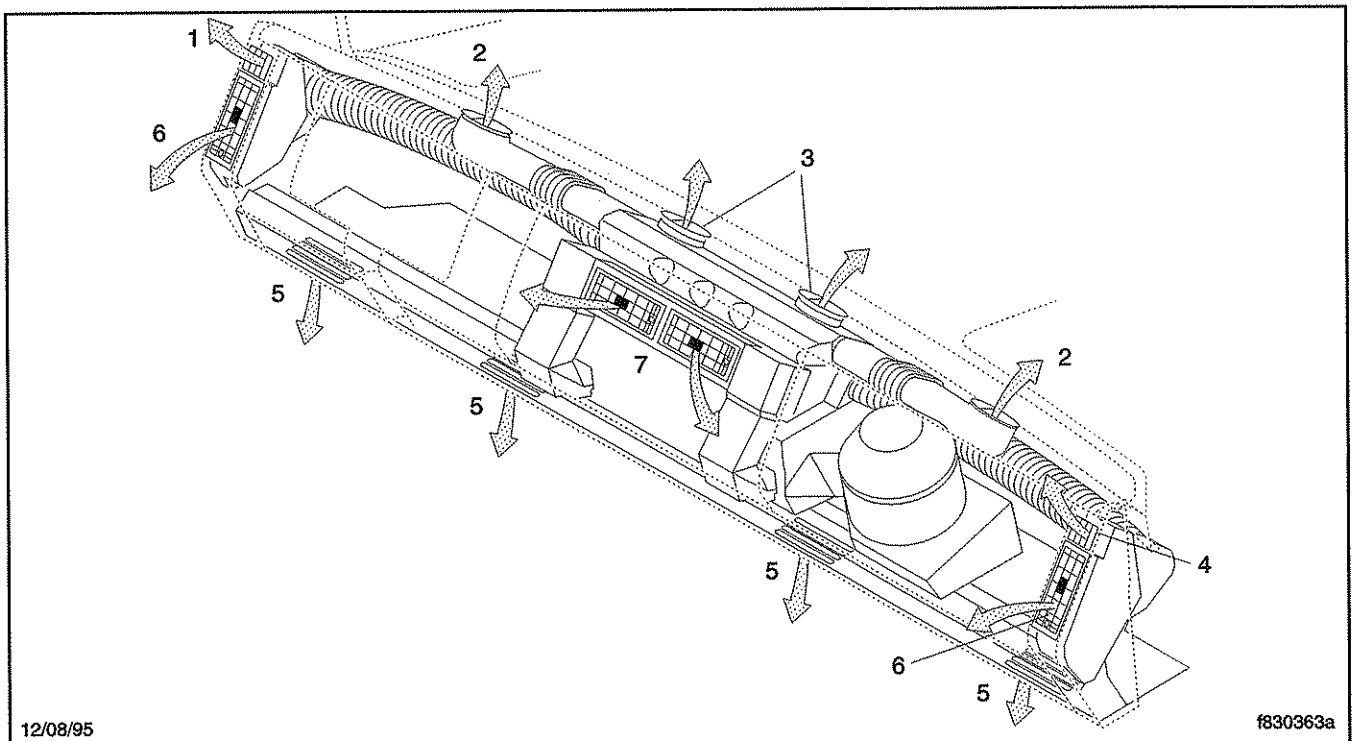
Refrigerant absorbs heat from the air in the cab and releases it to the air outside the cab.

In an open container, refrigerants boil at temperatures below the freezing point of water; sealing and pressurizing refrigerant in the air conditioning system raises its boiling-point temperature.

During compressor operation, refrigerant constantly changes from a liquid to a gas. It absorbs heat (boiling) in the low-pressure evaporator coils, and it changes from a gas to a liquid as it releases absorbed heat in the high-pressure condenser.

Expansion Valve

The expansion valve is a dividing point between the high-and low-pressure parts of the refrigerant system. High-pressure liquid refrigerant from the receiver-drier



1. Driver's Door Window Defrost Outlet
2. Windshield Defrost Outlet
3. Windshield Defrost Outlets
4. Passenger's Door Window Defrost Outlet
5. Floor Outlet
6. Dash/Door Window Vent
7. Center Dash Vents

Fig. 1, Air Outlet System

General Information, Description of Components, Definition of Terms, and Principles of Operation

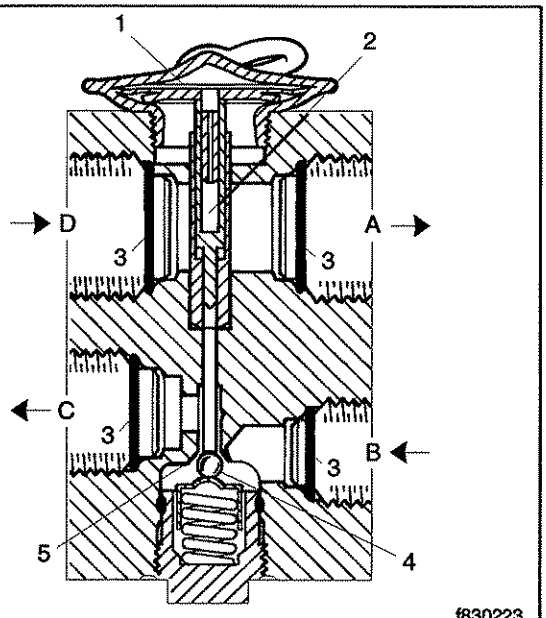
passes through the expansion valve and moves into the low-pressure area of the evaporator coil.

An expansion valve controls the flow rate of refrigerant in proportion to the rate of evaporation in the evaporator. If the amount of liquid in the evaporator drops off, the temperature of the gas going to the compressor rises. This causes a diaphragm in the expansion valve to react, which causes an orifice in the valve to open or close. Refer to **Fig. 2**. Through the orifice, liquid refrigerant is metered into the evaporator, as needed.

Evaporator Coil

Because the evaporator coil is an area of low pressure in the system, the boiling point of refrigerant lowers, which causes it to absorb heat from the tubing walls and fins of the coils. As it absorbs heat, liquid refrigerant quickly boils and turns into a gas.

As heat is absorbed from the outside surfaces of the evaporator coil, air passing over the unit loses its heat to these cooler surfaces. Moisture in the air condenses on the outside of the coil and drains off as water (the air becomes dehumidified).



A. to compressor.
B. from receiver-drier.
C. to evaporator.
D. from evaporator.
1. Diaphragm
2. Temperature Sensor
3. O-Rings
4. Metering Orifice
5. Ball and Spring

Fig. 2, Expansion Valve

Refrigerant Compressor

"Heat" in the low-pressure gas of the evaporator coils is not heat that can be noticed by touch, because liquid refrigerant boils at a temperature much lower than the temperature at which water turns to ice. By touch, the "heated" gas in the coils is very cold. As a result, there is the problem of how to remove heat from subfreezing gas using outside air that may be higher than 100°F (38°C).

With a refrigerant compressor, low-pressure gas from the evaporator can be squeezed into a much smaller space. When the gas is compressed, the heat it contains becomes concentrated. In this way, the gas is made hotter than the outside air, without adding heat.

Another function of the compressor is to move refrigerant through the system.

Condenser

A condenser turns hot refrigerant gas, coming from the compressor, into liquid. Mounted in front of the radiator, it is made up of a coiled tube and a series of fins. Because of its location, the condenser transfers heat to air that is drawn in by the engine fan and by air that is forced into the engine compartment as the vehicle moves forward (ram air).

Receiver-Drier

Used as a reservoir and filter for liquid refrigerant from the condenser, a receiver-drier also removes water and acids from the refrigerant. The water-absorbing material (desiccant) in the unit helps stop blockages from forming in the expansion valve and in other parts of the system.

A moisture indicator shows the amount of water in the refrigerant. A sight glass (aperture) on the unit contains a specially treated element (litmus paper) that changes color, depending on the amount of water in the refrigerant. The indicator changes from a deep cobalt blue (dry) to light greyish-blue (wet) to lilac, lavender, and finally pink (very wet). Any color other than cobalt blue is considered wet. Any time the system is evacuated (dehydrated), replace the receiver-drier.

General Information, Description of Components, Definition of Terms, and Principles of Operation

Thermostatic Switch

The temperature of the evaporator coil is monitored by a fixed-temperature thermostatic switch.

The probe from the switch extends to the evaporator coil, and the switch is mounted on the right side of the heater and air conditioner housing. This switch disengages the compressor to prevent the evaporator coil from freezing up due to, for example, an expansion valve that is stuck open.

Binary Switch

A binary switch disengages the refrigerant compressor to protect it from harmful operating conditions. It performs two functions:

1. If refrigerant is lost or the outside temperature is too low, the binary switch will keep the compressor from operating. The switch disengages the compressor when falling pressure goes below 26 to 31 psig (179 to 214 kPa); normal compressor operation resumes when rising pressure reaches 0.1 to 3 psig (0.6 to 21 kPa) above shut-off pressure.
2. If the compressor cylinder head pressure increases to unsafe levels above 356 to 413 psig (2454 to 2847 kPa), the binary switch shuts off the compressor. Too much pressure may be caused by blocked air flow through the condenser, a plugged expansion valve or receiver-drier, or too much refrigerant in the system. When pressure falls back 57 to 11 psig (393 to 786 kPa) from shut-off pressure, the compressor resumes operation.

Heater Core

The heater core is a series of fins through which tubing is routed. When the heating system is on, engine coolant flows through the heater core tubes, heating the tubes and fins. The heat is absorbed by air that is forced through the heater core by the blower motor.

Water Regulating Valve

When opened, the water regulating valve allows engine-heated coolant to flow through the heater core.

Air Blower, Resistor Block Assembly

An air blower forces air through the heater core and evaporator coil, and into the cab. The resistor block assembly regulates the voltage to the blower motor. The voltage controls the blower motor speed. The resistor assembly has a thermal cutout which shuts off current to the blower motor in case the motor malfunctions.

DEFINITION OF TERMS

Refer to the following terms for a better understanding of the heater/air-conditioning system.

Air Conditioner A system used to control the temperature, humidity, and movement of air.

Ambient Air Temperature The temperature of air around an object; the outside temperature.

Binary Switch Disengages the refrigerant compressor to protect it from harmful operating conditions.

Blower A motor and fan used to draw air through the evaporator, and force it through the heater core and into the cab.

Blower Resistor Block Assembly Inline resistors that control the amount of voltage going to the blower motor. By controlling the voltage, you can control the fan speed.

Boiling Point The temperature at which a liquid changes to a gas. The boiling point varies with pressure.

Bulk Charging Use of large containers of refrigerant for charging a refrigerant system. Normally used for charging empty systems.

Carbon Dioxide A colorless, odorless, dry, inert gas that can be used to purge light contaminants (for example, dust) from air conditioner parts.

CFM Cubic feet per minute

Charge A specific amount of refrigerant or oil by volume or weight. Also, the act of placing an amount of refrigerant or oil in the air conditioning system.

Clutch Cycling Switch Engages or disengages the compressor depending on changes in system pressure or evaporator temperature.

Cold The absence of heat. (The lowest possible temperature is thought to be –459 °F [–273 °C].)

Compressor A device used to draw low-pressure refrigerant gas from the evaporator and squeeze it into a high-temperature, high-pressure gas. A second purpose of the compressor is to move refrigerant through the system.

General Information, Description of Components, Definition of Terms, and Principles of Operation

Condensate Water, taken from the air, which forms on the outer surface of the evaporator.

Condenser A heat exchanger that is used to remove heat from the refrigerant, changing it from a high-pressure hot gas to a high-pressure warm liquid.

Condensing Pressure Pressure, as read from the gauge at the discharge service valve; pressure from the discharge side of the compressor into the condenser.

Contaminants Anything other than refrigerant or refrigerant oil in the system. Usually means water in the system. When water and refrigerant mix, corrosive hydrochloric acid forms.

Cycling Clutch System A system which controls compressor clutch operation in order to raise or lower the temperature in the cab.

Dehumidify To remove water from the air, at the evaporator coil.

Dehydrate To remove all traces of moisture from the refrigerant system. Normally called evacuation.

Desiccant A drying agent used in the refrigerant system (in the receiver-drier) to remove water and create an extremely dry condition.

Discharge To bleed some or all of the refrigerant from a system by opening a valve or hose connection and recovering the refrigerant from the system.

Discharge Line Connects the refrigerant compressor outlet to the condenser inlet.

Discharge Pressure Pressure of the refrigerant being discharged from the compressor; high-side pressure.

Drive Pulley A V-pulley attached to the front of the engine crankshaft. It drives the compressor clutch pulley with a belt.

Drying Agent See "Desiccant."

Duct A passageway for the transfer of air from one point to another.

Evacuate To place a high vacuum in the air-conditioning system and dehydrate or remove all traces of wet air.

Evaporate To change state from a liquid to a gas.

Evaporator Coil A component in which liquid refrigerant changes to a gas after it absorbs heat from the air. Also removes some water from the air.

Expansion Valve A device that causes a pressure-drop of the refrigerant and also regulates its flow.

Flooding A condition caused by too much liquid refrigerant going into the evaporator; usually caused by an expansion valve that is stuck open.

Flushing A process of passing liquid refrigerant through an air-conditioner component to remove dirt and water from the part. Liquid refrigerant removes heavy contamination, such as gritty dirt and large dirt build-up, which cannot be removed by purging with a gas.

Foaming Bubbles of oil and refrigerant caused by a rapid boiling out of refrigerant dissolved in the oil when the pressure is suddenly reduced. Foam in the sight glass means a very low refrigerant charge.

Freeze-Up Failure of a unit to operate properly because of ice forming at the expansion valve orifice or on the evaporator coils and fins.

Head Pressure Refrigerant pressure from the discharge side of the compressor to the condenser and expansion valves.

Heater Core A part of the heating system in which hot engine coolant flows to provide heat to the cab or to adjust the temperature produced by the air conditioner.

High-Side Service Valve A device located on the liquid line near the thermostatic expansion valve; it allows high-side pressure to be checked and other service operations to be performed.

Humidity The amount of water vapor in the air.

Hydraulic Lock The return of liquid refrigerant to the compressor, which could destroy the unit.

Hydrochloric Acid A highly corrosive substance that forms when water and refrigerant mix in a refrigerant system.

Hydrofluorocarbon The chemical name for R–134a.

Leak Detector Any device used to detect refrigerant leaks in a refrigerant system.

Liquid Pressure Pressure of refrigerant in the liquid line from the receiver-drier to the thermostatic expansion valve.

General Information, Description of Components, Definition of Terms, and Principles of Operation

Low Head Pressure High-side pressure that is lower than normal due to a system problem.

Low Suction Pressure Low-side pressure that is lower than normal due to a system problem.

Magnetic Clutch An electrical coupling device used to engage or disengage the compressor.

Manifold Device to control refrigerant flow for system test purposes; used with manifold gauges.

Manifold Gauge A calibrated instrument used for measuring system pressures.

Manifold Gauge Set A manifold that is complete with gauges and charging hoses and is used to measure or test pressure.

Micron A metric measurement of mercury; one-tenth of an inch of mercury equals 2540 microns. Measurement in microns is the only accurate way to determine the amount of pressure that is left in a refrigerant system by a high vacuum pump.

Moisture Indicator Litmus paper in a sight glass receiver-drier; shows how much water is in the system.

Nitrogen A colorless, odorless, dry, inert gas that can be used to purge light contaminants (for example, dust) from air conditioner parts.

Opacity A condition that is used to describe contamination of refrigerant oil in the compressor. Fresh refrigerant oil is clear; when contaminated, it appears cloudy or may have fine particles held in suspension.

Overcharge Too much refrigerant or oil in the system.

Phosgene Fumes Poisonous gas produced when refrigerant contacts an open flame or some other source of intense heat.

psia Pounds per square inch, absolute pressure.

psig Pounds per square inch, gauge pressure.

Purge To remove damp air, traces of refrigerant, and loose dirt from a system or part by flushing with a dry, inert gas, such as nitrogen.

Receiver-Drier A combination desiccant, filter, and storage container for liquid refrigerant.

Refrigerant–12 (R–12) A cooling agent used in automotive air conditioning systems. It is being phased out due to environmental concerns.

Refrigeration Cycle The complete circulation of refrigerant through an air conditioning system, accompanied by changes in temperature and pressure.

Refrigerant Oil Highly refined oil compatible with air-conditioning system refrigerants.

Relative Humidity The actual water content of the air in relation to the total water vapor the air can hold at a given temperature.

Resistor A voltage-dropping device, usually wire-wound, for controlling fan speed.

Schrader Valve A spring-loaded valve (similar to but not interchangeable with a tire valve) located inside the compressor service valve fitting to hold refrigerant in the system. Special adaptors must be used with the gauge hose to get into the system.

Sight Glass A window in the receiver-drier (moisture indicator) used to check the refrigerant charge.

Suction Line The line connecting the evaporator outlet to the compressor inlet.

Suction Pressure Compressor inlet pressure (the system's low-side pressure).

Suction Service Valve A device located on the suction hose near the thermostatic expansion valve that allows low-side pressure to be checked and other service operations to be performed.

Suction Side The low-pressure area of the system, extending from the expansion valve to the compressor inlet.

Thermistor A temperature-sensing resistor that is used to measure (in microns) internal system vacuum levels during evacuation.

Thermostatic Switch A temperature-sensitive switch used to control system temperature and prevent evaporator freeze-up; it does this by cycling the compressor's operation.

Thermostatic Vacuum Gauge A high-vacuum gauge sensitive to pressures ranging from atmospheric pressure to less than 1 micron, with scales reading from 25,000 microns to 1 micron.

Undercharge A system low on refrigerant, resulting in lack of cooling and possible compressor damage.

Vacuum Refers to pressure that is less than atmospheric pressure.

General Information, Description of Components, Definition of Terms, and Principles of Operation

Vacuum Pump A mechanical device used to evacuate and place a high vacuum in the refrigerant system.

Vacuum Pump Oil Water soluble oil used in some vacuum pumps to absorb water from the refrigerant system.

Vapor The gaseous state of a material.

Water Regulating Valve A valve, mechanically operated, for controlling the flow of hot coolant to the heater core.

Principles of Operation

HEATER

Moving the temperature control toward maximum heat opens the water regulating valve, which allows engine-heated coolant to flow through the heater core. Heat absorbed by the air passing over the heater core fins is forced through ducts and into the cab.

AIR CONDITIONER

When the air conditioner is on, the motion of the compressor squeezes the refrigerant into a high-pressure, high-temperature gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid. After it is compressed, refrigerant gas moves out of the discharge port of the compressor, and on to the condenser.

At the condenser, air passing over the coil's fins absorbs heat from the hot refrigerant gas and causes it to change into a liquid. The liquid moves to the receiver-drier, which filters it and removes traces of water and acids. The receiver-drier then stores the refrigerant until it is needed by the system.

From the receiver-drier, liquid refrigerant moves to the expansion valve, which meters the flow into the evaporator coil and acts as a boundary between the high-and low-pressure sides of the system. The metered release of the expansion valve greatly drops the liquid's pressure, causing it to expand. The pressure drop lowers the boiling point of the refrigerant, and causes it to evaporate quickly as it absorbs heat from air passing over the coil. The resulting cool air is forced into the cab by the blower; the heated refrigerant gas is drawn back into the compressor, where the cycle is repeated.

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold refrigerant, you must discharge, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the air conditioning system has been discharged to a refrigerant recovery unit through the service valves on the compressor.

Refrigerants are safe when used under the right conditions. Always wear safety goggles and non-leather gloves while discharging, purging, flushing, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

⚠ WARNING

Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should first be treated with a few drops of sterile mineral oil in the eyes, and then rinsed with a weak boric acid solution. Do not rub the eyes. Call a doctor right away.

Refrigerant splashed on the skin should be treated the same as for frostbite: gently pour cool water on the area, but do not rub the skin. Keep the skin warm with layers of soft, sterile cloth. Call a doctor right away.

Even though refrigerant does not burn, when it contacts extreme heat or flame, poisonous phosgene gas is created. This gas also is produced when an open flame leak detector is used. Phosgene fumes have an acrid (bitter) smell.

⚠ WARNING

Do not work in an area where refrigerant may contact an open flame or any burning material, such as a cigarette. When it contacts extreme heat, refrigerant breaks down into poisonous phosgene gas which, if breathed, causes severe respiratory irritation. Do not breathe the fumes from an open flame leak detector.

You must work in an area where there is a constant flow of fresh air when the system is discharged, flushed, charged, and leak tested using an open flame leak detector.

Changes in both federal and state laws will affect the way dealerships service air-conditioning systems. Under current federal laws, refrigerant must be recovered and recycled by all users to protect the environment, and not released into the atmosphere. Many service operations not directly involving the air-conditioning system require the release of the refrigerant charge. Under the new regulations, dealerships not having the required recovery and recycling equipment (and properly trained and certified personnel) will not be allowed to do any of this service work.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant cans from exploding, never expose them to temperatures higher than 125°F (52°C). Never leave refrigerant cans in the sun, and do not store them in sun-exposed areas where heat can build up, such as in gloveboxes, automobile trunks, etc.

Heater Core Removal and Installation

Removal

1. Set the temperature control on the dash to its warmest setting.

⚠ WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

2. Drain the coolant.
3. Disconnect the batteries.
4. Remove the extruded rubber strip at the top of the dashboard. See **Fig. 1.**
5. Remove dash panel D. See **Fig. 2** and **Fig. 3.**
   - 5.1 Remove the two screws from the top of dash panel D.
   - 5.2 Lift out the dash panel.
6. Pull out the windshield defrost duct. See **Fig. 4.**
7. Remove the parking brake knob and, if so equipped, the trailer brake knob. See **Fig. 5.** Then, remove dash panel B.
8. Remove dash panel C. See **Fig. 2.**
   - 8.1 Remove the bezel around the heater/ air-conditioner control panel.
   - 8.2 Remove the four screws (**Fig. 6**) holding the control panel to dash panel C.
   - 8.3 Remove the two screws from the top of dash panel C.
   - 8.4 Lift out the dash panel and set it aside.
9. Remove the dashboard gauge cover by pushing down on the four locking tabs. See **Fig. 7.**
10. Remove the two screws at the top of dash panel A. See **Fig. 8.**
11. Remove the dash top panel.
    - 11.1 Remove the two screws holding each dash end cap; then remove the end caps. See **Fig. 9.**
    - 11.2 Remove the screws at the base of the windshield holding the dash top panel.

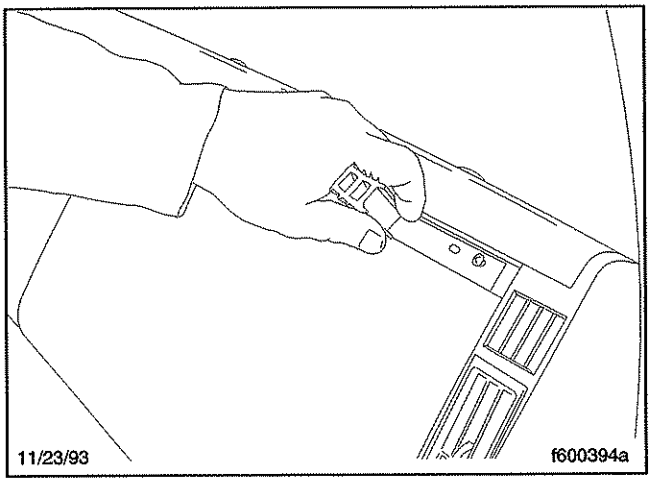
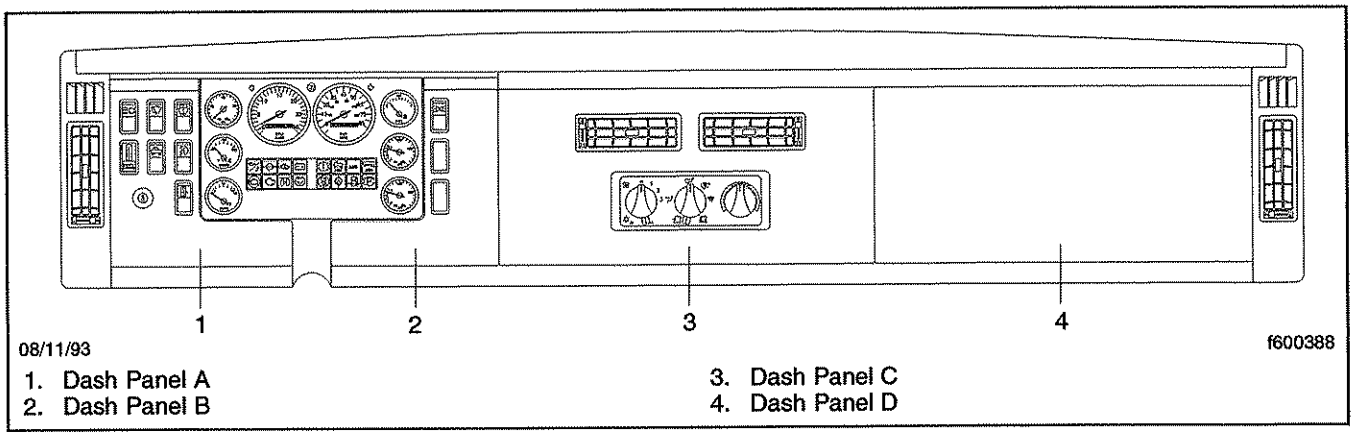


Fig. 1, Remove the Rubber Strip



1. Dash Panel A
2. Dash Panel B
3. Dash Panel C
4. Dash Panel D

Fig. 2, Dash Panel

Heater Core Removal and Installation

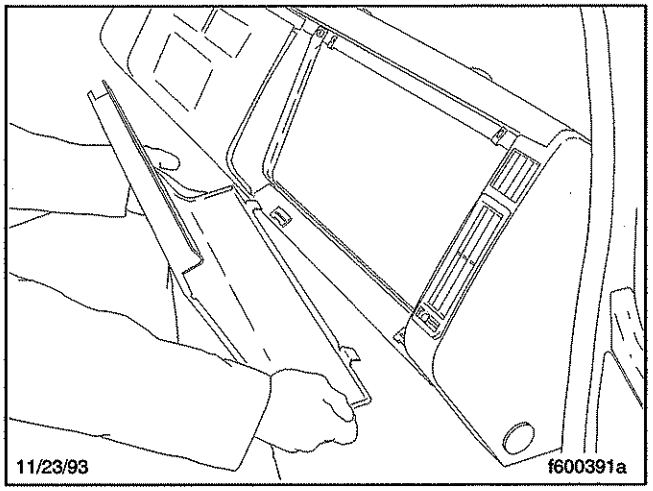


Fig. 3, Remove the Dash Panel

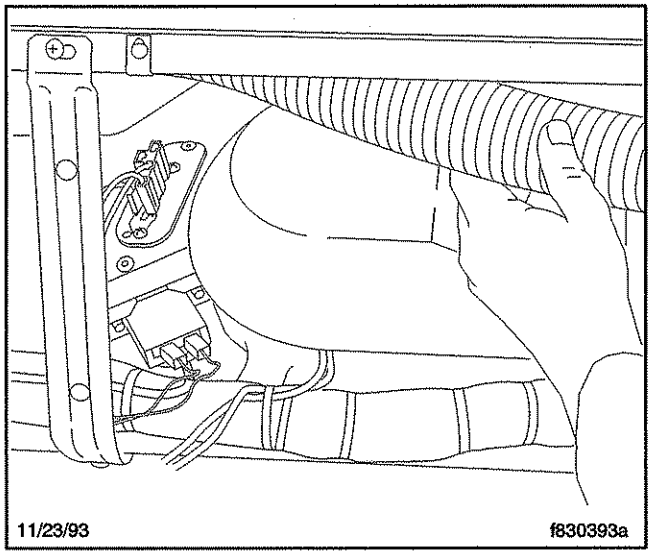


Fig. 4, Remove the Windshield Defrost Duct

11.3 Remove the screw at the top of the dashboard brace (**Fig. 10**) and the screws at the top of the gauge cluster.

11.4 Lift off the dash top panel. See **Fig. 11**.

12. Remove the dash side vent flexible air ducts. See **Fig. 12**.

13. Remove the air plenum.

13.1 Disconnect the defrost door control cable from the face duct. See **Fig. 13**.

13.2 Remove the face duct.

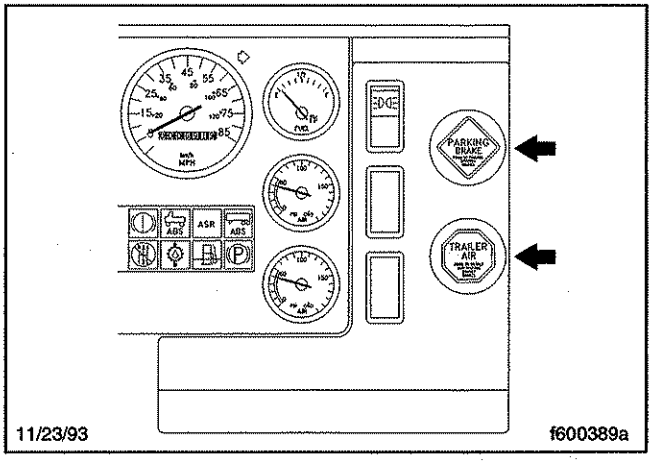


Fig. 5, Parking Brake and Trailer Brake Knobs

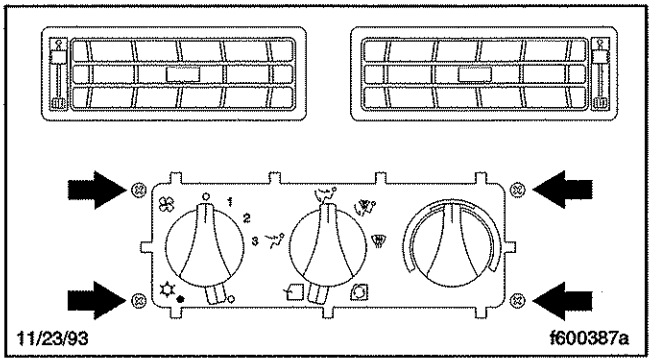


Fig. 6, Control Panel

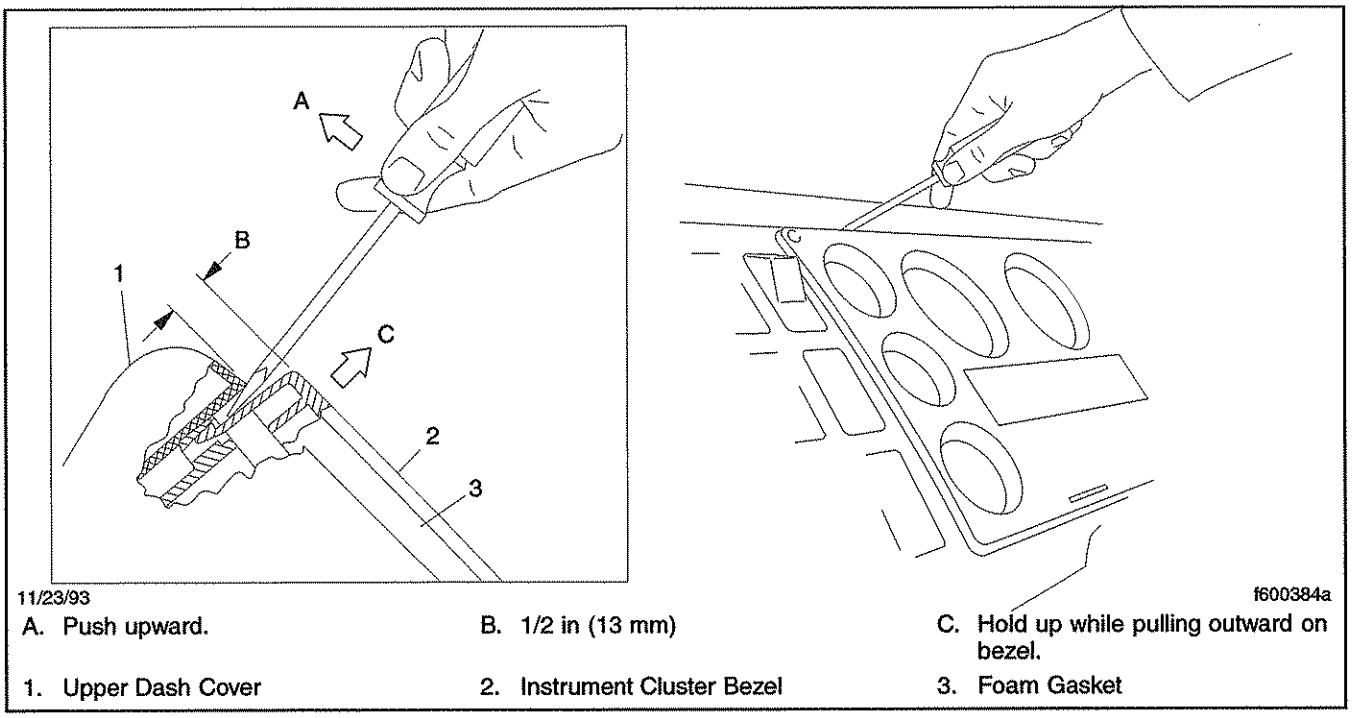
13.3 Remove the two screws in the air plenum; then, lift out the plenum. See **Fig. 14**.

14. Disconnect the hoses from the heater core. See **Fig. 15**.

⚠ WARNING

Always wear protective gloves when handling the heater core. Failure to do so could result in serious skin cuts from the sharp edges on the heater core fins.

15. Remove the heater core. See **Fig. 16**.



A. Push upward.
B. 1/2 in (13 mm)
C. Hold up while pulling outward on bezel.
1. Upper Dash Cover
2. Instrument Cluster Bezel
3. Foam Gasket

Fig. 7, Dashboard Gauge Cover

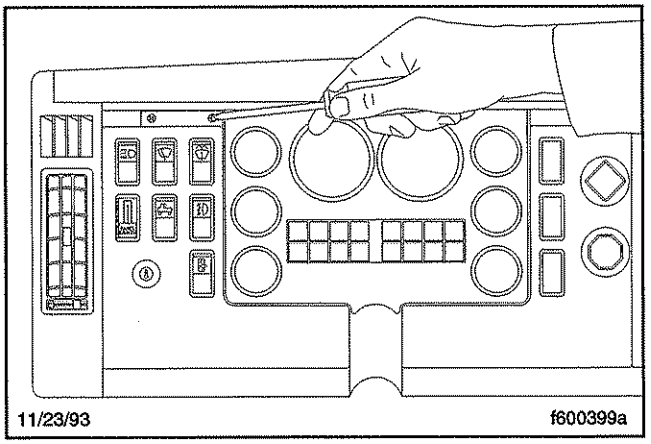


Fig. 8, Dash Panel

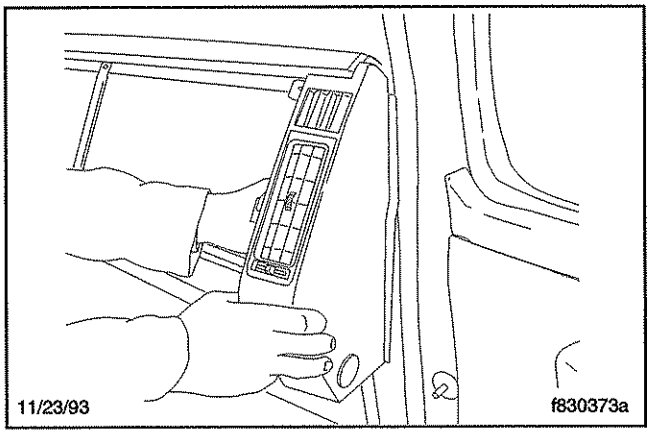


Fig. 9, Remove the Dash End Caps

Installation

⚠ WARNING

Always wear protective gloves when handling the heater core. Failure to do so could result in serious skin cuts from the sharp edges on the heater core fins.

1. Install the heater core, inserting the pipes through the holes in the firewall. See **Fig. 16.**
2. Connect the hoses to the heater core. See **Fig. 15.**
3. Check the heater core for leaks.

Heater Core Removal and Installation

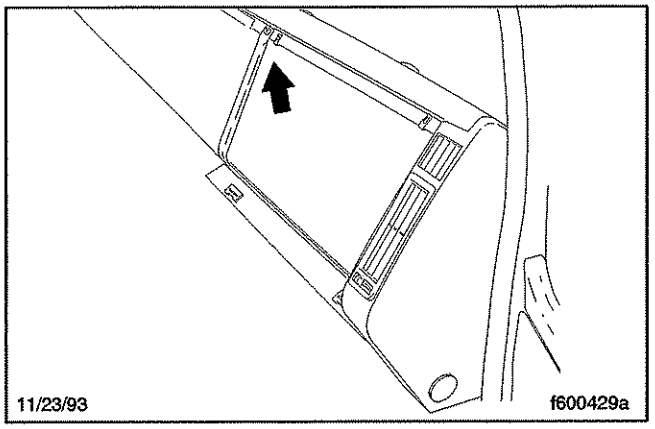


Fig. 10, Dashboard Brace

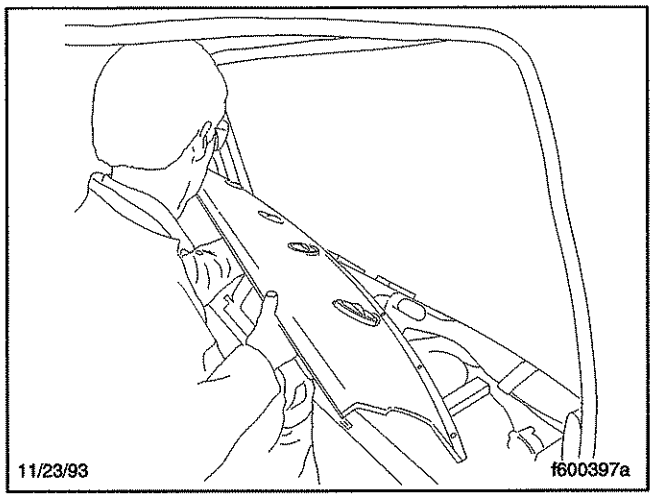


Fig. 11, Remove the Dash Top Panel

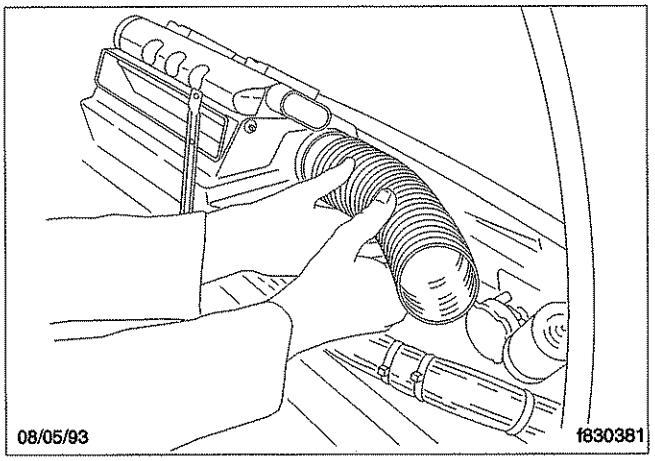
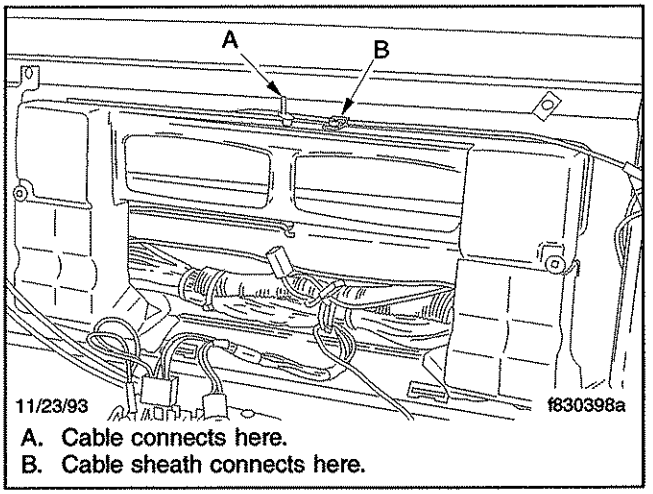


Fig. 12, Dash Side Vent Air Duct



A. Cable connects here.
B. Cable sheath connects here.

Fig. 13, Defrost Door Control Cable

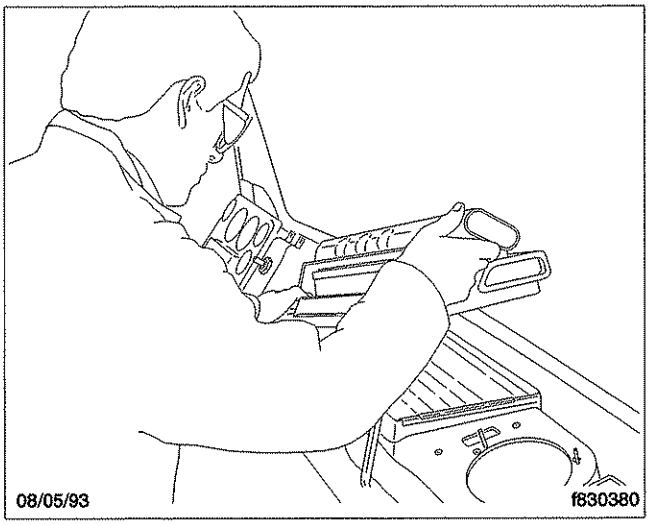


Fig. 14, Remove the Air Plenum

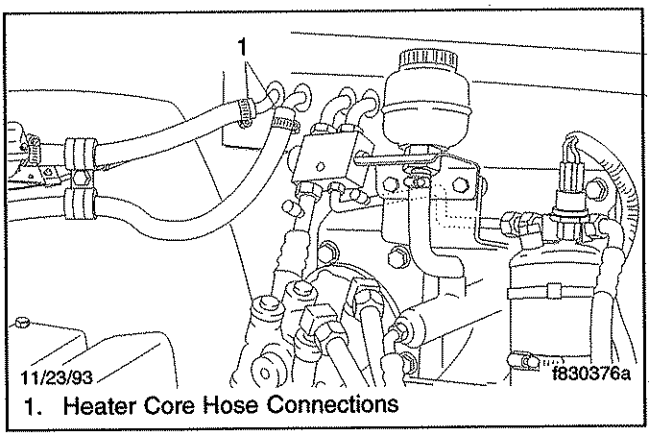
3.1 Connect the batteries.

3.2 Close the radiator drain valve.

3.3 Fill the cooling system with approved coolant. See **Group 20** of the *Business Class Trucks Maintenance Manual.*

3.4 Start the engine and set the temperature control to the warmest setting. When the engine thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again and fill as needed.

Heater Core Removal and Installation



1. Heater Core Hose Connections

Fig. 15, Heater Core Hose Connections

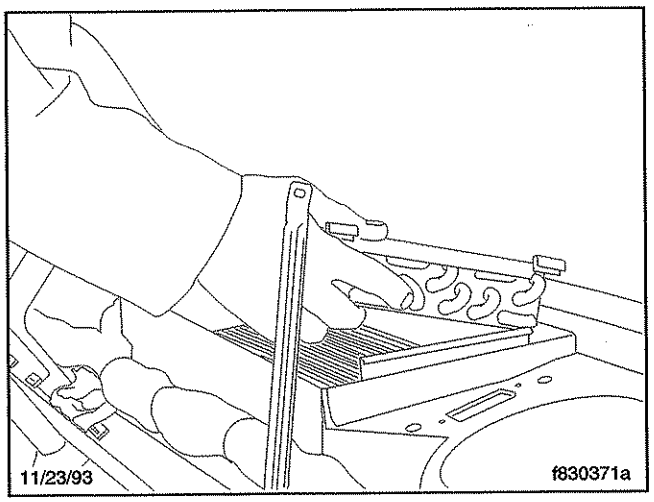


Fig. 16, Remove the Heater Core

3.5 Check the heater core hose connections (**Fig. 15**) for leaks. Tighten the hose clamps if needed.

3.6 Shut down the engine and disconnect the batteries.

4. Install the air plenum. See **Fig. 14.** Install the screws in the plenum.
5. Install the face duct. Connect the defrost door control cable and the cable sheath to the face duct. See **Fig. 13.**
6. Install the flexible air ducts to the dash side vents. See **Fig. 12.**
7. Install the dash top panel (**Fig. 11**) and the screws at the base of the windshield.
8. Install the dash end caps (**Fig. 9**) and their mounting screws (two each).
9. Install the brace screw (**Fig. 10**) and the screws at the top of the gauge cluster.
10. Install dash panel A and its two mounting screws (**Fig. 8**).
11. Install the cover over the dashboard gauges. Make sure the tabs are locked. See **Fig. 7.**
12. Install dash panel C (**Fig. 2**) and its mounting screws.
13. Install dash panel B (**Fig. 2**) and its two mounting screws. If so equipped, install the parking brake knob and the trailer brake knob.
14. Install the windshield defrost duct. See **Fig. 4.**
15. Install dash panel D (**Fig. 2** and **Fig. 3**) and its two mounting screws.
16. Install the extruded rubber strip at the top of the dashboard. See **Fig. 1.**
17. Connect the batteries.

Evaporator Coil Removal and Installation

Removal

IMPORTANT: Before replacing any refrigerant parts, read **Subject 220**. Always discharge the system before disconnecting a refrigerant line. If the system is contaminated, purge or flush it before you install replacement parts.

1. Review the information under **Safety Precautions, 100.**

⚠ WARNING

Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

2. Disconnect the batteries.
3. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to **Subject 220.**
4. Remove the heater core. Refer to **Subject 110.**

⚠ CAUTION

Water and dirt can damage the refrigerant system. Five minutes of being uncapped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

5. Disconnect the evaporator coil lines from the expansion valve in the engine compartment. See **Fig. 1.** Save the O-rings if they are in good condition.
6. Cap or plug the evaporator coil lines and the expansion valve ports.

⚠ WARNING

Always wear protective gloves when handling the evaporator coil. Failure to do so could result in serious skin cuts from the sharp edges on the evaporator coil fins.

7. Lift the evaporator coil out of the housing. See **Fig. 2.**

Installation

⚠ WARNING

Always wear protective gloves when handling the evaporator coil. Failure to do so could result in serious skin cuts from the sharp edges on the evaporator coil fins.

1. Wearing protective gloves, place the evaporator coil in the housing. See **Fig. 2.** Make sure the evaporator coil lines extend through the holes in the firewall.
2. Remove the caps or plugs from the evaporator coil lines and the expansion valve ports.
3. Lubricate the rubber O-rings with refrigerant oil and install them in the fittings.

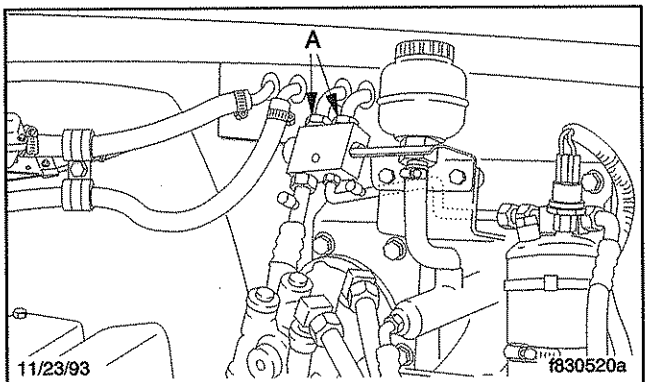
NOTE: The previously removed O-rings can be used again if they are in good condition.

4. Apply Loctite® 242 or 592 to the male fitting threads; then, connect the evaporator coil

   lines to the expansion valve ports. Tighten the fittings as follows:

   - Large fitting—24 lbf·ft (33 N·m)
   - Small fitting—18 lbf·ft (24 N·m)

5. Evacuate and charge the air conditioning system with refrigerant. For instructions, refer to **Subject 220.** Be sure to add refrigerant oil to the compressor to replace that which was lost when the system was discharged. Refer to the applicable refrigerant compressor section.



A. Disconnect here.

Fig. 1, Evaporator Coil Lines

Evaporator Coil Removal and Installation

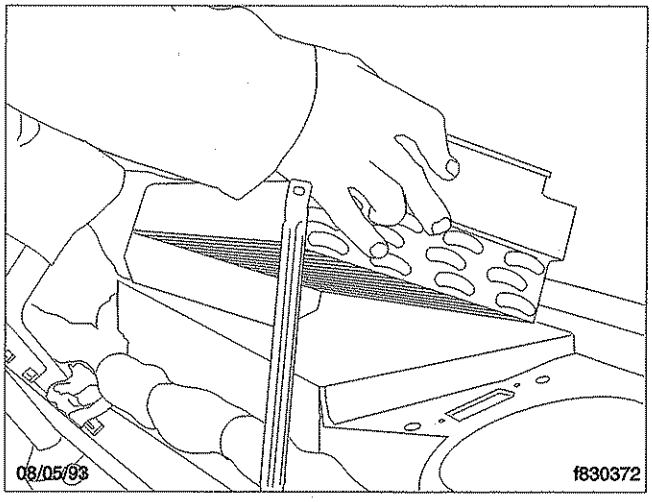


Fig. 2, Remove the Evaporator Coil

NOTE: If the system will not hold a vacuum, check the evaporator coil connections for tightness or check for a missing O-ring.

6. Install the heater core and the other removed components. Refer to **Subject 110** for instructions.

Thermostatic Switch Replacement

Replacement

1. Disconnect the batteries.
2. Remove the extruded rubber strip at the top of the dashboard. See **Fig. 1**.
3. Remove dash panel D. See **Fig. 2** and **Fig. 3**.
4. If so equipped, remove the parking brake knob and the trailer brake knob. Then, remove dash panel B.
5. Remove dash panel C. See **Fig. 4**.

NOTE: It isn't necessary to remove the control panel from dash panel C or to disconnect the control cables.

6. Remove the thermostatic switch. See **Fig. 5**.
   - 6.1 Disconnect the wires from the thermostatic switch.
   - 6.2 Remove the two allen-head screws holding the thermostatic switch.
   - 6.3 Carefully pull the capillary tube, which extends from the bottom of the thermostatic switch, out of the air duct.
   - 6.4 Remove the thermostatic switch.
7. Install the new thermostatic switch.
   - 7.1 Carefully insert the capillary tube into the hole in the air duct.
   - 7.2 Position the thermostatic switch and secure it with the two allen-head screws.
   - 7.3 Connect the wires to the switch.
8. Install dash panel C and its mounting screws.
9. Install dash panel B and its mounting screws. Install the parking brake knobs.
10. Install dash panel D and its mounting screws.
11. Install the extruded rubber strip at the top of the dashboard.
12. Connect the batteries.

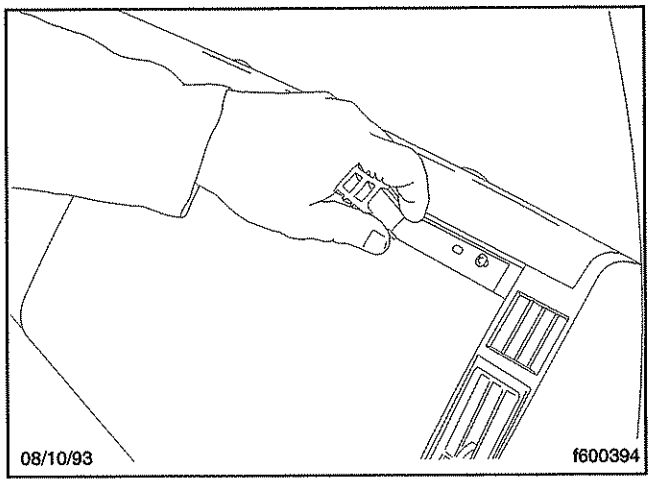
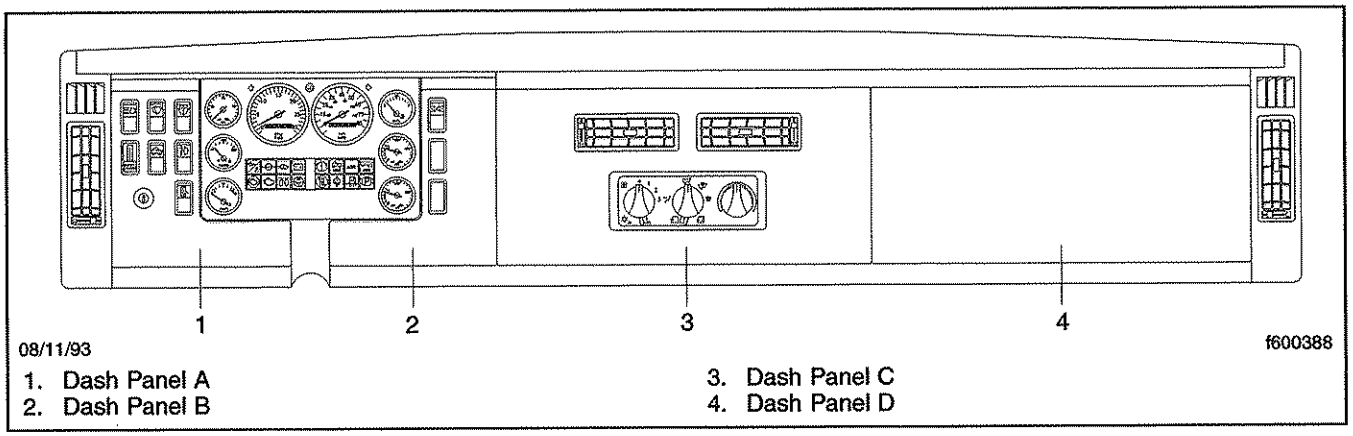


Fig. 1, Remove the Rubber Strip



1. Dash Panel A
2. Dash Panel B
3. Dash Panel C
4. Dash Panel D

Fig. 2, Dash Panel

Thermostatic Switch Replacement

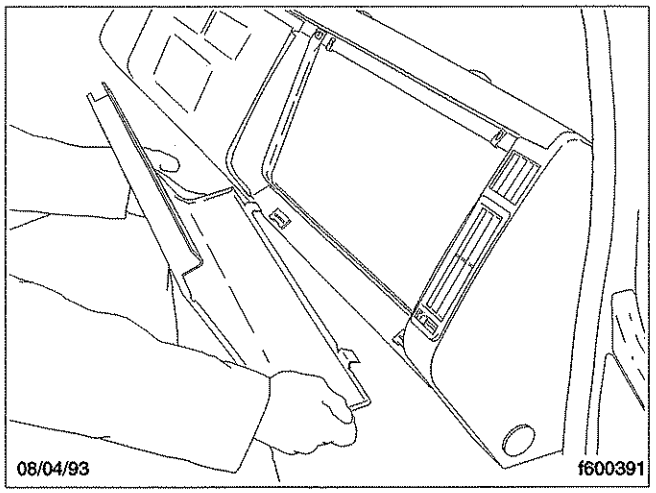


Fig. 3, Remove the Dash Panel

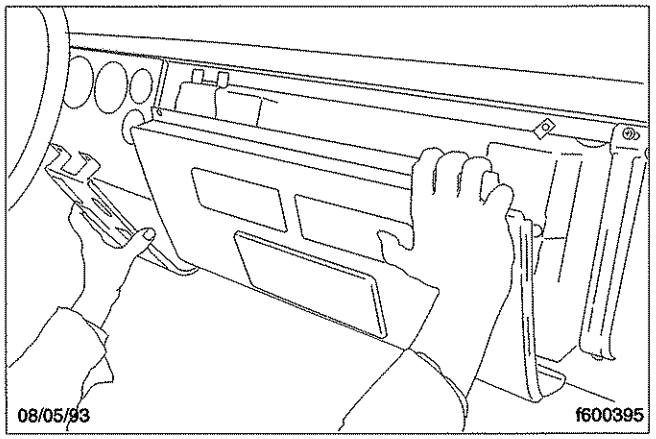
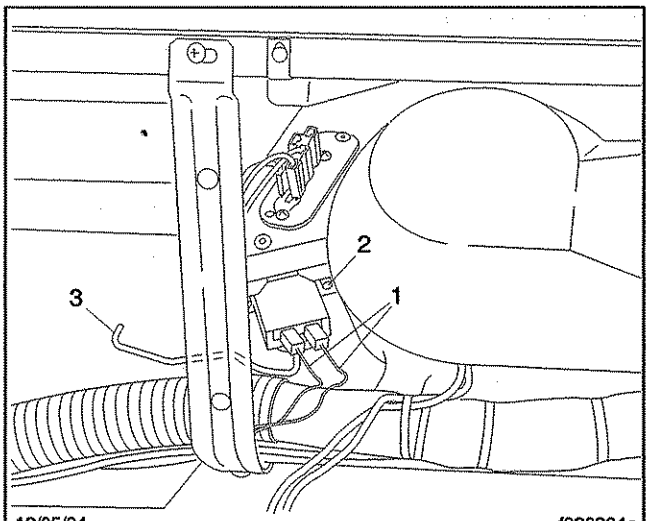


Fig. 4, Remove the Dash Panel



1. Thermostatic Switch Wires
2. Allen-Head Screw
3. Capillary Tube

Fig. 5, Remove the Thermostatic Switch

Replacement

1. Disconnect the batteries.
2. Remove the extruded rubber strip at the top of the dashboard. See **Fig. 1**.
3. Remove dash panel D. See **Fig. 2** and **Fig. 3**.
4. Remove the blower motor cover. See **Fig. 4**.
5. Disconnect the blower motor electrical connector. See **Fig. 5**.
6. Remove the two remaining nuts holding the blower motor (**Fig. 6**); then, lift out the blower motor.
7. Install the new blower motor. Install the two nuts. Tighten them 17 lbf·in (192 N·cm).
8. Connect the blower motor electrical lead (**Fig. 5**).
9. Install the blower motor cover. See **Fig. 4**.
10. Install and tighten the knurled thumb screw on the blower motor cover finger tight.
11. Install dash panel D (**Fig. 3**) and its two mounting screws.
12. Install the extruded rubber strip at the top of the dashboard. See **Fig. 1**.
13. Connect the batteries and check the blower operation. Refer to the vehicle driver's manual for instructions.

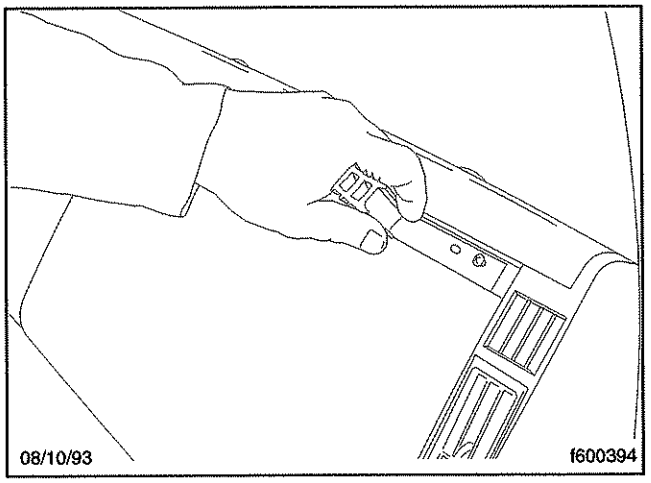
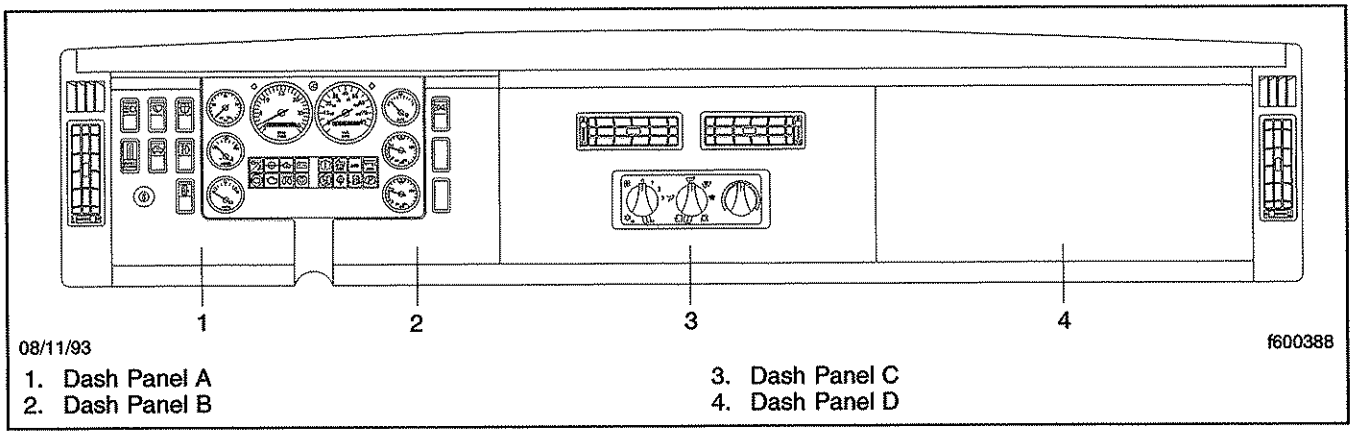


Fig. 1, Remove the Rubber Strip



1. Dash Panel A
2. Dash Panel B
3. Dash Panel C
4. Dash Panel D

Fig. 2, Dash Panel

Blower Motor Replacement

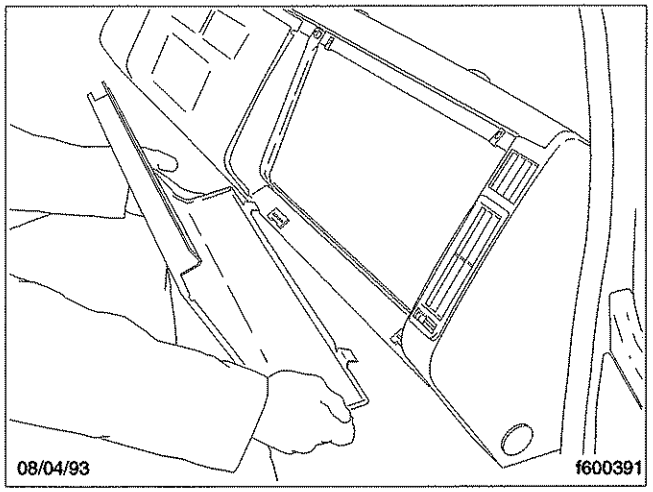


Fig. 3, Remove the Dash Panel

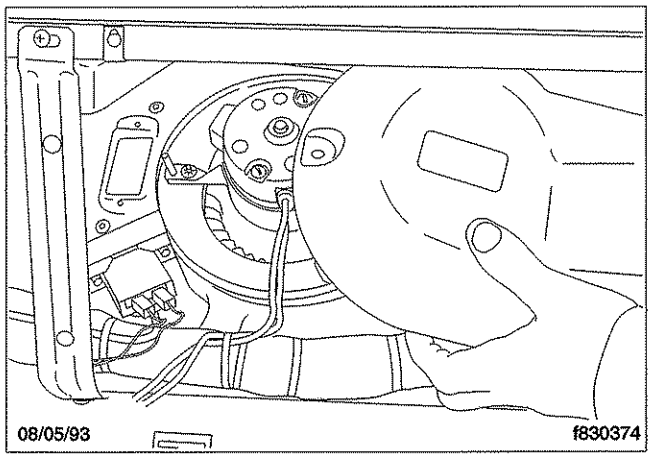


Fig. 4, Remove the Blower Motor Cover

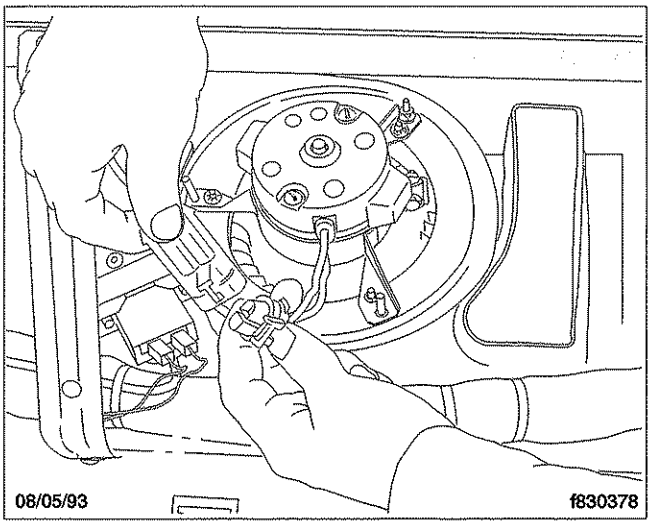


Fig. 5, Disconnect the Blower Motor Electrical Connector

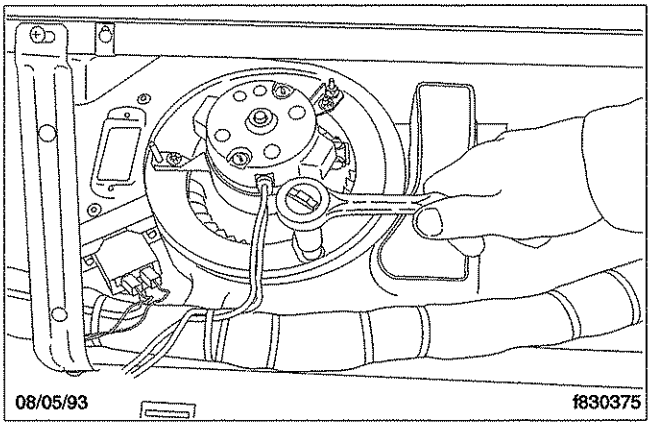


Fig. 6, Remove the Blower Motor Nuts

Resistor Block Replacement

Replacement

1. Disconnect the batteries.
2. Remove the extruded rubber strip at the top of the dashboard. See **Fig. 1**.
3. Remove the two mounting screws from dash panel D; then, remove the panel. See **Fig. 2** and **Fig. 3**.
4. Remove the resistor block. See **Fig. 4**.
   - 4.1 Unplug the connector from the resistor block.
   - 4.2 Remove the two mounting screws.
   - 4.3 Remove the resistor block.
5. Install the resistor block with the two mounting screws; then, connect the electrical plug.
6. Connect the batteries and check the blower operation.
7. Install dash panel D and the two mounting screws.
8. Install the extruded rubber strip at the top of the dashboard.

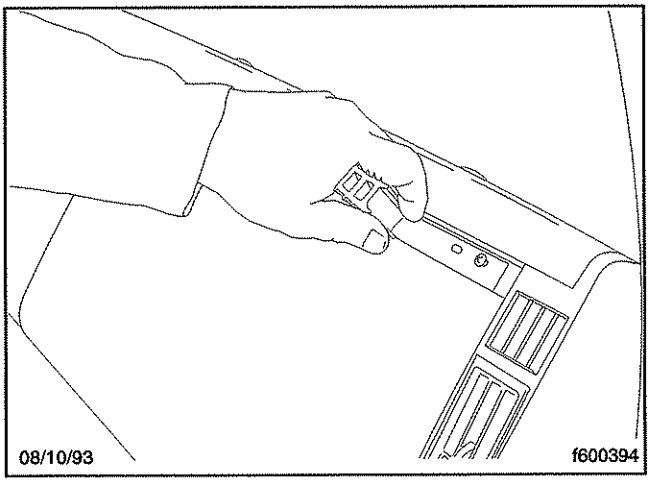
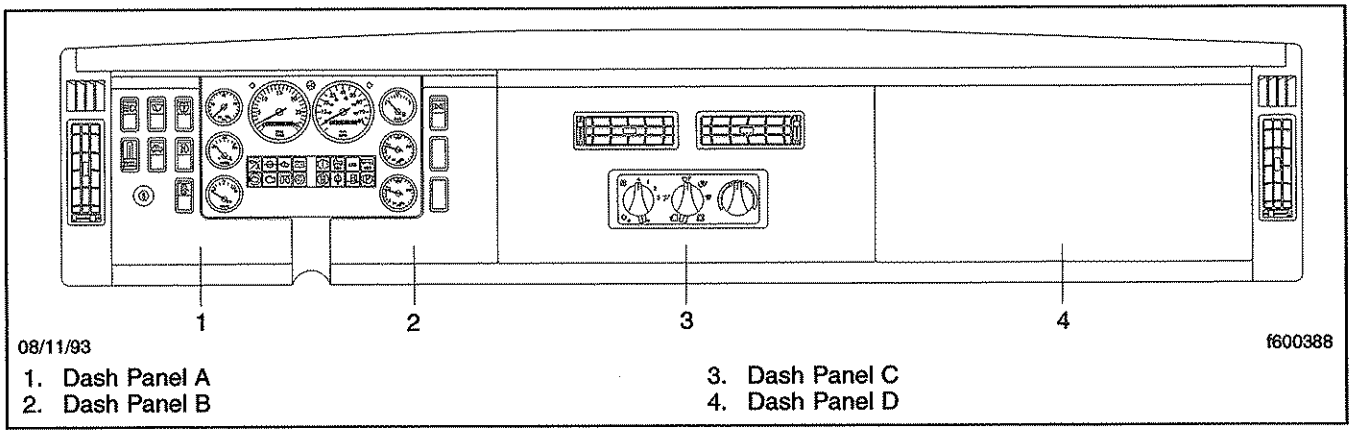


Fig. 1, Remove the Rubber Strip



1. Dash Panel A
2. Dash Panel B
3. Dash Panel C
4. Dash Panel D

Fig. 2, Dash Panel

Resistor Block Replacement

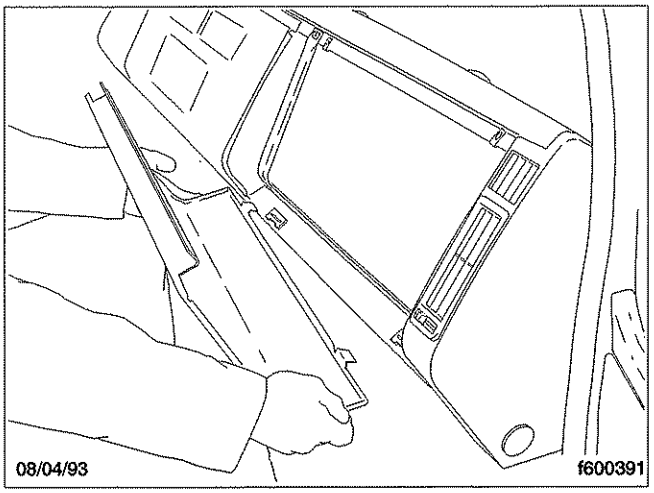
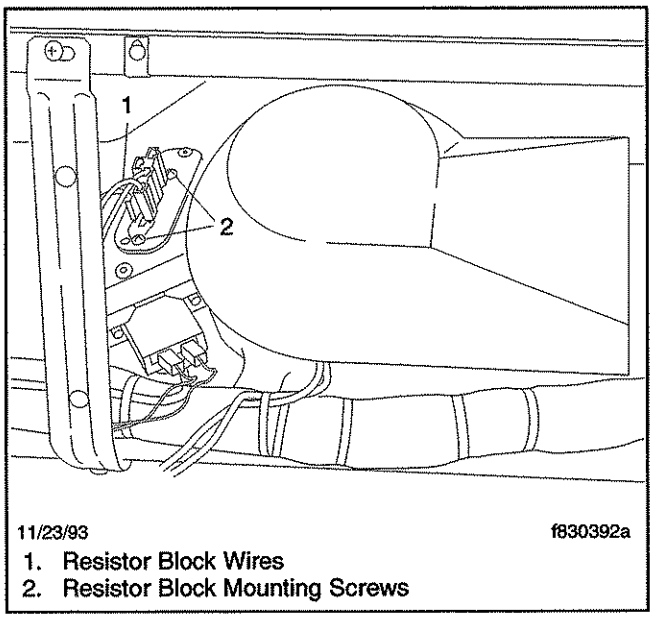


Fig. 3, Remove the Dash Panel



1. Resistor Block Wires
2. Resistor Block Mounting Screws

Fig. 4, Remove the Resistor Block

Water Regulating Valve Replacement

Replacement (See Fig. 1)

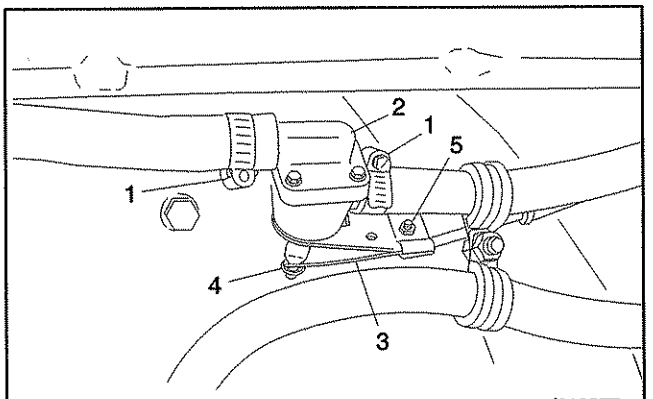
1. Tilt the hood.
2. Set the heater temperature control to the warmest setting.

⚠ WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

3. With the engine cold, drain enough coolant into a clean drain pan to lower the coolant level below the water regulating valve.
4. Remove the screw (Ref. 5) that holds the control cable to the valve base plate.
5. Remove the internal toothed clip (Ref. 4), and detach the control cable (Ref. 3).
6. Disconnect the heater hoses from the valve. Remove and discard the valve.
7. Install the new valve in the heater hoses. Tighten the hose clamps.
8. Slip the end of the control cable over the post on the valve control lever, and install a new internal toothed clip.
9. Adjust the control cable.
   - 9.1 Set the heater temperature control to the coolest position.
   - 9.2 Set the water regulating valve to the closed position.
   - 9.3 Slide the control cable in the clamp until the screw (Ref. 5) in the clamp lines up with the hole in the valve base plate.
   - 9.4 Tighten the screw (Ref. 5) to hold the cable in place.
   - 9.5 Check that the valve closes when the temperature control is at the coolest setting and opens toward the warmest setting.

   NOTE: The valve is fully closed or fully open before it reaches the mechanical stops at either end of its travel. After adjusting for the coolest setting, it is not necessary to adjust for the warmest setting.
10. Fill the cooling system with approved coolant. See **Group 20** of the *Business Class Trucks Maintenance Manual* for instructions.
11. Start the engine. When the engine thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again and fill as needed.
12. Check the valve and the hose connections for leaks. Tighten the hose clamps if needed.
13. Lower the hood.



1. Hose Clamp
2. Valve Body
3. Control Cable
4. Internal Toothed Clip
5. Cable Mounting Screw

Fig. 1, Water Regulating Valve

Replacement (See Fig. 1)

IMPORTANT: Before replacing any refrigerant parts, read **Subject 220**. Always discharge the system at the compressor before disconnecting a refrigerant line. If the system is contaminated, purge or flush it before you install replacement parts.

1. Review the information under **Safety Precautions, 100**.

⚠ WARNING

Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

2. Tilt the hood.
3. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to **Subject 220**.
4. Disconnect the four refrigerant lines from the expansion valve; then, remove and discard the valve. If the O-rings are in good condition, save them for later use.

⚠ CAUTION

Water and dirt can damage the refrigerant system. Five minutes of being uncapped is the limit for any hose or component.

Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

5. Lubricate the rubber O-rings with refrigerant oil and install them in the fittings.

NOTE: The previously removed O-rings can be used again if they are in good condition.

6. Apply Loctite® 242 or 592 to the male fitting threads. Connect the lines from the evaporator coil to the expansion valve ports. Connect the line from the receiver-drier to the expansion valve port and the line that runs from the expansion valve port to the compressor.

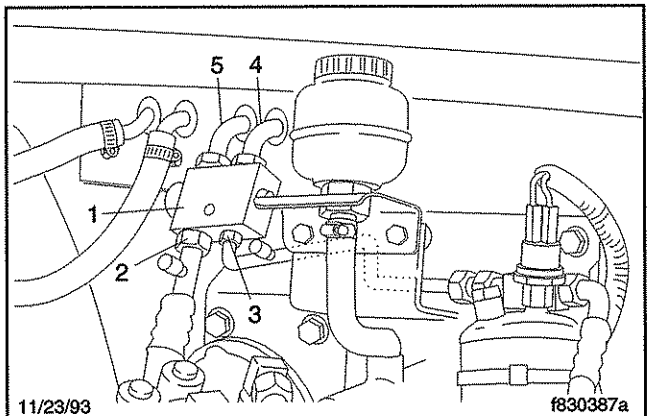
   Tighten the connections as follows:

   - Evaporator coil large fitting—24 lbf·ft (33 N·m)
   - Evaporator coil small fitting—18 lbf·ft (24 N·m)
   - receiver-drier line—12 lbf·ft (16 N·m)
   - Compressor line—18 lbf·ft (24 N·m)

7. Evacuate and charge the air conditioning system with refrigerant. For instructions, refer to **Subject 220**. Be sure to add refrigerant oil to the compressor to replace that which was lost when the system was discharged. Refer to the applicable refrigerant compressor section.

NOTE: If the system will not hold a vacuum, check the connections for tightness or check for a missing O-ring.

8. Lower the hood.



1. Expansion Valve Body
2. Compressor Line
3. Receive-Drier Line
4. Evaporator Coil Small Line
5. Evaporator Coil Large Line

Fig. 1, Expansion Valve

Replacement (See Fig. 1)

IMPORTANT: Before replacing any refrigerant parts, read **Subject 220.** Always discharge the system at the compressor before disconnecting a refrigerant line. If the system is contaminated, purge or flush it before you install replacement parts.

1. Review the information under **Safety Precautions, 100.**

⚠ WARNING

Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

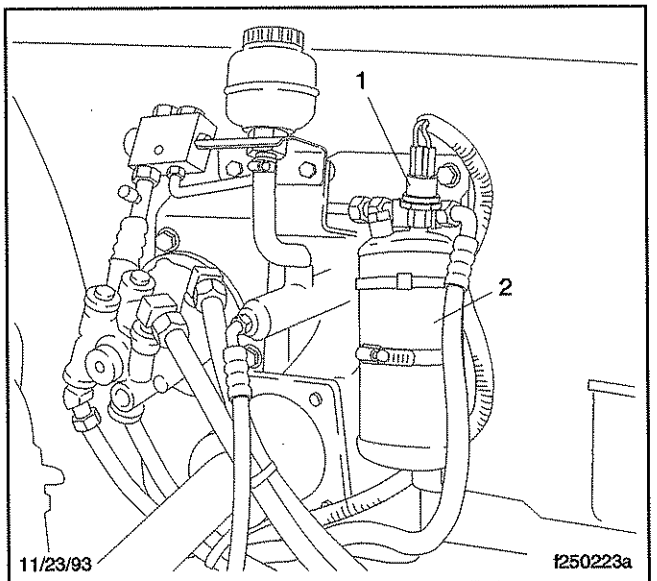
2. Tilt the hood.
3. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to **Subject 220.**
4. Disconnect the electrical leads from the binary switch.
5. Unscrew the binary switch.
6. Disconnect the inlet and outlet lines. Use two wrenches to avoid twisting the hoses.

⚠ CAUTION

Contaminants, such as water and dirt, can damage the refrigerant system. Five minutes of being uncapped is the limit for any part. Do not blow shop air through the refrigerant hoses since shop air is wet (humid).

IMPORTANT: If the desiccant cartridge inside the old receiver-drier has fallen apart, flush the entire system and replace the expansion valve and the refrigerant compressor. Desiccant matter can't be removed from these parts. A cartridge may fall apart from too much water in the system, because of poor evacuation of the system, or from lack of care.

7. Loosen the clamp that holds the receiver-drier to the bracket on the firewall. Remove and discard the receiver-drier .
8. Mount the new receiver-drier and tighten the clamp.
9. Screw the binary switch into the receiver-drier . Tighten the switch 108 lbf·in (1220 N·cm) or one-eighth turn past hand-tight. Connect the electrical leads to the switch.
10. Connect the inlet and outlet lines to the receiver-drier . Tighten the connections 108 lbf·in (45 N·m).
11. Evacuate and charge the air conditioning system with refrigerant. For instructions, refer to **Subject 220.** Be sure to add refrigerant oil to the compressor to replace that which was lost when the system was discharged. Refer to the applicable refrigerant compressor section.
12. Lower the hood.



1. Binary Switch 2. Receiver-Drier

Fig. 1, Receiver-Drier

Replacement (See Fig. 1)

NOTE: A Schrader valve in the receiver-drier prevents loss of refrigerant when removing the binary switch.

1. Tilt the hood.
2. Disconnect the electrical leads from the binary switch.
3. Unscrew the binary switch from the receiver-drier.
4. Screw the new binary switch into the receiver-drier. Tighten the switch 108 lbf·in (1220 N·cm) or one-eighth turn past hand-tight. Connect the electrical leads to the switch.
5. Check the operation of the air-conditioning system.
6. Lower the hood.

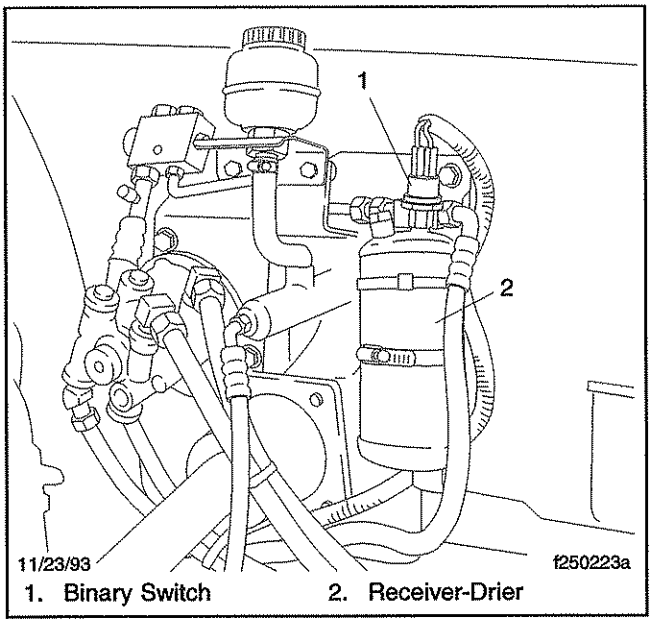


Fig. 1, Binary Switch

Condenser Replacement

Replacement (See Fig. 1)

IMPORTANT: Before replacing any refrigerant parts, read **Subject 220**. Always discharge the system at the compressor before disconnecting a refrigerant line. If the system is contaminated, purge or flush it before you install replacement parts.

1. Review the information under **Safety Precautions, 100.**

⚠ WARNING

Failure to review the safety precautions, and to be aware of the dangers involved when working with refrigerant, could result in serious personal injury.

2. Tilt the hood.
3. Wearing protective goggles and gloves, discharge the refrigerant system. For instructions, refer to **Subject 220.**
4. Disconnect the refrigerant hoses from the condenser. Use two wrenches to avoid damaging the condenser.

⚠ CAUTION

Contaminants, such as water and dirt, can damage the refrigerant system. Five minutes of being uncapped is the limit for any part. Do not blow shop air through the refrigerant hoses since shop air is wet (humid).

5. Cap the refrigerant hoses.
6. Remove the four condenser mounting bolts.
7. Remove the condenser.
8. Position the condenser on the radiator. Install the capscrews and tighten them 15 lbf·ft (20 N·m).
9. Remove the plugs from the new condenser. Coat the O-rings with refrigerant oil and apply Loctite® 242 or 592 to the male fitting threads.
10. Connect the refrigerant lines to the condenser. Using two wrenches, tighten the fittings 33 lbf·ft (45 N·m). *Be sure to add refrigerant oil to the compressor*, to replace that which was lost in the old condenser. Refer to the applicable compressor section.
11. Charge the system with refrigerant; for instructions, refer to **Subject 220.**
12. Lower the hood.

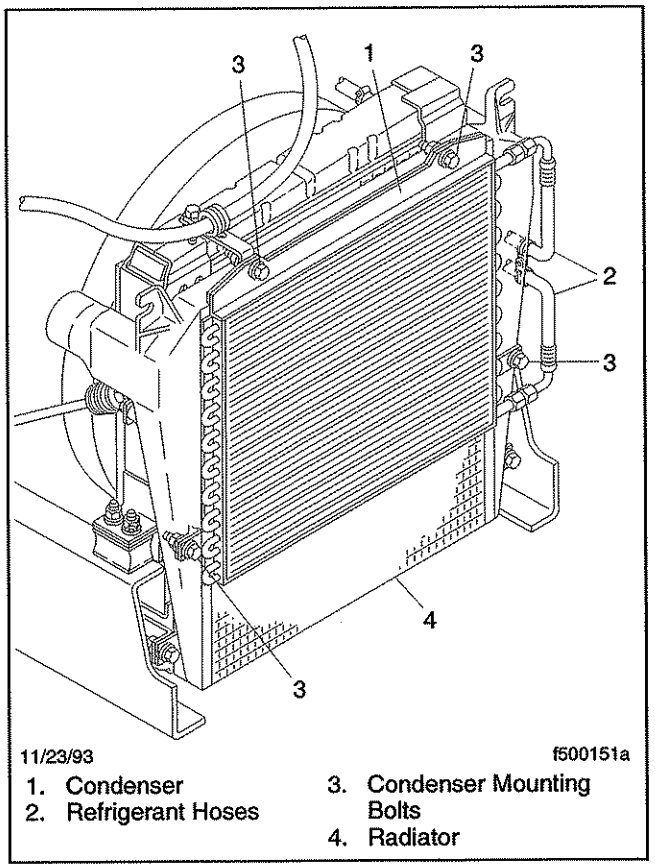


Fig. 1, Condenser

Replacement

1. Disconnect the batteries.
2. Remove the extruded rubber strip at the top of the dashboard. See **Fig. 1**.
3. Remove dash panel D. See **Fig. 2** and **Fig. 3**.
4. Remove dash panel B. See **Fig. 2**.
   - 4.1 If so equipped, remove the parking brake knob and the trailer brake knob.
   - 4.2 Lift off the panel.
5. Remove dash panel C.
6. Remove the control panel from dash panel C.
   - 6.1 Gently pry the bezel from the control panel in the center of dash panel C. See **Fig. 4**.
   - 6.2 Remove the panel light and disconnect the electrical connectors from the control panel. Label the connectors so they can be installed in the same positions later.
   - 6.3 Label the control cables for later reference. See **Fig. 5**.
   - 6.4 Remove the screws that hold the control cables to the control panel; then, disconnect the cables.
   - 6.5 Remove the four screws holding the control panel to dash panel C. See **Fig. 6**.
   - 6.6 Lift out the control panel.
7. Install the new control panel in dash panel C.
   - 7.1 Position the control panel and install the four screws that mount it to the dash panel.
   - 7.2 Attach the control cables to the control panel. Install the control cable mounting screws.
   - 7.3 Insert the panel light and connect the wiring.
   - 7.4 Install the bezel around the control panel.
8. Adjust the control cables. See **Fig. 5** and **Fig. 7**.
   - 8.1 To adjust the cable (**Fig. 5**, Ref. 1) to the water regulating valve, set the dashboard control to the coolest setting (fully counterclockwise). Adjust the turnbuckle until the

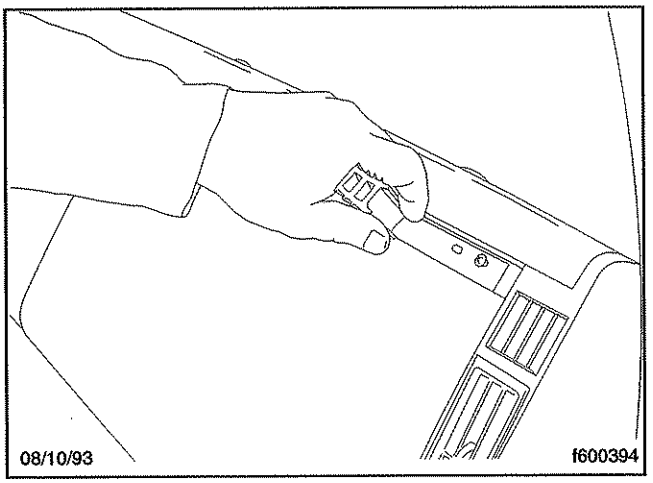
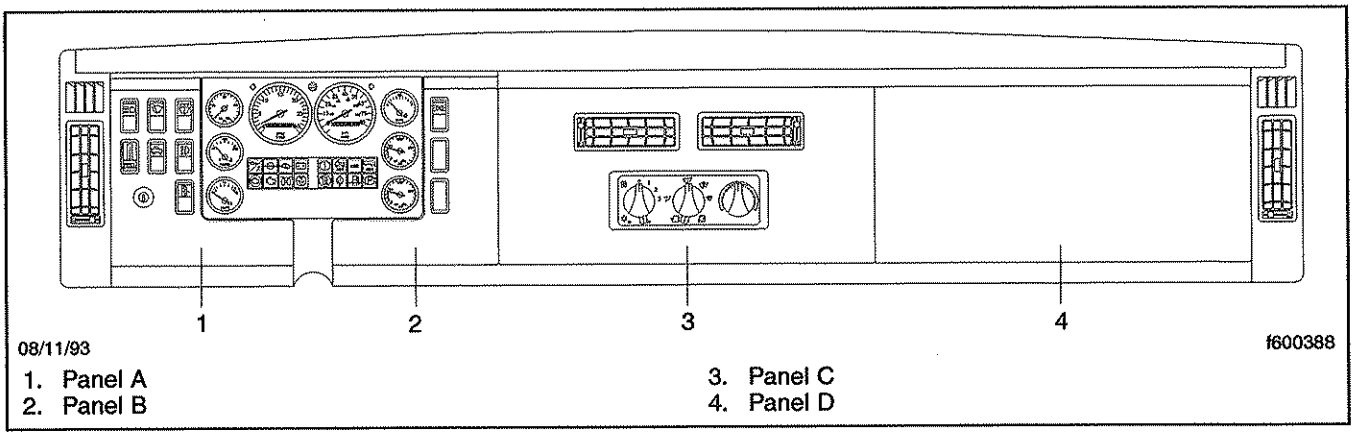


Fig. 1, Remove the Rubber Strip



1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2, Dash Panel

Control Panel Replacement

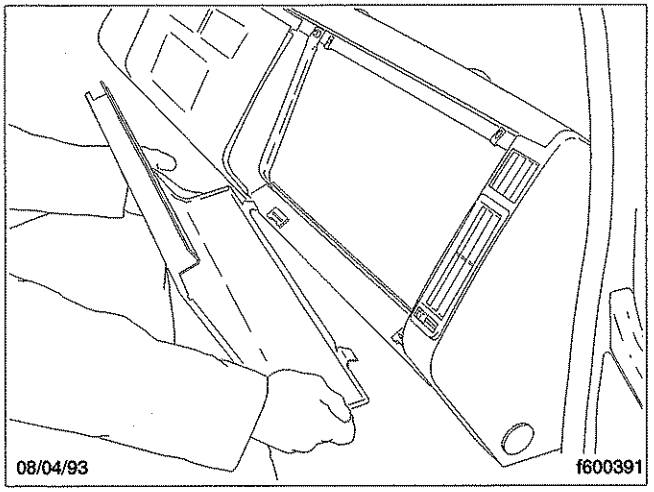


Fig. 3, Remove the Dash Panel

valve is almost at its mechanical stop in the closed position.

NOTE: The valve is fully closed or fully open before it reaches the mechanical stops at either end of its travel. After adjusting for the coolest setting, it is not necessary to adjust for the warmest setting.

8.2 To adjust the fresh air/recirculation door cable (**Fig. 5**, Ref. 2), remove the kick panel under the dashboard on the passenger side for access to the door. Move the control lever to the fresh air position.

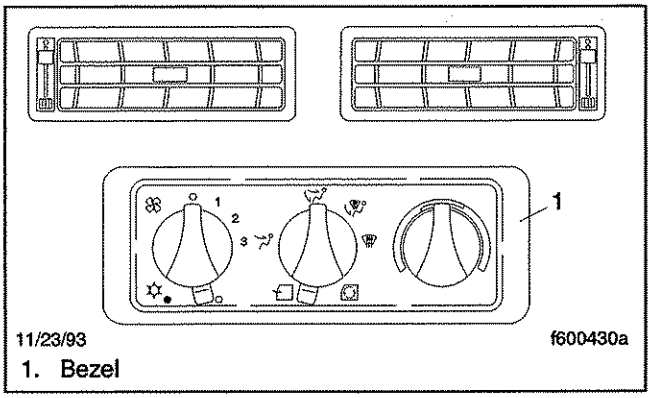


Fig. 4, Control Panel

Adjust the turnbuckle (**Fig. 7**, Ref. 2) under the dashboard until the door snaps into the horizontal position and closes off the opening to the cab. Move the lever to the recirculation position and make sure the door snaps open. If necessary, readjust the turnbuckle so the door is in the correct position for each control lever setting.

8.3 To adjust the face/floor duct door and defrost duct door cables (**Fig. 5**, Refs. 3 and 4), set the control knob in the twelve o'clock position. Both face/floor duct doors should be open to direct air to the floor, and the defrost duct door should be open to let air out the face ducts. Adjust the turnbuckle

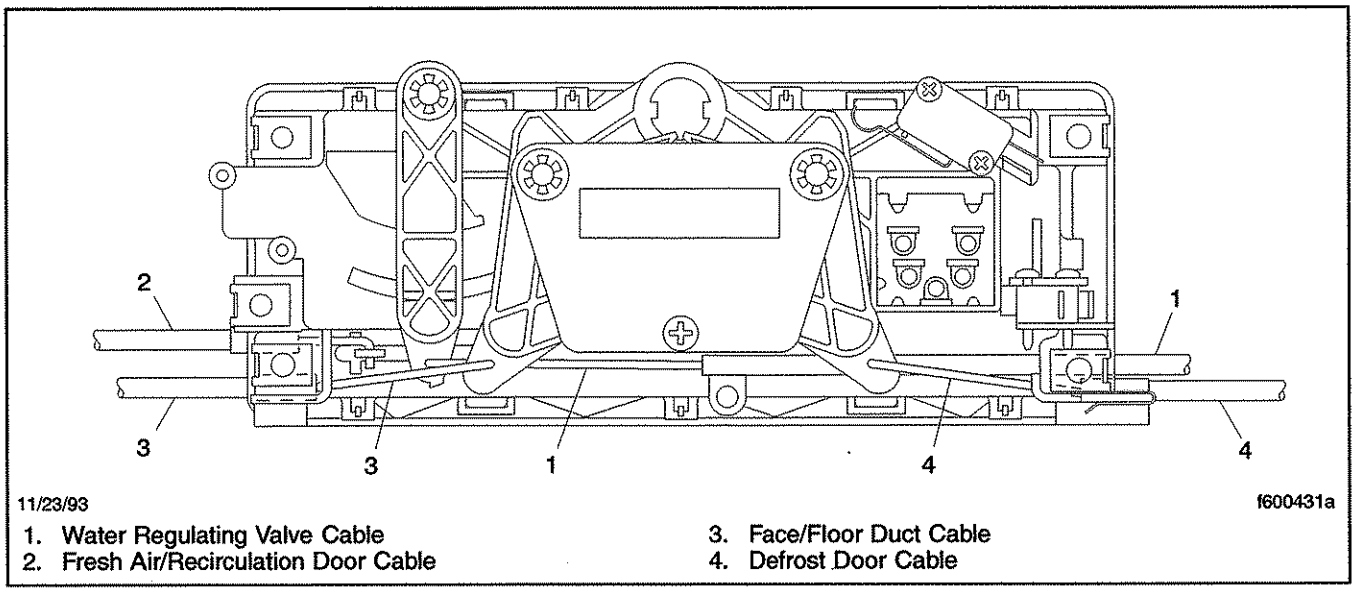


Fig. 5, Control Cables

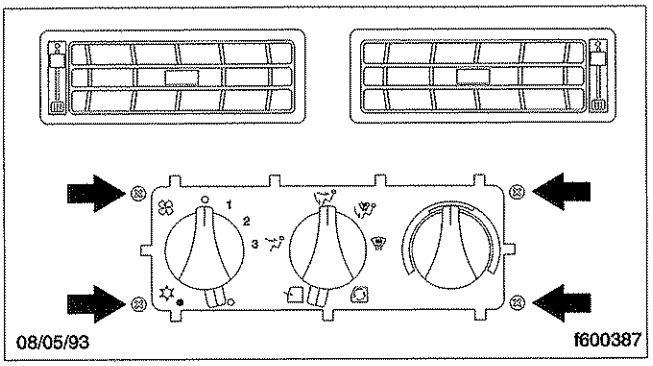


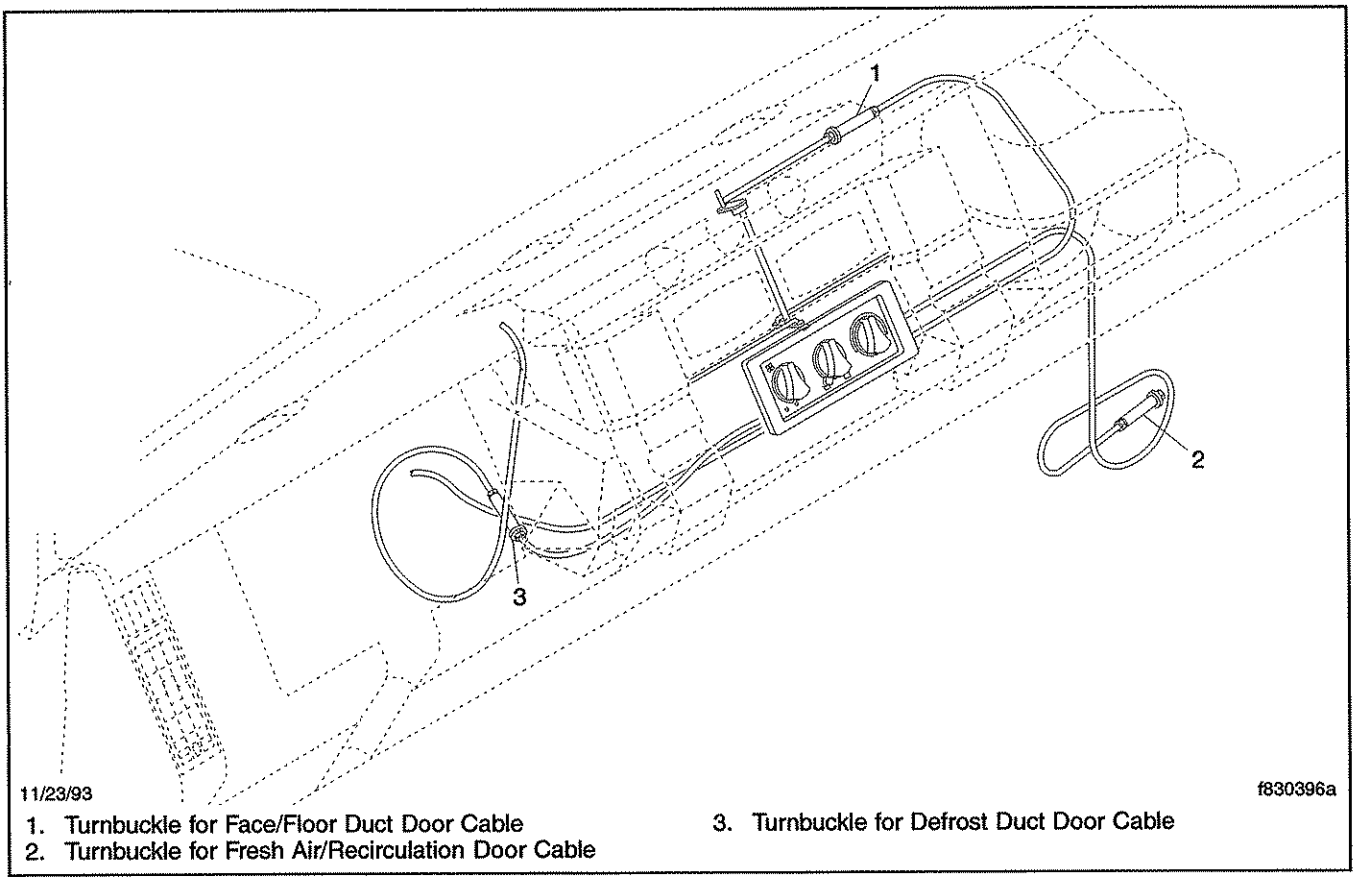
Fig. 6, Control Panel

(**Fig. 7**, Ref. 3) on the defrost duct door cable if necessary.

Turn the control knob fully counterclockwise; the face/floor duct doors should close. Remove the bottom section of one of the floor ducts to check the door position. See **Fig. 8.** Adjust the turnbuckle (**Fig. 7**, Ref. 1) on the face/floor duct door cable if necessary.

Make sure there is a smooth transition from one cable to the other as the control knob moves through the twelve o'clock position. The defrost duct door cable should move when the control is to the right of the twelve o'clock position; the face/floor duct door cable should move when the control is to the left of the twelve o'clock position. As the control knob passes through twelve o'clock, one cable should stop moving and the other cable should start to move. If the cables are adjusted incorrectly, either the control knob will lock up before reaching twelve o'clock or the control knob movement will get very stiff.

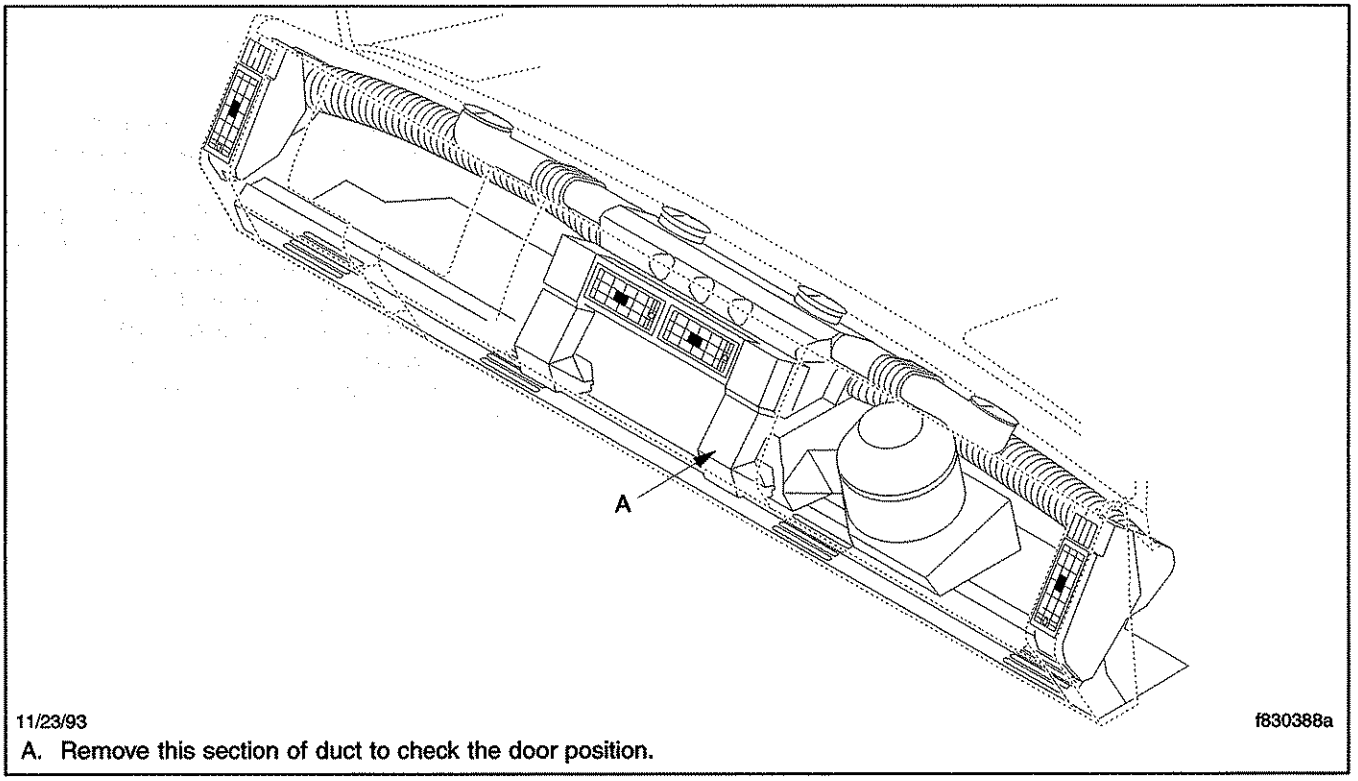
9. Install dash panel C and its mounting screws.



1. Turnbuckle for Face/Floor Duct Door Cable
2. Turnbuckle for Fresh Air/Recirculation Door Cable
3. Turnbuckle for Defrost Duct Door Cable

Fig. 7, Turnbuckles

Control Panel Replacement



A. Remove this section of duct to check the door position.

Fig. 8, Check the Door Position

10. Install dash panel B. Install the parking brake knob and, if so equipped, the trailer brake knob.
11. Install dash panel D and its two mounting screws.
12. Install the extruded rubber strip at the top of the dashboard.
13. Connect the batteries.

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

Discharging

Discharging the air conditioning system removes most of the refrigerant charge in the system.

1. Tilt the hood.

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

2. Remove the caps from the suction and discharge service valves. See **Fig. 1.**

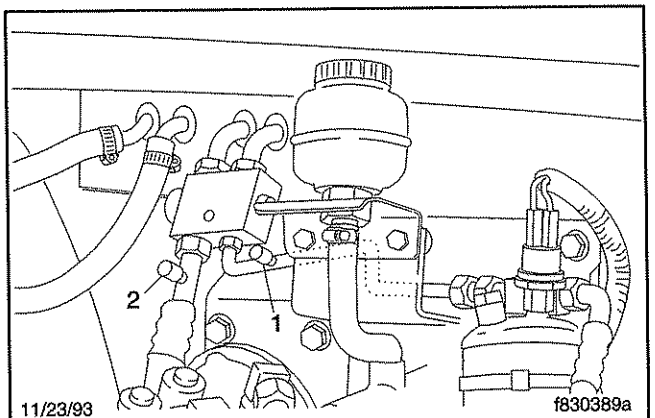
IMPORTANT: The suction and discharge service valves have Schrader valves, which are similar to but not the same as tire valves. Be sure the manifold gauge set has a valve core depressor on the end of each hose.

3. Wearing protective goggles and nonleather gloves, attach a manifold gauge set to the valves. See **Fig. 2.**

   3.1 Close both manifold valves.

   3.2 Connect the manifold high-side hose to the compressor discharge service valve.

   3.3 Connect the manifold low-side hose to the compressor suction service valve.



1. Discharge Service Valve
2. Suction Service Valve

Fig. 1, Service Valves

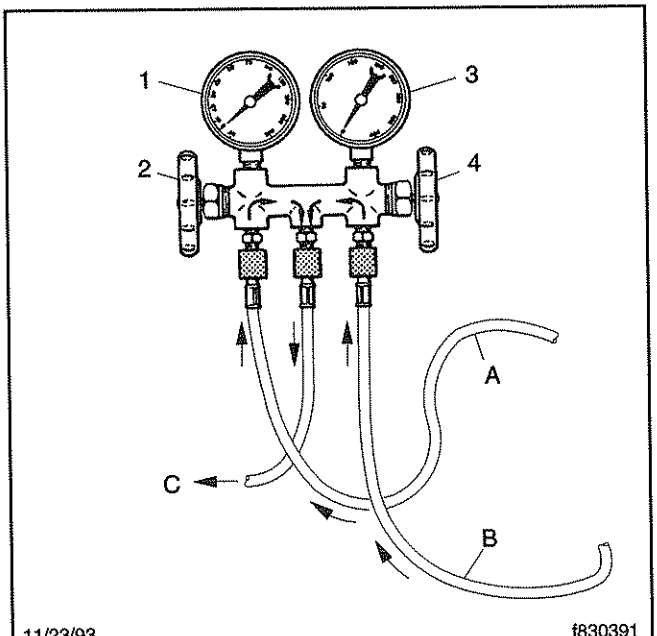
   3.4 Connect the manifold center hose to an Underwriters Laboratories (U.L.) approved recovery/recycling station.

4. Follow the recovery/recycling station manufacturer's instructions and recover all of the refrigerant from the system.

IMPORTANT: Always comply with all local regulations regarding R–12 disposal. You may be subject to substantial penalties for improper disposal.

5. Measure the oil in the recovery and recycling equipment. The compressor will have to be refilled with the same quantity of new refrigerant oil.

   If the system is contaminated, all of the compressor oil must be replaced with clean oil after purging and flushing the system. If the system is heavily contaminated with desiccant or grit, replace the compressor, expansion valve, and receiver-drier.



A. Connect to the suction service valve.
B. Connect to the discharge service valve.
C. To a recycling station.

1. Low-Side Gauge
2. Manifold Suction Hand Valve (open)
3. High-Side Gauge
4. Manifold Discharge Hand Valve (open)

Fig. 2, Discharging Hookup

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

Purging and Flushing

General Information

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

Purging removes damp air, traces of refrigerant, and loose dirt from refrigerant parts by passing a stream of inert, dry gas through the parts. If left in the system, these contaminants would have a bad effect on the life and operation of the air conditioning system.

Flushing removes heavy contamination, such as gritty oil and large dirt buildup, which can't be removed by purging with gas. When a part is flushed, liquid refrigerant is forced through it. The liquid picks up the contaminants and flushes them out.

Whether to purge or flush a part depends on how much contamination there is as described above.

Normally the system always has pressure in it. Some loss of refrigerant from one season to the next is normal and does not mean that the system is dirty. If refrigerant has leaked until the system is nearly empty or if refrigerant parts show signs of internal corrosion and grit, the system is contaminated.

If the system is contaminated with moisture, purge or flush all sections of the system. Then change the oil in the compressor and replace the receiver-drier prior to evacuating and charging the system.

If the system is heavily contaminated or if desiccant has circulated through the system, replace the receiver-drier, expansion valve, and compressor.

Do not purge the receiver-drier or the compressor.

Flush the system in segments to lessen the chance of blowing deposits against a port. See **Fig. 3**.

Purge or flush the system in the opposite direction of refrigerant flow (in other words, backflush the sections).

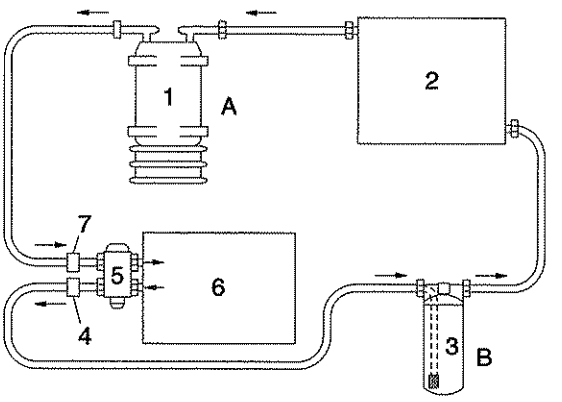
NOTE: Dry nitrogen gas is recommended for purging, but any safe, inert, dry gas, such as carbon dioxide or argon, may be substituted. A pressure regulator is required to regulate from 0 to 200 psi (0 to 1379 kPa). Commercial cylinders of nitrogen contain pressures in excess of 2000 psi (13 790 kPa). This pressure must be reduced to 200 psi (1379 kPa) for purging.

Flushing parts with refrigerant requires a recovery/recycling station.

Purging Procedure

NOTE: Dry nitrogen gas is recommended for purging, but any safe, inert, dry gas, such as carbon dioxide or argon, may be substituted. A pressure regulator is required to regulate from 0 to 200 psi (0 to 1379 kPa). Commercial cylinders of nitrogen contain pressures in excess of 2000 psi (13 790 kPa). This pressure must be reduced to 200 psi (1379 kPa) for purging.

1. Discharge the system.
2. Disconnect both ends of the line or part being purged. Tightly cap the rest of the system.
3. Make sure valves 1, 2, and 3, are closed. See **Fig. 4**.



11/23/93 f830395

NOTE: Arrows denote purge and flush points and direction of flow for gas/liquid.

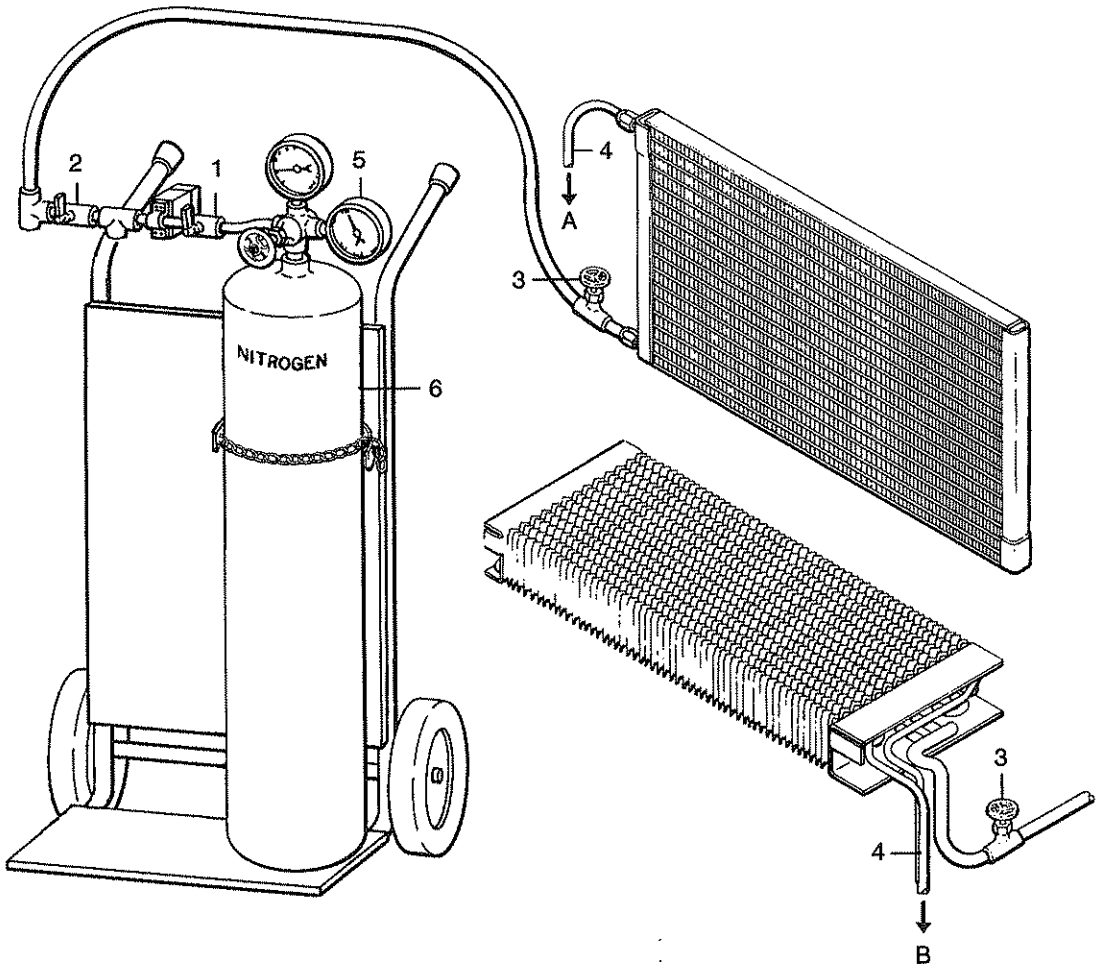
A. Do not purge; instead, replace.
B. Do not purge; instead, replace.

1. Refrigerant Compressor
2. Condenser
3. Receiver-Drier
4. High-Side Service Valve
5. Expansion Valve
6. Evaporator
7. Suction Service Valve

Fig. 3, Purge and Flush Points

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

4. Connect the supply line valve to the outlet end of the part or line.
5. Connect the drain line to the inlet end of the part or line.
6. Place the outlet of the drain line into a recycling system container.
7. Adjust the nitrogen bottle regulator to 200 psi (1379 kPa). Open the nitrogen bottle control valve and the purging control valve. Then slowly open the supply line valve. Check the drain line for gas flow.
8. Let the nitrogen flow at 200 psi (1379 kPa) for 25 to 30 seconds.
9. Lower the pressure to 4 psi (28 kPa) and let it flow for 1 to 2 minutes. If the line or part was very wet, allow it to flow until there is no trace of refrigerant oil or solid bits of dirt or grit flowing from the drain tube.



03/04/94 f830066a

A. To Waste Container
B. To Recycling System Container
1. Nitrogen Bottle Control Valve
2. Purging Control Valve
3. Supply Line Valve
4. Drain Line
5. Nitrogen Bottle Regulator/Gauge
6. Nitrogen Bottle

Fig. 4, Purging Station

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

10. Close the nitrogen bottle control valve and the purging control valve first, then close the supply line valve.
11. Disconnect the supply line valve and the drain line. Tightly cap both ends of the part or line.

Flushing Procedure

1. Discharge the system.
2. Disconnect both ends of the line or part being flushed. Tightly cap the lines to the rest of the system.
3. Heat R–12 in a dial-a-charge.
4. Connect the dial-a-charge outlet hose to the outlet side of the system. This will ensure that R–12 will flow in the reverse direction of normal flow.
5. Connect a line from the inlet side of the system to a recovery station or a collection bottle.

NOTE: If the system is extremely contaminated, install a receiver-drier inline as a prefilter for the recovery station.

6. Turn on the recovery station and open the outlet valve for the dial-a-charge. Allow about 2 pounds (1 kilogram) of R–12 to flow through the system.
7. Close the supply line valve and wait for the recovery station to shut off.
8. Disconnect the supply line and the drain line from the dial-a-charge and the recovery station. Connect the lines to a nitrogen bottle.
9. Purge the system and check the collection bottle or recovery station for contaminants. Repeat the process if needed.
10. Disconnect the lines from the part and tightly cap both ends of the part.

Evacuating (dehydration)

General Information

Moisture in a Refrigerant System

Moisture damages air conditioning systems in three ways.

First, water forms ice crystals at the thermostatic expansion valve. Ice crystals retard or stop the flow of refrigerant, causing a reduction or complete loss of cooling. As the expansion valve warms due to the lack of refrigerant, the ice melts and passes through the expansion valve. Then refrigerant will flow again until the ice crystals re-form. The result is intermittent cooling.

Second, water causes corrosion. Refrigerants may contain chlorine, which combined with water forms hydrochloric acid. This acid corrodes steel and copper plating.

Third, water mixes with refrigerant oil forming sludge. This reduces the lubricating ability of the oil and can plug the condenser, evaporator, and thermostatic expansion valve.

Effects of Pressure on the Boiling Points of Water

Water boils at 212°F (100°C) at an atmospheric pressure of 14.7 psi (101 kPa) (sea level). At higher elevations the atmospheric pressure is lower which allows water to boil at lower temperatures. See **Table 1** for boiling temperatures of water at converted pressures.

Similarly we can boil and remove water from the air conditioning system by lowering the system pressure to a vacuum to cause the moisture to boil at normal ambient temperatures. A vacuum pump can reduce the pressure in the system. Since the pressure is the lowest at the pump, water vapor is pulled out of the system. See **Fig. 5**. This process is called evacuation or dehydration.

Vacuum Pump Selection

The purpose of a high-vacuum pump is to reduce and hold a vacuum in the air conditioner system so moisture can be boiled at ambient temperature. For example, a vacuum pump capable of pulling a vacuum of 28.89 inHg (733.8 mmHg), is able to boil water at 80°F (27°C). There are various types of vacuum pumps available. Only some types are recommended for truck air conditioning evacuation.

Air pump-type vacuum pumps are designed to remove large volumes of air but do not develop high vacuum. They cannot pull more than 28 inHg (711 mmHg) which boils water at 100°F (38°C).

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

Boiling Temperatures of Water at Converted Pressures		
Boiling Temperature of Water: °F (°C)	Absolute Pressure: psi (microns)	Vacuum: inHg (mmHg)
212 (100)	14.696 (759993.4)	0 (0)
205 (96)	12.770 (660400.0)	3.92 (99.6)
194 (90)	10.169 (523881.6)	9.22 (234.2)
176 (80)	6.8699 (355269.8)	15.93 (404.6)
158 (70)	4.5207 (233786.7)	20.72 (526.3)
140 (60)	2.8900 (14958.7)	24.04 (610.6)
122 (50)	1.7987 (92555.1)	26.28 (667.5)
104 (40)	1.0700 (55336.4)	27.74 (704.6)
89 (30)	0.61540 (31826.2)	28.67 (728.2)
86 (27)	0.57010 (26220.4)	28.89 (733.8)
76 (24)	0.44435 (22979.9)	29.02 (737.1)
72 (22)	0.38856 (20094.7)	29.13 (739.9)
69 (21)	0.35084 (18143.7)	29.21 (741.9)
64 (18)	0.29505 (15258.5)	29.32 (744.7)
59 (15)	0.24720 (12783.8)	29.42 (747.3)
53 (12)	0.19888 (10285.0)	29.52 (749.8)
45 (7)	0.14746 (7625.8)	29.62 (752.3)
32 (0)	0.08858 (4579.6)	29.74 (755.4)
21 (–6)	0.05293 (2738.1)	29.81 (757.2)
6 (–14)	0.02521 (1304.0)	29.87 (758.7)
–24 (–31)	0.004905 (253.7)	29.911 (759.74)
–35 (–37)	0.002544 (131.6)	29.915 (759.84)
–60 (–51)	0.0004972 (25.7)	29.9200 (759.968)
–70 (–57)	0.0002443 (12.69)	29.92050 (759.9807)
–90 (–68)	0.0000526 (2.72)	29.92089 (759.9906)

Table 1, Boiling Temperatures of Water at Converted Pressures

Compressor-type vacuum pumps come in two designs: piston-type and rotary-vane type. A piston-type compressor can typically pull a vacuum of 28.2 inHg (716.3 mmHg) which boils water at 96°F (36°C). A rotary-vane type compressor may pull a vacuum of 29.82 inHg (757.4 mmHg) which boils water at 21°F (–6°C), but it is limited to pumping 0.4 to 0.8 cfm, which is too slow to handle truck air conditioners.

High-vacuum pumps are available in single-stage and two-stage models. A single-stage pump is adequate, but a two-stage pump is recommended to save time and assure complete evacuation. See **Fig. 6.**

Most single-stage high-vacuum pumps with a gas ballast will pull down to about 29.88 inHg (758.95 mmHg) which boils water at 4°F (–16°C).

A two-stage high-vacuum pump features a second pump to reach a higher vacuum than a single-stage

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

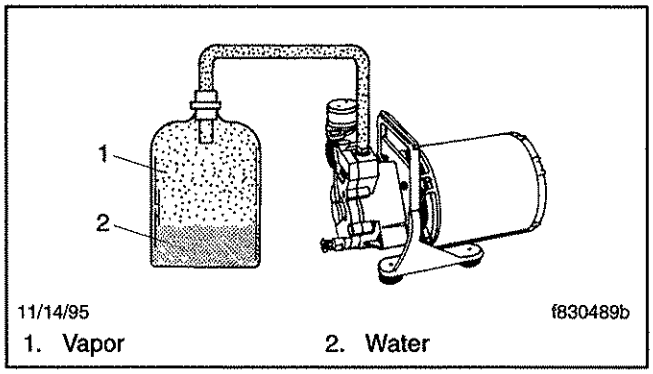


Fig. 5, Water to Vapor

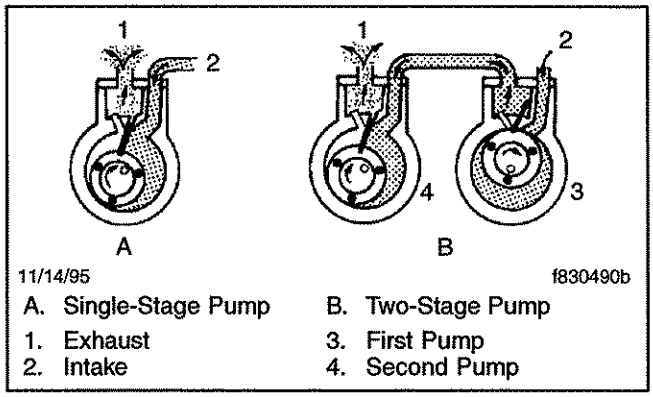


Fig. 6, Vacuum Pumps

pump. In a two-stage pump, the exhaust of the first pump discharges into the intake of the second pump. The second stage pumps at a lower pressure and therefore pulls a higher vacuum on the system than the first pump can by itself.

Two-stage high-vacuum pumps are capable of pulling down to 29.9192 inHg (759.95 mmHg) of vacuum for prolonged periods, which boils water at –60°F (–51°C).

The discharge line restriction is a factor affecting pump-down time. Pump-down time can be significantly reduced by use of larger diameter hoses, as short in length as possible.

Pumping capacity affects pump-down time. It is perfectly acceptable to use a large vacuum pump on a small system. Using too small of a pump on a large system could cause premature pump wear, or require excessive time to pull a vacuum, even though the pump may be able to draw adequate vacuum.

The suggested minimum cfm for pumps on different size air conditioners are listed in **Table 2**.

Minimum CFM for Pumps on Different Size Air Conditioners	
System Size	**Suggested High-Vacuum Pump Size**
Panel Trucks Large Window Units	2.2 cfm
Tractor/Trailers, Buses Rooftop A/C Systems	3.0 cfm
Refrigeration Van	15.0 cfm

Table 2, Minimum CFM for Pumps on Different Size Air Conditioners

Measuring Vacuum

Gauges

Vacuum can be measured with:

- A standard compound gauge;
- A closed-end manometer;
- An electronic thermistor vacuum gauge.

A standard compound gauge reads low pressures in inches of mercury. It is not suitable for measuring high vacuum.

A closed-end U-tube mercury manometer can be read with good accuracy. High vacuum readings can only be read from laboratory-style U-tube manometers.

Electronic thermistor vacuum gauges are designed for use with high vacuum pumps and can accurately read as low as 100 microns. This gauge can use an analog scale or a digital (LED) display.

Procedure

The location of the vacuum gauge will affect the reading. The closer to the vacuum source, the lower will be the reading.

Isolate the vacuum pump with a good vacuum valve and allow the pressure in the system to stabilize before taking a final reading.

If the pressure will not stabilize, it is an indication of a leak. If it does stabilize at a vacuum which is too high (for example, 1500 microns), it is an indication of moisture and more evacuation is required.

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

Maintaining the Vacuum Pump

Maintenance is important for high-vacuum pumps. The oil must be changed at regular intervals to prevent moisture buildup which will cause eventual pump failure.

Pumping down for extremely wet air conditioning systems can completely saturate the pump oil.

⚠ CAUTION

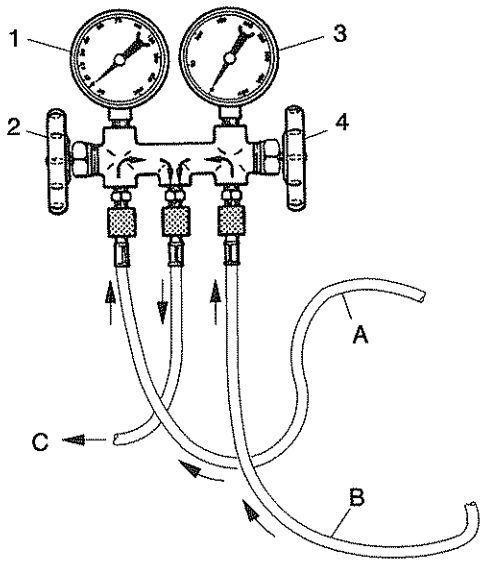
Flush the vacuum pump every fourth time it is used and before storing for long periods of time. Acid will form and corrode the pump if water-laden oil remains in the pump for an extended period.

Vacuum pump oil is water soluble. This aids the pump in reaching a high vacuum by absorbing water and sealing the pump.

Only vacuum pump oil should be used as a flushing agent and lubricant. Do not use any solvent or any other oil. Clean oil should be run through the pump until it runs out clear. Oil should be added to the fill level indicated on the pump. Check the oil level before each use.

Evacuation Procedure

1. The system must be discharged and, if contaminated, purged or flushed and the compressor filled with the correct amount of refrigerant oil. Replace the receiver-drier if the system is opened.
2. Close both manifold hand valves on the manifold gauge set.
3. If using a thermistor vacuum gauge, connect the gauge between the manifold center service hose and the vacuum pump. See **Fig. 7**.
4. Connect the manifold discharge line to the discharge service valve.
5. Connect the manifold suction line to the suction service valve.
6. Connect the center manifold line to the vacuum pump.
7. Open the manifold hand valves.
8. Turn on the vacuum pump, and open the pump control valve.
9. If using a thermistor gauge, open the thermistor gauge valve.
10. Allow the pump to draw to at least 29.90 inHg (759.5 mmHg).
11. Close the pump valves, and turn off the pump.
12. Allow the system to stabilize for five minutes.
13. If not using a thermistor gauge, go to the next step. If using a thermistor gauge, proceed as follows:
    - 13.1 If the thermistor gauge reading does not rise above 29.85 inHg (758.2 mmHg), the system is okay. Proceed to "Charging."
    - 13.2 If the thermistor gauge reading rises above 29.85 inHg (758.2 mmHg) and stops, there is moisture in the system. Repeat the steps above beginning with turning on the pump and opening the control valve.



11/23/93 f830391

A. Connect to the suction service valve.
B. Connect to the discharge service valve.
C. To vacuum pump.
1. Low-Side Gauge
2. Manifold Suction Hand Valve (open)
3. High-Side Gauge
4. Manifold Discharge Hand Valve (open)

Fig. 7, Evacuation Hookup

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

13.3 If the thermistor gauge reading rises above 29.85 inHg (758.2 mmHg) and continues to rise, add a partial charge of refrigerant and leak test the system. Repair any leaks and reevacuate the system. See "Leak Testing" for instructions.

14. If not using a thermistor gauge, proceed as follows:

14.1 Note the low pressure gauge needle position.

14.2 Wait 15 minutes, then check the low pressure gauge needle position again.

14.3 If the needle has not moved, turn on the vacuum pump and open the pump control valve. Let the pump run for one hour. Go to "Charging."

IMPORTANT: A gauge reading of over 29.85 inHg (758.2 mmHg) indicates that there is still water in the system.

14.4 If the needle has moved, add a partial charge of refrigerant and leak test the system. Repair any leaks and reevacuate the system. See "Leak Testing" for instructions.

Charging

General Information

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

The recommended way of charging a system is by adding refrigerant as a gas. High-side liquid charging may cause liquid refrigerant to enter the compressor. If this happens, it may cause a hydraulic lock in the compressor and destruction of the unit.

If a charging cylinder is used—one that heats refrigerant and allows the worker to make exact refrigerant measurements—follow the instructions of the equipment manufacturer.

Gas Charging Procedure

NOTE: The system must be evacuated, with the manifold gauge set connected to the compressor, before a full charge can be added to the system.

1. Obtain enough refrigerant to fully charge the system. A full charge is 48 ounces (1362 grams) of refrigerant.

   If a tank (bulk quantity) is used, it should be set on a scale and its weight noted so that the correct amount of refrigerant enters the system. This prevents overcharging, which could damage the compressor.

   If one-pound cans of refrigerant are used, obtain enough to fully charge the system.

NOTE: Each one-pound can actually holds 14 ounces (397 grams) of refrigerant.

2. Close the manifold hand valves.
3. Connect the manifold center service hose to the refrigerant can, as shown in **Fig. 8**. Do not release the refrigerant at this time. Place the can in an upright position so that refrigerant enters the system as a gas. **Do not allow liquid refrigerant to enter the compressor by tipping the refrigerant can.**

⚠ CAUTION

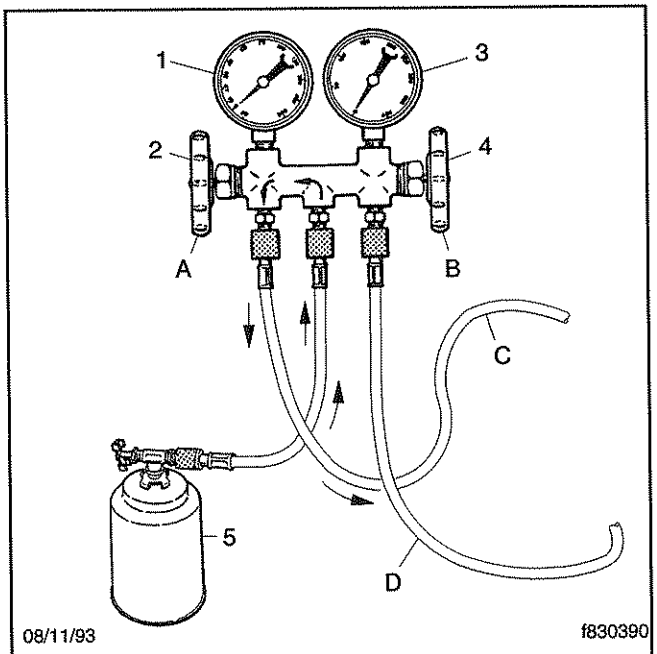
If the refrigerant can is tilted during service operations, liquid refrigerant could enter the compressor through its suction port, which may damage the unit once it is turned on.

4. With the engine off, open the manifold low-side hand valve. Do not open the manifold high-side hand valve.
5. Open the valve on the refrigerant can to allow the refrigerant vapor to enter the system.

IMPORTANT: On bulk quantity tanks, larger hoses are used. These hoses alone may carry 8 ounces (227 grams) or more of refrigerant.

6. Close the valve on the refrigerant can. If a full charge did not enter the system, the rest will be added while the compressor is on.

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing



A. Low-Side Hand Valve
B. High-Side Hand Valve
C. Connect to the suction service valve.
D. Connect to the discharge service valve.

1. Low-Side Gauge
2. Manifold Suction Hand Valve (open)
3. High-Side Gauge
4. Manifold Discharge Hand Valve (closed)
5. Refrigerant

Fig. 8, Gas Charging Hookup

⚠ WARNING

Any other way of warming refrigerant, such as using a torch, is dangerous and should never be tried. Using extreme heat on an refrigerant can could cause an explosion and serious bodily injury.

7. Start the engine and run it at 1500 rpm. Set the cab air conditioner controls at maximum cooling and fan speed. The refrigerant compressor must engage. Open the valve on the refrigerant can. Leave the valve open until a full charge of refrigerant has entered the system. Close the valve on the refrigerant can.

   To know when a one-pound can is empty, tap it on the bottom. A hollow ringing will be heard. **Do not tip the refrigerant can.**

NOTE: If refrigerant is slow to enter the system because of low outside temperatures, vaporization can be quickened by placing the refrigerant can in a tub of warm water no warmer than 125°F (52°C).

8. When enough refrigerant has entered the system, look at the sight glass. No frothing or bubbles should appear when the compressor is on. If frothing occurs, leak test the system.
9. While the compressor is engaged, check the operating pressures at the suction and discharge ports. See the applicable compressor section in this manual. If the operating pressures are not acceptable, see **Troubleshooting 300** for possible causes.
10. Shut down the engine. Close both manifold hand valves.
11. All of the manifold gauge hoses are under pressure. Disconnect them from the compressor and the refrigerant can. Install the caps on the compressor service valves.

Liquid Charging Procedure

NOTE: Before charging, the system must be recovered and evacuated with the recovery and recycling station connected to the service and discharge port connections.

1. Obtain enough refrigerant to fully charge the system. A full charge is 48 ounces (1362 grams) of refrigerant.

   If a tank (bulk quantity) is used, it should be set on a scale and its weight noted so that the correct amount of refrigerant enters the system. This prevents overcharging, which could damage the compressor.

   If one-pound cans of refrigerant are used, obtain enough to fully charge the system.

NOTE: Most one-pound cans actually hold 14 ounces (397 grams) of refrigerant.

2. Close the manifold hand valves.
3. Disconnect the vacuum pump. Connect the manifold center service hose to the refrigerant container and purge the air from the hose.
4. With the engine off, open the manifold high-side hand valve. **Do not** open the manifold low-side hand valve. See **Fig. 9.**

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

5. If charging from a tank (bulk quantity), turn the tank upside down. Open the valve on the refrigerant container to allow the refrigerant liquid to enter the system.

NOTE: If refrigerant is slow to enter the system because of low outside temperatures, vaporization can be quickened by placing the refrigerant tank in a tub of warm water no warmer than 125°F (52°C).

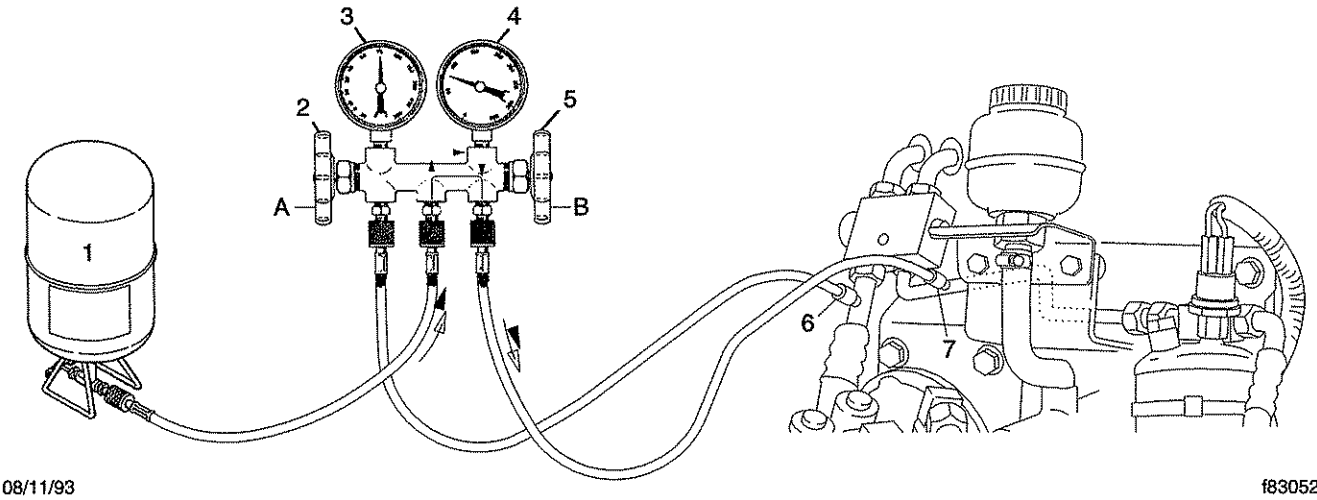
6. Close the high-side hand valve. If a full charge did not enter the system, the rest will be added while the compressor is on.
7. Start the engine and run it at 1500 rpm. Set the cab air conditioner controls at maximum cooling and fan speed. The refrigerant compressor must engage. If charging from a tank (bulk quantity), place the tank in the upright position. Open the low-side hand valve. Leave the valve open until a full charge of refrigerant has entered the system. Close the valve on the refrigerant container. Close the low-side hand valve. Disconnect the hoses.
8. When enough refrigerant has entered the system, look at the sight glass. No frothing or bubbles should appear when the compressor is on. If frothing occurs, leak test the system.
9. While the compressor is engaged, check the operating pressures at the suction and discharge ports. See the applicable compressor section in this manual. If the operating pressures are not acceptable, see **Troubleshooting 300** for possible causes.
10. Shut down the engine.
11. All of the manifold gauge hoses are under pressure. Disconnect them from the service valves. Disconnect the hoses from the refrigerant compressor. Install the caps on the service valves.

Charge Checking

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

In a system that is fully charged, some bubbles will show as the compressor cycles. Very high outside temperatures may cause occasional bubbles when the



08/11/93 f830526

A. Manifold Low-Side Hand Valve
B. Manifold High-Side Hand Valve
1. R–12 Bulk Container
2. Closed Manifold Suction Hand Valve
3. Low-Side Gauge
4. High-Side Gauge
5. Open Manifold Discharge Hand Valve
6. Suction Service Valve
7. Discharge Service Valve

Fig. 9, Liquid Charging Hookup

compressor is running; this is normal. For additional information, see "Refrigerant Check" in **Troubleshooting 300**.

Leak Testing

General Information

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.

Refrigerant is odorless. As a result, all of it may leak away and not be noticed until the system stops cooling. All vehicle refrigerant systems lose some refrigerant, depending on the condition of the system. High loss rates signal a need to locate and repair the leaks.

Leaks are most often found at the compressor hose connections and at the various fittings and joints in the system. Refrigerant can be lost through hose permeation. Leaks can also be traced to pinholes in the evaporator caused by acid, which forms when water and refrigerant mix.

Leak Detection

There are two ways of finding the locations of leaks:

- sight detection
- electronic leak detection

The electronic leak detection method is the recommended method and the most precise method of detecting leaks.

The sight detection method may be used to find large leaks. Many large leaks will cause oil to escape along with refrigerant at the point of the leak. A deposit of oil may be a sign of a leak. Verification of leaks must be done using the electronic leak detection method.

Freightliner recommends using only the Heated Diode type of electronic leak detector. This type of detector can be identified by its construction and power supply. It has a heated element which requires periodic replacement and uses either a 12V DC or 120V AC power supply, or has a rechargeable battery. The Heated Diode type detector is sensitive only to gases containing halogen, such as R–134a and R–12 refrigerants. It will not detect other substances and is more likely to detect all of the leaks in a system. This type has both visual and audio indicators and self-tests to confirm operation.

Recommended electronic Heated Diode type leak detectors are available from their manufacturers. See **Table 3**.

Another type of detector, the Corona Discharge type, is the kind most commonly found in service and repair shops. This detector requires very little power and can operate on as few as four AA alkaline batteries. The Corona Discharge detector is not sufficiently sensitive and will create false alarms by detecting moisture and antifreeze or solvent vapors. This type of detector is specifically **not recommended**.

When checking for leaks, always focus your attention on the lowest portion of the fitting or part being tested. Refrigerant is heavier than air and will collect at the low point. Oil will also flow toward the low point.

NOTE: Do not try to use a leak tester right after connecting or disconnecting service hoses. Traces of refrigerant at the fittings can falsely signal a leak. Always verify a leak by blowing shop air in to the area of the suspected leak and checking the area again.

Use the following procedures to locate A/C system refrigerant gas leaks using a heated diode type electronic leak detector.

1. Operate the electronic leak detector in accordance with the manufacturer's instructions.
2. Leak test with the engine turned off.
3. Charge the air conditioning system with sufficient refrigerant to indicate a gauge pressure of at least 50 psi (340 kPa) with the system not operating. It may not be possible to produce this amount of pressure and measure leakage if the ambient temperature is less than 59°F (15°C).
4. Be careful not to contaminate the detector probe tip if the part being tested is not clean. Wipe the part off with a dry shop towel or blow it off with shop air. Do not use cleaners or solvents as many detectors are sensitive to their chemical ingredients.

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

Electronic Leak Detectors		
Designation	**Manufacturer**	**Comments**
D-TEK	Leybold Inficon 2 Technology Place East Syracuse NY 13057 (315) 434–1144	• Rechargeable battery • Hand-held design • Simple to operate
H–10 Professional	Bacharach Inc. c/o Yokogawa Corp. of America 2 Dart Road Newnan GA 30265 (800) 850–0044	• Rechargeable battery • Carrying case with strap • Calibration leak bottle • Manual sensitivity control • Most sensitive available
J 39400	SPX Kent-Moore 28635 Mound Road Warren MI 48092–3499 (800) 328–6657	• 12V DC or 120V AC • Carrying case with strap • Calibration leak bottle • Manual sensitivity control • Manual balance control

Table 3, Electronic Leak Detectors

5. Visually inspect the entire refrigerant system. Look for air conditioning lubricant leakage and corrosion or damage to lines, hoses, and all other components. Inspect each questionable location carefully with the detector probe. Check all fittings, couplings, refrigerant controls, service ports (with caps installed), brazed or welded areas, and areas around attachment points and hold-downs.
6. Follow the path of the refrigerant system methodically so that no leaks are missed. If a leak is found, continue to test the rest of the system.
7. Inspect an area of possible leakage slowly and close to the part, moving completely around the part. Move the probe no faster than one to two inches (25 to 50 mm) per second and no farther away than 1/4 inch (6.4 mm) from the part.
8. If a large leak is present in either the system being serviced or the service equipment, the surrounding air will be saturated with refrigerant gas. In this situation the leak detector operates erratically and will indicate leakage without being near a possible leak source. Place a large fan so that a light breeze blows through the work area. Verify a leak by blowing shop air into the area and repeating the inspection. Pinpoint a large leak by blowing out the area often.
9. You may test the evaporator core while it is in its housing. Turn on the blower motor for a minimum of 15 seconds. Shut off the blower and wait for refrigerant gas to accumulate in the housing. Follow the detector instructions for the specific length of time to wait for the gas to accumulate. Insert the detector probe into the blower resistor block, or condensate drain hole if no water is present. If this is not possible insert the probe into the closest opening to the evaporator, such as a heater or vent duct.
10. Leak test the front seal area of the compressor. Blow shop air into the cavities in and around the clutch for at least 15 seconds. Let the compressor stand for one minute and then test for leakage. Inspect rotary type compressors (Sanden or Sel-Tec) by placing the probe near the holes at the front of the clutch. Inspect two-cylinder reciprocating type compressors (Climate Control) by placing the probe between the clutch coil and the compressor.

Discharging, Purging and Flushing, Evacuating, Charging, Charge Checking, and Leak Testing

IMPORTANT: Be careful not to damage the clutch bearing seal with high pressure shop air.

11. Leak test repaired areas of the system after repairs have been performed. Leak test the service ports (with caps installed) after any service which disturbs the refrigerant system.

Preliminary Checks

Before testing the operation of the air conditioning system, make the following checks.

1. Make sure the refrigerant compressor's drive belt is not damaged and is correctly tensioned. Also check the compressor mountings for tightness. For instructions and other information, refer to the applicable refrigerant compressor section elsewhere in this group.
2. Using a feeler gauge, check for correct refrigerant compressor clutch clearance. For instructions, refer to the applicable refrigerant compressor section elsewhere in this group.
3. Check for broken, burst, or cut hoses; also check for loose fittings on all parts.
4. Check for road debris build-up on the condenser coil fins. Using air pressure and a whiskbroom or a soapy spray of water, carefully clean off the condenser; be careful not to bend the fins.
5. Check the moisture indicator sight glass for the moisture content of the refrigerant and the state of the charge. The air conditioner should be on when checking the indicator; you should make this check at the end of a day's run. Replace the charge if it is wet. If there are bubbles in the sight glass, the refrigerant charge could be low; add more R–12 to the system. Refer to **Subject 220** for instructions.
6. If there is not enough airflow, make sure that leaves or other debris has not entered the fresh air ports under the windshield. If debris has entered, it could clog the fins of the evaporator coils, and block airflow.

   Also, be sure that all ducts are connected to the dash louvers and that the air-control flaps in the heater housing are moving properly (this requires removal of the right and center dash panel).

Performance Tests

Following is a brief description of symptoms or conditions that will exist if something goes wrong in a refrigerant part.

COOLING CHECK

When outside temperature and humidity are high, it will take longer to cool the cab, especially if the fresh air vents are left open.

To determine if the air conditioner is cooling enough:

1. Set the engine speed at 1500 rpm.
2. Close the doors and windows.
3. Turn on the air conditioner; set the controls at maximum cooling (recirculated air) and blower speed. The compressor must be engaged during this test.
4. Allow the system to run for at least 10 minutes (longer on hot and humid days).
5. Place a thermometer inside the louver or air duct; make sure the controls are set so that air flows out of the duct being tested.
6. Compare the measured temperature readings to the readings in **Table 1** below. If the duct's air temperature is higher than normal readings, the system isn't cooling enough. For possible causes, refer to the troubleshooting tables.

Temperature Comparison	
Outside Temperature	**Center Vent Temperature**
60 to 80°F (16 to 27°C)	58°F (14°C) or lower
80 to 90°F (27 to 32°C)	60°F (16°C) or lower
90 to 100°F (32 to 38°C)	64°F (18°C) or lower

Table 1, Temperature Comparison

REFRIGERANT CHECK

There are four conditions to look for when checking refrigerant in the sight glass.

1. Bubbles normally show only when the system is started and then disappear after a few seconds. If these bubbles *continue all the time* the system is running, the system is merely low on (not completely out of) refrigerant. Only an occasional bubble should be seen during normal operation.
2. A clear sight glass means that the system has enough refrigerant to work properly, that it is completely out of refrigerant, or that it is overcharged.

3. A cloudy sight glass means that dirt or broken-down bits of desiccant are flowing through the system. This is a serious condition that requires a complete flushing out of the system, installation of a new receiver-drier, expansion valve, and, if the desiccant cartridge of the receiver-drier has fallen apart, installation of a new refrigerant compressor.
4. Oil streaks in the sight glass mean low refrigerant or too much oil in the system.

RECEIVER-DRIER

The receiver-drier is normally at outside temperature. To the touch, the entire length of the unit should be the same temperature. If noticeable cool spots exist, replace the receiver-drier.

A blockage at the inlet of the unit will cause high head pressures; outlet blockages will cause low head pressures and little or no cooling.

If the moisture indicator isn't blue, the receiver-drier is saturated with water and acid, and must be replaced.

COOLING SYSTEM

Although they are not physically connected, there is a close tie between a vehicle's air conditioner and its cooling system. Poor air conditioner cooling can be the result of a problem in the cooling system.

If the cooling system does not work correctly, the heat of the engine will rise to abnormal levels. The added heat will transfer to the air conditioner, other underhood parts, and maybe make its way into the cab. The added heat makes it necessary for the air conditioner to work harder and, at the same time, it reduces the air conditioner's ability to cool down the air in the cab.

Refer to the engine cooling section for cooling system troubleshooting and to the engine manufacturer's service manual for other details about cooling system problems.

EXPANSION VALVE

Problems that start in the expansion valve show up as follows: when stuck closed, the evaporator coil and the expansion valve will be at outside temperature; when stuck open, both the coil and the valve will be extremely cold with frost or ice build-up.

Because the expansion valve is very sensitive to contamination, blockages in the system tend to be found here. Usually, the contaminant is water; less than a drop of water is all it takes to make the valve inoperative. When water reaches the valve, the extreme cold that results from the pressure drop freezes the water, forming a block of ice in the valve. After the system shuts down and the valve warms up, the ice melts, and the valve operates again, only to freeze up when the water returns.

On-and-off operation of the expansion valve means that the receiver-drier is not removing water and acids from the system. These contaminants should cause the moisture indicator's element to turn pink or white.

REFRIGERANT COMPRESSOR

Compressor problems usually show in one of four ways: abnormal noise; seizure; leakage; or low suction and discharge pressures.

Resonant compressor noises are not causes for alarm; irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Low discharge pressure may be caused by not enough refrigerant, not enough belt tension, or a blockage somewhere in the system. These things should be checked before servicing the compressor.

EVAPORATOR

The evaporator coils are basically trouble-free when airflow over the fins is not blocked. External or, less often, internal blockages will cause low suction pressure as well as little or no cooling.

If hydrochloric acid has formed in the system (the result when refrigerant mixes with water), it may cause pinholes to form in the evaporator coil. If a leak exists in the system, and it cannot be traced to other parts or fittings, suspect damage to one of the evaporator coils.

CONDENSER

The condenser is also usually trouble-free when road debris, such as leaves or dirt buildup, is removed. If debris cakes up, airflow over the condenser fins is blocked; air is not able to absorb enough heat to turn the hot refrigerant gas into a liquid. High head pressures will result. In these cases, carefully clean off the outer surfaces of the condenser with compressed air or a soap and water solution; be careful not to bend the fins.

High head pressures will also occur if the condenser's tubing is abnormally bent, blocking the flow of refrigerant.

Less common internal blockages (bits of foreign material or metallic grit build-up) will stop the flow of refrigerant.

A quick test to check that poor system performance is caused by the condenser is to direct a spray of water onto the condenser while the system is running. If the air conditioner cools better because of the assist provided by the water, it is a sign that the condenser is not working.

When troubleshooting a suspected condenser problem, remember that the problem may be caused by the cooling system transferring high levels of heat to the condenser. Refer to **Group 20** for cooling system troubleshooting and to the engine manufacturer's service manual for other details about cooling system problems.

THERMOSTATIC SWITCH

Before troubleshooting the thermostatic switch, be sure there is a full charge of refrigerant in the system. The compressor will not operate, or will cycle too often, if there is not enough refrigerant in the system.

Quick or delayed cycling of the compressor may be caused by a thermostatic switch that is working, but is out of adjustment. If, after doing the tests below, the switch seems to be out of adjustment, replace it (the thermostatic switch cannot be recalibrated).

1. Be sure the compressor clutch is operating correctly. Refer to the applicable refrigerant compressor section elsewhere in this group.
2. Expose the evaporator coil. Refer to **Subject 120** for instructions.
3. Connect the batteries and start the engine. Place the air conditioner control at its coldest setting; turn on the air conditioner and the fan.
4. Place an accurate thermometer in contact with a tube on the evaporator coil. Be sure the thermometer is in good contact with the tube, or you will get a wrong reading.

   When the temperature drops below 31° to 36°F (–1° to 2°C), the compressor clutch should disengage and remain this way until the temperature rises to 39° to 44°F (4° to 7°C).
5. If the compressor did not engage when the temperature was above the accepted high range, check the thermostatic switch and its wiring.

   5.1 Connect a voltmeter or a test light from one of the terminals on the thermostatic switch to ground. Repeat this test with the other terminal on the switch.

   5.2 With the engine running and the air conditioner and blower on, both terminals will show voltage when the compressor should be engaged; one terminal will show voltage when the compressor should be disengaged.

   If there is no voltage, there is a problem in the electrical system from the batteries to the thermostatic switch. Check all circuits for the cause, and repair or replace the wiring or parts.

   In all other cases where the compressor is not engaging and disengaging properly, the thermostatic switch is the cause. Replace it with a new switch.
6. Shut down the engine and, to prevent accidental electric shock or shorting during dash assembling, disconnect the batteries.
7. Assemble the dash; refer to **Subject 120** for instructions.

LINE RESTRICTIONS

A restricted suction line causes low suction pressure at the compressor and little or not cooling. A restriction in a line between the compressor and the expansion valve can cause high discharge and low suction pressure, and insufficient cooling.

Usually, areas of ice or frost build-up mean a blockage. Parts that often freeze up are probably corroded or inoperative and should be replaced. Parts (such as the expansion valve) that freeze up once in a while may do so because of water in the system, which will cause the moisture indicator's element to turn pink; if this happens, replace the receiver-drier, purge or flush the lines and parts, and recharge the system.

Fault Analysis Flow Chart

Troubleshooting

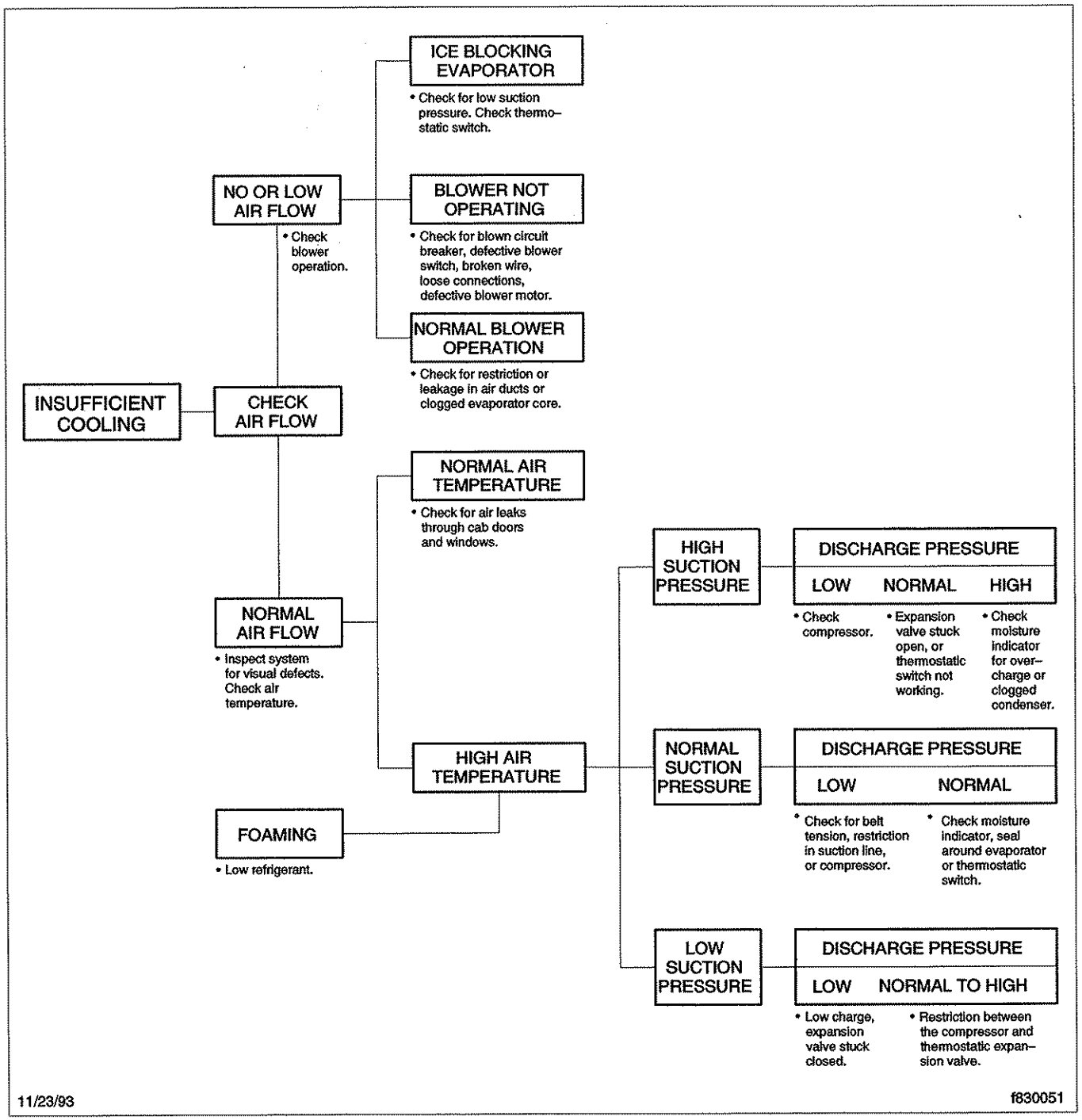


Fig. 1, Fault Analysis Flow Chart

Troubleshooting Tables

Problem—Little or No Airflow

Problem—Little or No Airflow	
Possible Cause	**Remedy**
The blower is not operating.	Check for an open circuit breaker. An open circuit breaker indicates a short in the electrical system, which must be located and repaired.
	Check the air conditioner relays for operation. Replace, as necessary.
	Make sure the blower motor switch is working. Replace, if necessary.
	Check the wiring to the blower motor. If any connections are loose, securely tighten them. Make sure the wiring conforms to the diagram under **Specifications, 400.**
	Check the blower motor for operation. Replace if sticking or otherwise inoperative.
	Check the resistor block. Replace, if necessary. **CAUTION:** Never try to by pass the fuse in the resistor block. To do so could cause the blower motor to overheat, resulting in serious damage to the heater/ air-conditioning system.
There are restrictions or leaks in the air ducts.	Examine all air ducts and remove any blockages. Stop any leaks or replace any portion where the leaks cannot be stopped.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Review "Performance Tests" in this subject for possible causes and corrective action.

Problem—Warm Airflow When the Air Conditioner Is On

Problem—Warm Airflow When the Air Conditioner Is On	
Possible Cause	**Remedy**
There is no refrigerant charge in the system.	Perform a leak test. Repair any leaks, purge the system, replace the receiver-drier, and add a full charge of refrigerant.
Moisture in the system.	If moisture is in the system, ice crystals may form at the expansion valve, blocking the flow of refrigerant (off and on). Discharge the refrigerant charge, purge the system, replace the receiver-drier, and add a full charge of refrigerant.
The refrigerant compressor is not operating.	If the refrigerant charge is low, charge and leak test the system. Repair any leaks.
	The refrigerant compressor clutch or drive belt needs repair or replacement. For instructions, refer to the refrigerant compressor section elsewhere in this group.
The air-conditioner microswitch is not working.	Replace the microswitch.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Review "Performance Tests" in this subject for possible causes and corrective action.

Troubleshooting

Problem—Foaming in the Receiver-Drier Sight Glass

Problem—Foaming in the Receiver-Drier Sight Glass	
Possible Cause	**Remedy**
There is an insufficient refrigerant charge in the system.	Add refrigerant.
There are leaks in the system.	Perform a leak test. Stop all leaks, exhaust the old refrigerant from the system, and add a new charge.
Restriction in the line between the condenser and the receiver-drier is slowing refrigerant flow.	Remove the restrictions from the line. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.

Problem—Low Evaporator Coil Outlet Pressure (Low Compressor Suction Pressure)

Problem—Low Evaporator Coil Outlet Pressure (Low Compressor Suction Pressure)	
Possible Cause	**Remedy**
The expansion valve is not working.	Replace the expansion valve. If moisture or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
There are restrictions in the line to the expansion valve.	Remove the line restrictions. If moisture or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
There is an insufficient refrigerant charge in the system.	Add refrigerant.

Problem—High Compressor Discharge Pressure

Problem—High Compressor Discharge Pressure	
Possible Cause	**Remedy**
Airflow through the condenser is restricted.	Remove the debris from the condenser.
There is an internal restriction in the condenser. (The return tube bends should all be the same temperature).	Replace the condenser. If water or corrosion is present, evacuate the system, replace the receiver-drier, and add a full charge of refrigerant.
Air is present in the system.	Perform a leak test. Repair any leaks, evacuate the system, and add a full charge of refrigerant.
The system has too much refrigerant.	Drain some of the refrigerant charge at the discharge service valve.
Heavy frosting on the suction line suggests that the evaporator coil is flooded.	Defrost the evaporator coil before resuming operation of the air conditioner. If the problem recurs, there is probably moisture (ice crystals) blocking the expansion valve. Exhaust the refrigerant charge, purge the system, replace the receiver-drier, and add a full charge of refrigerant.
The engine is over-heated.	Refer to the engine manufacturer's operations manual for corrective measures.
Restriction in the compressor discharge line.	Repair or replace the line.

Problem—Evaporator Outlet Air Temperature Increases as the Compressor Discharge Pressure Drops

Problem—Evaporator Outlet Air Temperature Increases as the Compressor Discharge Pressure Drops	
Possible Cause	**Remedy**
There are leaks in the system.	Leak test the system. Repair any leaks, exhaust the old refrigerant, and add a full charge of refrigerant.
The expansion valve setting is too low.	Replace the expansion valve. Add a full charge of refrigerant.
Too much oil is in the system. An indication of this is clutch or belt slippage at governed engine speed.	Check and remove excess refrigerant oil. For instructions, refer to the refrigerant compressor section elsewhere in this group.

Problem—Compressor Operates Too Often or Continuously

Problem—Compressor Operates Too Often or Continuously	
Possible Cause	**Remedy**
There is too little refrigerant in the system.	Perform a leak test. Repair any leaks, and add a full charge of refrigerant.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Check the operation of the thermostatic switch, and replace as necessary.
There is a restriction in the refrigerant system.	Remove the restriction from the line. If water or corrosion is present, purge or flush the system, replace the receiver-drier, and add a full charge of refrigerant.
Dirt and debris are clogging the condenser fins.	Remove all dirt and debris from the condenser fins.
The thermostatic switch isn't working.	Replace the thermostatic switch.

Problem—Quick or Delayed Cycling of the Compressor

Problem—Quick or Delayed Cycling of the Compressor	
Possible Cause	**Remedy**
The thermostatic switch operates, but is out of adjustment.	Replace the thermostatic switch. Do not attempt to adjust it.
Loss of refrigerant is causing a delayed cycling of the compressor.	Leak test and add a full charge of refrigerant.

Problem—Temperature in the Cab Too Low or No Heat

Problem—Temperature in the Cab Too Low or No Heat	
Possible Cause	**Remedy**
The water regulating valve is not opened.	Turn the temperature control knob toward "warm."
The water regulating valve is not opening all the way.	Adjust the water regulating valve cable.
The water regulating valve isn't working.	Replace the water regulating valve.
A heater hose is pinched or twisted.	Repair or replace the heater hose.
Coolant is leaking from the system.	Check for leakage at the heater core, and at all hose connections from the heater core to the engine. Check the radiator coolant level, as instructed in the vehicle driver's manual, and add coolant, if necessary. Check and repair any leaks at the radiator.
Dust or dirt is clogging the heater core fins.	Remove and clean the heater core.

Troubleshooting

Problem—Condensed Water Is Leaking from the Air Conditioner

Problem—Condensed Water Is Leaking from the Air Conditioner	
Possible Cause	**Remedy**
The drain tubes are plugged.	Clean the drain holes and drain tubes.

Specifications

See **Fig. 1** for the air conditioning wiring diagram. See **Fig. 2** for the air conditioning air conditioner plumbing diagram. See **Fig. 3** for the heater plumbing diagram for Cummins B Series engines. See **Fig. 4** for the heater plumbing diagram for Cummins C Series engines. See **Fig. 5** for the heater plumbing diagram for Mercedes-Benz OM 366LA engines.

A/C Fitting Torque Specifications*	
Hose Size	**Torque lbf·ft (N·m)**
#6	20–25 (27–34)
#8	30–35 (41–47)
#10 and #12	35–40 (47–54)

* One-inch fittings on the A/C compressor need to be torqued 21 to 27 lbf·ft (28 to 37 N·m) regardless of hose size.

Table 1, A/C Fitting Torque Specifications

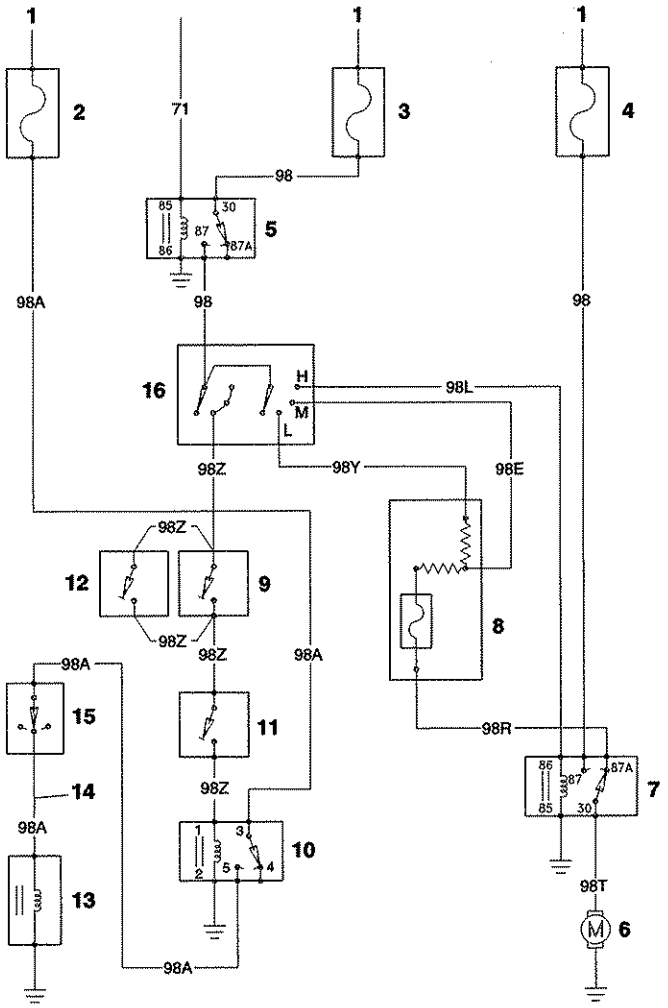
3/4- and 5/8-Inch Heater Hose Clamp Torque Values	
Description	**Torque lbf·in (N·cm)**
Standard Hose Clamp	40 (452)
Worm-Gear Hose Clamp	40 (452)
Breeze Constant-Torque Hose Clamp	40 (452)
Oetiker Constant-Torque Hose Clamp	18 (203)

Table 2, 3/4- and 5/8-Inch Heater Hose Clamp Torque Values

Electronic Leak Detectors		
Designation	**Manufacturer**	**Comments**
D-TEK	Leybold Inficon 2 Technology Place East Syracuse, NY 13057 (315) 434–1144	• Rechargeable battery • Hand-held design • Simple to operate
H–10 Professional	Yokogawa Corp. of America 2 Dart Road Newnan, GA 30265 (800) 258–2552	• Rechargeable battery • Carrying case with strap • Calibration leak bottle • Manual sensitivity control • Most sensitive available
J 39400	Kent-Moore 29784 Little Mack Roseville, MI 48066–2298 (810) 578–7285	• 12V DC or 120V AC • Carrying case with strap • Calibration leak bottle • Manual sensitivity control • Manual balance control

Table 3, Electronic Leak Detectors

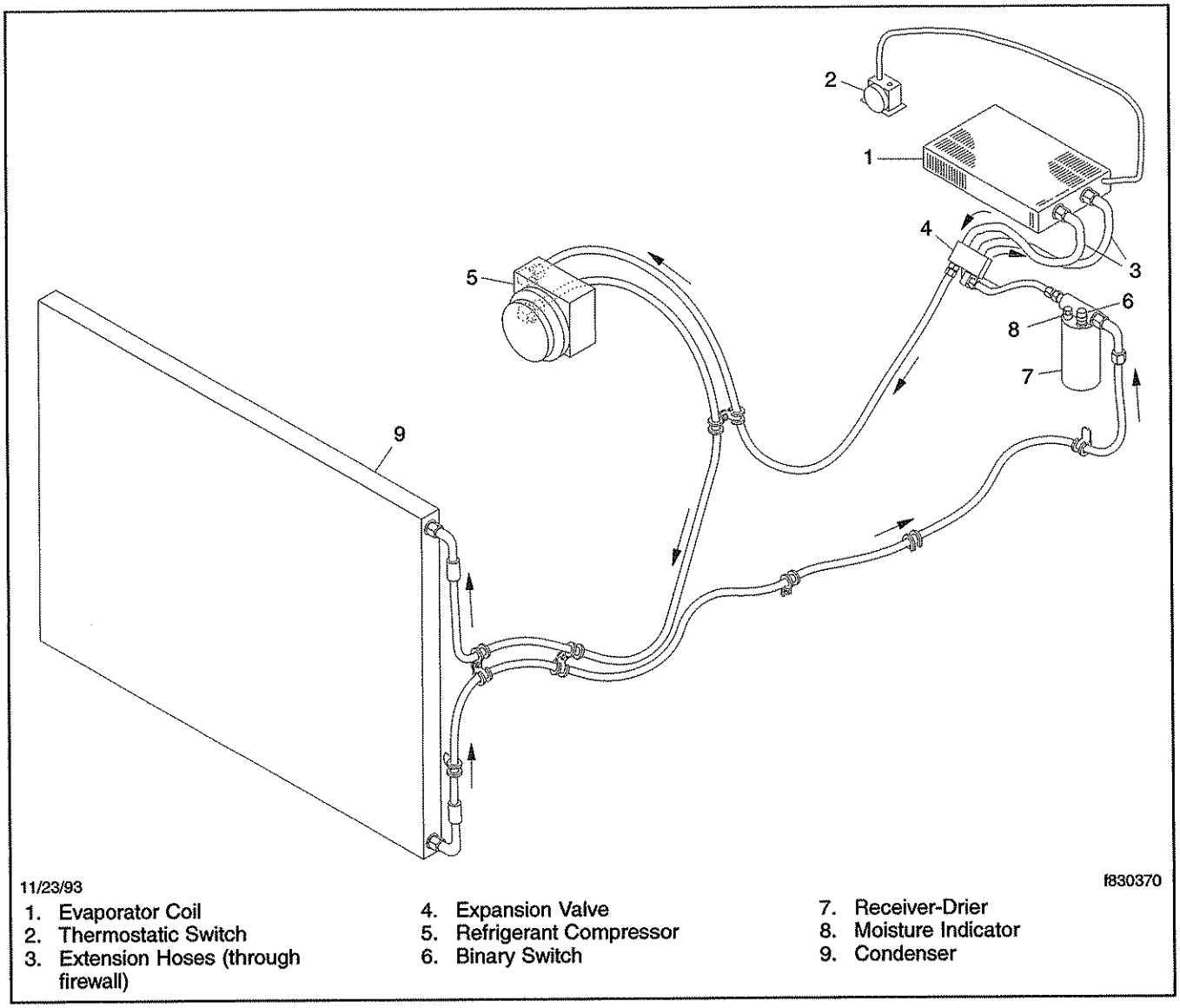
Specifications



11/23/93 f540349

1. To 14.
2. 10A
3. 15A
4. 40A
5. Heater/Air-Conditioner Relay
6. Blower Motor
7. Heater Blower Relay
8. Resistor
9. Defroster/Dehumidifier Microswitch
10. Compressor Clutch Relay
11. Thermostatic Switch
12. Air Conditioner On/Off Microswitch
13. Air Conditioner Compressor Clutch
14. Black
15. Binary Switch
16. Blower Motor Switch

Fig. 1, Air Conditioning Wiring



1. Evaporator Coil
2. Thermostatic Switch
3. Extension Hoses (through firewall)
4. Expansion Valve
5. Refrigerant Compressor
6. Binary Switch
7. Receiver-Drier
8. Moisture Indicator
9. Condenser

Fig. 2, Air Conditioner Plumbing

Specifications

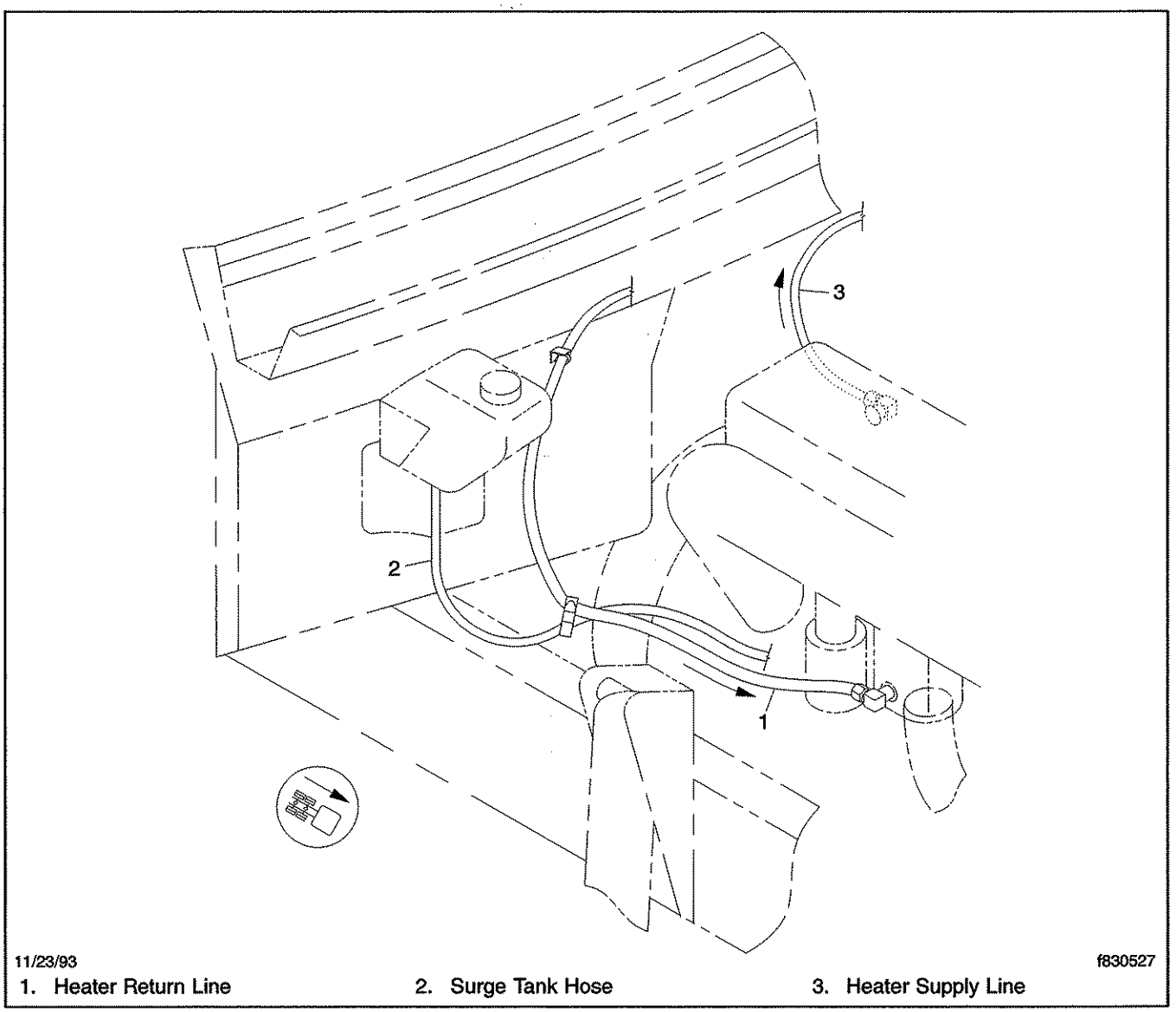
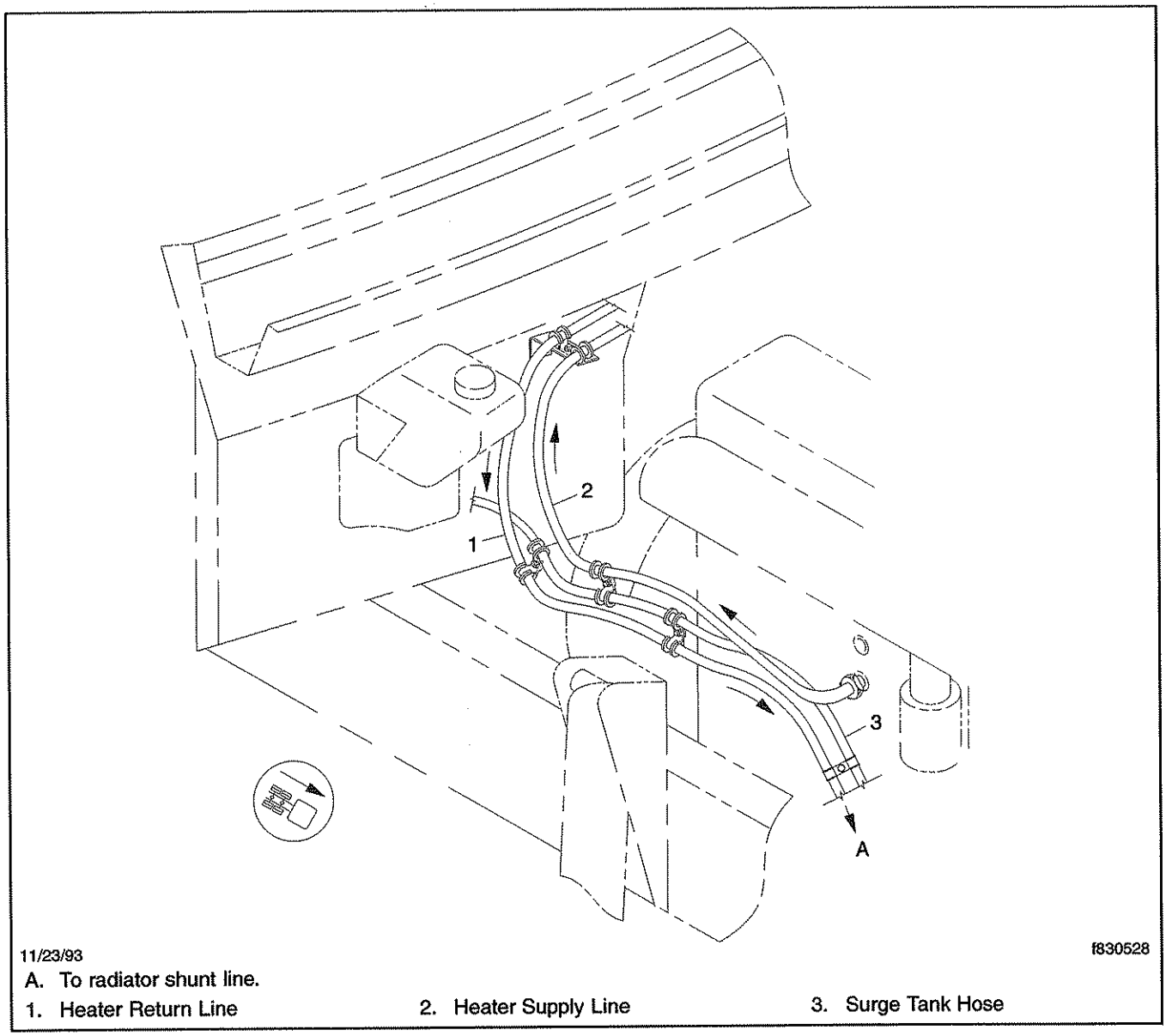


Fig. 3, Heater Plumbing for Cummins B Series Engines

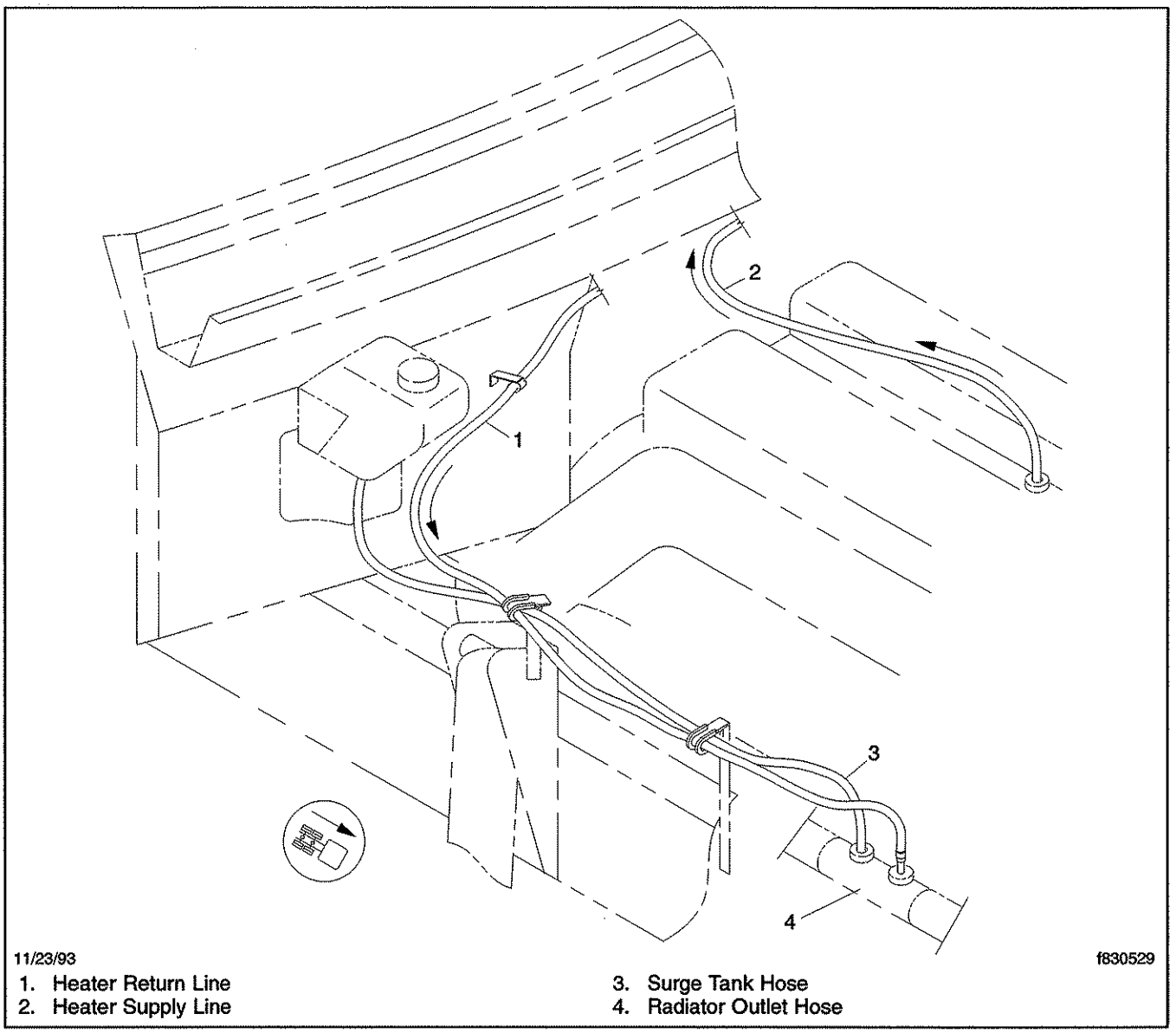


A. To radiator shunt line.

1. Heater Return Line
2. Heater Supply Line
3. Surge Tank Hose

Fig. 4, Heater Plumbing for Cummins C Series Engines

Specifications



1. Heater Return Line
2. Heater Supply Line
3. Surge Tank Hose
4. Radiator Outlet Hose

Fig. 5, Heater Plumbing for Mercedes-Benz OM 366LA Engines

Contents

Subject	Subject Number
General Information	050
Service Operations	
Safety Precautions	100
Pre-Service Checks	110
Compressor Suction and Discharge Pressure Checking	130
Compressor Removal and Installation	140
Oil Check and Adding Oil to the Compressor	150
Magnetic Clutch Assembly Removal, Inspection, and Installation	160
Shaft Seal Replacement	170
Running-In Operations	180
Storing a Repaired Compressor	200
Specifications	400

General Information

The main purpose of the refrigerant compressor **(Fig. 1)** is to draw refrigerant gas from the evaporator and squeeze it into high-pressure gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid so that it can be used for cooling again. A second purpose of the compressor is to move refrigerant through the air conditioning system.

The compressor is cycled by a thermostatic switch. When there is enough of a temperature drop in the cab, the switch breaks the circuit to the compressor's clutch. When the clutch is disengaged, its pulley is free-wheeling and the compressor shaft is not turning. When the clutch is engaged, it holds to the pulley, and the turning of the pulley causes the compressor shaft to turn.

Refer to the heater and air conditioner section for more information.

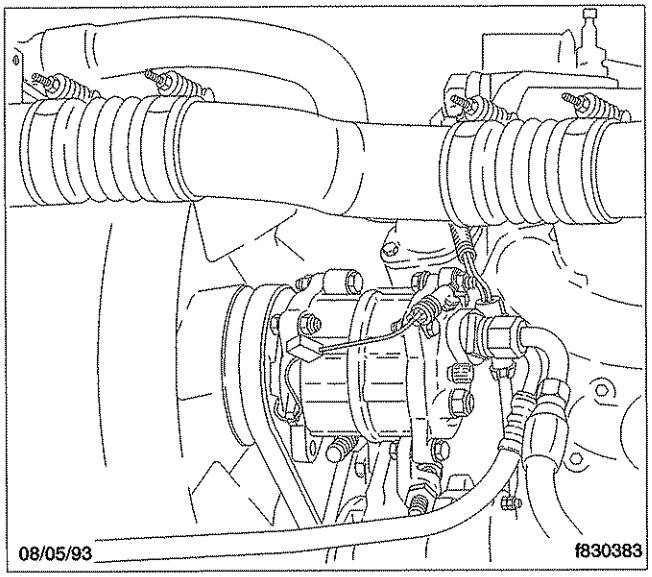


Fig. 1

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold refrigerant, you must discharge, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure. You should disconnect them only after the air conditioning system has been discharged to a refrigerant recovery unit through the service valves.

Refrigerants are safe when used under the right conditions. Always wear safety goggles and non-leather gloves while discharging, purging, flushing, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

⚠ WARNING

WARNING: Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should first be treated with a few drops of sterile mineral oil in the eyes, and then rinsed with a weak boric acid solution. Do not rub the eyes. Call a doctor right away.

Refrigerant splashed on the skin should be treated the same as for frostbite: gently pour cool water on the area, but do not rub the skin. Keep the skin warm with layers of soft, sterile cloth. Call a doctor right away.

Even though refrigerant does not burn, when it contacts extreme heat or flame, poisonous gas is created.

⚠ WARNING

WARNING: Do not work in an area where refrigerant may contact an open flame or any burning material, such as a cigarette. When it contacts extreme heat, refrigerant breaks down into poisonous gas which, if breathed, causes severe respiratory irritation. If an open flame leak detector is used, follow the manufacturer's safety precautions.

If a refrigerant recovery and recycling station is available, discharge the air conditioning system into the station. Refer to the manufacturer's operating instructions.

If a refrigerant recovery and recycling station is not available, check local regulations for disposal methods.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant cans from exploding, never expose them to temperatures higher than 52°C (125°F). Never leave refrigerant cans in the sun, and do not store them in sun-exposed areas where heat can build up, such as in glove boxes, automobile trunks, etc.

Checks

⚠ WARNING

WARNING: Before doing any work, read the information under Safety Precautions, 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

Some special tools are needed for doing repair work on the compressor. Tool kits can be bought from the suppliers listed in **Specifications, 400.**

The checks below should be made whenever the air conditioning system is not cooling enough and the causes are unknown.

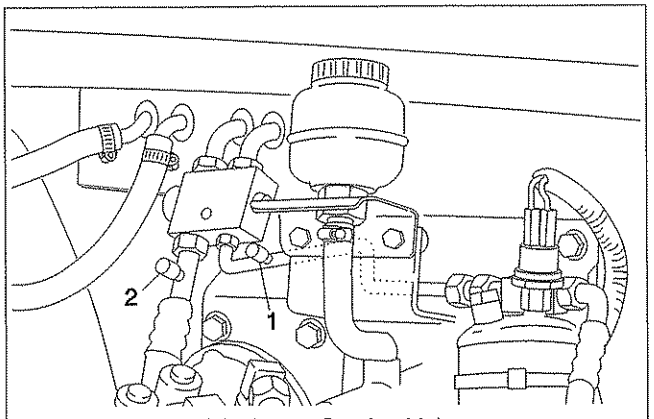
1. Be sure to check the moisture indicator, to see if moisture is the cause of the problems. The air conditioner should be on when checking the indicator; it is better to check it at the end of a day's run.
2. Check the drive belt and mounting as follows:
   - 2.1 On the drive belt, look for wear, damage, or oil. If worn, oil-soaked, or damaged, remove it and install a new one. Refer to the applicable section in **Group 01** for instructions.
   - 2.2 Check the compressor mounting parts for loose fasteners, cracks, or other damage. Tighten loose fasteners to the torque value in the applicable table in **Specifications, 400.** Repair or replace cracked or damaged brackets.
   - 2.3 Check the tension of the compressor drive belt. Refer to the applicable section in **Group 01** for instructions.
3. Check the wiring and connections to the compressor clutch. Replace damaged wiring and tighten loose connections.
4. Check for road debris build-up on the condenser coil fins. Using air pressure and a whiskbroom or a solution of soap and water, carefully clean the condenser; be careful not to bend the fins.
5. Check the refrigerant charge in the air conditioning system; for instructions, refer to the heater and air conditioner section in this group.
6. Check the suction pressure and discharge pressure of the refrigerant compressor; refer to **Subject 130.**

NOTE: For other possible causes of air conditioner problems, refer to the heater and air conditioner section in this group.

Compressor Suction and Discharge Pressure Checking

Checking

1. Read the information under **"Safety Precautions, 100."**
2. Attach a manifold gauge set to the service ports. Equip the manifold gauge set with a valve core depressor.
   - 2.1 Remove the protector caps from the service valve ports on the firewall. **See Fig. 1.**
   - 2.2 Close both of the valves on the manifold gauge set. Cap the manifold center hose.
   - 2.3 Connect the high-side hose to the discharge service port. The connection should be finger-tight.
   - 2.4 Open the high-side manifold valve one turn. Open the low-side manifold valve just enough to allow refrigerant gas to slowly escape from the low-side hose. Allow gas to escape for three seconds, then close both manifold valves.
   - 2.5 Quickly connect the low-side hose to the suction service port. The connection should be finger-tight.
3. Start the engine and set it to run at 1500 rpm.
4. Turn on the heater/air-conditioner blower, and set the air conditioner controls to the coldest setting, so that the compressor is operating. If the outside temperature is cooler than 21°C (70°F), *partially* block the air to the condenser.



1. Discharge Service Valve
2. Suction Service Valve

Fig. 1

5. Look at the manifold suction and discharge pressure gauges. The pressures on the gauges should be within the range listed in the **temperature/pressure specifications table in "Specifications, 400."**
   - 5.1 If the suction pressure is normal and the discharge pressure is too high, skip the following sub-steps and proceed.
   - 5.2 If the suction and discharge pressures are both too high, there is air in the refrigerant, or too much refrigerant in the system; check the charge; for instructions, refer to the heater and air conditioner section in this group.
   - 5.3 If the suction pressure is too high and the discharge pressure is normal, check the wiring to the thermostatic switch beside the blower motor; repair or replace the wiring, as needed. If the wiring is correct and there is power to the switch, check that the probe of the thermostatic switch is correctly installed in the evaporator coil. For instructions, refer to the heater and air conditioner section in this group. If everything checks out okay, replace the thermostatic switch at the climate control panel.
   - 5.4 If the suction pressure is too low and the discharge pressure is normal or too low, check for passage of air through the evaporator coils. If airflow is blocked, remove the blockage. If airflow is satisfactory, check for blockages in the line to the suction side of the compressor.
   - 5.5 If the suction pressure is normal or too high and the discharge pressure is too low, skip the following step and proceed.
6. If the suction pressure is normal and the discharge pressure is too high, airflow through the condenser may not be enough to carry away the heat.

   Check for dirt or debris causing reduced airflow. Also check for a blockage in the refrigerant path indicated by an icy area on the condenser or hoses.
   - 6.1 Place a large fan in front of the radiator; place it so that the airflow goes through the condenser. After two minutes of operating

Compressor Suction and Discharge Pressure Checking

the air conditioner and the fan at the same time, look at the manifold pressure gauges again. (One other procedure is to direct a spray of water onto the condenser while the system is running.)

6.2 If the discharge pressure is still too high, the lines between the compressor and the receiver-dryer are restricted, or the condenser is restricted internally. Discharge, flush, evacuate, charge, and leak test the system. If the restriction can't be removed by flushing, replace the restricted line or condenser. After flushing and before placing a vacuum in the system, *be sure to add the correct amount of refrigerant oil to the compressor*. For instructions, **refer to "Oil Check and Adding Oil to the Compressor, 150."**

7. If the suction pressure is normal or too high and the discharge pressure is too low, check for a slipping clutch or wrong-sized clutch pulley or accessory drive pulley. Replace parts as needed.

   If the suction pressure is still normal or too high and the discharge pressure is still too low, the compressor is the problem. Repair or replace the compressor.

Compressor Removal and Installation

Removal

1. Discharge the air conditioning system; for instructions, refer to the heater and air conditioner section in this group.
2. Remove the clamps holding the charge air pipe; then, remove the pipe. See **Fig. 1**.
3. Thoroughly clean the compressor around the hose connections. Disconnect the suction and discharge hoses from the compressor. Quickly cap the discharge and suction ports and plug the hoses. Under no circumstances should you leave the ports uncapped or the hoses unplugged for longer than a total of five minutes.
4. Disconnect the compressor magnetic clutch electrical wire. See **Fig. 2**.
5. Remove the V-belt.
   - 5.1 Loosen both the adjustment and jam nuts on the compressor lower mounting strut. See **Fig. 3**.
   - 5.2 Loosen the two compressor upper mounting bolts. See **Fig. 4**.
   - 5.3 Pivot the compressor down to relieve the belt tension.
   - 5.4 Remove the V-belt.

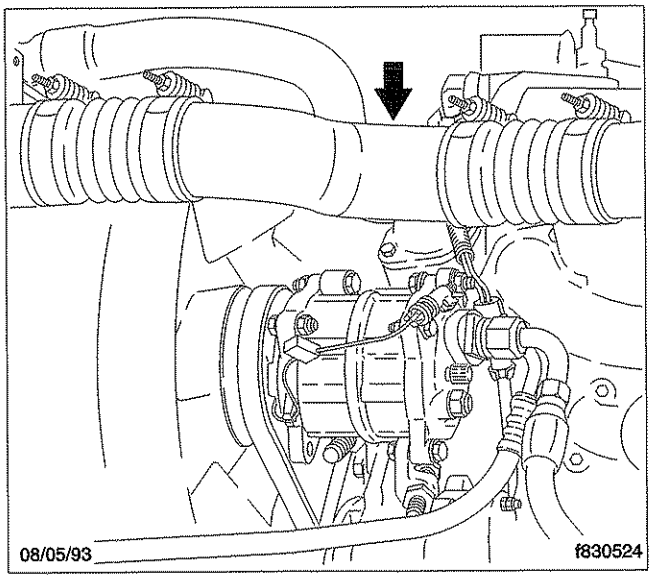


Fig. 1, Charge Air Pipe

6. Remove all three compressor mounting bolts (**Fig. 4**) and lift out the compressor.

Installation

IMPORTANT: A new compressor is filled with nitrogen gas and 200 mL (6.8 fl oz) of refrigerant oil. When installing a new compressor on the vehicle, do all of the steps below; if installing a used compressor, skip the following step, and proceed with the installation:

1. Flush a new compressor.
   - 1.1 Slowly release the nitrogen from the discharge side of the compressor. Be careful not to let the oil flow out.
   - 1.2 Turn the compressor several times by hand to expel the oil from the cylinders.

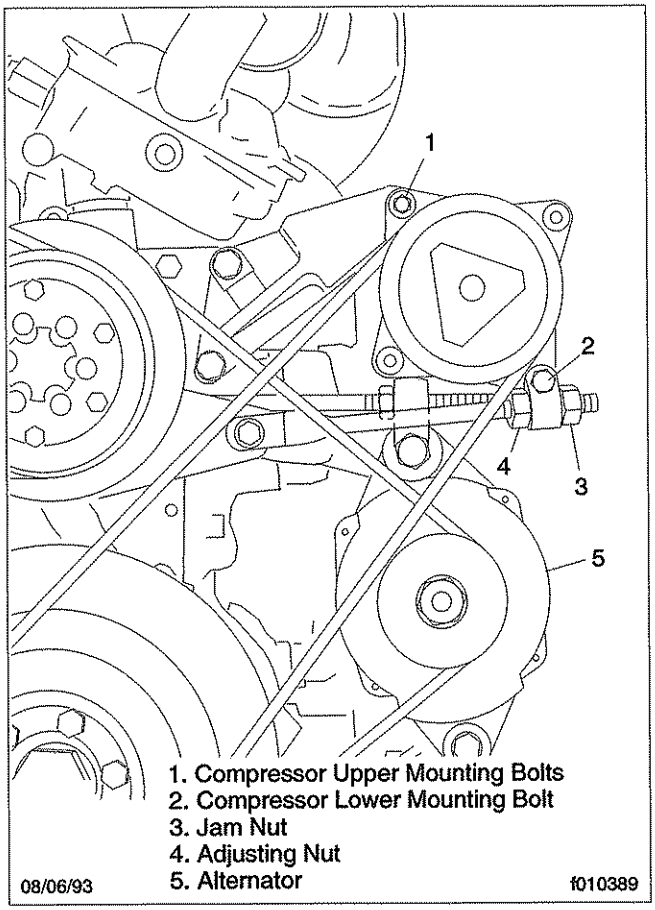


Fig. 2

Compressor Removal and Installation

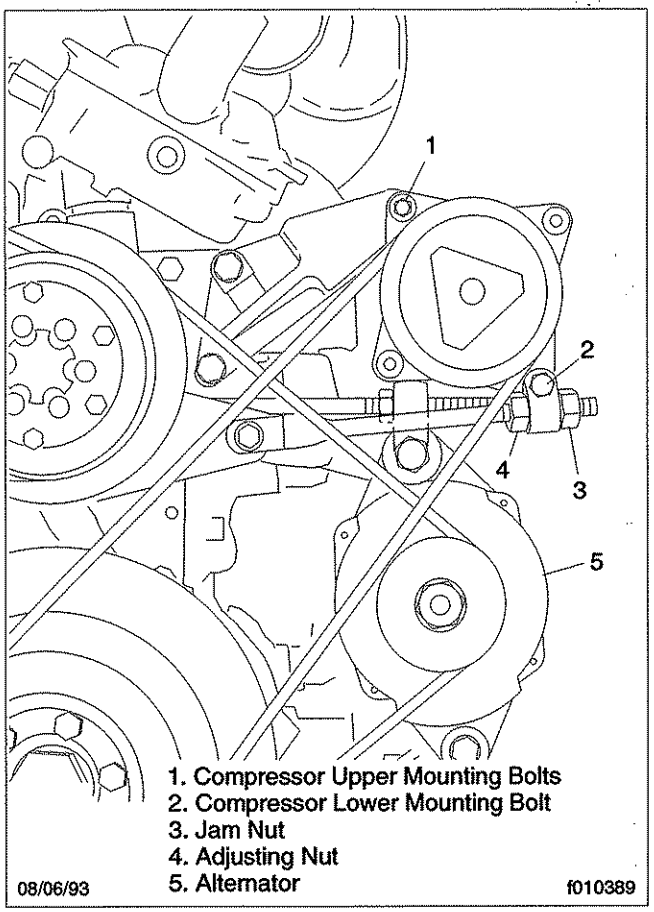


Fig. 3

1.3 When installing the compressor on a completely flushed (cleaned) system, install the compressor as it is; when installing it on a system that has not been flushed, install the compressor after adjusting the amount of oil. For instructions, refer to **Subject 150.**

2. Place the compressor in position against the mounting bracket and install the mounting bolts, washers, and nuts (**Fig. 3**, Refs. 1 and 2).

NOTE: The two long bolts go on top.

3. Hand tighten the nuts.

4. Install the V-belt. Adjust the belt tension. For instructions, the applicable section in **Group 01.**

5. Tighten the compressor mounting bolts 45 N·m (33 lbf·ft).

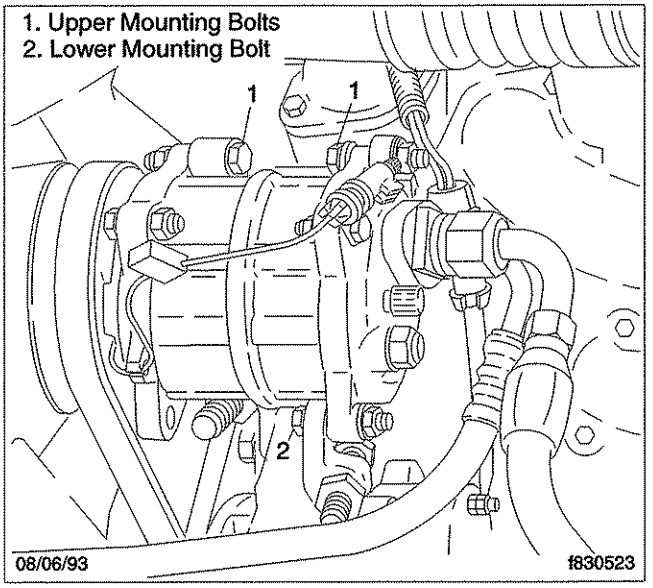


Fig. 4

6. Uncap the suction and discharge ports on the compressor. Unplug the hose connections. Check the hose connections and the surface of the suction and discharge ports. They must be clean and free of nicks, gasket residue, and other foreign material.

IMPORTANT: Under no circumstances should you leave the compressor's ports uncapped or the hoses unplugged for longer than five minutes total.

7. Attach the refrigerant hoses to the system hose connections. Tighten the suction (large) fitting 39 N·m (29 lbf·ft); tighten the discharge (small) fitting 37 N·m (27 lbf·ft).

8. Connect the compressor magnetic clutch electrical wire.

9. Evacuate, charge, and leak test the air conditioning system. For instructions, refer to the heater and air conditioner section in this group.

10. Install the charge air pipe. Tighten the constant torque hose clamps 7 N·m (5 lbf·ft).

Oil Check and Adding Oil to the Compressor

Procedure

IMPORTANT: New compressors are factory-charged with 200 mL (6.8 fl oz) refrigerant oil, which does not require periodic checking. Refrigerant oil circulates through the system with the refrigerant. The oil cannot leave the system except through a leak, when the system is discharged for service, or when a system part is replaced.

Add only FREOL DS-83P refrigerant compressor oil. Oil must be from a container that has not been opened, or that has been tightly sealed since its last use. Tubing, funnels, or other equipment used to transfer the oil should be very clean and dry.

When replacing system parts, add the following amounts of oil to the compressor, to replace that which is lost with the discarded part:

A. *Receiver-dryer*— 80 mL (2.7 fl oz);

B. *Condenser*— 30 mL (1.0 fl oz);

C. *Evaporator coil*— 20 mL (0.7 fl oz) each;

D. *Entire system*— 264 mL (8.9 fl oz). Add this amount of oil to the compressor if the entire system (including the compressor) has been discharged of refrigerant and oil, and all parts and hoses have been flushed.

When handling refrigerant oil:

- The oil should be free of water, dust, metal powder, and other foreign substances.
- Do not mix refrigerant oil with other types or viscosities of oil.
- Refrigerant oil absorbs water when exposed to the air for short periods. After use, quickly seal the oil container.

During normal operation, part of the oil recirculates with the refrigerant in the system. When checking the amount of oil in the system, first run the compressor to return the oil to the compressor.

1. Turn on the air conditioner (the compressor must be engaged), and set the blower fan at high speed.
2. With the compressor engaged, run the engine for at least 20 minutes between 800 and 1200 rpm.
3. After turning off the engine, remove the compressor from the vehicle.
4. Remove the compressor drain plug; then, drain the compressor oil into a clean container. **See Fig. 1.** Rotate the drive plate several times by hand to extract the remaining oil through the discharge-side port. About 30 mL (1 fl oz) of oil will remain in the compressor and cannot be removed without disassembling it.
5. Measure the drained oil with a measuring cylinder.
6. Check the oil for signs of contamination.
   - 6.1 Check for cloudiness or increased opacity.
   - 6.2 Check for a color change to red.
   - 6.3 Check for the presence of foreign particles (metal powder, etc.).

   NOTE: Unlike engine oil, compressor oil contains no added cleaning agent. Even after an entire season of use the oil should not become cloudy, as long as there is nothing wrong with the compressor or the way it is used.
7. If the oil is contaminated, flush all parts of the system and replace the receiver-dryer. For instructions, refer to the heater and air conditioner section in this group.
8. Install the drain plug and a new O-ring lightly coated with clean compressor oil. Tighten the plug 1280 to 1460 N·cm (113 to 130 lbf·in).

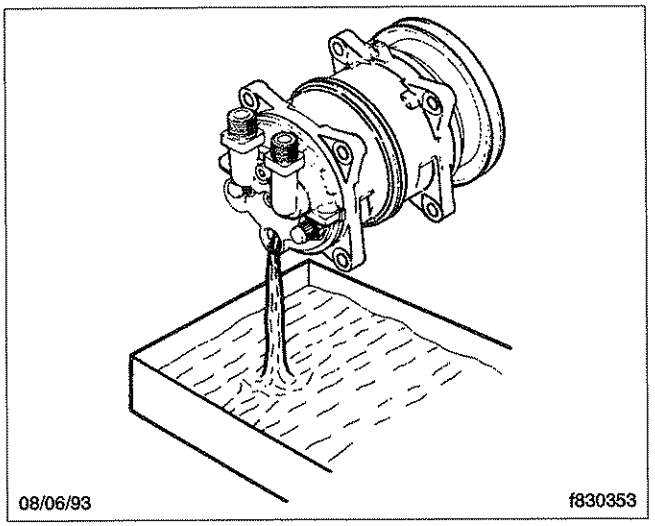


Fig. 1

Oil Check and Adding Oil to the Compressor

9. Fill the compressor with oil through the suction-side hose fitting. **See Fig. 2. Refer to Table 1** for the charging amount.

Collected Amount	Charging Amount
More than 120 mL (4 fl oz)	Same as collected amount; do not exceed 264 mL (8.9 fl oz)
Less than 120 mL (4 fl oz)	120 mL (4 fl oz)

Table 1

10. If an oil return operation (above) could not be done, check the compressor oil as follows:
    - 10.1 Remove the damaged compressor from the vehicle.
    - 10.2 Remove the drain plug, and drain the oil.
    - 10.3 Using a measuring cylinder, measure the drained oil.
    - 10.4 Check the oil for contamination.
    - 10.5 Fill the new compressor with oil through the suction-side connector. Refer to the table above for the correct amount of oil.
    - 10.6 Install the new compressor on the vehicle.

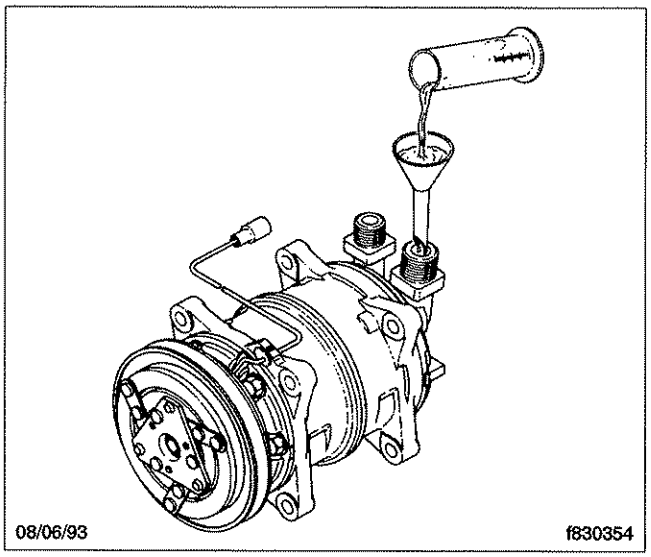


Fig. 2

- 10.7 Perform the oil return operation.
- 10.8 Remove the compressor and check the amount of oil again.
- 10.9 Fill the compressor with oil again. **Refer to Table 1** for the correct amount of oil.

Magnetic Clutch Assembly Removal, Inspection, and Installation

Removal (Refer to Fig. 1)

NOTE: The special tools available from independent suppliers may look different from those shown in the figures below, but they are functionally identical.

1. Remove the compressor from the vehicle. For instructions, **refer to "Compressor Removal and Installation, 140."**
2. Remove the center bolt using the drive plate holder[1] to prevent drive-plate rotation. **See Fig. 2.**
3. Using the drive-plate puller[1], remove the drive plate. **See Fig. 3.** Then, remove the shims from either the driveshaft or the drive plate.
4. Using external snap-ring pliers, remove the snap ring; then, remove the cover. **See Fig. 4.**
5. Using the pulley puller and the spacer [1] positioned on the cylinder head hub, remove the pulley assembly. **See Fig. 5.**

NOTE: To avoid damaging the pulley groove, the puller claws should be hooked into (not under) the pulley groove.

6. Remove the coil's lead wire from the wire holder on the compressor; then, remove the three screws and the coil. **See Fig. 6.**

⚠ CAUTION

CAUTION: Do not hold the coil by the lead wire. This could damage the coil.

Inspection (Refer to Fig. 7)

1. Inspect the drive plate. If the frictional surface shows signs of damage due to too much heat, replace the drive plate and pulley assembly.
2. Check the appearance of the pulley assembly. If the frictional surface of the pulley shows signs

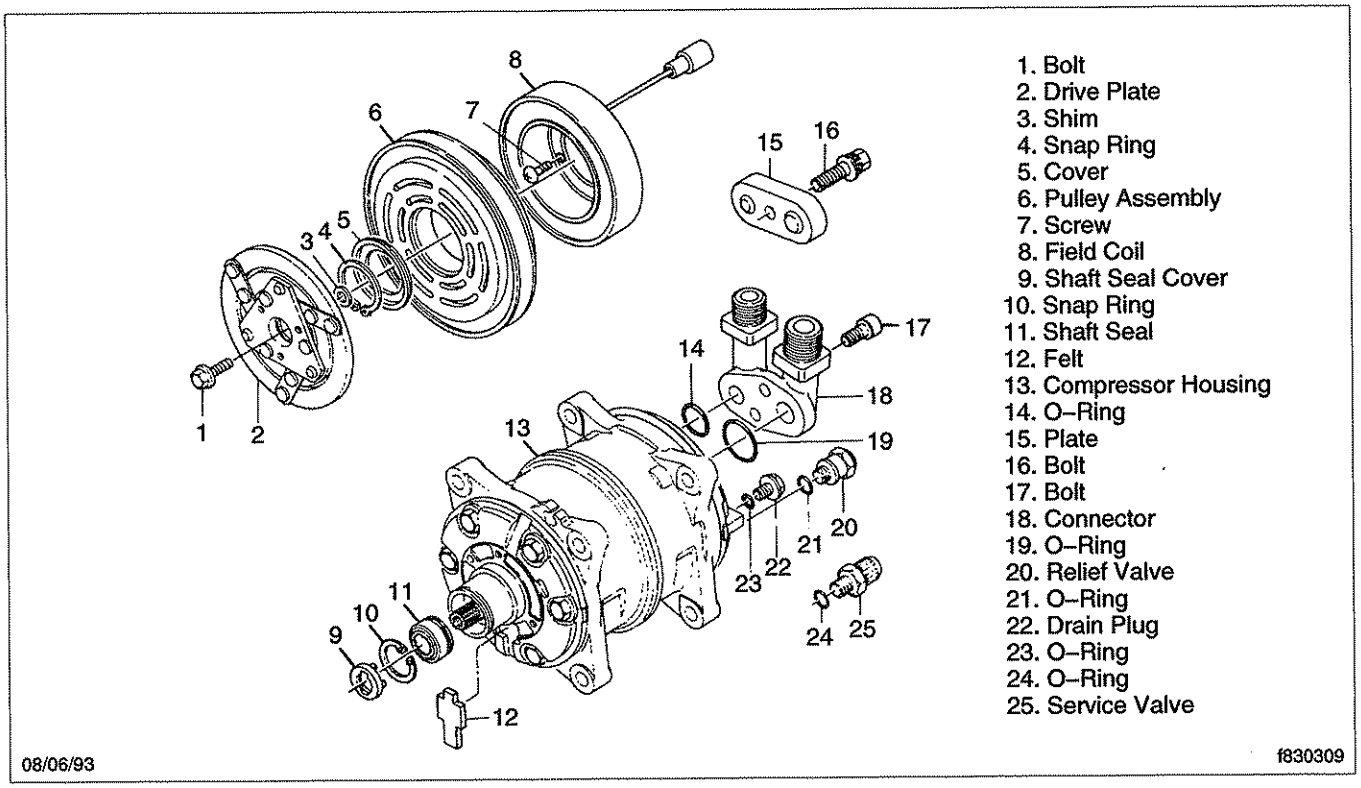


Fig. 1

[1] **Refer to "Specifications, 400"** for suppliers of the special tools.

Magnetic Clutch Assembly Removal, Inspection, and Installation

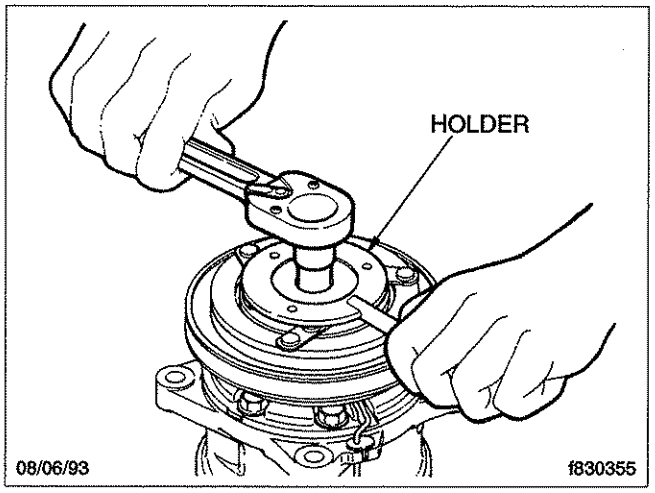


Fig. 2

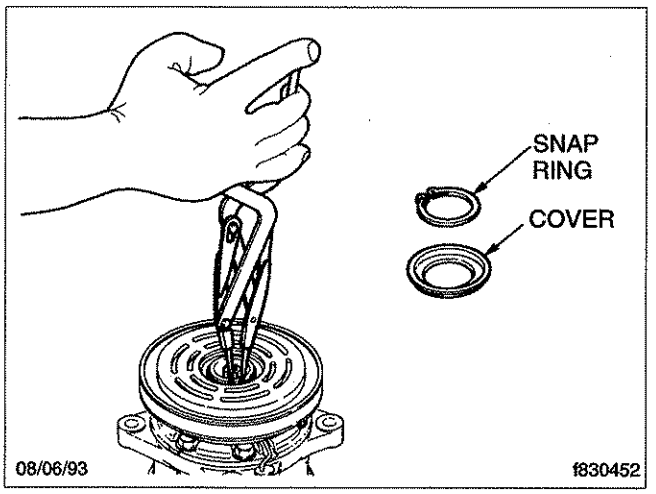


Fig. 4

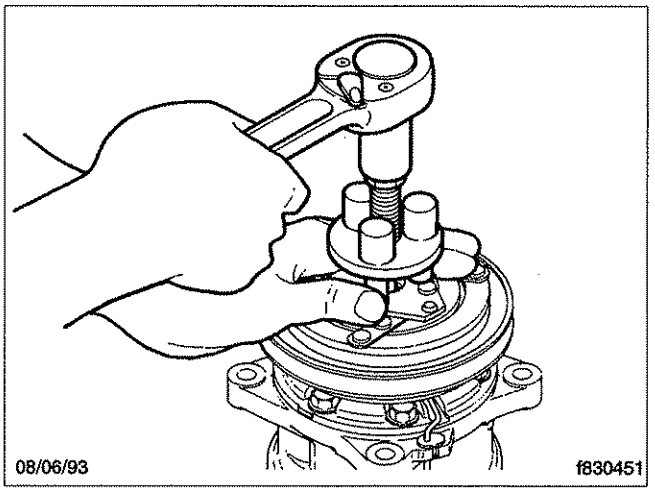


Fig. 3

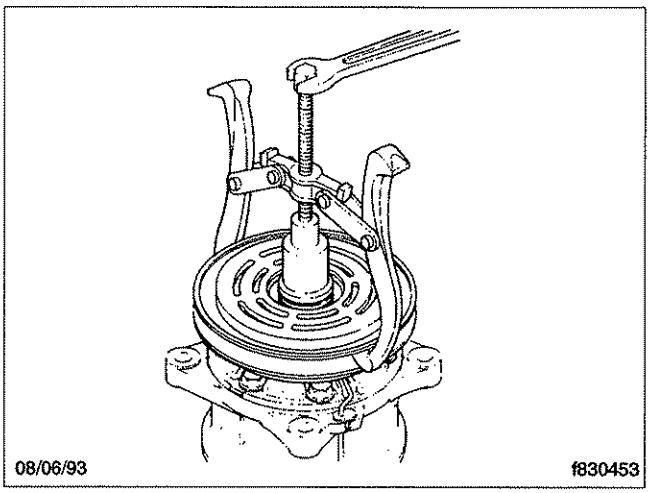


Fig. 5

of too much grooving due to slippage, replace both the pulley and drive plate. Clean the frictional surfaces of the pulley assembly before installing it.

3. Check the coil for a loose connector and for cracked insulation. Replace it if necessary.

Installation

1. Make sure the felt is installed on the front cylinder head. **See Fig. 8.**
2. Install the coil on the compressor (lead wire on top).
3. Make sure the concave portion of the coil is aligned with the felt; then, tighten the mounting screws 400 to 580 N·cm (35 to 52 lbf·in). **See Fig. 8.**
4. Install the lead wire in the wire holder on the compressor.
5. Using the installation tool [1] and a hand press, install the pulley assembly. **See Fig. 9.** Install the bearing cover and the snap ring. **See Fig. 10.**

NOTE: The chamfered edge of the snap ring should face upward.

Magnetic Clutch Assembly Removal, Inspection, and Installation

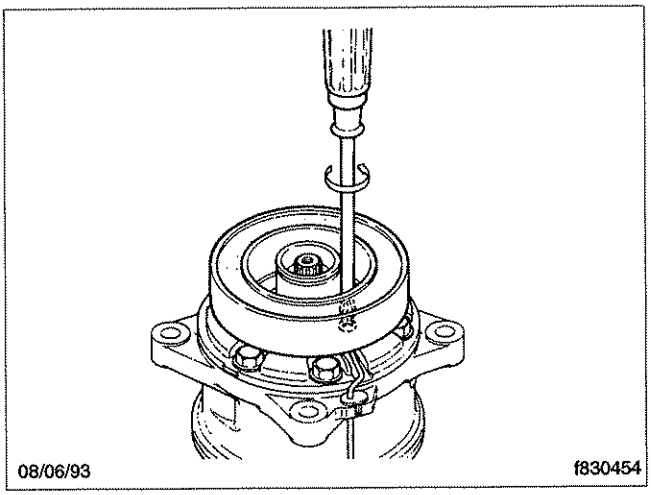


Fig. 6

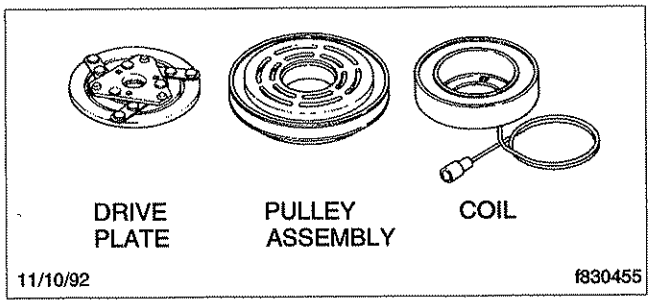


Fig. 7

6. Install the drive plate on the compressor driveshaft, together with the original shim(s). **See Fig. 11.** Press the drive plate down by hand.
7. Using the clutch holder [1] to prevent drive-plate rotation, tighten the bolt 1180 to 1360 N·cm (104 to 121 lbf·in).

NOTE: After tightening the bolt, check that the pulley turns smoothly.

8. Using a feeler gauge, check that the clutch clearance is 0.3 to 0.6 mm (0.01 to 0.02 inch). **See Fig. 12.** Adjust the clearance using shims, as necessary. Adjusting shims are available in the following thicknesses: 0.1 mm; 0.3 mm; 0.5 mm; 0.8 mm; and 2.2 mm.
9. Install the compressor on the vehicle. For instructions, **refer to "Compressor Removal and Installation, 140."**
10. Perform a running-in operation on the clutch. For instructions, **refer to "Running-In Operations, 180."**

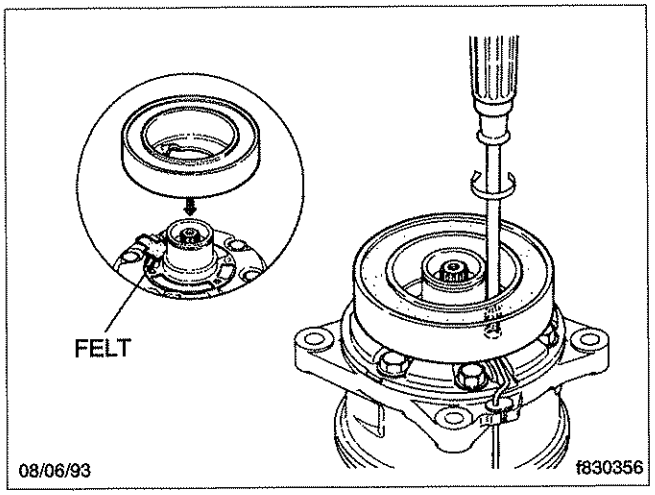


Fig. 8

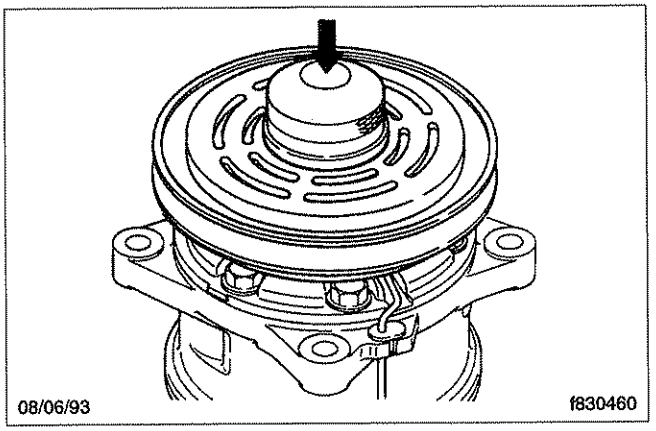


Fig. 9

Magnetic Clutch Assembly Removal, Inspection, and Installation

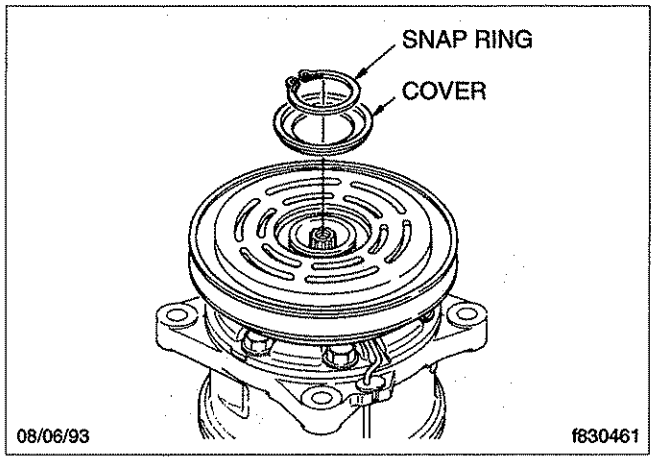


Fig. 10

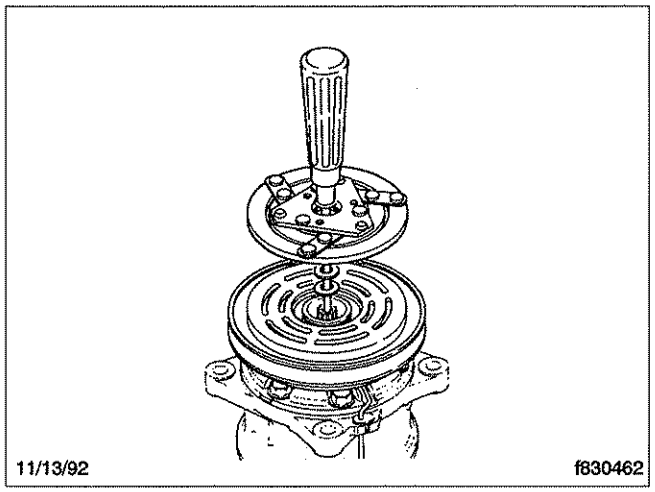


Fig. 11

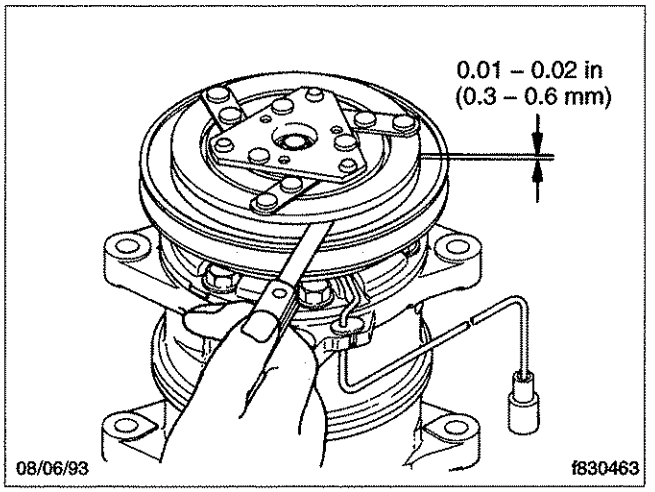


Fig. 12

Replacement

NOTE: The special tools available from independent suppliers may look different from those shown in the figures below, but they are functionally identical.

1. Remove the magnetic clutch assembly, as described in **"Magnetic Clutch Removal, Inspection, and Installation: Removal, 160."**
2. Remove the felt. **See Fig. 1.**
3. Using the remover[2], remove the shaft seal cover by engaging the hook on the remover with the hook on the shaft seal cover and slowly drawing out the cover. **See Fig. 1.** Discard the shaft seal cover.
4. Using internal snap-ring pliers, remove the snap ring. **See Fig. 2.**
5. Using the remover[2], remove the shaft seal by engaging the hook on the remover with the hook on the shaft seal and slowly drawing out the shaft seal. **See Fig. 3.**

NOTE: The shaft seal and shaft seal cover should not be re-used. Always use a new seal kit. Be very careful that the lip of the shaft seal to be installed is not scratched or damaged in any way. Make sure the shaft seal is free of lint and dirt, which could damage the shaft seal surface.

6. Clean the sealed section of the front cylinder head.
7. Apply clean compressor oil to the new shaft seal and to the front cylinder head. If the slip faces are dirty, clean them with thinner, dry them, and apply clean compressor oil to them.
8. Install the guide[2] onto the end of the driveshaft. **See Fig. 4.**
9. Insert the shaft seal over the guide into the front cylinder head. **See Fig. 5.**
10. Using the installing end of the remover[2], install the shaft seal as far as possible into the front cylinder

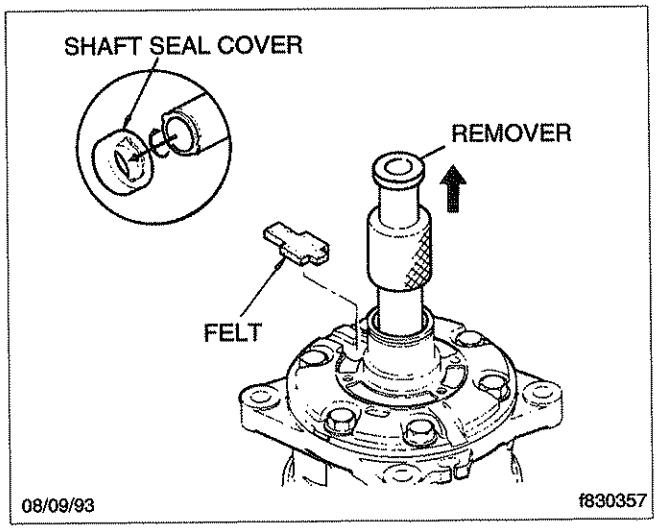


Fig. 1

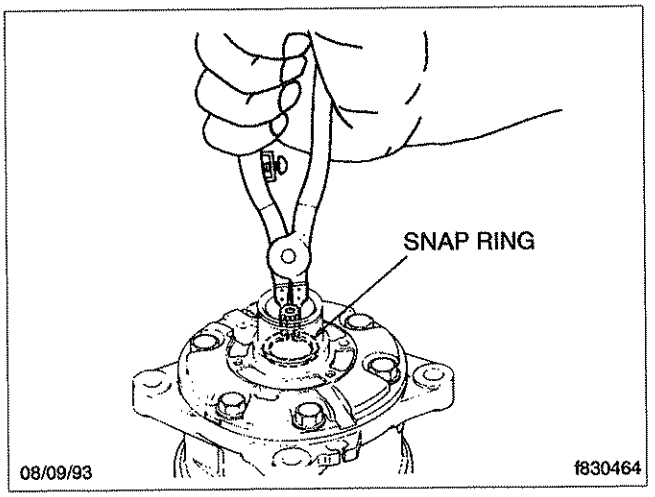


Fig. 2

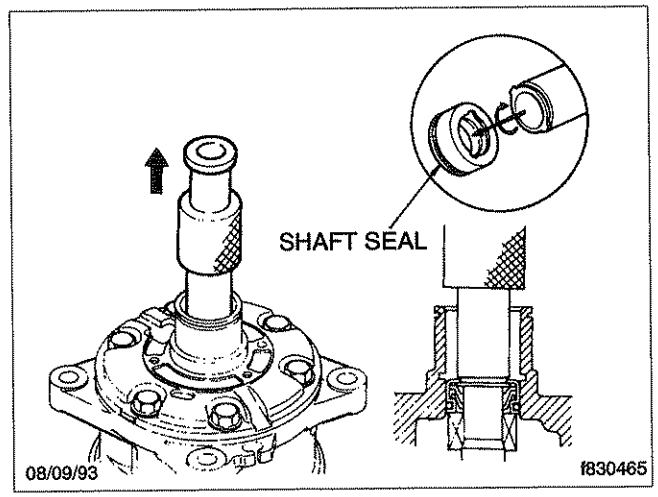


Fig. 3

[2] **Refer to "Specifications, 400"** for suppliers of the special tools.

Shaft Seal Replacement

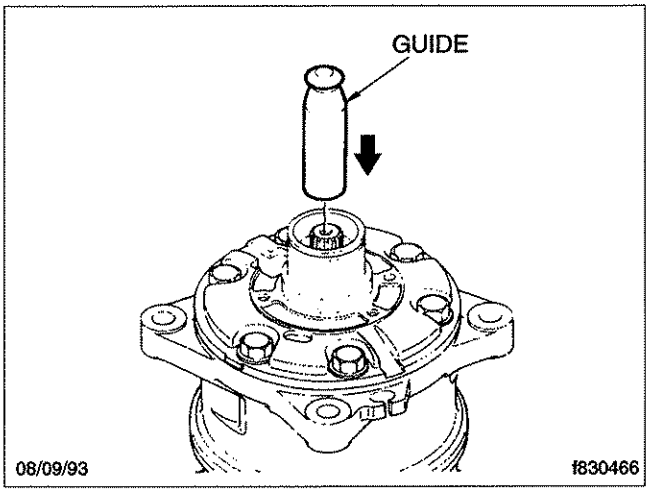


Fig. 4

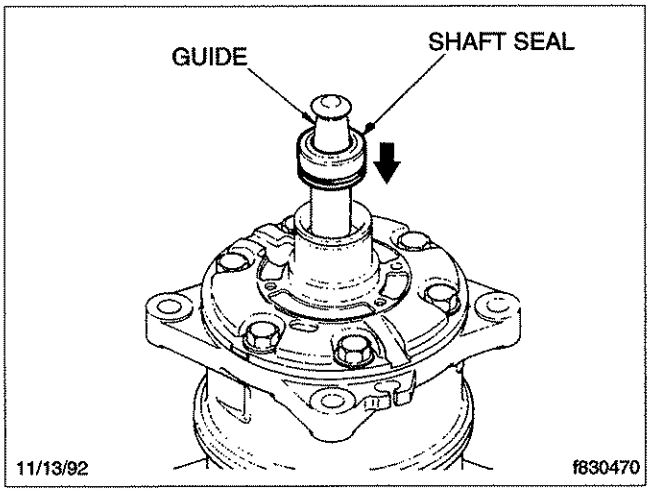


Fig. 5

head. **See Fig. 6.** Remove the guide installed earlier from the driveshaft.

11. Using internal snap-ring pliers, install the snap ring. **See Fig. 7.** Press the snap ring using the installing end of the remover[2] until a click is heard.

NOTE: When installing the snap ring, the round edge of the snap ring must face downward, **as shown in Fig. 8.**

12. Fit the guide[2] onto the end of the driveshaft. **See Fig. 9.** Using the installing end of the remover[2], install the shaft seal cover.

NOTE: The installation position of the shaft seal cover is shown **in Fig. 10.**

13. Install a new felt. **See Fig. 10.**

14. Install the magnetic clutch assembly, as described in **"Magnetic Clutch Removal, Inspection, and Installation, 160."**

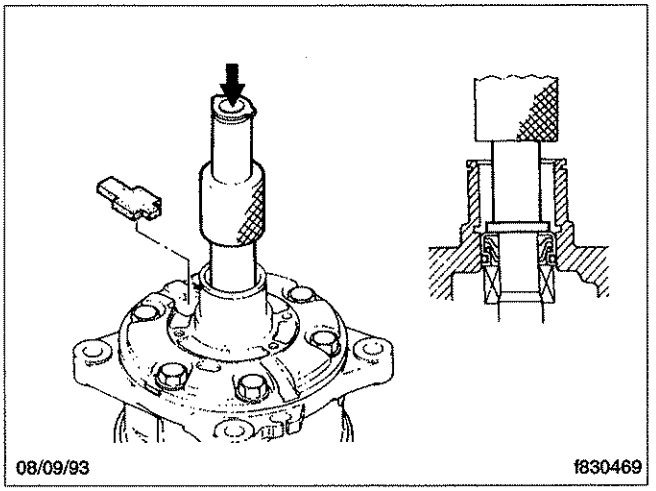


Fig. 6

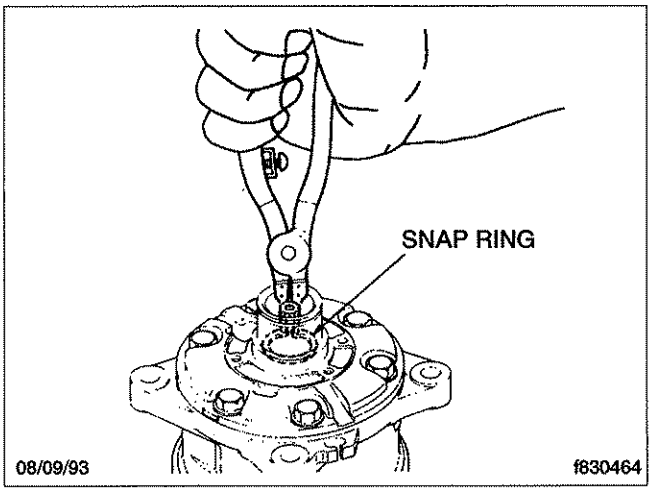


Fig. 7

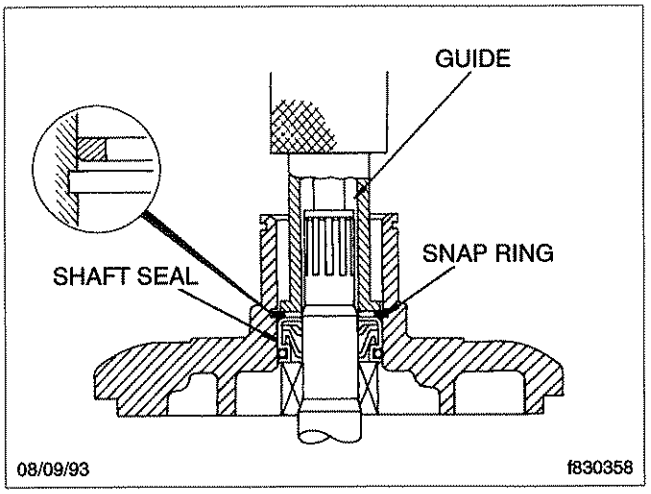


Fig. 8

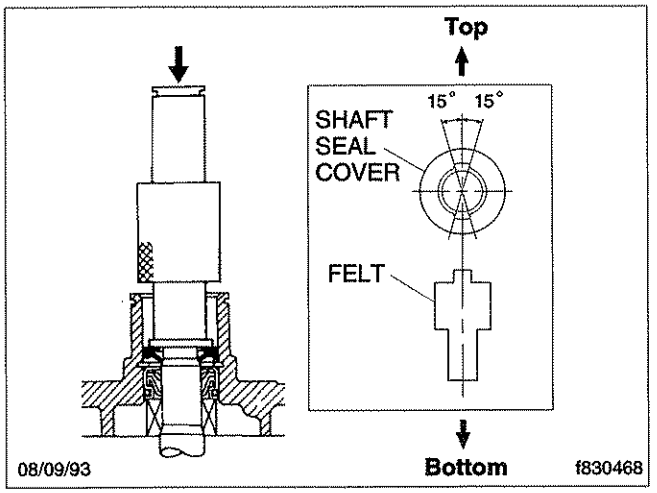


Fig. 10

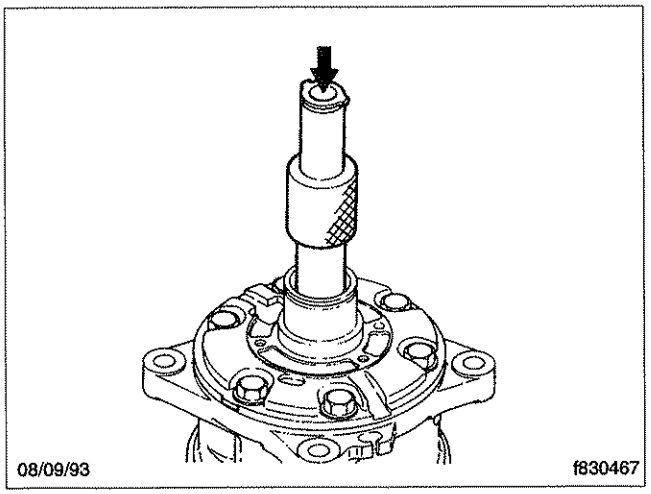


Fig. 9

Leak Test

Check the compressor for refrigerant leaks after it is repaired, as follows:

1. Install blanking caps in the suction and discharge fittings on the compressor.
2. Connect a manifold gauge set to the compressor's service ports. Close the discharge hand valve on the manifold. Fill refrigerant gas through the service port on the suction side fitting, raising the pressure to at least 482 kPa (70 psi).
3. Check the compressor for leakage using a leak detector.
4. Slowly release the refrigerant from the compressor. Remove the caps just before connecting the hoses to the compressor.

Magnetic Clutch Running-In

1. Install the compressor on the vehicle, and charge the system with refrigerant.
2. Turn on the engine and the air conditioner. Keep the compressor's speed at 500 rpm.
3. Operate the air conditioner switch on the climate control panel through the on and off cycle at least 50 times (on for 10 seconds; off for 10 seconds).

Storing a Repaired Compressor

Procedure

If it is necessary to store a repaired compressor for some time before installation, evacuate the compressor and fill refrigerant through the service port on the suction side fitting to raise the refrigerant pressure to 482 kPa (70 psi).

Specifications

Special tools can be purchased from the following independent suppliers:

Classic Tool Design
31 Walnut St.
New Windsor, NY 12550
(914) 562-8700

Mastercool USA Inc.
216 Route 10, Bldg. 3
Randolph, NJ 07869
(201) 366-1101

Description	Torque	
	N·cm (lbf·in)	N·m (lbf·ft)
Adjusting Rod Jam Nut	—	190 (140)
Compressor Mounting Nuts	—	45 (33)
Compressor Clutch Coil Mounting Screws	400–580 (35–52)	—
Clutch Assembly Bolt	1180–1360 (104–121)	—
Oil Drain Plug	1280–1460 (113–130)	—

Table 1, Torque Values, DKS–15CH

Model	Refrigerant Oil
DKS–15CH	FREOL DS-83P

Table 2, Refrigerant Oil Specifications

Outside Temperature °C (°F)	Maximum Center Vent Temperature °C (°F)	Operating Suction Pressure (Low Side) kPa (psig)	Maximum Liquid Line Pressure (High Side) kPa (psig)
16 to 27 (60 to 80)	14 (58)	55–103 (8–15)	1138 (165)
27 to 32 (80 to 90)	16 (60)	83–124 (12–18)	1276 (185)
32 to 38 (90 to 100)	18 (64)	103–138 (15–20)	1413 (205)

Table 3, Temperature/Pressure Specifications

Contents

Subject	Subject Number
General Information	050
Service Operations	
Safety Precautions	100
Pre-Service Checks	110
Compressor Suction and Discharge Pressure Checking	120
Compressor Removal and Installation	130
Oil Check and Adding Oil to the Compressor	140
Magnetic Clutch Removal, Inspection, and Installation	150
Shaft Seal Replacement	160
Head and Valve Plate Removal and Installation	170
Pistons, Connecting Rods, Crankshaft, and Bearing Removal and Installation	180
Specifications	400

General Information

The main purpose of the refrigerant compressor is to draw refrigerant gas from the evaporator and squeeze it into high-pressure gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid so that it can be used for cooling again. A second purpose of the compressor is to move refrigerant through the air conditioner system.

The compressor is cycled by a thermostatic switch, which is located on the blower motor housing in the cab. When there is enough of a temperature drop in the cab, the switch breaks the circuit to the compressor's magnetic clutch. When the clutch is disengaged, its pulley is free-wheeling and the compressor shaft is not turning. When the clutch is engaged, it holds to the pulley, and the turning of the pulley causes the compressor shaft to turn.

The Climate Control compressor is a two-piston design. The pistons are driven by a crankshaft and connecting rods. Refer to the heater and air conditioner section in this group for other information.

Safety Precautions

⚠ CAUTION

CAUTION: Different refrigerant oils are used in compressors on R–12 and R–134a air conditioning systems. Always use the correct refrigerant oil and never mix oils. If the wrong oil is used, or if oils are mixed, the compressor could seize due to improper lubrication.

Refrigerant R–134a Air Conditioning Systems

Whenever repairs are made to any air conditioner parts that hold R–134a refrigerant, you must recover, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the refrigerant charge has been recovered (discharged) at the service valves.

Refrigerant R–134a is safe when used under the right conditions. Always wear safety goggles and non-leather gloves while recovering, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

⚠ WARNING

WARNING: Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should be rinsed with lukewarm water, not hot or cold. Do not rub the eyes. Apply a light bandage and contact a physician right away.

Refrigerant splashed on the skin should be rinsed with lukewarm water, not hot or cold. Do not rub the skin. Apply a light coat of a nonmedicated ointment, such as petroleum jelly. Contact a physician right away.

R–134a refrigerant does not burn at ambient temperatures and atmospheric pressure. However, it can be combustible at pressures as low as 139 kPa absolute (5.5 psig) at 177°C (350°F) when mixed with air concentrations that are greater than 60 percent.

⚠ WARNING

WARNING: R–134a air conditioning systems should not be pressure tested or leak tested with compressed air (R–134a may be safely pressured with dry nitrogen). Combustible mixtures of air and R–134a may form, resulting in a fire or explosion, which could cause personal injury or property damage.

You must work in an area where there is a constant flow of fresh air when the system is recovered, evacuated, charged, and leak tested. R–134a vapors have a slightly sweet odor that is difficult to detect. Frequent leak checks and air monitoring equipment are recommended to ensure a safe working environment.

IMPORTANT: When servicing an R–134a air conditioning system, use only service equipment certified to meet the requirements of SAE J2210 (R-134a recycling equipment). The equipment should be operated only by qualified personnel who are familiar with the recycling station manufacturer's instructions.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant containers from exploding, never expose them to temperatures higher than 52°C (125°F).

On R–134a refrigerant systems, polyalkylene glycol (PAG) or polyol ester (POE) oil is used in the compressor. When handling these oils, observe the following:

- keep the oil free of contaminants
- do not expose the a/c system or the oil container to air for long periods of time; PAG and POE oils have a high moisture absorption capacity
- use care when handling: painted surfaces, plastic parts, and other components (drive belts) could be damaged if the oil is spilled on them
- never mix the oils with other types of refrigerant oil

Refrigerant R–12 Air Conditioning Systems

Whenever repairs are made to any air conditioner parts that hold refrigerant, you must discharge, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the air conditioning system has been

Safety Precautions

discharged to a refrigerant recovery unit through the service valves on the compressor.

Refrigerants are safe when used under the right conditions. Always wear safety goggles and non-leather gloves while discharging, purging, flushing, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

⚠ WARNING

WARNING: Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should first be treated with a few drops of sterile mineral oil in the eyes, and then rinsed with a weak boric acid solution. Do not rub the eyes. Call a doctor right away.

Refrigerant splashed on the skin should be treated the same as for frostbite: gently pour cool water on the area, but do not rub the skin. Keep the skin warm with layers of soft, sterile cloth. Call a doctor right away.

Even though refrigerant does not burn, when it contacts extreme heat or flame, poisonous phosgene gas is created. This gas also is produced when an open flame leak detector is used. Phosgene fumes have an acrid (bitter) smell.

⚠ WARNING

WARNING: Do not work in an area where refrigerant may contact an open flame or any burning material, such as a cigarette. When it contacts extreme heat, refrigerant breaks down into poisonous phosgene gas which, if breathed, causes severe respiratory irritation. Do not breathe the fumes from an open flame leak detector.

You must work in an area where there is a constant flow of fresh air when the system is discharged, flushed, charged, and leak tested using an open flame leak detector.

Changes in both federal and state laws will affect the way dealerships service air-conditioning systems. Under current federal laws, refrigerant R–12 must be recovered and recycled by all users to protect the environment, and not released into the atmosphere. Many service operations not directly involving the air-conditioning system require the release of the refrigerant charge. Under the new regulations, dealerships not having the required recovery and recycling equipment (and properly trained and certified personnel) will not be allowed to do any of this service work.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant cans from exploding, never expose them to temperatures higher than 52°C (125°F). Never leave refrigerant cans in the sun, and do not store them in sun-exposed areas where heat can build up, such as in gloveboxes, automobile trunks, etc.

Pre-Service Checks

⚠ WARNING

WARNING: Before doing any work, read the information under Safety Precautions, 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

⚠ CAUTION

CAUTION: Determine if the air conditioning system is charged with refrigerant R–134a or R–12. Check the label on the radiator shroud (the side the compressor is on), the compressor identification tag, and the caution labels on system components, for verification. Service procedures are different for these refrigerant systems. Failure to properly identify the refrigerant system prior to servicing could cause component malfunction and system contamination.

Some special tools are needed for doing repair work on the compressor. Refer to **Specifications, 400.**

The checks below should be made whenever the air conditioning system is not cooling enough and the causes are unknown.

1. Be sure to check the moisture indicator, to see if moisture is the cause of the problems. The air conditioner should be on when checking the indicator; it is better to check it at the end of a day's run.
2. Check the drive belt and mounting as follows:
   - 2.1 On the drive belt, look for wear, damage, or oil. If worn, oil-soaked, or damaged, remove it and install a new one. Refer to **Group 01** in this manual for instructions.
   - 2.2 Check the compressor mounting parts for loose fasteners, cracks, or other damage. Tighten loose fasteners to the following torque values:
     - Compressor Mounting bolt, 3/8–16: 47 N·m (35 lbf·ft)
     - Compressor mounting bracket pivot bolt, 1/2–13: 81 N·m (60 lbf·ft)
   - 2.3 Repair or replace cracked or damaged brackets.
   - 2.4 Check the tension of the compressor drive belt. Refer to **Group 01** in this manual for instructions.
3. Check the wiring and connections to the compressor clutch. Replace damaged wiring and tighten loose connections.
4. Check for road debris build-up on the condenser coil fins. Using air pressure and a whiskbroom or a solution of soap and water, carefully clean the condenser; be careful not to bend the fins.
5. Check the refrigerant charge in the air conditioning system; for instructions, refer to the applicable heater and air conditioner section in this group.
6. Check the suction pressure and discharge pressure of the refrigerant compressor; refer to **Subject 120.**

NOTE: For other possible causes of air conditioner problems, refer to the applicable heater and air conditioner section in this group.

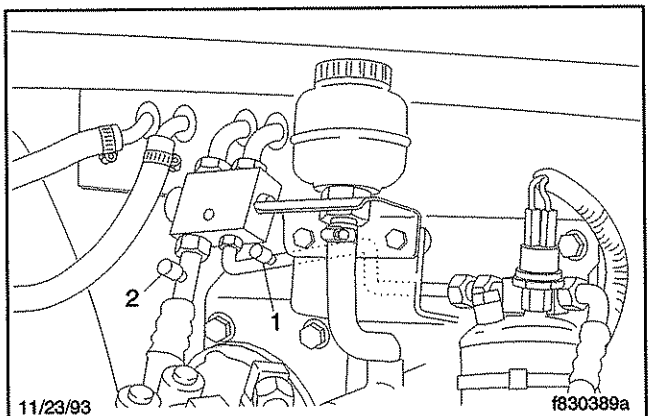
Compressor Suction and Discharge Pressure Checking

Checking

⚠ WARNING

WARNING: Before doing any of the work below, read the information under Safety Precautions, 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

1. Attach a manifold gauge set to the service ports. Make sure that the manifold gauge set is equipped with a valve core depressor.
   - 1.1 Remove the protector caps from the service valve ports on the compressor (R–12 systems), or at the firewall (R–134a systems). **See Fig. 1.**
   - 1.2 Make sure that the valves on the recovery and recycling station are closed. Cap the manifold center hose.
   - 1.3 Connect the red high-side hose to the discharge service valve, and the blue low-side hose to the suction service valve.
2. Start the engine and set it to run at 1500 rpm.
3. Turn on the heater-air conditioner blower, and set the air conditioner controls to the coldest setting, so that the compressor is operating. If the outside temperature is cooler than 70°F (21°C), *partially* block the air to the condenser.



1. Dischage Service Valve
2. Suction Service Valve

Fig. 1, Service Port Locations, R–134a System

4. Look at the manifold suction and discharge pressure gauges. The pressure on the gauges should be within the range in **Table 1** or **Table 2.**
   - 4.1 If the suction and discharge pressures are both too high, there is air in the refrigerant, or too much refrigerant in the system; check the charge; for instructions, refer to the applicable heater and air conditioner section in this group.
   - 4.2 If the suction pressure is too high and the discharge pressure is normal, check the wiring to the thermostatic switch on the blower motor housing; repair or replace the wiring, as needed. If the wiring is correct and there is power to the switch, check that the probe of the thermostatic switch is correctly installed in the evaporator coil. Refer to the applicable heater and air conditioner section in this group for instructions. If everything checks out okay, but the problem persists, replace the thermostatic switch at the climate control panel.
   - 4.3 If the suction pressure is too low and the discharge pressure is normal or too low, check for passage of air through the evaporator coils. If airflow is blocked, remove the blockage. If airflow is satisfactory, check for blockages in the line to the suction side of the compressor.
5. If the suction pressure is normal and the discharge pressure is too high, airflow through the condenser may not be enough to carry away the heat.
   - 5.1 Place a large fan in front of the radiator, so that the airflow goes through the condenser. After two minutes of operating the air conditioner and the fan at the same time, look at the manifold pressure gauges again. (One other procedure is to direct a spray of water onto the condenser while the system is running.)
   - 5.2 If the discharge pressure is still too high, the lines between the compressor and the receiver-drier are blocked, or the condenser is blocked internally. Discharge, flush, evacuate, charge, and leak test the system. If the blockage can't be removed by flushing, replace the blocked line or blocked condenser. After flushing and before placing a vacuum in the system, *be*

Compressor Suction and Discharge Pressure Checking

sure to add the correct amount of refrigerant oil to the compressor. For instructions, refer to **Subject 140.**

6. If the suction pressure is normal or too high and the discharge pressure is too low, check for a slipping clutch or wrong-sized clutch pulley or accessory drive pulley. Replace parts as needed.

   If the suction pressure is still normal or too high and the discharge pressure is still too low, the compressor is the problem. Repair or replace the compressor.

Outside Temperature °C (°F)	Maximum Center Vent Temp. °C (°F)	Low Pressure (suction) kPa (psi)	High Pressure (discharge) kPa (psi)
16 to 27 (60 to 80)	14 (58)	41–103 (6–15)	1138 (165)
27 to 32 (80 to 90)	16 (60)	69–124 (10–18)	1276 (185)
32 to 38 (90 to 100)	18 (64)	83–138 (12–20)	1413 (205)

Table 1, Temperature/Pressure Specifications, R–12 Systems

Relative Humidity	Outside Temperature °C (°F)	Maximum Center Vent Temperature °C (°F)	Low Pressure (suction) kPa (psi)	High Pressure (discharge) kPa (psi)
Low (40%)	24 (75)	4 (39)	97 (14)	965 (140)
	29 (85)	4 (39)	103 (15)	1145 (166)
	38 (100)	5 (40)	110 (16)	1503 (218)
High (90%)	24 (75)	3 (38)	97 (14)	896 (130)
	29 (85)	4 (39)	110 (16)	1103 (160)
	38 (100)	5 (40)	124 (18)	1517 (220)

Table 2, Temperature/Pressure Specifications, R–134a Systems

Removal

1. Recover the refrigerant from the air conditioning system; for instructions, refer to the applicable heater and air conditioner section in this group.
2. Disconnect the suction and discharge hose fittings at the compressor. **See Fig. 1.**
3. Plug the hoses to prevent contamination.
4. Disconnect the compressor magnetic clutch electrical connection. **See Fig. 2.**
5. Remove the V-belt. **See Fig. 3, Fig. 4, or Fig. 5.**

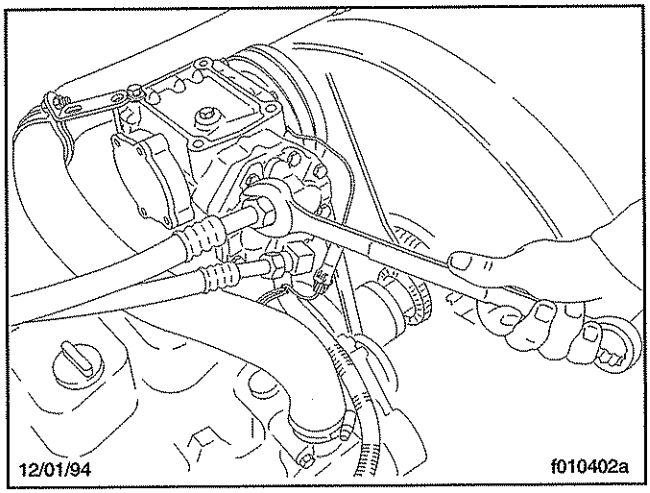


Fig. 1, Disconnect the Suction and Discharge Hose Fittings

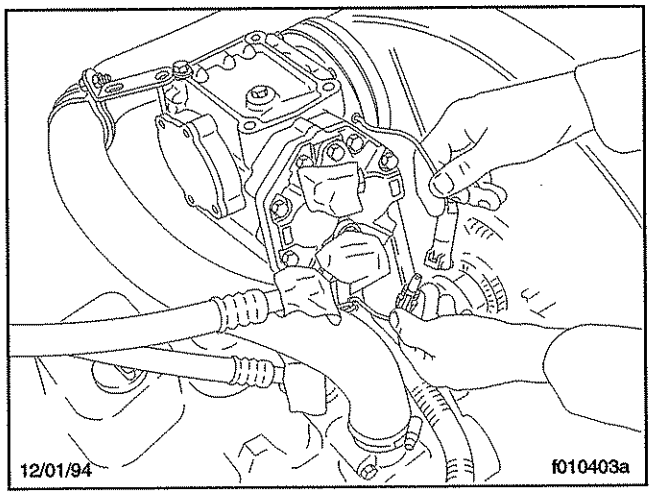


Fig. 2, Disconnect the Electrical Connection

5.1 Loosen the compressor pivot bolts (Ref. 3).

5.2 Loosen the adjusting rod jam nut (Ref. 1), then back off the adjustment nut (Ref. 2) until the belt can be removed.

5.3 Remove the belt. Don't pry or roll it off the pulleys.

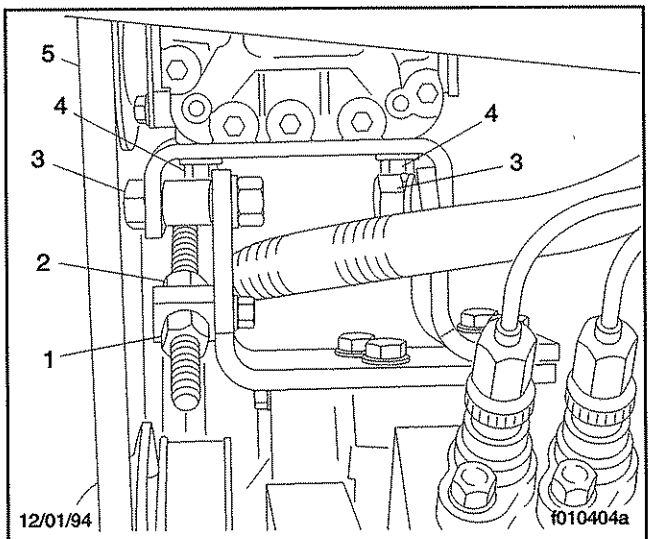
6. Remove the compressor.

6.1 Pivot the compressor mounting bracket for access to the three compressor mounting bolts (**Fig. 3**, Ref. 4).

6.2 Remove the three compressor mounting bolts (Ref. 4).

On Cummins C Series engines, remove the bolt (**Fig. 5**, Ref. 6) that attaches the adjusting rod to the compressor support bracket (Ref. 7).

6.3 Remove the compressor.



1. Jam Nut
2. Adustment Nut
3. Pivot Bolt
4. Compressor Mounting Bolt (3 qty.)
5. V-Belt

Fig. 3, Compressor Mounting on Cummins B Series Engines (earlier installations)

Compressor Removal and Installation

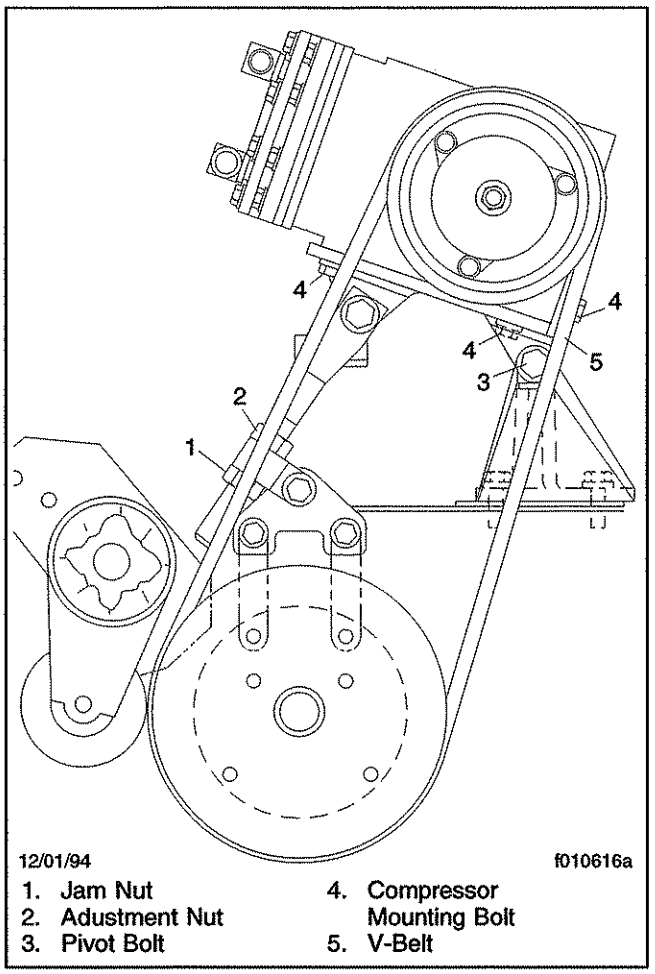


Fig. 4, Compressor Mounting on Cummins B Series Engines (current installations)

Installation

IMPORTANT: A new compressor is filled with refrigerant oil and nitrogen gas. When installing a new compressor on the vehicle, do all of the steps below; if installing a used compressor, position the compressor on the mounting bracket, and begin installation.

1. To prepare a new compressor for installation, gently release the nitrogen gas from the discharge side of the compressor; be careful not to let the oil flow out. Turn the compressor shaft several times by hand to distribute oil which has settled in the cylinder.
2. Position the compressor against the mounting bracket.
3. On Cummins B Series engines, install the mounting bolts and washers to hold the compressor in place. Tighten the nuts 47 N·m (35 lbf·ft).

   On Cummins C Series engines, install the adjusting rod attachment bolt. Tighten the bolt 87 N·m (64 lbf·ft).
4. Install the V-belt.

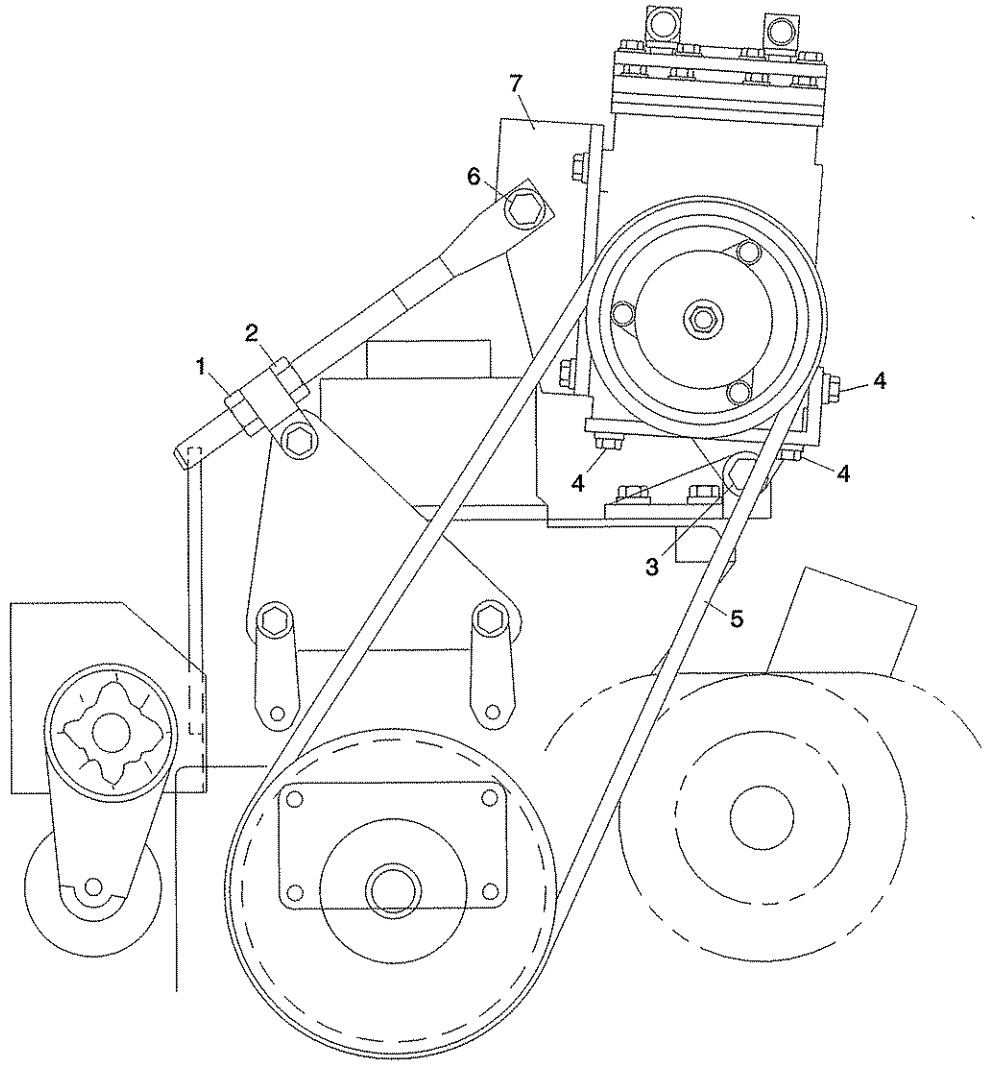
   4.1 Position the V-belt over the pulleys.

   4.2 Adjust the V-belt tension by screwing the adjustment nut on the lower mounting strut in or out. Refer to **Group 01** in this manual for instructions.
5. Tighten the compressor pivot bolts 87 N·m (64 lbf·ft).
6. Uncap the discharge and suction ports. Unplug the suction and discharge hose connections. Check the hose connections and the surface of the discharge and suction ports. Surfaces must be clean and free of nicks, gasket residue, and other foreign matter.

IMPORTANT: Under no circumstances should you leave the compressor's ports uncapped for longer than five minutes total.

7. Connect the refrigerant hoses to the compressor. Tighten the fittings 45 N·m (33 lbf·ft).
8. Connect the electrical wire to the compressor magnetic clutch.
9. Replace the receiver-drier.
10. Check the oil in the compressor as specified in **Subject 140.**
11. Evacuate, charge, and leak test the refrigerant system. For instructions, refer to the applicable heater and air conditioner section in this manual.

Compressor Removal and Installation



1. Jam Nut
2. Adustment Nut
3. Pivot Bolt
4. Compressor Mounting Bolt
5. Fan Belt
6. Adjusting Rod Attaching Bolt
7. Compressor Support Bracket

Fig. 5, Compressor Mounting on Cummins C Series Engines

Oil Check and Adding Oil to the Compressor

Oil Check and Adding Oil

⚠ CAUTION

Different refrigerant oils are used in compressors on R–12 and R–134a air conditioning systems. Always use the correct refrigerant oil and never mix oils. If the wrong oil is used, or if oils are mixed, the compressor could seize due to improper lubrication.

IMPORTANT: On R–12 air conditioning systems, new compressors are factory-charged with about 12.2 oz (360 mL) of refrigerant oil. On R–134a air conditioning systems, new compressors are factory-charged with about 14 oz (414 mL) of refrigerant oil. Some refrigerant oil is circulated through the system with the refrigerant, and cannot leave the system except through a leak, when the system is discharged or recovered, or when a system part is replaced.

Oil must be from a container that has not been opened, or that has been tightly sealed since its last use. Check the labelling on the compressor to determine the recommended refrigerant oil. Tubing, funnels, or other equipment used to transfer the oil should be very clean and dry.

When handling refrigerant oil:

- The oil should be free of water, dust, metal powder, and other foreign substances.
- Don't mix refrigerant oil with other types or viscosities of oil.
- Refrigerant oil absorbs moisture when exposed to the air for any period of time. After use, quickly seal the oil container.

IMPORTANT: Add the same amount of oil that is removed when the system is discharged or recovered, or when a system part is replaced. The two lists that follow provide approximate refill amounts for R–12 and R–134a air conditioning systems. Make sure you use the correct list.

The following is for R–12 air conditioning systems only:

A. Refrigerant charge—0.7 fl oz (20 mL): This amount of oil may be removed from the system each time the system loses its charge, due to routine discharging or due to a slow leak; no other parts of the system have been purged, flushed, or replaced.

IMPORTANT: The items below list oil quantities that include the amounts that are lost during discharging. Do not add an additional 0.7 fl oz (20 mL)—the amount described in the item above—to the quantities listed.

B. Receiver-drier—2.7 fl oz (80 mL);

IMPORTANT: A new receiver-drier may contain 3.4 fl oz (100 mL) of refrigerant oil, eliminating the need to add oil before installation. Confirm the oil level in a new receiver-drier; don't add any oil if it already contains 3.4 fl oz (100 mL).

C. Condenser—1.0 fl oz (30 mL);

D. Evaporator coil—0.7 fl oz (20 mL);

E. Entire system—15 fl oz (450 mL) with or without an auxiliary heater/air-conditioner. Add this amount of oil to the compressor if the entire system (including the compressor) has been discharged of refrigerant and oil, and all parts and hoses have been flushed.

The following is for R–134a air conditioning systems only:

A. Oil charge—the entire system should have *about* 14 fl oz (414 mL) of refrigerant oil. There should be 10 fl oz (296 mL) in the compressor. Each major component has *about* 2.0 fl oz (59 mL) of oil (this amount has been rounded off for ease of adding oil to the compressor). Therefore, additional oil must be added to the compressor when a major component is replaced.

NOTE: As an example, if the condenser and the receiver-drier are to be replaced, first check the oil level of the compressor. The compressor should have 10 fl oz (296 mL). Add oil if needed. Then, after replacing the condenser and the receiver-drier, add an additional 4.0 fl oz (118 mL) of oil to the compressor. The entire system should then have about 14 fl oz (414 mL).

IMPORTANT: Replacing only the amount of oil that is removed during evacuation may result in the wrong oil charge because the oil charge may have been incorrect prior to evacuation. The only way to ensure the proper oil charge is to check the oil level of the compressor with a dipstick.

B. Receiver-drier—when the receiver-drier is replaced, *about* 2.0 fl oz (59 mL) must be added to the compressor in addition to the 10 fl oz (296 mL) that the compressor requires).

Oil Check and Adding Oil to the Compressor

IMPORTANT: A new receiver-drier does not contain any refrigerant oil.

C. Condenser—when the condenser is replaced, *about* 2.0 fl oz (59 mL) must be added to the compressor in addition to the 10 fl oz (296 mL) that the compressor requires.

D. Evaporator coil—when the evaporator coil is replaced, *about* 2.0 fl oz (59 mL) must be added to the compressor in addition to the 10 fl oz (296 mL) that the compressor requires.

IMPORTANT: Check the compressor oil level whenever the system has been opened.

⚠ WARNING

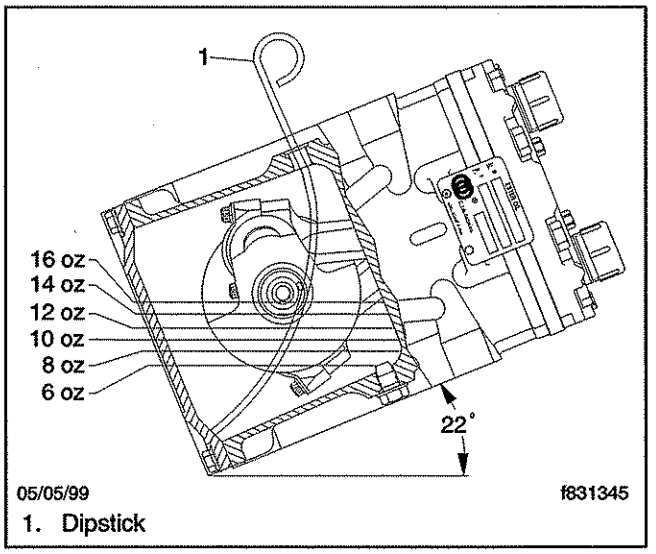
Don't remove the oil fill plug without first recovering or discharging the system. Failure to recover or discharge the system could cause uncontrolled release of high-pressure refrigerant, which can freeze skin and eye tissue causing serious injury or blindness.

1. Remove the oil fill plug and O-ring.
2. Check the oil level with the dipstick. When the compressor is mounted vertically, use either plug; when mounted in any other orientation, use the upper plug. **Figure 1** shows the oil level with the refrigerant compressor mounted at 22 degrees. **Figure 2** shows the oil level with the refrigerant compressor mounted at 45 degrees.

   If the dipstick bottoms out before going in more than 3 inches (75 mm), it is hitting the compressor crankshaft. Rotate the drive plate by hand and insert the dipstick again until it contacts the bottom of the sump. See **Table 1** to determine the oil quantity. Add or remove oil from the compressor so that the oil charge is 10 fl oz (296 mL).

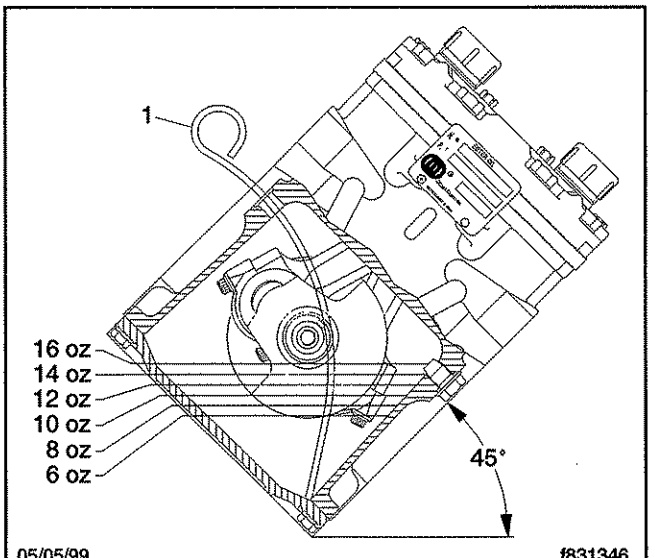
NOTE: A dipstick can be made locally or purchased from a special tools supplier. Refer to the special tools table in **Specifications 400**. If made locally, it can be formed from 1/8-inch diameter by 8-5/16 inch long stock. See **Fig. 3**. Use a nonferrous material that is not subject to corrosion. Notching the end makes it easier to see the oil depth.

3. Being careful not to twist the O-ring, slip it over the oil fill plug threads. Insert the plug in the oil fill opening and tighten it until snug. If the plug leaks, don't attempt to stop the leak by overtightening. Leaks may be caused by dirt under the O-ring, dirt on the seat, a broken O-ring, or a damaged seat on the oil fill plug or opening. Correct the problem and install a new O-ring.



1. Dipstick

Fig. 1, Oil Level With Refrigerant Compressor Mounted at 22 Degrees



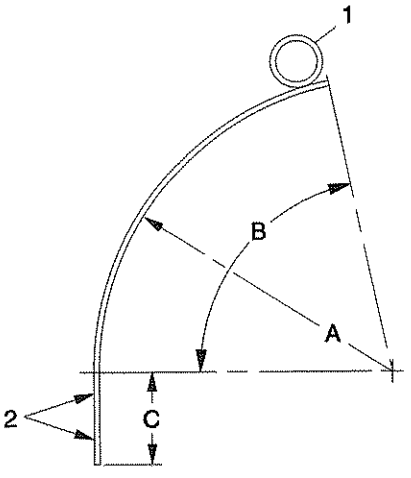
1. Dipstick

Fig. 2, Oil Level With Refrigerant Compressor Mounted at 45 Degrees

Oil Check and Adding Oil to the Compressor

Oil Quantity at Various Dipstick Depths				
Dipstick Depth				Oil Quantity fl oz (mL)
0-Degree Mount (horizontal) inches (mm)	22-Degree Mount inches (mm)	45-Degree Mount inches (mm)	90-Degree Mount (vertical) inches (mm)	
13/16 (20.6)	1-3/4 (44.5)	1-5/8 (41.3)	7/8 (22.2)	6 (177)
1 (25.4)	2-1/16 (52.4)	1-13/16 (46)	1 (25.4)	8 (237)
1-3/16 (30.2)	2-5/16 (58.7)	2 (50.8)	1-1/8 (28.6)	10 (296)
1-5/8 (41.3)	2-9/16 (65.1)	2-1/4 (57.2)	1-7/16 (36.5)	12 (355)
1-13/16 (46)	2-7/8 (73)	2-7/16 (61.9)	1-11/16 (43)	14 (414)
1-15/16 (49.2)	3-1/8 (79.4)	2-5/8 (66.7)	1-7/8 (47.6)	16 (473)

Table 1, Oil Quantity at Various Dipstick Depths



05/03/94 f010242a

NOTE: Left-Hand Mounting: Check oil when shaft key is down. Right-Hand Mounting: Check oil when shaft key is up.

A. 4-3/4 Inches (121 mm) Radius
B. 78°
C. 1-1/2 Inches (38 mm)

1. Finger Ring
2. 12 Notches, 1/8 Inch (3.2 mm) Apart

Fig. 3, Dipstick Specifications

Magnetic Clutch Removal, Inspection, and Installation

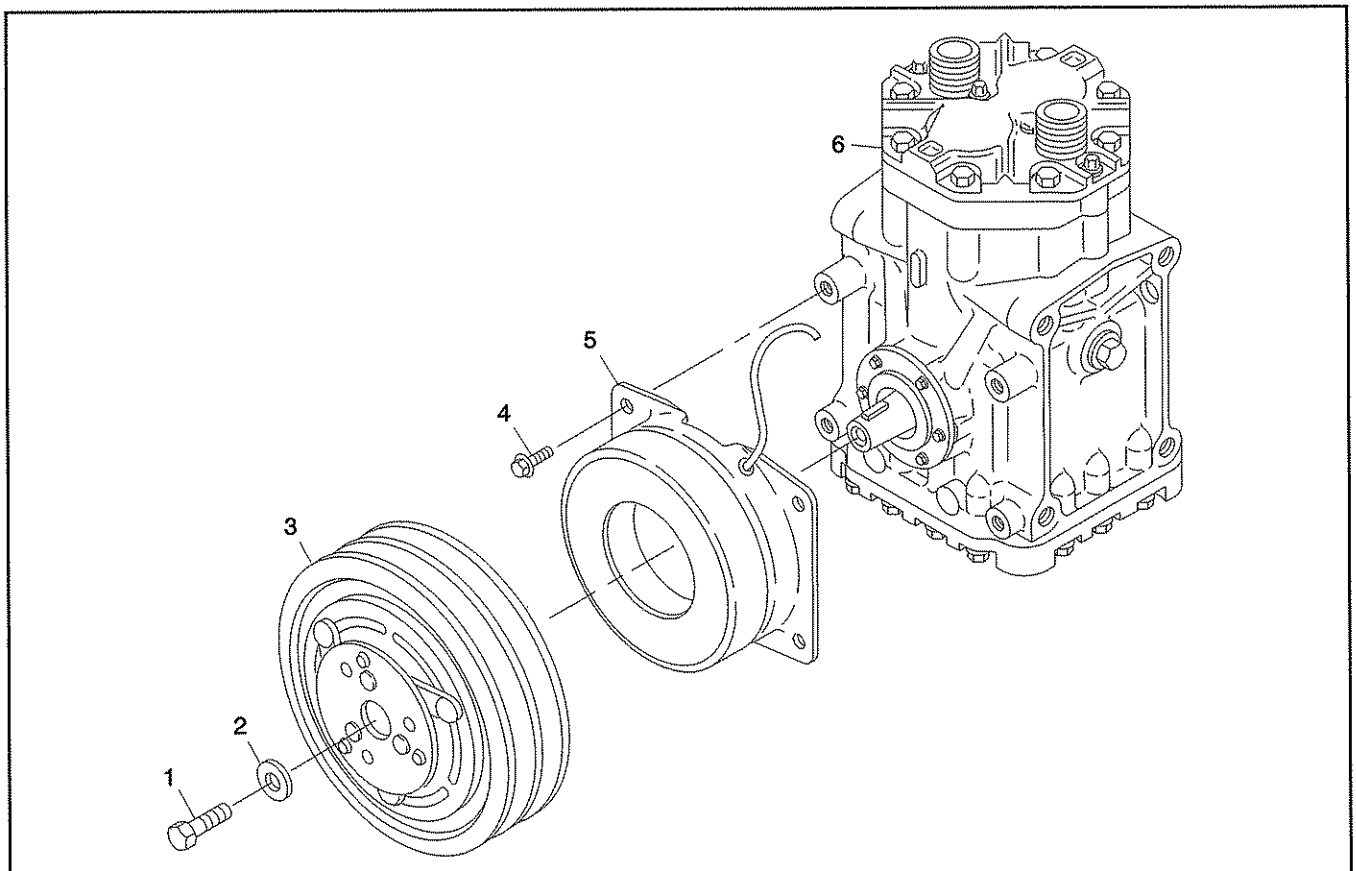
Removal (See Fig. 1)

1. Remove the pulley rotor assembly.
   - 1.1 Remove the 5/16-inch pulley rotor retaining bolt from the center of the pulley rotor.
   - 1.2 Install a 5/8–11 capscrew in the hub of the pulley rotor assembly.
   - 1.3 Tighten the screw to pull the pulley rotor assembly off the compressor shaft.

⚠ CAUTION

CAUTION: Do not try to remove the pulley rotor assembly by prying or hammering. This can damage the assembly.

2. Remove the field coil assembly.
   - 2.1 Disconnect the field coil electrical lead wire.
   - 2.2 Remove the four 1/4–20 capscrews holding the field coil assembly to the compressor housing.



1. Pulley Rotor Retaining Bolt
2. Washer
3. Pulley Rotor Assembly
4. Capscrew
5. Field Coil Assembly
6. Compressor

Fig. 1, Pulley Rotor and Field Coil Assemblies

Magnetic Clutch Removal, Inspection, and Installation

Inspection

1. Inspect the drive plate. If the friction surface shows signs of damage due to too much heat, replace the drive plate and pulley assembly.
2. Check the pulley assembly. If the friction surface of the pulley shows signs of too much grooving due to slippage, replace both the pulley and drive plate. Clean the friction surfaces of the pulley assembly before installing it.
3. Check the coil for a loose connector and for cracked insulation. Replace it, if necessary.

Installation

1. Position the field coil assembly on the compressor housing with the four screw mounting holes aligned with the bosses on the housing.
2. Apply Loctite® 262 or 680 to the four 1/4–20 capscrews (on those threads that do not already have dry Loctite on them).
3. Install the capscrews and gradually tighten them to align the coil assembly. Final torque should be 20 N·m (15 lbf·ft).
4. Taking care to properly align and seat the shaft and hub keyways, attach the pulley rotor assembly to the compressor shaft.
5. Install the 5/16–24 center bolt and washer. Tighten the bolt about 27 N·m (20 lbf·ft).
6. Turn the pulley rotor assembly by hand to make sure it moves freely without interference with the field coil assembly.
7. Connect the lead wire from the field coil to the vehicle electrical circuit.
8. Engage and disengage the clutch several times to check for correct operation.

Replacement (See Fig. 1)

1. Remove the compressor from the vehicle. For instructions, see **Subject 130.**
2. Remove the clutch. For instructions, see **Subject 150.**
3. Remove the seal.
   - 3.1 Remove the dust cover if present.
   - 3.2 Remove the seal cover plate. Using the seal puller, pull out and discard the seal gland. Do not use a screwdriver to pry the seal gland from the compressor shaft; this could damage the shaft. Discard all seal parts including the O-ring.
4. Clean the shaft and seal cavity with a clean lint-free cloth.
5. Install the new seal.
   - 5.1 Dip the new seal gland assembly (**Fig. 1**, Ref. 5) in refrigerant oil.
   - 5.2 Remove the carbon ring from the seal gland assembly; then, push the assembly over the end of the shaft. Make sure the carbon ring retainer is facing out. Use the seal installer tool to move the seal gland assembly into position on the shaft.
   - 5.3 Place the carbon ring in the ring retainer so the lapped surface is facing out. The indentations in the outside edge of the carbon ring must engage the driving lugs and be firmly seated in the retainer.
   - 5.4 Coat a new O-ring with refrigerant oil so it will stick; then, install it in the seal cover plate groove.
   - 5.5 Install the seal cover plate so there is equal clearance around the shaft. Install the capscrews, and tighten them 60 to 84 lbf·in (680 to 940 N·cm) in the sequence shown in **Fig. 2.**
   - 5.6 Place the dust cover on the shaft before inserting the shaft key. As the clutch bolt is tightened, the dust cover will be drawn into the proper position.
6. Install the clutch. For instructions, see **Subject 150.**

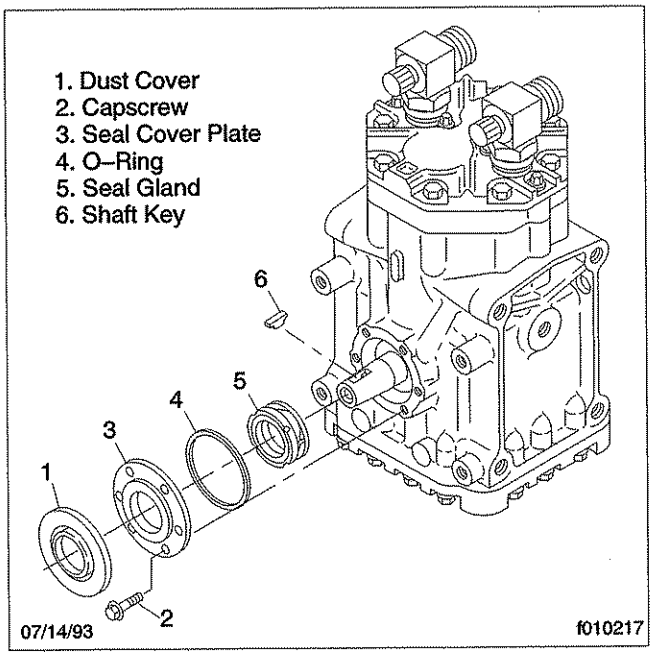


Fig. 1

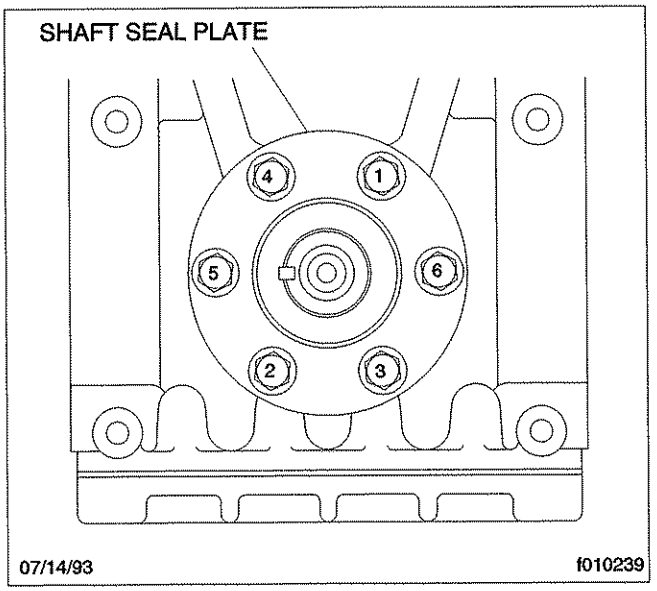


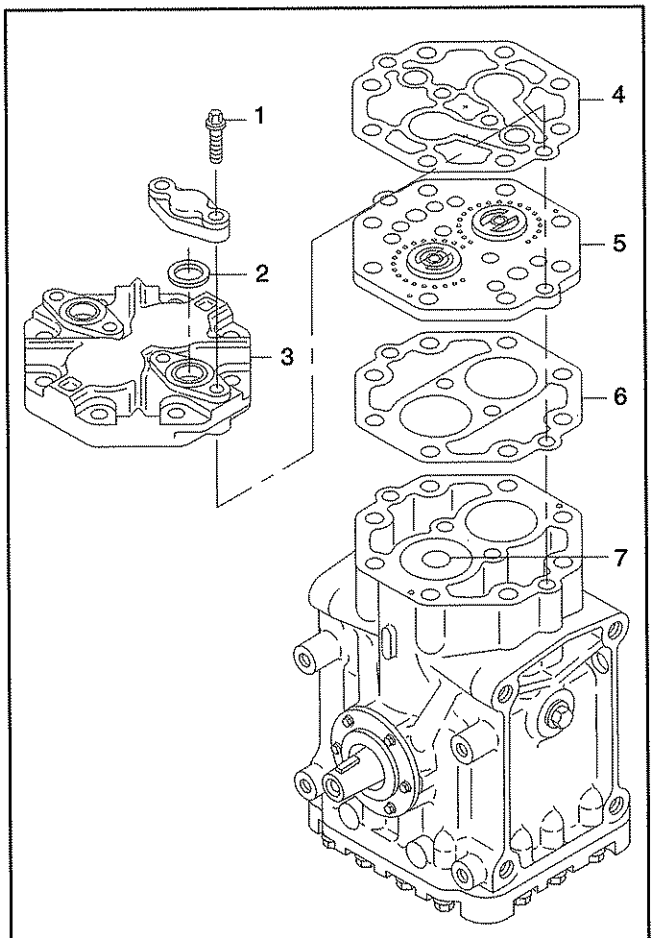
Fig. 2, Tightening Sequence

Head and Valve Plate Removal and Installation

Removal (See Fig. 1)

NOTE: Before doing any work on the head and valve plate, open both service valves to release any gas pressure in the compressor. The cylinder head is made of aluminum; be careful when removing it not to damage the sealing surfaces.

1. Remove the screws from the service valves. **See Fig. 2**, Refs. 1, 2, 11, and 12.



1. Capscrew
2. O-Ring
3. Cylinder Head
4. Cylinder Head Gasket
5. Valve Plate
6. Cylinder Gasket
7. Piston

Fig. 1, Compressor Head and Valve Plate Assembly

   If equipped with flanged-type service valves, these four screws are longer than the remaining head screws.

   If equipped with Rotalock or Tube-O type valves, remove them by loosening the hexnuts which are part of the valve assembly.

2. Remove the remaining screws from the head.
3. Remove the valve plate and head from the cylinder by prying or tapping under the ears extending from the valve plate. If the head and valve plate adhere, hold the head and tap the valve plate ears away from the head with a soft hammer.

⚠ CAUTION

CAUTION: Do not hit or tap the head to separate it from the valve plate. Damage to the head may result.

4. Being careful not to scratch or nick the machined sealing surfaces, remove all gasket material adhering to the head, valve plate, or cylinder.

Installation

NOTE: Valves and valve plates are furnished only as a complete assembly.

⚠ CAUTION

CAUTION: Different refrigerant oils are used in compressors on R–12 and R–134a air conditioning systems. Always use the correct refrigerant oil and never mix oils. If the wrong oil is used, or if oils are mixed, the compressor could seize due to improper lubrication.

1. Apply a thin film of clean refrigerant oil to the area of the crankcase to be covered by the cylinder gasket. Place the cylinder gasket in position on the cylinder so the dowel pins in the crankcase pass through the dowel pin holes in the cylinder gasket.
2. Apply a thin film of clean refrigerant oil to the top and bottom valve plate areas to be covered by gaskets. Place the valve plate in position on the cylinder gasket so the discharge valve assemblies are facing up and the locating dowel pins go through the dowel pin holes in the valve plate.

Head and Valve Plate Removal and Installation

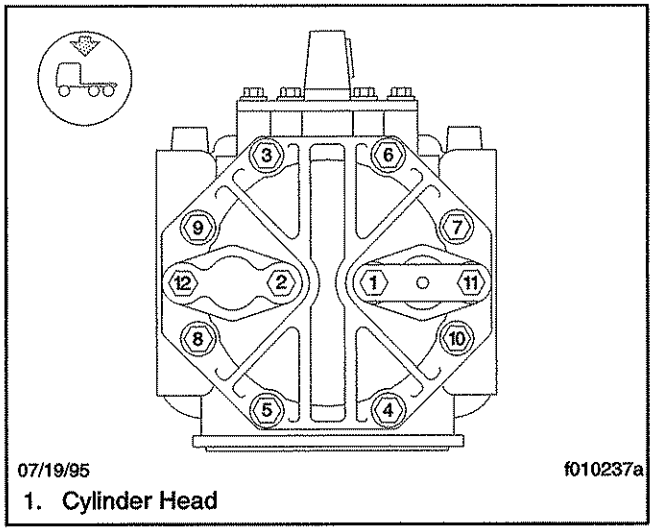


Fig. 2, Cylinder Head Capscrew Tightening Sequence

The discharge valve assemblies are the smaller diameter ones with the restrainer over the valve reed.

3. Place the head gasket in position on the valve plate so the dowel pins go through the dowel pin holes in the gasket.
4. Apply a light film of clean refrigerant oil to the machined surface of the cylinder head which contacts the head gasket. Place the head on the cylinder head gasket so the dowel pins go into the dowel pin holes in the head.
5. Apply a thin film of clean refrigerant oil to the service valve flanges. Place a service valve gasket in position on the cylinder head service valve flanges. Place the service valves in position on the proper service valve ports (suction or discharge) and insert the four longer screws through the service valve mounting pads, the head, the valve plate, and into the crankcase.

   If equipped with Rotalock or Tube-O type valves, insert the longer screws on the inside of the service valve ports and the shorter screws on the outside.

   Insert the remaining head screws and tighten all the screws until the heads make contact.
6. Tighten the head and service valve screws 23 to 34 N·m (17 to 25 lbf·ft) in sequence. **See Fig. 2.**

Pistons, Connecting Rods, Crankshaft, and Bearing Removal and Installation

Piston and Connecting Rod Removal

The pistons and connecting rods are easily accessible after removing the head, valve plate assembly, and base plate. If the connecting rods will be reused, mark the rod, cap and crankshaft throw so the rod can be installed in exactly the same position on the crank pin.

Crankshaft and Bearing Removal

NOTE: When replacing the crankshaft, both the front (seal end) and rear main bearings should also be replaced since they may be damaged during removal.

1. Remove the four capscrews from the rear bearing cover plate.
2. Remove the cover plate by gently prying it loose from the crankcase, being careful that the housing is pulled parallel to the bearing surface.
3. Remove all components down to the crankcase, crankshaft, and seal end main bearing assembly.
4. Wash this assembly in an OSHA-approved solvent to remove all traces of oil and grease. Allow it to dry.
5. Heat the assembly in an oven set to 150°C (300°F).

⚠ CAUTION

CAUTION: Heat the complete assembly evenly in an oven. Localized heating may crack the crankcase.

6. Remove the crankshaft and ball bearing assembly from the crankcase.
7. If the crankshaft is reusable, remove the ball bearing assembly. Hold the crankshaft vertically in a vise with the flywheel end up, gripping the shaft at the unmachined center throw. Using two large screwdrivers as a pry under the bearing race, force the bearing upward and remove it from the shaft.

Crankshaft and Bearing Installation

1. Press the rear ball bearing onto the crankshaft by exerting pressure on the bearing inner race.
2. Make sure that the shaft, bearing, and recess in the crankcase are clean and free of burrs.
3. Heat the crankcase in an oven set to 150°C (300°F).

⚠ CAUTION

CAUTION: Heat the complete assembly evenly in an oven. Localized heating may crack the crankcase.

4. Using the opening in the bottom of the crankcase as a point of entry, place the seal end bearing in the recess. If necessary, apply force to the outer race to be sure that it is seated in the bottom of the recess.
5. Allow the crankcase to cool. Install the crankshaft through the rear bearing cover plate opening, and guide the flywheel end through the inner race of the ball bearing.
6. Place the crankcase so that it is completely supported on the ball bearing inner race. Then, press the shaft into place until the shaft boss contacts the inner bearing race.

⚠ CAUTION

CAUTION: If the housing is not completely supported by the inner bearing race, the bearing may be destroyed.

7. Install the rear bearing cover plate with the O-ring in the crankcase. A slight force may be required due to the small clearances between the outer race of the ball bearing and the bearing cover plate recess.
8. Install the four capscrews and tighten them 1220 to 2300 N·cm (108 to 204 lbf·in) in the sequence **shown in Fig. 1.**

Piston and Connecting Rod Installation

⚠ CAUTION

CAUTION: Different refrigerant oils are used in compressors on R–12 and R–134a air conditioning

Pistons, Connecting Rods, Crankshaft, and Bearing Removal and Installation

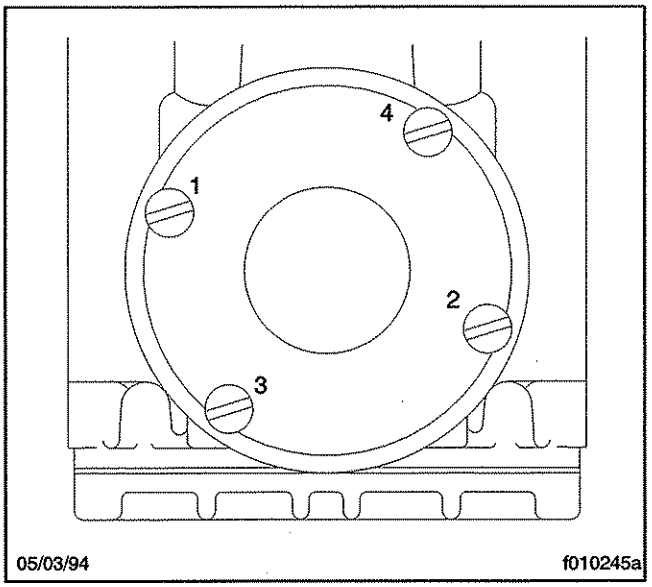


Fig. 1, Rear Bearing Cover Plate Capscrew Tightening Sequence

systems. Always use the correct refrigerant oil and never mix oils. If the wrong oil is used, or if oils are mixed, the compressor could seize due to improper lubrication.

NOTE: When installing either the original or a new piston and connecting rod assembly, coat all bearing surfaces with clean oil of the same brand used in the crankcase.

When installing the assembly into the cylinder, the wrist pin roll pin must be positioned toward the center of the compressor. If positioned toward the outside, the roll pin may hit the crankshaft when the piston is at bottom dead center.

When installing a used connecting rod, match up the marks made during removal. When installing a new connecting rod, the dowel pins in the bearing cap must be positioned to enter the holes in the rod.

1. Install the piston and connecting rod assemblies.
2. Install the connecting rod capscrews and tighten them 16 to 22 N·m (12 to 16 lbf·ft).
3. Wipe all parts with a lint free cloth to make sure they are clean.
4. Install the base plate. Tighten the capscrews 16 to 24 N·m (12 to 18 lbf·ft) in sequence. **See Fig. 2.**
5. Install the head and valve plate assembly. For instructions, **Subject 170.**
6. Check the labelling on the compressor to determine the recommended refrigerant oil. Fill the crankcase with the recommended oil.
7. Close all openings to prevent the entrance of foreign material.

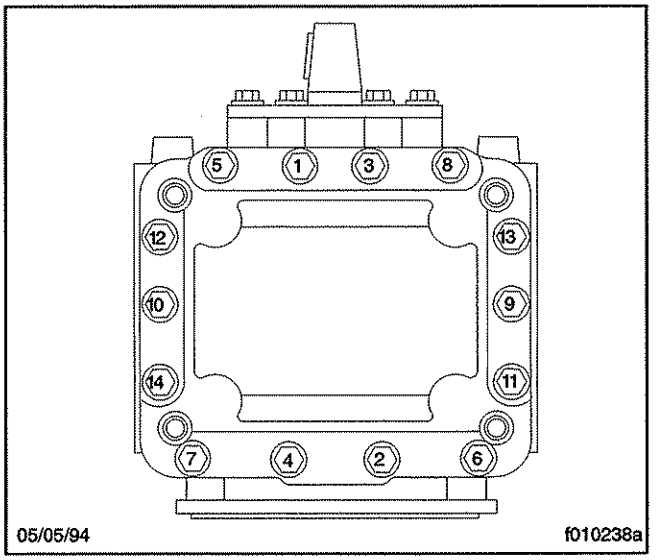


Fig. 2, Baseplate Capscrew Tightening Sequence

Specifications

Tightening Torques				
Location	Thread	Head Type	Torque	
			lbf.ft (N.m)	lbf.in (N.cm)
Base Plate	1/4–20 UNC	Hex	10–16 (14–22)	—
Connecting Rod	1/4–20 UNC	12-pt	12–16 (16–22)	—
Rear Bearing Cover Plate	1/4–20 UNC	Flat	10–16 (14–22)	—
Cylinder Head	5/16–18 UNC	Hex	17–25 (23–34)	—
Seal Plate	10–24 UNC	Hex	—	60–84 (680–940)
Flange Valve	5/16–18 UNC	Hex	17–25 (23–34)	—
Tube-O Valve	1"–14 NS	Hex	35–40 (47–54)	—
Rotalock Valve	1"–14 NS	Hex	35–40 (47–54)	—
Mounting Screw	3/8–16 UNC	Hex	35 (47)	—
Oil Fill Plug	3/8–24 UNF	Hex	—	60–120 (680–1360)
Clutch Bolt	5/16–24 UNF	Hex	20 (27)	—

Table 1, Tightening Torques

Temperature/Pressure Specifications, R–12 Systems			
Outside Temperature °F (°C)	Maximum Center Vent Temp. °F (°C)	Low Pressure (suction) psi (kPa)	High Pressure (discharge) psi (kPa)
60–80 (16–27)	58 (14)	6–15 (41–103)	165 (1138)
80–90 (27–32)	60 (16)	10–18 (69–124)	185 (1276)
90–100 (32–38)	64 (18)	12–20 (83–138)	205 (1413)

Table 2, Temperature/Pressure Specifications, R–12 Systems

Temperature/Pressure Specifications, R–134a Systems						
Ambient Air Temperature °F (°C)	Humidity		Dash Louver Temperature °F (°C)†	Service Port Pressures*†		A/C Compressor Cycling On?
	Target	Actual (Relative Humidity)		High (psi)	Low (psi)	
70 (21)	Low	25%	44 (6)	144	20.1	Yes
70 (21)	High	55%	45 (7)	146.6	21.6	Yes
80 (27)	Low	25%	46 (8)	164.4	20.1	Yes
80 (27)	High	55%	51 (11)	201.8	24.4	No
90 (32)	Low	25%	49 (9)	219.8	22.6	No
90 (32)	High	55%	60 (16)	242.1	31.5	No

Specifications

Temperature/Pressure Specifications, R–134a Systems						
Ambient Air Temperature °F (°C)	Humidity		Dash Louver Temperature °F (°C)†	Service Port Pressures*†		A/C Compressor Cycling On?
	Target	Actual (Relative Humidity)		High (psi)	Low (psi)	
100 (38)	Low	25%	57 (14)	261.3	29.5	No
100 (38)	High	55%	68 (20)	309.3	42.5	No

* Service port pressures recorded with A/C compressor running.
† Fresh air mode in use.

Table 3, Temperature/Pressure Specifications, R–134a Systems

Recommended Refrigerant Oils, R–12 Systems	
Manufacturer	Type
Texaco	Capella WF100
Suniso	No. 5
FREOL	DS83P

Table 4, Recommended Refrigerant Oils, R–12 Systems

Recommended Refrigerant Oils, R–134a Systems	
Description	Part Number
Polyalkylene Glycol (PAG)	CFC/PAG21941
Polyol Ester (POE)	CFC ESTER25065

Table 5, Recommended Refrigerant Oils, R–134a Systems

Special Tools	
Tool	Part Number*
Seal Puller	10549
Seal Installer	10547
Oil Dipstick	10545
Clutch Spanner Wrench	A-10546
Clutch Removing Bolts (2)	A-10548
Kit: Includes seal puller, seal installer, oil dipstick, clutch spanner wrench, and two bolts.	10550
12-Point Socket, 5/16", 1/4 Drive	12245
12-Point Socket, 1/4", 1/4 Drive	12244
Piercing Pressure Gauge	10562

* Order tools directly from: Robinair Division SPX Corporation Robinair Way Montpelier, OH 43543-0193, telephone (419) 485-5561

Table 6, Special Tools

Torque Values for Fittings on Reciprocating Refrigerant Compressors		
Outside Diameter of Metal Tube (inches)	Torque for Steel Tubes lbf.ft (N.m)	Torque for Aluminum or Copper Tubes lbf.in (N.cm) or lbf.ft (N.m)
1/4	10–15 (14–20)	60–80 lbf.in (680–900 N.cm)
3/8	30–35 (41–47)	11–13 lbf.ft (15–18 N.m)
1/2	30–35 (41–47)	15–20 lbf.ft (20–27 N.m)

Specifications

Torque Values for Fittings on Reciprocating Refrigerant Compressors		
Outside Diameter of Metal Tube (inches)	**Torque for Steel Tubes lbf.ft (N.m)**	**Torque for Aluminum or Copper Tubes lbf.in (N.cm) or lbf.ft (N.m)**
5/8	30–35 (41–47)	21–27 lbf.ft (28–37 N.m)
3/4	30–35 (41–47)	28–33 lbf.ft (38–45 N.m)

Table 7, Torque Values for Fittings on Reciprocating Refrigerant Compressors

Contents

Subject	Subject Number
General Information	050
Service Operations	
Safety Precautions	100
Heater Core Removal and Installation	110
Evaporator Coil Removal and Installation	120
Thermostatic Switch Replacement	130
Blower Motor Replacement	140
Resistor Block Replacement	150
Water Regulating Valve Replacement	160
Expansion Valve Replacement	170
Receiver-Drier Replacement	180
Fan Cycling Switch Replacement	185
Binary Switch Replacement	190
Condenser Replacement	200
Control Panel Replacement	210
Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing	220
Air Conditioning Protection and Diagnostics System Electronic Control Module Replacement	230
Air Conditioning Protection and Diagnostics System Pressure Switch Replacement	240
Troubleshooting	300
Specifications	400

General Description

The heating, ventilation, and air conditioning (HVAC) unit uses a common blower motor and duct work to heat or cool the cab. Airflow rate is controlled by a three-speed blower switch. Air outlets are located in the instrument panel, along the bottom of the dash, at the windshield, and also at the side windows. See **Fig. 1**.

Both left-hand drive (LH DR) and right-hand drive (RH DR) vehicles use the same HVAC unit. On RH DR, components are moved to the opposite side of the cab. The blower motor, on the right-hand (passenger's) side on LH DR, moves to the left-hand (passenger's) side on RH DR.

When equipped with an air conditioner, temperature can be moderated by opening or closing a water regulating valve, which controls the flow of warm engine coolant to the heater core. The temperature of the air inside the cab partly depends on how much coolant is flowing through the heater core, and how much liquid refrigerant is in the evaporator coil.

The air conditioning system also includes a cycling-clutch refrigerant compressor, a condenser, an expansion valve, an evaporator coil, a fixed-temperature thermostatic switch, and mechanically operated controls.

DESCRIPTION OF COMPONENTS

Refrigerant

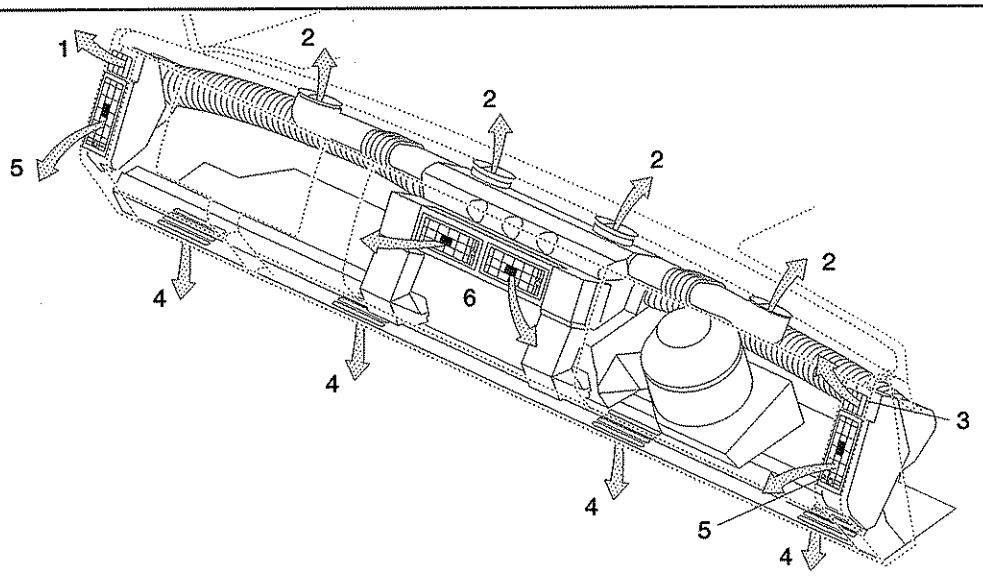
Refrigerant absorbs heat from the air in the cab and releases it to the air outside the cab.

In an open container, refrigerants boil at temperatures below the freezing point of water; sealing and pressurizing refrigerant in the air conditioning system raises its boiling-point temperature.

During compressor operation, refrigerant constantly changes from a liquid to a gas. It absorbs heat (boiling) in the low-pressure evaporator coils, and it changes from a gas to a liquid as it releases absorbed heat in the high-pressure condenser.

Expansion Valve

The expansion valve is a dividing point between the high- and low-pressure parts of the refrigerant system. High-pressure liquid refrigerant from the receiver-drier passes through the expansion valve and moves into the low-pressure area of the evaporator coil.



Left-hand drive shown; right-hand drive opposite

1. Driver's Door Window Defrost Outlet
2. Windshield Defrost Outlets
3. Passenger's Door Window Defrost Outlet
4. Floor Outlet
5. Dash/Door Window Vent
6. Center Dash Vents

Fig. 1, Air Outlet System

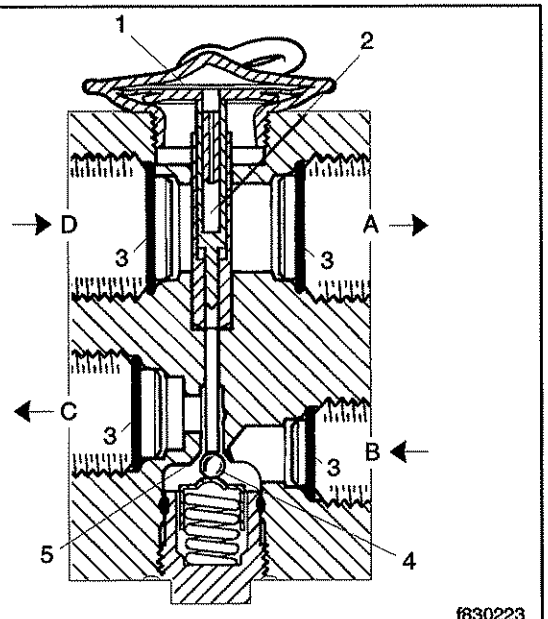
General Information

An expansion valve controls the flow rate of refrigerant in proportion to the rate of evaporation in the evaporator. If the amount of liquid in the evaporator drops off, the temperature of the gas going to the compressor rises. This causes a diaphragm in the expansion valve to react, which causes an orifice in the valve to open or close. See **Fig. 2**. Through the orifice, liquid refrigerant is metered into the evaporator, as needed.

Evaporator Coil

Because the evaporator coil is an area of low pressure in the system, the boiling point of refrigerant lowers, which causes it to absorb heat from the tubing walls and fins of the coils. As it absorbs heat, liquid refrigerant quickly boils and turns into a gas.

As heat is absorbed from the outside surfaces of the evaporator coil, air passing over the unit loses its heat to these cooler surfaces. Moisture in the air condenses on the outside of the coil and drains off as water (the air becomes dehumidified).



A. To compressor
B. From receiver-drier
C. To evaporator
D. From evaporator
1. Diaphragm
2. Temperature Sensor
3. O-Ring
4. Metering Orifice
5. Ball and Spring

Fig. 2, Expansion Valve

Refrigerant Compressor

"Heat" in the low-pressure gas of the evaporator coils is not heat that can be noticed by touch, because liquid refrigerant boils at a temperature much lower than the temperature at which water turns to ice. By touch, the "heated" gas in the coils is very cold. As a result, there is the problem of how to remove heat from subfreezing gas using outside air that may be higher than 38°C (100°F).

With a refrigerant compressor, low-pressure gas from the evaporator can be squeezed into a much smaller space. When the gas is compressed, the heat it contains becomes concentrated. In this way, the gas is made hotter than the outside air, without adding heat.

Another function of the compressor is to move refrigerant through the system.

Condenser

A condenser turns hot refrigerant gas, coming from the compressor, into liquid. Mounted in front of the radiator, it is made up of a coiled tube and a series of fins. Because of its location, the condenser transfers heat to air that is drawn in by the engine fan and by air that is forced into the engine compartment as the vehicle moves forward (ram air).

Receiver-Drier

Used as a reservoir and filter for liquid refrigerant from the condenser, a receiver-drier also removes water and acids from the refrigerant. The water-absorbing material (desiccant) in the unit helps stop blockages from forming in the expansion valve and in other parts of the system.

A moisture indicator shows the amount of water in the refrigerant. A sight glass (aperture) on the unit contains a specially treated element (litmus paper) that changes color, depending on the amount of water in the refrigerant. The indicator changes from a deep cobalt blue (dry) to light greyish-blue (wet) to lilac, lavender, and finally pink (very wet). Any color other than cobalt blue is considered wet. Any time the system is evacuated (dehydrated), replace the receiver-drier.

Thermostatic Switch

The temperature of the evaporator coil is monitored by a fixed-temperature thermostatic switch.

The probe from the switch extends to the evaporator coil, and the switch is mounted on the right side of the heater and air conditioner housing. This switch disengages the compressor to prevent the evaporator coil from freezing up due to, for example, an expansion valve that is stuck open.

Fan Cycle Switch (On-Off Fan Only)

Located on the receiver-drier, the fan cycle switch activates a solenoid to turn the fan on or off, depending on refrigerant pressure.

On vehicles built before November 1994, the fan will come on if refrigerant pressure is greater than 260 ± 10 psi (1800 kPa). The fan turns off when pressure drops below 174 ± 10 psi (1200 kPa).

On vehicles built from November 1994, the fan will come on if refrigerant pressure is greater than 300 ± 10 psi (2070 kPa). The fan turns off when pressure drops below 250 ± 10 psi (1725 kPa).

Binary Switch

A binary switch disengages the refrigerant compressor to protect it from harmful operating conditions. It performs two functions:

1. If refrigerant is lost or the outside temperature is too low, the binary switch will keep the compressor from operating. The switch disengages the compressor when falling pressure goes below 26 to 31 psig (180 to 215 kPa); normal compressor operation resumes when rising pressure reaches 0.1 to 3.0 psig (0.6 to 21.0 kPa) above shutoff pressure.
2. If the compressor cylinder head pressure increases to unsafe levels above 356 to 413 psig (2455 to 2845 kPa), the binary switch shuts off the compressor. Too much pressure may be caused by blocked air flow through the condenser, a plugged expansion valve or receiver-drier, or too much refrigerant in the system. When pressure falls back 57 to 114 psig (395 to 785 kPa) from shutoff pressure, the compressor resumes operation.

Heater Core

The heater core is a series of fins through which tubing is routed. When the heating system is on, engine coolant flows through the heater core tubes, heating the tubes and fins. The heat is absorbed by air that is forced through the heater core by the blower motor.

Water Regulating Valve

When opened, the water regulating valve allows engine-heated coolant to flow through the heater core.

Air Blower, Resistor Block Assembly

An air blower forces air through the heater core and evaporator coil, and into the cab. The resistor block assembly regulates the voltage to the blower motor. The voltage controls the blower motor speed. The resistor assembly has a thermal cutout which shuts off current to the blower motor in case the motor malfunctions.

Air Conditioning Protection and Diagnostics System (APADS™)

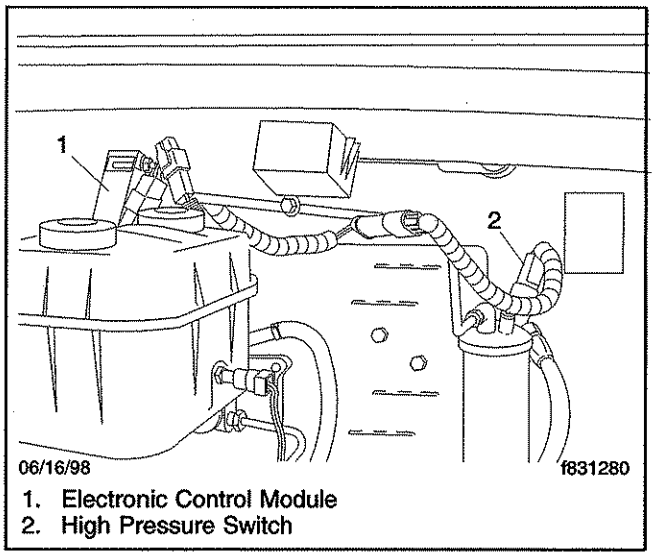
The APADS™ control and diagnostics system is designed to increase the life of the air conditioning system components, reduce air conditioning maintenance, and aid the diagnosis of system faults. The APADS™ control system consists of an electronic control module, high and low pressure switches, and an evaporator thermostat. The electronic control module actively monitors system conditions and controls the operation of the refrigerant compressor and the fan clutch. Refer to Principles of Operation for more information on this system.

Located under the hood on the left-hand side of the frontwall, the electronic control module registers fault codes that warn of existing or impending problems in the air conditioning system. See **Fig. 3**. Diagnostic information and system status are communicated by red and green light emitting diodes (LEDs) built into the electronic control module. Since only one blink code can be displayed, the fault code of highest priority takes precedence. For more information on fault codes, see **Troubleshooting 300**.

APADS™ High Pressure Switch

Located on the discharge side of the refrigerant compressor, the high pressure switch signals the electronic control module to turn the fan on and to prevent operation of the refrigerant compressor in the event of a high pressure condition. When the pressure increases above 290 to 310 psi (1999 to 2137 kPa) on vehicles built before December 11, 1998 or 340 to 375 psi (2344 to 2586 kPa) on vehicles built from December

General Information



1. Electronic Control Module
2. High Pressure Switch

Fig. 3, APADS Control Module

11, 1998 the electronic control module shuts down the refrigerant compressor if necessary, and turns the fan on. When the pressure returns to 250 to 270 psi (1724 to 1862 kPa), the compressor resumes normal operation and the electronic control module turns the fan off.

APADS™ Low Pressure Switch

Located on the suction side of the refrigerant compressor, the low pressure switch signals the electronic control module to shut down the refrigerant compressor in extremely cold temperatures, or if there is a loss of charge. When the pressure falls below 10 psi (69 kPa) the electronic control module shuts down the refrigerant compressor. When the pressure is above 34 psi (234 kPa) the compressor resumes normal operation.

APADS™ Evaporator Thermostat

The evaporator thermostat is the main air conditioning system control. The evaporator thermostat is wired in series with the air conditioning system on/off switch. It opens at 32°F (0°C) or below, and closes at 38°F (3°C) or above.

DEFINITION OF TERMS

Refer to the following terms for a better understanding of the heater/air-conditioning system.

Air Conditioner A system used to control the temperature, humidity, and movement of air in the cab.

Air Conditioning Protection and Diagnostics System (APADS™) A system that actively monitors air conditioner conditions and controls the refrigerant compressor and the on/off fan drive. Existing or impending problems are registered as fault codes on the electronic control module.

Ambient Air Temperature The temperature of air around an object; the outside temperature.

Binary Switch Disengages the refrigerant compressor to protect it from harmful operating conditions.

Blower A motor and fan used to draw air through the evaporator, and force it through the heater core and into the cab.

Blower Resistor Block Assembly In line resistors that control the amount of voltage going to the blower motor. By controlling the voltage, you can control the fan speed.

Boiling Point The temperature at which a liquid changes to a gas. The boiling point varies with pressure.

Bulk Charging Use of large containers of refrigerant for charging a refrigerant system. Normally used for charging empty systems.

Carbon Dioxide A colorless, odorless, dry, inert gas that can be used to purge light contaminants (for example, dust) from air conditioner parts.

CFM Cubic feet per minute.

Charge A specific amount of refrigerant or oil by volume or weight. Also, the act of placing an amount of refrigerant or oil in the air conditioning system.

Clutch Cycling Switch (Thermostatic Switch) Engages or disengages the compressor depending on changes in system pressure or evaporator temperature.

Cold The absence of heat. The lowest possible temperature is thought to be –459°F (–273°C).

Compressor A device used to draw low-pressure refrigerant gas from the evaporator and squeeze it into a high-temperature, high-pressure gas. A second purpose of the compressor is to move refrigerant through the system.

Condensate Water, taken from the air, which forms on the outer surface of the evaporator.

General Information

Condenser A heat exchanger that is used to remove heat from the refrigerant, changing it from a high-pressure hot gas to a high-pressure warm liquid.

Condensing Pressure Pressure, as read from the gauge at the discharge service valve; pressure from the discharge side of the compressor into the condenser.

Contaminants Anything other than refrigerant or refrigerant oil in the system. Usually means water in the system. When water and refrigerant mix, corrosive hydrochloric acid forms.

Cycling Clutch System A system which controls compressor clutch operation in order to raise or lower the temperature in the cab.

Dehumidify To remove water from the air, at the evaporator coil.

Dehydrate To remove all traces of moisture from the refrigerant system. Normally called evacuation.

Desiccant A drying agent used in the refrigerant system (in the receiver-drier) to remove water and create an extremely dry condition.

Discharge Line Connects the refrigerant compressor outlet to the condenser inlet.

Discharge Pressure Pressure of the refrigerant being discharged from the compressor; high-side pressure; condensing pressure.

Drive Pulley A V-pulley attached to the front of the engine crankshaft. It drives the compressor clutch pulley with a belt.

Drying Agent See "Desiccant."

Duct A passageway for the transfer of air from one point to another.

Evacuate To place a high vacuum in the air-conditioning system and dehydrate or remove all traces of moisture.

Evaporate To change state from a liquid to a gas.

Evaporator Coil A component in which liquid refrigerant changes to a gas after it absorbs heat from the air. Also removes some moisture from the air.

Evaporator Thermostat (APADS™) The evaporator thermostat is the main air conditioning system control. It is used to turn off the refrigerant compressor whenever frost begins to form on the evaporator.

Expansion Valve A device that causes a pressure-drop of the refrigerant and also regulates its flow.

Flooding A condition caused by too much liquid refrigerant going into the evaporator; usually caused by an expansion valve that is stuck open.

Flushing A process of passing liquid refrigerant through an air-conditioner component to remove dirt and water from the part. Liquid refrigerant removes heavy contamination, such as gritty dirt and large dirt buildup.

Freeze-Up Failure of a unit to operate properly because of ice forming at the expansion valve orifice or on the evaporator coils and fins.

Heater Core A part of the heating system in which hot engine coolant flows to provide heat to the cab or to adjust the temperature produced by the air conditioner.

High-Side Service Valve A device located on the liquid line near the thermostatic expansion valve; it allows high-side pressure to be checked and other service operations to be performed.

High Pressure Switch (APADS™) Located on the discharge side of the refrigerant compressor, the high pressure switch signals the electronic control module to turn the fan on and to prevent operation of the refrigerant compressor in the event of a high pressure condition.

Humidity The amount of water vapor in the air.

Hydraulic Lock The return of liquid refrigerant to the compressor, which could destroy the unit.

Leak Detector Any device used to detect refrigerant leaks in a refrigerant system.

Liquid Pressure Pressure of refrigerant in the liquid line from the receiver-drier to the thermostatic expansion valve.

Low Pressure Switch (APADS™) Located on the suction side of the refrigerant compressor, the low pressure switch signals the electronic control module to shut down in extremely cold temperatures, or if there is a loss of charge.

Low-Air Pressure Switch An air operated electrical switch that is normally open, but closes when the system pressure rises to 65 to 75 psi (450 to 515 kPa). Its purpose is to prevent the refrigerant compressor from turning on if the vehicle's air system pressure is too low to activate the cooling fan.

General Information

Low Head Pressure High-side pressure that is lower than normal due to a system problem.

Low Suction Pressure Low-side pressure that is lower than normal due to a system problem.

Magnetic Clutch An electrical coupling device used to engage or disengage the compressor.

Manifold Device to control refrigerant flow for system test purposes; used with manifold gauges.

Manifold Gauge A calibrated instrument used for measuring system pressures.

Manifold Gauge Set A manifold that is complete with gauges and charging hoses and is used to measure or test pressure.

Micron A metric unit of length equal to one-millionth of a meter; used to measure vacuum drawn from a refrigerant system by a vacuum pump.

Moisture Indicator Litmus paper in a sight glass receiver-drier; shows how much moisture is in the system.

Nitrogen A colorless, odorless, dry, inert gas that can be used to purge light contaminants (for example, dust) from air conditioner parts.

Opacity A condition that is used to describe contamination of refrigerant oil in the compressor. Fresh refrigerant oil is clear; when contaminated, it appears cloudy or may have fine particles held in suspension.

Overcharge Too much refrigerant or oil in the system.

Polyalkylene Glycol (PAG) and Polyol Ester (POE) Highly refined synthetic oils that are used in R–134a air conditioning systems.

psia Pounds per square inch. Pressure exerted by the air at sea level. Atmospheric pressure is usually measured with a mercury barometer.

psig Pounds per square inch, gauge pressure. Any pressure above normal atmospheric pressure (14.7 psi) is referred to as gauge pressure.

Purge To remove damp air, traces of refrigerant, and loose dirt from a system or part by flushing with a dry, inert gas, such as nitrogen.

Receiver-Drier A combination desiccant, filter, and storage container for liquid refrigerant.

Recovery Removal of the refrigerant from air conditioning systems.

Recycling Removal of contaminants and moisture from R–134a using a recovery and recycling station.

Refrigerant–134a (R–134a) The cooling agent used in automotive air conditioning systems. The chemical name for R–134a is Tetrafluoroethane.

Refrigeration Cycle The complete circulation of refrigerant through an air conditioning system, accompanied by changes in temperature and pressure.

Relative Humidity The actual water content of the air in relation to the total water vapor the air can hold at a given temperature.

Resistor A voltage-dropping device, usually wire-wound, for controlling fan speed.

Suction Line The line connecting the evaporator outlet to the compressor inlet.

Suction Pressure Compressor inlet pressure (the system's low-side pressure).

Suction Service Valve A device located on the suction hose near the thermostatic expansion valve that allows low-side pressure to be checked and other service operations to be performed.

Suction Side The low-pressure area of the system, extending from the expansion valve to the compressor inlet.

Thermistor A vacuum pressure sensor that is used to measure (in microns of mercury) internal system vacuum levels after evacuation.

Thermostatic Switch A temperature-sensitive switch used to control system temperature and prevent evaporator freeze-up; it does this by cycling the compressor's operation.

Thermostatic Vacuum Gauge A high-vacuum gauge sensitive to pressures ranging from atmospheric pressure to less than 1 micron of mercury, with scales reading from 25,000 microns to 1 micron of mercury.

Undercharge A system low on refrigerant, resulting in lack of cooling and possible compressor damage.

Vacuum Refers to pressure that is less than atmospheric pressure.

Vacuum Pump A mechanical device used to evacuate and place a high vacuum in the refrigerant system.

Vacuum Pump Oil Water soluble oil used in some vacuum pumps to absorb moisture from the refrigerant system.

Vapor The gaseous state of a material.

Water Regulating Valve A valve, mechanically operated, for controlling the flow of hot coolant to the heater core.

Principles of Operation

HEATER

Moving the temperature control toward maximum heat opens the water regulating valve, which allows engine-heated coolant to flow through the heater core. Heat absorbed by the air passing over the heater core fins is forced through ducts and into the cab.

AIR CONDITIONER

When the air conditioner is on, the motion of the compressor squeezes the refrigerant into a high-pressure, high-temperature gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid. After it is compressed, refrigerant gas moves out of the discharge port of the compressor, and on to the condenser.

At the condenser, air passing over the coil's fins absorbs heat from the hot refrigerant gas and causes it to change into a liquid. The liquid moves to the receiver-drier, which filters it and removes traces of moisture and acids. The receiver-drier then stores the refrigerant until it is needed by the system.

From the receiver-drier, liquid refrigerant moves to the expansion valve, which meters the flow into the evaporator coil and acts as a boundary between the high- and low-pressure sides of the system. The metered release of the expansion valve greatly drops the liquid's pressure, causing it to expand. The pressure drop lowers the boiling point of the refrigerant, and causes it to evaporate quickly as it absorbs heat from air passing over the coil. The resulting cool air is forced into the cab by the blower; the heated refrigerant gas is drawn back into the compressor, where the cycle is repeated.

AIR CONDITIONING PROTECTION AND DIAGNOSTICS SYSTEM (APADS™)

After the engine is started, the electronic control module prevents operation of the refrigerant compressor for 15 seconds. After the 15 second delay, the compressor comes on for 15 seconds. This start-up cycle is accomplished with the control module ignoring all input from the thermostat. The purpose of engaging the compressor is to circulate lubricant within the compressor, which is beneficial to the system especially when it is not used frequently. If the high or low pressure switches indicate out of bound or fault conditions, the compressor is turned off after the initial 15 seconds.

The evaporator thermostat is the primary control of the air conditioning system. The refrigerant compressor will cycle at the frequency governed by the thermostat, but is limited to a maximum of one cycle per 15 seconds.

When the high pressure switch indicates a high pressure condition, the refrigerant compressor is allowed to stay on for an algorithmically determined variable period, limited to 10 seconds. The compressor is allowed to turn on after the high pressure switch resets, and the maximum cycle rate of the compressor is limited to once every 15 seconds as governed by the control logic.

When the low pressure switch indicates a low pressure condition, the refrigerant compressor is turned off. The compressor is allowed to turn on after the low pressure switch resets, and the maximum cycle rate of the compressor is limited to once every 15 seconds as governed by the control logic.

Additional air conditioning system controls performed by APADS™ include shut down of the refrigerant compressor if the supply voltage drops below 11 volts. It is allowed to turn on again after there has been a sufficient rise in system voltage. The refrigerant compressor is shut down until the next ignition cycle if any of the following faults occur:

- high pressure
- open clutch
- shorted clutch

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold R–134a refrigerant, you must recover, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the refrigerant charge has been recovered (discharged) at the service valves.

Refrigerant R–134a is safe when used under the right conditions. Always wear safety goggles and non-leather gloves while recovering, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

⚠ WARNING

WARNING: Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should be rinsed with lukewarm water, not hot or cold. Do not rub the eyes. Apply a light bandage and contact a physician right away.

Refrigerant splashed on the skin should be rinsed with lukewarm water, not hot or cold. Do not rub the skin. Apply a light coat of a nonmedicated ointment, such as petroleum jelly. Contact a physician right away.

R–134a refrigerant does not burn at ambient temperatures and atmospheric pressure. However, it can be combustible at pressures as low as 5.5 psig (139 kPa absolute) at 350°F (177°C) when mixed with air concentrations that are greater than 60 percent.

⚠ WARNING

WARNING: R–134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R–134a may form, resulting in a fire or explosion, which could cause personal injury or property damage. R–134a may be safely pressured with dry nitrogen.

You must work in an area where there is a constant flow of fresh air when the system is recovered, evacuated, charged, and leak tested. R–134a vapors have a slightly sweet odor that is difficult to detect. Frequent leak checks and air monitoring equipment are recommended to ensure a safe working environment.

IMPORTANT: When servicing an R–134a air conditioning system, use only service equipment certified to meet the requirements of SAE J2210 (R-134a recycling equipment). The equipment should be operated only by qualified personnel who are familiar with the recycling station manufacturer's instructions.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant containers from exploding, never expose them to temperatures higher than 125°F (52°C).

On R–134a refrigerant systems, polyalkylene glycol (PAG), or polyol ester (POE) oil is used in the compressor. When handling these oils, observe the following:

- keep the oil free of contaminants
- do not expose the a/c system or the oil container to air for long periods of time; PAG and POE oils absorb moisture quickly
- use care when handling: painted surfaces, plastic parts, and other components (drive belts) could be damaged if the oil is spilled on them
- never mix the oils with other types of refrigerant oil

Heater Core Removal and Installation

Removal

⚠ WARNING

Before doing any of the work below, read the information under Subject 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

1. Disconnect the batteries.
2. Set the temperature control on the dash to its warmest setting.

⚠ WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

3. Drain the coolant.
4. Remove the vinyl extrusion trim at the top of the dash. See **Fig. 1**.
5. Remove dash panel D. See **Fig. 2** and **Fig. 3**.
   - 5.1 Remove the two screws from the top of dash panel D.
   - 5.2 Lift out the dash panel. Set it and the two mounting screws aside.
6. Pull out the windshield defrost duct. See **Fig. 4**.

NOTE: On vehicles with right-hand drive, loosen panel B. On these vehicles, the panel has enough slack that it does not need to be removed.

7. Remove dash panel B.
   - 7.1 Remove the knobs from the parking brake air valve and the trailer brake air valve, if so equipped. See **Fig. 5**.
   - 7.2 Remove the two mounting screws.
   - 7.3 Lift out the dash panel. Set it and the two mounting screws aside.
8. Remove dash panel C. See **Fig. 2**.
   - 8.1 Remove the bezel around the HVAC control panel.

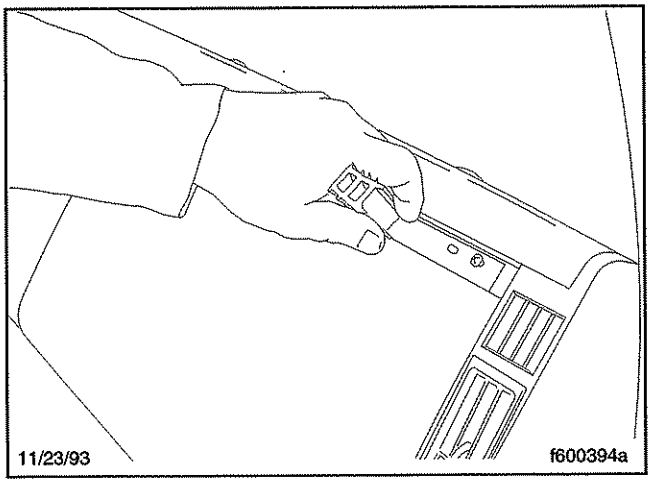
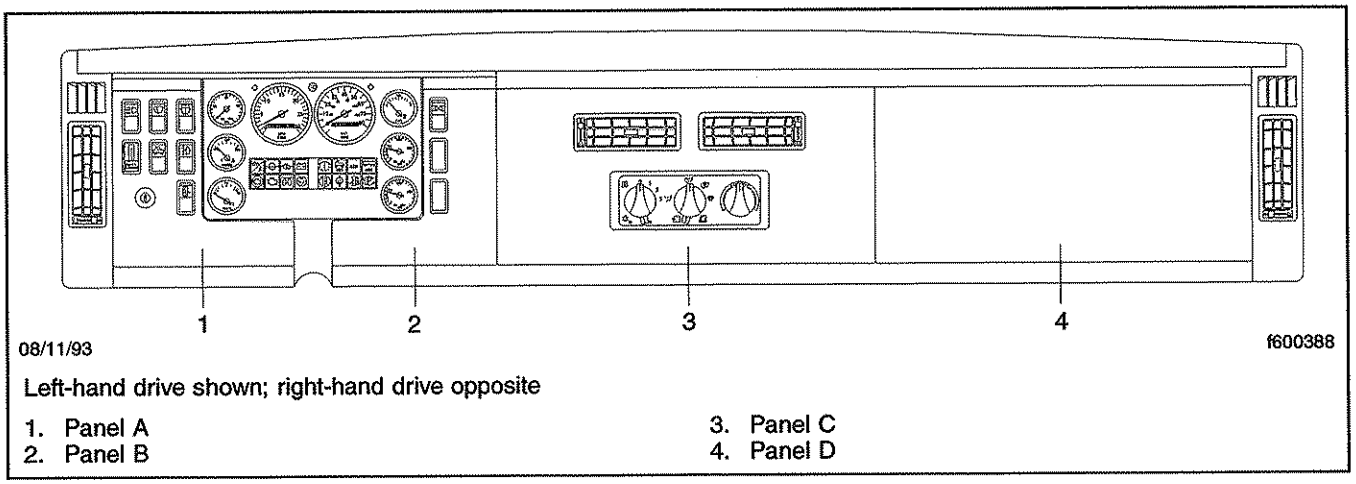


Fig. 1, Removing the Vinyl Extrusion Trim

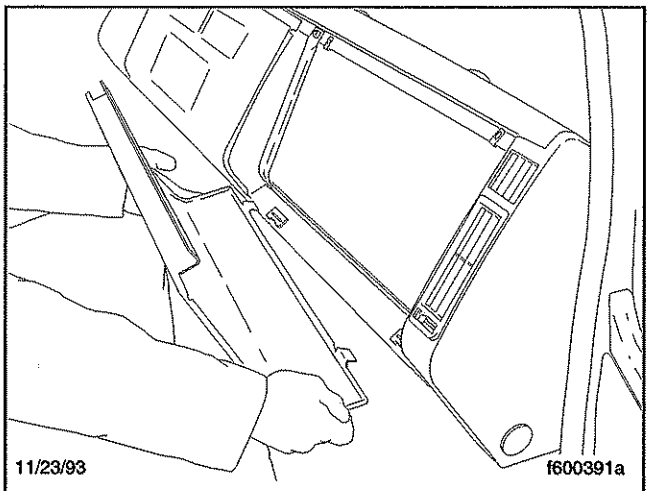


Left-hand drive shown; right-hand drive opposite

1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2, Dash Panels

Heater Core Removal and Installation



Left-hand drive shown; right-hand drive opposite

Fig. 3, Removing Panel D

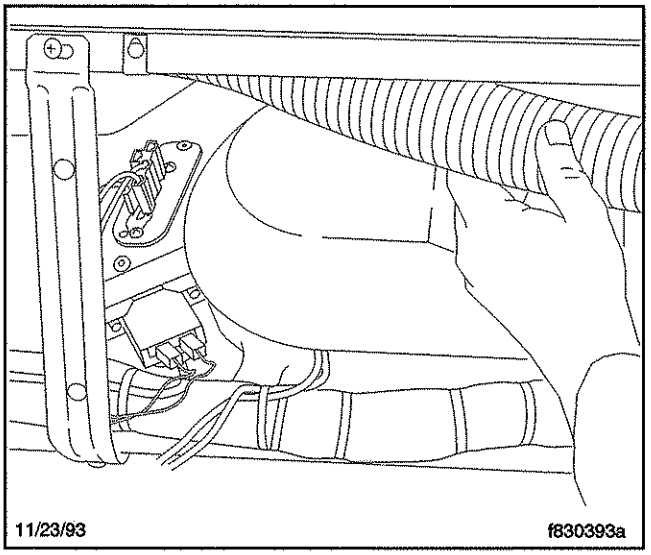


Fig. 4, Pulling Out the Windshield Defrost Duct

8.2 Remove and set aside the four screws (see **Fig. 6**) holding the control panel to dash panel C.

8.3 Remove the two screws from the top of dash panel C.

8.4 Lift out the dash panel. Set it and the two mounting screws aside.

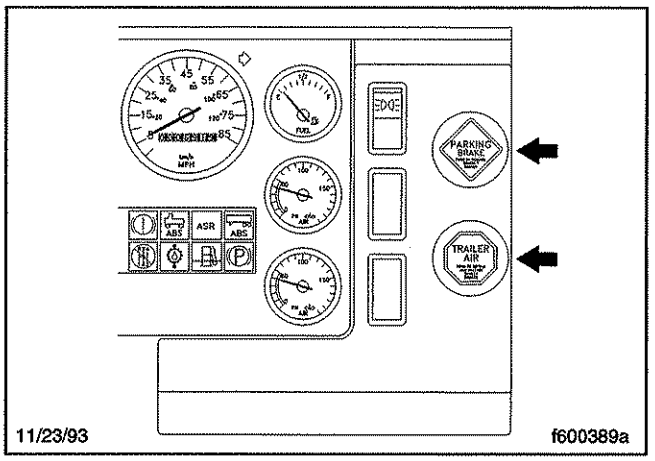


Fig. 5, Air Valve Knobs

NOTE: On vehicles with right-hand drive, loosen the instrument panel. On these vehicles, the panel has enough slack that it does not need to be removed.

9. Remove the instrument panel. See **Fig. 7**.

   9.1 On vehicles built after late January/early February 1997, remove the four spring-loaded Torx®-head screws.

   On vehicles built earlier, insert a screwdriver in the locking tabs and push upward to release.

   9.2 Pull out the panel and disconnect all the electrical connectors.

   9.3 Disconnect the two air pressure lines.

   9.4 Disconnect the oil pressure line.

10. Remove and set aside the two screws at the top of dash panel A. See **Fig. 8**.

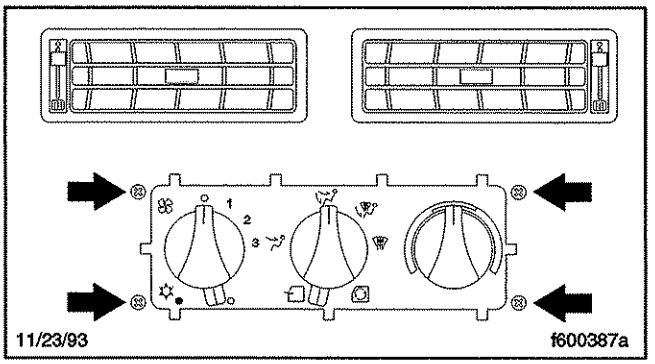
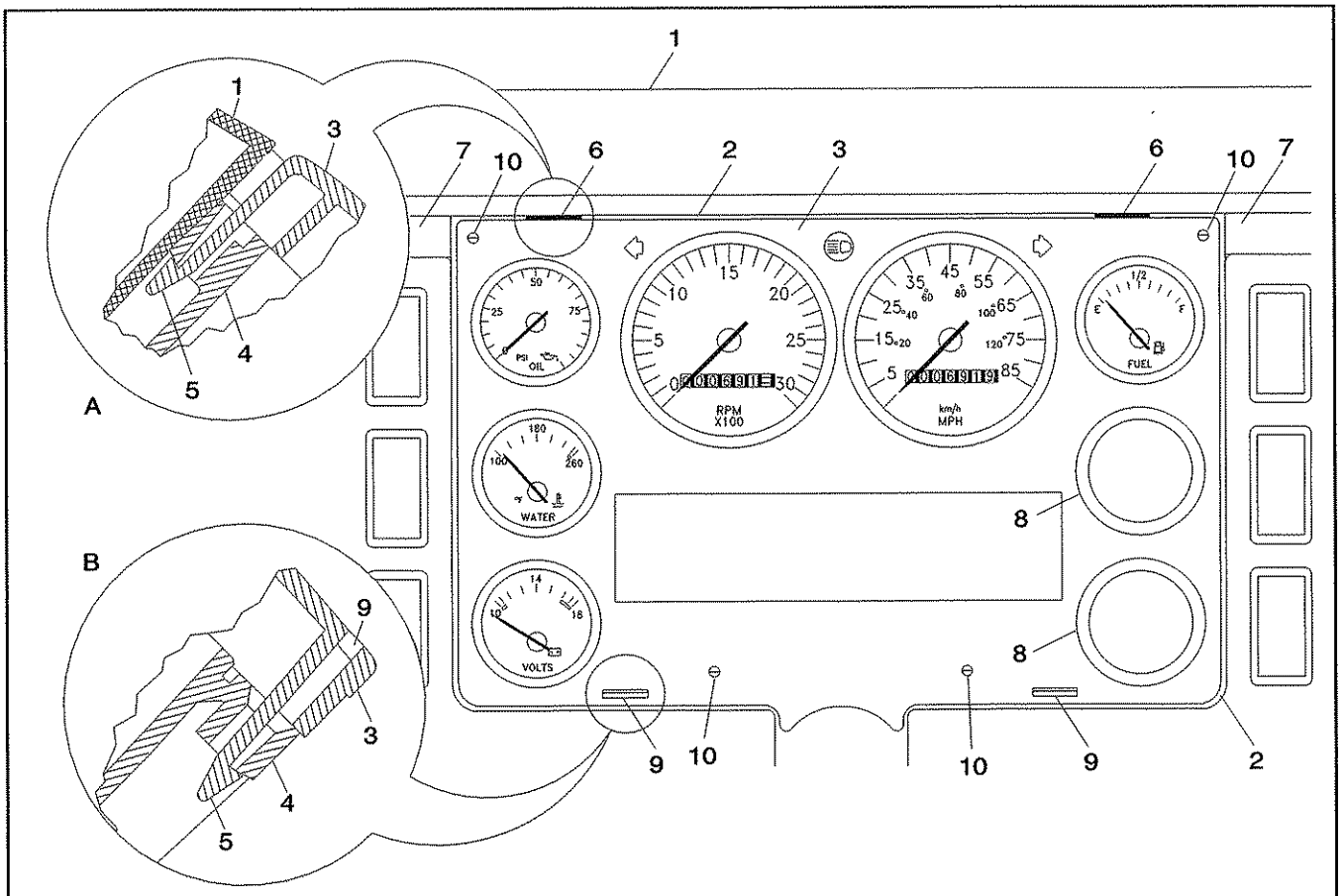


Fig. 6, HVAC Control Panel



On vehicles built after late January/early February 1997, remove the four spring-loaded Torx®-head screws. On vehicles built earlier, insert a screwdriver in the locking tabs and push upward to release.

A. Sectional Detail (top)
1. Upper Dash Cover
2. Foam Gasket
3. Instrument Panel
4. Gauge Housing

B. Sectional Detail (bottom)
5. Panel Locking Tab
6. Opening in Foam Gasket
7. Vinyl Extrusion Trim
8. Gauge Blank (block-off plug)
9. Slot in Panel
10. Torx-Head Screw

Fig. 7, Instrument Panel Removal

11. Remove the upper dash cover.

    11.1 Disconnect the harness for the turn signal switch.

    11.2 Pull dash panel A forward. Remove the screws holding each dash end cap; pull the end caps forward and out of the way. See **Fig. 9.**

    11.3 Remove the screws at the base of the windshield holding the upper dash cover.

    11.4 Remove the screw at the top of the dash brace (see **Fig. 10**) and the screws at the top of the gauge cluster.

    11.5 Lift off the upper dash cover. See **Fig. 11.**

12. Disconnect the defrost door control cable from the face duct. See **Fig. 12.**

13. Remove the face duct.

Heater Core Removal and Installation

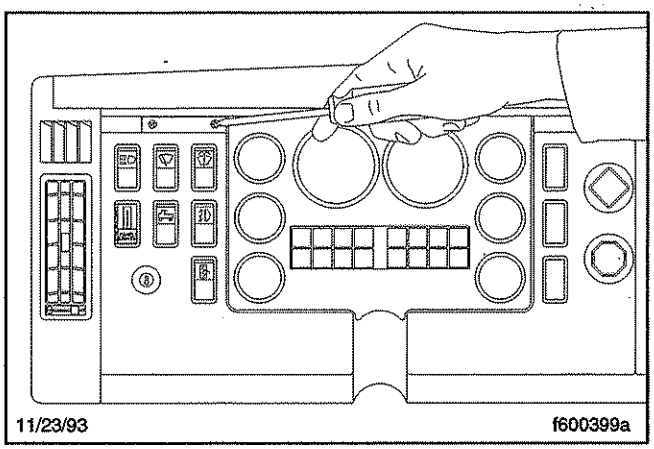
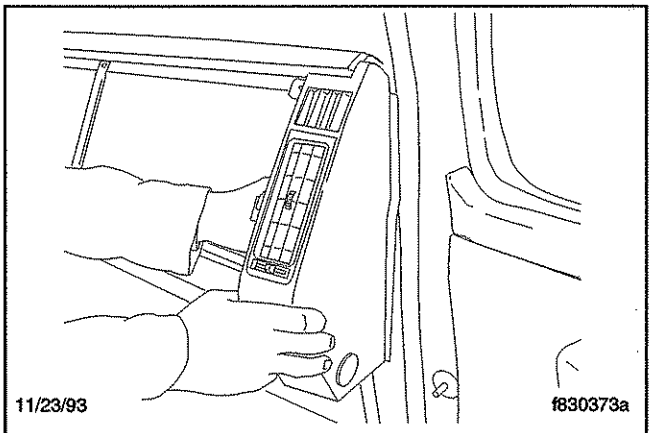
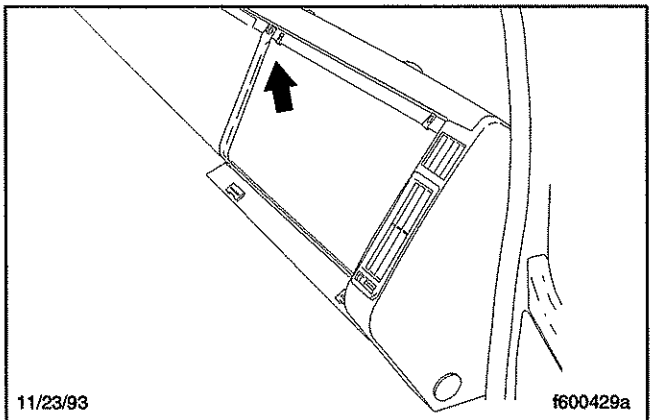


Fig. 8, Removing the Fasteners on Panel A



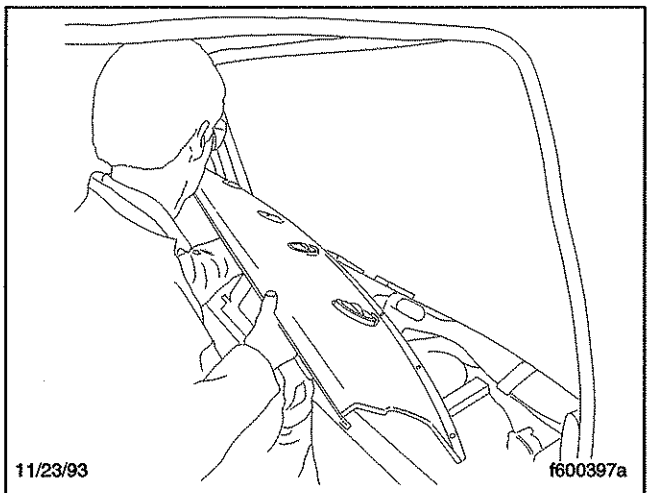
Left-hand drive shown; right-hand drive opposite

Fig. 9, Removing the Dash End Caps



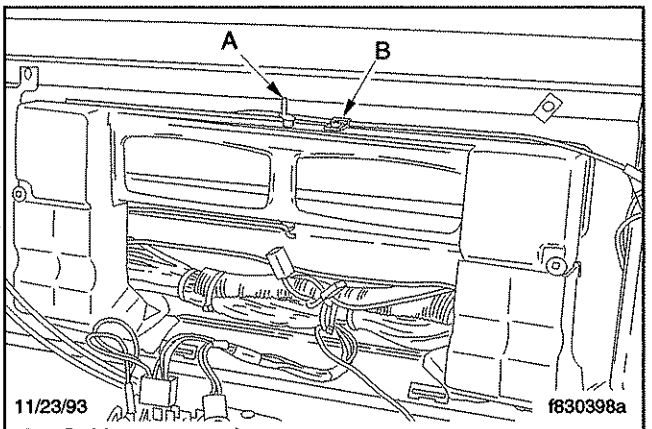
Left-hand drive shown; right-hand drive opposite

Fig. 10, Dash Brace Top Screw



Left-hand drive shown; right-hand drive opposite

Fig. 11, Lifting Off the Upper Dash Cover



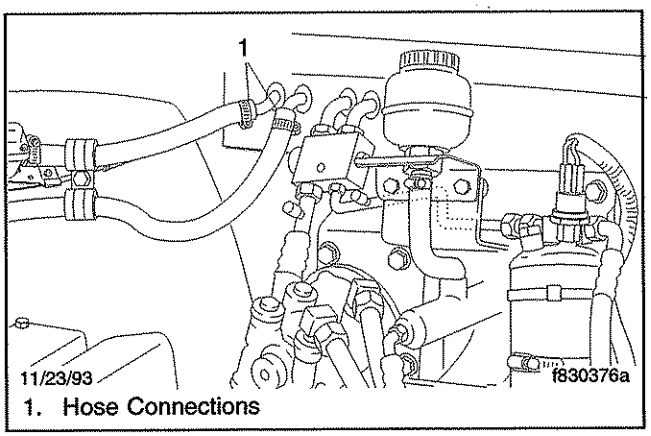
A. Cable connects here.
B. Cable sheath connects here.

Fig. 12, Defrost Cable Connections

14. Remove the four fasteners from the heater top cover, then set the cover aside.
15. Disconnect the hoses from the heater core. See **Fig. 13.**

⚠ WARNING

Always wear protective gloves when handling the heater core. Failure to do so could result in serious skin cuts from the sharp edges on the heater core fins.



1. Hose Connections

Fig. 13, Heater Core Hoses

16. Remove the heater core. See **Fig. 14.**

Installation

⚠ WARNING

Always wear protective gloves when handling the heater core. Failure to do so could result in serious skin cuts from the sharp edges on the heater core fins.

1. Install the heater core, inserting the pipes through the holes in the frontwall. See **Fig. 14.**
2. Connect the hoses to the heater core. See **Fig. 13.**
3. Check the heater core for leaks.

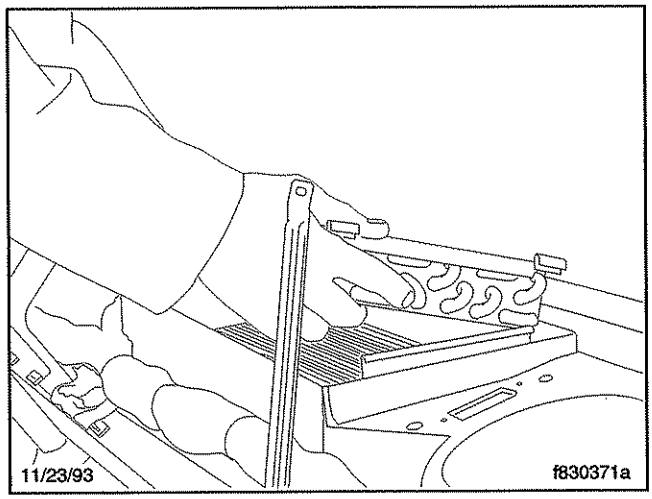


Fig. 14, Removing the Heater Core

3.1 Connect the batteries.

3.2 Close the radiator drain valve.

3.3 Fill the cooling system with approved coolant. See the vehicle maintenance manual.

3.4 Start the engine and set the temperature control to the warmest setting. When the engine thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again and fill as needed.

3.5 Check the heater core hose connections (see **Fig. 13**) for leaks. Tighten the hose clamps if needed.

3.6 Shut down the engine and disconnect the batteries.

4. Install the heater top cover.
5. Install the face duct. Connect the defrost door control cable and the cable sheath to the face duct. See **Fig. 12.**
6. Install the upper dash cover (see **Fig. 11**) and tighten the screws at the base of the windshield.
7. Install the dash end caps (see **Fig. 9**) and their mounting screws (two each).
8. Install the brace screw (see **Fig. 10**) and the screws at the top of the gauge cluster.
9. Install dash panel A and tighten its two mounting screws (see **Fig. 8**).
10. Install the instrument panel, as removed. See **Fig. 7.**

10.1 Connect the oil pressure line (brown).

10.2 Connect the two air pressure lines (green on top).

10.3 Connect all the electrical connectors.

10.4 On vehicles built after late January/early February 1997, install the four spring-loaded Torx®-head screws.

On vehicles built earlier, insert the locking tabs into the slots in the panel and push inward until they click into place. Make sure the tabs are locked.

Heater Core Removal and Installation

11. Install dash panel C and tighten its two mounting screws (see **Fig. 2**).
12. Install dash panel B and tighten its two mounting screws (see **Fig. 2**). Install the knobs on the parking brake air valve and the trailer brake air valve, as removed.
13. Install the windshield defrost duct. See **Fig. 4**.
14. Install dash panel D and tighten its two mounting screws (see **Fig. 2** and **Fig. 3**).
15. Install the vinyl extrusion trim at the top of the dash. See **Fig. 1**.
16. Connect the wiring harness to the turn signal switch.
17. Connect the batteries.

Evaporator Coil Removal and Installation

Removal

⚠ WARNING

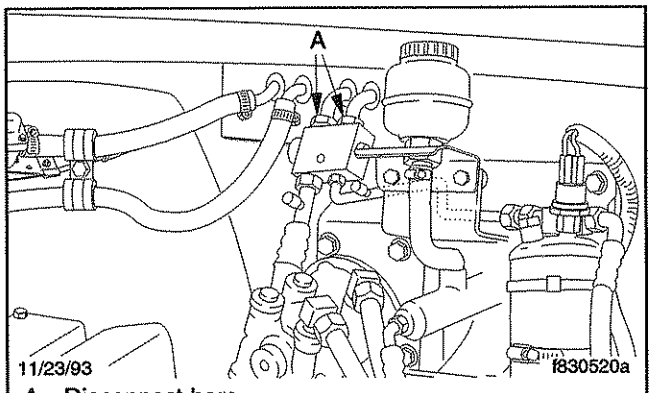
WARNING: Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to personal injury.

1. Disconnect the batteries.
2. Wearing protective goggles and gloves, recover the refrigerant system. For instructions, refer to **Subject 220.**
3. Remove the heater core. For instructions, refer to **Subject 110.**

⚠ CAUTION

CAUTION: Water and dirt can damage the refrigerant system. Five minutes of being uncapped is the limit for any hose or component. Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

4. Disconnect the evaporator coil lines from the expansion valve in the engine compartment. **See Fig. 1.** Save the O-rings if they are in good condition.
5. Cap or plug the evaporator coil lines and the expansion valve ports.



A. Disconnect here.

Fig. 1, Disconnect the Evaporator Coil Lines

⚠ WARNING

WARNING: Always wear protective gloves when handling the evaporator coil. Failure to do so could result in serious skin cuts from the sharp edges on the evaporator coil fins.

6. Lift the evaporator coil out of the housing. **See Fig. 2.**

Installation

⚠ WARNING

WARNING: Always wear protective gloves when handling the evaporator coil. Failure to do so could result in serious skin cuts from the sharp edges on the evaporator coil fins.

1. Wearing protective gloves, place the evaporator coil in the housing. **See Fig. 2.** Make sure the evaporator coil lines extend through the holes in the firewall.
2. Remove the caps or plugs from the evaporator coil lines and the expansion valve ports.
3. Lubricate the rubber O-rings with mineral oil and install them in the fittings.

NOTE: The previously removed O-rings can be used again if they are in good condition.

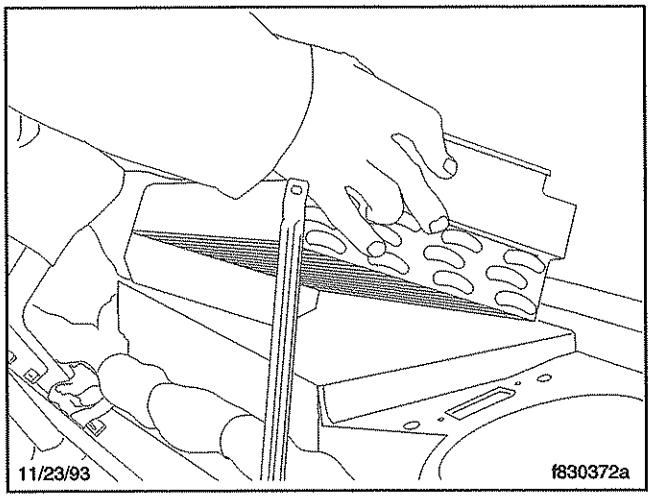


Fig. 2, Lift out the Evaporator Coil

Evaporator Coil Removal and Installation

4. Apply Loctite 242 or 592 to the male fitting threads; then, connect the evaporator coil lines to the expansion valve ports. Tighten the fittings as follows:
   - Large fitting—33 N·m (24 lbf·ft)
   - Small fitting—24 N·m (18 lbf·ft)
5. Evacuate and charge the air conditioning system with refrigerant. For instructions, refer to **Subject 220**. Be sure to add refrigerant oil to the compressor to replace that which was lost when the system was discharged. Refer to the applicable refrigerant compressor section elsewhere in this group.

NOTE: If the system will not hold a vacuum, check the evaporator coil connections for tightness or check for a missing O-ring.

6. Install the heater core and the other removed components. For instructions, refer to **Subject 110.**
7. Connect the batteries.

Thermostatic Switch Replacement

Replacement

1. Disconnect the batteries.
2. Remove the vinyl extrusion trim at the top of the dash. See **Fig. 1**.
3. Remove dash panel D and set it and the two mounting screws aside. See **Fig. 2** and **Fig. 3**.
4. Remove dash panel B.
   - 4.1 Remove the knobs from the parking brake air valve and the trailer brake air valve, if so equipped.
   - 4.2 Remove the two mounting screws.

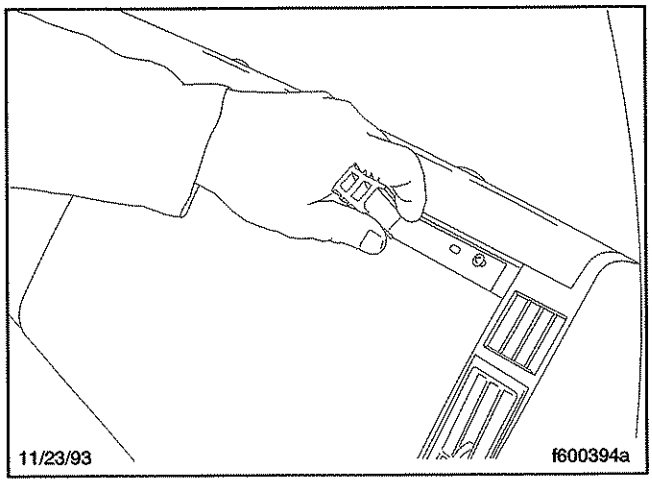
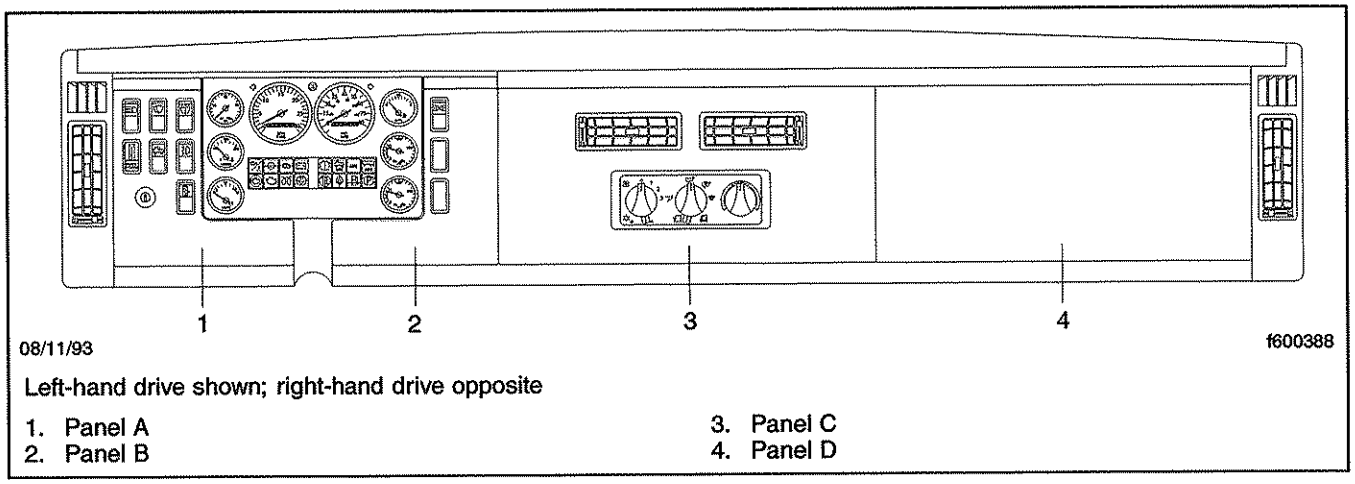


Fig. 1, Removing the Vinyl Extrusion Trim

   - 4.3 If necessary in order to remove panel B, loosen the fasteners on the instrument panel. For detailed instructions, see **Subject 110**.
   - 4.4 Lift off the dash panel. Set it and the two mounting screws aside.
5. Remove dash panel C and set it and the two mounting screws aside. See **Fig. 4**.

NOTE: It isn't necessary to remove the control panel from dash panel C or to disconnect the control cables.

6. On right-hand drive (RH DR) vehicles, detach the ignition keyswitch from panel A.
7. Remove the two screws holding the thermostatic switch to the ducting. Remove the thermostatic switch from the vehicle. See **Fig. 5**.
   - 7.1 Disconnect the wires from the thermostatic switch.
   - 7.2 Remove the two capscrews holding the thermostatic switch.
   - 7.3 Move the air duct to access the capillary tube. Carefully pull the capillary tube, which extends from the bottom of the thermostatic switch, out of the air duct.
   - 7.4 Remove the thermostatic switch.
8. Install the new thermostatic switch.
   - 8.1 Carefully insert the capillary tube into the hole in the air duct.



Left-hand drive shown; right-hand drive opposite

1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2, Dash Panels

Thermostatic Switch Replacement

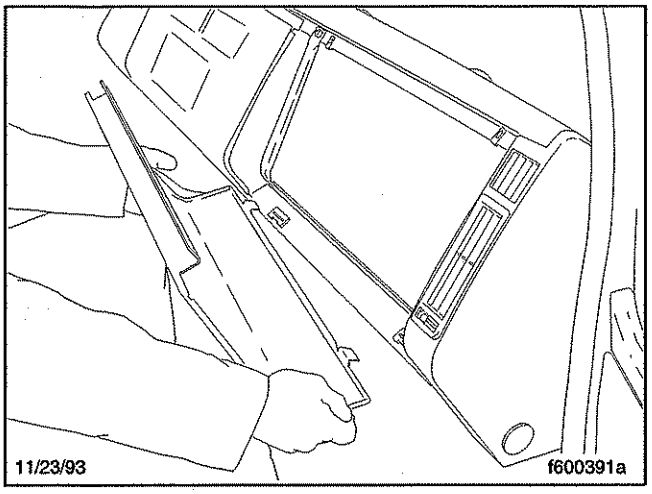


Fig. 3, Removing Panel D

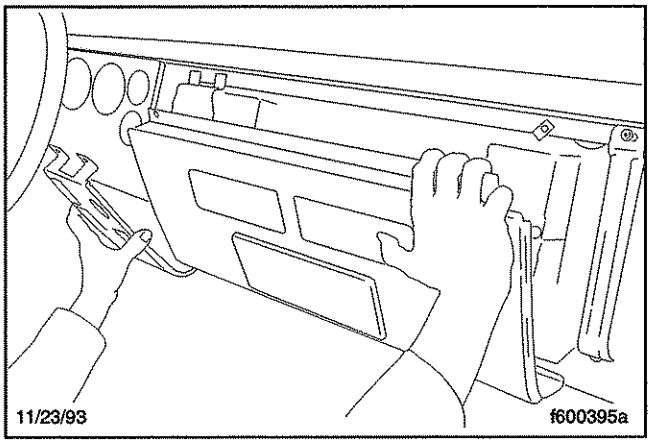


Fig. 4, Removing Panel C

8.2 Position the thermostatic switch and secure it to the ducting using the two screws, as removed.

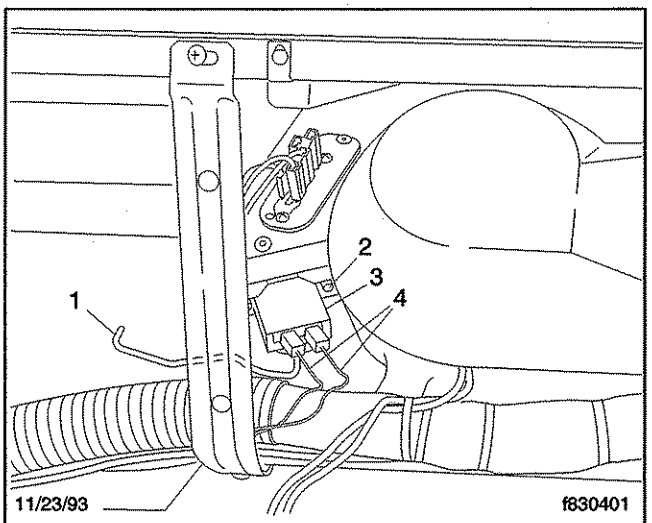
8.3 Connect the wires to the switch.

8.4 Move the air duct into position.

9. On RH DR, attach the ignition keyswitch to panel A.

10. Install dash panel C and tighten its two mounting screws.

11. Install dash panel B and tighten its two mounting screws. Install the knobs for the parking brake air valve and the trailer brake air valve, as removed.



1. Capillary Tube
2. Allen-Head Screw
3. Thermostatic Switch
4. Thermostatic Switch Wires

Fig. 5, Thermostatic Switch

12. Install dash panel D and tighten its two mounting screws.

13. Install the vinyl extrusion trim at the top of the dashboard.

14. Connect the batteries.

Replacement

1. Disconnect the batteries.
2. Remove the vinyl extrusion trim at the top of the dash. See **Fig. 1**.
3. Remove dash panel D and set it and the two mounting screws aside. See **Fig. 2** and **Fig. 3**.
4. On right-hand drive (RH DR) vehicles, remove the upper dash cover.
5. Remove the blower motor cover. See **Fig. 4**.
6. Disconnect the blower motor electrical connector. See **Fig. 5**.

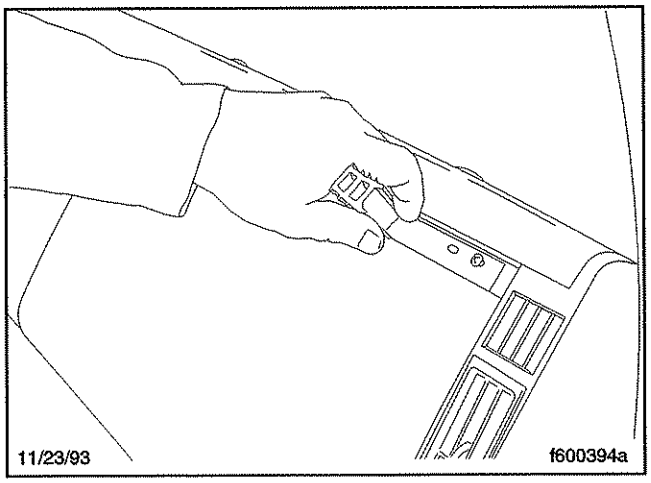
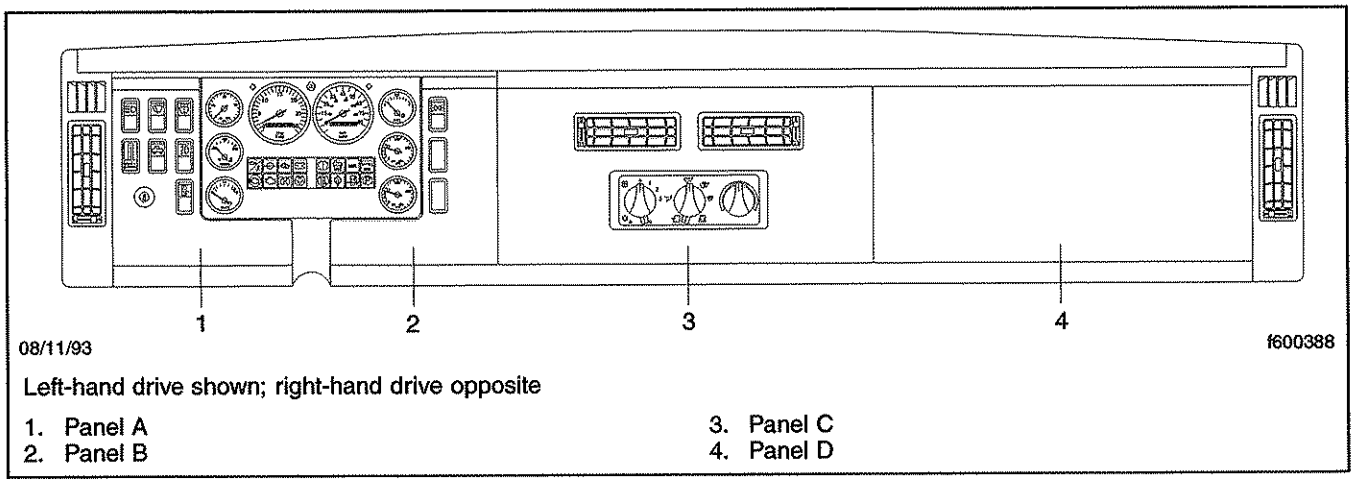


Fig. 1, Removing the Vinyl Extrusion Trim

7. Remove the three mounting nuts holding the blower motor (see **Fig. 6**); then, lift out the blower motor and remove it from the dash.
8. Position the new blower motor in the dash. Install the three mounting nuts and tighten them 17 lbf·in (192 N·cm).
9. Connect the blower motor electrical connector (see **Fig. 5**).
10. Install the blower motor cover. See **Fig. 4**.
11. Install the knurled thumb screw on the blower motor cover finger-tight.
12. On RH DR vehicles, install the upper dash cover.
13. Install dash panel D (see **Fig. 3**) and tighten the two mounting screws.
14. Install the vinyl extrusion trim at the top of the dash. See **Fig. 1**.
15. Connect the batteries and check the blower operation. See the vehicle driver's manual for instructions.



Left-hand drive shown; right-hand drive opposite

1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2, Dash Panels

Blower Motor Replacement

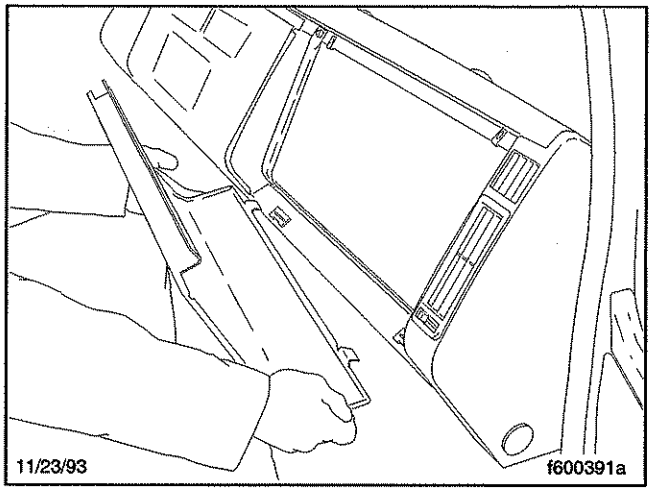


Fig. 3, Removing Panel D

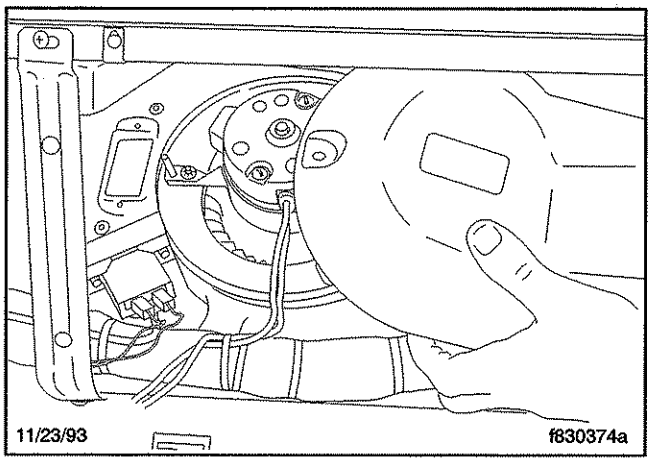


Fig. 4, Removing the Blower Motor Cover

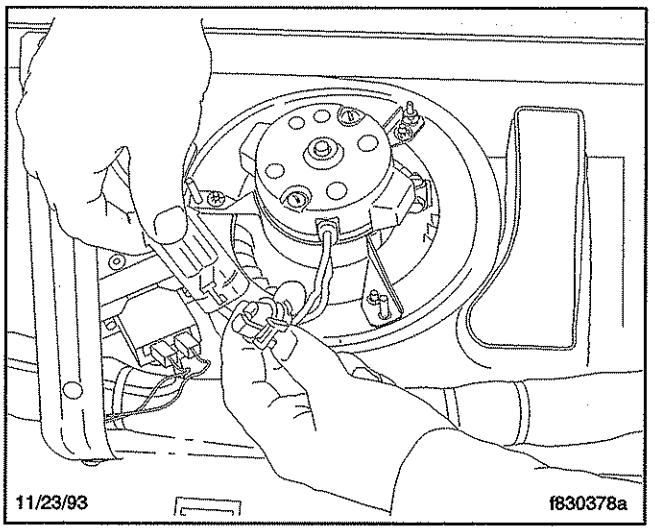


Fig. 5, Disconnecting the Electrical Connector

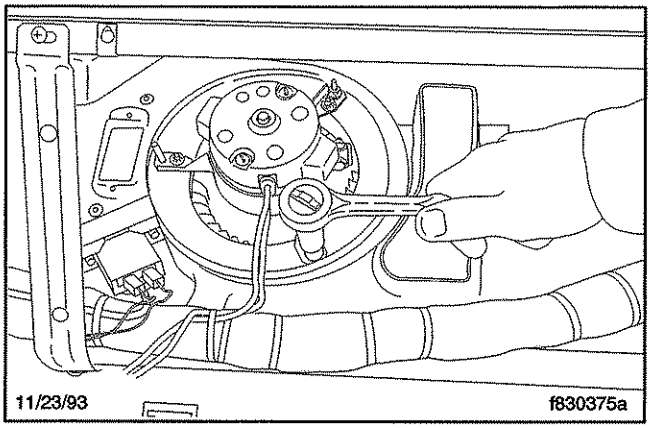


Fig. 6, Removing the Blower Motor

Resistor Block Replacement

Replacement

1. Disconnect the batteries.
2. Remove the extruded rubber strip at the top of the dashboard. **See Fig. 1.**
3. Remove the two mounting screws from dash panel D; then, remove the panel. See **Fig. 2** and **Fig. 3.**
4. Remove the resistor block. **See Fig. 4.**
   - 4.1 Unplug the connector from the resistor block.
   - 4.2 Remove the two mounting screws.
   - 4.3 Remove the resistor block.
5. Install the resistor block with the two mounting screws; then, connect the electrical plug.
6. Connect the batteries and check the blower operation.
7. Install dash panel D and the two mounting screws.
8. Install the extruded rubber strip at the top of the dashboard.

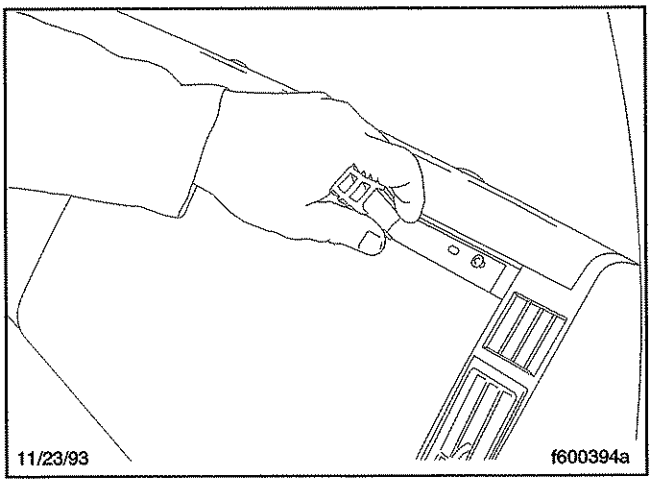
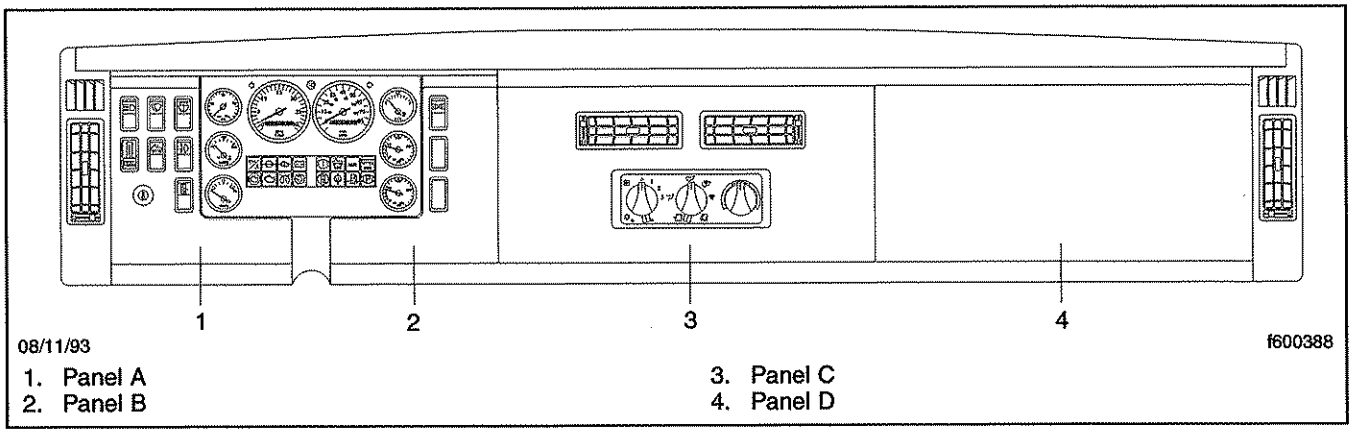


Fig. 1



1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2

Resistor Block Replacement

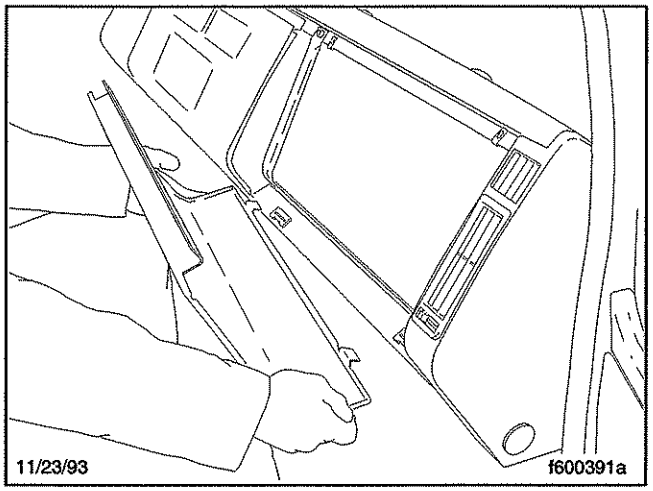
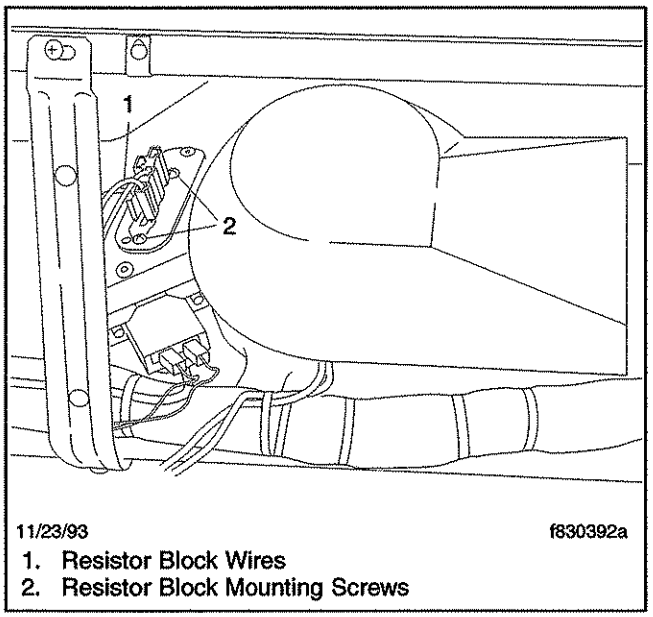


Fig. 3



1. Resistor Block Wires
2. Resistor Block Mounting Screws

Fig. 4

Water Regulating Valve Replacement

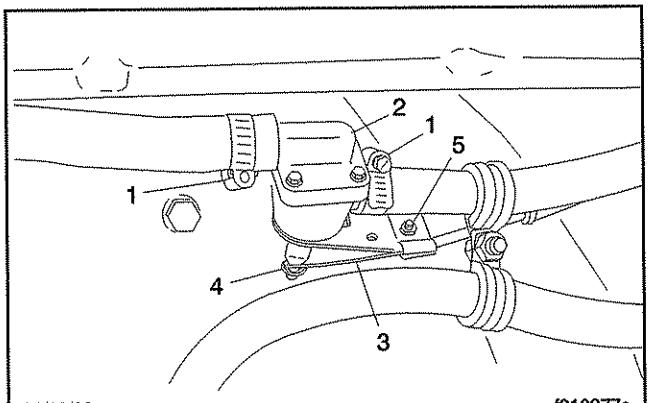
Replacement (See Fig. 1)

1. Tilt the hood.
2. Set the heater temperature control to the warmest setting.

⚠ WARNING

WARNING: Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

3. With the engine cold, drain enough coolant into a clean drain pan to lower the coolant level below the water regulating valve.
4. Remove the screw (Ref. 5) that holds the control cable to the valve base plate.
5. Remove the internal toothed clip (Ref. 4), and detach the control cable (Ref. 3).
6. Disconnect the heater hoses from the valve. Remove and discard the valve.
7. Install the new valve in the heater hoses. Tighten the hose clamps.
8. Slip the end of the control cable over the post on the valve control lever, and install a new internal toothed clip.



1. Hose Clamp
2. Valve Body
3. Control Cable
4. Internal Toothed Clip
5. Cable Mounting Screw

Fig. 1

9. Adjust the control cable.
   - 9.1 Set the heater temperature control to the coolest position.
   - 9.2 Set the water regulating valve to the closed position.
   - 9.3 Slide the control cable in the clamp until the screw (Ref. 5) in the clamp lines up with the hole in the valve base plate.
   - 9.4 Tighten the screw (Ref. 5) to hold the cable in place.
   - 9.5 Check that the valve closes when the temperature control is at the coolest setting and opens toward the warmest setting.

   NOTE: The valve is fully closed or fully open before it reaches the mechanical stops at either end of its travel. After adjusting for the coolest setting, it is not necessary to adjust for the warmest setting.
10. Fill the cooling system with approved coolant. Refer to the vehicle maintenance manual.
11. Start the engine. When the engine thermostat opens, air will be forced from the heater core as the coolant circulates. Check the coolant level again and fill as needed.
12. Check the valve and the hose connections for leaks. Tighten the hose clamps if needed.
13. Lower the hood.

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

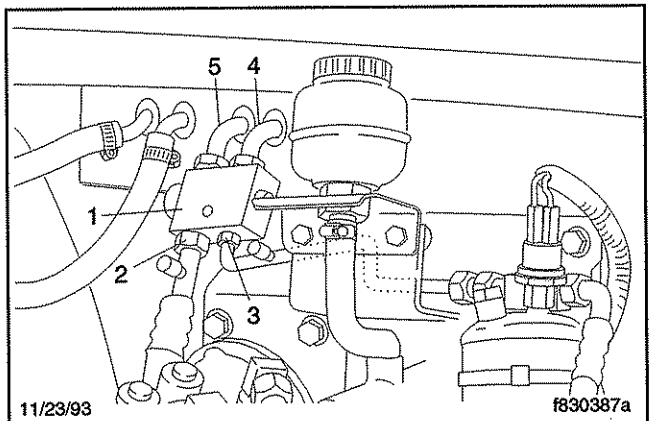
1. Tilt the hood.
2. Wearing protective goggles and gloves, recover the refrigerant system. For instructions, refer to **Subject 220.**
3. Disconnect the four refrigerant lines from the expansion valve; then, remove and discard the valve and the O-rings.

⚠ CAUTION

CAUTION: Water and dirt can damage the refrigerant system. Five minutes of being uncapped is the limit for any hose or component.

Do not blow shop air through the refrigerant hoses; shop air is wet (humid).

4. Lubricate the new rubber O-rings with mineral oil and install them in the fittings.



1. Expansion Valve Body
2. Compressor Line
3. Receiver-Drier Line
4. Evaporator Coil (small line)
5. Evaporator Coil (large line)

Fig. 1, Expansion Valve

5. Apply Loctite 242 or 592 to the male fitting threads. Connect the lines from the evaporator coil to the expansion valve ports. Connect the line from the receiver-drier to the expansion valve port and the line that runs from the expansion valve port to the compressor.

   Tighten the connections as follows:

   - Evaporator coil large fitting—33 N·m (24 lbf·ft)
   - Evaporator coil small fitting—24 N·m (18 lbf·ft)
   - Receiver-drier line—16 N·m (12 lbf·ft)
   - Compressor line—24 N·m (18 lbf·ft)

6. Evacuate and charge the air conditioning system with refrigerant. For instructions, refer to **Subject 220.** Be sure to add refrigerant oil to the compressor to replace that which was lost when the system was discharged. Refer to the applicable refrigerant compressor section in this group.

NOTE: If the system will not hold a vacuum, check the connections for tightness or check for a missing O-ring.

7. Lower the hood.

Receiver-Drier Replacement

Replacement (See Fig. 1)

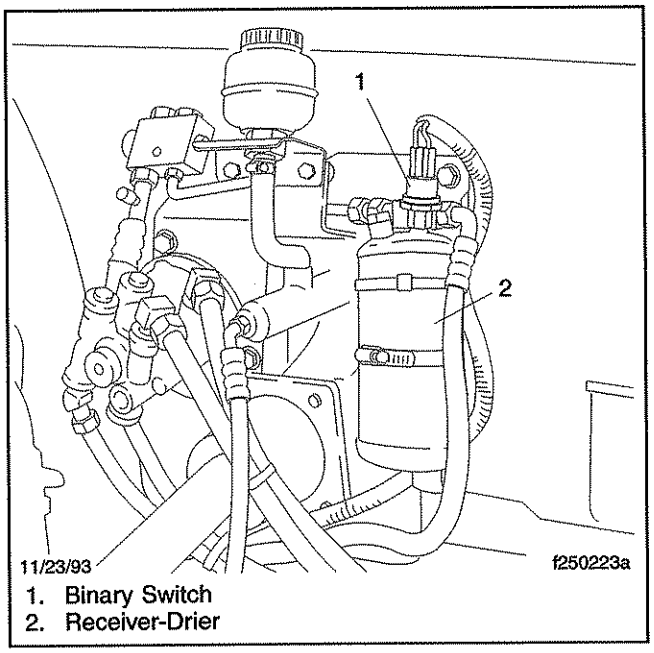
⚠ WARNING

WARNING: Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

1. Tilt the hood.
2. Wearing protective goggles and gloves, recover the refrigerant system. For instructions, refer to **Subject 220.**
3. Disconnect the electrical leads from the binary switch and the fan control switch (if equipped).
4. Disconnect the inlet and outlet lines. Use two wrenches to avoid twisting the hoses.

⚠ CAUTION

CAUTION: Contaminants, such as water and dirt, can damage the refrigerant system. Five minutes of being uncapped is the limit for any part. Do not blow shop air through the refrigerant hoses since shop air is wet (humid).



1. Binary Switch
2. Receiver-Drier

Fig. 1, Receiver-Drier Installation

IMPORTANT: If the desiccant cartridge inside the old receiver-drier has fallen apart, flush the entire system and replace the expansion valve and the refrigerant compressor. Desiccant matter can't be removed from these parts. A cartridge may fall apart from too much moisture in the system, because of poor evacuation of the system, or from lack of care.

5. Loosen the clamp that holds the receiver-drier to the bracket on the firewall. Remove and discard the receiver-drier.
6. Unscrew the binary switch. Remove the fan control switch (if equipped).
7. Mount the new receiver-drier and tighten the clamp.
8. If equipped with a fan cycle switch:

   On vehicles built before November 1994, apply Loctite 242 or 592 to the male threads of the coupling. Install the fan cycle switch, and tighten it 108 lbf·in (1220 N·cm) or one-eighth turn past hand-tight.

   On vehicles built from November 1994, lubricate a new O-ring with mineral oil, then install it over the male threads of the receiver-drier coupling. Install the fan cycle switch and tighten it 20 to 25 lbf·ft (27 to 34 N·m).

   Connect the wiring harness to the switch.

9. On vehicles built before November 1994, apply Loctite 242 or 592 to the male threads of the binary switch coupling. Install the binary switch, and tighten it 108 lbf·in (1220 N·cm) or one-eighth turn past hand-tight.

   On vehicles built from November 1994, lubricate a new O-ring with mineral oil, then install it over the male threads of the receiver-drier coupling. Install the binary switch and tighten it 20 to 25 lbf·ft (27 to 34 N·m).

   Connect the wiring harness to the switch.

10. Connect the inlet and outlet lines to the receiver-drier. Tighten the connections 45 N·m (33 lbf·ft).
11. Evacuate and charge the air conditioning system with refrigerant. For instructions, refer to **Subject 220.** Be sure to add refrigerant oil to the compres-

Receiver-Drier Replacement

sor to replace that which was lost when the system was discharged. Refer to the applicable refrigerant compressor section in this group.

12. Lower the hood.

Fan Cycling Switch Replacement

Replacement

⚠ WARNING

WARNING: Before doing any of the work below, read the information under Safety Precautions, 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

1. Tilt the hood.
2. Disconnect the harness connectors and unscrew the switch from its coupling on the receiver-drier. **See Fig. 1.**
3. On vehicles built before November 1994, apply Loctite 242 or 592 to the male threads of the coupling. Install the fan cycle switch, and tighten it 108 lbf·in (1220 N·cm) or one-eighth turn past hand-tight.

   On vehicles built from November 1994, lubricate a new O-ring with mineral oil, then install it over the male threads of the receiver-drier coupling. Install the fan cycle switch and tighten it 20 to 25 lbf·ft (27 to 34 N·m).
4. Connect the wiring harness to the switch.
5. Check the system charge and charge the system with refrigerant if needed. Refer to **Subject 220** for instructions.
6. Lower the hood.

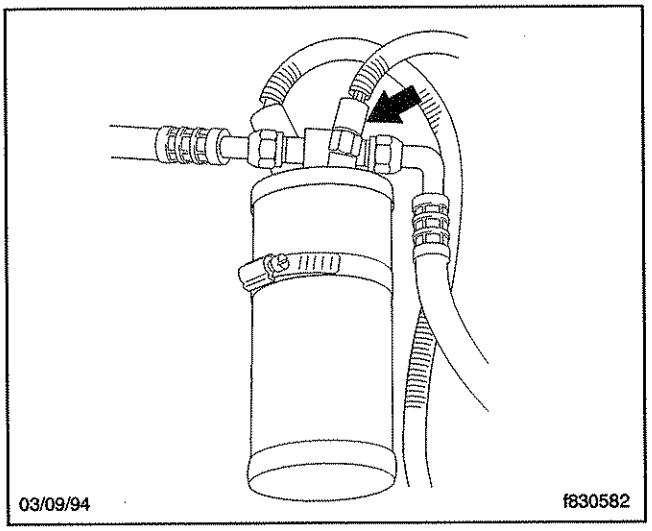


Fig. 1, Fan Cycling Switch

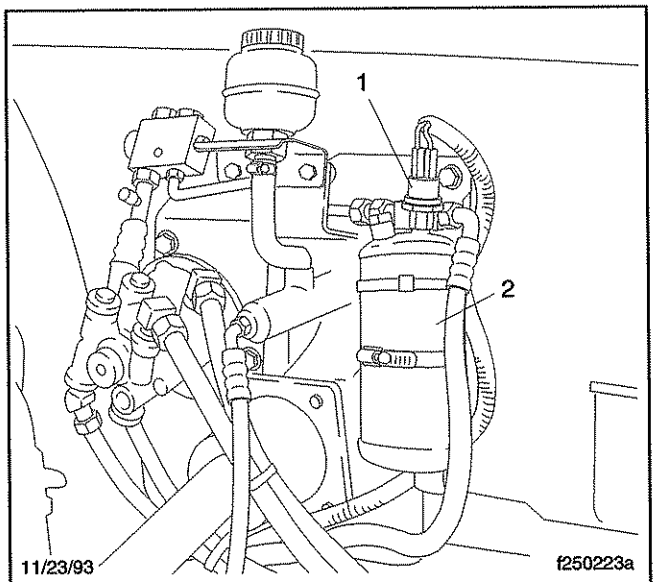
Binary Switch Replacement

Replacement (See Fig. 1)

NOTE: A Schrader valve in the receiver-drier prevents loss of refrigerant when removing the binary switch.

1. Tilt the hood.
2. Disconnect the electrical leads from the binary switch.
3. Unscrew the binary switch from the receiver-drier.
4. On vehicles built before November 1994, apply Loctite® 242 or 592 to the male threads of the binary switch coupling. Install the binary switch, and tighten it 108 lbf·in (1220 N·cm) or one-eighth turn past hand-tight.

   On vehicles built from November 1994, lubricate a new O-ring with mineral oil, then install it over the male threads of the receiver-drier coupling. Install the binary switch and tighten it 20 to 25 lbf·ft (27 to 34 N·m).
5. Check the operation of the air-conditioning system.
6. Lower the hood.



1. Binary Switch
2. Receiver-Drier

Fig. 1, Binary Switch Installation

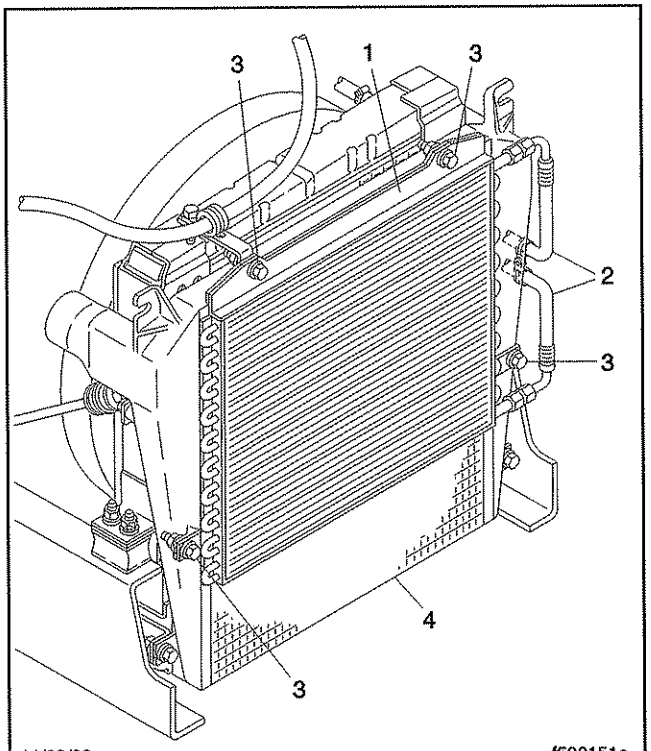
Condenser Replacement

Replacement (See Fig. 1)

⚠ WARNING

WARNING: Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

1. Tilt the hood.
2. Wearing protective goggles and gloves, recover the refrigerant system. For instructions, refer to **Subject 220.**
3. Disconnect the refrigerant hoses from the condenser. Use two wrenches to avoid damaging the condenser.



11/23/93 f500151a

1. Condenser
2. Refrigerant Hoses
3. Condenser Mounting Bolt
4. Radiator

Fig. 1, Condenser Installation

⚠ CAUTION

CAUTION: Contaminants, such as water and dirt, can damage the refrigerant system. Five minutes of being uncapped is the limit for any part. Do not blow shop air through the refrigerant hoses since shop air is wet (humid).

4. Cap the refrigerant hoses.
5. Remove the four condenser mounting bolts.
6. Remove the condenser.
7. Position the condenser on the radiator. Install the capscrews and tighten them 20 N·m (15 lbf·ft).
8. Remove the plugs from the new condenser. Coat the O-rings with mineral oil and apply Loctite 242 or 592 to the male fitting threads.
9. Connect the refrigerant lines to the condenser. Using two wrenches, tighten the fittings 45 N·m (33 lbf·ft). *Be sure to add refrigerant oil to the compressor,* to replace that which was lost in the old condenser. Refer to the applicable compressor section in this group.
10. Charge the system with refrigerant; for instructions, refer to **Subject 220.**
11. Lower the hood.

Replacement

1. Disconnect the batteries.
2. Remove the vinyl extrusion trim at the top of the dash. See **Fig. 1.**
3. Remove dash panel D. Set it and its two mounting screws aside. See **Fig. 2** and **Fig. 3.**
4. Remove dash panel B. See **Fig. 2.**
   - 4.1 If so equipped, remove the knobs from the parking brake air valve and the trailer brake air valve.
   - 4.2 If necessary in order to remove panel B, loosen the fasteners on the instrument panel. For detailed instructions see **Subject 110.**
   - 4.3 Lift off the panel. Set it and its two mounting screws aside.
5. Remove dash panel C.
   - 5.1 Gently pry the bezel from the control panel in the center of dash panel C. See **Fig. 4.**
   - 5.2 Remove and set aside the four screws holding the control panel to dash panel C. See **Fig. 5.**
   - 5.3 Remove the two mounting screws from the top of dash panel C.
   - 5.4 Lift out the dash panel. Set it and the two mounting screws aside.
6. Remove the old control panel.
   - 6.1 Remove the panel light and disconnect the electrical connectors from the control panel. Label the connectors so they can be installed in the same positions later.
   - 6.2 Label the control cables for later reference. See **Fig. 6.**
   - 6.3 Remove the screws that hold the control cables to the control panel; then, disconnect the cables.
   - 6.4 Lift out the control panel.
7. Install the new control panel.

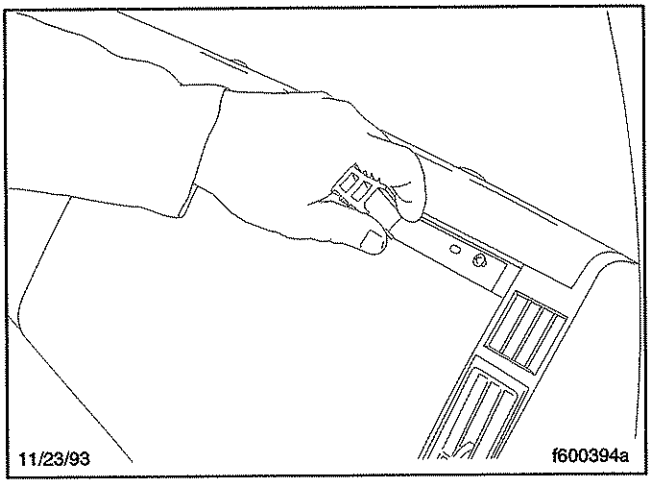
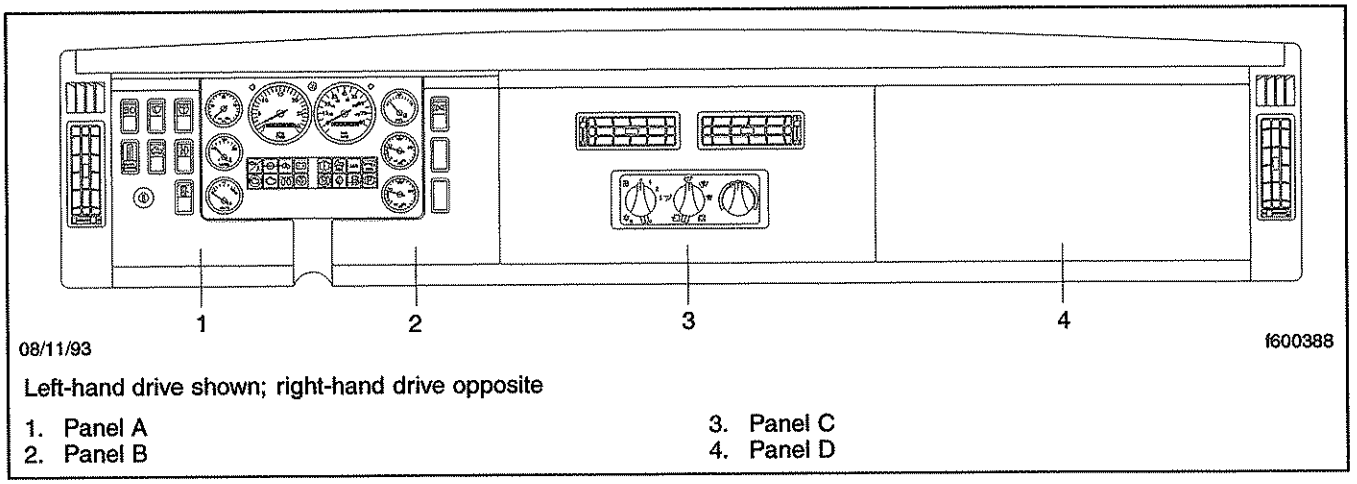


Fig. 1, Removing the Vinyl Extrusion Trim



Left-hand drive shown; right-hand drive opposite

1. Panel A
2. Panel B
3. Panel C
4. Panel D

Fig. 2, Dash Panels

Control Panel Replacement

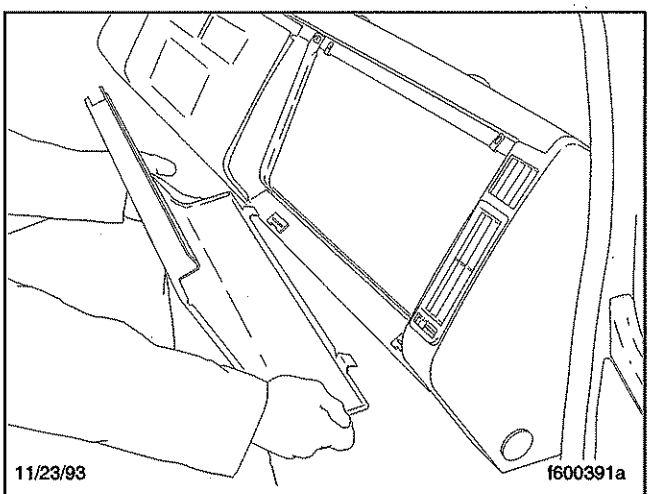


Fig. 3, Removing Panel D

7.1 Position the control panel and install the four screws that mount it to the dash panel.

7.2 Attach the control cables to the control panel. Install the control cable mounting screws.

7.3 Insert the panel light and connect the wiring.

7.4 Install the bezel around the control panel.

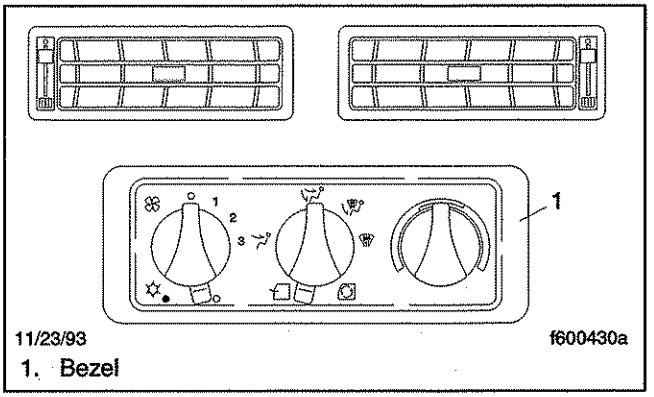


Fig. 4, HVAC Control Panel

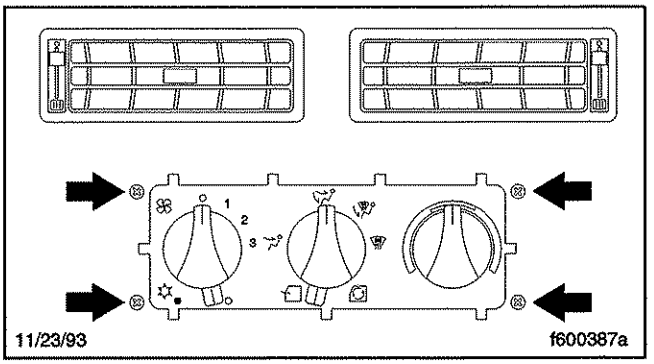


Fig. 5, Control Panel Mounting Screws

8. Adjust the control cables. See **Fig. 6** and **Fig. 7**.

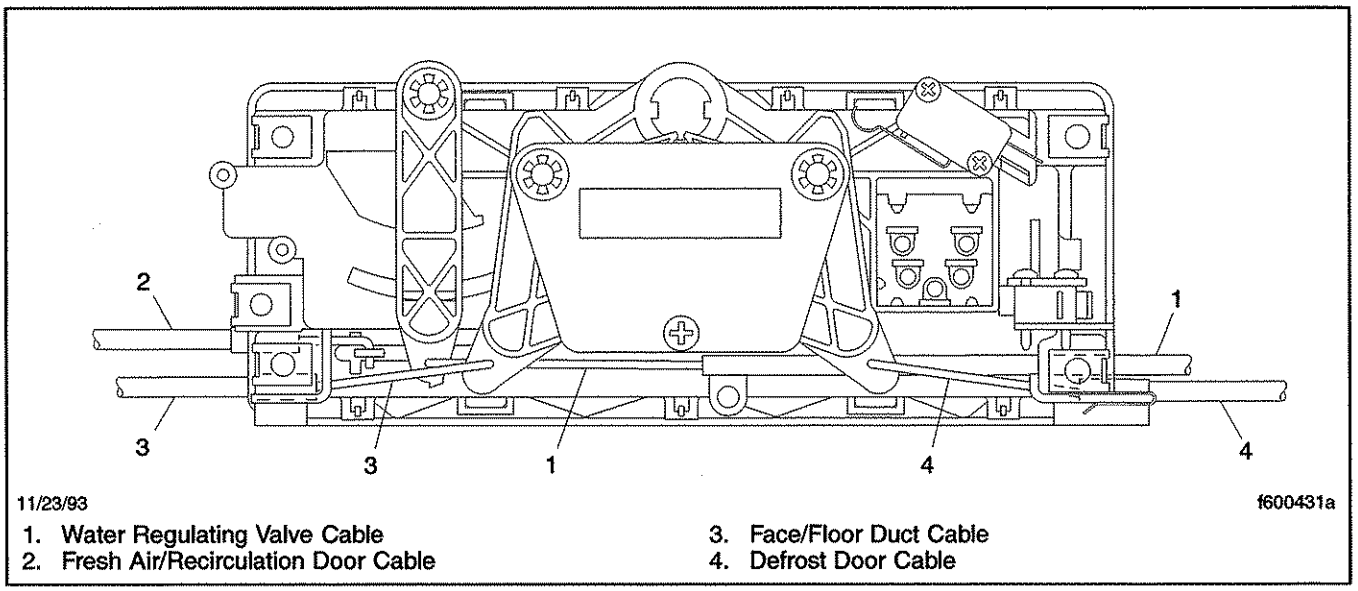


Fig. 6, HVAC Control Cables

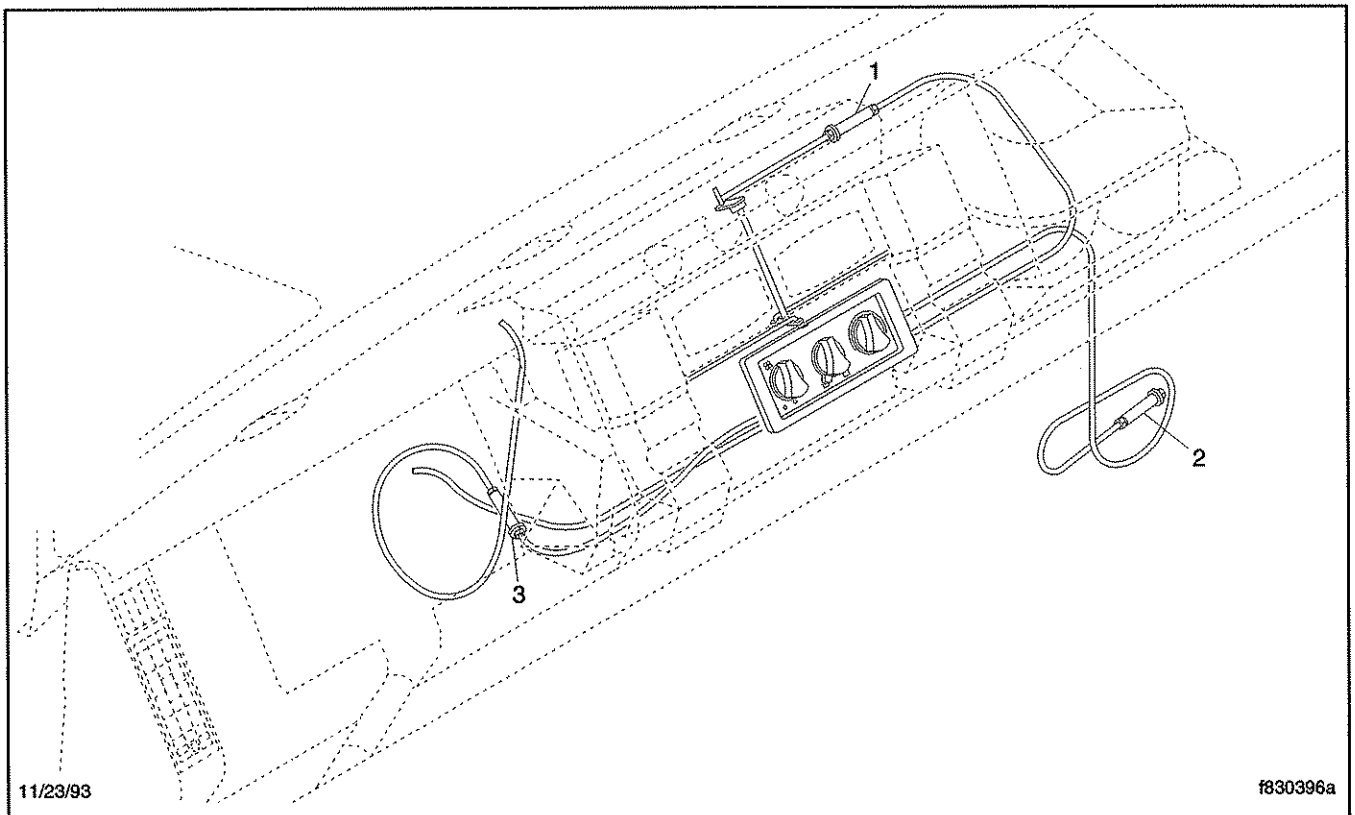
8.1 To adjust the cable (**Fig. 6**, Ref. 1) to the water regulating valve, set the dashboard control to the coolest setting (fully counterclockwise). Adjust the turnbuckle until the valve is almost at its mechanical stop in the closed position.

NOTE: The valve is fully closed or fully open before it reaches the mechanical stops at either end of its travel. After adjusting for the coolest setting, it is not necessary to adjust for the warmest setting.

8.2 To adjust the fresh air/recirculation door cable (**Fig. 6**, Ref. 2), remove the kick panel under the dashboard on the passenger side for access to the door. Move the control lever to the fresh air position. Adjust the turnbuckle (**Fig. 7**, Ref. 2) under the dashboard until the door snaps into the horizontal position and closes off the opening to the cab. Move the lever to the recirculation position and make sure the door snaps open. If necessary, readjust the turnbuckle so the door is in the correct position for each control lever setting.

8.3 To adjust the face/floor duct door and defrost duct door cables (**Fig. 6**, Refs. 3 and 4), set the control knob in the twelve o'clock position. Both face/floor duct doors should be open to direct air to the floor, and the defrost duct door should be open to let air out the face ducts. Adjust the turnbuckle (**Fig. 7**, Ref. 3) on the defrost duct door cable if necessary.

Turn the control knob fully counterclockwise; the face/floor duct doors should



Left-hand drive shown; right-hand drive opposite

1. Turnbuckle for Face/Floor Duct Door Cable
2. Turnbuckle for Fresh Air/Recirculation Door Cable
3. Turnbuckle for Defrost Duct Door Cable

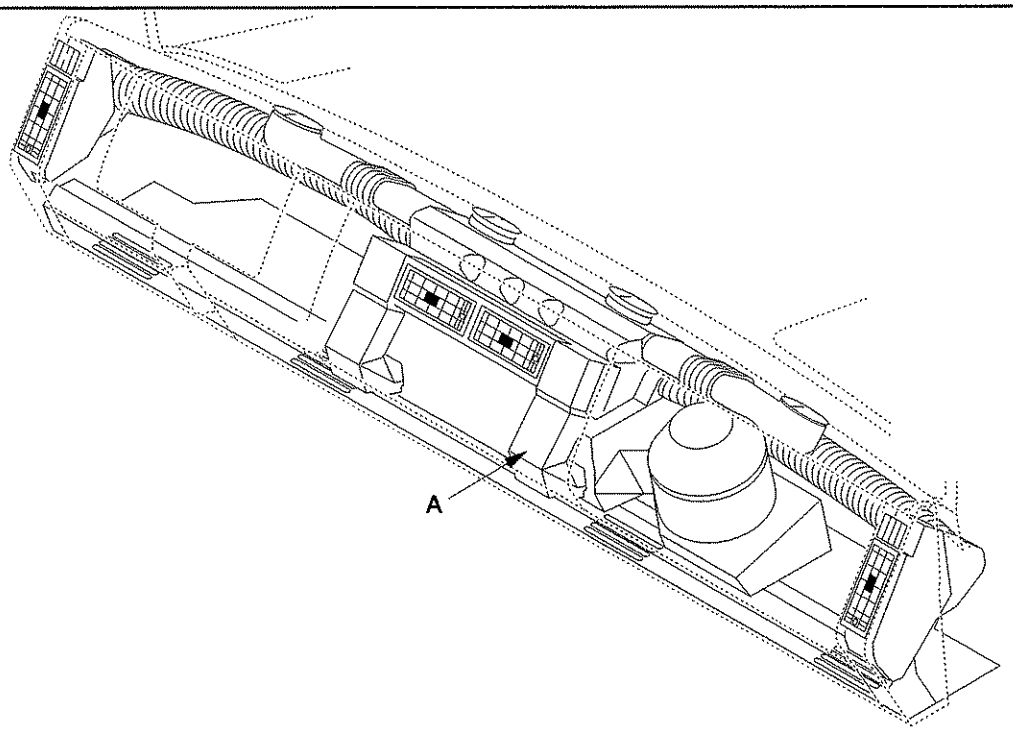
Fig. 7, Control Cable Adjustment

Control Panel Replacement

close. Remove the bottom section of one of the floor ducts to check the door position. See **Fig. 8**. Adjust the turnbuckle (**Fig. 7**, Ref. 1) on the face/floor duct door cable if necessary.

Make sure there is a smooth transition from one cable to the other as the control knob moves through the twelve o'clock position. The defrost duct door cable should move when the control is to the right of the twelve o'clock position; the face/floor duct door cable should move when the control is to the left of the twelve o'clock position. As the control knob passes through twelve o'clock, one cable should stop moving and the other cable should start to move. If the cables are adjusted incorrectly, either the control knob will lock up before reaching twelve o'clock or the control knob movement will get very stiff.

9. Install dash panel C and tighten its two mounting screws.
10. Install dash panel B and tighten its two mounting screws. Install the knobs on the parking brake air valve and the trailer brake air valve, as removed.
11. If loosened, tighten the fasteners on the instrument panel. For detailed instructions, see **Subject 110**.
12. Install dash panel D and tighten its two mounting screws.
13. Install the vinyl extrusion trim at the top of the dash.
14. Connect the batteries.



11/23/93 f830388a

Left-hand drive shown; right-hand drive opposite

A. Remove this section of duct to check the door position.

Fig. 8, Duct Door Position Adjustment

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing

Recovery

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

The recovery process removes most of the refrigerant charge in the system.

1. Tilt the hood.
2. If equipped with a swashplate-type compressor, start the engine and run the air conditioning system for 5 minutes. Shut down the engine.
3. Remove the caps from the suction and discharge service valves. See **Fig. 1**.
4. Wearing protective goggles and nonleather gloves, attach the recover/recycling station's hoses to the valves. See **Fig. 2**.

   IMPORTANT: Push down firmly on the hose connectors until a clicking sound is heard. This will ensure that the coupler is locked.

   4.1 Make sure that the recovery and recycling station's valves are closed.

   4.2 Connect the red high-side hose to the discharge service valve.

   4.3 Connect the blue low-side hose to the suction service valve.

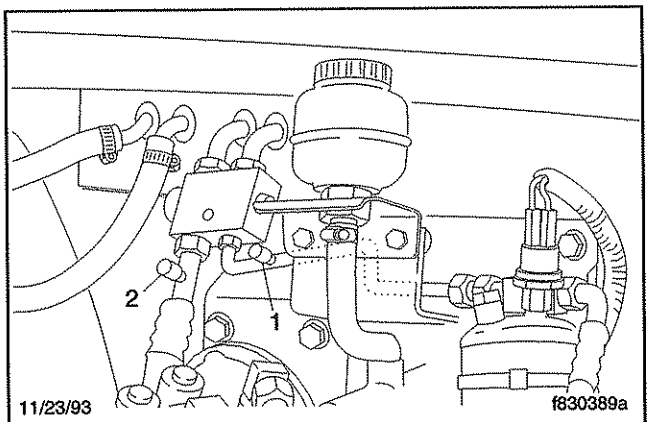
   4.4 Turn the knob clockwise on each coupler to open the Schrader valves.

5. Follow the recovery and recycling station manufacturer's instructions and recover all of the refrigerant from the system.

IMPORTANT: Always comply with all local regulations regarding refrigerant disposal. You may be subject to substantial penalties for improper disposal.

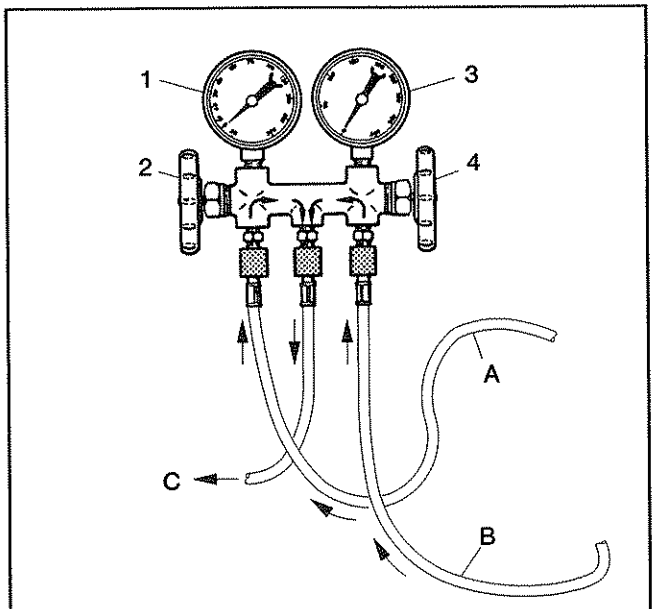
6. Measure the oil recovered during this procedure. The compressor will have to be refilled with the same quantity of new refrigerant oil.

   If the system is contaminated with moisture, all of the compressor oil must be replaced with clean oil. If the system is heavily contaminated with desiccant or grit, replace the compressor, expansion valve, and receiver-drier.



1. Discharge Service Valve
2. Suction Service Valve

Fig. 1, Service Valves



A. Connect to the suction service valve.
B. Connect to the discharge service valve.
C. To a recycling station.

1. Low-Side Gauge
2. Manifold Suction Hand Valve (Open)
3. High-Side Gauge
4. Manifold Discharge Hand Valve (Open)

Fig. 2, Discharging Hookup

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing

Evacuating (Recycling)

GENERAL INFORMATION

Moisture in a Refrigerant System

Water forms ice crystals at the thermostatic expansion valve. Ice crystals retard or stop the flow of refrigerant, causing a reduction or complete loss of cooling. As the expansion valve warms, due to the lack of refrigerant, the ice melts and passes through the expansion valve. Then refrigerant will flow again until the ice crystals reform. The result is intermittent cooling.

Refrigerant oil has an extremely high moisture absorption capacity. This reduces the lubricating ability of the oil, which could damage the compressor and other system components.

Effects of Pressure on the Boiling Points of Water

Water boils at 212°F (100°C) at an atmospheric pressure of 14.7 psi (sea level). At higher elevations the atmospheric pressure is lower which allows water to boil at lower temperatures. See **Table 1** for boiling temperatures of water at converted pressures.

Boiling Temperatures of Water at Converted Pressures

Boiling Temperature of Water °F (°C)	Absolute Pressure psi (microns Hg)	Vacuum inHg (mmHg)
212 (100)	14.696 (759993.4)	0 (0)
205 (96)	12.770 (660400.0)	3.92 (99.6)
194 (90)	10.169 (523881.6)	9.22 (234.2)
176 (80)	6.8699 (355269.8)	15.93 (404.6)
158 (70)	4.5207 (233786.7)	20.72 (526.3)
140 (60)	2.8900 (14958.7)	24.04 (610.6)
122 (50)	1.7987 (92555.1)	26.28 (667.5)
104 (40)	1.0700 (55336.4)	27.74 (704.6)
89 (30)	0.61540 (31826.2)	28.67 (728.2)
86 (27)	0.57010 (26220.4)	28.89 (733.8)
76 (24)	0.44435 (22979.9)	29.02 (737.1)
72 (22)	0.38856 (20094.7)	29.13 (739.9)
69 (21)	0.35084 (18143.7)	29.21 (741.9)
64 (18)	0.29505 (15258.5)	29.32 (744.7)
59 (15)	0.24720 (12783.8)	29.42 (747.3)
53 (12)	0.19888 (10285.0)	29.52 (749.8)
45 (7)	0.14746 (7625.8)	29.62 (752.3)
32 (0)	0.08858 (4579.6)	29.74 (755.4)
21 (–6)	0.05293 (2738.1)	29.81 (757.2)
6 (–14)	0.02521 (1304.0)	29.87 (758.7)
–24 (–31)	0.004905 (253.7)	29.911 (759.74)
–35 (–37)	0.002544 (131.6)	29.915 (759.84)
–60 (–51)	0.0004972 (25.7)	29.9200 (759.968)

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing

Boiling Temperatures of Water at Converted Pressures		
Boiling Temperature of Water °F (°C)	Absolute Pressure psi (microns Hg)	Vacuum inHg (mmHg)
–70 (–57)	0.0002443 (12.69)	29.92050 (759.9807)
–90 (–68)	0.0000526 (2.72)	29.92089 (759.9906)

Table 1, Boiling Temperatures of Water at Converted Pressures

Similarly we can boil and remove water from the air conditioning system by lowering the system pressure to a vacuum to cause the moisture to vaporize at normal ambient temperatures. A vacuum pump can reduce the pressure in the system. Since the pressure is the lowest at the pump, water vapor is pulled out of the system. See **Fig. 3**. This process is called evacuation or dehydration. Also, most recover and recycling stations automatically recycle refrigerant during this process to ensure the system will be charged with the cleanest refrigerant possible.

Vacuum Pump Selection

The purpose of a high-vacuum pump is to reduce and hold a vacuum in the air conditioner system so moisture can be boiled at ambient temperature. For example, a vacuum pump capable of pulling a vacuum of 28.89 inHg (734 mmHg), is able to boil water at 80°F (27°C). There are various types of vacuum pumps available. Only some types are recommended for truck air conditioning evacuation.

Air pump-type vacuum pumps are designed to remove large volumes of air but do not develop high vacuum. They cannot pull more than 28 inHg (711 mmHg) which boils water at 100°F (38°C).

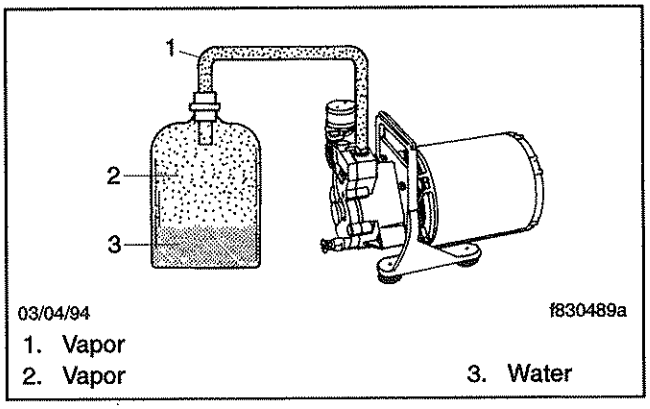


Fig. 3, Water to Vapor

Compressor-type vacuum pumps come in two designs: piston-type and rotary-vane type. A piston-type compressor can typically pull a vacuum of 28.2 inHg (716.3 mmHg) which boils water at 96°F (36°C). A rotary-vane type compressor may pull a vacuum of 29.82 inHg (757 mmHg) which boils water at 21°F (–6°C), but it is limited to pumping 0.4 to 0.8 CFM, which is too slow to handle truck air conditioners.

High-vacuum pumps are available in single and two-stage models. A single-stage pump is adequate, but a two-stage pump is recommended to save time and ensure complete evacuation. See **Fig. 4**.

Most single-stage high-vacuum pumps with a gas ballast will pull down to about 29.88 inHg (758.95 mmHg) which boils water at 4°F (–16°C).

A two-stage high-vacuum pump features a second pump to reach a higher vacuum than a single-stage pump. In a two-stage pump, the exhaust of the first pump discharges into the intake of the second pump. The second stage pumps at a lower pressure and therefore pulls a higher vacuum on the system than the first pump can by itself.

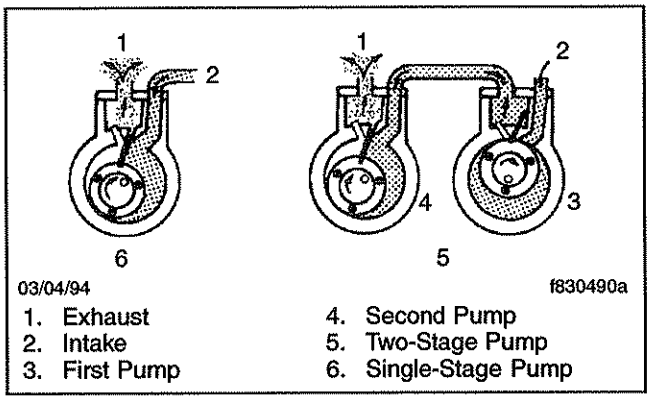


Fig. 4, Vacuum Pumps

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing

Two-stage high-vacuum pumps are capable of pulling down to 29.9192 inHg (759.95 mmHg) of vacuum for prolonged periods, which boils water at –60°F (–51°C).

The discharge line restriction is a factor affecting pump-down time. Pump-down time can be significantly reduced by use of larger diameter hoses, as short in length as possible.

Pumping capacity affects pump-down time. It is perfectly acceptable to use a large vacuum pump on a small system. Using too small of a pump on a large system could cause premature pump wear, or require excessive time to pull a vacuum, even though the pump may be able to draw adequate vacuum.

The suggested *minimum* CFMs for pumps on different size air conditioners are listed in **Table 2.**

Minimum CFMs for Pumps on Different Size Air Conditioners	
System Size	**Suggested High-Vacuum Pump Size**
Panel Trucks Large Window Units	2.2 CFM
Tractor/Trailers, Buses Rooftop A/C systems	3.0 CFM
Refrigeration Van	15.0 CFM

Table 2, Minimum CFMs for Pumps on Different Size Air Conditioners

MEASURING VACUUM

Gauges

Vacuum can be measured with:

1. *Standard compound gauge.*

   A standard compound gauge reads low pressures in inches of mercury. It is not suitable for measuring high vacuum.

2. *Closed end manometer.*

   A closed end U-tube mercury manometer can be read with good accuracy. High vacuum readings can only be read from laboratory-style U-tube manometers (which are not practical for service shops).

3. *Electronic thermistor vacuum gauge.*

   An electronic thermistor vacuum gauge is designed for use with high vacuum pumps and can accurately read as low as 100 microns. This gauge can use an analog scale, a digital or LED display.

Procedure

The location of the vacuum gauge will affect the reading. The closer to the vacuum source, the lower will be the reading.

Isolate the vacuum pump with a good vacuum valve and allow the pressure in the system to stabilize before taking a final reading.

If the pressure will not stabilize, it is an indication of a leak. If it does stabilize at a vacuum which is too high (for example, 1500 microns), it is an indication of moisture, and more evacuation is required.

MAINTAINING THE VACUUM PUMP

Maintenance is important for high-vacuum pumps. The oil must be changed at regular intervals to prevent moisture buildup which will cause eventual pump failure.

Pumping down for extremely wet air conditioning systems can completely saturate the pump oil.

⚠ CAUTION

Flush the vacuum pump every fourth time it is used and before storing for long periods of time.

Vacuum pump oil is water soluble. This aids the pump in reaching a high vacuum by absorbing water and sealing the pump.

⚠ CAUTION

Acid will form and corrode the pump if water-laden oil remains in the pump for an extended period.

Only vacuum pump oil should be used as a lubricant. Do not use any solvent or any other oil. Clean oil should be run through the pump until it runs out clear. Oil should be added to the fill level indicated on the pump. Check the oil level before each use.

EVACUATION PROCEDURE

1. The system must have been recovered and the compressor filled with the correct amount of refrig-

erant oil. Replace the receiver-drier if the system is opened.

2. Wearing protective goggles and nonleather gloves, attach the recovery/recycling station's hoses to the valves (see **Fig. 1**).

   IMPORTANT: Push down firmly on the hose connectors until a clicking sound is heard. This will ensure that the coupler is locked.

   2.1 Make sure that the recovery and recycling station's valves are closed.

   2.2 Connect the red high-side hose to the discharge service valve.

   2.3 Connect the blue low-side hose to the suction service valve.

   2.4 Turn the knob clockwise on each coupler to open the Schrader valves.

3. Follow the recovery and recycling station manufacturer's instructions and evacuate/recycle the refrigerant system.

Purging and Flushing

GENERAL INFORMATION

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

Purging removes damp air, traces of refrigerant, and loose particles from refrigerant parts by passing a stream of inert, dry nitrogen gas through the parts. If left in the system, these contaminants adversely affect the life and operation of the air conditioning system.

Flushing removes heavy contamination, such as gritty oil and large dirt buildup, which can't be removed by purging with gas. When a part is flushed, liquid refrigerant is forced through it; the liquid picks up the contaminants and flushes them out.

Whether to purge or flush a part depends on how much contamination there is, as described above.

Normally, the system always has pressure in it. Some loss of refrigerant from one season to the next is normal, and does not mean that the system is dirty. If refrigerant has leaked until the system is nearly empty, or if refrigerant parts show signs of internal corrosion and grit, the system is contaminated.

If the system is contaminated with moisture, purge all sections of the system. Then change the oil in the compressor and replace the receiver-drier prior to evacuating and charging the system.

If the system is heavily contaminated, or if desiccant has circulated through the system, replace the receiver-drier, expansion valve, and compressor.

Do not purge the receiver-drier or the compressor.

Flush the system in segments to lessen the chance of blowing deposits against a port. See **Fig. 5**.

Purge or flush the system in the opposite direction of refrigerant flow (in other words, backflush the sections).

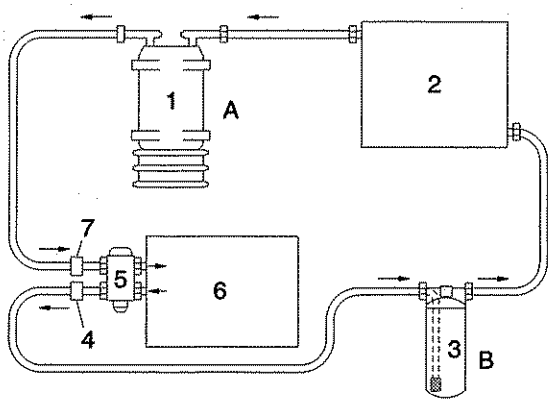
Flushing parts with refrigerant requires a recovery and recycling station.

PURGING PROCEDURE (See Fig. 6)

NOTE: Dry nitrogen gas is recommended for purging. A pressure regulator is required to regulate between 0 to 200 psi. Commercial cylinders of nitrogen contain pressures in excess of 2000 psi (13 780 kPa); This pressure must be reduced to 200 psi (1378 kPa) for purging.

1. Recover the system refrigerant.
2. Disconnect both ends of the line or part being purged. Tightly cap the rest of the system.
3. Make sure valves 1, 2, and 3 are closed.
4. Connect the supply line valve to the outlet end of the part or line.
5. Connect the drain line to the inlet end of the part or line.
6. Place the outlet of the drain line into a recycling system container.
7. Adjust the nitrogen bottle regulator to 200 psi (1378 kPa). Open the nitrogen bottle control valve and the purging control valve. Then, slowly open the supply line valve. Check the drain line for gas flow.

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing



11/23/93 f830395

NOTE: Arrows denote purge and flush points and direction of flow for gas/liquid.

A. Do not purge; instead, replace.
B. Do not purge; instead, replace.

1. Refrigerant Compressor
2. Condenser
3. Receiver-Drier
4. High-Side Service Valve
5. Expansion Valve
6. Evaporator
7. Suction Service Valve

Fig. 5, Purge and Flush Points

8. Let the nitrogen flow at 200 psi (1378 kPa) for 25 to 30 seconds.
9. Lower the pressure to 4 psi (28 kPa) and let it flow for 1 to 2 minutes. If the line or part was very wet, allow it to flow until there is no trace of refrigerant oil or solid bits of dirt or grit flowing from the drain tube.
10. Close the nitrogen bottle control valve and the purging control valve first, then close the supply line valve.
11. Disconnect the supply line valve and the drain line. Tightly cap both ends of the part or line.

FLUSHING PROCEDURE

1. Recover the system refrigerant.
2. Disconnect both ends of the line or part being flushed. Tightly cap the lines to the rest of the system.
3. Heat R–134a in a charging cylinder or pressurize the refrigerant as recommended by the manufacturer.
4. Connect the charging cylinder outlet hose to the outlet side of the system (this will ensure that R–134a will flow in the reverse direction of normal flow).
5. Connect a line from the inlet side of the system to a recovery/recycling station.

NOTE: If the system is extremely contaminated, install a receiver-drier inline as a prefilter for the recovery/recycling station.

6. Turn on the recovery/recycling station and open the outlet valve for the charging cylinder. Allow about 2 pounds (1 kilogram) of R–134a to flow through the system.
7. Close the supply line valve and wait for the recovery station to shut off.
8. Disconnect the supply line and the drain line from the charging cylinder and the recovery station. Connect the lines to a nitrogen bottle.
9. Purge the system and check the collection bottle for contaminants. Repeat the process if needed.
10. Disconnect the lines from the part and tightly cap both ends of the part.

Charging

⚠ WARNING

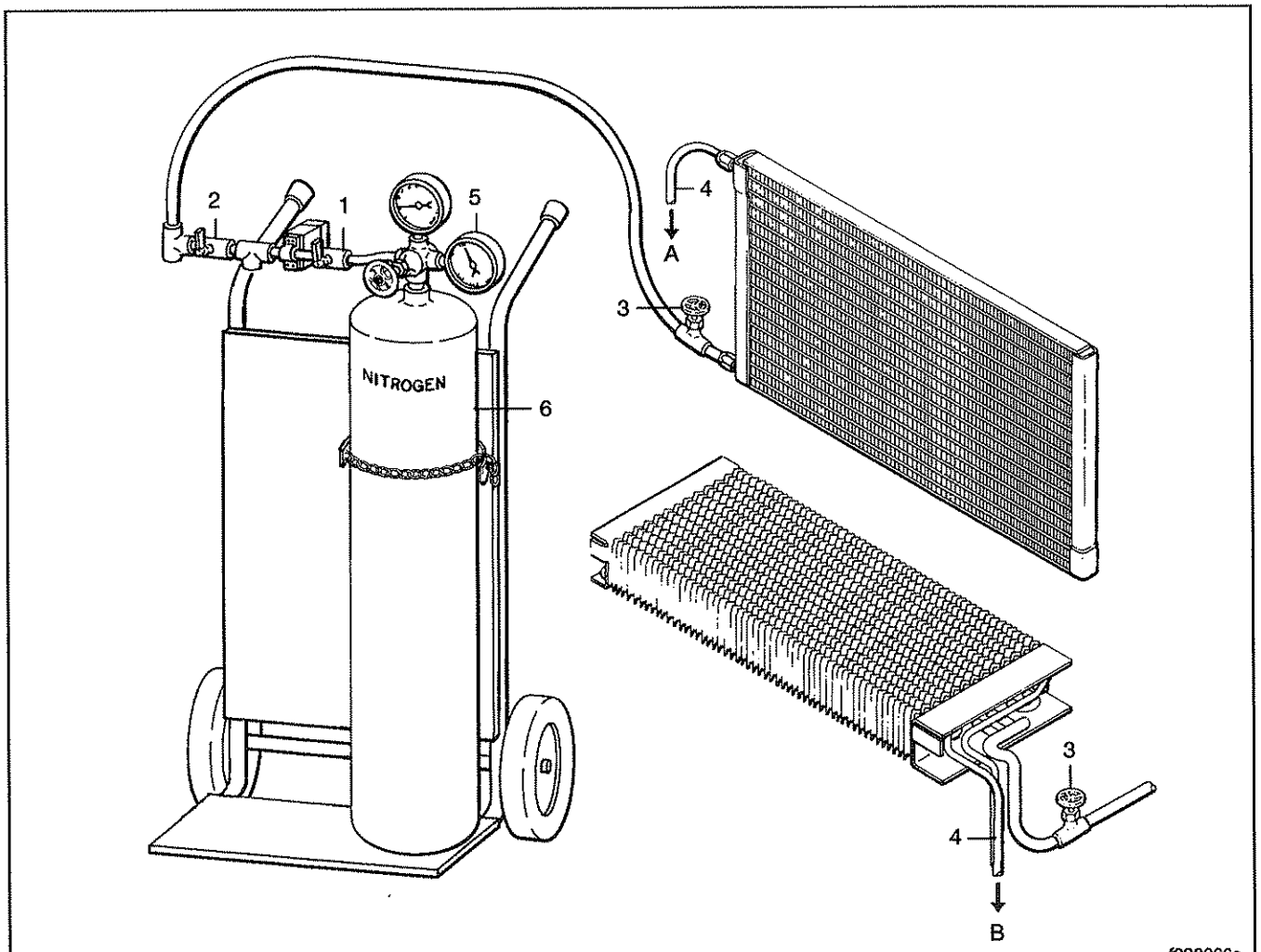
Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

NOTE: Before charging, the system must be recovered and evacuated with the recovery and recycling station connected to the service and discharge port connections.

1. Obtain 52 oz (1.47 kg) of refrigerant to fully charge the system.

   Set the tank on a scale and weigh it so that the correct amount of refrigerant enters the system.

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing



A. To Waste Container
1. Nitrogen Bottle Control Valve
2. Purging Control Valve
3. Supply Line Valve
B. To Recycling System Container
4. Drain Line
5. Nitrogen Bottle Regulator/Gauge
6. Nitrogen Bottle

Fig. 6, Purging Station

This prevents overcharging, which could damage the compressor.

2. Charge the refrigerant system.

   NOTE: If equipped with a recovery, recycling, and recharging station, charge the system on the high side following the manufacturer's instructions. If charging from a bulk container, do the following.

   2.1 Turn the tank (bulk container) upside down. With the engine off, open the high-side hand valve. *Do not* open the low-side hand valve

   2.2 Allow refrigerant to enter the system until the correct charge (by weight) has entered. Then, close the high-side hand valve.

   2.3 Start the engine and run it at 1500 rpm. Set the cab air conditioner controls at maximum cooling and fan speed; the refrigerant compressor must engage.

Recovery, Evacuating/Recycling, Purging and Flushing, Charging, and Leak Testing

2.4 If a full charge did not enter the system, place the tank (bulk container) in the upright position, then open the *low-side valve* to draw vapor into the system; leave the valve open until the correct weight of refrigerant has entered the system, then close the low-side valve.

NOTE: If refrigerant is slow to enter the system because of low outside temperatures, vaporization can be quickened by placing the refrigerant tank in a tub of warm water, no warmer than 125°F (52°C).

3. While the compressor is engaged, check the operating pressures at the suction and discharge ports; see the applicable compressor section in this manual. If the operating pressures are not acceptable, see **Troubleshooting 300** for possible causes.
4. Disconnect the high-side hose. With the engine running, open the low-side and high-side hose valves to recover the refrigerant from the lines.
5. Shut down the engine.

Leak Testing

GENERAL INFORMATION

⚠ WARNING

Before doing any of the work below, read the information under Safety Precautions 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

Refrigerant is odorless; as a result, all of it may leak away and not be noticed until the system stops cooling. All vehicle refrigerant systems lose some refrigerant, depending on the condition of the system. Higher loss rates signal a need to locate and repair the leaks.

Leaks are most often found at the compressor hose connections and at the various fittings and joints in the system. If unapproved replacement hoses are installed, refrigerant can be lost through hose permeation.

METHODS OF LEAK DETECTION

When checking for leaks, always focus your attention on the lowest portion of the fitting or part being tested. Refrigerant is heavier than air and will collect at the low point. Oil will also flow toward the low point. Listed in sequence from least precise to most precise, the methods for locating leaks are:

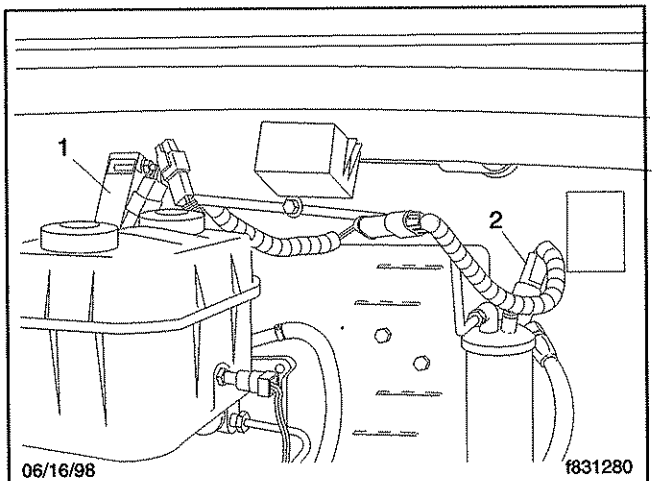
1. *Soapsuds solution.* A solution of soap and water can be squirted onto a suspected fitting or part. If the leak is large enough it will cause bubbles to form in the soapy solution at the point of the leak.
2. *Electronic leak detectors.* Electronic leak detectors are battery or 115-volt powered and rely on a very sensitive signal when a leak is found. In addition to being very precise, electronic leak detectors can be used in tight places.

NOTE: Do not try to use a leak tester right after connecting or disconnecting service hoses. Traces of refrigerant at the fittings can falsely signal a leak.

Air Conditioning Protection and Diagnostics System Electronic Control Module Replacement

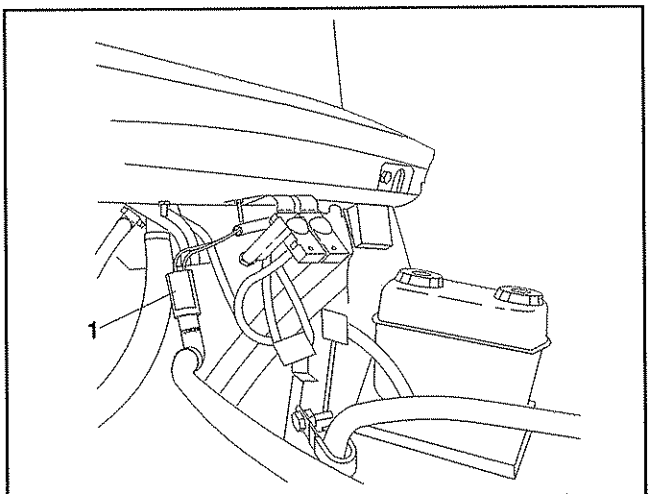
Replacement

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the batteries.
3. Open the hood.
4. Disconnect the high and low pressure switch harnesses on the Air Conditioning Protection and Diagnostics System (APADS™) electronic control module. See **Fig. 1** and **Fig. 2**.
5. Remove the two bolts, washers, and nuts that fasten the APADS™ electronic control module to the mounting bracket. Keep the fasteners for installation.
6. Attach the new APADS™ electronic control module to the mounting bracket using the bolts, washers, and nuts. Tighten the bolts securely.
7. Connect the high and low pressure switch harnesses to the connectors.
8. Close the hood.
9. Connect the batteries.
10. Remove the chocks from the tires.



1. Electronic Control Module
2. High Pressure Switch

Fig. 1, APADS™ Electronic Control Module



1. Low Pressure Switch

Fig. 2, APADS™ Low Pressure Switch

Air Conditioning Protection and Diagnostics System Pressure Switch Replacement

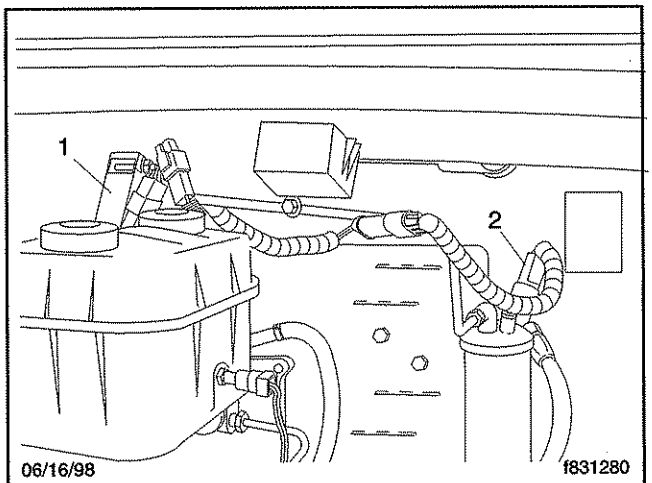
Replacement

NOTE: This procedure can be used for replacing both the low pressure switch and the high pressure switch.

1. Turn off the engine, apply the parking brakes, and chock the tires.
2. Disconnect the batteries.
3. Open the hood.
4. Disconnect the pressure switch harness on the Air Conditioning Protection and Diagnostics System (APADS™) electronic control module. See **Fig. 1** and **Fig. 2.**
5. Remove the pressure switch from its port on the refrigerant line.
6. Lubricate a new O-ring with mineral oil, and place it on the coupling on the refrigerant line.
7. Attach the pressure switch to the port and tighten 20 to 25 lbf·ft (27 to 34 N·m).

IMPORTANT: After replacing the high pressure switch, clear the blink code by cycling the ignition switch—one cycle on, one cycle off—for four consecutive cycles.

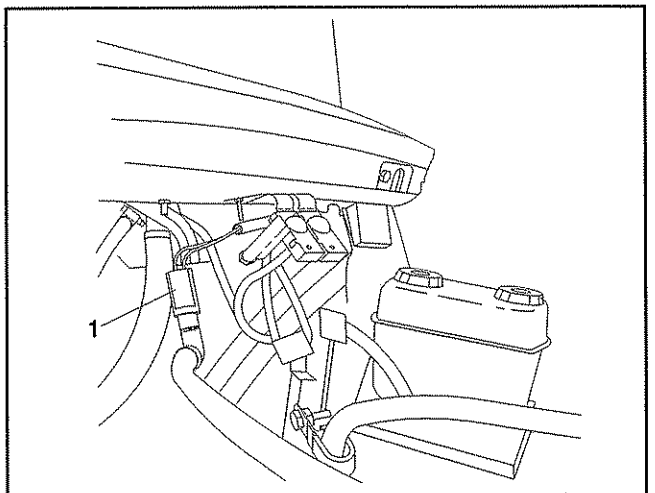
8. Connect the pressure switch harness to the connector.
9. Close the hood.



1. Electronic Control Module
2. High Pressure Switch

Fig. 1, APADS™ High Pressure Switch

10. Connect the batteries.
11. Remove the chocks from the tires.



1. Low Pressure Switch

Fig. 2, APADS™ Low Pressure Switch

Preliminary Checks

Before testing the operation of the air conditioning system, make the following checks.

1. Make sure the refrigerant compressor's drive belt is not damaged and is correctly tensioned. Also check the compressor mountings for tightness. For instructions and other information, see the applicable refrigerant compressor section elsewhere in this group.
2. Using a feeler gauge, check for correct refrigerant compressor clutch clearance. For instructions, see the applicable refrigerant compressor section elsewhere in this group.
3. Check for broken, burst, or cut hoses; also check for loose fittings on all parts.
4. Check for road debris buildup on the condenser coil fins. Using air pressure and a whiskbroom or a soapy spray of water, carefully clean off the condenser; be careful not to bend the fins.
5. Check the color of the moisture indicator sight glass. If the color is a deep cobalt blue, the refrigerant charge is dry. If the indicator is *not* blue, the system is contaminated with moisture; recover the refrigerant, evacuate the system, replace the receiver-drier, and add a full refrigerant charge.
6. If there is not enough airflow, make sure that leaves or other debris has not entered the fresh air ports under the windshield. If debris has entered, it could clog the fins of the evaporator coils, and block airflow.

   Also, be sure that all ducts are connected to the dash louvers and that the air-control flaps in the heater housing are moving properly (this requires removal of the right and center dash panel).

Performance Tests

Following is a brief description of symptoms or conditions that will exist if something goes wrong in a refrigerant part.

AIR CONDITIONING PROTECTION AND DIAGNOSTICS SYSTEM (APADS™)

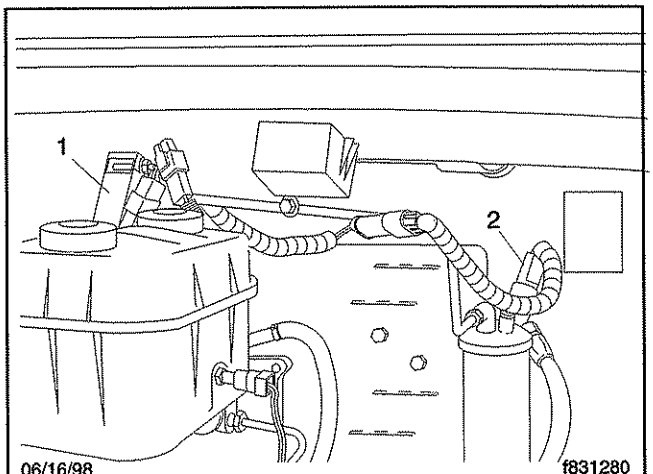
The Air Conditioning Protection and Diagnostics System consists of an electronic control module, high and low pressure switches, and an evaporator thermostat. The electronic control module actively monitors system conditions and controls the operation of the refrigerant compressor and the fan clutch.

Located under the hood on the left-hand side of the frontwall (**Fig. 1**), the electronic control module registers fault codes that warn of existing or impending problems in the air conditioning system. Diagnostic information is provided by blinking red and green LEDs (light emitting diodes) built into the electronic control module. Since only one blink code can be displayed, the fault code of highest priority takes precedence. See **Table 1** for the fault code order of priority. Only the highest priority fault code is held in memory. Once the fault code is cleared, a new fault must occur to initiate a new blink code.

A "blink" is approximately 1/4 second in duration. Once the number of blinks has been broadcast, there is a delay time of two seconds before the blink code is repeated. See **Table 2** for a description of blink codes.

The blink code is cleared by two methods:

- Cycle the ignition switch—one second on, one second off—for four consecutive cycles.
- Self-clearing based on the persistence of the fault. If a fault condition occurs once and does not repeat, the fault code is held for an extended period of time and then cleared. If the fault is



1. Electronic Control Module
2. High Pressure Switch

Fig. 1, APADS Control Module and Pressure Switch

Troubleshooting

repetitive, it will always be retained in memory until the problem is fixed.

For APADS™ troubleshooting information, see **Table 3.**

APADS™ Fault Code Order of Priority			
Priority	**Fault Code Name**	**Fault Description**	**LED Blinks**
1	Static low pressure	Full loss of charge	1
2	Dynamic low pressure	Partial loss of charge	1
3	High pressure	Overcharge, blocked condenser	2
4	Open clutch	Clutch wire open	3
5	Shorted clutch	Shorted clutch coil	3
6	Low pressure switch open	Cut wire to low pressure switch	4
7	High pressure switch open	Cut wire to high pressure switch	4
8	Low voltage	Low battery voltage	Rapid Green
9	No faults	No faults, module functional	Red off, Green slow blink

Table 1, APADS Fault Code Order of Priority

APADS™ Blink Codes	
Condition	**Description**
Slow Green	Unit is functioning properly
Fast Green	Low system voltage
One Red Blink	Loss of refrigerant
Two Red Blinks	Fan failure or external condenser blockage
Three Red Blinks	Voltage drop out, open or shorted wire to compressor clutch
Four Red Blinks	Open wire in pressure switch circuit

Table 2, APADS Blink Codes

APADS™ Troubleshooting Table			
Condition	**Definition**	**Possible Cause**	**Action**
Slow flashing green light.	Two seconds on, 1/2 second off.	Unit is functioning properly.	No action is needed.
Rapid flashing green light.	Low system voltage, indicates low supply voltage condition. Voltage has dropped below 11.0 volts.	Possibly caused by a damaged alternator, discharged batteries, poor ground, or an excessive electrical load.	Check voltage at the control harness by probing pins 4 (ground) and 2 (power). If voltage is less than 11.0 volts, start checking for voltage drops or a poor ground.

APADS™ Troubleshooting Table			
Condition	**Definition**	**Possible Cause**	**Action**
Ignition on, LEDs not flashing on control module or no lights on module.	Control module not receiving battery voltage.	Fuse or circuit breaker is blown.	Repair the fuse or reset the circuit breaker.
		Broken power or ground wire to control module.	Repair the wiring.
		Damaged control module.	Replace the APADS™ electronic control module, or retrofit the APADS with a binary switch. For instructions, see **Service Bulletin 83–74.**
Red light flashing one blink in sequence.	Low pressure fault. This is detected by monitoring the ambient temperature and switching activity of the low pressure switch.	Partial or total loss of refrigerant.	Install service gauges and the check system for leaks.
		A damaged low pressure switch.	Disconnect the low-side pressure switch connector and measure the resistance value of the switch. If the resistance shows 2.49k ohms, the switch is operating properly. If the resistance shows less than 5 ohms, replace the switch. NOTE: This check must be done with the switch installed on the vehicle, and the ignition in the off position and proper charge.
Red light flashing two blinks in sequence.	High pressure fault. The system is exhibiting abnormal high pressure activity.	Fan drive failure.	Inspect proper operation of the solenoid valve, relay, and/or related components.
		Blocked air flow through the condenser.	Remove the restriction from the condenser.
Red light flashing three blinks in sequence.	Open wire to A/C clutch. Detected by inadequate current through the compressor clutch. If no current is sensed when the A/C drive is turned on, an open connection to the clutch coil is indicated.	A break in the wiring between the control module and the A/C compressor clutch, or a break in the clutch coil.	With the use of an ohmmeter, check the resistance of the clutch coil. If the reading is less than 2.8 ohms, replace the clutch.
	Shorted wire or shorted A/C clutch. Detected by excessive current through the compressor clutch.	This indicates either a shorted clutch coil or shorted wiring to the clutch.	Locate and repair the shorted or frayed wiring between the control module and the A/C clutch.
	Fluctuating battery voltage.	Fluctuation of greater than one volt caused by a damaged voltage regulator.	Replace the alternator.

Troubleshooting

APADS™ Troubleshooting Table			
Condition	**Definition**	**Possible Cause**	**Action**
Red light flashing four blinks in sequence.	Opening in wiring harness to high or low pressure switches.	Unseated connector.	Check the connectors at the module and the pressure switch for loose pins.
		Break between wiring harness and pressure switch.	With the use of an ohmmeter, probe the yellow and yellow/ black pins of the module harness. Resistance should read less than 5 ohms.
		Moisture intrusion into the connectors or switch.	Check the seals and inspect the wires for continuity.
		The use of a non-Index pressure switch.	Install the correct pressure switch.
A/C clutch is not engaging during the first 15 seconds after the ignition is turned on.	—	Unit is working. Regardless of A/C system state at start-up, the A/C clutch is disengaged for the first 15 seconds.	—
When the engine is turned on, and the A/C controls are set to the on position, the compressor is off for 15 seconds, on for 15 seconds, and then remains off indefinitely.	No voltage going to A/C compressor clutch.	Unsatisfactory A/C input signal.	Check for a break in the wiring between A/C clutch and the A/C controls.
			Check for a bad A/C on/off control switch.
			Check for a bad A/C relay.
At start-up, after 15 seconds, compressor clutch doesn't engage, but engine fan engages.	Control module sensing an opening in the high pressure switch circuit.	High-side pressure switch failure.	Check the switch by measuring the resistance value across the leads. If the resistance shows less than 1k ohms, the switch is functioning properly. If resistance is greater than 100 ohms, replace the switch.
Slow flashing green, compressor is on for a short period of time, off for 15 seconds in a repetitive sequence.	Indicates that the system is exhibiting abnormal high or low pressure activity.	Blockage on the high side of the system or in the condenser.	Repair the restriction.
		Partial loss of refrigerant.	Check the system for loss of refrigerant.
Slow flashing green light, not engaging in defrost mode or in cold weather.	—	The unit is more than likely functioning correctly. If the ambient temperature is too low, the compressor clutch is not allowed to engage because of low system pressure.	—
Slow flashing green, clutch is engaged, A/C is not cooling.	—	Inoperative blower motor.	Check for proper operation of the blower motors.
		Loose or broken compressor belts.	Tighten or replace the compressor belts.

Table 3, APADS Troubleshooting Table

COOLING CHECK

When outside temperature and humidity are high, it will take longer to cool the cab, especially if the fresh air vents are left open.

To determine if the air conditioner is cooling enough:

1. Set the engine speed at 1500 rpm.
2. Close the doors and windows.
3. Turn on the air conditioner. Set the controls at maximum cooling (recirculated air) and blower speed. The compressor must be engaged during this test.
4. Allow the system to run for at least 10 minutes (longer on hot and humid days).
5. Place a thermometer inside the louver or air duct; make sure the controls are set so that air flows out of the duct being tested.
6. Compare the measured temperature readings to the readings in **Table 4**. If the duct's air temperature is higher than normal readings, the system isn't cooling enough. For possible causes, see the troubleshooting tables.

RECEIVER-DRIER

The receiver-drier is normally at outside temperature. To the touch, the entire length of the unit should be the same temperature. If noticeable cool spots exist, replace the receiver-drier.

A blockage at the inlet of the unit will cause high head pressures; outlet blockages will cause low head pressures and little or no cooling.

If the moisture indicator is pink or white (showing that the system is wet), the receiver-drier is saturated with moisture and must be replaced.

COOLING SYSTEM

Although they are not physically connected, there is a close tie between a vehicle's air conditioner and its cooling system. Poor air conditioner cooling can be the result of a problem in the cooling system.

If the cooling system does not work correctly, the heat of the engine will rise to abnormal levels. The added heat will transfer to the air conditioner, other underhood parts, and maybe make its way into the cab. The added heat makes it necessary for the air conditioner to work harder and, at the same time, it reduces the air conditioner's ability to cool down the air in the cab. Also, if the water regulating valve isn't closing all the way, heat will enter the cab, giving the impression that the air conditioning system is not working.

Temperature/Pressure Specifications						
Ambient Air Temperature °F (°C)	Humidity		Dash Louver Temperature °F (°C)†	Service Port Pressures*†		A/C Compressor Cycling On?
	Target	Actual (Relative Humidity)		High (psi)	Low (psi)	
70 (21)	Low	25%	44 (6)	144	20.1	Yes
70 (21)	High	55%	45 (7)	146.6	21.6	Yes
80 (27)	Low	25%	46 (8)	164.4	20.1	Yes
80 (27)	High	55%	51 (11)	201.8	24.4	No
90 (32)	Low	25%	49 (9)	219.8	22.6	No
90 (32)	High	55%	60 (16)	242.1	31.5	No
100 (38)	Low	25%	57 (14)	261.3	29.5	No
100 (38)	High	55%	68 (20)	309.3	42.5	No

* Service port pressures recorded with A/C compressor running.
† Fresh air mode in use.

Table 4, Temperature/Pressure Specifications

Troubleshooting

See **Group 20** of this manual for cooling system troubleshooting and to the engine manufacturer's service manual for other details about cooling system problems.

EXPANSION VALVE

Problems that start in the expansion valve show up as follows: when stuck closed, the evaporator coil and the expansion valve will be at outside temperature; when stuck open, both the coil and the valve will be extremely cold with frost or ice buildup.

Because the expansion valve is very sensitive to contamination, blockages in the system tend to be found here. Usually, the contaminant is water; less than a drop of water is all it takes to make the valve inoperative. When water reaches the valve, the extreme cold that results from the pressure drop freezes the water, forming a block of ice in the valve. After the system shuts down and the valve warms up, the ice melts, and the valve operates again, only to freeze up when the moisture returns.

On-and-off operation of the expansion valve means that the receiver-drier is not removing moisture from the system. This should cause the moisture indicator's element to turn white and then pink.

REFRIGERANT COMPRESSOR

Compressor problems usually show in one of four ways: abnormal noise; seizure; leakage; or low suction and discharge pressures.

Resonant compressor noises are not causes for alarm; irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Low discharge pressure may be caused by not enough refrigerant, not enough belt tension, or a blockage somewhere in the system. These things should be checked before servicing the compressor.

EVAPORATOR

The evaporator coils are basically trouble-free when airflow over the fins is not blocked. External or, less often, internal blockages will cause low suction pressure as well as little or no cooling.

If a leak exists in the system, and it cannot be traced to other parts or fittings, suspect damage to one of the evaporator coils.

CONDENSER

The condenser is also usually trouble-free when road debris, such as leaves or dirt buildup, is removed. If debris cakes up, airflow over the condenser fins is blocked; air is not able to absorb enough heat to turn the hot refrigerant gas into a liquid. High head pressures will result. In these cases, carefully clean off the outer surfaces of the condenser with compressed air or a soap and water solution; be careful not to bend the fins.

High head pressures will also occur if the condenser's tubing is abnormally bent, blocking the flow of refrigerant. Frost will appear at the point where the flow is restricted.

Less common internal blockages (bits of foreign material or metallic grit buildup) will stop the flow of refrigerant.

A quick test to check that poor system performance is caused by the condenser is to direct a spray of water onto the condenser while the system is running. If the air conditioner cools better because of the assist provided by the water, it is a sign that the condenser is not working.

When troubleshooting a suspected condenser problem, remember that the problem may be caused by the cooling system transferring high levels of heat to the condenser. See **Group 20** of this manual for cooling system troubleshooting and to the engine manufacturer's service manual for other details about cooling system problems.

THERMOSTATIC SWITCH

Before troubleshooting the thermostatic switch, be sure there is a full charge of refrigerant in the system. The compressor will not operate, or will cycle too often, if there is not enough refrigerant in the system.

Quick or delayed cycling of the compressor may be caused by a thermostatic switch that is working, but is out of adjustment. If, after doing the tests below, the switch seems to be out of adjustment, replace it (the thermostatic switch cannot be recalibrated).

NOTE: If the thermostatic switch is removed, it must be inserted at the same location of depth.

1. Be sure the compressor clutch is operating correctly. See the applicable refrigerant compressor section elsewhere in this group.

2. Expose the evaporator coil. See **Subject 120** for instructions.
3. Start the engine. Place the air conditioner control at its coldest setting. Turn on the air conditioner and the fan.
4. Place an accurate thermometer in contact with a tube on the evaporator coil. Be sure the thermometer is in good contact with the tube, or you will get a wrong reading.

   When the temperature drops below 31° to 36°F (–1° to 2°C), the compressor clutch should disengage and remain this way until the temperature rises to 39° to 44°F (4° to 7°C).
5. If the compressor did not engage when the temperature was above the accepted high range, check the thermostatic switch and its wiring.

   5.1 Connect a voltmeter or a test light from one of the terminals on the thermostatic switch to ground. Repeat this test with the other terminal on the switch.

   5.2 With the engine running and the air conditioner and blower on, both terminals will show voltage when the compressor should be engaged; one terminal will show voltage when the compressor should be disengaged.

   If there is no voltage, there is a problem in the electrical system from the batteries to the thermostatic switch. Check all circuits for the cause, and repair or replace the wiring or parts.

   In all other cases where the compressor is not engaging and disengaging properly, the thermostatic switch is the cause. Replace it with a new switch.
6. Shut down the engine and, to prevent accidental electric shock or shorting during dash assembling, disconnect the batteries.
7. Assemble the dash; see **Subject 120** for instructions.

LINE RESTRICTIONS

A restricted suction line causes low suction pressure at the compressor and little or no cooling. A restriction in a line between the compressor and the expansion valve can cause high discharge and low suction pressure, and insufficient cooling.

Usually, areas of ice or frost buildup mean a blockage. Parts that often freeze up are probably corroded or inoperative and should be replaced. Parts (such as the expansion valve) that freeze up once in a while may do so because of moisture in the system, which will cause the moisture indicator's element to turn white or pink; if this happens, recover the refrigerant charge, evacuate/recycle the system refrigerant, replace the receiver-drier, and install a new charge.

Fault Analysis Flow Chart

See **Fig. 2** for the fault analysis flow chart.

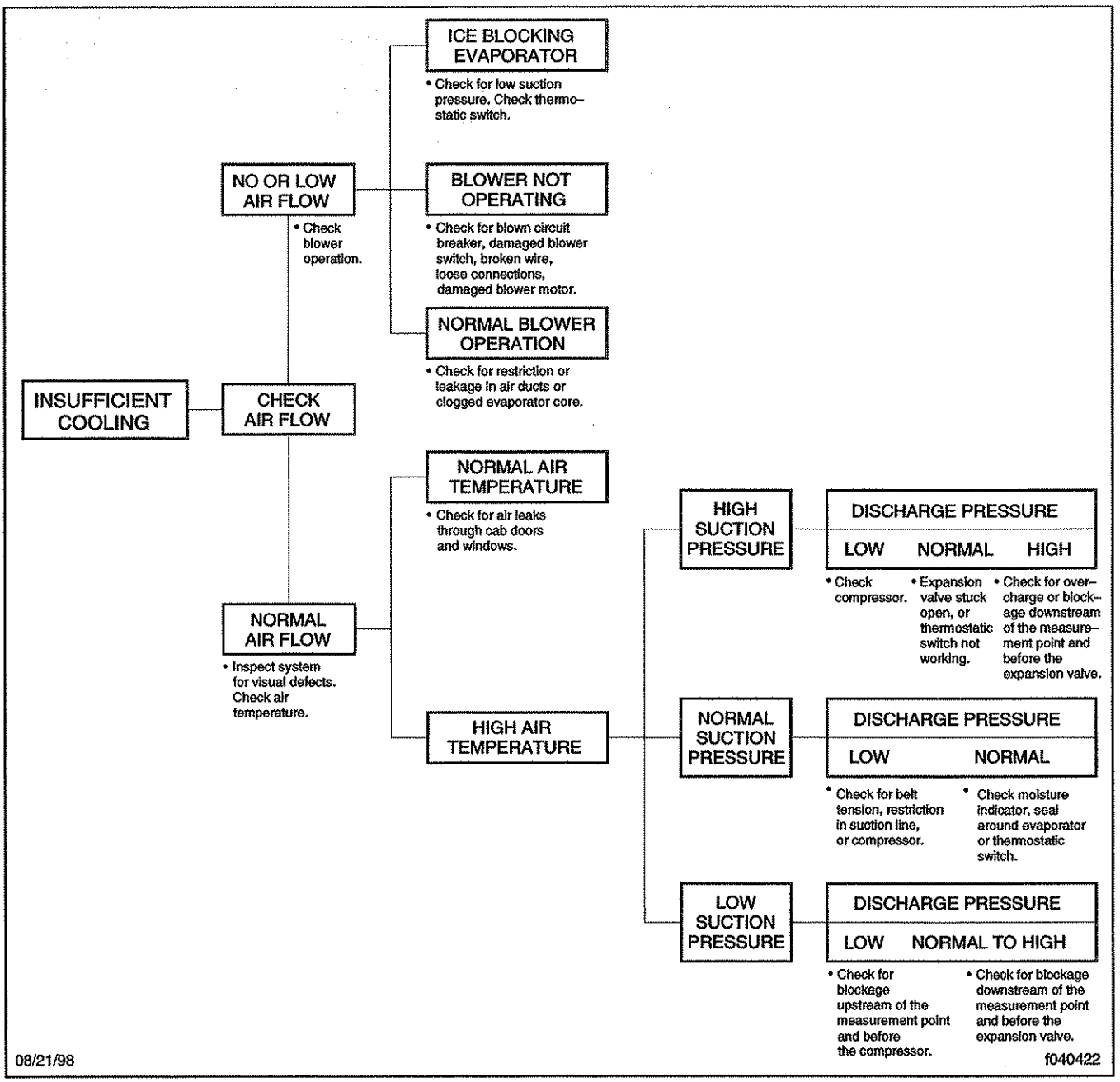


Fig. 2, Fault Analysis Flow Chart

Troubleshooting Tables

Problem—Little or No Airflow

Problem—Little or No Airflow	
Possible Cause	**Remedy**
The blower is not operating.	Check for an open circuit breaker. An open circuit breaker indicates a short in the electrical system, which must be located and repaired.
	Check the air conditioner relays for operation. Replace, as necessary.
	Make sure the blower motor switch is working. Replace, if necessary.
	Check the wiring to the blower motor. If any connections are loose, securely tighten them. Make sure the wiring conforms to the diagram under **Specifications, 400.**
	Check the blower motor for operation. Replace if sticking or otherwise inoperative.
	Check the resistor block. Replace, if necessary. **⚠ CAUTION** Never try to by-pass the fuse in the resistor block. To do so could cause the blower motor to overheat, resulting in serious damage to the heater/air-conditioning system.
There are restrictions or leaks in the air ducts.	Examine all air ducts and remove any blockages. Stop any leaks or replace any portion where the leaks cannot be stopped.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Review "Performance Tests" in this subject for possible causes and corrective action.

Problem—Warm Airflow When the Air Conditioner Is On

Problem—Warm Airflow When the Air Conditioner Is On	
Possible Cause	**Remedy**
There is no refrigerant charge in the system.	Perform a leak test. Repair any leaks, evacuate the system, replace the receiver-drier, and add a full charge of refrigerant.
Moisture in the system.	If moisture is in the system, ice crystals may form at the expansion valve, blocking the flow of refrigerant (off and on). Recover the refrigerant charge, replace the receiver-drier, evacuate the system, and add a full charge of refrigerant.
The refrigerant compressor is not operating.	If the refrigerant charge is low, charge and leak test the system. Repair any leaks.
	The refrigerant compressor clutch or drive belt needs repair or replacement. For instructions, see the refrigerant compressor section elsewhere in this group.
The air-conditioner microswitch is not working.	Replace the microswitch.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Review "Performance Tests" in this subject for possible causes and corrective action.

Troubleshooting

Problem—Low Evaporator Coil Outlet Pressure (Low Compressor Suction Pressure)

Problem—Low Evaporator Coil Outlet Pressure (Low Compressor Suction Pressure)	
Possible Cause	**Remedy**
The expansion valve is not working.	Replace the expansion valve.
There are restrictions in the line to the expansion valve.	Remove the line restrictions.
There is an insufficient refrigerant charge in the system.	Locate the leak. Recover the charge, replace the receiver-drier, and add a full refrigerant charge.

Problem—High Compressor Discharge Pressure

Problem—High Compressor Discharge Pressure	
Possible Cause	**Remedy**
Airflow through the condenser is restricted.	Remove the debris from the condenser.
There is an internal restriction in the condenser. (Ice buildup on the condenser or a cool spot on the line from the condenser to the receiver-drier).	Replace the condenser.
Air is present in the system.	Perform a leak test. Repair any leaks, evacuate the system, and add a full charge of refrigerant.
Heavy frosting on the suction line suggests that the evaporator coil is flooded.	Defrost the evaporator coil before resuming operation of the air conditioner.
The engine is over-heated.	See the engine manufacturer's operations manual for corrective measures.
Restriction in the compressor discharge line.	Repair or replace the line.

Problem—Evaporator Outlet Air Temperature Increases as the Compressor Discharge Pressure Drops

Problem—Evaporator Outlet Air Temperature Increases as the Compressor Discharge Pressure Drops	
Possible Cause	**Remedy**
There are leaks in the system.	Leak test the system.
The expansion valve setting is too low.	Replace the expansion valve. Add a full charge of refrigerant.
Too much oil is in the system. An indication of this is clutch or belt slippage at governed engine speed.	Check and remove excess refrigerant oil. For instructions, see the refrigerant compressor section elsewhere in this group.

Problem—Compressor Operates Too Often or Continuously

Problem—Compressor Operates Too Often or Continuously	
Possible Cause	**Remedy**
There is too little refrigerant in the system.	Perform a leak test. Repair any leaks, and add a full charge of refrigerant.
Ice has formed on the evaporator coil.	Defrost the evaporator coil before resuming operation of the air conditioner. Check the operation of the thermostatic switch, and replace as necessary.
There is a restriction in the refrigerant system.	Remove the restriction from the line.

Problem—Compressor Operates Too Often or Continuously	
Possible Cause	**Remedy**
Dirt and debris are clogging the condenser fins.	Remove all dirt and debris from the condenser fins.
The thermostatic switch isn't working.	Replace the thermostatic switch.

Problem—Quick or Delayed Cycling of the Compressor

Problem—Quick or Delayed Cycling of the Compressor	
Possible Cause	**Remedy**
The thermostatic switch operates, but is out of adjustment.	Replace the thermostatic switch. Do not attempt to adjust it.
Loss of refrigerant is causing a delayed cycling of the compressor.	Leak test and add a full charge of refrigerant.

Problem—Temperature in the Cab Too Low or No Heat

Problem—Temperature in the Cab Too Low or No Heat	
Possible Cause	**Remedy**
The water regulating valve is not opened.	Turn the temperature control knob toward "warm."
The water regulating valve is not opening all the way.	Adjust the water regulating valve cable.
The water regulating valve isn't working.	Replace the water regulating valve.
A heater hose is pinched or twisted.	Repair or replace the heater hose.
Coolant is leaking from the system.	Check for leakage at the heater core, and at all hose connections from the heater core to the engine. Check the radiator coolant level, as instructed in the vehicle driver's manual, and add coolant, if necessary. Check and repair any leaks at the radiator.
Dust or dirt is clogging the heater core fins.	Remove and clean the heater core.

Problem—Condensed Water Is Leaking from the Air Conditioner

Problem—Condensed Water Is Leaking from the Air Conditioner	
Possible Cause	**Remedy**
The drain tubes are plugged.	Clean the drain holes and drain tubes.

Specifications

See **Fig. 1** for the air conditioning wiring diagram.

See **Fig. 2** for the air conditioning plumbing diagram.

See **Fig. 3** for the heater plumbing diagram for Cummins B Series engines.

See **Fig. 4** for the heater plumbing diagram for Cummins C Series engines.

See **Fig. 5** for the heater plumbing diagram for Mercedes-Benz OM 366LA engines.

See **Fig. 6** for the heater plumbing diagram for Dodge Magnum engines.

See **Fig. 7** for the APADS™ electronic control module wiring diagram.

See **Fig. 8** for the Cummins mechanical engine and APADS™ schematic.

Torque Values		
Description	**Torque**	
	lbf·ft (N·m)	**lbf·in (N·cm)**
Expansion Valve Fittings:		
Evaporator Large Line	24 (33)	—
Evaporator Small Line	18 (24)	—
Receiver-Drier Line	12 (16)	—
Refrigerant Compressor Line	18 (24)	—
Blower Motor Mounting Nuts	—	17 (192)
Condenser Mounting Bolts	15 (20)	—
Condenser Refrigerant Line Fittings	33 (45)	—
Receiver-Drier Fittings	33 (45)	—
Binary Switch	—	108 (1220)

Table 1, Torque Values

Temperature/Pressure Specifications						
Ambient Air Temperature °F (°C)	**Humidity**		**Dash Louver Temperature °F (°C)†**	**Service Port Pressures*†**		**A/C Compressor Cycling On?**
	Target	**Actual (Relative Humidity)**		**High (psi)**	**Low (psi)**	
70 (21)	Low	25%	44 (6)	144	20.1	Yes
70 (21)	High	55%	45 (7)	146.6	21.6	Yes
80 (27)	Low	25%	46 (8)	164.4	20.1	Yes
80 (27)	High	55%	51 (11)	201.8	24.4	No
90 (32)	Low	25%	49 (9)	219.8	22.6	No
90 (32)	High	55%	60 (16)	242.1	31.5	No
100 (38)	Low	25%	57 (14)	261.3	29.5	No
100 (38)	High	55%	68 (20)	309.3	42.5	No

* Service port pressures recorded with A/C compressor running.
† Fresh air mode in use.

Table 2, Temperature/Pressure Specifications

Specifications

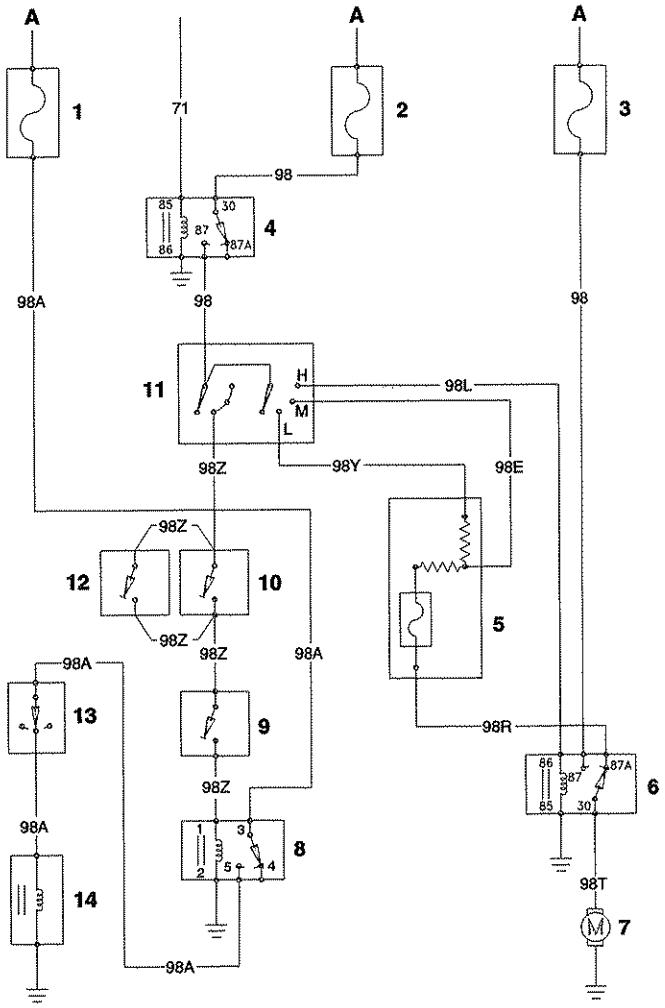
3/4- and 5/8-Inch Heater Hose Clamp Torque Values	
Description	**Torque lbf·in (N·cm)**
Standard Hose Clamp	40 (452)
Worm-Gear Hose Clamp	40 (452)
Breeze Constant-Torque Hose Clamp	40 (452)
Oetiker Constant-Torque Hose Clamp	18 (203)

Table 3, 3/4- and 5/8-Inch Heater Hose Clamp Torque Values

APADS™ Parametric Specifications*				
Parameter	**Minimum**	**Typical**	**Maximum**	**Units†**
Supply Voltage (continuous operation)	10.0	13.5	16.0	Volts
Supply Voltage (absolute maximum, two minute duration)			24.0	Volts
Supply Current (no load)			50.0	mAmps
Load (AC clutch drive)	3.0	4.0		Ohms
Load (AC clutch drive)		0.1	0.20	Henries
Load Energy $\frac{1}{2}$ LI^2			1.5	Joules
Relay Contact Voltage Drop		0.04	0.10	Volts
Load (fan actuator circuit)	13.0			Ohms
Load (fan actuator circuit)			80.0	mHenries
Input Debounce Delay	0.3		1.1	Seconds
Open Clutch Sense Current	0.15	0.5	1.27	Amps
Shorted Clutch Cut Out Resistance	1.7		2.4	Ohms
Voltage Cut Out Off Threshold	10.8	11.0	11.2	Volts
Evaporator Thermostat On Range	5.0		VIGN	Volts
Evaporator Thermostat Off Range	0		1.0	Volts

* Applicable over the full operating range: –40° to 212°F (–40° to 100°C)
† All voltages referenced are to ground lead of the device.

Table 4, APADS Parametric Specifications



04/15/94 f540349a

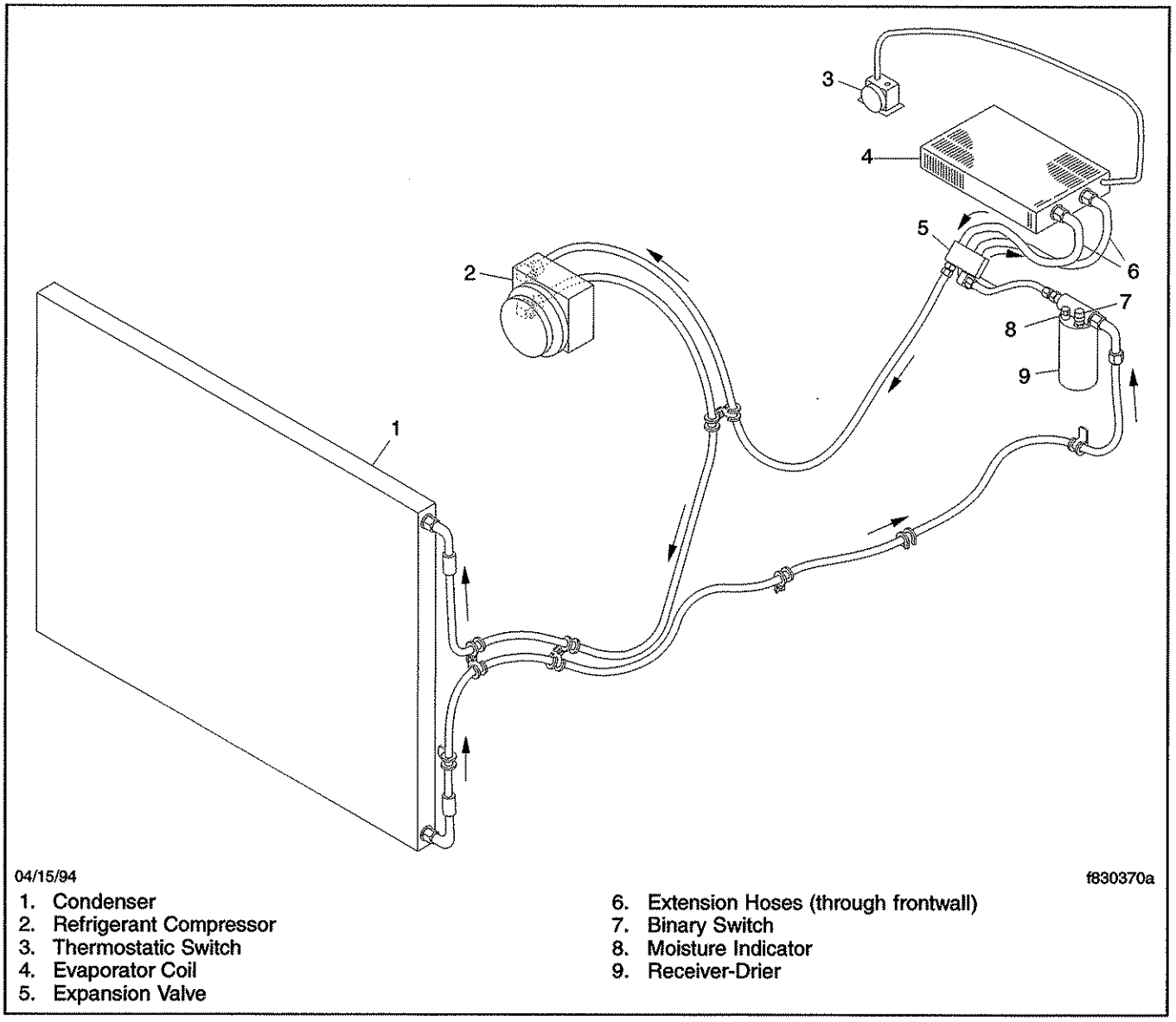
NOTE: For the specific location of each circuit breaker/fuse/relay in the electrical center, refer to the Wiring Diagram and Circuits, Vehicle section in **Group 54.**

A. To circuit 14

1. 10A
2. 15A
3. 40A
4. Heater/Air-Conditioner Relay
5. Resistor
6. Heater Blower Relay
7. Blower Motor
8. Compressor Clutch Relay
9. Thermostatic Switch
10. Defroster/Dehumidifier Microswitch
11. Blower Motor Switch
12. Air Conditioner On/Off Microswitch
13. Binary Switch
14. Air Conditioner Compressor Clutch

Fig. 1, Air Conditioning Wiring

Specifications



1. Condenser
2. Refrigerant Compressor
3. Thermostatic Switch
4. Evaporator Coil
5. Expansion Valve
6. Extension Hoses (through frontwall)
7. Binary Switch
8. Moisture Indicator
9. Receiver-Drier

Fig. 2, Air Conditioner Plumbing

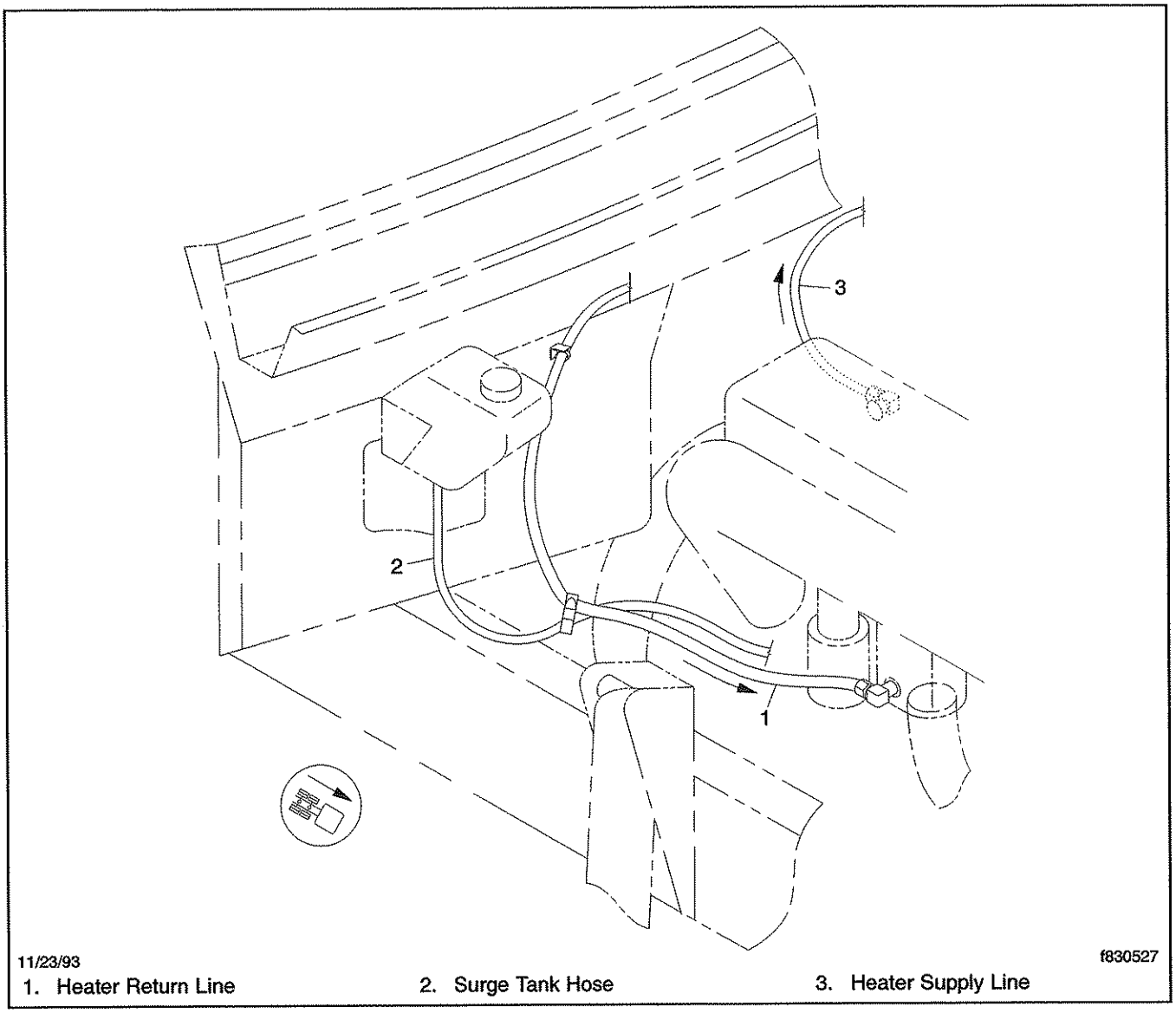
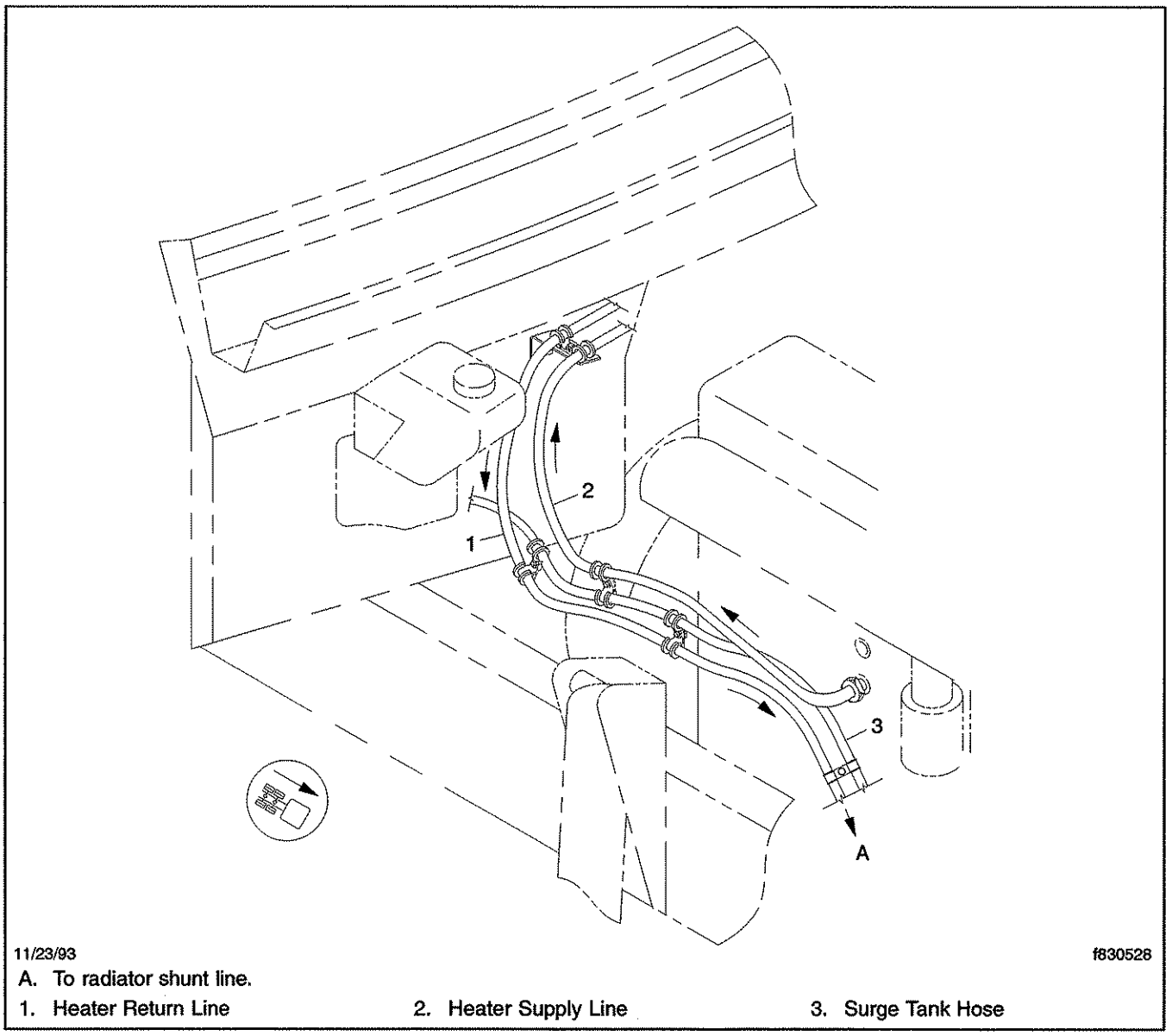


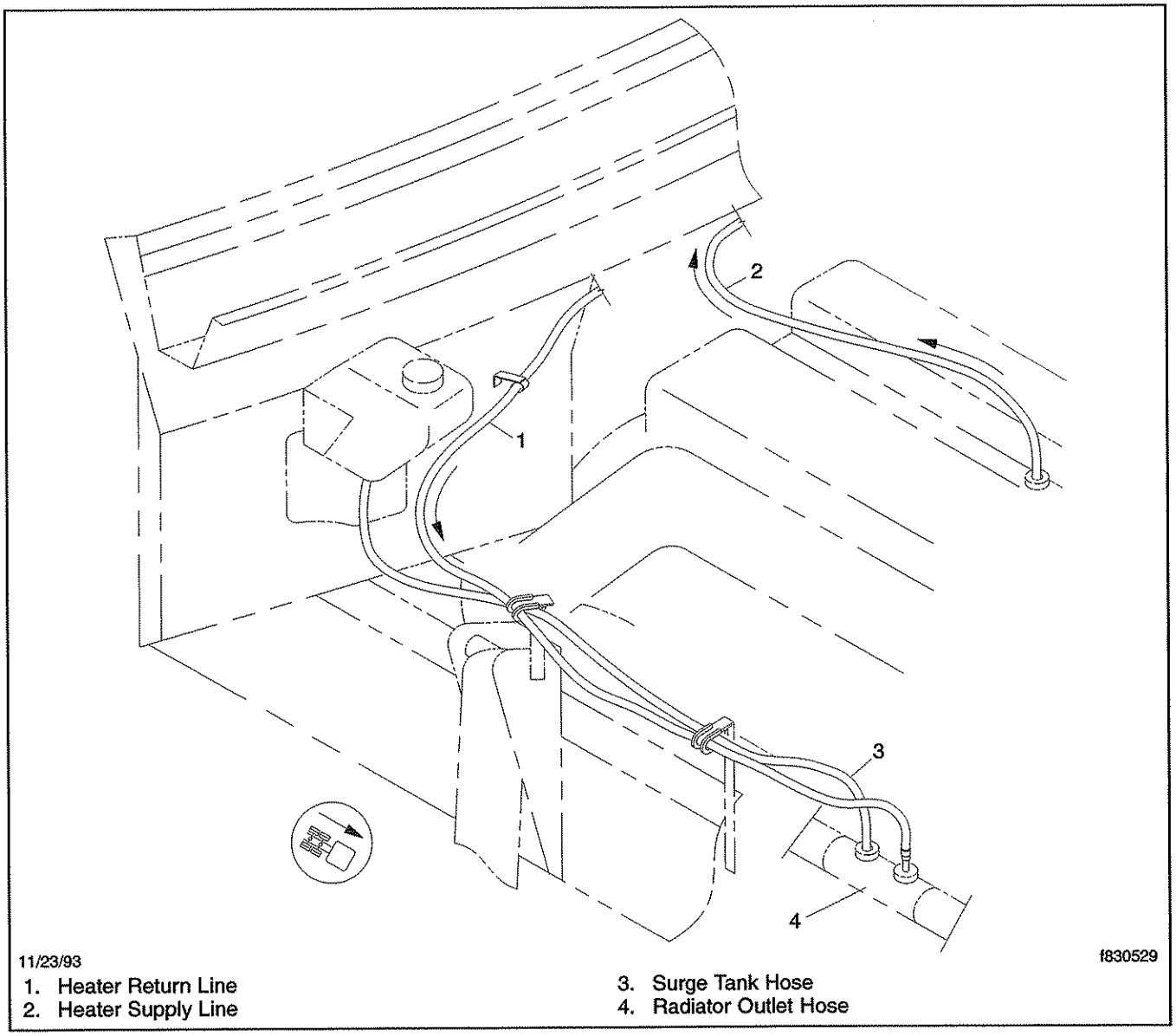
Fig. 3, Heater Plumbing for Cummins B Series Engines

Specifications



A. To radiator shunt line.
1. Heater Return Line
2. Heater Supply Line
3. Surge Tank Hose

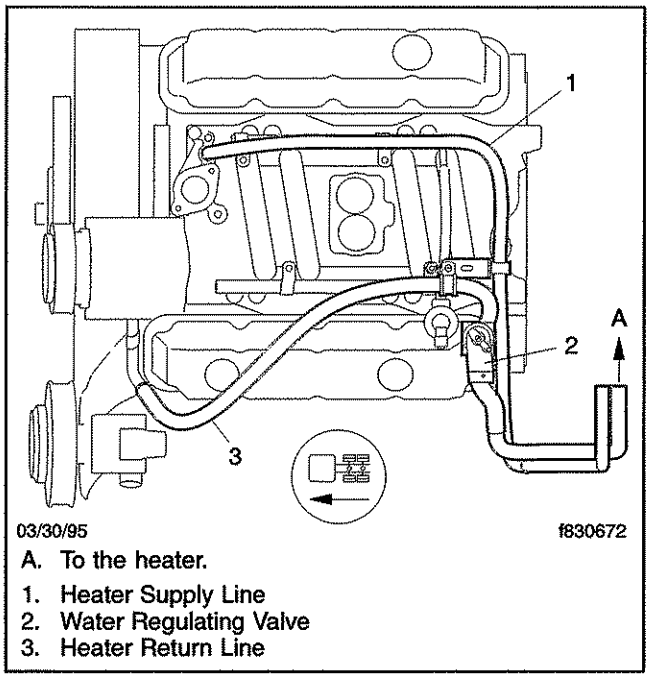
Fig. 4, Heater Plumbing for Cummins C Series Engines



1. Heater Return Line
2. Heater Supply Line
3. Surge Tank Hose
4. Radiator Outlet Hose

Fig. 5, Heater Plumbing for Mercedes-Benz OM 366LA Engines

Specifications



A. To the heater.
1. Heater Supply Line
2. Water Regulating Valve
3. Heater Return Line

Fig. 6, Heater Plumbing for Dodge Magnum Engines

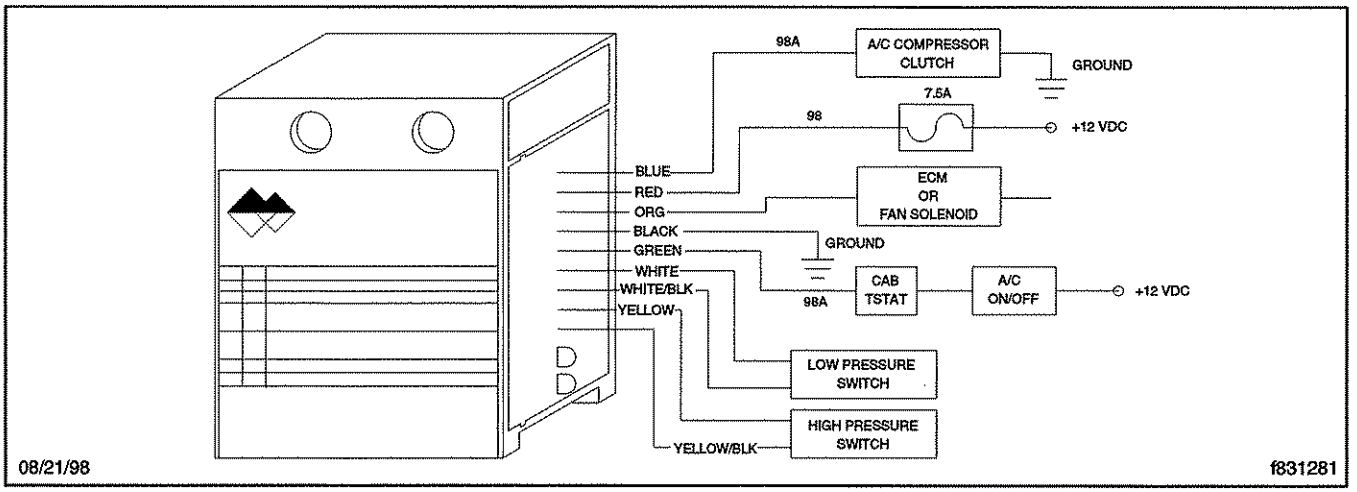


Fig. 7, APADS Electronic Control Module Wiring Diagram

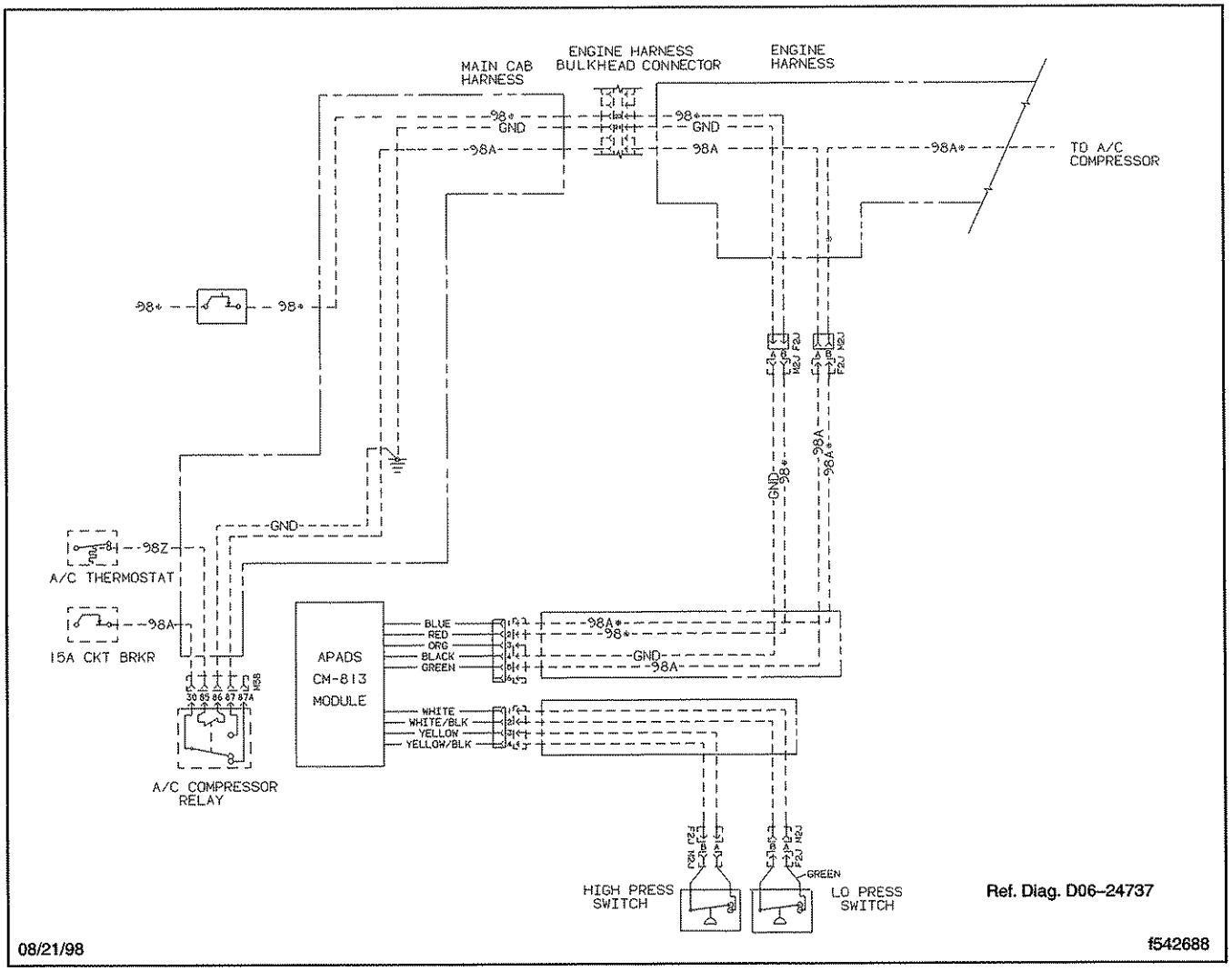


Fig. 8, Cummins Mechanical Engine and APADS Schematic

Contents

Subject	Subject Number
General Information	050
Service Operations	
Safety Precautions	100
Pre-Service Checks	110
Compressor Suction and Discharge Pressure Checking	120
Compressor Removal and Installation	130
Oil Check and Adding Oil to the Compressor	140
Clutch Assembly Removal, Inspection, and Installation	150
Shaft Seal Replacement	160
Head and Valve Plate Removal and Installation	170
Specifications	400

General Information (See Fig. 1 or Fig. 2)

The main purpose of the refrigerant compressor is to draw refrigerant gas from the evaporator and squeeze it into high-pressure gas. High pressure raises the condensation point of refrigerant gas, which allows the condenser to change it to a liquid so that it can be used for cooling again. A second purpose of the compressor is to move refrigerant through the air conditioning system.

The compressor is cycled by a thermostatic switch. When there is enough of a temperature drop in the cab, the switch breaks the circuit to the compressor's clutch. When the clutch is disengaged, its pulley is free-wheeling and the compressor shaft is not turning. When the clutch is engaged, it holds to the pulley, and the turning of the pulley causes the compressor shaft to turn.

Refer to the cab air conditioner section in this group for more information.

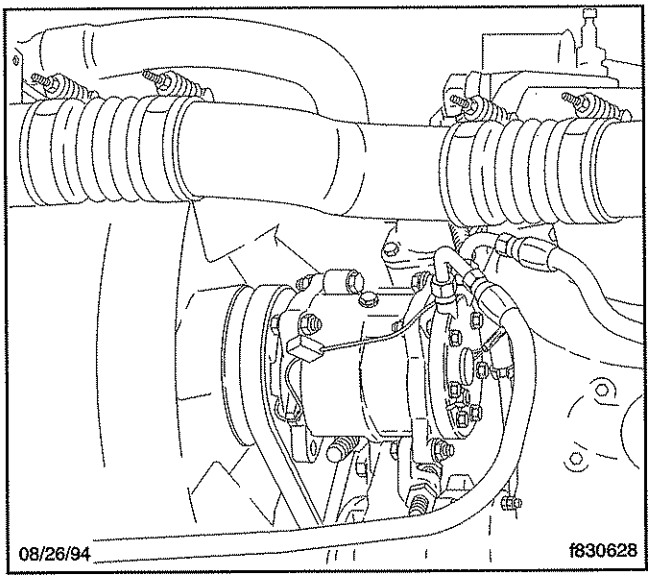


Fig. 1, OM 366LA Engine Mounting

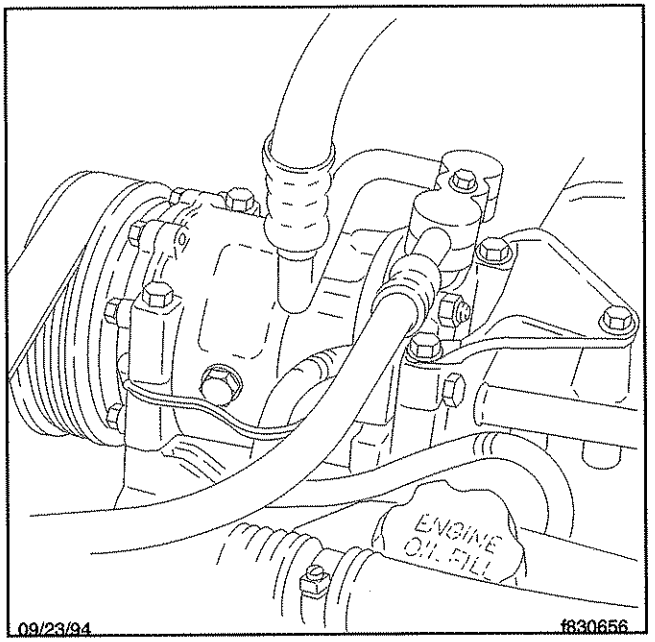


Fig. 2, Dodge Magnum Engine Mounting

Safety Precautions

Whenever repairs are made to any air conditioner parts that hold R–134a refrigerant, you must recover, purge or flush (if contaminated), evacuate, charge, and leak test the system. In a good system, refrigerant lines are always under pressure and you should disconnect them only after the refrigerant charge has been recovered (discharged) at the service valves.

Refrigerant R–134a is safe when used under the right conditions. Always wear safety goggles and non-leather gloves while recovering, evacuating, charging, and leak testing the system. Do not wear leather gloves; when refrigerant gas or liquid contacts leather, the leather will stick to your skin.

⚠ WARNING

WARNING: Use care to prevent refrigerant from touching your skin or eyes, because liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Serious injury or blindness could result if you come into contact with liquid refrigerant.

Refrigerant splashed in the eyes should be rinsed with lukewarm water, not hot or cold. Do not rub the eyes. Apply a light bandage and contact a physician right away.

Refrigerant splashed on the skin should be rinsed with lukewarm water, not hot or cold. Do not rub the skin. Apply a light coat of a nonmedicated ointment, such as petroleum jelly. Contact a physician right away.

R–134a refrigerant does not burn at ambient temperatures and atmospheric pressure. However, it can be combustible at pressures as low as 139 kPa absolute (5.5 psig) at 177°C (350°F) when mixed with air concentrations that are greater than 60 percent.

⚠ WARNING

WARNING: R–134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R–134a may form, resulting in a fire or explosion, which could cause personal injury or property damage. R–134a may be safely pressured with dry nitrogen.

Always work in an area where there is a constant flow of fresh air when the system is recovered, evacuated, charged, and leak tested. R–134a vapors have a slightly sweet odor that is difficult to detect. Frequent leak checks and air monitoring equipment are recommended to ensure a safe working environment.

IMPORTANT: When servicing an R–134a air conditioning system, use only service equipment certified to meet the requirements of SAE J2210 (R–134a recycling equipment). The equipment should be operated only by qualified personnel who are familiar with the recycling station manufacturer's instructions.

Because of its very low boiling point, refrigerant must be stored under pressure. To prevent the refrigerant containers from exploding, never expose them to temperatures higher than 52°C (125°F).

On R–134a refrigerant systems, polyalkylene glycol (PAG) oil is used in the compressor. When handling PAG oil, observe the following:

- keep the oil free of contaminants
- do not expose the a/c system or the PAG oil container to air; PAG oil has a high moisture absorption capacity and the oil container should be immediately sealed after each use.
- use care when handling: painted surfaces, plastic parts, and other components (drive belts) could be damaged if PAG oil is spilled on them
- never mix PAG oil with other types of refrigerant oil

Pre-Service Checks

⚠ WARNING

WARNING: Before doing any work, read the information under Safety Precautions, 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

⚠ CAUTION

CAUTION: Determine whether the air conditioning system is charged with refrigerant R–134a or with R–12. Check the label on the radiator shroud (the side the compressor is on), the compressor identification tag, and the caution labels on system components for verification. Service procedures are different for these refrigerant systems. Failure to properly identify the refrigerant system prior to servicing could cause component malfunction and system contamination.

Some special tools are needed for doing repair work on the compressor. Refer to the special tools table in **Specifications 400.** Tool kits can be bought from the distributor listed under the special tools table in **Specifications 400.**

NOTE: Compressor problems usually show in one of four ways: abnormal noise; seizure; leakage; or low suction and discharge pressures. Resonant compressor noises are not causes for alarm; irregular noise or rattles are likely to be caused by broken parts. To check for seizure, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Do the following checks whenever the air conditioner system is not cooling enough and the causes are unknown.

1. Be sure to check the moisture indicator, to see if moisture is the cause of the problems. The air conditioner should be on when checking the indicator; it is better to check it at the end of a day's run.
2. Check the drive belt and mounting:
   - 2.1 On the drive belt, look for wear, damage, or oil. If worn, oil-soaked, or damaged, remove it and install a new one. Refer to the drive belt section in **Group 01** of this manual for instructions.
   - 2.2 Check the compressor mounting parts for loose fasteners, cracks, or other damage. Tighten loose fasteners to the torque value in the torque specifications table under **Specifications 400.** Repair or replace cracked or damaged brackets.
   - 2.3 Check the tension of the compressor drive belt. Refer to the drive belt section in **Group 01** of this manual for instructions.
   - 2.4 Check the compressor oil level. **Refer to Subject 140** for instructions.
3. Check the wiring and connections to the compressor clutch. Replace damaged wiring and tighten loose connections.
4. Check for road debris build-up on the condenser coil fins. Using air pressure and a whiskbroom or a solution of soap and water, carefully clean the condenser; be careful not to bend the fins.
5. Check the refrigerant charge in the air conditioner system; for instructions, refer to the section on R–134a heater and air conditioner systems in this group.
6. Check the suction pressure and discharge pressure of the refrigerant compressor; **refer to Subject 120.**
7. Check the valve plate and cylinder gasket (**Subject 170**), and the shaft seal (**Subject 160**) for damage. Replace as needed.

NOTE: For other possible causes of air conditioner problems, refer to the section on R–134a heater and air conditioner systems in this group and to the applicable fan clutch section in **Group 20** of this manual.

Compressor Suction and Discharge Pressure Checking

Checking

⚠ WARNING

WARNING: Before doing any of the work below, read the information under Safety Precautions, 100. Failure to read the safety precautions, and to be aware of the dangers involved when working with refrigerant, could lead to serious personal injury.

1. Attach a manifold gauge set to the service ports. Make sure that the manifold gauge set is equipped with a valve core depressor.

   1.1 Remove the protector caps from the service valve ports. **See Fig. 1.**

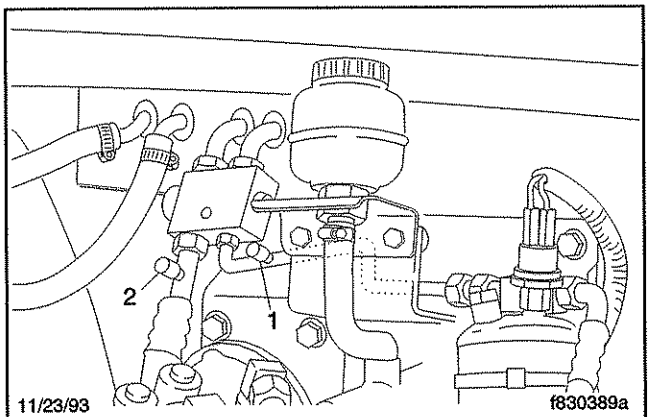
   IMPORTANT: Push down firmly on the hose connectors until a clicking sound is heard. This will ensure that the coupler is locked.

   1.2 Make sure that the valves on the recovery and recycling station are closed. Cap the manifold center hose.

   1.3 Connect the red high-side hose to the discharge service valve, and the blue low-side hose to the suction service valve.

2. Start the engine and set it to run at 1500 rpm.

3. Turn on the heater-air conditioner blower, and set the air conditioner controls to the coldest setting, so that the compressor is operating. If the outside temperature is cooler than 21°C (70°F), *partially* block the air to the condenser.



1. Discharge Service Valve
2. Suction Service Valve

Fig. 1

4. Look at the manifold suction and discharge pressure gauges. The pressure on the gauges should be within the range in the temperature/pressure specifications table in **Specifications 400.**

   4.1 If the suction and discharge pressures are both too high, there is air in the refrigerant, or too much refrigerant in the system; check the charge; for instructions, refer to the section on R–134a heater and air conditioner systems in this group.

   4.2 If the suction pressure is too high and the discharge pressure is normal, check that the probe of the thermostatic switch is correctly installed in the evaporator coil. Refer to the section on R–134a heater and air conditioner systems in this group for instructions.

   4.3 If the suction pressure is too low and the discharge pressure is normal or too low, check for passage of air through the evaporator coils. If airflow is blocked, remove the blockage. If airflow is satisfactory, check for blockages in the line to the suction side of the compressor.

5. If the suction pressure is normal and the discharge pressure is too high, airflow through the condenser may not be enough to carry away the heat.

   5.1 Place a large fan in front of the radiator; place it so that the airflow goes through the condenser. After two minutes of operating the air conditioner and the fan at the same time, look at the manifold pressure gauges again. (One other procedure is to direct a spray of water onto the condenser while the system is running.)

   5.2 If the discharge pressure is still too high, the line between the compressor and the receiver-drier is blocked, or the condenser is blocked internally. Recover, flush, evacuate, charge, and leak test the system. If the blockage can't be removed by flushing, replace the blocked line or blocked condenser. After flushing and before placing a vacuum in the system, *be sure to add the correct amount of refrigerant oil to the*

Compressor Suction and Discharge Pressure Checking

compressor. For instructions, refer to **Subject 140.**

6. If the suction pressure is normal or too high and the discharge pressure is too low, check for a slipping clutch or wrong-sized clutch pulley or accessory drive pulley. Replace parts as needed.

   If the suction pressure is still normal or too high and the discharge pressure is still too low, the compressor is the problem. Repair or replace the compressor.

Compressor Removal and Installation

Removal

1. Recover the refrigerant from the air conditioning system; for instructions, refer to the section on R–134a heater and air conditioner systems in this group.
2. If equipped with an OM 366LA engine do the following. If equipped with a Dodge Magnum engine, go to the next step.
   - 2.1 Remove the clamps holding the charge air pipe; then, remove the pipe. **See Fig. 1.**
   - 2.2 Clean the compressor around the hose connections. Disconnect all of the lines from the compressor. Quickly cap the discharge and suction ports and plug the hoses.
   - 2.3 Disconnect the compressor clutch electrical wire. **See Fig. 2.**
   - 2.4 Loosen both the adjusting and jam nuts on the compressor lower mounting strut. **See Fig. 3**, Refs. 13 and 11.
   - 2.5 Loosen the two compressor upper mounting bolts.
   - 2.6 Pivot the compressor down to relieve the belt tension.
   - 2.7 Remove the V-belt.

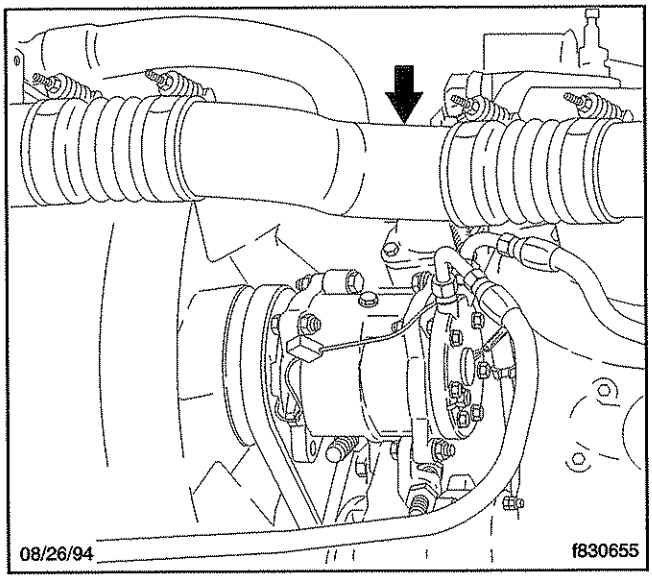


Fig. 1, Charge Air Pipe

   - 2.8 Remove all three compressor mounting bolts and lift out the compressor.
3. If equipped with a Dodge Magnum engine, remove the compressor. **See Fig. 4.**
   - 3.1 Turn the belt tensioner counterclockwise to loosen the drive belt.
   - 3.2 Remove the fastener from the junction block assembly. Move the junction block assembly out of the way. Quickly cap the discharge and suction ports and plug the hoses.
   - 3.3 Cut the tie strap that secures the clutch wiring. Disconnect the wiring.
   - 3.4 Remove the five mounting fasteners, then remove the compressor.

Installation

IMPORTANT: A new compressor is filled with nitrogen gas and 200 mL (6.8 fl oz) of refrigerant oil. When installing a new compressor on the vehicle, do all of the steps below; if installing a used compressor, skip the following step, and proceed with the installation:

1. Prepare a new compressor.

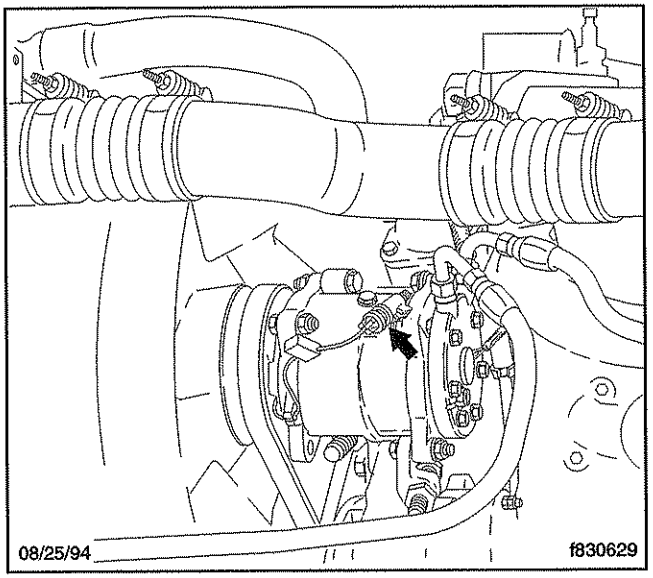
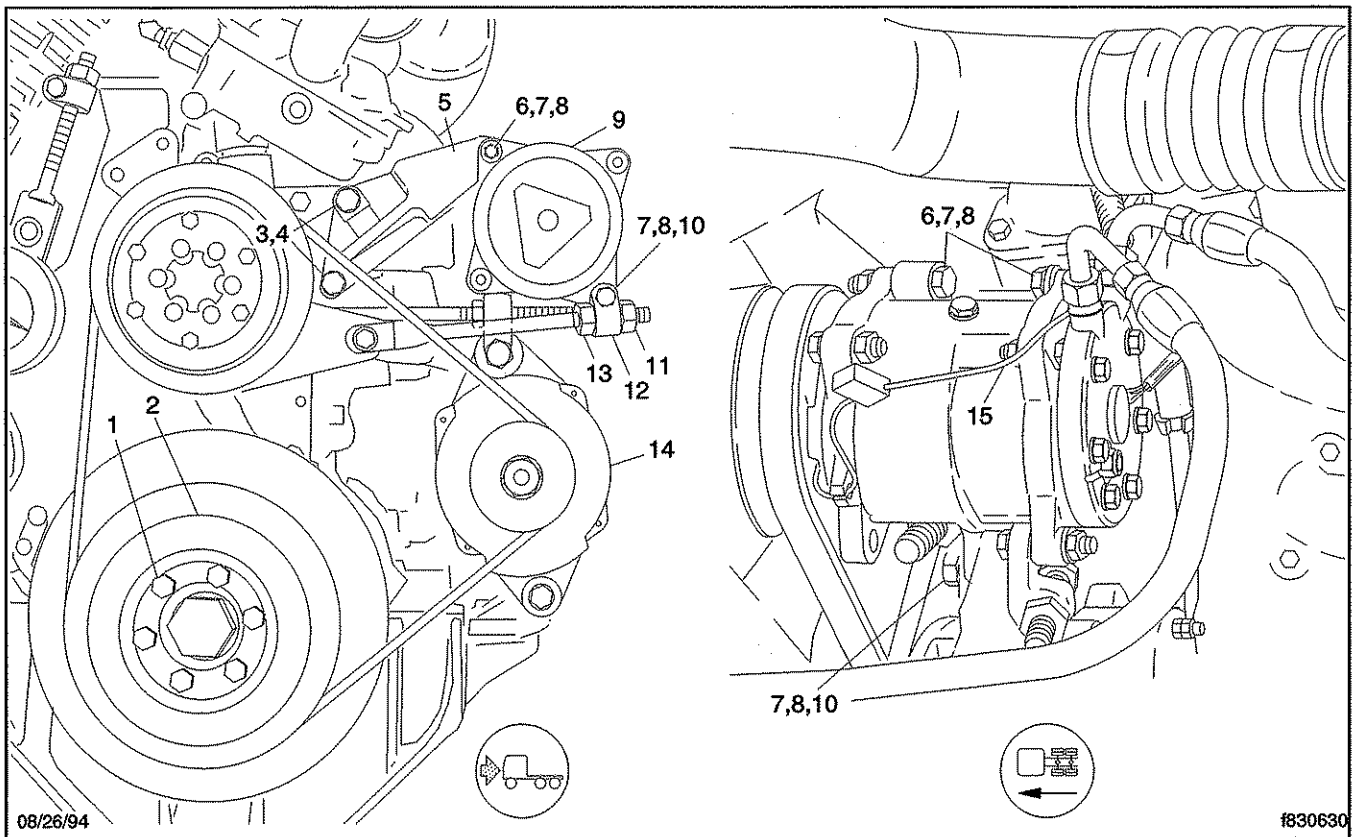


Fig. 2

Compressor Removal and Installation



1. Capscrew, M10 x 55
2. Pulley
3. Capscrew, M10 x 45
4. Lockwasher, 7/16-inch
5. Compressor Mounting Bracket
6. Capscrew, 3/8–16 x 1.75
7. Bearing Washer, 3/8-inch
8. Locknut, 3/8-inch
9. Compressor
10. Capscrew, 3/8–16 x 1.5
11. Jam Nut
12. Adjusting Rod End
13. Adjusting Nut
14. Alternator
15. Binary Switch

Fig. 3

1.1 Slowly release the nitrogen from the discharge side of the compressor. Be careful not to let the oil flow out.

1.2 Turn the compressor shaft several times by hand to distribute oil which has settled in the cylinders.

2. If equipped with an OM 366LA engine, install the compressor as follows. If equipped with a Dodge Magnum engine, go to the next step.

2.1 Place the compressor in position against the mounting bracket and install the mounting bolts, washers, and nuts.

NOTE: The two long bolts go on top.

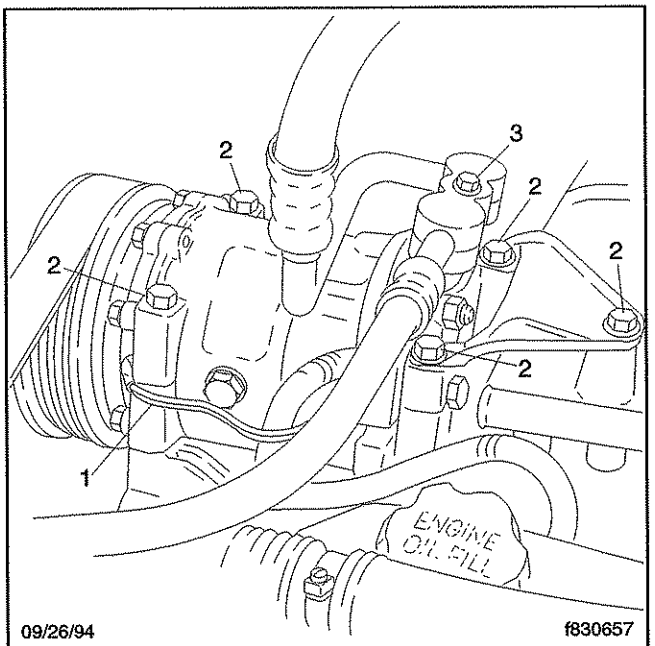
2.2 Hand tighten the nuts.

2.3 Install the V-belt. Adjust the belt tension. For instructions, refer to the applicable section in **Group 01.**

2.4 Tighten the compressor mounting bolts 45 N·m (33 lbf·ft).

2.5 Uncap the suction and discharge ports on the compressor. Unplug the hose connections. Check the hose connections and the surface of the suction and discharge ports. They must be clean and free of nicks, gasket residue, and other foreign material.

IMPORTANT: Under no circumstances should you leave the compressor's ports uncapped or the hoses unplugged for longer than five minutes total.



1. Clutch Electrical Wire
2. Compressor Mounting Fasteners
3. Junction Block Mounting Fastener

Fig. 4

2.6 Attach the refrigerant hoses to the system hose connections. Tighten the suction (large) fitting 39 N·m (29 lbf·ft); tighten the discharge (small) fitting 37 N·m (27 lbf·ft).

2.7 Connect the compressor clutch electrical wire.

2.8 Install the charge air pipe. Tighten the constant torque hose clamps 680 N·cm (60 lbf·in).

3. If equipped with a Dodge Magnum engine, install the compressor.

3.1 Position the compressor on the mounting block.

3.2 Position the retaining bracket at the rear of the compressor.

3.3 Install the five mounting fasteners and tighten them 27 N·m (20 lbf·ft).

3.4 Uncap the suction and discharge ports on the compressor. Unplug the hose connections. Check the hose connections and the surface of the suction and discharge ports. They must be clean and free of nicks, gasket residue, and other foreign material. Replace both O-rings, then install the block assembly on the compressor. Tighten the fastener 25 N·m (19 lbf·ft).

IMPORTANT: Under no circumstances should you leave the compressor's ports uncapped or the hoses unplugged for longer than five minutes total.

3.5 Turn the belt tensioner counterclockwise and slip the belt over the pulley.

4. Evacuate, charge, and leak test the air conditioning system. For instructions, refer to the section on R–134a heater and air conditioner systems in this group.

Oil Check and Adding Oil to the Compressor

General Information

⚠ CAUTION

Different refrigerant oils are used in compressors on R–12 and R–134a air conditioning systems. Always use the correct refrigerant oil and never mix oils. If the wrong oil is used, or if oils are mixed, the compressor could seize due to improper lubrication.

IMPORTANT: New compressors are factory-charged with about 6.8 oz (200 mL) of refrigerant oil. Some refrigerant oil is circulated through the system with the refrigerant, and cannot leave the system except through a leak, when the system is recovered, or when a system part is replaced.

Oil must be from a container that has not been opened, or that has been tightly sealed since its last use. For R–134a systems, order Sanden oil SKI/7803-1997 from your local Freightliner parts distribution center. Tubing, funnels, or other equipment used to transfer the oil should be very clean and dry.

IMPORTANT: Add the same amount of oil that is removed when the system is discharged or recovered, or when a system part is replaced. The list below contains approximate refill amounts for R–134a air conditioning systems.

A. Refrigerant charge—0.7 fl oz (20 mL): This amount of oil may be lost from the system each time the system loses its charge, due to routine recovery or due to a slow leak; no other parts of the system have been replaced.

IMPORTANT: The items below list oil quantities that include the amounts that are lost during recovery. Do not add an additional 0.7 fl oz (20 mL)—the amount described in the item above—to the quantities listed.

B. Receiver-drier—2.7 fl oz (80 mL);

IMPORTANT: A new receiver-drier does not contain any refrigerant oil.

C. Condenser—1.0 fl oz (30 mL);

D. Evaporator coil—0.7 fl oz (20 mL);

E. Entire system—14 fl oz (414 mL) with or without an auxiliary heater/air-conditioner. Add this amount of oil to the compressor if the entire system (including the compressor) has been recovered of refrigerant and oil, and if the system has been evacuated.

When handling refrigerant oil:

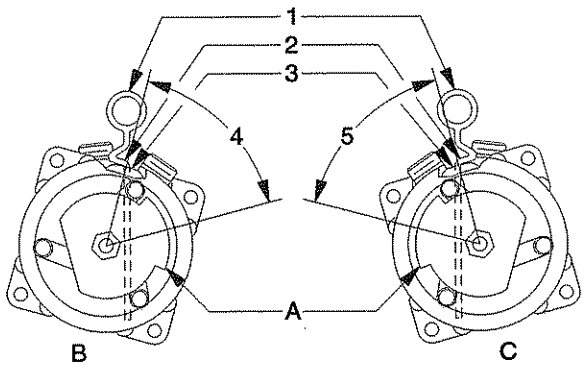
- The oil should be free of water, dust, metal powder, and other foreign substances.
- Don't mix refrigerant oil with other types or viscosities of oil.
- Refrigerant oil absorbs moisture when exposed to the air for any period. After use, quickly seal the oil container.

IMPORTANT: Check the compressor oil level at the time of installation and whenever a loss of refrigerant oil has occurred.

⚠ WARNING

Don't remove the oil fill plug without first recovering the system. Failure to recover the system could cause uncontrolled release of high-pressure refrigerant, which can freeze skin and eye tissue causing serious injury or blindness.

1. Run the compressor for 10 minutes with the engine at idle. Shut down the engine.
2. Recover all of the refrigerant from the system.
3. Determine the mounting angle of the compressor from horizontal (oil fill plug on top).



08/11/94 f830631

A. Position of counterweight.
B. Mounting angle right.
C. Mounting angle left.

1. Dipstick
2. Dipstick Stop
3. Oil Fill Hole
4. 2 o'Clock
5. 10 o'Clock

Fig. 1, Checking the Oil Level

Oil Check and Adding Oil to the Compressor

4. Remove the oil fill plug. Using a socket wrench on the armature retaining nut, turn the shaft clockwise until the counterweight is positioned correctly. See **Fig. 1.**
5. Check the oil level with the dipstick. Make sure the angle of the dipstick stop is pointing in the right direction. See **Fig. 1.**

   Remove the dipstick and count the number of notches covered by the oil. If the number of notches covered by oil does not match the specifications for the appropriate mounting angle in **Table 1**, add or subtract oil to the midrange value. For example, if the mounting angle is zero degree, add oil until 6 notches on the dipstick are covered by oil.

Oil Specifications at Various Mounting Angles	
Mounting Angle	**Number of Notches Covered by Oil**
0°	5 to 7
10°	6 to 8
20°	7 to 9
30°	8 to 10
40°	9 to 11
50°	10 to 12
60°	11 to 13
90°	16 to 18

Table 1, Oil Specifications at Various Mounting Angles

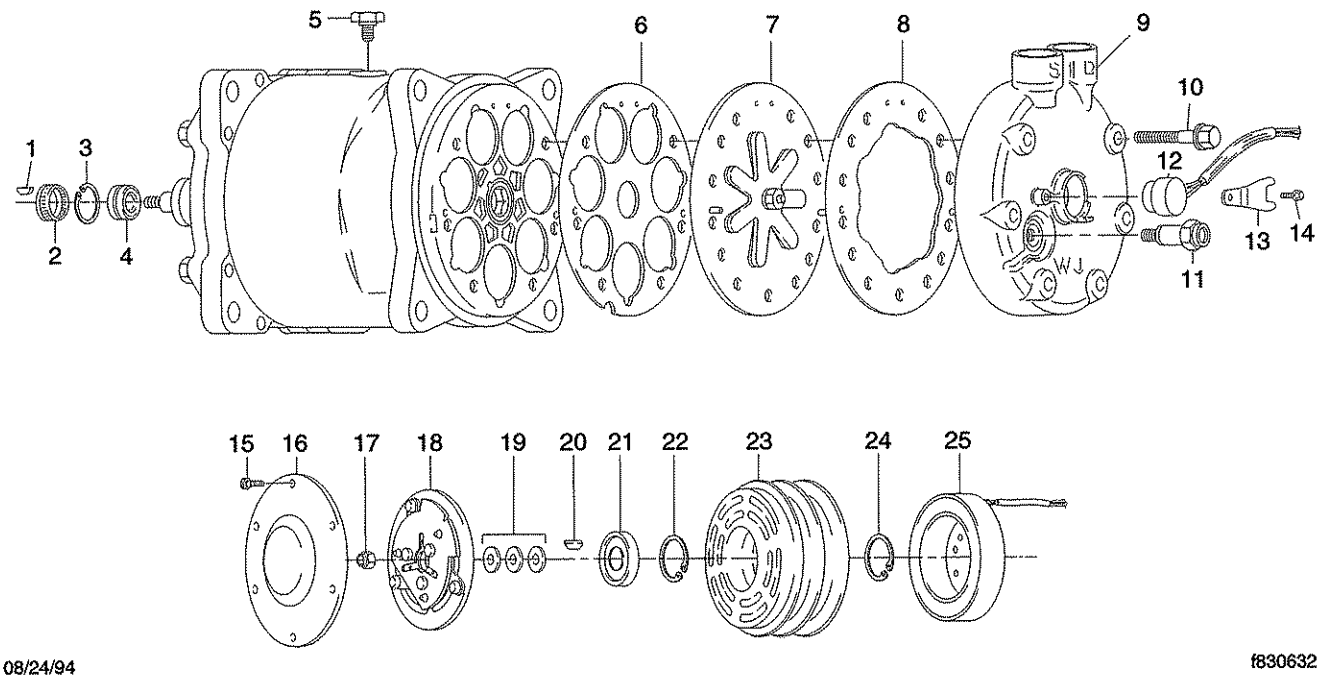
NOTE: A dipstick can be made locally or purchased from a special tools supplier. Refer to the list of special tool suppliers in **Specifications 400.**

6. Being careful not to twist the O-ring, insert the plug in the oil fill opening. Tighten the plug 11 to 19 lbf·ft (15 to 25 N·m).

Clutch Assembly Removal, Inspection, and Installation

Removal (See Fig. 1)

1. Remove the compressor from the vehicle. For instructions, refer to **Subject 130**.
2. Remove the six bolts that attach the drive plate cover and remove the cover.
3. Insert the pins of the drive plate spanner into the threaded holes of the drive plate. Hold the drive plate securely while removing the retaining nut. See **Fig. 2**.
4. Using the drive-plate puller, thread the three puller bolts into the drive plate. Turn the center screw clockwise to loosen and remove the drive plate. See **Fig. 3**.
5. Remove the pulley bearing dust cover (if equipped), the shaft key, and the clutch shims. Use a slotted screwdriver and hammer to tap the shaft key loose. See **Fig. 4**.
6. Using external snap-ring pliers, remove the pulley assembly snap ring.
7. Remove the pulley assembly.
   - 7.1 Insert the lip of the pulley puller jaws into the snap ring groove. See **Fig. 5**.
   - 7.2 Place the puller shaft protector over the exposed shaft.



1. Shaft Key
2. Felt Ring
3. Shaft Seal Snap Ring
4. Shaft Seal (with O-ring)
5. Oil Plug
6. Block Gasket
7. Valve Plate Assembly
8. Head Gasket
9. Cylinder Head
10. Cylinder Head Bolt
11. Pressure Relief Valve
12. Thermal Protector Switch, TPS (optional)
13. TPS Clip (optional)
14. TPS Screw (optional)
15. Bolt
16. Drive Plate Cover
17. Shaft Nut
18. Drive Plate
19. Clutch Shims
20. Shaft Key
21. Pulley Bearing Dust Cover
22. Pulley Snap Ring
23. Pulley Assembly
24. Field Coil Assembly Snap Ring
25. Field Coil Assembly

Fig. 1, Sanden SD7 Series Refrigerant Compressor

Clutch Assembly Removal, Inspection, and Installation

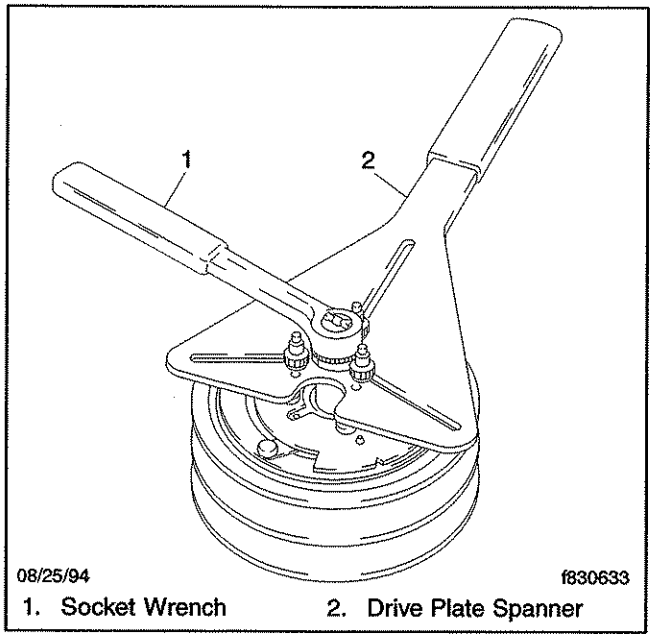


Fig. 2, Remove the Retainer Nut

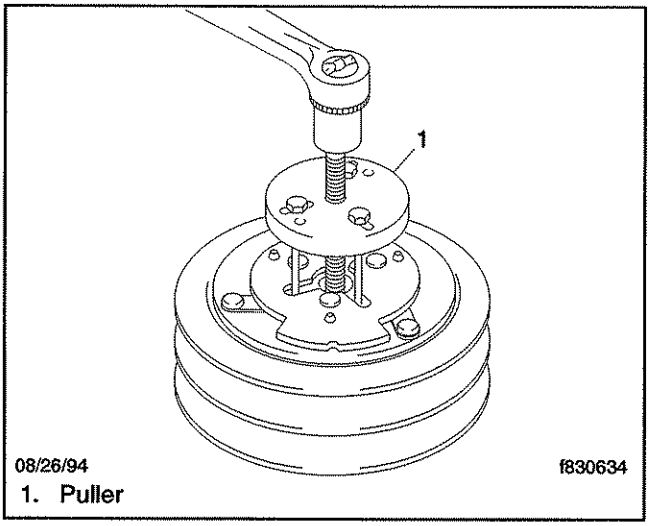


Fig. 3, Remove the Drive Plate

7.3 Align the thumb screws to the puller jaws. Tighten the screws finger tight.

7.4 Using a socket wrench, turn the puller center bolt clockwise and remove the pulley.

8. Remove the coil assembly.

8.1 Remove the coil's lead wire from the wire holder on the compressor.

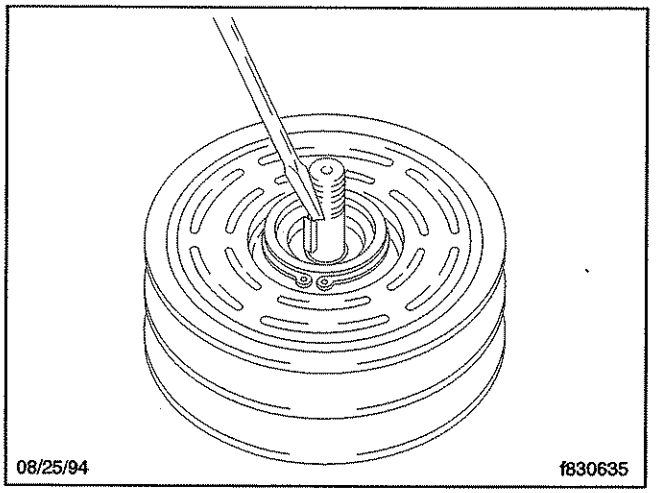


Fig. 4, Tap the Shaft Key Loose

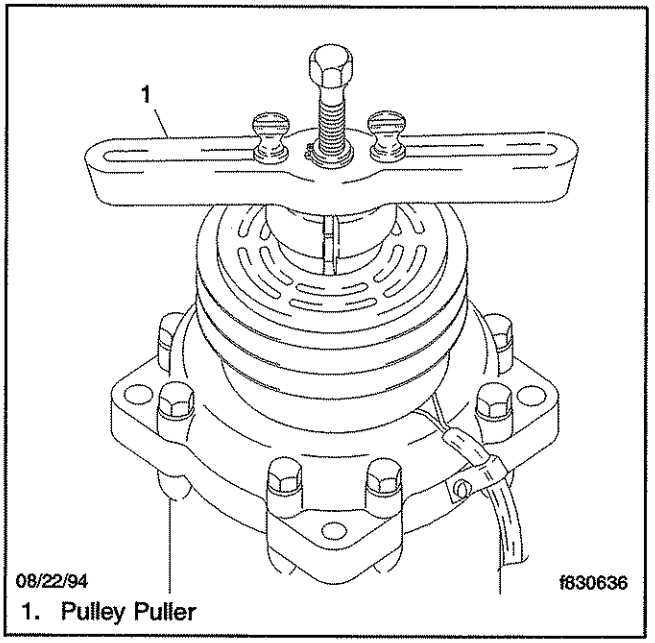


Fig. 5, Pulley Assembly

8.2 Disconnect the wiring harness.

8.3 Remove the snap ring (**Fig. 6**); then, remove the coil assembly.

Clutch Assembly Removal, Inspection, and Installation

Inspection

1. Inspect the drive plate. If the frictional surface shows signs ofdamage due to too much heat, replace the drive plate and pulley assembly.
2. Check the appearance of the pulley assembly. If the friction surface of the pulley shows signs of too much grooving due to slippage, replace both the pulley and drive plate. Clean the friction surfaces of the pulley assembly before installing it.
3. Check the coil for a loose connector and for cracked insulation.Replace it if necessary.

Installation

NOTE: When supporting the compressor in a vise, clamp only on the mounting ears, never on the body of the compressor.

1. Install the coil assembly.
   - 1.1 Position the coil assembly on the compressor.
   - 1.2 Install the snap ring.
   - 1.3 Attach the coil's lead wire to the wire holder on the compressor.
   - 1.4 Connect the wiring harness.
2. Install the pulley assembly.

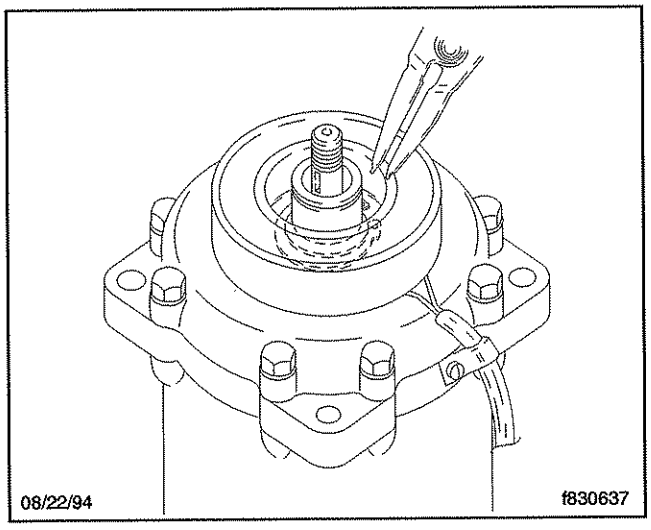


Fig. 6, Coil Assembly

   - 2.1 Position the pulley over the boss of the front housing.
   - 2.2 Place the pulley installer ring into the bearing bore. Make sure that the edge rests only on the inner race of the bearing, not on the seal, pulley, or outer race of the bearing.
   - 2.3 Place the driver into the ring. Using a hammer or arbor press, drive the pulley down against the front housing step. See **Fig. 7**.
   - 2.4 Using internal snap ring pliers, install the pulley bearing snap ring.
   - 2.5 Using external snap ring pliers, install the pulley snap ring. If a bevel is present on the snap ring, make sure that it is facing up (away from the body of the compressor).
   - 2.6 Install the pulley bearing dust cover by gently tapping it into place.
3. Install the drive plate assembly.
   - 3.1 Using pliers, install the shaft key. See **Fig. 8**.
   - 3.2 Install the shims.
   - 3.3 Align the keyway in the drive plate assembly with the shaft key. Using a driver, and a hammer or an arbor press, drive the assembly down over the shaft until it bottoms on the shims. See **Fig. 9**.
   - 3.4 Install the retaining nut. Tighten the nut to the torque in **Specifications 400**.
4. Using a feeler gauge, check that the clutch clearance is 0.4 to 0.8 mm (0.02 to 0.03 inch). See **Fig. 10**. Adjust the clearance by gently tapping down on the front plate at the high spots, or gently prying up at the low spots.
5. Install the drive plate cover. Tighten the bolts to the torque in **Specifications 400**.
6. Install the compressor on the vehicle. For instructions, refer to **Subject 130**.

Clutch Assembly Removal, Inspection, and Installation

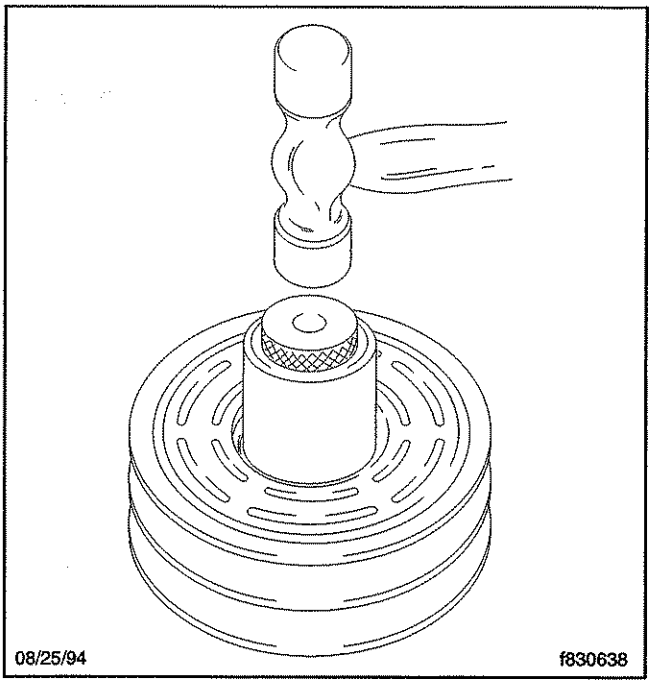


Fig. 7, Drive the Pulley Down

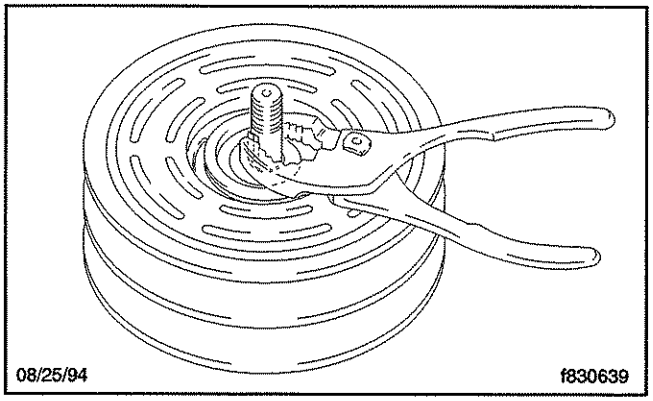


Fig. 8, Install the Shaft Key

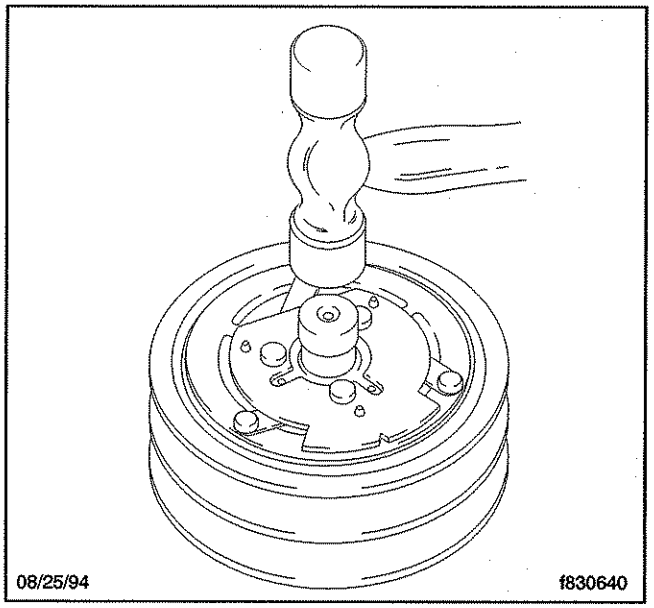


Fig. 9, Drive Plate Assembly

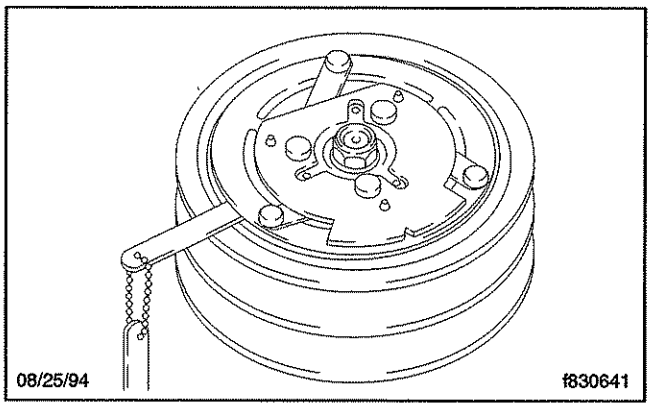


Fig. 10, Check the Clutch Clearance

Replacement

1. Remove the drive plate and pulley assemblies. For instructions, refer to **Subject 150.**
2. Using snap ring pliers, remove the felt ring retainer. **See Fig. 1.** Then remove the felt ring.
3. Using snap ring pliers, remove the shaft seal snap ring.
4. Position the shaft seal removal and installation tool on the shaft seal. Twist the tool until the hooks on the tool engage the slots in the shaft seal housing, then pull the seal out with a twisting motion. **See Fig. 2.**

NOTE: The shaft seal and felt ring should not be reused. Always use a new seal kit. Be very careful that the lip of the shaft seal to be installed is not scratched or damaged in any way. Make sure the shaft seal is free of lint and dirt, which could damage the shaft seal surface.

5. Using a non-petroleum based solvent and a lint-free cloth, clean the shaft seal cavity. Then, use dry compressed air to blow out the shaft seal cavity.
6. Position the shaft seal protective sleeve over the compressor shaft. **See Fig. 3.** Make sure that the sleeve has no scratches so that the shaft seal will not be damaged. Also, make sure that there is no gap between the end of the sleeve and the seal surface of the shaft.

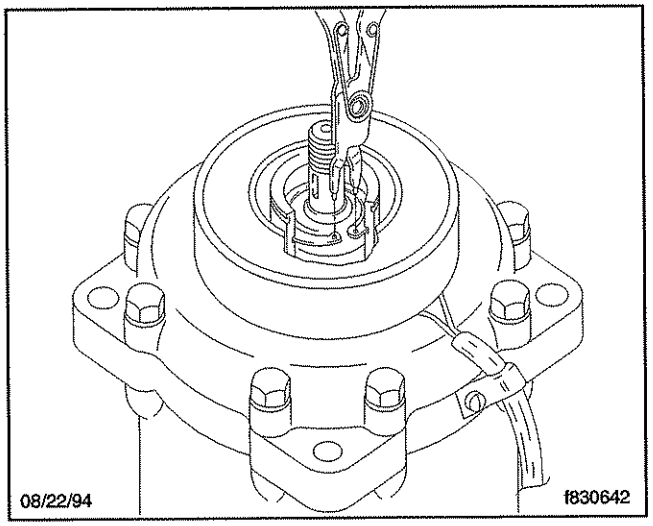
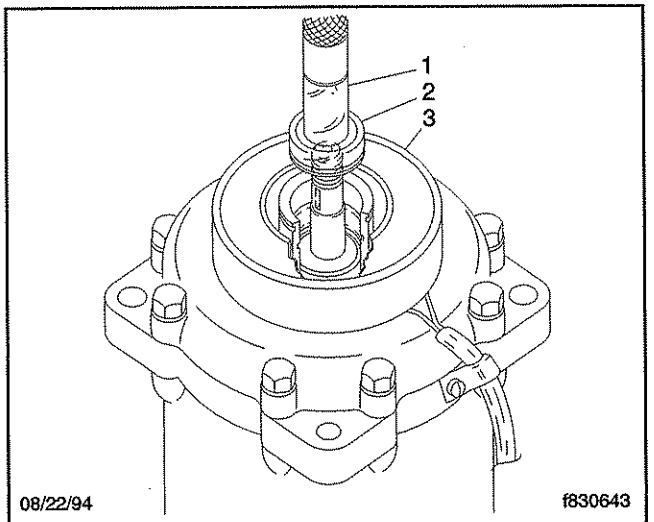


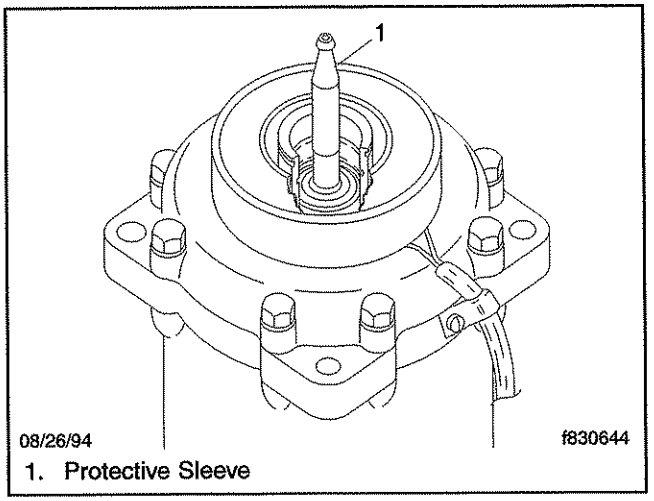
Fig. 1

7. Position the shaft seal removal and installation tool until the hooks on the tool engage the slots in the new shaft seal housing.
8. Place the entire assembly into clean 5GS refrigerant oil. **See Fig. 4.**
9. Insert the shaft seal over the protective sleeve, then press it down as far as possible. Twist the removal and installation tool to remove it from the seal. Remove the tool and the protective sleeve.



1. Shaft Seal Removal and Installation Tool
2. Shaft Seal
3. Coil Assembly

Fig. 2



1. Protective Sleeve

Fig. 3

Shaft Seal Replacement

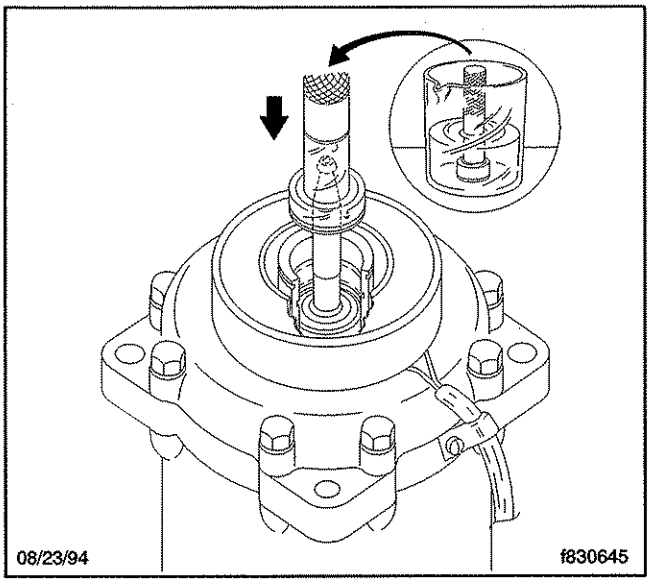


Fig. 4

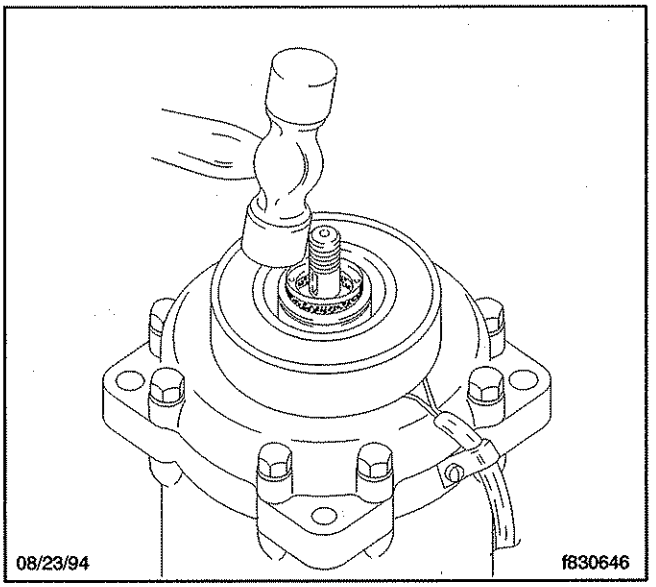


Fig. 5

10. Using internal snap-ring pliers, install the snap ring. **See Fig. 1.** If needed, gently tap the snap ring to ensure that it is seated in the groove.

NOTE: When installing the snap ring, the beveled end of the snap ring must face away from the compressor body.

11. Gently tap the new felt ring in place. **See Fig. 5.**

12. Install the drive plate and pulley assemblies. For instructions, refer to **Subject 150.**

Head and Valve Plate Removal and Installation

Removal

NOTE: Before doing any work on the head and valve plate, open both service valves to release any gas pressure in the compressor.

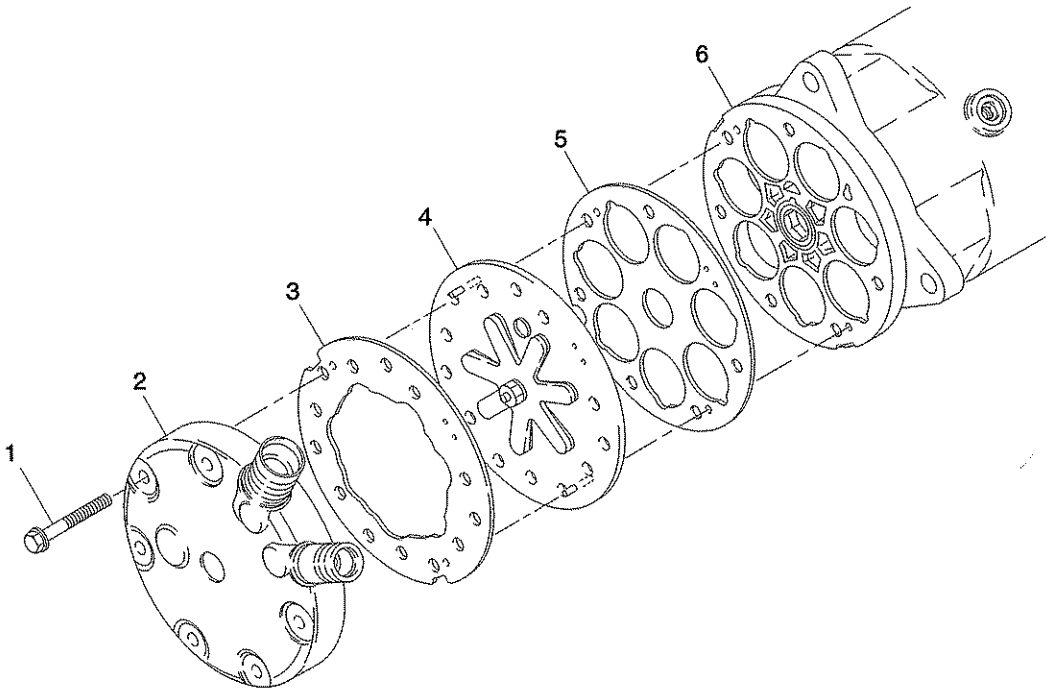
1. Remove the bolts from the cylinder head. **See Fig. 1.**
2. Remove the valve plate assembly and the cylinder head from the compressor. Use a gasket scraper to separate the cylinder head from the valve plate. **See Fig. 2.** Use care not to scratch the gasket surface of the cylinder head.

⚠ CAUTION

CAUTION: Do not hit or tap the head to separate it from the valve plate. Damage to the head may result.

NOTE: It is recommended that the head gasket (located between the cylinder head and the valve plate) and the block gasket (located between the valve plate and the cylinder block) be replaced any time the cylinder head is removed.

3. Being careful not to scratch or nick the machined sealing surfaces, remove all gasket material adhering to the head, valve plate, or compressor block.



08/25/94 f830647

1. Cylinder Head Bolt
2. Cylinder Head
3. Head Gasket
4. Valve Plate Assembly
5. Block Gasket
6. Compressor Body

Fig. 1

Head and Valve Plate Removal and Installation

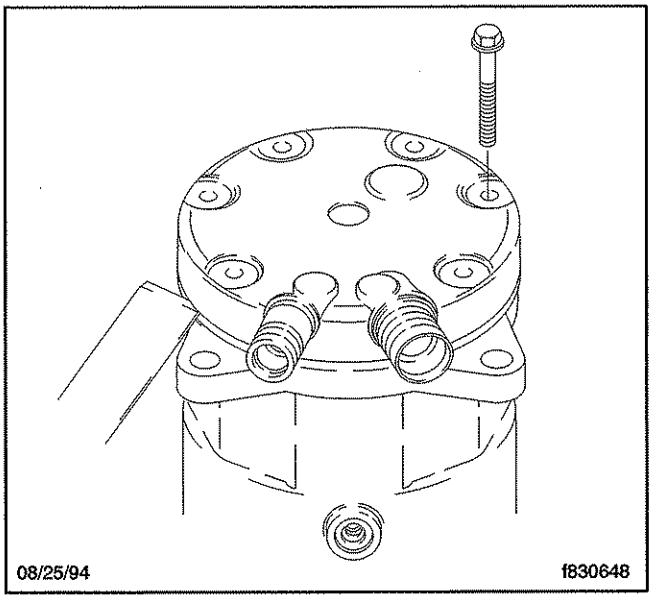


Fig. 2

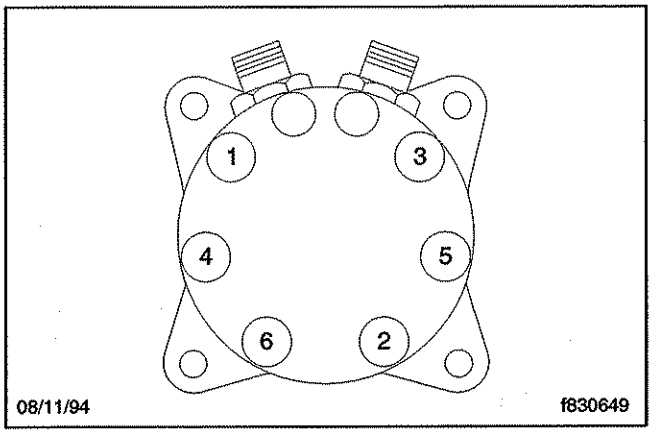


Fig. 3

Installation

1. Apply a thin film of clean 5GS refrigerant oil to the new block gasket. Place the block gasket in position on the compressor so that the pin holes in the compressor block line up with the pin holes in the block gasket.
2. Place the valve plate assembly in position on the block gasket so that the discharge valve, retainer, and the nut are facing up (away from the cylinder block). Make sure that the locating pins on the valve plate go through the pin holes in the gasket.
3. Remove all residual oil from each bolt hole on the cylinder block.
4. Apply a thin film of clean 5GS refrigerant oil to the new head gasket. Place the gasket in position over the valve plate locating pins. Make sure that the locating pins on the valve plate go through the pin holes in the gasket.
5. Place the head on the cylinder head gasket so that the dowel pins go into the dowel pin holes in the head.
6. Install the head bolts. Tighten the bolts in sequence to the values given in **Subject 400. See Fig. 3** for the tightening sequence.

Special tools can be purchased from the following independent suppliers:

Classic Tool Design
31 Walnut St.
New Windsor, NY 12550
(914) 562-8700

Mastercool USA Inc.
216 Route 10, Bldg. 3
Randolph, NJ 07869
(201) 366-1101

Description	Torque	
	N·cm (lbf·in)	N·m (lbf·ft)
Adjusting Rod Jam Nut	—	190 (140)
Compressor Mounting Fasteners:		
OM 366LA Engine	—	38 (28)
Dodge Magnum Engine	—	27 (20)
Clutch Retaining Nut (1/2")	—	30 (22)
Clutch Retaining Nut (M8)	—	18 (13)
Oil Drain Plug	—	20 (15)
Cylinder Head Bolts, M6	—	14 (10)
Cylinder Head Bolts, M8	—	34 (25)
Pressure Relief Valve	120 (11)	—
Dust Cover Screws, M5	880 (78)	—
Clutch Lead Wire Clamp Screw	1500 (132)	—
Rotalock Valve	—	37 (27)

Table 1, Torque Values

Outside Temp. °C (°F)	Maximum Center Vent Temp. °C (°F)	Operating Suction Pressure (Low Side) kPa (psi)	Maximum Liquid Line Pressure (High Side) kPa (psi)
16–27 (60–80)	14 (58)	55–103 (8–15)	1138 (165)
27–32 (80–90)	16 (60)	83–124 (12–18)	1276 (185)
32–38 (90–100)	18 (64)	103–138 (15–20)	1413 (205)

Table 2, Temperature/Pressure Specifications