Carrier HEATING & COOLING

Air Conditioners and Heat Pumps using Puron™ (R-410A) Refrigerant

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Application Guideline and Service Manual

SAFETY CONSIDERATIONS

Installation, service, and repair of these units should be attempted only by trained service technicians familiar with standard service instruction and training material.

All equipment should be installed in accordance with accepted practices and unit Installation Instructions, and in compliance with all national and local codes. Power should be turned off when servicing or repairing electrical components. Extreme caution should be observed when troubleshooting electrical components with power on. Observe all warning notices posted on equipment and in instructions or manuals.

⚠ CAUTION

→ Puron (R-410A) systems operate at higher pressures than standard R-22 systems. Do not use R-22 service equipment or components on Puron (R-410A) equipment. Ensure service equipment is rated for Puron (R-410A).

Refrigeration systems contain refrigerant under pressure. Extreme caution should be observed when handling refrigerants. Wear safety glasses and gloves to prevent personal injury. During normal system operation, some components are hot and can cause burns. Rotating fan blades can cause personal injury. Appropriate safety considerations are posted throughout this manual where potentially dangerous techniques are addressed.

INTRODUCTION

Section 1 of this Application Guideline and Service Manual provides the required system information necessary to install Puron (R-410A) equipment in all applications. Section 2 provides the necessary information to service, repair, and maintain the family of Puron (R-410A) air conditioners and heat pumps. Section 3 of this manual is an appendix. Use the Table of Contents to locate desired topics.

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SECTION 1—APPLICATION GUIDELINE

INSTALLATION GUIDELINE

Step 1—Residential New Construction

Specifications for this unit in the residential new construction market require the outdoor unit, indoor unit, refrigerant tubing sets, metering device, and filter drier listed in Product Data Sheet (PDS). DO NOT DEVIATE FROM PDS. Consult unit Installation Instructions for detailed information.

Step 2—Add-On Replacement (Retrofit)

Specifications for this unit in the add-on replacement/retrofit market require change-out of outdoor unit, metering device, and all capillary tube coils. Change-out of indoor coil is recommended. There can be no deviation.

1. If system is being replaced due to compressor electrical failure, assume acid is in system. If system is being replaced for any other reason, use approved acid test kit to determine acid level. If even low levels of acid are detected install factory approved, 100% activated alumina suction-line filter drier in addition to the factory supplied liquid-line filter drier. Remove the suction line filter drier as soon as possible, with a maximum of 72 hrs.
2. Drain oil from low points or traps in suction-line and evaporator if they were not replaced.
3. Change out indoor coil or verify existing coil is listed in the Product Data Sheets.
4. → Unless indoor unit is equipped with an Puron (R-410A) approved metering device, change out metering device to factory-supplied or field-accessory device specifically designed for Puron (R-410A).
5. Replace outdoor unit with Puron (R-410A) outdoor unit.
6. Install factory-supplied liquid-line filter drier.

⚠ WARNING

Never install a suction-line filter drier in the liquid-line of a Puron (R-410A) system. Failure to follow this warning can cause a fire, personal injury, or death.

7. If suction-line filter drier was installed for system clean up, operate system for 10 hr. Monitor pressure drop across drier. If pressure drop exceeds 3 psig, replace suction-line and liquid-line filter driers. Be sure to purge system with dry nitrogen and evacuate when replacing filter driers. Continue to monitor pressure drop across suction-line filter drier. After 10 hr of run time, remove suction-line filter drier and replace liquid-line filter drier. **Never leave suction-line filter drier in system longer than 72 hr (actual time).**
8. Charge system. (See unit information plate.)

Step 3—Seacoast (For Air Conditioners Only)

Installation of these units in seacoast locations requires the use of a coastal filter. (See section on cleaning.)

ACCESSORY DESCRIPTIONS

Refer to Table 1 for an Accessory Usage Guide for Puron (R-410A) Air Conditioners and Table 2 for Puron (R-410A) Heat Pumps. Refer to the appropriate section below for a description of each accessory and its use.

Step 1—Compressor Crankcase Heater

→ An electric heater which mounts to base of compressor to keep lubricant warm during off cycles. Improves compressor lubrication on restart and minimizes chance of refrigerant slugging and oil pumpout. The crankcase heater may or may not include a thermostat control. For units equipped with crankcase heaters, apply power for 24 hrs before starting compressor.

Step 2—Evaporator Freeze Thermostat

An SPST temperature activated switch stops unit operation when evaporator reaches freeze-up conditions.

Step 3—Winter Start Control

An SPST delay relay which bypasses the low-pressure switch for approximately 3 minutes to permit start up for cooling operation under low-load conditions.

Step 4—Compressor Start Assist—PTC

Solid-state electrical device which gives a "soft" boost to the compressor at each start.

Step 5—Compressor Start Assist-Capacitor/Relay

Start capacitor and start relay gives "hard" boost to compressor motor at each start. Required with Liquid Line Solenoid or hard shutoff TXV for all Series A equipment.

Table 1—Required Field-Installed Accessories for Puron (R-410A) Air Conditioners

ACCESSORY	ORDERING NUMBER	REQUIRED FOR LOW-AMBIENT APPLICATIONS (BELOW 55°F)	REQUIRED FOR LONG-LINE APPLICATIONS (50-175 FT)	REQUIRED FOR SEACOAST APPLICATIONS (WITHIN 2 MILES)
Crankcase Heater	KAACH1201AAA	Yes	Yes	No
Evaporator Freeze Thermostat	KAAFT0101AAA	Yes	No	No
Winter Start Control	KAAWS0101AAA	Yes	No	No
Compressor Start Assist—PTC	KAACS0201PTC	Yes	Yes	No
or				
Compressor Start Assist—Capacitor/Relay	KSAHS1501AAA KSAHS1601AAA			
Low-Ambient Controller	P251-0083 (RCD)	Yes	No	No
or				
MotorMaster® Control	32LT660004 (RCD)*			
or				
Low-Ambient Pressure Switch	KSALA0301410			
Wind Baffle	N/A	Yes	No	No
Coastal Filter	KAACF0201MED	No	No	Yes
Support Feet	KSASF0101AAA	Recommended	No	Recommended
Puron (R-410A) Hard Shutoff TXV		No	Yes	No

* Fan motor with ball bearings required.

Table 2—Required Field-Installed Accessories for Puron (R-410A) Heat Pumps

ACCESSORY	ORDERING NUMBER	REQUIRED FOR LOW-AMBIENT COOLING APPLICATIONS (BELOW 55°F)	REQUIRED FOR LONG-LINE APPLICATIONS (50-175 FT)
Crankcase Heater	KAACH1201AAA	Yes	Yes
Evaporator Freeze Thermostat	KAAFT0101AAA	Yes	No
Compressor Start Assist—Capacitor and Relay	KSAHS1501AAA KSAHS1601AAA	Yes	Yes
Puron (R-410A) Low-Ambient Pressure Switch	KSALA0301410	Yes	No
Wind Baffle	N/A	Yes	No
Support Feet	KSASF0101AAA	Recommended	No
Puron (R-410A) Hard Shutoff TXV	KSATX0201HSZ KSATX0301HSZ KSATX0401HSZ KSATX0501HSZ	Yes*	Yes*
Puron (R-410A) Liquid-Line Solenoid Valve for Heating	KHALA0401AAA	No	Yes

* Required for all applications.

Step 6—Low-Ambient Controller

→ Low-ambient controller is a cycle control device activated by a temperature sensor mounted on a header tube of the outdoor coil. It is designed to cycle the outdoor fan motor in order to maintain condensing temperature within normal operating limits (approximately 100°F high, and 60°F low). The control will maintain working head pressure at low-ambient temperatures down to 0°F when properly installed.

→ Step 7—MotorMaster® Control

A fan speed control device activated by a temperature sensor. It is designed to control condenser fan motor speed in response to the saturated, condensing temperature during operation in cooling mode only. For outdoor temperature down to -20°F, it maintains condensing temperature at 100°F ± 10°F. Requires a ball bearing fan motor.

→ Step 8—Low-Ambient Pressure Switch

A long life pressure switch which is mounted to outdoor unit service valve. It is designed to cycle the outdoor fan motor in response to condenser pressure in cooling mode in order to maintain head pressure within normal operating limits (approximately 200 psig to 365 psig). The control will maintain working head pressure at low-ambient temperatures down to 0°F when properly installed.

Step 9—Wind Baffle

A field-fabricated sheet metal cover used to stop prevailing winds or where outdoor ambient temperature is less than 55°F during unit operation of cooling mode.

Step 10—Coastal Filter (Air Conditioner Only)

A mesh screen inserted under top cover and inside base pan to protect condenser coil from salt damage without restricting airflow.

Step 11—Support Feet

Four adhesive plastic feet which raise unit 4 in. above mounting pad. This allows sand, dirt, and other debris to be flushed from unit base; minimizes corrosion.

Step 12—Liquid Line Solenoid Valve

An electrically operated shutoff valve to be installed at outdoor or indoor unit (depending on tubing configuration) which stops and starts refrigerant liquid flow in response to compressor operation. Maintains a column of refrigerant liquid ready for action at next compressor operation cycle. Requires Compressor Start Assist - Capacitor and Relay. Do not use with TXV.

→ Step 13—Thermostatic Expansion Valve

A modulating flow control device which meters refrigerant flow rate into the evaporator in response to the superheat of the refrigerant gas leaving the evaporator. Puron (R-410A) TXVs are hard shutoff only. Only use factory specified TXV's. Requires Compressor Start Assist - Capacitor and Relay. Do not use with Liquid Line Solenoid Valve.

LOW-AMBIENT GUIDELINE

→ The minimum operating temperature for these units in cooling mode is 55°F outdoor ambient without additional accessories. This equipment may be operated in cooling mode at ambient temperatures below 55°F when the accessories listed in Table 1 or 2 are installed. Wind baffles are required when operating in cooling mode at ambients below 55°F. Refer to Fig. 1 for wind baffle construction details.

LONG-LINE GUIDELINE

This guideline provides the required system changes for the Puron (R-410A) air conditioner having piping requirements greater than 50 ft or installations where indoor unit is located above and/or below outdoor unit, by more than 20 ft. This guide is intended to cover applications outside standard Installation Instructions.

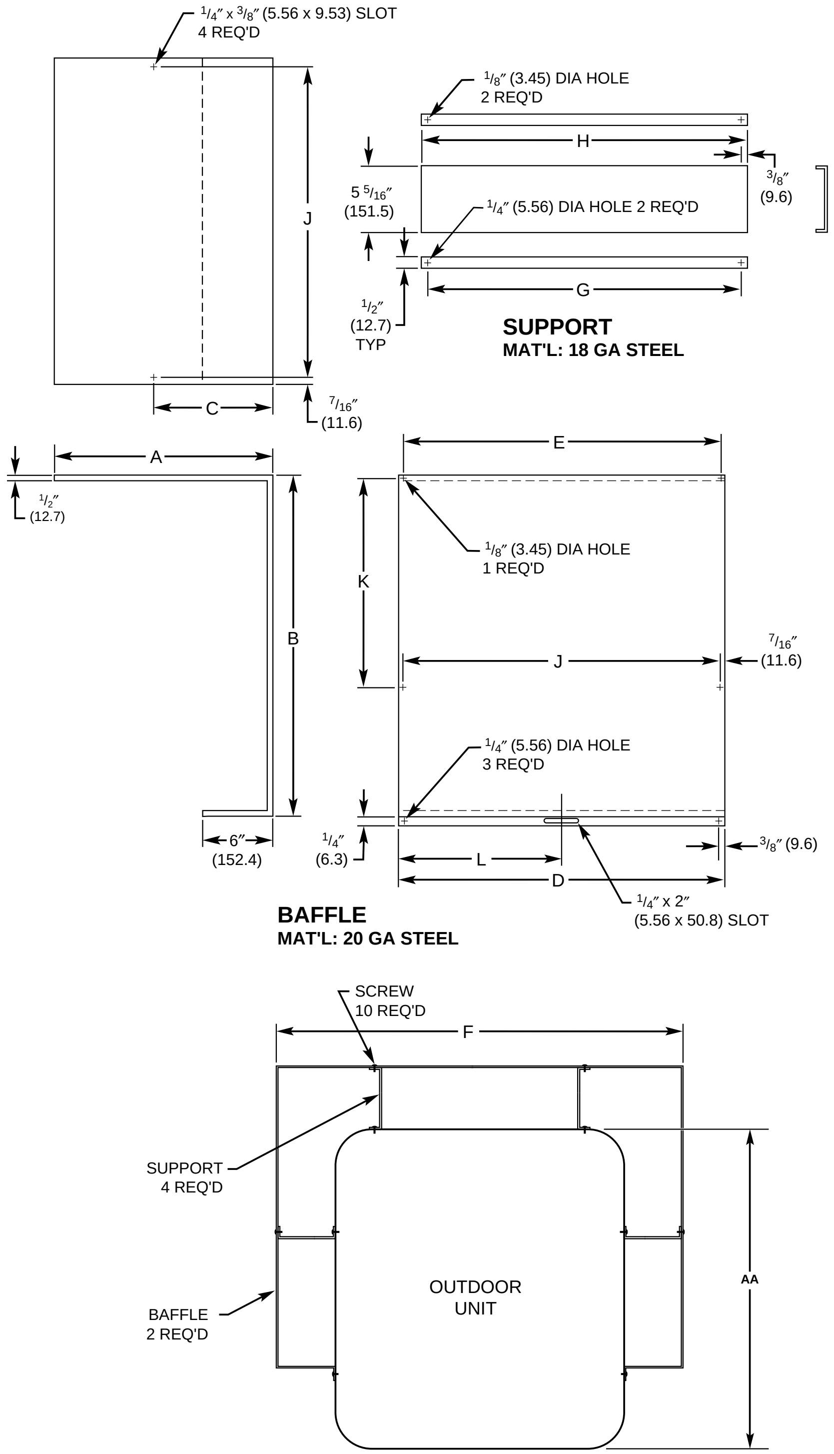
→ All air conditioners and heat pumps require a hard shutoff TXV, a compressor start capacitor and relay, and a crankcase heater in long-line installations.

Step 1—Interconnecting Tubing

→ Table 3a lists the required interconnecting vapor line diameters for heat pumps. Puron systems installed in long-line applications must use **only 3/8-in. liquid lines**. Equivalent line lengths equal the linear length (measured) of the interconnecting vapor tubing plus losses due to elbows. (See Table 4 and Fig. 3.) Table 3B provides estimated percentage of nominal cooling capacity losses based on standard required vapor line size versus what is selected for long-line application.
Refer to outdoor unit presale literature for the required vapor line diameter.

Calculate linear length of vapor tube required, adding any losses for total number of elbows for application. (See Table 4.) Using this equivalent length, select desired vapor line size from Table 3B. Subtract nominal percentage loss from outdoor unit presale literature Detailed Cooling Capacities for given indoor/outdoor combination. Reference all notes of Table 3B.

NOTE: When specifying the vapor line insulation, be aware of the following standard practice.



BAFFLE ASSEMBLY

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Dimensions (In.)

UNIT SIZE	AA	UNIT HEIGHT	A	B	C	D	E	F	G	H	J	K	L
Small	26-3/16	23-13/16	17-1/4	24-5/16	10-1/4	19-3/4	20-1/2	34-1/2	19-5/8	20-3/8	19-5/8	0	0
		27-13/16	17-1/4	24-5/16	10-1/4	23-3/4	24-1/2	34-1/2	23-5/8	24-3/8	23-5/8	0	11-7/8
		33-13/16	17-1/4	24-5/16	10-1/4	29-3/4	30-1/2	34-1/2	29-5/8	30-3/8	29-5/8	0	14-7/8
Medium	33	27-13/16	21	30-5/8	10-1/4	23-3/4	24-1/2	42	23-5/8	24-3/8	23-5/8	17-1/8	11-7/8
		33-13/16	21	30-5/8	10-1/4	29-3/4	30-1/2	42	29-5/8	30-3/8	29-5/8	17-1/8	14-7/8
		39-13/16	21	30-5/8	10-1/4	35-3/4	36-1/2	42	35-5/8	36-3/8	35-5/8	17-1/8	17-7/8
Large	42-1/16	33-13/16	25-5/16	39-3/4	10-1/4	29-3/4	30-1/2	50-9/16	29-5/8	30-3/8	29-5/8	21-11/16	14-7/8
		39-13/16	25-5/16	39-3/4	10-1/4	35-3/4	36-1/2	50-9/16	35-5/8	36-3/8	35-5/8	21-11/16	17 7/8

Fig. 1—Wind Baffle Construction/Dimensions

Table 3a—Refrigerant Connections and Recommended Liquid and Vapor Tube Diameters (Heat Pumps)

UNIT SIZE	CONNECTION DIAMETER (IN.)		TUBE DIAMETER (IN.)		TUBE DIAMETER (ALTERNATE) (IN.)	RST TUBE DIAMETERS NOT PERMITTED (IN.)
	Liquid	Vapor	Liquid	Vapor	Vapor	Vapor
024	3/8	5/8	3/8	5/8	3/4 ACR	3/4
030	3/8	3/4	3/8	3/4	7/8	1-1/8
036	3/8	3/4	3/8	3/4	7/8	1-1/8
042, 048	3/8	7/8	3/8	7/8	7/8	3/4 and 1-1/8
060	3/8	7/8	3/8	1-1/8	7/8	3/4

NOTE: 1. Tube diameters are for lengths up to 50 ft. For tubing lengths greater than 50 ft, consult the Application Guideline and Service Manual for Residential Split-System Air Conditioners and Heat Pumps Using R-410 A Refrigerant.
2. Refrigerant tubes and indoor coils must be evacuated to 500 microns to minimize contamination and moisture in the system.

Tubing kits should meet the following recommendations to minimize losses through insulation: 5/8-in. and 3/4-in. tubing kits should be supplied with 3/8-in. insulation; 7/8-in. and 1-1/8-in. tubing kits should be supplied with 1/2-in. insulation. For minimal capacity loss in long-line application, 1/2-in. insulation should be specified.

NOTE: Special consideration must be given to isolating interconnecting tubing from building structure. Isolate tubing so that vibration or noise is not transmitted into structure. (See Fig. 2.)

→ Step 2—Metering Device-Long Line Set

A hard shutoff TXV must be used instead of a piston for an indoor metering device. When sizing an accessory TXV, refer to unit presale literature.

Heat pumps with equivalent lengths over 100 ft must increase outdoor piston one size. No piston change is required for the allowable 30 ft vertical differential.

A liquid-line solenoid must be used for all long-line heat pump applications. The solenoid valve has a flow arrow stamped in the valve body. This flow arrow must point toward the outdoor unit.

Step 3—Tubing Configuration

Fig. 4 through 6 detail the proper installation of equipment and provide applications where accessories may be required. Reference all notes of appropriate figure.

Step 4—Charging Information

Use subcooling charging method. The standard subcooling charging methods can be found in refrigerant system charging section of Service Manual. Since total system charge is increased for long-line application, it is necessary to calculate additional refrigerant charge. The rating plate charge of a given outdoor unit is for a standard application of 15 ft of interconnecting tubing. For line lengths greater than 15 ft, add 0.60 oz of refrigerant per foot of additional line length. The rating plate charge can be found on outdoor unit rating plate or in the outdoor unit presale literature. Long-line applications do not require additional oil charge.

NOTE: Avoid contact between tubing and structure

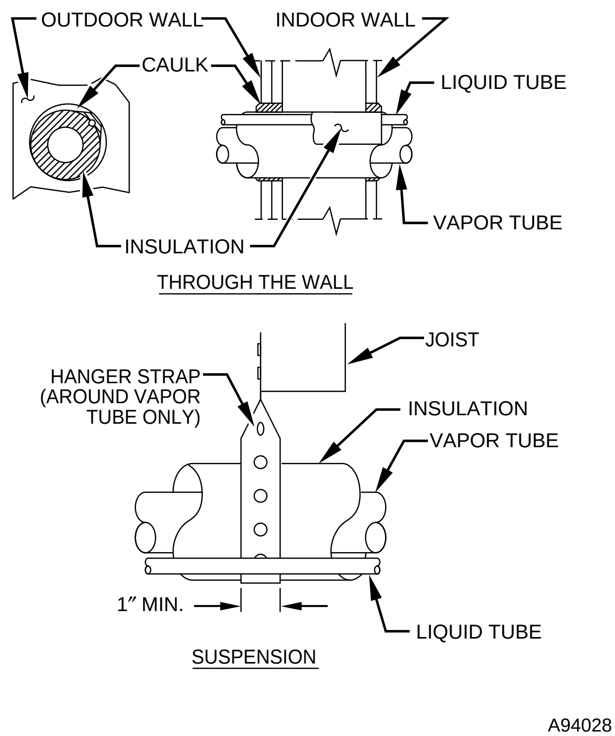

Fig. 2—Tubing Support

→ **NOTE:** Excessive charge will increase risk of refrigerant migration and compressor damage. Charging units with long refrigerant lines must be done carefully to avoid over-charging. Pressure and temperature changes are slower with long lines. Adding or removing charge must be done slowly to allow time for system to stabilize.

Table 3b—Estimated Percentage of Nominal Cooling Capacity Losses

UNIT NOMINAL SIZE (BTU)	STANDARD VAPOR LINE* (IN.)	LONG-LINE VAPOR LINE† (IN.)	PERCENTAGE OF COOLING CAPACITY LOSS (BTU) VERSUS EQUIVALENT LENGTH‡						
			25 Ft	50 Ft	75 Ft	100 Ft	125 Ft	150 Ft	175 Ft
24,000	5/8	5/8	0	1	2	3	4	6	7
		3/4	0	0	0	1	1	2	2
		7/8**	0	0	0	0	0	1	1
30,000	3/4	5/8**	1	2	3	4	5	6	7
		3/4	0	0	1	1	2	2	2
		7/8	0	0	0	0	1	1	1
36,000	3/4	5/8**	1	3	5	6	8	9	11
		3/4	0	1	1	2	3	3	4
		7/8	0	0	0	0	1	1	2
42,000	7/8	3/4**	0	1	2	2	3	4	5
		7/8	0	0	0	1	1	1	2
		1-1/8**	0	0	0	0	0	0	0
48,000	7/8	3/4**	1	1	2	3	2	4	7
		7/8	0	0	1	1	2	3	3
		1-1/8**	0	0	0	0	0	0	1
60,000	1-1/8	3/4**	2	3	5	7	8	10	11
		7/8	1	2	2	3	4	5	6
		1-1/8	0	0	1	1	1	1	2

* Vapor line diameter that may be selected for a long-line application. If smaller vapor lines are selected but not specified within the table, large capacity losses will occur and defrost capacities will be reduced. If larger vapor lines are selected but not specified within the table, refrigerant oil return will be impaired due to velocity losses.
‡ Standard vapor line diameter required per outdoor unit presale literature.
† The estimated percentage of cooling capacity that must be subtracted from Detailed Cooling Capacities specified in outdoor unit presale literature for any given indoor/outdoor combination.
** Air Conditioners Only

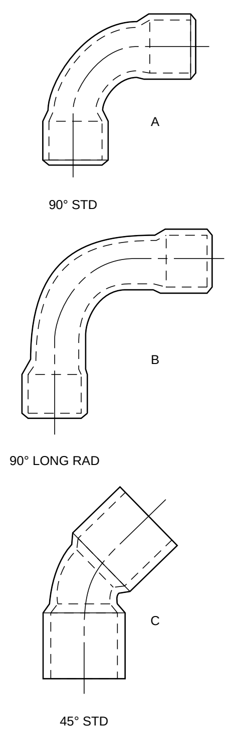

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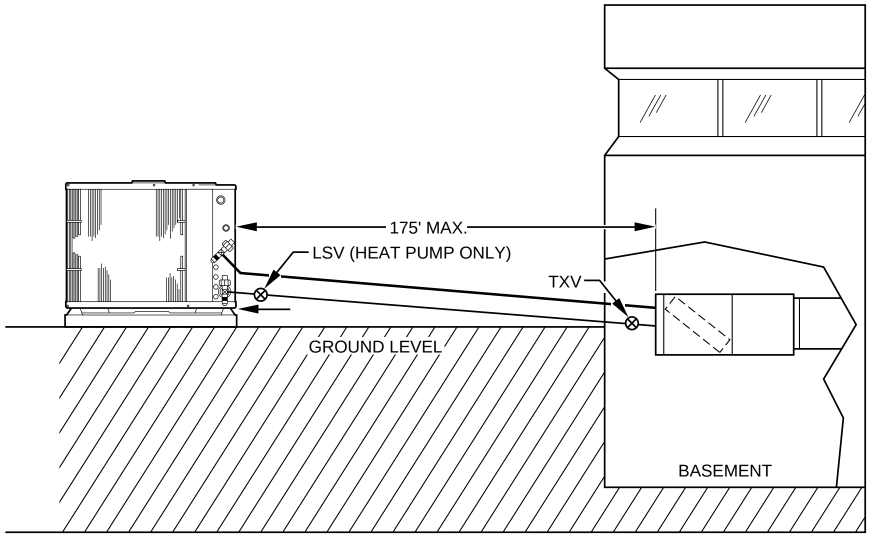
Fig. 3—Tube Bend Losses

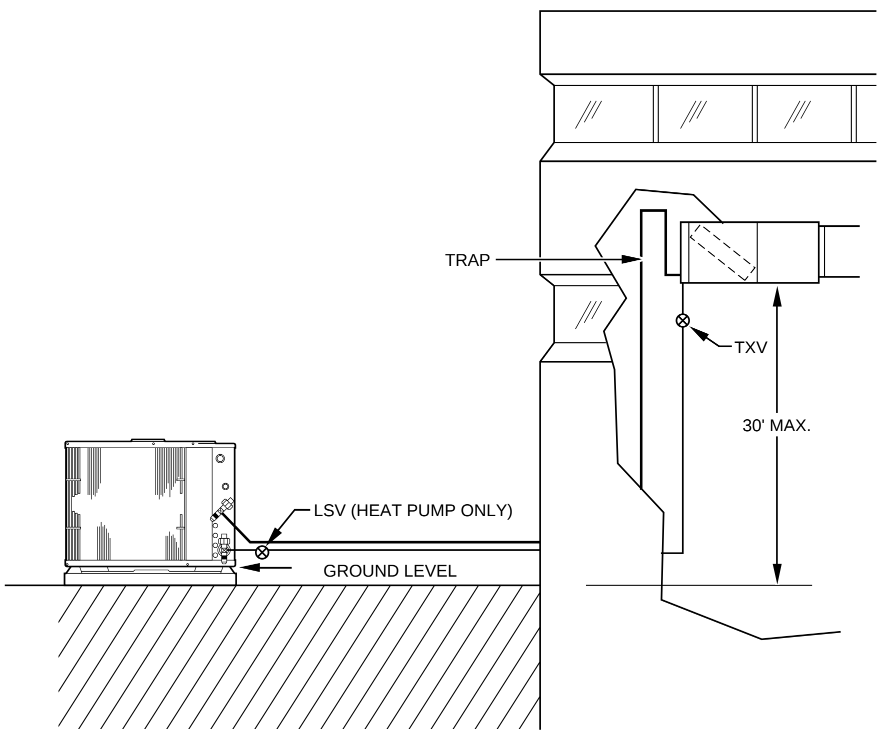
Table 4—Fitting Losses in Equivalent Ft

TUBE SIZE OD (IN.)	REFERENCE DIAGRAM IN FIG. 3		
	A	B	C
5/8	1.6	1.0	0.8
3/4	1.8	1.2	0.9
7/8	2.0	1.4	1.0
1-1/8	2.6	1.7	1.3



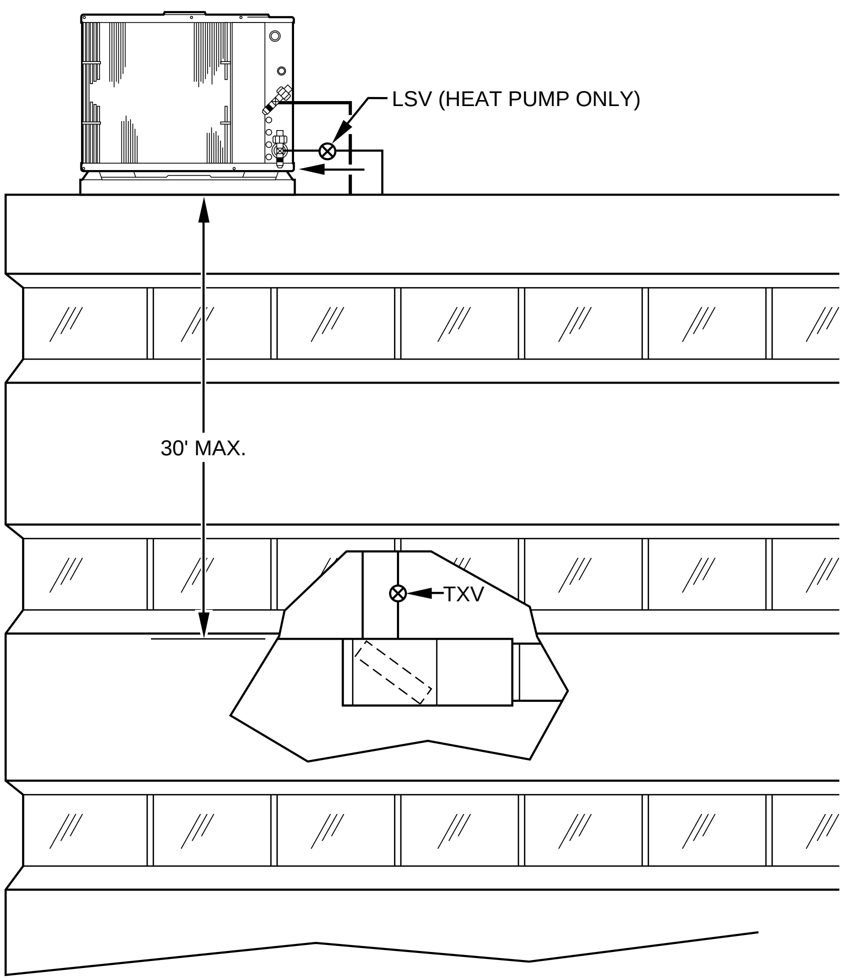
- A hard shutoff TXV must be installed at indoor unit.
- A crankcase heater must be installed on compressor.
- Vapor line should slope toward indoor unit.
- The above requirements provide refrigerant migration protection during off-cycle due to temperature or slight elevation differences between indoor and outdoor units.
- Maximum equivalent line length is 175 ft between indoor and outdoor units.
- Heat Pump Only—Bi-flow liquid-line solenoid must be installed witihn 2 ft of outdoor unit with arrow pointing toward outdoor unit.

Fig. 4—Application with Air Conditioner or Heat Pump Installed in a Horizontal Configuration



- A crankcase heater must be installed on compressor.
- An inverted vapor-line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil.
- The above requirements provide protection against condensed refrigerant collecting in the vapor line.
- Maximum elevation between units is 30 ft. Maximum equivalent total line length is 175 ft.
- Heat Pump Only—Bi-flow liquid-line solenoid must be installed witihn 2 ft of outdoor unit with arrow pointing toward outdoor unit.

Fig. 5—Application with Air Conditioner or Heat Pump Installed with Indoor Unit Above Outdoor Unit



- A crankcase heater must be installed on compressor.
- The above requirements provide protection against refrigerant migration to compressor when outdoor temperature is lower than indoor temperature.
- Maximum elevation between units is 30 ft. Maximum equivalent total line length is 175 ft.
- Heat Pump Only—Bi-flow liquid-line solenoid must be installed witihn 2 ft of outdoor unit with arrow pointing toward outdoor unit.

Fig. 6—Application with Air Conditioner or Heat Pump with Indoor Unit Below Outdoor Unit

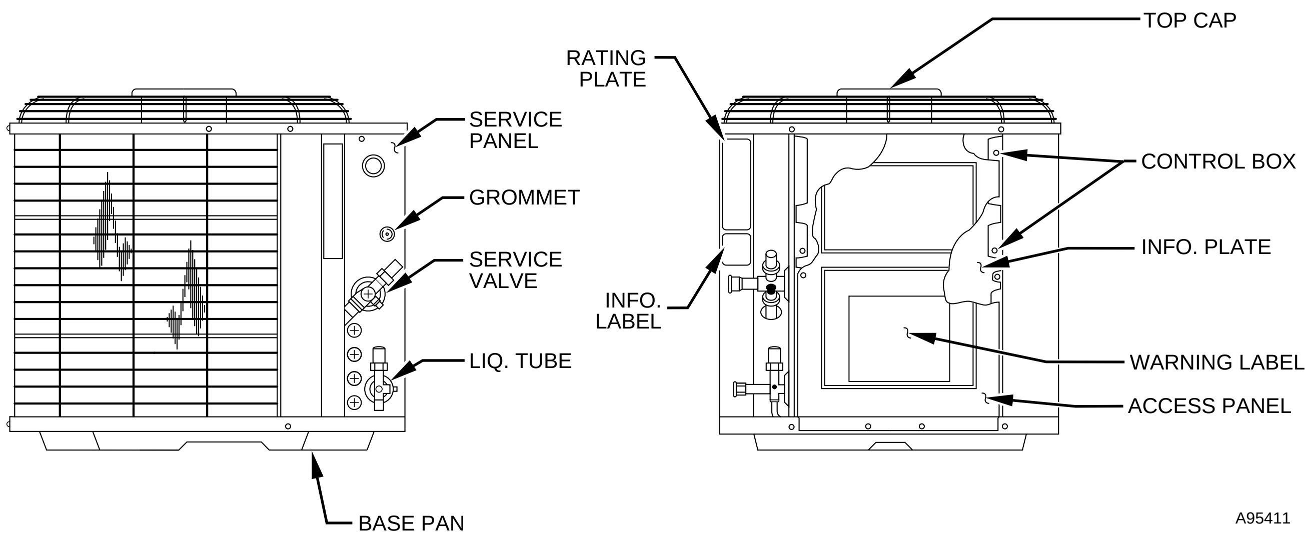


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Fig. 7—Callouts for R-410A Air Conditioner and Heat Pump

⚠ WARNING

→ Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause personal injury, death, or property damage. Consult a qualified installer, service agency or your distributor or branch for information or assistance. The qualified installer or agency must use factory-authorized kits, accessories, or replacement components when modifying this product.

Troubleshooting Charts for Puron (R-410A) Air Conditioners and Heat Pumps are provided in the appendix at back of this manual. They enable the service technician to use a systematic approach to locating the cause of a problem and correcting system malfunctions.

UNIT IDENTIFICATION

This section explains how to obtain the model and serial number from unit rating plate. These numbers are needed to service and repair the Puron (R-410A) air conditioner or heat pump.

Step 1—Model Number Nomenclature

Model number is found on unit rating plate. (See Fig. 8 and 10.)

Step 2—Serial Number Nomenclature

Serial number is found on unit rating plate. (See Fig. 9 and 10.)

CABINET ASSEMBLY

Certain maintenance routines and repairs require removal of cabinet panels.

Step 1—Remove Top Cover

1. Turn off all power to outdoor and indoor units.
2. Remove access panel.
3. Remove information plate.
4. Disconnect fan motor wires and cut wire ties. Remove wires from control box. Refer to unit wiring label.
5. Remove screws holding top cover to coil grille and corner posts.
6. Lift top cover from unit.
7. Reverse sequence for reassembly.

Step 2—Remove Fan Motor Assembly

1. Perform items 1 through 6 from above.
2. Remove nuts securing fan motor to top cover.
3. Remove motor and fan blade assembly.
4. Reverse sequence for reassembly.
5. Prior to applying power, check that fan rotates freely.

Step 3—Information Plate

The information plate is secured to front of control box and provides the control box cover. (See Fig. 10.) This plate also provides a surface to attach the wiring schematic, superheat charging tables with instructions, and warning labels. The plate has 2 tabs on top edge that are bent down at slightly more than 90°. When information plate is removed, these tabs can be inserted into 2 mating slots in bottom front edge of control box and plate will hang down forming a lower front panel. (See Fig. 11.) This is convenient when access to controls is required while unit is operating. The information plate on small size casing completely covers opening below the control box. On larger models information plate may not cover entire opening. In this instance, access panel can be removed and placed on its side to cover additional space.

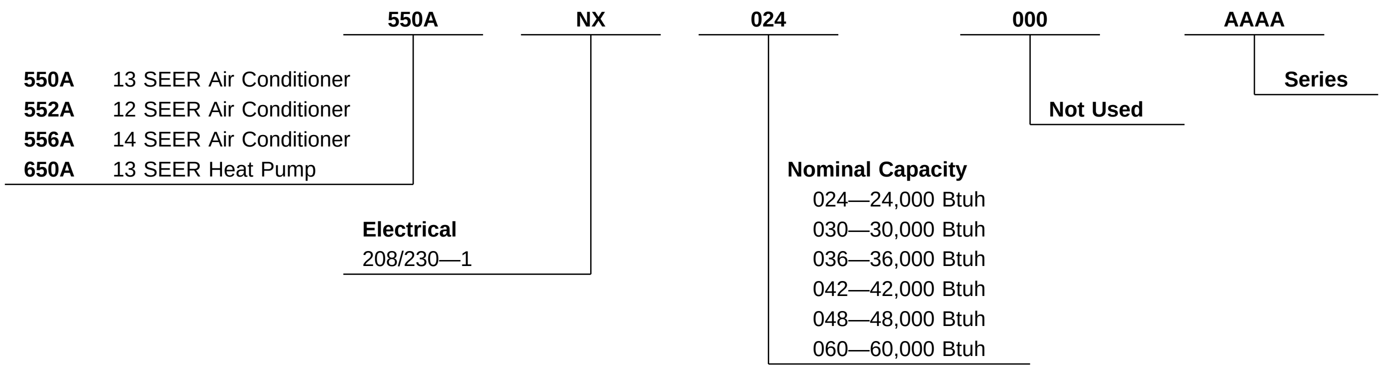

Fig. 8—Model Number Nomenclature

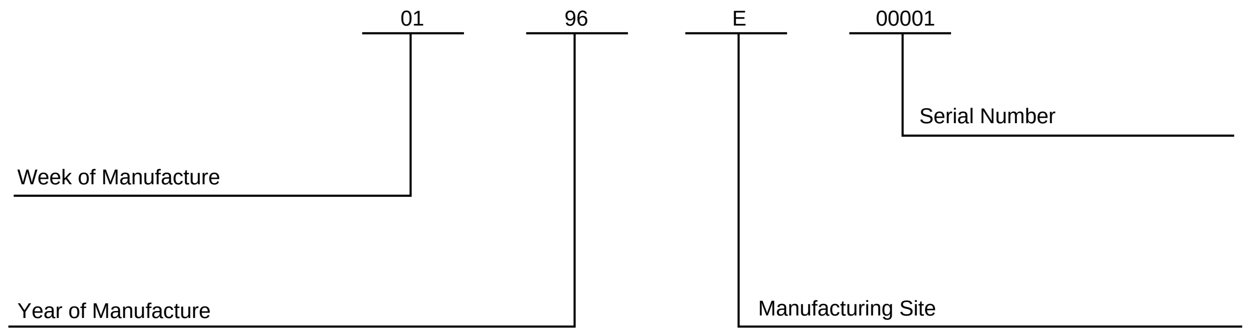

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Fig. 9—Serial Number Nomenclature

ELECTRICAL

⚠ WARNING

Exercise extreme caution when working on any electrical components. Shut off all power to system prior to troubleshooting. Some troubleshooting techniques require power to remain on. In these instances, exercise extreme caution to avoid danger of electrical shock. ONLY TRAINED SERVICE PERSONNEL SHOULD PERFORM ELECTRICAL TROUBLESHOOTING. Failure to follow this warning can cause a fire, personal injury, or death.

Step 1—Aluminum Wire

⚠ CAUTION

Aluminum wire may be used in the branch circuit (such as the circuit between the main and unit disconnect), but only copper wire may be used between the unit disconnect and the unit.

Whenever aluminum wire is used in branch circuit wiring with this unit, adhere to the following recommendations.

Connections must be made in accordance with the National Electrical Code (NEC), using connectors approved for aluminum wire. The connectors must be UL approved (marked Al/Cu with the UL symbol) for the application and wire size. The wire size selected must have a current capacity not less than that of the copper wire specified, and must not create a voltage drop between service panel and unit in excess of 2 percent of unit rated voltage. To prepare wire before installing connector, all aluminum wire must be "brush-scratched" and coated with a corrosion inhibiter such as Pentrox A. When it is suspected that connection will be exposed to moisture, it is very important to cover entire connection completely to prevent an electrochemical action that will cause connection to fail very quickly. Do not reduce effective size of wire, such as cutting off strands so that wire will fit a connector. Proper size connectors should be used. Check all factory and field electrical connections for tightness. This should also be done after unit has reached operating temperatures, especially if aluminum conductors are used.

Step 2—Contactor

The contactor provides a means of applying power to unit using low voltage (24v) from transformer in order to power contactor coil. (See Fig. 12.) Depending on unit model, you may encounter single- or double-pole contactors. Exercise extreme caution when troubleshooting as 1 side of line may be electrically energized.

The contactor coil is powered by 24vac. If contactor does not operate:

1. With power off, check whether contacts are free to move. Check for severe burning or arcing on contact points.
2. With power off, use ohmmeter to check for continuity of coil. Disconnect leads before checking. A low resistance reading is normal. Do not look for a specific value, as different part numbers will have different resistance values.
3. Reconnect leads and apply low-voltage power to contactor coil. This may be done by leaving high-voltage power to outdoor unit off and turning thermostat to cooling. Check voltage at coil with voltmeter. Reading should be between 20v and 30v. Contactor should pull in if voltage is correct and coil is good. If contactor does not pull in, replace contactor.
4. With high-voltage power off and contacts pulled in, check for continuity across contacts with ohmmeter. A very low or 0 resistance should be read. Higher readings could indicate burned or pitted contacts which may cause future failures.

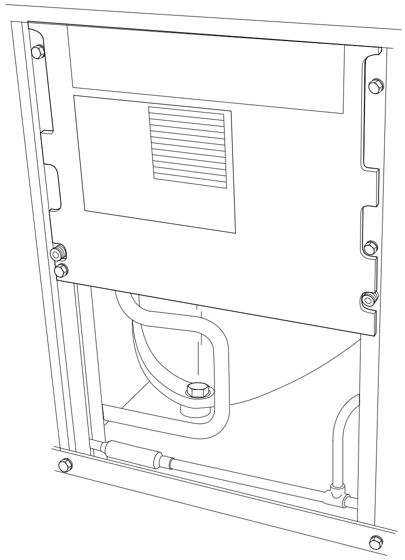

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Fig. 10—Information Plate

Step 3—Capacitor

⚠ WARNING

Capacitors can store electrical energy when power is off. Electrical shock can result if you touch the capacitor terminals and discharge the stored energy. Exercise extreme caution when working near capacitors. With power off, discharge stored energy by shorting across the capacitor terminals with a 15,000-ohm, 2-watt resistor. Failure to follow this warning can cause a fire, personal injury, or death.

NOTE: If bleed resistor is wired across start capacitor, it must be disconnected to avoid erroneous readings when ohmmeter is applied across capacitor. (See Fig. 13.)

⚠ WARNING

Always check capacitors with power off. Attempting to troubleshoot a capacitor with power on can be dangerous. Defective capacitors may explode when power is applied. Insulating fluid inside is combustible and may ignite, causing burns. Failure to follow this warning can cause a fire, personal injury, or death.

Capacitors are used as a phase-shifting device to aid in starting certain single-phase motors. Check capacitors as follows.

1. With power off, discharge capacitors as outlined above. Disconnect capacitor from circuit. Put ohmmeter on R X 10k scale. Using ohmmeter, check each terminal to ground (use capacitor case). Discard any capacitor which measures 1/2 scale deflection or less. Place ohmmeter leads across capacitor and place on R X 10k scale. Meter should jump to a low resistance value and slowly climb to higher value. Failure of meter to do this indicates an open capacitor. If resistance stays at 0 or a low value, capacitor is internally shorted.
2. Capacitance testers are available which will read value of capacitor. If value is not within ± 10 percent value stated on capacitor, it should be replaced. If capacitor is not open or shorted, the capacitance value is calculated by measuring voltage across capacitor and current it draws.

⚠ WARNING

Exercise extreme caution when taking readings while power is on. Electrical shock can cause personal injury or death.

Use following formula to calculate capacitance:

$$\text{Capacitance (mfd)} = \frac{2650 \text{ X amps}}{\text{volts}}$$

3. Remove any capacitor that shows signs of bulging, dents, or leaking. Do not apply power to a defective capacitor as it may explode.

Step 4—PTC Devices

Sometimes under adverse conditions, a standard run capacitor in a system is inadequate to start compressor. In these instances, a start assist device is used to provide an extra starting boost to compressor motor. This device is called a positive temperature coefficient (PTC) or thermistor. (See Fig. 14.) It is a resistor wired in parallel with the run capacitor. As current flows through the PTC at start-up, it heats up. As PTC heats up, its resistance increases greatly until it effectively lowers the current through itself to an extremely low value. This, in effect, removes the PTC from the circuit.

After system shutdown, resistor cools and resistance value returns to normal until next time system starts. Thermistor device is adequate for most conditions, however, in systems where off cycle is short, device cannot fully cool and becomes less effective as a start device. It is an easy device to troubleshoot. Shut off all power to system.

Check thermistor with ohmmeter as described below. Shut off all power to unit. Remove PTC from unit. Wait at least 10 minutes for PTC to cool to ambient temperature.

Measure resistance of PTC with ohmmeter as shown in Fig. 14.

The cold resistance (RT) of any PTC device should be approximately 100-180 percent of device ohm rating.

12.5-ohm PTC = 12.5-22.5 ohm resistance - beige color

If PTC resistance is appreciably less than rating or more than 200 percent higher than rating, device is defective.

Step 5—Cycle Protector

Solid-state cycle protector protects unit compressor by preventing short cycling. After a system shutdown, cycle protector provides for a 5 ± 2-minute delay before compressor restarts. On normal start-up, a 5-minute delay occurs before thermostat closes. After thermostat closes, cycle protector device provides a 3-sec delay. (See Fig. 15, 16, and 17.)

Cycle protector is simple to troubleshoot. Only a voltmeter capable of reading 24v is needed. Device is in control circuit, therefore, troubleshooting is safe with control power (24v) on and high-voltage power off.

With high-voltage power off, attach voltmeter leads across T1 and T3, and set thermostat so that Y terminal is energized. Make sure all protective devices in series with Y terminal are closed. Voltmeter should read 24v across T1 and T3. With 24v still applied, move voltmeter leads to T2 and T3. After 5 ± 2 minutes, voltmeter should read 24v, indicating control is functioning normally. If no time delay is encountered or device never times out, change control.

Step 6—Crankcase Heater

Crankcase heater is a device for keeping compressor oil warm. By keeping oil warm, refrigerant does not migrate to and condense in compressor shell when the compressor is off. This prevents flooded starts which can damage compressor.

On units that have a single-pole contactor, the crankcase heater is wired in parallel with contactor contacts and in series with compressor. (See Fig. 18.) When contacts open, a circuit is completed from line side of contactor, through crankcase heater, through run windings of compressor, and to other side of line. When contacts are closed, there is no circuit through crankcase heater because both leads are connected to same side of line. This allows heater to **operate** when system **is not** calling for cooling. The heater **does not operate** when system **is** calling for cooling.

The crankcase heater is powered by high-voltage power of unit. Use extreme caution troubleshooting this device with power on. The easiest method of troubleshooting is to apply voltmeter across crankcase heater leads to see if heater has power. Do not touch heater. Carefully feel area around crankcase heater. If warm, crankcase heater is probably functioning. Do not rely on this method as absolute evidence heater is functioning. If compressor has been running, the area will still be warm.

With power off and heater leads disconnected, check across leads with ohmmeter. Do not look for a specific resistance reading. Check for resistance or an open circuit. Change heater if an open circuit is detected.

Step 7—Time-Delay Relay

The TDR is a solid-state control, recycle delay timer which keeps indoor blower operating for 90 sec after thermostat is satisfied. This delay enables blower to remove residual cooling in coil after compression shutdown, thereby improving efficiency of system. The sequence of operation is that on closure of wall thermostat and at end of a fixed on delay of 1 sec, fan relay is energized. When thermostat is satisfied, an off delay is initiated. When fixed delay of 90 ± 20 sec is completed, fan relay is de-energized and fan motor stops. If wall thermostat closes during this delay, TDR is reset and fan relay remains energized. TDR is a 24-v device that operates within a range of 15v to 30v and draws about 0.5 amps.

If the blower runs continuously instead of cycling off when the fan switch is set on AUTO, the TDR is probably defective and must be replaced.

Step 8—Pressure Switches

Pressure switches are protective devices wired into control circuit (low voltage). They shut off compressor if abnormally high or low pressures are present in the refrigeration circuit. These pressure switches are specifically designed to operate with Puron (R-410A) systems. R-22 pressure switches must **not** be used as replacements for the Puron (R-410A) air conditioner. Puron pressure switches are identified by a pink stripe down each wire.

LOW-PRESSURE SWITCH (AIR CONDITIONER ONLY)

The low-pressure switch is located on suction line and protects against low suction pressures caused by such events as loss of charge, low airflow across indoor coil, dirty filters, etc. It opens on a pressure drop at about 50 psig. If system pressure is above this, switch should be closed.

To check switch:

1. Turn off all power to unit.
2. Disconnect leads on switch.
3. Apply ohmmeter leads across switch. You should have continuity on a good switch.

NOTE: Because these switches are attached to refrigeration system under pressure, it is not advisable to remove this device for troubleshooting unless you are reasonably certain that a problem exists. If switch must be removed, remove and recover all system charge so that pressure gages read 0 psi. Never open system without breaking vacuum with dry nitrogen.

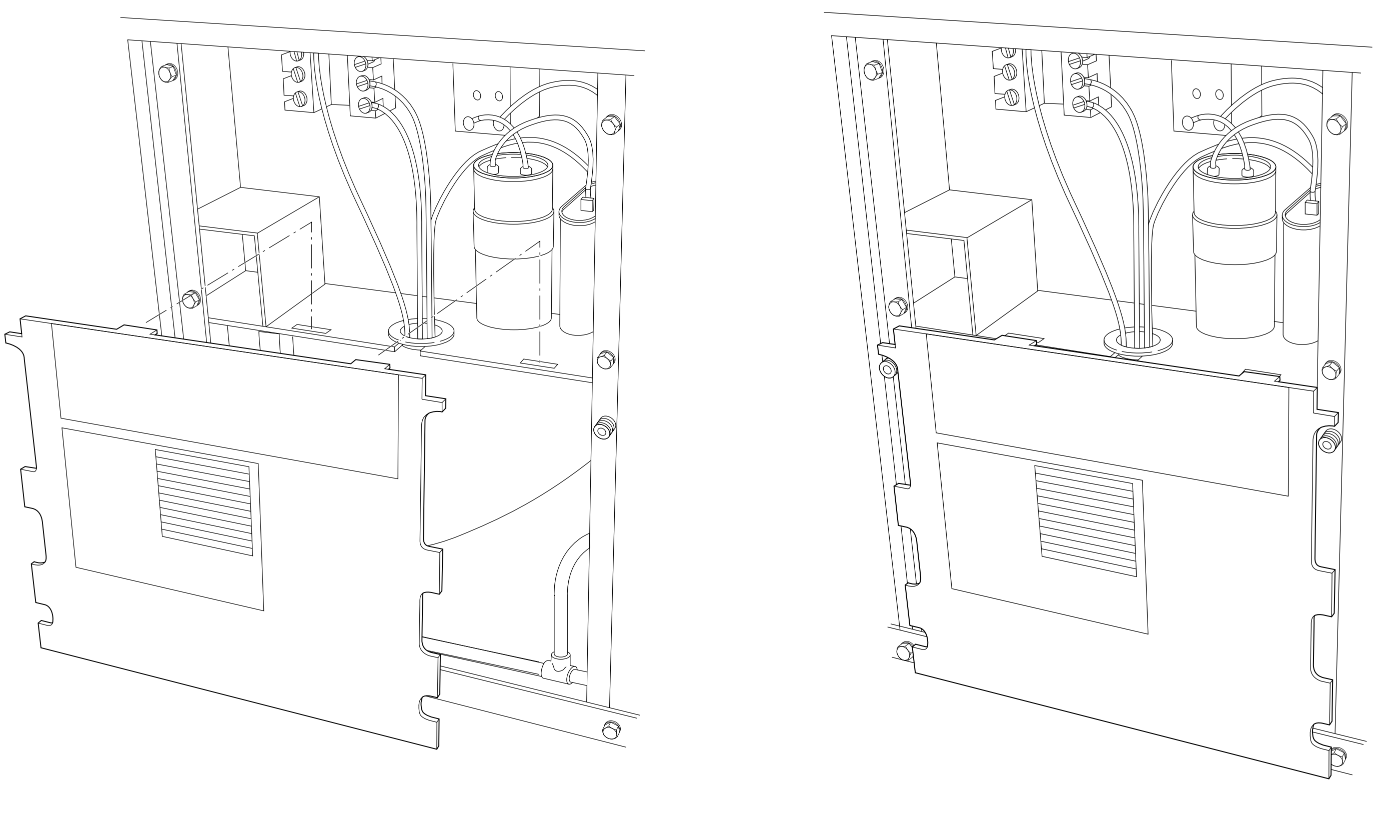

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Fig. 11—Information Plate Removed/Installed Below Control Box

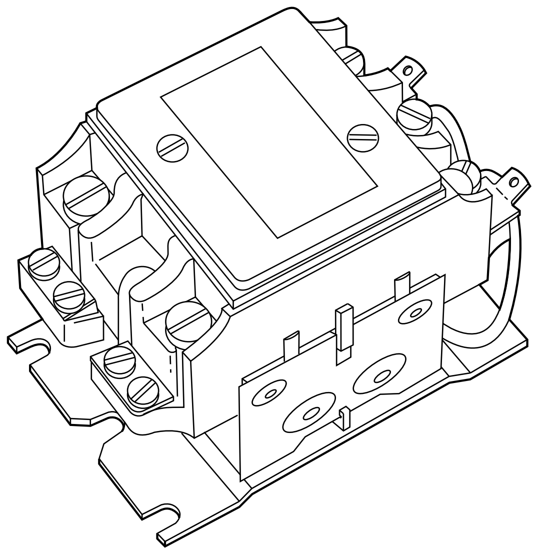

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Fig. 12—Contactor

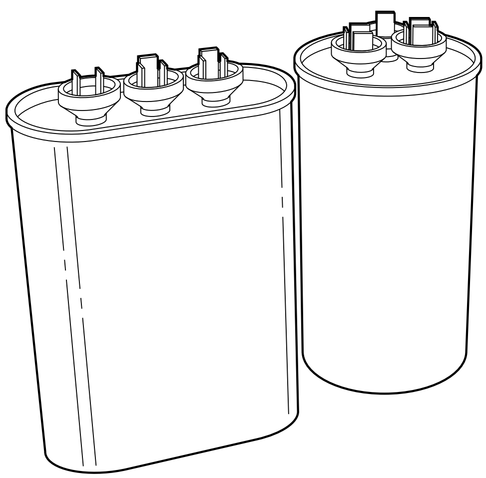

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Fig. 13—Capacitor

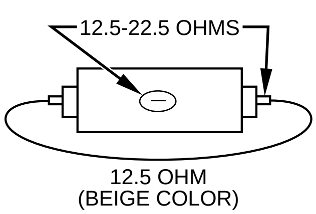

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Fig. 14—PTC Device

⚠ CAUTION

Wear safety glasses and gloves when working with refrigerants.

To replace switch:

1. Apply heat with torch to solder joint and remove switch.

⚠ CAUTION

Wear safety glasses when using torch. Have quenching cloth available. Oil vapor in line may ignite when switch is removed.

2. Braze in 1/4-in. flare fitting and screw on replacement pressure switch.

HIGH-PRESSURE SWITCH

The high-pressure switch is located in liquid line and protects against excessive condenser coil pressure. It opens at 610 psig. High pressure may be caused by a dirty condenser coil, failed fan motor, or condenser air recirculation.

To check switch:

1. Turn off all power to unit.
2. Disconnect leads on switch.
3. Apply ohmmeter leads across switch. You should have continuity on a good switch.

NOTE: Because these switches are attached to refrigeration system under pressure, it is not advisable to remove this device for troubleshooting unless you are reasonably certain that a problem exists. If switch must be removed, remove and recover all system charge so that pressure gages read 0 psi. Never open system without breaking vacuum with dry nitrogen.

⚠ WARNING

Wear safety glasses and gloves when working with refrigerants.

To replace switch:

1. Apply heat with torch to solder joint and remove switch.

⚠ CAUTION

Wear safety glasses when using torch. Have quenching cloth available. Oil vapor in line may ignite when switch is removed.

2. Braze in 1/4-in. flare fitting and replace pressure switch.

→ LOSS OF CHARGE SWITCH (HEAT PUMP ONLY)

Located on liquid line of heat pump only, the liquid line pressure switch functions similar to conventional low-pressure switch. Because heat pumps experience very low suction pressures during normal system operation, a conventional low-pressure switch cannot be installed on suction line. This switch is installed in liquid line instead and acts as loss-of-charge protector. The liquid line is the low side of the system in heating mode. It operates identically to low-pressure switch except it opens at 23 psi. Troubleshooting and removing this switch is identical to procedures used on other switches. Observe same safety precautions.

→ PRESSUREGUARD™ HEATING VAPOR PRESSURE SWITCH

This outdoor unit is equipped with a heating vapor pressure limiting device which cycles the outdoor fan at high ambient heating conditions.

Because Puron (R-410A) is a high-pressure refrigerant, this switch provides maximum flexibility and minimum cost for the installer/owner by not requiring special thicker wall vapor tubing and indoor coils, thus allowing limited retrofit. The use of this switch also allows the maximum number of indoor coil choices at minimum cost for the installer/owner, since it can use standard refrigeration tubing.

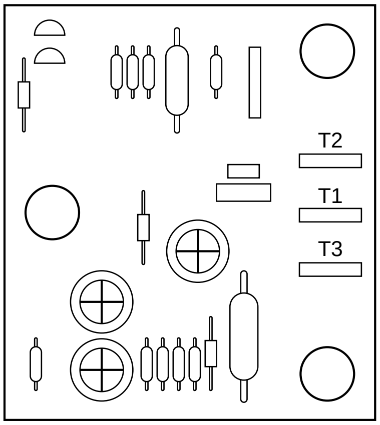

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Fig. 15—Cycle Protector Device

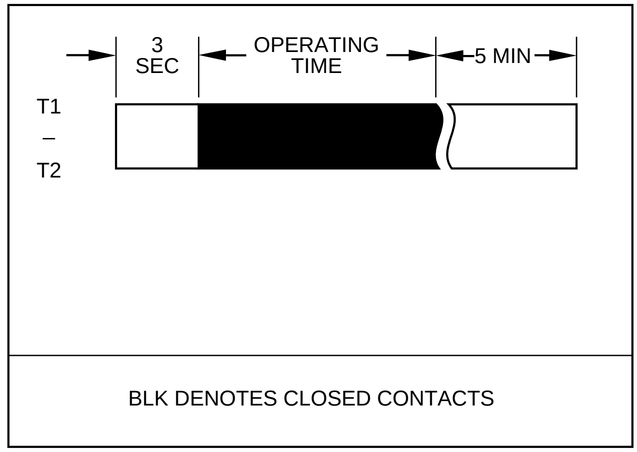

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Fig. 16—Cycle Protector Sequence

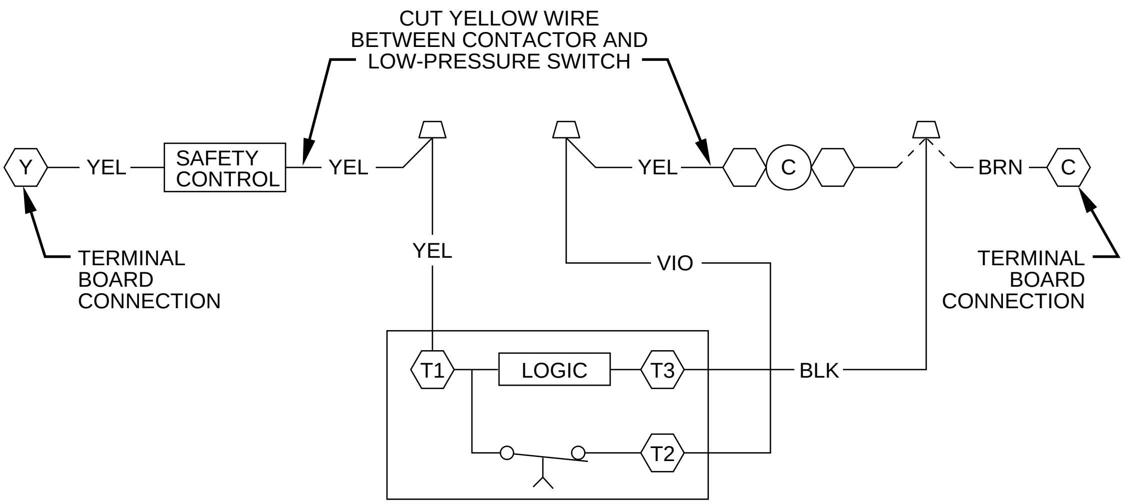

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Fig. 17—Cycle Protector Wiring

The effect of outdoor fan cycling on the HSPF (Heating Seasonal Performance Factor) is minimal due to its occurance at outdoor ambients where building load is very low.

The exact ambient which the outdoor fan cycles depends on the indoor unit size, indoor airflow (including restricted filter and/or coil), refrigerant charge and AccuRater®.

If PresureGuard™ cycles at unsatisfactory low outdoor ambients, check each of the following items.

Ensure ARI approved indoor/outdoor combination is used.

Check for proper airflow per the Product Data Sheets. Airflow may be drastically affected by dirty filters, dirty coils, poor duct work and/or poor duct design.

Check refrigerant charge. If in doubt about the proper charge, recharge the unit by the ″weigh-in″ method if ambient temperature does not allow checking the charge by subcooling method in cooling mode.

Check to ensure the proper outdoor AccuRater® is installed according to the rating plate or the Long Line Guideline.

NOTE: Due to the presence of a vapor pressure switch in outdoor unit fan circuit and the possibility of fan cycling, this unit may go into brief defrost at high ambient heating conditions.

Step 9—Check Defrost Thermostat

There is a liquid header with a brass distributer and feeder tube going into outdoor coil. At the end of 1 of the feeder tubes, there is a 3/8-in. OD stub tube approximately 3 in. long. (See Fig. 19.) The defrost thermostat should be located on stub tube. Note that there is only 1 stub tube used with liquid header, and on most units it is the bottom circuit.

Step 10—Defrost Thermostats

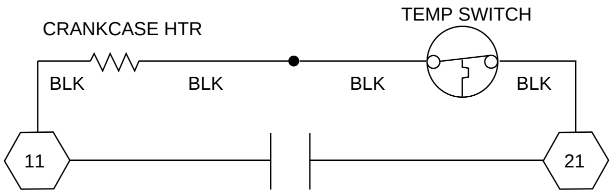
Defrost thermostat signals heat pump that conditions are right for defrost or that conditions have changed to terminate defrost. It is a thermally actuated switch clamped to outdoor coil to sense its temperature. Normal temperature range is closed at 30° ± 3°F and open at 80° ± 5°F.

NOTE: The defrost thermostat must be located on the liquid side of the outdoor coil on the bottom circuit and as close to the coil as possible.

Step 11—Defrost Control Board

Solid-state defrost boards used on heat pumps replace electromechanical timer and defrost relay found on older defrost systems. The defrost control board can be field set to check need for defrost every 30, 50, or 90 minutes of operating time by connecting the jumper (labeled W1 on the circuit board) to the terminal for the defrost time desired. The board is set at factory for 90 minutes. The defrost period is field selectable, depending upon geographic areas and defrost demands.

Troubleshooting defrost control involves a series of simple steps that indicate whether or not board is defective.



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→ **Fig. 18—Wiring for Single-Pole Contactor**

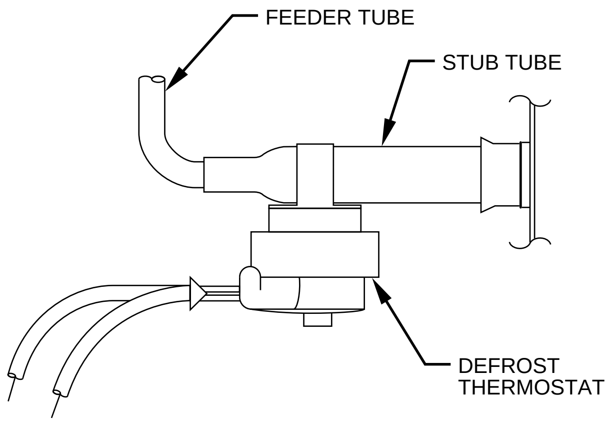

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Fig. 19—Defrost Thermostat Location

NOTE: This procedure allows the service technician to check control board and defrost thermostat for defects. First, troubleshoot to make sure unit operates properly in heating and cooling modes. This ensures operational problems are not attributed to the defrost control board.

Step 12—CES0110063 Defrost Control

All heat pumps in this line use the CES0110063 defrost control. This control board has a connector plug with stripped wire leads. It also contains a feature that allows the heat pump to restart in defrost if the room thermostat is satisfied during defrost. The board also contains a 5-minute cycle protector that prevents the unit from short cycling after it cycles off or after a power interruption. To troubleshoot the board, perform the following items:

1. Turn thermostat to OFF. Shut off all power to outdoor unit.
2. Remove control box cover for access to electrical components and defrost control board.
3. Disconnect defrost thermostat leads from control board, and connect to ohmmeter. Thermostat leads are the black, insulated wires connected to DFT and R terminals on control board. Resistance reading may be zero (indicating closed defrost thermostat), or infinity (∞ for open thermostat) depending on outdoor temperature.
4. Jumper between DFT and R terminals on control board as shown in Fig. 20.
5. Disconnect outdoor fan motor lead from OF2. Tape lead to prevent grounding.
6. Turn on power to outdoor unit.
7. Restart unit in heating mode, allowing frost to accumulate on outdoor coil.
8. After a few minutes in heating mode, liquid line temperature at defrost thermostat should drop below closing set point of defrost thermostat of approximately 30°F. Check resistance across defrost thermostat leads using ohmmeter. Resistance of zero indicates defrost thermostat is closed and operating properly.
9. Short between the speed-up terminals using a thermostat screwdriver. This reduces the timing sequence to 1/256 of original time. (See Fig. 20 and Table 5.)

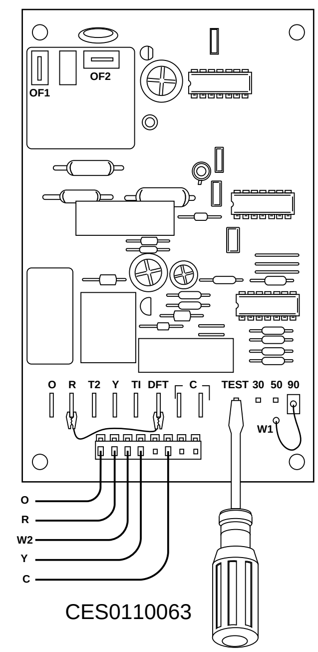

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Fig. 20—CES0110063 Defrost Control

Table 5—Defrost Control Speed-Up Timing Sequence

PARAMETER	MINIMUM (MINUTES)	MAXIMUM (MINUTES)	SPEED-UP (NOMINAL)
30-minute cycle	27	33	7 sec
50-minute cycle	45	55	12 sec
90-minute cycle	81	99	21 sec
10-minute cycle	9	11	2 sec
5 minutes	4.5	5.5	1 sec

NOTE: Since Fig. 19 shows timing cycle set at 90 minutes, unit initiates defrost within approximately 21 sec. When you hear the reversing valve change position, remove screwdriver immediately. Otherwise, control will terminate normal 10-minute defrost cycle in approximately 2 sec.

⚠ CAUTION

Exercise extreme caution when shorting speed-up pins. If pins are accidentally shorted to other terminals, damage to the control board will occur.

10. Unit is now operating in defrost mode. Check between C and W2 using voltmeter as shown in Fig. 21.

Reading on voltmeter should indicate 24v. This step ensures defrost relay contacts have closed, energizing supplemental heat (W2) and reversing valve solenoid (O).

11. Unit should remain in defrost no longer than 10 minutes. Actual time in defrost depends on how quickly speed-up jumper is removed. If it takes 2 sec to remove speed-up jumper after unit has switched to defrost, the unit will switch back to heat mode.
12. After a few minutes in defrost (cooling) operation, liquid line should be warm enough to have caused defrost thermostat contacts to open. Check resistance across defrost thermostat.

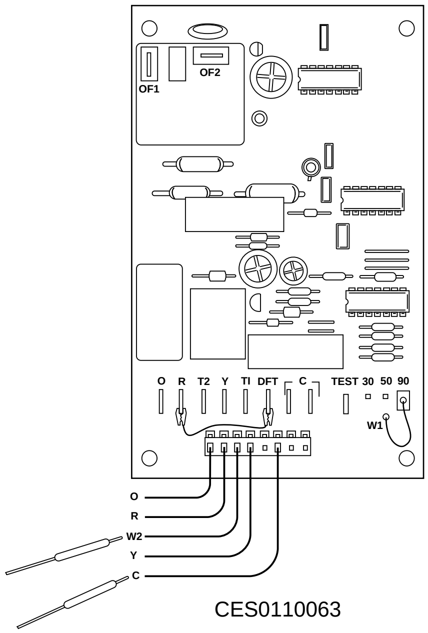

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Fig. 21—Checking Between C and W2

Ohmmeter should read infinite resistance, indicating defrost thermostat has opened at approximately 80°F.

13. Shut off unit power and reconnect fan lead.
14. Remove jumper between DFT and R terminals. Reconnect defrost thermostat leads. Failure to remove jumper causes unit to switch to defrost every 30, 50, or 90 minutes and remain in defrost for full 10 minutes.
15. Replace control box cover. Restore power to unit.

If defrost thermostat does not check out following above items or incorrect calibration is suspected, check for a defective thermostat as follows:

1. Follow items 1-5 above.
2. Route sensor or probe underneath coil (or other convenient location) using thermocouple temperature measuring device. Attach to liquid line near defrost thermostat. Insulate for more accurate reading.
3. Turn on power to outdoor unit.
4. Restart unit in heating.
5. Within a few minutes, liquid line temperature drops within a range causing defrost thermostat contacts to close. Temperature range is from 33°F to 27°F. Notice temperature at which ohmmeter reading goes from ∞ to zero ohms. Thermostat contacts close at this point.
6. Short between the speed-up terminals using a small slotted screwdriver.
7. Unit changes over to defrost within 21 sec (depending on timing cycle setting). Liquid line temperature rises to range where defrost thermostat contacts open. Temperature range is from 75°F to 85°F. Resistance goes from zero to ∞ when contacts open.
8. If either opening or closing temperature does not fall within above ranges or thermostat sticks in 1 position, replace thermostat to ensure proper defrost operation.

Step 13—Fan Motor

Fan motor rotates fan blade that draws air through outdoor coil to perform heat exchange. Motors are totally enclosed to increase reliability. This also eliminates need for rain shield. For the correct position of fan blade assembly, the fan hub should be flush with the motor shaft. Replacement motors and blades may vary slightly

⚠ WARNING

Turn off all power to unit before servicing or replacing fan motor. Be sure unit main power switch is turned off. Failure to do so may result in electric shock, death, or injury from rotating fan blade.

The bearings are permanently lubricated, therefore, no oil ports are provided.

For suspected electrical failures, check for loose or faulty electrical connections, or defective fan motor capacitor. Fan motor is equipped with thermal overload device in motor windings which may open under adverse operating conditions. Allow time for motor to cool so device can reset. Further checking of motor can be done with an ohmmeter. Set scale on R X 1 position, and check for continuity between 3 leads. Replace motors that show an open circuit in any of the windings. Place 1 lead of ohmmeter on each motor lead. At same time, place other ohmmeter lead on motor case (ground). Replace any motor that shows resistance to ground, arcing, burning, or overheating.

Step 14—Compressor Plug

The compressor electrical plug provides a quick-tight connection to compressor terminals. The plug completely covers compressor terminals and mating female terminals are completely encapsulated in plug. Therefore, terminals are isolated from any moisture so corrosion and resultant pitted or discolored terminals are reduced. The plug is oriented to relief slot in terminal box so cover cannot be secured if wires are not positioned in slot, assuring correct electrical connection at the compressor. The plug can be removed by simultaneously pulling while "rocking" plug. However, these plugs are specialized and vary in terminal orientation. Therefore, plugs can be used on only specific compressor. The configuration around the fusite terminals is outline of the terminal covers. The slot through which wires of plug are routed is oriented on the bottom and slightly to the left. The correct plug can be connected easily to compressor terminals and plug wires routed easily through slot in terminal cover.

Step 15—Low-Voltage Terminals

The low-voltage terminal designations and their description/function are used on all split-system condensers.

W—Energizes first-stage supplemental heat through defrost relay (wht).
L—Energizes light on thermostat with service alarm.
W3—Energizes second- or third-stage supplemental heat.

R—Energizes 24-v power from transformer (red).

Y—Energizes contactor for first-stage cooling or first-stage heating for heat pumps (yel).
O—Energizes reversing valve on heat pumps (orn).

C—Common side of transformer (blk).

COPELAND SCROLL COMPRESSOR (PURON REFRIGERANT)

The compressor used in this product is specifically designed to operate with Puron (R-410A) refrigerant and cannot be interchanged.

The compressor is an electrical (as well as mechanical) device. Exercise extreme caution when working near compressors. Power should be shut off, if possible, for most troubleshooting techniques. Refrigerants present additional safety hazards.

⚠ WARNING

Wear safety glasses and gloves when handling refrigerants. Failure to follow this warning can cause a fire, personal injury, or death.

The scroll compressor pumps refrigerant through the system by the interaction of a stationary and an orbiting scroll. (See Fig. 22.) The scroll compressor has no dynamic suction or discharge valves, and it is more tolerant of stresses caused by debris, liquid slugging, and flooded starts. The compressor is equipped with an anti-rotational device and an internal pressure relief port. The anti-rotational device prevents the scroll from turning backwards and replaces the need for a cycle protector. The pressure relief port is a safety device, designed to protect against extreme high pressure. The relief port has an operating range between 550 and 625 psi differential pressure.

The Copeland scroll compressor uses Mobil EAL ARTIC 22CC® oil. The is the only oil allowed for oil recharge. (See Table 6.)

Table 6—Oil Charging

COMPRESSOR PART NO.	COLD RECHARGE OZ.
ZP23-26	38
ZP32-41	42
ZP54	53

Step 1—COMPRESSOR FAILURES

Compressor failures are classified in 2 broad failure categories; mechanical and electrical. Both types are discussed below.

Step 2—MECHANICAL FAILURES

A compressor is a mechanical pump driven by an electric motor contained in a welded or hermetic shell. In a mechanical failure, motor or electrical circuit appears normal, but compressor does not function normally.

⚠ WARNING

Do not supply power to unit with compressor terminal box cover removed. Failure to follow this warning can cause a fire, personal injury, or death.

⚠ WARNING

Exercise extreme caution when reading compressor currents when high-voltage power is on. Correct any of the problems described below before installing and running a replacement compressor. Wear safety glasses and gloves when handling refrigerants. Failure to follow this warning can cause a fire, personal injury, or death.

Locked Rotor

In this type of failure, compressor motor and all starting components are normal. When compressor attempts to start, it draws locked rotor current and cycles off on internal protection. Locked rotor current is measured by applying a clamp-on ammeter around common (blk) lead of compressor. Current drawn when it attempts to start is then measured. Locked rotor amp (LRA) value is stamped on compressor nameplate.

If compressor draws locked rotor amps and all other external sources of problems have been eliminated, compressor must be replaced. Because compressor is a sealed unit, it is impossible to determine exact mechanical failure. However, complete system should be checked for abnormalities such as incorrect refrigerant charge, restrictions, insufficient airflow across indoor or outdoor coil, etc., which could be contributing to the failure.

Table 7—PressureGuard™ Heating Vapor Pressure Switch

STANDARD VAPOR LINE SIZE (IN.)	PART NUMBER*	CUT IN (PSI)	CUT OUT (PSI)
5/8	HK02ZB325	325	400
3/4	HK02ZB309	309	384
7/8	HK02ZB325	325	400
1 1/8	HK02ZB300	300	374

*Use only factory approved Part Numbers

Runs, Does Not Pump

In this type of failure, compressor motor runs and turns compressor, but compressor does not pump refrigerant. A clamp-on ammeter on common leg shows a very low current draw, much lower than rated load amp (RLA) value stamped on compressor nameplate. Because no refrigerant is being pumped, there is no return gas to cool compressor motor. It eventually overheats and shuts off on its internal protection.

Noisy Compressor

Noise may be caused by a variety of internal or external problems such as loosened hardware. System problems such as an overcharged compressor (especially at start-up) may also cause excessive noise.

Electrical Failures

The compressor mechanical pump is driven by an electric motor within its hermetic shell. In electrical failures, compressor does not run although external electrical and mechanical systems appear normal. Compressor must be checked electrically for abnormalities.

Before troubleshooting compressor motor, review this description of compressor motor terminal identification.

Single-Phase Motors

To identify terminals C, S, and R:

1. Turn off all unit power.
2. Discharge run and start capacitors to prevent shock.
3. Remove all wires from motor terminals.
4. Read resistance between all pairs of terminals using an ohmmeter on 0-10 ohm scale.
5. Determine 2 terminals that provide greatest resistance reading.

Through elimination, remaining terminal must be common (C). Greatest resistance between common (C) and another terminal indicates start winding because it has more turns. This terminal is start (S). Remaining terminal will be run winding (R). (See Fig. 21.)

NOTE: If compressor is hot, allow time to cool and internal line break to reset. There is an internal line break protector which must be closed.

NOTE: Ohm readings in Fig. 23 are examples, not actual measurements.

All compressors are equipped with internal motor protection. If motor becomes hot for any reason, protector opens. Compressor should always be allowed to cool and protector to close before troubleshooting. Always turn off all power to unit and disconnect leads at compressor terminals before taking readings.

Most common motor failures are due to either an open, grounded, or short circuit. When a compressor fails to start or run, 3 tests can help determine the problem. First, all possible external causes should be eliminated, such as overloads, improper voltage, pressure equalization, defective capacitor(s), relays, wiring, etc. Compressor has internal line break overload, so be certain it is closed.

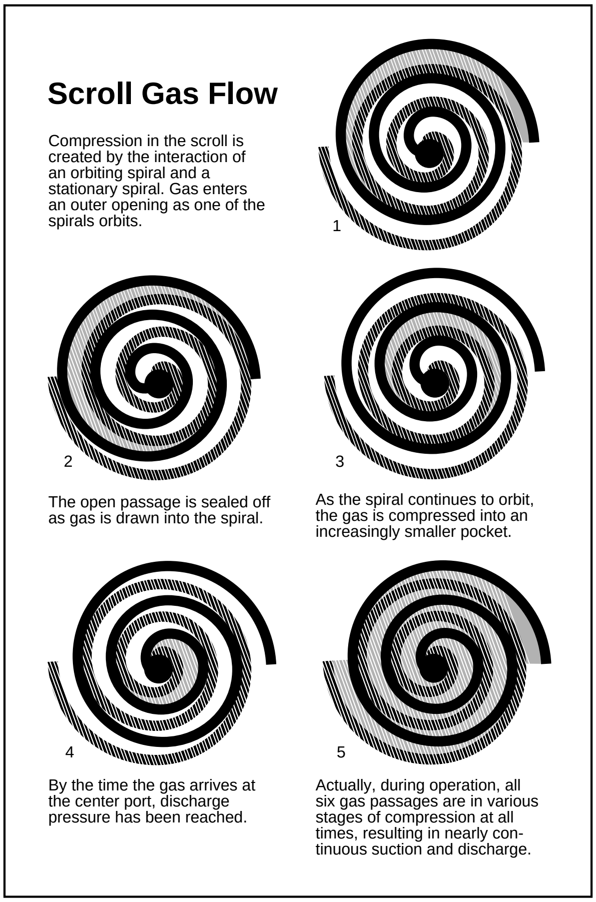

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Fig. 22—Scroll Compressor Refrigerant Flow

Open Circuit

To determine if any winding has a break in the internal wires and current is unable to pass through, follow these steps.

1. Be sure all power is off.
2. Discharge all capacitors.
3. Remove wires from terminals C, S, and R.
4. Check resistance from C-R, C-S, and R-S using an ohmmeter on 0-1000 ohm scale.

Because winding resistances are usually less than 10 ohms, each reading appears to be approximately 0 ohm. If resistance remains at 1000 ohms, an open or break exists and compressor should be replaced.

⚠ CAUTION

Be sure internal line break overload is not temporarily open.

Ground Circuit

To determine if a wire has broken or come in direct contact with shell, causing a direct short to ground follow these steps.

1. Allow crankcase heaters to remain on for several hr before checking motor to ensure windings are not saturated with refrigerant.
2. Using an ohmmeter on R X 10,000 ohm scale or megohmmeter (follow manufacturer's instructions).
3. Be sure all power is off.
4. Discharge all capacitors.
5. Remove wires from terminals C, S, and R.
6. Place 1 meter probe on ground or on compressor shell. Make a good metal-to-metal contact. Place other probe on terminals C, S, and R in sequence.
7. Note meter scale.
8. If reading of 0 or low resistance is obtained, motor is grounded. Replace compressor.

Compressor resistance to ground should not be less than 1000 ohms per volt of operating voltage.

Example:

230 volts X 1000 ohms/volt = 230,000 ohms minimum.

Short Circuit

To determine if any wires within windings have broken through their insulation and made contact with other wires, thereby shorting all or part of the winding(s), be sure the following conditions are met.

1. Correct motor winding resistances must be known before testing, either from previous readings or from manufacturer's specifications.
2. Temperature of windings must be as specified, usually about 70 °F.
3. Resistance measuring instrument must have an accuracy within ± 5-10 percent. This requires an accurate ohmmeter such as a Wheatstone bridge or null balance-type instrument.
4. Motor must be dry or free from direct contact with liquid refrigerant.

Make This Critical Test

(Not advisable unless above conditions are met)

1. Be sure all power is off.
2. Discharge all capacitors.
3. Remove wires from terminals C, S, and R.
4. Place instrument probes together and determine probe and lead wire resistance.
5. Check resistance readings from C-R, C-S, and R-S.
6. Subtract instrument probe and lead resistance from each reading.

If any reading is within ± 20 percent of known resistance, motor is probably normal. Usually a considerable difference in reading is noted if a turn-to-turn short is present.

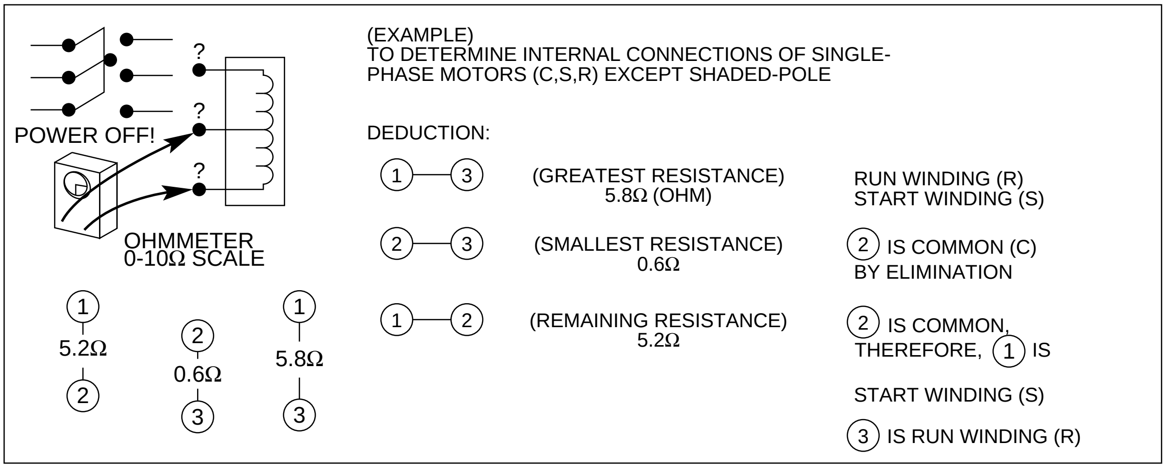
REFRIGERATION SYSTEM

Step 1—Refrigerant

⚠ CAUTION

This system uses Puron (R-410A) refrigerant which has higher pressures than R-22 and other refrigerants. No other refrigerant may be used in this system. Gage set, hoses, and recovery system must be designed to handle Puron. If you are unsure consult the equipment manufacturer.

In an air conditioning and heat pump system, refrigerant transfers heat from one place to another. The condenser is the outdoor coil in the cooling mode and the evaporator is the indoor coil. The condenser is the indoor coil in the heating mode and the evaporator is the outdoor coil. Compressed hot gas leaves the compressor and enters the condensing coil. As gas passes through the condenser coil, it rejects heat and condenses into liquid. The liquid leaves condensing unit through liquid line and enters metering device at



A88344

Fig. 23—Identifying Internal Connections

evaporator coil. As it passes through metering device, it becomes a gas-liquid mixture. As it passes through indoor coil, it absorbs heat and the refrigerant moves to the compressor and is again compressed to a hot gas, and cycle repeats.

Step 2—Compressor Oil

⚠ CAUTION

The compressor in this system uses a polyol ester (POE) oil Mobil EAL ARTIC 22CC. This oil is extremely hygroscopic, meaning it absorbs water readily. POE oils can absorb 15 times as much water as other oils designed for HCFC and CFC refrigerants. Take all necessary precautions to avoid exposure of the oil to the atmosphere.

Step 3—Servicing Systems on Roofs With Synthetic Materials

POE (polyol ester) compressor lubricants are known to cause long term damage to some synthetic roofing materials. Exposure, even if immediately cleaned up, may cause embrittlement (leading to cracking) to occur in one year or more. When performing any service which may risk exposure of compressor oil to the roof, take appropriate precautions to protect roofing. Procedures which risk oil leakage include but are not limited to compressor replacement, repairing refrigerant leaks, replacing refrigerant components such as filter drier, pressure switch, metering device, coil, accumulator, or reversing valve.

SYNTHETIC ROOF PRECAUTIONARY PROCEDURE

1. Cover extended roof working area with an impermeable polyethelene (plastic) drop cloth or tarp. Cover an approximate 10 x 10 ft area.
2. Cover area in front of the unit service panel with a terry cloth shop towel to absorb lubricant spills and prevent run-offs, and protect drop cloth from tears caused by tools or components.
3. Place terry cloth shop towel inside unit immediately under component(s) to be serviced and prevent lubricant run-offs through the louvered openings in the base pan.
4. Perform required service.
5. Remove and dispose of any oil contaminated material per local codes.

Step 4—Brazing

When brazing is required in the refrigeration system, certain basics should be remembered. The following are a few of the basic rules.

1. Clean joints make the best joints. To clean:
   a. Remove all oxidation from surfaces to a shiny finish before brazing.
   b. Remove all flux residue with brush and water while material is still hot.
2. Use "sil-fos" or "phos-copper" for copper-to-copper only. No flux is required.
3. Silver solder is used on copper-to-brass, copper-to-steel, or copper-to-copper. Flux is required when using silver solder. Do not use low temperature solder.
4. Fluxes should be used carefully. Avoid excessive application and do not allow fluxes to enter into the system.
5. Brazing temperature of copper is proper when it is heated to a dull red color.

This section on brazing is not intended to teach a technician how to braze. There are books and classes which teach and refine brazing techniques. The basic points above are listed only as a reminder.

Step 5—Service Valves and Pumpdown

Service valves provide a means for holding original factory charge in outdoor unit prior to hookup to indoor coil. They also contain gage ports for measuring system pressures, and provide shut-off convenience for certain types of repairs. (See Fig. 24.)

The service valve is a combination front seating/back seating valve, which has a metal-to-metal seat in both the open and closed positions. When it is fully back seated, the service port is not pressurized. To pressurize the service port, this valve must be moved off the back seating position. This valve does not contain a Schrader fitting. The service valves are designed for sweat connection to the field tubing.

The service valves in outdoor unit come from factory front seated. This means that refrigerant charge is isolated from line-set connection ports. Heat pumps are shipped with sweat adapter tube. This tube must be installed on the liquid service valve. When checking piston, replace teflon washer. Tighten nut finder tight and then with wrench an additional 1/2 turn (15 ft/lb). **Do not overtighten!** After connecting the sweat adapter to the service valve of a heat pump, the valves are ready for brazing.The interconnecting tubing (line-set) can be brazed to service valves using either silver bearing or non-silver bearing brazing material. Consult local codes. Before brazing line-set to valves, belled ends of sweat connections on service valves must be cleaned so that no brass plating remains on either inside or outside of bell joint. **To**

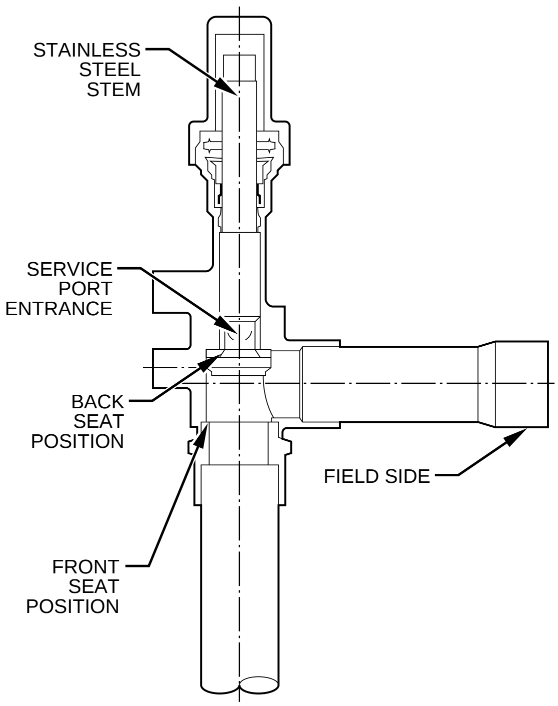


Fig. 24—Service Valve

prevent damage to valve and/or cap "O" ring, use wet cloth or other acceptable heat-sinking material on valve before brazing. To prevent damage to unit, use a metal barrier between brazing area and unit.

After the brazing operation and the refrigerant tubing and evaporator coil have been evacuated, valve stem can be turned counterclockwise until it opens or back seats, which releases refrigerant into tubing and evaporator coil. The system can now be operated.

Back seating service valves must be back seated (turned counterclockwise until seated) before service port caps can be removed and hoses of gage manifold connected. In this position, refrigerant has access from and through outdoor and indoor unit.

The service valve stem cap is tightened to 20 ft/lb torque and service port caps to 9 ± 2 ft/lb torque. The seating surface of valve stem has a knife set edge against which caps are tightened to attain a metal-to-metal seal.

The service valve cannot be field repaired, therefore, only a complete valve or valve stem and service port caps are available for replacement.

If the service valve is to be replaced, a metal barrier must be inserted between the valve and unit to prevent damaging unit exterior from heat of brazing operations.

⚠ WARNING

Wear safety glasses and gloves when handling refrigerants. Failure to follow this warning can cause a fire, personal injury, or death.

Pumpdown Procedure

Service valves provide a convenient shut-off valve useful for certain refrigeration system repairs. System may be pumped down to make repairs on low side without losing complete refrigerant charge.

1. Attach pressure gage to suction service valve gage port.
2. Front seat liquid-line valve.
3. Start unit in cooling mode. Run until low-pressure switch opens at 50 psig (350kPa) or loss of charge switch opens at 23 psig. Do not allow compressor to pump to a vacuum.
4. Shut off unit. Front seat suction valve.
5. Recover remaining refrigerant.

NOTE: All outdoor unit coils will hold only factory-supplied amount of refrigerant. Excess refrigerant, such as in long-line applications, may cause unit to relieve pressure through internal pressure relief valve (indicated by sudden rise of suction pressure) before suction pressure reaches cut out pressure of vapor pressure switch. If this occurs, shut off unit immediately, front seat suction valve, and recover remaining refrigerant.

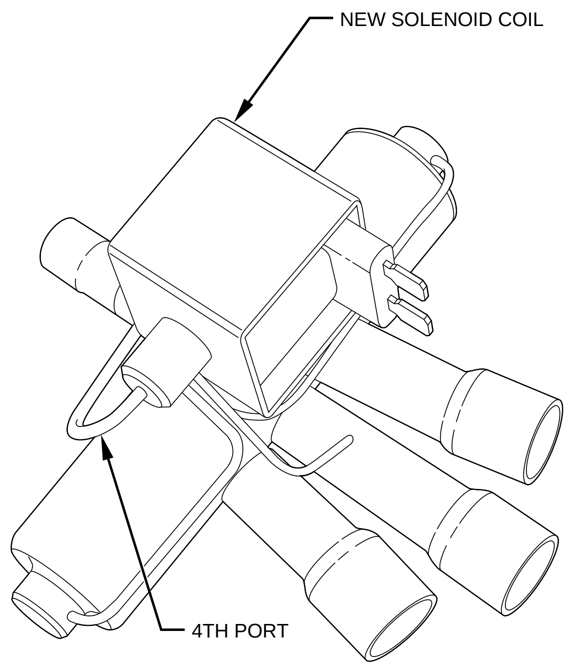


Fig. 25—Reversing Valve

Reversing Valve

In heat pumps, changeover between heating and cooling modes is accomplished with a valve that reverses flow of refrigerant in system. (See Fig. 25.) This reversing valve device is easy to troubleshoot and replace. The reversing valve solenoid can be checked with power off with an ohmmeter. Check for continuity and shorting to ground. With control circuit (24-v) power on, check for correct voltage at solenoid coil. Check for overheated solenoid.

With unit operating, other items can be checked, such as frost or condensate water on refrigerant lines.

The sound made by a reversing valve as it begins or ends defrost is a "whooshing" sound, as the valve reverses and pressures in system equalize. An experienced service technician detects this sound and uses it as a valuable troubleshooting tool.

Using a remote measuring device, check inlet and outlet line temperatures. DO NOT touch lines. If reversing valve is operating normally, inlet and outlet temperatures on appropriate lines should be close. Any difference would be due to heat loss or gain across valve body. Temperatures are best checked with a remote reading electronic-type thermometer with multiple probes. Route thermocouple leads to inside of coil area through service valve mounting plate area underneath coil. Fig. 26 and Fig. 27 show test points (TP) on reversing valve for recording temperatures. Insulate points for more accurate reading.

If valve is defective:

1. Shut off all power to unit and remove all charge from system.
2. Check valve design. If valve is of the 3-port design and new replacement is of the 4-port design, replacement of the solenoid coil and wire leads is necessary. valve bodies are interchangeable, but solenoid and wires are not. Three-port reversing valve and solenoid coil with leads must be used together. New solenoid coil cannot be used on a 3-port valve. Four-port reversing valve uses solenoid with quick-connect terminals for leads connection. Old solenoid coils cannot be used on 4-port reversing valves. If for any reason a new wire cord is not available, cut the leads ont the old solenoid coil as close to the coil as possible. Terminate the leads with 2 female 1/4-in. quick-connects. Connect terminals to new solenoid and tape co
3. Remove solenoid coil from valve body. Remove valve by cutting it from system with tubing cutter. Repair person should cut in such a way that stubs can be easily rebrazed back into system. Do not use hacksaw. This introduces chips into system that cause failure. After defective valve is removed, wrap it in wet rag and carefully unbraze stubs. Save stubs for future use. Because defective valve is not overheated, it can be analyzed for cause of failure when it is returned.
4. Braze new valve onto used stubs. Keep stubs oriented correctly. Scratch corresponding matching marks on old valve and stubs and on new valve body to aid in lining up new valve properly. When brazing stubs into valve, protect valve body with wet rag to prevent overheating.
5. Use slip couplings to install new valve with stubs back into system. Even if stubs are long, wrap valve with a wet rag to prevent overheating.
6. After valve is brazed in, check for leaks. Evacuate and charge system. Operate system in both modes several times to be sure valve functions properly.

Step 6—Liquid Line Filter Drier

The filter drier is specifically designed to operate with Puron, use only factory-authorized components. Filter drier must be replaced whenever the refrigerant system is opened. When removing a filter drier, use a tubing cutter to cut the drier from the system. **Do not unsweat a filter drier** from the system. Heat from unsweating will release moisture and contaminants from drier into system.

Step 7—Suction Line Filter Drier

The suction line drier is specifically designed to operate with Puron, use only factory authorized components. Suction line filter drier is used in cases where acid might occur, such as burnout. Heat pump units must have the drier installed between the compressor and accumulator only. Remove after 10 hours of operation. Never leave suction line filter drier in a system longer than 72 hours (actual time).

Step 8—Accumulator

The accumulator is specifically designed to operate with Puron, use only factory-authorized components. Under some light load conditions on indoor coils, liquid refrigerant is present in suction gas returning to compressor. The accumulator stores liquid and allows it to boil off into a vapor so it can be safely returned to compressor. Since a compressor is designed to pump refrigerant in its gaseous state, introduction of liquid into it could cause severe damage or total failure of compressor.

The accumulator is a passive device which seldom needs replacing. Occasionally its internal oil return orifice or bleed hole may become plugged. Some oil is contained in refrigerant returning to compressor. It cannot boil off in accumulator with liquid refrigerant. The bleed hole allows a small amount of oil and refrigerant to enter the return line where velocity of refrigerant returns it to compressor. If bleed hole plugs, oil is trapped in accumulator, and compressor will eventually fail from lack of lubrication. If bleed hole is plugged, accumulator must be changed. The accumulator has a fusible element located in the bottom end bell. (See Fig. 28.) This fusible element will melt at 430° F and vent the refrigerant if this temperature is reached either internal or external to the system. If fuse melts, the accumulator must be replaced.

To change accumulator:

1. Shut off all power to unit.

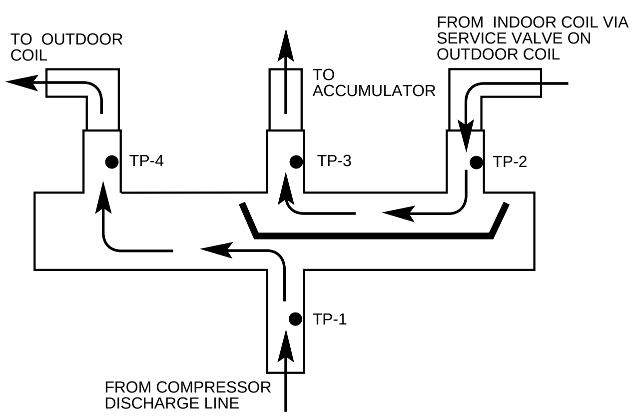


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Fig. 26—Reversing Valve (Cooling Mode or Defrost Mode, Solenoid Energized)

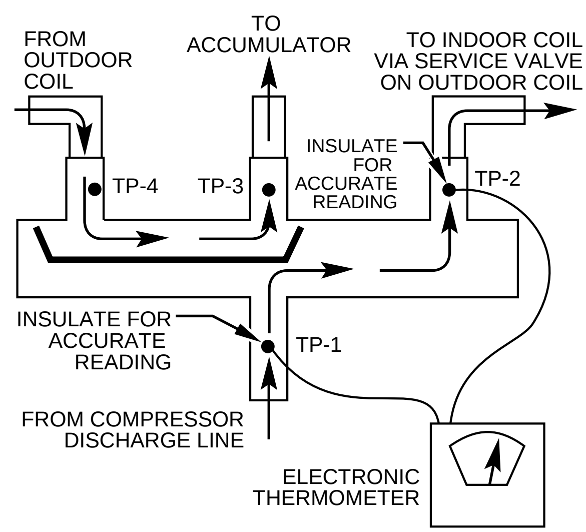

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Fig. 27—Reversing Valve (Heating Mode, Solenoid De-Energized)

2. Recover all refrigerant from system.
3. Break vacuum with dry nitrogen. Do not exceed 5 psig.

NOTE: Coil may be removed for access to accumulator. Refer to appropriate sections of Service Manual for instructions.

⚠ WARNING

Wear safety glasses and gloves when working on refrigerants and when using brazing torch. Failure to follow this warning can cause a fire, personal injury, or death.

4. Remove accumulator from system with tubing cutter.
5. Tape ends of open tubing.
6. Scratch matching marks on tubing stubs and old accumulator. Scratch matching marks on new accumulator. Unbraze stubs from old accumulator and braze into new accumulator.
7. Thoroughly rinse any flux residue from joints and paint with corrosion-resistant coating such as zinc-rich paint.
8. Install factory authorized accumulator into system with copper slip couplings.
9. Evacuate and charge system.

Pour and measure oil quantity (if any) from old accumulator. If more than 20 percent of oil charge is trapped in accumulator, add new POE oil to compressor to make up for this loss. (See Table 6.)

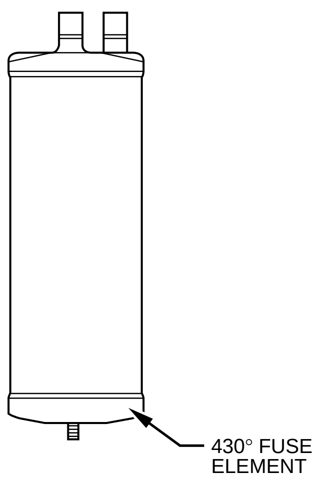

Fig. 28—Accumulator

Step 9—AccuRater®

AccuRater® piston has a refrigerant metering hole through it. The retainer forms a sealing surface for liquid-line flare connection. Any R-22 piston must be replaced with factory approved piston for Puron. If air conditioner is shipped with a piston ring (located in piston bag) be sure it is installed per Fig. 29. The piston ring will ensure piston stays seated during all operating conditions. For Heat Pumps, piston ring not used at outdoor piston. To check, clean, or replace piston follow these steps. (See Fig. 30.)

1. Shut off power to unit.
2. Pump unit down using pumpdown procedure described in this service manual.
3. Loosen nut and remove liquid line flare connection from AccuRater®.
4. Pull retainer out of body, being careful not to scratch flare sealing surface. If retainer does not pull out easily, carefully use locking pliers to remove it.
5. Slide piston and piston ring out by inserting a small soft wire with small kinks through metering hole. Do not damage metering hole, sealing surface around piston cones, or fluted portion of piston.
6. Clean piston refrigerant metering hole.
7. Install a new retainer O-ring, retainer assembly, or teflon washer before reassembling AccuRater®.

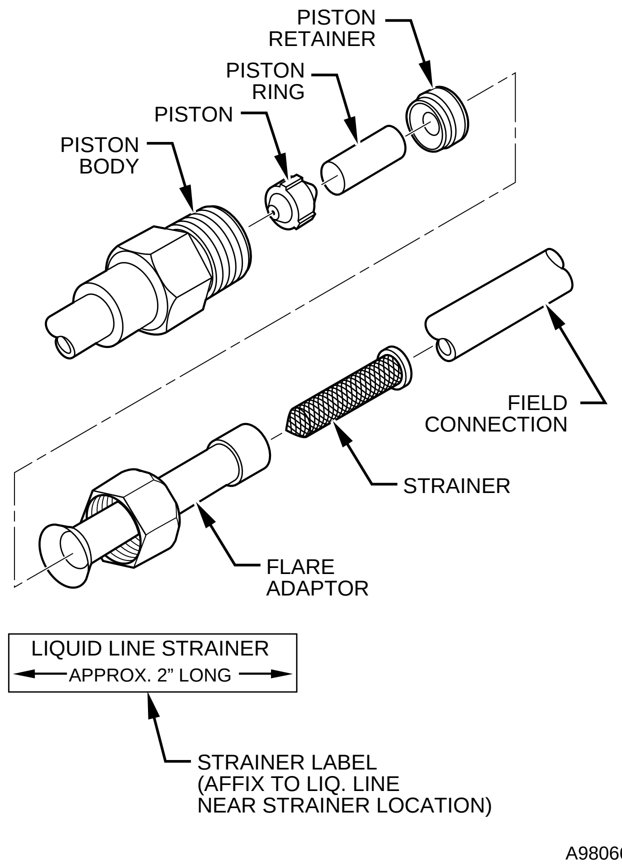

Fig. 29—Air Condioner AccuRater® Components

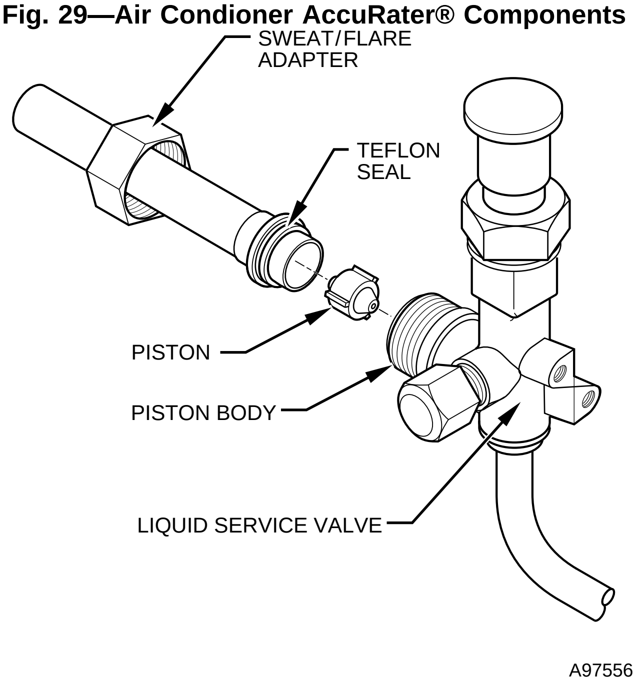

Fig. 30—Heat Pump AccuRater® Components

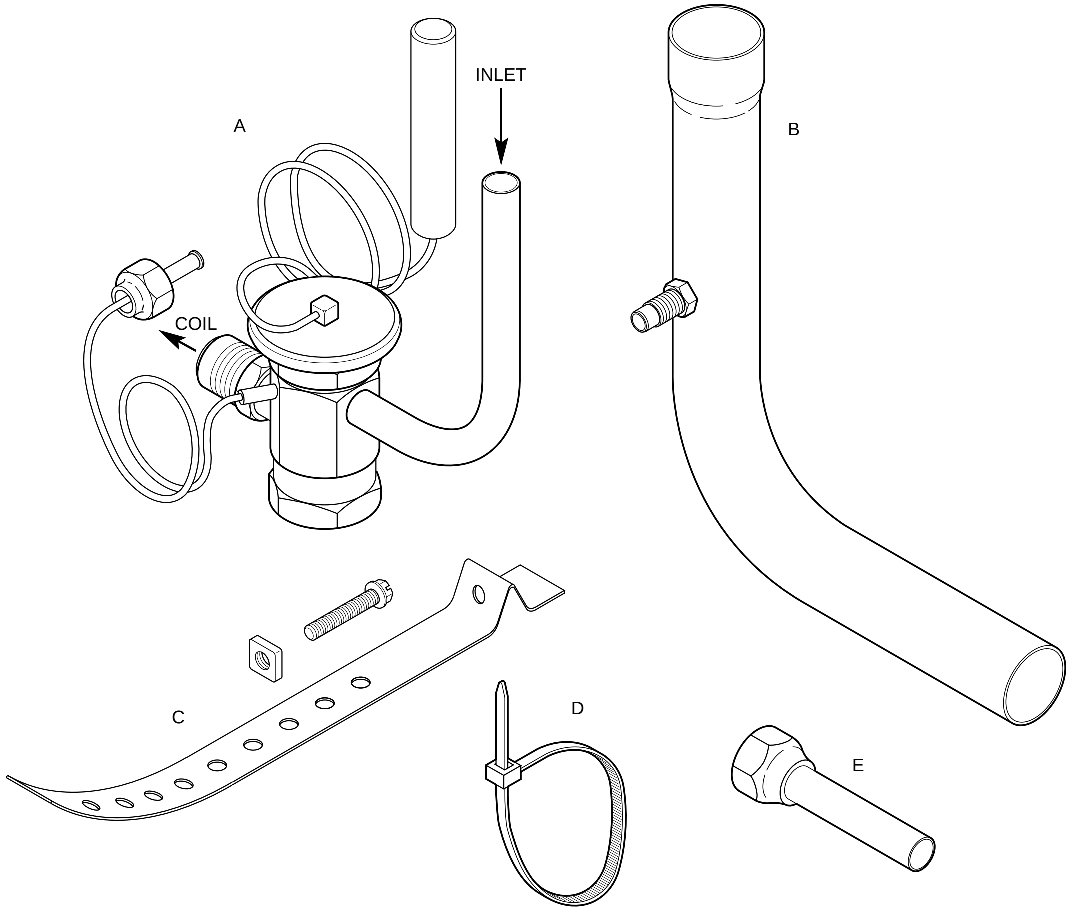

Fig. 31—Puron (R-410A) TXV Kit Components

Step 10—Thermostatic Expansion Valve (TXV)

The thermostatic expansion valve is specifically designed to operate with Puron, use only factory authorized TXV. **Do not use an R-22 TXV**.

Step 11—Hard Shutoff (HSO)

Has no bleed port and allows no bleed through after system shutdown. No pressure equalization occurs.

The TXV is a metering device that is used in air conditioning and heat pump systems to adjust to changing load conditions by maintaining a preset superheat temperature at the outlet of the evaporator coil. The volume of refrigerant metered through the valve seat is dependent upon the following: (See Fig. 34.)

1. Superheat temperature sensed by cap tube sensing bulb on suction tube at outlet of evaporator coil. As long as this bulb and cap tube contains some liquid refrigerant, this temperature is converted into suction pressure pushing downward on the diaphragm, which tends to open the valve via the pushrods.
2. The suction pressure at the outlet of the evaporator coil is transferred via the external equalizer tube to the underside of the diaphragm.
3. The needle valve on the pin carrier is spring loaded, which exerts pressure on the underside of the diaphragm via the pushrods and tends to close the valve. Therefore, bulb pressure equals evaporator pressure (at outlet of coil) plus spring pressure. If the load increases, the temperature increases at the bulb, which increases the pressure on the top side of the diaphragm, which pushes the pin carrier away from the seat, opening the valve and increasing the flow of refrigerant. The increased refrigerant flow causes increased leaving evaporator pressure which is transferred via the equalizer tube to the underside of the diaphragm. This tends to cause the pin carrier spring pressure to close the valve. The refrigerant flow is effectively stabilized to the load demand with negligible change in superheat.

Step 12—Replacing R-22 Expansion Device with Puron (R-410A) TXV

An existing R-22 TXV must be replaced with a factory approved TXV specifically designed for Puron (R-410A).

NOTE: All Puron (R-410A) Heat Pumps require a hard shutoff Puron (R-410A) TXV.

For existing R-22 TXV Fan Coils and Furnace Coils, the TXV must be replaced with a factory approved TXV specifically designed for Puron (R-410A). Fan Coils with internal TXV's may have TXV directly replaced with TXV from kit. Fan coils and furnace coils with pistons, TXV must be located external to cabinet as shown in Fig. 33. See Fig. 32 for proper sensing bulb position and Fig. 33 for proper sensing bulb location. Follow instructions included with Puron (R-410A) TXV kit for specific details. (See Fig. 31.)

REFRIGERATION SYSTEM REPAIR

Step 1—Leak Detection

New installations should be checked for leaks prior to complete charging.

If a system has lost all or most of its charge, system must be pressurized again to approximately 150 psi minimum and 375 psi maximum. This can be done by adding refrigerant using normal charging procedures or by pressurizing system with nitrogen (less expensive than refrigerant). Nitrogen also leaks faster than R-410A. Nitrogen cannot, however, be detected by an electronic leak detector. (See Fig. 35.)

⚠ WARNING

Due to the high pressure of nitrogen, it should never be used without a pressure regulator on the tank. Failure to follow this warning can cause a fire, personal injury, or death.

Assuming that a system is pressurized with either all refrigerant or a mixture of nitrogen and refrigerant, leaks in the system can be found with an electronic leak detector that is capable of detecting HFC refrigerant.

If system has been operating for some time, first check for a leak visually. Since refrigerant carries a small quantity of oil, traces of oil at any joint or connection is an indication that refrigerant is leaking at that point.

A simple and inexpensive method of testing for leaks is to use soap bubbles. (See Fig. 36.) Any solution of water and soap may be used. Soap solution is applied to all joints and connections in system. A small pinhole leak is located by tracing bubbles in soap solution around leak. If the leak is very small, several minutes may pass before a bubble will form. Popular commercial leak detection solutions give better, longer-lasting bubbles and more accurate results than plain soapy water. The bubble solution must be removed from the tubing and fittings after checking for leaks as some solutions may corrode the metal.

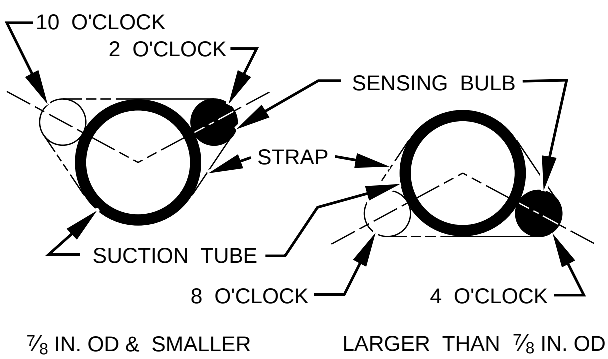

Fig. 32−Position of Sensing Bulb

You may use an electronic leak detector designed for HFCs to check for leaks. (See Fig. 35.) This unquestionably is the most efficient and easiest method for checking leaks. There are various types of electronic leak detectors. Electronic leak detectors must be suitable for R-410A (HFC) refrigerant. Check with manufacturer of equipment for suitability. Generally speaking, they are portable, lightweight, and consist of a box with several switches and a probe or sniffer. Detector is turned on and probe is passed around all fittings and connections in system. Leak is detected by either the movement of a pointer on detector dial, a buzzing sound, or a light.

In all instances when a leak is found, system charge must be recovered and leak repaired before final charging and operation. After leak testing or leak is repaired, replace liquid line filter drier, evacuate system, and recharge with correct refrigerant quantity.

Step 2—Coil Removal

Coils are easy to remove if required for compressor removal, or to replace coil.

1. Shut off all power to unit.
2. Recover refrigerant from system through service valves.
3. Break vacuum with nitrogen.

1. Remove top cover. (See Remove Top Cover in Cabinet section of the manual.)
2. Remove screws in base pan to coil grille.
3. Remove coil grille from unit.
4. Remove screws on corner post holding coil tube sheet.

⚠ WARNING

Cut tubing to reduce possibility of fire and personal injury.

5. Use midget tubing cutter to cut liquid and vapor lines at both sides of coil. Cut in convenient location for easy reassembly with copper slip couplings.

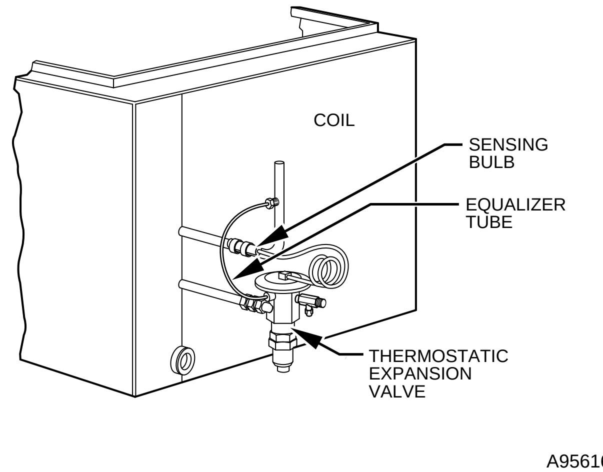

Fig. 33—Typical TXV Installation

6. Lift coil vertically from basepan and carefully place aside.
7. Reverse procedure to reinstall coil.
8. Replace filter drier, evacuate system, recharge, and check for normal system operation.

Step 3—Compressor Removal and Replacement

Once it is determined that compressor has failed and the reason established, compressor must be replaced.

⚠ CAUTION

Turn off all power to unit before proceeding. Wear safety glasses and gloves when handling refrigerants. Acids formed as a result of motor burnout can cause burns.

⚠ WARNING

Wear safety glasses and gloves when handling refrigerants and when using brazing torch. Failure to follow this warning can cause a fire, personal injury, or death.

1. Shut off all power to unit.
2. Remove and recover all refrigerant from system until pressure gages read 0 psi. Use all service ports. Never open a system under a vacuum to atmosphere. Break vacuum with dry nitrogen holding charge first. Do not exceed 5 psig.
3. Disconnect electrical leads from compressor. Disconnect or remove crankcase heater and remove compressor hold-down bolts.

4. Cut compressor from system with tubing cutter. Do not use brazing torch for compressor removal. Oil vapor may ignite when compressor is disconnected.
5. Scratch matching marks on stubs in old compressor. Make corresponding marks on replacement compressor.
6. Use torch to remove stubs from old compressor and to reinstall them in replacement compressor.
7. Use copper couplings to tie compressor back into system.
8. Replace filter drier, evacuate system, recharge, and check for normal system operation.

⚠ CAUTION

Do not leave system open to atmosphere. Product damage could occur. Compressor oil is highly susceptible to moisture absorption.

Step 4—System Clean-Up After Burnout

Some compressor electrical failures can cause motor to burn. When this occurs, byproducts of burn, which include sludge, carbon, and acids, contaminate system. Test the oil for acidity using POE oil acid test to determine burnout severity. If burnout is severe enough, system must be cleaned before replacement compressor is installed. The 2 types of motor burnout are classified as mild or severe.

In mild burnout, there is little or no detectable odor. Compressor oil is clear or slightly discolored. An acid test of compressor oil will be negative. This type of failure is treated the same as mechanical failure. Liquid-line strainer should be removed and liquid-line filter drier replaced.

In a severe burnout, there is a strong, pungent, rotten egg odor. Compressor oil is very dark. Evidence of burning may be present in tubing connected to compressor. An acid test of compressor oil will be positive. Follow these additional steps.

1. TXV must be cleaned or replaced.
2. Drain any trapped oil from accumulator if used.
3. Remove and discard liquid-line strainer and filter drier.
4. After system is reassembled, install liquid and suction-line Puron (R-410A) filter driers.

NOTE: On heat pumps, install suction line drier between compresser and accumulator.

5. Operate system for 10 hr. Monitor pressure drop across drier. If pressure drop exceeds 3 psig replace suction-line and liquid-line filter driers. Be sure to purge system with dry nitrogen when replacing filter driers. If suction Line driers must be replaced, retest pressure drop after additional 10 hours (run time). Continue to monitor pressure drop across suction-line filter drier. After 10 hr of run time, remove suction-line filter drier and replace liquid-line filter drier. **Never leave suction-line filter drier in system longer than 72 hr (actual time).**
6. Charge system. (See unit information plate.)

Step 5—Evacuation

Proper evacuation of the system will remove non-condensibles and assure a tight, dry system before charging. The 2 methods used to evacuate a system are the deep vacuum method and the triple evacuation method.

DEEP VACUUM METHOD

The deep vacuum method requires a vacuum pump capable of pulling a vacuum of 500 microns and a vacuum gage capable of accurately measuring this vacuum depth. The deep vacuum method is the most positive way of assuring a system is free of air and moisture. (See Fig. 37.)

TRIPLE EVACUATION METHOD

The triple evacuation method should be used only when vacuum pump is capable of pumping down to only 28 in. of mercury vacuum, and system does not contain any moisture. The procedure is as follows. (See Fig. 38.)

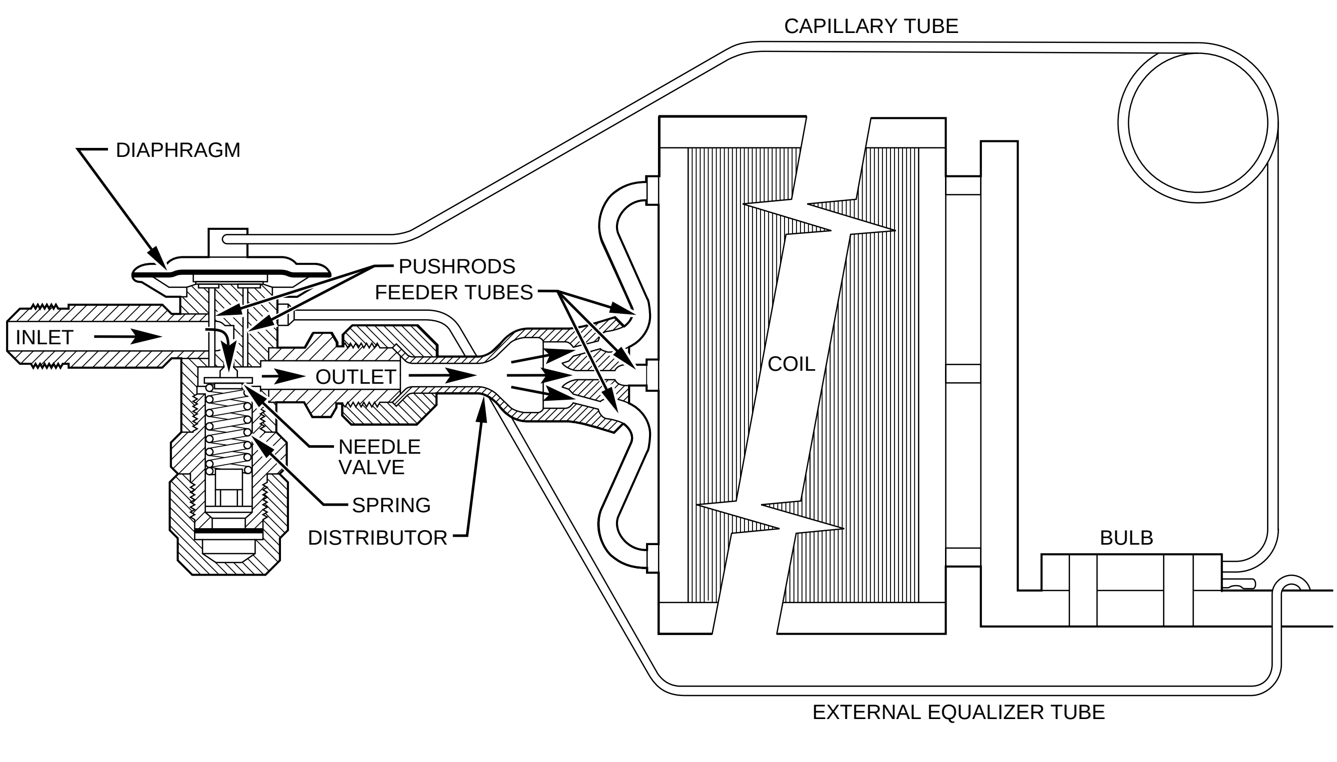

Fig. 34—TXV Operation

1. Pump system down to 28 in. of mercury vacuum and allow pump to continue to operate for additional 15 minutes.
2. Close service valves and shut off vacuum pump.
3. Connect a nitrogen cylinder and regulator to system and open until system pressure is 2 psig.
4. Close service valve and allow system to stand for 1 hr, during which time dry nitrogen will be able to diffuse throughout the system, absorbing moisture.
5. Repeat procedure 3 times. System will then be free of any contaminants and water vapor.

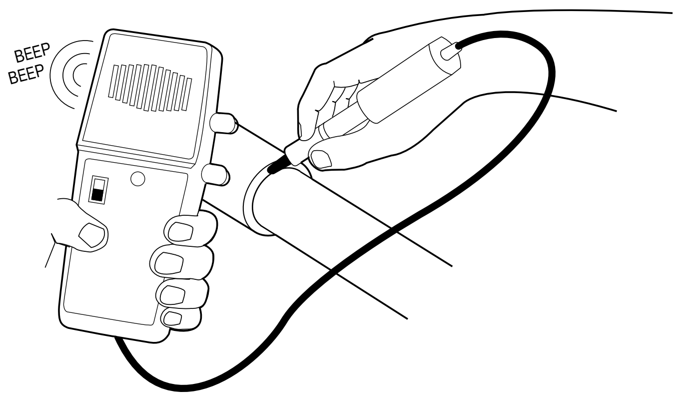

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Fig. 35—Electronic Leak Detection

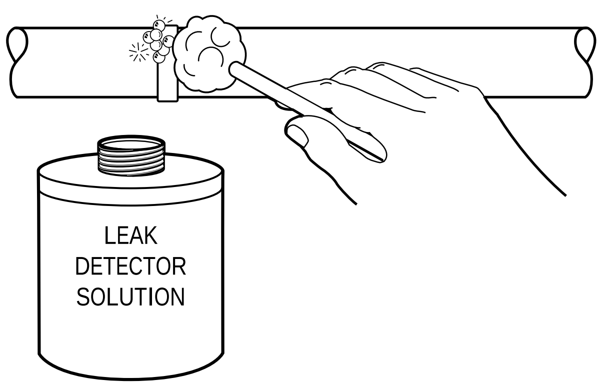

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Fig. 36—Bubble Leak Detection

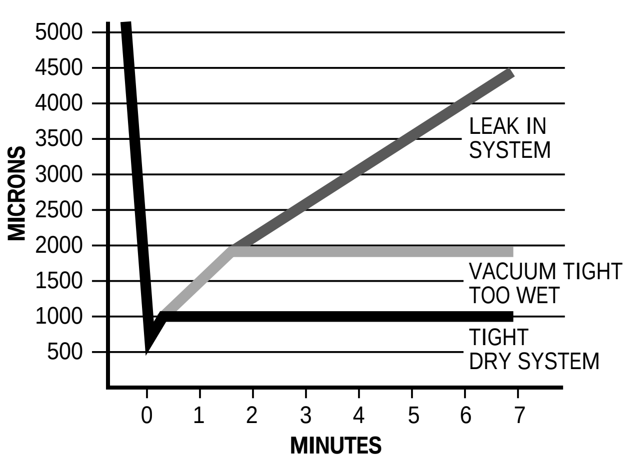

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Fig. 37—Deep Vacuum Graph

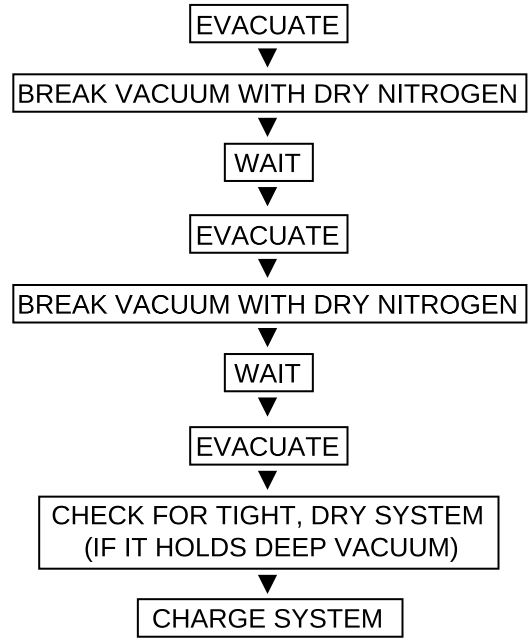

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Fig. 38—Triple Evacuation Method

Step 6—Puron (R-410A) Refrigerant Charging

Refer to unit information plate for superheat charging procedure. **R-410A refrigerant cylinders contain a dip tube which allows liquid refrigerant to flow from cylinder in upright position**. Charge Puron units with cylinder in upright position and a commercial type metering device in manifold hose. Charge refrigerant into suction-line.

For all approved combinations, system must be charged correctly for normal system operation and reliable operation of components. (See Fig. 39.)

If system has lost all charge, weigh in charge using digital scales.

System charge should be fine tuned by using superheat method or subcooling method as defined by cooling mode metering device.

For charging during heating season, charge must be weighed in accordance with unit rating plate ± 0.6 oz/ft of 3/8 in. liquid line above or below 15 ft respectively.

Step 7—Checking Charge

SUPERHEAT CHARGING METHOD

Superheat charging is the process of charging refrigerant in a system until the temperature (superheat) of suction gas entering compressor reaches a prescribed value. Small variations of charge affect suction gas superheat temperatures greatly. Therefore, this method of charging is very accurate. This method can be used with fixed restrictor type metering devices such as AccuRater. For units using a TXV, the subcooling method must be used. To charge by superheat, a service technician will need an accurate superheat thermocouple or thermistor-type thermometer, a sling psychrometer, and a gage manifold. Do not use mercury or small dial type thermometers as they are not adequate for this type of measurement. Refer to unit information plate for superheat charging procedure.

SUBCOOLING CHARGING METHOD (SEE CHARGING TABLE IN APPENDIX)

1. Operate unit a minimum of 15 minutes before checking charge.
2. Measure liquid service valve pressure by attaching an accurate gage to service port.

CHARGE ACCURATELY

Undercharge	Proper Charge	Overcharge
• LOW LOW-SIDE PRESSURE • HIGH SUPERHEAT • OVERHEATED COMPRESSOR AND MOTOR • LOW SYSTEM CAPACITY • POOR EFFICIENCY • SLUDGE/ CARBONIZATION	• LONG LIFE • SAFE OPERATION • DESIGN CAPACITY • PEAK EFFICIENCY	• HIGH HIGH-SIDE PRESSURE • HIGH DISCHARGE TEMPERATURE • FLOODBACK • LOW SYSTEM CAPACITY • POOR EFFICIENCY • SLUDGE/ CARBONIZATION

Fig. 39—Charging

3. Measure liquid-line temperature by attaching an accurate thermistor-type or electronic thermometer to liquid line near outdoor coil.
4. Refer to unit information plate to find required subcooling temperature for unit. Find point at which required subcooling temperature intersects measured liquid service valve pressure.
5. Add refrigerant if liquid-line temperature is higher than indicated. Remove refrigerant if temperature is lower. Allow a tolerance of 3°F.

CARE AND MAINTENANCE

To assure high performance and minimize possible equipment malfunction, it is essential that maintenance be performed periodically on this equipment. The frequency with which maintenance is performed is dependent on such factors as hours of operation, geographic location, and local environmental conditions.

⚠ WARNING

Disconnect all electrical power to unit before performing any maintenance or service on outdoor unit. Remember to disconnect power supply to air handler as this unit supplies low-voltage power to the outdoor unit. Failure to follow this warning can cause a fire, personal injury, or death.

The minimum maintenance that should be performed on this equipment is as follows.

1. Check outdoor coil for cleanliness each month during cooling season and clean as necessary.
2. Check fan motor and blade for cleanliness each heating and cooling season and clean as necessary.
3. Check electrical connections for tightness and controls for proper operation each cooling season and service as necessary.

⚠ CAUTION

Because of possible damage to the equipment or personal injury, maintenance should be performed by qualified personnel only.

Step 1—Cleaning

CLEANING COIL

1. Remove top cover. (See Remove Top Cover in Cabinet section of this manual.)

⚠ CAUTION

Coil fin damage can result in higher operating costs or compressor damage. Do not use flame, high-pressure water, steam, volatile or corrosive cleaners on fins or tubing.

2. Clean coil using vacuum cleaner and its crevice tool. Move crevice tool vertically, close to area being cleaned, making sure tool touches only dirt on fins and not fins. To prevent fin damage, do not scrub fins with tool or move tool horizontally against fins.
3. If oil deposits are present, spray coil with ordinary household detergent. Wait 10 minutes, and proceed to next step.
4. Using garden hose, spray coil vertically downward with constant stream of water at moderate pressure. Keep nozzle at a 15- to 20° angle, about 3 in. from coil face and 18 in. from tube. Spray so debris is washed out of coil and basepan.
5. Reinstall top cover and position blade.
6. Reconnect electrical power and check for proper operation.

CLEANING OUTDOOR FAN MOTOR AND BLADE

1. Remove fan motor and blade. Be careful not to bend or dent fan blade.
2. Clean motor and blade with soft brush or cloth. Be careful not to disturb balance weights on fan blade.
3. Check fan blade setscrew for tightness.
4. Reinstall fan motor and blade to top cover and check for alignment.
5. Reinstall top cover and position blade.
6. Reconnect electrical power and check for proper operation.

ELECTRICAL CONTROLS AND WIRING

1. Disconnect power to both outdoor and indoor units.
2. Check all electrical connections for tightness. Tighten all screws on electrical connections. If any connections appear to be burned or smokey, disassemble the connection, clean all parts and stripped wires, and reassemble. Use a new connector if old one is burned or corroded, and crimp tightly.
3. Reconnect electrical power to indoor and outdoor units and observe unit through 1 complete operating cycle.
4. If there are any discrepancies in operating cycle, troubleshoot to find cause and correct.

REFRIGERANT CIRCUIT

1. Check refrigerant charge using the superheat method, and if low on charge, check unit for leaks using an electronic leak detector.
2. If any leaks are found, remove and reclaim or isolate charge (pumpdown) if applicable. Make necessary repairs.
3. Evacuate, recharge, and observe unit through 1 complete operating cycle.

FINAL CHECK-OUT

After the unit has been operating, the following items should be checked.

1. Check that unit operational noise is not excessive due to vibration of component, tubing, panels, etc. If present, isolate problem and correct.
2. Check to be sure caps are installed on service valves and are tight.
3. Check to be sure tools, loose parts, and debris are removed from unit.
4. Check to be sure all panels and screws are in place and tight.

Step 2—Desert and Seacoast Locations

Special consideration must be given to installation and maintenance of condensing units installed in coastal or desert locations. This is because salt and alkali content of sand adheres to aluminum fins of coil and can cause premature coil failure due to corrosion from salt, alkali, and moisture.

Preventive measures can be taken during installations, such as:

1. Locate unit on side of structure opposite prevailing winds.
2. Elevate unit to height where drifting sand cannot pile up against coil. Four in. high mounting feet are available as accessories and can be used to elevate unit.
3. Addition of coastal filter (See Product Data Sheet for accessory listing.)

Maintenance in desert and seacoast locations

1. Frequent inspection of coil and basepan especially after storms and/or high winds.
2. Clean coil by flushing out sand from between coil fins and out of basepan as frequently as inspection determines necessary.
3. In off season, cover with covering that allows air to circulate through but prevents sand from sifting in (such as canvas material). Do not use plastic because plastic will hold moisture.

Pressure vs. Temperature Chart
R-410A

PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F
12	-37.7	114	37.8	216	74.3	318	100.2	420	120.7	522	137.6
14	-34.7	116	38.7	218	74.9	320	100.7	422	121.0	524	137.9
16	-32.0	118	39.5	220	75.5	322	101.1	424	121.4	526	138.3
18	-29.4	120	40.5	222	76.1	324	101.6	426	121.7	528	138.6
20	-36.9	122	41.3	224	76.7	326	102.0	428	122.1	530	138.9
22	-24.5	124	42.2	226	77.2	328	102.4	430	122.5	532	139.2
24	-22.2	126	43.0	228	77.8	330	102.9	432	122.8	534	139.5
26	-20.0	128	43.8	230	78.4	332	103.3	434	123.2	536	139.8
28	-17.9	130	44.7	232	78.9	334	103.7	436	123.5	538	140.1
30	-15.8	132	45.5	234	79.5	336	104.2	438	123.9	540	140.4
32	-13.8	134	46.3	236	80.0	338	104.6	440	124.2	544	141.0
34	-11.9	136	47.1	238	80.6	340	105.1	442	124.6	548	141.6
36	-10.1	138	47.9	240	81.1	342	105.4	444	124.9	552	142.1
38	-8.3	140	48.7	242	81.6	344	105.8	446	125.3	556	142.7
40	-6.5	142	49.5	244	82.2	346	106.3	448	125.6	560	143.3
42	-4.5	144	50.3	246	82.7	348	106.6	450	126.0	564	143.9
44	-3.2	146	51.1	248	83.3	350	107.1	452	126.3	568	144.5
46	-1.6	148	51.8	250	83.8	352	107.5	454	126.6	572	145.0
48	0.0	150	52.5	252	84.3	354	107.9	456	127.0	576	145.6
50	1.5	152	53.3	254	84.8	356	108.3	458	127.3	580	146.2
52	3.0	154	54.0	256	85.4	358	108.8	460	127.7	584	146.7
54	4.5	156	54.8	258	85.9	360	109.2	462	128.0	588	147.3
56	5.9	158	55.5	260	86.4	362	109.6	464	128.3	592	147.9
58	7.3	160	56.2	262	86.9	364	110.0	466	128.7	596	148.4
60	8.6	162	57.0	264	87.4	366	110.4	468	129.0	600	149.0
62	10.0	164	57.7	266	87.9	368	110.8	470	129.3	604	149.5
64	11.3	166	58.4	268	88.4	370	111.2	472	129.7	608	150.1
66	12.6	168	59.0	270	88.9	372	111.6	474	130.0	612	150.6
68	13.8	170	59.8	272	89.4	374	112.0	476	130.3	616	151.2
70	15.1	172	60.5	274	89.9	376	112.4	478	130.7	620	151.7
72	16.3	174	61.1	276	90.4	378	112.6	480	131.0	624	152.3
74	17.5	176	61.8	278	90.9	380	113.1	482	131.3	628	152.8
76	18.7	178	62.5	280	91.4	382	113.5	484	131.6	632	153.4
78	19.8	180	63.1	282	91.9	384	113.9	486	132.0	636	153.9
80	21.0	182	63.8	284	92.4	386	114.3	488	132.3	640	154.5
82	22.1	184	64.5	286	92.8	388	114.7	490	132.6	644	155.0
84	23.2	186	65.1	288	93.3	390	115.0	492	132.9	648	155.5
86	24.3	188	65.8	290	93.8	392	115.5	494	133.3	652	156.1
88	25.4	190	66.4	292	94.3	394	115.8	496	133.6	656	156.6
90	26.4	192	67.0	294	94.8	396	116.2	498	133.9	660	157.1
92	27.4	194	67.7	296	95.2	398	116.6	500	134.0	664	157.7
94	28.5	196	68.3	298	95.7	400	117.0	502	134.5	668	158.2
96	29.5	198	68.9	300	96.2	402	117.3	504	134.8	672	158.7
98	30.5	200	69.5	302	96.6	404	117.7	506	135.2	676	159.2
100	31.2	202	70.1	304	97.1	406	118.1	508	135.5	680	159.8
102	32.2	204	70.7	306	97.5	408	118.5	510	135.8	684	160.3
104	33.2	206	71.4	308	98.0	410	118.8	512	136.1	688	160.8
106	34.1	208	72.0	310	98.4	412	119.2	514	136.4	692	161.3
108	35.1	210	72.6	312	98.9	414	119.6	516	136.7	696	161.8
110	35.5	212	73.2	314	99.3	416	119.9	518	137.0		
112	36.9	214	73.8	316	99.7	418	120.3	520	137.3		

*Based on ALLIED SIGNAL Data

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REQUIRED LIQUID LINE TEMPERATURE						
LIQUID PRESSURE AT SERVICE VALVE (PSIG)	REQUIRED SUBCOOLING TEMPERATURE (°F)					
	8	10	12	14	16	18
189	58	56	54	52	50	48
195	60	58	56	54	52	50
202	62	60	58	56	54	52
208	64	62	60	58	56	54
215	66	64	62	60	58	56
222	68	66	64	62	60	58
229	70	68	66	64	62	60
236	72	70	68	66	64	62
243	74	72	70	68	66	64
251	76	74	72	70	68	66
259	78	76	74	72	70	68
266	80	78	76	74	72	70
274	82	80	78	76	74	72
283	84	82	80	78	76	74
291	86	84	82	80	78	76
299	88	86	84	82	80	78
308	90	88	86	84	82	80
317	92	90	88	86	84	82
326	94	92	90	88	86	84
335	96	94	92	90	88	86
345	98	96	94	92	90	88
354	100	98	96	94	92	90
364	102	100	98	96	94	92
374	104	102	100	98	96	94
384	106	104	102	100	98	96
395	108	106	104	102	100	98
406	110	108	106	104	102	100
416	112	110	108	106	104	102
427	114	112	110	108	106	104
439	116	114	112	110	108	106
450	118	116	114	112	110	108
462	120	118	116	114	112	110
474	122	120	118	116	114	112
486	124	122	120	118	116	114
499	126	124	122	120	118	116
511	128	126	124	122	120	118

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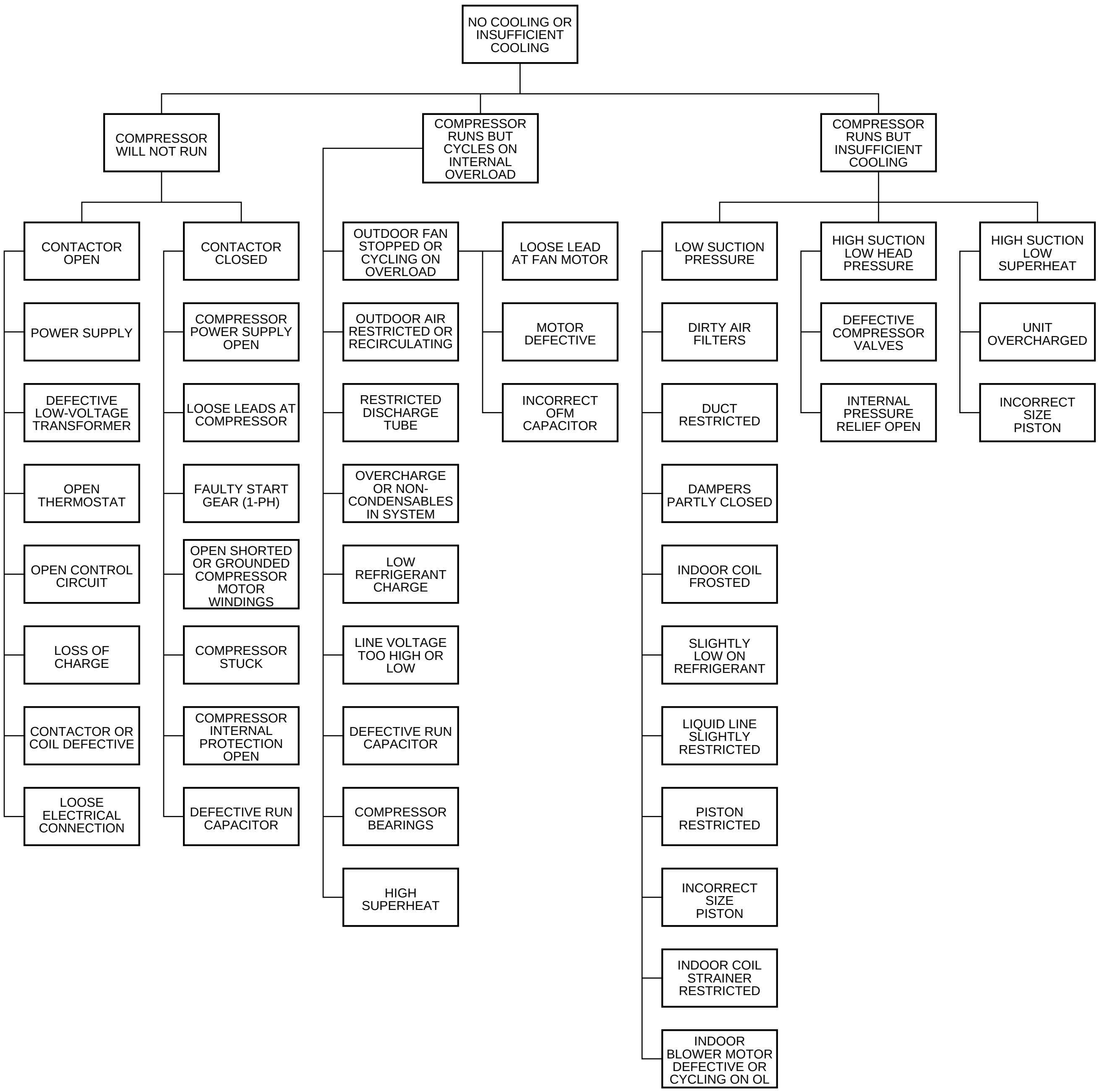
Subcooling Charging Table

AIR CONDITIONER AND HEAT PUMP WITH PURON (R-410A)—QUICK REFERENCE GUIDE

- Puron (R-410A) refrigerant operates at 50%-70% higher pressures than R-22. Be sure that servicing equipment and replacement components are designed to operate with Puron (R-410A).
- Puron (R-410A) refrigerant cylinders are rose colored.
- Puron (R-410A) refrigerant cylinders have a dip tube which allows liquid to flow out of cylinder in upright position.
- Recovery cylinder service pressure rating must be 400 psig, DOT 4BA400 or DOT BW400.
- Puron (R-410A) systems should be charged with liquid refrigerant. Use a commercial type metering device in the manifold hose.
- Manifold sets should be 700 psig high side and 180 psig low side with 550 psig low-side retard.
- Use hoses with 700 psig service pressure rating.
- Leak detectors should be designed to detect HFC refrigerant.
- Puron (R-410A), as with other HFCs, is only compatible with POE oils.
- Vacuum pumps will not remove moisture from oil.
- Only use factory specified liquid-line filter driers with rated working pressures less than 600 psig.
- Do not install a suction-line filter drier in liquid-line.
- POE oils absorb moisture rapidly. Do not expose oil to atmosphere.
- POE oils may cause damage to certain plastics and roofing materials.
- Wrap all filter driers and service valves with wet cloth when brazing.
- A liquid-line filter drier is required on every unit.
- Do not use an R-22 TXV.
- If indoor unit is equipped with a TXV, it must be changed to a Puron (R-410A) TXV.
- Never open system to atmosphere while it is under a vacuum.
- When system must be opened for service, break vacuum with dry nitrogen and replace filter driers.
- Always replace filter drier after opening system for service.
- Do not vent Puron (R-410A) into the atmosphere.
- Do not use capillary tube coils.
- Observe all **warnings**, **cautions,** and **bold** text.
- All Puron (R-410A) heat pumps must have indoor R-410A TXV.
- Do not leave Puron suction line driers in place for more than 72 hrs.

AIR CONDITIONER
TROUBLESHOOTING CHART



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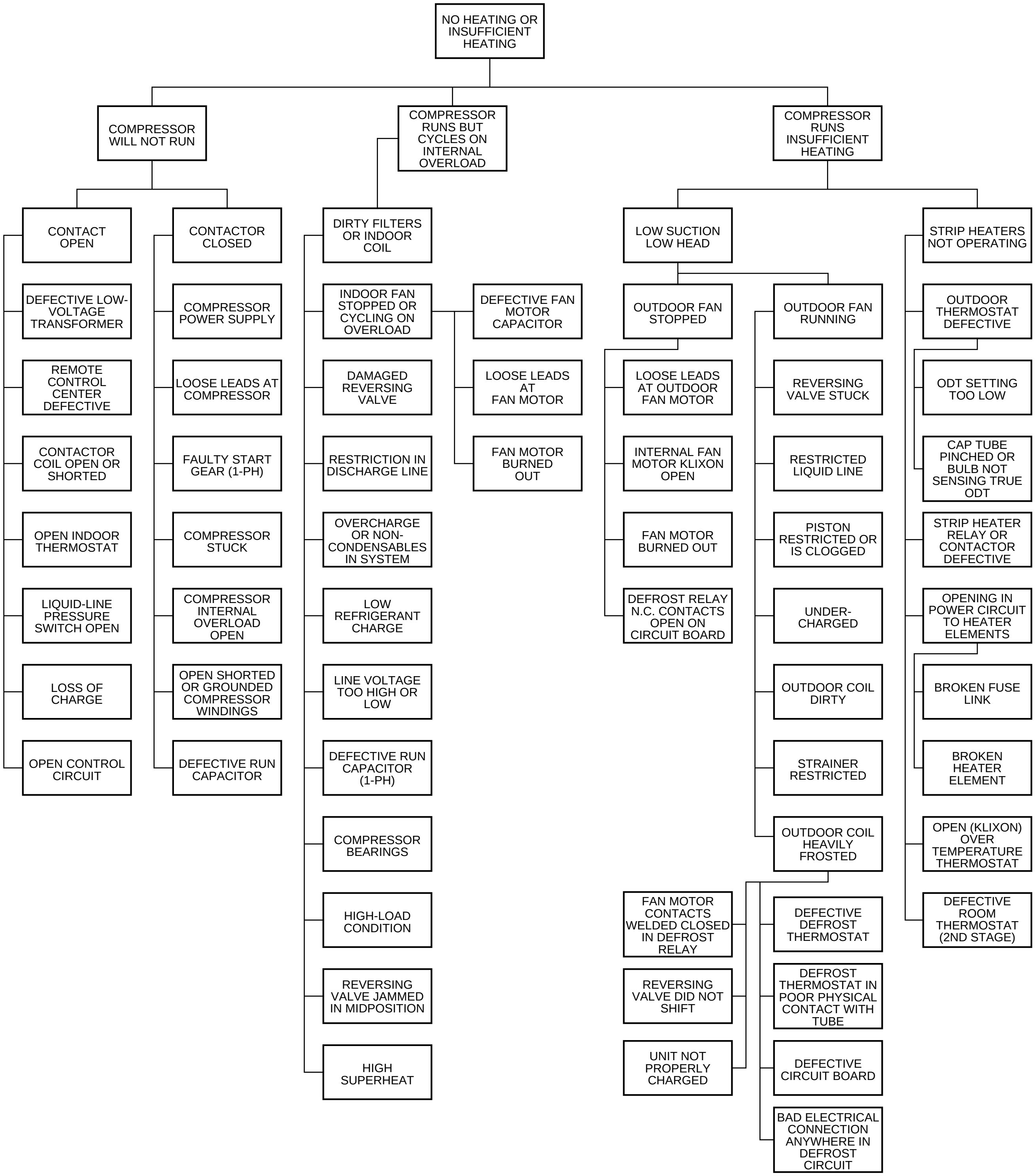
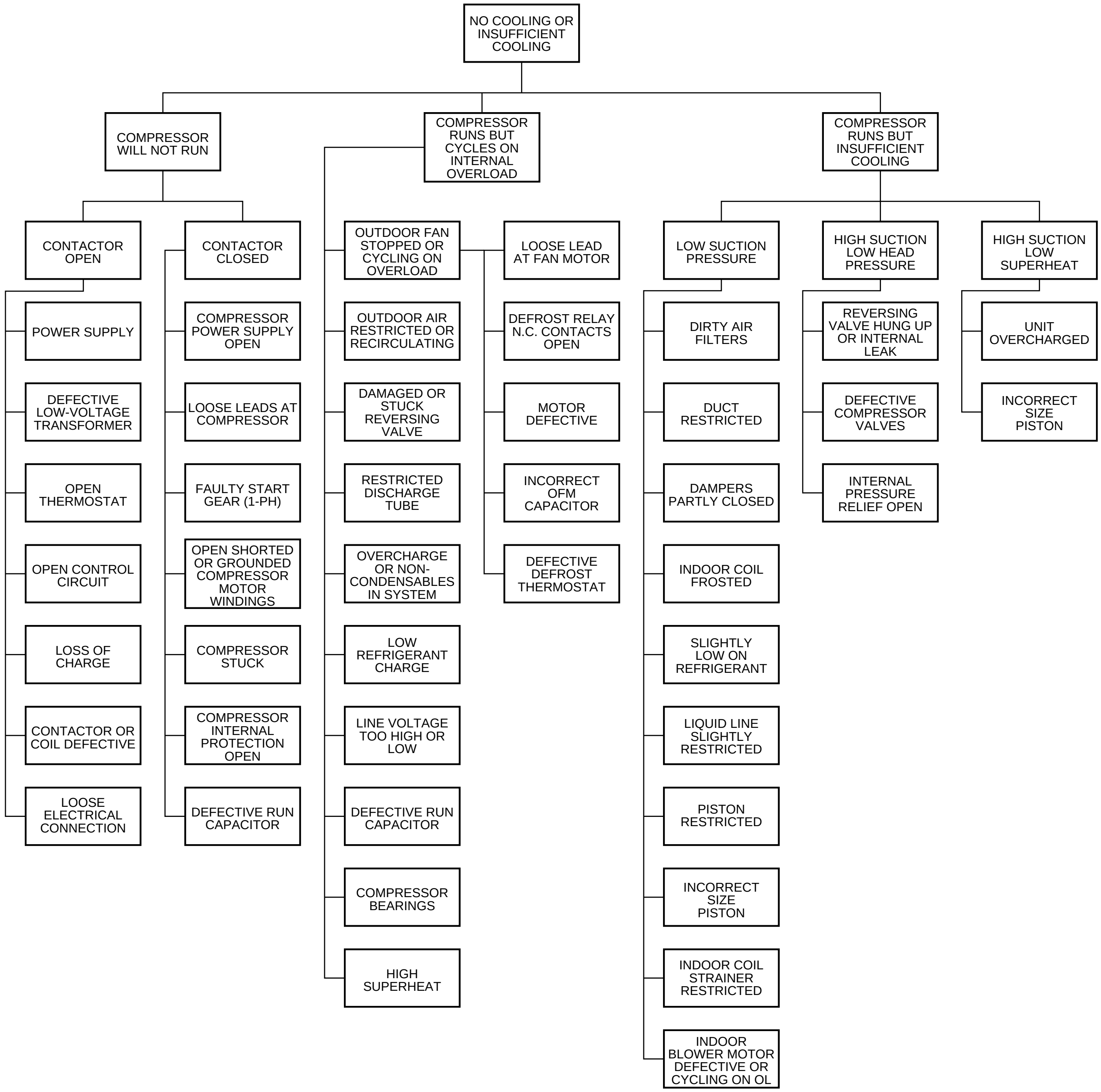
HEAT PUMP
TROUBLESHOOTING–HEATING CYCLE



HEAT PUMP
TROUBLESHOOTING–COOLING CYCLE



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