Hermetic Compressor
Service Handbook

Tecumseh

Wholesale Distribution
North America

Hermetic Compressor Service Handbook

Ann Arbor, MI 48108

REV 3/11

Handbook Purpose and Description

Tecumseh Products Company has prepared this Service Handbook to assist service personnel in safely installing and servicing refrigeration and air conditioning equipment. The information in this Service Handbook is generally limited to the compressor and to items and conditions affecting the installation, operation, and servicing of the compressor. It is not designed to be a textbook or to replace the training required for professional service technicians. Also, it is not intended to replace other information available from the refrigeration and air conditioning system manufacturers.

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Tecumseh

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Chapter 1

Introduction

Tecumseh Products Company has prepared this handbook to assist service personnel in safely working with refrigeration and air conditioning equipment that uses Tecumseh Products Company hermetic compressors. It is not designed to replace the training required for professional service personnel. It is also not intended to replace other information available from refrigeration and air conditioning equipment manufacturers.

Trained Personnel Only

Servicing, repairing, and troubleshooting refrigeration and air conditioning systems should be done only by those with the necessary knowledge, training, and equipment.

Terminal Venting and Electrocution

Improperly servicing, repairing, or troubleshooting a compressor can lead to electrocution or fire due to terminal venting with ignition. Follow the precautions below to avoid serious injury or death from electrocution or terminal venting with ignition.

Fire Hazard from Terminal Venting with Ignition

Oil and refrigerant can spray out of the compressor if one of the terminal pins is ejected from the hermetic terminal. This “terminal venting” can occur as a result of a ground fault (also known as a short circuit to ground) in the compressor. The oil and refrigerant spray from terminal venting can be ignited by electricity and produce flames that can lead to serious burns or death. See figures 1-1 through 1-3 for details.

⚠ WARNING ⚠

Never service, repair, or troubleshoot unless you are qualified to perform these functions. Improper servicing can lead to serious injury or death from fire, electrical shock, or explosion.

Terminal Venting and Electrocution Precautions

To reduce the risk of electrocution or serious burns or death from terminal venting with ignition:

- *Be alert for sounds of arcing (sizzling, sputtering or popping) inside the compressor. IMMEDIATELY GET AWAY if you hear these sounds.*
- *Disconnect ALL electrical power before removing the protective terminal cover.* Make sure that all power legs are open. (NOTE: The system may have more than one power supply.)
- *Never energize the system unless: 1) the protective terminal cover is securely fastened, and 2) the compressor is properly connected to ground.* Figures 1-4 through 1-6 illustrate the different means of fastening protective terminal covers.
- *Never reset a breaker or replace a fuse without first checking for a ground fault (a short circuit to ground).*

  An open fuse or tripped circuit breaker is a strong indication of a ground fault (also know as a short circuit to ground). Use only a megohmmeter (“megger”) or a Hi-Potential Ground tester (Hi-Pot) to check for a ground fault. A conventional ohmmeter will not reliably detect a ground fault under certain circumstances. See the Service Handbook for more information on checking for a ground fault. Also, always follow the megger or Hi-Pot manufacturer’s procedures and safety rules.

  If a ground fault does exist, keep the power off. WARNING! To avoid electric shock, electrocution, and terminal venting with ignition, do not energize a compressor that has a ground *fault. Mark and red tag the compressor to indicate that there is a ground fault. Do not reconnect the power leads. Tape and insulate each power lead separately.*

- *Disconnect power before servicing. Always disconnect power before servicing unless* it is required for a specific troubleshooting technique. In these situations, use extreme caution to avoid electric shock.

FIGURE 1-1: Compressor with (1) protective cover and (2) bale strap removed to show (3) hermetic terminal.

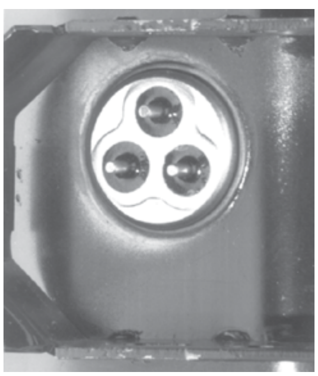


FIGURE 1-2: Close up view of hermetic terminal showing individual terminal pins with power leads removed.

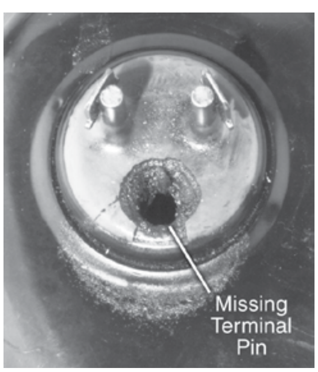


FIGURE 1-3: Close up view of hermetic teminal after it has vented.

FIGURE 1-4: Compressor with (1) protective cover held in place by (2) metal bale strap.

FIGURE 1-5: Compressor with (1) protective cover held in place by (2) nut.

FIGURE 1-6: Compressor with (1) snap in protective cover.

Refrigerants and Other Chemicals

Contact with refrigerant, mixtures of refrigerant and oil, or other chemicals can cause a variety of injuries including burns and frostbite. For example, if refrigerant contacts skin or eyes, it can cause severe frostbite. Also, in the event of a compressor motor failure, some refrigerant and oil mixtures can be acidic and can cause chemical burns.

To avoid injury, wear appropriate protective eye wear, gloves, and clothing when servicing an air conditioning or refrigeration system. Refer to your refrigerant supplier for more information.

If refrigerant or mixtures of refrigerant and oil come in contact with skin or eyes, flush the exposed area with water and get medical attention immediately.

Compressor Removal

Failure to properly remove the compressor can result in serious injury or death from electrocution, fire, or sudden release of refrigerant and oil.

Follow these precautions when removing a compressor from a system:

- *Disconnect ALL electrical power.* Disconnect all electrical power supplies to the system making sure that all power legs are open. (NOTE: the system may have more than one power supply.)
- *Be sure refrigerant is recovered before removing compressor.* Attempting to remove the compressor before removing all refrigerant from the system can cause a sudden release of refrigerant and oil. Among other things, this can:
  - »cause a variety of injuries including burns and frostbite.
  - »cause a fire if a torch is used to disconnect tubing.
  - »expose the service person to toxic gas.

- To avoid serious injury or death, be sure to remove and recover all refrigerant before removing the compressor.
- *Use a tubing cutter, not a torch.* Use a tubing cutter to remove the compressor. A torch can cause even trace amounts of refrigerant to decompose and release toxic fumes. In addition, using a torch to remove the compressor can cause a fire. If you ignore this recommendation and use a torch, be prepared to extinguish a fire.

System Flushing, Purging, and Pressure Testing for Leaks

Failure to properly purge or pressure test a system for leaks can result in serious injury or death from explosion, fire, or contact with acid-saturated refrigerant or oil mists.

Follow these precautions when purging or pressure testing a system for leaks:

- *Tecumseh discourages the use of flushing products and recommends the use of suction line filter-drier and proper oil changes. If the use of a flushing agent is absolutely necessary, follow the flushing agent manufacturer's instructions.*
- *To purge a system, use only dry nitrogen.*
- *When pressure testing for leaks, use only regulated dry nitrogen or dry nitrogen plus trace amounts of the serial label refrigerant.*
- *When purging or pressure testing any refrigeration or air conditioning system for leaks, never use air, oxygen or acetylene.*
  - »Oxygen can explode on contact with oil.
  - »Acetylene can decompose and explode when exposed to pressure greater than approximately 15 psig.
  - »Combining an oxidizing gas such as oxygen or air, with an HCFC or HFC refrigerant under pressure can result in a fire or explosion.

- *Use a pressure regulating valve and pressure gauges.*

  Commercial cylinders of nitrogen contain pressures in excess of 2000 psig at 70°F. At pressures much lower than 2000 psig, compressors can explode and cause serious injury or death. To avoid over pressurizing the system, always use a pressure-regulating valve on the nitrogen cylinder discharge (see Figure 1-7). The pressure regulator must be able to reduce the pressure down to 1 or 2 psig and maintain this pressure.

  The regulating valve must be equipped with two pressure gauges:

  »one gauge to measure cylinder pressure, and

  »one gauge to measure discharge or downstream pressure.

- *Use a pressure relief valve.*

  In addition to a pressure regulating valve and gauges, always install a pressure relief valve. This can also be a frangible disc type pressure relief device. This device should have a discharge port of at least ½" MPT size. The valve or frangible disc device must be set to release at 175 psig (see Figure 1-7).

- *Do not pressurize the system beyond 150 psig field leak test pressure.*

  When field testing a system for leaks, 150 psig is adequate test pressure.

- *Disconnect nitrogen cylinder and evacuate the system before connecting the refrigerant container.*

  Disconnect the nitrogen cylinder and evacuate the system according to the equipment manufacturer's recommendations prior to charging the system.

System Charging

Failure to properly charge the system can result in serious injury or death from explosion or fire.

Follow these precautions when charging a system:

- *Do not operate the compressor without charge in the system.*

  Operating the compressor without a charge in the system can damage the hermetic terminal. As always, to avoid serious injury or death from terminal venting with ignition, never energize the compressor unless the protective terminal cover is securely fastened.

- *Use proper refrigerant.*

  Use only the serial label refrigerant when charging the system. Using a different refrigerant can lead to excess system pressure and an explosion. Use of a refrigerant other than the serial label refrigerant will void the compressor warranty.

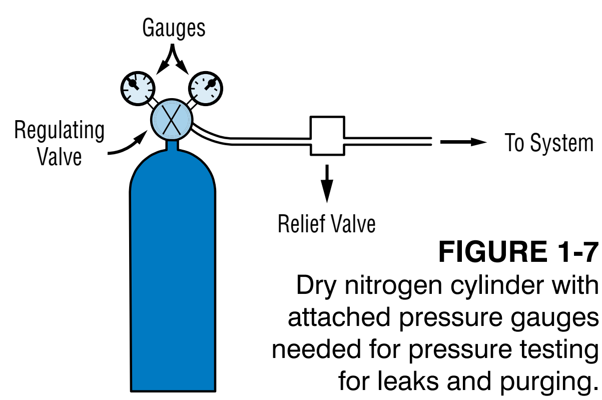


FIGURE 1-7
Dry nitrogen cylinder with attached pressure gauges needed for pressure testing for leaks and purging.

- *Do not overcharge a refrigeration or air conditioning system.*

  Overcharging a refrigeration or air conditioning system can result in explosion. To avoid serious injury or death, never overcharge the system. Always use proper charging techniques. Limit charge amounts to those specified on the system equipment serial label or in the original equipment manufacturer's service information.

  Overcharging the system immerses the compressor motor, piston, connecting rods, and cylinders in liquid refrigerant. This creates a hydraulic block preventing the compressor from starting. The hydraulic block is also known as locked rotor.

  Continued supply of electricity to the system causes heat to build in the compressor. This heat will eventually vaporize the refrigerant and rapidly increase system pressure. If, for any reason, the thermal protector fails to open the electrical circuit, system pressure can rise to high enough levels to cause a compressor housing explosion.

Prevention of Water-Utilizing System Explosions

In certain water-utilizing refrigeration systems, water can leak into the refrigerant side of the system. This can lead to an explosion of system components including, but not limited to, the compressor. If such an explosion occurs, the resulting blast can kill or seriously injure anyone in the vicinity.

Systems at Risk of Explosion

Water-utilizing systems that have single-wall heat exchangers may present a risk of explosion. Such systems may include:

- water source heat pump/air conditioning systems, and
- water cooling systems, such as icemakers, water coolers, and juice dispensers.

Water-utilizing systems that have single-wall heat exchangers present a risk of explosion unless they have either:

- a high pressure cut-out which interrupts power to ALL leads to the compressor, **or**
- an external pressure relief valve.

How an Explosion Occurs

If the refrigerant tubing in the heat exchanger develops a leak, water can enter the refrigerant side of the system. Water entering the refrigerant side can come in contact with live electrical connections in the compressor causing a short circuit or a path to ground. When this occurs, extremely high temperatures can result. The heat build-up creates steam vapor that can cause excessive pressure throughout the entire system. This system pressure can lead to an explosion of the compressor or other system components.

Service Procedures

In light of the risk of explosion, be especially alert for signs of water leaking into the refrigerant side of the system. Whenever servicing or troubleshooting a water-utilizing system, always check to see if it has either a pressure relief valve or a high-pressure cutout as previously described. If the system does not have at least one of these, DISCONNECT ALL ELECTRICAL POWER and look for indications that water has leaked into the refrigerant side of the system. These indications may include:

- Observation or a report of a blown fuse or tripped circuit breaker.
- Signs that water has leaked to the outside of the system.
- Reports that the system has made gurgling or percolating noises.
- A history of loss of refrigerant charge without a leak being found in the system.
  NOTE: Common leak detection methods will not detect a water-to-refrigerant leak in the system's heat exchanger(s).
- Observation of or a report of the compressor giving off an unusual amount of heat.

If ANY of these indications are present, do the following checks to determine if water has leaked into the refrigerant side:

Step 1: Check for a Ground Fault (a Short to Ground)

Use only a megohmmeter ("megger") or a Hi-Potential Ground tester ("Hi-Pot") to check for a ground fault. A conventional ohmmeter will not reliably detect a ground fault under certain circumstances. To check for a ground fault, use the procedure outlined on pages 40-41.

- If a ground fault does not exist, go to Step 2.
- If a ground fault does exist, keep the power off.

WARNING! *To avoid electric shock, electrocution and terminal venting with ignition, do not energize a compressor that has a ground fault. Mark and red tag the compressor to indicate that there is a ground fault. Do not reconnect the power leads. Tape and insulate each power lead separately. Proceed to Step 2. Do not replace the compressor or energize the system before performing Step 2.*

Step 2: Check for Water in the System

Once the compressor is cool to the touch, open the system process valve slightly to see if any water comes out of the system. **WARNING!** Opening the system process valve while the compressor is hot can cause severe burns from steam coming out of the valve.

If ANY water comes out of the process valve, the entire system ***must*** be replaced. See "replacing a Single-wall Water-utilizing System" below.

If water does not come out of the process valve, there is still a possibility that some water has leaked into the refrigerant side of the system. To address this possibility, determine if the system has a history of losing refrigerant charge without a leak being found or repaired.

If you find ANY indication of a history of losing refrigerant charge without detection of a leak, this is a sign that refrigerant has leaked in the water inside the heat exchanger. The entire system ***must*** be replaced. See "Replacing a Single-wall Water-utilizing System" on page 33.

If you do not find any indication of a history of loss of charge without detection of a leak, you still need to install:

» a high-pressure cut-out which interrupts power to ALL leads to the compressor, **or**

» an external pressure relief valve.

Also, if you found a ground fault in the compressor in Step 1, replace the compressor before applying power to the system.

Start Capacitor Overheating

An overheated start capacitor can burst and spray or splatter hot material that can cause burns. Applying voltage to a start capacitor for more than a few seconds can cause the capacitor to overheat.

Check capacitors with a capacitance meter, and never check a capacitor with the power on.

System Evacuation

Never use a compressor to evacuate a system. Instead, use a high-vacuum pump specifically designed for that purpose.

Never start the compressor while it is under deep vacuum. Always break a vacuum with a minimum 2 psig refrigerant charge before energizing the compressor.

The compressor is cooled primarily by the flow of refrigerant. Running a system that is low on charge will reduce the life of the comperssor.

Failure to follow these instructions can damage the hermetic terminal. As always, to avoid serious injury or death from terminal venting with ignition, never energize the compressor unless the protective terminal cover is securely fastened.

Model and Application

Chapter 2

Tecumseh Compressor Model Number Codes

AE	A	4	4	40	Y	XA	XC
Compressor Family	Release Variant (Generation)	Application	Number of Digits in Rated BTU Capacity	First Two Digits of Rated BTU Capacity	Refrigerant	Voltage	Condensing Units

Compressor Family

AE
AG
AH
AJ
AK
AN
AV
AW
AZ
HG
RG
RK
RN
SA
SF
TP
TH
TW
VS

Release Variant (Generation)

A = 1st
B = 2nd
C = 3rd
etc...

In this example (4) total digits, with the first two (40), or 4,000 BTU capacity

See unit information in ***Condensing Units Fast Reference***

Primary Application Parameters		
Evap Temperature	**Rating Point**	**Motor Starting Torque**
1. Low	-10°F	Normal
2. Low	-10°F	High
3. High	+45°F	Normal
4. High	+45°F	High
5. Air Cond	+45°F	Normal
6. Medium	+20°F	Normal
7. Medium	+20°F	High
8. Air Cond	+49°F	Normal
9. Commercial	+20°F	High
0. Commercial	+20°F	Normal
F. Low – Vapor Inj	-10°F	High
G. Low – Vapor Inj	-10°F	High

Primary Refrigerants
A = R12
B = R410A
C = R407C
E = R22
J = R502
U = R290
M = R600a
Y = R134a
Z = R404A/R507

Voltage Codes
XA = 115-60-1; 100-50-1
XB = 230-60-1; 200-50-1
XC = 220-240-50-1
XD = 208-230-60-1; 200-50-1
XF = 208-230-60-3;200-240-50-3
XG = 460-60-3; 380-420-50-3
XH = 575-60-3; 480-520-50-3
XN = 208-230-60-1; 200-220-50-1
XP = 220-60-1; 200-50-1
XT = 200-230-60-3; 200-220-50-3
XU = 100-60-1; 100-50-1
XV = 265-60-1
AB = 115-60-1; 90-50-1
VA = 265-60-1; 220-240-50-1
NA = 208-230-60-1
AA = 115-60-1

NOTE: For explanation of compressor families and codes, contact Tecumseh Products Company.

FIGURE 2-1: Compressor model number codes

AEA4440YXA XC

Condensing Unit Model Number Codes

- **E and G** = Evaporative Condensate Units
- **S** = Shaded Pole Fan Motor (Celseon)
- **C** = Electrically Commutated Fan Motor (Celseon)
- **X** = A holding character, reserved for future use
- H = Housed Unit

Condensing Unit Features, see chart below

The letters I, O, and Q are eliminated		Fan Cooled	Water Cooled	Air Water Cooled	Receiver Tank	BX Cable	Interconnect Compressor	See B/M	Accumulator
A	Standard Unit	•							
B	Std. Unit W/Receiver Tank	•			•				
C	Std. Unit W/Receiver Tank & BX Cable	•			•	•			
D	Std. Unit W/BX Cable	•				•			
E,F,K	Physical Design Variant (Conduit)	•				•		•	
G,H,J,L,P	Physical Design Variant (Standard)	•						•	
M	Advanced Commercial Design	•			•	•			•
N	Advanced Commercial Design	•				•			•
S	Customer Special							•	
T	Interconnect Compressor						•		
U	Water Cooled - Adv. Commercial Design		•		•	•			•
V	Electrical Special (Conduit Design)	•				•		•	
W	Water Cooled Unit		•		•	•			
X	Interconnect Unit	•			•	•	•		
Y	Air Water Cooled Unit			•		•			
Z	Electrical Special (Standard Unit)	•						•	
Evaporative Condensate Units Plastic Base									
EC	Large Evaporative Condensate Units Black Plastic Base	•							
ED	Large Evaporative Condensate Units Black Plastic Base	•							
EE	Large Evaporative Condensate Units Black Plastic Base	•							
GC	Small - Fan Guard, Power Cord, Receiver Tank, Service Valves				•				
GB	Small - Fan Guard, Power Cord, Receiver Tank				•				
GK	Small - Fan Guard, Power Cord								
GL	Small - Fan Guard								
Outdoor Condensing Units									
HL	Outdoor Condensing Unit with Options	•						•	
Celseon® Air Cooled Units									
CB	Std. Unit W/EC Fan Motor, Sweat Conns, Power Cord & Receiver Tank	•			•				
CC	Std. Unit W/EC Fan Motor, Sweat Conns, Power Cord, Receiver Tank & Service Valves	•			•				
CK	Std. Unit W/EC Fan Motor, Sweat Conns, Power Cord	•							
CS	Std. Unit W/EC Fan Motor, Sweat Conns, Power Cord & Service Valves	•							
SB	Std. Unit W/SP Fan Motor, Sweat Conns, Power Cord & Receiver Tank	•			•				
SC	Std. Unit W/SP Fan Motor, Sweat Conns, Power Cord, Receiver Tank & Service Valves	•			•				
SK	Std. Unit W/SP Fan Motor, Sweat Conns, Power Cord	•							
SS	Std. Unit W/SP Fan Motor, Sweat Conns, Power Cord & Service Valves	•							

FIGURE 2-2: Condensing Unit model number codes

Follow the Labels

Tecumseh Products Company compressors have labels and markings with important information. For your safety and the safety of others, read the labels and markings on the product.

Serial Label Information

The only source for complete compressor information is on the compressor serial label. On earlier compressors, the serial plate is usually spot-welded on the upper housing of the compressor. For current compressors, the serial label is affixed in the same location. Both describe the characteristics of the compressor.

The months are identified in Table 2-1.

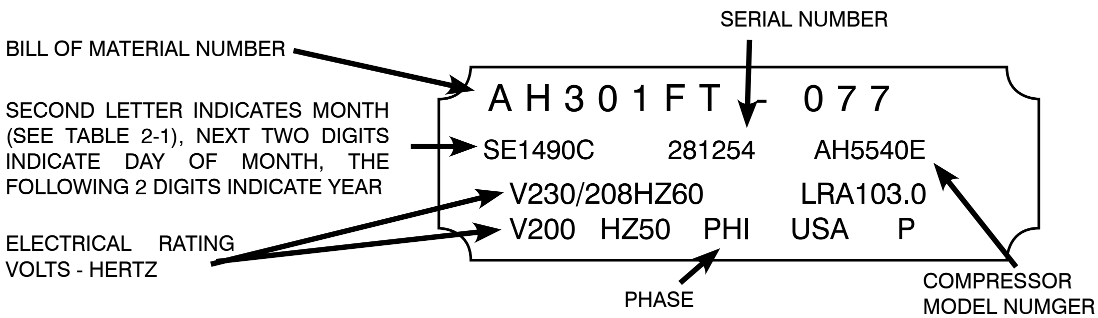


FIGURE 2-3: Example of compressor serial plate

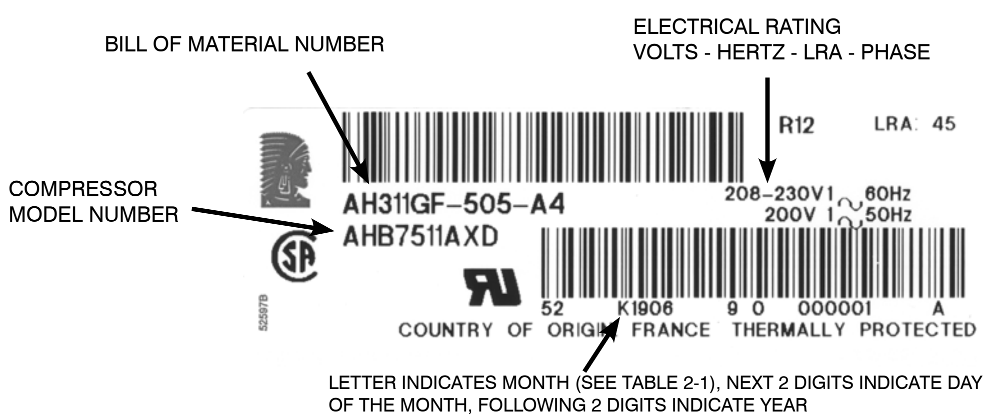


FIGURE 2-4: Example of compressor serial label

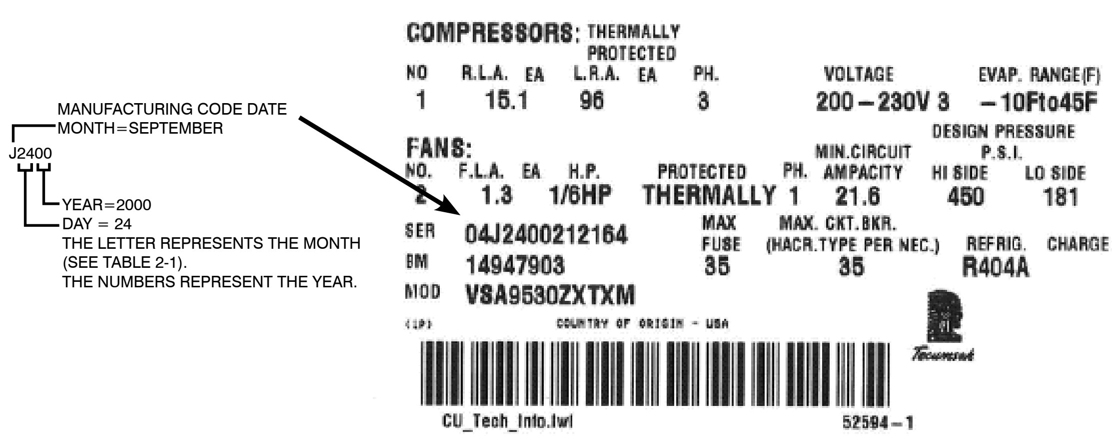


FIGURE 2-5: Example of condensing unit serial label

Table 2-1: Serial Label Month Identifiers			
A – January	D – April	G – July	K – October
B – February	E – May	H – August	L – November
C – March	F – June	J – September	M – December

Basic Application Information for Hermetic Compressors

Tecumseh hermetic compressors are engineered to do specific air conditioning and refrigeration tasks. Hermetic compressors are designed for a particular evaporator temperature range and a specific refrigerant.

Evaporator Temperatures

The key specification is the evaporator temperature of the system. Compressors that are operating outside their design evaporator temperature range can be expected to have poor pumping efficiency and experience motor problems.

Tecumseh hermetic compressors are designed for one of the following evaporator temperature ranges shown in Table 2-2.

Refrigerant

Use only the serial label refrigerant when charging the system. Using a different refrigerant can lead to excess system pressure, damage to the compressor and an explosion. For example, using R-404A in a compressor designed for R-134a can lead to higher operating pressures that can overload the bearings and overwork the motor. Use of a refrigerant other than the serial label refrigerant will void the compressor warranty.

Table 2-2: Evaporator Temperature Ranges

Application	Approved Evaporator Temperatures
Air conditioning	+32°F to +55°F
Improved performance air conditioning	+32°F to +57°F
Heat pump (approved models)	-15°F to +55°F
High evaporator temperature	+20°F to +55°F
Medium evaporator temperature	-10°F to +30°F
Low evaporator temperature (normal torque motor)	-10°F to +30°F
Low evaporator temperature (high torque motor)	-40°F to +10°F
Commercial	0°F to +50°F*
Low Evaporator Temperature - Vapor Injection (high torgue motor)	-40°F to +10°F
Low Evaporator Temperature - Liquid Injection (high torque motor)	-40°F to +10°F

*Some exceptions exist, contact Tecumseh Products Company

Compressor Motor and Component

Chapter 3

Single-phase Compressor Motor Types

Tecumseh hermetic compressors contain motors designed for specific requirements of starting torque and running efficiency. There are four general types of single-phase motors, each distinctly different from the others. Each type of motor may have two to four different configurations depending on the compressor components.

Resistance Start — Induction Run (RSIR)

This motor, also known as a split-phase motor, is used on many small hermetic compressors up through 1/3 HP. The motor has low starting torque and must be applied to complete self-equalizing capillary tube systems such as household refrigerators, freezers, small water coolers, and dehumidifiers. This motor has a high resistance start winding which is not designed to remain in the circuit after the motor has come up to speed (see Figure 3-1). A relay is necessary to perform the function of disconnecting the start winding as the motor comes up to design speed. Three types of relays are used with this motor:

- a current relay,
- a wired-in Positive Temperature Coefficient (PTC) relay (see Figure 3-2), **or**
- a module Positive Temperature Coefficient (PTC) relay.

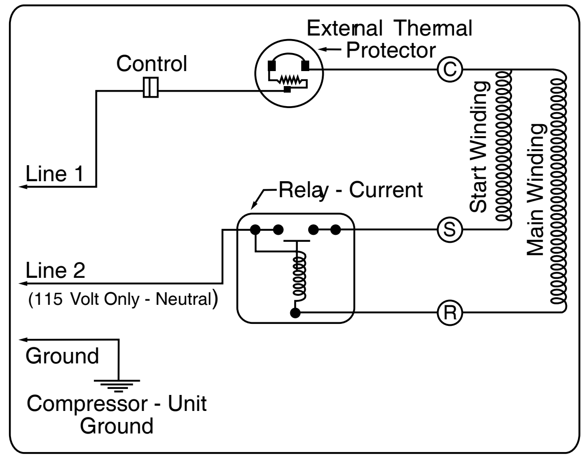


FIGURE 3-1: RSIR motor diagram with current relay

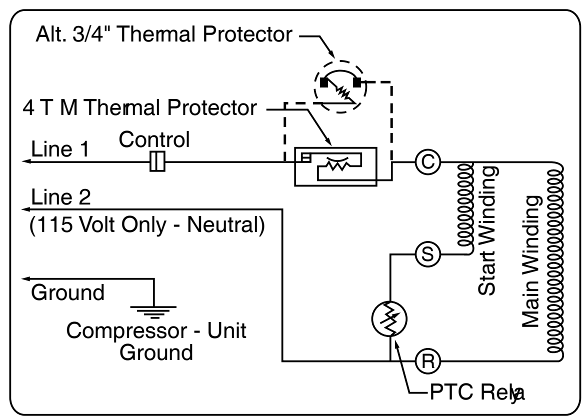


FIGURE 3-2: RSIR motor diagram with wired-in PTC relay

Capacitor Start — Induction Run (CSIR)

The CSIR motor is similar to RSIR except a start capacitor is included in series with start winding to produce a higher starting torque (see Figure 3-3). This is commonly used on commercial refrigeration systems through ¾ HP. Two types of relays are used with this motor:

- a current relay, **or**
- a potential relay.

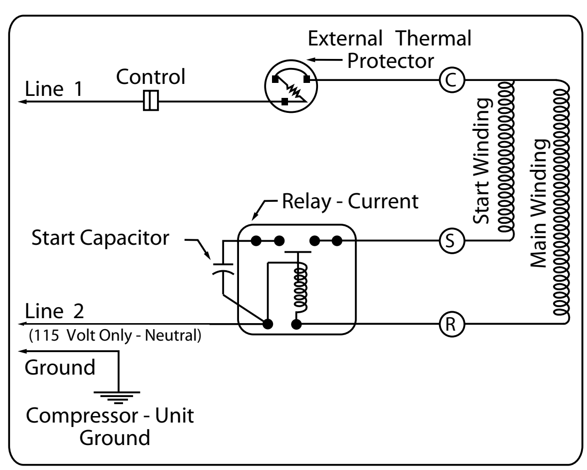


FIGURE 3-3: CSIR motor diagram

Capacitor Start and Run (CSR)

This motor arrangement uses a start capacitor and a run capacitor in parallel with each other and in series with the motor start winding (see Figure 3-4). This motor has high starting torque, runs efficiently, and is used on many refrigeration and air conditioning applications through 5 HP. A potential relay removes the start capacitor from the circuit after the motor is up to speed. This motor may use either:

- an external thermal protector, **or**
- an internal thermal protector.

Permanent Split Capacitor (PSC)

Here a run capacitor is in series with the start winding. Both run capacitor and start winding remain in the circuit during start and after motor is up to speed (see Figure 3-5). This normal starting torque motor is sufficient for capillary and other self-equalizing system. No start capacitor or relay is necessary. For additional starting torque, a proper start assist kit may be added (see Figure 3-6). Some start assist kits may include:

- a wired-in Positive Temperature Coefficient (PTC) relay, **or**
- a module Positive Temperature Coefficient (PTC) relay.

This motor may use either:

- an external thermal protector, **or**
- an internal thermal protector.

PSC motors are basically air conditioning compressor motors and are very common up through 5 HP.

PSC Motor Starting

Tecumseh Products Company pioneered the development of Permanent Split Capacitor compressor motors. This type of motor eliminates the need for potentially troublesome and costly extra electrical components, e.g., start capacitors and potential motor starting relays (see Figure 3-5).

To fully realize the capabilities of this simplified type of compressor motor, it is necessary to understand its starting and operating characteristics and the field conditions that can affect it.

The following conditions affect PSC motor starting:

- *Low voltage:* Reduces motor starting and running torque. A 10% voltage drop reduces a motor's starting ability by 19%. Low voltage can cause no start, hard start, light flicker, and TV screen flip flop.

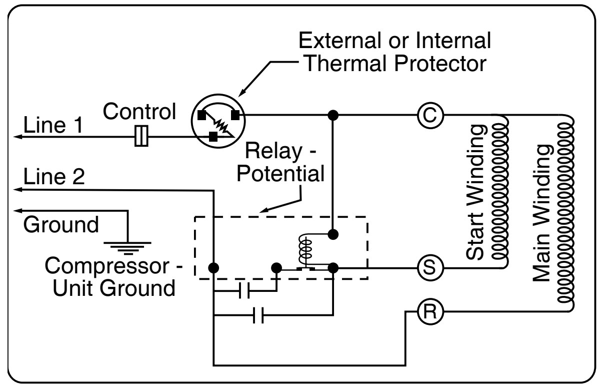


FIGURE 3-4: CSR motor diagram

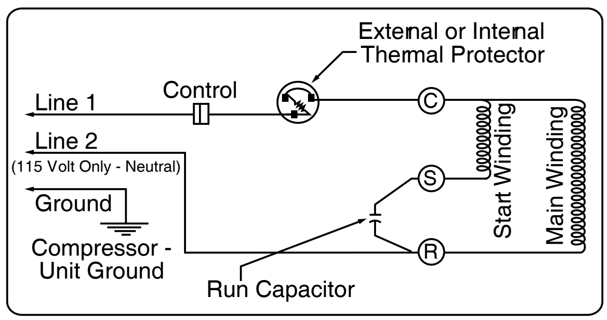


FIGURE 3-5: PSC motor diagram

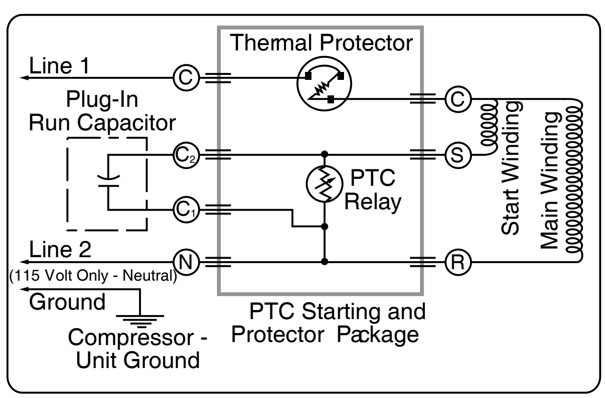


FIGURE 3-6: PSC motor diagram with start assist kit that includes a module PTC relay

Minimum starting voltage for the compressor when it is attempting to start (locked rotor) is listed in Table 3-1.

- *Unequalized system pressure:* Head and suction pressures must be equal and not more than the pressures listed in Table 3-2. Refrigeration metering device (cap tube or TX valve) should equalize system pressure within 3 minutes. Unequal system pressure may be caused by excessive refrigerant charge, short cycling thermostat, or system restriction.
- *Circuit breaker or fuse trips:* Branch circuit fuses or circuit breakers sized too small will cause nuisance tripping (see "Fuse and Circuit Breaker Sizing" on page 27). If the fuse or circuit breaker trips, see "Identifying Compressor Electrical Problems" on pages 40-41 for electrical troubleshooting techniques.
- *Electrical components:* A failed run capacitor will not allow the compressor to start, and it will trip the thermal protector. See "Identifying Compressor Electrical Problems" on pages 40-41 for electrical troubleshooting techniques.

Table 3-1: Minimum Starting Voltage	
Serial Label Voltage	**Min. Voltage for Start**
115	103
208	188
230	207
208/230	198
265	239

Table 3-2: Maximium Equalized Pressures	
Refrigerant	**Maximium Equalized Pressures**
R-410A	275 psig
R-22	170 psig
R-407C	180 psig
R-134a	104 psig
Pressures are at 90°F Ambient	

Hermetic Compressor Thermal Protectors

Hermetic compressor motors are protected from overheating by thermal protectors built into or mounted in contact with the compressor motor. See the Electrical Service Parts Guide Book for correct replacement thermal protectors.

When firmly attached to the compressor housing, the thermal protector device (See Figure 3-8) quickly senses any unusual temperature rise or excess current draw. The bi-metal disc within the thermal protector (see Figure 3-8) reacts to excess temperature and/or excess current draw by flexing downward and disconnecting the compressor from the power source.

Figures 3-9 and 3-10 show the installation of a thermal protector on an AE compressor. Table 3-2 lists useful information about thermal protectors.

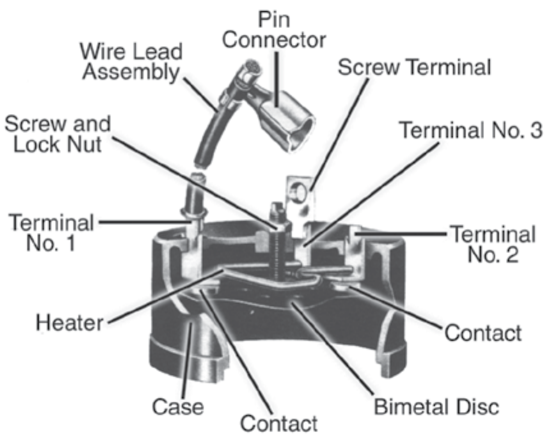


FIGURE 3-7: External thermal protector. (Models AE, TP, TH, AK AJ, CAJ AZ, HG, RK, RG, RN, TW and some CL)

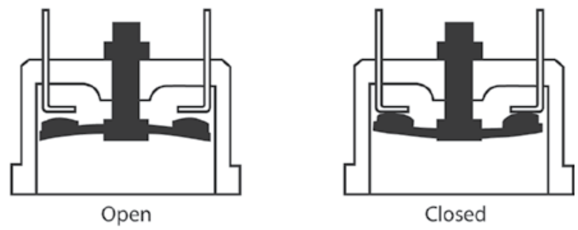


FIGURE 3-8: Bi-metal disc.

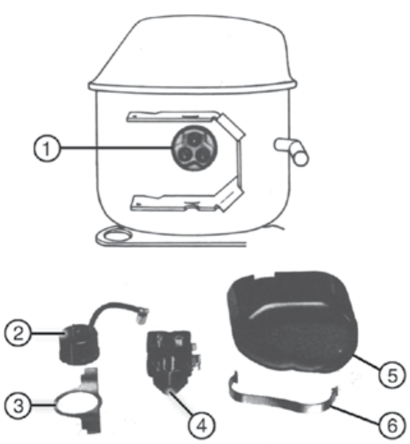


FIGURE 3-9: AE refrigeration compressor showing (1) hermetic terminal, (2) thermal protector, (3) thermal protector clip, (4) push-on relay, (5) protective terminal cover, and (6) bale strap.

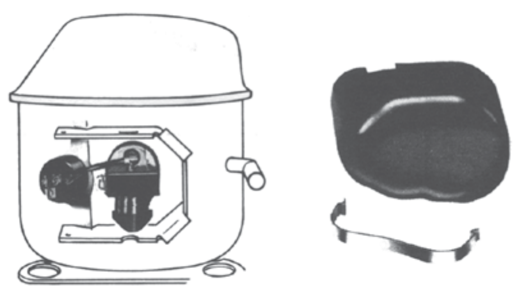


FIGURE 3-10: AE refrigeration compressor with the thermal protector and relay assembled.

Table 3-3: Facts About Thermal Protectors
External Line-Break Thermal Protectors
• Currently used on all AE, AK, AZ, TP, TH, TW, HG, RK, RG, RN, and AJ models. • Sense motor current and housing temperature or combination thereof • Break line current when tripped • Generally do not protect against loss of charge • When, by design, no air flow passes over housing, a special "static" thermal protector must be used • Are designed for specific compressors and their intended application. Make no substitutions • Will not protect motor if compressor is operated outside its evaporator temperature range
Internal Line-Break Thermal Protectors
• Currently used on all AH, AB, AV, AG, AW, VS and most AN, SA and SF models • Sense motor current and motor winding temperature or combination thereof • Break line current when tripped • Generally protect against loss of charge • Will not protect motor if compressor if operated outside its evaporator temperature range • Not repairable or replaceable
Line Voltage-Electronic Protection Module (note - for more specific details consult an authorized wholesaler)
• Originally used on some AN and SF models • Employs use of solid state temperature sensors in motor windings and compressor discharge muffler • Sensor resistance values change with temperature variations • Module will interrupt power to the contactor coil when resistance values of sensors exceed the specified range. This power interruption thus stops the compressor motor • Module provides protection against – Abnormal locked rotor conditions – Loss of refrigerant – High compressor discharge temperatures – Excessive current conditions – Time delays of 3 to 5 minutes occur on power interruption or sensor trip

Internal Thermal Protectors

Internal thermal protectors are completely internal and tamper-proof. They cannot be bypassed.

Single-phase Motor Thermal Protectors

Internal thermal protectors detect excess heat and/or current draw. They are located in the following single-phase motors: AB, AW, AN, AH, AV, AG, and VS.

Three-phase Motor Thermal Protectors

The 31HM, 32HM, 34HM and 35HM on-winding motor protectors are 3-phase line break, automatic reset devices wired in series with each phase at the neutral point and mounted on the windings. They are used in AB, AW, AN, AG, AV and VS models.

Compressor Motor Starting Relays

A hermetic motor starting relay is an automatic switching device to disconnect the motor start capacitor and/or start winding after the motor has reached running speed.

Never select a replacement relay solely by horsepower or other generalized rating. Select the correct relay from the Tecumseh Electrical Service Parts Guide Book.

There are two types of motor starting relays used in refrigeration and air conditioning applications: the current responsive type and the potential (voltage) responsive type.

Current Type Relay

When power is applied to a compressor motor, the relay solenoid coil attracts the relay armature upward causing bridging contact and stationary contact to engage. This energizes the motor start winding. When the compressor motor attains running speed, the motor main winding current is such that the relay solenoid coil de-energizes allowing the relay contacts to drop open thereby disconnecting motor start winding. The relay must be mounted in true vertical position so armature and bridging contact will drop free when relay solenoid is de-energized. See Figure 3-11.

PTC Type Relay

PTC type relay is a solid state current sensitive relay. Certain ceramic materials have the unique property of greatly increasing their resistance as they heat up from current passing through them. A PTC solid state starting device is placed in series with the start winding and normally has a very low resistance. Upon startup, as current starts to flow to the start winding, the resistance rapidly rises to a very high value thus reducing the start winding current to a trickle and effectively taking that winding out of operation. See Figure 3-12.

Usage is generally limited to domestic refrigeration and freezers. Because it takes 3 to 10 minutes to cool down between operating cycles, it is not feasible for short cycling commercial applications.

Potential Type Relay

Potential type relays are generally used with large commercial and air conditioning compressors (capacitor start, capacitor run) to 5 HP. Relay contacts are normally closed. The relay coil is wired across the start winding and senses voltage change. Starting winding voltage increases with motor speed. As the voltage increases to the specific pickup value, the armature pulls up, opening the relay contacts, de-energizing the start winding capacitor. After switching, there is still sufficient voltage induced in the start winding to keep the relay coil energized and the relay starting contacts open. When power is shut off to the motor, the voltage drops to zero, the coil is de-energized, and the start contacts reset. See Figure 3-13.

When changing a compressor relay, care should be taken to install the replacement in the same position as the original. Table 3-4 lists useful information regarding starting relays.

FIGURE 3-11:
Current Type Relay

FIGURE 3-12:
PTC Type Relay

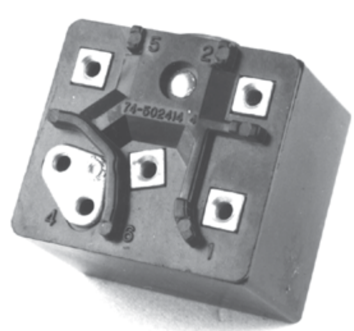


FIGURE 3-13:
Potential Type Relay

Table 3-4: Facts about Starting Relays		
Relay Type	**Compressor Motor Type**	**Characteristics**
Current Relay	RSIR and CSIR	• Sense starting current to main (run) windings • Contacts normally open • Contacts close and then release in less than 1 second as motor starts • Must be installed vertically since contacts open by gravity
PTC Relay	RSIR and PSC	• Sense starting current to start winding • Solid state device whose resistance increases with heat from current as motor starts • Takes 3 to 10 minutes to cool down between operating cycles
Potential Relay	CSR	• Sense voltage generated by start winding • Contacts normally closed • Contacts open in less than 1 second as motor starts

Potential Type Relay Supplier Code Designations

In recent years, Tecumseh has used an increasing number of potential relays with hermetic compressors. A large number of these have been used on air conditioning applications, but there are also many other applications. Since there are many variations with regard to these relays such as number of terminals, coil group, hot pick up, and mounting position, an explanation of the code numbers should be useful in the field.

Tecumseh has two major suppliers of potential relays: the General Electric Company and the White Rodgers Company. An explanation of the code designation for relays manufactured by each of these companies is provided in Figures 3-14 and 3-15.

NOTE: The G.E. and White Rodgers relay model numbers indicate the position the relay is to be mounted. Refer to Figures 3-14, 3-15 and 3-16. It is of utmost importance that the relays be mounted in the required position. Mounting in any other position can change the relay's operating characteristics enough so that the compressor will not start properly. This can result in compressor motor failure.

Example: 3ARR3-A5C3

3ARR3-	A	5	C	3
POTENTIAL RELAY TYPE	NUMBER OF TERMINALS AND BRACKET	COIL GROUP (CONTINUOUS VOLTAGE)	CALIBRATION (HOT PICKUP) (VOLTS)	MOUNTING POSITION

Number of terminals and bracket:

- A = 5 screw terminal "L" bracket
- B = 5 screw terminal flat bracket
- C = 3 screw terminal "L" bracket
- D = 3 screw terminal flat bracket
- U = 5 quick connect terminal "L" bracket

Coil group (continuous voltage):

2 = 168	21=148
3 = 332	22=194
4 = 502	23=292
5 = 253	24=383
6 = 420	25=450
7 = 130	26=479
8 = 214	27=564
10 = 375	28=530

Calibration (hot pickup) (volts):

A = 260-280	P = 170-180
B = 280-300	R = 180-190
C = 300-320	S = 190-200
D = 320-340	T = 200-220
E = 340-360	U = 220-240
F = 350-370	V = 240-260
G = 360-380	W = 210-230
H = 365-395	BA=290-310
J = 120-130	BB=110-120
K = 130-140	TP=170-180
L = 140-150	TV=240-260
M = 150-160	TW=210-230
N = 160-170	

NOTE: Room temperature calibration is 5 to 7% lower than these values.

Mounting position:

See note on page 22.

- 1 = Face down
- 2 = Face up
- 3 = Face out - numbers horizontal
- 4 = Face out - rotated 90° clockwise from number 3 position
- 5 = Face out - numbers upside down - horizontal
- 6 = Face out - rotated 90° counterclockwise from number 3 position

FIGURE 3-14: Explanation of GE Potential Relay Code.

Example: 128-122-1335CA

128-	12	2-	13	3	5	C	A
POTENTIAL RELAY TYPE	TYPE OF BRACKET	CONTACT STRUCTURE	TERMINALS, TYPE AND LOCATION	COIL GROUP (CONTINUOUS VOLTAGE)	MOUNTING POSITION	CALIBRATION (HOT PICK UP) (VOLTS)	CUSTOMER'S PART NUMBER (TO BE STAMPED ON RELAY)

Type of bracket:

- 11 = Flat bracket remote (Tecumseh)
- 12 = "L" bracket (Tecumseh)
- 16 = "L" bracket for "FB" model compressors
- 20 = "L" bracket for Tecumseh Twins = 1½ HP and larger
- 21 = "L" bracket for capacitor box mounting
- 29 = Flat bracket (Marion) was "14" (under cover)

Contact structure:

- 2 = SPNC - less than 1½ HP
- 6 = SPNC - 1½ and larger

Terminals, type and location:

- 11 = 3 screw terminal
- 12 = 4 screw terminal (seldom used)
- 13 = 5 screw terminal
- 23 = 5 quick connect terminals

Coil group (continuous voltage):

- 1 = 130
- 2 = 170
- 3 = 256
- 4 = 336
- 5 = 395
- 6 = 420
- 7 = 495

Calibration (hot pick up) (volts):

A = 260-280	L = 140-150
B = 280-300	M = 150-160
C = 300-320	N = 160-170
D = 320-340	P = 170-180
E = 340-360	R = 180-190
F = 350-370	S = 190-200
G = 360-380	T = 200-220
H = 365-395	U = 220-240
J = 120-130	V = 240-260
K = 130-140	W = 210-230

NOTE: Room temperature calibration is 5 to 7% lower than these values.

Mounting position:

See note on page 22.

- 1 = Face down
- 2 = Face up
- 3 = Face out - numbers horizontal
- 4 = Face out - rotated 90° clockwise from number 3 position
- 5 = Face out - numbers upside down - horizontal
- 6 = Face out - rotated 90° counterclockwise from number 3 position

FIGURE 3-15: Explanation of White Rodgers Potential Relay Code.

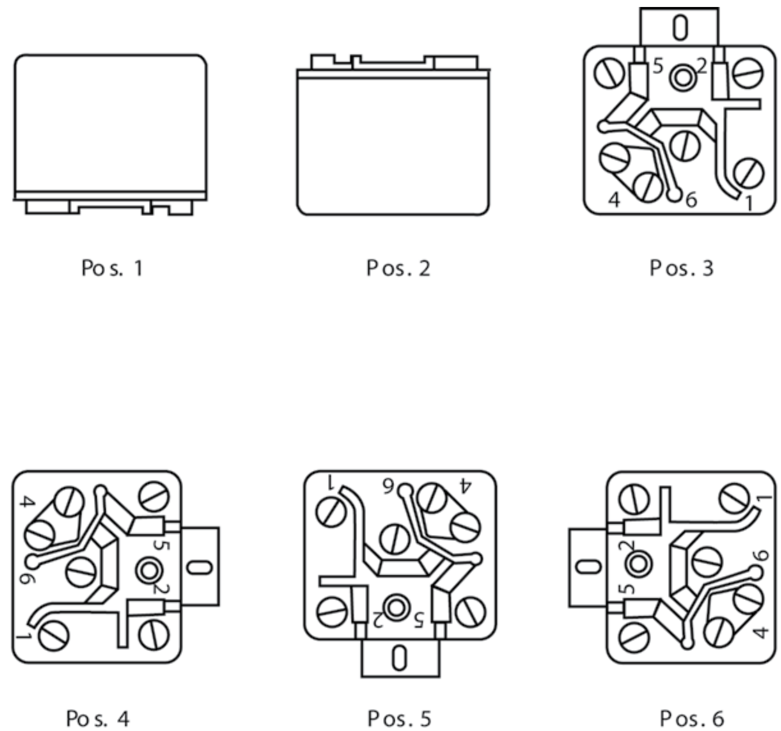


FIGURE 3-16: Potential type relay mounting positions.

Selecting Capacitors

Never use a capacitor with a lower voltage rating than that specified. A higher voltage rating than that specified is acceptable.

Start Capacitor Bleeder Resistors

Modern high power factor, low current single-phase compressor motors which required start and run capacitors used with potential type relays can created electrical circuits which could cause starting relay damage resulting in compressor failure.

The high voltage stored in the start capacitor could discharge across the contacts of the starting relay thus welding them and preventing the relay from functioning. Capacitor failure and/or starting winding failure could result.

To eliminate this, Tecumseh Products Company start capacitors are equipped with bleeder resistors wired across the capacitor terminals. No start capacitor used in conjunction with a potential relay and run capacitor should be installed without such a bleeder resistor.

In an emergency where no bleeder resistor equipped capacitors are available, a two watt 15,000 ohm resistor can be obtained and soldered across the capacitor terminals. See Figure 3-17.

Start Capacitor Substitution

If the specified start capacitor is not available, the next larger sized MFD capacitor at the same or higher voltage rating may be used. Do not add excessive starting capacitance.

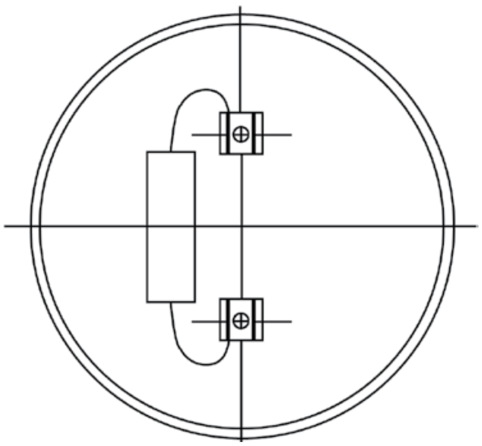


FIGURE 3-18: 15000 OHMS 2 WATT ± 20% bleeder resistor wired across capacitor terminals.

Run Capacitors

Since January 1979, capacitors provided by Tecumseh have contained non-PCB oils or have been constructed using non-PCB impregnated metallized paper electrodes and polypropylene dielectric. These capacitors are protected against case rupture by a device within the capacitor can if failure occurs. The operation of this safety device could cause the terminal end to bulge outward ½". Suitable head space and/or rubber caps should be provided when installing such capacitors.

In some instances, for reasons of both space and economics, it is advantageous to use two capacitors whose MFD values add up to the total amount specified. In these cases, the capacitors should be connected in parallel. Rated voltage for each should not be less than that specified.

The tolerance on a run capacitor is 10%, and therefore only one rating figure is given. You should not go below this figure on any application. You may exceed this figure by a small amount, and the limits are shown in Table 3-5:

Remember the voltage rating of all capacitors must be the same or greater than the original rating. If the voltage rating is not known, use 370 volt capacitors on 115 volt units and 440 volt capacitors on 230 volt units. Table 3-6 lists useful information regarding capacitors.

Table 3-5: Limits for Run Capacitor Ratings

Specific Rating	Maximum Addition
10 to 20 MFD	+ 2 ½ MFD
20 to 50 MFD	+ 5 MFD
Over 50 MFD	+ 10 MFD

Table 3-6: Facts about Capacitors

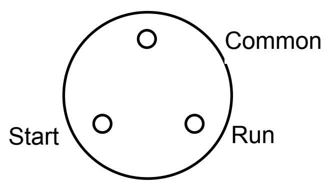
Capacitor Type	Compressor Motor Type	Characteristics
Start Capacitor	CSIR and CSR	• Designed to operate for only a few seconds during start • Taken out of start winding circuit by relay • Excessive start capacitor MFD increases start winding current, increases start winding temperature, and may reduce start torque • Capacitors in CSR motors should have 15,000 ohm, 2 watt bleed resistor across terminals • Capacitor rated voltage must be equal to or more than that specified • Capacitor MFD should not be more than that specified

Table 3-5: Facts about Capacitors continued on next page

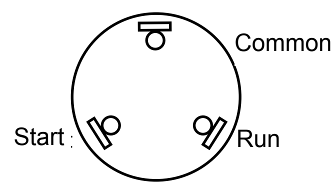
Table 3-6: Facts about Capacitors		
Capacitor Type	**Compressor Motor Type**	**Characteristics**
Run Capacitor	CSR and PSC	• Permanently connected in series with start winding • Excessive MFD increases running current and motor temperature • Fused capacitors not recommended for CSR and not required for PSC motors • Capacitor rated voltage must be equal to more than that specified • Capacitor MFD should not exceed limits shown in Table 3-5 on page 25

Identification of Terminal Pins

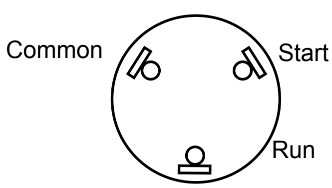
There are several different types of terminals used on the various models of Tecumseh compressors. Tecumseh terminal pins may be considered in the following order: Common, Start, Run. To identify the terminal pins, we read the order exactly as we would read a book, that is, we start at the top left hand corner and read across the first "line" from left to right. We then drop down to the second line starting at the left and read across. Some compressor models have terminal pin identification embossed on the protective terminal cover. While the protective terminal cover may identify the terminal pins, it is primarily designed to reduce the risk of serious injury or death from electrocution or terminal venting with ignition. Never energize the system unless the protective terminal cover is securely fastened.



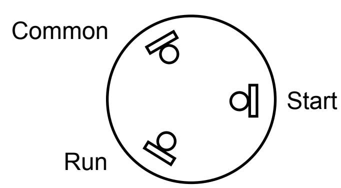
Push-On Terminal Pins
P, R, AP & AR Models (1953 to phaseout)
T & AT Models
AZ & AE (Refrigeration Models)
TH, TP, TW



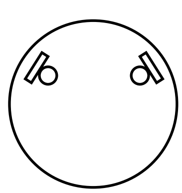
Spade Type Terminal Pins
AU & AR26 Air Conditioning Models
AE Air Conditioning Models
AW, AB, AJ, RK, RG and HG



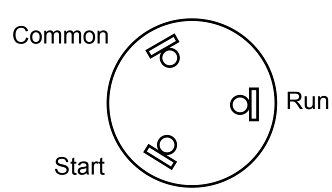
Spade Type Terminal Pins
S & C Models (1955 to phaseout)
AK & VS Models



Spade Type Terminal Pins
AV Models



Internal Thermostat Terminal Pins
Many CL Models



Spade Type Terminal Pins
RN Models

Fuse and Circuit Breaker Sizing

The following information applies to compressor motor branch circuit, short circuit and ground fault protection only.

NEC Article 440

Hermetic compressors should be protected in accordance with Article 440 of the National Electric Code which calls for substantially larger circuit breakers than are required for open type motors.

Maximum Size

The maximum size of the fuse or circuit breaker used to protect against short circuit and/or ground fault of a unit utilizing a hermetic compressor shall be *no more than* the sum of 225% of the compressor Rated Load Amps (RLA) as marked on the system serial label, plus the RLA values of each of the other motors which use the same branch circuit.

Minimum Size

The minimum value of the fuse or circuit breaker shall be *no less than* 175% of the RLA of the compressor. The interpretations and directions given above apply only to single branch power supplies and do NOT pertain to any plug-in type of appliances. Also, see "PSC Motor Starting" on pages 17-18.

Servicing

Chapter 4

Introduction to Servicing

This chapter provides information to assist service personnel in identifying and correcting compressor problems. It provides a general troubleshooting chart that relates complaints or problems to possible causes and solutions. This chapter also provides greater detail about specific compressor problems.

For your safety, read and follow the “General Service Safety Precautions” on pages 2-7.

Before Servicing

Think Safety...

- **Be alert for sounds of arcing** (sizzling, sputtering or popping), inside the compressor. IMMEDIATELY GET AWAY if you hear these sounds.
- **Disconnect ALL electrical power** before removing the protective terminal cover.
- **Never energize the system unless:**
  - the protective terminal cover is securely fastened, and
  - the compressor is properly connected to ground.
- **Never reset a breaker or replace a fuse** without first checking for a ground fault (also known as a short circuit to ground.)

Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions

In certain water-utilizing refrigeration systems, water can leak into the refrigerant side of the system. This can lead to an explosion of system components, including but not limited to, the compressor. If such an explosion occurs, the resulting blast can kill or seriously injure anyone in the vicinity.

Systems at Risk of Explosion

Water-utilizing systems that have single-wall heat exchangers may present a risk of explosion. Such systems may include:

- water source heat pump/air conditioning systems, and
- water cooling systems such as icemakers, water coolers, and juice dispensers.

Water-utilizing systems that have single-wall heat exchangers present a risk of explosion unless they have either:

- a high pressure cut-out which interrupts power to ALL leads to the compressor, or
- an external pressure relief valve.

How an Explosion Occurs

If the refrigerant tubing in the heat exchanger develops a leak, water can enter the refrigerant side of the system. Water entering the refrigerant side can come in contact with live electrical connections in the compressor causing a short circuit or a path to ground. When this occurs, extremely high temperatures can result. The heat build-up creates steam vapor that can cause excessive pressure throughout the entire system. This system pressure can lead to an explosion of the compressor or other system components.

Service Procedures

In light of the risk of explosion, be especially alert for signs of water leaking into the refrigerant side of the system. Whenever servicing or troubleshooting a water-utilizing system, always check to see if it has either a pressure relief valve or a high pressure cut-out as previously described. If the system does not have at least one of these, DISCONNECT ALL ELECTRICAL POWER and look for indications that water has leaked into the refrigerant side of the system. These indications may include:

- Observation of or a report of a blown fuse or tripped circuit breaker.
- Signs that water has leaked to the outside of the system.
- Reports that the system has made gurgling or percolating noises.
- A history of loss of refrigerant charge without a leak being found in the system. NOTE: common leak detection methods will not detect a water-to-refrigerant leak in the system's heat exchanger(s).
- Observation of or a report of the compressor giving off an unusual amount of heat.

If ANY of these indications are present, do the following checks to determine if water has leaked into the refrigerant side:

Step 1: Check for a Ground Fault (a Short to Ground)

Check the compressor for a ground fault (also known as a short circuit to ground) using the procedure outlined in “Identifying Compressor Electrical Problems” on pages 40-41.

- If a ground fault does not exist, go to Step 2.
- If a ground fault does exist, keep the power off. WARNING! To avoid electric shock, electrocution or terminal venting with ignition, do not energize a compressor that has a ground fault. Mark and red tag the compressor to indicate that there is a ground fault. Do not reconnect the power leads. Tape and insulate each power lead separately. Proceed to Step 2. Do not replace the compressor or energize the system before performing Step 2.

Step 2: Check for Water in the System

Once the compressor is cool to the touch, open the system process valve slightly to see if any water comes out of the system. **WARNING!** *Opening the system process valve while the compressor is hot can cause severe burns from steam coming out of the valve.*

If water does come out of the process valve, the entire system must be replaced. See “Replacing a Single-wall Water-utilizing System” below.

If water does not come out of the process valve, there is still a possibility that some water has leaked into the refrigerant side of the system. To address this possibility, determine if the system has a history of losing refrigerant charge without a leak being found or repaired.

If you find ANY indication of a history of losing refrigerant charge without detection of a leak, this is a sign that refrigerant has leaked in the water inside the heat exchanger. The entire system must be replaced. See “Replacing a Single-wall Water-utilizing System” below.

If you do not find any indication of a history of loss of charge without detection of a leak, you still need to install:

- a high-pressure cut-out which interrupts power to ALL leads to the compressor, or
- an external pressure relief valve.

Also, if you found a ground fault in the compressor in Step 1, replace the compressor before applying power to the system.

Replacing a Single-wall Water-utilizing System

When replacing a single-wall water-utilizing system, replace the system with one that has:

- a double-wall heat exchanger(s), or
- a high-pressure cut-out which interrupts power to ALL leads to the compressor, or
- an external pressure relief valve.

Troubleshooting Chart

For your safety, review the “General Service Safety Precautions” (on pages 2-7) before using the troubleshooting chart below. The “General Service Safety Precautions” section provides information on the following topics:

- Trained Personnel Only
- Terminal Venting and Electrocution
- Refrigerants and Other Chemicals
- Compressor Removal
- System Flushing, Purging, and Pressure Testing for Leaks
- System Charging
- Prevention of Water-Utilizing System Explosions
- Start Capacitor Overheating
- System Evacuation

This Troubleshooting Chart (Table 4-1) is not designed to replace the training required for a professional air conditioning/refrigeration service person, nor is it comprehensive.

If you have any questions about returns under warranty, see “Is Your Compressor Eligible for Return Under Warranty” on page 70.

Table 4-1: Troubleshooting Chart

Complaint	Possible Causes	Response
Compressor will not start - no hum	System component not functioning properly: 1. Control/ contactor stuck in open position 2. Control off due to cold location 3. Thermostat not functioning properly	Refer to the original equipment manufacturer (OEM) service information
	Line disconnect switch open	Close the start switch or the disconnect switch
	Circuit breaker tripped or fuse open or removed	Before resetting breaker or replacing fuse, see "Identifying Compressor Electrical Problems" on pages 40-41
	Thermal protector not working properly	See "Identifying Compressor Electrical Problems" on pages 40-41
	Wiring improper or loose	Check against wiring diagram and wire properly
	Compressor motor has a ground fault (also known as a short circuit to ground)	See "Identifying Compressor Electrical Problems" on pages 40-41

Table 4-1: Troubleshooting Chart		
Complaint	**Possible Causes**	**Response**
Compressor will not start - hums but trips on thermal protector	Improperly wired	Check against wiring diagram and wire properly
	Low voltage to compressor	Turn off system until proper voltage is restored
	System component, such as thermostat or control/ contactor, not functioning properly	Refer to the OEM service information
	Compressor electrical problems: 1. Compressor motor has a winding open or shorted 2. Start capacitor not working properly 3. Relay does not close	See "Identifying Compressor Electrical Problems" on pages 40-41
	Liquid refrigerant in compressor	Add crankcase heater and a suction line accumulator. It is difficult to determine how liquid refrigerant got into the compressor. A crankcase heater along with a suction-line accumulator will prevent liquid refrigerant from getting into the compressor
	Internal mechanical trouble in compressor.	See "Checking for Adequate Compressor Pumping" on page 70
Compressor starts, but does not switch off of start winding	Improperly wired	Check against wiring diagram and wire properly
	Low voltage to compressor	Turn off system until proper voltage is restored
	Compressor electrical problems: 1. Compressor motor has a winding open or shorted 2. Relay failing to open 3. Run capacitor not working properly	See "Identifying Compressor Electrical Problems" on pages 40-41

Table 4-1: Troubleshooting Chart		
Complaint	**Possible Causes**	**Response**
Compressor starts, but does not switch off of start winding (continued)	Discharge pressure too high	If this is a water-utilizing system, see "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33 Also refer to the OEM service information
	Internal mechanical trouble in compressor	See "Checking for Adequate Compressor Pumping" on page 70
Compressor starts and runs, but short cycles on thermal protector	Too much current passing through thermal protector: 1. Extra sources of current draw 2. Compressor motor has winding shorted	1. Check wiring diagram. Check for extra sources of current passing through thermal protector (such as fan motors, pumps.) Refer to the OEM service information 2. See "Identifying Compressor Electrical Problems" on pages 40-41
	Low voltage to compressor (single phase) or unbalanced voltage (three-phase)	Turn off system until proper voltage is restored
	Compressor electrical problems, such as thermal protector or run capacitor not working properly	See "Identifying Compressor Electrical Problems" on pages 40-41
	Discharge pressure too high	If this is a water-utilizing system, see "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33. Also, refer to the OEM service information
	Suction pressure too high	If this is a water-utilizing system, see "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33. Also, refer to the OEM service information

Table 4-1: Troubleshooting Chart

Complaint	Possible Causes	Response
Compressor starts and runs, but short cycles on thermal protector (continued)	Return gas too warm	If this is a water-utilizing system, see "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33. Also, refer to the OEM service information
Unit runs OK, but run cycle is shorter than normal (due to component(s) other than thermal protector)	System components, such as thermostat, control or contactor, not functioning properly	Refer to the OEM service information
	High pressure cut-out due to: 1. Insufficient air or water supply 2. Overcharge of refrigerant 3. Air in system 4. Water leak into refrigerant side of a water-utilizing system	1. - 3. Refer to the OEM service information 4. See "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33. Also, refer to the OEM service information
	Low pressure cut-out due to: 1. Liquid line solenoid leaking 2. Undercharge of refrigerant 3. Restriction in expansion device	1. Repair or replace solenoid valve 2. Refer to the OEM service information 3. Repair or replace expansion device
Unit operates long or continuously	Undercharge of refrigerant	If this is a water-utilizing system, see "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33. Also, refer to the OEM service information
	System components, such as thermostat or contactor not functioning properly or control contacts stuck or frozen closed	Refer to the OEM service information

Table 4-1: Troubleshooting Chart		
Complaint	**Possible Causes**	**Response**
Unit operates long or continuously (continued)	Refrigerated or air conditioned space has excessive load or poor insulation, or system inadequate to handle load	Refer to the OEM service information
	Evaporator coil iced	Refer to the OEM service information
	Restriction in refrigeration system	Refer to the OEM service information
	Dirty condenser	Refer to the OEM service information
	Filter dirty	Refer to the OEM service information
Space or cabinet temperature too high	System problems, such as: 1. Control setting too high 2. Expansion device restricted or too small 3. Cooling coils too small 4. Inadequate air circulation	Refer to the OEM service information
	Water leaked into refrigerant side of a water-utilizing system	See "Servicing or Troubleshooting Water-Utilizing Systems: Preventing Explosions" on pages 32-33. Also, refer to the OEM service information
Suction line frosted or sweating	First measure superheat to determine if line frosting or sweating is due to floodback. If floodback is confirmed, possible problems are: 1. Expansion valve passing excess refrigerant or is oversized 2. Expansion valve is stuck open 3. Evaporator fan not running 4. Overcharge of refrigerant	Refer to the OEM service information

Complaint	Possible Causes	Response
Liquid line frosted or sweating	System problems such as, restriction in filter-drier or strainer or liquid shut-off (king valve) partially closed	Refer to the OEM service information
	Water leak into refrigerant side of a water-utilizing system	
System rattles or vibrates during operation	Loose parts or mountings, tubing rattle, bent fan blade causing vibration, fan motor bearings worn, etc	Refer to the OEM service information

Identifying Compressor Electrical Problems

This section describes procedures for checking the compressor's electrical circuits and components. Before doing so, follow the original equipment manufacturer's service information (OEM) to make sure the system is getting proper voltage and that the control, thermostat, and contactor are working properly. If you are servicing a water-utilizing system, see "Servicing or Troubleshooting Water-utilizing Systems: Preventing Explosions" on pages 32-33.

Whenever you suspect that there is an electrical problem with the compressor (for example, there has been a tripped circuit breaker):

- FIRST, check for a ground fault (also known as a short circuit to ground) in the motor using a megohmmeter ("megger") or a Hi-Potential Ground Tester ("Hi-Pot") (See below).
- SECOND, check the motor windings for proper continuity and resistance (See page 42).
- THIRD, check the compressor's electrical components (See pages 43-69).

When checking for electrical problems it is important to follow all safety precautions (see warning below) and use the proper equipment and procedures.

⚠ WARNING ⚠

Oil and refrigerant can spray out of the compressor if one of terminal pins is ejected from the hermetic terminal. This can occur as a result of a ground fault in the compressor. The oil and refrigerant spray can be ignited by electricity and produce flames that can lead to serious burns or death. If this spray is ignited, it is called "terminal venting with ignition."

To reduce the risk of electrocution, serious burns or death from terminal venting with ignition:

- Be alert for sounds of arcing (sputtering or popping) inside the compressor. IMMEDIATELY GET AWAY if you hear these sounds.
- Disconnect ALL electrical power before removing the protective terminal cover.
- Never energize the system unless:
  - »the protective terminal cover is securely fastened, and
  - »the compressor is properly connected to ground.
- Never reset a breaker or replace a fuse without first checking for a ground fault. An open fuse or tripped circuit breaker is a strong indication of a ground fault.

Checking for a Ground Fault (a Short to Ground)

Step 1: Disconnect Power

Disconnect all electrical power supplies to the system, making sure that all power legs are open. (NOTE: the system may have more than one power supply.)

Step 2: Check for a Ground Fault

Remove the protective terminal cover. If there is any evidence of overheating at any lead, this is a good indication that a compressor motor problem exists. At this time, do not replace or reattach leads or connectors that have been damaged by overheating.

Disconnect leads and/or remove all components (such as relays and capacitors) from the terminal pins. **CAUTION:** *If a capacitor is present, discharge before removing it from the system using a 20,000 ohm resistor, to avoid damage to measuring devices and risk of electric shock*. When removing a current type relay, keep it upright.

Check the compressor for a ground fault using either a megohmmeter ("megger") or a Hi-Potential Ground Tester ("Hi-Pot"). See Figure 4-1. **WARNING!** *To reduce the risk of* *electrocution, always follow the manufacturer's procedures and safety rules when using these devices.*

Connect one lead of either the megger or Hi-Pot to the copper suction line. Connect the other lead to one of the terminal pins.

Repeat this procedure for the two remaining terminal pins. If the instrument indicates any resistance less than 2 megohms between any pin and the housing (copper suction line), a ground fault exists.

WARNING! *To avoid electric shock, electrocution, and terminal venting with ignition do not energize a compressor that has a ground fault.*

If a ground fault exists, keep the power off and replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" on pages 83-86. If the compressor is not replaced immediately, mark and red tag the compressor to indicate there is a ground fault. Do not reconnect the power leads. Tape and insulate each power lead separately.

If a ground fault does not exist, leave the power off and all external components disconnected from the terminal pins. Check for continuity and proper resistance using the procedure on page 42.

Why use a megger or Hi-Pot?

Tecumseh Products Company recommends checking for a ground fault only with a megger or Hi-Pot. A conventional ohmmeter will not reliably detect a ground fault under certain circumstances.

A megger is a special type of ohmmeter that is capable of measuring very high resistances by using high voltages. A Hi-Pot is a device that uses high voltages to measure the flow of current across the insulation. Unlike an ohmmeter, even one that can measure millions of ohms, a megger or a Hi-Pot can detect a breakdown in motor winding insulation before the motor fails.

WARNING! *To reduce the risk of electrocution, always follow the manufacturers' procedures and safety rules.*

FIGURE 4-1: *Top:* Amprobe megohmmeter (commonly referred to as a "megger"). (Photo courtesy of Amprobe.) *Bottom:* A Slaughter Hi-Potential Ground Tester (commonly referred to as a "Hi-Pot"). (Photo courtesy of Slaughter.)

Checking for Continuity and Proper Resistance

If no ground fault has been detected using the procedures on pages 40-41, determine whether there is an open or short circuit in the motor windings or if the heater element of the thermal protector is open. Use the procedure in Table 4-2 to check single- and 3-phase motors.

Table 4-2: Checking for Proper Continuity and Resistance

		Single Phase Compressors	3-Phase Compressors
Step One	Allow Thermal Protector to Reset	When servicing single compressors with internal thermal protectors, be sure to allow time for the thermal protector to reset prior to starting these electrical wiring checks. For some compressors, the internal thermal protector may take as long as an hour to reset	When servicing 3-phase compressors with internal thermal protectors, be sure to allow time for the thermal protector to reset prior to starting these electrical wiring checks. For some compressors, the internal thermal protector may take as long as an hour to reset
Step Two	Check Continuity	Check the start winding by measuring continuity between terminal pins C and S. (See "Identification of Terminal Pins" on page 26. If there is no continuity, replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" on pages 83-86. Check the run winding by measuring continuity between terminal pins C and R. If there is no continuity, replace the compressor.	Check the windings by measuring between each pair of terminal pins: Leg_1 - Leg_2, Leg_2 - Leg_3, and Leg_1 - Leg_3. If there is no continuity, replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" on pages 83-86.
Step Three	Measure the Resistance	Measure the resistance (ohms) between each pair of terminal pins: C and S, C and R, and S and R. Add the resistance between C and S to the resistance between C and R. This sum should equal the resistance found between S and R. A small deviation in the comparison is acceptable. Proper resistance may also be confirmed by comparing measured resistance to the resistance specifications for the specific compressor model. Call 1-800-211-3427 to request resistance specifications. If the resistance is not correct, replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" on pages 83-86. If the resistance is correct, leave the leads off and follow the instructions in the next section to check other compressor electrical components.	Measure the resistance (ohms) between each pair of terminal pins: Leg_1 - Leg_2, Leg_2 - Leg_3, and Leg_1 - Leg_3. The resistance found between each of the pairs Leg_1 - Leg_2, Leg_2 - Leg_3, and Leg_1 - Leg_3 should all be greater than zero and within approximately 10% of one another. Proper resistance may also be confirmed by comparing measured resistance to the resistance specifications for the specific compressor model. Call 1-800-211-3427 to request resistance specifications. If the resistance of Leg_1 - Leg_2, Leg_2 - Leg_3, and Leg_1 - Leg_3 does not approximate the resistance of each other, then there is a short circuit. Replace the compressor. See "System Cleanup and Compressor Replacement After Compressor Failure" on pages 83-86.

Checking for Other Electrical Problems in Single-phase Motors

This section provides procedures for checking the components such as the thermal protector, relay and capacitor in a single-phase compressor. Table 4-3 (below) can be used to locate the appropriate procedure for the compressor you are servicing. Examine the compressor and determine presence and/or the type of:

- Thermal protector (internal or external)
- Relay (current, potential or PTC)
- Capacitor(s) (start or run)

With that information, use Table 4-3 to determine the location of the procedure for the compressor you are servicing.

For more information on:

- Compressor motor types, see “Single-phase Compressor Motor Types” on pages 16-17.
- Thermal protectors, see “Hermetic Compressor Thermal Protectors” on page 19.
- Starting relays, see “Compressor Motor Starting Relays” on pages 21-24.
- Capacitors, see “Selecting Capacitors” on pages 24-26.

Table 4-3: Locating Service Procedures by Component Types

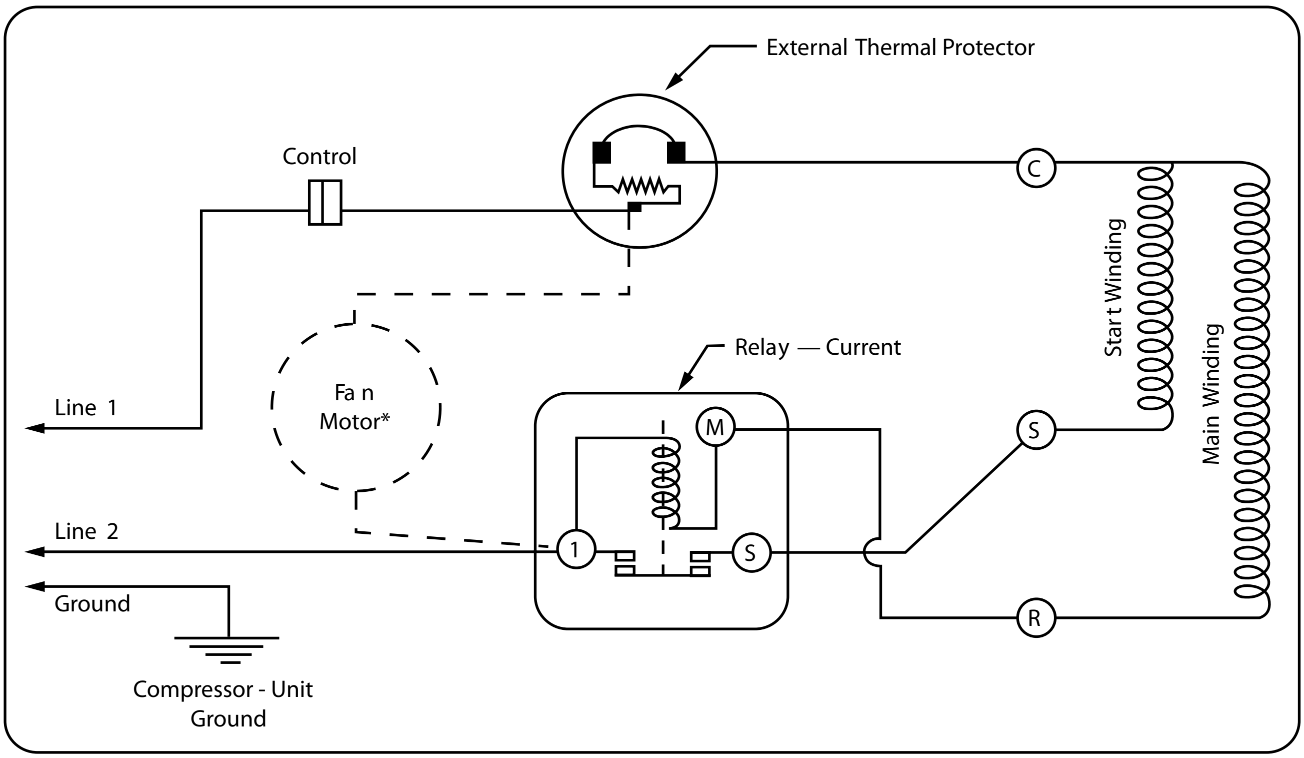
If your compressor has:								Go To:
Compressor Motor Type	Thermal Protector Type		Relay Type			Capacitor Type		Page
	Internal	External	Current	Potential	PTC	Run	Start	
Resistance Start Induction Run (RSIR) (Split-Phase)		√	√					44
		√			WIRED			46
		√			MODULE			48
Capacitor Start Induction Run (CSIR)		√	√				√	50
		√		√			√	53
Capacitor Start and Run (CSR)		√		√		√	√	56
	√			√		√	√	59
Permanent Split Capacitor (PSC)		√				√		62
	√					√		64
		√			WIRED	√		66
		√			MODULE	√		68

This RSIR (Split-Phase) compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√	√				

The electrical system on this type of motor is shown in FIGURE 4-2. The actual position of terminals on the relay may be different than shown in FIGURE 4-2. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-2: RSIR compressor motor with external thermal protector and current type relay mounted on hermetic terminal.

Step 1: Before Continuing with Troubleshooting…

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked with windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 4: Check Current Relay

Keep the relay upright. Check the relay by measuring continuity between:

Relay terminals 1 (or L) and S. If there is continuity, then the contacts are closed when they should be open. Replace the current relay.

Relay terminals 1 (or L) and M. If there is no continuity, replace the current relay.

Step 5: Replace Current Relay

If all above tests prove satisfactory, there is no capillary restriction, and the unit still fails to operate properly, replace the relay. The new relay will eliminate any electrical problems which cannot be determine with the above tests.

Step 6: Continue Troubleshooting

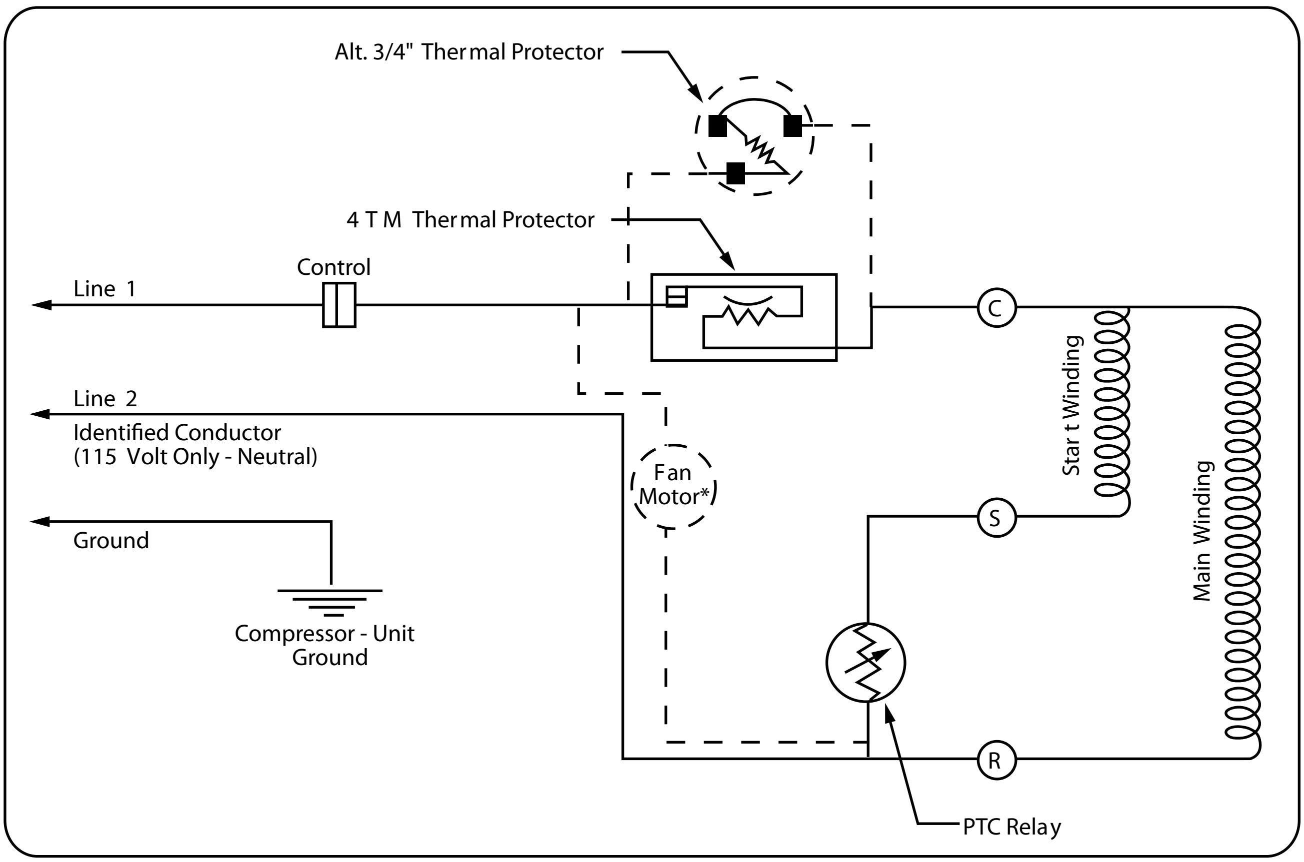
If the new relay does not correct the problem, check for adequate compressor pumping as outlined in the procedure on page 70.

This RSIR (Split-Phase) compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√			√ WIRED		

The electrical system on this type of motor is shown in FIGURE 4-3. The actual position of terminals on the relay may be different than shown in FIGURE 4-3. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-3: RSIR compressor motor with external thermal protector and wired-in PTC relay.

Step 1: Before Continuing Troubleshooting…

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check Wired-in PTC Relay

Check the relay by measuring continuity between the pin holes where the R and S pins on the compressor are inserted. If there is no continuity, the relay may be open. Wait 3 minutes, then check continuity again. If there is still no continuity, replace the relay.

Step 4: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 5: Continue Troubleshooting

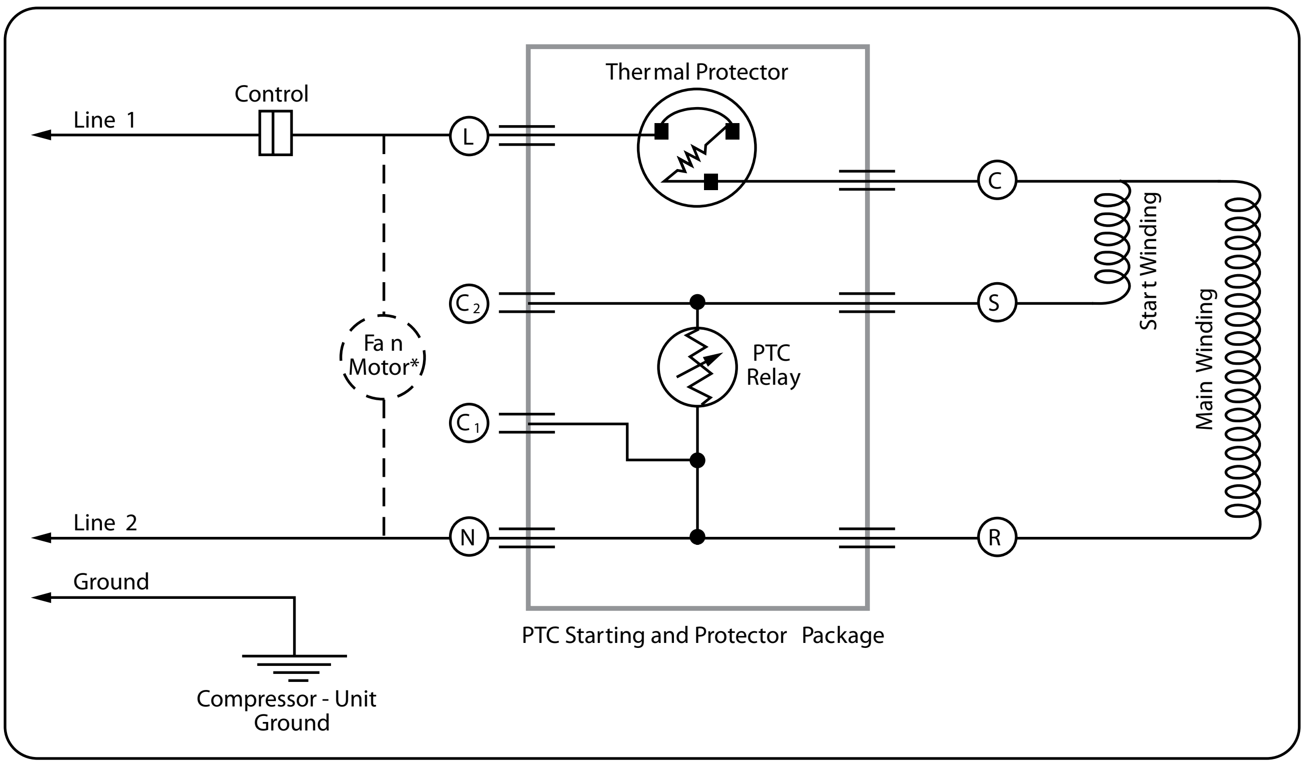
If all above tests prove satisfactory and unit still fails to operate properly check for adequate compressor pumping as outlined in the procedure on page 70.

This RSIR (Split-Phase) compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√			√ MODULE		

The electrical system on this type of motor is shown in FIGURE 4-4. The actual position of terminals on the relay may be different than shown in FIGURE 4-4. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-4: RSIR compressor motor type with external PTC starting and protector package.

Step 1: Before Continuing with Troubleshooting…

WARNING! All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41). You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

For GE modules, replace the entire starting and protector package.

For TI (Sensata) modules, replace the thermal protector.

Step 4: Check Module PTC Relay

Check the relay be measuring continuity between the starting and protector package pin holes where the R and S pins on the compressor are inserted. If there is no continuity, the relay may be open. Wait 3 minutes, then check continuity again. If there is still no continuity, replace the protector package.

Step 5: Continue Troubleshooting

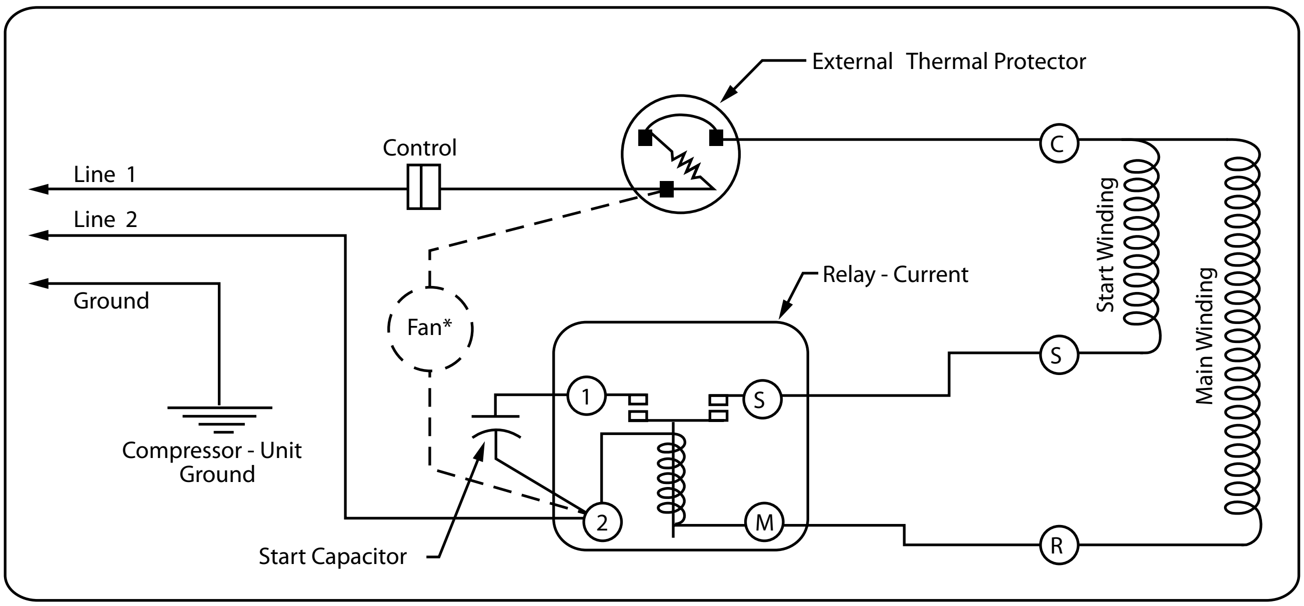
If all above tests prove satisfactory and unit still fails to operate properly, check for adequate compressor pumping as outlined in the procedure on page 70.

This CSIR compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√	√				√

The electrical system on this type of motor is shown in FIGURE 4-5. The actual position of terminals on the relay may be different than shown in FIGURE 4-5. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-5: CSIR compressor motor type with external protector, current type relay mounted on hermetic terminal and start capacitor.

Step 1: Before Continuing with Troubleshooting…

WARNING! All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41). You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 4: Check Current Relay

Keep the relay upright. Check the relay by measuring continuity between:

Relay terminals 1 and S. If there is continuity, then the relay contacts are closed when they should be open. Replace the current relay.

Relay terminals 2 and M. If there is no continuity, replace the current relay.

Step 5: Check Start Capacitor

CAUTION: *using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.* Disconnect the start capacitor from the system. Use a capacitance meter to measure the capacitance. The capacitance value should be the rated value minus 0% to plus 20%. If it is outside of this range, then the start capacitor needs to be replaced.

As an alternative, check the start capacitor by measuring continuity across capacitor terminals:

- Rx1 scale: If there is continuity, then the start capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the start capacitor is open and needs to be replaced.

Possible reasons that a start capacitor is not working properly include:

- **Use of incorrect start capacitor.** Replace with proper start capacitor.
- **The relay contacts are not working properly.** Replace the relay.
- **Prolonged operation on start cycle due to low voltage.** Determine if the line voltage is too low (less than 90% of rated voltage).
- **Prolonged operation on start cycle due to incorrect relay.** Replace with correct relay.

- **Prolonged operation on start cycle due to starting load too high.** Refer to the OEM service information to use pump down arrangement, if necessary.
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For more information on troubleshooting the system components, refer to the OEM service information.

Step 6: Replace Current Relay

If all above tests prove satisfactory, there is no capillary restriction, and the unit still fails to operate properly, replace the relay. The new relay will eliminate any electrical problems which cannot be determined with above tests.

Step 7: Continue Troubleshooting

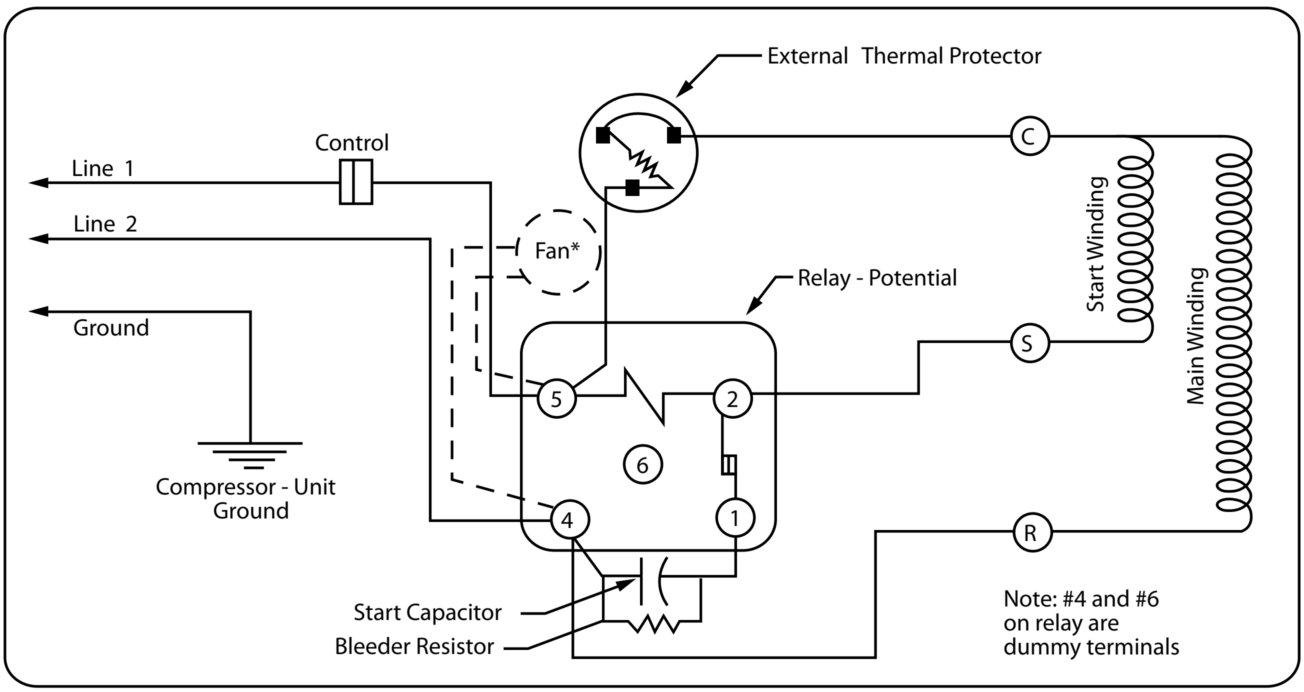
If the new relay does not correct the problem, check for adequate compressor pumping as outlined in the procedure on page 70.

This CSIR compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√		√			√

The electrical system on this type of motor is shown in FIGURE 4-6. The actual position of terminals on the relay may be different than shown in FIGURE 4-6. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-6: CSIR compressor motor type with external thermal protector, potential relay mounted remote and start capacitor.

Step 1: Before Continuing with Troubleshooting…

WARNING! All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41). You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 4: Check Protector Wiring

Confirm that there is continuity between:

The power input terminal on the thermal protector and 5 on relay.

The protector common lead wire and C.

Step 5: Check Potential Relay

Before checking the relay, be sure it is mounted at the proper position (see pages 28-32). Check the potential relay by measuring continuity between:

- Relay terminals 5 and 2. If there is no continuity, replace the relay.
- Relay terminals 2 and 1. If there is no continuity, then the contact are open. Replace the relay.

Possible reasons that a relay is not working properly include:

- **Use of incorrect relay.** Replace with correct relay.
- **Line voltage is too high or low (greater than 100% or less than 90% of rated voltage).**
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For more information on troubleshooting the thermal protector, see Step 3. For troubleshooting the system components, refer to the OEM service information.
- **Vibration due to loose relay mounting.** Tighten relay mounting.
- **Use of incorrect run capacitor.** Replace with proper run capacitor.

Step 6: Check Start Capacitor

CAUTION: using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.

Disconnect the start capacitor from the system. Remove the bleed resistor. Use a capacitance meter to measure the capacitance. The capacitance value should be the rated value minus 0% to plus 20%. If it is outside of this range, then the start capacitor needs to be replaced.

As an alternative, check the start capacitor by measuring continuity across the capacitor terminals.

Using the Rx1 ohm scale: If there is continuity the start capacitor is shorted and needs to be replaced.

Using the Rx100,000 ohm scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the start capacitor is open and needs to be replaced.

Possible reasons that a start capacitor is not working properly include:

- **Use of incorrect start capacitor.** Replace with proper start capacitor.
- **The relay contacts are not working properly.** Replace the relay.
- **Prolonged operation on start cycle due to low voltage.** Determine if the line voltage is too low (less than 90% of rated voltage).
- **Prolonged operation on start cycle due to incorrect relay.** Replace with correct relay.
- **Prolonged operation on start cycle due to starting load too high.** Refer to the OEM service information to use pump down arrangement if **necessary.**
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For more information on troubleshooting the thermal protector, see Step 3. For troubleshooting the system components, refer to the OEM service information.

Step 7: Check Protector Wiring

Confirm that there is continuity between 2 and S and between 4 and R, then reconnect unit.

Step 8: Replace Potential Relay

If all above tests prove satisfactory, there is no capillary restriction, and the unit still fails to operate properly, replace the relay. The new relay will eliminate any electrical problems which cannot be determined with above tests.

Step 9: Continue Troubleshooting

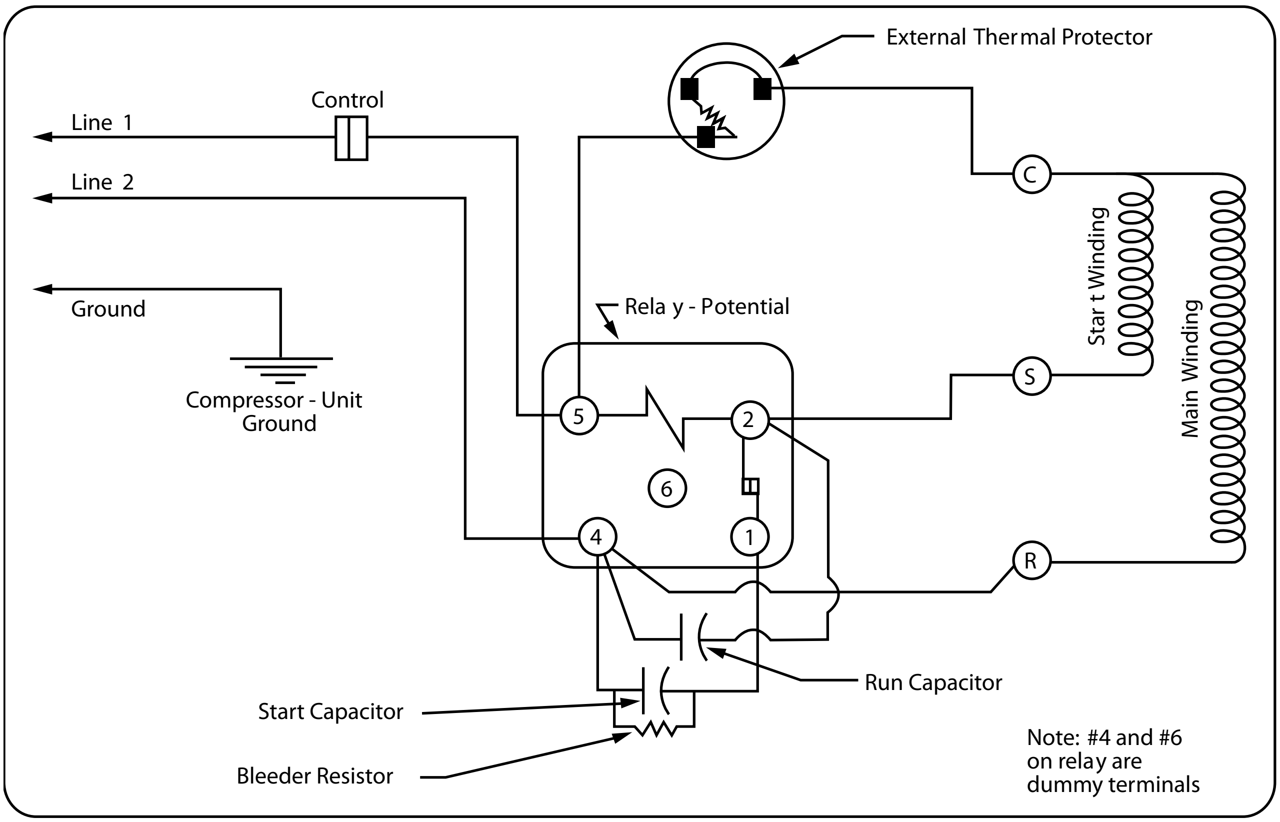
If the new relay does not correct the problem, check for adequate compressor pumping as outlined in the procedure on page 70.

This CSR compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√		√		√	√

The electrical system on this type of motor is shown in FIGURE 4-7. The actual position of terminals on the relay may be different than shown in FIGURE 4-7. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-7: CSR compressor motor type with external thermal protector, potential relay mounted remote and run and start capacitors.

Step 1: Before Continuing with Troubleshooting…

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Check Potential Relay

Before checking the relay, be sure it is mounted at the proper position (see pages 21-23). Check the potential relay by measuring continuity between:

- Relay terminals 5 and 2. If there is no continuity, replace the relay.
- Relay terminals 2 and 1. If there is no continuity, then the contacts are open. Replace the relay.

Possible reasons that a relay is not working properly include:

- **Use of incorrect relay.** Replace with correct relay.
- **Line voltage is too high or low** (greater than 110% or less than 90% of rated voltage).
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For more information on troubleshooting the thermal protector, see Step 5. For troubleshooting the system components, refer to the OEM service information.
- **Vibration due to loose relay mounting.** Tighten relay mounting.
- **Use of incorrect run capacitor.** Replace with proper run capacitor.

Step 3: Check Run Capacitor

CAUTION: *using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.* Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be 10% of the marked capacitor value.

As an alternative, check the run capacitor by measuring continuity across the capacitor terminals:

- Rx1 scale: If there is continuity, then the run capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the run capacitor is open and needs to be replaced.

Possible reasons that a run capacitor is not working properly include:

- **Use of incorrect run capacitor.** Replace with proper run capacitor.
- **Line voltage is too high** (greater than 100% of rated voltage).

Step 4: Check Start Capacitor

CAUTION: using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.

Disconnect the start capacitor from the system. Remove the bleed resistor. Use a capacitance meter to measure the capacitance. The capacitance value should be the rated value minus 0% to plus 20%. If it is outside of this range, then the start capacitor needs to be replaced.

As an alternative, check the start capacitor by measuring continuity across the capacitor terminals.

Using the Rx1 ohm scale: If there is continuity the start capacitor is shorted and needs to be replaced.

Using the Rx100,000 ohm scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the start capacitor is open and needs to be replaced.

Possible reasons that a start capacitor is not working properly include:

- **Use of incorrect start capacitor.** Replace with proper start capacitor.
- **The relay contacts are not working properly.** Replace the relay.
- **Prolonged operation on start cycle due to low voltage.** Determine if the line voltage is too low (less than 90% of rated voltage).
- **Prolonged operation on start cycle due to incorrect relay.** Replace with correct relay.
- **Prolonged operation on start cycle due to starting load too high.** Refer to the OEM service information to use pump down arrangement if necessary.
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For troubleshooting the system components, refer to the OEM service information.

Step 5: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 6: Check Wiring

Confirm that there is continuity between 5 and C, 2 and S, and 4 and R. Reconnect wiring.

Step 7: Replace Potential Relay

If all above tests prove satisfactory, there is no capillary restriction, and the unit still fails to operate properly, replace the relay. The new relay will eliminate any electrical problems which cannot be determined with above tests.

Step 8: Continue Troubleshooting

If the new relay does not correct the problem, check for adequate compressor pumping as outlined in the procedure on page 70.

This CSR compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
√			√		√	√

The electrical system on this type of motor is shown in FIGURE 4-8 and 4-9. The actual position of terminals on the relay may be different than shown in FIGURE 4-8 and 4-9. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.

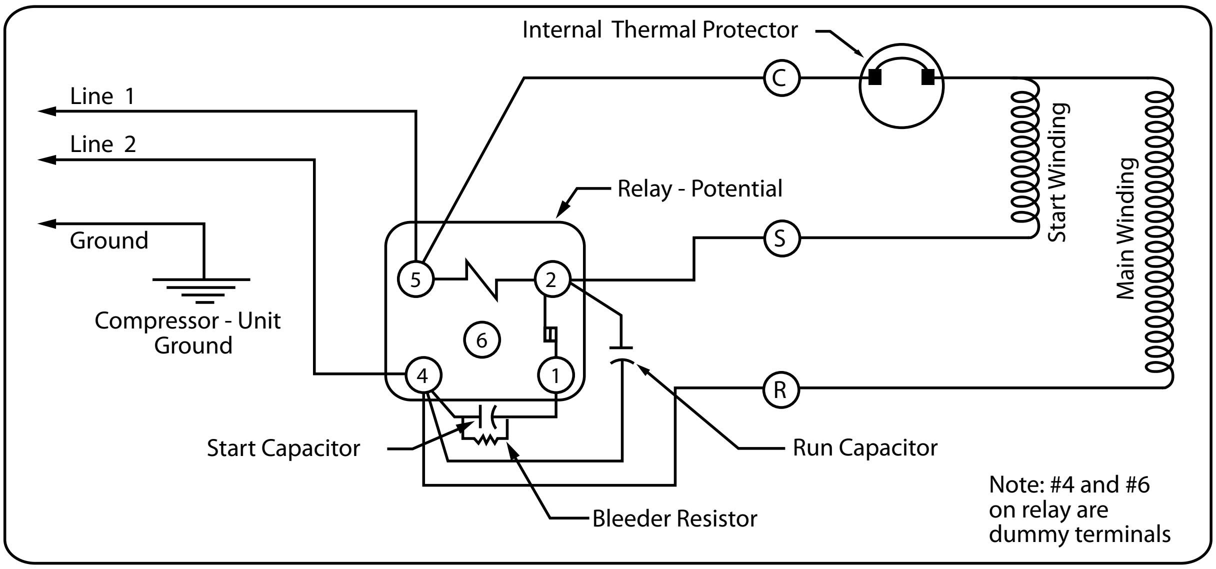


FIGURE 4-8: CSR compressor motor type with internal thermal protector without start winding protection, potential relay and run and start capacitors.

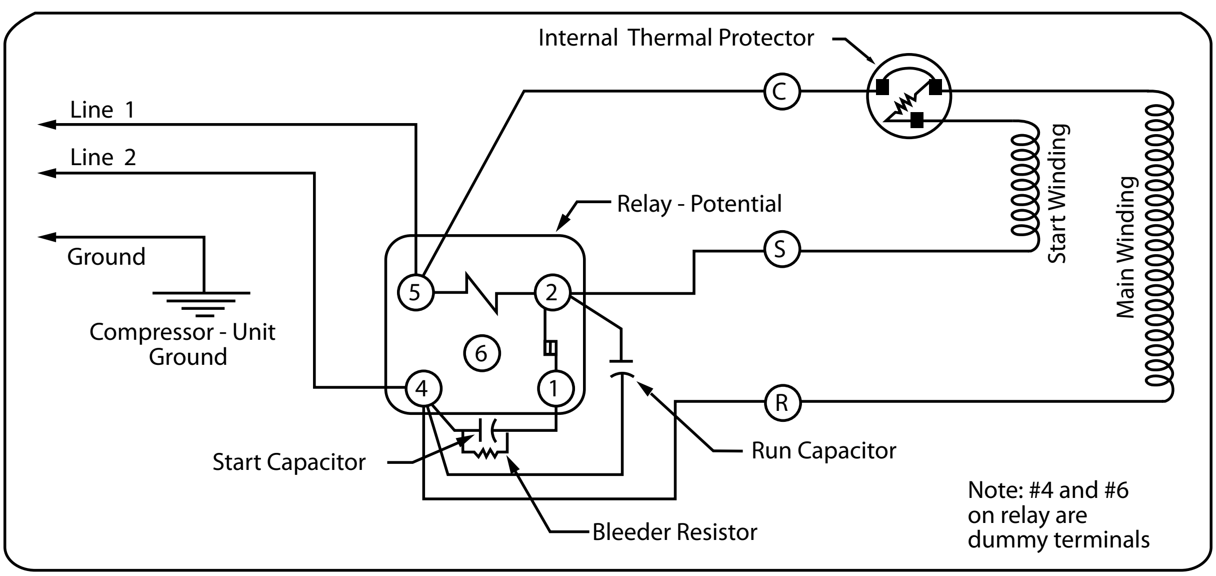


FIGURE 4-9: CSR compressor motor type with internal thermal protector with start winding protection, potential relay and run and start capacitors.

Step 1: Before Continuing with Troubleshooting

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

NOTE: the compressor housing MUST be at 130°F or less for the following checks. This temperature can be read by Tempstik or is that temperature which will allow the hand to remain in contact with the compressor housing without discomfort.

Step 2: Check Internal Thermal Protector

If there is continuity between all terminals the thermal protector should be good. If R to S has continuity and R to C and S to C do not, the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the compressor.

Step 3: Check Run Capacitor

CAUTION: *using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.* Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be 10% of the marked capacitor value.

As an alternative, check the run capacitor by measuring continuity across the capacitor terminals:

- Rx1 scale: If there is continuity, then the run capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the run capacitor is open and needs to be replaced.

Possible reasons that a run capacitor is not working properly include:

- **Use of incorrect run capacitor.** Replace with proper run capacitor.
- **Line voltage is too high** (greater than 100% of rated voltage)**.**

Step 4: Check Potential Relay

Before checking the relay, be sure it is mounted at the proper position (see pages 28-32). Check the potential relay by measuring continuity between:

- Relay terminals 5 and 2. If there is no continuity, replace the relay.
- Relay terminals 2 and 1. If there is no continuity, then the contacts are open. Replace the relay.

Possible reasons that a relay is not working properly include:

- **Use of incorrect relay.** Replace with correct relay.
- **Line voltage is too high or low** (greater than 110% or less than 90% of rated voltage).
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For more information on troubleshooting the thermal protector, see Step 2. For troubleshooting the system components, refer

to the OEM service information.

- **Vibration due to loose relay mounting.** Tighten relay mounting.
- **Use of incorrect run capacitor.** Replace with proper run capacitor.

Step 5: Check Start Capacitor

CAUTION: using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.

Disconnect the start capacitor from the system. Remove the bleed resistor. Use a capacitance meter to measure the capacitance. The capacitance value should be the rated value minus 0% to plus 20%. If it is outside of this range, then the start capacitor needs to be replaced.

As an alternative, check the start capacitor by measuring continuity across the capacitor terminals.

Using the Rx1 ohm scale: If there is continuity the start capacitor is shorted and needs to be replaced.

Using the Rx100,000 ohm scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the start capacitor is open and needs to be replaced.

Possible reasons that a start capacitor is not working properly include:

- **Use of incorrect start capacitor.** Replace with proper start capacitor.
- **The relay contacts are not working properly.** Replace the relay.
- **Prolonged operation on start cycle due to low voltage. Determine if the line voltage is too low** (less than 90% of rated voltage)**.**
- **Prolonged operation on start cycle due to incorrect relay.** Replace with correct relay.
- **Prolonged operation on start cycle due to starting load too high.** Refer to the OEM service information to use pump down arrangement if necessary.
- **Excessive short cycling.** Short cycling can be caused by problems with the compressor's thermal protector or system components such as the thermostat, control, contactor, or high or low pressure cut-out. For more information on troubleshooting the thermal protector, see Step 2. For troubleshooting the system components, refer to the OEM service information.

Step 6: Replace Potential Relay

If all above tests prove satisfactory, there is no capillary restriction, and the unit still fails to operate properly, replace the relay. The new relay will eliminate any electrical problems which cannot be determined with above tests.

Step 7: Continue Troubleshooting

If the new relay does not correct the problem, check for adequate compressor pumping as outlined in the procedure on page 70.

This PSC compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√				√	

The electrical system on this type of motor is shown in FIGURE 4-10.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.

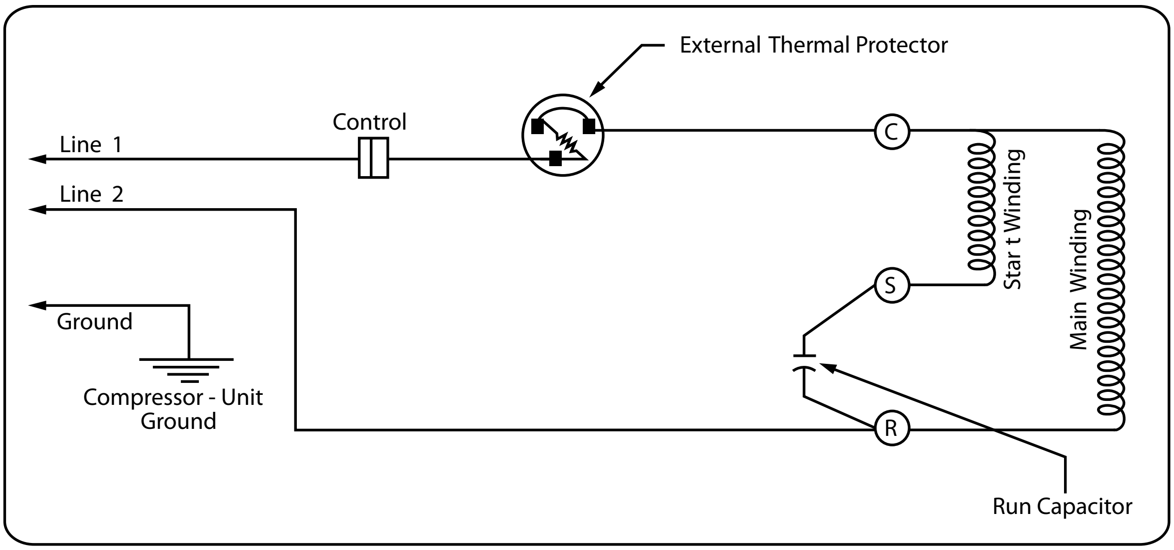


FIGURE 4-10: PSC compressor motor with external thermal protector and run capacitor.

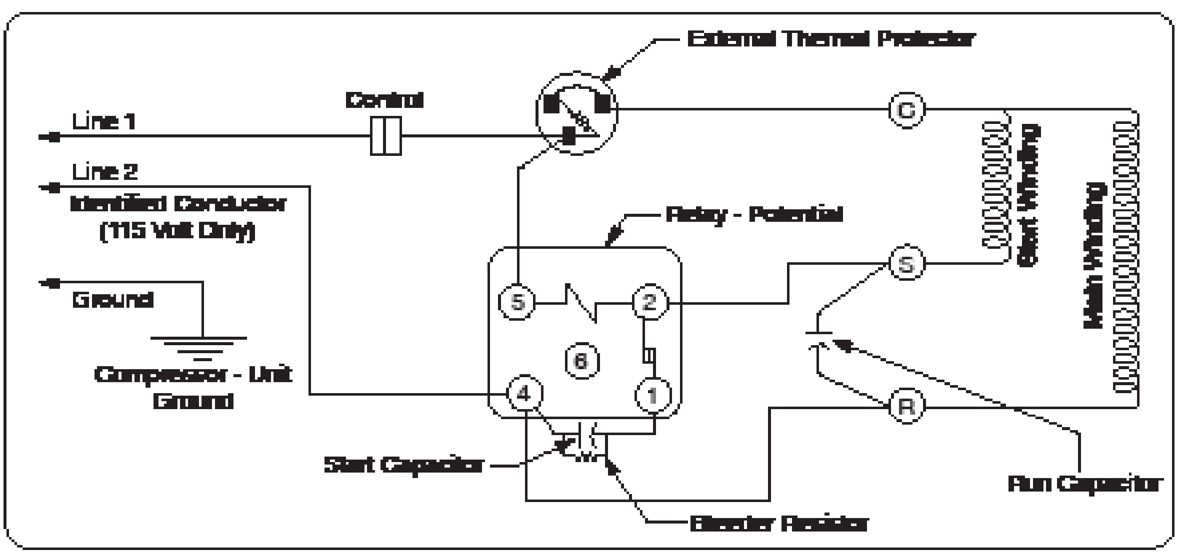


FIGURE 4-11: PSC compressor motor with external thermal protector and a start assist kit that in cludes a potential relay.

Step 1: Before Continuing with Troubleshooting

WARNING! All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41). You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Check Wiring

Confirm that there is continuity between C and the protector common lead wire.

Step 3: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 4: Check Run Capacitor

CAUTION: *using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.* Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be 10% of the marked capacitor value.

As an alternative, check the run capacitor by measuring continuity across the capacitor terminals:

- Rx1 scale: If there is continuity, then the run capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the run capacitor is open and needs to be replaced.

Possible reasons that a run capacitor is not working properly include:

- **Use of incorrect run capacitor.** Replace with proper run capacitor.
- **Line voltage is too high** (greater than 100% of rated voltage)**.**

Step 5: Reconnect Run Capacitor

Reconnect the run capacitor into circuit at terminals S and R. (Marked terminal should go to R.)

Step 6: Add Start Assist Kit

If the compressor checks out satisfactorily on all the above PSC tests but still doesn't operate, add proper start assist kit to provide additional starting torque. See Figure 4-11 for proper wiring.

Step 7: Continue Troubleshooting

If all above tests prove satisfactory and unit still fails to operate properly, check for adequate compressor pumping as outlined in the procedure on page 70.

This PSC compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
√					√	

The electrical system on this type of motor is shown in FIGURE 4-12 and 4-13. The actual position of terminals on the relay may be different than shown in FIGURE 4-12 and 4-13. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.

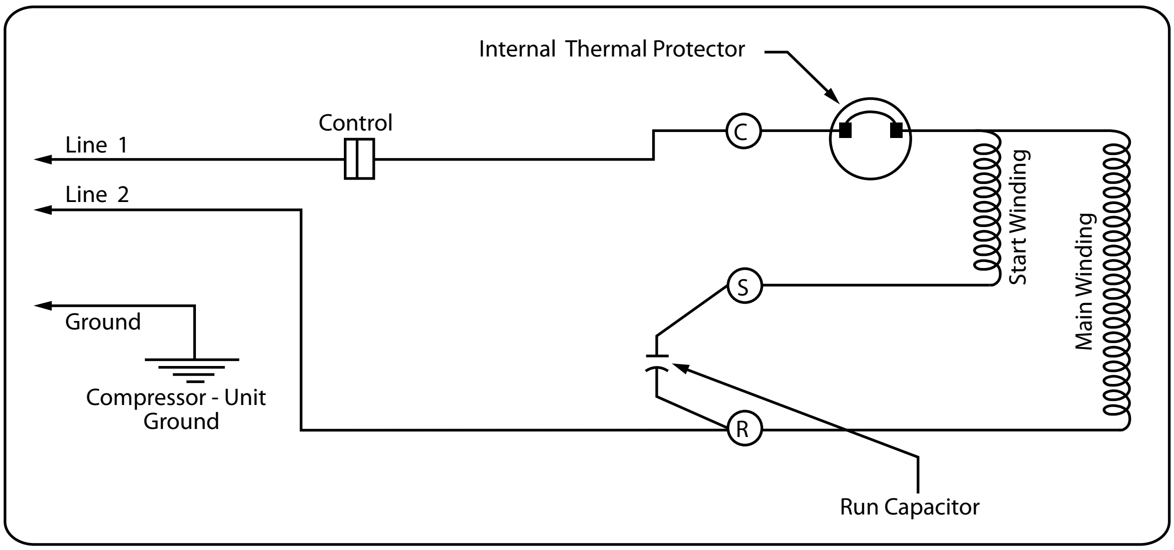


FIGURE 4-12: PSC compressor motor type with internal protector without start winding protection and run capacitor.

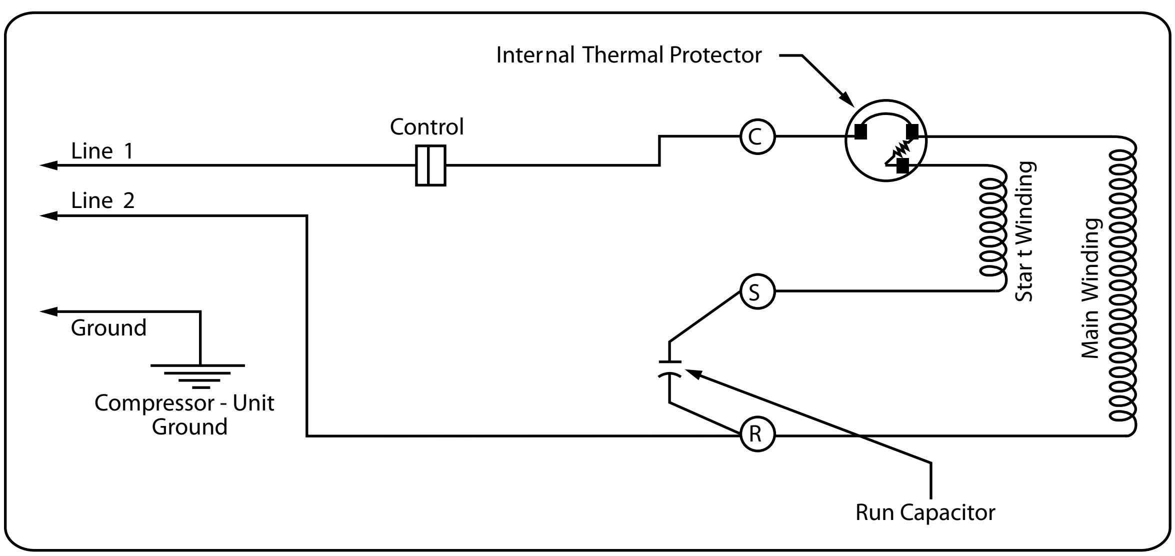


FIGURE 4-13: PSC compressor motor type with internal thermal protector with start winding protection and run capacitor.

Step 1: Before Continuing with Troubleshooting

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42, made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

NOTE: the compressor housing MUST be at 130°F or less for the following checks. This temperature can be read by Tempstik or is that temperature which will allow the hand to remain in contact with the compressor housing without discomfort.

Step 2: Check Internal Thermal Protector

If there is continuity between all terminals the thermal protector should be good. If R to S has continuity and R to C and S to C do not, the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the compressor.

Step 3: Check Run Capacitor

CAUTION: using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock. Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be 10% of the marked capacitor value.

As an alternative, check the run capacitor by measuring continuity across the capacitor terminals:

- Rx1 scale: If there is continuity, then the run capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the run capacitor is open and needs to be replaced.

Possible reasons that a run capacitor is not working properly include:

- **Use of incorrect run capacitor.** Replace with proper run capacitor.
- **Line voltage is too high** (greater than 100% of rated voltage).

Step 4: Reconnect Run Capacitor

Reconnect the run capacitor into circuit at terminals S and R. (Marked terminal should go to R.)

Step 5: Continue Troubleshooting

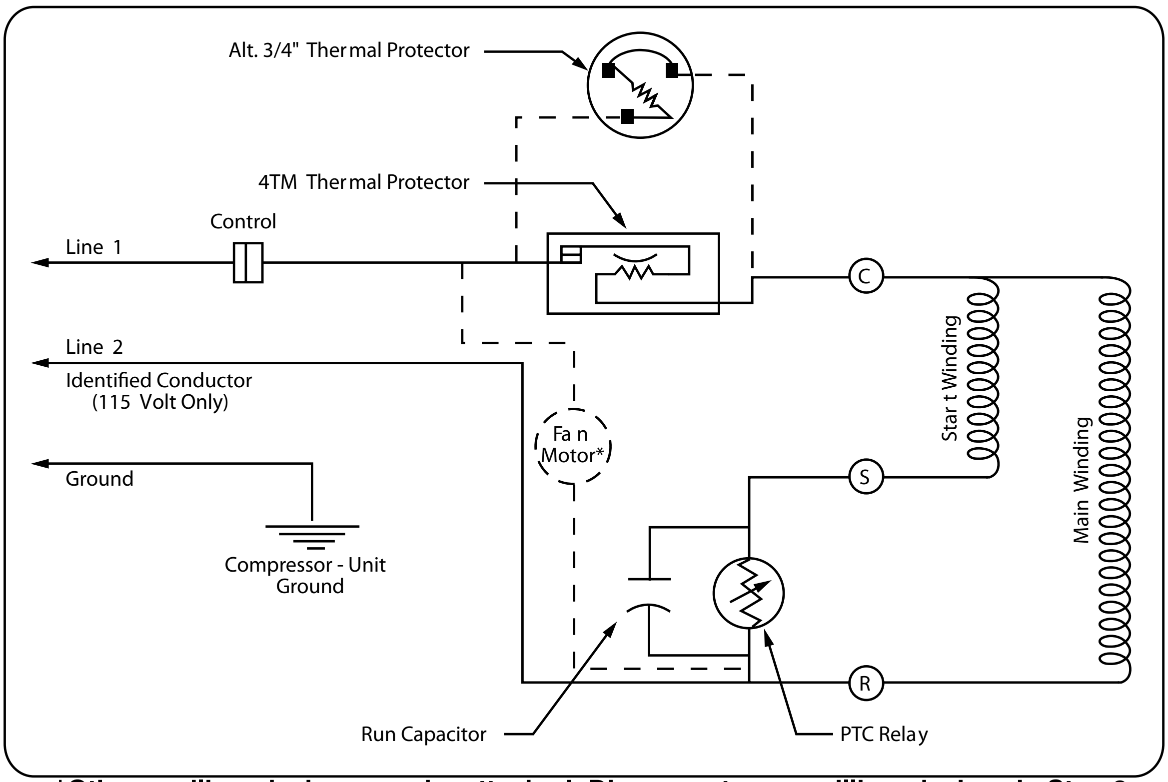
If all above tests prove satisfactory and unit still fails to operate properly, check for adequate compressor pumping as outlined in the procedure on page 70.

This PSC compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√			√ WIRED	√	

The electrical system on this type of motor is shown in FIGURE 4-14. The actual position of terminals on the relay may be different than shown in FIGURE 4-14. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-14: PSC compressor motor type with external thermal protector, wired-in PTC relay and run capacitor

Step 1: Before Continuing with Troubleshooting

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check Run Capacitor

CAUTION: *using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.* Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be 10% of the marked capacitor value.

As an alternative, check the run capacitor by measuring continuity across the capacitor terminals:

- Rx1 scale: If there is continuity, then the run capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the run capacitor is open and needs to be replaced.

Possible reasons that a run capacitor is not working properly include:

- **Use of incorrect run capacitor.** Replace with proper run capacitor.
- **Line voltage is too high** (greater than 100% of rated voltage)**.**

Step 4: Check Wired-in PTC Relay

Check the relay by measuring continuity between the pin holes where the R and S pins on the compressor are inserted. If there is no continuity, the relay may be open. Wait 3 minutes, then check continuity again. If there is still no continuity, replace the relay.

Step 5: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

Step 6: Continue Troubleshooting

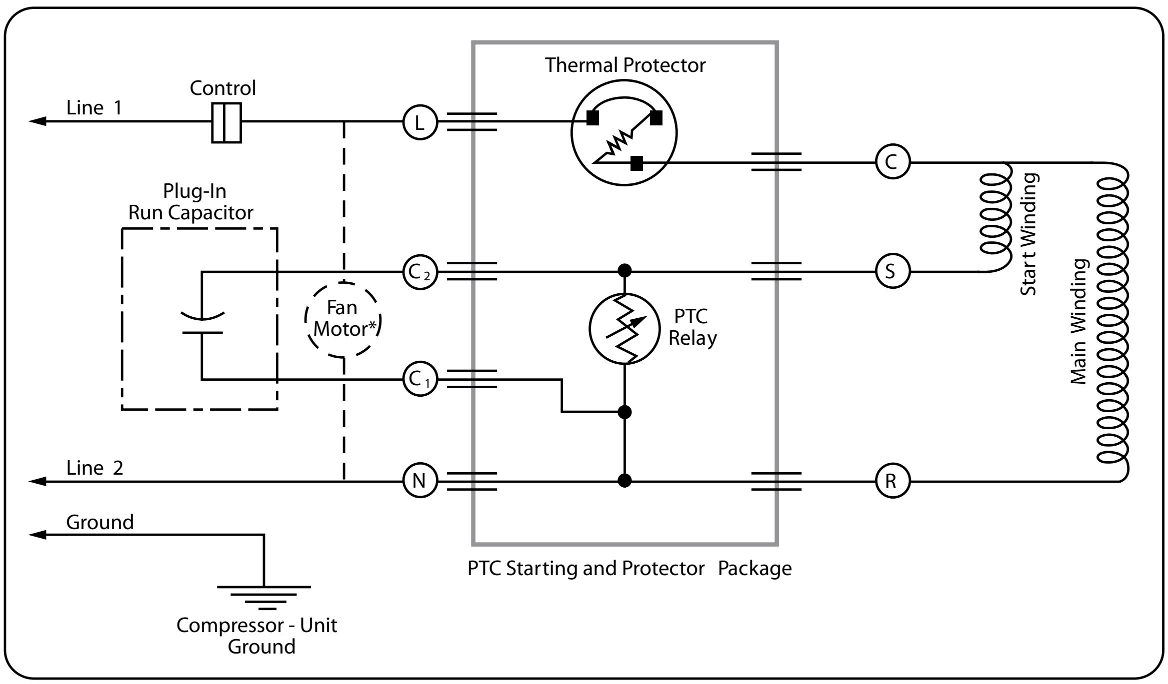
If all above tests prove satisfactory and unit still fails to operate properly, check for adequate compressor pumping as outlined in the procedure on page 70.

This PSC compressor has the following components:

Thermal Protector Type		Relay Type			Capacitor Type	
Internal	External	Current	Potential	PTC	Run	Start
	√			√ WIRED	√ PLUG-IN	

The electrical system on this type of motor is shown in FIGURE 4-15. The actual position of terminals on the relay may be different than shown in FIGURE 4-15. Use the letters and/ or numbers on the actual relay to locate the terminals.

If replacement parts are needed, refer to the Tecumseh Electrical Service Parts Guide Book for information on proper replacement parts, or call Tecumseh Products Company at 1-800-211-3427.



***Other auxiliary devices may be attached. Disconnect any auxilliary devices in Step 2.**

FIGURE 4-15: PSC compressor motor type with an external PTC starting and protector package and plug-in run capacitor.

Step 1: Before Continuing with Troubleshooting

WARNING! *All electric power should be disconnected and you should have already made sure that the compressor does not have a ground fault (see "Checking for a Ground Fault" on pages 40-41).* You should have also checked the windings for continuity and proper resistance (see "Checking for Continuity and Proper Resistance" on page 42), made sure the system is getting proper voltage, and that the control, thermostat, and contactor are working properly.

Step 2: Disconnect Fan Motor or Any Other Devices

If there is a fan motor or any other auxiliary device, open the circuit for the fan motor or any other device.

Step 3: Check Plug-in Run Capacitor

CAUTION: *using a 20,000 ohm resistor, discharge the capacitor before removing it from the system to avoid damage to measuring devices and risk of electric shock.* Disconnect the run capacitor from the system. Use a capacitance meter to check capacitor. Capacitance should be 10% of the marked capacitor value.

As an alternative, check the run capacitor by measuring continuity across the capacitor terminals:

- Rx1 scale: If there is continuity, then the run capacitor is shorted and needs to be replaced.
- Rx100,000 scale: If there is no needle deflection on an analog meter or if a digital meter indicates infinite resistance, then the run capacitor is open and needs to be replaced.

Possible reasons that a run capacitor is not working properly include:

- **Use of incorrect run capacitor.** Replace with proper run capacitor.
- **Line voltage is too high** (greater than 100% of rated voltage)**.**

Step 4: Check External Thermal Protector

Check for continuity across the thermal protector (line 1 and compressor terminal connection). If there is no continuity then the thermal protector may be tripped. Wait for the protector to cool off and close. This may take more than an hour. Check continuity gain. If there is no continuity, replace the protector.

For GE modules, replace the entire starting and protector package.

For TI (Sensata) modules, replace the thermal protector.

Step 5: Check Module PTC Relay

Check the relay by measuring continuity between the starting and protector package pin holes where the R and S pins on the compressor are inserted. If there is no continuity, the relay may be open. Wait 3 minutes, then check continuity again. If there is still no continuity, replace the protector package.

Step 6: Continue Troubleshooting

If all above tests prove satisfactory and unit still fails to operate properly, check for adequate compressor pumping as outlined in the procedure on page 70.

Checking for Adequate Compressor Pumping

Before checking for adequate compressor pumping, you should have already checked for compressor electrical problems as outlined in "Identifying Compressor Electrical Problems" on pages 40-41.

To check for adequate pumping, connect service gauges to system (add line taps if necessary). Then turn on power to system. If the system has an adequate refrigeration charge, the compressor should maintain at least 150 psig pressure difference between suction and discharge. If the compressor does not pump adequately, it must be replaced with no further testing.

Is Your Compressor Eligible for Return Under Warranty?

Authorized Tecumseh wholesalers are asked to test every in-warranty compressor that is returned to them. The Tecumseh factory tears down and examines a representative sample of compressors returned by authorized wholesalers and notes the reason for failure.

In the field, it can be determined if a compressor is eligible for return under warranty by FIRST checking for electrical problems and then checking for adequate compressor pumping. If the compressor passes all electrical troubleshooting tests and pumps adequately, the compressor is operating properly, and the problem lies elsewhere in the system.

Installation and Replacement

Chapter 5

Compressor Tube Connections

Tecumseh Products Company supplies compressors to hundreds of manufacturers requiring different tubing sizes and arrangements. Because of this the same compressor model may be found in the field in many suction and discharge tube variations, each depending upon the specific application in which it is installed.

Suction connections can usually be identified as the largest diameter stub tube in the housing. If 2 stubs have the same outside diameter (OD), then the one with the heavier wall will be the suction connection. If both of the largest stub tubes are the same OD and wall thickness, then either can be used as the suction connection. Whenever possible, suction connections should be kept away from the hermetic terminal area so that condensation will not drip on hermetic terminals, causing corrosion.

The stub tube, not chosen for the suction connection, may be used for processing the system.

Identification of compressor connections can usually be accomplished without difficulty; however, occasionally some question arises concerning oil cooler tubes and process tubes.

Oil cooler tubes are found only in low temperature refrigeration models. These tubes connect to a coil or hairpin bend within the compressor oil sump. This coil or hairpin bend is not open inside the compressor and its only function is to cool the compressor sump oil. The oil cooler tubes are most generally connected to a separated tubing circuit in the air-cooled condenser.

Process tubes are installed in compressor housings during manufacture as an aid in factory dehydration and charging.

Standard discharge tubing arrangements for Tecumseh hermetic compressors are outlined below. Discharge tubes are generally in the same position within any model family. Suction and process tube positions may vary substantially.

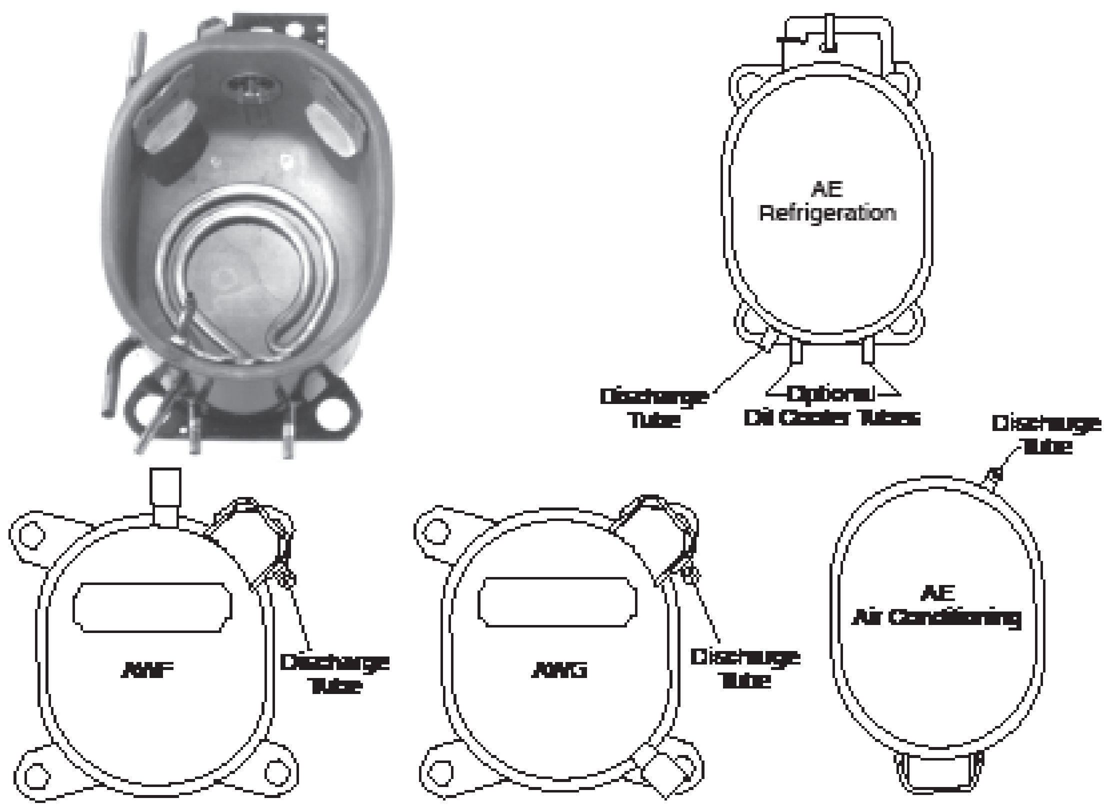


FIGURE 5-1: Standard discharge tubing arrangements.

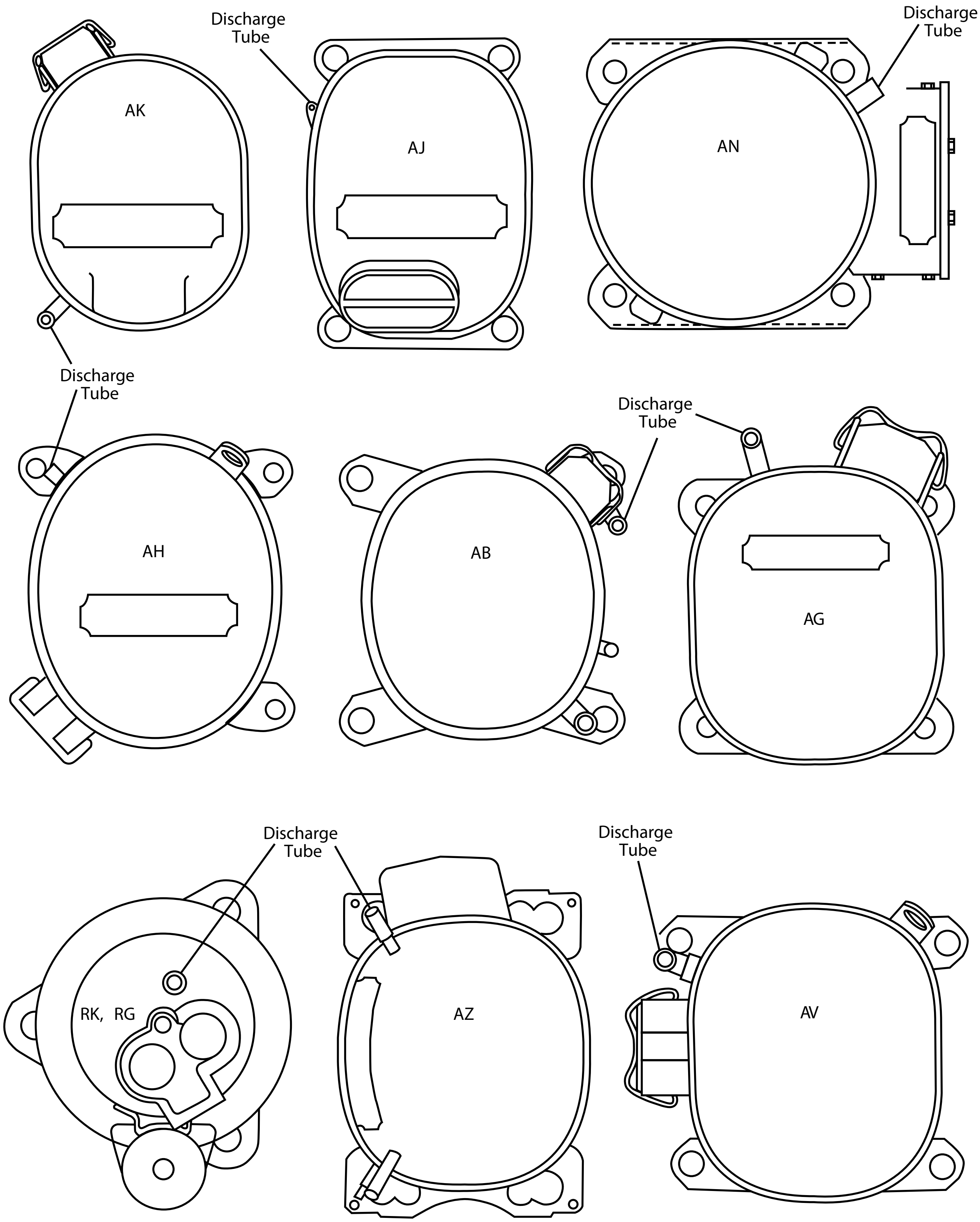


FIGURE 5-1 (cont.): Standard discharge tubing arrangements.

Refrigerant Line Sizes

R-12, R-134a and R-404A Refrigerant Line Sizes for Remote Systems Commercial Refrigeration

Refer to Tables 5-1 through 5-8. The recommended suction line sizes are based on a pressure drop no greater than the equivalent of a 1.5°F change in saturation temperature. The resulting pressure drop should provide sufficient refrigerant velocities necessary for proper oil return for suction lines up to 100 ft in length.

Suction line sizes that provide a minimum 1500 ft/min velocity are provided as a reference when sizing risers.

On heat pump systems, the lines serving as both a discharge line and suction line should be sized as a suction line.

Refer to these installation considerations for good oil return on commercial systems.

- Slope horizontal suction line downwards in the direction of the compressor at least ½" fall per 10 feet of line.
- For systems using a thermostatic expansion valve (TEV), the valve should be set to its proper setting. A typical superheat setting for commercial refrigeration applications is 6°F to 8°F. For low temperature refrigeration, a superheat setting of 4°F to 6°F is usually appropriate.
- In the case of a flooded type evaporator (bottom feed, top suction header, large internal volume, low refrigerant/oil velocities), it is necessary to maintain a liquid spillover into the suction line so as to return the oil with the liquid refrigerant and to minimize oil trapping in the evaporator. If because of the spillover, the return gas is "wet" at the compressor, a suction line accumulator should be installed adjacent to the compressor.
- Install a suction accumulator to prevent liquid refrigerant from entering the compressor, particularly when long suction lines are being used.
- On multiple evaporator systems, prevent oil and refrigerant from collecting in an idle coil. If the evaporator coils are to operate independently of each other, each should have its own suction riser sized to the coil's capacity.
- Insulate suction lines.
- Suction lines longer than 100 ft are not recommended.

The recommended discharge line sizes are based on a pressure drop no greater than the equivalent of a 1.5°F change in saturation temperature. Discharge line sizes that provide a minimum 1500 ft/min velocity are provided as a reference when sizing risers.

The recommended liquid line sizes are based on a pressure drop no greater than the equivalent of a 1°F change in saturation temperature. Liquid lines sizes that provide a minimum 100 ft/min velocity are provided as a reference.

Table 5-1: R-22 Refrigerant Line Sizes, 45°F Evap Temp, 65°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

Cond. Unit CAPACITY (Btu/h)	Line Size, Type L Copper OD (in)														
	SUCTION LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*	LIQUID LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 100 fpm*	DISCHARGE LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*
	10	25	50	100		10	25	50	100		10	25	50	100	
1,000	1/4	1/4	5/16	5/16	3/16	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	~
2,000	1/4	5/16	5/16	3/8	1/4	3/16	3/16	3/16	1/4	~	1/4	1/4	1/4	5/16	3/16
3,000	5/16	5/16	3/8	1/2	5/16	3/16	3/16	1/4	1/4	3/16	1/4	1/4	5/16	3/8	3/16
4,000	5/16	3/8	3/8	1/2	5/16	3/16	1/4	1/4	1/4	3/16	1/4	5/16	5/16	3/8	1/4
6,000	3/8	3/8	1/2	1/2	3/8	3/16	1/4	1/4	5/16	1/4	5/16	5/16	3/8	1/2	5/16
8,000	3/8	1/2	1/2	5/8	3/8	1/4	1/4	5/16	5/16	1/4	5/16	3/8	1/2	1/2	5/16
10,000	1/2	1/2	1/2	5/8	1/2	1/4	1/4	5/16	5/16	5/16	3/8	3/8	1/2	1/2	3/8
12,000	1/2	1/2	5/8	5/8	1/2	1/4	5/16	5/16	3/8	5/16	3/8	1/2	1/2	1/2	3/8
18,000	1/2	5/8	5/8	3/4	5/8	1/4	5/16	3/8	3/8	3/8	3/8	1/2	1/2	5/8	3/8
24,000	5/8	5/8	3/4	7/8	3/4	5/16	3/8	3/8	1/2	3/8	1/2	1/2	5/8	5/8	1/2
30,000	5/8	3/4	7/8	7/8	3/4	5/16	3/8	1/2	1/2	1/2	1/2	5/8	5/8	3/4	5/8
36,000	5/8	3/4	7/8	1 1/8	7/8	5/16	3/8	1/2	1/2	1/2	1/2	5/8	3/4	3/4	5/8
48,000	3/4	7/8	1 1/8	1 1/8	7/8	3/8	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8	3/4
60,000	3/4	7/8	1 1/8	1 1/8	1 1/8	3/8	1/2	1/2	5/8	5/8	5/8	3/4	7/8	7/8	3/4
72,000	7/8	7/8	1 1/8	1 3/8	1 1/8	1/2	1/2	5/8	5/8	3/4	5/8	3/4	7/8	1-1/8	7/8

* Largest line size that will maintain the stated refrigerant velocity. Please consult industry references such as the ASHRAE Refrigeration Handbook for additional information regarding how to properly size suction and discharge line risers and condenser to receiver condensate lines.

Table 5-2: R-22 Refrigerant Line Sizes, 20°F Evap Temp, 40°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

Cond. Unit CAPACITY (Btu/h)	Line Size, Type L Copper OD (in)														
	SUCTION LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*	LIQUID LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 100 fpm*	DISCHARGE LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*
	10	25	50	100		10	25	50	100		10	25	50	100	
1,000	1/4	5/16	5/16	3/8	1/4	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	3/16
2,000	5/16	5/16	3/8	1/2	5/16	3/16	3/16	3/16	1/4	~	1/4	1/4	1/4	5/16	1/4
3,000	5/16	3/8	1/2	1/2	3/8	3/16	3/16	3/16	1/4	3/16	1/4	1/4	5/16	3/8	1/4
4,000	3/8	1/2	1/2	1/2	3/8	3/16	3/16	1/4	1/4	3/16	1/4	5/16	5/16	3/8	1/4
6,000	3/8	1/2	1/2	5/8	1/2	3/16	1/4	1/4	5/16	1/4	5/16	5/16	3/8	1/2	5/16
8,000	1/2	1/2	5/8	5/8	1/2	1/4	1/4	5/16	5/16	1/4	5/16	3/8	1/2	1/2	5/16
10,000	1/2	5/8	5/8	3/4	5/8	1/4	1/4	5/16	5/16	5/16	3/8	3/8	1/2	1/2	3/8
12,000	1/2	5/8	3/4	3/4	5/8	1/4	5/16	5/16	3/8	5/16	3/8	1/2	1/2	1/2	3/8
18,000	5/8	3/4	3/4	7/8	3/4	5/16	5/16	3/8	3/8	3/8	1/2	1/2	5/8	5/8	1/2
24,000	5/8	3/4	7/8	1 1/8	7/8	5/16	3/8	3/8	1/2	3/8	1/2	1/2	5/8	3/4	1/2
36,000	3/4	7/8	1 1/8	1 1/8	1 1/8	5/16	3/8	1/2	1/2	1/2	1/2	5/8	3/4	3/4	5/8
48,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	3/8	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8	3/4

Table 5-3: R-134a Refrigerant Line Sizes, 45°F Evap Temp, 65°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

1,000	1/4	5/16	5/16	3/8	1/4	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	3/16
2,000	5/16	5/16	3/8	1/2	5/16	3/16	3/16	1/4	1/4	~	3/16	1/4	1/4	5/16	3/16
3,000	5/16	3/8	1/2	1/2	5/16	3/16	1/4	1/4	1/4	3/16	3/16	1/4	5/16	5/16	1/4
4,000	3/8	1/2	1/2	5/8	3/8	3/16	1/4	1/4	5/16	3/16	1/4	5/16	5/16	3/8	1/4
6,000	1/2	1/2	5/8	5/8	1/2	1/4	1/4	5/16	5/16	1/4	1/4	5/16	3/8	3/8	5/16
8,000	1/2	1/2	5/8	3/4	1/2	1/4	1/4	5/16	5/16	1/4	5/16	3/8	3/8	1/2	3/8
10,000	1/2	5/8	5/8	3/4	5/8	1/4	5/16	5/16	3/8	5/16	5/16	1/2	1/2	1/2	3/8
12,000	1/2	5/8	3/4	3/4	5/8	1/4	5/16	5/16	3/8	5/16	3/8	1/2	1/2	1/2	3/8
18,000	5/8	3/4	7/8	7/8	3/4	5/16	3/8	3/8	1/2	3/8	3/8	1/2	5/8	5/8	1/2

* Largest line size that will maintain the stated refrigerant velocity. Please consult industry references such as the ASHRAE Refrigeration Handbook for additional information regarding how to properly size suction and discharge line risers and condenser to receiver condensate lines.

Table 5-4: R-134a Refrigerant Line Sizes, 20°F Evap Temp, 40°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

Cond. Unit CAPACITY (Btu/h)	Line Size, Type L Copper OD (in)														
	SUCTION LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*	LIQUID LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 100 fpm*	DISCHARGE LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*
	10	25	50	100		10	25	50	100		10	25	50	100	
1,000	5/16	5/16	3/8	1/2	1/4	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	3/16
2,000	3/8	3/8	1/2	1/2	3/8	3/16	3/16	1/4	1/4	~	3/16	1/4	1/4	5/16	3/16
3,000	3/8	1/2	1/2	5/8	3/8	3/16	1/4	1/4	1/4	3/16	3/16	1/4	5/16	5/16	1/4
4,000	1/2	1/2	5/8	5/8	1/2	3/16	1/4	1/4	5/16	3/16	1/4	5/16	5/16	3/8	1/4
6,000	1/2	5/8	5/8	3/4	5/8	1/4	1/4	5/16	5/16	1/4	1/4	5/16	3/8	3/8	5/16
8,000	1/2	5/8	3/4	7/8	5/8	1/4	1/4	5/16	3/8	1/4	5/16	3/8	3/8	1/2	3/8
10,000	5/8	3/4	3/4	7/8	3/4	1/4	5/16	5/16	3/8	5/16	5/16	1/2	1/2	1/2	3/8
12,000	5/8	3/4	7/8	1 1/8	7/8	1/4	5/16	3/8	3/8	5/16	3/8	1/2	1/2	1/2	3/8
18,000	3/4	7/8	1 1/8	1 1/8	7/8	5/16	3/8	3/8	1/2	3/8	3/8	1/2	5/8	5/8	1/2

Table 5-5: R134a Refrigerant Line Sizes, -10°F Evap Temp, 40°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

1,000	3/8	1/2	1/2	1/2	3/8	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	3/16
2,000	3/8	1/2	5/8	5/8	1/2	3/16	3/16	1/4	1/4	3/16	3/16	1/4	5/16	5/16	1/4
3,000	1/2	5/8	3/4	3/4	5/8	3/16	1/4	1/4	1/4	3/16	1/4	5/16	5/16	3/8	1/4
4,000	1/2	5/8	3/4	7/8	3/4	3/16	1/4	1/4	5/16	3/16	1/4	5/16	3/8	3/8	5/16
6,000	5/8	3/4	7/8	1 1/8	7/8	1/4	1/4	5/16	5/16	1/4	5/16	3/8	3/8	3/8	1/2

* Largest line size that will maintain the stated refrigerant velocity. Please consult industry references such as the ASHRAE Refrigeration Handbook for additional information regarding how to properly size suction and discharge line risers and condenser to receiver condensate lines.

Table 5-6: R-404A Refrigerant Line Sizes, 45°F Evap Temp, 65°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

Cond. Unit CAPACITY (Btu/h)	Line Size, Type L Copper OD (in)														
	SUCTION LINE SIZES OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*	LIQUID LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 100 fpm*	DISCHARGE LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*
	10	25	50	100		10	25	50	100		10	25	50	100	
1,000	1/4	1/4	5/16	5/16	3/16	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	~
2,000	1/4	5/16	5/16	3/8	1/4	3/16	3/16	1/4	1/4	3/16	1/4	1/4	1/4	5/16	3/16
3,000	5/16	3/8	3/8	1/2	5/16	3/16	1/4	1/4	1/4	3/16	1/4	1/4	5/16	5/16	3/16
4,000	5/16	3/8	1/2	1/2	5/16	3/16	1/4	1/4	5/16	1/4	1/4	5/16	5/16	3/8	1/4
6,000	3/8	1/2	1/2	5/8	3/8	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	5/16
8,000	3/8	1/2	1/2	5/8	3/8	1/4	5/16	5/16	3/8	5/16	5/16	3/8	3/8	1/2	5/16
10,000	1/2	1/2	5/8	5/8	1/2	1/4	5/16	5/16	3/8	3/8	5/16	3/8	1/2	1/2	3/8
12,000	1/2	1/2	5/8	3/4	1/2	1/4	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	3/8
18,000	1/2	5/8	3/4	3/4	5/8	5/16	3/8	3/8	1/2	1/2	3/8	1/2	1/2	5/8	3/8
24,000	5/8	3/4	3/4	7/8	3/4	5/16	3/8	1/2	1/2	1/2	1/2	1/2	1/2	5/8	1/2
30,000	5/8	3/4	7/8	1 1/8	3/4	3/8	1/2	1/2	1/2	5/8	1/2	5/8	5/8	3/4	1/2
36,000	5/8	3/4	7/8	1 1/8	7/8	3/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	3/4	5/8
42,000	3/4	7/8	1 1/8	1 1/8	7/8	3/8	1/2	1/2	5/8	3/4	5/8	5/8	5/8	7/8	5/8

* Largest line size that will maintain the stated refrigerant velocity. Please consult industry references such as the ASHRAE Refrigeration Handbook for additional information regarding how to properly size suction and discharge line risers and condenser to receiver condensate lines.

Table 5-7: R-404A Refrigerant Line Sizes, 20°F Evap Temp, 40°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

Line Size, Type L Copper OD (in)

Cond. Unit CAPACITY (Btu/h)	SUCTION LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*	LIQUID LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 100 fpm*	DISCHARGE LINE SIZE OD (in) Line Length, Equivalent Feet				Velocity = 1500 fpm*
	10	25	50	100		10	25	50	100		10	25	50	100	
1,000	1/4	5/16	5/16	3/8	1/4	3/16	3/16	3/16	3/16	~	3/16	3/16	1/4	1/4	~
2,000	5/16	3/8	3/8	1/2	5/16	3/16	3/16	1/4	1/4	3/16	1/4	1/4	1/4	5/16	3/16
3,000	3/8	3/8	1/2	1/2	3/8	3/16	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	3/16
4,000	3/8	1/2	1/2	5/8	3/8	3/16	1/4	1/4	5/16	1/4	1/4	5/16	5/16	3/8	1/4
6,000	1/2	1/2	5/8	5/8	1/2	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	1/2	5/16
8,000	1/2	5/8	5/8	3/4	1/2	1/4	5/16	5/16	3/8	5/16	5/16	3/8	3/8	1/2	5/16
10,000	1/2	5/8	3/4	3/4	5/8	1/4	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	3/8
12,000	1/2	5/8	3/4	7/8	5/8	1/4	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	3/8
18,000	5/8	3/4	7/8	1 1/8	3/4	5/16	3/8	3/8	1/2	1/2	1/2	1/2	1/2	5/8	1/2
24,000	3/4	7/8	7/8	1 1/8	7/8	5/16	3/8	1/2	1/2	1/2	1/2	1/2	5/8	5/8	1/2
30,000	3/4	7/8	1 1/8	1 1/8	7/8	3/8	1/2	1/2	1/2	5/8	1/2	5/8	5/8	3/4	1/2
36,000	3/4	7/8	1 1/8	1 3/8	1 1/8	3/8	1/2	1/2	5/8	5/8	1/2	5/8	3/4	3/4	5/8
48,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1/2	1/2	5/8	5/8	3/4	5/8	3/4	3/4	7/8	3/4
60,000	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1/2	1/2	5/8	5/8	7/8	5/8	3/4	7/8	1 1/8	7/8

Table 5-8: R-404A Refrigerant Line Sizes, -10°F Evap Temp, 40°F Suction Vapor Temp, 105°F Condensing and Liquid Temp

1,000	5/16	3/8	3/8	1/2	5/16	3/16	3/16	3/16	3/16	~	3/16	1/4	1/4	1/4	~
2,000	3/8	1/2	1/2	5/8	3/8	3/16	3/16	1/4	1/4	3/16	1/4	1/4	1/4	5/16	3/16
3,000	1/2	1/2	5/8	5/8	1/2	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	1/4
4,000	1/2	5/8	5/8	3/4	1/2	1/4	1/4	1/4	5/16	1/4	5/16	5/16	5/16	3/8	1/4
6,000	1/2	5/8	3/4	7/8	5/8	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8	1/2	5/16
8,000	5/8	3/4	3/4	7/8	3/4	1/4	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	3/8
10,000	5/8	3/4	7/8	1 1/8	7/8	1/4	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	3/8
12,000	3/4	7/8	7/8	1 1/8	7/8	5/16	5/16	3/8	1/2	3/8	3/8	1/2	1/2	5/8	3/8
18,000	3/4	7/8	1 1/8	1 1/8	1 1/8	5/16	3/8	1/2	1/2	1/2	1/2	1/2	5/8	5/8	1/2

* Largest line size that will maintain the stated refrigerant velocity. Please consult industry references such as the ASHRAE Refrigeration Handbook for additional information regarding how to properly size suction and discharge line risers and condenser to receiver condensate lines.

Service Valves

As shipped with the compressors, the rotolock service valves have a small plastic dust plug inside the threaded end. Be sure to remove this plug before installing.

Service valves on Tecumseh systems are “front seated” by turning the valve stem clockwise. This closes the valve and opens the gauge port.

Turning the stem counter-clockwise “back seats” the valve and thus opens the system and closes the gauge port.

If present, the valve port to the system control (high pressure cutout, low pressure control, fan control, etc.) is always open regardless of the position of the valve stem.

If the system is to be operated with the service gauge functioning, it is necessary to “crack” the valve from its back seated position for the gauges to perform. Before removing the gauges, close the gauge port by returning the valves to their fully open position (back seated).

Remember to check the packing gland nut (if present) on the stem for snugness before leaving the job. Install the cover nut over the valve stem as a secondary safeguard against leaks at the stem.

Processing the System

The performance and longevity of a refrigeration system is strongly influenced by how the system was “processed,” that is, how the system was prepared for operation at the time of installation. The procedure is:

1. On split systems, install the liquid and suction line. See “Refrigerant Line Sizes” on pages 76-81 for recommended line sizes. A properly sized suction line accumulator is recommended. See “Accumulator Selection” on page 98 for accumulator sizing. Insulate the suction line to reduce heat exchange and excessive return gas temperatures to the compressor.
2. To prevent oxidation and scale forming inside the tubes, it is good practice to flow dry nitrogen through the tubing during the soldering operations. A light flow of about ¼ cubic feet per minute is sufficient.
3. Install a properly sized filter-drier in the liquid line immediately ahead of the capillary tube or thermostatic expansion valve (TEV).
4. A properly sized suction line filter-drier is recommended to protect the compressor. A suction accumulator must be installed on those systems having defrost cycles (heat pumps, low temperature refrigeration) or the likelihood of periodic floodbacks (bulk milk coolers, ice machines). See “Accumulator Selection” on page 98 for accumulator sizing.
5. Pressure test the system for leaks using the safety precautions outlined in “System Flushing, Purging, and Pressure Testing for Leaks” on pages 4-5. Do not pressurize the system beyond 150 psig field leak test pressure.
6. Use a vacuum pump (not the compressor) to draw a vacuum of 500 microns or less from both sides of the system. Entry must be made to both the high and low sides of the system to properly evacuate that portion of the system. Use a good micron gauge to measure the vacuum. An accurate reading cannot be made with a refrigeration gauge.

   WARNING! *Never use a compressor to evacuate a system. Instead, use a high vacuum pump specifically designed for that purpose. Never start the compressor while it is under deep vacuum. Always break a vacuum with refrigerant charge before energizing the compressor. Failure to follow these instructions can damage the hermetic terminal and may result in terminal venting. As always, to reduce the risk of serious injury or death from fire due to terminal venting, never energize the compressor unless the protective terminal cover is securely fastened.*

7. If a suction line accumulator is present, charge into the accumulator to prevent liquid refrigerant from reaching the compressor. If this is not possible, then break the vacuum by allowing refrigerant vapor to enter the low side at the suction service valve. When the system pressure reaches 60 psig for R-22 (70 psig for R-502 & R-404A, 35 psig for R-12 & R-134a), start the compressor and continue charging at rate not more than 5 pounds per minutes for the larger systems and somewhat less for smaller systems. Follow the safety precautions outlined in "System Charging" on page 5.
8. Check fans and blowers for correct direction of rotation, belt tension, and proper air flow (CFM).
9. With the protective terminal cover securely fastened, run the compressor and allow the system pressures and temperatures to stabilize. Systems vary in their operating characteristics, but generally these approximations will apply:

Table 5-6: Pressure and Temperature Stabilization	
Pressure	**Temperature**
Saturated head pressure	Ambient temperature °F + 20°F for air cooled condenser
Water cooled	Discharge water °F + 10°F
Saturated evaporator pressure	
Air conditioning	Discharge air °F -20°F
Medium temperature	Product temperature -10°F to -12°F
Low temperature	Product temperature -6°F to -8°F

10. Before leaving the job, run the system for a while. Listen for abnormal noises. Feel the bottom crankcase housing and determine that it is warm. Is the compressor upper housing sweating indicating that liquid refrigerant is reaching the compressor? Is the return gas temperature at the compressor within proper limits for the application (i.e. not too low to cause flooding or not too high to produce high discharge and motor temperatures)? Recheck pressures, amps, fan motors, belts, CFM, etc.

System Cleanup and Compressor Replacement After Compressor Failure

Once you determine that a compressor needs to be replaced, you must determine whether the system has been contaminated. Compressor motor failure can lead to such contamination. (While compressor motor failure is sometimes referred to as motor "burnout," it does not mean that a fire actually occurs inside a hermetic compressor.) Even small amounts of contamination must be removed from the system to avoid damaging the replacement compressor. Therefore, it is important to thoroughly clean a refrigeration/air conditioning system if system contamination is present.

⚠ WARNING ⚠

If a compressor motor failure has occurred, refrigerant or mixtures of refrigerant and oil in the system can be acidic and can cause chemical burns. As always, to avoid injury, wear appropriate protective eye wear, gloves and clothing when servicing an air conditioning or refrigeration system. If refrigerant or mixtures of refrigerant and oil come in contact with skin or eyes, flush the exposed area with water and get medical attention immediately.

The following outlines a process for compressor replacement and system clean-up for a system equipped with a Tecumseh compressor. You should refer to the original equipment manufacturer's (OEM) service information.

Determine Extent of System Contamination

Following the precautions in ”Refrigerants and Other Chemicals” and “Compressor Removal” on page 4, remove the compressor.

Use the following guidelines to determine whether contamination, if any, is limited to the compressor or extends to the system.

If the discharge line shows no evidence of contamination and the suction stub is clean or has only light carbon deposits, then the contaminants are limited to the compressor housing (Compressor Housing Contamination). A single installation of liquid and suction line filter-driers should clean up the system.

If, however, the discharge line or the suction line shows evidence of contamination, the compressor was running at the time of the motor failure and contaminants were pumped throughout the system (System Contamination). If System Contamination has occurred, several changes of the liquid and suction line filter-driers will be needed to cleanup the system. In addition, the expansion device will need to be replaced. If the system is a heat pump, the four way valve should be replaced.

Install Replacement Compressor and Components

1. Install the replacement compressor with new external electrical components (capacitors, relay, overloads, etc., where applicable). Check the contacts of the starting control or contactor.
2. Install an oversized liquid line filter-drier.
3. Install a generously sized suction line filter-drier immediately upstream of the compressor. The filter-drier when permanently installed in a clean system or as initially installed in a dirty system, must have a pressure drop not more than listed in Table 5-7. Pressure taps must be supplied immediately before and after the suction filter-drier to permit the pressure drop to be measured.

   If a suction line accumulator is present and System Contamination has occurred, it must be thoroughly flushed to remove any trapped sludge and thus prevent it from plugging the oil return hole. The filter-drier should be installed upstream of the accumulator and the compressor.

   In the case of Compressor Housing Contamination, the filter-drier should be installed between the compressor and the suction line accumulator.

   Rubber refrigeration hoses are not satisfactory for temporarily hooking up the suction line filter-drier to the system since the acid quickly breaks down the rubber and plastic.
4. Follow the precautions in “System Flushing, Purging, and Pressure Testing or Leaks” on pages 4-5 to purge the system and pressure test for leaks.

Evacuate the System

Evacuate the system to less than 500 microns using a good vacuum pump (not a compressor) and an accurate high vacuum gauge.

An alternate and more thorough method of evacuation known as "triple evacuation" is as follows:

1. Evacuate the system to 1500 microns. Break vacuum with the serial label refrigerant or an inert gas up to 2 psig. Leave vapor charge in system for a minimum of five minutes.
2. Repeat Step 1.
3. Evacuate system to 500 microns. Charge system with the specified kind and quantity of refrigerant.

WARNING! *Never use a compressor to evacuate a system. Instead, use a high vacuum pump specifically designed for that purpose.*

Never start the compressor while it is under deep vacuum. Always break a vacuum with refrigerant charge before energizing the compressor.

Failure to follow these instructions can damage the hermetic terminal and may result in terminal venting. As always, to reduce the risk of serious injury or death from fire due to terminal venting, never energize the compressor unless the protective terminal cover is securely fastened.

Charge the System and Check the Pressure Drop

Charge the system and place in operation. Follow the safety precautions outlined in "System Charging" on pages 5-6. Immediately after startup, check the pressure drop across the suction line filter-drier. This will serve two purposes:

» Verify that the filter-drier selection was properly sized.

» Serve as a base point to which subsequent pressure checks can be compared.

Because the permissible pressure drop across the drier is relatively small, it is suggested that a differential pressure gauge be used for the measurement.

Measure the Pressure Drop

After the system has been operating for an hour or so, measure the pressure drop across the suction line filter-drier.

In the case of Compressor Housing Contamination, little change should be noted. The pressure drop will, in most instances, be below that tolerable for a permanent installation (see Table 5-7).

On the other hand, where System Contamination occurred, an increased pressure drop will be measured. Change the suction filter-drier and the liquid line filter-drier whenever the pressure drop approaches or exceeds that allowed for temporary operation during cleanup (see Table 5-8).

Keep changing both the suction and liquid line filter-driers until the pressure drop stabilizes at a figure equal to or below that permitted for permanent operation in a system (see Table 5-7). At this point, it is the service person's option as to whether to leave the suction drier in the system or remove it from operation.

If the system is to be opened to permit the permanent removal of the suction filter-drier, the liquid line filter-drier should be changed once more.

Table 5-7: Suggested Maximum Pressure Drop (psi) for Permanent Suction Filter-Drier Installation

Application	Air Cond	High	Medium	Low	
Evaporator Range, °F	+55 to +32	+55 to +20	+30 to -10	+10 to -20	-20 to -40
R-12, R-134a	2	2	1 1/2	1/2	1/2
R-22, R-404A, R-407C, R-502, R-507	3	3	2	1	1/2

Table 5-8: Suggested Maximum Pressure Drop (psi) for Temporary Suction Filter-Drier Installation During Cleanup					
Application	Air Cond	High	Medium	Low	
Evaporator Range, °F	+55 to +32	+55 to +20	+30 to -10	+10 to -20	-20 to -40
R-12, R-134a	6	6	3	2	3/4
R-22, R-404A, R-407C, R-502, R-507	8	8	4	3	1 1/2

Test for Acidity if Multiple Motor Failures Have Occurred

If the system has suffered multiple motor failures, it is advisable that the oil of the replacement be tested and judged acid free before the system is considered satisfactorily cleaned. An oil sample may be taken from a hermetic system if at the time the replacement compressor was installed an oil trap is installed in the suction line (see Figure 5-12). When the trapped oil level appears in the sight glass (less than an ounce is needed) the oil may be slowly transferred to the beaker of the acid test kit as available from several manufacturers. A reading of less than 0.05 acid number is an indication that the system is free of acid. A reading of higher than 0.05 means continued cleaning is required. Replace liquid line filter-drier.

Monitor the System

The above procedure for the cleanup of hermetic systems after motor failure through the use of suction line filter-drier will prove satisfactory in most instances provided the system is monitored and kept clean by repeated drier changes, if such are needed. The failure to follow these minimum cleanup recommendations will result in an excessive risk of repeat motor failure.

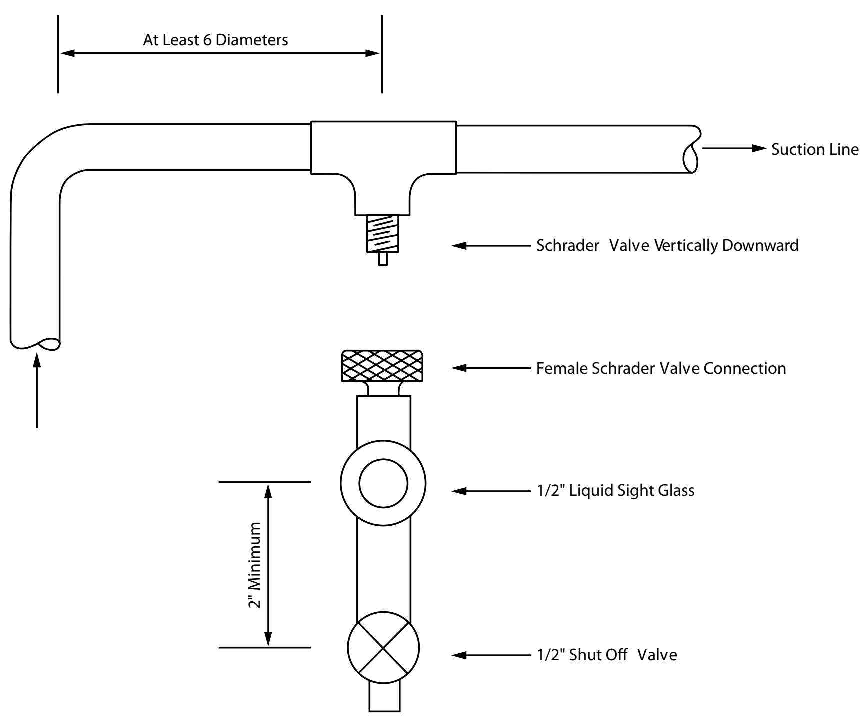


FIGURE 5-12: **Method of obtaining oil sample on hermetic system. After satisfactory oil test, Schrader valve may be capped and the oil sample taken to the next job.**

Replacing Compressors in Water-Utilizing Systems: Preventing Explosions

In certain water-utilizing refrigeration systems, water can leak into the refrigerant side of the system. This can lead to an explosion of system components including but not limited to, the compressor. If such an explosion occurs, the resulting blast can kill or seriously injure anyone in the vicinity.

Water-utilizing systems that have single-wall heat exchangers may present a risk of explosion. Such systems may include:

- water source heat pump/air conditioning systems, and
- water cooling systems such as icemakers, water coolers, and juice dispensers.

Water-utilizing systems that have single-wall heat exchangers present a risk of explosion unless they have either:

- a high pressure cut-out which interrupts power to ALL leads to the compressor or
- an external pressure relief valve.

Before replacing a compressor in a water-utilizing system, read and follow "Prevention of Water-utilizing System Explosions" on pages 6-7.

Operation

Chapter 6

Control of Liquid Migration to the Compressor During Shutdown

Liquid Refrigerant Migration to Compressor During Shutdown

Liquid refrigerant migration to the compressor is a natural occurrence within refrigeration and air conditioning systems (see Figure 6-1). The amount and severity of this liquid refrigerant migration depends on several things such as the size of refrigerant and oil charge and the length of shutdown interval.

This discussion shows that while Tecumseh compressors enjoy a fine reputation for reliability and long life, there are application safeguards that can be employed to increase compressor life and eliminate unnecessary service calls. These action photographs (see Figures 6-2 to 6-4) were taken in the engineering laboratories of Tecumseh Products Company. A five ton split air conditioning system was used with a four inch sign glass installed in the compressor housing. The condensing unit and evaporator sections were connected by approximately 25 feet of suction and discharge tubing. The first internal view shows the system shut down for a weekend. The temperatures of the compressor and evaporator are the same, 76°F.

Even at this condition, the fluid in the evaporator, which is mostly refrigerant, has a higher vapor pressure than the fluid in the crankcase, which is mostly oil. This difference in vapor pressure acts as a driving force for the refrigerant to migrate to the crankcase—to become absorbed in the oil until the pressures are equalized and saturation has been reached.

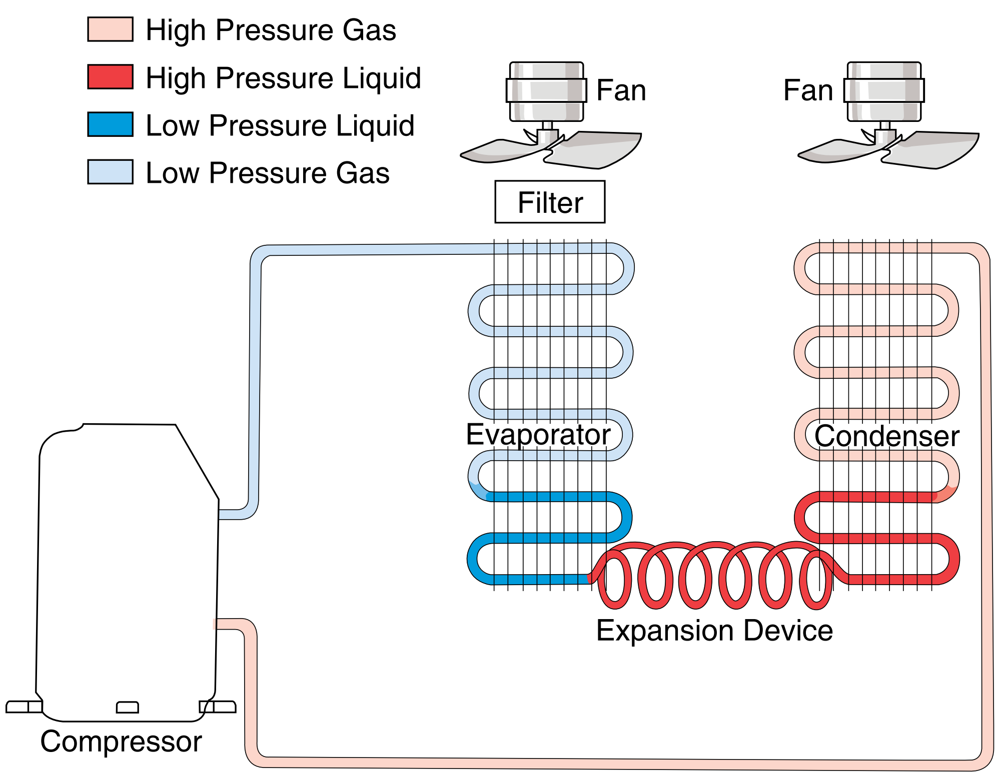


FIGURE 6-1: Liquid refrigerant migration to compressor

FIGURE 6-2: Refrigerant and oil mixture fill sight glass after weekend shutdown

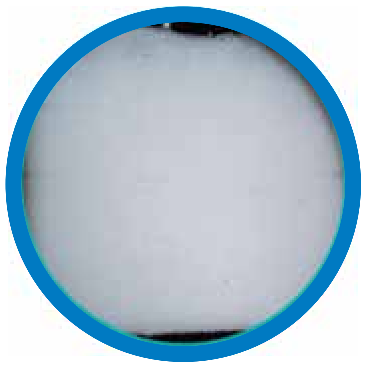


FIGURE 6-3: Five seconds after start-up, violent foaming action fill sight glass as refrigerant boils away taking oil charge with it

FIGURE 6-4: More than 60 seconds after start-up, oil level is well below normal operating levels - a condition that is an important factor in compressor bearing wear.

Crankcase Heater Prevents Liquid Migration

This sequence (see Figures 6-6 and 6-7) shows the effects of an electric strap-on crankcase heater applied to the compressor (also see Figure 6-5). The system was again shutdown for a weekend under identical conditions with the exception that the heater was energized throughout the shutdown period. By raising the temperature of the oil, we have reduced its ability to attract and hold refrigerant.

Note that liquid refrigerant accumulation in the compressor can also be caused by liquid floodback under certain conditions while operating. This condition can be controlled by the application of a suction line accumulator. Crankcase heat does nothing to prevent liquid floodback and an accumulator does nothing to prevent refrigerant migration. Each without the other is half a job. Both together provide balanced compressor protection.

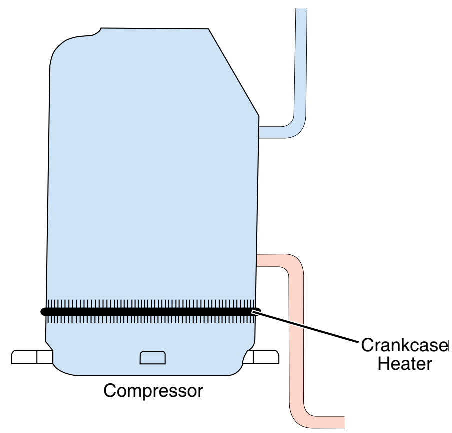


FIGURE 6-5: **When applied to a compressor with a low pressure housing, an electric strap-on crankcase heater prevents liquid migration.**

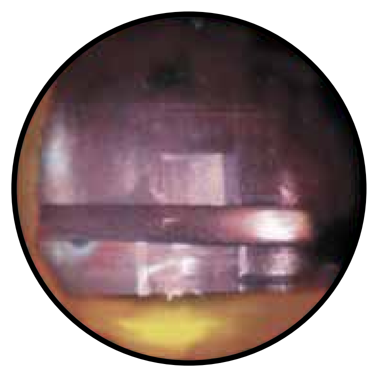


FIGURE 6-6: **View through sight glass shows that the crankcase heater effectively prevents migration of liquid refrigerant to the compressor.**

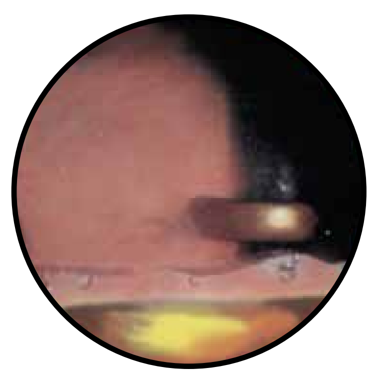


FIGURE 6-7: **Normal run with heat. Oil level is maintained thereby assuring effective lubrication for compressor bearings.**

Crankcase Heaters

When most air conditioning and commercial systems are started up for the first time each season, a large part of the system refrigerant charge is in the compressor. On startup, the refrigerant boils off taking the oil charge with it, and the compressor is forced to run for as long as 3 or 4 minutes until the oil charge circulates through the system and returns to the crankcase. Obviously, this is not good for the compressor and definitely shortens its service life.

The initial solution is to charge the system so that little or no refrigerant collects in the crankcase and to operate the crankcase heater at least 12 hours before startup or after a prolonged shut-down.

Three types of crankcase heaters are in common use on Tecumseh compressors: wrap-around resistance heater (belly band), immersion type integral heater, and the run capacitance off-cycle heat. The wrap-around heater should be strapped to the housing below the oil level and in close contact with the housing. A good heater will maintain the oil at least 10°F above the temperature of any other system component and (when the compressor is stopped) desirably at or above a minimum temperature of 80°F. The immersion type heater is factory assembled and is presently used with AB, AW, AG, AV, and AN compressors. It is self-regulating and energy efficient.

In the run capacitance off-cycle heat method used by some OEM, single-phase compressors are stopped by opening only one leg (L2) and thus the other power supply leg (L1) to the run capacitor remains "hot." A trickle current through the start windings results thereby warming the motor windings and thus the oil on the "off-cycle."

WARNING! *Before servicing systems with off-cycle run capacitor type heaters, be sure to disconnect ALL power supplies. Make sure that all power legs are open. Failure to do so can result in serious injury or death from electric shock.*

Capacitance crankcase heat systems can be recognized by one or more of the following:

- Contactor or thermostat breaks only one leg to the compressor (and condenser fan).
- Equipment should carry a notice indicating power is on compressor when it is not running and that main breaker should be opened before servicing.
- Run capacitor is sometimes split (3 terminals) so that only part of the capacitance is used for off-cycle heating. NOTE: use exact replacement when changing such dual purpose run capacitors. Capacitor must be fused and carry a bleeder resistor across the terminals. See Figure 6-8 for the basic wiring diagram for a PSC compressor with run capacitance off-cycle heat.

Starting a System with Liquid Refrigerant in the Compressor

When most air conditioning and commercial systems are started up for the first time each season, a large part of the system refrigerant charge is in the compressor. If there is no crankcase heater or the heat is not operating properly and the unit must be started at the time of the service, then follow these guidelines:

- DO NOT attempt to heat the crankcase by applying a flame to the compressor. Not only is this process slow and likely to be ineffective, it may damage electrical wires, paint, and the oil.
- If there is no evidence of a compressor electrical problem (for example, tripped breaker or blown fuse or reports of such), then "jog" the compressor. To "jog" the compressor, apply power for one to two seconds, then wait 1 to 2 minutes. After 3 or 4 jogs, apply power continuously.

WARNING! *Jogging a compressor that has an electrical problem can increase the likelihood of terminal venting. To reduce the risk of serious burns or death from terminal venting with ignition, you must FIRST check for a ground fault whenever you suspect an electrical problem. See "Identifying Compressor Electrical Problems" on pages 40-41 for additional information.*

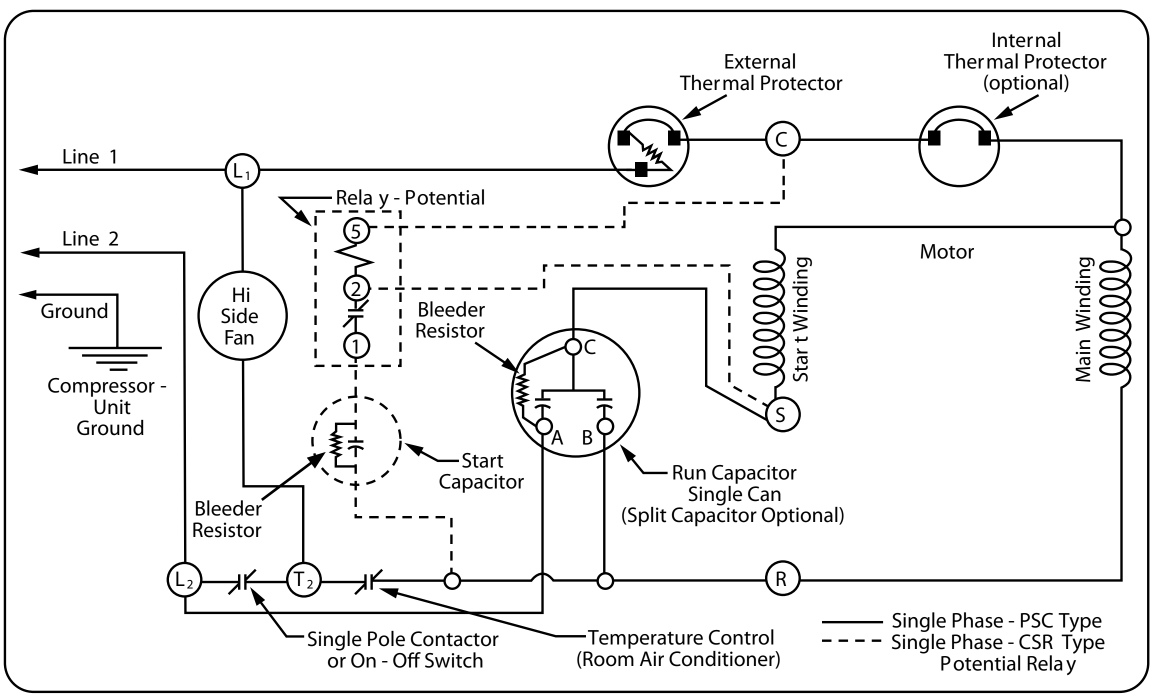


FIGURE 6-8: Wiring diagram for PSC compressor with run capacitance off-cycle heat.

Control of Liquid Refrigerant Floodback to the Compressor During Operation

Liquid floodback during operation (see Figure 6-9) can be caused by fan failure or dirty clogged filters that can reduce the heat transfer rate to such a point that the liquid refrigerant floods through instead of vaporizing. When this situation occurs, liquid refrigerant may enter the compressor under conditions that result in separation of the oil and refrigerant. This separation may result in an accumulation of the refrigerant under the oil (see Figure 6-10). Thus, when the compressor is started, the first liquid to be pumped to the bearings will probably be refrigerant, not oil. Even if this oil-refrigerant separation does not occur, the large amount of liquid refrigerant in the crankcase will instantly vaporize and boil away the oil charge when the compressor starts (see Figure 6-11) thereby leaving the compressor oil-starved for many seconds (see Figure 6-12).

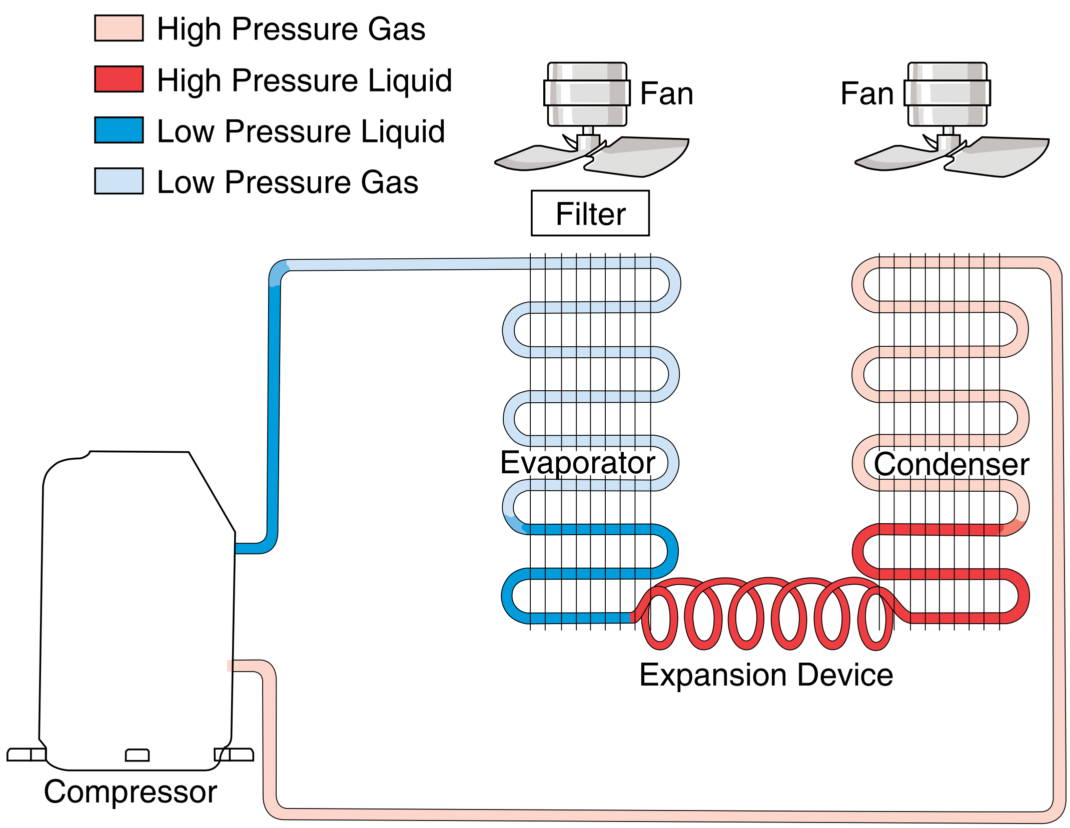


FIGURE 6-9: Liquid refrigerant floodback to the compressor.

FIGURE 6-10: **Liquid refrigerant enters compressor and settles to the bottom, below the oil.**

FIGURE 6-11: **Five seconds after start-up, violent foaming action fills sight glass as refrigerant boils away taking the oil charge with it.**

FIGURE 6-12: **More than 60 seconds after start-up, oil level is well below normal operating levels - a condition that is an important factor in compressor bearing wear.**

Liquid floodback can be prevented by the application of a properly designed and sized suction line accumulator (see Figures 6-13 and 6-14 below and “Accumulator Selection” on page 98). When properly selected based upon system charge, a suction line accumulator will improve compressor reliability and endurance by preventing damaging liquid refrigerant floodback. Note that liquid refrigerant accumulation in the compressor can also be caused by liquid migration to the compressor during periods of shutdown. This condition can be controlled by the application of a crankcase heater. A suction line accumulator does nothing to prevent liquid migration and a crankcase heater does nothing to prevent liquid floodback. Each without the other is half a job. Both together provide balanced compressor protection.

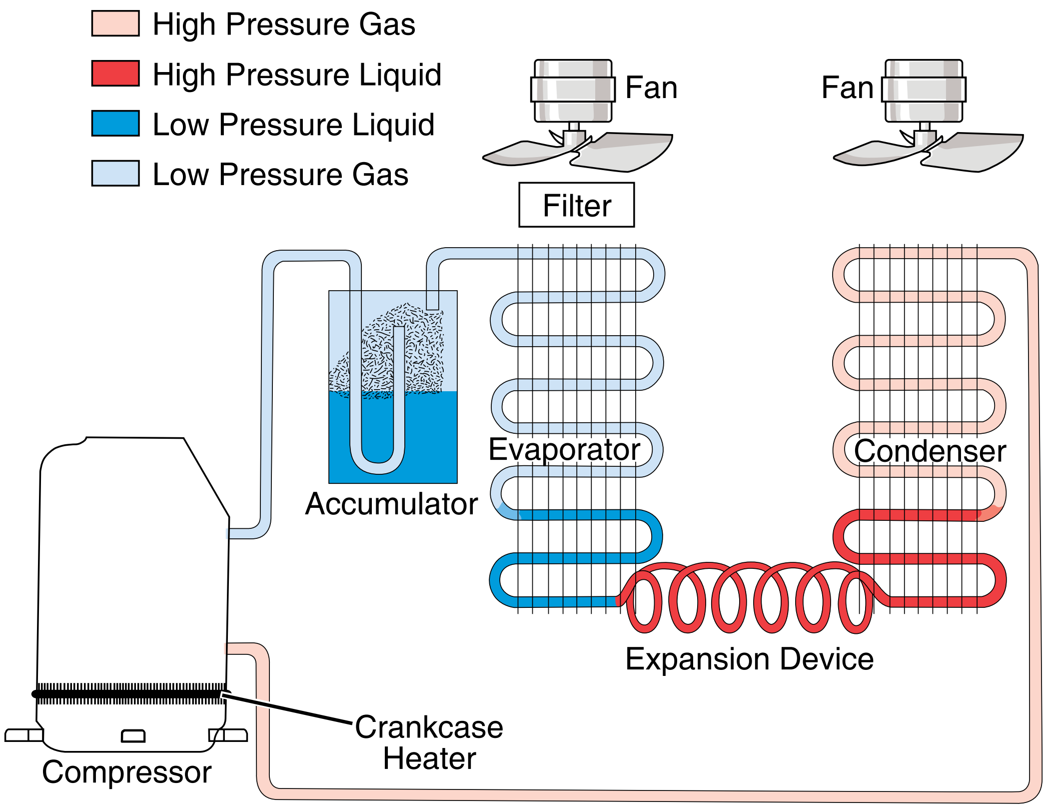


FIGURE 6-13: Application of a properly designed and sized suction line accumulation.

FIGURE 6-14: A suction line accumulator prevents damaging liquid refrigerant floodback.

Accumulator Selection

Selecting the proper size is of primary importance. Only one factor need be considered in order to assure the correct accumulator for a particular system -- the total refrigerant charge in that system.

It is not necessary to know the holding capacity of the accumulator or system variants such as evaporator temperature and capacity in tons of refrigeration. These factors were considered in the design and testing of the accumulator.

On older systems, if the system refrigerant charge is not known, consider the "rule of thumb" provided in Table 6-1 when selecting the correct size of suction accumulator:

Table 6-1: Selecting Correct Suction Accumulator

Application	System Charge (lb/HP)
Air conditioning and heat pump and high evaporator temperature	3
Medium evaporator temperature	5
Low evaporator temperature	7

Internal Pressure Relief Valves

Certain air conditioning compressors in the AJ, AW, AH, AV, AG, and SF families are quipped with a unique internal pressure relief (IPR) valve. It prevents abnormally high head pressures from developing if a condenser fan motor fails or air passages in the condenser coil become blocked by dirt, leaves, paper, etc. The IPR valve relieves pressure from the high pressure side to the low pressure side of the system. It does not relieve pressure from the system to the atmosphere. See Table 6-2.

Compressors with IPR valves are frequently used in air conditioning and heat pump systems, and occasionally used in refrigeration systems. The IPR valve may also open to relieve hydraulic pressures in the event of slugging. This is apt to occur on startup if refrigerant has been allowed to migrate to the compressor crankcase. It is a characteristic of the IPR valve that once it has “popped,” it will not reset until the compressor has been stopped and the pressure allowed to equalize.

If a high to low side leak within the compressor is suspected, stop the system, equalize the pressures, permit the IPR valve to close, and restart the compressor to double check before deciding to change the compressor.

Table 6-2: Compressors with IPR valves

AG Models	AHA7513Z	SFA5560E
AV Models	AHA7515J	SFA5572E
AW Models	AHA7521Z	SFA5581E
AHA4520E	AHA7524J	SFAA530Z
AHA4522E	AJC5519E	SFAA536Z
AHA4524E	AJD8520E	SFAA540Z
AHA4531E	SFA5554E	
AHA4540E	SFA5558E	

Appendix

The Basic Refrigeration Cycle

Mechanical refrigeration is accomplished by continuously circulating, evaporating, and condensing a fixed supply of refrigerant in a closed system. Evaporation occurs at a low temperature and low pressure while condensation occurs at a high temperature and high pressure. Thus, it is possible to transfer heat from an area of low temperature (i.e., refrigerator cabinet) to an area of high temperature (i.e., kitchen).

Beginning the cycle at the evaporator inlet (1) the low pressure liquid expands, absorbs heat, and evaporates, changing to a low pressure gas at the evaporator outlet (2).

The compressor (4) pumps this gas from the evaporator through the accumulator (3), increases its pressure, and discharges the high pressure gas to the condenser (5). The accumulator is designed to protect the compressor by preventing slugs of liquid refrigerant from passing directly into the compressor. An accumulator should be included on all systems subjected to varying load conditions or frequent compressor cycling. In the condenser, heat is removed from the gas, which then condenses and becomes a high pressure liquid. In some systems, this high pressure liquid drains from the condenser into a liquid storage or receiver tank (6). On other systems, both the receiver and the liquid line valve (7) are omitted.

A heat exchanger (8) between the liquid line and the suction line is also an optional item, which may or may not be included in a given system design.

Between the condenser and the evaporator an expansion device (10) is located. Immediately preceding this device is a liquid line filter-drier (9) which prevents plugging of the valve or tube by retaining scale, dirt, and moisture. The flow of refrigerant into the evaporator is controlled by the pressure differential across the expansion device or, in the case of a thermostatic expansion valve (TEV), by the amount of superheat of the suction gas. Thus, the TEV shown requires its sensing bulb located at the evaporator outlet. The TEV allows the flow of refrigerant into the evaporator to increase as the evaporator load increases.

As the high pressure liquid refrigerant enters the evaporator, it is subjected to a much lower pressure due to the suction of the compressor and the pressure drop across the expansion device. Thus, the refrigerant tends to expand and evaporate. In order to evaporate, the liquid must absorb heat from the air passing over the evaporator.

Eventually, the desired air temperature is reached and the thermostat or cold control (11) will break the electrical circuit to the compressor motor and stop the compressor.

As the temperature of the air through the evaporator rises, the thermostat or cold control remakes the electrical circuit. The compressor starts, and the cycle continues.

In addition to the accumulator, a compressor crankcase heater (12) is included on many systems. This heater prevents accumulation of refrigerant in the compressor crankcase during the non-operating periods and prevents liquid slugging or oil pump-out on startup.

Additional protection to the compressor and system is afforded by a high and low pressure cutout (13). This control is set to stop the compressor in the event that the system pressures rise above or fall below the design operating range.

Other controls not indicated on the basic cycle which may be part of a system include: evaporator pressure regulators, hot gas bypass regulators, electric solenoid valves, crank case pressure regulators, condenser pressure regulators, oil separators, etc.

It is extremely important to analyze completely every system and understand the intended function of each component before attempting to determine the cause of a malfunction or failure.

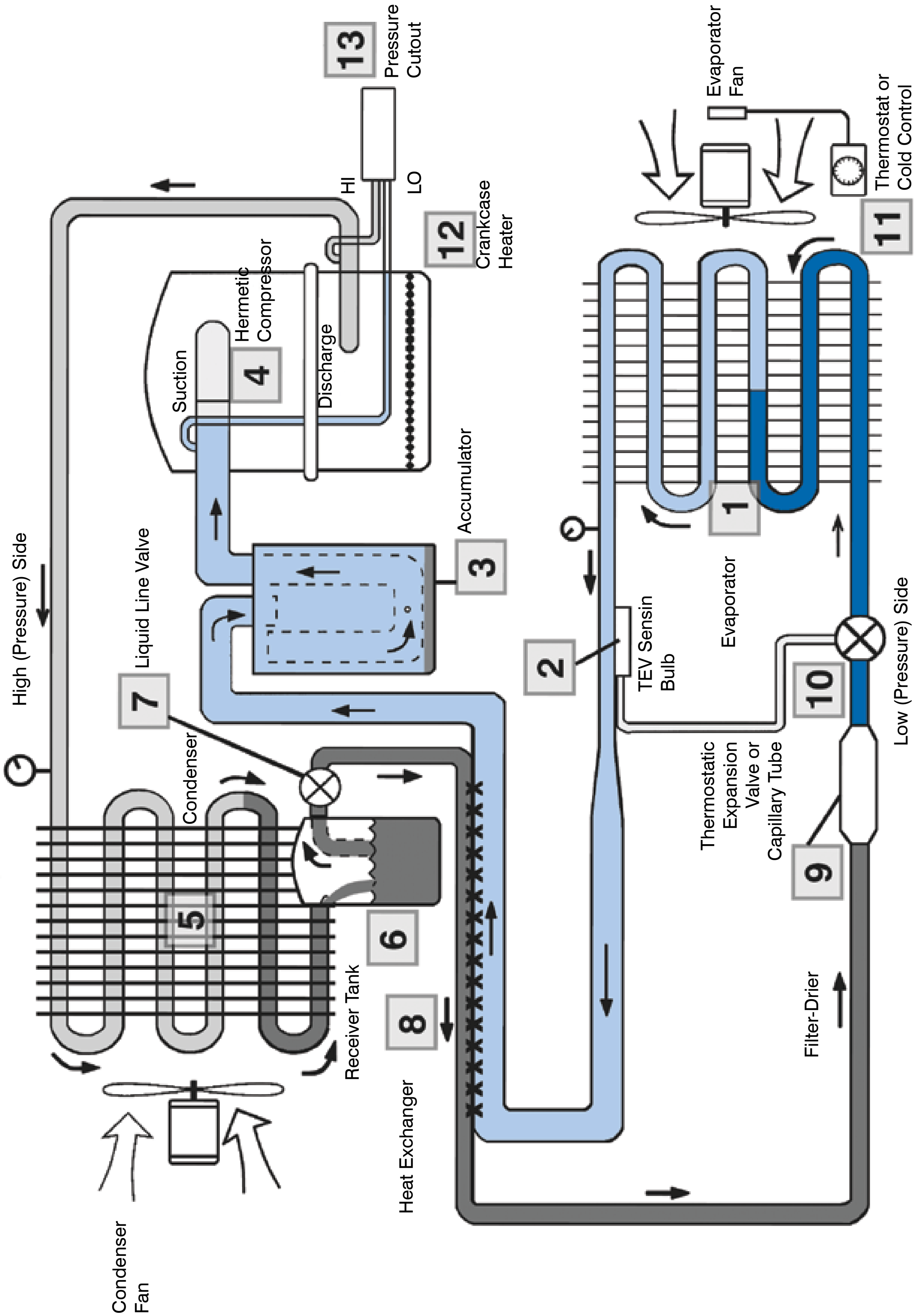


FIGURE A-1: Basic Refrigeration Cycle

Example of a Tecumseh Hermetic Compressor

A Tecumseh hermetic compressor is a direct-connected motor compressor assembly enclosed within a steel housing and designed to pump low pressure refrigerant gas to a higher pressure.

The major internal parts of a Tecumseh hermetic compressor are shown in Figure A-2 and are listed in the same sequence as that of the refrigerant gas flow through the compressor. First, the suction is drawn into the compressor housing, then to and through the electric motor which provides power to the crankshaft. The crankshaft revolves in its bearings, driving the piston(s) in the cylinder(s). The crankshaft is designed to carry oil from the oil pump in the bottom of the compressor to all bearing surfaces. Refrigerant gas surrounds the compressor crankcase and motor as it is drawn through the compressor housing and into the cylinder(s) through the suction muffler and suction valves. As the gas is pressured by the moving piston, it is released through the discharge valves, discharge muffler and compressor discharge tube.

Some Tecumseh hermetic compressors are low pressure housing compressors. These compressor housings are not normally subjected to discharge pressure—operating instead at relatively low suction pressures. These Tecumseh compressors are general installed on equipment where it is impractical to disconnect or isolate the compressor from the system during pressure testing; therefore, do no exceed a field leak test pressure of 150 Psig when pressurizing such a complete system.

Many Tecumseh hermetic compressors contain internal motor protectors—the details of these are covered under “Hermetic Compressor Thermal Protectors” on pages 19-20.

Reciprocating Compressor

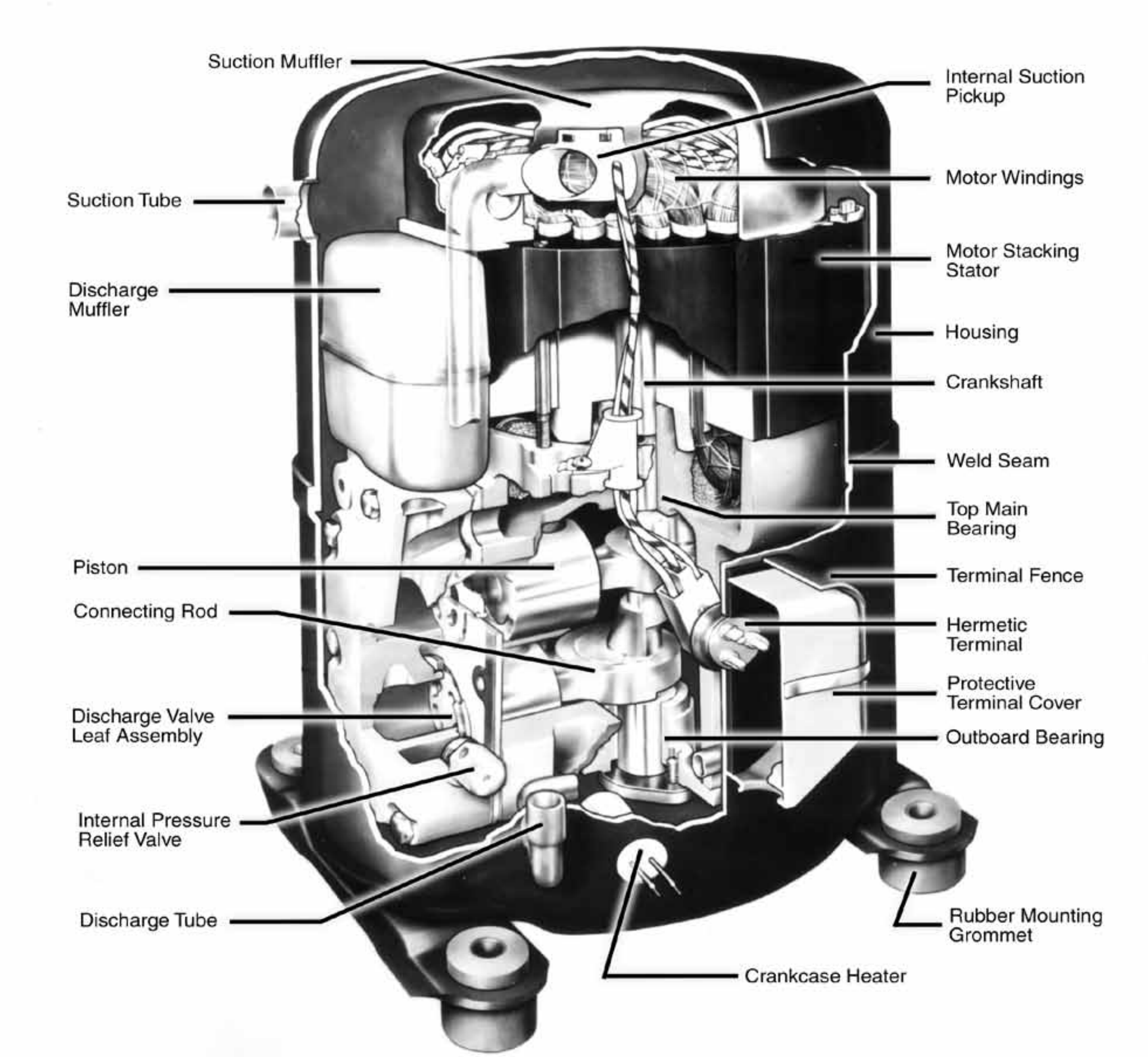


FIGURE A-2: Internal view of typical air conditioning compressor

Capillary Tube Sizing

Suggested Capillary Tube Data for Domestic and Commercial Refrigeration Applications

The following suggestions listed in Table A-1 and the correction factors listed in Table A-2 assume a 115°F liquid temperature, no subcooling prior to the heat exchanger, and 3 ft of heat exchange with the suction line.

Capillary tube capacity data was generated using the Wolf and Pate 2002 correlation (ASHRAE Research Project, RP-948)

Example No. 1

Select the capillary required for a Tecumseh R-22 compressor model AEA5460EXA rated at 6,000 Btu/h at 45°F evaporator. Table A-1, we find 13 ft length of 0.064 in capillary tube.

Example No. 2

Select the capillary required for a Tecumseh R-134a compressor model AJA7461YXA rated at 6,110 Btu/h at 20°F evaporator. From Table A-1, we find 9 ft length of 0.052 in capillary tube, 2 required piped in parallel.

Table A-1: Capillary tube selections assume a 115°F liquid temperature and 3 ft of heat exchange length

Capillary Tube, Length - OD				
		Evaporator Temperature, °F		
Refrigerant	Btu/h per circuit	-10	20	45
22	500	19 ft - 0.026"	18 ft - 0.026"	17 ft - 0.026"
	750	12 ft - 0.028"	11 ft - 0.028"	10 ft - 0.028"
	1,000	11 ft - 0.031"	10 ft - 0.031"	10 ft - 0.031"
	1,250	16 ft - 0.036"	15 ft - 0.036"	15 ft - 0.036"
	1,500	11 ft - 0.036"	10 ft - 0.036"	10 ft - 0.036"
	2,000	14 ft - 0.042"	13 ft - 0.042"	13 ft - 0.042"
	3,000	19 ft - 0.052"	18 ft - 0.052"	18 ft - 0.052"
	4,000	10 ft - 0.052"	10 ft - 0.052"	9 ft - 0.052"
	6,000	14 ft - 0.064"	13 ft - 0.064"	13 ft - 0.064"
	8,000	10 ft - 0.052" (2)	10 ft - 0.052" (2)	9 ft - 0.052" (2)
	10,000	13 ft - 0.059" (2)	12 ft - 0.059" (2)	12 ft - 0.059" (2)
	12,000	14 ft - 0.064" (2)	13 ft - 0.064" (2)	13 ft - 0.064" (2)
134a	500	14 ft - 0.028"	14 ft - 0.028"	14 ft - 0.028"
	750	10 ft - 0.031"	10 ft - 0.031"	10 ft - 0.031"
	1,000	12 ft - 0.036"	12 ft - 0.036"	12 ft - 0.036"
	1,250	18 ft - 0.042"	18 ft - 0.042"	18 ft - 0.042"
	1,500	12 ft - 0.042"	12 ft - 0.042"	12 ft - 0.042"
	2,000	22 ft - 0.052"	22 ft - 0.052"	22 ft - 0.052"
	3,000	9 ft - 0.052"	9 ft - 0.052"	9 ft - 0.052"
	4,000	10 ft - 0.059"	10 ft - 0.059"	10 ft - 0.059"
	6,000	9 ft - 0.052" (2)	9 ft - 0.052" (2)	9 ft - 0.052" (2)
	8,000	10 ft - 0.059" (2)	10 ft - 0.059" (2)	10 ft - 0.059" (2)
	10,000	10 ft - 0.064" (2)	10 ft - 0.064" (2)	10 ft - 0.064" (2)
	12,000	10 ft - 0.059" (3)	10 ft - 0.059" (3)	10 ft - 0.059" (3)

Table A-1: continued

Capillary Tube, Length - OD				
		Evaporator Temperature, °F		
Refrigerant	Btu/h per circuit	-10	20	45
404A/507	500	17 ft - 0.031"	18 ft - 0.031"	19 ft - 0.031"
	750	16 ft - 0.036"	17 ft - 0.036"	18 ft - 0.036"
	1,000	9 ft - 0.036"	9 ft - 0.036"	10 ft - 0.036"
	1,250	12 ft - 0.042"	13 ft - 0.042"	14 ft - 0.042"
	1,500	9 ft - 0.042"	9 ft - 0.042"	10 ft - 0.042"
	2,000	15 ft - 0.052"	16 ft - 0.052"	17 ft - 0.052"
	3,000	13 ft - 0.059"	14 ft - 0.059"	14 ft - 0.059"
	4,000	11 ft - 0.064"	12 ft - 0.064"	12 ft - 0.064"
	6,000	13 ft - 0.059" (2)	14 ft - 0.059" (2)	14 ft - 0.059" (2)
	8,000	11 ft - 0.064" (2)	12 ft - 0.064" (2)	12 ft - 0.064" (2)
	10,000	10 ft - 0.059" (3)	11 ft - 0.059" (3)	11 ft - 0.059" (3)
	12,000	11 ft - 0.064" (3)	12 ft - 0.064" (3)	12 ft - 0.064" (3)

Table A-2: Capillary tube correction factors assume a 115°F liquid temperature and 3 ft of heat exchange length

	(1) Capillary Tube Size from Table A-1								
(2) Desired Capillary Tube Size	Tube ID (in)	0.026	0.028	0.031	0.036	0.042	0.052	0.059	0.064
	0.026	1.00	0.66						
	0.028	1.52	1.00	0.56	0.24				
	0.031	2.71	1.78	1.00	0.43				
	0.036			2.34	1.00	0.42			
	0.040				1.82	0.76			
	0.042				2.40	1.00	0.30		
	0.044					1.30	0.39		
	0.049					2.40	0.71	0.35	
	0.050						0.80	0.39	
	0.052						1.00	0.49	0.31
	0.054						1.24	0.60	0.38
	0.055						1.38	0.67	0.42
	0.059						2.05	1.00	0.63
	0.064							1.59	1.00
	0.070							2.64	1.66
	0.075								2.46

Example No. 1

To convert 16 ft of 0.031" capillary to 0.028", multiply length by 0.56, i.e., 16 ft * 0.56 = 9 ft.

As a result, 9 ft of 0.028" capillary has aprroximately the same capacity as 16 ft of 0.031" capillary

Approved Hermetic Compressor Oils

Use the proper type and amount of oil. A proper oil charge contributes materially to successful compressor operation and long service life.

Tecumseh Products Company has determined the optimum oil charge for each of its compressors, and this amount is specified on the compressor bill of material. This is a mandatory oil charge based on the premise that the compressor will be installed in a close-coupled system designed in accordance with good engineering practice.

Some system designs containing unusual evaporators and/or extensive interconnected piping may required additional oil. However, since excess oil can also damage compressors, care should be taken not to exceed the oil charge amounts specified. See "Refrigerant Line Sizes" on pages 76-81. If the correct oil charge is in doubt, please obtain assistance from your Tecumseh Technical Service Representative.

The approved and alternate oils are shown on Table A-3 and A-4.

Table A-3: Approved and Alternate Compressor Oils

Refrigerant	Approved Oil Types
CFC's	Naphthenic Synthetic Alkylate (Alkylbenzene) Paraffinic
HCFC-22	Naphthenic Synthetic Alkylate (Alkylbenzene) Naphthenic / Paraffinic
HCFC-Other	Synthetic Alkylate (Alkylbenzene)
HFC's	Polyol Ester Polyvinyl Ether

Legend

Table A-4: Most Common Oil Types to be Used in Compressor Families

1. AE manufactured in Brazil. Ak, AV and AW manufactured in India

2. (LBP and CBP using R22, R502) for AE, AJ,AH, AK, AV, and AW. For compressor manufactued in Brazil only, AE, AZ, THB, AK, and TW. (R-12 and R-22)

3. AG, AK,AV,and AW. EXCEPTION: Not to be used in AWA & AWF families. NOTE: These oils must be used with SYN-O-AD 8478LW.

4. AE and AZ families

5. HG, RG, RK & RK split systems, and AG CBP using R-22 or R-502. NOTE: These oils must be used with SYN-O-AD 8478LW.

6. Tecumseh Brazil built AE (R-12 models) HBP and CBP only. For Tecumseh Brazil Market Only

7. AZ, AE, AK, AJ, AH, AV, AW using R-134a, R-404A, and R-507 refrigerant. NOTE: These oils must be used with SYN-O-AD 8478LW.

8. AW-F family only. NOTE: These oils must be used with SYN-O-AD 8478LW.

9. THA,THB, TP, TS, TW using R-134a.

10. VS and HS using R-404A and R-410A

11. RG, HG, RK, RN using R-134a, R-404A, R-410A, and R-407C refrigerant.

Table A-4: Most Common Oil Types to be Used in Compressor Families

Source	Compressor Families																	
	AZ	AE	AK	AJ	AH	AW	AV	AG	RK	RG	THA	THB	TP	TS	TW	HG	RN	VS
Naphthenic																		
Witco Suniso 3 GS						8												
Witco Suniso 1 GS		1	1			1	1											
Lubrax CP-32-RF		1	1			1	1											
Synthetic Alkylate (Alkylbenzene)																		
Zerol 150TD	2	1,2	1,2	2	2	1,2	1,2					2			2			
Venoco DL-008AS	2	2	2	2	2	2	2					2			2			
Zerol 150T	4	4																
Venoco DL-008A	4	4																
Zerol 300 SUS								5	5	5						5		
Soltex SA56								5	5	5						5		
Lubrax BR-069C-EX	4	4																
Lubrax ALP-415-LCR	4	4																
Naphthenic / Paraffinic																		
Sonneborn (Witco) LP 200			3			3	3	3										
Penreco-Sontex 200LT, (A) LT			3			3	3	3										
Paraffinic																		
Total Oil Company 68CST		6																
Petrobas CP-68-RAD		6																
Polyol Ester																		
ProEco 32M	7	7	7	7	7	7	7											
CP-2932-E	7	7	7	7	7	7	7											
ProEco RF32	7	7	7	7	7	7	7											
Hatcol 3680											9	9	9	9	9			
Emkarate RL15H											9	9	9	9	9			
Emkarate RL10H											9	9	9	9	9			
ProEco 3844											9	9	9	9	9			
ProEco 10S											9	9	9	9	9			
CP-2910-E											9	9	9	9	9			
ProEco 22S											9	9	9	9	9			
CP-2922-E											9	9	9	9	9			
Freol Alpha 10W											9	9	9	9	9			
Freol Alpha 22E											9	9	9	9	9			
Hatcol 3681																		10
Polyvinyl Ether																		
Apollo America Corp FVC68D									11	11						11	11	

Notes

When it comes to compressors...

Think Safety!

Be alert for sounds of arcing (sizzling, sputtering or popping) inside the compressor. IMMEDIATELY GET AWAY if you hear these sounds.

Disconnect ALL electrical power before removing the protective thermal cover.

Never energize the system unless
- the protective terminal cover is securely fastened and
- the compressor is properly connected to ground

Never reset a breaker or replace a fuse without first checking for a ground fault (also known as a short circuit to ground).

Tecumseh

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