

*Holdover Plates
Transport Refrigeration Systems*



Hercules Manufacturing Company

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The Refrigeration Cycle

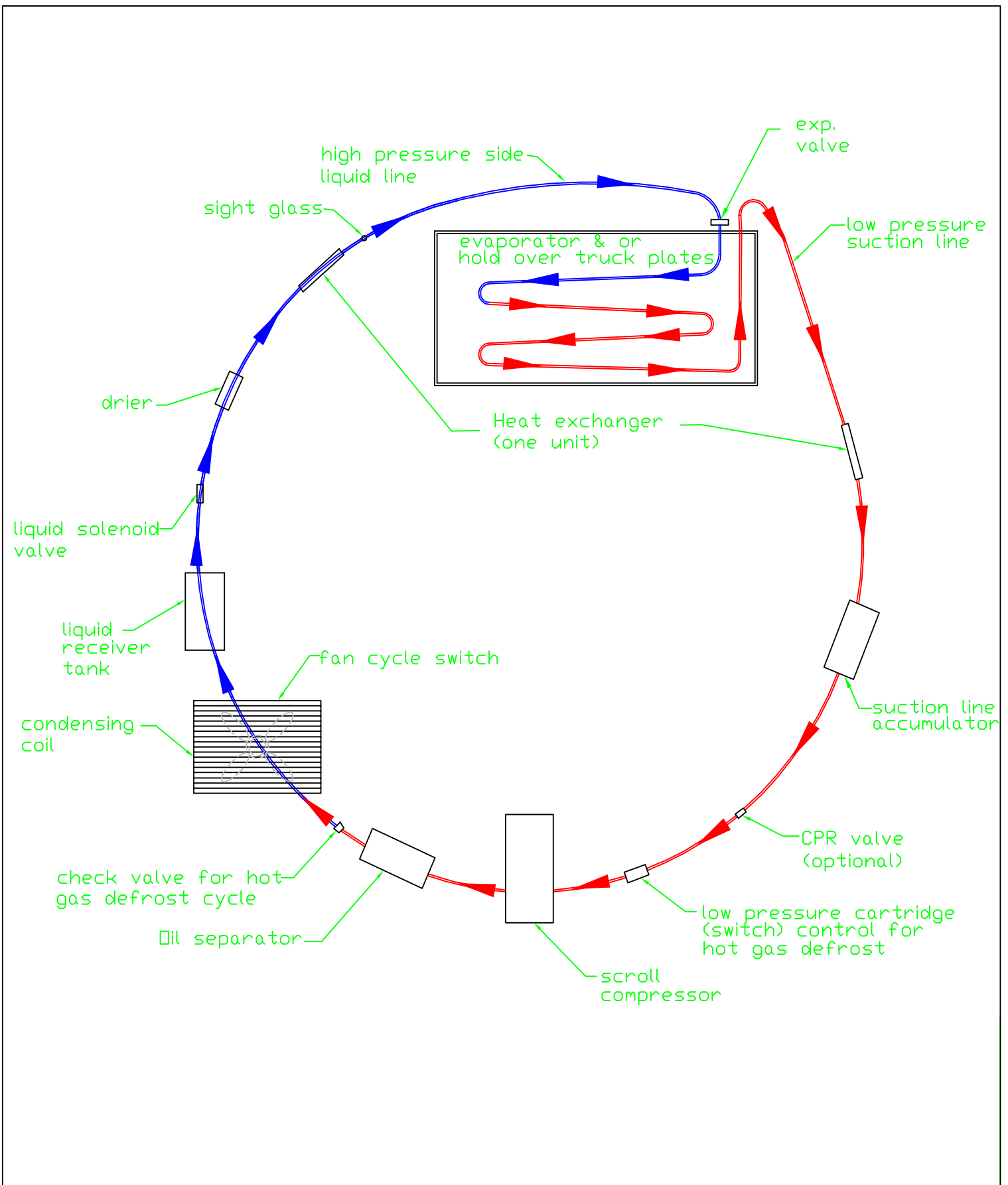
Continuous Refrigeration can be accomplished by several different processes, but the most popular process is the Vapor Compression System.

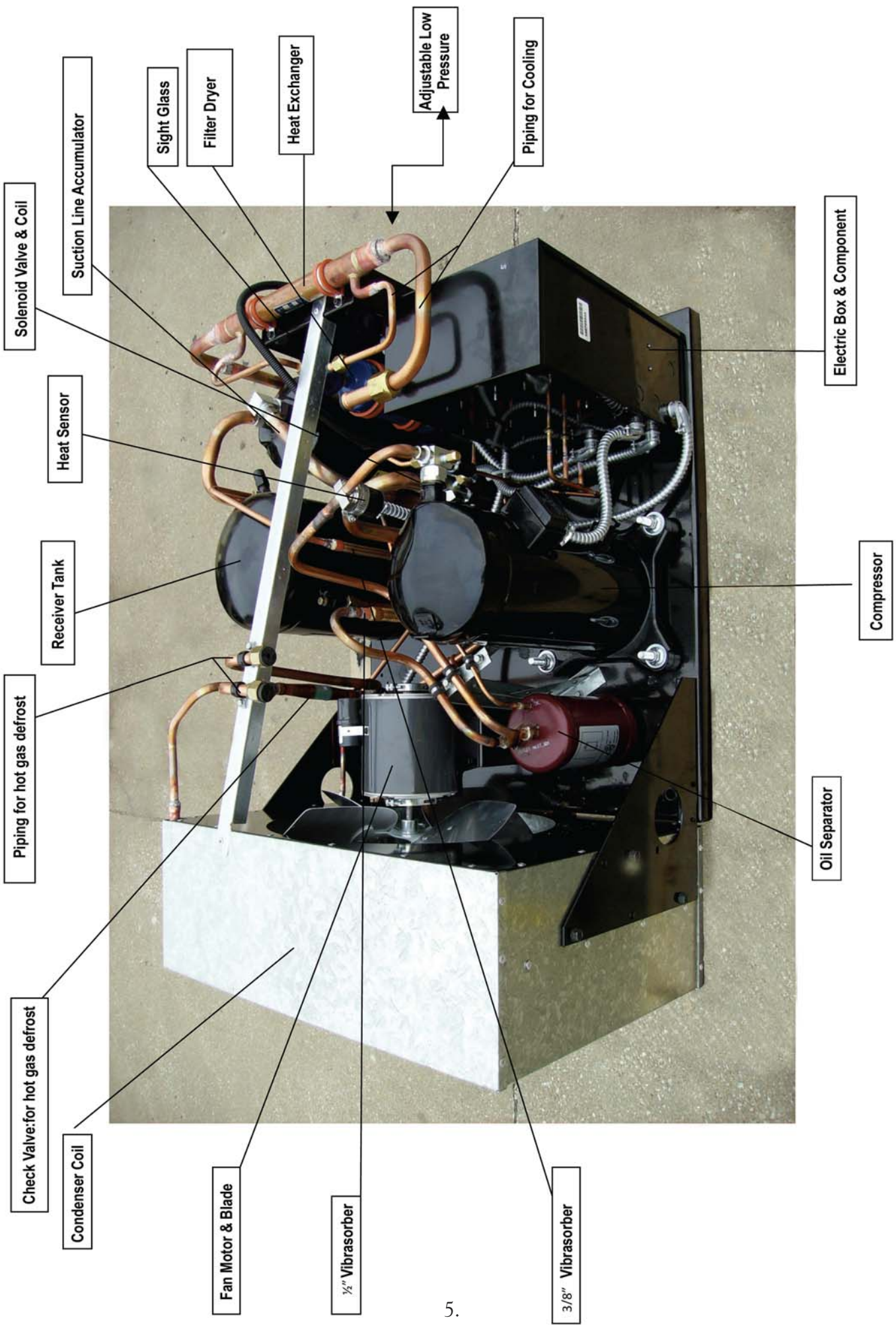
In a compression system, there are two existing pressures: the evaporating or low pressure, and the condensing or high pressure. The refrigerant acts as the transportation medium between the evaporator and the condenser.

What Is The Refrigeration Cycle?

Basic Cycle Operation

1. High pressure liquid refrigerant is fed from the **condenser** through the liquid line and the **filter-drier** to the metering device.
2. The high pressure side is separated from the low-pressure side using a **thermostatic expansion valve** (TEV).
3. The TEV controls the quantity of liquid refrigerant entering the **evaporator**. It causes the pressure of the refrigerant to the low side to be reduced. In reducing the low side pressure, the refrigerant reaches its boiling point and begins to vaporize.
4. The low pressure, low temperature refrigerant passes through the evaporator coil and heat flows through the walls of the tubing into the refrigerant to continue the boiling action until the refrigerant is completely vaporized.
5. The refrigerant is superheated to ensure there is no liquid fed through the compressor. As the refrigerant vapor flows through the **compressor** it is converted from a low pressure vapor to a hot, high pressure vapor and is forced out the compressor's discharge valve.
6. After leaving the compressor, the hot high pressure vapor enters the condensing coils and is air-cooled. The vapor returns to liquid state and the process repeats.





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Compressor

The compressor has two functions in the refrigeration cycle. It removes refrigerant vapor from the evaporator and reduces the pressure in the evaporator to a point where the required temperature can be maintained. Also, the compressor raises the pressure of the refrigerant vapor to a high enough level that it can be changed into liquid as it flows through the condenser.

Scroll Compressor Protection

1. *Temperature Operated Disk (TOD)*

A bi-metallic disk that senses compressor discharge temperature and opens at 270 degrees F.

2. *Internal Pressure Relief (IPR):*

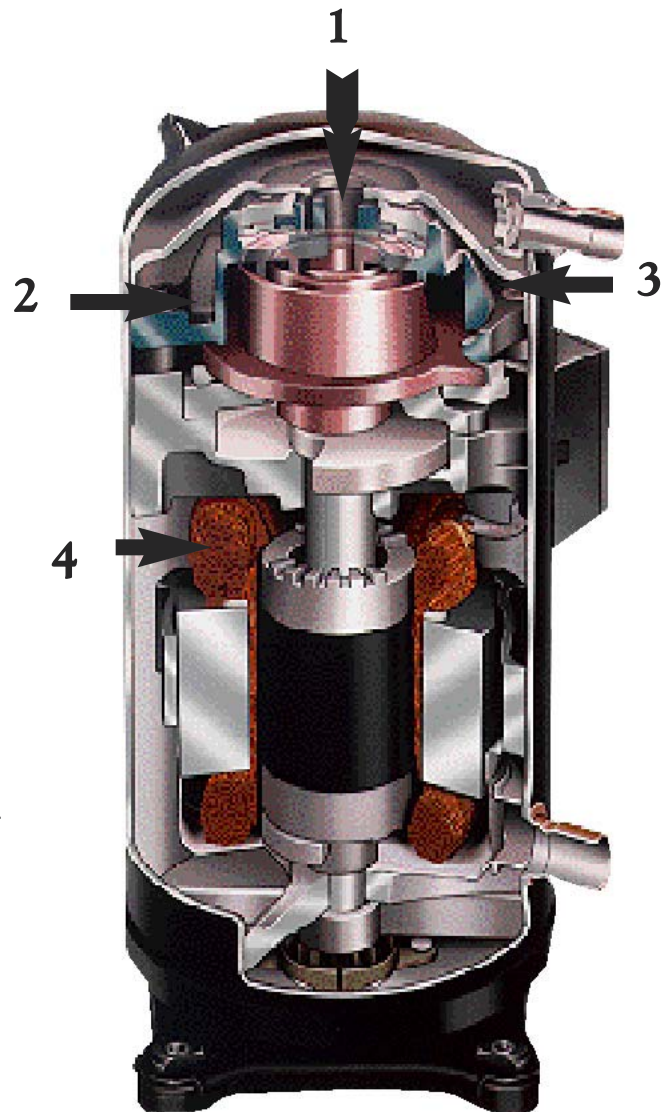
Opens at approximately 400+/-50 psi differential between high and low side pressures.

3. *Floating Seal:*

Separates the high side from the low side. Also prevents the compressor from drawing into a deep vacuum and damaging (shorting) the Fusite electrical terminal.

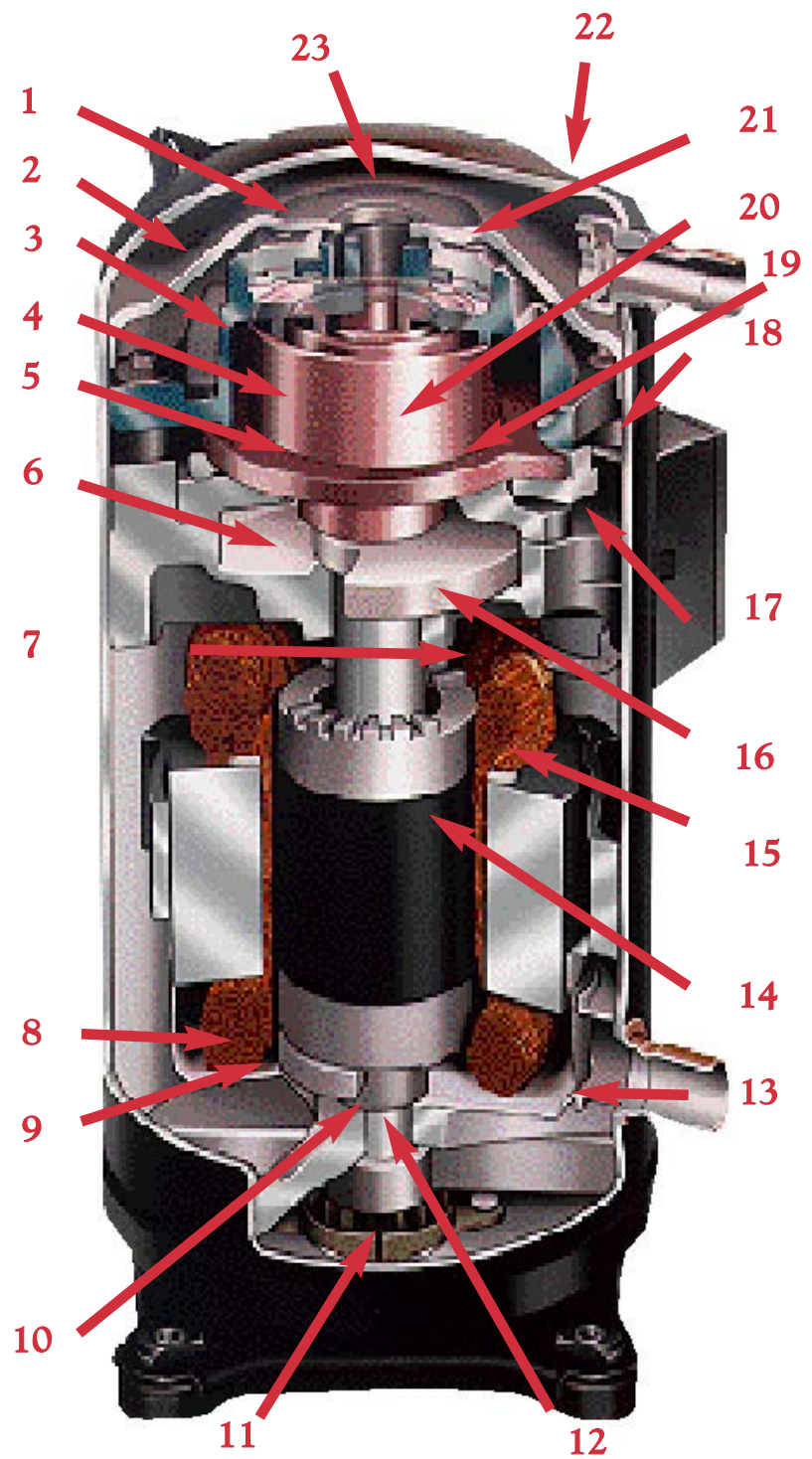
4. *Internal Motor Protection:*

An inherent protector sensing both internal temperatures and amperages.



Compressor - Key Components

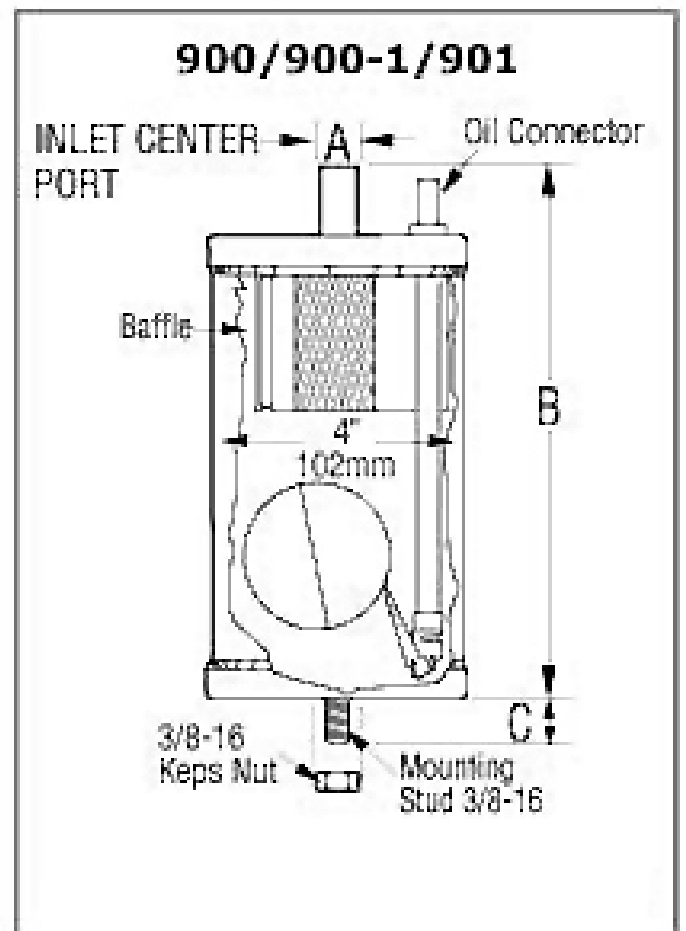
1. Discharge Plenum
2. Upper Shell
3. Fixed Scroll
4. Orbiting Scroll
5. Crankcase
6. Stator Winding
7. Eccentric Shaft
8. Lower Bearing Ring
9. Lower Bearing
10. Thrust Washer
11. Magnet
12. Oil Tube
13. Shell
14. Rotor
15. Stator
16. Counterweight
17. Electric Terminal
18. Terminal Cover
19. Suction Baffle
20. Slider Block
21. Separator Plate
22. Discharge Tube
23. Check Valve



Oil Separators

An oil separator is a separation chamber for oil and discharge gas. It is installed on the discharge line between the compressor and the condenser. By using baffles and reducing the gas velocity, the oil is separated from refrigerant and returned to the crankcase of the compressor by means of a float valve and connecting tube.

900/900-1/901 Hermetic Coalescent Oil Separator

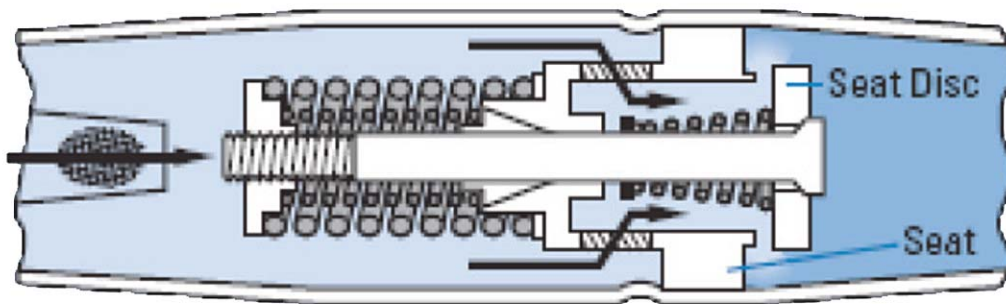


Hot Gas Defrost Check Valve

(Sporlan ORD-4-20 Head Pressure Control Valve)

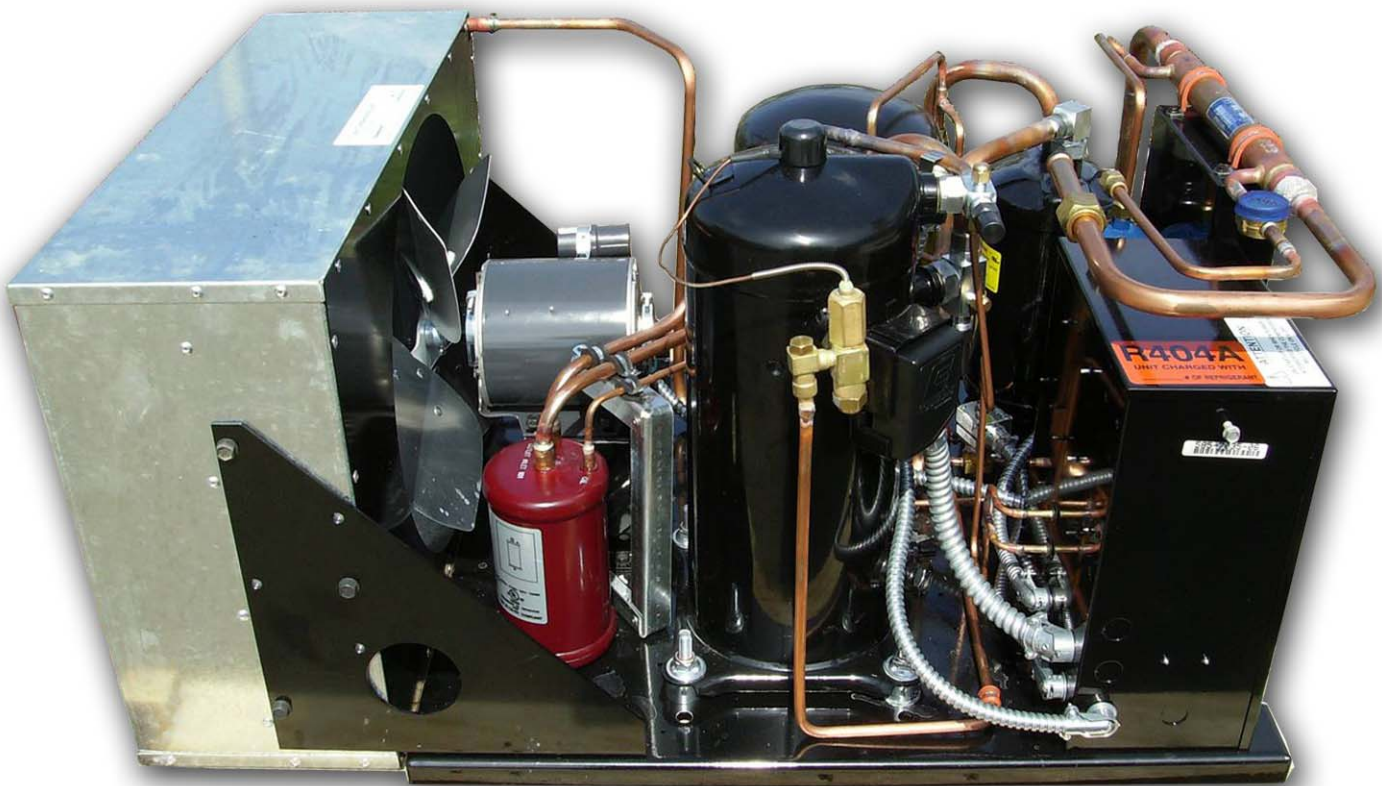
ORD - The **ORD** valve is a **pressure differential valve** that responds to changes in the pressure difference across the valve. The valve designation stands for (**Opens on Rise of Differential pressure**.) Therefore, the **ORD** is dependent on some other control valve or action for its operation.

(When defrost system is initiated, liquid line solenoid valves on plate, one is energized, the other valve de-energized, check valve responds to changes in pressure differential.) This will allow the hot gas out of compressor to bypass the condenser and circulate through the piping of one selected plate, melting any frost accumulation. Returning hot gas will now circulate through the condenser and back to the other plates for cooling.



Air Cooled Condenser

The condenser reverses the evaporator process. It changes high temperature, high pressure refrigerant vapor into refrigerant liquid. To drop the temperature of the vapor, an external device must be used to extract heat. Some systems are water-cooled and others are air-cooled. A water-cooled system can be more desirable if low cost condensing water is available. To cool the refrigerant cold water is fed through the condensing coils to absorb heat. The condensed refrigerant liquid exits the system by way of a refrigerant liquid line. In this application an air-cooled system is used. It is easier to install, inexpensive and require no water. Furthermore, there is no risk of water freezing in colder, ambient temperatures. To cool the refrigerant, a fan blows over the condensing coils. The air absorbs the heat and becomes warmer, but the refrigerant successively becomes cooler in each row as it rejects more heat and returns to liquid state.



Normally the condenser fan, if located so that it discharges on the compressor, will provide satisfactory cooling. For proper cooling, the fan must discharge air directly against the compressor.

Fan Cycle Switch

Condensing Temperature Control

Condensing temperature must be controlled to maintain condensing pressure to guarantee proper system operation. The condensing temperature must be controlled so that liquid sub-cooling and liquid line flash gas can be maintained, adequate pressure at the inlet side of the thermo valve to obtain sufficient pressure drop across the valve port is provided, and systems with hot gas defrost can operate properly. Condensing temperature is controlled by fan-cycling and head-pressure regulator valves.

To maintain air-cooled pressures in lower ambient conditions, a condenser fan pressure control may be used. The control acts to break the circuit to the condenser fan on a drop in condensing pressure and high pressure control, this is often described as a reverse-acting high pressure control.

Fan cycle switch in this case is hard piped with the following non-adjustable settings:

Cut-out 185 + or - 10 psig

Cut-in 235 + or - 10 psig

Fan Cycling Control
Part # 085-7011-03

(Note: there is a difference between the High Pressure Control and the Fan Cycle Switch. The two differences are the spade orientation and the P/N)



High Pressure Control Switch



High Pressure Cutout
Part # 085-7015-03

The high pressure safety switch is installed (in Condenser box) inside electric box next to the fan cycle switch as a precaution to shut off compressor motor when discharge pressure reaches 440 PSI to avoid damage to compressor.

(Note: there is a difference between the High Pressure Control and the Fan Cycle Switch. The two differences are the spade orientation and the P/N)

Liquid Receiver Tank

A receiver is primarily a liquid storage tank for refrigerant which is not in circulation. All air cooled units equipped with expansion valves require a separate receiver to allow for the wide swings in ambient temperatures. In order to provide space to store the refrigerant charge when maintenance is required on the system, the receiver should be large enough to hold the entire refrigerant charge. A valve at the receiver outlet is required in order to pump the refrigerant charge into the receiver, an operation commonly called “pumping the system down”.

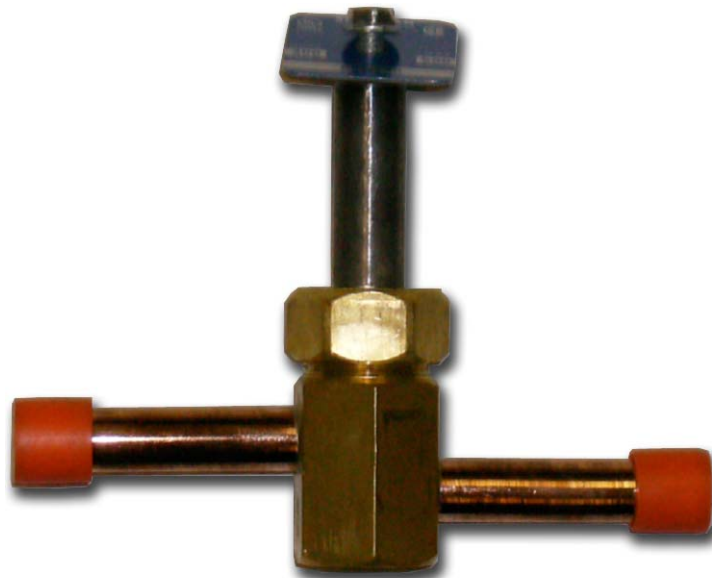


Liquid Solenoid Valve

A solenoid valve is an electrically controlled refrigerant flow control valve. It does not modulate; it is either open or closed. A solenoid valve is made up of a body, a plunger with an iron core that seats the valve orifice and an electrical solenoid coil. There are two types, “normally open” and “normally closed”. In this application, it is normally closed. The solenoid valve is closed when the coil is de-energized and the plunger is seated.

Solenoid valves are used to trap the liquid refrigerant in the receiver tank and also for pump down purposes when servicing system.

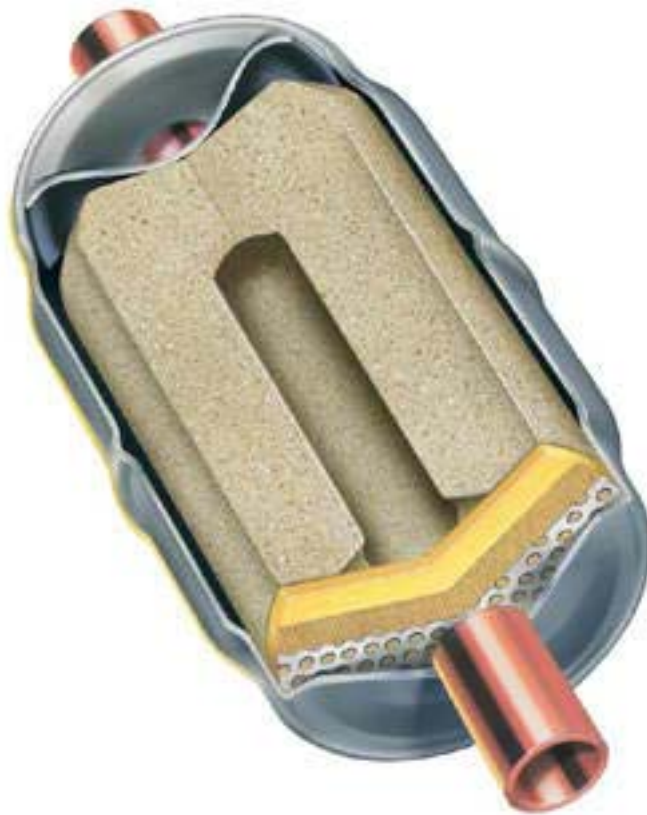
Direct acting Solenoid Valve operation, the plunger is mechanically connected to the needle valve. When the coil is energized, the plunger pulling the needle off the orifice is raised into the center of the coil.



Solenoid valves are also used on Hot Gas Auto Defrost Systems, two on each plate, one normally open and the other normally closed. Normally closed valve must be energized or magnetized to open during system evacuation or pump down.

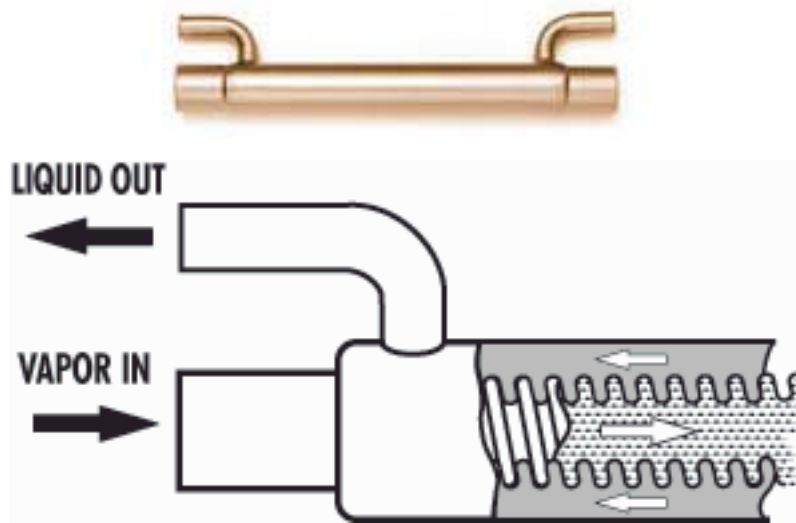
Filter-Drier

Filter-driers are used to protect the compressor from contamination, particularly moisture, left in the system at the time of installation and keeps the system free of impurities during operation, such as motor burn byproducts.



Heat Exchangers

Heat Exchangers are specifically designed for application on refrigeration systems to transfer heat Between liquid refrigerant leaving the condenser on the high pressure side of the system and refrigerant vapor leaving the evaporator on the low pressure side of the system.



Heat transfer may be desirable for several reasons:

- To raise the vapor temperature to prevent frosting or condensation on the suction line.
- To evaporate any remaining liquid in the vapor stream to prevent possible compressor damage.
- To subcool the liquid to prevent flash gas in the liquid line.
- To increase system refrigerating capacity.

Refrigerant vapor flows through the inner tube in a counterflow direction to the liquid refrigerant flowing in the annuls between the inner and outer tube. This counterflow path provides the greatest temperature difference between the two refrigerant streams to yield optimum heat transfer. To further maximize heat exchanger performance with minimum size, the inner tube is convulted to impart turbulence to both refrigerant flows while the straight through design helps maintain low refrigerant pressure drops.

Sight Glass & Hermetic Moisture Indicators

The HMI was designed to provide an accurate method of determining the moisture content of a system's refrigerant.

Unique 3% high accuracy moisture indicator.

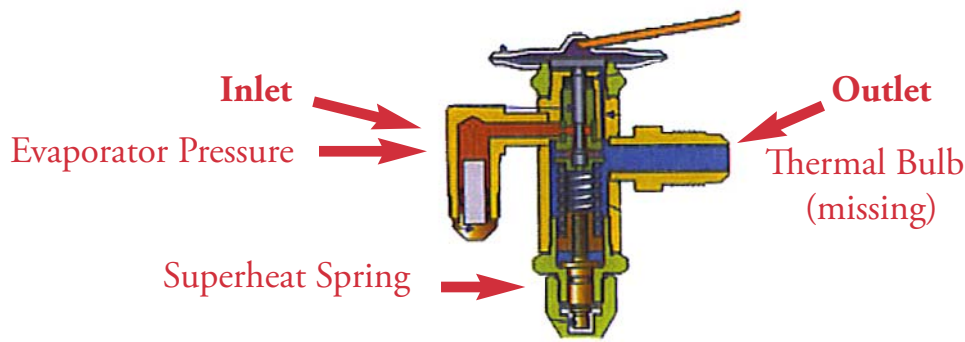
Refrigerant level indicator.



**IF IT'S NOT BLUE,
IT'S NOT DRY!
(NOT NECESSARILY TRUE)**

Thermostatic Expansion Valves

THERMOSTATIC EXPANSION VALVES: The most commonly used device for controlling the flow of refrigerant is the thermostatic expansion valve. Temperature of the vapor leaving the evaporator controls the flow leaving the expansion valve. The flow is controlled by a needle and diaphragm in the valve. The diaphragm is subject to three forces: evaporator pressure, the superheat spring and pressure exerted by the charge in the thermal bulb. As the refrigerant is in the evaporator, it is evaporating at its saturation temperature and pressure. As long as the thermal bulb is exposed to a higher temperature than the refrigerant in the evaporator the valve remains open. The superheat spring valve is fixed to close whenever the net difference between the bulb pressure and the evaporator pressure is less than the superheat setting. As the temperature of the refrigerant gas leaving the evaporator rises (an increase in superheat) the pressure exerted by the bulb increases and, in turn, the flow increases through the expansion valve. Alternately, when the superheat decreases (evaporator temperature of gas leaving is decreased) the thermal bulb pressure decreases as well and the flow through the expansion valve is reduced.



Cross-Section of Thermostatic Expansion Valve

Setting SUPERHEAT for Expansion Valves:

Having the proper setting for the expansion valve is very important for the operation of the plates. In order to give the maximum performance without refrigerant flooding back on the compressor, the superheat of the system must be set.

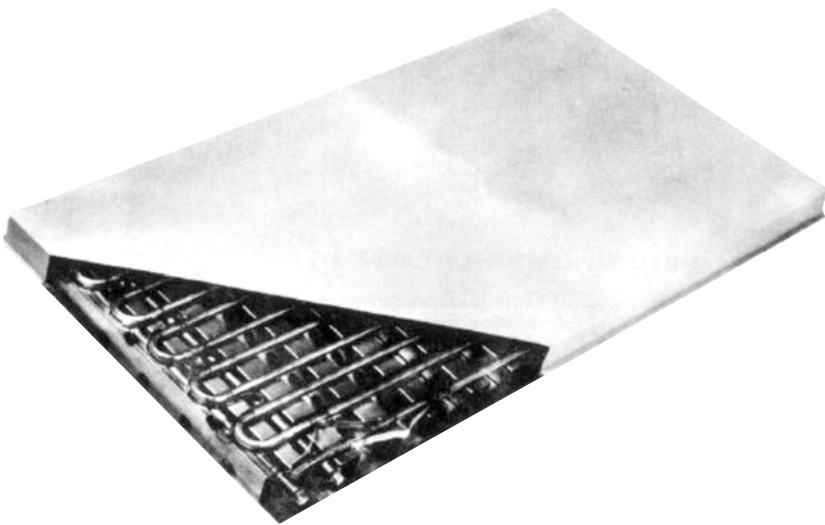
To set the SUPERHEAT for a one or multiple plate circuit, on a medium or low temperature truck body.

1. Measure the temperature at the outlet of the expansion valve 1/2" line.
2. Measure the temperature at bulb on suction line.
3. Adjust each expansion valve at the low end or bottom space of pull down to where there is only 5 degrees F to 10 degrees F temperature difference between the outlet of the expansion valve and at the expansion valve bulb. (At low end or bottom of pull down) when plates are near freezing. Example: valve 5 degrees F, bulb 10 degrees F. Temperature difference is 5 degrees F; this would be a good setting.

Note: In this application and for better performance Hercules uses Sporlan Balanced Port TEV

Evaporator (Plates)

The evaporator is the main part of the low pressure side of the refrigeration system. In the evaporator, liquid refrigerant boils and evaporates. As the liquid refrigerant changes to vapor, the heat is absorbed in the evaporator and freezes the eutectic solution to desired temperature.



Suction Line Accumulator

A suction accumulator is used to prevent liquid flood-back. It intercepts liquid refrigerant before it can reach the compressor crank case. It is located in the compressor suction line between the compressor and the evaporator.

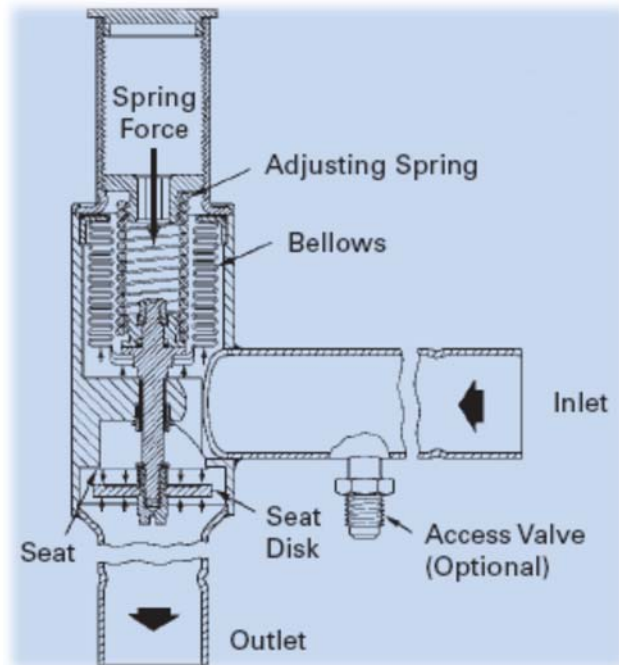
*Prevents Compressor
Damage Due to
Sudden Return of
Liquid Refrigerant
Through the
Suction Line*



When a system sends a slug of oil and refrigerant to the accumulator, oil must be returned to the crankcase at a fast enough rate to prevent bearing damage. At the same time liquid refrigerant must be metered back slowly enough to prevent valve or other compressor damage.

CPR Valve

The Crankcase Pressure Regulator Valve (CPR Valve) regulates suction pressure at the compressor to prevent overloading on the compressor motor. The valve setting is determined by a pressure spring and the valve modulates from fully open to fully closed in response to the outlet pressure. Located between the evaporator and the condenser, the CPR valve is normally used to prevent motor overloading during pull-down cycle.



Service:

Since the CPR valve is hermetic, it cannot be disassembled for inspection and cleaning, and usually must be replaced if it becomes inoperative. Failure of a CPR valve to operate can be caused by foreign material inside the valve. It is possible this material can be dislodged by opening the adjustment screw all the way with the system running. If this does not correct the malfunction, the valve should be removed and replaced with a new CPR. (For better performance the CPR valve is not recommended for use in conjunction with hot gas defrost and not necessary for a scroll compressor.)

Cartridge Low Pressure (Switch) Control for Hot Gas Defrost - Opens on Pressure Fall

The Safety Low Pressure Switch (+15 - +35 psi) is activated during Hot Gas operation to allow the minimum suction pressure within the performance window of the compressor.

Upon start up of Defrost, operational adjustable Low Pressure Switch (set at 25 to 30 psi) will be disabled while this safety switch will be activated to allow compressor to operate

- (A) During low ambient conditions
- (B) Plates not completely depleted
- (C) Used only on medium temperature system



SLP1535 15 35 +/- 5 PSI

Hot Gas Discharge By-Pass Valve (DBV) (Low Temp)



DBV is used on low -plates blower equipped with Hot Gas Defrost Check Valve (head pressure control valve) to adapt compressor capacity to actual evaporator load by supplying a replacement capacity in the form of Hot Gas. The pressure setting of the DVB (10-11#) must be lower than the check valve setting (20#) for each valve to function properly.

DBV with external equalizer is installed in a bypass line between the high and low pressure sides of the refrigeration system and is designed for direct Hot Gas injection into the suction line.

DBV responds to changes in down-stream of suction pressure. When the evaporating pressure is above the valve setting, the valve remains closed. As the suction pressure drops below the valve setting, the valve responds and begins to open. As with all modulating type valves, the amount of opening is proportional to the change in the variable being controlled - in this case the suction pressure. As the suction pressure continues to drop, the valve continues to open until the limit of the valve stroke is reached.

Low Pressure Control



The low pressure control is used to protect the motor. It operates by cutting a circuit when the evaporating pressure becomes too low, causing the assembly to contract and the contacts to open. When this happens, the motor in the compressor shuts off.

There are also dual controls available with one switch that cuts out on either high or low pressure.

Reverse Phase Relay (& Timer)

(Used on 3 Phase Motors Only)

**Located in the Condenser Box inside electrical box.
This Phase sensitive control provides an isolated
contact closure to protect 3 phase compressor
motor from incorrect rotation.**



Start & Run Capacitor

Normally used on single phase motors where system design requires high starting torque & to improve run efficiency. Located in condenser box & inside electrical box & possibly on motor housing.

Capacitor must be discharged before testing with OHM meter with capacitor testing capabilities. No resistance indicates faulty or damaged capacitor.

The PTC Start Assistance

The PTC (Positive Temperature Coefficient) resistor is used for applications where high starting torque is not required. The PTC resistor is connected in parallel with the run capacitor, placing it in series with the start winding. The PTC has a low resistance when it is cold. When the motor starts, the low resistance causes a large current to flow through the resistor. The current drawn by the resistor is out of phase with the current drawn by the motor windings, and this provides the torque to start. As soon as the resistor draws current, it begins to heat, and the positive temperature effect of the resistor causes it to rapidly increase its resistance. By the time the motor reaches full speed, very little current is drawn.

Run Capacitors

Run capacitors are used on compressors to improve efficiency, raise the motor's power factor, and lower noise. Run capacitors are continuously in the operating circuit and are normally of the metallized film type. They are manufactured in oval or round cans.



Start Capacitor



Run Capacitor

Basic Systems Operations Special Conditions & Maintenance

Eutectic cold plate passive refrigeration systems are designed to provide consistent uniform temperature throughout the load space during the delivery day.

This is accomplished by freezing eutectic plates with an electrically controlled and operated condenser unit during “off delivery” time. Components consist of holdover plate assemblies mounted across the front wall, ceiling and side walls to minimize load space taken up by the unit.

Adequate plug-in time (10-12 hours) is essential to insure that all plates are totally frozen to allow maximum holdover times for route delivery.

***NOTE**:* Plates are designed with a specific eutectic temperature in cooling. Extreme freeze is called sub-cooled. A plate is only designed to go 10 degrees F below the plate specifications.

COLD AMBIENT CONDITIONS:

Medium temperature systems that operate in colder than desired body operating temperatures may experience lower body/product temperatures. Some occasions could result in frozen product.

The conditions that may lead to product temperature problems usually occur when plate systems are operated on electric power and product is loaded at or near proper temperature and body is exposed to low ambient temperatures for longer than overnight. Normally this would be a weekend or a period of several days. A partially loaded body may contribute to the problem, as product will freeze faster due to a smaller product mass.

The ONLY positive method to prevent product freezing is to load trucks just prior to beginning of the delivery day or to add an auxiliary heating system. However, again, product freezing MAY occur if ambient temperatures remain below critical product temperatures and allow body temperature to drop below critical temperature during multiple door openings.

Auxiliary electric heaters are available for product freeze prevention/reduction and may be wired directly to the refrigeration power receptacle. The heater thermostat should be set slightly above product freezing temperature.

RECOMMENDED OPERATING PROCEDURES: The following operation procedure guidelines are essential to maximize refrigeration system performance and extend component life:

1. Always insure that unit master control switches are OFF before connecting or disconnecting 220vac AC electrical power.
2. Insure that all plates are relatively free of frost and ice buildup (see defrosting procedure).
3. Insure that all product loaded is at proper temperature.

Basic Systems Operations Special Conditions & Maintenance

4. Insure that product stacking allows for proper air circulation.
5. Check all door seals for leaks.
6. Open doors only as necessary to load or remove product and minimize door open times.
7. Fans on blower units are activated with door switches and should stop when any door is opened and run when all doors are closed and thermostat is satisfied.
8. Dust and dirt accumulations on condenser coils should be removed when buildup occurs or every 30 days during hot weather. This will dramatically enhance pull-down times and extend compressor life.

The following suggestions may reduce product freeze damage in many instances:

1. When extended periods of colder ambient temperature exist, plug system into electrical power, but do not turn on condenser unit. This will allow fans to operate only on blower systems and circulate air in body.
2. Set fan thermostat on blower systems close to desired body temperatures to allow air circulation for longer periods. However, be aware that fans will shut down as body temperature drops below thermostat setting.

Plates Manual Defrost

WHY DEFROST PLATES:

The purpose of any defrosting procedure is to maximize the ability of the holdover plate to absorb heat and thus improve the system to maintain body temperatures.

SOME FACTORS that affect frost formation and the need to defrost are:

- 1) Climate conditions.
- 2) Temperatures of holdover plates.
- 3) Operational conditions relating to door open frequency and open time duration.
- 4) Equipment conditions caused by poor gaskets allowing air to leak into the body.
- 5) Moisture buildup on Product.

A GENERAL RULE OF THUMB. Any accumulation of ice on plates will severely affect cooling capacity. Be **AWARE** when the accumulation becomes about ¼” to 3/8” thick or more and be **ALARMED** when accumulation becomes ½” thick. Ice buildup of ¾” or more can cause severe damage to product and plates. Plates frosted to the ceiling, wall or each other have lost a minimum of half their ability to absorb heat. Major structural damage will occur over several days, as ice accumulation can “jack” the plates off the wall or ceiling. This accumulation may occur in several days.

HOW TO DEFROST PLATES

Preferred Defrost Method:

Use of **HOT** water (up to 140 degrees F) is the most efficient method of defrosting, as it is very quick and will minimize the thawing of the holdover plate. This requires less time for holdover plate refreeze and body temperature recovery. Water spray header lines are incorporated into the Dole blower system to help simplify defrosting. Water enters through a hose connection near the roadside condenser section and is piped to these header lines above the plates. It is then distributed evenly over the plate surfaces. After defrost water cascades over the plates, slush is eliminated from the system through drain holes in the front pan of the body. Collapsible neoprene tubing (Kazoos) prevents air infiltration when these holes are in use as drains.

First Alternate Method:

Use of readily available **COLD** water will also defrost the holdover plates, however, much longer time is required and additional holdover plate thawing will occur.

Second Alternate Method:

Leave the body doors open and allow ambient air to circulate over the plates. However, this method takes considerably more time and additional plate refreeze and body temperature recovery time.

Hot Gas Auto Defrost and Blower System (with Dole Controller)

Overview. This Econo-Cel Blower Unit has three cold plates, three propeller fans, and electric controls for 12 volt DC & 220 VAC for fan operation. The Unit is rated 112,030 BTU holdover capacity with +18 degrees F eutectic. When matched with an air-cooled condensing unit it can provide cooling all day for a refrigerated delivery truck. The condensing unit is plugged into 220 VAC supply overnight to freeze the eutectic plates for the next day's service. Until now this unit was defrosted once or twice a week using a water hose connection to shower the plate surface with water. Now, a hot-gas defrost feature has been added to make defrost completely automatic. Each plate will be defrosted once every 3 days using computerized controls.

Details. This system utilizes the heat from the refrigeration that usually goes out the air cooled condenser to defrost the cold plate. The same tubing in the cold plate that freezes the solution is used to thaw the frost and ice on the plate. There are 12 volt DC solenoid valves in the Econo-Cel package that control the flow of refrigerant for freezing or defrosting. While one plate is being defrosted the other plates are being frozen. Normal defrost time is 120 minutes, and during this time ALL the cooling performance is focused on 2 plates while 1 plate is being defrosted.

The condensing unit will have an additional gas pressure regulated check valve.

Hot Gas Auto Defrost and Blower System

(continued)

Hot gas defrost operation is controlled by a computerized unit that will control the defrost schedule for Cold Plates. The controller is programmed by the factory, thus there is no setting required from the user and/or service personnel.

Controller is wired to:

12vdc from the vehicle battery

A dry contact relay in the condensing unit,

to initiate defrost upon plug in and to activate hot gas defrost 12 volt solenoids.

OPERATION:

Length of defrosting: The controller will sense when the truck is plugged in from the “dry” contact closure. The first time used it will defrost for two hours and then switch the defrost off. It will defrost for two hours and then switch the defrost off. If during the two hours, the truck is unplugged (or if there is a power failure), it will keep track of the available time and try to defrost for a total cumulative period of 2 hours within the first four hours after it is first plugged in. After the four actual hours expire there will be no more defrost allowed until the next day.

NOTE: While a plate is defrosting, all other plates are being refrigerated.

Example 1: The truck is plugged in at 6pm. From 6 until 10pm 2 hours will be spent in defrost. If there is no power failure or unplugging, then defrost is done at 8pm.

Example 2: The truck is plugged in at 6pm. There is a power failure from 7 to 8pm. Defrost is done at 9pm.

Example 3: The truck is plugged in at 6pm. The truck is unplugged at 6:30pm for tire changing. The truck is plugged back in at 9pm the same night. There is only ½ hour of defrost this evening.

Example 4: The truck is plugged in at 6pm and unplugged at 10pm for servicing. The truck is plugged back in at 1am the following morning. There are 2 hours defrost from 6 to 8 pm. The event from 10pm to 1am is ignored. There is no more defrost until after the next work shift.

Hot Gas Auto Defrost and Blower System

(continued)

Sequential operation: After a defrost period is completed and the truck is left unplugged for a work shift, the next defrost bank (or plate) will be selected and defrosted. The controller senses the time the truck is unplugged in order to learn when the next defrost is needed and thus learns to ignore most power failures.

If the 12vdc is removed (i.e. truck battery is removed) from the controller and then reapplied, the controller goes back to start and may start to defrost the first bank (plate).

The controller is factory programmed and will keep the program for years in the internal EEPROM.

The controller works without knowing the actual time of day or day of the week; there is no programming required from the user. The controller learns from the driver's habits.

Trucks with 24 volt starting: controller must be connected to the battery that has the negative connected to the chassis.

Special programming can be provided by the factory (Dole Refrigerating Co.).

Other functional details:

There is no on/off switch

There is an automatic reset circuit breaker to protect the solenoid wiring in case of short circuits.

There is no installer or operator programming or settings required. There is no opportunity for someone to interrupt proper defrosting.

Impact of Ice & Frost Build UP

Accumulation of frost and ice on plates will severely effect cooling capacity. (SEE CHART BELOW). Be AWARE when the accumulation becomes about ¼” to 3/8” thick or more and be ALARMED when the accumulation becomes ½” thick. Ice buildup of ¾” or more can cause severe damage to product and plates. Plates frosted to the ceiling, wall or each other will lose 30% or more of their ability to absorb heat. In addition, major structure damage may occur as the ice can “jack” the plates off the wall or ceiling. This accumulation may occur in several days.

DOLE RERIGERATING COMPANY, Lewisburg, TN, Engineering Department
 “IMPACT OF ICE BUILDUP ON PLATES EFFICIENCY” Snow Ice and Hard Ice

--FROST/SNOW--

Potential Temperature Increase
 Passive Plates and Econo-Cels--
 -PHOS- -CHOS-

Thickness	Efficiency	Loss		
¼ inch	89%	11%	-----2 DEG. F-----	4 DEG. F
3/8 inch	85%	15%	-----2.7-----	5.3
½ inch	80%	20%	-----3.6-----	7
5/8 inch	77%	27%	-----4.1-----	8.1
¾ inch	73%	30%	-----4.9-----	9.5
7/8 inch	70%	30%	-----5.4-----	10.5
1 inch	67%	33%	-----6-----	11.6

--HARD ICE--

Potential Temperature Increase
 Passive Plates and Econo-Cels—
 -PHOS- -CHOS-

Thickness	Efficiency	Loss		
¼ inch	97%	3%	-----.05 Deg.F-----	1.1 Deg/F
3/8 inch	95%	5%	-----0.9-----	1.8
½ inch	94%	6%	-----1.1-----	2.1
5/8 inch	92%	8%	-----1.4-----	2.8
¾ inch	91%	9%	-----1.6-----	3.2
7/8 inch	90%	10%	-----1.8-----	3.5
1 inch	88%	12%	-----2.2-----	4.2

‘K’ Snow = 0.34 BTU / Hr. Sq. Ft. F Ft. – or – 4.08 BTU / Hr. Sq. Ft. F Ft.
 ‘K’ Hard Ice = 1.26 BTU / Hr. Sq. Ft. F Ft. – or – 15.12 BTU / Hr. Sq. Ft. F Ft.
 ‘U’ Plates = 2 BTU / Hr. Sq. Ft. F.
 ‘Q’ = UATD = 2 (1) (18) = 36 BTUH (clean plate; -18F Eutectic & of truck).
 ‘Q’ = UATD1 = KATD2
 TD1 / TD2 = K/U; for U = 2; TD1 / TD2 = K/2

DRIVER TUTORIAL
AUTO-SEQUENTIAL DEFROST SYSTEM
WITH 1ST GENERATION (2008)/2ND GENERATION (2009/2010)

ATTENTION DRIVER:

FOR YOUR SAFTY: Shore power must be turned OFF and the condensing unit ON/OFF switch must be turned OFF prior to plugging/unplugging condensing unit.

-Condensing unit is equipped with a bump start. Upon plug in & turning the condensing unit ON compressor will cycle three (3) times and then run continuously.

-When condensing unit is plugged in and turned ON there will be a five (5) second delay and then the compressor will go into defrost for a maximum of two (2) hours defrost time in an available four (4) hour window. The defrost cycle will terminate on time (or 1st Generation (2008) ONLY on time or temperature).

-One plate is defrosted during each defrost cycle. Ten (10) hours after the initiation of a defrost cycle, the cold plate sequencer (CPS) will advance to the next plate, which will be defrosted during the next defrost cycle.

-At the initiation of a defrost cycle, you will note the condensing unit fan is not running as it would upon plug-in on a standard unit. This is normal for the condensing unit fan to not be running while the compressor is in defrost and you will hear an audible humming sound as the compressor continues to run. When the compressor terminates the defrost cycle, you will note the condensing unit fan operates as usual.

2nd Generation (2009/2010) ONLY: Your Dole blower unit is equipped with a trickle charger connected to your truck batteries. When the refrigeration unit is connected to shore power, the trickle charger is activated and charging your truck batteries. When you turn the truck engine OFF you will hear the blower fans running for several minutes. Along with the trickle charger your Dole blower unit also has a low voltage switch and once the voltage drops the switch will shut down the blower fans and conserve battery power for engine startup.

2nd Generation (2010) ONLY: On the roadside of your body mounted underneath the rub rail, you will note an electrical box with red, yellow and green LED indicator lights which illuminate when the compressor is in defrost mode and indicate which plate is in defrost-red for plate #1, yellow for plate #2, green for plate #3. These lights allow for monitoring that the defrost system is working correctly and cycling to a different plate each day. In the event that the same light illuminates each day the sequential system is not operating correctly, and Hercules should be notified.

-Once a week, the plates in the Dole blower unit should be visually inspected for correct defrost system operation. In the event of significant frost or ice buildup, a water defrost should be initiated, and Hercules should be notified.

-The defrost cycle is electronically controlled by factory installed programming. Generally speaking, the defrost system requires no regular PM, with the exception of 1st Generation (2008) systems on which the defrost control box should be opened and inspected for moisture and the inverter should be inspected for proper operation (fan is still working, etc.).

-Your condensing unit will only run when system pressure dictates. During cold ambient conditions, when the condensing unit is plugged in and turned ON it will **ONLY** run if the cold plates require additional refrigeration. In cold ambient conditions, condensing unit **MAY NOT** run enough to support effective defrost cycles, and a heightened level of attention needs to be directed to the condition of the cold plates, including the necessity of initiating a water defrost during these conditions.

-The following are estimated suggestions based on several variables, including plate freeze level, location, temperature of product when loaded, etc. Prudent judgment and common sense are your guide.

During winter months (starting with frozen plates) and when ambient daytime outside temperature is as follows:

Below 34 degrees	Plates must be charged once a week.
35-45 degrees	Plates must be charged every third day
46-65 degrees	Plates must be charged every other day
65 degrees & over	Plates must be charged daily

-Again, above are suggestions. Driver must make sure that plates are frozen enough to maintain body & product temperature between 33 degrees and 38 degrees throughout the day.

-You must plug in daily to shore power (condensing unit ON/OFF switch turned OFF): (1) to allow blower fans to circulate air as dictated by thermostat, (2) 2nd Generation (2009/2010) ONLY to allow the trickle charger to charge truck batteries, and (3) and condensing unit ON/OFF switch turned ON to charge (freeze) & defrost plates. See schedule in above paragraph (during winter months).

Trouble Shooting

Compressor Won't Run

- I. Check power source and make sure power is on all legs.
- II. Check coil on contactor.
- III. Check contacts.
- IV. Check high/low pressure switch in pressure controller.
- V. Check bump start time delay relay.
- VI. Check discharge line heat switch.
- VII. Unit out of refrigerant. Check gauges. Lack of pressure indicates system is out of refrigerant. Find leak and repair, evacuate and charge.
- VIII. Check CPR valve adjustment (if supplied).
- IX. Check phase reversing relay. Replace if necessary.
- X. Check liquid line solenoid valve coil.
- XI. Check fan cycle switch if supplied.
- XII. Check start and run capacitor (single phase only).

Q. Compressor and condenser fan are cycling?

A. Check pressure with gauges and check sight glass. Low pressure and bubbles in sight glass will be an indication of refrigerant leak. Repair leak, evacuate, system and charge (replace filter/drier if needed).

Q. What is a normal head pressure on medium and low temperature system?

A. Head pressure varies depending on ambient temperature. The hotter the ambient temperature, equate to higher head pressure. (head pressure will vary between 270# to 325#). Head pressure will decline as temperature of plates become colder. When plates are frozen head pressure could be as low as 225#. Head pressure on a system with hot gas defrost is 170#, while low pressure (suction side) could be as low as 15# depending on settings of pressure controller. (Medium temperature low pressure setting should not go below 15#). Normal suction pressure on a low temperature unit could go as low as 5#.

Trouble Shooting (continued)

Plate Suspected of Not Performing Properly

1. Check solution eutectic having leaked out of the holdover plate. This will show up on the plate's exterior surface as well as on the floor or the adjacent wall.
2. Refrigerant Leak in the tubing inside the plate; the outer surface will exhibit a large bulge in the plate sides. Contact Dole Refrigeration for replacement and/or repair. Remove and replace upon arrival of the repaired plate.
3. Malfunctioning of the expansion valve. A malfunctioning expansion valve is usually caused by moisture collecting in the form of ice on the valve seat, or bulb not properly secured to the suction line with cork tape or an improperly adjusted valve can give similar results.
4. Pump down system, clean expansion valve filter, evacuate and charge.

BLOWER UNIT FAN continues to run when door is open.

1. Check door switch re-alignment and/or replace if switch is damaged.
2. Check thermostat for proper operation.
3. Check for short in circuit.

BLOWER THERMOSTAT SETTING

Keep the thermostat adjusted to attain desired temperature in body. The function of the thermostat is to start and stop the blower fans only. It has NO CONTROL over the operation of the condensing unit.

FAN MOTORS

Blower fan motors are brushless. No maintenance required.

System Troubleshooting Guide

System Problem	Discharge Pressure	Suction Pressure	Superheat	Subcooling	Amps
Overcharge	↑	↑	↓	↑	↑
Undercharge	↓	↓	↑	↓	↓
Liquid Restriction (Drier)	↓	↓	↑	↑	↓
Dirty Condenser	↑	↑	↑	↑	↑
Low Outside Ambient Temperature	↓	↓	↓	↑	↓
Inefficient Compressor	↓	↑	↑	↑	↓
TXV Bulb Loose Mounted	↑	↑	↓	↓	↑
TXV Bulb Lost Charge	↓	↓	↑	↑	↓
Poorly Insulated Bulb	↑	↑	↓	↓	↑