OBSOLETE & TRANSFER 591-920 1/24/74

Chapter 1 - General Information

Obsolete (591-920) per 7/14/89 Sample Mail

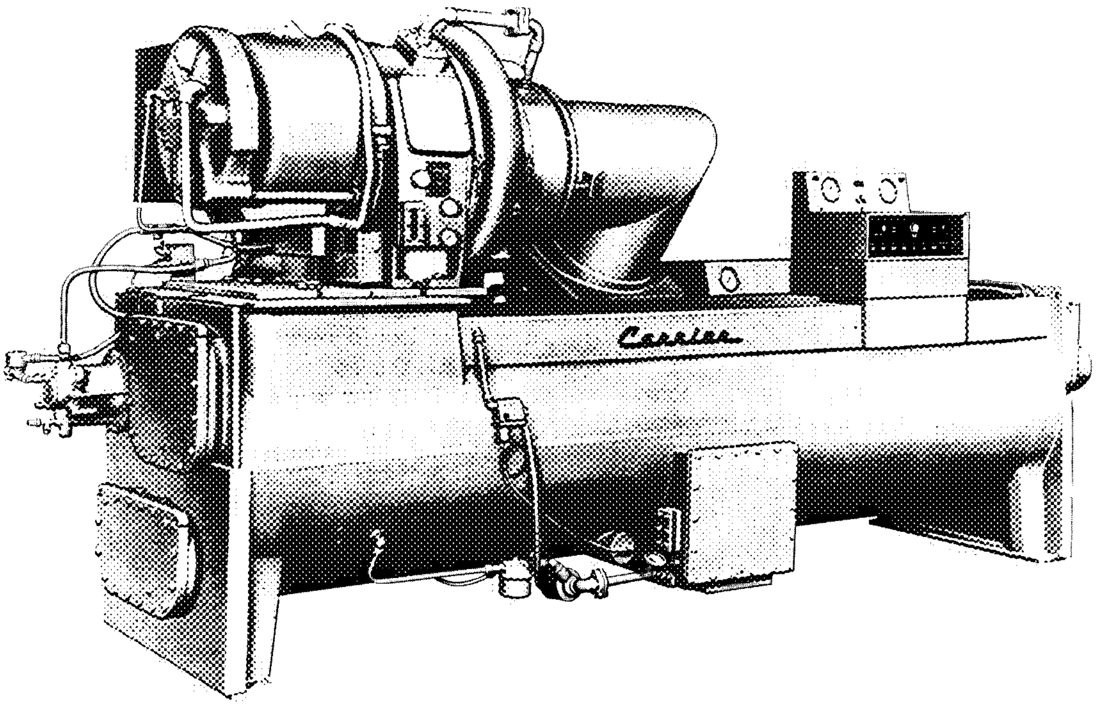


Fig. 1-1 - 19DA Refrigeration Machine

INTRODUCTION

This booklet is a guide for operation and preventive maintenance of the standard 19DA Hermetic Centrifugal Refrigeration Machine, and is not intended as a manual for repairs.

NOTE: The illustrations shown are considered typical. Some machines will differ in some details.

MACHINE COMPONENTS

The Carrier 19DA Hermetic Centrifugal Machine is a complete assembly consisting of the following components:

Unishell Cooler-Condenser - The unishell contains the cooler, condenser, lubrication package and float valve chamber. The cooler is located at the bottom of the unishell, and is the heat exchanger that cools the brine passing thru the tubes. This is accomplished by evaporation of the refrigerant in which the tubes are emersed. The condenser, located at the top of the unishell, is the heat exchanger that liquefies the refrigerant passing thru it from the compressor. The float chamber is a metering device between the condenser and cooler which controls the flow of refrigerant.

NOTE: The term brine is used throughout this booklet as applied to the substance cooled, which is usually water, but may be a brine or other fluid.

Compressor - The compressor receives evaporated refrigerant from the cooler, compresses and discharges it to the condenser.

Purge Recovery Unit - The purge recovery unit is actually a small condensing unit with separator which continuously extracts gas from the top of the condenser and purifies it by removing any air and water vapor present.

Controls - These instruments control the brine temperature, protect the various machine components, and automatically start and stop the compressor.

Additional automatic controls are furnished when specified for fully automatic operation of pumps and fans.

Drive - The drive is a hermetically enclosed electric motor which supplies the power to drive the compressor thru a transmission.

REFRIGERATION CYCLE

The 19DA Hermetic Centrifugal Refrigeration Machine operates on a standard compression cycle using Refrigerant 11.

The refrigerant cycle, illustrated in Fig. 1-2, begins at the cooler. The brine flowing thru the cooler tubes is warmer than the refrigerant in the shell around the tubes, consequently, heat is transferred from the brine to the refrigerant, thus cooling the brine. This heat evaporates the refrigerant at a temperature corresponding with the low pressure in the cooler, as maintained by the compressor. (See Pressure-Temperature Curve, Fig. 1-3.)

The evaporated refrigerant vapor (gas) flows to the prewhirl vanes in the single stage compressor where it is compressed by the impeller and discharged into the condenser.

The refrigerant vapor discharged by the compressor condenses on the outside of the condenser tubes, at a temperature corresponding with the condenser pressure (Fig. 1-3). This temperature is higher than the temperature of the water in the tubes; therefore the heat is transferred into the condenser water. The liquefied refrigerant drains into the float chamber, where a float valve maintains a liquid seal to prevent gas from passing into the cooler. As the refrigerant level in the float chamber rises, the float valve opens and allows the liquid refrigerant to pass over into the cooler.

As the liquid refrigerant passes from the float chamber into the cooler distribution channel, it is subjected to a lower pressure. A small amount of the liquid refrigerant flashes off and cools the remaining portion of the liquid down to a temperature which corresponds with the lower pressure. The liquid refrigerant is distributed evenly throughout the entire length of the cooler thru the distribution channel, and the cycle repeats.

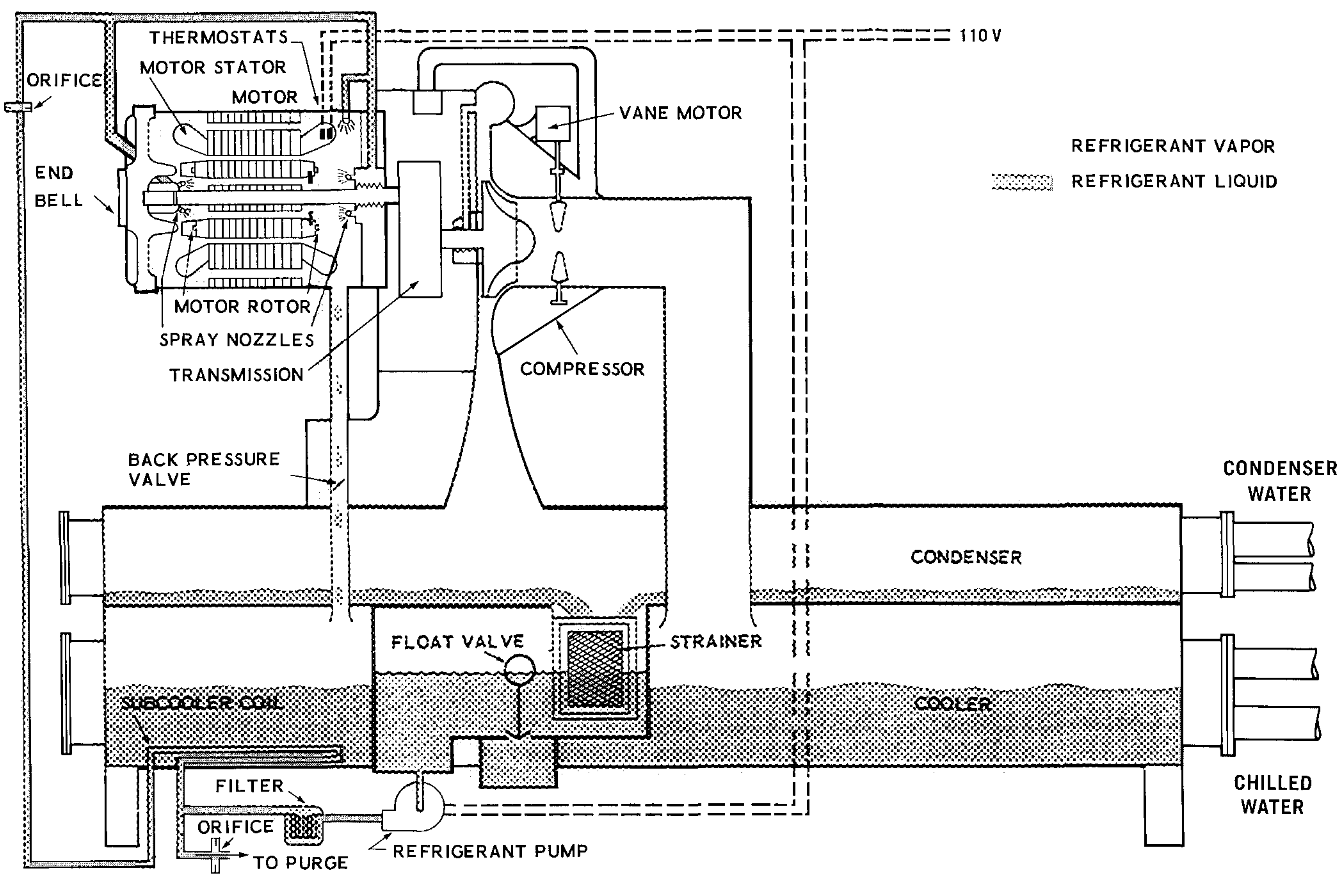


Fig. 1-2 - Refrigeration Cycle

Refrigerant 11 - Refrigerant 11 is a colorless liquid at normal atmospheric pressures and temperatures. It is very volatile and boils at 74.8 F. It may be handled in open containers with little loss by evaporation. The liquid is about 1.5 times as heavy as water and weighs about 12-1/2 lb per gallon. A mixture of water and liquid refrigerant will separate completely, the water floating above the heavier refrigerant. The liquid will dissolve oils and greases in all proportions. It dries the skin by removing the natural oils. It also dissolves rubber and will, therefore, destroy packing materials containing rubber. Neoprene, however, is safe to use in contact with this refrigerant.

The vapor is heavy - about 4.8 times as heavy as air, and will drop to the floor of a room and settle in low places. For this reason, openings in the top of chambers containing refrigerant vapor will cause little loss.

The odor of the vapor is sweet. Large concentrations in air are not harmful, but will cause dizziness and eventually headache.

The vapor will not support combustion and is classed as noninflammable and nontoxic. Direct contact with a flame, however, will break it down into a toxic gas. Breathing of such fumes should be avoided.

The refrigerant is shipped in drums of 100, 200 and 600 lb net. The quantities for charging machines depend on the cooler size and may be determined by reference to Chapter 7 of these instructions.

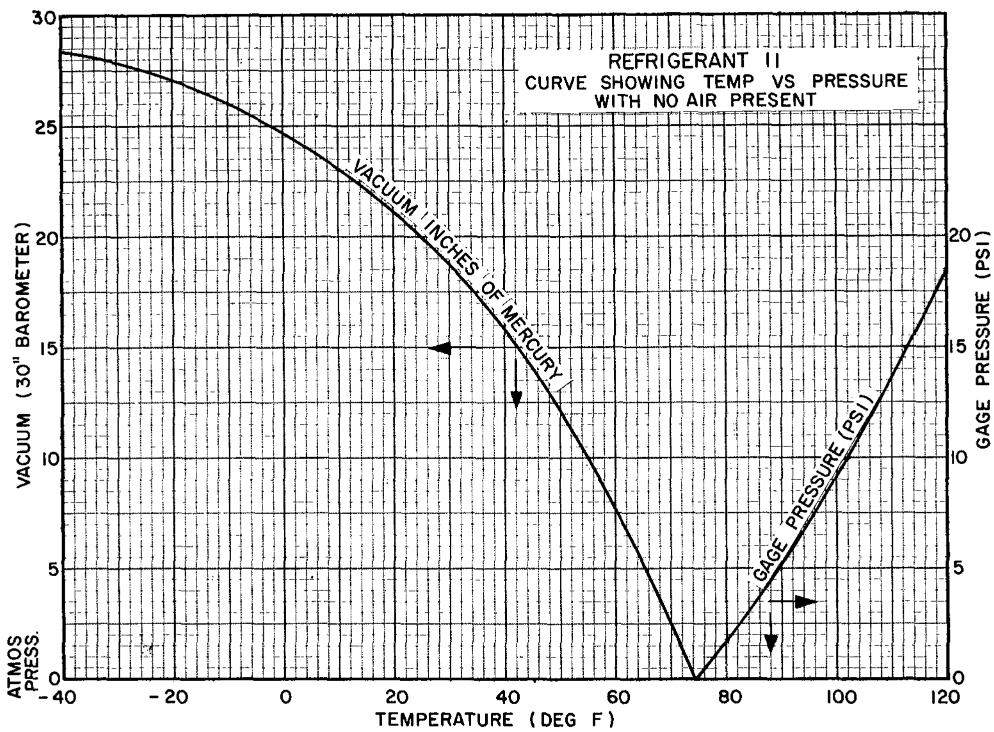


Fig. 1-3 - Pressure Temperature Curve

Chapter 2 - Compressor and Motor

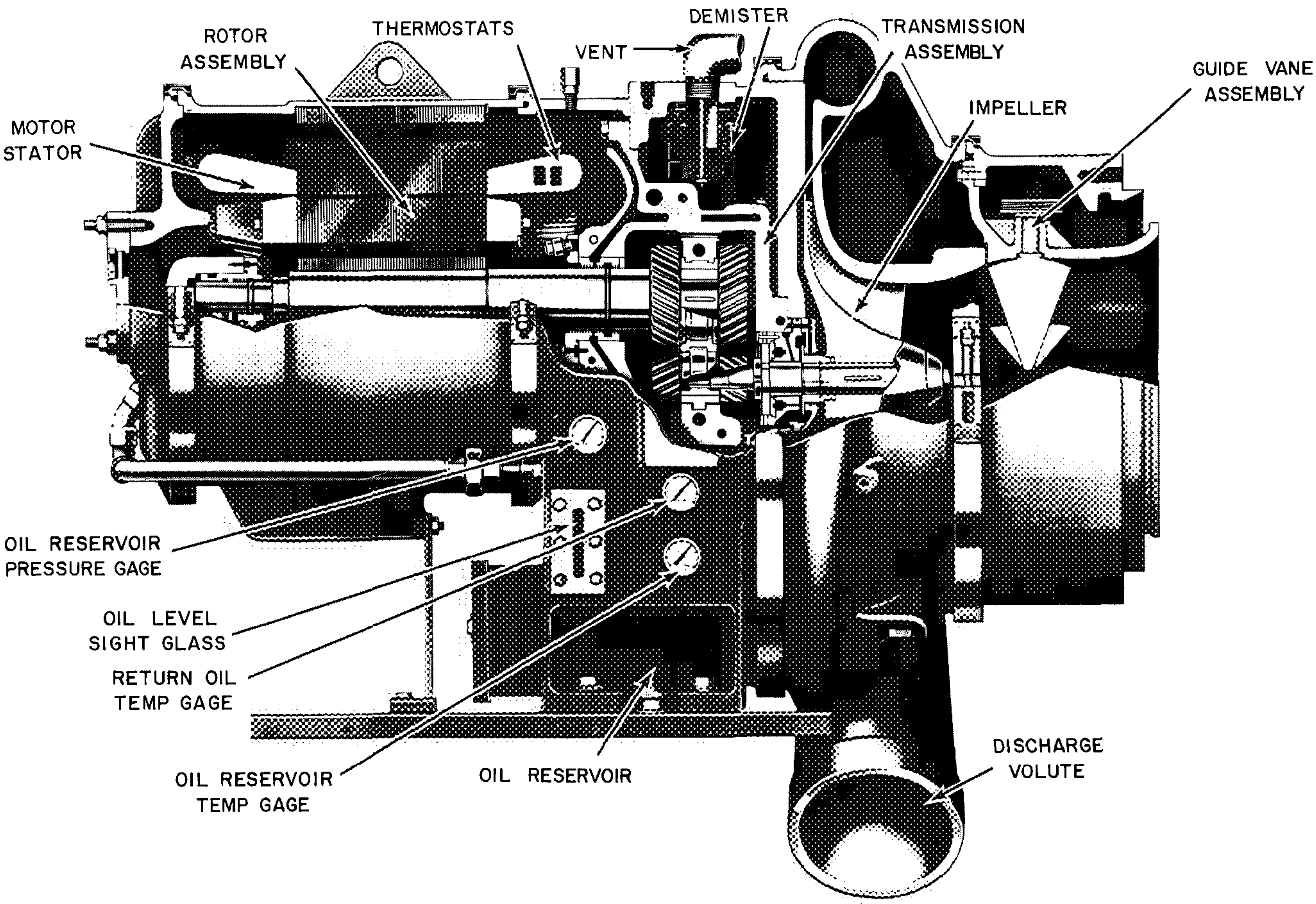


Fig. 2-1 - Compressor Assembly

DESCRIPTION

The 19DA compressor is a single stage centrifugal compressor used to raise refrigerant vapor by means of compression from a low temperature and pressure to a higher temperature and pressure, thus maintaining the proper pressure and temperature levels required in the cooler. The compressor also raises the pressure and temperature of the refrigerant gas removed from the cooler to a pressure corresponding to a higher temperature than that of the condenser water supply.

Centrifugal compressors create a gas velocity thru centrifugal force provided by the impeller. A diffuser converts this velocity into pressure. Labyrinths are provided on each side of the compressor transmission to restrict the refrigerant gas from leaking into the oil reservoir.

COMPRESSOR ASSEMBLY

The 19DA compressor assembly (Fig. 2-1) consists of a guide vane assembly, impeller, discharge volute, transmission, and motor drive. The compressor, motor housing, and oil reservoir form a single hermetic assembly. Since this assembly is hermetically sealed, a seal is not required on the rotor shaft. All compressor flanges are vertical, and are sealed with "O" ring gaskets. The major compressor components are secured with stainless steel aircraft type V-band couplings.

A more detailed description of the compressor assembly components is provided in the following paragraphs.

Guide Vane, Motor and Seal Assembly - The radial guide vanes, located at the compressor inlet, control compressor intake by regulating the flow of refrigerant gas into the compressor.

A standard electric vane motor is used to automatically position the radial guide vanes to regulate compressor intake. The electric vane motor turns the guide vanes thru a linkage system and drive shaft. The drive shaft is keyed to a drive pulley which is attached to one of the nine radial guide vanes. A precision cable and pulley system connects the remaining blades. The guide vanes are supported on bearings with a teflon and bronze surface which reduces bearing friction. The drive shaft assembly includes a mechanical seal as well as an oil seal to prevent refrigerant leakage to atmosphere, or air leakage into the machine. An oiler is provided for lubrication of the seal (Fig. 2-2).

Motor - The 19DA compressor motor is a 2-pole squirrel cage induction motor. The motor windings are insulated and impregnated with a varnish that is impervious to refrigerant. The shell is also impregnated with varnish.

Motor Rotor and Shaft Assemblies - The motor rotor and shaft assemblies consist of a shaft, rotor, and gear. The motor rotor assembly is statically and dynamically balanced, and operates on bearings that are pressure lubricated.

Impeller - The impeller is mounted on a high speed shaft with three keys, and held in place with a lockwasher and impeller cap. The high speed impeller shaft fits inside the pinion, and is driven by the spline in the pinion.

Inlet Volute Drain System - This system (Fig. 2-3) is provided to drain any refrigerant which may condense and accumulate in the cavity next to the discharge volute. Rather than return this refrigerant directly to the cooler (because of possible oil accumulation), it is directed thru a filter to the compressor base. Any oil which may have accumulated is retained in the compressor base while the refrigerant passes thru the vent line and demister to the compressor suction. Discharge pressure is used as a means of transfer.

Transmission - The Carrier Dynapoise® transmission is designed with a double helical type pinion and gear to eliminate gear thrust loading. These gears are positioned in the housing by self-aligning bearings.

The pinion is free to float axially to align itself with the gear. An opposite hand helix design permits this. The gear is rigidly attached, keyed, and locked to the rotor shaft.

Bearings - There are four journal bearings and one thrust bearing in the 19DA compressor. All bearing surfaces are pressure lubricated with metering orifices for the oil on the leaving side of the bearing. This method of lubrication ensures a pressurized oil wedge at all times.

MOTOR END BEARING - The motor end bearing (Fig. 2-4) is a one-piece bearing with a babbitted sleeve. This assembly also includes labyrinths to prevent oil leakage into the motor housing.

TRANSMISSION PINION BEARINGS - The two transmission bearings (Fig. 2-4) consist of two split steel-backed babbitted sleeves. The bearings are pressure lubricated and self-aligning. Dowel pins in the transmission housing maintain the proper location and prevent the rotation of the bearings. The gear bearing has a babbitted shoulder on each end to axially position the motor rotor. The small pinion bearing is free to "float" in order to properly position the pinion to the gear. This equalizes the gear teeth loading.

MAIN BEARING ASSEMBLY - This assembly consists of a journal bearing and a thrust bearing in the same housing and is protected against excessive temperatures by a thermostat located in the bearing housing which shuts down the compressor if the preset high temperature cutout of this thermostat is ever reached during operation.

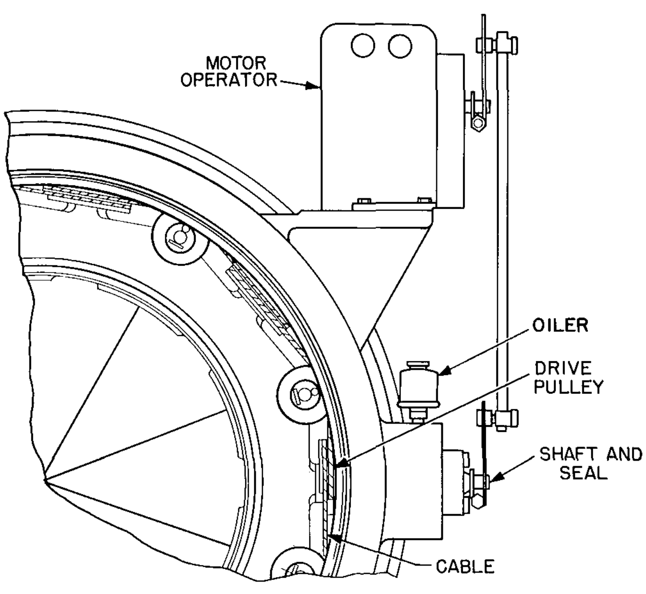


Fig. 2-2 - Guide Vane Motor and Seal Assembly

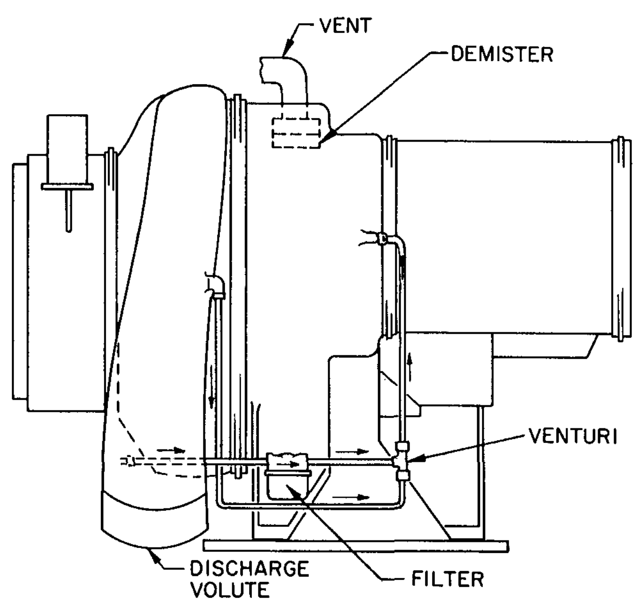


Fig. 2-3 - Inlet Volute Drain System

The thrust bearing is a self-aligning load equalizing bearing that has six shoes which tilt to form an oil film wedge against the thrust disc. It is pressure lubricated, and includes an oil pocket that contains oil in case of a power failure. Should a power failure occur, and the oil pump be shut down, the oil pocket would provide lubrication during compressor coastdown.

The 19DA compressor has been designed to eliminate counter-thrust forces. If they should occur, counter-thrust would be absorbed by the slinger ring riding on an oil film against the babbitted surface of the journal bearing.

LUBRICATION CYCLE

Figure 2-4 schematically illustrates the oil lubrication cycle for the 19DA compressor. The vane type positive displacement oil pump discharges oil around the motor windings, over the cooling coil, and then thru the oil filter where all foreign particles are removed.

The internal oil pressure relief valve regulates oil pressure by relieving excess oil back to the oil reservoir. Oil that is not relieved passes across a magnetic plug and then splits into two lines. One oil line supplies oil under pressure to the end bell bearing. This oil returns back to the oil reservoir thru a return line. The other oil line supplies oil to the transmission bearings, main journal bearing, and thrust bearing. Oil returning from the main bearing and transmission bearings passes over a thermometer indicating oil temperature.

Oil sprays lubricate the pinion teeth and the spline teeth in the transmission.

A low oil pressure cutout shuts down the compressor if the oil pressure drops below the minimum setting.

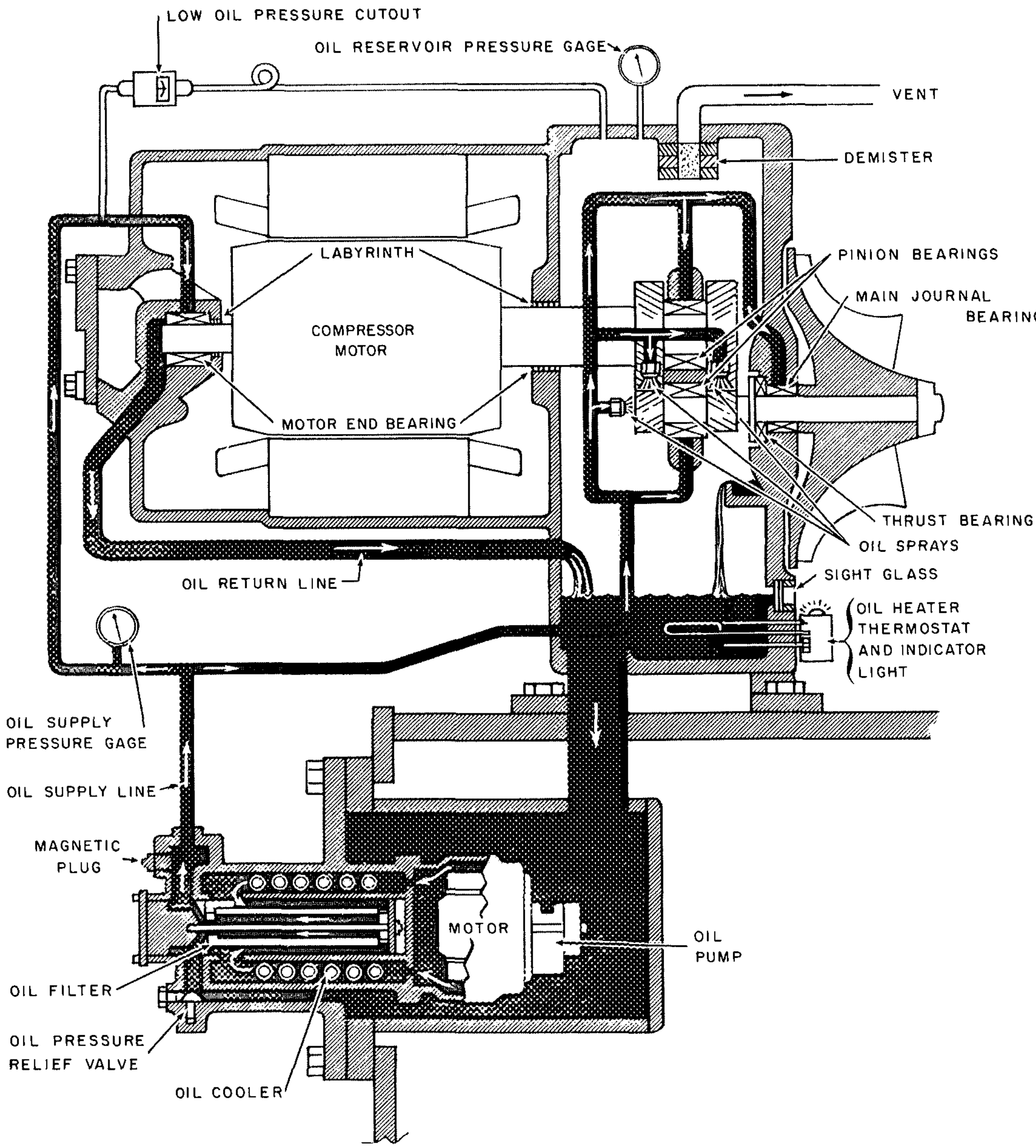


Fig. 2-4 - Lubrication Cycle

The oil heater is controlled by its thermostat to maintain oil temperature in the oil reservoir at 140 to 145 F in order to minimize refrigerant absorption. Refrigerant gas that is released travels thru the demister which removes oil droplets. The gas returns to the compressor thru the vent. The indicator light goes on when the heater is energized. Oil level in the oil reservoir can be observed thru the oil level sight glass.

The discharge oil pressure can be read at the pressure gage on the pump assembly.

Temperature of the oil supplied to the bearings and transmission can be regulated by installing a throttling valve in the water line to the oil cooler. A solenoid valve is provided to shut the water supply when the machine is shut down.

Compressor time delay in the control panel allows the oil pump to operate for approximately one minute before compressor starts. This insures an adequate supply of oil at start-up. A second time delay relay in the control panel allows oil pump to operate for one to two minutes after shut down. This provides lubrication to the bearings and transmission during coastdown.

An oil charging and drain valve is provided on the bottom of the oil pump assembly to add or remove oil.

MOTOR COOLING CYCLE

The motor is cooled with refrigerant taken from the condenser float chamber at condenser pressure. Flow is maintained by a pressure difference in the system. Liquid refrigerant in the float chamber flows thru the strainer, filter, and then to a subcooler in the bottom of the cooler. From there it travels thru an orifice to spray nozzles on each end of the motor rotor. The spray nozzles atomize the refrigerant into very fine vapor droplets.

The nozzles on the transmission end are directed behind a centrifugal dam to holes in the rotor core. The refrigerant droplets travel thru the rotor core to the fan end of the motor rotor, and then mix with refrigerant droplets from the end bell. The rotor fan breaks up the refrigerant vapor droplets further and directs them thru holes in the motor stator to cool the stator. The refrigerant vapor returns to the cooler thru a back pressure valve which maintains a small flow of refrigerant gas thru the shaft labyrinths.

If condensing temperatures and pressures are low, a small refrigerant pump automatically pumps liquid refrigerant for cooling the compressor motor. When the switch is in AUTO position, the pump operates from a thermostat imbedded in the compressor motor windings. The thermostat is preset at approximately 176 F. An indicator light on the gage panel lights whenever the refrigerant pump is operating. The compressor motor is further protected by a second thermostat imbedded in its windings. If the motor windings temperature reaches 221 F, the compressor will automatically shut down.

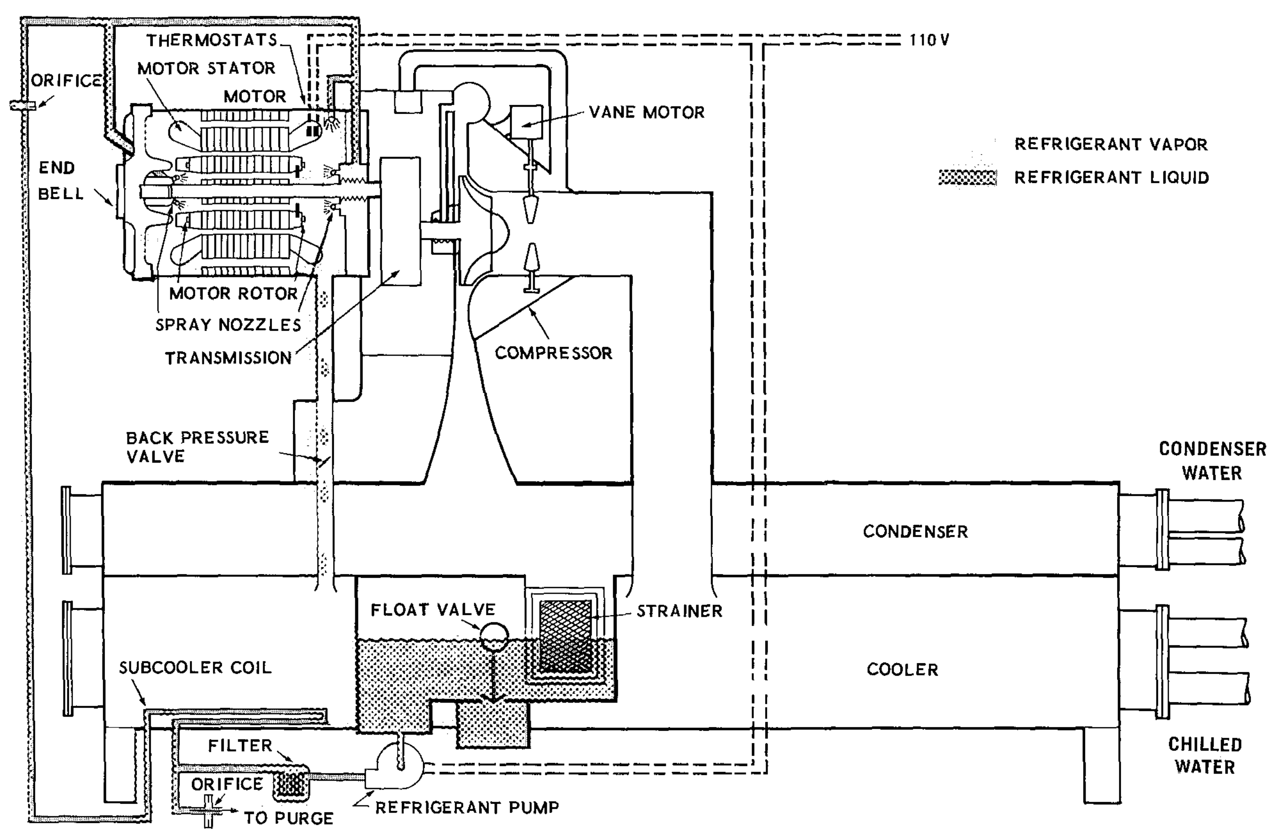


Fig. 2-5 - Motor Cooling Cycle

Chapter 3 - Unishell Cooler and Condenser

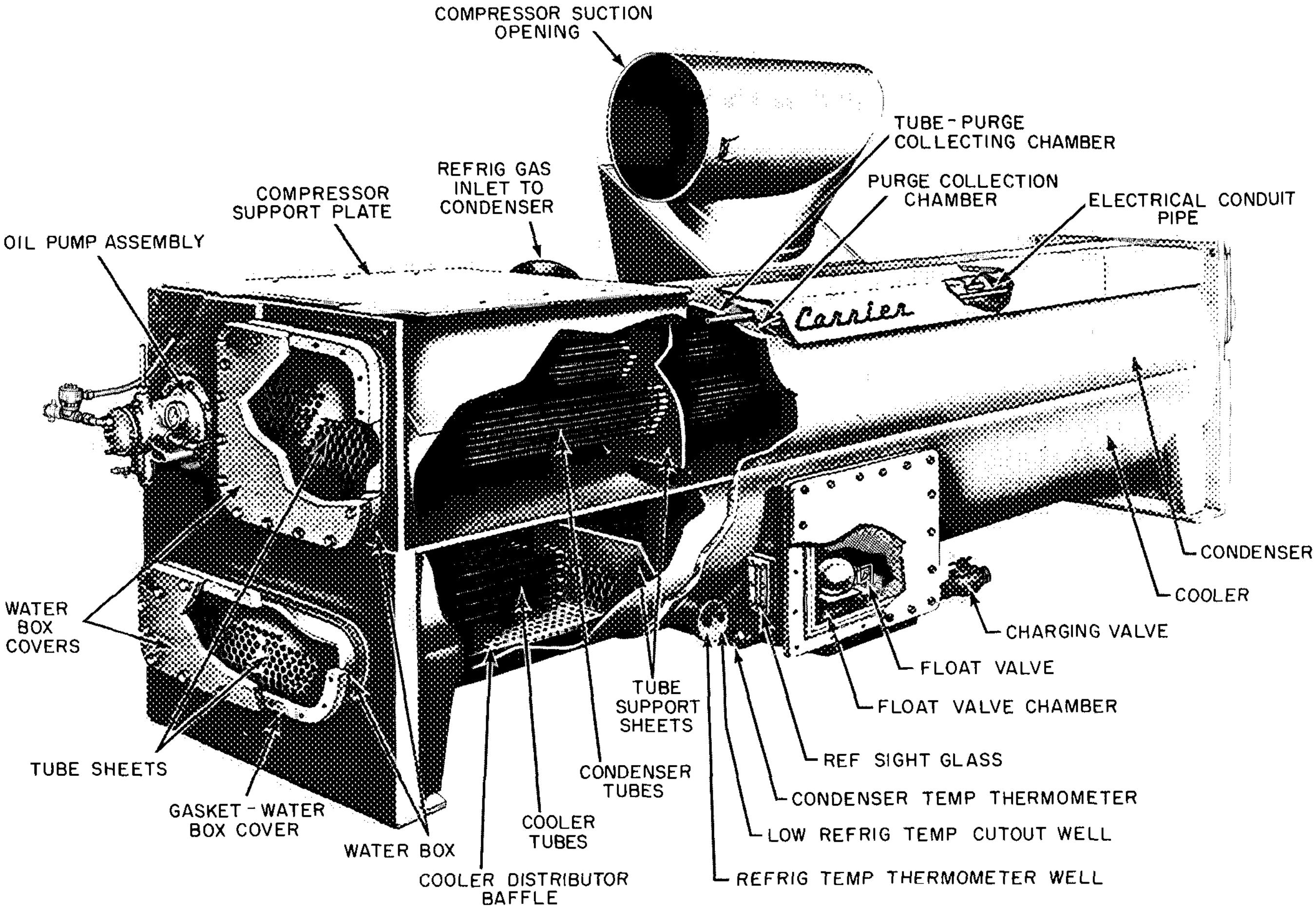


Fig. 3-1 - Unishell Cooler and Condenser

DESCRIPTION

The cooler and condenser are heat exchangers housed in the unishell (Fig. 3-1). The cooler, located at the bottom of the unishell, cools the brine passing thru its tubes by means of evaporation of refrigerant in which the tubes are emersed. The condenser, located at the top of the unishell, liquefies the refrigerant vapor delivered by the compressor.

The float valve meters the flow of refrigerant between the cooler and the condenser and maintains the required pressure differential.

UNISHELL CONSTRUCTION

The unishell is constructed and tested in accordance with ASA-B9.1 Safety Code for Mechanical Refrigeration which requires conformance to the "ASME Unfired Pressure Vessel Code" where applicable.

Shell - The shell-and-tube unishell is constructed of high grade steel welded to end flanges of heavy steel. The cooler and condenser are separated internally by a heavy concave steel plate.

Tubes - The condenser and cooler tubes are copper skipfin type. Each tube has external fins thru its full length except where it is rolled into the tube sheet, and where it is supported by the tube support sheets. The tubes in the cooler are expanded into the cooler support sheets.

The tube fins have the same outside diameter as the plain section of the tubes which are expanded into the tube sheet hole. This ensures that the tubes will be easily removable whenever required.

Tube Sheets - The tube sheets are an integral part of the unishell end flange. Each tube hole in the tube sheet is double-grooved inside to obtain greater strength, and better sealing when the tube is expanded into the hole.

Tube Support Sheets - These maintain accurate spacing of the tubes and add strength to the assembly. Tubes are expanded into the tube holes at each support sheet in the cooler.

The condenser and cooler have three tube support sheets, each equally spaced thru the length of the unishell.

Float Valve - The float valve serves as a metering device to control the flow of refrigerant between the condenser and cooler. This Carrier designed valve is a butterfly type, direct acting valve. It maintains a liquid seal between the cooler and condenser.

Three liquid baffles prevent liquid from vortexing (whirlpool action) when the valve opens. The damper shaft is of noncorrosive stainless steel to prevent binding of the valve assembly.

Float Valve Chamber - This chamber is located in the center of the unishell to improve refrigerant distribution. This chamber houses the float valve, fine mesh screens to keep the chamber clean, and a refrigerant sight glass to observe refrigerant level at machine shutdown.

Water Boxes and Division Plates - These parts are machine welded to the unishell end flange. Openings are provided on the water box for vent and drain connections and for the electronic control element and low chilled water temperature and recycle switch. The water boxes are designed for 150 psig working pressure.

Steel division plates separate the water passes. Extruded gasket material is provided on the edges of the division plates to prevent water bypass. The division plates can be easily removed for servicing the tubes.

Charging Valve - The refrigerant charging valve can be used for removing refrigerant from the cooler in addition to charging refrigerant. For this reason, the charging line extends to the bottom of the cooler.

Cooler Distribution Baffle - The refrigerant distribution system consists of the float chamber, refrigerant return channel and the distribution baffle. Liquid refrigerant from the float chamber flows thru the return channel to the bottom of the cooler where it splits horizontally toward each end of the cooler. Refrigerant is then evenly distributed and sprayed up thru the perforated distribution baffle and around the cooler tubes.

Refrigerant Agitator - To maintain high performance when the cooler is at partial load, a refrigerant agitator line (Fig. 3-2) splits into two lines on larger machine sizes and is installed from the condenser to the bottom of the cooler at a point below the distribution baffle. Each agitator line is opened and closed by a solenoid valve that is

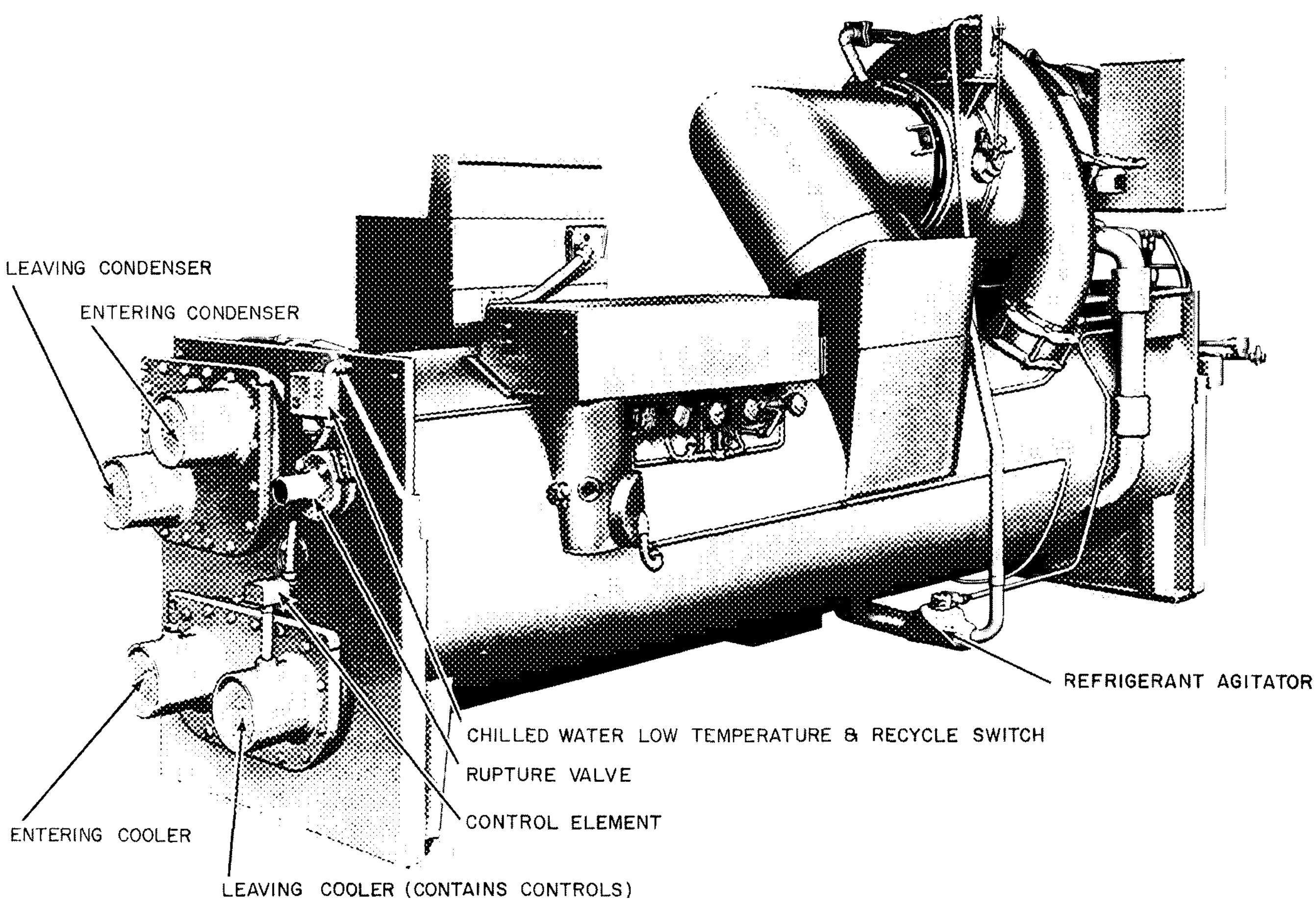


Fig. 3-2 - Typical Unishell Assembly

controlled by a factory set microswitch located in the guide vane motor on the compressor.

At low loads, with guide vanes nearly closed, a small amount of condenser gas flows directly to the bottom of the cooler below the distribution baffle. This condenser gas agitates and foams the liquid refrigerant which has the effect of raising the refrigerant level and covering more cooler tubes with refrigerant. This maintains high efficiency in a partially loaded system.

Purge Collection Chamber - If noncondensable gases and water vapor are present in the system, they will collect in an external collection chamber which is connected internally to the condenser by small holes in the condenser shell. A single condenser water tube, supported by the three condenser support sheets, condenses refrigerant gas and concentrates noncondensable gases and water vapor in the chamber. These noncondensables are then removed by the purge.

Rupture Valve - The rupture valve (Fig. 3-3) is a safety feature containing a replaceable Impervite rupture disc designed to rupture at 15 psig. This prevents dangerous pressures from developing in the machine in case of fire in the machine area.

CAUTION: Do not allow brine at a temperature greater than 100 F to flow thru the cooler.

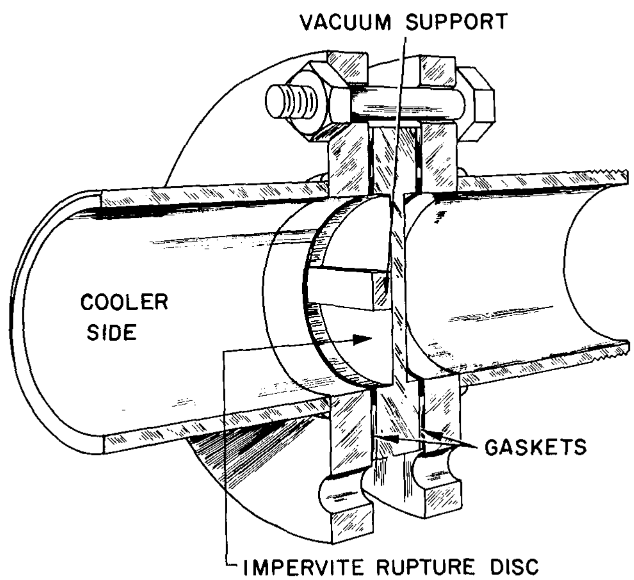


Fig. 3-3 - Rupture Valve Assembly

Chapter 4 - Purge Recovery System

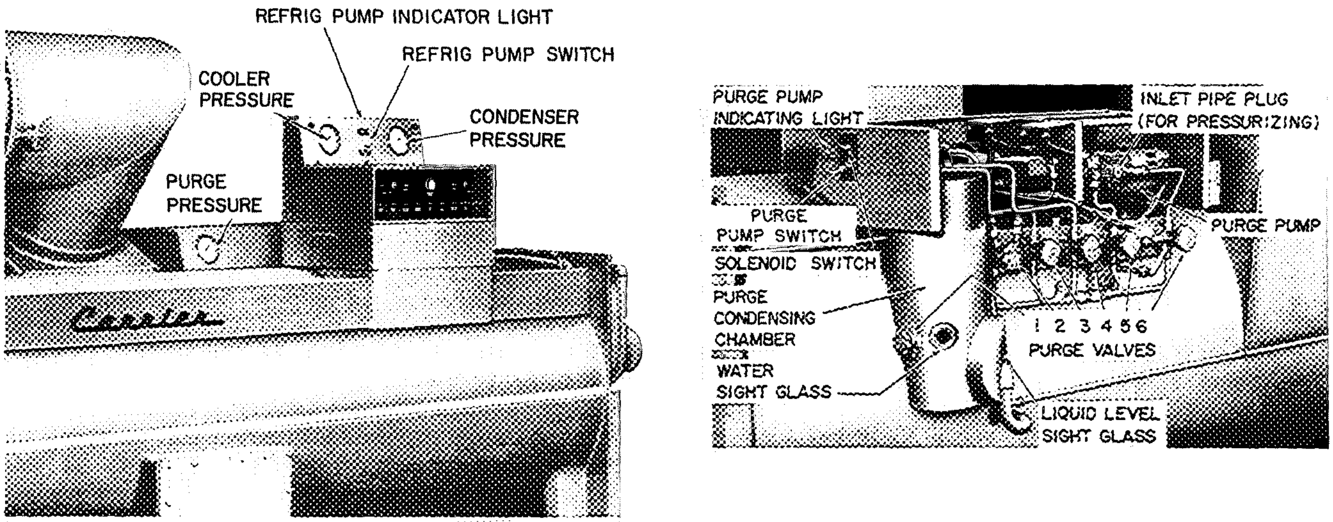


Fig. 4-1 - Purge Recovery System

DESCRIPTION

The purpose of the purge recovery system is to:

1. Indicate air or water leakage
2. Remove water and noncondensable gases
3. Recover refrigerant
4. Evacuate the machine after repairs

The system is composed of a pump, a 110-volt motor assembly, purge condensing chamber, gages, valves, and interconnecting piping. The cooler pressure gage, condenser pressure gage, and purge pressure gage are panel mounted (Fig. 4-1). Operation is normally automatic but can be controlled manually.

COMPONENTS

Purge Pump - The purge pump is a positive displacement, piston type pump, directly connected to a 110-volt motor and does not require lubrication for operation. The pump is provided to pump noncondensable gases to atmosphere, pressurize the machine for leak testing, and to evacuate air after machine inspections or repairs.

Purge Valves - The positions of the purge operating valves and switches during specific operations are described on the metal instruction plate located on the purge panel above the valves.

Strainer-Orifice Assembly -The noncondensable gases, together with water and refrigerant vapors, flow thru a strainer-orifice assembly before going to the purge.

The 1/16-inch orifice maintains a pressure differential between the purge collection chamber on the unishell and the purge condensing chamber in the purge. The strainer protects the orifice by removing any dirt that may be present in the system.

Purge Condensing Chamber - The purge condensing chamber separates the noncondensable gases and water vapor if present, from the refrigerant vapor by passing liquid refrigerant thru a finned coil in the stainless steel chamber. The chamber has sight glasses that allow observation of any water accumulation and refrigerant level.

Float Valve - The float valve is the only moving part of the condensing chamber. An access opening is provided for inspection and maintenance of the float valve.

Safety and Operating Switches - Safety and operating differential pressure switches are provided to automatically start and stop the purge pump. These switches are similar in construction. A bellows inside the housing moves a plunger which operates a microswitch. The switches are factory set in accordance with Table 4-1.

The purge safety switch de-energizes the purge pump circuit on machine shutdown.

Purge Pump Switch and Indicator Light - The purge pump switch and indicator light are located on the end of the purge panel along with the purge solenoid switch.

Refrigerant Pump Switch Indicator Light - The refrigerant pump switch and indicator light are located on the front control panel.

Table 4-1 - Safety and Operating Switch Settings

Switch	Normal Position	Differential Pressure Setting		Connection
		Cutout	Cut-in	
Purge Safety	Open	6 psi	8 psi	Condenser-Cooler
Purge Operating	Closed	4 psi	2 psi	Purge Condenser-Condenser

PURGE CYCLE

In Fig. 4-2, the segregated compartment on the upper left side of the condenser shell serves as a collection chamber. Here, noncondensable gases along with water vapor and refrigerant vapor accumulate. The condenser water tube in this collection chamber condenses refrigerant gas and concentrates the noncondensables and water vapor in the chamber. These gases and vapors then pass thru a strainer, an orifice and valve No. 2 into the purge condensing chamber. A condensing coil in this chamber is supplied with liquid refrigerant from the condenser with flow controlled by a small orifice. Since the leaving side of this coil connects directly with the system cooler, temperature and pressure of the refrigerant approximate that of the cooler. Refrigerant gas and water vapor condense on the coil and drop into a settling chamber, where the water is separated. The refrigerant liquid being heavier, passes thru a loop seal and falls into a float chamber. As the liquid rises, the float valve opens and returns the refrigerant to the system. Water, when present, can be observed in a sight glass and drained off thru hand valve No. 1. A small hermetic refrigerant pump in the refrigerant circuit is used for shutdown and service operation only.

As noncondensable gases accumulate in the purge condensing chamber, pressure inside the chamber rises to approach condenser pressure. This closes the contacts of the purge operating switch, opening the solenoid valve and starting the purge pump. Air and other noncondensables are then discharged to the atmosphere thru valve No. 6. As pressure in the purge condensing chamber drops, the purge operating switch contacts open, closing the solenoid valve and stopping the purge pump.

When the refrigerating machine is shut down, pressures throughout the system equalize. To prevent automatic operation of the purge during shutdown, a purge safety switch, connected between the cooler and condenser, de-energizes the pump circuit when the differential pressure reaches the safety switch setting (Table 4-1).

When the machine is operating and the purge switch is in automatic position, the purge cycle

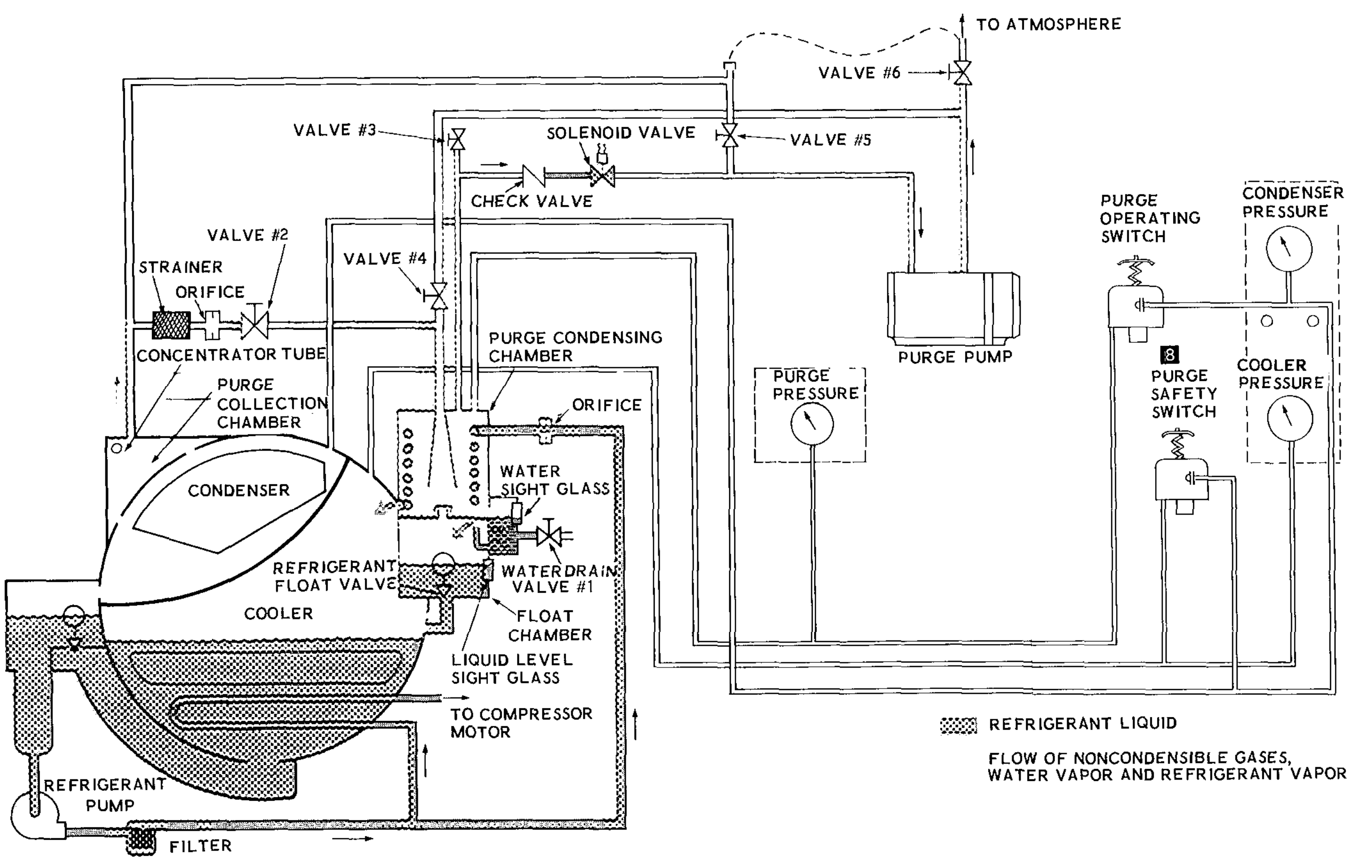


Fig. 4-2 - Purge Cycle

is a continuous process. However, the purge pump operates only when there is air or noncondensables in the system, and as such it provides a check on tightness of the refrigeration system.

OPERATING PROCEDURES

During normal operation of the refrigeration system it is recommended that the purge be operated in Normal-Automatic as described on the metal instruction plate (Fig. 4-3) mounted on the panel above the purge valves. In Normal-Automatic the "water sampling" continues even if the purge pump is not operating. The purge pump operates only when noncondensable gases accumulate sufficiently to raise the pressure in the condensing chamber to energize the purge operation switch.

Even though a machine may be perfectly airtight it can develop a water leak. This condition can be detected by observation thru the water sight glass (Fig. 4-2). If water is allowed to remain in the machine, serious damage will result.

OPERATION R-11 PURGE		VALVE NUMBER						SWITCH	
		1	2	3	4	5	6	Purge	Sol
1	Normal – Automatic	Close	Open	Close	Close	Close	Open	Auto.	On
2	Remove air after opening machine	Close	Close	See Note #3	Open	Open	Close	Man.	Off
3	To pressurize system for leak test (See note #1)	Close	Close	Close	Close	Close	Open	Man.	Off
4	To remove water (See note #2)	Open Note #2	Close	Open	Close	Close	Close	Off	Off

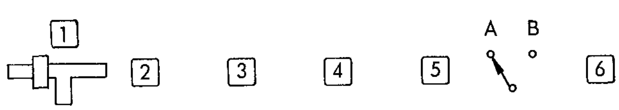
NOTES:

#1. Reverse fittings A & B and remove pipe plug from purge pump inlet.

#2. When purge press gage reads zero, open water drain valve #1.

#3 Set valve #3 so that purge gage reads 15 – 18 psi, with purge pump running

VALVE LOCATIONS



NOTICE

It is recommended that the purge unit be operated in "Normal – Automatic" at all times when the centrifugal compressor is running.

If excessive air enters the unit, either during operation or shut-down, the purge can be operated in condition #2. Do not run in this manner continuously.

Fig. 4-3 - Purge Valve and Switch Setting Chart

Remove water by following operation 4 outlined on instruction plate (Fig. 4-3).

The purge is controlled thru a MANUAL-OFF-AUTO switch (Fig. 4-4). With the switch in the AUTO position, on machine start-up the purge operating switch will open and the purge safety switch will close. In this position, the purge motor and solenoid valve will energize whenever the purge operating switch closes.

The MANUAL position of the purge switch allows operation of the purge pump for removing air after service work or when pressurizing the system for leak testing.

CAUTION: Operate the refrigerant pump manually to supply refrigerant to the purge condensing chamber when operating the purge in MANUAL to remove air (Operation 2 - Fig. 4-3) if refrigerant is left in the cooler. Operate the refrigerant pump only when there is refrigerant in the cooler, otherwise damage to the pump will result.

If the condenser pressure rises above normal, and causes the centrifugal compressor to surge at start-up, air has entered the machine during shutdown. Unless the condenser pressure reaches the safety cutout point, surging may continue and diminish slowly until all air is removed by the purge. The yellow purge indicating light will light frequently indicating cycling of the purge motor and solenoid valve. If the condenser pressure reaches the cutout point, the machine will shut down and the light on the control panel marked condenser pressure will go out. If this occurs, reposition the valve and purge pump switch (Operation 2 - Fig. 4-3). After air and noncondensable gases have been removed, set purge switch in the AUTO position (Operation 1 - Fig. 4-3) and repeat machine start-up procedure.

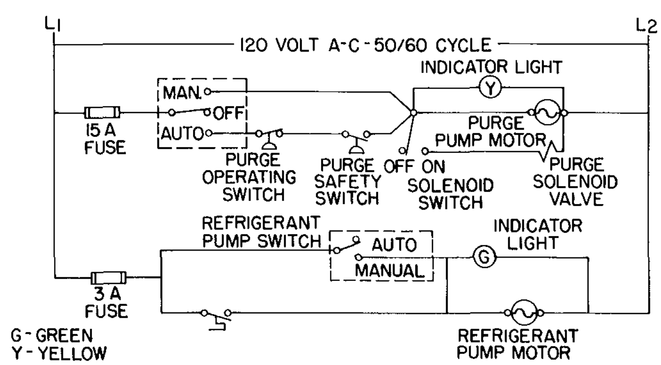


Fig. 4-4 - Typical Purge Wiring Diagram

Chapter 5 - Controls and Wiring

CONTROL SYSTEM

Description - The control center (Fig. 4-1) houses the main operating controls of the machine. The upper control section includes the cooler and condenser pressure gages, the refrigerant pump switch, and refrigerant pump indicator light.

The STOP and START buttons together with the control ON-OFF switch, oil pump switch, chilled water thermostat and safety control indicator lights, are on the forward panel of the control section.

The control section with lift-up door contains the electronic controls, relays, and electrical connections.

The purge panel (Fig. 4-2) located at the rear of the control panel contains the purge pump switch and indicator light, solenoid switch and purge pressure gage. The purge pressure gage is visible from the front of the unit (Fig. 4-1).

ELECTRONIC CONTROLS

Description - The electronic control system regulates chilled water temperature and prevents motor overload, by positioning prewhirl vanes with an electric actuator motor and linkage system. Under normal conditions the water temperature leaving the cooler is controlled by the chilled water temperature controller. A resistance element immersed in the chilled water reacts to the temperature. The element is part of a bridge circuit from which signals are strengthened by an electronic amplifier, which in turn activates relays. The relays open, or close, to drive an electric vane motor which opens or closes the compressor vanes. When the temperature of the water leaving the cooler increases, the vanes will move toward the open position. A decrease in temperature results in a movement toward the closed position.

Motor overload is detected by a current transformer and resistor in the starter. An increase in current flow causes a change in voltage drop across the resistor. The change in voltage is amplified sufficiently to activate relays. The relays can interrupt the amplifier circuit independently of the chilled water control relays, and can even prevent the vanes from opening further or cause them to close.

A vane close switch located in the vane motor together with an interlocking circuit, ensures the prewhirl vanes being closed before the compressor motor will start. To ensure closed vanes in the event of control failure, a "closed" relay is actuated to drive the vanes closed. If the machine shuts down with the guide vanes open, the restoring of current to the control will cause the vanes to close before the compressor can be restarted.

The electronic control switch should be turned to ON at the beginning of the cooling season and left in that position until the cooling season is over. For a normal start-up during the cooling season, with the electronic control switch ON and the condenser pressure, motor bearing temperature and refrigerant temperature indicator lights lit, it is merely necessary to push the START button. The auxiliary equipment (chilled water and condensing water pump if wired into the circuit for full automatic operation) will start immediately; the oil pump time delay relay will pull in, starting the oil pump and building up oil pressure, and light the indicator light on the control panel. The START button has a momentary contact. It is necessary to depress the START button long enough to start the water pumps and other auxiliaries, close the auxiliary contacts and light the indicator lights. The oil pump time delay relay will warm up, close its contacts and start the oil pump before the compressor will start.

The holding coil (Fig. 5-1) to control relay R_1 will energize when the safety circuit is completed, and close contacts R_1 around the START button and in the main control relay 1CR circuit. If the prewhirl vanes are closed, the holding coil to the main control relay 1CR in the starter will be energized and the compressor will start. At the same time, it closes the auxiliary contact 1CR to bypass the vane closed switch.

Some starters are equipped with a time delay relay, set for approximately 30 seconds. This permits the compressor motor to come up to speed before the prewhirl vanes start opening.

With the compressor running and the start-up sequence completed as described in previous paragraphs, the chilled water is controlled by a resistance element sensing the leaving water temperature. A rise in temperature sends a signal to the chilled water amplifier to position the prewhirl vanes towards OPEN. The chilled water resistance element is part of a bridge circuit and any unbalance in the bridge (caused by a resistance change due to temperature change) is detected by the amplifier. (See Fig. 5-3 or 5-4 for schematic representation of the chilled water temperature control operation.)

Figure 5-1 shows a typical control wiring diagram for purposes of illustration in this manual. The exact job wiring diagram may differ slightly from this diagram. Terminals are provided for automatic start-stop operation and for auxiliary flow switches if called for by job specifications.

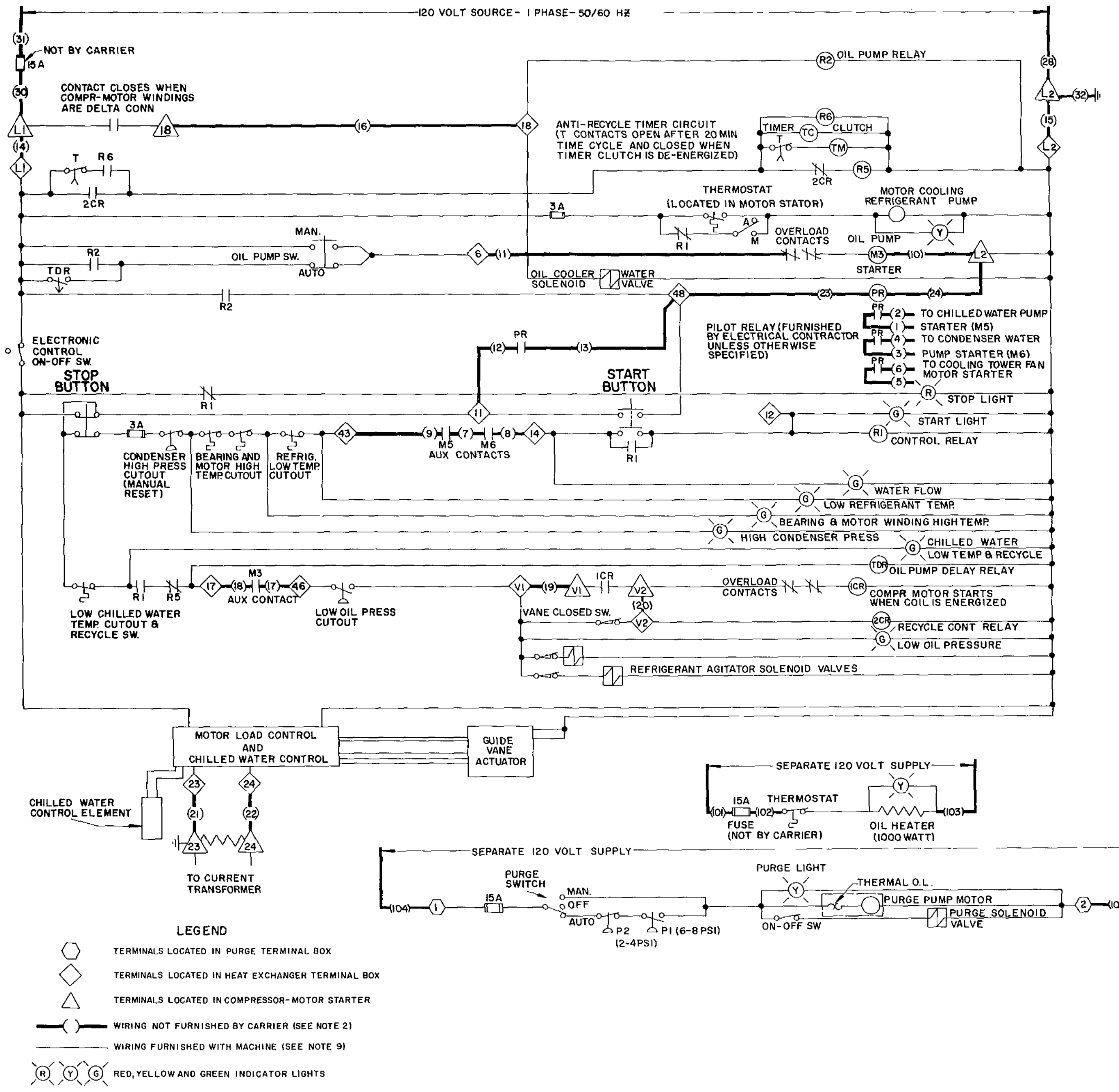
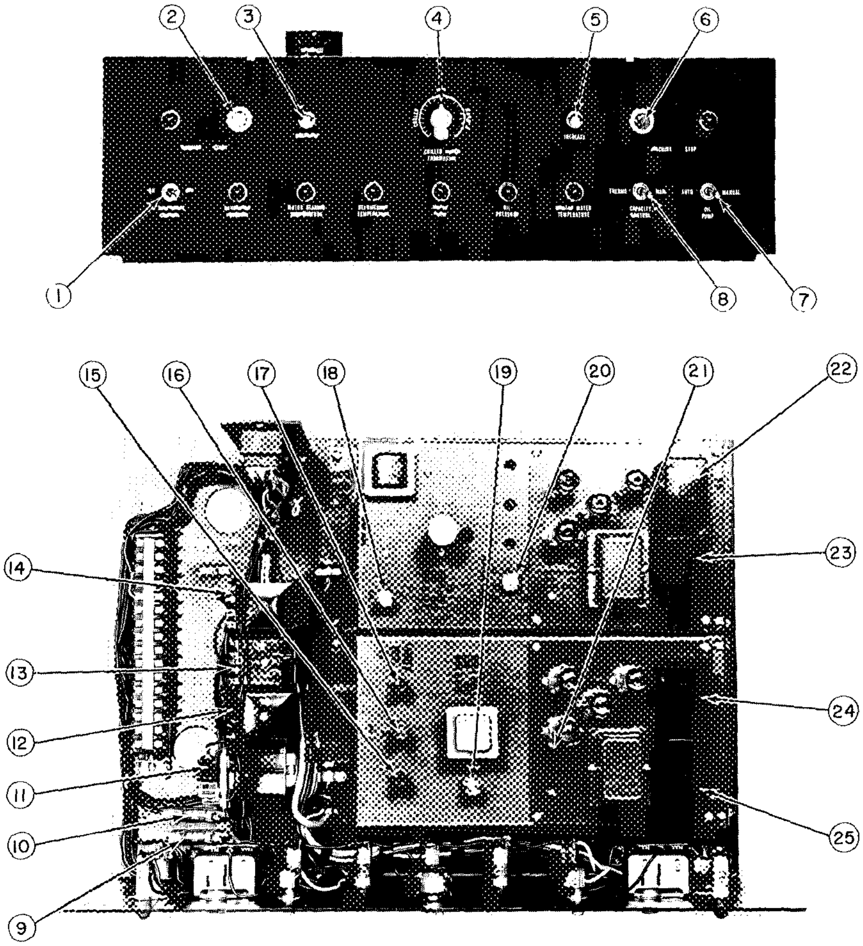


Fig. 5-1 - Typical 19DA Control Wiring



LEGEND

1 ELECTRONIC CONTROL "ON-OFF" SWITCH
2 MACHINE "START" BUTTON
3 VANE "DECREASE" BUTTON
4 CHILLED WATER THERMOSTAT
5 VANE "INCREASE" BUTTON
6 MACHINE "STOP" BUTTON
7 OIL PUMP "AUTO-MANUAL" SWITCH
8 CAPACITY CONTROL "THERMOSTATIC-MANUAL" SWITCH
9 3-AMP FUSE - SAFETY CONTROL CIRCUIT
10 3-AMP FUSE - REFRIGERANT PUMP
11 OIL PUMP TIME DELAY RELAY
12 RELAY R-4
13 RELAY R-2
14 RELAY R-1
15 DIFFERENTIAL ADJUSTING SCREW
16 CAPACITY BALANCE ADJUSTING SCREW
17 CALIBRATION ADJUSTING SCREW - CHILLED WATER
18 CALIBRATION ADJUSTING SCREW - MOTOR LOAD
19 THROTTLING RANGE ADJUSTING SCREW
20 ELECTRICAL DEMAND CONTROL KNOB
21 TEST JACK
22 RELAY CR1
23 RELAY CR2
24 RELAY CRC
25 RELAY CRO

Fig. 5-2 - Honeywell Electronic Control

Honeywell Control - (See Fig. 5-2 and 5-3.) If the water temperature is within 1/2 F of the set point, the relay contact CRC will be closed and CRO will be open. Under this condition, neither the OPEN winding nor the CLOSE winding of the capacitor start vane motor will be energized, and the vanes will remain in a fixed position (Fig. 5-3). If the water temperature rises above the set point, relay CRO pulls in, energizing the OPEN winding. The vanes will open until a new equilibrium position is reached. Relay CRO will then open, de-energizing the OPEN winding and stopping the vanes.

A similar action takes place when the water temperature drops below the set point. Relay CRC will open, closing contacts R_4 and energizing the CLOSE winding on the vane actuator motor. The vanes will close until a new temperature equilibrium is reached, opening relay CRC and stopping the vane motor.

The Honeywell vane actuator motor is supplied with travel limit switches which open when the motor reaches its full CLOSED or full OPEN position. Relay R4 causes the vanes to close on machine shutdown and stay in that position until the machine is restarted.

Motor overload is detected by a current transformer and resistor in the starter. An increase in current flow causes a change in voltage drop across the resistor. The magnitude of change is increased by the electronic amplifier. This voltage signal at terminals 23 and 24 should be approximately one-half volt when the motor reaches full load amperage. See Fig. 5-3 for schematic representation of the motor overload control operation as described below.

If the current flow reaches 103 percent of full motor rating, relay CR_2 will open and prevent the vanes from opening further. If the current continues to increase and reaches approximately 108 percent of full motor rating, relay CR_1 will open and cause the vanes to close, reducing the load until the current is down to approximately 106 percent. Relay CR_1 will open causing the vanes to stop moving. When the current flow drops below 100 percent, relay CR_2 will close and the chilled water control will actuate the prewhirl vanes.

The control panel includes the machine START-STOP buttons, control ON-OFF switch, manual LOWER and HIGHER capacity buttons, chilled water thermostat, thermostatic-manual switch, and oil pump switch (Fig. 5-2).

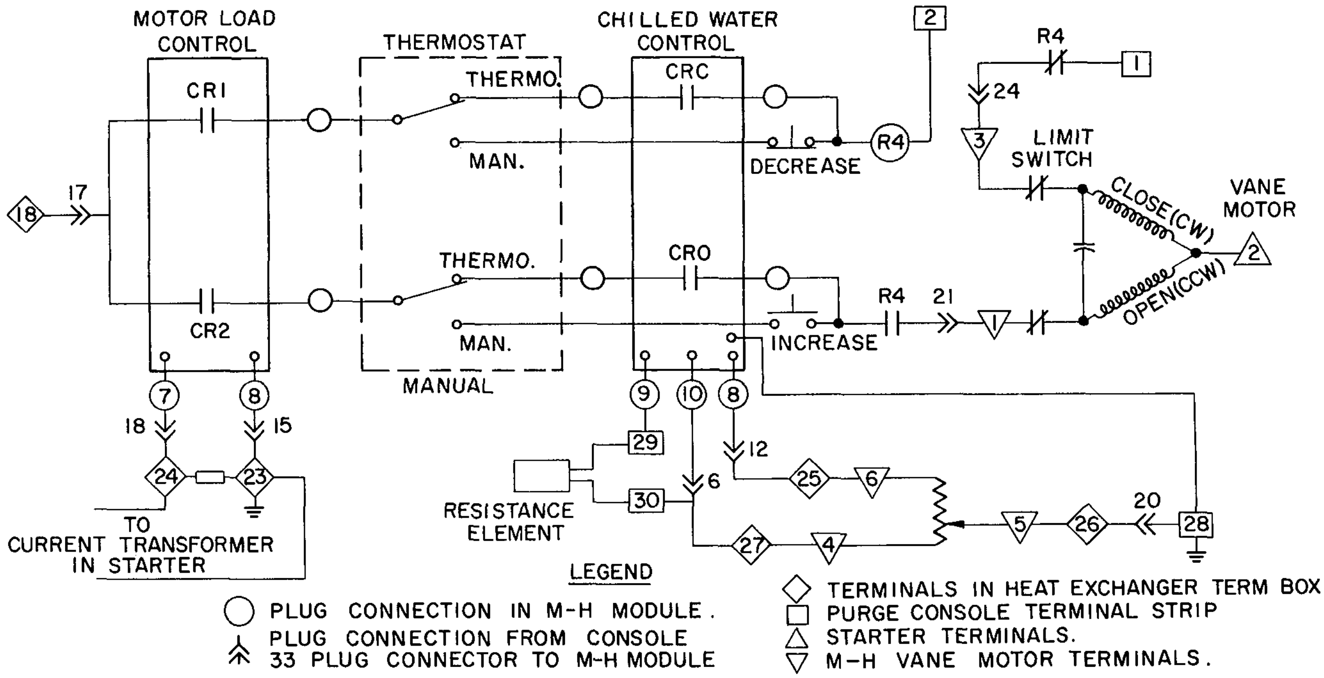


Fig. 5-3 - Honeywell Control Diagram

Barber-Colman Control - If the chilled water temperature is within 1/2 F of the set point, the chilled water micro-relay contacts, CRC and CRO will open. Under this condition, neither the OPEN winding nor the CLOSE winding will be grounded and the guide vanes will remain in a fixed position (Fig. 5-4). If the water temperature rises above the set point, the CRO micro-relay contacts close, grounding the OPEN shaded-pole coil of the actuator motor. The vanes will open until a new equilibrium is reached. The CRO micro-relay will then open, locking the vane actuator and stopping the vanes.

A similar action takes place when the water temperature drops below the set point. The CRC micro-relay contacts will ground the CLOSED shaded-pole coil, driving the actuator to close the vanes until a new equilibrium is reached. The CRC micro-relay will then open, locking the vane actuator and stopping the vanes.

The Barber-Colman vane actuator motor is supplied with travel limit switches which open when the motor reaches its full "closed" or "open" position. Relay R_2 causes the vanes to close on machine shutdown and stay in that position until the machine is restarted.

Motor overload is detected by a current transformer and resistor in the starter. An increase in current flow causes a change in voltage drop across the resistor. The magnitude of change is increased by the electronic amplifier. This voltage signal at terminals 23 and 24 should be approximately one-half volt when the motor reaches full load amperage. See Fig. 5-4 for schematic representation of the motor overload control operation as described below.

If the current flow reaches 103 percent of full motor rating, relay CR_2 will open and prevent the vanes from opening further. If the current continues to increase and reaches approximately 108 percent of full motor rating, relay CR_1 will close, grounding the closed pole of the actuator motor, causing the vanes to close and reducing the load until the current is down to approximately 106 percent. Relay CR_1 will then open, causing the vanes to stop. When the current flow drops below approximately 100 percent, relay CR_2 will close and the chilled water amplifier will take over control of the prewhirl vanes.

The Barber-Colman control panel includes the machine START-STOP buttons, control ON-OFF switch, chilled water thermostat, oil pump switch and indicator lights (Fig. 5-5).

The capacity control switch with its LOWER, HIGHER, and AUTO positions is located inside the cabinet and is part of the chilled water amplifier.

Operating Controls

CAPACITY CONTROL - (Honeywell) - The Honeywell capacity control switch on the control panel allows the operator to put the machine on THERMOSTATIC or MANUAL control. When on MANUAL the leaving chilled water temperature is controlled thru use of the HIGHER and LOWER (capacity) push buttons. The prewhirl vanes will move only when one of the buttons is depressed or if the motor overload closes them. The motor overload control can override the manual signals at any time to prevent overloading the motor. When on THERMOSTATIC the chilled water temperature is automatically controlled.

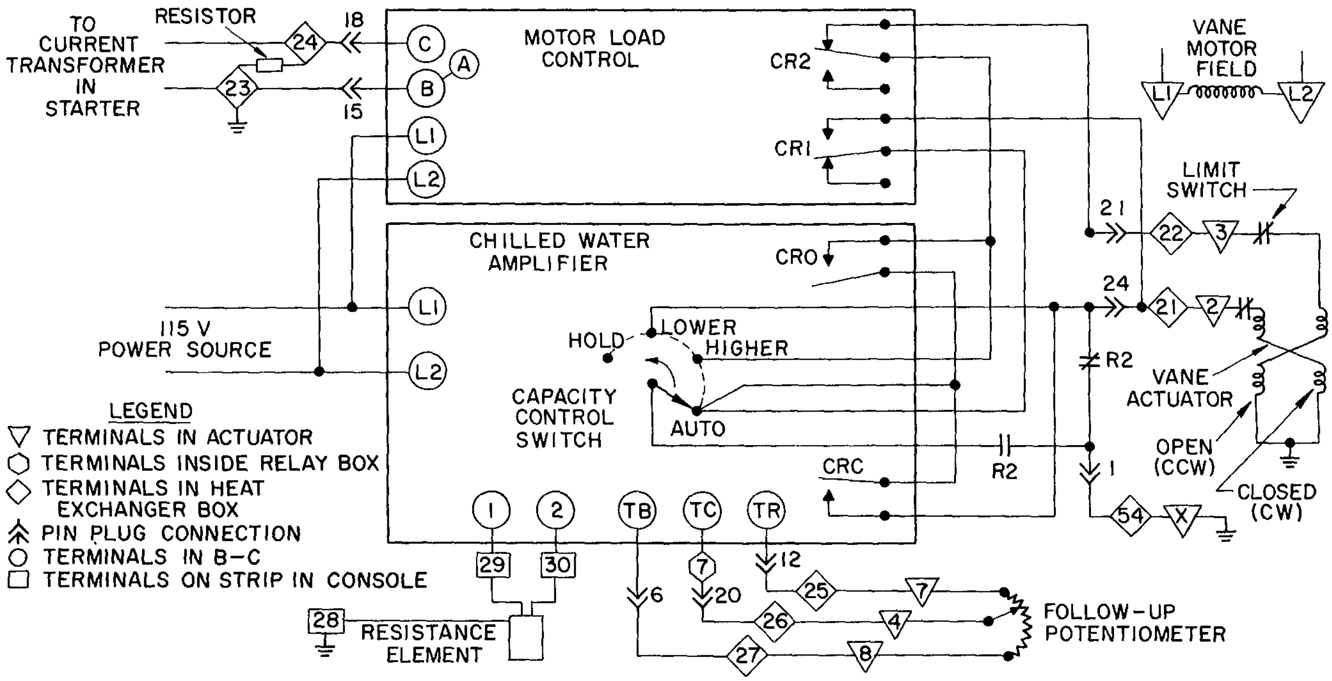
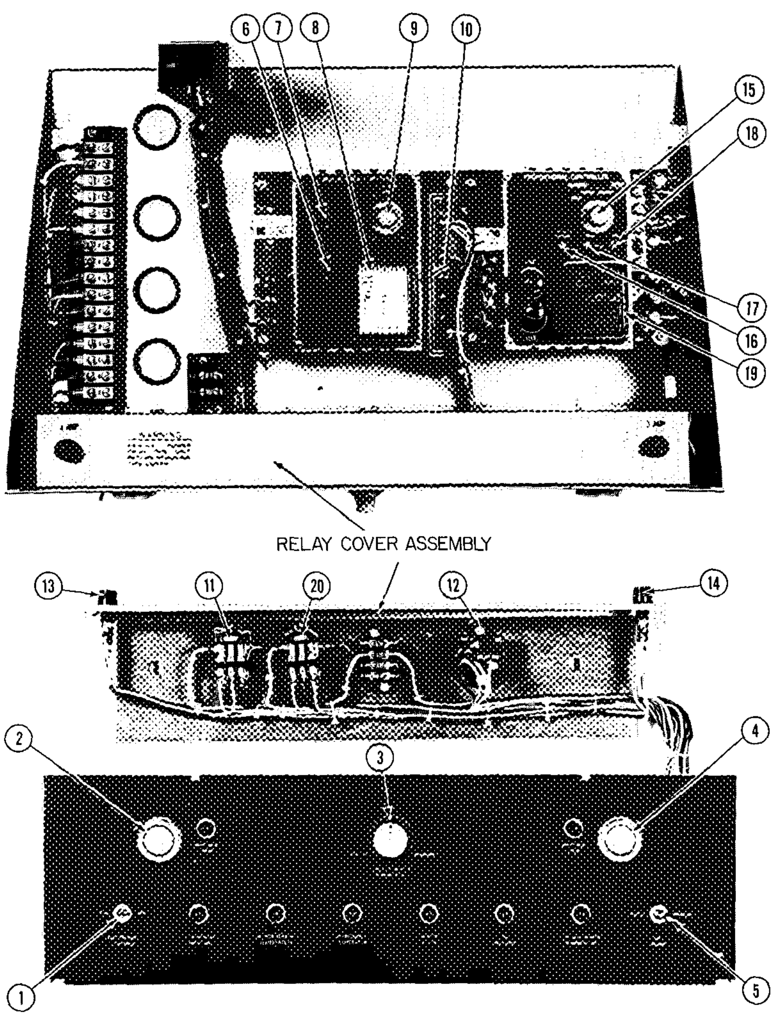


Fig. 5-4 - Barber-Colman Control Diagram



LEGEND

1 ELECTRONIC CONTROL "ON-OFF" SWITCH
2 MACHINE "START" BUTTON
3 CHILLED WATER THERMOSTAT
4 MACHINE "STOP" BUTTON
5 OIL PUMP "AUTO-MANUAL" SWITCH
6 CR1 CALIBRATION ADJUSTING SCREW - MOTOR LOAD
7 CR2 CALIBRATION ADJUSTING SCREW - MOTOR LOAD
8 MOTOR LOAD MICRO-RELAY
9 ELECTRICAL DEMAND CONTROL KNOB
10 MODULE TERMINALS (HIDDEN)
11 RELAY R1
12 OIL PUMP TIME DELAY RELAY
13 3-AMP FUSE - REFRIGERANT PUMP
14 3-AMP FUSE - SAFETY CONTROL CIRCUIT
15 CAPACITY CONTROL "AUTO-MANUAL" SWITCH
16 CAPACITY BALANCE ADJUSTING SCREW - "SENS"
17 THROTTLING RANGE ADJUSTING SCREW
18 CALIBRATION ADJUSTING SCREW - TEMPERATURE BRIDGE
19 CHILLED WATER MICRO-RELAY
20 RELAY R2

Fig. 5-5 - Barber-Colman Electronic Control

CAPACITY CONTROL - (Barber-Colman) - The Barber-Colman capacity control switch is located on the chilled water proportional amplifier in the electronic control section of the control center. When the knob is on MANUAL the leaving chilled water temperature is controlled thru movement of the knob from LOWER to HIGHER. The pre-whirl vanes will move only when the knob is in one of those positions and will remain stationary when the knob is in the HOLD position. When on AUTOMATIC the chilled water temperature is automatically controlled.

ELECTRICAL DEMAND CONTROL - An adjustable knob on the control allows the operator to reduce the amount of current which can be drawn by the motor down to 40 percent of full load amperage. This permits taking advantage of the prevailing electric demand rate during off-season operation.

ELECTRONIC CONTROL ON-OFF - The electronic control switch located on the control panel provides electricity to the electronic controls, and compressor starting circuit. The switch is normally left ON for the operating season so that the electronic components are not subjected to alternate cooling and heating stresses.

CHILLED WATER THERMOSTAT - A potentiometer with an adjusting knob located on the control panel is electrically connected to the chilled water control. One division of the thermostat dial equals approximately 1 F. When calibrated the pointer will be approximately at the center of the dial when set for design chilled water temperature. This permits manual adjustment for warmer or colder water.

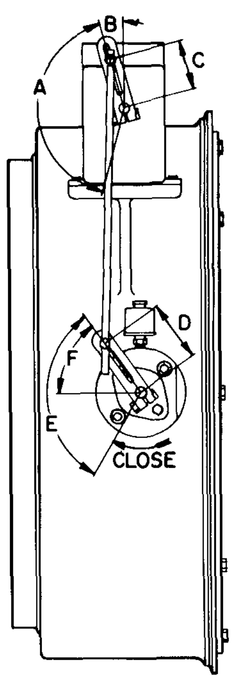
VANE CLOSED SWITCH - The vane closed switch, located in the vane actuator, is wired into the compressor starting circuit so that the circuit can be completed only when the vanes are closed. This prevents motor overload due to open pre-whirl vanes at start-up. During operation the switch is bypassed by an auxiliary contact.

OIL PUMP SWITCH - The oil pump switch, located on the control panel, is spring loaded so that it must be held in the MANUAL position for manual operation of the pump. When released the switch returns to AUTOMATIC. In this position the pump will start when the machine START button is depressed.

REFRIGERANT AGITATOR - The refrigerant agitator valves located behind the unishell are controlled by microswitches and cams located in the vane motor. Figure 5-6 and accompanying chart outlines the opening position of the agitator valves, and includes important linkage and angle dimensions for all compressor sizes.

SAFETY CONTROLS

Chilled Water Low Temperature Cutout and Recycle Switch - A thermostat with its sensing bulb in one of the cooler tubes in the leaving pass acts as a recycle control. If the chilled water temperature drops to approximately 5 F below normal set point, the thermostat will open and shut down compressor motor. The chilled water pump will continue to run. When temperature of water rises approximately 10 F, the thermostat will close and automatically restart compressor motor.



COMPRESSOR SIZE	CONTROL VENDOR	NO. OF AGITATOR VALVES/SWITCHES	CRANK ANGLE "B" WHEN AGITATOR VALVES OPEN	LINKAGE DIMENSIONS - VANES CLOSED					
				A	B	C (IN.)	D (IN.)	E	F
19D11	BARBER - COLMAN	1/1	42°	150°	15°	$2\frac{19}{32}$	$3\frac{1}{16}$	111°	48°
19D21		1/1	42°	150°	15°	$2\frac{19}{32}$	$3\frac{1}{16}$	111°	53°
19D31		2/2	VALVE 1 42° VALVE 2 $28\frac{1}{2}$°	150°	15°	$2\frac{19}{32}$	$3\frac{1}{16}$	111°	53°
19D11	HONEYWELL	1/1	42°	150°	15°	$2\frac{9}{16}$	3	111°	48°
19D21		1/1	42°	150°	15°	$2\frac{9}{16}$	3	111°	$52\frac{1}{2}$°
19D31		2/2	VALVE 1 42° VALVE 2 $28\frac{1}{2}$°	150°	15°	$2\frac{9}{16}$	3	111°	$52\frac{1}{2}$°

Fig. 5-6 - Vane Motor Crank Angle

Condenser High Pressure - A high limit pressure switch is arranged to interrupt the compressor circuit in the event of high condenser pressure. This switch must be manually reset whenever it is tripped. Before resetting, the condition causing the high pressure must be corrected. (See Chapter 7 - Air Leaks and Water Leaks.)

Refrigerant Low Temperature Cutout - This is a low limit temperature switch located on the cooler side of the float chamber. If the refrigerant temperature falls below the set temperature, the switch opens the STOP circuit to shut down the compressor. To restart the compressor, the START button on control panel must be pressed.

Low Oil Pressure Cutout - A differential pressure switch is provided to sense the amount of oil pressure available. This switch closes automatically when the oil pressure builds up to its set point (approximately 14 psi above the oil reservoir pressure) allowing the compressor START circuit to be completed. If the oil pressure drops to approximately 9 psi, the switch opens, shutting down the compressor motor.

Bearing-Transmission High Temperature Cutout - A high temperature cutout is imbedded in the thrust assembly of the compressor transmission. If the transmission or transmission bearing temperatures exceed the cutout setting, the compressor motor will shut down.

Motor Winding High Temperature Cutout - A normally closed thermostat imbedded in the compressor motor windings will open and shut down the compressor motor if the winding temperature reaches the set point of 221 F.

Pump Auxiliary Contact - The oil pump, chilled water pump, and condenser water pump starters have auxiliary contacts wired into the safety and starting circuits which prevents machine start-up unless these pumps are operating.

Anti-Recycle Timer - A timer and the necessary relays are located in a separate box in the purge section of the console. The timer, normally set at 20 minutes, provides motor and start-up protection against rapid recycling.

Referring to Fig. 5-1, relay 2CR is energized on start-up, closing contacts 2CR and energizing the timer clutch and relay R_6. While the timer is timing out, relay R_5 remains de-energized until a second start is attempted during the timing cycle. If this occurs, relay R_5 is energized, opens contacts R_5 in the starting circuit and remains open until the timer times out.

Oil Pump Time Delay Relay - The time delay relay located in the control section of the console is provided to keep oil pump running for approximately one minute after conpressor has started to coast to a stop on shutdown. The design of this relay is such that a delay of approximately one minute will occur when starting compressor. This enables the machine operator to check his auxiliaries to be sure they are running properly.

Compressor Time Delay Relay - This time delay relay permits the oil pump to run for approximately one minute before the compressor starts, providing full oil pressure at start-up.

STARTERS

Starter circuit diagrams are shown in Fig. 5-7 and 5-8 for Star-Delta open and closed transition (low-voltage application) type starters. These diagrams are intended to show starting sequence only and not to represent the actual wiring of any starter. Refer to actual starter manufacturer's wiring drawings for complete details.

Star-Delta Starter - Open Transition - In a star connection, one side of each motor winding is connected to a supply line, the other side to a common center. In "delta" arrangement, each winding is connected to alternate pairs of the three supply lines. The essential difference is that, for the same motor winding, the star connection will draw only one-third as much current as the delta connection.

Control relay (CR) Fig. 5-7, is energized when the start button is closed and operating and safety controls are satisfied. When relay contact (CR) closes, relay (S) is energized. This closes the main contacts to form the common center of the "star" circuit in the starter. Auxiliary (S) contacts energize coils (M1) and (TR) and open the circuit to coil (M2). Coil (M1) closes main contacts which supply line voltage to one side of each motor winding. This completes the "star" circuit so the motor starts with a low current inrush.

The time delay relay (TR), though energized at the same time as (M1), has an adjustable time delay from zero to three minutes. The preset delay period allows the motor to come up to speed so that the shift to the delta winding does not draw excessive current. The motor will accelerate to full speed on the star winding. The time delay may be adjusted so that the incremental inrush at switch-over from "star" to "delta" does not exceed the initial "star" inrush. Opening the normally closed time delay contact (TR) de-energizes coil (S). This opens the initially shorted side of the motor windings and at the same time closes the circuit to coil (M2). The (M2) contacts then close and connect the shorted side of the motor to the alternate power lines thereby forming the complete "delta" circuit. The (S) and (M2) contacts are mechanically interlocked, such that the (S) contacts will open before the (M2) contacts close.

The motor is "delta" wound but has six leads built into the motor terminal block to accommodate "star-delta" starting.

Star-Delta Starter - Closed Transition - Operation of the closed transition "star-delta" starter (Fig. 5-8) is similar to that of the open transition with additional protection provided against high inrush current during the switch-over period from "star" to "delta" winding. The switch-over inrush current is limited by inserting external resistance in series with the motor winding. The control relay (CR) is energized when the "START" button is closed and the operating and safety controls are satisfied. Closing the normally open (CR) contact energizes the relay (S) which closes the main contacts to form the common center of the "star" circuit. Auxiliary (S) contacts energize coil (M1) and the time delay relay (TR) and open the circuit to coil (M2). Coil (M1) closes its contacts which supply line voltage to one side of each motor winding. This completes the "star" circuit which starts the motor with low current inrush.

The time delay relay (TR), though energized at the same time as coil (M1), has an adjustable time delay period of zero to three minutes. The preset delay period allows the motor to come up to speed so that the shift to "delta" winding does not draw excessive current. The action of the (TR) contacts energizes coil (T) and de-energizes coil (S). This closes the circuit to coil (M2). The (M2) contacts then close and connect the shorted side of the motor to the alternate power lines by forming the complete "delta" circuit. The (M2) and (S) contacts are mechanically interlocked to provide the following sequence of switch operation: main (T) contacts close; main (S) contacts open; contacts (M2) close. The switch-over operation occurs in .05 to .06 seconds during which time the current is allowed to flow thru the resistors in series with the motor windings.

Initial inrush is thus the same as in the open transition arrangement. However, assuming a given setting of the timer, incremental inrush is reduced with closed transition because current does not first drop to zero before increasing to higher value permitted by the "delta" connection. The time delay may be adjusted so that the incremental inrush with an open transition starter is only slightly greater than with a closed transition.

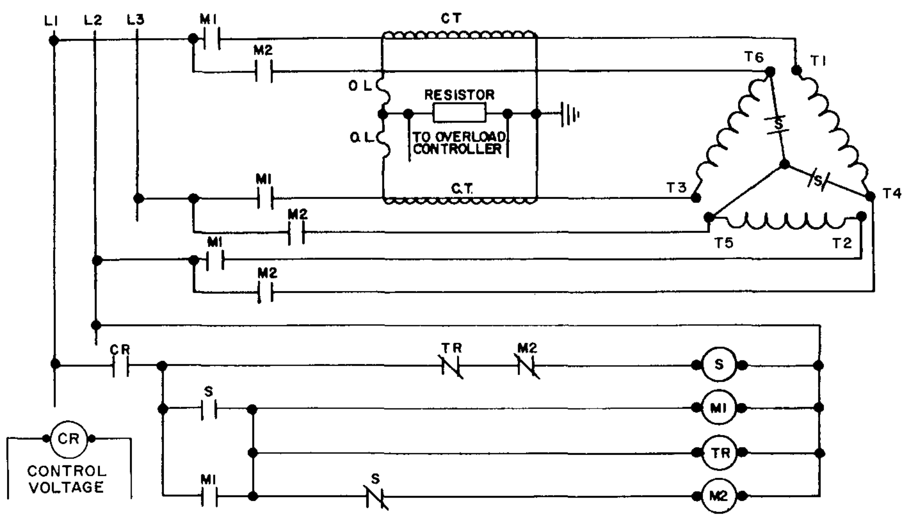


Fig. 5-7 - Star-Delta Circuit Diagram (Open Transition up to 600 V)

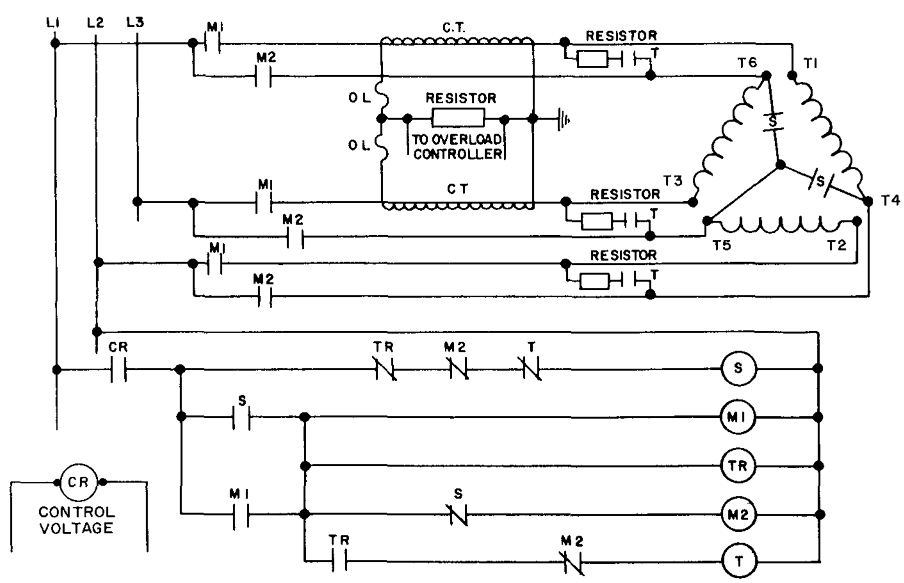


Fig. 5-8 - Star-Delta Circuit Diagram (Closed Transition up to 600 V)

Chapter 6 - Start-Stop Procedure

The control circuit of the Carrier 19DA machine is designed to provide completely automatic operation. The exact start-stop procedure will depend upon the extent to which the auxiliary equipment, such as pumps and cooling tower fan, are tied in with the control circuit of any particular machine.

IN GENERAL

1. Leave control switch in ON position during the cooling season to ensure that the electronic components are not subjected to alternate cooling and heating stresses.
2. It is recommended that the purge unit be operated in **Normal-Automatic** at all times unless performing other purge operations (Fig. 4-3, Chapter 4).
3. Put the capacity control switch on AUTO (Barber-Colman) or THERMO (Honeywell).
4. Be sure that there is power to all auxiliaries.
5. Check the cooling tower to be sure that it contains water.

> NOTE: During cool weather operation, maintain a minimum leaving condenser water temperature of 65 F. This can be done by any one or a combination of the following:
>
> 1. Throttle a condenser water valve.
> 2. Bypass water around the cooling tower.
> 3. Turn off cooling tower fan.

After Limited Shutdown - It should not be necessary to perform any special operations except to check the oil level in the reservoir before depressing the START button.

> NOTE: At start-up after a limited shutdown, the compressor will probably operate at full capacity for a short period of time even though the conditioned spaces indicate a low load. The "demand limit control" (see Chapter 5 - CONTROLS AND WIRING) may be adjusted to avoid a high demand charge for the short period of full capacity operation.

After Extended Shutdown

1. Check compressor oil level. An abnormally high level indicates refrigerant absorption by the oil. Raise setting of oil heater thermostat to drive off any refrigerant present in the oil.

> WARNING: Do not start compressor if oil temperature is below 135 F.

2. Check refrigerant level. If it appears low or is not visible, the refrigerant charge may be low. This should be checked when machine is operating. Proper refrigerant charge is indicated when the difference between leaving chilled water temperature and cooler temperature reaches design condition at full load.
3. With the control switch in ON position, the condenser high pressure, bearing high temperature, and refrigerant low temperature indicating lights on the control panel should come on.
4. Open water shut-off valve supplying oil cooler.
5. Open all valves in chilled water and condenser water circuits which may have been closed.

> CAUTION: Do not permit brine at a temperature greater than 100 F to flow thru the cooler.

6. The main circuit breaker must be closed. The machine can now be started in the same manner as after daily shutdown.

Completely Automatic System - Starting and stopping the machine is accomplished by a thermostat, timeclock, or other such control. All auxiliary equipment are tied into the control circuit of the machine and its auxiliary equipment are operating satisfactorily.

Semiautomatic System - All auxiliary equipment is tied in directly to the machine control system thru a pilot relay, but it is necessary for the operating engineer to push the START button. Pushing the START button will start the chilled water pump, condenser water pump, cooling tower fan (if used), and energize the oil pump time delay relay.

> NOTE: The START button is a momentary button and as such must be depressed for a few seconds while the auxiliaries come up to speed and satisfy the control circuit. In addition, the oil pump time delay relay is of such a design that it will delay on START as well as shutdown. When the oil pump time delay relay contacts close the oil pump starts. Compressor time delay relay is energized permitting the oil pump to run for one minute before the compressor starts.

Semiautomatic with Manual Auxiliaries - All auxiliaries must be started manually in the following order:

1. Start the chilled water pump.

2. Start the condenser water pump and cooling tower fan, if required.

NOTE: Some cooling tower fans operate automatically on an auxiliary thermostat.

3. Push the START button. (See Note under Semiautomatic System.)
4. Check all auxiliary equipment to ensure proper operation.

Operating Checks - Table 6-1 gives the operating temperature and pressure ranges of a standard 19DA refrigeration machine. After the compressor has started, the operator should observe these temperatures and pressures to make certain that the machine is operating properly. Water should be visible at the open drain from the oil cooler. Check the auxiliary equipment, pumps, fans, and water treatment system periodically for proper operation.

Table 6-1 - Temperature and Pressure Ranges

Oil Reservoir Temp	140–150 F
Bearing Oil Return Temp	150–175 F
Oil Level	1/2 sight glass
Oil Pressure	20–25 psig*
Condenser Temp	75–105 F†
Cooler Temp	30–40 F†

*Pounds per square inch differential between pump discharge and oil reservoir.

†Refer to specific design condenser and cooler temperatures used in selection of equipment.

SHUTDOWN

1. Push the STOP button on the control panel.

WARNING: Do not shut down machine with electronic control on-off switch. This will stop oil pump during compressor coastdown.

2. Shut down auxiliary equipment if system is not automatic or semiautomatic.
3. The oil pump will remain ON for one to two minutes during machine coastdown.
4. The inlet guide vanes will close automatically.

If the machine is to be shut down for an extended period of time, see Chapter 7 for more details.

NOTE: Should the machine fail to stop, pull main circuit breaker. DO NOT restart machine until malfunction is located and corrected.

MANUAL OPERATION - The capacity of the machine can be manually controlled by switching capacity control switch to MANUAL and opening or closing vanes manually.

The occasion for this would be:

1. To pull down water temperature below normal control point without disturbing the automatic setting, to check safety cutout points, or overcool building prior to anticipated heavy load.
2. To check operation of controls by lowering or raising water temperature off the control point to see if it will return back to control point.
3. To control machine in an emergency situation.

Chapter 7 - Preventive Maintenance

PROCEDURES

The following information provides the routine steps necessary for normal preventive maintenance on the 19DA Hermetic Centrifugal Machine. It is recommended that these steps be performed as often as indicated, and that an accurate operating log be kept so that it can be referred to at later dates as an aid in diagnosing troubles. If this schedule is adhered to, the 19DA Machine will provide continued satisfactory performance.

NOTE: Maintenance performed can be described in the remarks section of the Refrigeration Log.

Periodic preventive maintenance is outlined in the following paragraphs.

EACH WEEK

Vane Seal Oiler - The vane seal oiler supplies lubrication oil to the vane shaft seal. Mark the edge of the sight glass with a pencil and observe the oil level each week. An appreciable drop in oil level may indicate a seal leak. Replace seal if it leaks.

Oil Reservoir Level - The oil reservoir level can be observed at the reservoir sight glass. Mark the edge of the sight glass with a pencil and observe the oil level each week during machine shutdown. Keep a record of date and amount of any oil added.

To add oil while machine is under vacuum, proceed as follows:

1. Attach a copper tube to the oil charging valve at the bottom of the reservoir, and place the other end in a container of oil.

NOTE: When adding oil, do not break the oil container seal until ready to charge the oil into the reservoir.

2. Open the charging valve.
3. Keep the end of the tube submerged in the oil to prevent air from entering the machine.
4. Observe the reservoir sight glass, and as the oil reaches the required level, close the charging valve.

IMPORTANT: Make sure that the charging valve is fully closed to prevent air from entering the machine.

5. Remove copper tube from charging valve. If the machine has been shut down for a period of time, and the machine pressure is above atmospheric pressure, a small hand pump will be necessary for pumping the oil into the oil reservoir. Use the same general procedures as outlined.

Oil Temperature - The temperature of the oil in the oil reservoir must be maintained between 140 F and 145 F to minimize refrigerant absorption in the oil.

A 1000-watt oil heater element is submerged in the oil reservoir to maintain the oil temperature at the desired level at all times during machine operation and during shutdown. The oil heater thermostat should be set to maintain the 140 F to 145 F level.

A small pilot light on the oil heater electrical box cover lights whenever the heater is energized. If the pilot light is out when the oil heater should be energized, feel the sides of the oil reservoir. If the oil reservoir is warm, the pilot light may be burned out. To verify this, check the thermostat terminals with a test lamp to see if the contacts are closed. If the pilot light bulb is burned out, replace it.

CAUTION: Do not start the 19DA Hermetic Machine if the oil temperature in the oil reservoir is below 135 F. Wait for oil heater to raise oil temperature before starting machine.

Frequency of Purge Pump Operation - Since the purge pump operates only when there is air in the system, it is a very good indicator of system leak tightness. Note the frequency that the purge pump operates. If a small leak is present, the purge pump will operate several times per hour. If this is the case, see Refrigerant Loss, and Leak Testing in this chapter.

Water in Purge Water Chamber - Water that is removed from the system by the purge accumulates in the water compartment of the purge condensing chamber. Any accumulation of water can be seen floating on top of the refrigerant thru the water sight glass.

Remove any water accumulation by using operation 4 on purge valve and switch setting chart (Fig. 4-3). Always drain the water into a glass container so that the water can be measured and an accurate record kept of the amount removed.

A certain amount of moisture will enter the machine any time that air enters the machine. This moisture will show up as water in the water compartment of the purge condensing chamber. If water is continually being drained from the water compartment, and the purge pump is not cycling, the services of a Carrier Service Mechanic should be obtained from your nearest Carrier Office to determine the source of water. If water is allowed to remain in the machine, serious damage will result.

EVERY SIX MONTHS

Safety Controls - The various safety controls on the 19DA machine perform the important job of protecting the machine should any unusual condition occur. Although the settings of the safety controls will not normally change, it is recommended that they be checked at least once every six months during the operating season.

CHILLED WATER LOW TEMPERATURE CUTOUT AND RECYCLE SWITCH

1. With capacity control in the MANUAL position, open the prewhirl vanes while observing the thermometer on the leaving chilled water line.
2. The chilled water low temperature cutout and recycle switch should open at approximately 5 F below the design chilled water temperature and shut the machine down.
3. On recycle, the chilled water pump keeps running and the chilled water temperature will start to rise. When the chilled water temperature reaches approximately 5 F above the design chilled water temperature, the compressor should restart.
4. The cutout adjustment and the differential adjustment can be made if necessary. If the control is readjusted, go thru the above procedure to check the setting.

IMPORTANT: The chilled water low temperature cutout and recycle switch must open ahead of the refrigerant low temperature cutout switch or the machine will not recycle automatically.

REFRIGERANT LOW TEMPERATURE CUTOUT SWITCH

1. Place a jumper wire across the chilled water low temperature cutout switch.
2. Start the machine and observe chilled water temperature and refrigerant temperature.
3. Open the prewhirl vanes manually while observing these temperatures.
4. The machine should shut down when the refrigerant temperature reaches 1 F below the design suction temperature or 34 F, whichever is lower.

CAUTION: Do not allow the chilled water temperature to drop below 33 F. The refrigerant low temperature cutout switch should open before the chilled water temperature drops to 33 F. Adjust the control adjusting screw as required.

CONDENSER HIGH PRESS. CUTOUT SWITCH - The condenser high pressure cutout switch can be set to shut the machine down when the condenser pressure reaches approximately 15 psig. Check the switch setting with a metered supply of air while observing the pressure gage and the switch contacts.

LOW OIL PRESSURE CUTOUT SWITCH - The low oil pressure cutout switch is connected between the pump discharge and the oil reservoir. This switch is set to open and shut down the compressor if the oil pressure differential between the pump discharge pressure and the oil reservoir pressure drops to 9 psig. When the oil pressure differential reaches 14 psig the switch contacts close.

1. Disconnect the two copper tubing connections at the pump discharge and at the oil reservoir, and quickly install a flare cap on the lines to prevent loss of machine vacuum.
2. Connect the pressure supply of a small pump or a metered supply of air to the high pressure side of the switch. Leave the low pressure side open to atmosphere.
3. Check switch settings and adjust calibration screw as required to get the above settings.

Tighten Dresser Coupling Gasket — On those machines with dresser couplings, the gaskets may deform slightly into their final sealing position during the first year of operation. Check coupling bolts on suction and discharge piping for required torque of 75 foot pounds.

EVERY YEAR

Change Oil Charge and Oil Filter - The oil charge should be changed yearly, or more often if the machine has been opened for repairs. Oil used any longer than one year loses its inhibitor agents which have been purposely added to keep the oiling system clean.

Oil charges are as follows:

Compressor Size	Oil Charge (gallons)
19DA11	7
19DA21	9
19DA31	11

To remove the oil charge from the oil reservoir, proceed as follows:

1. Break machine vacuum, and raise machine pressure to approximately 5 psig with the purge pump. (See Chapter 4.)
2. Attach a copper tube to the oil charging valve, open the valve, and drain oil into a container.
3. Oil trapped in the oil filter compartment can be removed by removing the flare plug at the tee located on the bottom of the lubrication package.

4. Remove the cover plate on the end of the lubrication package. Remove oil filter cartridge and install new one. Oil filter cartridges can be ordered from your nearest Carrier office.

IMPORTANT: For proper lubrication, use only high-grade oil such as that originally furnished with the machine. An additional supply can be ordered from the nearest Carrier office. If oil other than that furnished by Carrier is used, it must conform to the "Lubricant Specifications" listed below.

LUBRICANT SPECIFICATIONS

Viscosity at 100 F SSU	350 ± 25
Viscosity at 210 F SSU	50 to 55
Viscosity Index (Minimum)	90
Pour Point (Maximum)	0 F
Foam Stability	Foam Volume (ml) at ASTM D892 end of 10 min. settling period:
At 75 F	0
At 200 F	0
At 75 F after test at 200 F	0
Foaming Tendency	Foam Volume (ml) at ASTM D892 end of 5 minute blowing period:
At 75 F	45
At 200 F	30
At 75 F after test at 200 F	45
Neutralization number, mg, KOH/gm	.5

Rust Inhibiting Characteristics:

The material shall pass the ASTM Rust Test D665-54. Procedure A will be used with a test period of 24 hours.

Oxidation Resistance:

The material shall pass the ASTM Oxidation Test B943-54 for a minimum of 1500 hours. The acid number at the end of the test shall not exceed 2.0 mg of KOH per gram of oil.

NOTE: In recommending oil suitable for use in centrifugal compressors, Carrier assumes no responsibility other than that covered by the standard guarantee.

Change Refrigerant and Volute Drain Filters - The Refrigerant Filter (Fig. 2-3) and the Volute Drain Filter (Fig. 2-5) have replaceable filter cartridges.

The refrigerant filter cartridge is identical to the volute drain filter cartridge and both must be changed yearly. To replace the filter element, remove the steel bolt and lower the bottom half of the filter housing. Filter elements can be ordered from the nearest Carrier office.

Refrigerant Float Chamber

1. Remove the float chamber cover and clean the float chamber of any dirt that may have accumulated.
2. Clean the wire mesh screen.
3. Operate the float valve manually. The valve must operate freely to its full travel. (Refer to the float valve assembly, Fig. 7-1).
4. The damper blade assembly must be clean, free of dirt, and must operate freely. If binding is experienced, remove the blade assembly by removing the two cap screws. Replace the blade assembly if it binds or if it shows signs of wear.
5. When reassembling blade assembly, maintain the 2-5/8 inch dimension (full open position) by adjusting bolt.
6. When replacing the damper blade assembly, install it so that the machined side bears against the deck plate. This float valve assembly is not a positive seating valve. The minimum contact for each blade is 50 percent of the contact surface. The maximum gap allowable for each blade is .015 in.

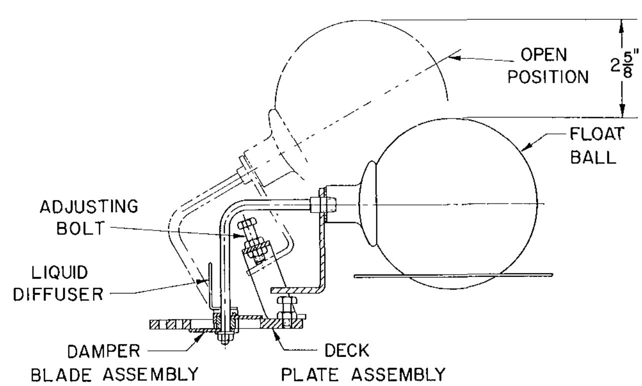


Fig. 7-1 - Float Valve Assembly

Examine Unishell Tubes

COOLER - At the end of the first operating season, check and clean the cooler tubes. Tube condition at this time acts as a guide for frequency of cleaning in the future, and indicates whether or not water treatment is required in the "brine" circuit.

CONDENSER - The condenser water circuit is usually an open system using a cooling tower, and requiring make-up water to replace the water lost due to evaporation. For this reason, the condenser tubes are subject to contamination by foreign matter, scale, algae, etc. Since water conditions vary in all parts of the country, it is recommended that a reliable water treatment specialist be consulted, and a sample of the condenser water source be tested to determine the type of water treatment required, if any.

Clean the condenser tubes at least once a year, or more frequently if the water is contaminated. Higher than normal condenser pressure usually indicates dirty tubes. However, air in the machine also results in higher than normal condenser pressures. To be sure of a correct analysis, check condenser pressure against actual condensing temperature as described under "Air Leaks and Water Leaks." A condenser water temperature and actual condensing temperature coupled with a smaller difference in temperature of leaving and entering condenser water, is an indication of dirty tubes. To use this method, a log must be made of the temperature difference when the machine is new and operating under full load. Comparisons made later should be at full load with identical entering condensing water temperature.

NOTE: Tube cleaning brushes, especially designed to prevent scraping or scratching of copper tube walls are available thru Carrier Service Parts Center.

Where tubes are covered with a coating of hard scale, it may be necessary to clean them with chemicals. (See Water Treatment.)

Purge Maintenance - The purge recovery unit, in performing its job of protecting the machine, handles corrosive mixtures which are at their highest concentration as they are purged. It is important, therefore, that the purge be kept in good repair. Repairs to the purge are much more economical than repairs to the major components of the machine.

For purge maintenance proceed as follows:

1. Remove the cover from the purge refrigerant float chamber.
2. Clean the refrigerant float chamber of any dirt that may have accumulated.
3. Operate the purge float valve thru its full travel. The valve must operate freely without binding.
4. Remove the float valve plunger. Examine the plunger and its seat for evidence of dirt or wear. Replace the valve plunger and seat assembly if they show any signs of deterioration or wear.
5. Clean the inside of the condensing chamber and reinstall components.
6. Check the 1/16-inch orifice in the purge suction line. Replace the strainer element in this orifice-strainer assembly.
7. For continued trouble-free operation of the purge pump, it is recommended that the inlet and exhaust valves be changed yearly. Replaceable parts can be purchased from your Carrier office.

Starters

1. Open the disconnect switch ahead of the starter before performing any maintenance on the starter.
2. Clean the air gap surfaces on the starter contactors.
3. Refer to the starter manufacturer's instructions for lubrication and other maintenance requirements.

MAINTENANCE AS REQUIRED

Electronic Vacuum Tubes or Relays - The maintenance of the electronic controls is limited to replacement of vacuum tubes and relays, tightening of connections, and general cleaning.

It is recommended that operating engineers stock spare vacuum tubes and relays and replace these items each spring at start-up to ensure uninterrupted operation during the cooling season. When replacing tubes and relays, check part numbers and make sure that the replacement items have the same part numbers.

CAUTION: Do not interchange vacuum tubes or relays as improper operation will result.

Keep the control compartment clean and free of dust and dirt. Vacuum the control compartment yearly and more often if necessary.

CAUTION: Make sure that the starter main disconnect switch is OFF before tightening any connections on the terminal board.

Carrier stocks replacement electronic control modules. Consult your nearest Carrier office.

Compressor, Motor and Transmission Bearings - The best bearing maintenance consists primarily of maintaining clean oil in the lubrication system. Bearings should be examined every year or two for signs of wear. Removal and examination of bearings should be done by a trained service mechanic. Consult your nearest Carrier office for assistance.

Bearing wear can sometimes be detected thru increased vibration or increased bearing temperatures. If these symptoms appear, notify the nearest Carrier office for assistance by a Carrier Service Mechanic.

Vane Shaft Seal - The continual adding of oil to the vane shaft seal oiler indicates a leaky seal which should be replaced.

Mechanical Data - Table 7-1 shows the clearances, fits, and torque requirements for compressor components and is intended to be used only as a guide. This guide, as well as good judgment, should be used when checking, replacing or fitting a replacement part.

Refrigerant Loss - Refrigerant can be lost due to air leaking into the machine. Since it is impossible to completely separate the air from the refrigerant, some refrigerant will always be discharged from the machine as the purge unit removes air. Therefore, any leaks which cause the purge unit to cycle often in order to discharge air should be located and repaired.

Charging or Removing Refrigerant - To charge or add refrigerant to the cooler, use a drum charging valve and fitting as shown in Fig. 7-2.

CHARGING

1. Install charging valve on 3/4-inch drum opening (Fig. 7-2). When 3/4-inch pipe nipple is screwed into drum opening, the nipple will force the bottle cap off.
2. Connect a short length of clear plastic hose or copper tubing from drum valve to cooler charging valve.
3. Start chilled water pump and circulate chilled water during charging process.
4. Check cooler pressure gage (Fig. 4-1) on control panel to determine if cooler pressure corresponds to 32 F saturation temperature (18.05 inches of mercury vacuum) of the refrigerant.
5. If machine pressure is below 18.05 in. Hg then liquid refrigerant must not be charged into the cooler. Keep refrigerant drain upright and open valves. Machine vacuum will cause liquid refrigerant in the drum to boil off, drawing the refrigerant vapor inside the cooler, raising its pressure, preventing possible cooler tube freezing.
6. When machine pressure reaches the pressure-temperature ratio indicated in Fig. 1-3 or higher, invert drum and charge liquid refrigerant to mark on sight glass.

REMOVING REFRIGERANT - To remove refrigerant from the cooler, proceed as follows:

1. Connect a copper tube or a clear plastic tube to the cooler charging valve, and place the other end into the refrigerant drum. Extend the tube to the bottom of the drum to prevent flashing of the refrigerant.
2. Raise the pressure in the cooler to approximately 5 psig. (See Chapter 4 - PURGE RECOVERY SYSTEM.)

Table 7-1 - Mechanical Data for Compressor Components

Description (Measurement)	19DA Compr Size	Clearance (in.) Min	Clearance (in.) Max
A. Impeller			
Impeller to Intake Wall (Axial)	11 21 31	.035 .045 .055	.040 050 .060
B. Bearings			
Motor End Bearing (Diam)	11,21,31	.0015	.003
Gear Bearing (Diam)	11 21 31	0025 .0025 .004	004 .004 .0055
Pinion Bearing (Diam)	11 21 31	.002 0025 .003	.0035 .004 .0045
Thrust Bearing (Axial)	11,21,31	.008	.014
Journal Bearing (Diam)	11 21 31	.0014 .0017 .002	.0022 .0028 .0031
C. Labyrinths			
Transmission Labyrinth to Rotor Shaft (Diam)	11,21,31	.006	.010
Motor End Labyrinth to Rotor Shaft (Diam)	11,21,31	.0045	.007
Compressor Labyrinth (Diam)	11,21,31	.007	011
D. General			
Motor Cooling Orifice (Diam)	11 21 31	1/16 3/16 7/32	
	Compr Size	Torque (Ft-Lb)	
E. Torques			
Impeller Shaft Cap	11 21 31	110 130 180	
Gear Locknut	11 21 31	210 250 275	
V-Band Clamps	11,21,31	120 In.-Lb	

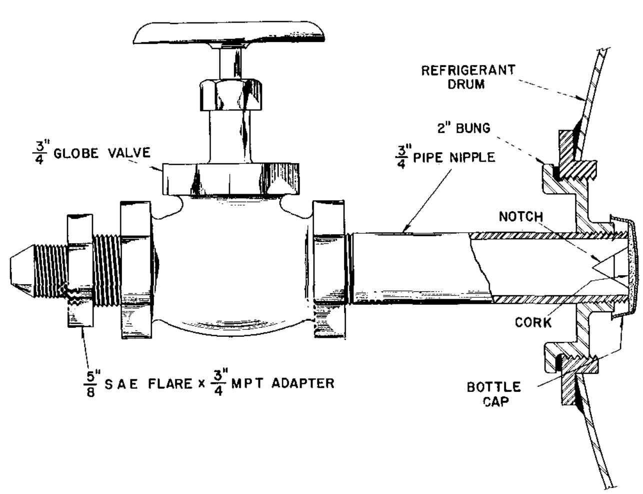


Fig. 7-2 - Drum Charging Valve and Fitting

3. Open the cooler charging valve to allow refrigerant to flow into the drum.

CAUTION: Leave about a 3-inch space above the liquid in the drum to permit the refrigerant to expand. If the large bung is removed and the refrigerant is put into the drum thru this opening, the level can be easily observed with a flashlight.

WARNING: Store drums containing Refrigerant 11 in a cool place. If the temperature of the drum is allowed to rise above the boiling point (74.8 F), there will be some pressure in the drum. Opening a drum that contains pressure in any way other than that described in above procedures could result in loss of refrigerant and possible injury to the operator.

Air Leaks and Water Leaks - The presence of air in the machine is indicated by an increase in condenser pressure. However, dirty tubes will also cause an increase in condenser pressure. To be sure of a correct analysis, check the condenser pressure against the actual condensing temperature. The correct temperature for the pressure is shown on the condenser pressure gage.

1. Install a thermometer in the condenser well provided in the float chamber.
2. If the thermometer reading in the float chamber is more than 2 F below the temperature listed for the existing pressure, air is present in the machine.
3. If the temperature and condenser pressure correspond, there is no air in the machine and the high condenser pressure is due to either high entering condensing water temperature, lack of condensing water or dirty tubes.
4. Locate and repair air leaks as soon as possible. (See Leak Testing, below.)

If the purge unit is operating properly and in good repair, frequent energizing of the purge pilot light will give the first indication of air in the machine.

An accumulation of water in the purge separation chamber could be caused by a water leak in the condenser or in the cooler. Locating and repairing water leaks should be done by a Carrier Service Mechanic.

NOTE: Remember that air entering the machine will bring some moisture with it. Therefore, small amounts of water accumulating in the water compartment of the purge separation chamber do not necessarily indicate a water leak.

Breaking Vacuum with Nitrogen - Whenever the machine vacuum must be broken for service work or extended shutdown, it is recommended that dry nitrogen be used. Nitrogen is superior to air in that it will not admit moisture into the machine and, therefore, avoids exposing the interior of the machine to corrosive conditions. The use of nitrogen to break machine vacuum is especially important in areas of high humidity. If service work is being performed, and the machine is left open to atmosphere for a period of time, machine vacuum should first be broken with nitrogen, the machine pressurized to 5 psig, and then remove the refrigerant. This will minimize refrigerant loss. (See Charging or Removing Refrigerant.)

Leak Testing - To leak test the 19DA machine, it is first necessary to shut down the machine, and then pressurize it with dry nitrogen.

WARNING: Never pressurize the machine with oxygen. A serious explosion will result.

To pressurize the machine with nitrogen, proceed as follows:

1. Connect a copper line between cooler charging valve and regulating valve on nitrogen cylinder.

   CAUTION: Never apply full cylinder pressure to the pressurizing line. Be sure to perform Steps 2 and 3 in proper sequence.

2. Open cooler charging valve wide open.
3. Open the regulating valve and admit nitrogen slowly.
4. Observe machine pressure on the cooler pressure gage or the condenser pressure gage. Close nitrogen regulating valve when the pressure gage reads test pressure of 5 to 8 psig.

   CAUTION: Test pressure must not exceed 10 psig or the cooler rupture valve disc will burst.

5. Close cooler charging valve and remove copper line.

If nitrogen is not readily available, the machine may be pressurized with air using the purge pump. To pressurize the machine with air, proceed as follows:

1. If possible, raise the machine pressure by raising the chilled water temperature. This will minimize the amount of air admitted into the system.
2. Disconnect the condenser pressure gage line. This will admit air into the machine until machine pressure reaches atmospheric pressure.
3. Reconnect the gage line.
4. Drain any water from the purge condensing chamber by opening valve 1. The water will drain by gravity.
5. Set the purge for pressurizing as described in operation 3 shown on valve chart (Fig. 4-3).
6. Place purge solenoid switch in OFF position, and place purge switch in MANUAL position to start purge pump.

7. Observe machine pressure on the cooler pressure gage or the condenser pressure gage. Stop the purge pump when the machine pressure reaches 5 to 8 psig.
8. Test all joints and flanges including purge unit using a halide or electronic leak detector.

CAUTION: Test pressure must not exceed 10 psig or the cooler rupture valve disc will burst.

The refrigerant need not be removed from the cooler when leak testing. In the event that a leak test is being made with the refrigerant removed, recharge approximately one gallon of Refrigerant 11 into the machine before pressurizing, so that the leak will show on a detector.

IMPORTANT: A heavy concentration of refrigerant in the room will decrease the efficiency of the test. It is best to ventilate the room before attempting to leak test.

Winter or Extended Shutdown - The refrigerant in the cooler may eventually rise to atmospheric pressure. It is desirable to hold the pressure below atmospheric to avoid excessive absorption of the refrigerant into the lubricating oil and to minimize refrigerant loss. (See Charging or Removing Refrigerant.)

If machine pressure cannot be maintained below atmospheric, it is recommended that the refrigerant be removed and stored in drums to be sure of minimum refrigerant loss. (See Charging or Removing Refrigerant.)

IMPORTANT: If the machine will be exposed to freezing temperatures during winter shutdown, special precautions must be taken. All water must be drained from the chilled water, condenser water and oil cooler lines, and purge condensing chamber. After draining the water lines, leave the water box drains open until it is time to refill. In addition to draining the water lines to the oil circuit, it will be necessary to disconnect the water lines and blow out the cooling coil with air.

It is desirable to leave the oil in the reservoir during an extended shutdown to eliminate any remote possibility of operating the compressor without proper lubrication. Be sure to leave the oil heater energized to maintain a minimum oil temperature of 140 F during the shutdown to minimize the absorption of refrigerant into the oil.

IMPORTANT: If the refrigerant is left in the cooler and the water lines are not drained during extended shutdown, mark the refrigerant level and check weekly. Watch for any increase in refrigerant level which may indicate a water leak. If this occurs, locate and correct the leak immediately.

Water Treatment - Water treatment includes the proper bleed-off of condensing water in the cooling tower and the treatment of the water to prevent scaling and corrosion.

When a large condensing water system is first filled, the scale causing impurities in the water are not enough to effect heat transfer, even if they are all deposited. Scale formation takes place only when the concentration of impurities increases because of evaporation of water in the cooling tower. When the cooling tower water evaporates, it leaves the impurities behind. More impurities are added to the system by water used to replace the evaporated water. As the concentration of impurities increases, a limit of solubility is reached and the impurities are deposited as scale.

In hard water areas, the condensing water system must be cleaned frequently or at least yearly to prevent a rise in condenser pressure. Proper water treatment and cooling tower bleed-off reduces the amount of scaling, thus reduces frequency of tube cleaning required.

By checking the leaving condensing water temperature and the actual condensing temperature, it can be determined if the condenser tubes are becoming dirty. A larger than normal difference between leaving condensing water temperature and actual condensing temperature, coupled with a smaller difference in temperature of entering and leaving condensing water, is an indication of dirty tubes. (See Examine Unishell Tubes.)

Since water conditions vary in all parts of the country, it is recommended that a reliable water treatment specialist be consulted and a sample of the condensing water be tested to determine the type of water treatment required.

Ordering Replacement Parts - Order Carrier Specified Parts from your nearest Carrier office. To speed up the process of filling parts orders, the following information must accompany order:

1. Name, quantity and part number of the part required.
2. Component (compressor, unishell, purge) serial number.
3. Machine size.
4. Delivery address and mode of shipment.

Refrigeration Log - A refrigeration log that is properly kept can be valuable in many ways. It can familiarize an operator with machine operation; it can be of assistance when planning maintenance; and it can be beneficial when diagnosing machine trouble. Therefore, it is recommended that a refrigeration log such as shown in Fig. 7-3 be maintained. Copies of this refrigeration log sheet may be obtained by contacting your local Carrier office. Specify form number located in the lower left-hand corner.

Carrier *Air Conditioning Company*
A DIVISION OF CARRIER CORPORATION

DATE ____________________

REFRIGERATION LOG
CARRIER 19D HERMETIC CENTRIFUGAL REFRIGERATION MACHINE

PLANT ____________________ MACHINE SERIAL NO. ____________________ MACHINE SIZE ____________________

	COOLER					CONDENSER				COMPRESSOR						PURGE				
	GPM ____					GPM ____					OIL									
Time	Vacuum	Refrigerant Temperature	Refrigerant Level	Water Temperature IN	Water Temperature OUT	Vacuum or Pressure	Condensing Temperature	Water Temperature IN	Water Temperature OUT	Bearing and Transmission Temperature	Level	Temperature	Pressure	Reservoir Pressure	Motor Amps or Vane Position	Refrigerant Level	Condenser Pressure	Frequency of Pump Operation	Refrigerant Pump On or Off	Operator's Initials
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

REMARKS: Indicate shut-downs on safety controls, repairs made, oil or refrigerant added or removed, and water drained from purge. Include amounts.

E-56A (10-65)

Fig. 7-3 - Refrigeration Log

Chapter 8 - Trouble Shooting Guide

TROUBLE/SYMPTOM	PROBABLE CAUSE	REMEDY
1. COMPRESSOR WILL NOT START. a. Panel lights out.	A. Power failure.	A. 1. Check for building power failure. 2. Check and reset circuit breaker.
	B. Control "ON-OFF" switch in "OFF" position.	B. Turn control switch to "ON."
	C. Blown fuse.	C. 1. Check 15 amp fuse in control circuit. 2. Check 3 amp fuse in starting circuit.
b. All panel lights on.	A. Overload relays in starter tripped.	A. 1. Check overload relays and reset. 2. Check calibration of motor overload module. Module is not stopping vanes when motor reaches 108 percent of full load amperage. 3. Check setting of overload relay per manufacturer's instructions.
	B. Compressor time delay relay.	B. It is normal for the relay to delay one minute after the oil pump starts. If compressor does not start after one minute check time delay relay.
	C. Vanes are open and/or vane closed switch is open.	C. Check position of vane motor and vane closed switch. Vane closed switch must be closed for starting.
c. All panel lights on except low oil pressure light.	A. Anti-recycle timer circuit open.	A. Check R_5 relay contacts. If contacts are open, timer has not timed out. Wait until the time setting has expired. (0 - 20 minutes, check timer dial.)
	B. Oil pump not running.	B. Check oil pump time delay relay. It is normal for the relay to delay 30 - 90 seconds on START. Wait until the oil pump starts. If pump does not start, trouble may be in time delay relay or in the following: 1. Faulty oil pump starter, circuit breaker, fuses, or starter contacts. 2. Faulty wiring from pump starter to the pump. 3. Faulty pump motor.

TROUBLE/SYMPTOM	PROBABLE CAUSE	REMEDY
	C. Low oil pressure, or defective cutout switch.	C. 1. Check to be sure that low oil pressure cutout contacts are closed. 2. Check low oil pressure cutout switch for improper setting. 3. Check oil level. Add oil if required. If level is high, see Chap. 7 for corrections.
	D. Oil filter dirty.	D. Replace filter if necessary.
d. Water flow light out, START light out and low oil pressure light out - others on.	A. Water pumps not running.	A. Check cooler and condenser water pumps for operation. If a pilot relay is installed for automatic pump starting, check relay for possible sticking contacts.
e. Low refrigerant temperature light out, water flow light out, green START light out and low oil pressure light out - others on.	A. Refrigerant temperature below normal.	A. 1. Check low refrigerant cutout. 2. Check the refrigerant level. Determine cause of refrigerant loss. Add refrigerant. 3. Check leaving chilled water temperature to be sure it is not below normal. 4. Check the capacity control switch for proper position. THERMOSTATIC (Honeywell) or AUTO (Barber-Colman). 5. Check cooler float valve. Be sure it is not binding. Binding float would cause refrigerant to accumulate in condenser.
f. Bearing and motor temperature light out, refrigerant temperature light out, water flow light out, the green START light out and low oil pressure light out - others on.	A. Bearing or motor winding temperature too high.	A. 1. Check for possible low oil pressure. Check setting of the low oil pressure cutout switch. (See Item 1, c.) 2. Check for high oil temperature in reservoir. (See Item 7.) 3. Check bearing return oil temperature on temperature gage. If temperature is below 180 F when compressor shuts down, fault may be in bearing thermostat. WARNING: If the bearing temperature did rise to 180 F or above, do not attempt to restart machine. Contact your Carrier representative.

TROUBLE/SYMPTOM	PROBABLE CAUSE	REMEDY
		4. Check motor cooling system. Clean orifices and replace filter. Check refrigerant pump at MANUAL setting. If operating satisfactorily, winding thermostat is faulty. NOTE: With Honeywell controls, thermostat must be replaced before compressor is run. With Barber-Colman controls, run refrigerant pump in MANUAL until thermostat is replaced.
g. All panel lights out except chilled water low temperature.	A. High condenser pressure.	A. Check the items listed under Item 4.
h. Chilled water temperature light out and low oil pressure light out - all other panel lights on.	A. Chilled water temperature below normal.	A. Check the chilled water temperature. If below normal, allow the temperature to rise and machine will restart automatically. The chilled water pump should be running.
	B. Improper setting of chilled water low temperature cutout and recycle switch.	B. Check setting. Reset if necessary.
2. CHILLED WATER TEMPERATURE TOO HIGH (Compressor is running).	A. Chilled water thermostat set too high.	A. Check and reset position of thermostat.
	B. High temperature in conditioned area. Refrigeration load excessive.	B. Machine loaded to capacity. Excessive infiltration of outside air may be the cause.
	C. Vanes not fully open.	C. 1. Check the capacity control switch. Switch must be in THERMOSTATIC (Honeywell) or AUTO (Barber-Colman) position. If vanes will not open in MANUAL position, trouble is in the chilled water module. Replace vacuum tubes, one at a time. If this fails to correct the trouble, replace the chilled water module. 2. Excessive load in conditioned area. Vane opening limited by the motor overload module. 3. Check vane motor and vane linkage to be sure that the linkage and shaft are not slipping. (See CONTROLS AND WIRING, Fig. 5-6 for linkage dimensions.)
	D. High condenser pressure.	D. Check Item 4 for causes of high condenser pressure.

TROUBLE/SYMPTOM	PROBABLE CAUSE	REMEDY
	E. Gradual increase in temperature difference in refrigerant and chilled water.	E. 1. Shut down the machine and check refrigerant level. To determine cause of refrigerant loss, see Chap. 7. Add refrigerant as required. 2. Check cooler for dirty or obstructed tubes and clean if necessary. (See Chap. 7.) 3. Check the division plates and division plate gaskets in cooler water box for possible water bypass.
3. CHILLED WATER TEMPERATURE TOO LOW (Compressor is running).	A. Chilled water thermostat set too low.	A. Reset thermostat.
	B. Vanes open too far.	B. 1. Check to be sure capacity control switch is in the THERMOSTATIC (Honeywell) or AUTO (Barber-Colman) position. 2. Check calibration of chilled water module.
	C. Low chilled water temperature cutout and the recycle switch not operating properly.	C. Check setting of recycle control. Reset if necessary. Control must shut down machine when the water temperature is 5 F below design temperature.
4. CONDENSER PRESSURE TOO HIGH.	A. Low condenser water flow, or high condensing water temperature.	A. 1. Check the condensing water pump for proper operation. 2. Check to be sure all valves in condensing water circuit are open. 3. Check cooling tower fan and fan control for proper operation. 4. Check tower make-up water valve to be sure valve is not stuck closed. 5. Check the strainer in condenser water line. 6. Check the condensing water temperature in and out of condenser to determine if water box division plate or gaskets are damaged. This could cause water bypass.
	B. Air in condenser.	B. 1. Check for presence of air. (See Chap. 7.) 2. Check purge for proper valve and switch settings. Refer to metal instruction plate at the valves (Fig. 4-3).

TROUBLE/SYMPTON	PROBABLE CAUSE	REMEDY
	C. Fouled condenser tubes.	C. Check for fouled condenser tubes. (See Chap. 7 for instructions to clean tubes.)
5. CONDENSER PRESSURE TOO LOW.	A. Excessive water flow or water temperature too low.	A. Check for excessive flow. Adjust flow to maintain minimum leaving condensing water temperature of 60 F.
6. OIL TEMPERATURE IN RESERVOIR TOO LOW.	A. Too much water flow thru oil cooler.	A. Regulate water flow to maintain proper oil temperature.
	B. Faulty thermostat and/or heater.	B. With a voltmeter, check for voltage across the thermostat while adjusting thermostat. If the thermostat contacts do not close, replace thermostat. If heater is receiving power but does not heat, replace heater.
	C. Incorrect oil heater thermostat setting.	C. Adjust thermostat setting, or if thermostat is electrically correct and adjustment does not light the indicator light, replace the indicator light.
7. OIL TEMPERATURE IN RESERVOIR TOO HIGH.	A. Incorrect thermostat setting.	A. Check setting of thermostat.
	B. Insufficient water flow to oil cooler.	B. Increase water flow to cooler to maintain proper oil temperature.
	C. Oil cooler solenoid valve does not open.	C. Check solenoid valve operation. Repair or replace coil or valve as required.
	D. Fouled oil cooling coil.	D. Check, clean, or replace coil as required.
8. PURGE DOES NOT OPERATE IN AUTO POSITION.	A. Normal.	A. Purge pump cycling may not be required if machine tightness does not warrant. Compare the purge and condenser pressure gages to determine if purge should be cycling. If purge should be cycling, check the condenser for evidence of air present. (See Chap. 7.)
	B. Blown fuse.	B. Check 15 amp fuse located inside purge electrical switch box. Replace if necessary.
	C. Loose connections or broken wires.	C. Check the electrical connections at purge switch, solenoid switch and coil, purge motor, 15 amp fuse indicator light. Be sure connections are tight and wires or their insulation are not broken.

TROUBLE/SYMPTOM	PROBABLE CAUSE	REMEDY
	D. Defective purge electrical switch.	D. Disconnect the leads from the purge switch and check it with a volt-ohmmeter using the ohm scale with the leads across the switch lugs. Check the switch for continuity with the switch in the closed position. Replace switch if faulty. The solenoid switch can be checked in a similar manner.
	E. Incorrect purge safety or operating switch setting.	E. Recalibrate the purge operating switch or the purge safety switch settings (Table 4-1).
9. PURGE CYCLES OFTEN IN AUTO POSITION.	A. Purge valves are not tightly closed.	A. Check to be sure that the purge valves are set in accordance with the purge valve chart. Be sure that the valves that should be closed are closed tightly.
	B. Solenoid valve or check valve leaking.	B. Direct acting solenoid valve and check valve prevent leakage from atmosphere to condensing chamber. Close valves 4, 5 and 6 and remove the inlet pipe plug to the purge pump. Allow cigarette smoke to drift pass the pump inlet. If check valve and/or solenoid valve are leaking, smoke will be drawn into the line. If found leaking, replace valves. The replacement valves must be designed for refrigerant duty.
	C. Incorrect operating switch setting.	C. Recalibrate purge operating switch to the settings listed in Table 4-1.
	D. Excessive air leakage into machine.	D. Check the machine for leak tightness. (See Chap. 7 - Air Leaks.)
	E. Condenser chamber float valve stuck in closed position.	E. Check float chamber to be sure that a refrigerant level can be seen. If level is above the sight glass, valve is stuck in closed position. Remove the valve and determine cause of sticking.
10. EXCESSIVE REFRIGERANT LOSS.	A. Purge pump cycles often in AUTO position.	A. See Item 9 for causes.
	B. Float valve stuck in closed position or refrigerant return line plugged.	B. Check float valve chambers for refrigerant level. If level is above the sight glass, valve is stuck in closed position. Check refrigerant return line for obstructions. Correct as required.

For replacement items use Carrier specified parts.

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