THE TRANE COMPANY
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FILE:
TRANE REFRIGERATION PRODUCTS
RECIPROCATING COMPRESSOR-
CONDENSING UNITS
OPEN A-B
Maintenance

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OPEN RECIPROCATING COMPRESSORS

MODELS A AND B
4-6-8 CYLINDERS
UNIT MAINTENANCE

GENERAL DESCRIPTION

Trane refrigeration units Model BT and CT are equipped with Trane type A and B reciprocating compressors. These compressors are direct drive, constant speed units incorporating unloaded starting, crankcase oil foam breaker, totally enclosed, fully automatic capacity control and large suction separating chamber. The compressor is driven by a normal torque motor.

The Model CT unit consists of a compressor, motor, coupling guard, base, water-cooled condenser, condenser supports, suction and discharge service valves, high and low pressure cut-out switch and an oil pressure failure protection control.

The Model BT unit consists of a compressor, motor, coupling, coupling guard, base, suction and discharge service valves, high and low pressure cut-out switch and an oil pressure failure protection control.

BT and CT units are recorded and identified by the data on the serial nameplate located on the refrigerating unit base. Each compressor is further identified by its own nameplate located on the compressor suction chamber.

TABLE 1 - COMPRESSOR GENERAL INFORMATION

COMPRESSOR MODEL	SPEED (RPM)	BORE (IN.)	STROKE (IN.)	NO. OF CYLINDERS	CRANKCASE OIL CHARGE (QUARTS)
A-514 2A-514	1750	3-1/4	2-3/4	4	10 10
A-516 2A-516 A-516R 2A-516R	1750	3-1/4	2-3/4	6	10 10 10 10
A-518 2A-518 A-518R 2A-518R	1750	3-1/4	2-3/4	8	10 10 10 10
B-514 2B-514	1750	2-1/2	2	4	5 5
B-516 2B-516	1750	2-1/2	2	6	5 5
B-518 2B-518	1750	2-1/2	2	8	5 5

TABLE 4 - CONNECTION LINE SIZES

UNIT SIZE	SUCTION LINE O.D.	DISCHARGE LINE O.D.	LIQUID LINE O.D.*
10BT-CT	2-1/8"	1-1/8"	7/8"
15BT-CT	2-1/8"	2-1/8"	7/8"
20BT-CT	2-5/8"	2-1/8"	1-1/8"
215BT-CT	2-1/8"	2-1/8"	7/8"
225BT-CT	2-1/8"	2-1/8"	7/8"
230BT-CT	2-5/8"	2-1/8"	1-1/8"
25BT-CT	3-1/8"	2-1/8"	1-1/8"
40BT-CT	4-1/8"	2-5/8"	1-3/8"
50BT-CT	4-1/8"	3-1/8"	1-5/8"
60BT-CT	3-1/8" & 4-1/8"	2-5/8" & 2-5/8"	1-5/8"
75BT-CT	4-1/8" & 4-1/8"	2-5/8" & 2-5/8"	1-5/8"
100BT-CT	4-1/8" & 4-1/8"	3-1/8" & 3-1/8"	2-1/8"
240BT-CT	3-1/8"	2-5/8"	1-3/8"
260BT-CT	3-1/8"	2-5/8"	1-5/8"
275BT-CT	4-1/8"	3-1/8"	2-1/8"
2100BT-CT	3-1/8" & 4-1/8"	2-5/8" & 2-5/8"	1-5/8"
2125BT-CT	4-1/8" & 4-1/8"	2-5/8" & 2-5/8"	2-1/8"
2150BT-CT	4-1/8" & 4-1/8"	3-1/8" & 3-1/8"	2-1/8"

*CT UNITS ONLY

TABLE 5- REFRIGERANT AND CONDENSER

UNIT SIZE	TYPE REGRIGERANT	OPERATING CAPACITY	CONDENSER* PUMPDOWN CAPACITY	RELIEF SETTING
10BT-CT	12	10	80	200
15BT-CT	12	10	80	200
20BT-CT	12	11	120	200
215BT-CT	22	11	70	300
225BT-CT	22	14	109	300
230BT-CT	22	25	215	300
25BT-CT	12	13	119	200
40BT-CT	12	20	218	200
50BT-CT	12	22	320	200
60BT-CT	12	41	299	200
75BT-CT	12	49	367	200
100BT-CT	12	73	431	200
240BT-CT	22	23	199	300
260BT-CT	22	37	322	300
275BT-CT	22	42	385	300
2100BT-CT	22	73	391	300
2125BT-CT	22	95	513	300
2150BT-CT	22	95	471	300

*CT UNITS ONLY

(c) Install hub washer and mounting screw in shaft end and tighten screw.

(d) Place key in position on motor shaft and install motor hub on motor shaft. DO NOT TIGHTEN SET SCREWS IN MOTOR HUB.

(e) Adjust the motor hub so that the distance between the innermost faces of the compressor hub flange and the motor hub flange is 3-13/16". Tighten motor flange set screws.

(f) Insert short screws in hub flanges. Place bevel washers, laminated shims and nuts on short screws. Tighten all nuts on the short screws.

(g) Insert long through-bolt from motor end through flange of motor hub and feed bevel washers, spacers and center section on to the through-bolt as it is pushed forward and through the flange of the compressor hub. Place nut on through-bolt but do not tighten. Insert remaining through-bolts in a similar manner. When all through-bolts have been inserted, tighten nuts on the through-bolts.

(h) Coupling bolts and set screws must be maintained tight at all times. Loose bolts and set screws cause noisy operation and may result in damage to the coupling, motor shaft or compressor shaft. After four or five hours of operation check coupling bolts and set screws to be sure that they are tight.

(i) Install coupling guard.

If either the motor or the compressor is removed from the base, it will be necessary to carefully realign the shafts before installing the drive coupling. If the base is twisted during shipment or distorted during installation, it will also be necessary to realign the shafts before the coupling is operated. Misalignment of the shafts and coupling assembly will cause noisy operation of the coupling and promote rapid wear of the parts for the coupling and possibly cause breakage and severe damage to the coupling parts. A rough check for coupling misalignment may be made by observing the laminations in the coupling while the coupling is rotating at full motor speed. If the laminations appear fuzzy or fanned out, the coupling is misaligned. If the coupling is properly aligned, the laminations will appear to be a solid piece with the same thickness all the way around.

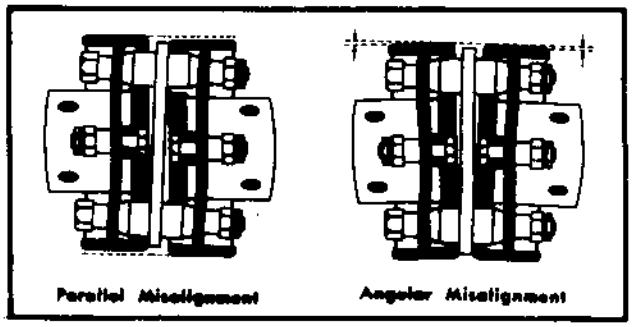

FIGURE 2
Illustration of Coupling Misalignment

Couplings should be aligned with a dial indicator. Install coupling following steps (c) through (g) under "TO INSTALL COUPLING", Page 4.

ALIGNING COMPRESSORS AND MOTOR

Roughly align motor to compressor by shimming or shifting motor and compressor until the flanges are in approximate alignment (single compressor units). Draw the compressor and motor mounting bolts up tight. Attach a dial indicator to the motor hub and check the motor and compressor hub for parallel alignment as shown in Figure 3. Rotate the motor hub and dial indicator at four equally spaced distances around the outside circumference of the compressor hub. Shift or shim (see Figure 5 and "To Shift or Shim Motor" Page 6) the motor until both hubs are within .005" alignment of each other.

Angular alignment may be checked as shown in Figure 4. Rotate the motor hub and dial indicator taking readings at four equally spaced distances around the inside of the compressor hub. Shift or shim the motor as necessary until angular alignment of both hubs are within .005" of each other. Recheck parallel and angular alignment in that order.

The high pressure side of the control is factory set to cutout and stop operation of the compressor at the designated psig discharge pressure. The differential is fixed and not adjustable. This means that the unit will automatically cut in and start at a designated point below the cut-out setting point.

The low pressure side of the switch has an adjustable cut-out setting point and an adjustable differential so that it can be set to meet specific installation requirements. This switch is factory set to cut out at a designated psig suction pressure and to cut in at a higher designated psig suction pressure.

The operation and cut-in and cut-out points of both the high and the low side of the switch should be checked in the field when placing the unit in operation. It may be necessary to reset or calibrate this switch when placing the unit in operation.

To Remove Dual Pressure Control:

(a) Pump down the refrigeration system.
(b) De-energize electrical control circuit to the dual pressure control. Remove the wires from the switch terminals. Tag the wires so that the control may be rewired correctly. Disconnect the conduit and wires from the switch.
(c) Make certain that the suction and discharge pressures are above zero pounds pressure (1 to 2 psig). The bellows is connected to the compressor with a full size 1/4" copper tube with flare nuts at both ends of the tube (Figure 6). With these switches the connection is broken at the bellows on the switch. If connections are broken with a slight positive pressure within the compressor and the openings to the compressor quickly plugged or capped while bleeding refrigerant, no air or dirt will enter the compressor. If this practice is followed when removing and reinstalling the controls it will eliminate the need for compressor evacuation.
(d) The control is attached to the control bracket by mounting screws inserted from the back of the control bracket. Remove these mounting screws and the dual pressure control.

To Install Dual Pressure Control:

(a) Position the dual pressure control against the control mounting bracket with the spacer in place between the control and the mounting bracket. Insert and tighten the two control mounting screws.
(b) Before connecting control bellows to the compressor, make sure that a positive pressure of approximately 1 to 2 psig exists within the compressor. Reconnect bellows to the compressor quickly while refrigerant is escaping from the compressor so that air or dirt will not enter the compressor.
(c) Connect conduit and control wiring to the switch terminals.

To Adjust Dual Pressure Control:

Both the high and low pressure sections of each switch can be adjusted. The settings should be checked after adjustments are made and the dial recalibrated if necessary. Figures 6 and 7 show the adjusting and calibrating screws.

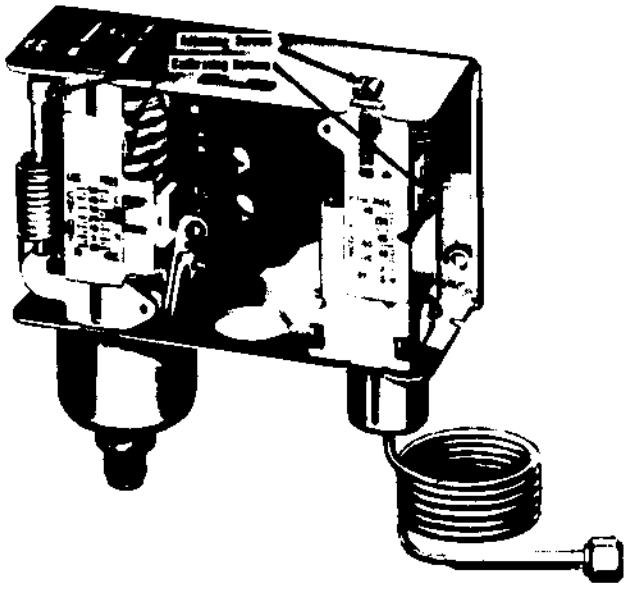

FIGURE 6
Dual Pressure Control Penn 271AP12AN

point, the differential pressure switch closes and energized the heater-resistor circuit which in turn affects the bimetal element which maintains the contacts in a closed position. The instant these contacts open, the compressor magnetic starter holding coil circuit is de-energized and the compressor stops. The contacts can be closed again only after the resistor-heater circuit cools off and the reset button is pushed. Should the oil pressure drop below the cut-out setting (factory setting 12 psig) the pressure differential contacts close. If the oil pressure should again build up to a pressure differential above the cut-in setting (factory setting 20 psig) before the "timer switch" has heated sufficiently to cut out, the control circuit to the heater will be broken through the pressure differential switch contacts and the heater circuit will be de-energized.

On systems utilizing two compressors, the Penn 274AP20 differential pressure switch is a single circuit, single pole with 1/4" S.A.E. flare connections

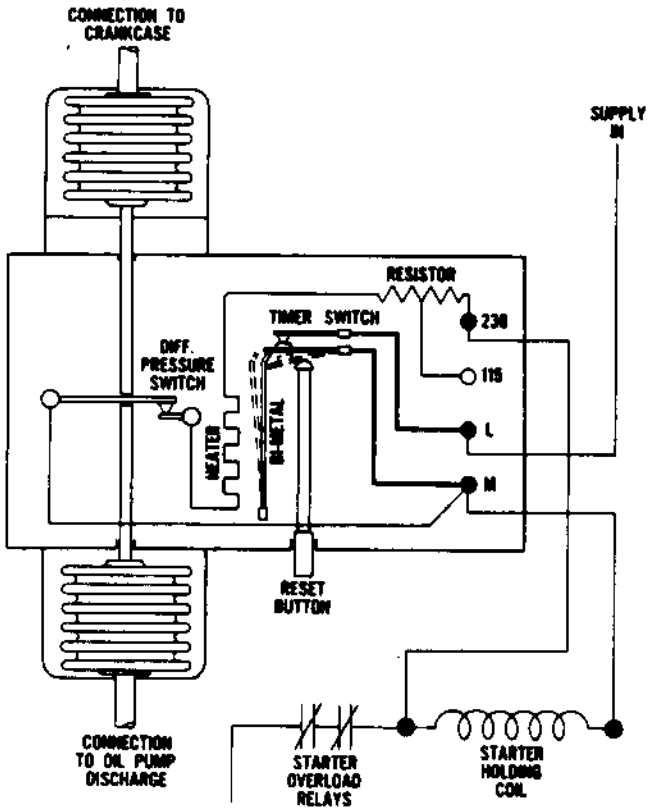

FIGURE 9
Oil Pressure Failure Protection Control Wiring Diagram

to the left hand compressor. During normal operation, when the delivered oil pressure of the left hand compressor is above the cut-out setting, the differential switch (Figure 10) remains open. When the delivered oil pressure drops below this point, the differential pressure switch closes and energizes the heater-resistor circuit in the Penn 275AP10, and de-energizes the motor magnetic starter holding coil circuit and stops the motor.

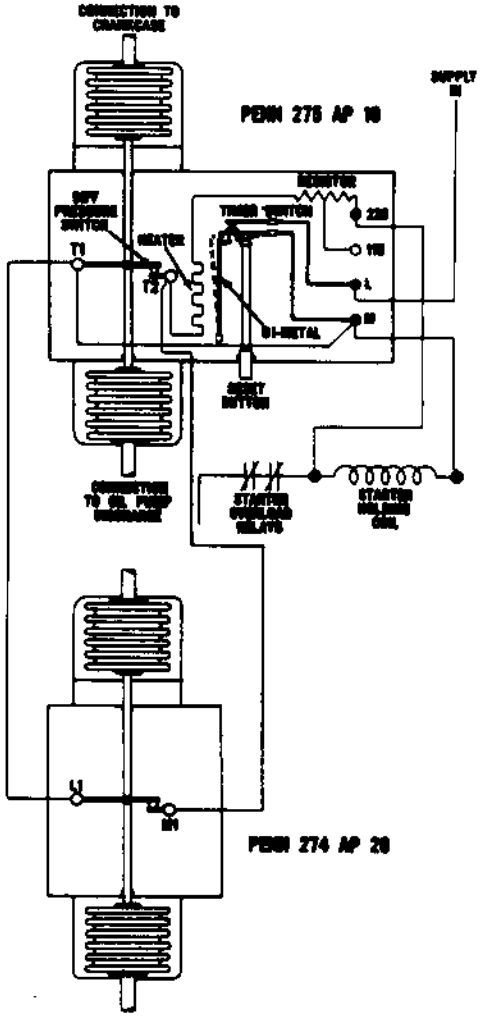

FIGURE 10
Oil Failure Protection Control Wiring Diagram
(Penn 275AP10 and Penn 274AP20)

Checking And 'Time Out' Period

All controls must be checked at the time the refrigeration equipment is initially placed in operation. All safety devices should be checked periodically. The oil failure switch is checked for two reasons: (1) To determine that the switch is wired in properly and (2) to determine the length of the 'time out' period.

liquid refrigerant will tend to collect in the compressor crankcase. Excess liquid in the crankcase causes oil foaming which results in the loss of oil and oil pressure.

Failure Diagnosis And Correction

To properly diagnose what causes the oil failure control to 'time out' and stop the operation of the compressor, it is first necessary to observe the oil pressure delivered by the compressor oil pumps. This can be read on service gauges properly attached to the compressor or compressors. The normal oil pressure delivered by the Trane Compressor is approximately 35 to 55 pounds above suction pressure. It must be determined whether there is a true compressor oil failure or whether the 'time out' occurred because of some electrical circuit difficulty. If the oil pump pressure as read on the gauges is steady and above the cut-out point, yet the control "times out" the trouble is electrical. Figure 11 shows the switches properly wired into a complete control circuit. Electrical difficulties are as follows:

1. Improper wiring hookup through controls.
2. Improper wiring in some other part of the electrical circuit.
3. Time-out period too short.
4. Defect within the oil failure controls.

Of the listed troubles, item four is infrequent and the difficulty is usually a result of one or more of the first three items.

Items one and two will show up quickly at the time the refrigeration system is initially placed in operation. If the electrical circuit is laid out and connected as shown in Figure 11, the control should function properly.

Item three usually occurs on systems which are not in constant operation and are shut down for extended periods. The difficulty in this instance is usually due to the fact that the oil failure control does not have a long enough 'time out' period for the specific application. The 'time out' period should be approximately 100 to 140 seconds. If the 'time out' period exceeds 140 seconds or is less than 100 seconds, replace the switch with a new one which has a proper 'time out' period. In some cases it may be possible to adjust the timing period. Instructions for this procedure should be obtained through the local Trane sales office.

Each time the compressor control circuit is energized, the resistor-heater circuit of the oil failure switch is also energized. This circuit will remain energized until oil pressure is built up to a sufficient point to open the differential pressure switch. A control of this type does not cool down instantly and holds residual heat in the resistor-heater circuit. Therefore, rapid short-cycling (due to high head pressure or low suction pressure) will affect the oil failure control and cause it to 'time out' although there has been no oil failure. The cure for this is, of course, to correct the cause of the short cycling.

To Remove Oil Pressure Failure Protection Control Switch

(a) Pump down the refrigeration system (see section "OPERATION").
(b) De-energize the control circuit to the oil pressure control. Remove wires from the switch terminals, tag wire to terminals to assist in rewiring the control. Withdraw wires and conduit from control closure.
(c) Disconnect the control line fittings at the bellows flare connection if the switch has flare connections or at the compressor if the control line is of the capillary tube type. Before the control line connections to the compressor are broken, there should be a slight positive pressure of approximately 1 to 2 psig within the compressor. If the connections to the compressor are

tions quickly to the compressor allowing refrigerant to bleed off while the connections are open so that dirt and moisture do not enter the compressor while the unit is open. If this procedure is followed, the compressor does not have to be re-evacuated after the installation of the control. The control line, if of the capillary type, should be properly coiled behind the control bracket so that the capillary tubing does not vibrate or wear through. Care should be exercised to see that the capillary tubing is properly taped and supported so it does not rub against other tubing or come in contact with the compressor coupling.

(c) Reconnect the control wires and conduit to the switch.

CONTROL BRACKET

The control bracket serves as a mounting support for both the dual pressure and at the same time supports the coupling guard.

To Remove Control Bracket:

(a) Remove coupling guard (see Page 4).
(b) Remove dual pressure control (see Page 7).
(c) Remove oil pressure control (see Page 11).
(d) Remove screws which hold control bracket to base and remove bracket.

To Install Control Bracket:

(a) Place control bracket in position and fasten to base.
(b) Install coupling guard (see Pages 4-5).
(c) Install dual pressure control (see Page 7).

COMPRESSORS

Trane BT and CT units are equipped with Type A and B compressors. Each compressor may be identified by the nameplate mounted on the compressor suction chamber.

If a replacement compressor is being used, carefully uncrate and inspect it for damage in shipment. The shipping crate for the replacement compressor may be used to return the old compressor. When received, the replacement compressor will contain a gas holding charge and a full charge of crankcase oil. The gas holding charge should not be saved and may be discharged to the atmosphere.

To Remove Compressor:

(a) Pump out refrigerant from the compressor. If compressor is damaged so that it cannot be operated or will not pump down, it will be necessary to close the suction and discharge valves and pump out the compressor with an auxiliary unit, or discharge remaining refrigerant in the compressor through the gauge port on the suction or discharge service valves. Before removing compressor, both suction and discharge service valves must be closed tight against the front seat. DO NOT OPEN COMPRESSOR WITH A VACUUM IN IT. IF THE COMPRESSOR IS OPENED WHEN UNDER A VACUUM, AIR AND MOISTURE WILL BE DRAWN INTO THE COMPRESSOR AND WILL RESULT IN ADDITIONAL SERVICE TROUBLES.
(b) On dual compressor units, close the shut-off valve on the oil equalizing line so that oil will not be lost in the other compressor. Disconnect the flange union on the oil equalizing line nearest the compressor being removed.
(c) Drain crankcase oil.
(d) Remove coupling guard (see Page 4).
(e) Remove control bracket (see Page 13).
(f) Remove coupling (see Page 4).
(g) Disconnect and remove control line leads from the suction service valve to the dual pressure control. Note that this line connects to the line side of the suction service valve and therefore is subjected to whatever pressure exists in the suction line. The fitting on the suction valve should be quickly capped with 1/4" flare cap to prevent the loss of refrigerant. Remove all straps and screws used to anchor the control line to the base of the unit to prevent

(four and eight pass water circuiting) water supply line is connected to Opening A. Opening C is plugged.

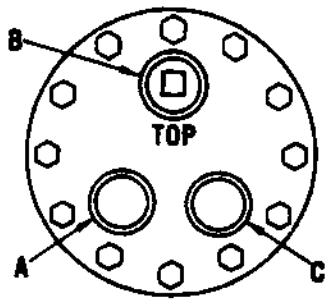

FIGURE 12
View of Condenser Supply Heater

For parallel flow arrangement (two or four pass water circuiting), water supply line is connected to openings A and B and water return line is connected to opening C.

While all condensers as shipped from the factory are set up with water connections on the compressor end of the condenser, the heads can be interchanged on the job site and set up for right hand water connections if desired. If heads are changed from one end to the other it is necessary to transfer the gaskets along with the heads. Be sure that the gaskets are correctly positioned between the head and the condenser tube sheet.

The condenser is equipped with a large refrigerant sump thereby maintaining maximum efficiency due to relatively few tubes in the bottom of the condenser being covered with liquid refrigerant during actual operation.

Sources of condenser water available contain varying quantities of minerals that will precipitate out upon the condenser tubing walls as a carbonate scale. The rate of accumulation will be speeded at high condensing temperatures and with water having a high mineral content. Cooling towers when used, may also collect dust and foreign materials at the bottom of the condenser tubes as a sludge, especially under conditions where the water velocity through the tubes is quite low.

To insure maximum efficiency, the condenser must be kept free of both scale and sludge. Even a very thin coating on the tube surface will greatly decrease the heat transfer capacity of the condenser. This is indicated by a decreased water flow, low temperature difference between the inlet and outlet water and abnormally high condensing pressure.

Two methods are in general acceptable for cleaning condenser tubes. These are: mechanical and chemical.

The mechanical method is generally used for removing mud and other loose material settled in the condenser tubes. Access to the condenser tubes is obtained by removing the condenser headers. These can be taken off by disconnecting the water piping and removing the nuts on the studs and easing the headers off the ends of the condenser.

A round brush attached to a rod can be used to work in and out of the tubes to loosen the mud. After tubes have been cleaned with brush, flush by running water through them.

Chemical means have proved to be the most effective and practical method of removing scale deposits. In this treatment, an inhibited acid solution is circulated through the condenser tubes and headers. The water circuit is composed solely of copper, steel and cast iron. Any of the larger chemical supply companies will be able to recommend an inhibited acid suitable for cleaning condensers. Reliable companies in the area of the installation have the advantage of knowing the particular chemistry of the water in the area.

Provisions for cleaning connections can best be made at the time of installation by putting a pipe connection with plug in both inlet and outlet piping of the condenser between the headers and the shut-off valve used to isolate the condenser from the remainder of the condenser water circuit. Figure 13 shows a typical chemical cleaning set-up. All materials used in the external circulating system, quantity

(d) Remove motor mounting screws from the feet of the motor and shift the motor off the base.

If the motor is to be returned to the factory, its return should be made in the same shipping crate that the replacement motor was received in. By exercising proper precautions during uncrating of the replacement motor, the shipping crate can usually be reused without repair of the crate. Make certain that the motor being returned is properly prepared and crated to prevent damage.

To Install Motor:

If a new motor is being used, check the electrical characteristics of the motor to be sure they are the same as the power supply to which the motor is to be connected.

(a) Place the motor on the base and replace the motor mounting screws.
(b) Do not tighten the motor mounting screws. Install coupling (see Page 4-5).
(c) Install control bracket (see Page 13).
(d) Secure the conduit to the motor terminal box and connect motor leads. Make certain that connections are correct, tight and properly insulated.
NOTE: Motor may rotate in either direction since the compressor oil pump is a self-reversing pump.
(e) Be sure the motor is properly lubricated before placing in operation.
(f) After placing the motor in operation, it should be checked with an ammeter to be sure operation is in accordance with rated amperage as indicated on the motor nameplate.

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