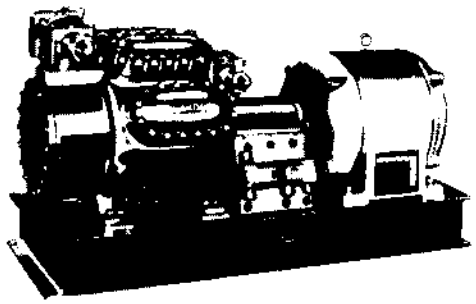
THE TRANE COMPANY
LA CROSSE, WISCONSIN
PRINTED IN U.S.A.

FILE:
TRANE REFRIGERATION PRODUCTS
RECIPROCATING COMPRESSOR — CONDENSER UNITS
Open E-F
Operation — Maintenance

LITERATURE FILE NO.
OCOM-M-1
OPER.-MAIN.

JULY, 1970
SUPERSEDES 2C2A
DATED DEC., 1964



OPEN MODEL E AND F RECIPROCATING COMPRESSORS

NORMAL OPERATING CONDITIONS

The pressures and conditions observed at the compressor or condensing unit reflect the general operating condition of the entire system. A range of suction and discharge pressures that may be expected for Refrigerant-12 and 22 systems, air and water condensing, are given in Table 1.

TABLE 1 — Normal Refrigerant Pressures

NORMAL PRESSURES	REFRIGERANT-22		REFRIGERANT-12	
	WATER COOLED CONDENSING	AIR COOLED CONDENSING	WATER COOLED CONDENSING	AIR COOLED CONDENSING
SUCTION PRESSURE	55-65	55-65*	30-50	30-50*
DISCHARGE PRESSURE	170-260	260-350**	100-160	160-210**

* For 35 to 50 F suction temperature.
** For 100 to 140 F condensing temperature.

The compressor oil level and pressure range are as follows:

Oil level — ½ of oil level sight glass covered when compressor is running.

7/8 of oil level sight glass covered when compressor is not running.

Oil pressure — 60 to 70 psig, usable oil pressure.

NOTE: Usable oil pressure is the difference between the oil pressure and the suction pressure gauge readings.

PERIODIC MAINTENANCE

If the unit does not operate properly during these inspections, consult the "Trouble Analysis" section of the Trane Reciprocating Refrigeration Manual.

ONCE A WEEK:

1. Check the oil level in the compressor. Before adding oil, allow the compressor to operate continuously for three or four hours, checking the oil level every half hour. If the oil level does not return to the proper level, add oil.
2. Check the oil pressure.
3. The flow of refrigerant through the liquid line sight glass should be without bubbles. The appearance of bubbles indicates a shortage of refrigerant, probably caused by a leak. Repair the leak and add refrigerant.
4. Stop the compressor and inspect the shaft seal for evidence of excessive oil leakage. If excessive oil is found, test the seal for refrigerant leakage.
5. Inspect the entire system for any unusual conditions (noisy fan or bearings, rattles, frosting on liquid line drier, air filters, etc.).

ONCE A MONTH:

1. Perform the recommended weekly inspections.
2. Inspect all air handling equipment. Lubricate where necessary.
3. Check the system discharge pressure. If the pressure is above or below normal, see the "Trouble Analysis" section of the Trane Reciprocating Refrigeration Manual.
4. Clean the fins of the air-cooled condenser and/or direct expansion coil, if used. Refer to Section 10B1A of the Trane Refrigeration Service Manual for air-cooled condenser maintenance information.

ONCE A YEAR:

1. Perform the recommended weekly and monthly inspections.

2. Inspect all air handling equipment for worn or frayed belts. Replace belts where necessary.

3. Inspect the contacts of the motor starters and controls.

4. If a water condenser is used, completely drain the condensing water system. Inspect all valves, piping, etc. Clean the strainers. Clean the condenser tubes, if necessary.

5. If a cooling tower is used, flush the tanks and pumps. Remove rust and corrosion and paint all surfaces.

SEASONAL SHUTDOWN

To avoid unnecessary strains on the equipment during long periods of shutdown, the system should be pumped down and the refrigerant held in the condenser or receiver (if used) during the off season.

1. Pump down the system (see "System Pumpdown," page 9).

2. Allow the system to stand idle for a few minutes. Pressure may build up on the low side, caused by refrigerant evaporating out of the oil in the compressor crankcase.

3. Repeat the pumpdown procedure until the low side pressure holds a 2 psig when the compressor is shut down.

4. Open the system master switch. Make sure that the switch will not be closed while the system is in the shutdown condition.

5. Take the following shutdown precautions with systems equipped with water-cooled condensers:

   a. Test the condenser for refrigerant leaks.

   b. If the system will be subject to freezing temperatures during the shutdown period, drain the condenser and piping. Refill the condenser and piping with a permanent type antifreeze solution to prevent the formation of rust on the inner surfaces of the water circuit.

   c. If a cooling tower is used, drain the system and close the makeup water supply valve. Flush the sump and packing slats with a hose. If corrosion or rust is found, clean and paint.

6. If an air-cooled condenser is used, valve-off the condenser and receiver from the rest of the system and test them for leaks.

7. If a shell and tube evaporator is used and it will be subject to freezing temperatures, service it as recommended for the water-cooled condenser.

SEASONAL START-UP

1. Inspect all air handling equipment.

2. If a water-cooled condenser is used, turn the condenser supply water on. If a cooling tower is employed, make sure that the sump is full and the circulating pump is in operating condition. Make sure that the cooling system has the proper level of water.

3. If an air-cooled condenser is used, service it in accordance with the instructions provided in Section 10B1A of the Trane Refrigeration Service Manual.

4. Back-seat the compressor suction and discharge service valves and then crack them off the back-seat to open the suction and discharge pressure gauge lines to system pressures (see Figure 1 and 2).

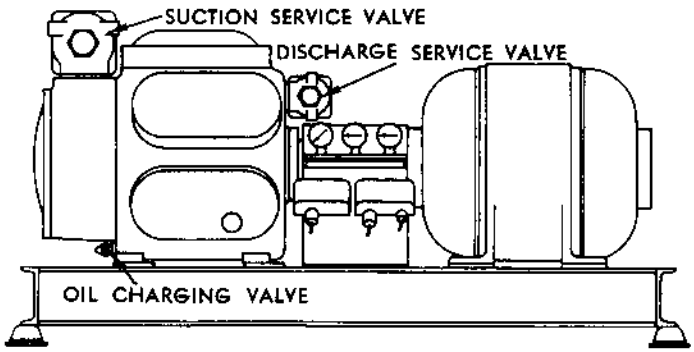


FIGURE 1 – Compressor Unit

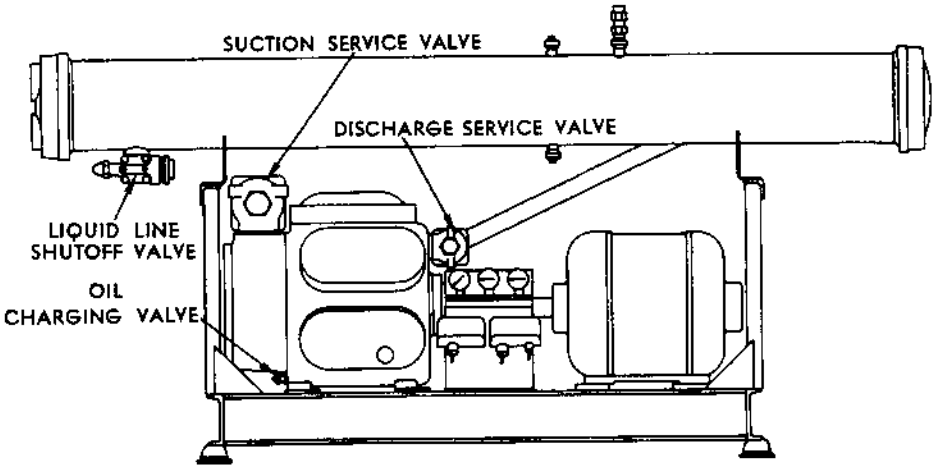


FIGURE 2 – Condensing Unit

5. Open the shutoff valves in the refrigerant circuit.

6. Test the entire refrigerant system for leaks.

7. Jog the compressor motor once or twice to make sure that all of the electrically interlocked equipment is in operation.

8. After the compressor has run for fifteen or twenty minutes, check the oil level and pressure.

9. If bubbles appear in the liquid line sight glass, retest the system for leaks. Make repairs and add refrigerant.

10. If the discharge pressure is above or below normal, see the discharge "Trouble Analysis" section of the Trane Reciprocating Refrigeration Manual.

CONTROL SETTING AND ADJUSTMENT

The controls were set at the time of installation to properly control the unit under the design conditions. Do not attempt to adjust the controls unless the unit operation is not satisfactory.

If any control fails to function properly after the control setting procedure has been followed, repair or replace the control (see "Repairs and Parts Replacement," Page 6).

CAPACITY CONTROL

The point at which the compressor is to operate fully loaded or unloaded will vary with different systems. Most systems are designed so that the compressor will start unloading as the suction pressure falls below design full load conditions.

For duplex units, perform the control setting operations for each compressor separately.

CONTROL SETTING

1. Connect a clamp-on voltammeter to one of the compressor motor leads and remove the cap from the capacity control adjustment screw, located on the control handhole cover (see Figure 3).

2. With the compressor operating at design full load suction pressure, turn the capacity control adjustment screw in a clockwise direction, as far as it will go. This should fully unload the compressor.

3. Watching the ammeter, slowly turn the adjustment screw in a counterclockwise direction. As the screw is turned, the compressor will load in stages. Each stage of loading will increase the ammeter reading in definite steps. When the compressor has reached its final stage of loading, the ammeter reading will closely approximate the compressor motor full load amperage rating.

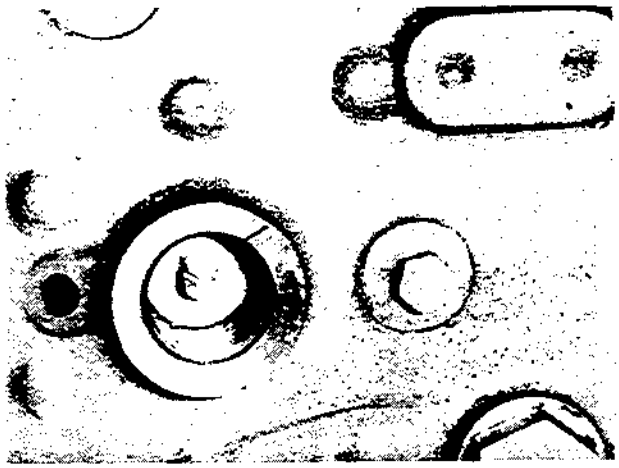


FIGURE 3 – Capacity Control Adjusting Screw

The compressor is now set to run fully loaded at design full load suction pressure and to control over a 9 to 10 pound suction pressure range.

REFRIGERANT PRESSURE CONTROL

The Refrigerant Pressure Control (RPC) contains a single set of pressure operated contacts.

A high pressure bellows, sensing compressor discharge pressure, opens the control contacts, stopping the compressor, when the pressure rises above the normal operating range. The differential of the high pressure sensing device is

fixed at 50 pounds and it is not field adjustable. Once the control cuts out on high pressure, a reset button, located on the face of the control, must be depressed before operation can be resumed.

A low pressure bellows, sensing compressor suction pressure, opens the control contacts, stopping the compressor, when the pressure drops below design limits. Once the control cuts out on low pressure, the control contacts are automatically reset after normal suction pressure has been reestablished.

High Pressure Cutout

Control Checkout:

1. With the system in operation, throttle the flow of water to the condenser, raising the compressor discharge pressure. If an air-cooled condenser is used, stop the fan motor or block the coil.

2. Watching the discharge pressure gauge, permit the pressure to rise until the setting of the High Pressure Cutout Switch (HPC) is reached. See Table 2. At this point the contacts of the switch should open, stopping the compressor.

   NOTE: If the compressor has not been stopped by the time the pressure reaches 10 psi above the cut-out setting, stop the compressor immediately.

TABLE 2 — Pressure Control Settings.

CONTROL SETTINGS	REFRIGERANT-22		REFRIGERANT-12	
	WATER COOLED CONDENSING	AIR COOLED CONDENSING	WATER COOLED CONDENSING	AIR COOLED CONDENSING
HIGH PRESSURE CUTOUT				
CUT OUT	265 PSIG	365 PSIG	175 PSIG	220 PSIG
CUT IN	215 PSIG	315 PSIG	140 PSIG	185 PSIG
LOW PRESSURE CUTOUT				
CUT OUT	45 PSIG	45 PSIG	15 PSIG	15 PSIG
CUT IN	70 PSIG	70 PSIG	35 PSIG	35 PSIG

Differential Checkout:

1. Open the condenser water supply valve, lowering the discharge pressure. If an air-cooled condenser is used, start the fan or remove the restriction from the coil.

2. As the pressure falls, depress, and hold, the manual reset button located on the face of the control. The compressor should not start until the fall in pressure equals the differential of the switch (35 psig for R-12 and 50 psig for R-22).

   NOTE: The differential is fixed and is not field adjustable.

Control Setting:

If the switch failed to stop the compressor, or stopped the compressor below the cut-out setting, open the condenser water supply valve, lowering the pressure. If an air-cooled condenser is used, start the fan or remove the restriction from the coil.

1. Lower or raise the setting of the switch, as required, by turning the High Pressure Cutout adjustment screw (1—Figure 4) and continue with the test.

2 When the switch is cutting out at the correct gauge pressure, recalibrate the scale by loosening the calibration screw (2—Figure 4) and sliding the indicator (3—Figure 4) until it indicates the gauge pressure at which the switch is cutting out. Tighten the screws.

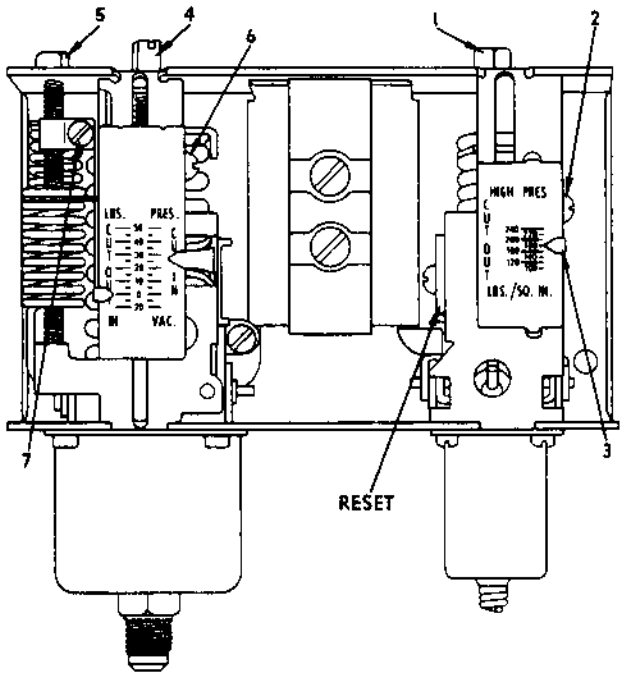


FIGURE 4 — Refrigerant Pressure Control

Low Pressure Cutout

Control Checkout:

1. With the system in operation, slowly close the liquid line shutoff valve, lowering the compressor suction pressure.

2. Watching the suction pressure gauge, permit the pressure to drop until the cutout setting of the Low Pressure Cutout Switch (LPC) is reached. At this point the contacts of the switch should open, causing the compressor to pumpdown and stop (see Table 2).

   CAUTION: If the compressor has not been stopped by the time the pressure reaches 10 psig below the cutout setting, stop the compressor immediately.

   Under no circumstances allow the suction pressure to be pumped into a vacuum.

3. Slowly open the liquid line shutoff valve, raising the suction pressure. When the pressure rises to the cut-in setting of the switch, the contacts should close, restarting the compressor (see Table 2).

Control Setting:

1. If the switch fails to function in the manner described above, raise or lower the cut-in and cut-out pressure settings, as required, by turning the adjusting screws (4 and 5—Figure 4) and continue with the test.

2. When the switch is operating correctly, loosen the calibration screw (6—Figure 4) and slide the scale until the gauge pressure at which the compressor cuts in is indicated on the right side of scale. Loosen calibration screw (7—Figure 4) and slide the indicator to the gauge pressure at which the compressor stops. Tighten the screws.

OIL FAILURE PROTECTION CONTROL

The Oil Failure Protection Control (OPC) (see Figure 5) contains a normally closed, heat actuated, time delay mechanism. When the control senses less than a minimum operating oil pressure, the time delay mechanism goes into a 100-140 second delay period. If normal operating pressure is not restored within this period, the control stops the compressor, preventing damage to the unit. This delay period provides time for the compressor oil pump to develop normal operation pressure at the time of starting and regain pressure, if temporarily interrupted, during the normal operation of the unit.

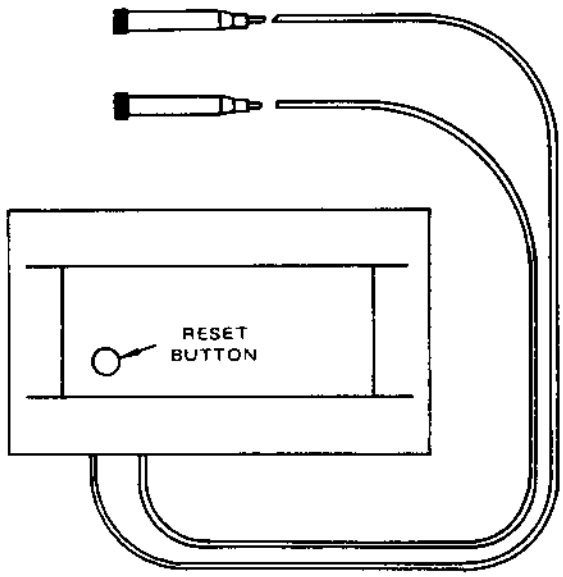


FIGURE 5 – Oil Failure Protection Control

The control is factory set to begin time delay period at 30 psig and to stop time delay period, resuming normal operation, at 35 psig usable oil pressure.

> NOTE: Usable oil pressure is difference between "Suction Pressure" and "Oil Pressure" gauge readings.

If a prolonged period of low oil pressure causes contacts of control to open, they are again closed by operating control reset button.

> NOTE: Allow a 5 to 10 minute cooling period before resetting control contacts.

Control Checkout:

1. Disconnect the motor leads from the compressor starter(s).

2. Close the fused disconnect switches required to energize the control system.

3. Lower the thermostat setting to energize the compressor starter(s). Within 100-140 seconds the time delay contacts (Figure 6) should open and de-energize the compressor starter(s).

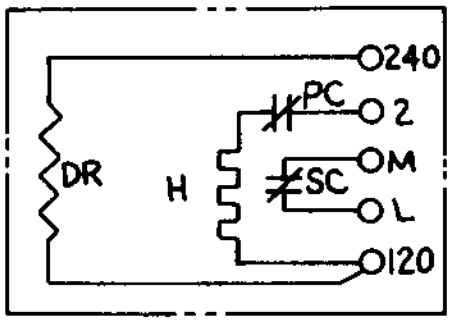


FIGURE 6 – Oil Pressure Control Wiring

DR – VOLTAGE DROPPING RESISTOR
H – TIME DELAY HEATER
SC – HEATER ACTUATED SAFETY CONTACTS
PC – CONTACTS ON PRESSURE OPERATED SWITCH
SC – CONTACTS RATED 750 VA-120/240 V.A.C.

Control Checkout - Duplex Units:

Duplex units have two oil failure protection controls which are identical to the control described previously. Disconnect the leads of one control, check the second control as outlined above and then repeat for the first control. In this manner, each control is checked individually.

VALVES

Thermostatic Expansion Valve

A Thermostatic Expansion Valve meters the amount of liquid refrigerant that enters the evaporator. If too little refrigerant enters, it is soon evaporated and too much of the evaporating surface becomes ineffective. If too much liquid enters, some will carry over into the suction line, possibly causing severe damage to the compressor. A proper superheat setting prevents liquid carry-over.

Superheat Checkout:

1. Remove a small patch of insulation from the suction line near the remote bulb of the Thermostatic Expansion Valve.

2. Firmly attach the bulb of an accurate thermometer to the bare line and cover the bulb with insulating material.

3. Start the unit and allow the thermometer reading to stabilize.

4. Using the saturation table for the type of refrigerant being used, R-12 or R-22, convert the suction pressure gauge reading to degrees F.

5. The degree difference between the thermometer reading and the pressure-to-temperature conversion of the suction pressure is the amount of superheat. The amount of superheat should be approximately 10 degrees.

Superheat Setting:

1. Remove the nut covering the superheat adjustment screw, located on the side of the expansion valve body.

2. Turn the adjusting screw in small increments until a stable 10 degree superheat is indicated. Wait until conditions stabilize before turning each increment.

Water Regulating Valve

A Water Regulating Valve (see Figure 7) is employed when city water is used for condensing purposes. Correctly adjusted, the valve maintains design condensing temperature and pressure by automatically throttling the volume of water entering the condenser.

Valve Setting:

1. Start the unit.

2. Slowly raise or lower the valve flow setting until the condenser pressure gauge reading falls within the design limits.

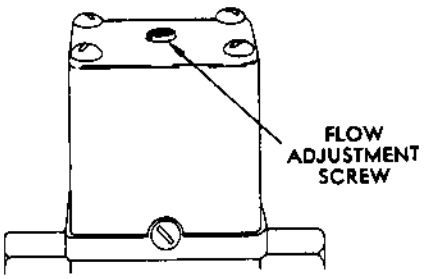


FIGURE 7 – Water Regulating Valve

SERVICING THE SYSTEM

CONDENSER

Mechanical Cleaning:

The mechanical cleaning method is used for removing mud and other loose material from the condenser tubes.

1. Turn off condenser supply water and remove the condenser headers.

2. Run a round brush through the tubes to loosen the mud.

3. Flush the tubes with water.

Chemical Cleaning:

Chemical cleaning is the most satisfactory means for the removal of scale deposits from the tubes.

The condenser water circuit is composed of copper, steel and cast iron. With this information, any water treatment firm will be able to recommend a suitable chemical for this purpose. If a water treatment service is not available, a chemical supply house may be consulted.

Figure 8 illustrates a typical chemical cleaning hookup. All materials used in the external circulating system, quantity of cleaning material, duration of cleaning period and any safety precautions necessary for the handling of the cleaning agent should be approved by the company furnishing the materials for the job.

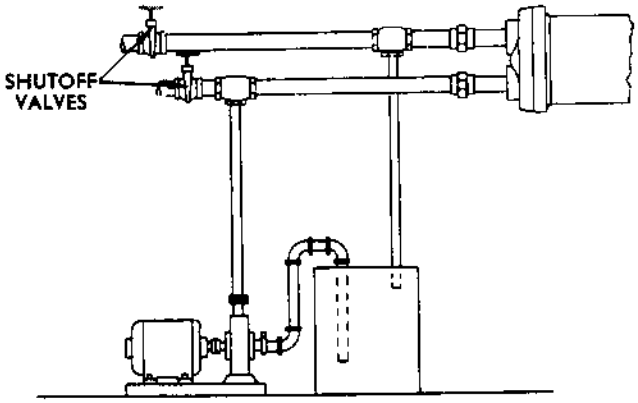


FIGURE 8 – Recommended Chemical Cleaning Hookup

Air-Cooled Condenser

Clean the fins of the air-cooled condenser occasionally by flushing them with cool water.

Additional service suggestions may be found in Section 10B1A of the Trane Refrigeration Service Manual.

COMPRESSOR OIL

Oil may be added to or removed from the compressor crankcase through the oil charging valve. See Figures 1 and 2.

Use only the following oils:

1. Ansul 300

2. Cities Service Oil Company – Trane 1001

3. Standard Oil of Indiana – LM Industrial Oil No. 32-P

4. Trane Code No. 1-45008900

Step-by-step instructions are contained in the Trane Reciprocating Refrigeration Manual.

REPAIRS AND PARTS REPLACEMENT

IMPORTANT: Replace the dryer-strainer core whenever the system is opened for repairs.

When soldering is done during system repairs, an inert gas, such as nitrogen, must be continually passed through the connection being soldered to prevent the formation of harmful oxides.

LOW SIDE REPAIRS

Pump the system down (see "System Pumpdown").

Vent the low side of the system through the liquid line charging valve. Close the charging valve.

Allow the refrigerant piping to warm up to room temperature. If the piping is colder than the surrounding air condensate will form on the inside of the open piping.

Plug the open end of all refrigerant piping immediately after opening.

Admit low pressure nitrogen (or other inert gas) through the liquid line charging valve. Shut off the gas supply before soldering the final connection.

After the repairs have been completed, pressure test and evacuate the low side of the system.

HIGH SIDE AND EXTENSIVE REPAIRS

If the high side of the system must be opened, or if extensive repairs are to be made, it is recommended that the charge be removed.

Evacuate and recharge after the repairs are completed.

CONTROLS

Be sure to de-energize the control circuit before removing any controls.

Pump the system down (see "System Pumpdown") before removing the Refrigerant Pressure Control or the Oil Failure Protection Control.

Cap the end of all open tubes and connections immediately after removing the control.

COMPRESSOR

Consult the Compressor Parts List and Compressor Service and Overhaul sections of the Trane Refrigeration Service Manual before attempting any repairs on the compressor.

Whenever the compressor is opened, the compressor oil should be changed.

After repairs have been completed, the compressor must be evacuated before the system is returned to operation.

> NOTE: If both the compressor and the low side have been opened, the compressor may be pressure tested and evacuated with the low side. Back-seat the compressor suction service valve, and proceed with the normal low side pressure testing and evacuation procedures.

Removal:

1. Front seat the service valves and remove them from the compressor housing. Support the refrigerant piping to prevent excessive strain on the lines.
2. Remove the coupling (see "Coupling").
3. Disconnect the control tubing from the compressor fittings.
4. Remove the compressor mounting bdts and shift the compressor off the base.

Replacement:

1. Shift the new compressor onto the base and install the four mounting bolts.
2. Install the suction and discharge service valves on the compressor housing.
3. Align the compressor and motor shafts and install the coupling (see "Coupling" and "Shaft Alignment").
4. Evacuate the compressor.

COUPLING

Before removing the coupling, open the motor fused disconnect switch to prevent the motor from being started.

Removal:

1. Loosen, but do not remove, all nuts and bolts within the coupling.
2. Remove the nuts (1—Figure 9) from the long through bolts (2—Figure 9) and draw the bolts through the openings in the flange of the motor hub. As the through bolts are being removed, use care to prevent the loss of the bevel washers and spacers (3 and 4—Figure 9). As the last through bolt together with its bevel washers and spacers is removed, the center flange (5—Figure 9) is freed and removed.
3. Remove the nuts (6—Figure 9) from the short bolts (7—Figure 9) in the flange of the motor hub and the flange of the compressor hub. Remove the bevel washers (8—Figure 9) and the laminations (9—Figure 9) from the bolts. Remove the short bolts from the flange of each hub.

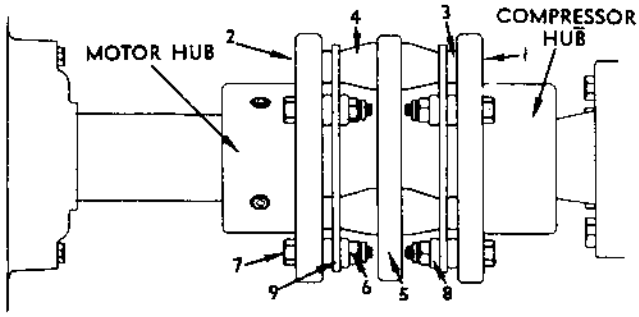


FIGURE 9 – Coupling Assembly

4. Remove the mounting bolt and washer from the end of the compressor shaft. Remove the compressor hub by tapping lightly with a rawhide mallet.

   DO NOT STRIKE THE HUB WITH A STEEL HAMMER. DISTORTION WILL PERMANENTLY DAMAGE IT.

   If the hub cannot be freed by tapping with a rawhide mallet, use a wheel puller. Be sure to place the mounting bolt washer between the jackscrew of the wheel puller and the end of the compressor shaft to prevent damage to the shaft threads.

5. Loosen the setscrews in the motor hub and slide the hub off the motor shaft. If the hub is tight, use a wheel puller to remove it.

Replacement:

If the motor or compressor has been removed, bring the motor and compressor shafts into rough alignment by shimming and shifting the motor. Tighten the motor mounting bolts.

1. Put the compressor shaft key in place and slide the compressor hub on to the shaft. Be sure that the hub and shaft are clean so that the hub will draw evenly on to the shaft.

2. Install the mounting bolt and washer in the end of the compressor shaft and tighten the bolt.

3. Put the motor shaft key in place and slide the motor hub on to the shaft. Do not tighten the setscrews.

4. Position the motor shaft midway between its limits of end play.

5. After the motor and compressor hubs have been installed, align the motor and compressor shafts (see "Shaft Alignment").

6. Insert the short bolts in the hub flanges and place the bevel washers, laminations and nuts on the bolts. Tighten all short bolts and nuts.

7. Insert the long through bolts from the motor end of the coupling and feed the bevel washers, spacers and center flange on to the bolts as they are pushed through into the compressor hub flange. Place the nuts on the through bolts and tighten them evenly.

   As the nuts are tightened, the coupling hubs will be spaced properly. Tighten the motor hub setscrews.

After four or five hours of operation, inspect the coupling bolts and setscrews to see that they are tight.

SHAFT ALIGNMENT

Misalignment of the shafts and coupling assembly will cause noisy operation of the coupling, rapid wear of the coupling parts and possible breakage or severe damage to the coupling (see Figure 10).

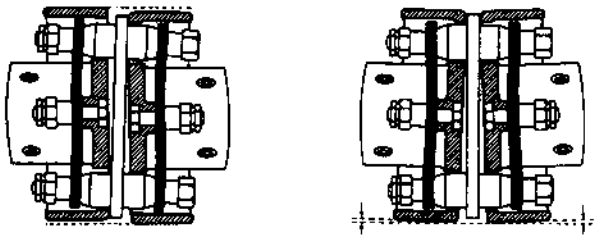


FIGURE 10 – Coupling Misalignment

Align the motor and compressor shafts with a dial indicator as outlined in the following directions:

1. Mount the dial indicator on the flange of the motor hub with the stem of the indicator riding on the flange of the compressor hub (see Figure 11).

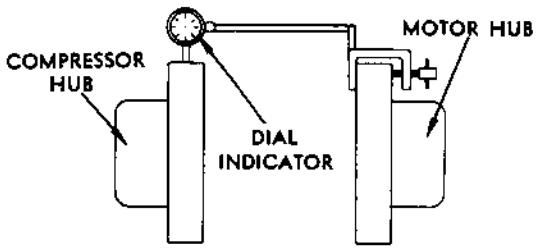


FIGURE 11 – Dial Indicator -- Parallel Alignment

2. Rotate the motor hub and dial indicator, taking readings on the dial indicator at four equally spaced locations around the circumference of the compressor hub flange. Shift and shim the motor as necessary until the hubs are within .005" parallel alignment (see "Motor Shimming").

   NOTE: When aligning the shafts on duplex units, keep the motor stationary and shift or shim the compressors. The procedure is essentially the same.

3. Mount the dial indicator on the flange of the motor hub with the stem of the indicator riding on the face of the compressor hub flange (see Figure 12).

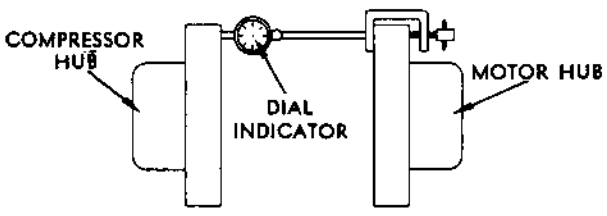


FIGURE 12 – Dial Indicator -- Angular Alignment

4. Again rotate the motor hub and take readings at four equally spaced locations. Shift and shim the motor until the angular alignment is within .005". Recheck the parallel and angular alignment in that order.

MOTOR SHIMMING

In raising the motor with shim stock, elevate one side of the motor at a time, keeping the other side firmly bolted to the base. This will prevent the motor from shifting out of alignment (see Figure 13).

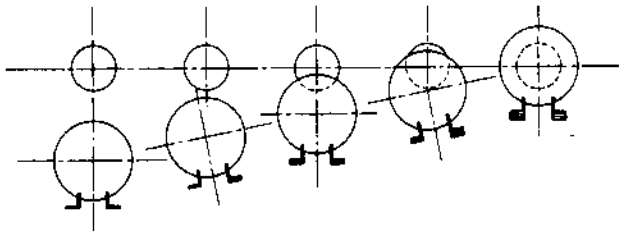


FIGURE 13 – Shimming Procedure

Dial readings at the top and bottom of the compressor hub flange will indicate the thickness of shim stock necessary to bring the motor into horizontal alignment.

With duplex units, keep the motor stationary and shim each compressor into proper horizontal alignment.

SYSTEM PUMPDOWN

The purpose of the system pumpdown is to pump the greater part of the refrigerant charge into the receiver or condenser, reducing the pressure in the low side of the system. This is done before the low side is opened for service or repairs and when the system is to be shut down for long periods of time.

Refer to the Trane Reciprocating Refrigeration Manual for complete instructions to pumpdown the system.

PRESSURE TESTING, EVACUATION AND CHARGING THE SYSTEM

After the system has been opened for major repairs, all joints and connections must be pressure tested with oil-pumped dry nitrogen and refrigerant and then evacuated to remove all air and moisture. Pressure tests must conform to codes and double evacuation to 2.5 mm Hg absolute is recommended.

With the system free of leaks and clean, the refrigerant may be charged and operating pressures checked.

Complete instructions are contained in the Trane Reciprocating Refrigeration Manual. Included also are steps for inspection before charging, calculating the charge and adding small amounts of refrigerant.