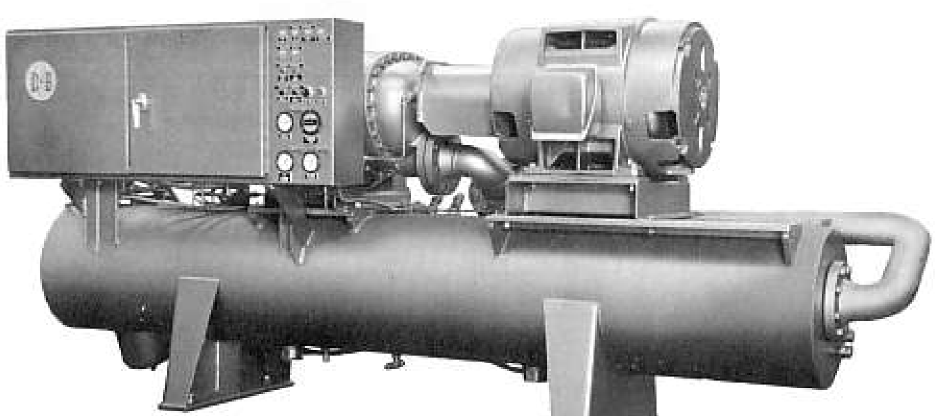
FORM NO. 6143
DECEMBER 1971

DUNHAM-BUSH

DBX

OPEN TYPE CONDENSING UNITS & COMPRESSOR UNITS



Installation, Operation, Maintenance, and Trouble Shooting Manual

DUNHAM-BUSH, INC. • WEST HARTFORD DIVISION
WEST HARTFORD, CONNECTICUT 06110, U.S.A. one of The Signal Companies

INDEX

CONTENTS

PAGE

I INSTALLATION

A. GENERAL

WARRANTY: We agree that the apparatus manufactured by the Seller will be free from defects in material and workmanship for a period of one year under normal use and service and when properly installed; and our obligation under this agreement is limited solely to repair or replacement at our option, at our factories, of any part or parts thereof, which shall, within one year from date of original installation or 18 months from date of shipment from factory to the original purchaser, whichever date may first occur, be returned to us with transportation charges prepaid, which our examination shall disclose to our satisfaction to have been defective. This agreement to repair or replace defective parts is expressly in lieu of and is hereby in disclaimer of all other express warranties, and is in lieu of and in disclaimer of any implied warranties of merchantability and fitness for a particular purpose, as well as all other implied warranties, in law or equity, and of all other obligations or liabilities on our part. There are no warranties which extend beyond the description hereof. We neither assume nor authorize any person to assume for us any liability or obligation in connection with the sale of our apparatus, except said repair or replacement of the defective parts as set forth above. Our liability does not include any labor charges for replacement of parts, adjustments, repairs, or any other work done outside our factories and our liability does not include any resulting damage to persons, property, equipment, goods, merchandise, profits, good will or reputation arising out of any defect in or failure of our apparatus. OUR OBLIGATION TO REPAIR OR REPLACE SHALL NOT APPLY TO ANY APPARATUS WHICH SHALL HAVE BEEN REPAIRED OR ALTERED OUTSIDE OF OUR FACTORY IN ANY WAY, OR WHICH HAS BEEN SUBJECT TO NEGLIGENCE, TO MISUSE, OR TO PRESSURES IN EXCESS OF STATED LIMITS. On parts not of our manufacture, such as motors, controls, etc., we extend only the same warranties given by the Seller. Our agreement hereunder runs only to the immediate purchasers and does not extend, expressly or by implication, to any other person.

These instructions and the drawings supplied with the DBX Unit must be followed carefully to insure proper installation, operation, and maintenance.

This manual is written and illustrated for a single DBX Unit installation. For instructions concerning a multiple unit installation, consult Dunham-Bush, Inc.

> **CAUTION** **CAUTION** **CAUTION**
>
> Valves or connections which can cause loss of the factory installed refrigerant holding charge and lubricating oil charges shall not be opened under any conditions. The system shall not be dismantled or opened except under the supervision of a Dunham-Bush, Inc. Service Representative.
>
> The DBX Unit shall NOT be started following installation except under the direct supervision of a Dunham-Bush, Inc., authorized start-up representative.

Compliance with the above is mandatory in order that the warranty shall not be jeopardized. All contacts with Dunham-Bush, Inc., regarding requests for information, service, or parts should be made to the nearest sales office.

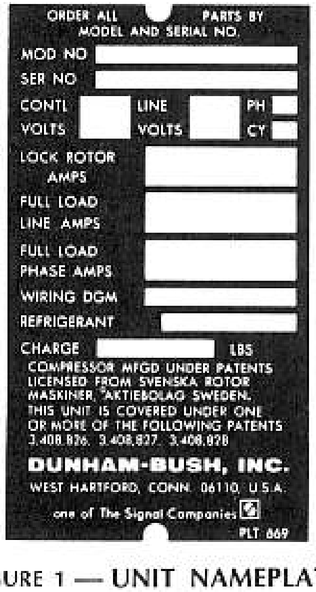


FIGURE 1 — UNIT NAMEPLATE

B. SHIPMENT

Shipping skids are attached to the unit when shipped and the oil system is fully charged. Refrigerant system contains a holding charge only. The condenser water connection flanges (condensing units only) have covers installed to prevent contamination of the vessel.

C. RECEIVING INSPECTION

Upon receipt of the unit and in the presence of the carrier's representative, immediately inspect the unit for evidence of shipping damage. Any damage noted should be entered on the carrier's delivery receipt before it is signed. A damage claim should then be filed against the delivering carrier as all shipments are made at the buyer's risk. The power requirements, installation wiring diagram number, type of refrigerant will be found on the unit nameplate which is mounted on a bracket on the oil sump.

D. RIGGING AND MOVING

Riggers and installers must use every precaution to prevent damage while moving the unit from the point of shipment to its permanent location. Pushing, pulling or climbing on any of the unit components or piping can easily create damage that will result in costly repairs of leaks and malfunctioning components. The only places it is safe to apply hoisting, jacking, pushing, or pulling forces are to the shipping skids.

Spreaders shall be used as necessary to prevent damage to the unit by the lifting cables.

Skidding may be done directly on the shipping skids or on properly spaced rollers under the skids. Pushing and pulling should only be directed against the skids.

E. INSTALLATION

1. Location

The location of the unit may be any foundation or deck that is generally level within 1/8 inch between mounting feet and structurally capable of supporting the weight of the unit. For ease of operation and maintenance, a cleared area around the unit should be provided. Provide access for removal of components.

2. Mounting

"Unisorb" vinyl coated pads are provided for installation under the mounting legs. The unit may be cemented or lagged to the foundation if so desired, but this is not mandatory. For critical installations, Dunham-Bush, Inc., will provide whatever type of vibration isolator the customer specifies, to be installed and adjusted in accordance with the isolator manufacturer's instructions.

3. Leveling

When the unit is at its final location, it should be jacked or hoisted, the shipping skids removed then let down on the isolator equipment supplied (felt pads or vibration isolators). It should then be checked for level longitudinally at the top center of the condenser shell (on condensing units, or oil sump/separator (on compressor units) and laterally across the compressor motor feet. Use steel shims under the isolator pads as necessary to level the unit.

F. EXTERNAL CONNECTIONS

All external water piping, external wiring and satellite equipment installations such as water pumps and cooling towers are to be provided by the customer.

1. Water Connections

After the unit has been leveled, the external water piping to the condenser and/or oil cooler may be made up. Air vent valves should be installed at all high points to facilitate access for air venting the system.

All external plumbing should have manual shut-off valves and strainers installed in close proximity to the unit to prevent contamination of the unit and its satellite equipment and to facilitate servicing and maintenance. The external plumbing must be carefully located and adequately supported by blocking and hangers so that it will not create twisting or bending stresses on the unit when the flanges are bolted. It is recommended that flanges be used at the connection to the condenser (condensing units only) so that the external piping will not interfere with pulling and cleaning of the condenser tubes. Following make up of the external plumbing, it should be thoroughly cleaned to remove all foreign material, connected to the unit, filled, all entrapped air bled off, and leak tested. A check should then be made for piping stresses at the unit piping flanges as follows: Remove condenser, and oil cooler connecting flange bolts. If any bolts are bound in the bolt holes so that the flanges spring out of line when the bolts are removed, adjust external piping blocking or hangers to properly align the flanges.

2. Refrigerant Connections

All refrigerant piping must follow recommended practices of the ASHRAE guide and the American Standard Code for Pressure Piping Section B31.5 Refrigeration Piping. Consideration must be given to the Refrigerant being used, capacity (tonnage), length of lines, refrigerant velocity, pressure drops to insure proper operation.

All piping after soldering or welding must be thoroughly cleaned. It is recommended that dry nitrogen be used when soldering copper tubing to prevent scaling. Silver solder is recommended on all copper connections.

All piping must be supported properly so that thers is no strain on any of the equipment. Remove suction, discharge (or liquid line) flange bolts. If any bolts are bound in the bolt holes so that the flanges spring out of line, adjust the external piping to properly align the flanges. Stress on the suction line flange will disrupt compressor - motor alignment.

When all the connection of the refrigerant piping have been completed a leak check should be performed. If the refrigerant system is sound, the unit should be subjected to a vacuum of 1000 microns. Insulation should be installed on suction line to prevent sweating.

3. Electrical Connections

The unit is completely wired at the factory prior to delivery. The connections which must be made by the installer are to the main power source, starting equipment and interlocking of the satellite equipment with the unit. Each of these circuits must have adequate circuit protection devices incorporated in it. The power voltage, frequency, and phase must be in accordance with that shown on the unit nameplate (Fig. 1) All wiring must be in accordance with the wiring diagram specified on the unit nameplate, the National Electrical Code, and any local codes that may apply. Any deviations from the above requirements must have the prior approval of Dunham-Bush, Inc. Customer supplied starters for the compressor motor must be in compliance with Dunham-Bush, Inc. Engineering Specification No. ELC–ES–9–3 (Appendix B) or as individually approved by Dunham-Bush, Inc.

COMPRESSOR MOTOR UNIT MOTOR WIRING

The following external wiring is to be provided by the installer.

a. Power supply to compressor motor starter with circuit protection, and from starter to compressor motor.

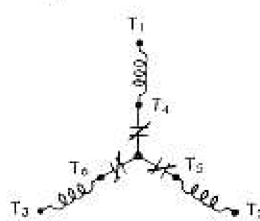
b. Power supply to oil pump motor contactor or starter with circuit protection.

c. Condenser water pump starter control circuit to control panel (condensing units only).

d. Compressor motor starter control circuitry to control panel.

e. Control transformer (3KVA) or 115V/60Hz/PH power supply to control panel with circuit protection.
Interlocked with control relay (if automatic pump down is not used).

f. All customer supplied components must have the prior approval of Dunham-Bush, Inc.



DBX	CONNECTIONS		
LINE	L_1	L_2	L_3
MOTOR	T_1	T_2	T_3

T_4, T_5, and T_6 wired at factory.

OIL PUMP MOTOR

G. WATER TREATMENT

Most industrial water supplies contain dissolved or suspended materials which cause scale formation, corrosion, and propagate slime, algae, etc. If these are permitted to exist in the condenser and/or oil cooler water systems, maintenance costs can soar due to delays for scale removal, replacement of corroded parts, etc. It is strongly recommended that a water treatment specialist be consulted for additive systems to counteract or prevent the damages caused by these impurities.

If desired, an anti-corrosive agent known as "Corrode Stop" is available from Dunham-Bush, Inc. to be used as specified in Dunham-Bush, Inc., Engineering Specification No. MAT–ES–26 Anodic Corrosion Inhibiter (Appendix A).

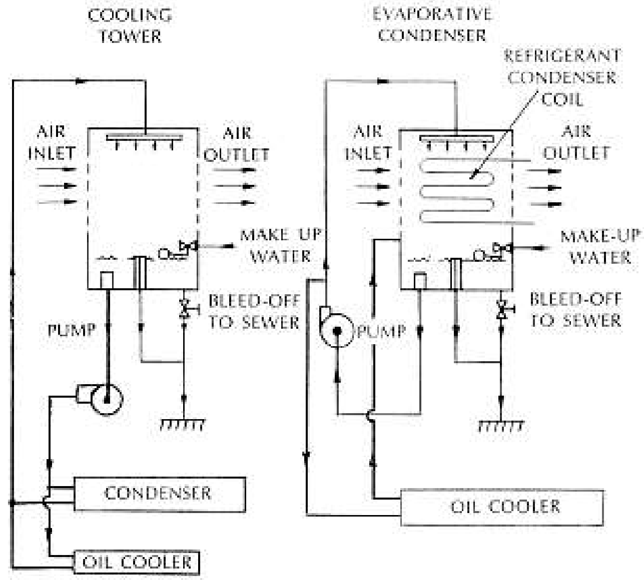


Figure 6 – TYPICAL BLEED–OFF SYSTEM

Dunham-Bush, Inc. will not be liable for any damage or failure resulting from the physical or chemical properties of any liquid or gas used in this equipment. Cooling towers and evaporative coolers experience a constant loss of water due to evaporation. Since evaporation is a distillation process, an increasing concentration of suspended and dissolved impurities occurs as they do not evaporate. This increasing concentration of impurities can be greatly reduced by a bleed-off system which allows a small amount of the contaminated water to be constantly bled-off and replaced with fresh water through the sump float valve.

Chemical water treatment in addition to the above bleed-off should be determined by a water treatment specialist and a daily check should be made to be sure the correct bleed-off rate is maintained.

H. INSTALLATION CHECK LIST

Following completion of the unit installation, plumbing and wiring, but prior to initial start-up, the installation check list will serve to assure the customer and Dunham-Bush, Inc., that the installation contractor has completed the installation of the unit and its satellite equipment to the satisfaction of the customer.

The following is an amplification of the check list:

A. Mounting and Leveling

1. Erected on foundation . . . in accordance with construction and electrical drawings supplied to the customer and the requirements of this manual.

2. Spring isolators or pads installed and adjusted to level unit . . . in accordance with isolator manufacturers instructions and the requirements of this manual.

B. Water Piping

1. Condenser or oil cooler cooling water piping installed between condenser pumps and cooling tower or

well . . . as specified in this manual (condensing units only).

2. Make-up and fill lines installed to cooling tower water system . . . and chemical treatment and bleed-off systems as needed.

3. Thermometer wells installed in condenser water inlet and outlet lines, if required.

4. All piping checked for strain . . . as specified in this manual.

5. Water and refrigerant piping leak tested, flushed or cleaned and water strainers checked after flushing to be certain they are not clogged; water piping vented.

6. Condenser and oil cooler water supply available in sufficient quantity to meet unit design requirements . . . and with adequate water treatment.

C. Electrical Wiring

1. Power supply available . . . with circuit protection and in accordance with the requirements on the unit nameplate supplied, and this manual.

2. Wiring completed from power supply through circuit protection to compressor motor starter and compressor motor . . . in accordance with drawing supplied and the requirements of this manual.

3. Wiring completed from power supply through circuit protection to oil pump motor contactor or starter . . . in accordance with drawing supplied and the requirements of this manual.

4. Wiring completed from power supply through circuit protection to 115V control circuit in unit control panel (or through 115V transformer to control circuit) . . . in accordance with drawing supplied and requirements of this manual.

5. Wiring from power supply through circuit protection to satellite equipment and interlocks wired to control panel . . . in accordance with drawing supplied and requirements of this manual.

6. Phasing correct for direction of rotation of all motors except compressor and oil pump motors . . . phasing of compressor and oil pump motor will be checked by Dunham-Bush, Inc., start-up representative.

D. Refrigerant Piping

1. All refrigerant piping must be installed in accordance with accepted refrigeration design and practice. – Vents must be provided at high points to insure removal of non-condensibles. – All external refrigerant piping must be pressure tested and properly dehydrated.

E. Conditions

1. Load available for operation and testing . . . a refrigeration load adequate to cause normal operation of unit MUST BE AVAILABLE.

2. Operating personnel assigned on the job for start-up instructions . . . a list of the names of customer personnel to be instructed by the Dunham-Bush, Inc., authorized representative in the operation and maintenance of the unit.

I. REQUEST FOR AUTHORIZED START–UP REPRESENTATIVE

When the installation is completed, fill out Form 9193 (enclosed with unit). This form is a check list to make sure all work is completed and the unit is ready for start-up. Following receipt of this signed form by Dunham-Bush, Inc., a representative will be sent to the customer. He will inspect the installation to determine whether it meets Dunham-Bush, Inc. requirements, perform the initial start-up of the installation to determine whether it is in satisfactory operating condition and instruct the specified customer personnel in its operation and maintenance for the length of time specified in the purchase contract.

NOTE: The oil heater circuit breaker (CB2) must be turned on about 24 hours prior to arrival of the start-up representative. This will insure that the oil is warm enough to vaporize any refrigerant in the oil and that the oil is at the normal operating temperature. Indication of oil heater operation is the "Low Oil Sump Temperature" caution light on the instrument panel.

MAINTAINING RECEIVER PRESSURE FOR UNIT STARTING

This applies to receiver applications on all Screw Compressor Products. A liquid line check valve must be installed by the customer between the remote condenser and the liquid receiver. This check valve should have not over 3 psi pressure drop at maximum flow.

A 70°F minimum receiver temperature must be maintained during the off cycle to provide sufficient pressure to feed the expansion valves during startup.

CASE I:

UNIT WITH RECEIVER INSTALLED IN A ROOM WHICH IS ALWAYS 70°F OR ABOVE:

A check valve must be installed at the receiver, in the liquid line from the remote condenser to the receiver. This will prevent:

1. Loss of receiver charge to the condenser, or
2. Thermosyphon cooling of the receiver by the condenser when condenser ambients below 70° are encountered. D/B does not supply this check valve as standard equipment.

well . . . as specified in this manual (condensing units only).

2. Make-up and fill lines installed to cooling tower water system . . . and chemical treatment and bleed-off systems as needed.

3. Thermometer wells installed in condenser water inlet and outlet lines, if required.

4. All piping checked for strain . . . as specified in this manual.

5. Water and refrigerant piping leak tested, flushed or cleaned and water strainers checked after flushing to be certain they are not clogged; water piping vented.

6. Condenser and oil cooler water supply available in sufficient quantity to meet unit design requirements . . . and with adequate water treatment.

C. Electrical Wiring

1. Power supply available . . . with circuit protection and in accordance with the requirements on the unit nameplate supplied, and this manual.

2. Wiring completed from power supply through circuit protection to compressor motor starter and compressor motor . . . in accordance with drawing supplied and the requirements of this manual.

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4. Wiring completed from power supply through circuit protection to 115V control circuit in unit control panel (or through 115V transformer to control circuit) . . . in accordance with drawing supplied and requirements of this manual.

5. Wiring from power supply through circuit protection to satellite equipment and interlocks wired to control panel . . . in accordance with drawing supplied and requirements of this manual.

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1. Loss of receiver charge to the condenser, or
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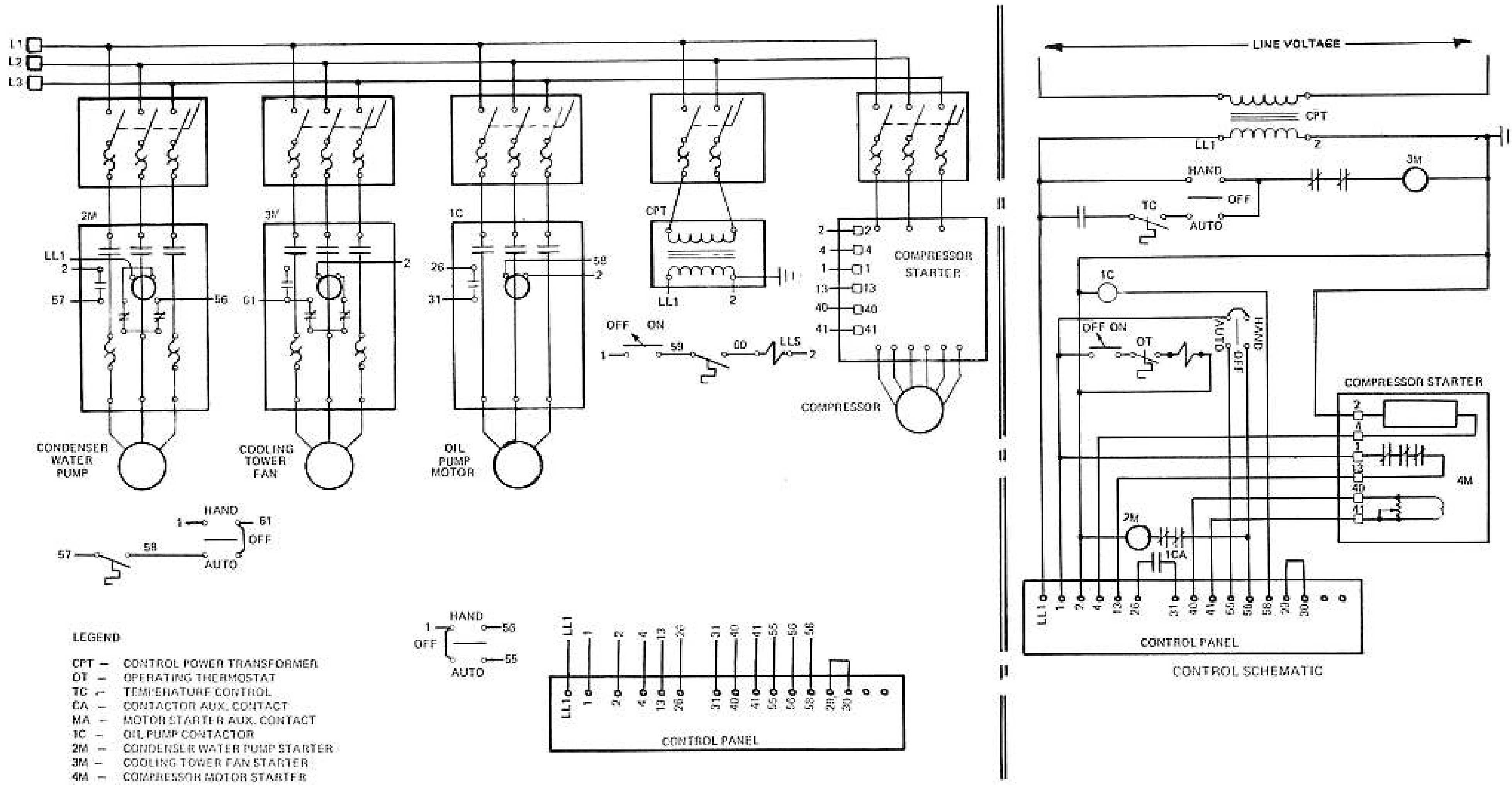


LEGEND

CPT – CONTROL POWER TRANSFORMER
OT – OPERATING THERMOSTAT
TC – TEMPERATURE CONTROL
CA – CONTACTOR AUX. CONTACT
MA – MOTOR STARTER AUX. CONTACT
1C – OIL PUMP CONTACTOR
2M – CONDENSER WATER PUMP STARTER
3M – COOLING TOWER FAN STARTER
4M – COMPRESSOR MOTOR STARTER
DS – DISCONNECT SW

C5-DGM 1388

TYPICAL EXTERNAL WIRING DIAGRAM

DUNHAM-BUSH

ROTARY SCREW COMPRESSOR/CONDENSING UNIT
REQUEST FOR AUTHORIZED START–UP REPRESENTATIVE

DUNHAM–BUSH, INC.
NATIONAL SERVICE DEPARTMENT
175 SOUTH STREET
WEST HARTFORD, CONNECTICUT 06110

JOB NAME ____
LOCATION ____
CUSTOMER ORDER NO. ____
DUNHAM-BUSH ORDER NO. ____

UNIT MODEL NO. ____ SERIAL NO. ____

This work (as checked below) is in progress and will be completed by Month ____ Day ____ Year ____

A. DUNHAM-BUSH DBX UNIT

1. Erected on foundation .... ___
2. Spring isolators or iso pads installed and adjusted to level unit .... ___

B. WATER PIPING

1. Condenser water piping installed between condenser, pumps and cooling tower (where required) .... ___
2. Make-up and fill lines installed to cooling tower (where required) .... ___
3. Thermometer wells and gage connections installed in water lines (where required) .... ___
   All water piping checked for strain .... ___
4. All water piping leak tested flushed and vented water strainers checked after flushing to be certain they are not clogged (where required) ..... ___
5. Condenser water supply available (where required) .... ___
6. Strain relieve suction and discharge piping .... ___
7. Clean out refrigerant piping .... ___
8. Check refrigerant piping for leaks .... ___
9. Evacuate system (1000 Microns) .... ___

C. ELECTRICAL WIRING

1. Power supply available .... ___
2. Wiring completed from supply to fused disconnect to starter to compressor motor .... ___
3. Power wiring completed from supply to fused disconnect to oil pump starter .... ___
4. Starter initiating relay coil, disconnected .... ___
5. 115 Volt service completed to control panel ...... ___
6. Wiring completed to the following motors and the rotation of each checked .... ___
   (a) Condenser water or cooling tower pumps (where required) .... ___
   (b) Cooling tower fan (if used) .... ___
   (c) Oil cooler water pump (where required) ... ___
7. Properly sized overload elements installed on a, b, c .... ___
8. Turn on oil pump heaters 24 hours prior to start-up .... ___
9. Wiring from load limiter resistors in starter brought out to MLC in control panel .... ___
10. Compressor motor overload in starter panel connected to control panel terminal .... ___
11. Tie in low side of system in accordance with shut down desired .... ___
   (a) Automatic pump down .... ___
   (b) Single pump down .... ___
   (c) On-Off .... ___
   State which:
   On (b) and (c) customer relay contact wired into circuit as per option on Dunham-Bush control circuit diagram .... ___

Note: Do not start compressor or oil pump.

D. AIR COOLED OR EVAPORATIVE CONDENSER

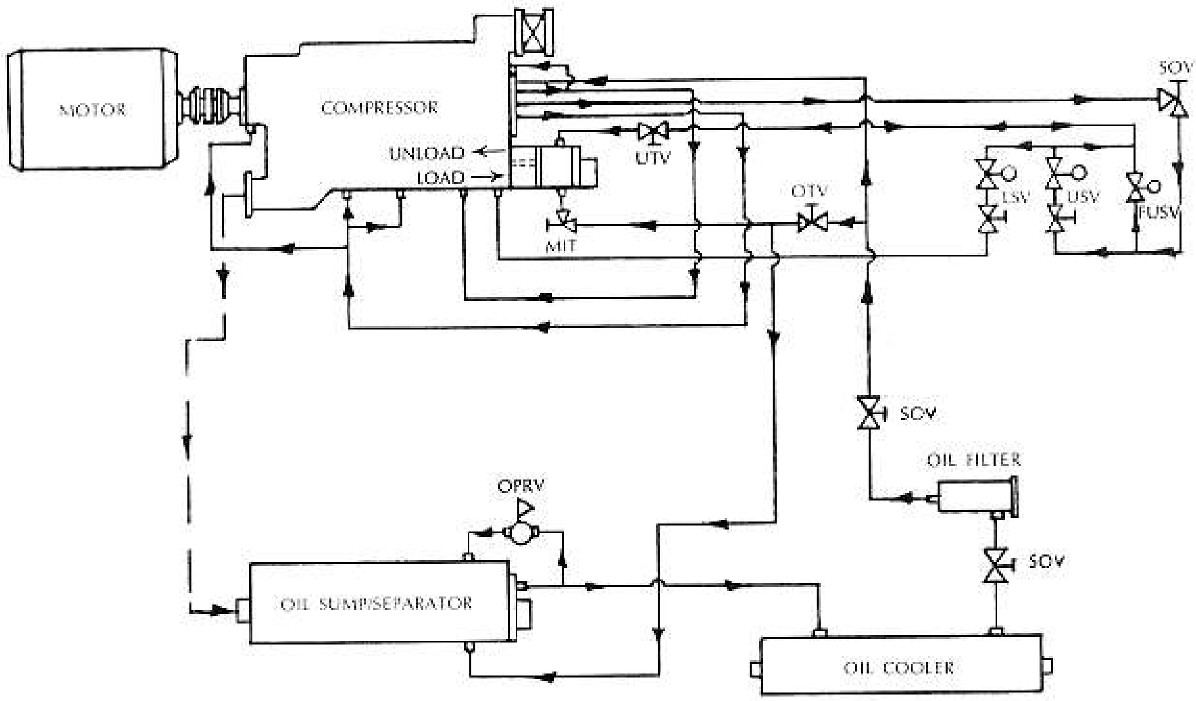
1. A contact in control panel is supplied to cycle condenser pump or fans with compressor, if this is desired. Wiring must be installed .... ___
2. LHPC (Low head pressure control) customer supplied–to be connected .... ___
3. Condenser fan cycling pressure controls installed, wired and tested .... ___

E. CONDITIONS

1. Load available for start-up unit operation .... ___
2. System evacuated to 1000 Microns (leave vacuum pump connected) .... ___
3. Qualified refrig. contractor on site to charge unit under factory engineer supervision .... ___
4. Operating personnel assigned on the job for start-up instructions .... ___
   Names of Personnel:
   ____
   ____
   ____
   ____
   ____

OIL PIPING SCHEMATICS

OIL SCHEMATIC CONDENSING UNITS & COMPRESSOR UNITS



LEGEND

→ — Oil Line
--→ — Discharge Line
UTV— Unload Throttling Valve
MIT— Main Injection Throttling Valve
LSV— Load Solenoid Valve
USV— Unload Solenoid Valve
FUSV— Fast Unload Solenoid Valve
SOV— Shut Off Valve
OTV— Oil Throttling Valve
OPRV— Oil Pressure Relief Valve

Oil entrained with discharge refrigerant gas is effectively separated by a mechanical demister downstream of the compressor.

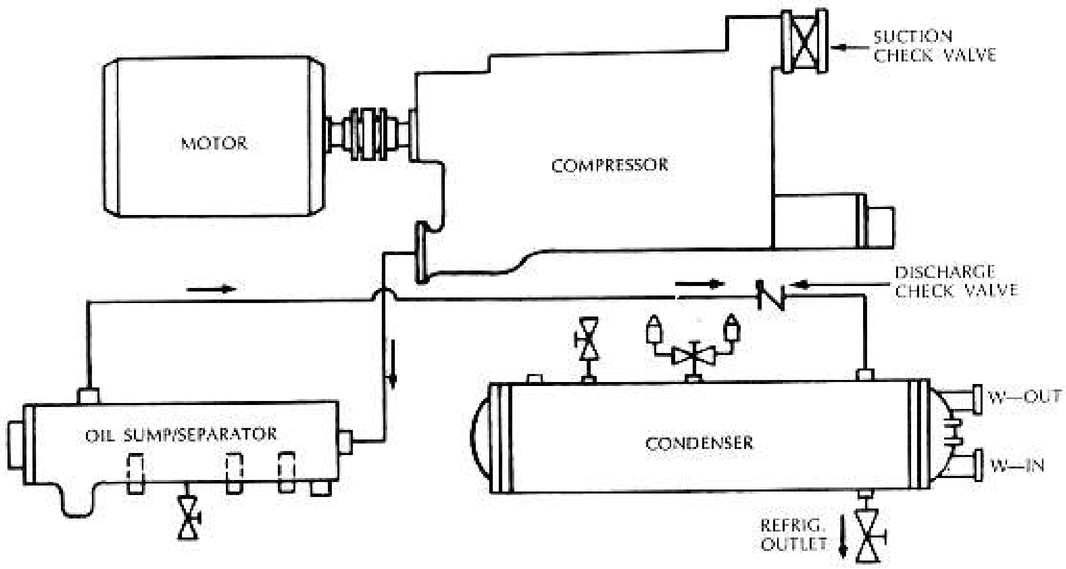
Oil is delivered from the sump to a "shell and tube" cleanable oil cooler by a hermetic gear type oil pump located in the sump end cover. A regulated supply of water on the tube side of the oil cooler cools the oil to the desired temperature prior to passing through a replaceable cartridge oil filter.

Oil is then distributed to the various injection ports and capacity control solenoid valves, the compressor bearings and the hydraulic thrust balancing piston.

Immersion type heaters keep oil at a safe operating temperature and prevent oil dilution by the refrigerant during an off cycle.

REFRIGERATION SCHEMATIC

CONDENSING UNITS



Refrigerant gas free of entrained oil passes from the oil separator/sump into the condenser. Condensing units are furnished as shown with check valve between the oil sump/separator and condenser inlet.

Compressor units are furnished with a discharge check valve and suitably capped flange connection at the oil sump/separator outlet. In accordance with good piping practice, a shut off valve should be field installed between the condenser outlet and receiver inlet.

II. OPERATION

A. GENERAL

WARNING: Do not operate this equipment in excess of its rated capacity nor otherwise than in accordance with the instructions contained in this manual. This equipment has been tested prior to shipment and found satisfactory for the conditions under which it was sold. Operation in excess of these conditions will subject this equipment to stresses in excess of those for which it was designed. Failure to heed this warning may result in injury to operating personnel and may jeopardize the warranty under which it was sold.

While this unit is a greatly simplified unit incorporating safety features to protect it against damage from almost all conceivable malfunctions, it does represent a considerable investment and deserves the attention and care normally given to any fine piece of equipment. Reliable and economical operation will be achieved if the instructions in this manual are carefully studied and adhered to.

B. NOMENCLATURE

The following terms common in the refrigeration industry are defined as used in this manual.

Ambient Temperature—The existing temperature in the surrounding area.

Compressor—A pump used to raise the pressure of hot refrigerant vapor so that it will condense in the condenser at a higher temperature than it vaporized at in the chiller.

High Side— The portion of the refrigerant system that is under discharge or condenser pressure. Extending from the compressor discharge to the expansion valve(s) inlet.

Low Side—The portion of the refrigerant system in which the refrigerant is at low pressure; extending from the expansion valve(s) outlet to the suction inlet of the compressor.

Condenser—A vessel in which the compressed (and vaporized) refrigerant is liquified by removal of heat.

psia—Stands for "pounds per square inch absolute" and is an indication of the total pressure which includes atmospheric pressure (about 14.7 psi).

psid—Stands for "pounds per square inch differential" and is an indication of the pressure differential between two separate pressure sources.

psig—Stand for "pounds per square inch gauge" and is an indication of the pressure above atmospheric pressure.

Pump-down—The operation by which the refrigerant in a charged system is pumped into the condenser/receiver.

Refrigerant—The working fluid in a refrigeration cycle, absorbing heat from the medium to be cooled at low temperature and rejecting that heat at a higher temperature.

Satellite Equipment—All equipment external of the unit such as condenser water pumps, cooling towers, air cooled or evaporative condensers.

Ton of Refrigeration—The rate of heat transfer equal to 288,000 BTU per 24 hours or 12,000 BTU per hour. It is the equivalent in effect to melting one ton of ice in 24 hours.

C. SYSTEM COMPONENTS

1. Refrigerant System

a. Suction Check Valve

The suction check valve is of the spring loaded swing type mounted in the horizontal run of the suction line ahead of the suction strainer. It serves the following purposes:

1. Prevents reverse rotation during shutdown
2. Allows automatic pump down operation

The suction strainer is a truncated wound type wire mesh strainer with back up reinforcing mesh. It is mounted directly ahead of the compressor at the compressor inlet flange.

b. Compressor

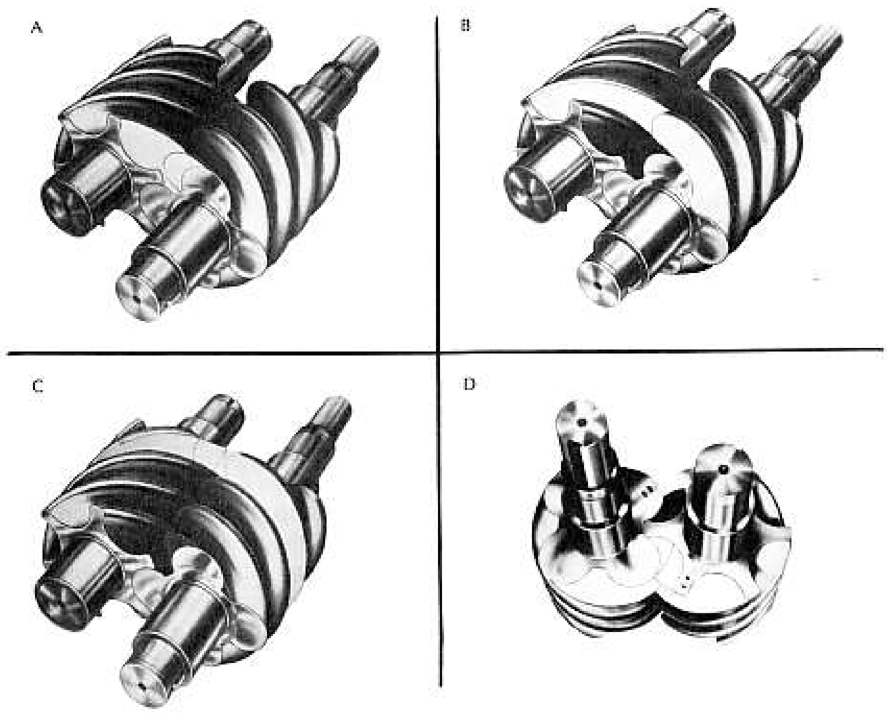
The compressor used is a positive displacement, helical-axial flow compressor designed for use with high pressure refrigerants, thereby eliminating the need for a purge system.

The compressor consists basically of two intermeshing helixes, a male helix or pump and a female helix or valve. The compressor operation is best described by considering one lobe of the male rotor and one interlobe space for the female rotor as follows:

SUCTION PHASE: (A)

As a lobe of the male rotor begins to unmesh from an interlobe space in the female rotor, a void is created and gas is drawn in through the inlet port as the rotors continue to turn, the interlobe space increases in size and gas flows continuously into the compressor. Just prior to the point at which the interlobe space leaves the inlet port, the entire length of the interlobe space is completely filled with drawn in gas.

COMPRESSOR ROTOR OPERATION



COMPRESSION PHASE: (B, C)

As rotation continues, the gas in the interlobe space is carried circumferentially around the compressor housing. Further rotation meshes a male lobe with the interlobe space on the suction end and squeezes (compresses) the gas in the direction of the discharge port. Thus the occupied volume of the trapped gas within the interlobe space is decreased and the gas pressure consequently increased.

DISCHARGE PHASE: (D)

At a point determined by the designed "built in" compressor ratio, the discharge port is uncovered and the compressed gas is discharged by further meshing of the lobe and interlobe space. Since all the compressed gas is discharged, there is no residual gas volume to re-expand; effectively, a "zero" clearance volume compressor. While the meshing point of a pair of lobes is moving axially, the next charge is being drawn into the unmeshed portion and the working phases of the compressor cycle are repeated. A very smooth continuous flow of gas and extremely uniform torque are obtained due to the fact that several inlet and discharge cycles involving pairs of lobes are occurring at the same time.

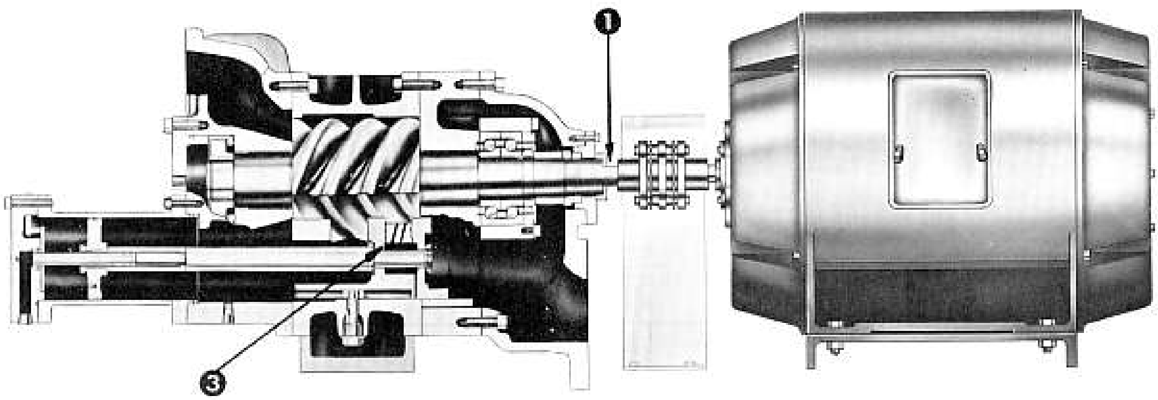
CAPACITY CONTROL:

Figure shows the capacity control slide valve within the rotor housing. Axial movement of this valve is hydraulically actuated. When the compressor is fully loaded, the slide valve is in the closed position and the flow of all the gas through the rotor housing is as described above. Unloading starts when the slide valve is moved back away from the valve stop. Movement of valve creates an opening in the bottom of the rotor housing through which suction gas can pass back from the rotor housing to the inlet port area before it has yet been compressed. Since no significant amount of work has been done on this return gas, there are no appreciable losses incurred. Reduced compressor capacity is obtained from the gas which is inside the inner part of the rotors and which is compressed in the ordinary manner. Capacity reduction down to 10% of full load is realized by progressive backward movement of the slide valve away from the valve stop. In principle, enlarging the opening in the rotor housing effectively reduces compressor displacement.

COMPRESSOR SLIDE VALVE OPERATION

CLOSED

OPEN



c. Compressor Motor

The compressor motor is connected to the compressor with a flexible coupling and is a standard NEMA drip-proof motor unless otherwise specified.

d. Discharge Check Valve

The discharge check valve on condensing units is in the piping between the oil separator and the condenser to prevent refrigerant migration into the evaporator during off cycles, and to aid in serviceability. On compressor units it is mounted on the outlet of the oil separator.

e. Condenser (condensing units only)

The condenser is a "shell and tube" type heat exchanger containing externally finned tubing. Two relief valves are mounted on the condenser. Oil cooler water connections and condenser water connections are located in one of the condenser headers. If water flow across condenser is lower than 8 psi, oil cooler water should be pumped, and cooler should be supplied unpiped. A king valve is supplied at the condenser refrigerant outlet. Refrigerant is on the outside of the tubes and the water passes through the tubes. The water tubes are accessible for cleaning, removal, and replacement when the heads are removed.

2. LUBRICATING OIL SYSTEM

a. Oil Separator

The standard oil separator is of the horizontal mesh bed type with the integral sump and pump. It contains various required equipment for proper operation of the unit, such as oil heaters, oil level sight glasses, oil thermostat bulbwell, relief valves, and various pressure taps.

The oil pump is a gear type pump mounted in the outlet header of the sump. Thermal switches are imbedded in the oil pump windings to protect them from overheating. The unit oil sump also contains the oil separator. Down stream of the pump is a relief valve which relieves excessive oil pressure if necessary. A three phase inherent protection switch is located in the oil pump motor junction box.

b. Oil Cooler

The oil cooler is a "shell and tube" type heat exchanger. The cooling water flows through the cooler tubes and is metered by a thermally controlled valve which senses oil temperature out of the cooler.

c. Oil Filter

The oil filter contains a replaceable filter element; a pressure tap is provided on oil filter cover to facilitate taking pressure drop readings.

3. WATER SYSTEMS

a. Condenser and Oil Cooler Water

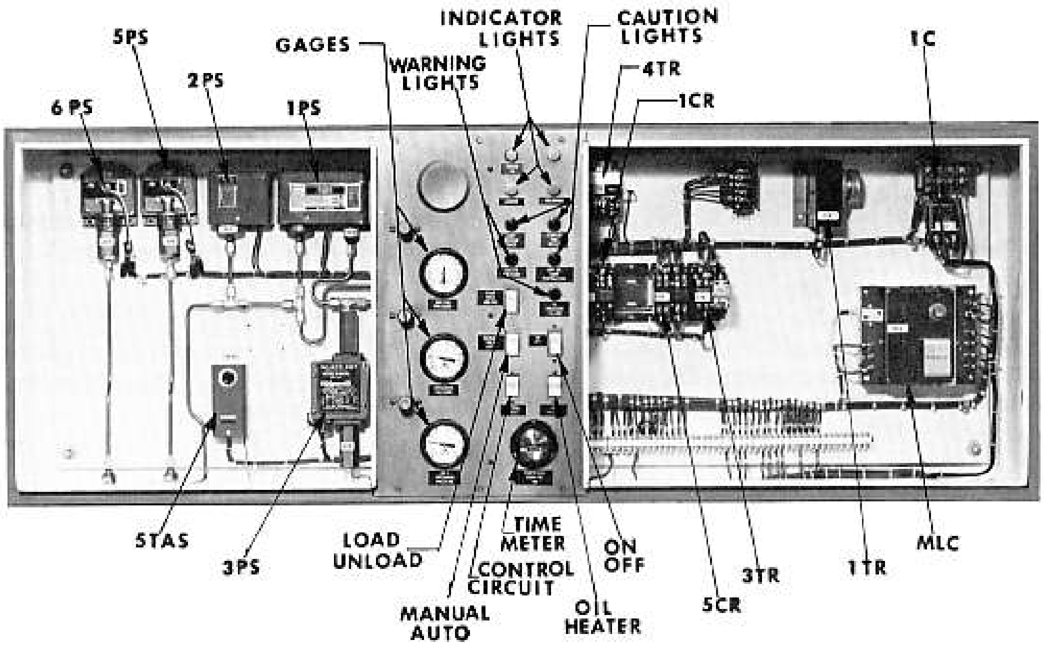
Cooled water is circulated through the tubes of the condenser to condense the refrigerant. Some of this water is bled off at the condenser water inlet and diverted through a thermally controlled valve to the oil cooler. The thermally controlled valve senses the temperature of the oil out of the cooler and meters the water flow to keep the oil temperature in the proper operating range.

D. CONTROL SYSTEM

The DBX control system is electrically interlocked with the condensing equipment provided, oil pump contactor or starter and the compressor motor starter for automatic operation and protection. Automatic protection is provided against.

a. Low Suction Pressure
b. High Discharge Pressure
c. Low Oil Pressure
d. High Oil Pump Motor Temperatures
e. Overcurrent
f. Low Oil Sump Temperature
g. High Discharge Temperature

The following pages describe the components of these systems and the operation of the automatic control and protection systems.



A. INSTRUMENT PANEL

The Instrument Panel is mounted on the control box and contains pressure and temperature gauges, indicator lights, circuit breakers, and "Off–On" switch described as follows:

1. GAUGES

a. **Suction Pressure**

The Suction Pressure gauge is calibrated from 30" to +150 psi and senses the pressure of the refrigerant vapor as it leaves the chiller (suction side of compressor).

b. **Discharge Pressure**

The Discharge Pressure gauge is calibrated from 30" to +400 psi and senses the pressure of the refrigerant vapor as it leaves the compressor.

c. **Oil & Discharge Pressure**

The Oil & Discharge Pressure gauge is calibrated from 30" to +400 psi and indicates the oil and compressor discharge pressure.

d. **Shutoff Valves**

A manual shutoff valve is located beside each of the above pressure gauges to protect the gauges from damage during maintenance and pressure testing.

e. **Compressor Operating Time (6TR line 22)**

A digital elapsed time indicator which shows the total operating hours the compressor has operated.

2. CIRCUIT BREAKERS

a. **Control Circuit (1CB)**

The Control Circuit Breaker supplies 115V power to the control box.

b. **Oil Heater (2CB)**

The Oil Heater circuit breaker supplies power to the oil sump heaters.

3. INDICATOR LIGHTS (white)

a. **Power On (1LT line 3)**

The Power On Light is energized whenever power is available and the control circuit breaker is on, supplying 115V power to the controls.

b. **Oil Pump (5LT line 10)**

The Oil Pump light is energized whenever the Oil Pump contactor or starter is energized, indicating the pump is operating.

c. **Loading (7LT line 18)**

The Loading light is energized whenever the load solenoid is energized, indicating that the compressor slide valve is being moved toward the closed position to increase the compressor capacity (displacement).

d. **Unloading** (8LT line 20)

The Unloading light is energized whenever the unload solenoid is energized, indicating that the compressor slide valve is being moved toward the open position to decrease the compressor capacity (displacement).

4. CAUTION LIGHTS (yellow)

a. **Start-up Time delay** (9LT line 23)

The Start-up Time Delay light is energized whenever the start-up time delay relay (4TR) is energized. It indicates that a two minute delay in compressor starting is in process to insure the lubrication system circulates thoroughly prior to start-up, and that the compressor is fully unloaded before starting.

b. **Anti-recycle Timer** (3LT line 10)

The Anti-recycle Timer light is energized anytime the Anti-recycle time delay relay is timing.

c. **Low Oil Sump Temperature** (4LT line 7)

The Low Oil Sump Temperature light is energized by the low oil sump temperature switch when the temperature of the oil in the sump is below 90° F. It indicates the oil sump heaters have been energized and the compressor is off. When the oil temperature is raised to 100°F, the compressor will be allowed to start.

5. WARNING LIGHTS (red)

a. **Safety Switches** (2LT line 7)

The Safety Switches light indicates one or more of the safety switches or relays has tripped out and must be reset to restart the unit.

b. **Oil Pressure Failure** (6LT line 13)

The Oil Pressure Failure light is energized whenever the lubricating oil pressure drops below 20 psi. The entire unit will shut down in a preset time if the pressure does not increase to 28 psi.

6. SWITCHES

a. **Off-On Switch** (HAND—OFF—AUTO lines 4&5)

The Off-On switch is the manual control switch.

b. **Manual-Hold-Automatic Switch** (2SS lines 15 & 17)

Allows the unloader to be controlled manually or automatically or locked in a fixed position.

c. **Load-Hold-Unload Switch** (3SS line 15)

When unit is in manual operation this switch allows the operator to load or unload the compressor or lock the unloader in a fixed position.

B. FUNCTION OF CONTROLS

1. AUTOMATIC CONTROLS

1CR — Master Control Relay: (line 6)

Allows the oil pump and compressor to be started or shut down - depending upon the operation of the safety controls, off/on switch, and low oil sump temperature switch.

OHTR1 and OHTR2 — Oil Heaters: (lines 1 & 2)

When the circuit breaker 2CB is energized, the oil heaters (OHTR1 and OHTR2) will be energized. When the sump temperature reaches its set point, 5TAS will close and energize the coil 1CR. 1CR oil heater contacts will open, deenergizing the oil heaters , and 1CR control circuit contacts will close to allow start up to begin.

1 TR — Anti-recycle Timer (line 8)

Prevents compressor short cycling on safety controls or suction pressure.

3TR — Oil Failure Time Delay Relay: (line 12)

3TR is de-energized when 3PS trips. If oil pressure doesn't return to the preset minimum, 3TR will time out and shut down the compressor.

1C or 1M — Oil Pump Contactor or Starter (line 9)

On all units operating on line voltage of less than 575 volts, a contactor (1 C) controls the oil pump. On units operating on line voltage of 575 volts, a starter (1 M) is used. The contactor or starter controls the operation of the oil pump and, through a set of auxiliary contacts (1 CA or 1 MA), keeps the compressor starter de-energized until the oil pump contactor or starter is energized. The starter overload relays will de-energize the master control relay whenever the oil pump motor is overloaded.

Oil Pump Motor 3 Phase Inherent Protector (see oil pump schematic)

A 3 phase inherent protector for the oil pump motor is located in the oil pump motor junction box when a contactor is furnished. Its function is similar to an overload relay on a starter.

3PS — Low Oil Pressure Switch (line 11)

The low oil pressure switch prevents the compressor from starting if sufficient oil pressure has not been developed by the oil pump. When the oil pressure is satisfactory, 3 PS will permit the DBX unit to start-up in its normal manner.

4TR — Start Up Time Delay Relay: (line 14)

4 TR times on energization for a predetermined period. When 4 TR times out, the compressor will start.

2PS — Low Suction Pressure Pump Down Switch (line 9)

The low pressure pump down switch (2 PS) is closed during start-up, thus allowing the compressor to start. When suction pressure drops to a predetermined point, 2 PS opens and shuts down the compressor. When suction pressure is back to normal, 2 PS closes allowing the compressor to restart.

5 CR — Compressor Load Relay (line 21)

Prevents the compressor from loading, but permits the compressor to unload before start up. When 4TR times out, 5CR will allow the compressor to load.

7 TR – Unloaded Start Time Delay Relay (optional)

7TR is used to energize the unloader start solenoid valve (7 SOL). When 7TR times out, it closes the unloader start solenoid valve. Maximum time setting.

7 SOL – Unloaded Start Solenoid Valve (optional)

The unloaded start solenoid valve bypasses refrigerant from the discharge line directly to the suction line.

CT – Current Transformer (optional)

Shall provide a metering current of **0.5** of a volt across a 1 OHM resistor (RE) at a 100% load current, for use with the Motor Load Controller (MLC).

MLC – Motor Load Controller (Optional)

Prevents excessive current draw during pulldown or transient conditions. Overrides the action of 5 PS. (see appendix D).

2. SAFETY CONTROLS

OL – Compressor Motor Starter Overload Relays (line 6)

The compressor motor starter overload relays (OL) shut off the compressor unit whenever the compressor motor is overloaded. The overload relays are the manual reset type.

OL – Oil Pump Motor Overload Relays (see oil pump schematic)

On units employing a starter, the oil pump motor overload relays function in the same manner as described under compressor motor starter.

1PS – High Discharge Pressure, Low Suction Pressure Cut-Out Switch: (line 6)

When the discharge or suction pressure reaches its' maximum set point, the compressor and oil pump will immediately shut down. 1PS must be manually reset on high pressure cut-out and will automatically reset on low suction pressure cut-out.

3 TAS – High Discharge Temperature Switch (line 6)

When the high discharge temperature switch (3 TAS) senses the discharge temperature above a predetermined high, it de-energizes the master control relay (1 CR) and shuts down the compressor. 3 TAS will automatically reset itself when the temperature gets below the trip point, and automatically restart the compressor through (1TR) anti-recycle timer.

5 TAS – Low Oil Sump Temperature Switch (line 6)

The low oil sump temperature switch (5TAS) de-energizes the master control relay (1CR) and shuts down the unit, should the oil temperature be lower than minimum operating levels.

When the oil is heated to the proper temperature, the unit will automatically restart through (1TR) anti-recycle timer.

2 TR – Oil Pump shutdown Time Delay Relay (line 9)

In the start-up sequence, if normal oil pressure is not developed within 45 seconds, 2 TR will time out and shut off the oil pump. Thus, the compressor will not start until 2 TR is manually reset and the trouble is corrected.

6 TAS – Oil Pump Motor Temperature Protector (line 9)

Motor winding thermostats are installed to protect the motor from temperatures in excess of 225°F. They shut off the oil pump and compressor immediately. As soon as the temperature is 210°F or lower, the DBX unit will automatically restart through (1 TR) anti-recycle timer.

3. REFRIGERATION CONTROLS

5 PS & 6PS – Suction Pressure Controllers:

5PS—When the suction pressure is above a pre-set pressure this control will remain closed allowing the unit to load. **(line 17)**

6PS—When the suction pressure drops below a pre-set pressure this control will close allowing the unit to unload. **(line 19)**

1 SOL – Load Solenoid Valve (line 17)

The load solenoid valve (1 SOL) is controlled by 5 PS. When energized, it allows hydraulic pressure to move the slide valve piston in the load direction.

2 SOL – Unload Solenoid Valve (line 19)

The unload solenoid valve (2 SOL) is controlled by 6PS. When energized, it allows hydraulic pressure to move the slide valve piston in the unload direction. The load and unload solenoid valves (1 SOL and 2 SOL) actually work together in three settings as follows:

1 SOL and 2 SOL closed—Slide valve locked in a specific position.

1 SOL open and 2 SOL closed—Slide valve piston being moved in the load direction by hydraulic pressure.

1 SOL closed and 2 SOL open—Slide valve piston being moved in the unload direction by hydraulic pressure.

Compressor Slide Valve Position Indicator

The compressor capacity control consists of a coil spring, an indicator to show the position of the slide valve and cam switches, if required.

3CS – Unloading Cam Switch (Low Temp. Units Only)

During operation, this switch prevents the compressor from unloading below 25% of its capacity.

ELECTRICAL CHARACTERISTICS

Standard motors are 2-pole squirrel cage, 3600 RPM open drip proof type. Due to the wide variation in FLA and LRA between competitive makes of motors of like nominal horsepower and voltage characteristics, it is impractical to attempt to include such information in this catalog. Actual BHP requirements for various operating conditions are shown in capacity tables.

Dunham-Bush reserves the right to furnish any one of several approved motors depending upon availability, etc. Specific motor data will be made available on request from the West Hartford Division, Application Department, should such be desired or required.

Special motors available—consult factory.

NOTES:

1) Customer Connections:

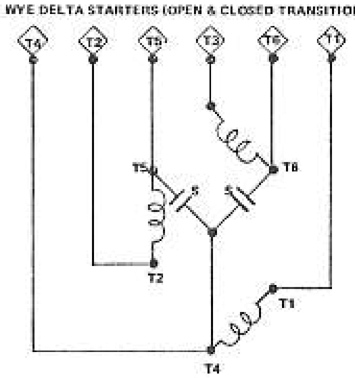
	TERMINALS	USED FOR
	L1, L2, L3	Power for Oil Pump Motor.
	LL1, 2	Control Circuit Voltage (115V).
	1, 2	Condenser Fan
	55, 56	Condenser Fan or Pump Start Contact (4TR)
(See Dgm.-1322 for connections to Compressor Motor Starter)	2, 4	Power to Compressor Motor Starter
	1, 13	Overloads of Compressor Motor Starter
	40, 41	Variable Resistor (RE) in Comp. Mtr. Str. Panel.

2) When supplied by D-B, transformer will be part of Compressor Motor Starter.

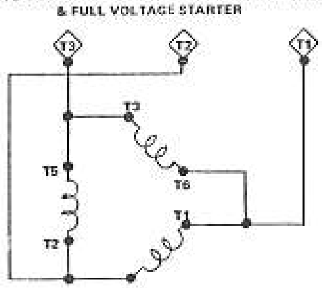
3) Cam switch (3CS) is furnished on low temperature units & the jumper (J46) is furnished on high temperature units. The cam switch must be set to cut-in above 25⁵/₈ slide valve travel and cut out below 25³/₈ slide valve travel.

BASIC COMPRESSOR MOTOR STARTER WIRING

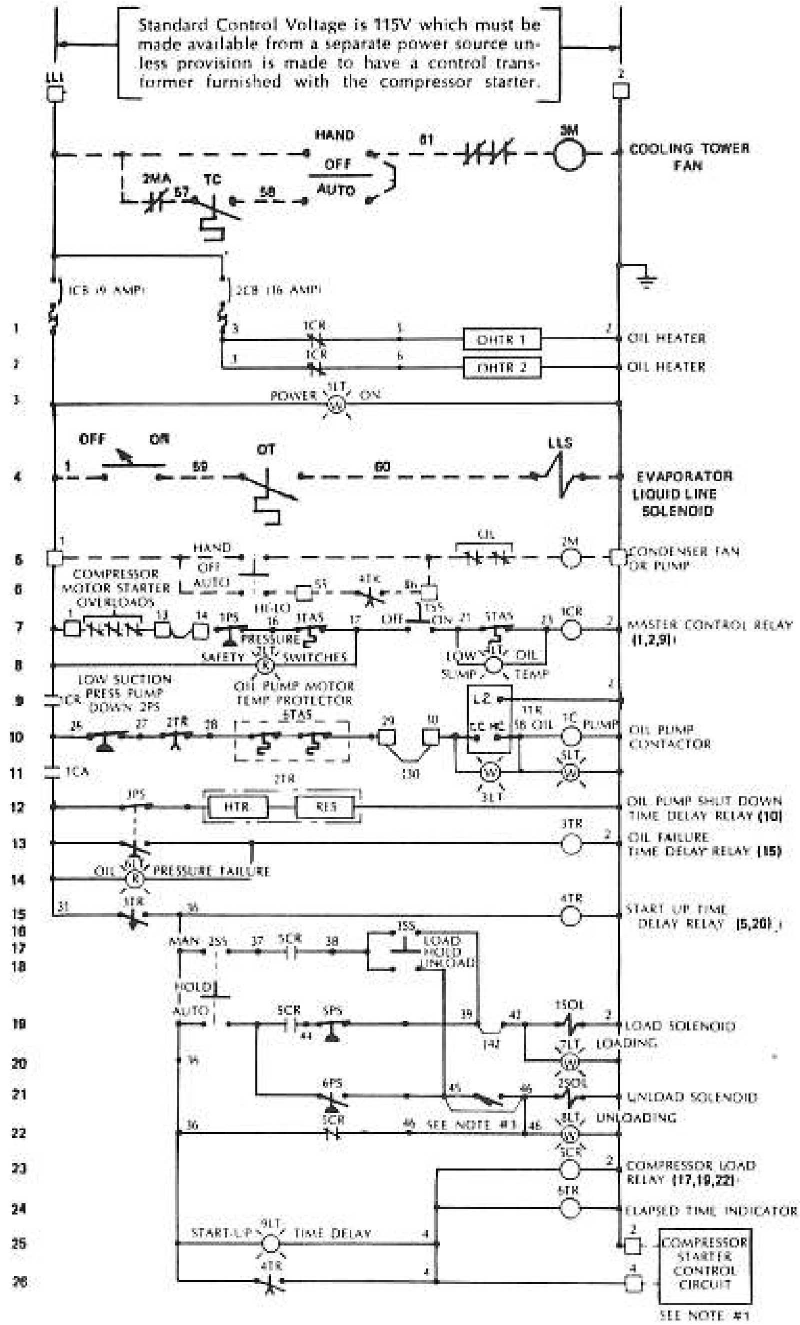
WYE DELTA STARTERS (OPEN & CLOSED TRANSITION)



AUTO TRANSFORMER STARTER (CLOSED TRANSITION) & FULL VOLTAGE STARTER



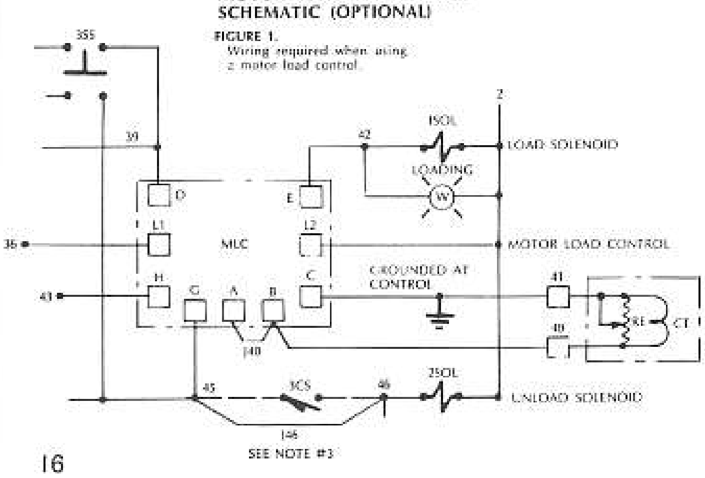
TYPICAL CONTROL SCHEMATIC



C5-DGM 1334

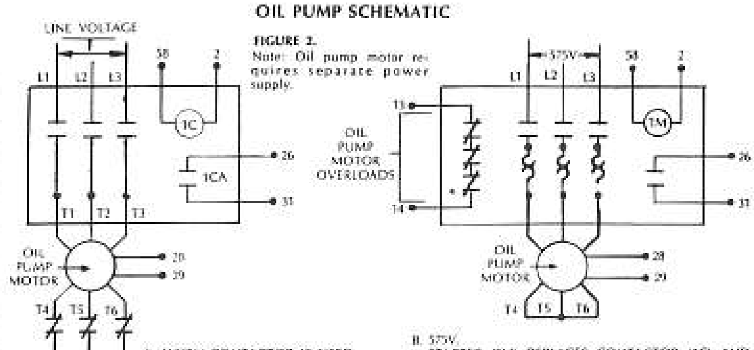
MOTOR LOAD CONTROLLER SCHEMATIC (OPTIONAL)

FIGURE 1.
Wiring required when using a motor load control.



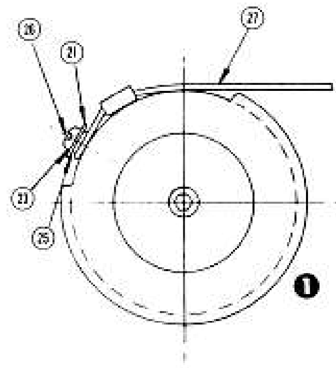
OIL PUMP SCHEMATIC

FIGURE 2.
Note: Oil pump motor requires separate power supply.

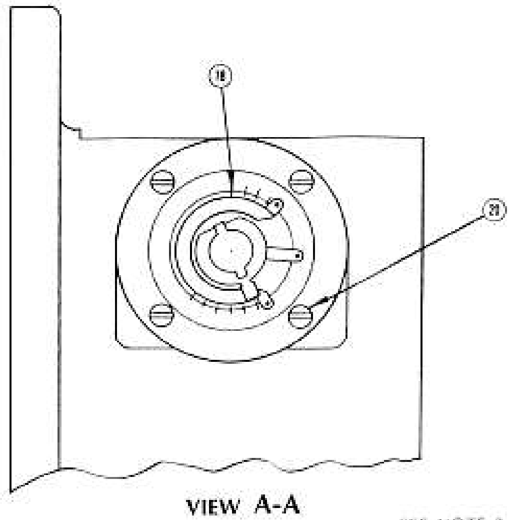


A. WHEN CONTACTOR IS USED (ALL VOLTAGES EXCEPT 575V)

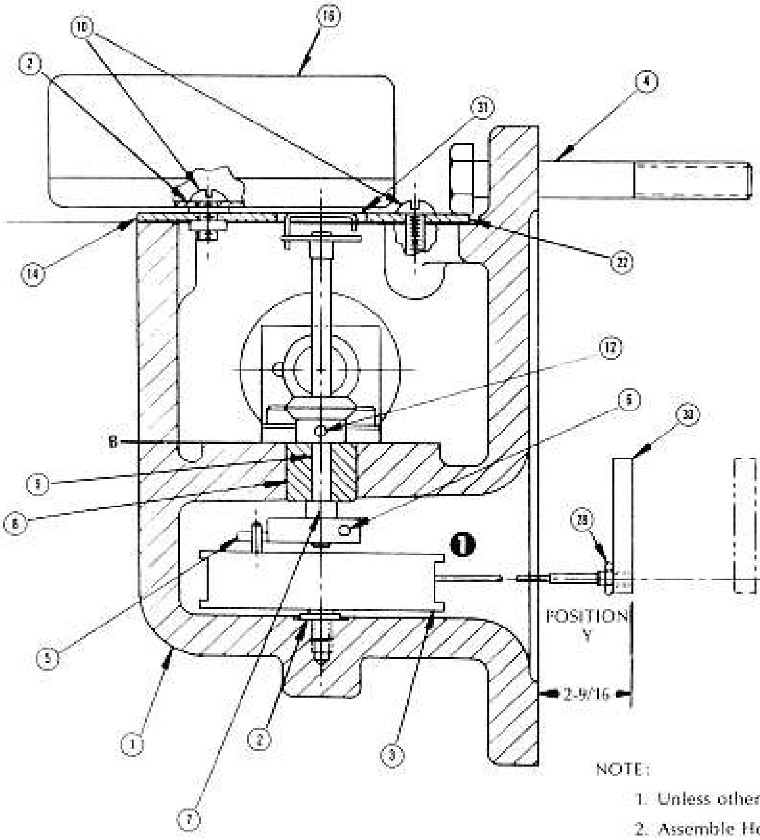
B. 575V.
STARTER (1M) REPLACES CONTACTOR (1C) AND OVERLOADS ARE WIRED INTO THE CIRCUIT

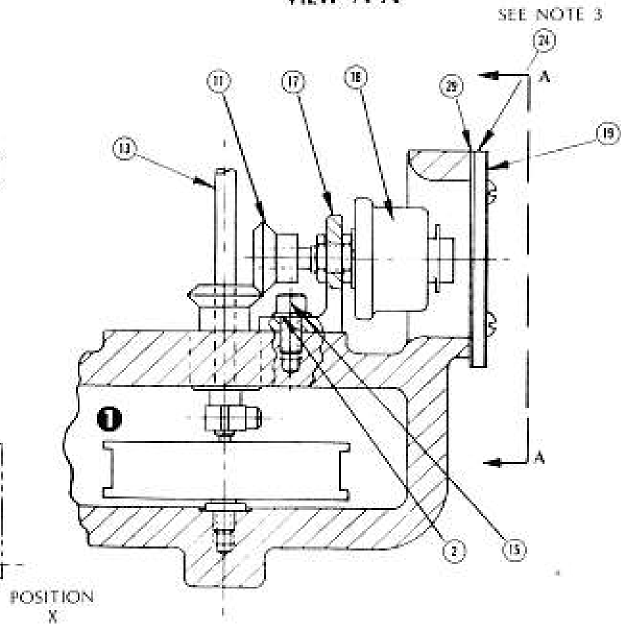


CABLE & REEL ASSEMBLY



VIEW A-A





SPRING TO BE WOUND 4 TO 5 TURNS SO THERE IS FULL TRAVEL TO POSITION "X" TENSION AT POSITION "Y" SHOULD BE 4¾ LBS MIN, PROVIDING CABLE FREELY REWINDS ENTIRE ASSY TO POSITION "Y" FROM POSITION "X"

NOTE:

1. Unless otherwise specified use Loctite "Screwlock" on all threaded items.
2. Assemble Housing (Item #1) & Bearing (Item #8) using Loctite "Bearing Mount."
3. Position Sight Glass (Item #24) on Housing (Item #1) so that Resistor Wiper Band (Item #18) is aligned with 100 when Controller is in fully loaded position.

ITEM	DESCRIPTION
1	Housing, unloader control
2	Washer, flat
3	Reel ass'y
4	Screw, hex head ½—13 x 3½ l'g
5	Clamp
6	Screw, soc. h'd cap #10—32 NF x ½ l'g
7	Bearing, bronze
8	Bearing, sleeve
9	"O" ring
10	Screw, round head ¼—20 x ½ l'g
11	Gear, miter
12	Screw, soc. h'd set (cup point) #6—32 NC x ¼ l'g
13	Bracket & shaft ass'y
14	Cover, lineloader 'hsg
15	Screw, soc. h'd cap ¼—20 x ½ l'g

ITEM	DESCRIPTION
16	Kit, switch
17	Bracket, resistor
18	Resistor, variable
19	Cover—resistor
20	Screw, round head #8—32 NC x 7/16 l'g
21	Washer flat
22	Gasket
23	Washer, external tooth # 8
24	Sight glass-resistor
25	Spacer, wire
26	Screw, pan head #8—32 NC x 3/18 l'g
27	Ass'y, cable
28	Nut, hex #10—24 NC
29	Gasket—resistor cover
30	Bracket, cable
31	O-ring

CAPACITY CONTROL

OPERATION

1. Initial Start-up

Following completion of the DBX Unit and Satellite equipment installation, plumbing and wiring, and completion of Dunham-Bush, Inc., Form No. 9193A, an authorized start-up representative will perform a thorough check of the entire installation for compliance with Dunham-Bush, Inc., requirements. He will then initially start the DBX Unit to insure the installation is in satisfactory operating condition and instruct the designated customer personnel in the operation and maintenance of the unit for the length of time specified in the purchase contract.

CAUTION: **The oil pump and compressor are NOT—repeat NOT —to be initially started except under the direct supervision of the Dunham-Bush, Inc. authorized start-up representative.**

Twenty-four hours before the arrival of the start-up representative, the oil heater circuit breaker should be turned on to raise the sump oil temperature to at least 100° F as the unit will not start at lower oil temperatures. This insures the oil is at proper operating temperature and any liquid refrigerant dilutant has been boiled out of the oil.

2. Normal Start-Up

a. **Oil Heater Circuit Breaker —ON (24 hours before start)**

b. **Cooling tower/fan or pump switches—AUTO**

c. **Control Circuit breaker —ON**

d. **Freeze-up, High/Low Pressure Cutout, Overloads and 2 TR—RESET**

e. **On—Off Switch — ON**

f. **Manual/Hold/Auto Switch — AUTO**

From this point on, the start-up is automatic and the following will be observed:

a. **At Once**

Power On Light	ON
Anti-recycle Timer Light	ON

b. **In 80 — 120 Sec.**

Anti-recycle Time Light	OFF
Oil Pump Light	ON
Oil Pressure Failure Light	ON

c. **Forty-five Seconds or Less**

Oil Pressure Failure Light	OFF
Start-Up Time Delay Light	ON
Unload Light	ON

d. **In Two Minutes**

Start-up Time DelayLight	OFF
Compressor Operating Timer	TIMING
Unloading Light	OFF
Suction Pressure Gauge	DECREASE
Loading Light	ON
Discharge Pressure Gauge	INCREASE

If the automatic start-up is not as shown above, consult the various wiring options on wiring diagram. If automatic start up is as shown above, the unit will operate automatically to meet the load requirements.

3. Normal Shutdown

a. **At Once**

On— Off Switch	OFF

b. **The following will now occur automatically At Once**

Compressor Operating Timer	STOPPED
Suction Pressure Gauge	INCREASE
Discharge Pressure Gauge	DECREASE
Oil & Discharge Pressure Gauge	DECREASE
Oil Heaters	ON

c. **To Secure the Control System**

Control Circuit Circuit Breaker	OFF

d. **To Secure the Oil Heater System**

Oil Heater Circuit Breaker	OFF

e. **To Complete Securing Unit**

Satellite Equipment Switches	OFF

NOTE: If the unit is to be restarted within 24 hours, **do not** turn off the Oil Heater Circuit Breaker.

III. MAINTENANCE

(A) GENERAL

Maintenance personnel should become thoroughly familiar with the unit and the contents of this manual in order to properly diagnose and rapidly correct minor difficulties. A comparison of the original log book entries with current entries and reference to the Trouble Shooting section in this manual will facilitate isolation of troubles. This section of the manual is divided into three sections as follows:

Periodic Maintenance — Maintenance performed at scheduled intervals.

Charging and Evacuating — The procedures to be followed when adding or removing refrigerant R-22 & R-12 or oil.

Component Maintenance — The procedures involved in the maintenance of the various components of the unit.

Maintenance Procedures — Specific maintenance procedures in detail.

Maintenance of the compressor is not necessary up to a minimum of 50,000 hours of operation. At the expiration of this time, it is requested that you have necessary service work performed by an authorized Dunham-Bush service representative.

NOTE: All threaded connections in the liquid systems use "Loctite," Catalog No. 71—41, thread sealant in accordance with the manufacturer's instructions.

(B) PERIODIC MAINTENANCE

(1) Pre-Initial Start-Up

(a) Check all piping stresses on unit (Refrigerant & water).

(b) All piping must be properly supported and vibration isolators installed as required.

(c) All piping must be clean and pressure tested. All refrigerant piping must be dehydrated to a maximum of 1000 microns.

(d) All piping must be designed and installed in accordance with recommended industrial practice. Necessary purge valves — Strainers — Check Valves — Automatic Control Valves — Test Valves — Charging Valves and Hand Valves must be furnished and installed as required to provide proper maintenance and servicing.

(e) All satellite equipment and associated control devices must be operationally checked and capable of handling their design capacities.

(f) DBX unit must be pressure tested and dehydrated to a maximum of 1000 microns. Sump oil heaters must be energized during dehydration cycle to insure proper dehydration of sump oil.

(g) All control, power and starter wiring must be checked for grounding and phasing.

(h) All automatic control devices must be checked for automatic operation.

(i) Sump oil level must be visible in sump site glass. Sump oil temperature must be at a minimum of 90°F.

(2) Daily Maintenance (a log of daily readings should be maintained)

(a) DBX unit (check the following)

(1) Refrigerant and oil pressures.
(2) Sump Oil Level.
(3) Condenser inlet and outlet temperatures.
(4) Evaporatc inlet and outlet temperatures.
(5) Compressor and oil pump motor amps.
(6) Oil cup levels on open motors.
(7) Bearing oil and compressor discharge temperature.

(b) Satellite equipment (check the following)

(1) Pump gland seal leakage.
(2) Cooling tower and tower and evaporative water bleed, and function of automatic water treating equipment.
(3) Air cooled condenser fans and belts.

(3) Monthly Maintenance (a log of monthly readings should be maintained)

(a) DBX unit (check the following)

(1) Stop unit — Remove coupling guard,observe condition of ring sets. If any rings are found to be cracked replace both ring sets and recheck coupling alignment. Visually check ring sets with flash light with unit running, If wavering is visible, stop unit and recheck alignment.

(2) Check pressure drop across oil filter. If pressure drop exceeds (5) psig replace oil filter. Refer to evacuation procedure section "C"

(3) An oil sample must be taken for acid content. If acid is found to be present, oil will have to be replaced and rechecked daily for acid. Acid contaminated oil must not be left in system. Oil will have to be changed daily until acid is no longer present. A weekly check must be made for four weeks after oil is acid free. A follow up acid check must be made after three months and a second follow up check made after six months.

(4) Measure seal leakage. If leakage is in excess of 10 cc/hr., seal leakage should be checked weekly to determine if leakage is increasing — local service engineer should be notified.

(b) Satellite Equipment (check the following)

Check wet/dry moisture indicator. If caution or wet condition is indicated unit must be thoroughly checked to determine cause and corrective action taken.

(1) Stop all belt driven equipment. Remove belt guards and check belt tension and wear. Tighten and replace all belts as required.

(2) Check amperage on all electric motors.

(3) Inspect tower and evaporater sumps and sprays — clean as required.

(4) Inspect air cooled condenser fins for cleanliness and remove all dirt from clogged fin areas.

(c) When brine solutions are in use solution density should be checked and density corrected as required.

(4) Semi-annual (a log of semi-annual readings should be maintained).

(a) DBX unit (check the following)

(1) Oil for acid content. If acid is found to be present oil must be changed and acid checks made as outlined above. A one quart sample of acid oil must be sent to oil manufacturer or test lab for complete analysis. Local service engineer should be called in to determine cause of oil failure.

(2) Operational performance check (using operational log) should be made and compared with previous logs. This log comparison will indicate what adjustments and settings should be made to insure best performance.

(b) Satellite equipment (check the following).

(1) Operational performance check should be made and compared with previous performance data.

(5) Annual check (a log of annual readings should be maintained).

(a) DBX unit (check the following).

(1) Pull condenser and oil cooler heads, clean tubes, tube sheets and heads. Inspect tube sheets and rolled portion of tubes for erosion and pitting. Leak test for refrigeration leaks between tubes and tube sheet.

(2) Leak test refrigerant and oil piping.

(3) Per manufacturer's lubricating instructions, flush and replace lubricant in compressor motor bearings.

(4) Check coupling parallel and angular alignment with dial indicator, refer to previous readings. If coupling alignment has changed coupling must be re-aligned. After coupling alignment is found to be correct, tighten hold down bolts & insure that dowel pins are tight and properly installed.

(5) With 500 volt/OHM meter meg compressor & oil pump motor windings; compare these readings with previous readings. Should a drop in meg/OHM readings be noted, consult local service representative of motor manufacturer or local D/B service engineer to insure that motor is satisfactory for continued operation.

(6) With unit in operation check the operation and calibration of all automatic control devices.

(b) Satellite equipment (check the following).

(1) All rotating equipment (fans and pumps) should be checked for alignment. Bearings flushed and relubricated per manufacturers requirements. Pump packing glands should be opened and packing inspected.

(2) All electric motors should be checked and serviced as outlined above.

(3) Cooling towers and evaporative condensers should be drained. Sumps and spray nozzles should be cleaned.

(4) Air cooled condenser fans and coils should be inspected and cleaned as required.

(5) All automatic control devices should be checked, link ages adjusted and lubricated.

(6) All automatic motor starters inspected for contact pitting, armature rusting, binding linkage; repair, replace and clean as required. Wye delta starters should be further checked for (YΔ) timing and mechanical interlock adjustment. Refer to manufacturers instructions.

(6) Seasonal Shut Down

(a) DBX unit and satellite equipment.

(1) Pump down refrigerant charge to receiver for storage.

(2) Drain water sides on all heat exchangers, cooling towers, evaporative condensers, pump casing and associated piping. Caution: any equipment subject to refilling from external sources must be protected. Areas that are subject to entrapping water must be blown out. All drain valves must be left open.

(3) Oil sump heaters should be left on for duration of shut down period.

(7) Seasonal start up (In general this should be treated in the same manner as initial start up or annual check)

(a) Prior to energizing compressor motor circuit the following checks should be made.

(1) Equalize high and low sides of refrigerant system and thoroughly leak check refrigerant and oil piping.

(2) Energize 115 volt pilot circuit and check the operation of all automatic control devices.

(3) Check the operation of compressor motor starter.

(4) Check phase rotation of compressor and oil pump motors.

(5) Check sump oil temperature and operation of sump heaters.

(6) Check operation of satellite equipment. Insure that design criteria is being met.

(7) Start oil pump and determine proper net oil pressure.

(b) Energize compressor motor circuit and make the following checks.

(1) Check proper sequence of start up. Hold compressor manually in the fully unloaded position.

(2) At start of compressor motor check compressor rotation.

(3) Load compressor to 25% capacity. Use operational log to record all temperatures and pressures. After determining satisfactory operation load compressor to 50% capacity, retake log readings. After determining satisfactory operation load compressor to 100% capacity, retake log readings. After determining satisfactory operation put compressor capacity control in automatic, log readings should be taken hourly for the first 6 to 8 hours operation.

(8) 50,000 Hour maintenance (A log should be kept of this inspection)

(a) Compressor should be opened up & inspected by factory personnel.

(b) Oil pump & hermetic motor assembly should be removed from sump.

(1) Pump star & rotor should be inspected for wear—caution:new "O" rings will be required for oil pump flange & oil sump flange.

(2) Pump shaft & bearing should be inspected for wear.

(3) Pump suction strainer should be cleaned.

(4) Oil sump should be inspected & cleaned.

(c) Oil charge should be replaced — caution: approximately 40 gallons of clean dry oil will be required.

(d) Compressor motor bearings should be opened up & inspected — Refer to Motor Manufacture's Instructions for Maintenance Instructions.

(e) Suction line strainer should be removed;inspected & cleaned as required.

(f) Liquid line filter drier blocks should be replaced.

(g) Annual maintenance logs should be reviewed thoroughly to determine what additional repairs or inspections are required.

(9) Adding oil to the system

Oil may be charged into the high side of the system at the oil sump, or into the low side of the system near the compressor suction, with compressor operating.

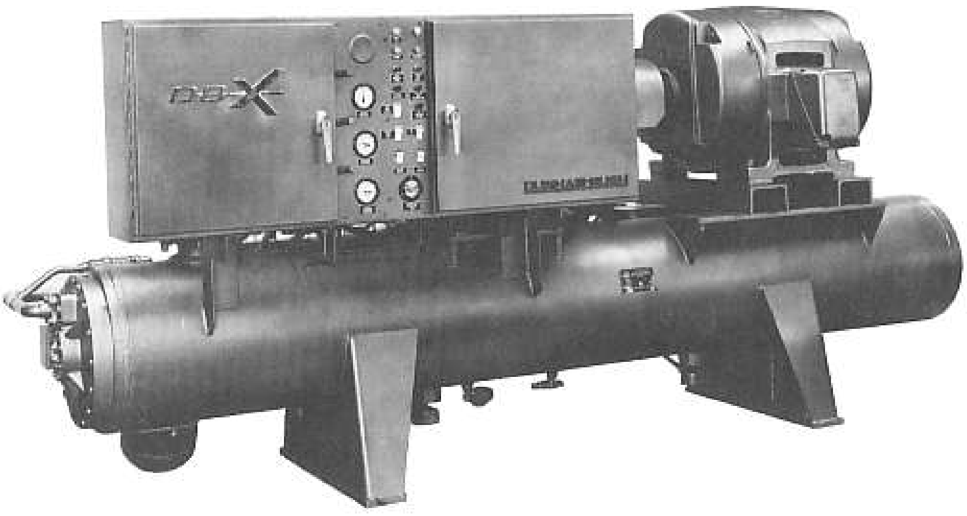
A small hand or electric portable pump, or a pressurized vessel may be used.

TROUBLE SHOOTING CHART

SYMPTOM		POSSIBLE CAUSE		SUGGESTED REMEDY	
(A)	**Unit Runs Continuously**				
(1)	High Suction & Discharge Pressure	(a)	Excessive Load	(a 1)	Reduced Load
		(b)	Reduced Condenser Capacity	(b 1)	Check GPM & Tube Fouling
				(b 2)	Check Cooling Tower Performance (or) Condenser Supply System
				(b 3)	Check Air or Evaporative Cooling Condenser Performance
				(b 4)	Check for Tube Fouling or other Air Flow Obstruction
				(b 5)	Check for Air Recirculation
				(b 6)	Check for Non Condensibles – Purge thru High Side if present
		(c)	Low Refrigerant Charge	(c 1)	Check all of the above before adding Refrigerant.
(2)	Low Suction & Discharge Pressure	(a)	Load Limiter Malfunction	(a 1)	Disconnect Load Limiter Circuit – If Unit will load in manual the problem is due to one of the following causes: (1) Improperly set or defective current transformer resistor. (2) Dirty (or) defective slide wire resistor. (3) Defective load limiter Refer to (Appendix F) For further instruction.
		(b)	Capacity Control Malfunction	(b 1)	If Unit Will Not Manually Load & Unload The Problem Is Due To One Of The Following Causes. (1) Improperly set or defective pressure switches. (2) Defective capacity control Refer To (Appendix F) (3) Units equipped with Static-O-Ring suction press controls; check the setting & operation of these controls.
		(c)	Excessive Condenser Capacity	(c 1)	Check GPM Flow
				(c 2)	Check Low Ambient Controls Readjust As Required.
		(d)	Improper Setting or Operation of Suction Pressure Actuated Fast Unload Control.	(d 1)	Check & Adjust As Required
		(e)	Low Refrigerant Charge	(e 1)	Check All Of The Above Before Adding Refrigerant.
(B)	**Unit Runs Continuously But Will Not Load To 100% Capacity.**	(a)	Improper Setting or Malfunction of Load Limiter or Capacity Control	(a 1)	Refer To (a 1 – Sect. A2) & (b1 – Sect. A2)
		(b)	Reduced Condenser Capacity	(b 1)	Refer To (b 1 - 2 - 3 - 4 - 5 - 6 Sect. A 1)
		(c)	Improper Setting or Operation of Suction Pressure Actuated Fast Unload Control.	(c 1)	Refer To (d 1 - Sect. A2)
(C)	**Unit Cycling On Low Suction Pressure Actuated Control**	(a)	Low Load	(a 1)	Increase Load
		(b)	Excessive Condenser Capacity	(b 1)	Refer To (c 1 - 2 Sect. A2)
		(c)	Capacity Control Malfunction	(c 1)	Unit Not Unloading Properly – Refer To (b 1 - Sect. A2)
		(d)	Restricted Refrigerant Flow	(d 1)	Improper Super Heat Adjustment – Check & Adjust
				(d 2)	Improper Operation Of TXV – Check For (1) Lost Charge In Power Assembly – (2) Piston Hang Up Within The TXV – (3) Condensing In Capilary Tube Between Feeler Bulb & Power Assembly – (4) Insufficent Liquid Refrigerant Supply To Power Assembly – Check For Restriction In Pilot Line And Or Insufficient Liquid Head To Fill Pilot Line.
				(d 3)	Plugged Filter Drier – Check (ΔP) Across Filter Drier. If In Excess Of 5 Lbs. Replace Filter Blocks.
				(d 4)	Plugged Suction Filter – Check (ΔP) Across Filter If In Excess Of 5 Lbs. Replace Filter.
		(e)	Low Refrigerant Charge	(e 1)	Check All Of The Above Before Adding Refrigerant

SYMPTOM	POSSIBLE CAUSE	SUGGESTED REMEDY
(D) Unit Cycling On High Head Pressure Actuated Control	(a) MLC improperly set (or) malfunctioning.	(a1) Refer to (a2 - Sect. A2)
	(b) Compressor Motor Overload Relays Improperly Set (or) Malfunctioning	(b1) Check current draw applied to overload relays — Set (or) replace overload relays and (or) heater elements as required.
	(c) Reduced Condenser Capacity	(c1) Refer to (b1 - 2 - 3 - 4 - 5 - 6 Sect. A2).
	(d) Overchange of refrigerant	(d1) Remove refrigerant until proper condenser balance is achieved — Recheck liquid sub cooling. This should be 5^{o} to 10^{o}.
(E) Unit Cycling on Compressor motor overload relays	(a) Load limiter improperly set (or) malfunctioning.	(a1) Refer to (a 1 -Sect. A2)
	(b) Compressor motor overload relays improperly set (or) malfunctioning.	(b1) Refer to (b1 — Sect. D)
	(c) Reduced condenser capacity	(c1) Refer to (b1 - 2 - 3 - 4 - 5 - 6 Sect. A1).
(F) High Discharge Temperature At Design Discharge Pressure.	(a) Non-condensibles in refrigerant.	(a1) Purge non-condensibles.
	(b) Insufficient oil cooling effect in compressor.	(b1) Check oil temperature leaving oil cooler — Range 100^{o} to 120^{o} F required. (b2) Check oil temperature leaving compressor — Range 4^{o} to 10^{o} F above discharge gas temperature — Insure proper oil flow thru compressor by checking proper setting of main & side injection hand regulated flow valves.
	(c) Excessive discharge superheat.	(c1) Discharge superheat range 30^{o} to 60^{o} F for (R-22) — 30^{o} to 90^{o} F for (NH3) — Check for (1) non condensibles (2) excessive suction superheat (3) insufficient oil cooling. (4) excessive pressure differential across across compressor (300 pound max.).
(G) High suction temperature at design suction pressure maximum suction temperature 100^{o}F.	(a) High to low side unloaded start by pass valve open	(a1) Check operation of solenoid valve 7 wiring.
	(b) Defrost solenoid valves malfunctioning (or) not properly adjusted.	(b1) Check operation & timing of defrost solenoid valves.
	(c) Reverse rotation.	(c1) Check rotation — should be (CCW) as viewed from drive end.
(H) Unit cycling on low net oil pressure (desired net oil pressure range 35 to 45 PSID)	(a) Restricted oil filter.	(a1) Check ( ) across oil filter — If in excess of 5 lbs. replace filter.
	(b) Excessively low oil level in sump.	(b1) Check discharge superheat — If below 30^{o}F oil may be carrying over into refrigerant system — Increase discharge superheat by (1) insuring proper suction superheat (2) insuring proper leaving oil temperature (100^{o} to 120^{o}F). b2) Short cycling of compressor — check the following for possible cause (1) fluctuating suction pressure; refer to Sect. C (2) fluctuating discharge pressure; Refer to Sect. D). * If it is necessary to add oil to sump, remove the excess oil when problem is remedied.
	(c) Insufficient oil pump capacity	(c1) Check for reverse rotation of pump. (c2) Excessively high ( ) across compressor — Check suction & discharge pressure — for high discharge pressure refer to (b1 - 2 - 3 - 4 - 5 - 6 Sect. A1) (c3) Improper setting of main injection oil flow — main injection pressure range is (15 to 25 PSI) below head pressure adjust hand throttling valve on main injection to achieve proper setting. * if it is necessary to add oil to sump — remove the excess oil when problem is remedied.

SYMPTOM		POSSIBLE CAUSE		SUGGESTED REMEDY	
(I)	Oil pump contactor trips out prior to compressor start.	(a)	Excessive Current draw on Oil pump motor.	(a1)	Check oil sump temperature — If below 75^{0} check the following (1) sump heater operation (2) over cooling of oil due to malfunction of oil cooler controls (3) excessive refrigerant in sump.
				(a2)	Oil pump seized — Inspect pump to determine cause.
		(b)	Failure to achieve net oil pressure in 45 sec.	(b1)	Excessive refrigerant in sump — Upon restart check the following (1) excessive refrigerant flooding due to faulty (TXV) operation (2) When used high to low side unloaded start by pass solenoid valve — This valve should only be open for 5 to 10 sec. during start of compressor motor (3) low sump level — Refer to (b1 - 2 Sect. H) (4) discharge check valve not closing allowing liquid refrigerant to accumulate in oil sump.
(J)	Compressor motor will not start.	(a)	Oil pump not running and/ or insufficient net oil pressure.	(a1)	Refer to a 1 - 2 - B1 Sect. I)
		(b)	Compressor motor over load relays tripped.	(b1)	Check & reset as required refer to (b1 - Sect. D)
		(c)	Defective holding coil in starter contactor and/or defect in relay & control circuit.	(c1)	
(K)	Compressor motor running — compressor not pumping.	(a)	Reverse rotation.	(a1)	Check rotation — male screw should revolve counter clockwise when viewed from coupling end.
		(b)	Total loss of refrigerant and/or refrigerant flow.	(b1)	Check the following (1) king valve open (2) (TXV) open (3) plugged filter drier and or suction filter — Refer to (d 1 - 2 - 3 - 4 - Sect. C)
				(b2)	Add refrigerant after checking all above.
(L) (1)	Wye Delta starter fails to pull out.	(a)	Malfunction of control	(a1)	Check wiring & controls.
		(b)	Malfunction of contactor holding coils.	(b1)	Check wiring & micro switches on size 6 & above starters check AC/DC rectifiers
(2)	Fails to transfer from Wye to Delta	(a)	Malfunction of control circuit and/on contactor holding coils.	(a1)	Check wiring & micro switches on size 6 & above starters check AC/DC rectifiers.
		(b)	Wye Delta transfer timer defective.	(b1)	With high voltage power off check timer — replace if defective.
		(c)	Mechanical interlock jammed.	(c1)	With high voltage power off check linkage — replace if defective.
(3)	Fails to release (S) contactor upon transfer	(a)	Jammed and/or improperly asjusted mechanical interlock	(a1)	Refer to (C1 - Sect. L2)
(4)	Repeatedly cycles back & forth from Wye to Delta.	(a)	Defective Micro switches and/or Wye Delta timer.	(a1)	With high voltage off check operation of micro switches & timer — Replace if defective.



APPENDIX

APPENDIX A

WATER TREATMENT

ANODIC CORROSION INHIBITOR

SPEC. NO. MAT-ES-26

This specification is based on the inhibitor identified as Corrode Stop and made by the Pyrolac Corporation.

Function

Corrode Stop is a water soluble, dry powder inhibitor. When used in the recommended concentrations, Corrode Stop will form an inorganic passivating film on the metal which continually heals itself. This coating effectively insulates, for example, copper from steel, without any adverse effects on heat transfer, thereby preventing the formation of galvanic current which causes corrosion of the steel. Because corrosion of metals normally forms at anodic areas on the metal surface, Corrode Stop must be present in sufficient concentration to maintain effective anodic polarization. For this reason, it is important to maintain the inhibitor concentration above the minimum required in any application. Excess above the minimum required does no harm. Corrode Stop protects all common metals such as iron, steel, zinc (galvanized), brass and aluminum, the exceptions being the combination of aluminum contact with copper. The presence of chlorides and sulphates in water make corrosion control more difficult and requires higher concentration of inhibitor.

Recommended Concentration

Use Corrode Stop at the rate of one pound (1 lb.) per one hundred gallons (100 gal.) of water to be treated. All internal surfaces should be clean and the water should be normal tap water. In a closed recirculating system, the above concentration will prevent corrosion indefinitely where there is no make up water. Further material should be added from time to time if there is make up water and the amount determined by the pH paper test, Part number PPR 3.

pH Paper Test

The use of Oxyphen pH paper is to establish the recommended concentration which, on a new system, should not be less than a pH factor of 8.0. The concentration should then be checked periodically and not allowed to go below a minimum pH factor of 5.0. When this minimum concentration is reached, additional Corrode Stop is to be added restoring it to the minimum pH factor of 8.0.

Application

For use with steel and bi-metallic heat exchangers in a closed recirculating water system with or without a make up supply.

Comments

Alternates acceptable if they provide self healing anodic polarization between dissimilar metals as specified in the function of the operation.

APPENDIX B

DBX STARTER SPECIFICATIONS

SPEC. NO. ELC-ES-9-3

General

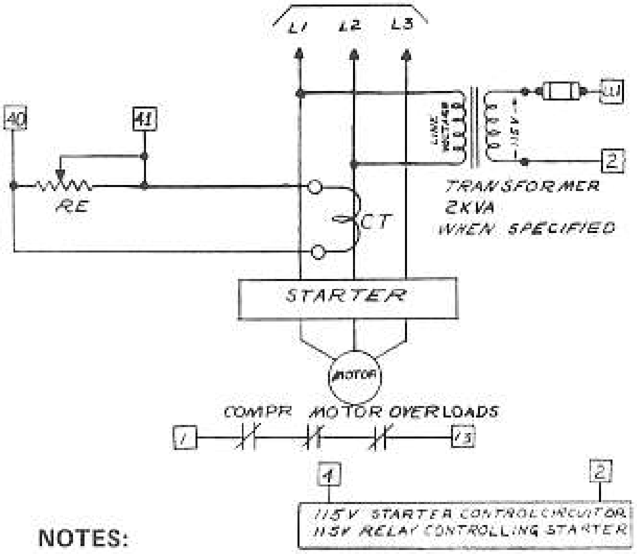
Any compressor motor starter to be supplied for use with DBX Model Compressor –

1. Unless otherwise specified, all starters shall comply with the requirements of the National Electrical Code National Electrical Manufacturers Association and any other state or municipal codes or restrictions.
2. All starters shall have NEMA Type I enclosures, unless otherwise specified, to comply with the requirements of national, state or municipal codes or restrictions.
3. The proper phase relationship shall be carried through the starter to the motor in accordance with NEMA standards. All terminals shall be identified with suitable markers.
4. Overload protection shall be provided in each phase of the motor during both the starting and running periods. The overload relays in starters for protection of open type motors may be either the magnetic type or ambient compensated bimetallic (standard trip) type. For protection of hermetic motors, magnetic type or ambient compensated bimetallic (quick trip) type overload relays are required. All overload relays shall be provided with manual reset features. Overload trip currents shall be 125 percent of the motor nameplate full load (line) current. On Wye-Delta starters, the overload relays are installed in the phase lines; this allows protection for "locked rotor" in the Wye connection as well as in the Delta connection. The overload trip currents of Wye-Delta starters must be 125 percent of the nameplate full load (line) current, divided by 1.73; in other words, the trip current must be 125 percent of the phase current.
5. A terminal block shall be provided (located in the enclosure) wired and marked.
6. If a current transformer and resistor are to be supplied for motor load limiting, they shall be connected to terminal blocks marked 40 and 41. The current transformer must sense "line" current.
7. The compressor motor starter shall be energized by a 115V single phase signal. The signal source shall be provided from the compressor control panel (for interconnecting requirements, refer to the basic wiring diagrams).
8. All auxiliary contacts on starters shall be rated a minimum of 370VA at 115 volts.
9. For electrical characteristics of the hermetic or direct drive motors, consult the factory.
10. The maximum transition time for the "2M" starter on the reduced voltage starters shall be no greater than 100 milliseconds.

APPENDIX C

STARTER CONNECTION REQUIREMENTS

DWG. NO A5-DGM 1322-1



NOTES:

(1) CT-The current transformer shall provide a metering current for the DBX motor-load controller (MLC). Must provide 6/10 volt across one ohm of resistance (RE) at 100% load current.

(2) Re-Variable resistor.

(3) Terminal point for interconnection to DBX panel.

APPENDIX D

The standard oil presently being used in the flurocarbon DBX Units is the Capella D for high temperature and Capella B for low temperature applications. Because of difficulty or impossibility of obtaining this oil in various parts of the world the following list of acceptable oils can be substituted.

MFR.	Above +20^{o} Evap. Temp.	Below +20^{o} Evap. Temp.
Sun Oil Co.	Suniso 4GS	Suniso 3GS
Esso	Zero - Mar R-48	Zerice R- 42
Shell	Clavus 33	Clavus 27
Mobil	Arctic 300	Arctic 155
Texaco	Capella D	Capella B

Note:

These oils should not be mixed. If oil has to be added to a unit that is different from the factory charge, the oil charge should be drained and a completely new charge of approved replacement oil be added.

APPENDIX E

OPERATIONAL & INSTALLATION INSTRUCTIONS FOR THE ANTI RECYCLE TIMER (SAFE–T–CYCLE)

GENERAL

The Safe-T-Cycle consists of a packaged timer with 3 cam operated switches, designed to delay the start of the compressor for a period of approximately 80 – 100 seconds after a demand by the control device under normal conditions. Under short cycling conditions the circuit is arranged so that the combined off and subsequent time will not be less than 20 min. In the event the power is interrupted between the line L1 and Terminal CC of the Safe-T-Cycle during the cycle period, by any of the controls between the line and terminal CC, the compressor starter holding coil will be locked out for the remainder of the cycle. The compressor will only start after the Safe-T-Cycle has reset.

TROUBLE SHOOTING THE ANTI RECYCLE TIMER

WHEN UNIT FAILS TO START

1. Check if power is available at terminals CC & L2 on the Safe-T-Cycle.

2. After determining that the power supply is available and the unit still fails to start, make certain that the full five minutes of the cycle has elapsed, since the last attempt to start the unit.

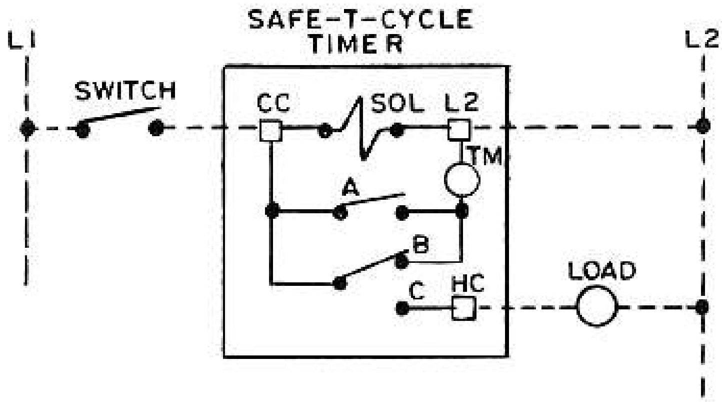
3. When the unit still fails to operate after following the procedures in Paragraphs 1 and 2, jumper terminals CC and HC. This bypasses the Safe-T-Cycle in the circuit. If the unit starts, the Safe-T-Cycle is defective and should be replaced.

4. If the preceding procedures fail to start the unit, the problem is in the system. Make a continuity check to ascertain if all the controls are in the "make" position.
   Trouble shoot the system as you would any similar system without a Safe-T-Cycle.

Note: The timer is fitted with a slotted shaft which protrudes through the case. For maintenance and emergency purposes, a screw driver can be used to turn this shaft in a clockwise direction to advance the timer through the 20 minute cycle. The shaft should be turned slowly until the load is energized; at this point, the screwdriver should be removed to allow the timer to complete its new cycle. Under normal circumstances the 20 minute timer has an inherent delay of 80 - 100 seconds before energizing the load.

DESCRIPTION OF OPERATION OF THE PARAGON SAFE–T–CYCLE TIMER

1. WIRING DIAGRAM



2. DESCRIPTION OF SWITCHING SEQUENCE (From De-Energized "Rest" Position)

STEP	POWER	SOL	SWT. "A"	SWT."B"	SWT. "C"	TM	COMMENTS
1	OFF	D	O	C	O	S	
2	ON	E	O	C	O	R	Cams revolve after a period of 80 - 100 seconds
3	ON	E	C	O	C	R	
4	ON	E	C	O	C	R	Timer continues to time out the cycle (20 min.).
5	ON	E	O	O	C	S	

3. Should any of the compressor controls open after the compressor has started and the timer has not completed its cycle, the following switching sequence will take place.

DESCRIPTION OF SWITCHING SEQUENCE (INTERRUPTION OF TIMER CYCLE)

STEP	POWER	SOL	SWT. "A"	SWT. "B"	SWT. "C"	TM	COMMENTS
1	ON	E	C	O	C	R	Load Energized.
2	OFF	D	C	C	O	S	Control Circuit interrupted Timer & Load De-energized.
3	ON	E	C	C	O	R	Control Circuit Remakes & Energizes Timer.
4	ON	E	C	C	O	R	Timer Continues To Time Thru The First Cycle Keep–ing The Load De-Energized.
5	ON	E	O	C	O	R	Timer Starts New Cycle.
6	ON	E	C	C	O	R	Timer In Delay Period (80–100 sec.)
7	ON	E	C	O	C	R	Timer Energized Load.
8	ON	E	C	O	C	R	Timer Continues To Complete The Cycle.
9	ON	E	O	O	C	S	Timer Has Reached The End Of It's Cycle. Load Remains Energized.

LEGEND:

D: De-Energized
E: Energized
O: Opened
C: Closed
S: Stopped
R: Running

DBX SHAFT SEAL

The shaft seals used on the PCX-O and DBX compressors are mechanical seal assemblies of the process type. Referring to the attached photographs and Engineering specifications ASY-EC-11, the two types of seals in current use are shown. Photo A shows the type 9 seal which is being used on the DBX 163 and 204 fluorocarbon applications and Photo B shows the type 8 seal which is being used on all the ammonia compressors and also on the DBX 255 fluorocarbon compressors.

The seal operates in an oil flooded seal chamber that is created by the seal housing and shaft seal ring. In operation the finely lapped rotating carbon ring is loaded against the ground and lapped stationary seat by a combination of spring pressure and hydraulic gas pressure. The seal is partially balanced so that the operating face pressure changes with compressor operating discharge conditions. The two surfaces are separated by a hydrodynamic oil film which varies in thickness due to changes in compressor head pressure and oil viscosity. Since the seal is operating at 3500 RPM the normal hydrodynamic laws apply as in the case of flat plate thrust bearings design. Also since the seal is operating between compressor discharge pressure and atmospheric pressure there is a considerable change in pressure involved, as compared to standard low side seal applications. In some cases this change in pressure can approach 300 psi, as in the case of air cooled condensing applications.

It is the effect of the high pressure differential and the finite oil film thickness that separates the rotating carbon face from the stationary ring and causes the seal to exhibit a slight amount of leakage. This hydrodynamic film between the faces is in effect an orifice with the internal pressure causing oil flow outwards. Without this leakage lubrication, the seal could run dry or have boundary lubrication which would cause excessive frictional heat build-up resulting in premature seal failure.

The DBX compressor shaft seals will exhibit slight oil leakage amounts. During the first few hours of operation the leakage can be as high as 4 – 6 cc/hr. After the seal runs in the leakage usually drops to 0.5 to 2.0 cc/hr. Engineering tests have proved that this slight oil leakage is not accompanied by refrigerant leakage in any significant amount. A trace of refrigerant may be detected if the oil is tested with a sensitive Electronic leak detector, since the oil is heated as it weeps thru the seal and the dissolved refrigerant in the oil is liberated to the atmosphere.

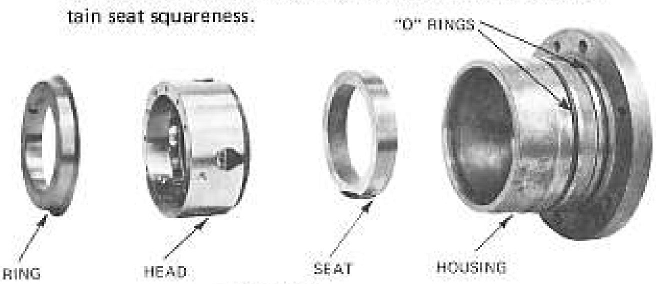
A connection is provided on all seal housings to which a drip tube can be attached so that the slight oil leakage may be in a suitable container and not mar the appearance of the unit.

Most of the early PCX/DBX units are still operating with their original shaft seals. Some of these units have operating times in excess of 15,000 to 20,000 hours with the seals still exhibiting a slight amount of oil leakage. However if it should become necessary to replace the seal for any reason it is essential that both the stationary seat and rotating member be replaced.

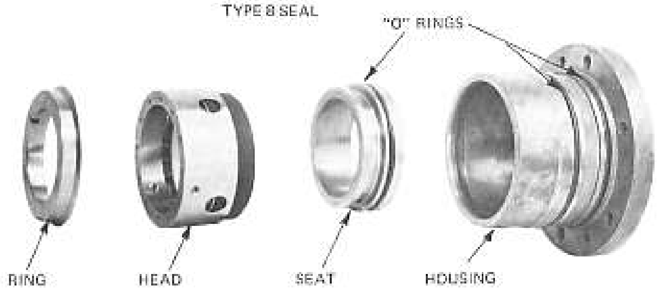
ASSEMBLY OF DBX MECHANICAL SHAFT SEALS

This assembly method covers Type 9 and Type 8 shaft seals.

1. Remove all burrs, chips, and foreign material from shaft, seal cavity, and seal housing.
2. Inspect shaft journal for nicks, marks or other irregularities.
3. Install seal ring with drive pins on shaft.
4. Lubricate secondary seals located in seal carbon I.D. with clean refrigeration oil and install on shaft.
   a. Type 9 seals have 4 holding clips which compress the seal's multiple springs and relax the Teflon wedge located in carbon ID for ease of alignment and installation. Seal head should be installed on shaft and fully seated against seal ring with drive pin engaged in one of seal holder spring holes. Using one hand,exert force on the carbon to keep seal in position and use a needle nose pliers to remove the 4 clips, one at a time. Check to see that seal is still in position and has not jumped past step on shaft. By hand, push seal to fully seat against seal ring.
   b. Type 8 seals have "O" secondary seal in carbon ID and do not have holding clips. Seal can be slipped onto shaft and seated against seal ring.
5. Install seal stationary seat "O" ring and lip seal (if used) in seal housing.
   a. Type 9 seal has a seat stop pin that is installed prior to seat.
6. Install seal housing "O" rings on seal housing and lubricate with refrigeration oil.
7. Clean seat and carbon operating faces and apply a coating of clean refrigeration oil.
8. Visually line up and orientate seal housing with seal housing bore and begin assembly. Install 2 long studs in seal housing 180° apart and draw housing up squarely. If seal head was not fully seated against seal ring in step 4, drawing up the seal housing squarely will correct seal head position. Install correct bolts and pull up in an even manner and torque per ASY-ES-3.
9. When disassembling seal, remove parts per steps 1 thru 8 in reverse order.
10. To remove seal head, break free from shaft by exerting force on carbon by hand or with soft block. Place 2 pieces of rod (tip bent at 90° to form hook) into seal head body holes – and pull off shaft.
11. Use soft drift or rod to tap seat out of housing. Stone any burrs created before installing new seat in order to maintain seat squareness.



TYPE 8 SEAL



TYPE 9 SEAL

OPERATION & CALIBRATION OF BARBER–COLMAN Motor Load Control (MLC) – Optional

The Barber-Colman Motor Load Control is a current control device. Its normal function is to limit motor current to a safe value by limiting the position of the capacity control. On this application, the motor load control is wired to limit valve position at all times, whether the valve is being controlled manually or automatically.

Screwdriver calibration adjustments CR1 and CR2 provide individual adjustment of the reference voltage for each channel of the MLC. Actuation point of each relay and, differential between relays is determined by these adjustments. The main control point adjustment dial determines the maximum reference voltage level, thereby providing single dial adjustment of the control point of both relays, without changing the differential between them.

The current drawn by compressor motors may be several hundred amperes. To obtain a signal proportional to load current, a current transformer & load resistor is used to supply a .5 volt AC signal, at the motor current representing 100% load. The Barber-Colman motor load control is designed to provide two separate relay circuits actuated by this AC signal.

The main current transformer load resistor should be a fixed resistor wired so that the current transformer secondary is never opened when adjusting for the proper signal. If the secondary of the current transformer is opened when energized, dangerous voltage will appear across the secondary. One side of the secondary should always be grounded. It is also advisable to place the load resistor as near to the current transformer as practical; that is, within the same cabinet, in order to keep the leads carrying 5 amperes as short as possible.

Calibration: The motor load control is calibrated by adjusting the control point of each relay to operate at the desired motor current. Each relay is adjusted independently, and can be calibrated to operate anywhere from 20% to 105% of full load motor current. In order to take advantage of the full capacity of the motor, CR2 relay should be adjusted to operate at 100% and CR1 relay at 105%. When CR2 relay operates at 100%, it prevents further loading of the compressor either manually or automatically. The operation of CR1 relay unloads the compressor if necessary. To adjust, proceed as follows:

a. Set the "% Current Limit" dial knob at 100%.

b. Check for proper signal to motor load control by measuring the voltage signal across terminals "A" and "C" with an A.C. voltmeter. At full motor current (100%), the current transformer output signal should be between .45 volts and .55 volts A.C. (The actual motor load current is determined by placing a clamp-on ammeter on one of the motor leads.) The machine can be loaded by operating the manual positioning switch on the unit instrument panel. Note: If the machine will not load up to 100%, it may be necessary to turn the CR1 and CR2 adjustments full clockwise so that the motor load control does not limit the loading.

c. The CR1 relay adjustment should be made first as follows: With the manual switch, load the machine. It will be necessary to increase the head pressure to reach 105% of motor full load current. When the motor current reaches 105% as read on the clamp-on ammeter, slowly adjust CR1 calibration screw (CCW) until CR1 relay just energizes, and the unload solenoid valve is denergized. The relays can be observed by removing the relay cover.

d. Reposition the slide valve with the manual switch to obtain 100% load. Adjust CR2 calibration screw slowly (CCW) so that relay CR2 is deenergized and load solenoid valve is energized just as 100% load is reached.

e. Recheck the settings by repeating paragraphs "c" and "d" above. To load the machine to 105% it will now be necessary to place a jumper wire between terminals "D" and "E". Otherwise the valve will stop when 100% load is reached.

Note: Sometimes it will not be possible to fully load the machine during check-out, and full load current will not be available for adjustment purposes. In this case, set the "% Current Limit" dial to a lower setting to calibrate. The dial setting and the loads at which relays CR1 and CR2 should be calibrated to operate can be calculated as follows:

Assume full load current is 400 amps, but the machine can only be loaded to 320 amps.

$$\text{\% Load Setting} = \frac{\text{Max. Load Available} - \text{5\% of Full Load} \times 10}{\text{Full Load}}$$

$$= \frac{320 - (5\%\text{ of }400) \times 100}{400}$$

$$= 75\%$$

CR2 Calibration = 75% of Full Load

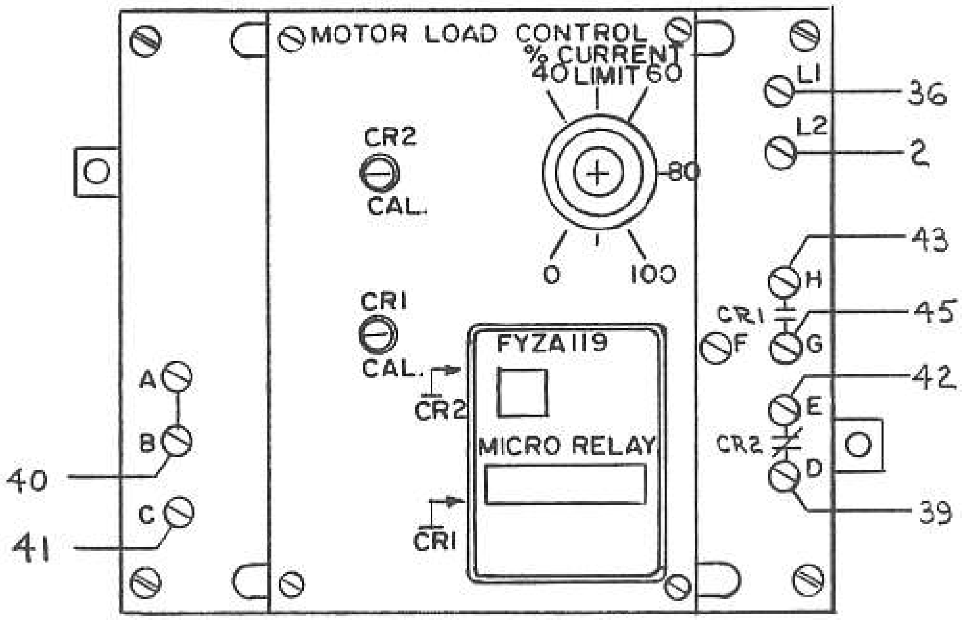
= .75 x 400 = 300 Amps

CR1 Calibration = CR2 Calibration + 5% of Full Load

= 300 + 20 = 320 Amps

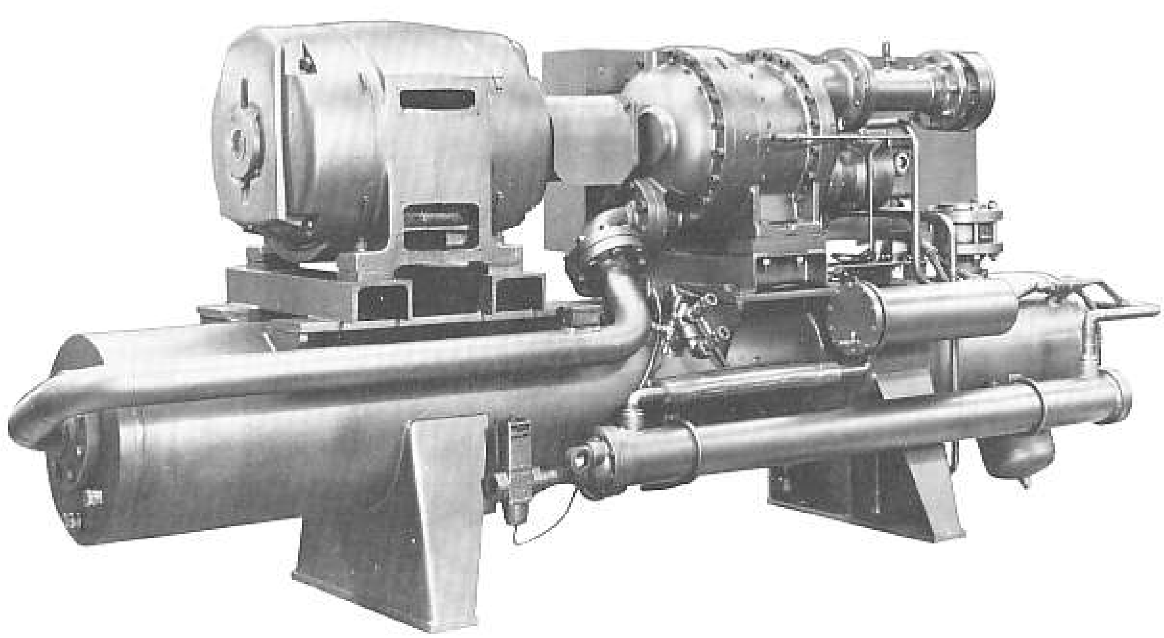
The CR1 relay must be adjusted first as shown in paragraphs "c" and "d". The "% Current Limit" knob can be set at 100%, or any other desired operating point.

MOTOR LOAD CONTROLLER (MLC)



RECEIVER CAPACITIES AT 80% VOLUME

SHELL O.D.	TOTAL VOLUME (Cu.Ft.)	80% TOTAL VOLUME (Cu.Ft.)	REFR. CAP'Y. R–12 90°F (80.14 lb/Cu.Ft.)	REFR. CAP'Y. R–22 90°F (72.81 Lb./Cu.Ft.)
14	13.05	10.45	837.46	760.86
16	17.27	13.82	1107.53	1006.23
18	21.47	17.18	1376.81	1250.88
20	26.85	21.48	1721.41	1563.96
22	32.86	26.28	2106.08	1913.45
24	38.63	30.90	2476.33	2249.83
30	62.18	49.74	3986.16	3621.57
36	91.68	73.35	5878.27	5340.61



PCX/DBX DAILY INSPECTION LOG

REFRIGERANT USED R–______

INSPECT. ED BY	DAY	ETM	O.A. TEMP	ACTUAL % LOAD	COMPRESSOR		OIL PUMP DISCH. PRESS.	OIL TEMP. LVNG. COOLER	CHILLED WATER		CONDENSER WATER		WATER TREATMENT	
					DISCH. PRESS.	SUCT. PRESS.			TEMP. IN	TEMP. OUT	TEMP IN	TEMP OUT	CHILLER	CONDENSER
	1													
	2													
	3													
	4													
	5													
	6													
	7													
	8													
	9													
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	31													

FORM NO. NS 71–01

PCX/DBX MONTHLY AND ANNUAL INSPECTION LOG

– MONTHLY –

CHECK FOR REFRIGERANT & OIL LEAKS		CHECK CONTROL PANEL FILTERS	
RECORD KW TO COMPRESSOR MOTOR		CHECK FOR RAPID CYCLING	
RECORD KW/HR		CHECK FOR DIRTY CONTACTS	
DRIVE MOTOR CURRENT		CHECK OPERATION OF PANEL INDICATOR LIGHTS	
DRIVE MOTOR VOLTS		WATER ΔP ACROSS CHILLER	
OIL PUMP CURRENT		WATER ΔP ACROSS CONDENSER	
VIBRATION		REFRIGERANT ΔP ACROSS FILTER/DRIERS	
CHECK REFRIGERANT MOISTURE INDICATION		CHECK SEAL LEAK RATE CC/HR	
– ANNUAL –			
CHECK CONTROL SETTINGS		OPEN & CHECK WATER SIDE OF CONDENSER	
CLEAN UNLOADER POT (CONTACT CLEANER)		OPEN & CHECK WATER SIDE OF CHILLER	
RECALIBRATE PANEL GAUGES		HAVE OIL ANALYZED	

COMMENTS: ____________________