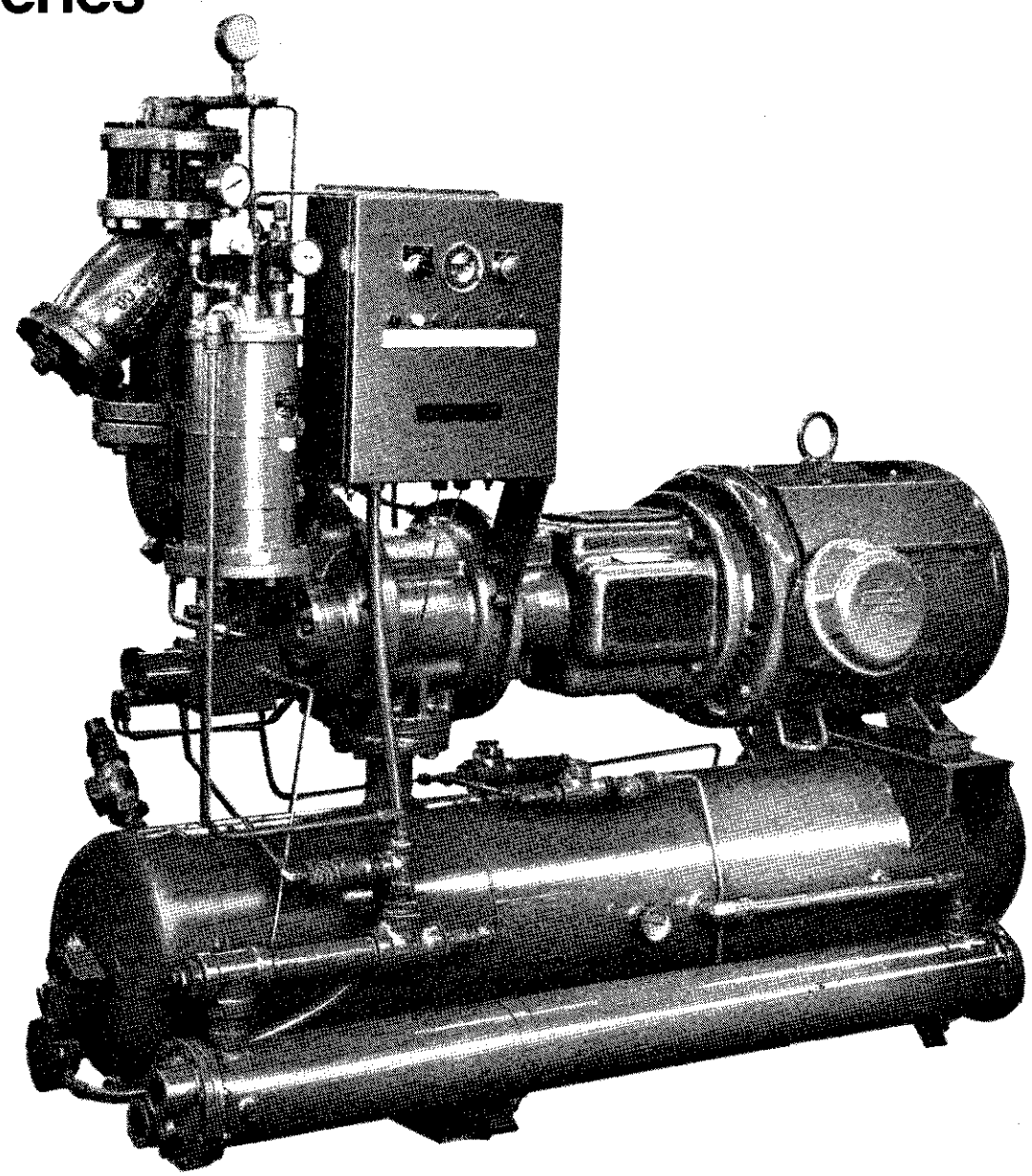
Operators Manual and Parts List

Sullair
Refrigeration Compressor

CB Series



Price $25

SULLAIR CB SERIES OPERATORS AND PARTS MANUAL P/N 253769 IN PDF FORMAT

REVISED BY MID-STATES REFRIGERATION SUPPLY INC.
JUNE 2010

THE LAST CB SERIES MANUAL WAS PRINTED 9/1979 AND WE AT MID-STATES REFRIGERATION HAVE UPDATED PORTIONS OF THE MANUAL AND ADDED ADDITIONAL PAGES

WE ARE ALSO ASKING YOU TO LOOK IN THE "A" SERIES OPERATORS AND PARTS MANUAL FOR MORE CURRENT OIL TUBING AND PIPING REQUIREMENTS ALONG WITH ADDITIONAL PARTS INFORMATION

THE "CB" SERIES PACKAGES WERE BUILT FROM 1976 TO APRIL OF 1985, THE NEXT MONTH THERE WAS A PACKAGE DESIGN CHANGE AND THE "A" SERIES WAS BORN.

THERE ALSO WERE DIFFERENT COMPRESSOR UNIT VERSIONS THAT RESULTED IN OIL TUBING MODIFICATIONS ALONG WITH SHAFT SEAL DESIGN CHANGES AND CAPACITY CONTROL OPERATION.

WHEN ORDERING PARTS FOR THE CB SERIES PACKAGES PLEASE PROVIDE PACKAGE MODEL NUMBER, PACKAGE SERIAL NUMBER, COMPRESSOR UNIT PART NUMBER AND COMPRESSOR UNIT SERIAL NUMBER.

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Section 1
DESCRIPTION

1.1 INTRODUCTION

Your new Sullair Refrigeration Screw Compressor will provide you with improved reliability and reduced maintenance if installed, started, operated and serviced according to this manual. As with all industrial compressors only trained and authorized personnel should install, operate and maintain the Sullair compressor. Take special note of items marked "important", "danger", or "warning", as overlooking these can lead to machine damage and/or hazardous situations. Should you have any questions which are not answered in this manual contact Sullair Refrigeration or their agents for assistance.

To ensure correct application the compressor package must be connected to a system designed and installed to good industrial practices such as described in the ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) "Systems Handbook" and the IIAR (International Institute of Ammonia Refrigeration) "Equipment Design and Installation of Ammonia Mechanical Refrigeration Systems". System valves and controls should be installed to the recommendations of the manufacturers or suppliers.

Immediately on arrival of your new Sullair compressor unpack all the crates and boxes and check the items against shipping lists for any possible shortages. Examine the compressor, package components and loose items for possible damage in transit. Notify the carrier of any shortages or damages and enter the appropriate claim with them.

Prior to proceeding any further, familiarize yourself with the compressor package components with the aid of figure 1-1.

1.2 THE PACKAGE

The compressor package is factory assembled and includes the following equipment:

- Sullair screw compressor unit
- Electric motor
- Lubrication system with oil separator and on high stage machines either a shell and tube water cooled oil cooler or a high pressure liquid refrigerant injection oil cooling system
- Suction strainer and check valves, discharge check valve, suction and discharge isolation valve
- Electrical control system

Refer to figure 1-1 for component identification.

1.3 THE COMPRESSOR

The U.S. Made Sullair Refrigeration Screw Compressor is an advanced design incorporating many years of experience in the screw compressor field. The single stage, positive displacement, pulse-free compressor includes the following design features:

- Non-symmetrical rotor profile
- 300 PSI (2.1 MPa) design casting
- Flange for direct mounting to the NEMA C flanged motor
- Anti friction bearings
- Oil flooded, carbon face shaft seal

Oil is injected into the compressor unit and mixes directly with the refrigerant as the rotors turn compressing the gas. The oil has three functions:

- As a coolant; it controls the rise of the gas temperature associated with the heat of compression.
- As a sealant; it seals the leakage paths between each rotor and the stator and also between the two rotors.
- As a lubricant; it acts as a lubricating film between the rotors allowing the male rotor to directly drive the female rotor.

The oil is separated from the refrigerant, after the refrigerant/oil mixture is discharged from the compressor unit. The refrigerant passes into the system, and the oil is cooled in preparation for injection.

The compressor capacity is varied by rotating a hollow cylindrical valve with openings distributed along its length so that the openings progressively correspond to ports in the stator, allowing the gas to return to suction rather than be compressed.

1.4 THE LUBRICATION SYSTEM

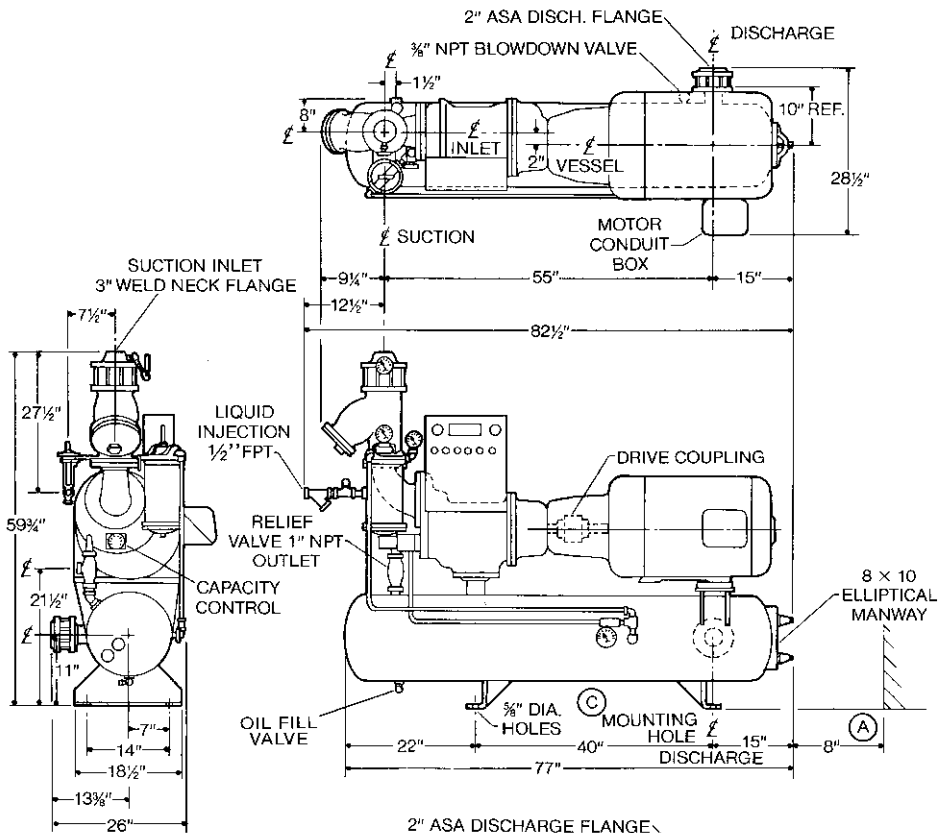
Figures 1-3 and 1-4 show the lubrication schematic for the CB12L package. Oil for bearings and injection is circulated by differential pressure between suction and discharge. Oil is passed through the main oil strainer then routed to the injection ports with the bearing oil filtered by a 15 micron fine filter before passing to the bearings. The compressor unit design is such that the differential pressure between suction and discharge normally creates an adequate bearing oil supply eliminating the need for an oil pump. However, under certain cold weather situations with single automatic start compressors some system modifications may be necessary (see section 3.5). On booster compressors the oil is circulated by a continuously running oil pump. The gas/oil mixture leaving the compressor discharge enters the oil separator/sump where the oil is separated. Sight glasses are installed in the sump portion of the separator to indicate oil level.

A thermostatically controlled oil heater is installed in the oil separator to maintain oil temperature when the compressor is not running. Oil cooling is accomplished by a shell and 3/8" O.D. tube oil cooler for water cooling or by direct injection of high pressure liquid refrigerant.

The water cooled oil cooling system is furnished with a water regulating valve which senses oil temperature.

The refrigerant cooled system includes a strainer, low discharge temperature switch, solenoid valve and temperature control valve. Refrigerant is injected directly into the compressor near the discharge port. The low discharge temperature sensor is included to stop refrigerant flow at low discharge temperatures and to prevent refrigerant overfeed.

Figure 1-1 Sullair Model CB 12 Rotary Screw Refrigeration Compressor

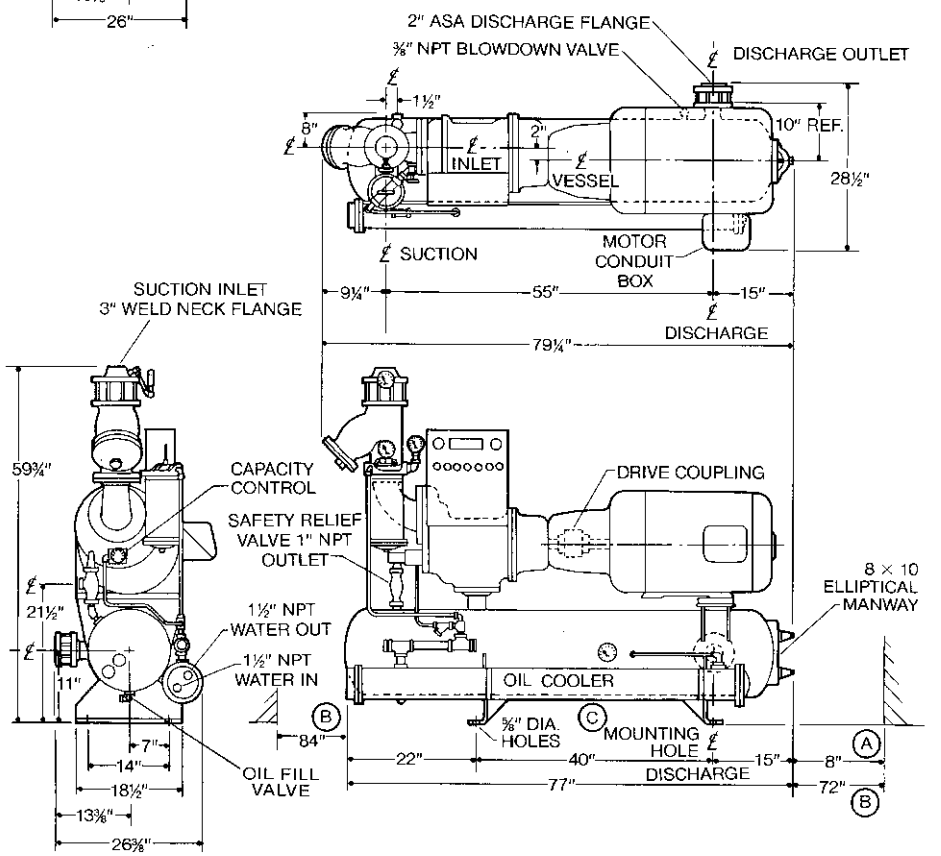


NOTES

(A) MIN. REQUIRED TO REMOVE SEPARATOR ELEMENT.

(C) DISCHARGE OUTLET & REAR MOUNTING HOLES ON SAME ℄

PACKAGE WEIGHT
2400 lbs. (1000 kgs.)
ALL DIMENSIONS
GIVEN IN INCHES.



NOTES

(A) MIN. REQUIRED TO REMOVE SEPARATOR ELEMENT.

(B) RECOMMENDED CLEARANCE FOR COOLER TUBE CLEANING.

(C) DISCHARGE OUTLET & REAR MOUNTING HOLES ON SAME ℄

PLEASE NOTE

IN THIS CB SERIES MANUAL THE PIPING

SCHEMATICS ARE FOR THE "A" MODEL OR VERSION

OF THE COMPRESSOR UNIT ONLY

YOU CAN DETERMINE WHICH MODEL OR VERSION OF COMPRESSOR UNIT YOU HAVE BY LOOKING UP THE COMPRESSOR UNIT PART NUMBER ON THE NEXT PAGE, THE FAR RIGHT COLUMN, IF YOU HAVE A "C" VERSION PLEASE REFER TO THE PIPING SCHEMATICS IN THE "A12" SERIES MANUAL. IF YOU HAVE A "C" VERSION COMPRESSOR UNIT OR A GEAR DRIVE COMPRESSOR PLEASE USE THE COMPRESSOR UNIT LEGENDS AND PIPING SCHEMATICS IN THE "A12" SERIES MANUAL.

SULLAIR A12/CB12 SHAFT SEAL KITS BY UNIT PART NUMBER

UNIT PART NUMBER	STYLE	USE KIT NUMBER	UNIT MODEL #
008432-001,004	GEAR DRIVE	001812B	C
008453-001,003,004	GEAR DRIVE	001812B	C
008573-011	GEAR DRIVE	001812B	C
008574-001,004	GEAR DRIVE	001812B	C
008578-001	GEAR DRIVE	001812B	C
008579-001,004	GEAR DRIVE	001812B	C
008724-001,004	GEAR DRIVE	001812B	C
02250064-160	GEAR DRIVE	02250047-688	
060564-1	DIRECT DRIVE	001812A	A
063048-100	DIRECT DRIVE	001812A	B
065067-100	DIRECT DRIVE	001812A	B
065096-300,310,320	DIRECT DRIVE	001919C	C
065453-300,310,320	GEAR DRIVE	001812B	C
065454-300,320	GEAR DRIVE	001812B	C
065455-300,320	GEAR DRIVE	001812B	C
066347-300,310,320	GEAR DRIVE	001812B	C
066348-300,310,320	GEAR DRIVE	001812B	C
066349-300,310,320	GEAR DRIVE	001812B	C
066351-300,310,320	DIRECT DRIVE	001919C	C
066570-300,310,320	DIRECT DRIVE	001919C	C
069571-100	DIRECT DRIVE	001812A	A
069698-200	GEAR DRIVE	001812B	B
069699-200	GEAR DRIVE	001812B	

AS OF DECEMBER 2004, 001812B & 001919C ARE TYPE 8 SEALS
AS OF DECEMBER 2004, 001812A IS A TYPE 21 SEAL

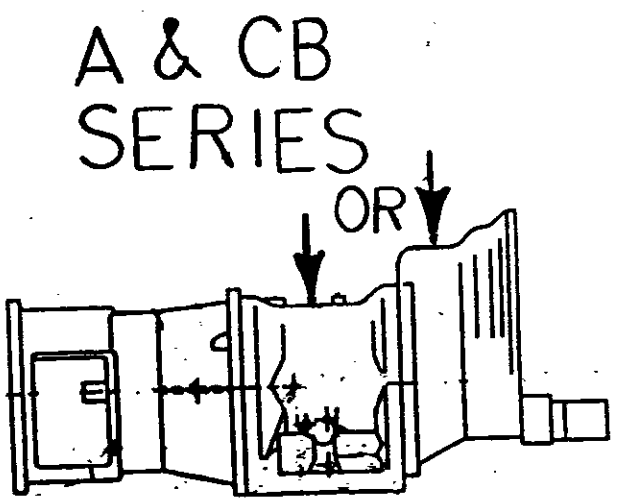


Figure 1-2 Legends For Figures 1-3 and 1-4

PRESSURE GAUGE (P)	TEMPERATURE GAUGE (T)	PRESSURE SWITCH (P)	TEMPERATURE SWITCH (T)	FILTER	STRAINER	ORIFICE	SNUBBER
SIGHT GLASS	PUMP	COMPRESSOR	MOTOR (M)	ROTARY ACTUATOR	STOP VALVE 2 WAY	GLOBE VALVE	CHECK VALVE
STOP VALVE 3 WAY	SOLENOID VALVE 2 WAY (S)	AMMONIA SOLENOID VALVE 3 WAY (S, "2", "1", "3")	FREON SOLENOID VALVE 3 WAY (S, From Oil Supply, "Valve", "Suction")	RELIEF VALVE 2 WAY	RELIEF VALVE 2 WAY	REGULATING VALVE 2 WAY TEMPERATURE CONTROL	REGULATING VALVE 3 WAY, PRESSURE CONTROL

REFRIGERANT OIL PIPING

OIL TUBING

CAPILLARY

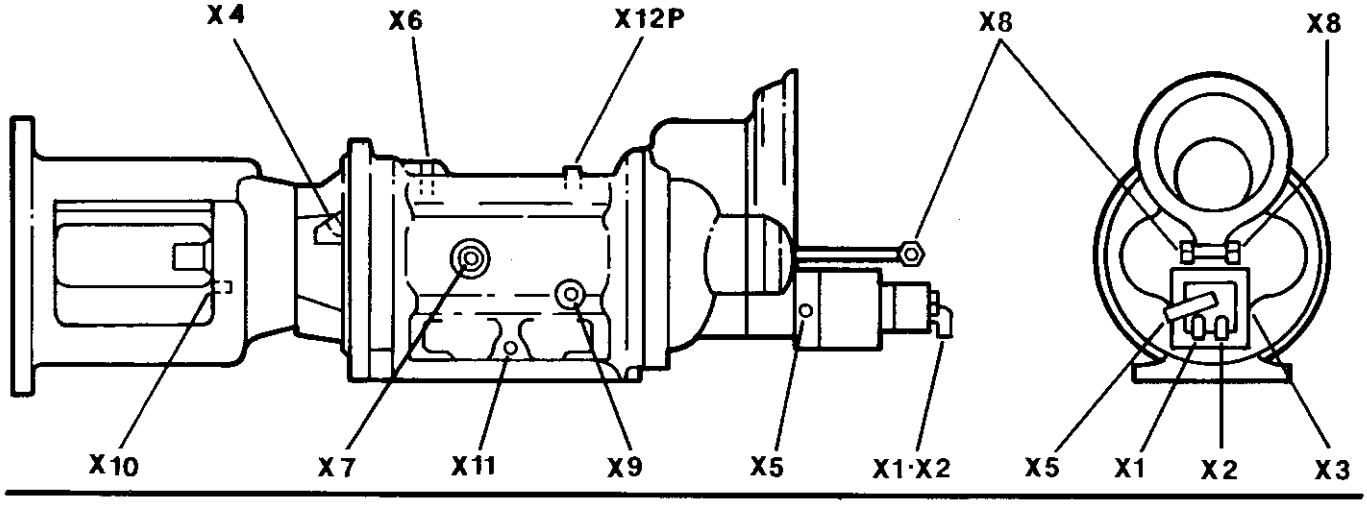
WIRING

CONTROL TUBING

INSIDE DASH-DOT LINE, INSTALLED AND/OR SUPPLIED BY CUSTOMER.

X1 OIL TO UNLOAD SIDE OF VALVE ACTUATOR
X2 OIL TO LOAD SIDE OF VALVE ACTUATOR
X3 OIL TO CAPACITY CONTROL VALVE BALANCE
X4 SULLISTAGE/LIQUID INJECTION
X5 MAIN OIL INJECTION
X6 OIL TO DISCHARGE BEARING
X7 OIL INJECTION—FEMALE ROTOR
X8 OIL TO INLET BEARINGS
X9 OIL DRAIN FROM SHAFT SEAL INTO COMPRESSOR
X10 OIL DRAIN FROM SHAFT SEAL
X11 DISCHARGE PRESSURE
X12 SUCTION PRESSURE

P NORMALLY PLUGGED



OIL ORIFICE
R-22- .090
R717 - .125

Figure 1-3 Water Cooled Piping Schematic

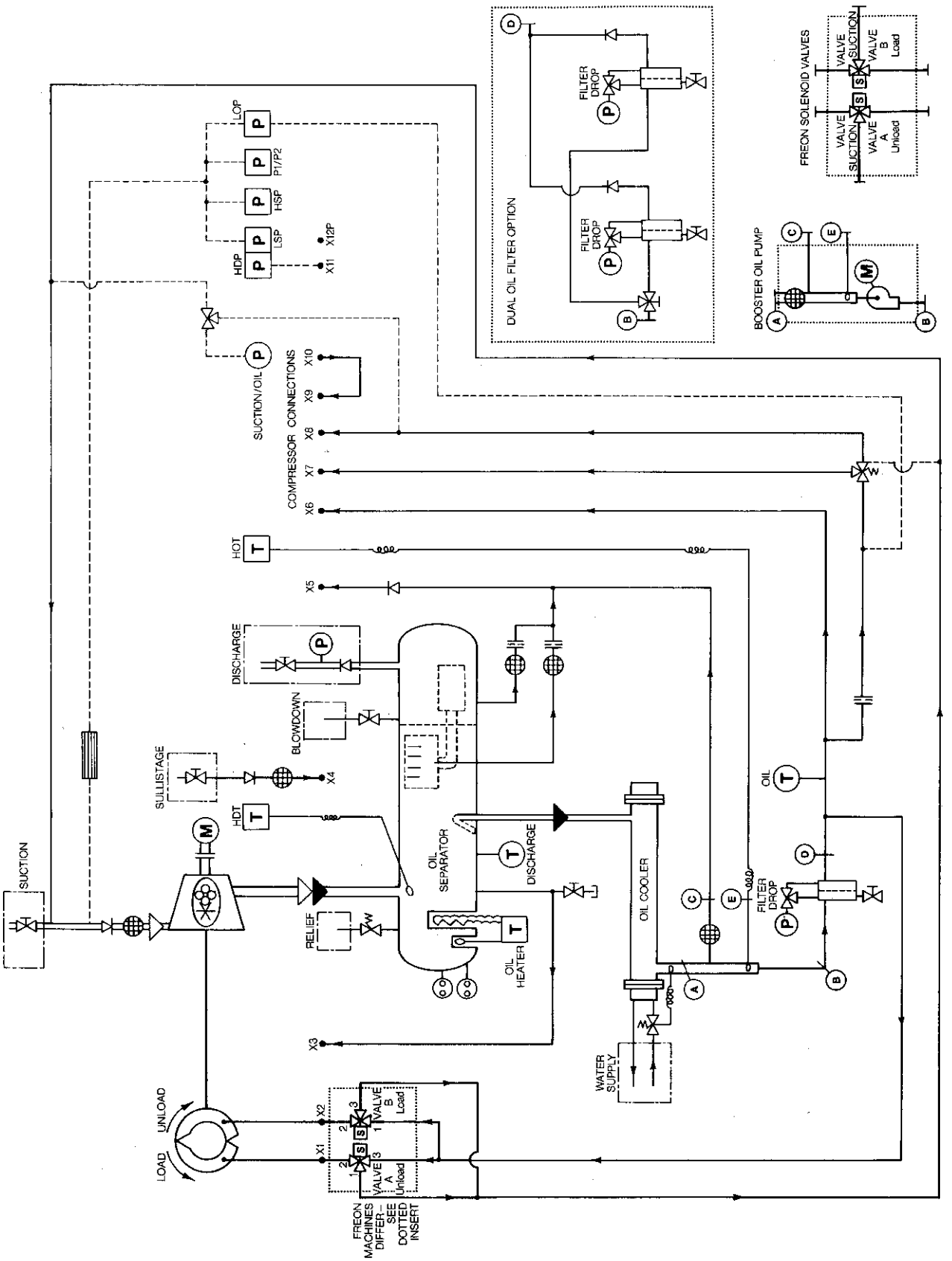
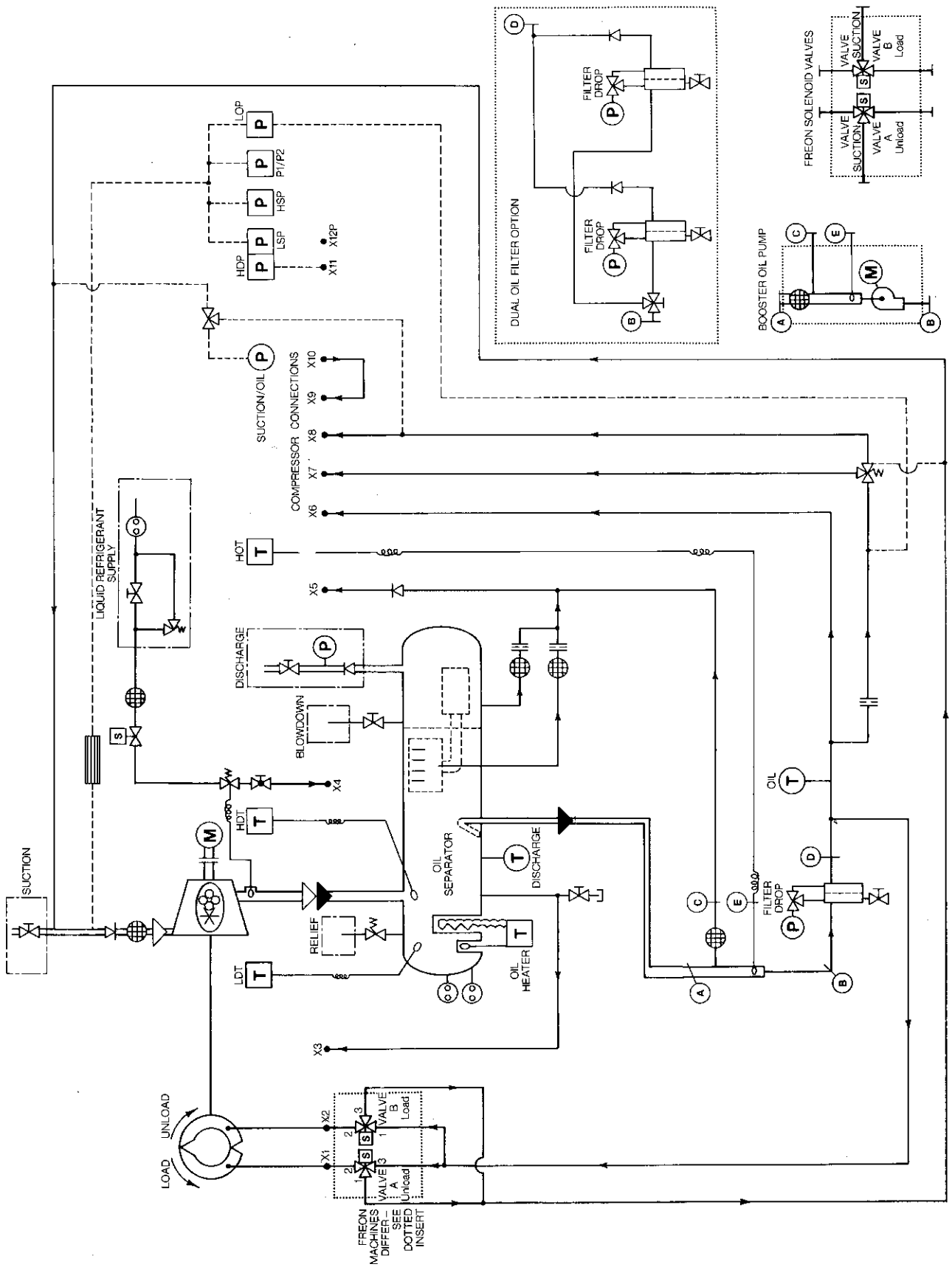


Figure 1-4 Liquid Injection Piping Schematic



Section 1
DESCRIPTION

The following optional lubrication system components are available:

- Dual oil filters
- Panel mounted pressure and temperature gauges

TABLE 1
TERMINOLOGY OF PRESSURE AND TEMPERATURE SWITCHES

First Letter: High or Low
Second Letter: Description
Third Letter: Pressure, Temperature

LSP	Low Suction Pressure Shutdown/Alarm (Manual Reset)
HSP	High Suction Pressure Start/Stop (Auto Reset)
HDP	High Discharge Pressure Shutdown/Alarm (Manual Reset)
HDP/LSP	High Discharge Pressure Shutdown/Alarm or Low Suction Pressure Shutdown/Alarm (Manual Reset)
LOP	Low Oil Pressure Shutdown/Alarm (Manual Reset)
SOP	Start-up Oil Pressure - Enables compressor start (Manual Reset)
LDT	Low Discharge Temperature (Auto Reset)
HOT	High Oil Temperature Shutdown/Alarm (Manual Reset)
HDT	High Discharge Temperature Shutdown/-Alarm (Manual Reset)

1.5 THE ELECTRICAL CONTROL SYSTEM

The package is supplied with a complete electrical control system (see figure 7-4). All normal running, protective controls and capacity control system controls are included.

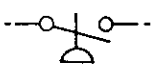
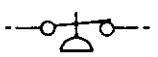
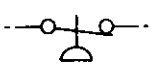
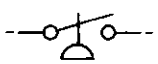
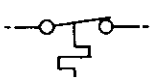
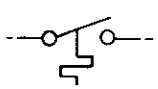
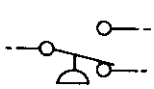
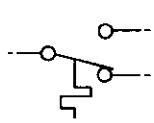
The control system is completely wired, piped and mounted to the package in a NEMA 1 control cabinet. The controls operate on 115V, 1 phase, 60 Hz power supply of 500 VA capacity. See the standard wiring diagram, figure 1-5, for additional details and keys to the description below. This diagram is only typical: see the wiring diagram for your machine for specific details.

All Sullair Refrigeration wiring diagrams are drawn with the relays de-energized and with 115V power supplied. The motor overload and the optional ampere relay have to be field wired and this is shown in dashed lines in figure 1-5.

The terminology and graphics of the pressure switches and temperature switches are given in tables 1 and 2.

The labeled wire numbers are shown on the wiring diagrams. The numbers on the far right hand side of the wiring diagrams refer to the line numbers where the contacts function. If the number is underlined, it refers to a normally closed contact.

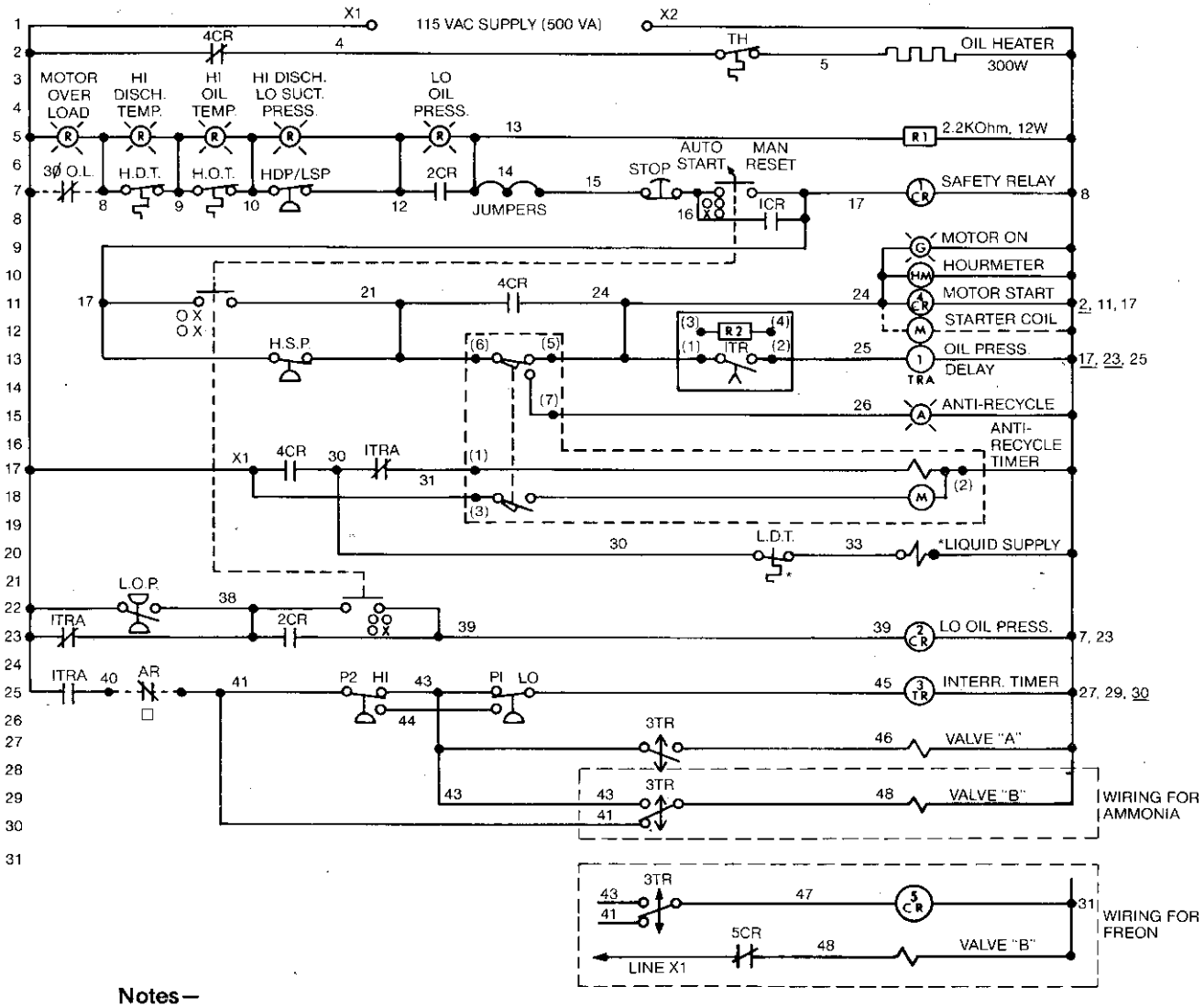
TABLE 2
GRAPHICS OF PRESSURE AND TEMPERATURE SWITCHES

	N.O.*	No Pressure Applied or Pressure Lower Than Set Point. Switch is Reset. (Special Case for HDP/LSP Switch Pressure Higher Than Lo Set Point *and* Lower Than Hi Set Point).
	N.C.**	
	N.C.	Pressure Applied Higher Than Set Point. Switch is Tripped. (Special Case for HDP/LSP Switch Pressure Higher Than Hi Set Point *or* Lower Than Lo Set Point.)
	N.O.	
	N.C.	Temperature Lower Than Set Point. Switch is Reset.
	N.O.	Temperature Higher Than Set Point. Switch is Tripped.
	N.O. N.C.	Some Switches Have A Common With A Double Contact.
	N.O. N.C.	

* N.O. = Normally open contact
** N.C. = Normally closed contact

The "Auto-Start"/"Manual-Reset" selector switch is a four function switch. In the wiring diagram, the contacts of this multi-function switch are shown with the switch in the left and right hand positions and the lower line shows the contact with the push button depressed and the switch in the left and right hand positions.

Figure 1-5 Wiring Diagram



Notes—

1—Field Wiring Shown in Dotted Lines.

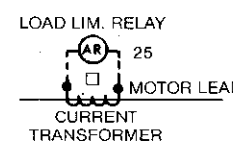
2—Contacts Shown With Relays De-Energized, Equalized Pressures, Normal Temperatures.

3—*Optional Liquid Injection Cooling.

4—For Ammonia Machines, Capacity Control Loads When Both Valves A & B On, Unloads When Both A & B Off, and Maintains Position When B On & A Off.

5—For Freon Machines, Capacity Control Loads When Valve A is On and B is Off, Unloads When A is Off and B is On, and Maintains Position When Both A & B Off.

6—□ Optional Load Limiting. Jumper 40 to 41 If Not Used. Field Wired Unless Machine Has Factory Mounted & Wired Starter.



Section 1
DESCRIPTION

RUNNING CONTROLS

Start Switch:

The start push button is a multi function switch allowing the compressor to operate in automatic or manual starting modes and also serving as a protective switch reset.

In automatic, the compressor will automatically start whenever the suction pressure rises above an adjustable high set point on the stop/start pressure switch (HSP).

The compressor will then load and unload as the system requires and will automatically shut down whenever the suction pressure falls below the lower adjustable set point on the HSP switch. If the suction pressure rises again to the higher set point automatic restart will occur. Auto restart will not occur when the compressor shuts down for a protective function, power interruption or if the "Stop" button is pushed.

To start the compressor manually, the push button is rotated to the "Auto-Start" position and pushed. The compressor will then start and stop in the automatic mode. If manual operation is desired after the start button has been pushed, the push button is rotated to the "Man-Reset" position. In the manual position, the compressor will load and unload as the system requires, but start up and shut down must be manually initiated.

After a protective switch shut down or whenever the control power is interrupted, resetting the control system is accomplished by rotating the start button to the "Man-Reset" position and pushing. The compressor can then be started again as described above.

Stop Switch:

The stop switch is a red push button which will shut down the compressor in any mode of operation.

High Suction Pressure Start/Stop Switch:

The dual set point high suction pressure switch (HSP) allows automatic starting and stopping of the compressor at set cut-in and cut-out suction pressures. The HSP is wired such that the protective circuit and the protective relay, 1CR remains energized during shutdown.

Low Discharge Temperature Switch:

On refrigerant cooled machines only, the low discharge temperature switch (LDT) prevents over feed of refrigerant to the oil cooling system. If the discharge temperature drops below the set point on the low discharge temperature switch, the main liquid line solenoid valve closes and stops the refrigerant flow to the compressor.

PROTECTIVE CONTROLS

Low Oil Pressure Switch:

The low oil pressure switch (LOP) consists of a pressure switch and a 10 second delay timer (1TR). During start-up, the low oil pressure switch is short circuited for ten seconds to allow the machine to build up sufficient oil pressure to close the low oil pressure protective switch contacts. The oil pressure relay (2CR) is energized during normal operation. If the oil pressure falls below the set limit, the LOP shuts down the compressor immediately and lights up the red indicating light. The LOP is reset by resetting the protective circuit with the manual reset push button. A power failure will also result in a low oil pressure indication which must be reset when power is restored.

This switch senses the oil pressure above discharge which is factory set and sealed at a 25 PSI (175 kPa) differential. It is non adjustable in the field. Removal of the seal constitutes abuse of the compressor under the terms of the warranty.

High Discharge Temperature, High Oil Temperature, High Discharge Pressure and Low Suction Pressure:

These protective devices are connected in series with the protective relay, 1CR. If the set point is exceeded on any switch, the compressor will immediately shut down and light up the red pilot light indicating the malfunction. Each must be manually reset on the respective switch after shut-down then the protective circuit must be manually reset by pushing the reset button. Refer to section 3.13 for adjustment.

Motor Thermal Overload:

A normally closed overload contact from the starter must be wired in series with the 1CR protective relay to shut-down the compressor in a motor overload situation.

Anti Recycle Timer:

The adjustable 0 to 30 minute timer prevents the motor from overheating by limiting the number of motor starts in a given period. It is energized everytime the compressor starts and the compressor cannot be restarted until it has timed out. If the start/stop switch or HSP calls for a restart before the timer has timed out, the machine will be in a standby condition and will automatically start when the set time has elapsed. An amber indicator light shows whenever the ART is timing.

The absence of control power will not allow the timer to time out. Control power must be restored to allow the timer to operate. If the machine has been off for a period of time exceeding the time set on the timer, the timer may be reset to zero to allow immediate start-up but it should be returned to the previous setting immediately.

REMAINING CONTROLS AND OPTIONAL CONTROLS

Oil Heater:

The oil heater and thermostat are connected through contacts of the starting relay (4CR) such that the oil heater circuit will be energized whenever the compressor is shut down and the control power is on. This heater prevents refrigerant from condensing in the oil and raises oil temperature for start up. Refer to section 3.12 for adjustment.

Pilot Lights:

Pilot indicating lights are provided for the following:

1. Motor run (green)
2. Anti recycle (amber)
3. Motor overload (red)
4. High discharge temperature (red)
5. High oil temperature (red)
6. High discharge pressure/low suction pressure (red)
7. Low oil pressure (red)

Protective device pilot lights are connected in parallel with each device and in series with resistor R1. An open contact causes a voltage difference across the pilot light which causes the light to come on.

Hour Meter:

An hour meter is supplied to record machine running time. Since the hour meter is connected across relay 4CR the recorded time advances only when the motor is running.

Optional Load Limit Relay
An optional load limit relay is available which will unload the compressor should the motor draw more than the current set point on the load limit relay. The load limit relay and current transformer are to be mounted in the motor starter.

Optional Ammeter
An optional ammeter is available to be mounted in starter to indicate motor current in one phase of the motor power supply.

Multiple Machine Sequencing
Multiple machine sequencing is accomplished by sequencial settings of the H.S.P. switch or a separate programmable controller.

Area Classification:
Optional electrical equipment is available for water tight NEMA 4 and hazardous locations NEMA 7 (Class 1, Group D, Division 1 or 2) area classifications.

1.6 THE CAPACITY CONTROL SYSTEM

Before a compressor can be started, the capacity control valve must be at minimum position for maximum bypassing of gas to suction. Whenever the compressor is shut down for any reason other than power failure, the capacity control valve automatically returns to the minimum position.

The capacity control system is connected through a timer (1TR) such that the machine cannot load during the initial 10 seconds of running. Once the initial time delay is complete after the initial start, the compressor may load or increase capacity.

The compressor capacity is controlled automatically from the suction pressure by a dual set point adjustable pressure switch (P1/P2). At the desired suction pressure which is midway between the two switch settings (or in the dead band) no control action occurs and the compressor remains in a constant capacity position. This adjustable dead band is approximately 2 PSI (15 kPa).

Above the high suction pressure set point, P2, the compressor loads. Below the low suction pressure set point. P1, the compressor unloads. Refer to section 4.6 for adjustment of these two pressure settings.

For ammonia machines, the controls operate so that the machine will increase capacity or load when both solenoids A and B are on. When both solenoids are off, the machine will decrease capacity or unload. In the condition of stable load, i.e., machine neither loads nor unloads, solenoid B is on, solenoid A is off.

For freon machines, the controls operate so that the machine will increase capacity or load when solenoid A is on and B is off. When solenoid A is off and B is on the machine will decrease capacity or unload. When both solenoids are off, the machine will neither load nor unload.

An automatic interrupter slows down the valve action so that the speed of response can be set to match individual system characteristics. This dual adjustment timer, 3TR, controls the "on" and "off" time of the capacity control actuator when there is either a load or unload signal. The actuator moves in a step wise fashion such that the "on" time adjustment varies the length or per cent capacity of each step and the "off" time adjustment varies the number of steps in a given amount of time. Refer to section 4.6 for adjustment of this timer.

An indicator/lever is provided which can be used to vary the capacity control valve position manually.

Other types of remote pressure or temperature controllers may be adapted to the capacity control system provided the same contact function as described above for P1/P2 is maintained.

Section 2
SPECIFICATIONS

2.1 OPERATING LIMITS AND SWITCH SETTINGS

** Anti Recycle Timer, Minimum (ART)	20 Minutes
* Oil Pressure Delay Timer (1TR)	10 Seconds
Oil Pressure, Above Suction Pressure	
Normal	35 PSI to 40 PSI (250 kPa to 275 kPa)
* Minimum (LOP)	25 PSI (175 kPa)
Maximum	60 PSI (400 kPa)
Oil Pressure Drop Across Filter, Maximum	25 PSI (175 kPa)
Oil Temperature	
Normal, Water Cooled	105°F to 115°F (40°C to 46°C)
Normal, Liquid Injection Cooled	118°F to 122°F (48°C to 50°C)
Absolute Minimum Before Starting	68°F (20°C) or 10°F (5°C) above saturation temp. of package pressure whichever is higher.
Ideal Minimum Before Starting	80°F to 100°F (27°C to 38°C)
** Maximum (HOT)	130°F (55°C)
** Oil Heater Thermostat (TH)	100°F (38°C) or 10°F (5°C) above condensing temp. whichever is higher.
Discharge Pressure	
Minimum, Liquid Injection Cooled	100 PSIG (700 kPag)
Maximum, Water Cooled	270 PSIG (1.9 MPag)
Maximum, Liquid Injection Cooled	210 PSIG (1.5 MPag)
** Maximum (HDP)	20 PSI (150 kPa) below system relief valve.
Discharge Temperature	
** Low, Liquid Injection Cooled (LDT)	105°F (40°C) or 10°F (5°C) above condensing temp. whichever is higher.
** Maximum, Water Cooled (HDT)	195°F (90°C)
** Maximum, Liquid Injection Cooled (HDT)	150°F (65°C)
Suction Pressure	
P1 Unload, Below Desired Suction Pressure	1 PSI to 2 PSI (7 kPa to 15 kPa)
P2 Load, Above Desired Suction Pressure	1 PSI to 2 PSI (7 kPa to 15 kPa)
Low (Compressor Stop or Cut Out), Below P1 Pressure (HSP)	5 PSI to 15 PSI (35 kPa to 100 kPa)
High (Compressor Start or Cut In), Above P2 Pressure (HSP)	2 PSI to 5 PSI (15 kPa to 35 kPa)
** Minimum, Below Low Suction Pressure (LSP)	2 PSI to 5 PSI (15 kPa to 35 kPa)
Maximum	100 PSIG (700 kPag)
Suction Temperature	
Maximum Superheat, Ammonia R12 or R22	20°F (11°C)
Suction/Discharge Differential Pressure, Maximum	275 PSI (1.9 MPa)
Water Temperature, Maximum Inlet Design	85°F (30°C)
Ambient Machine Room Temperature	
*** Minimum	50°F (10°C)
**** Maximum	104°F (40°C)
Compressor Speed	
Minimum	2900 RPM
Maximum	4000 RPM

NOTES

* This is factory preset and sealed to the above setting. Tampering with this device constitutes abuse of the compressor under the terms of the warranty.

** Set all protective devices and control switches to the above values.

*** If the machine is to be operated in an unheated machine room of 50°F (10°C) or lower, special modifications may be required. (Consult Sullair Refrigeration)

**** If the machine is to be operated in a machine room of 104°F (40°C) or higher, a motor having a higher class of insulation than Class B (standard) may be required. (Consult Sullair Refrigeration).

Section 2
SPECIFICATIONS

2.2 OIL SPECIFICATIONS

The oil specified for use in Sullair Refrigeration screw compressors is a refrigeration oil with a low pour point having a kinematic viscosity of 300 Saybolt Universal Seconds (SSU) at 100°F which is equivalent to 66 centi Stokes (cSt) at 40°C.

IMPORTANT

Used or filtered oil should *never* be added to a refrigeration screw compressor under any circumstance. Use only new oil from an oil manufacturer (any of the major oil companies or their approved dealers).

The oil must be changed every three months or 2000 hours unless the oil quality is assured by a qualified oil laboratory. See section 5.4 for further details of oil analysis.

The oil capacity is 15 gallons (55 litres).

Should you have other types of compressors in your system, it is recommended that you investigate changing their oil grade to that of the screw compressor. The screw compressor oil is usually satisfactory in other types of compressors, but the compressor manufacturer must be consulted for approval. This will minimize any possibility of the incorrect grade being added to the screw compressor.

Sullair Refrigeration assumes no responsibility for the quality, performance, availability, viscosity or pour point of the products in table 3 below.

TABLE 3
TYPICAL OIL SPECIFICATIONS

Manufacturer and Brand Name	Viscosity				Typical Viscosity Index	Pour Point			
	Specification		Typical			Typical		Maximum	
	SSU at 100°F	cSt at 40°C	SSU at 210°F	cSt at 100°C		°F	°C	°F	°C
American Oil Iso-vis Brand 38238	300-325	-	49.5	-	55	-30	-34	-25	-32
Exxon Zerice 68	319-349	61.2-66.2	51.1	7.4	71	-35	-37	-30	-34
Mobil Gargoyle Arctic 300	295-310	52-57.8	47.0	6.2	32	-	-	-35	-37
Shell Clavus 68	-	61.2-66.7	50.0	7.4	53	-25	-32	-20	-29
Sun Suniso 4G	280-300	-	47.0	6.2	21	-35	-37	-30	-34
Texaco Capella WF68	330-350	61.3-67.8	47.0	6.2	13	-35	-37	-30	-34
Union 76									
Klondyke 68	300-330	63.7-68.3	47.0	6.2		-25	-32	-20	-29
Turmaco 68	300-350	63.7-68.3	49.0	7.0	35	-50	-46	-30	-34

Section 3
INSTALLATION

3.1 GENERAL

This section contains instructions for the proper installation of Sullair CB Series Refrigeration Screw Compressors. All items in this section must be completed by those with installation responsibility before the Sullair Refrigeration Representative arrives for start-up. For answers to any specific questions about installation procedures, please contact Sullair.

3.2 START-UP SERVICE OUTLINE

The following items outline tasks that must be completed before the Sullair Refrigeration Representative arrives at the job site if start-up is included in the machine purchase price.

1. The compressor is to be leveled, securely anchored to the foundation and grouted.
2. All refrigeration piping is to be completed. Relief valves are to be properly vented.
3. The water piping is to be completed with the water valve installed for water cooled machines.
4. The refrigerant piping is to be completed for the refrigerant cooled machines.
5. The system and the compressor package are to be pressure tested for leaks.
6. The system is to be evacuated to remove air and moisture.
7. The coupling does not require alignment since it is flange mounted to the motor.
8. The electrical wiring is to be completed as per wiring diagrams. Do not energize the compressor control panel until oil is added or the oil heater is disconnected.
9. The compressor is to be filled with the correct type and amount of lubricating oil.
10. The oil is to be warmed up.
11. The control panel is to be energized to check the protective switches.
12. The direction of rotation of the motor is to be checked.

The Sullair Refrigeration Representative will supervise the following with customer supplied labor:

1. Check the general installation.
2. Check all electrical protective controls.
3. Start the compressor for the first time and adjust all the package valves and controls.
4. Set capacity control actuator adjustment.
5. Explain compressor operation to the operating personnel.

3.3 STORAGE

The compressor package should be stored at all times in a dry location to prevent corrosion damage. The suction and discharge lines are covered for shipment and short term storage. If the unit is to be stored for a prolonged period of time, the unit should be checked occasionally that the holding charge of dry nitrogen remains above atmospheric pressure. This will prevent corrosion from any moisture that might enter the compressor package.

3.4 FOUNDATION AND RIGGING

The compressor package can be mounted and secured to any hard rigid and level surface which is adequate to support the weight of the package. Since the screw compressor is a relatively vibration free rotary machine, it does not have to be mounted on an inertia block or pad.

Check the foundation anchor bolt spacings with the hole spacings in the package base.

Lift the package by placing slings under each end of the complete assembly. Use spreader bars or timber under the slings to prevent damage to the piping and components. Do not sling from the pipework, the suction strainer or the eyebolt holes in the motor. Eyebolts have been provided for lifting component pieces only and not the entire package. Do not fork lift the package without taking precautions against toppling as the package is top heavy.

If the mounting surface is not level, use shims under the frame to distribute the weight evenly over the entire frame. Any gross distortion of the frame when the anchor bolts are tightened will cause coupling misalignment.

In locations with excessive floor vibration, it may be necessary to mount the package on an inertia block or pad and isolate the package and pad from the floor.

Vibration isolation equipment can be effectively used only if flexible connectors are used in the piping and electrical conduit.

3.5 REFRIGERANT PIPING

All piping must conform to federal, state and local codes and good industrial practice (eg ANSI 31.5 and ASHRAE Systems Handbook).

The size and location of the package piping connections can be found on the general dimensions drawing of the package. Back-up weld rings should be used in all joints in the suction and discharge lines to minimize the amount of weld slag inside the system pipes. All steel lines (especially suction, Sullistage, and liquid injection lines) should be thoroughly cleaned, for example by power rotary wire brushing and blowing out with compressed air.

Do not ground through the compressor when arc welding.

The suction line and discharge line should be installed and supported such that there is *no load* exerted on the compressor frame.

IMPORTANT

If the system must be started automatically during cold weather or with equalized system pressure it may be necessary to install either a back pressure regulator at the compressor discharge since the oil is normally circulated by the gas pressure difference between the suction and discharge pressures. During cold weather it may take an excessive time period to warm the system such that the discharge pressure will be high enough to circulate oil and satisfy the low oil pressure switch.

3.6 COOLING WATER SUPPLY REQUIREMENTS

On water cooled machines, an adequate supply of clean or treated water must be available to the compressor. If tower or condenser pan water or hard untreated water is to be used consult Sullair for possible design modifications.

The oil cooler is designed for a 15°F (8°C) rise in water temperature with a maximum water inlet temperature of 85°F (30°C) and a water pressure of 25 PSI (175 kPa) or larger.

The water flow rate can be calculated from oil cooler heat load data (See Engineering Selection Information, normally 15 GPM to 20 GPM (1 L/s to 1.25 L/s) If optional closed circuit glycol cooling is used, the normal maximum inlet temperature is 90°F (32°C) with a temperature rise of 10°F (5°C).

For other cooling water temperature or special requirements, consult Sullair.

The 2-way water regulating valve supplied with the machine should be installed on the *inlet* side of the cooler with the temperature sensing bulb inserted into the bulbwell in the oil line leaving the oil cooler. Grease should be put into the bulbwell before inserting bulb to insure adequate heat transfer between the bulb and the oil. A water solenoid valve is recommended to stop the water flow upon shut down. Manual by-pass valves are recommended to allow water supply to the cooler in case of an inoperative water regulating valve.

Optional 3-way water regulating valves are available. If a 3-way valve is used, a manual balancing valve is recommended.

3.7 COOLING REFRIGERANT SUPPLY REQUIREMENTS

On machines furnished with direct refrigerant injection cooling, a reliable refrigerant supply must be piped to the refrigerant cooling system on the compressor. A pilot receiver should be used to assure a liquid supply at all times.

A 1/2" (15mm) pipe line must be installed from the high pressure receiver or auxiliary high pressure reservoir to the refrigerant cooling system inlet strainer. A relief valve must be installed in the 1/2" (15mm) line to prevent over pressure from liquid remaining in the line during periods of shut down. A sight glass should be mounted in the refrigerant line near the compressor.

For more detailed information on refrigerant cooling and liquid supply requirements, consult Sullair specifications No, 5843 and 5839 or the C Series Operator's Manual.

3.8 PRESSURE TEST

The Sullair refrigeration package components have all been pressure tested prior to leaving the factory. The compressor unit should, however, be leak-checked at the job site to detect leaks which may be present due to rough handling during shipment. This pressure test should be done simultaneously with the system leak check.

Recommended procedures are given in the C Series Operator's Manual.

3.9 SYSTEM EVACUATION

The system must be evacuated to remove both air and moisture according to good refrigeration practice. Any free moisture and air in a system will mix with the refrigerant and oil to form harmful organic contaminants in resinous sludge and wax like forms which will plug the oil filters and strainers and damage the compressor.

Recommended procedures are given in the C Series Operator's Manual.

3.10 ELECTRICAL CONNECTIONS

The package is supplied with a completely wired electrical control system which requires a 115 volt, single phase, 60 hertz power supply of 500 VA capacity and some field connections at the terminal strip. All electrical connections are to be made according to the wiring diagrams for your specific machine. Make sure that electrical interfacing with the compressor complies with local, state and federal codes.

⚠WARNING

Local codes may require a warning sign for automatically starting and stopping equipment.

IMPORTANT

Do not supply power to the compressor control panel until oil has been charged into the oil reservoir. Failure to observe this caution will result in a burned out oil heater.

Section 3
INSTALLATION

3.11 INITIAL OIL CHARGE

IMPORTANT

Used or filtered oil should *never* be added to a refrigeration screw compressor under any circumstance. Use only new oil from an oil manufacturer (any of the major oil companies or their approved dealers) as in table 3.

Sufficient oil should be charged into the oil separator resevoir to establish a level in the upper sight glass. This will be approximately 15 gallons (55 litres).

An additional gallon (four litres) of oil should be pumped into the filter through the valve in the cover of the filter housing to assure adequate lubrication during the initial start-up.

See section 2.2 for suggested oils.

3.12 INITIAL OIL WARM UP

Supply power to the compressor panel before the arrival of the Sullair Refrigeration Representative. This will allow the oil in the oil reservoir to warm to operating temperature and will help facilitate a smooth start-up. Set the oil heater thermostat at 100°F (38°C) or 10°F (5°C) above condensing temperature whichever is higher.

3.13 ELECTRICAL CHECK

Before attempting to start the compressor, the electrical control system protective switches and capacity controls must be checked in a simulated operating condition. Be sure there is oil in the separator so the oil heater will not burn out.

The simplest and most reliable method of checking the electrical system is to feed the power supply to the control panel with the main drive motor power disconnected. This can be accomplished by disconnecting the motor power at the main power disconnect. If the control power is also supplied from the main disconnect, a separate temporary 115 volt, single phase, 60 hertz, 500 VA source should be obtained or the motor starter coil should be disconnected.

⚠CAUTION

The electrical check must be made with the main motor disconnected.

PROTECTIVE SWITCH CHECK
All switches are to be adjusted to values shown in section 2-1.

Low Oil Pressure Protective Switch
With panel power on, simulate a start by pushing the start button to energize the main control relay, 4CR. After ten seconds, the time delay (1TR) will time out, de-energizing the main relay and causing the low oil pressure circuit to light up the pilot light on the control panel. This oil pressure switch is factory preset and sealed and requires no field adjustment. Tampering with this device constitutes abuse of the compressor under the terms of the warranty.

High Discharge Pressure/Low Suction Pressure, High Discharge Temperature and High Oil Temperature Protective Switches
To check the remaining protective switches, jumper the low oil pressure switch, then readjust or manually manipulate each protective switch after simulating a start and note whether the main control relay 4CR drops out. Also, check that the appropriate pilot light on the panel door lights up.

CAPACITY CONTROL CHECK
The capacity control system will be checked after the compressor is running during the setting of the capacity control pressure switches. Before starting, carefully remove the 3TR timer from its socket. This will hold the capacity control system in the unloaded or minimum position. Also, before start-up check to see that the capacity control actuator moves freely by manipulation of the capacity control indicator. Movement should be firm, but not sticking or binding. Move the capacity clockwise to the minimum position for low starting torque.

3.14 MOTOR ROTATION CHECK

Supply power to the motor starter and rotate the start button to the "Auto Start" position. Bump the motor by pushing the start button then pushing the stop button. Verify the motor rotation by observing the coupling.

IMPORTANT

The compressor shaft will rotate counterclockwise when facing the compressor shaft end when motor rotation is correct.

If the motor rotates in the wrong direction, disconnect the power supply to the starter at the circuit breaker and reverse two of the phases by interchanging two of the three electrical lines at the starter or at the motor terminal box.

IMPORTANT

Do not run the compressor in the reverse direction more than a few seconds. Failure to observe this caution could result in serious damage to the compressor.

Rotate the starting switch to the "Manual-Reset" position. Disconnect power from the motor starter.

Section 4
OPERATION

4.1 START-UP

After all the installation functions covered in section 3 have been completed, it will be possible for the Sullair Refrigeration Representative to perform start-up service. Sullair Refrigeration should be notified a minimum of two weeks before a scheduled start-up to assure timely arrival of the Sullair Refrigeration Representative. It is necessary that key plant operating personnel be available to go through the start-up, since a great deal of knowledge can be obtained in this manner. The operations covered in this section will be performed at start-up under the supervision of a Sullair Refrigeration Representative.

IMPORTANT

See section 3.2 before scheduling the start-up.

4.2 PRE-START CHECK LIST

The following section covers only the initial start of the compressor and not the remainder of the refrigeration system. Be sure that all necessary system valves are open and that the refrigeration system is ready for start-up. Use the following check list to guarantee that no items of importance regarding the compressor package have been overlooked.

1. Motor starter breaker disconnected from the electric supply line.
2. Low oil pressure protective switch reconnected.
3. Protective switches set to values in section 2.1.
4. All protective switches verified for correct operation.
5. Oil temperature above 68°F (20°C) or 10°F (5°C) above the saturation temperature of the package pressure whichever is higher, ideally 80°F to 100°F (27°C to 38°C).
6. Oil level established in upper sight glass.
7. One gallon (four liters) of oil pumped into filter to prelubricate the compressor bearings.
8. Cooling water to oil cooler turned on if water cooled.
9. Liquid refrigerant supply to compressor turned on if refrigerant cooled.
10. Stop valves to the pressure gauges are open.
11. Suction and discharge valves open.
12. Timer 3TR removed from socket.
13. Direction of motor rotation checked.
14. Motor bearings lubricated.
15. Capacity control actuator indicator at minimum.
16. Capacity control selection switch in manual.
17. Starting switch in the "Manual-Reset" position.

When the above items are verified, the compressor is ready for the initial start.

4.3 INITIAL START-UP PROCEDURE

Connect the starter to the electric supply line at the main breaker. With one hand over the stop button and someone standing by the main breaker (in case the starter contacts fail to disengage), energize the protective circuit by rotating the start switch to the "Auto-Start" position and pushing the button. The compressor will start automatically provided the suction pressure is above the "cut in" pressure on the unadjusted start/stop pressure switch (HSP). After starting, rotate this switch to the "Manual-Reset" position so the compressor will not automatically stop and start. If the suction pressure is below the "cut in" pressure, start the compressor by rotating the start switch to the "Manual-Reset" position. Check rotation direction, oil pressure and noise and vibration and if any of these items are abnormal, immediately stop the machine.

IMPORTANT

The actual oil pressure is the pressure difference between the "Oil Pressure" and the "Suction Pressure" with both read on the Suction Pressure Gauge.

If the oil pressure does not increase to more than 25 PSI (175 kPa) within 10 seconds, the low oil pressure protective switch will stop the compressor. After any protective device stops the compressor, the protective switch circuit must be reset by rotating the start switch to the "Manual-Reset" position and pushing the button. Restart the compressor and run in manual start/stop as before. If the compressor again stops, loosen the locknut on the oil pressure regulating valve and screw in the adjustment screw about five turns. Restart the compressor and if it again stops because of low oil pressure, clean the oil strainers and pump one gallon (four litres) of oil into the oil filter to prelubricate the compressor bearings. Restart the compressor and if it again stops because of low oil pressure, check the low oil pressure troubleshooting section 5.6.

IMPORTANT

Do not restart more than two times after stopping each time because of low oil pressure without pumping one gallon (four litres) of oil into the oil filter to prelubricate the compressor bearings.

If the "Oil Pressure" gauge exceeds the "Suction Pressure" gauge by 100 PSI (700 kPa) or more, loosen the locknut on the oil pressure regulating valve and back out the adjustment screw to relieve the excessive oil pressure to approximately 75 PSI (500 kPa).

The oil filter pressure drop can be found by subtracting the filter outlet oil pressure from the filter inlet oil pressure. Both pressures are read on the "Filter Drop" gauge. The filter inlet oil pressure is obtained by pushing the blue button (or turning the three way valve on some models) below the oil pressure gauge. The oil filter pressure drop should be carefully watched for excessive build up during the first few hours of operation. Change the filter cartridge if the pressure drop exceeds 25 PSI (175 kPa).

Continue to run the compressor. When the oil reaches its minimum operating temperature of 105°F (40°C), adjust the oil pressure regulating valve as described under "Oil Pressure Adjustment" below. Then stabilize the oil temperature by adjusting the controls as described under "Oil Temperature Adjustment" below. After the oil temperature has remained within the operating limits for fifteen minutes, make a final adjustment to the oil pressure if required.

4.4 OIL PRESSURE ADJUSTMENT

Before adjusting the oil pressure regulating valve, make certain that the oil strainers are clean and the oil temperature is at its normal operating temperature of 105°F to 115°F (40°C to 46°C) for water cooled or 118°F to 122°F (48°C to 50°C) for liquid injection cooled. The oil pressure is the difference between the oil pressure and the suction pressure reading when the oil temperature is at its normal operating temperature.

The oil pressure is read from the suction pressure gauge by pushing the blue button (or turning the three way valve to the indicated direction on some earlier models).

Loosen the locknut on the oil pressure regulating valve and turn the adjustment screw in to increase pressure and out to decrease pressure. Adjust so that the oil pressure is 35 PSI to 40 PSI (250 kPa to 275 kPa) above suction pressure and tighten the locknut.

4.5 OIL TEMPERATURE ADJUSTMENT

(a) WATER COOLED MACHINES

The normal operating oil temperature of 110°F (43°C) must be achieved by adjusting the water regulating valve. For Penn water valves turn the spindle counterclockwise when viewed from above to increase spring loading on the diaphragm and increase the temperature. Allow a few minutes after each water valve adjustment to allow the oil temperature to stabilize. Note that the final temperature at stable operating conditions can be 105°F to 115°F (40°C to 46°C).

(b) LIQUID INJECTION COOLED MACHINES

Refrigerant injection oil cooled machines require adjustment of both the low discharge temperature protective switch (controlling the refrigerant liquid feed solenoid valve) and the refrigerant regulating valve. Below the low discharge temperature of 105°F (40°C) the liquid solenoid valve is closed or de-energized and no refrigerant enters the compressor. When the low discharge temperature is exceeded, the solenoid valve opens and feeds liquid refrigerant to the refrigerant regulating valve. This regulating valve senses the oil temperature in the discharge pipe and varies the flow of refrigerant injected into the compressor discharge to maintain a constant oil temperature.

The low discharge temperature switch also prevents refrigerant overfeed by sensing the low discharge temperature caused by the unevaporated overfed liquid and immediately closes the solenoid valve shutting off the supply of liquid refrigerant.

Adjustment of the low temperature liquid shutoff control is accomplished by adjusting the low temperature switch located in the control panel to 105°F (40°C). Verify the calibration of the adjustment with the discharge temperature gauge when the machine is warming up and operating at the set point value.

The oil and discharge temperature is sensed in the discharge line by the bulb of the self contained refrigerant regulating valve. As the oil temperature increases, a portion of the liquid in the sensing bulb is vaporized which increases the pressure on both the diaphragm and the adjustment spring to open the regulating valve and admit more refrigerant.

IMPORTANT

The bulb of the refrigerant regulating valve should be coated with aluminum paste or grease to improve heat transfer and must be installed with the "Top" marking on the bulb in the up position.

Adjustment of the refrigerant regulating valve involves turning the adjusting wheel on the valve with the key supplied with the valve. Each quarter turn on the valve will cause a change in the valve control point temperature of approximately 1°F (0.5°C). The adjusting spring acts to close the valve. Turning the collar to the right (or up, or counterclockwise when viewed from above) increases the temperature set point.

The recommended setting procedure for the liquid injection system is as follows:

1. Start the compressor and leave in manual capacity control minimum position.
2. Close the hand globe valve (in the liquid line adjacent to the liquid injection port) and crack it open a quarter turn.
3. Turn the regulating valve adjusting wheel fully down (clockwise) to the jam nut so that the valve is wide open.
4. When the discharge temperature gauge (on the oil separator) is 104°F to 105°F (40°C) adjust the low discharge temperature switch (in the control panel) to open the liquid feed solenoid valve.
5. Open the globe valve very slowly and regulate to obtain 120°F (49°C) so that expansion occurs at the globe valve. Allow time for temperatures to stabilize after each adjustment. Note that changes in suction or discharge pressure will vary the heat of compression and the discharge temperature.

6. Adjust the regulating valve adjusting wheel up (counterclockwise) again allowing for temperatures to stabilize until the discharge temperature rises above 120°F (49°C). When this occurs, the expansion is occuring at the regulating valve rather than the globe valve. Stabilize the discharge temperature at 122°F (50°C).
7. Open the globe valve fully so that the regulating valve takes full control. This must be done very slowly.
8. Turn the regulating valve adjusting wheel down (clockwise) to bring the discharge temperature from 122°F (50°C) to 120°F (49°C).

After the adjustments are made, check to see that the discharge temperature is being controlled by the refrigerant regulating valve and not by the low temperature switch. This condition will occur if the refrigerant regulating valve set point is lower than specified or if the low temperature switch is set too high. Once the operation is verified and the machine is allowed to operate for twenty to thirty minutes, a slight readjustment may be necessary. A further check should be made when the machine is running at full load. The discharge temperature should always be more than 10°F (5°C) above the condensing temperature. Note that the final temperature at stable operating conditions can be 118°F to 122°F (48°C to 50°C).

During a start, the discharge temperature will rise to near the limits before the refrigerant regulating valve will respond. This is normal and should occur only on start-up.

4.6 CAPACITY CONTROL ADJUSTMENT

The P1/P2 pressure controller consists of a single adjustment, dual pressure switch assembly with a factory set dead band of approximately 2 PSI (15 kPa). This dead band is satisfactory for the majority of refrigeration systems.

To set the controller to the desired system suction pressure carry out the procedure as in steps 1 to 9 inclusive below.

Some models were supplied with P1/P2 dual adjustment dual pressure switches without a factory set dead band. The two switches P1 and P2 can be individually adjusted by replacing steps 5 to 7 with steps 10 to 17 inclusive.

1. Obtain a voltmeter or two 120V neon pilot lights with pigtails. The procedure is easier with the lights as they can remain connected throughout the setting procedure.

2. Remove the timer 3TR from its socket to place the capacity control system in the manual mode. Remove the cover from the P1/P2 switch.

3. To keep the capacity control valve stable in the same position:

   a) for ammonia machines jumper wire no. 48 to wire no. 41 on the 3TR socket to keep solenoid B on (solenoid A is already off because 3TR is removed).

   b) for freon machines jumper wire no. 47 to wire no. 41 on the 3TR socket to keep solenoid B off (solenoid A is already off because 3TR is removed).

4. Connect one pilot light to terminal 43 on the 3TR socket and to X2 on the other side of the socket. Connect the other pilot light to terminal 45 on the 3TR socket and to X2. See the wiring diagram in figure 1-5.

5. Vary the compressor capacity manually with the indicator handle on the end of the actuator until the desired suction pressure is obtained. In some systems, it may be necessary to throttle the suction valve to achieve the desired pressure.

6. When the desired suction pressure is reached and remains stable, adjust the P1/P2 controller by turning the control adjustment screw in the appropriate direction so that both pilot lights are off. If both lights are on, turn the adjustment screw clockwise (from above). If the light connected to terminal 43 is off while the light connected to terminal 45 is on, turn the adjustment screw counterclockwise (from above).

7. To widen the dead band, lower the low pressure switch P1 (turn the adjusting threaded insert counterclockwise from above) and raise the high pressure switch P2 (turn the adjusting threaded insert clockwise from above). Widen the band evenly about the control point by making equal adjustments to both P1 and P2. Conversely, the band can be narrowed by raising the low pressure switch P1 and lowering the high pressure switch P2.

8. Remove the jumper wire from between 41 and 47 or 48.

9. Plug the 3TR timer into its socket. The capacity control system is now in the automatic mode.

10. Turn the low pressure switch P1 adjusting screw several turns counterclockwise (from above) so that the micro switch lowers toward its acutator pin. This ensures that the setting is well below the desired low pressure set point, as shown in figure 4-1.

11. Turn the high pressure switch P2 adjusting screw several turns clockwise (from above) so that the micro switch rises above its actuator pin. This ensures that the setting is well above the desired high pressure set point, as shown in figure 4-1.

12. Manually load the machine by turning the capacity control actuator toward the maximum load position until the desired low pressure set point is indicated on the suction pressure gauge. In some cases the suction stop valve may have to be throttled to achieve the desired pressure. In this condition, the pilot light connected to terminal 45 should be off, as shown in table 4. If not, adjust P1 further counterclockwise and/or P2 further clockwise until the light is off.

Figure 4-1 Suction Pressure and Capacity Control Adjustment Steps

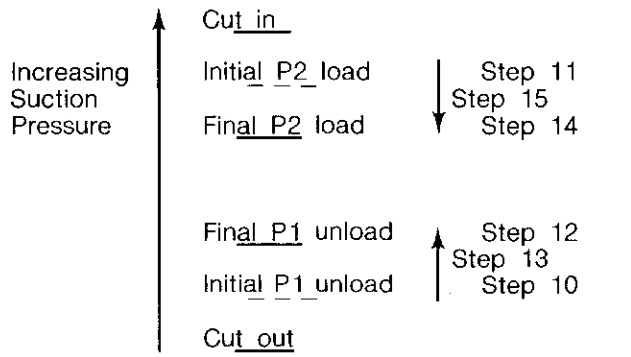


TABLE 4
PILOT LIGHTS AND CAPACITY CONTROL ADJUSTMENT STEPS

Light	Step			
	12	13	14	15
43	Off	Off	Off	On
45	Off	On	Off	On

Cut in

43,45 on P2 load

43, 45 off P1 unload

43 off, 45 on

Cut out

13. When the pressure is stable at the low pressure point where it is desired to have the machine unload, P1 may be adjusted by turning the P1 adjustment screw slowly clockwise until the pilot light connected to terminal 45 goes on, as shown in table 4. P1 is now correctly adjusted.

14. Manually unload the machine by turning the capacity control actuator toward the minimum load position until the desired high pressure set point is indicated on the suction pressure gauge. In this condition, the pilot light connected to terminal 43 should be off, as shown in table 4. If not, adjust P2 further clockwise until the light goes off.

15. When the pressure is stable at the high pressure point where it is desired to have the machine load, P2 may be adjusted by turning the P2 adjustment screw slowly counterclockwise until the pilot light connected to terminal 43 goes on, as shown in table 4. P2 is now correctly adjusted.

16.

IMPORTANT

There must be a minimum pressure difference of approximately 2 PSI (15 kPa) between the settings of P1 and P2.

17. Carry out steps 8 and 9 above.

The response time of the capacity control system is adjusted by the settings on the dual recycling timer, 3TR.

The red center knob controls the "on" time, adjustable from 0.6 to 30 seconds and the black outer knob controls the "off" time, adjustable from 1.2 to 120 seconds. Both increase time when turned clockwise. For adjustment, turn the black control fully clockwise and the red fully counterclockwise. Turn the red knob clockwise until the actuator moves a desirable distance. The longer the "on" time, the further the actuator will move (i.e. the increment or percentage load change at each movement will increase). The actuator moves in a stepwise fashion. The longer the "on" time, the greater percentage change per step. Turn the black knob counterclockwise until the desired time from full load to minimum is achieved after several steps. The "off" time determines the number of steps in a given amount of time.

Experience has shown that on large refrigeration systems, the smoothest operation and best control is achieved with slow machine response. (e.g. a short "on" time of one to two seconds and long "off" time of 120 seconds). Also, the best way to speed up the response is to slightly shorten the "off" time rather than increase the "on" time.

4.7 AUTOMATIC START/STOP PRESSURE SWITCH ADJUSTMENT

After stable automatic capacity control is achieved, the automatic start/stop switch or high suction pressure switch (HSP) may be adjusted to allow automatic starting and stopping of the compressor at set "cut in" and "cut out" pressures.

Set the "cut in" pressure adjustment to the pressure where it is desired to have the compressor automatically start. This pressure may be set above the pressure at which the capacity control calls for loading, usually 2 PSI to 5 PSI (15 kPa to 35 kPa).

Set the "cut out" pressure adjustment at the pressure where it is desired to have the compressor automatically stop. This pressure should be set sufficiently below the pressure at which the capacity control calls for unloading, usually 5 PSI to 15 PSI (35 kPa to 100 kPa). If short cycling or frequent starts and stops occur at low load conditions, this "cut out" setting may have to be lowered.

Rotate the start switch to the "Auto-Start" position so that the compressor starts and stops automatically.

4.8 OPTIONAL LOAD LIMIT RELAY ADJUSTMENT

Make sure that the high discharge pressure switch is set before adjusting the load limit relay.

The transformed current which activates the relay can be calculated by dividing full load current by the turns ratio of the current transformer. Set the load limit relay scale to this transformed current.

Artificially impose a high load on the motor until the motor ammeter indicates full load motor nameplate current by turning off condenser fans and water pumps one at a time. Do not throttle the discharge stop valve. Adjust the setting on the load limit relay until the unloading pilot light comes on. Check that the load limit relay at full motor load unloads the compressor until the excessive motor current is eliminated.

Set the 0 to 3 minute adjustable timer, 4TR to approximately 3 minutes by turning the little white wheel to the maximum time position and then backing it off two full turns. This timer prevents the compressor loading until the time setting has elapsed. Do not leave the timer in the maximum position as this effectively prevents the timer from timing out. An amber load limiting light shows whenever an increase load signal cannot be satisfied due to the load limiting timer.

4.9 START-UP DATA RECORD

After the compressor has run fully automatically for an hour and the pressures and temperatures have remained stable for 15 minutes, fill out the start up data record below. Send a copy to Sullair Refrigeration for the permanent file Sullair Refrigeration maintains on your machine.

IMPORTANT

Whenever the compressor stops, it runs in the reverse direction for several seconds. After the discharge check valve closes, the high pressure refrigerant in the oil separator expands back through the compressor to the closed suction check valve which causes the compressor to run in reverse. It is a completely normal action and is no cause for alarm. Continued back spin for more than 5 seconds indicates excess leakage through the suction check valve.

4.10 AFTER START-UP MAINTENANCE

After the compressor has run for twenty-four hours, clean the suction strainer, oil strainers and change the oil filter if its pressure drop exceeds 30 PSI (200 kPa).

Section 4
OPERATION

Customer_____ Contractor_____

_____ _____

_____ _____

Persons Contacted_____ Persons Contacted_____

_____ _____

Phone_____ Phone_____

Telex _____ Telex _____

Identification

Package Model No._____ Package Serial No._____

Compressor Serial No._____ Wiring Diagram No._____

Oil Cooling: Liquid Injection/Water/DX Sullistage: Yes/No

Protective Switch Settings

Anti Recycle Timer_____min.

Low Oil Pressure 25 PSI/175 kPa (Factory Set) High Oil Temperature_____°F/°C (Manual Reset)

Low Discharge Temperature _____°F/°C High Discharge Temperature_____°F/°C (Manual Reset)

Low Suction Pressure _____PSIG/in Hg/kPag (Manual Reset) High Discharge Pressure_____PSIG/kPag (Manual Reset)

Control Switch Settings

Suction Pressure: Cut In _____PSIG/in Hg/kPag Cut Out_____PSIG/in Hg/kPag

Capacity Control Pressure: P1 Unload_____PSIG/in Hg/kPag P2 Load_____PSIG/in Hg/kPag

Oil Heater Thermostat _____ °F/°C

Ampere Relay Unload _____ amps Current Transformer Ratio_____

Oil Pressure Delay, 1TR _____ sec.

Capacity Control, 3TR On_____sec. Off_____sec.

Load Limiting, 4TR _____min.

Section 4
OPERATION

Electrical Equipment

Motor Manufacturer_____ Sullair Supplied: Yes/No

Motor Serial Number_____ Frame_____

Motor Rated Power_____HP/kW Full Load Current_____amp

Electric Supply_____volts_____hertz_____phases

Starter Manufacturer_____ Type_____

Starter Rated Power_____HP/kW

Motor Overload_____amps Circuit Breaker_____amps

Operational Data

Refrigerant_____

Suction Pressure_____PSIG/in Hg/kPa Suction Temperature_____°F/°C

Sullistage Pressure_____PSIG/in Hg/kPa Sullistage Temperature_____°F/°C

Discharge Pressure_____PSIG/kPa Discharge Temperature_____°F/°C

Oil Pressure_____PSIG/kPag Oil Temperature_____°F/°C

Oil Filter Pressure Drop_____PSI/kPa Oil Type_____

Water Temperature: Inlet_____°F/°C Outlet_____°F/°C

Water Supply: Condenser/Cooling Tower/Treated/Untreated/Mains/Well/Other_____

Current_____amps at above condition with capacity control at_____%.

Comments:

_____

_____

_____

_____

_____

_____

Sullair Representative Signature_____ Date_____

Section 5
MAINTENANCE

5.1 GENERAL

Although the maintenance for your Sullair Refrigeration Compressor is minimal, it must be carried out for long compressor life. The instrumentation and indicators provided will alert you of the first sign of a maintenance requirement. Observe these instruments and indicators at regular intervals and be certain that the machine is performing properly. Become familiar with the normal operating sound of the compressor and if something does not sound just right, shut down the machine. Excessive vibration is a good indication that something is wrong. This precaution may save the cost of a major repair.

⚠WARNING

Before connecting work on any item on the package, carry out the shutdown procedure in section 6.2 for your own personal protection.

Keep the compressor package clean to minimize dirt entering the compressor whenever components are opened during routine maintenance.

Before cleaning a component with a solvent to remove gum or resin like deposits, remove all the O rings as they can be chemically attacked. Alternatively check the compatibility of the solvent with the O rings which are neoprene or Buna-N. Unfortunately those solvents which most readily remove carbon deposits (eg trichlorethylene) rapidly attack both neoprene and Buna-N. To ensure no traces of solvent will be left to react with the oil and refrigerant, thoroughly dry the component with an air blast.

5.2 DAILY OPERATION

After a routine start has been made, observe the instrument panel and be sure the gauges indicate the correct reading for that particular phase of operation.

After the machine has warmed up, check the overall compressor and instrument panel to make sure it is running properly. Particular attention should be given to the following:

- Oil Pressure Gauge
- Oil Temperature Gauge
- Discharge Temperature Gauge

Also check the setting of the suction, oil and discharge pressure protective switches. A log of the operating temperatures, pressures and service requirements can be invaluable in troubleshooting. It is strongly recommended that a log be kept of all readings at least every eight hours as in table 5.

While the compressor is running each sight glass contains slowly churning oil and small vapor bubbles. When clear vapor appears in the top sight glass the oil level may be low. The oil level can be accurately checked when the compressor has stopped and the oil has settled in the separator sump for about ten minutes. The oil level should be visible in the top sight glass.

IMPORTANT

Used or filtered oil should never be added to a refrigeration screw compressor under any circumstance. Use only new oil (as in section 2.2) from an oil manufacturer.

Oil should preferably be added after the compressor has stopped or been shut down. Add sufficient oil into the oil separator to bring the oil level into the top sight glass with a hand or electric pump capable of pumping oil against a pressure of 100 PSI (700 kPa). When the compressor is running use a hand or electric pump to add oil through a 100 mesh strainer into the normally plugged connection on top of stator at the suction end. (See figure 1-2).

If the addition of oil becomes too frequent, a problem may have developed causing this excessive loss. See troubleshooting (section 5.6) under high oil consumption for a probable cause and remedy.

5.3 MAINTENANCE AFTER THE INITIAL 200 HOURS OF OPERATION

After the initial 200 hours of operation a few maintenance tasks are necessary to rid the system of foreign materials which may have accumulated during assembly and installation. Other procedures, stated below are required to ensure that the initial operation of the machine is correct.

1. Change the oil.
2. Replace the oil filter cartridge.
3. Clean the oil strainers.
4. Clean the gas suction strainer.
5. Check the settings of the capacity control valve pressure switch, P1/P2.
6. Check the pressure gauge calibration (0 PSIG or 0 kPag when open to atmosphere).
7. Tighten all bolts, especially motor and compressor mounting bolts.
8. Check compressor shaft seals for excessive leakage of 10 drops per minute. A small oil loss of 1 to 2 drops per minute is normal.
9. Check low oil pressure protective switch.
10. Check high oil temperature protective switch.
11. Check high discharge temperature protective switch.
12. Restart and check all operating temperatures and pressures.

5.4 OIL ANALYSIS PROGRAM

The oil injection screw compressor has proved to be a most reliable and successful compressor, but because of the washing action of the oil, the oil quality must be checked closely for maximum compressor life. Since it is impossible to look at the oil and determine its quality, chemical analysis by a qualified concern signifies when to change the oil. Oil analysis has proved to be of great value in preventing lubrication problems by diagnosing poor quality or contamination before significant damage has been done.

TABLE 5

COMPRESSOR LOG EXAMPLE

Plant Name_____ Model No._____ Serial No._____

Date_____ Logged By (Initials) _____ Time Run (Hours) _____

Item	Symbols	Units	Normal Range		Time			Notes
			From	To	8 am	4 pm	12 pm	
Suction Pressure	Ps	PSIG/In Hg/kPag						
Suction Temperature	Ts	°F/°C						
Discharge Pressure	Pd	PSIG/kPag						
Discharge Temperature	Td	°F/°C						
Oil Pressure	Po	PSIG/kPag						
Oil Temperature	To	°F/°C						
Oil Pressure Minus Suction Pressure	Po-Ps	PSI/kPa						
Oil Pressure (at Filter Inlet)	Pfi	PSIG/kPag						
Oil Pressure (at Filter Outlet)	Pfo	PSIG/kPag						
Oil Filter Pressure Drop	Pfi-Pfo	PSI/kPa						
Water Temperature (at Cooler Inlet)	Ti	°F/°C						
Water Temperature (at Cooler Outlet)	To	°F/°C						
Oil Level	-							
Oil Added	-	Gal/L						
Capacity	-	%						
Motor Current	I	amp						
Receiver Liquid Level		ft/m						
Refrigerant Added		lb/kg						
Machine Room Temp		°F/°C						
Outside Temperature		°F/°C						
Outside Wet Bulb Temperature		°F/°C						

WHAT CAUSES THE OIL CONTAMINATION AND BREAKDOWN

Why oil breaks down or becomes contaminated is chemically complex and often cannot be easily evaluated. Several of the problems are:

1. Ammonia salts. These are formed with water from oil cooler leaks and condenser leaks during low head pressure operation or system shut down.
2. External dirt fines or liquids. Dirt comes from improperly cleaned new systems or old systems that contain used oil from reciprocating compressors.
3. Poor oil quality. Several systems have had problems with excessive oil breakdown, oil discoloration and/or incorrect oil viscosity. To avoid poor oil quality, purchase one of the oils suggested in section 2.2 directly from one of the major oil companies or their approved dealers.

IMPORTANT

Used or filtered oil should never be added to a refrigeration screw compressor under any circumstances. Use only new oil.

4. High oil viscosity. During normal operation, a small amount of oil will be lost from the compressor since the separator cannot be one hundred percent efficient. The oil that escapes tends to be the more volatile constituents resulting in increased viscosity in the remaining oil and improper bearing lubrication.
5. Low oil viscosity. If the system has other compressors using lower viscosity oils, the returning oil dilutes the oil and lowers its viscosity.
6. Oxygen. The air drawn in through valve glands, or pinhole leaks in low temperature systems where the evaporating pressure is less than atmospheric pressure or from air entering after servicing the system components forms oxygenated organic compounds. These are a constituent of varnish.

WHAT AN OIL ANALYSIS CHECKS

A proper analysis will check the following basic properties of the oil:

1. Viscosity
2. Color
3. Quantity or particle contamination
4. Moisture content
5. Acid level
6. Chemical analysis of metal contamination including tin, sodium, and other reactive metal ions.

Sullair Refrigeration strongly recommends an oil analysis for a new compressor after its initial operation to assist in evaluating potential problems during the early stages of its life. The initial oil analysis and follow up check have resulted in an early warning for many customers of oil contamination, break down and changes in viscosity, all of which can affect the lubricating quality of the oil and thus the machine life.

In order to have this service work carried out most efficiently and effectively, Sullair Refrigeration has designated Analysts, Inc. as the laboratory to perform the oil analysis. Sullair Refrigeration will submit an evaluation of the analysis to you.

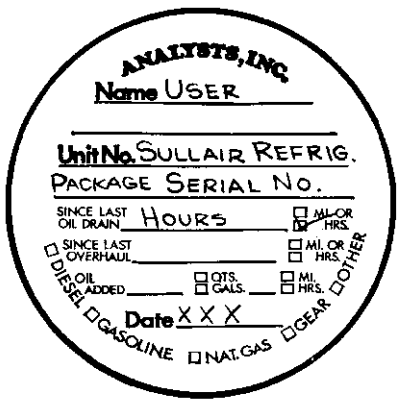
Included in the start up kit from Sullair Refrigeration is:

1. One "Oil Analysis Service Instruction" (Form 5161 of Sullair Refrigeration).
2. One "Compressor Identification Record" (Form 50-1 of Analysts).
3. Two "Oil Sample Data Sheet"s (Form 1000S of Analysts).
4. Six oil sample bottles.
5. Three oil sample mailers (shipping boxes).

INSTRUCTIONS FOR SULLAIR'S OIL ANALYSIS SERVICE

1. Issue an order to Sullair Refrigeration for oil analysis service, P/N 45556 and P/N 13214.
2. Oil samples are to be drawn from the oil drain valve on the oil separator sump while the oil is warm. Some oil should be allowed to flow to a waste container before the sample bottle is filled to ensure a representative sampling.
3. A label on the cap of the sample bottle has been provided for sample identification. This label must be properly filled out for the oil sample to be quickly processed. See figure 5-1.
4. Fill out the "Compressor Identification Record" (Form 50-1) as in figure 5-2. Note that the package serial number from the control panel name plate is important and must be included. Do not remove the backing paper from this tag.
5. Fill out one of the "Oil Sample Data Sheet"s (Form 1000S) as in figure 5-3.
6. Draw the *initial* oil sample at 150 hours of compressor operation. A new oil sample from your unused stock should be taken at the same time to evaluate the quality of the new oil.
7. Place the 150 hour used sample and the new oil sample in the mailer (shipping box) provided along with the Compressor Identification Record and the Oil Sample Data Sheet and mail them first class directly to Analysts, Inc. for prompt analysis.

Figure 5-1 Oil Sample Bottle Cap



8. You will receive by mail from Sullair Refrigeration a summary of the laboratory analysis of your 150 hour oil sample.

IMPORTANT

Regardless of the findings of the 150 hour analysis the oil must be changed after the initial 200 hours as described in section 5.3.

9. Draw the *second* oil sample at 1000 hours of compressor operation.
10. The 1000 hour sample should be accompanied by a filled out Oil Sample Data Sheet and again mailed first class directly to Analysts, Inc. for prompt analysis.
11. You will again receive by mail from Sullair Refrigeration a summary of the laboratory analysis of your oil. With the summary of your 1000 hour analysis, will come a recommendation on the time interval for future oil checks.

INSTRUCTIONS FOR CONTINUATION OF OIL ANALYSIS SERVICE

After the two initial oil analyses have been completed, Sullair Refrigeration recommends that this oil analysis program be continued as a part of a routine maintenance program. After the 150 hour and 1000 hour oil analyses, the following schedule is recommended for oil sample analyses:

1. Every 1000 hours of operation for the next 5000 hours.
2. Every 2000 hours thereafter or any time an unusual problem of discoloration, filter plugging or oil contamination occurs.

The cost of these oil analyses is insignificant when the value of a compressor is considered. It is recommended that your oil analysis program be continued with Analysts, Inc., to provide uniformity to the oil analysis, the oil analysis report and Sullair's interpretation of the analysis report. However, if you have had good experience with another laboratory or prefer dealing with your oil supplier, you can continue your oil analysis program with them. Be sure to send reports made by other labs to Sullair so we may assist you in analyzing the results of the test.

Compressor Identification Record For Oil Analysis (Form 50-1)
Analysts, Inc. requires a master record of the compressor identification for their records. The following information should be recorded on their *Form 50-1;*

- Name and address of Sullair
- Compressor Serial Number (The results will then be sent directly to Sullair)
- Compressor Model Number
- Oil Charge - Enter the following:

Model	Gallons
CB12L	15

Blank forms are available from:
Analysts, Inc.
P.O. Box 226
820 E. Elizabeth Avenue
Linden, New Jersey 07036

Figure 5-2 Compressor Identification Record

ANALYSTS, INC.
UNIT IDENTIFICATION FORM

SECTION I
CUSTOMER: Sullair Refrigeration, Inc.
ATT'N: Engineering Department
ADDRESS: 3700 E. Michigan Boulevard
CITY: Michigan City STATE: IN ZIP: 46360

SECTION II
PERSON(S) TO NOTIFY
(1) Service Department
(2) Engineering Department
PHONE: Area Code 219 No. 879-5451

SECTION III
Unit S/N: AAAAA
Manufacturer: Sullair Corporation
Model: BBBBB
Sump Capacity: CCCCC
Lubricant: Brand: Type & Grade:
Oil Additives:
Coolant Additives:
Fuel Additives:
No. of Oil Filters: One Type: Polypropylene
Operating Conditions:

SECTION IV
ENGINE:
Diesel Gasoline
Natural Gas LPG
Turbine
COMPONENT SYSTEM:
Transmission
Differential
Gear Box Air Compressor
Refrigeration Compressor X
Hydraulic Other

HAS THIS UNIT BEEN SAMPLED BEFORE?
Yes No
SAMPLE SHOULD BE TAKEN WHILE OIL IS AT OPERATING TEMPERATURE.

SECTION V
Additional Comments:

4 Form 50 1

Oil Sample Data Sheet (Form 1000S)
The following data should be submitted with each sample:

- Send the results directly to:
  Sullair Refrigeration, Inc.
  3700 E. Michigan Blvd.
  Michigan City, IN 46360
  Attn: Engineering Dept.
- Type and Brand of Oil
- Compressor Model/Serial No.
- Invoice to: Your Company Name or give P.O. directly to Sullair.
- Why was sample taken
- Is this the first sample
- Routine Spectro and Physical analysis should be run and include:
  1. Viscosity
  2. Color
  3. Quantity of Particle Contamination
  4. Moisture
  5. Acid
  6. Chemical Analysis of Metal Contamination including Tin, Sodium and other reactive Metal Ions
- Purchase Order Number
- Your Signature

Figure 5-3 Oil Sample Data Sheet

CUSTOMER SULLAIR REFRIGERATION
ADDRESS 3700 E. MICHIGAN BLVD.
CITY MICHIGAN CITY STATE IND ZIP 46360
ATTN: ENGINEERING DEPT.

ANALYSTS, INC.
820 East Elizabeth Avenue
Linden, New Jersey 07036
P.O. Box 226
Phone (201) 925-9393
REP____ COPIES____

EXTRA COPY TO:
NAME END USER NAME
ADDRESS ✓
CITY ✓ STATE ✓ ZIP ✓
ATTN: PLANT ENGINEER

SAMPLE IS:
☐ ENGINE OIL:* BRAND____ TYPE & GRADE____
☐ TRANSMISSION OIL: BRAND____ TYPE & GRADE____
☐ DIFFERENTIAL OIL: BRAND____ TYPE & GRADE____
☐ COMPRESSOR OIL: BRAND ✓ TYPE & GRADE ✓
☐ HYDRAULIC OIL: BRAND____ TYPE & GRADE____
☐ OTHER:____
*IF ENGINE OIL CHECK: DIESEL ☐ GASOLINE ☐
GAS (NATURAL GAS, LPG, ETC.) ☐ STEAM TURBINE ☐ GAS TURBINE ☐
UNIT MAKE & MODEL (from which sample is drawn) ✓
COOLING SYSTEM ADDITIVES (if any)____
CRANKCASE ADDITIVES (if any)____
FUEL USED: #1/#2 DIESEL ☐ GASOLINE ☐ GAS (LP, LNG) ☐ HEAVY (BUNKER C/#6) ☐
INVOICE TO: SULLAIR REFRIGERATION
3700 E. MICHIGAN BLVD.
MICHIGAN CITY, IND.

WHY WAS SAMPLE TAKEN?
☐ ROUTINE; NO KNOWN PROBLEMS
☐ FAILURE (explain) ✓
☐ OTHER (explain) ✓
YOUR IDENTIFICATION ✓
WAS THIS UNIT PREVIOUSLY SAMPLED? ☑ YES ☐ NO
If yes most recent Analysts Lab No. ✓ Your I.D.____
WHAT TESTS DO YOU WISH? ☐ Routine Spectro & Physical ☐ Analysts' discretion
☐ Other.
PURCHASE ORDER NO. FROM SULLAIR REFRIGERATION
YOUR SIGNATURE ✓

Section 5
MAINTENANCE

5.5 MAINTENANCE SCHEDULE

The following table is intended as a minimum maintenance schedule. Abnormal conditions may require more frequent action as determined by your daily log readings.

TABLE 6
MAINTENANCE SCHEDULE

OPERATION	SCHEDULING TIME PERIOD
1. Check all operating indicators per 2.1 operating limits and switch settings.	
Net Oil Pressure (Equals oil pressure gauge reading minus suction pressure gauge reading)	Daily
Oil Temperature	Daily
Discharge Pressure	Daily
Discharge Temperature	Daily
Suction Pressure	Daily
Oil Filter Pressure Drop	Daily
Oil Level	Daily
Motor Current	Daily
2. Test all protective controls per 2.1 operating limits and switch settings, and 3.13 electrical check.	
Low Oil Pressure Protective Switch	Monthly
High Oil Temperature Protective Switch	Monthly
High Discharge Temperature Protective Switch	Monthly
High Discharge Pressure-Low Suction Pressure Protective Switch	Monthly
Anti Recycle Timer Setting	Monthly
Oil Heater Thermostat Setting	Monthly
Capacity Control Timer	Monthly
Refrigerant Relief Valve Leakage	Monthly
3. Maintain oil quality per 5.4 oil analysis program.	
Sample oil to check appearance and run oil analysis	Every 1,000 hours for first 6,000 hours and every 2,000 hours thereafter.
Change oil	Every three months or 2,000 hours unless using oil analysis. Maximum time six months.
Change oil filter cartridge	Whenever oil is changed or when pressure drop across the filter exceeds 25 PSI (175 kPa) or is less than 4 PSI (30 kPa)
Clean Oil Strainers	Whenever oil is changed.
4. General Maintenance	
Check Noise Level	Daily
Check Electric Motor Bearings Temperature	Monthly or as recommended by motor manufacturer
Lubricate Electric Motor Bearings	Yearly or as recommended by motor manufacturer
Clean Suction Strainer	Yearly
Inspect Oil Cooler Cleanliness	Every three months until required cleaning frequency is established. Intervals between cleaning depend on contamination in cooling water.

Section 5
MAINTENANCE

TROUBLESHOOTING

The information contained in the troubleshooting chart has been compiled from data gathered from field service reports and factory experience. It contains symptoms and usual causes for the service problems described, however, DO NOT assume that these are the only problems that may occur. All available data concerning the trouble should be systematically analyzed before undertaking any repairs or component replacement procedures.

With any problem make a detailed visual inspection and look for heat damaged electrical parts (apparent by discoloration or burned odor), loose wiring and damaged piping. Then analyze the problem logically step by step with the aid of the troubleshooting chart.

Should your problem persist after making the recommended checks, consult the Sullair Corporation Service Department.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
1. Compressor will not start	A. One of the protective switches tripped. Remove cause. Check setting and reset. B. Recycle timer activated. Wait for timer to time out. C. No power supply to control circuit. Check power supply. D. Booster auxiliary oil pump defective. Check if motor is running in correct direction. Repair. E. Plugged oil strainer in booster auxiliary oil pump suction line. Clean. F. Booster start up oil pressure switch out of adjustment or defective. Adjust or repair.
2. Compressor shuts down immediately after starting	A. Low oil pressure. See "3". B. High discharge pressure. Open discharge stop valves and check condenser fan, condenser water pump and purge noncondensables from refrigerant in condenser. C. Low suction pressure. Open suction valves. Check capacity control to see if it unloads automatically. D. High oil or discharge temperature. See "6" and "7".
3. Low oil pressure **IMPORTANT** Do not restart more than two times without pumping one gallon (four litres) of oil into the oil filter to prelubricate the compressor bearings.	A. Oil pressure regulating valve out of adjustment or defective. Adjust or repair. B. Plugged oil strainer. Clean strainer. C. Plugged oil filter. Replace cartridge. Do not clean. D. Low oil charge. Check oil level with compressor shut down. E. Liquid refrigerant in oil. Stop liquid carryover. (a) Check oil heater and evaporator controls. (b) On liquid injection machines, check and adjust refrigerant regulating valve, solenoid valve and the low discharge temperature protection switch. For refrigerant regulating valve, see "11" items F to M. F. Low discharge pressure due to cold system starts with low ambient temperature. Since the oil is circulated by gas pressure difference it may be necessary to install a back pressure regulator set at 50 PSI (350 kPa) above suction pressure and mounted in the discharge line after the oil separator. Contact Sullair Refrigeration for details. The regulator would function only until the condensor warmed up and the discharge pressure increased to 50 PSI (350 kPa) above suction.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
3. Low Oil Pressure (continued)	G. Water in oil. Change or install filter drier. H. Low oil viscosity. Change oil. Investigate changing lower viscosity oils in other compressors on common system to screw compressor grade.
4. High oil pressure	A. Oil pressure regulating valve out of adjustment or defective. Adjust or replace. B. Oil temperature too low. See "5".
5. Low oil temperature	A. Water regulating valve or refrigerant regulating valve out of adjustment or defective. Adjust or repair. B. Liquid refrigerant in oil. (a) Check oil heater and evaporator controls. (b) On liquid injection machines, check and adjust refrigerant regulating valve, solenoid valve and the low discharge temperature protective switch. For refrigerant regulating valve see "11" items F to M.
6. High oil temperature	A. Water regulating valve or refrigerant regulating valve out of adjustment or defective. Adjust or repair. The water regulating valve and the refrigerant regulating valve are self contained temperature sensing valves that have a hermetically sealed thermal system. If the charge is lost, the valve will not open. Install a new thermal system. B. Inadequate water supply. Clean strainers and check pump. C. Dirty oil cooler. Clean tubes. Check water treatment. D. Refrigerant supply low (liquid injection machines). Check liquid supply, installation and stop valves fully open. See "11". E. Oil in liquid refrigerant supply. Drain oil from liquid receiver. Check oil carryover from compressors. See "12".
7. High discharge temperature (water cooled only)	A. High oil temperature. See "6". B. Plugged oil strainer. Clean strainer. C. Abnormal operating condition, e.g. abnormally high suction pressure, high suction superheat or high discharge pressure. Check system.
8. Low suction pressure	A. Excessive suction line pressure drop. Check system valves open. Clean suction strainer. B. Capacity control not modulating. See "10". C. Refrigerant charge low. Add refrigerant. D. Evaporators starving of refrigerant. Plugged liquid feed strainers. Clean.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
9. High suction pressure	A. Additional refrigeration load added. Check heat loads. B. Capacity control not modulating. See "10". C. Excessive refrigerant in evaporators. Check liquid feed valves for wear. Repair. D. Liquid refrigerant in suction vapor. Check evaporator controls. If problem persists, consider installation of suction liquid trap.
10. Capacity control not operating	A. Pressure switch P1-P2 out of adjustment or defective. Adjust or replace. B. Timer 3TR out of adjustment or defective. Adjust or replace. C. Capacity control actuator out of adjustment or defective. Adjust or repair. D. No power at terminal 41 on wiring diagram. ITRA contact on line 25 open. Relay ITRA or timer ITRA defective. Replace. E. Solenoid valves defective. Coil burnt out. Dirt under seat. Seats worn. Clean, repair or replace.
11. Erratic oil temperature. (liquid injection cooled only)	A. Erratic liquid refrigerant pressure or supply. Install sight glass and pressure gauge. Add refrigerant or check for improper installation. Check stop valves fully open. B. Oil in liquid refrigerant supply. Drain oil from liquid receiver. Check oil carryover from compressors. See "12". C. Low condensing pressure. Turn off condenser fan or water pump. D. Liquid solenoid defective. Check coil and valve seat. Repair or replace. E. Plugged solenoid strainer. Clean. F. "Top" of refrigerant regulating valve bulb not in vertical up position. ("Top" stamped on end of bulb outside bulb well). Reinstall correctly. G. Refrigerant regulating valve bulb not in good thermal contact with bulb well. Remove bulb and apply grease or aluminum paste. H. Defective refrigerant regulating valve thermal system. Replace. I. Crushed, kinked or twisted capillary. Repair or replace entire thermal system. J. Foreign matter in valve seat. Clean. K. Valve stroke out of adjustment. Adjust. L. Oversized port in valve. Check with Sullair Refrigeration. M. Valve plate and sliding disc upside down in valve. Turn both 180°. N. Low discharge temperature switch controlling discharge temperature instead of regulating valve. Adjust.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
12. High oil consumption	A. Oil not returning to compressor from final stage of oil separator. Check oil return sight glass at oil separator. If abnormal level shows, clean orifice and/or strainer. B. Oil separator element and gaskets are incorrectly seated and sealed or defective. Reseat and seal or replace. C. Excessive oil charge. Check oil level with compressor off. Drain. D. Liquid refrigerant in suction vapor. Check evaporator controls. If problem persists, consider installation of suction liquid trap.
13. Motor runs hot	A. Too many starts in a short period. Adjust and check the anti recycle timer. Replace if defective. B. Excessive current draw. Check ampere unloading relay and thermal overload. Replace if defective. C. Low voltage. Check voltage at the motor starter and the plant supply. Check with power supply utilities. The voltage at the motor should never be less than 90% of the nameplate rating at normal full load motor speed. D. Unequal phase voltages. Check at the motor starter and the plant supply. Check with power supply utilities. E. Blocked ventilation ports. Clean. F. High ambient temperature above 105°F (40°C). Reduce machine room temperature. G. Motor internal centrifugal fan backwards. Contact motor supplier. H. Insufficient or excessive grease in bearings. Add or remove grease. I. Bearings defective. Replace or contact motor supplier.
14. Compressor vibrating or noisy	A. Liquid refrigerant in suction vapor. Check evaporator controls. If problem persists, consider installation of suction liquid trap. B. Coupling out of alignment. Realign. C. Rotor end play excessive. Contact Sullair Refrigeration. D. Any other persistant vibration or noise, contact Sullair Refrigeration.

5.7 SEASONAL OR LONG TERM SHUT DOWN

To shut down a compressor for four months or longer, tightly shut both the suction and discharge stop valves, the liquid injection globe valve (if liquid injection cooled) and the Sullistage stop valve (if fitted with Sullistage) enclosing refrigerant at low pressure along with the used oil. Disconnect the power source from the compressor drive motor and the electrical control panel. Place a moisture absorbing compound (eg; a desiccant such as silica gel) inside the control panel. If water cooled, close the cooling water supply valves and drain the water from the oil cooler.

Place warning tags on the electrical system and all closed stop valves. Those who do not know the machine is shut down for a long term must not attempt to start the compressor until it is ready for normal operation.

Every month while the compressor is shut down, turn the compressor and motor over several turns.

Prior to starting up after a shut down, change the oil and pump down the compressor. Before pushing the start button check the items in section 4.2 noting items 5 and 7:

5. The oil in the separator sump is above 68°F (20°C) or 10°F (5°C) above the saturation temperature of the package pressure whichever is higher, ideally 80 to 100°F (27 to 38°C).

7. One gallon (four litres) of oil pumped into the filter to prelubricate the compressor bearings.

Section 6
SERVICING

6.1 GENERAL

The following paragraphs outline the various servicing procedures for the Sullair Refrigeration CB Series Compressors.

For assistance with any detail of service or servicing of an item not covered by this manual, please consult Sullair Refrigeration or their agents. Service supervisors are available from Sullair Refrigeration who will assist on any servicing procedure.

To prevent needless downtime, have available on site all parts that may be needed to carry out the repair before commencing any work.

To prevent dirt from entering opened components keep the surroundings clean and cover the exposed working areas with plastic whenever possible.

Before cleaning a component with a solvent to remove gum or resin like deposits, remove all the O rings as they can be chemically attacked. Alternatively check the compatibility of the solvent with the O rings which are neoprene or Buna-N. Unfortunately those solvents which most readily remove carbon deposits (eg trichlorethylene) rapidly attack both neoprene and Buna-N. To ensure no traces of solvent will be left to react with the oil and refrigerant, thoroughly dry the component with an air blast.

6.2 SHUTDOWN PROCEDURE

⚠WARNING

Do not remove caps, plugs or other components when compressor is running or pressurized. Stop the compressor and relieve all internal pressure before doing so.

⚠WARNING

Before commencing work on any item on the package, ensure that the following are carried out for your own personal protection.

1. Whenever the compressor is to be shut down for service, place warning tags on the electrical system and the line valves. Others who do not know the machine may be faulty or is being repaired must not attempt to start the compressor until the servicing is complete and it is ready for normal operation. Exposed electrical wiring must always carry a warning tag even though it is disconnected from the power supply.
2. Stop the compressor with the stop button on the control panel.
3. Disconnect the starter from the power supply.
4. Disconnect the control panel from the 115 V power supply.
5. Close compressor suction stop valve and discharge stop valve.
6. If the compressor is liquid injection cooled and fitted with a relief valve (between the main solenoid valve and the stop valve, relieving to the inlet of the stop valve), close the liquid feed stop valve. Do not trap liquid refrigerant between valves in a liquid line.
7. If the compressor is fitted with a Sullistage port, close the Sullistage stop valve.
8. Relieve the gas pressure in the package by opening the blow down valve on the oil separator to either a pump out compressor or to atmosphere. If using a pump out compressor, pull the package pressure to atmospheric pressure (15 PSIA or 100 kPaa on the suction pressure gauge) and open the blow down valve on the separator to atmosphere.
9. Leave the blow down valve open to the atmosphere all the time while working on the package.

6.3 BOLT TIGHTENING TORQUES

The tightening torques for servicing the various bolts and screws used in the package are given in table 7. All fasteners (eg, the ferry head screws) used in the compressor unit, are high tensile Grade 8 only and they must always be torqued to Condition B when the compressor is serviced. The fasteners on the package (eg, flange bolts) are either low or medium tensile Grade 2 or Grade 5 respectively and the tightening torques below may be used as a guide.

Bolts of different grades may be distinguished by the number of slashes on the hexagonal head, eg Grade 2 bolts have no slashes, Grade 5 bolts have three slashes and Grade 8 bolts have six slashes per table 7. All ferry head screws are Grade 8.

When a torque wrench is not available, it is possible to approximate these values by using an ordinary wrench or piece of pipe on wrench. For example, to obtain 100 pound-feet wrench torque, pull 100 pounds at 1 foot distance from center of pull to center of screw, or pull 50 pounds at a 2 feet distance, etc, in a direction perpendicular to the line connecting the center of the screw and the center of pull.

6.4 OIL FILTER CARTRIDGE REPLACEMENT

Whenever the oil pressure drop over the filter exceeds 25 PSI (175 kPa), the old oil filter cartridge should be discarded (not cleaned) and replaced with a new filter cartridge. If the oil pressure drop is less than 4 PSI (30 kPa), the filter may be defective and should be replaced immediately.
Refer to figure 6-1.

REMOVAL
1. Carry out the shut down procedure in section 6.2.
2. Open the drain valve on the bottom of the filter to drain the filter oil.
3. Remove the hex socket screws (4) from the bottom plate (1) on the filter body.
4. Remove the large center cap nut (2) and fiber washer (3).
5. Remove the bottom plate (1).
6. Remove the O ring (5) from the groove in the bottom of the filter body.
7. Remove both felt washers (6) and withdraw the cartridge assembly (7).

TABLE 7
TIGHTENING TORQUES FOR THREADED BOLTS

Fastener		Tightening torques: lb-ft in top line / N.m in bottom line														
Diameter	Pitch	Grade 2 **					Grade 5 **					Grade 8 **				
	Thread	*Condition					*Condition					*Conditon				
inch	inch	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1/4	20	5.5 7.5	4.0 5.4	3.7 5.0	2.8 3.8	5.0 6.8	8.0 10.8	6.0 8.1	5.5 7.5	4.0 5.4	7.2 9.8	12 16.3	9.0 12.2	8.0 10.8	6.0 8.1	11 14.9
5/16	18	11 14.9	8.0 10.8	7.5 10.2	5.5 7.5	10 13.6	17 23	13 17.6	11.5 15.6	8.5 11.5	15.3 21	25 34	18 24	17 23	12.5 16.9	22.5 31
3/8	16	20 27	15 20	13.5 18.3	10 13.6	18 24	30 41	23 31	20 27	15 20	27 37	45 61	35 47	31 42	22.5 31	40 54
1/2	13	50 68	35 47	34 46	25 34	45 61	75 102	55 75	50 68	38 52	68 92	110 149	80 108	74 100	55 75	99 134
5/8	11	100 136	75 102	67 91	50 68	90 122	150 203	110 149	100 136	75 102	135 183	220 298	170 230	147 199	110 149	198 268
3/4	10	175 237	130 176	117 159	68 92	158 214	260 353	200 271	174 236	130 176	234 317	380 515	280 380	255 346	190 258	342 464
7/8	9	165 224	125 169	110 149	82 111	148 201	430 583	320 434	288 390	215 291	387 525	600 813	460 624	402 545	300 407	540 732
1	8	250 339	190 258	168 228	125 169	225 305	640 868	480 650	429 582	320 434	576 781	900 1220	680 922	603 818	450 610	810 1098

GRADE **	INDENTIFICATION MARK	TENSILE STRENGTH PSI	TENSILE STRENGTH MPa	YIELD STRENGTH PSI	YIELD STRENGTH MPa	DIAMETER inch
2		74,000	510	57,000	390	Up to 3/4
		60,000	415	36,000	250	7/8 to 1
5		105,000	725	81,000	560	All Sizes
8		150,000	1035	130,000	900	All Sizes

*CONDITIONS

A) Non-lubricated solvent-cleaned and dry.

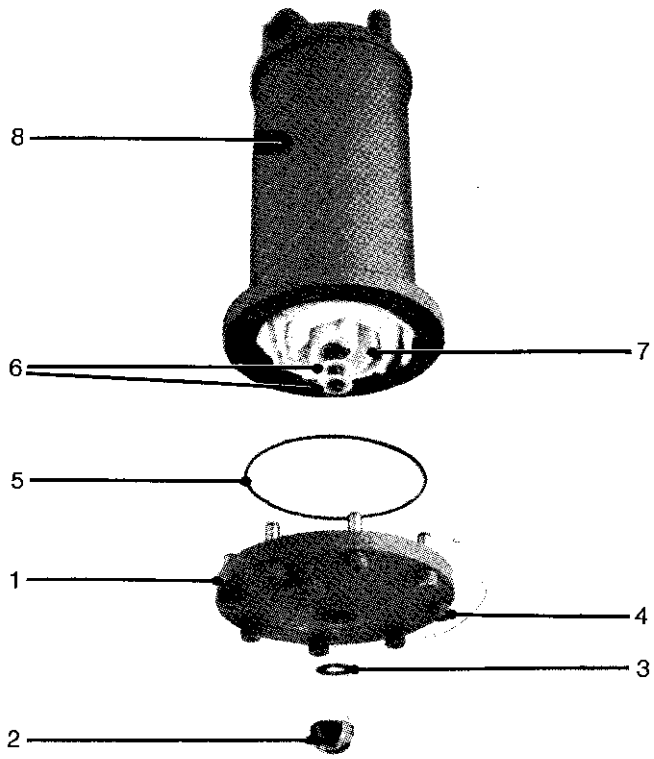
B) Lubricated with rust preventative or cadmium or zinc plated.

C) Lubricated with oil or grease.

D) Lubricated with dry lube film or graphite/oil mixture.

E) Lubricated with loctite or sealants.

Figure 6-1 Oil Filter Cartridge Replacement



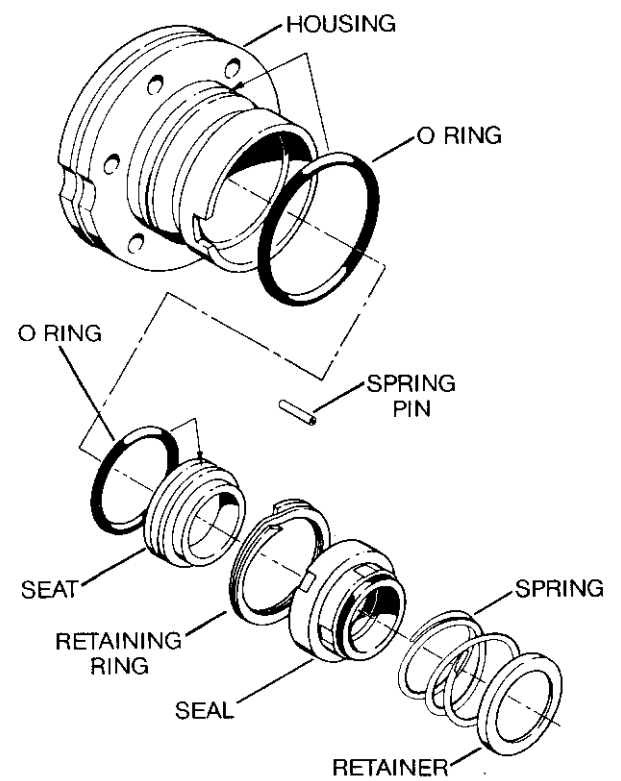
INSTALLATION

IMPORTANT

Ensure that the replacement cartridge, Sullair Part 42712 is labeled AF-45OD-Y15.

1. The clean cartridge must be rolled prior to installation. The end seams should be directly opposite each other when the cartridge is ready for installation.
2. Insert the cartridge (7) up into the filter body (8) with the central open tube (containing a triangular support) inserted first. Push the cartridge frame firmly up into the filter body and replace both small felt washers (6) on the bottom of the filter bolt. Do not place the small felt washers on the top of the filter.
3. Install a new O ring (5) in the groove in the bottom of the filter body (8), after smearing it with grease to keep it in place.
4. Place the bottom plate (1) on the filter body (8).
5. Install the hex socket screws (4) and tighten them evenly to 100 lb$_f$ft (135 N.m).
6. Mount the fiber washer (3) on the bottom plate.
7. Install the large center cap nut (2) on the filter bolt and tighten it to 50 lb. ft (70 N.m).
8. Pump one gallon (four liters) of oil through the oil drain valve into the oil filter to replenish the filter chamber.
9. Shut the oil drain valve.
10. Close the blowdown valve.
11. Open the suction stop valve and discharge stop valve.
12. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
13. If the compressor is fitted with a Sullistage port open the Sullistage stop valve.
14. Reconnect the control panel to the 115 V supply line.
15. Reconnect the starter to the electric supply line.
16. Start the compressor.

Figure 6-2 Shaft Seal Assembly



6.5 SHAFT SEAL REPLACEMENT

When shaft seal replacement is necessary, use replacement kit number 1812 A and follow the procedure explained below.

DISASSEMBLY

1. Remove the six capscrews which secure the shaft seal cover to the remainder of the compressor unit and remove the cover.
2. Press the old seat from the cover. Be absolutely sure that the cover is supported well enough to tolerate the stress which is present when pressing the seat out.

3. Remove the O ring from the cover.
4. Remove the seal from the shaft by removing the retaining ring from the seal and pulling it from the shaft.

NOTE

It will be necessary to break the bond between the shaft and the rubber bellows of the seal. This is done by pushing the seal further towards the compressor prior to pulling the seal from the shaft. Care must be taken not to score the shaft. Once the bond is broken, the seal can easily be removed from the shaft.

5. Pull the spring and retainer off the shaft.

REASSEMBLY

1. Check the shaft for burrs and sharp edges. The new seal must slide over the shaft, and sharp edges could easily damage the seal. Break all sharp edges and clean the shaft thoroughly with the fine emery cloth to remove any dirt and abrasions.
2. Install the new spring pin in the seal housing by tapping it lightly with a hammer. The pin must extend 1/8" to 3/16" (3 to 5mm) inside the seal housing. The pin may protrude through the exterior of the housing.
3. Lightly coat the seat and bore of the seal with clean refrigeration oil. By hand, press the new seat (with O ring in place) into the bore with the highly polished (lapped) surface facing out. Be sure to align the small hole in the seat with the spiral pin.

IMPORTANT

Care must be taken in handling the seat. Do not scratch the lapped surface. Place a thin coating of clean refrigeration oil on your thumbs prior to pressing the seal in place. After the seat is squarely in position, replace the retaining ring. Using a thin feeler gauge, check to see if the seat is squarely situated against the bottom of the bore in the seal housing.

4. Replace the retainer and spring and lightly coat the inside diameter and lapped carbon surface of the seal with clean refrigeration oil.
5. Install the new seal by carefully sliding it over the shaft with the lapped surface facing towards the end of the shaft. The seal assembly must be started squarely over the shaft. Slide it down the shaft until spring tension is apparent. If the seal becomes locked on the shaft, remove and start again. Extreme care must be taken not to damage the lapped carbon surface or rubber bellows on the inside diameter of the new seal. Improper positioning of the seal may cause the seal assembly to move too far onto the shaft. The rubber bellows will grip on the shaft stopping the spring from exerting the pressure necessary to seal the lapped surfaces. Excessive force should not be necessary. Final positioning is accomplished when installing the seal housing.
6. Clean the orifice of the seal housing with a small wire. Place the new O ring in position on the cover and line up the cover with the bolt circle of the compressor unit. Push squarely and slowly against the spring. Press until the cover makes contact with the compressor unit. Install and torque the capscrews to 35 ft lb. (47 N.m).

IMPORTANT

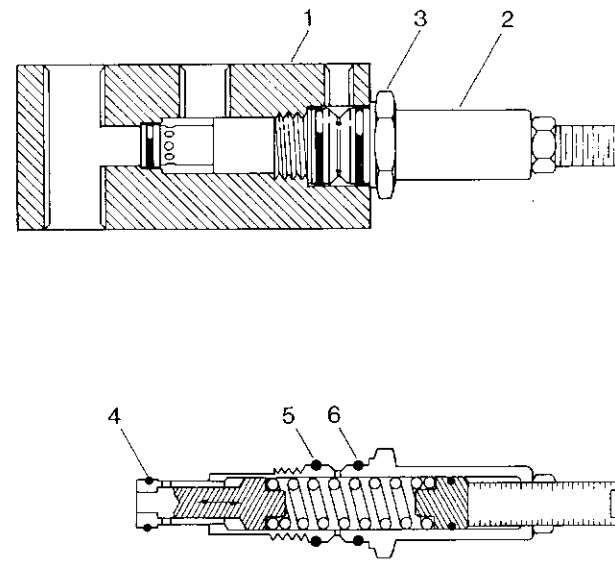
When the cover is replaced, proper centering in relation to the shaft is critical.

6.6 OIL PRESSURE REGULATING VALVE SERVICING

Refer to figure 6-3.

1. Carry out the shutdown procedure in section 6.2.
2. Replace the entire valve with a new valve.
3. Close the blowdown valve.
4. Open the suction stop valve and discharge stop valve.
5. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
6. If the compressor is fitted with a Sullistage port, open the Sullistage stop valve.
7. Reconnect the control panel to the 115 V supply line.

Figure 6-3 Oil Pressure Regulating Valve



8. Reconnect the starter to the electric supply line.
9. Start the compressor.
10. Run the compressor until the oil is at its normal operating temperature as in section 2.1.
11. Adjust the oil pressure regulating valve as in section 4.4.

6.7 OIL COOLER CLEANING

The internal diameter of the 5/8 in (16 mm) tube cooler is 0.402 in (10.2 mm).

The internal diameter of the 3/8 in (9.5 mm) tube cooler is 0.300 in (7.7 mm).
1. Disconnect the starter from the electric supply line.
2. Disconnect the control panel from the 115 V electric supply line.
3. Close water supply and return stop valves.
4. Remove the connecting water pipework from the cooler head (s).
5. If mechanical tube cleaning is desired, proceed to steps 7, 8, 9, 10 and 11.
6. Fit the necessary hose and fittings to the cooler head and flush through a proprietary chemical according to the manufacturer's instructions. Alternatively flush through a mild 4% sulfamic acid solution for 15 minutes or until no more scale exists in the outlet acid. As a last resort use a very weak 2% sulfuric acid solution with care as tube damage may result.

7. **IMPORTANT**

> To retain the correct angular orientation of the cooler heads make two marks adjacent to each other on the cooler head and the cooler with a punch or a file.

8. Remove the cooler heads from each end.
9. Mechanically rotary wire brush each tube in turn ensuring that the brush reaches the far end. Make sure all tubes are cleaned. Otherwise the flow may be partially blocked in some tubes causing overheating or cooling which results in severe expansion stresses, loosened tube joints and fractured tubes.
10. Clean the heat exchanger and cooler head.
11. Mount both cooler heads with new gaskets.
12. Thoroughly flush the cooler with clean water and dispose of this effluent properly.
13. Reconnect the water pipework to the cooler head.
14. Open the water supply and return stop valves.
15. Reconnect the control panel to the 115 V electric supply.
16. Reconnect the starter to the electric supply line.
17. Start the compressor.
18. After running for 15 minutes adjust the water regulating valve if necessary to achieve an operating oil temperature of 105°F to 115°F (40°C to 46°C).

6.8 OIL STRAINER SERVICING

(A) SINGLE OIL STRAINER SERVICING

The strainers in standard packages are shown in figures 1-3 and 1-4.

1. Carry out the shutdown procedure in section 6.2.

IMPORTANT

> If a pump out compressor is used to evacuate refrigerant from the package, do not lower the package pressure to less than atmospheric and be sure to open the blow down valve on the separator to the atmosphere.

If this is not done, when the strainer plugs are removed the sudden inrush of air to break the vacuum will backflush the foreign matter from the strainers into the lines. After reassembling the apparently clean strainers and running the compressor the strainers will again plug up.

2. Loosen the hexagonal screwed plug in the end of the strainer until the plug is held by about two threads.
3. Place a receptacle underneath the strainer to catch oil.
4. Unscrew the plug by hand, quickly remove the strainer element from the recess in the plug and replace and screw the plug about two threads into the empty strainer body.

⚠CAUTION

> Be careful to avoid being burned by the hot oil. Use rags or waste cloths for protection.

5. Remove any foreign matter from inside the strainer element (eg fibers) and clean the strainer with a light solvent (eg mineral spirits).
6. Again unscrew the plug by hand, quickly insert the strainer into the plug recess, renew the plug gasket if necessary and screw the plug into the strainer body. Tighten the plug firmly.
7. While the compressor package is blown down, clean all the oil strainers as in steps 2 to 6 above.
8. Close the blowdown valve.
9. Open the suction stop valve and discharge stop valve.
10. With the package pressurized, check that none of the strainers are leaking and if necessary tighten the plug (s) further.
11. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
12. If the compressor is fitted with a Sullistage port, open the Sullistage stop valve.
13. Reconnect the control panel to the 115 V supply line.
14. Reconnect the starter to the electric supply line.
15. Start the compressor.

6.9 OIL SEPARATOR ELEMENT SERVICING

Refer to figure 6-4.

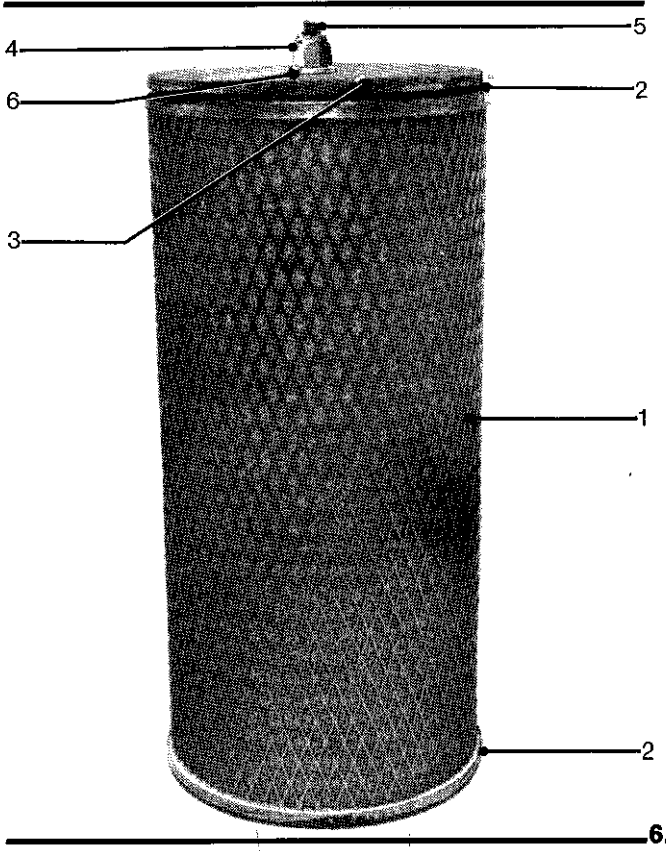
INSPECTION

1. Carry out the shut down procedure in section 6.2.
2. Remove access cover on the top of the separator.
3. Inspect the element gaskets (2) for tightness. If the gaskets are blown on either end they must be replaced. If the gaskets had been replaced recently and they are blown again, the elements are dirty and all the gaskets and elements have to be replaced.

REMOVAL

1. Remove locking nut (4), flat washer (6), and cover plate (3).
2. Remove element (1).
3. Scrape old gaskets from both ends of the element if the elements are to be reused.
4. Thoroughly clean the gasket surfaces, cover plate and the bulkhead in the separator.

Figure 6-4 Oil Separator Element



INSTALLATION

1. Cement new gaskets (2) to the element (1) using Loctite 404 (available from Sullair Refrigeration).
2. Replace element (1).
3. Tighten nut (4) until the cover plate (3) bows 1/16 in (1 mm).
4. Replace the access cover on the oil separator using a new gasket if necessary.
5. Close the blowdown valve.
6. Open the suction stop valve and discharge stop valve.
7. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
8. If the compressor is fitted with a Sullistage port, open the Sullistage stop valve.
9. Reconnect the control panel to the 115 V supply line.
10. Reconnect the starter to the electric supply line.
11. Start the compressor.

6.10 CAPACITY CONTROL SERVICING

Should it be necessary to replace the seals on the capacity control shaft refer to Figure 6-5 for component identification.

DISASSEMBLY

1. Carry out the shut down procedure in Section 6.2
2. Disconnect the actuator by removing the four screws with a 12 point socket.
3. Loosen the 4 mounting bolts from the mounting adaptor and remove the complete valve assembly. A 12 point socket set is necessary to fit the mounting bolts.
4. Remove retaining ring and pull the valve assembly from the adaptor.
5. Press oil seals from their mount.

REASSEMBLY

1. Deburr the capacity control valve shaft and adaptor.
2. Press seals into housing with a light coating of sealant around the OD of the seal to prevent leakage.
3. Carefully insert control valve and mount the seal ring and snap ring.
4. Reinsert valve assembly using care to properly align the assembly to prevent binding the valve as it is rotated.
5. Close the blowdown valve.
6. Open the suction stop valve and discharge stop valve.
7. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
8. If the compressor is fitted with a Sullistage port, open the Sullistage stop valve.
9. Reconnect the control panel to the 115 V supply line.
10. Reconnect the starter to the electric supply line.
11. Start the compressor.

6.11 CAPACITY CONTROL ACTUATOR SERVICING

Refer to figure 6-6.

DISASSEMBLY

1. Carry out the shut down procedure in section 6-2.
2. Disconnect fluid lines and drain the oil.
3. Remove the actuator as in section 6-10.
4. Remove all burrs from shaft assembly extension.
5. Remove screws & indicator screw & remove indicator.
6. Strike end of shaft opposite loosened head with plastic mallet to free it from dowels.

Figure 6-5 Capacity Control System

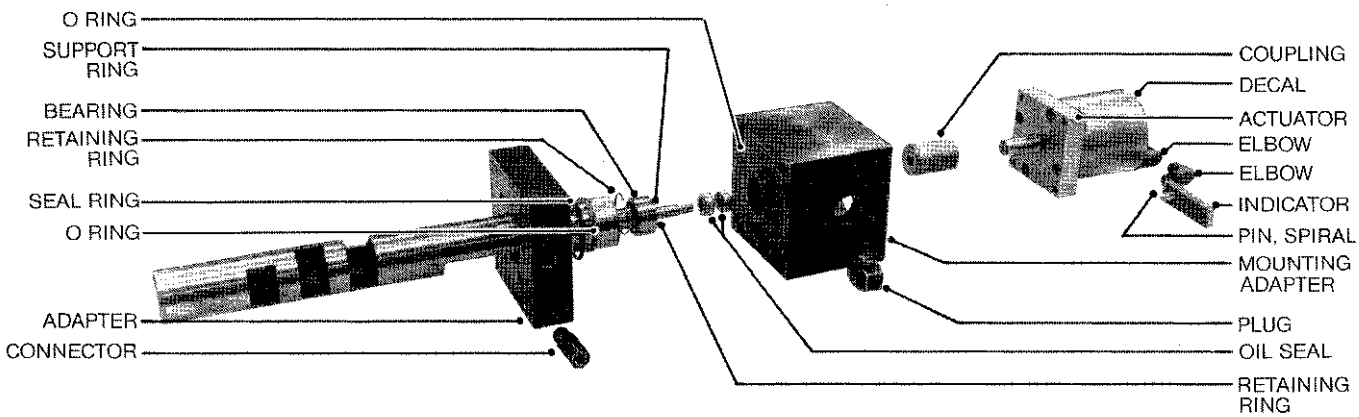
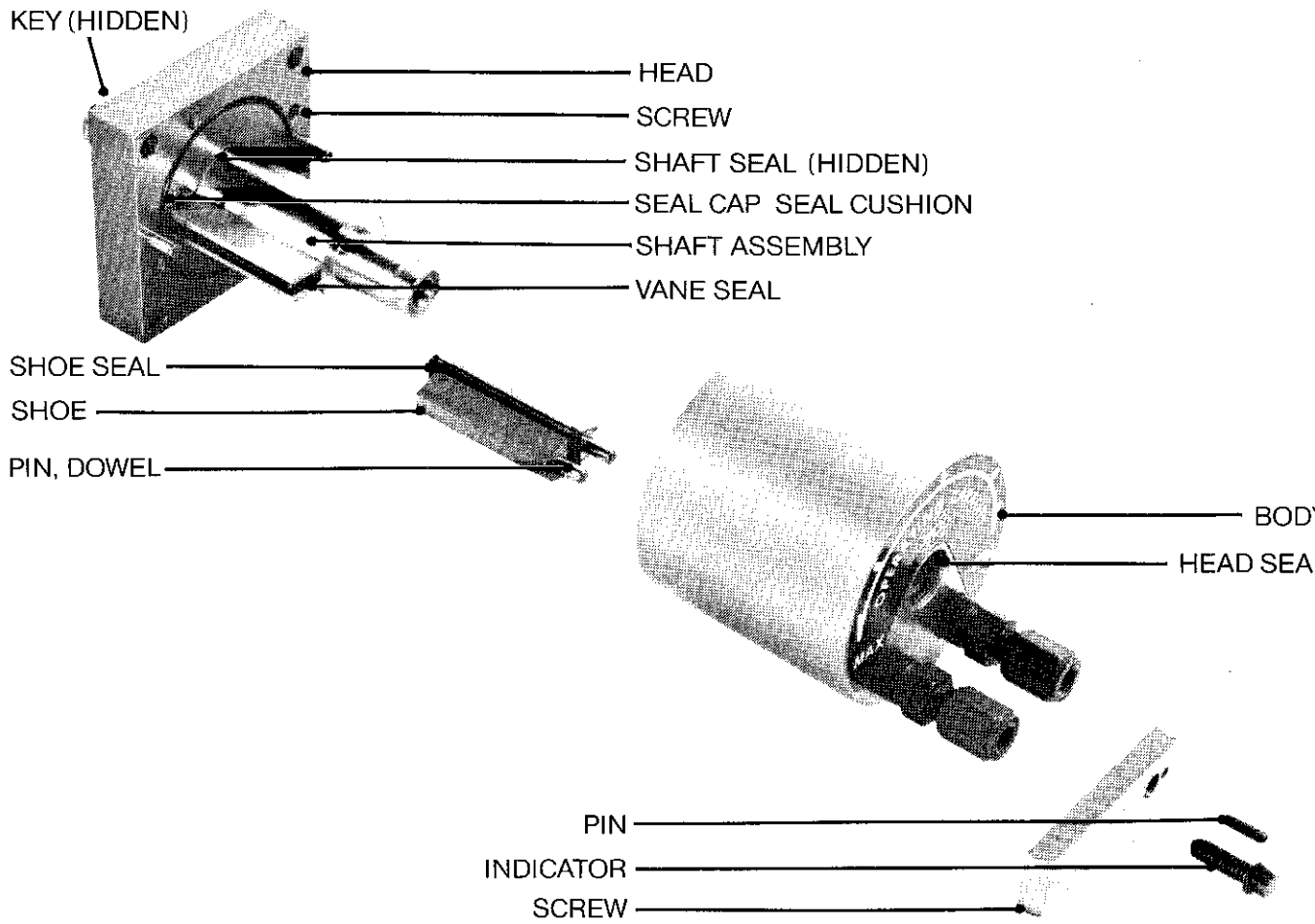


Figure 6-6 Valve Actuator



7. Remove head, shaft assembly, and shoe from body.
8. Remove all seals (and dowels if necessary for repair.)

INSPECTION AND REPAIR

1. Inspect inside of actuator, Presence of foreign material may indicate the need to clean and filter the driving system.
2. Inspect all internal surfaces for excessive scoring or galling which could cause seal damage or internal leakage.
3. Minor score marks can be polished out with fine emery cloth or equivalent. Score marks in any part in excess of .005 in (0.12mm) require replacement of that part.
4. Check dowel holes in head and body for elongation. Excessive elongation requires replacement of that part.
5. Place short end of shaft through bearing area in body, shake to determine the condition of the shaft bearing area. Repeat procedure using long end of shaft through head. If excessively worn, replacement of the head and/or body is necessary.

REASSEMBLY

1. Thoroughly wash all parts to remove any foreign material that might cause damage and remove any burrs. DO NOT break the corners of the body bore or the corners of the large diameter of the shaft.
2. Lubricate all seals and internal parts with grease compatible with the driving fluid used.
3. Replace and install shaft seal in its groove in the head and body.
4. Replace and install shoulder seal cushion in its groove in the head and body.
5. Replace and install shoulder seal cap with radiused corners toward cushion.

NOTE

Corner radii are very small. A magnifying glass may be necessary to determine proper seal orientation.

6. Replace and install head seal in its groove in the head.
7. Replace and install shoe seal in its groove around shoe.

NOTE

Replacement shoe must be aluminum or steel. No plastic acceptable.

8. Place vane seal in its groove around vane.
9. Insert dowel pins into body.
10. Install shoe into body. Leave approximately 1/8 inch (3mm) between end of shoe and body.
11. To assemble shaft, tuck in corners of seal. DO NOT TWIST. Push straight in until shaft is seated against end of body.
12. Complete shoe installation by seating shoe against end of body.
13. Press corners of shoe and vane seals below end surface of body.
14. Install head on body, pull down evenly and secure with screws and torque to 35 in.lb (4N.m)

ADJUSTMENT

1. With actuator in the position shown in right end view of sketch, rotate shaft counterclockwise until physical stop in actuator is reached.
2. Position indicator handle as shown in line with port.
3. Using pilot hole in indicator handle drill a 1/8" diameter hole in shaft approximately 5/16" deep. (This is not required on factory adjusted units.)
4. Insert spring pin in hole flush with indicator handle. Secure handle with bolt.
5. Install complete actuator in unit.
6. Reverse the shut down procedure in section 6.2.

6.12 ELECTRICAL CONTROLS SERVICING

Use the wiring diagram for the specific machine to assist in locating a defective electrical component. (The wiring diagram number is on the Sullair logo inside the electrical control panel). Replace defective controls with new standard industrial controls.

Do not attempt to repair electrical components.

6.13 COMPRESSOR UNIT REPLACEMENT

Should replacement of the Sullair compressor unit be necessary, the following procedures will ensure correct replacement and minimize down time. It is recommended that the Sullair Refrigeration Service Department be involved in the decision to change compressor units.

They will also assist in the ordering of the new unit and scheduling of Sullair Refrigeration Servicemen if required.

REMOVAL

1. Carry out the shut down procedure in section 6.2.
2. Remove tubing in large subassemblies. This will save time and confusion when installing the new unit. Avoid bending the tubing assemblies. In most cases, the assemblies will fit the new unit.
3. When removing the old unit, install temporary pipe hangers to facilitate installation of the new unit.
4. Return the old unit to Sullair Refrigeration in the same crate in which the replacement was shipped.

INSTALLATION

1. Change the oil filter cartridge and thoroughly clean every oil strainer.
2. Thoroughly clean all tubing and piping with solvent and brush before refitting to compressor.
3. Reconnect the tubing and piping as in figure 1-3 or 1-4, for a standard unit.
4. Follow the pressure test procedure, section 3.8.
5. Follow the evacuation procedure, section 3.9.
6. Drain and discard all the oil from the package, by opening the drain valve on the bottom of the oil separator, and then removing the drain plug from the bottom of the oil cooler (if water cooled).
7. Flush the package with clean oil through the discharge temperature connection on the oil separator.
8. Replace the drain plugs, close the oil separator drain valve and charge the system with new oil as in section 3.11.
9. Warm the oil, section 3.12.
10. Check the electrical system, section 3.13.
11. Check the protective switches, section 3.13.
12. Check the capacity control, section 3.13.
13. Follow the pre-start check list, section 4.2.
14. Follow the initial start-up procedure, section 4.3.
15. Follow the initial maintenance procedures as for a new machine, sections 5.2 and 5.3.

- NOTES -

PROCEDURE FOR ORDERING PARTS

Parts should be ordered from the nearest Sullair Distributor or the Contractor from whom the machine was purchased. If for any reason parts cannot be obtained in this manner, contact the factory directly at the address below.

When ordering parts always indicate the **Serial Number** of the machine. This can be obtained from the Bill of Lading for the machine or from the Serial Number Plate located on the machine.

Standard fasteners (capscrews, nuts, washers, etc.) tubing and fittings plus other standard hardware have not been included in the Parts List. These are items which can be obtained more quickly and economically from local sources.

SULLAIR REFRIGERATION, INC.
3700 East Michigan Boulevard
Michigan City, Indiana 46360

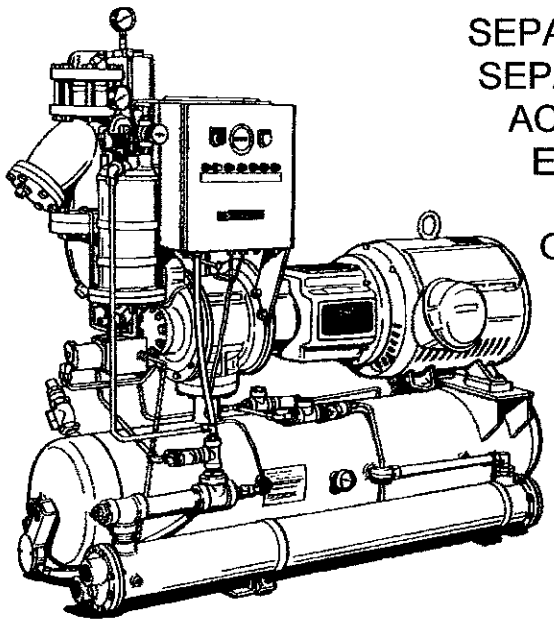
Telephone (219) 879-5451
Telex: 276103

7.1 RECOMMENDED SPARE PARTS LIST

DESCRIPTION	*PART NO.*	*QTY.*
Gasket, Oil Cooler	43912	2
Gasket, Oil Cooler	43906	2
Cartridge, Oil Filter	42712	4
O Ring, Oil Filter	826202-259	2
Screen, Oil Strainer	44055	2
Gasket, Oil Strainer	44060	6
Gasket, Suction Strainer	240245	2
Gasket, Oil Separator Access	240172	2
Gasket, Oil Separator Element	240229	2
Lamp, Pilot Light	43386	6
Valve, Solenoid-Capacity Control	47287	1
Shaft Seal, Compressor	240012	1
Seal, Shaft-Capacity Control	42874	2
Kit, Repair Capacity Control Valve Actuator	1804A	1

WHEN ORDERING PARTS ALWAYS INDICATE SERIAL NUMBER OF MACHINE.

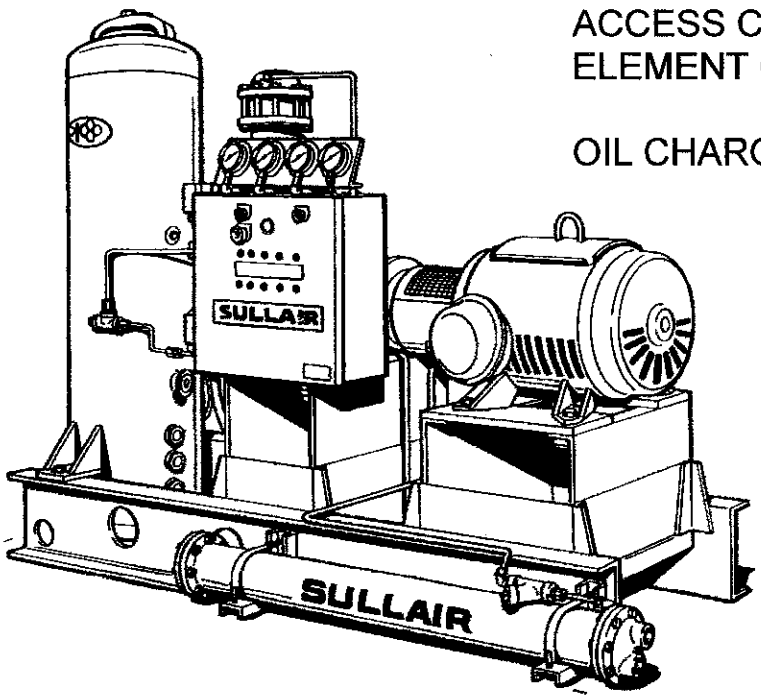
CB12LA717-3.0-100HP (DIRECT DRIVE)



SEPARATOR ELEMENT (R717) P/N 240158
SEPARATOR ELEMENT (R22) P/N 240812
ACCESS COVER GASKET P/N 240172
ELEMENT GASKET P/N 240620-008

OIL CHARGE - 15 TO 20 GALLONS

CB12LA717-251-3.0-150HP (GEAR DRIVE)
USES C16L SEPARATOR TANK



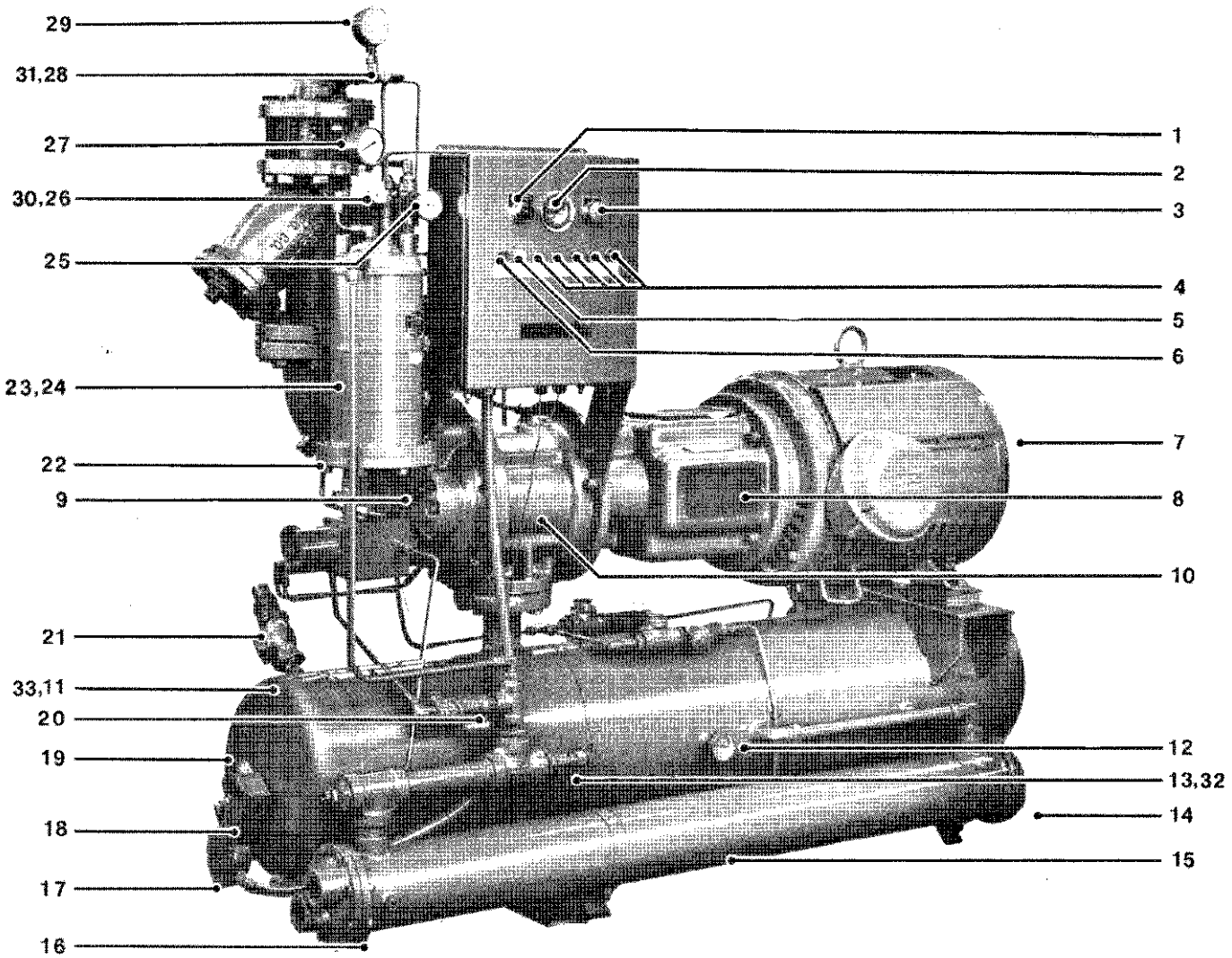
SEPARATOR ELEMENT P/N 044038
ACCESS COVER GASKET P/N 240177
ELEMENT GASKET P/N 026427

OIL CHARGE - 30 TO 35 GALLONS

Section 7

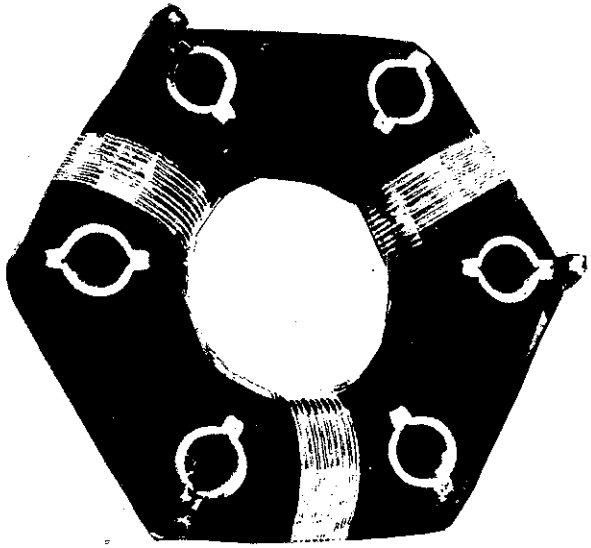
ILLUSTRATIONS AND PARTS LISTS

FIGURE 7.2 GENERAL (PANEL SIDE)



key number	*description*	*part number*	*quantity*
1	start switch	47097	1
2	hour meter	42988	1
3	stop switch	45494	1
4	pilot light lens - protective switches (red)	43384	5
5	pilot light lens - run (green)	43385	1
6	pilot light lens - anti recycle (amber)	47016	1
7	motor 75hp 460/220 volt/3/60	50191	1
	motor 100hp 460/220 volt/3/60	50192	1
	motor 125hp 460/220 volt/3/60	50193	1
8	drive coupling 75hp and 100hp (not shown)	240187	1
	drive coupling 125hp (not shown)	240225	1

BELOW IS SHOWN
A12 AND CB12 COUPLING ELEMENT
PART NUMBER 250018-551



7.2 GENERAL (PANEL SIDE) (Continued)

key number	*description*	*part number*	*quantity*
9	gasket, suction elbow	240705	1
10	compressor unit*	**	1
11	bulbwell, control valve (not shown)	240027	1
12	discharge temperature gauge	240054	1
13	bulbwell	42883	1
14	oil cooler gasket - return head	43912	1
15	oil cooler	43932	1
16	oil cooler gasket - in/out head	43906	1
17	oil heater	240067	1
18	oil heater thermostat	42589	1
19	oil separator/sump	18035	1
20	oil strainer	43325	1
	oil strainer screen	44055	1
	oil strainer gasket	44060	1
21	relief valve	44991	1
22	oil filter O ring (not shown)	826202-259	1
23	oil filter	42463	1
24	oil filter cartridge (not shown)	42712	1
25	oil temperature gauge	240054	1
26	three-way valve, filter pressure drop	241239	1
27	filter pressure drop gauge	240055	1
28	three way valve, suction pressure/oil pres	241239	1
29	suction pressure/oil pressure gauge	240055	1
30	nameplate, filter check	241325	1
31	nameplate, suction/oil pressure	241324	1
32	shield, capillary (temp.)	26356	2
33	shield, capillary (liq. inj.)	222195	1

R22 Gauges 240274

* See compressor unit serial no. nameplate.

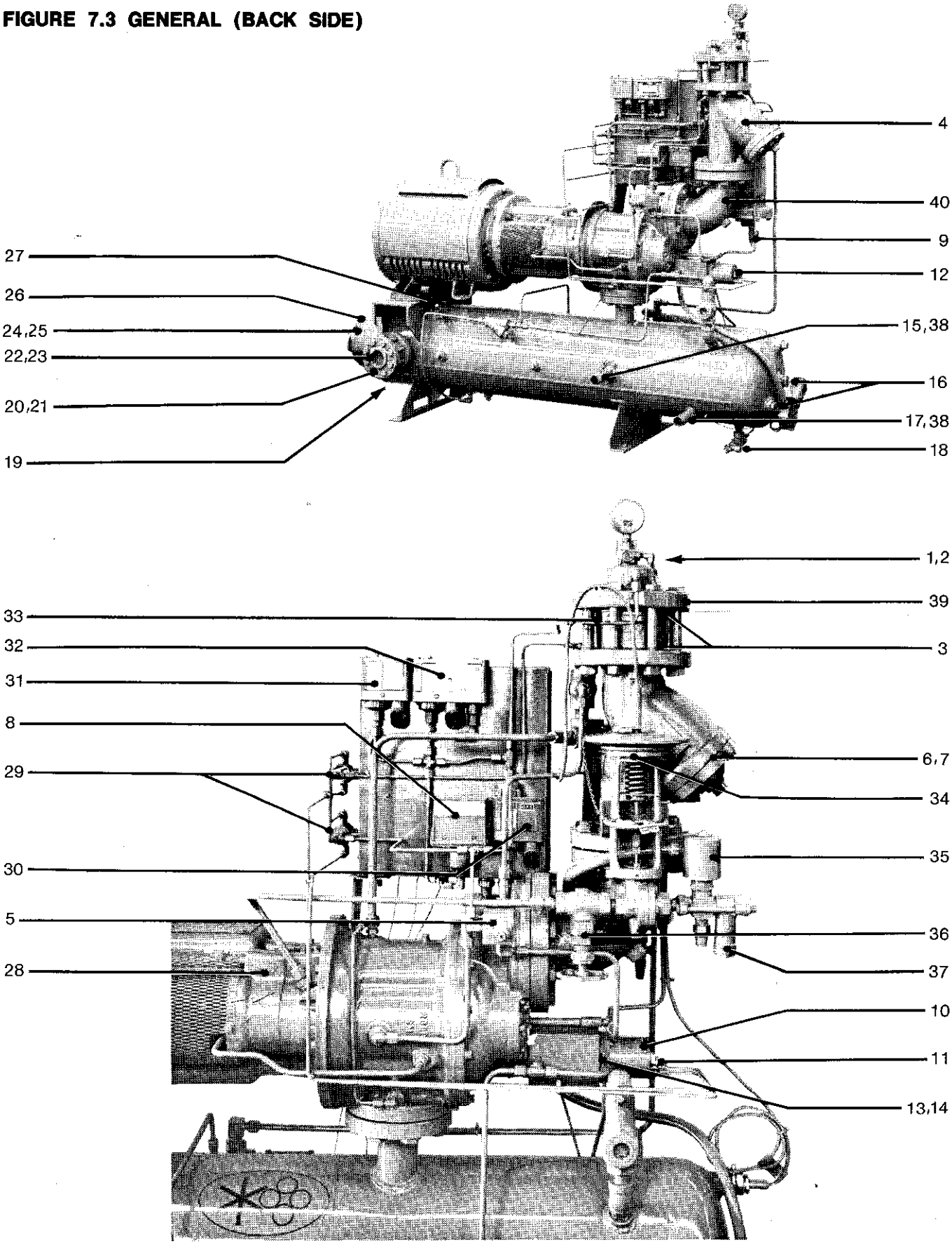
** The shaft seal or capacity control valve is the only spare part which can be purchased for the compressor unit. Any other part replacement must be made at the factory. Tampering with internal parts other than the shaft seal or capacity control valve constitutes abuse of the compressor under the terms of the warranty. There is an exchange program whereby a reconditioned (warranteed) compressor unit can be obtained from the factory at the price of reconditioning your unit.

WHEN ORDERING PARTS, ALWAYS INDICATE SERIAL NUMBER OF MACHINE

Section 7

ILLUSTRATIONS AND PARTS LISTS

FIGURE 7.3 GENERAL (BACK SIDE)



7.3 GENERAL (BACK SIDE)

key number	description	part number	quantity
1	suction stp valve, 3" st with flanges (not shown)	44578	1
2	gasket	43678	2
3	gasket (not shown)	44998	3
4	suction strainer	240163	1
5	oil pressure regulator**	42475	1
6	suction strainer screen (not shown)	240234	1
7	gasket (not shown)	240245	1
8	capacity control pressure switch (P1/P2)	47607	1
9	filter valve	44996	1
10	capacity control indicator	220225	1
11	capacity control actuator	240218	1
12	capacity decal (not shown)	240219	1
13	capacity control actuator coupling (not shown)	220224	1
14	capacity control actuator coupling key (not	*	1
15	bulbwell shown)	42883	1
16	oil level sight glass	41327	2
17	bulbwell	42883	1
18	oil drain valve	44997	1
19	discharge pressure gauge (not shown, shipped loose)	240055	1
20	discharge stop valve, 2" globe w/flanges (not	240065	1
21	gasket shown)	43676	2
22	discharge check valve, 2" (not shown, shipped loose)	240056	1
23	gasket (not shown)	240170	2
24	oil separator element (not shown)***	240158	1
25	oil separator element gasket (not shown)	240229	2
26	oil separator access cover gasket (not shown)	240172	1
27	blow down valve	44997	1
28	shaft seal (not shown)	240012	1
29	capacity control solenoid valve***	47287	2
30	low oil pressure protective switch	42464	1
31	suction pressure auto start-stop control	42888	1
32	high discharge/low suction pressure control	42465	1
33	suction check valve	240058	1
34	refrigerant regulating valve	240227	1
a.	refrigerant regulating valve replacement seats	240786	1
b.	refrigerant regulating valve thermal system	240882	1
c.	refrigerant regulating valve packing	240710	1
35	main solenoid valve	240228	1
36	liquid injection line manual valve	45626	1
37	strainer	240226	1
38	shield, capillary (temp.)	26356	2
39	suction flange	18125	1
40	suction elbow	221592	1

* Standard hardware item, purchase locally.

** Earlier machines equippped with "Fulflo" regulator #240066 - request conversion kit.

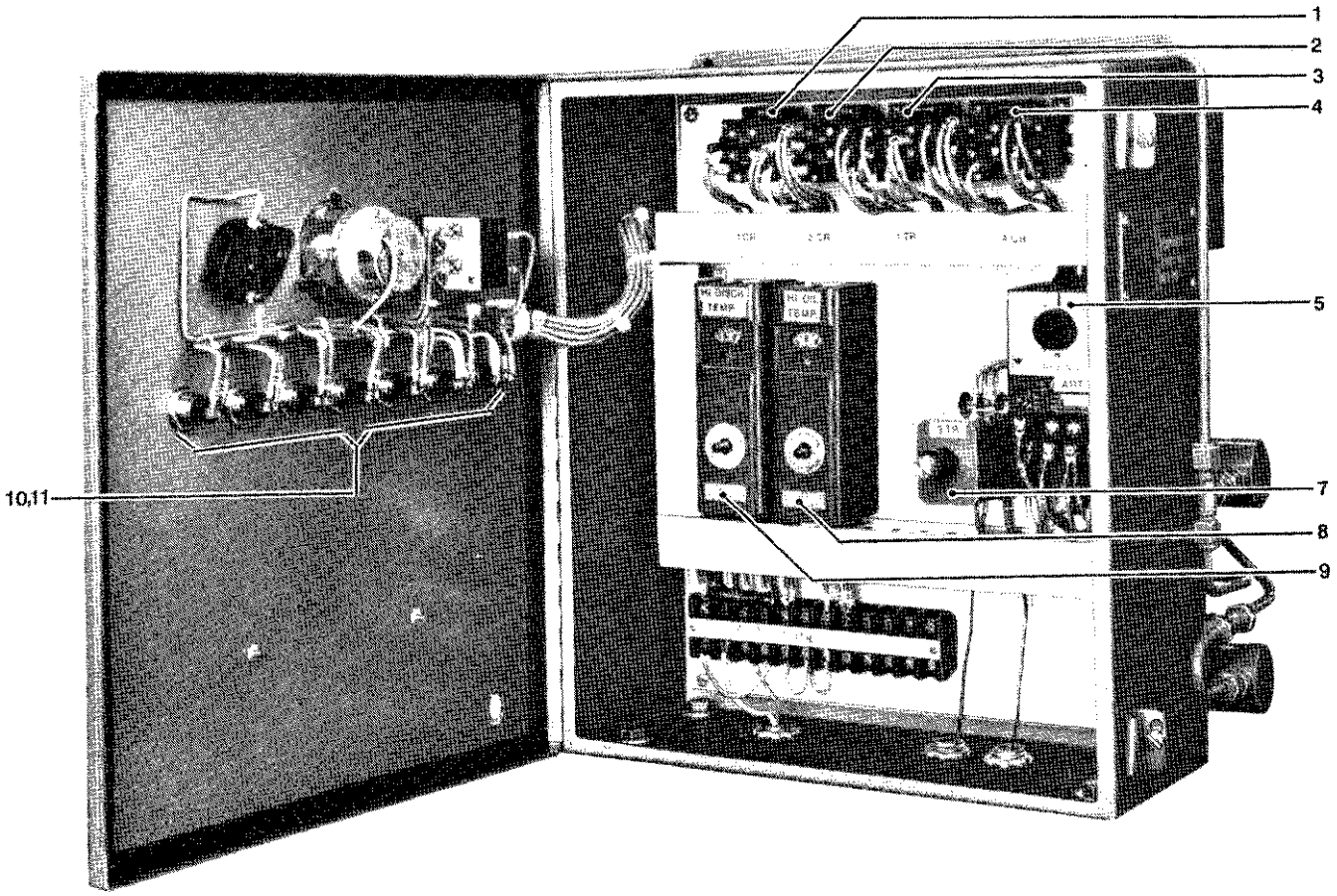
*** Freon machines use element #240812 & solenoid #240785.

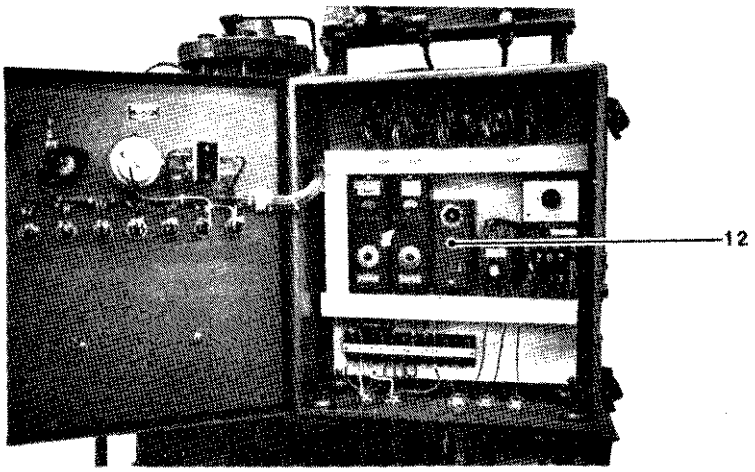
WHEN ORDERING PARTS, ALWAYS INDICATE SERIAL NUMBER OF MACHINE

Section 7

ILLUSTRATIONS AND PARTS LISTS

FIGURE 7.4 ELECTRICAL PARTS



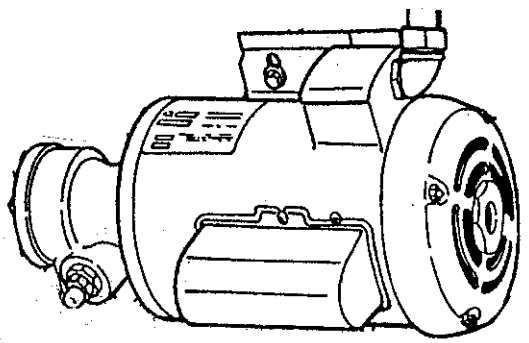


7.4 ELECTRICAL PARTS

key number	*description*	*part number*	*quantity*
1	protective relay (1cr)	46175	1
2	low oil pressure relay (2cr)	46175	1
3	oil pressure delay timer (1tr)	46178	1
4	motor run relay (4cr)	46175	1
5	anti-recycle timer (art)	46177	1
6	solenoid relay (freon only) not shown	45496	1
7	capacity control timer (3tr)	47087	1
8	high oil temperature control	45417	1
9	high discharge temperature control	45417	1
10	pilot light, lamp holder	43383	7
11	pilot lamp (not shown)	43386	7
12	low discharge temperature control	42589	1

WHEN ORDERING PARTS, ALWAYS INDICATE SERIAL NUMBER OF MACHINE

3/4 HP AUX OIL PUMP



P/N 045625, PUMP & 3/4 HP MOTOR COMPLETE

P/N 240870, PUMP ONLY (CCW ROTATION)

P/N 050484, 3/4 HP MOTOR ONLY

P/N 240317, PUMP SHAFT SEAL ONLY

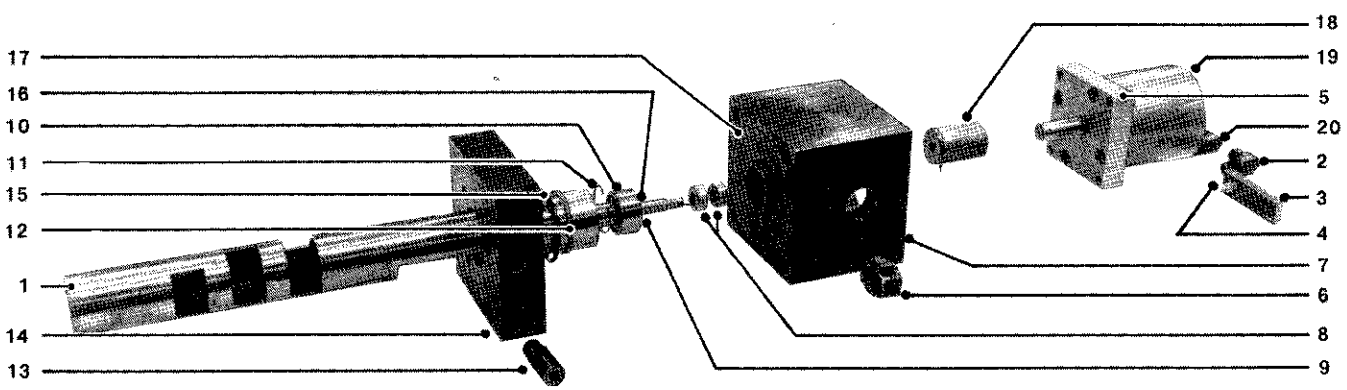
P/N 250026-891, COUPLING FOR MOTOR/PUMP

ILLUSTRATIONS AND PARTS LISTS

FIGURE 7.5 CAPACITY CONTROL VALVE

THIS CAPACITY CONTROL VALVE IS OF THE "A" MODEL OR VERSION OF THE COMPRESSOR UNIT

THE HYDRAULIC ACTUATOR DECAL IS P/N 240219 (MAX ON LEFT - MIN ON RIGHT)



7.5 CAPACITY CONTROL VALVE

key number	*description*	*part number*	*quantity*
1	capacity control valve		
	• high volume ratio	18112	1
	• low volume ratio	18107	1
2	elbow, tube 1/4"pipe x 1/2"tube	*	1
3	indicator	220225	1
4	pin, spiral 1/8" x 1/2"	*	1
5	actuator**	240218	1
6	plug, pipe 3/4"	*	1
7	adapter, mounting	220223	1
8	seal, oil	42874	2
9	ring, retaining	836251-046	1
10	bearing	42681	1
11	ring, retaining	836150-125	1
12	O ring	826202-224	1
13	connector, 1/4"pipe x 1/4"tube	*	1
14	adapter	220222	1
15	ring, glide	240195	1
16	ring, support	22939	1
17	O ring	826202-043	1
18	coupling	220224	1
19	decal	240219	1
20	elbow, tube 1/4"pipe x 1/4"tube	*	1

* Standard hardware item, purchase locally.

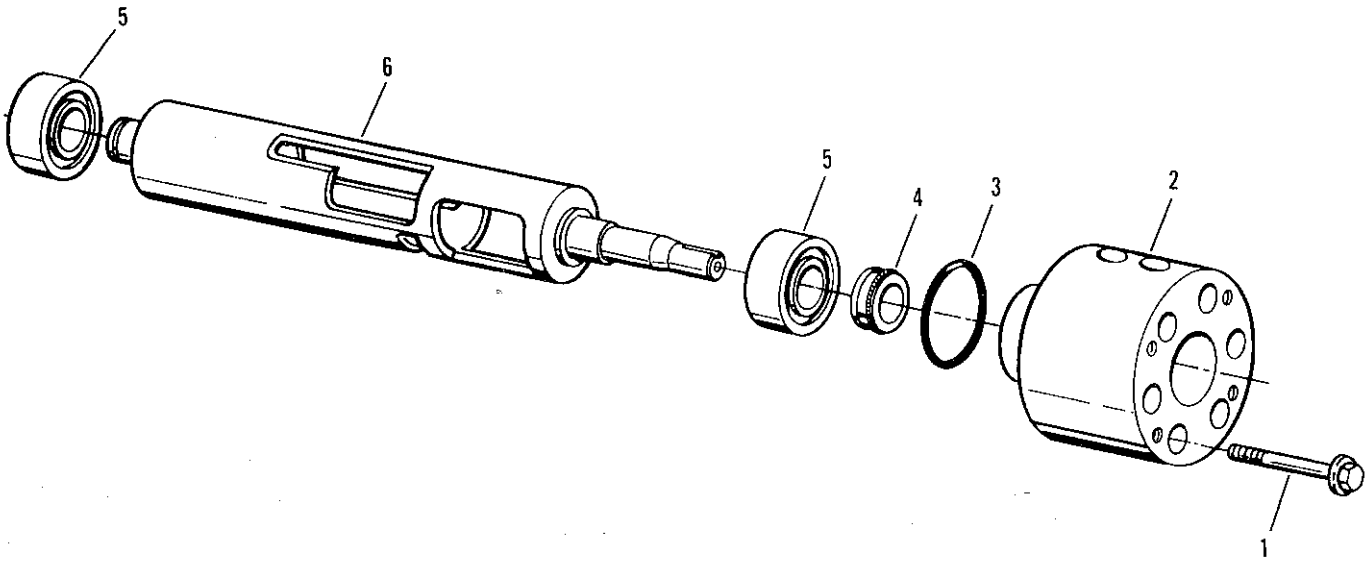
** For repair kit order no. 1804A (Does not include actuator 240218).

WHEN ORDERING PARTS, ALWAYS INDICATE SERIAL NUMBER OF MACHINE

7.8 CAPACITY CONTROL SYSTEM

THIS CAPACITY CONTROL VALVE IS OF THE "C" MODEL OR VERSION OF THE COMPRESSOR UNIT.

THE HYDRAULIC ACTUATOR DECAL IS P/N 232558 (MIN ON LEFT - MAX ON RIGHT)



KEYWAY OF THE ACTUATOR SHOULD LINE UP WITH THE KEYWAY OF THE TURN VALVE

7.8 CAPACITY CONTROL VALVE COMPLETE ACTUATOR P/N 250027-554*

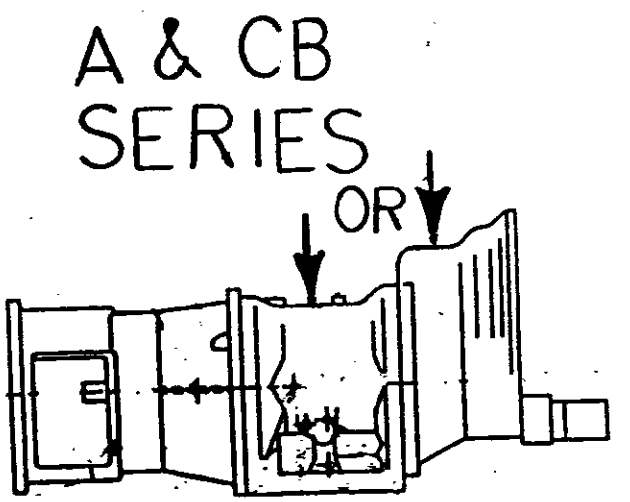
KEY NO	DESCRIPTION	PART NUMBER	QTY
1A	capscrew	828406-250	4
1B	capscrew	828406-400	2
2	actuator adaptor	232557	1
3	neoprene O-ring	826202-133	1
4	seal, 0.75	250002-758	1
5	bearing	499072-525	2
6	capacity control valve	017224	1

WHEN ORDERING PARTS, INDICATE SERIAL NUMBER OF COMPRESSOR

SULLAIR A12/CB12 SHAFT SEAL KITS BY UNIT PART NUMBER

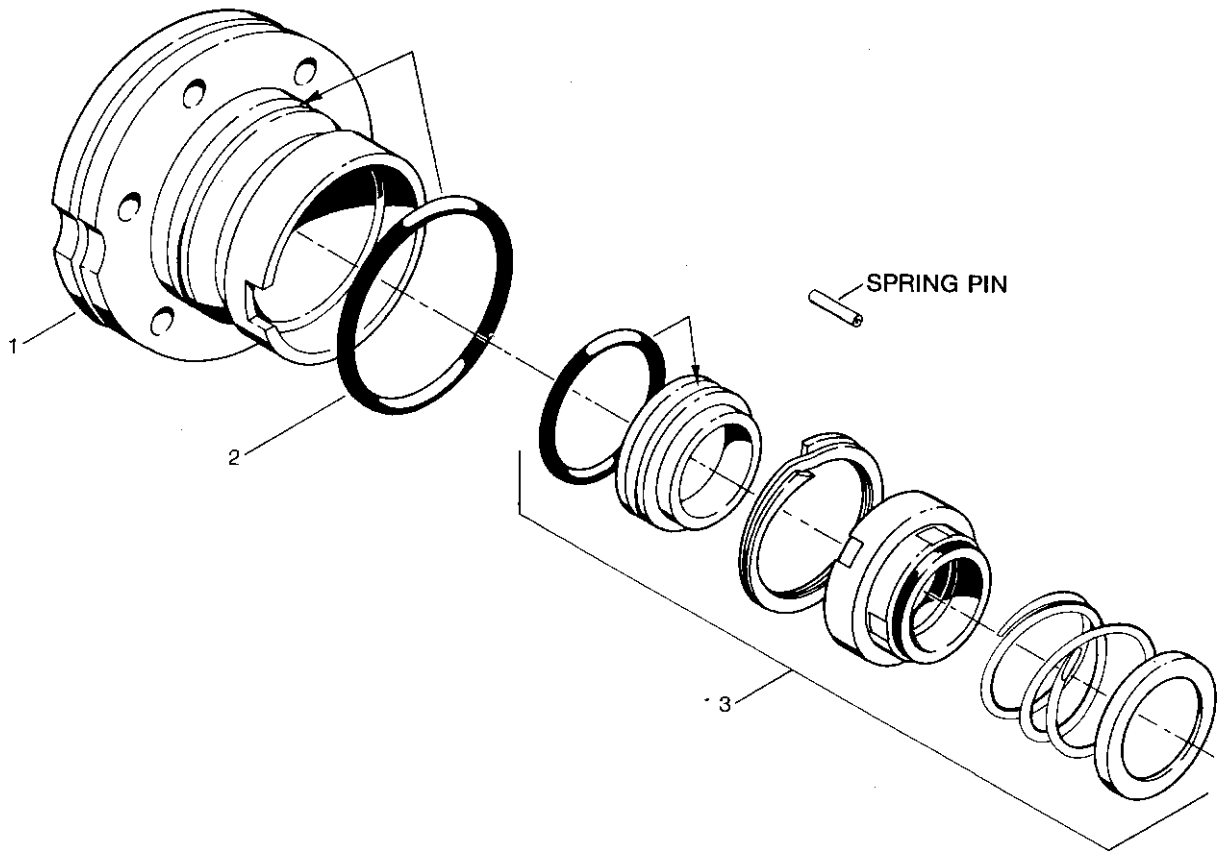
UNIT PART NUMBER	STYLE	USE KIT NUMBER	UNIT MODEL #
008432-001,004	GEAR DRIVE	001812B	C
008453-001,003,004	GEAR DRIVE	001812B	C
008573-011	GEAR DRIVE	001812B	C
008574-001,004	GEAR DRIVE	001812B	C
008578-001	GEAR DRIVE	001812B	C
008579-001,004	GEAR DRIVE	001812B	C
008724-001,004	GEAR DRIVE	001812B	C
02250064-160	GEAR DRIVE	02250047-688	
060564-1	DIRECT DRIVE	001812A	A
063048-100	DIRECT DRIVE	001812A	B
065067-100	DIRECT DRIVE	001812A	B
065096-300,310,320	DIRECT DRIVE	001919C	C
065453-300,310,320	GEAR DRIVE	001812B	C
065454-300,320	GEAR DRIVE	001812B	C
065455-300,320	GEAR DRIVE	001812B	C
066347-300,310,320	GEAR DRIVE	001812B	C
066348-300,310,320	GEAR DRIVE	001812B	C
066349-300,310,320	GEAR DRIVE	001812B	C
066351-300,310,320	DIRECT DRIVE	001919C	C
066570-300,310,320	DIRECT DRIVE	001919C	C
069571-100	DIRECT DRIVE	001812A	A
069698-200	GEAR DRIVE	001812B	B
069699-200	GEAR DRIVE	001812B	

AS OF DECEMBER 2004, 001812B & 001919C ARE TYPE 8 SEALS
AS OF DECEMBER 2004, 001812A IS A TYPE 21 SEAL



ILLUSTRATIONS AND PARTS LISTS

FIGURE 7.6 SHAFT SEAL ASSEMBLY



key number	*description*	*part number*	*quantity*
1	retainer, oil seal	220101	1
2	O ring	826202-238	1
3	seal, oil (neoprene)	240012	1

WHEN ORDERING PARTS, ALWAYS INDICATE SERIAL NUMBER OF MACHINE

Section 8
WARRANTY

8.1 STATEMENT OF WARRANTY - NEW PACKAGES

As Vendor, we, Sullair Refrigeration Inc., undertake to remedy as hereafter provided, any defect in the refrigeration compressor manufactured by us resulting from faulty materials or workmanship. The Vendor's obligations under this warranty shall be limited to defects appearing in the bare compressor within thirty months from the date of shipment of the package or two years from the date of start-up, whichever occurs first, whereas, repair of defects appearing in the package components shall be limited to eighteen months from the date of shipment of the package or one year from the date of start-up, whichever occurs first, excluding any prime mover or other component which is covered by the original manufacturer's warranty or which is furnished by the customer. Except where the nature of the defect is such that it is appropriate, in the sole judgement of the Vendor, to effect repairs on site, the Vendor's obligation hereunder to remedy defects shall be limited to repairing or replacing (at the Vendor's option), any part returned to the Vendor at the risk and cost of the purchaser. Field labor is not covered by this warranty. This warranty does not apply to (a) defects arising out of materials provided or a design stipulated by the purchaser; (b) defects due to the purchaser's improper erection, maintenance or use; alterations not authorized by the Vendor; or normal wear and tear.

Sullair (Sullair Refrigeration Inc. of Michigan City, Indiana or our accredited overseas agents) shall as part of our liability, fulfill this warranty under the following procedures:

a) Customer will provide Sullair with all obtainable information regarding the problem.

b) All field serviceable problems will be handled by customer's servicemen with assistance of information provided by Sullair. Sullair will provide replacement parts if covered by warranty as determined by Sullair.

c) A replacement compressor will be sent to the customer unless repair can be done at customer site at Sullair's option.

d) Method of shipment of replacement compressors to be option of Sullair and at the expense of the customer.

e) All parts shipped to replace warranty failures will be billed to the customer. Credit will be issued only if the parts are returned to Sullair along with a "Parts Adjustment Claim" (PAC) which can be obtained upon request from Sullair. The PAC must be completely filled out including a detailed report covering the defective item within 120 days of original invoice.

THIS STATEMENT OF WARRANTY IS EXPRESSLY IN LIEU OF AND DISCLAIMS ALL OTHER EXPRESS WARRANTIES, IMPLIED WARRANTIES OF MERCHANTABILITY AND ALL OTHER IMPLIED WARRANTIES. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. THIS WARRANTY DOES NOT INCLUDE LIABILITY FOR CONSEQUENTIAL DAMAGES.

Worldwide Sales and Service

SULLAIR REFRIGERATION, INC.

Mailing Address: 3700 East Michigan Blvd. Michigan City, Indiana 46360
Shipping Address: 1625 E. Second Street, Michigan City, Indiana 46360
Phone: (219) 879-5451 Telex: 276103

P/N 253769

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