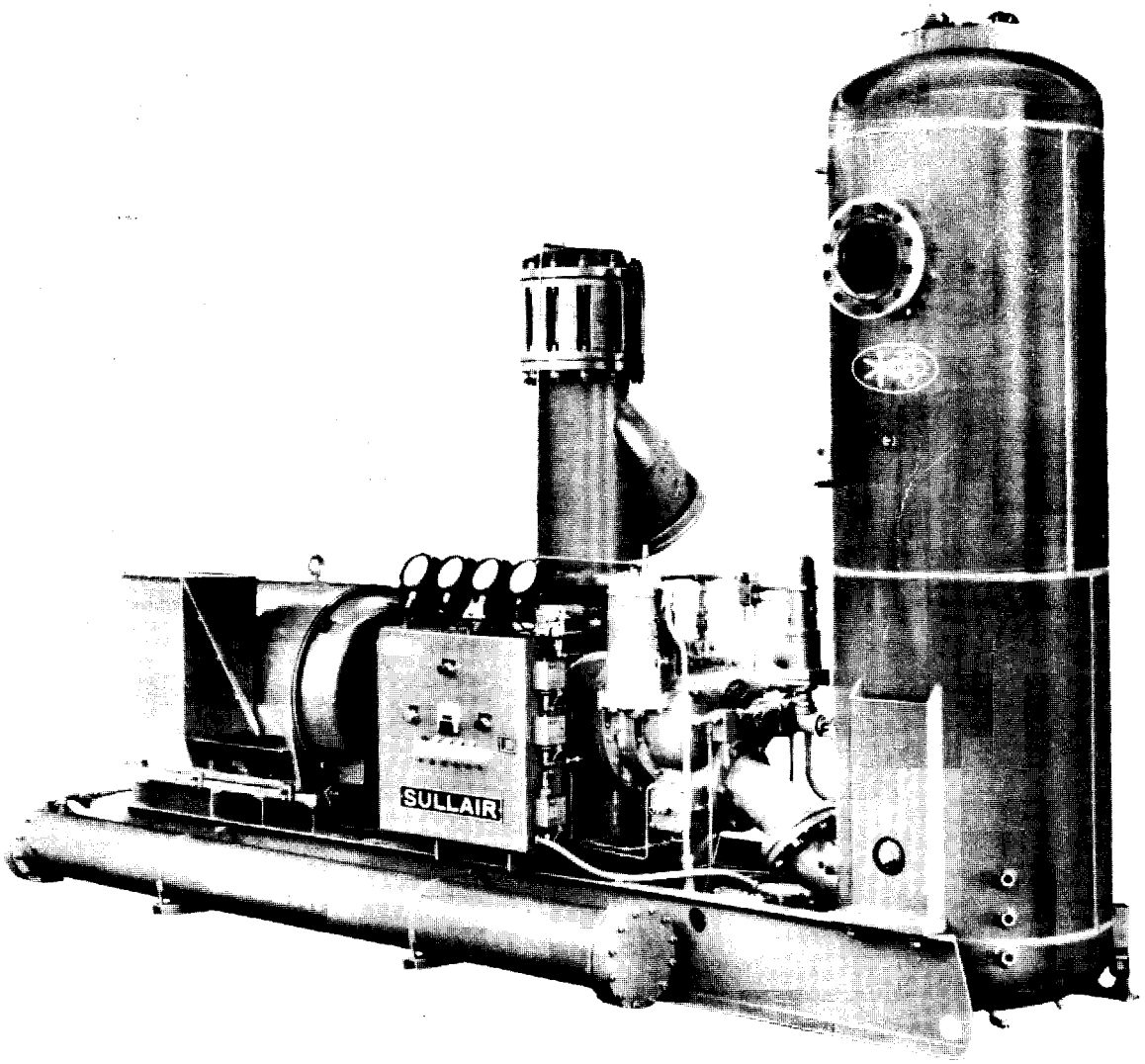
Operators Manual

P/N 252664
Revised by Mid-States Refrigeration
11-2004

Sullair Refrigeration Compressor

B Series



SULLAIR B SERIES

THIS SULLAIR B SERIES MANUAL WAS PRINTED IN 1981 AND WAS NEVER UPDATED THROUGH THE YEARS.

INFORMATION CONTAINED MAY COVER THE EQUIPMENT YOU ARE WORKING ON.

IF NOT

PLEASE CONTACT MID-STATES REFRIGERATION SUPPLY WITH THE PACKAGE MODEL NUMBER, PACKAGE SERIAL NUMBER, UNIT PART NUMBER AND UNIT SERIAL NUMBER.

PLEASE NOTE THAT IN THESE EARLY DAYS THE SAME PART NUMBER WAS USED WHEN SUPPLIED BY DIFFERENT VENDORS. WE NEED ALL THE INFORMATION YOU CAN PROVIDE TO GET YOU THE CORRECT REPLACEMENT PART.

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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 the 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, Refrigerator, 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 on a rugged steel base frame and includes the following equipment:

- Sullair screw compressor unit
- Coupling and guard
- Three stage vertical oil separator
- Lubrication system with either a shell and tube water-cooled oil cooler or a high pressure liquid refrigerant injection oil cooling system
- Electrical control system
- Suction strainer and suction check valve

Refer to figure 1-1 for component identification.

1.3 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
- 150 PSI (1MPa) design casting
- Compressor driven, positive displacement oil pump
- Oil flooded, carbon face shaft seal
- Anti-friction roller bearings

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 into the oil separator. The refrigerant passes into the system, and the oil is cooled and filtered in preparation for injection into the compressor.

1.4 CAPACITY CONTROL SYSTEM

The compressor capacity or displacement is varied according to the suction pressure by either throttling the suction flow with an electrically activated butterfly valve, or by a rotating cylindrical valve which allows the gas to be returned to suction rather than be compressed.

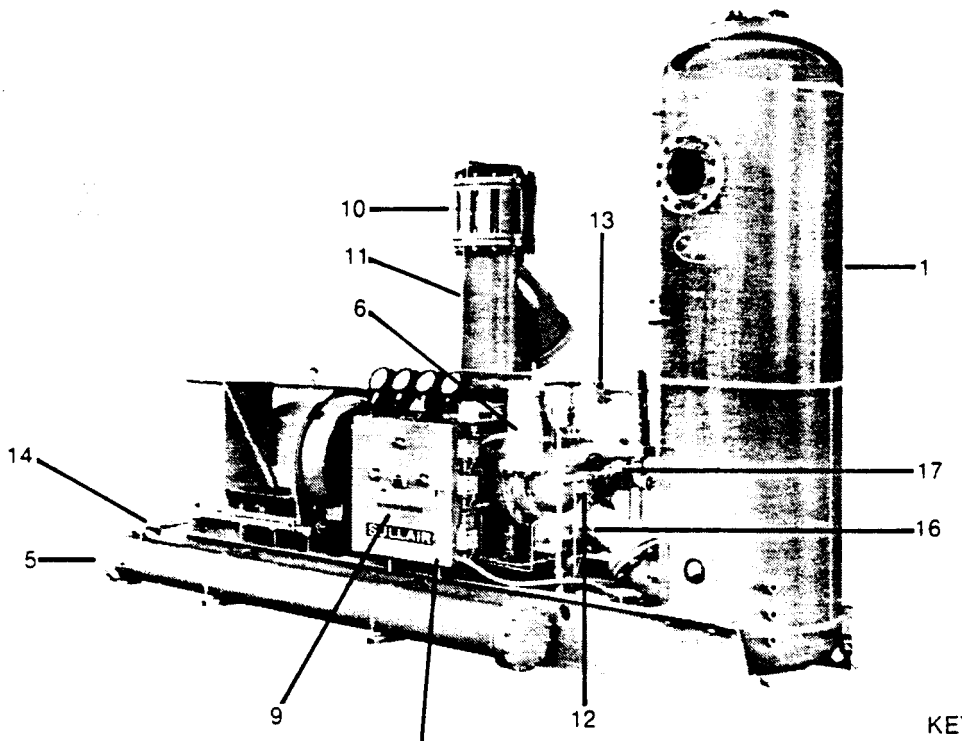
1.5 THE LUBRICATION SYSTEM

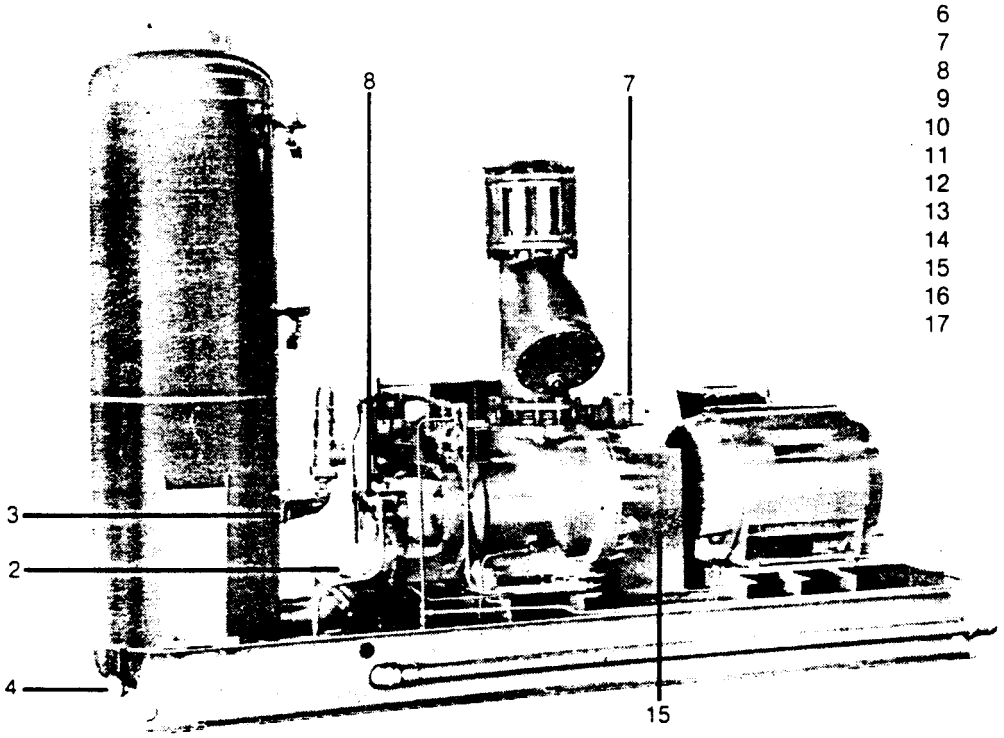
The standard lubrication schematics for the water-cooled and refrigerant cooled packages are shown in Figures 1-2 through 1-14.

The oil (from injection and the bearings) leaves the compressor in a refrigerant/oil mixture and is separated from the refrigerant in the three stage oil separator. Sight glasses are installed in the sump portion of the oil separator to indicate oil level. A thermostatically controlled oil heater is installed in the oil separator to maintain oil temperature and prevent refrigerant condensation when the compressor is not running.

The oil is cooled either with water in a shell and tube oil cooler or by injection of high pressure liquid refrigerant directly into the compressor near the discharge port. In the water-cooled system a valve senses oil temperature and varies the flow of water into the oil cooler to maintain a constant oil temperature. The refrigerant cooled system includes a strainer, a low discharge temperature switch, a solenoid valve and a refrigerant regulating valve. When the discharge temperature rises above the low discharge temperature setting, the solenoid valve opens and feeds refrigerant to the refrigerant regulating valve. This refrigerant regulating valve senses the oil temperature in either the discharge pipe or oil separator and varies the flow of liquid refrigerant into the compressor discharge to maintain a constant oil temperature. (A detailed description of the refrigerant injection cooling system is in Section 4.6).

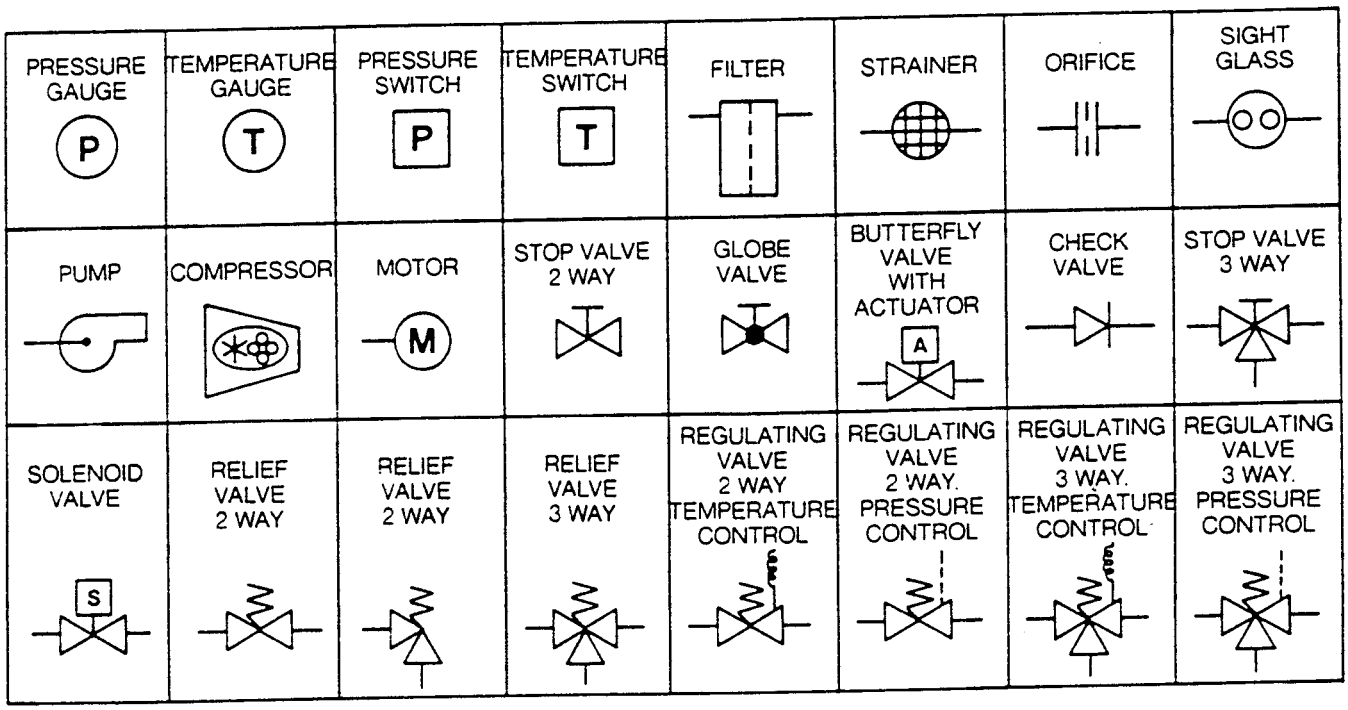
Figure 1-1 Sullair B Series Refrigeration Compressor





KEY NUMBER	DESCRIPTION
1	Oil Separator
2	Discharge Line to System
3	Discharge Temperature Gauge
4	Heater Element and Thermostat
5	Oil Cooler
6	Oil Filter
7	Electric Valve Actuator Assy.
8	Oil Pump
9	Control Panel
10	Suction Check Valve
11	Suction Strainer
12	Oil Pressure Relief Valve
13	Oil Pressure Regulating Valve
14	Oil Strainers
15	Coupling and Guard
16	Compressor Discharge
17	Oil Check Valve

Figure 1-2 B Series Legends



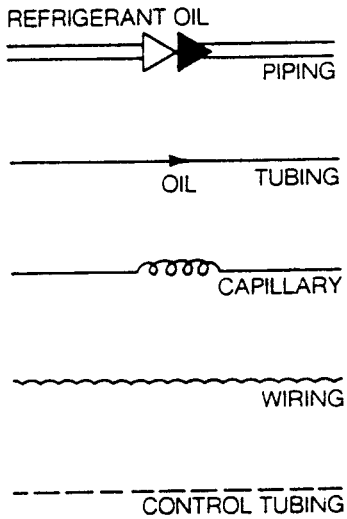
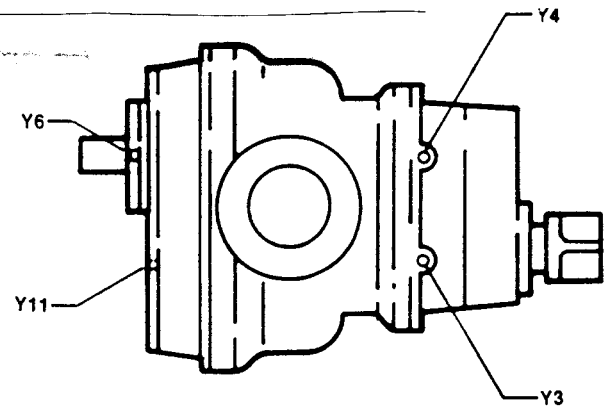
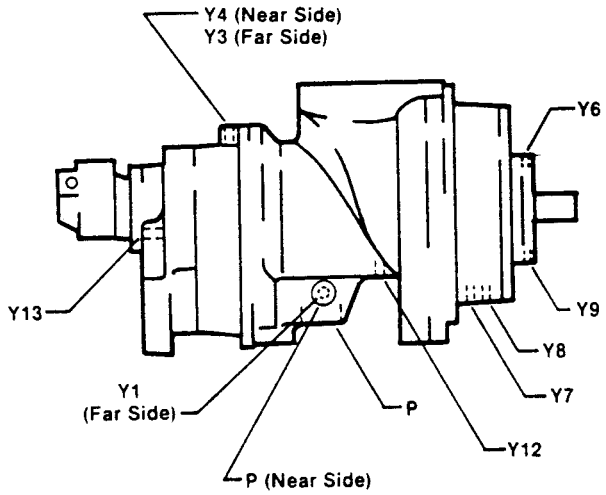


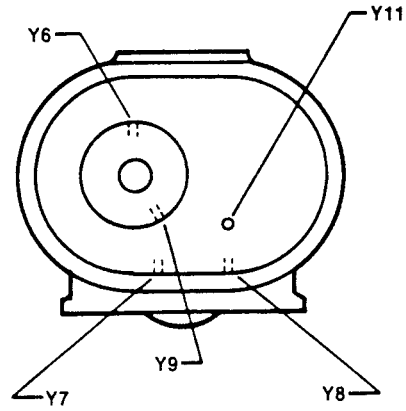
Figure 1-3 Direct Drive B20

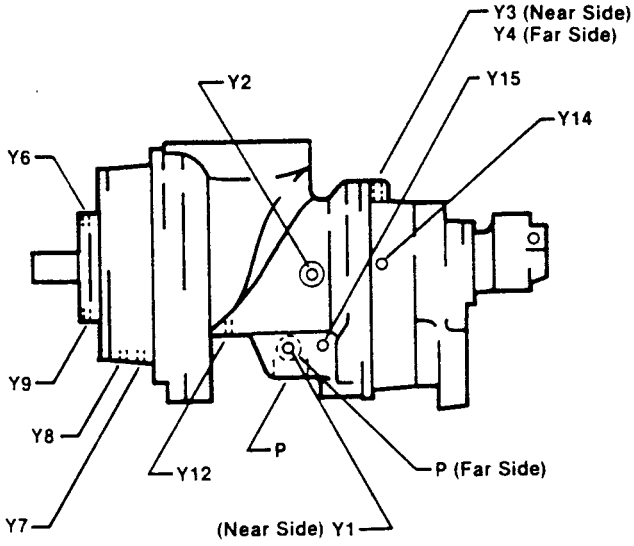
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

P	Normally Plugged
Y1	Main oil supply to unit
Y2	Oil injection-female rotor
Y3	Oil to female outlet bearing
Y4	Oil to male outlet bearing
Y5	Oil to gear housing
Y6	Oil to shaft seal
Y7	Oil to male inlet bearing
Y8	Oil to female inlet bearing
Y9	Shaft seal drain
Y10	Oil drain from Y9
Y11	Oil drain from gear housing (Gear drive) or, inlet bearing (Direct drive)
Y12	Oil drain from Y11 and Y13
Y13	Oil drain to Y12
Y14	Liquid injection inlet
Y15	Discharge port









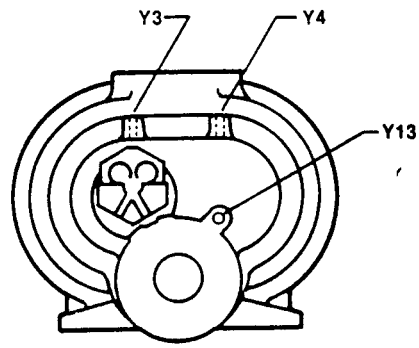
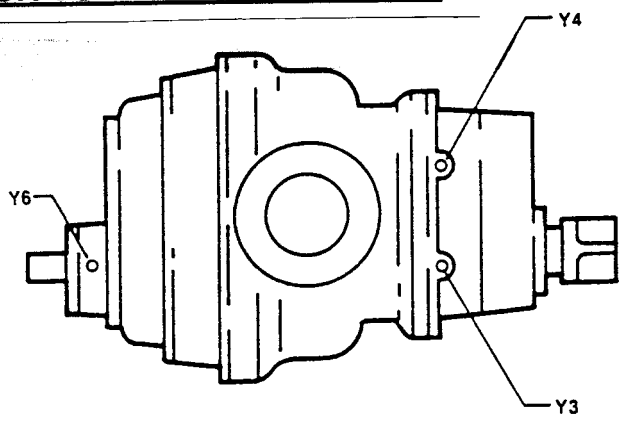
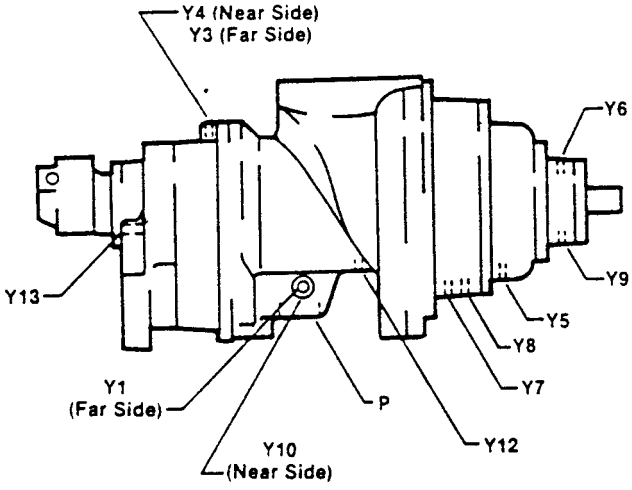


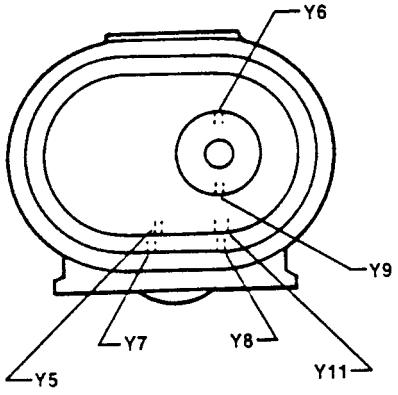
Figure 1-4 Gear Drive B20

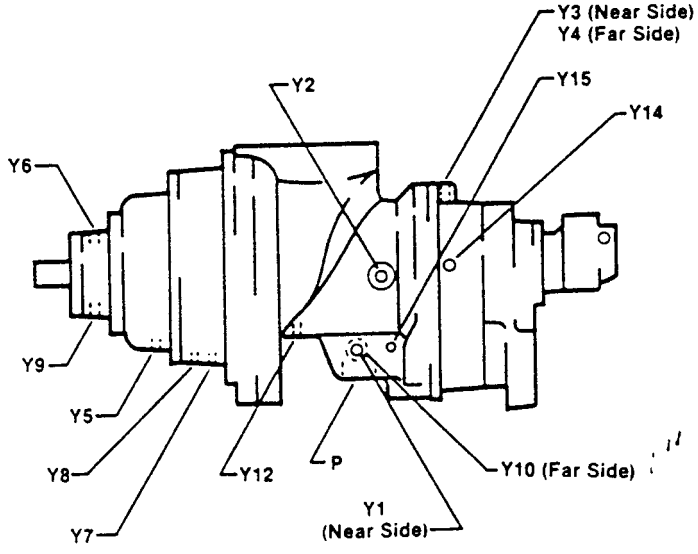
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

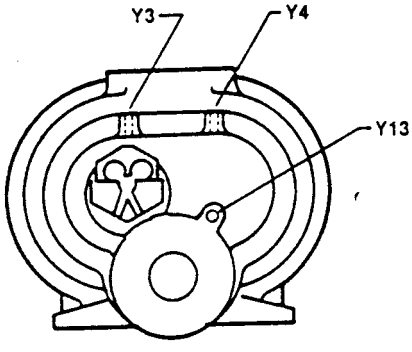
P	Normally plugged
Y1	Main oil supply to unit
Y2	Oil injection-female rotor
Y3	Oil to female outlet bearing
Y4	Oil to male outlet bearing
Y5	Oil to gear housing
Y6	Oil to shaft seal
Y7	Oil to male inlet bearing
Y8	Oil to female inlet bearing
Y9	Shaft seal drain
Y10	Oil drain from Y9
Y11	Oil drain from gear housing (Gear drive) or, inlet bearing (Direct drive)
Y12	Oil drain from Y11 and Y13
Y13	Oil drain to Y12
Y14	Liquid injection inlet
Y15	Discharge port





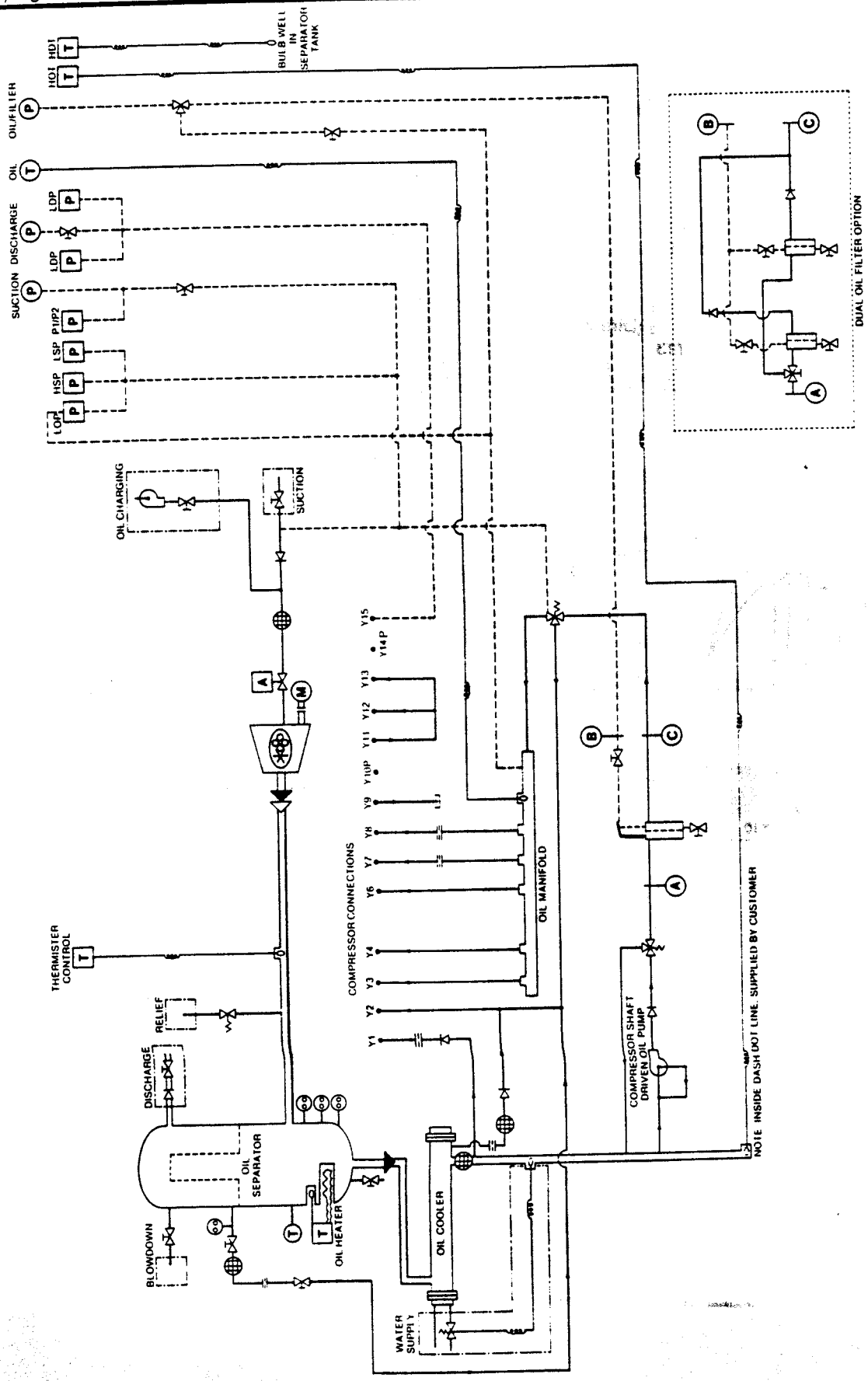






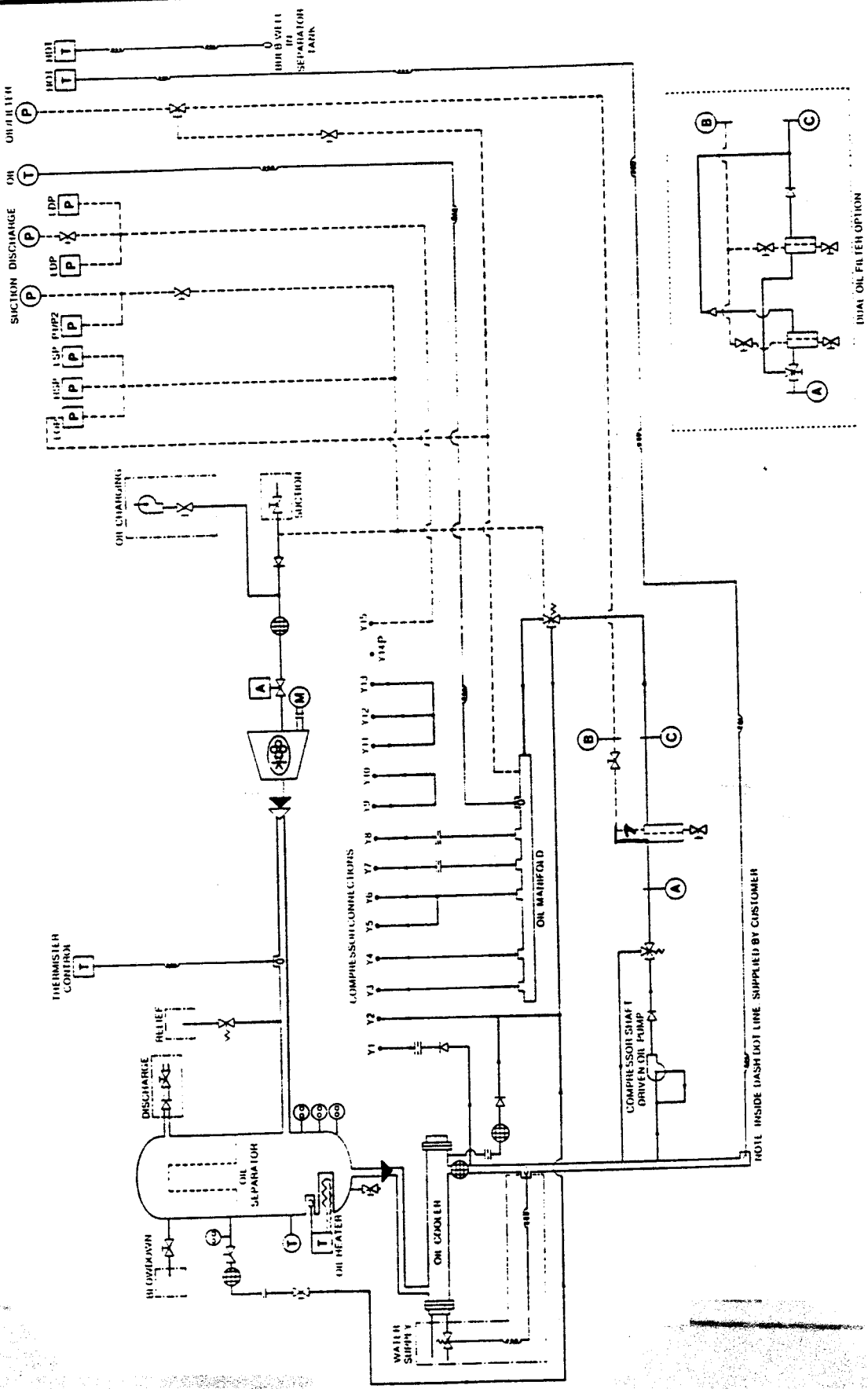
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-5 Piping Schematic (B20 Water-Cooled - Direct Drive)



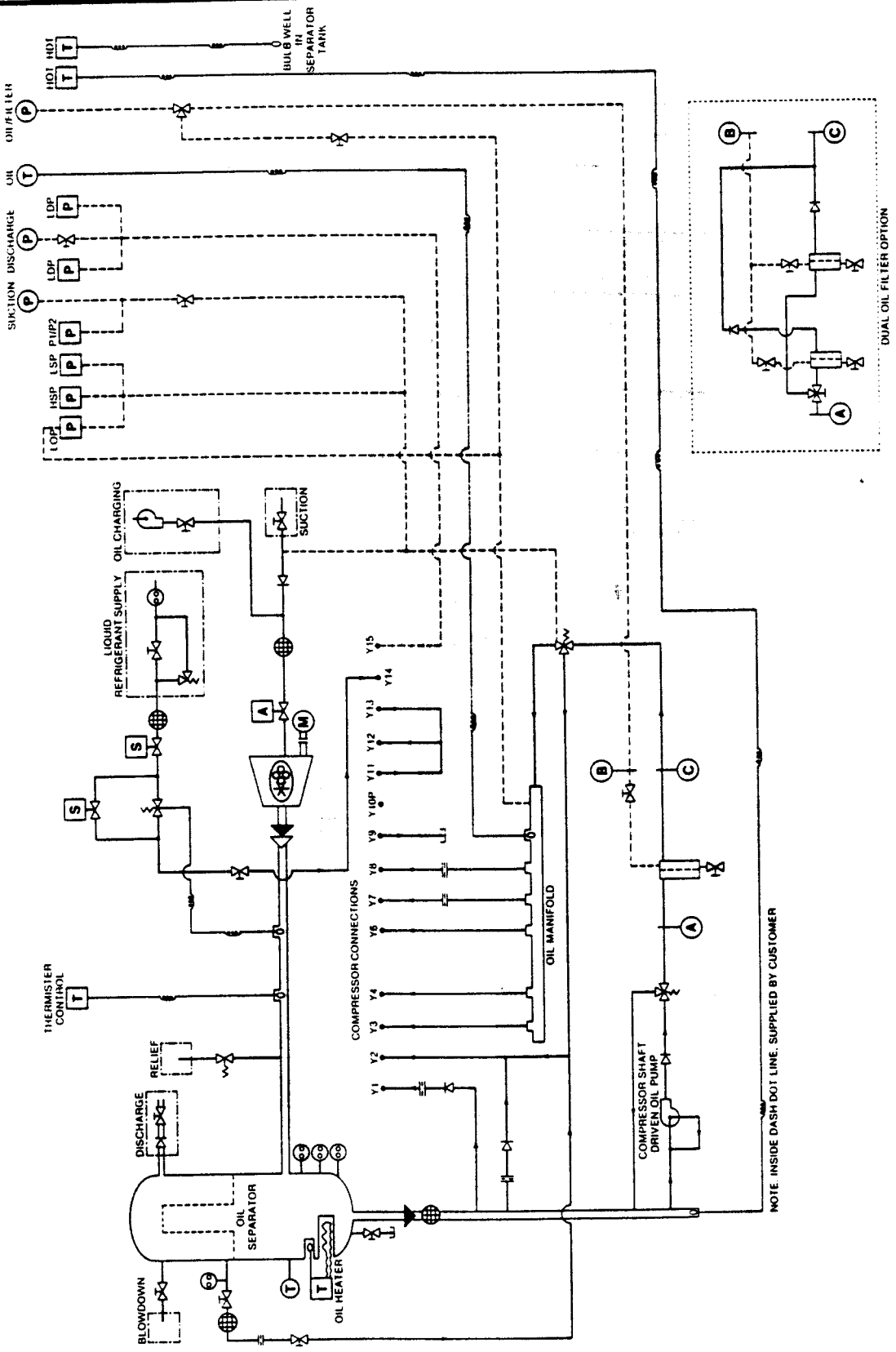
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-6 Piping Schematic (B20 Water-Cooled - Gear Drive)



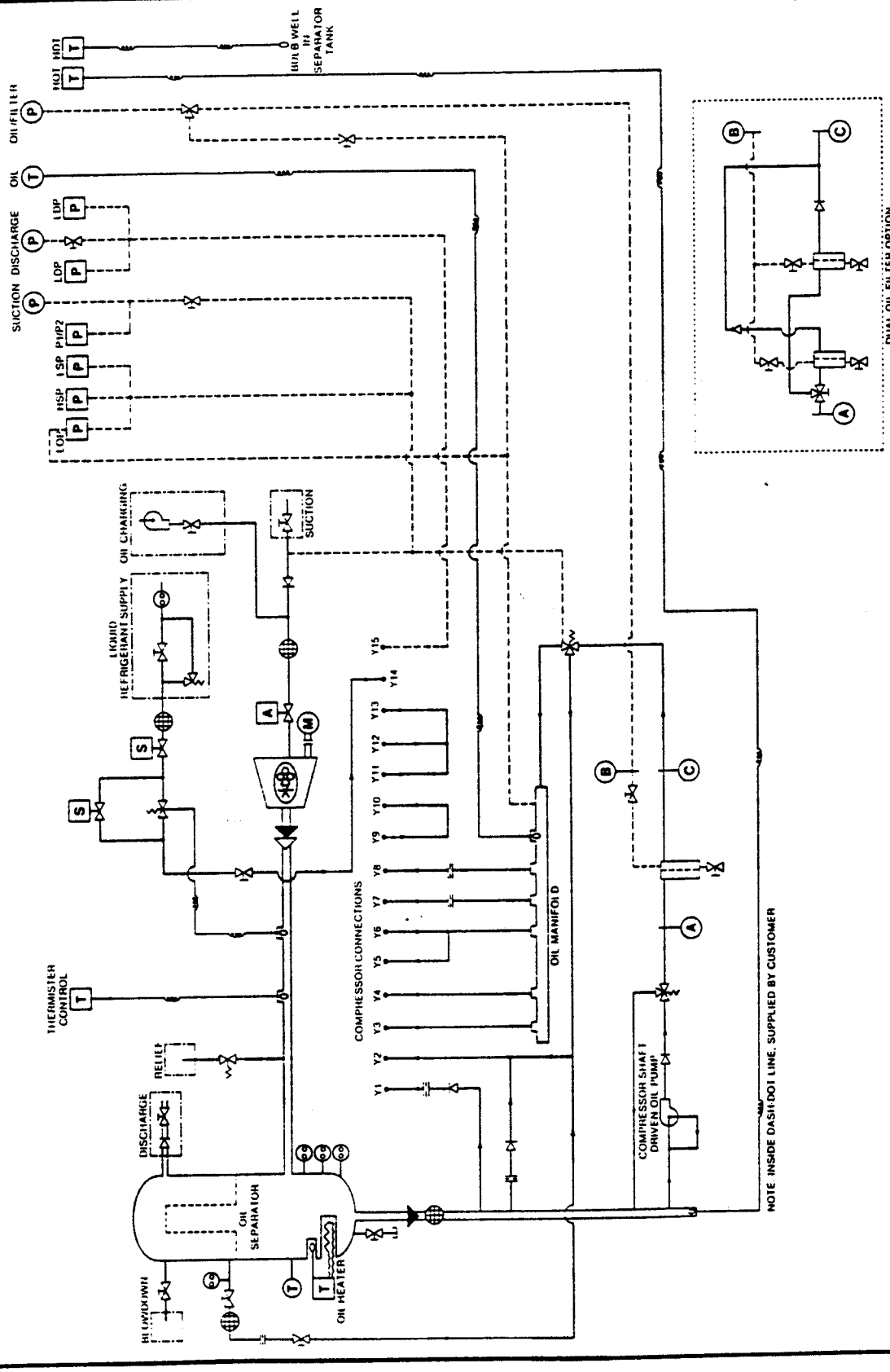
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-7 Piping Schematic (Liquid Injection B20 Direct Drive)



CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

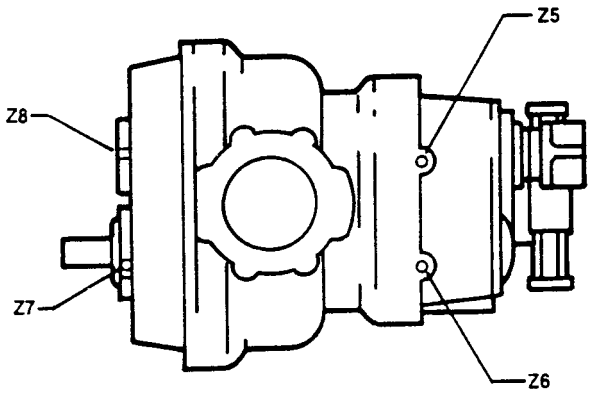
Figure 1-8 Piping Schematic (Liquid Injection B20 Gear Drive)

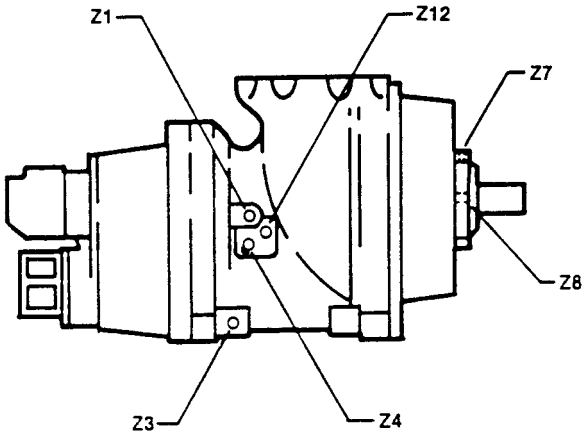


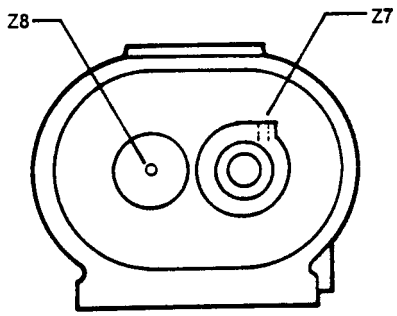
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

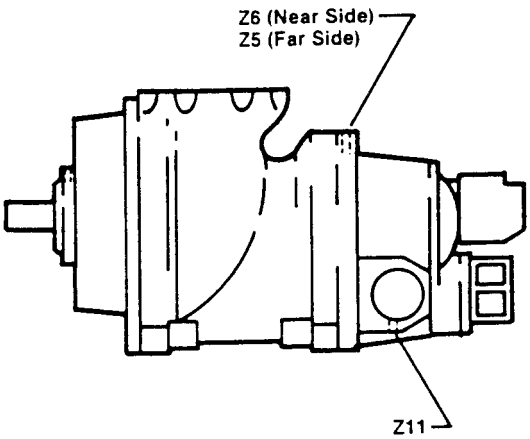
Figure 1-9 B25 Compressor

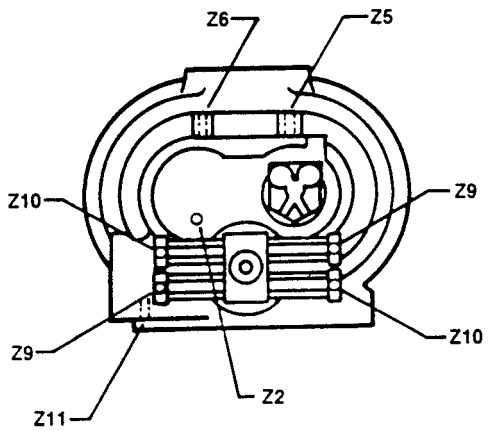
Z1 Oil to female return and oil return from separator
Z2 Discharge bearing drain
Z3 Oil injection male and female rotor
Z4 Oil to female rotor
Z5 Oil to female bearing outlet end
Z6 Oil to male bearing outlet end
Z7 Oil to male inlet bearing and shaft seal
Z8 Oil to female inlet bearing
Z9 Capacity control load signal
Z10 Capacity control unload signal
Z11 Discharge pressure connection
Z12 → Liquid injection inlet





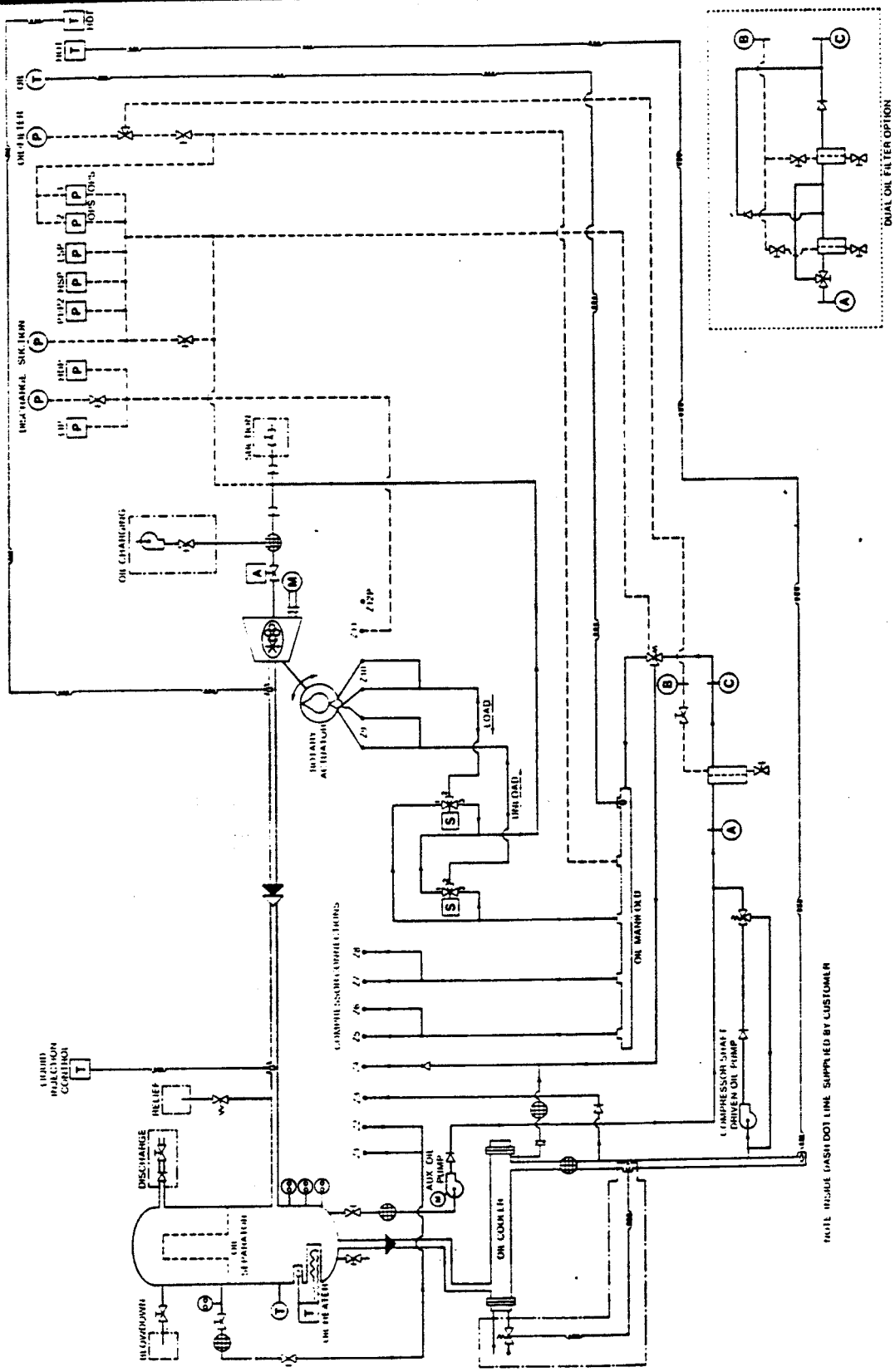






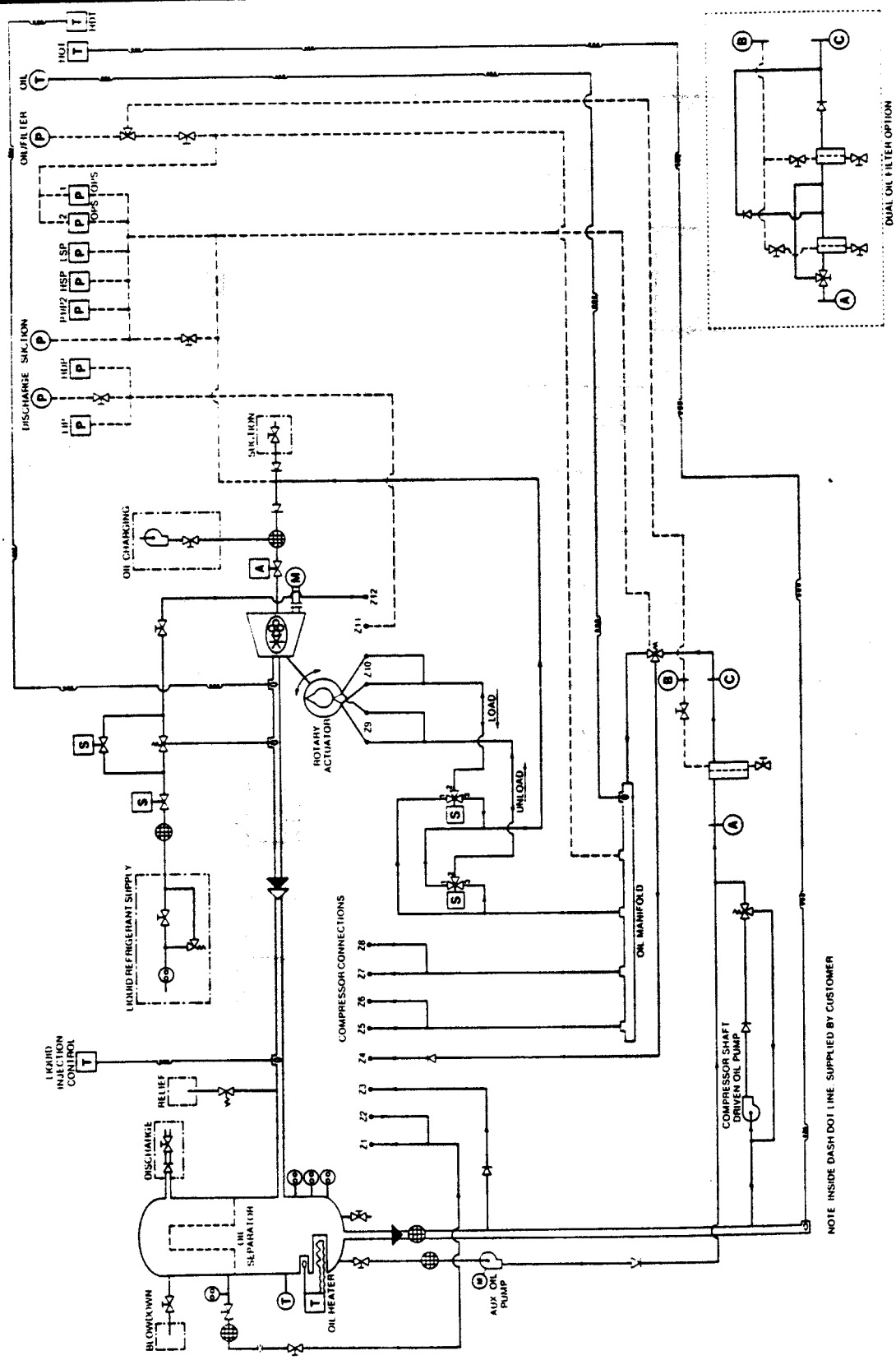
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-10 Piping Schematic (B25 Water-Cooled)



CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

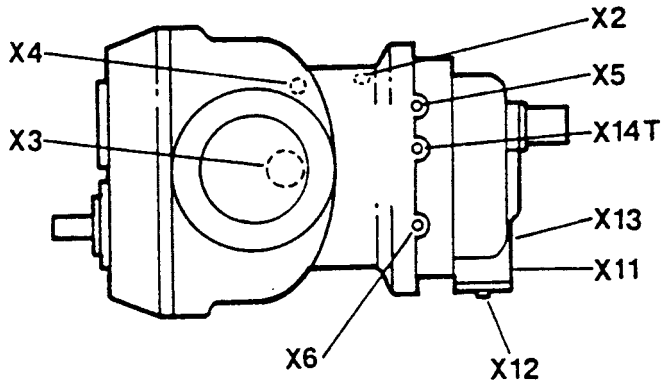
Figure 1-11 Piping Schematic (B25 Liquid Injection)

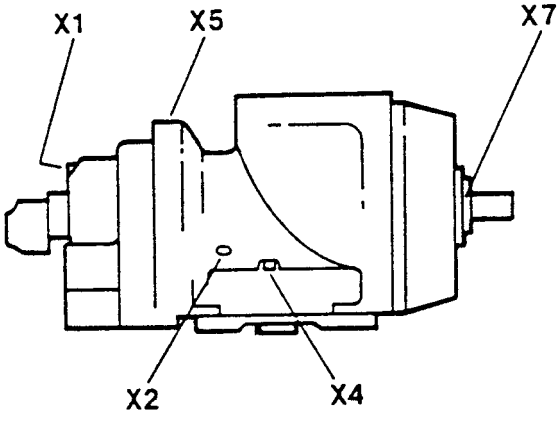


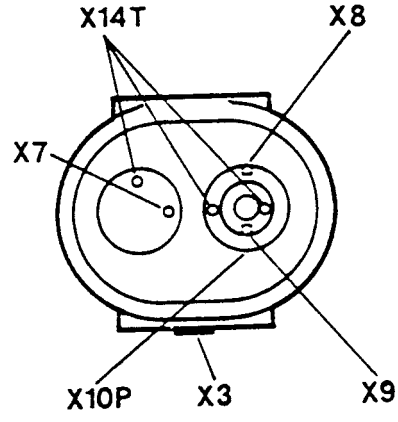
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

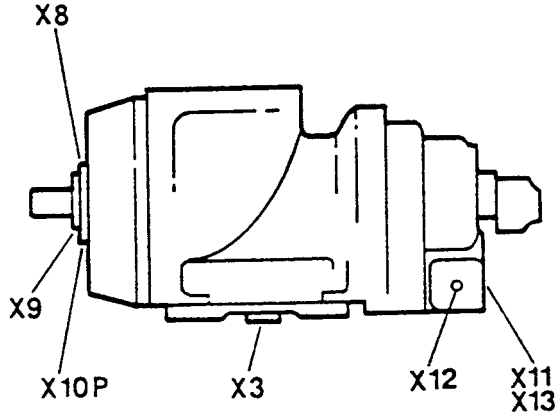
Figure 1-12 B32 Legends

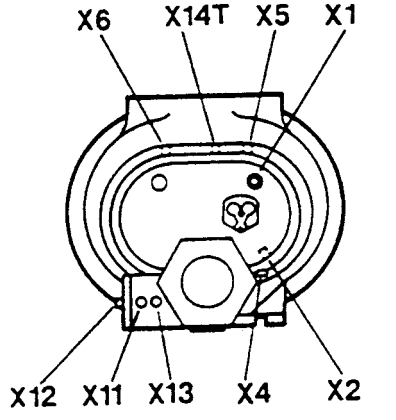
X1	Oil return from separator
X2	Refrigerant liquid injection
X3	Oil injection-male and female rotors
X4	Oil injection-female rotor
X5	Oil to female outlet bearing
X6	Oil to male outlet bearing
X7	Oil to female inlet bearing
X8	Oil to male inlet bearing & shaft seal
X9	Shaft seal drain
X10	Shaft seal pressure
X11	Discharge pressure
X12	Discharge temperature
X13	Liquid injection thermistor
X14	Lug or pull hole
P	Normally plugged
T	Normally drilled & tapped-blind hole





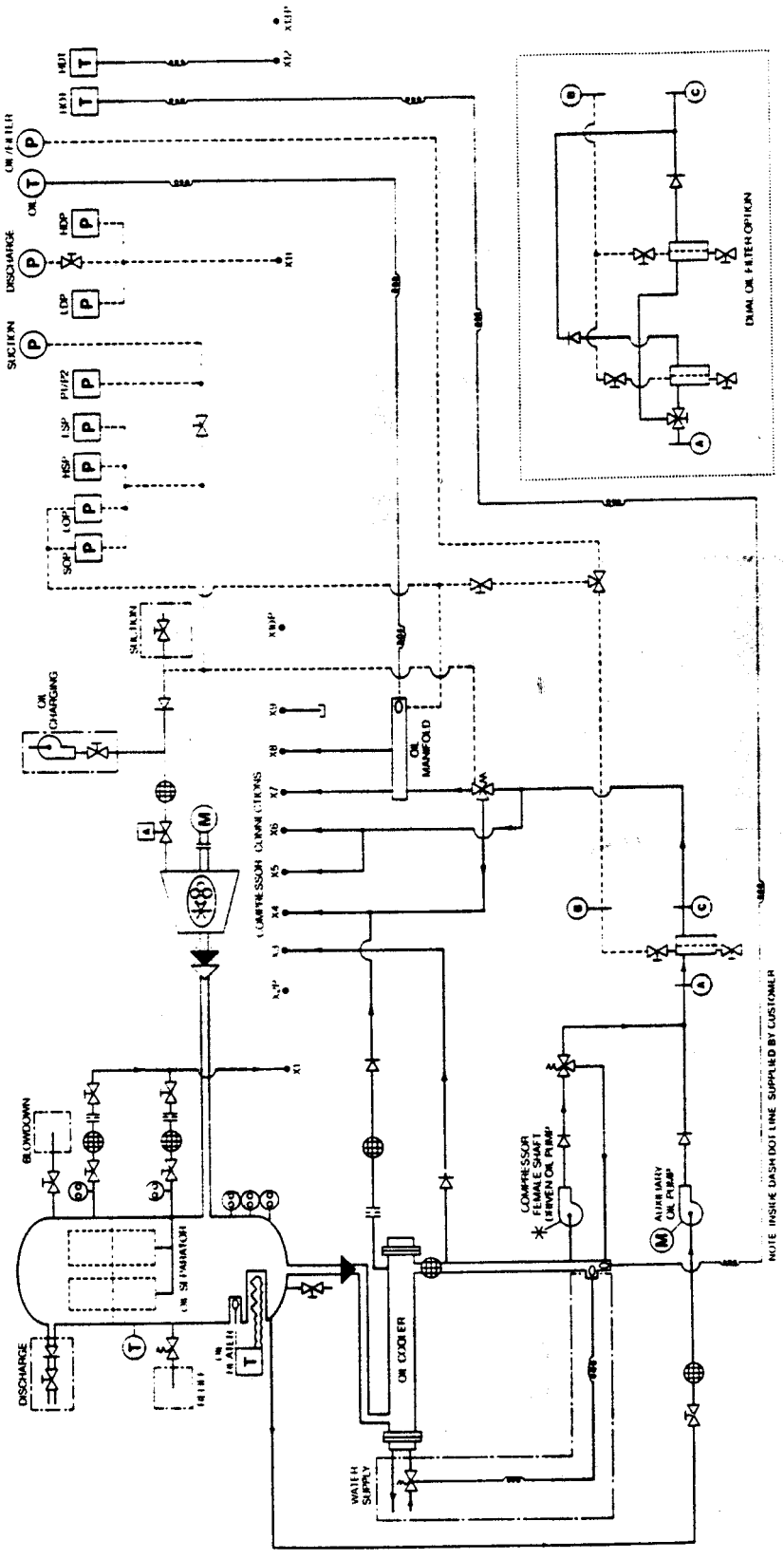






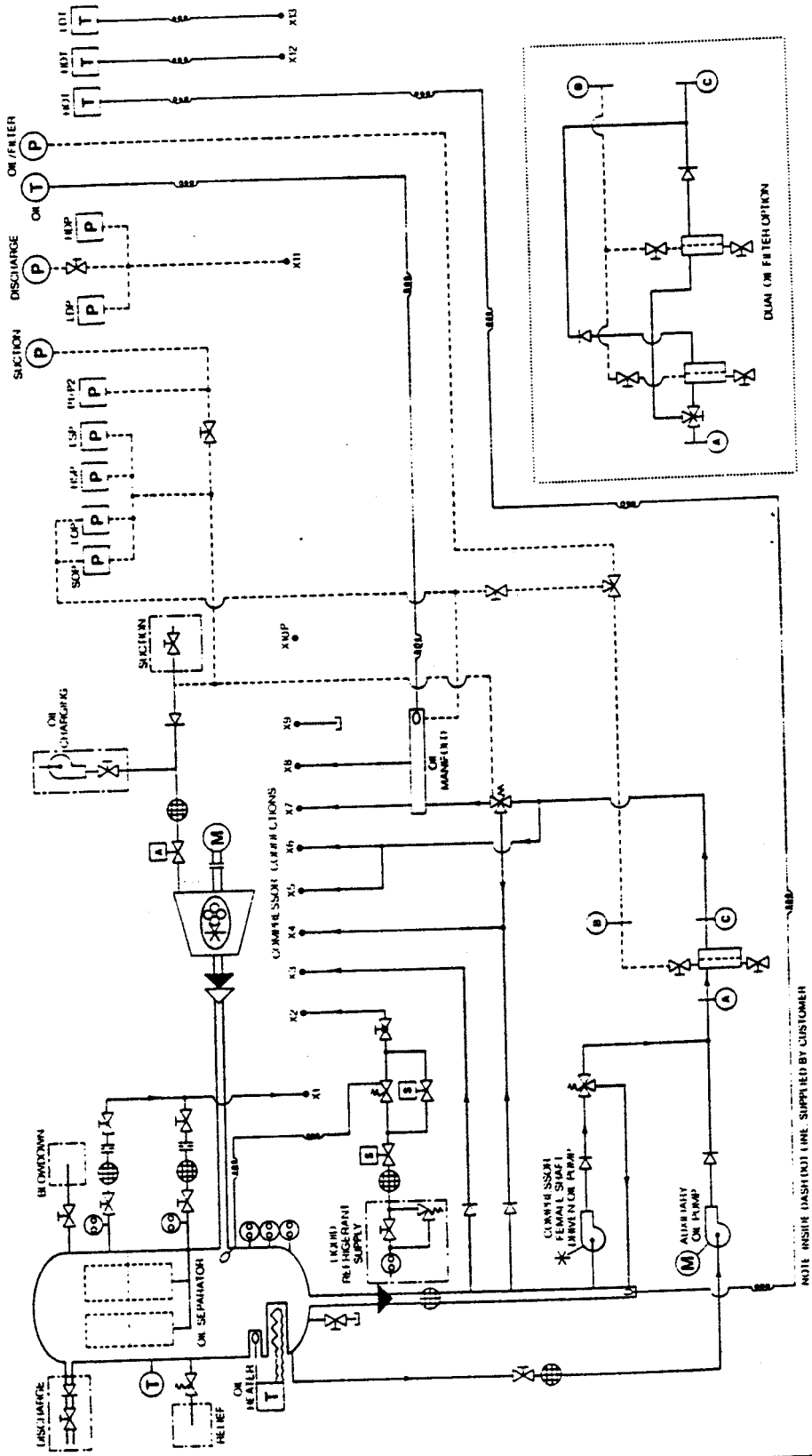
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-13 Piping Schematic (B32 Water-Cooled)



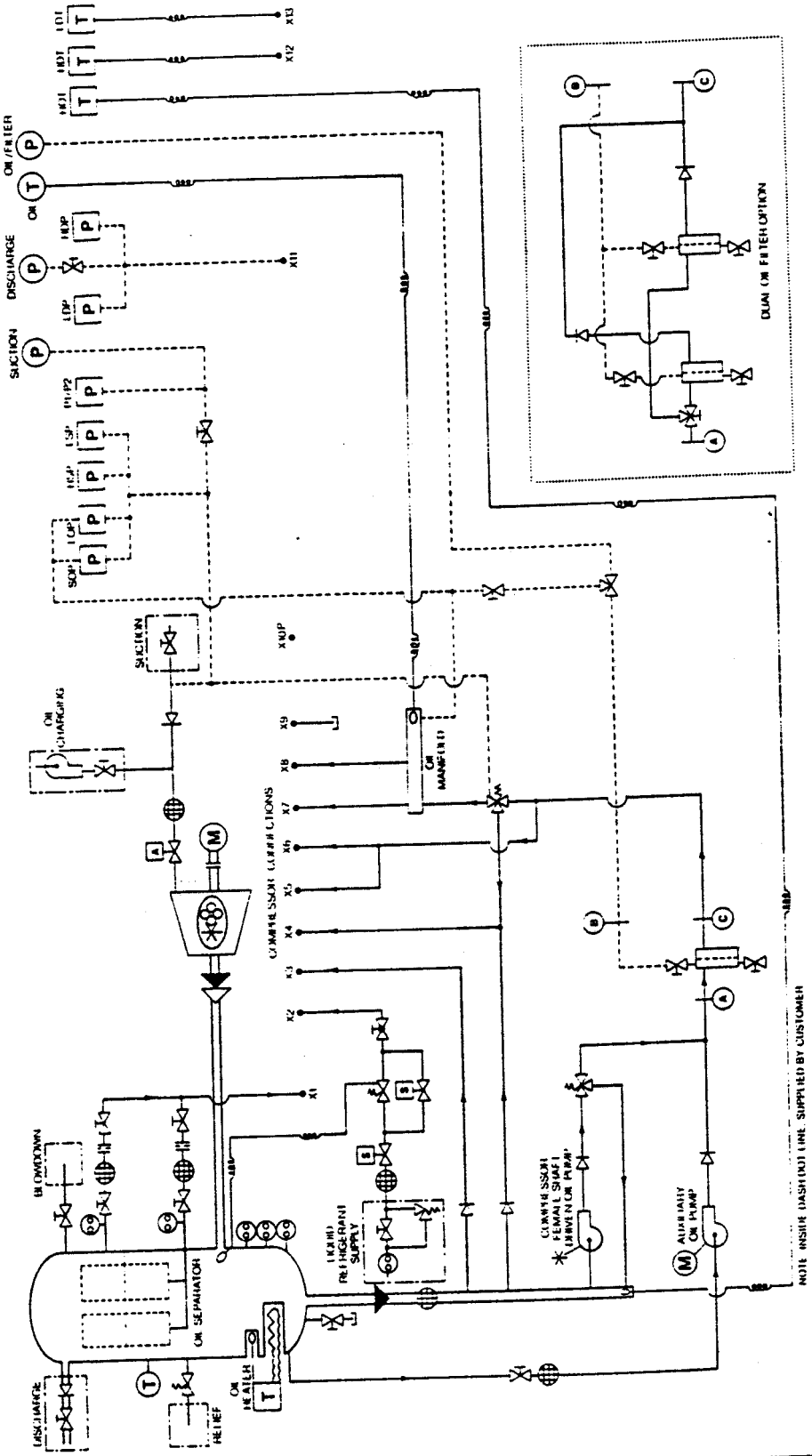
CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-14 Piping Schematic (B32 Liquid Injection)



CONTACT MID-STATES REFRIGERATION FOR CURRENT INFORMATION

Figure 1-14 Piping Schematic (B32 Liquid Injection)



Oil for injection (the majority of the oil is circulated by the pressure differential between the oil reservoir in the oil separator) is at discharge pressure and injected through ports which are just above suction pressure. The injection oil is passed through a fine strainer before reaching the injection ports.

The remainder of the oil is pumped by a gear pump which is driven directly by the female rotor shaft. This oil passes through a pressure relief valve, a very fine filter, and a pressure regulating valve to the oil manifold where both oil temperature and pressure are also monitored. From the manifold it is distributed to the bearings and the shaft seal.

On machines equipped with an auxiliary oil pump, the auxiliary oil pump operates at compressor start-up to raise the oil pressure to 10-15 PSI (69-103 kPa) before the compressor motor can begin rotation. After the compressor has run for ten seconds the auxiliary oil pump shuts down automaticlly.

Oil may be added to or drained from the oil separator through the valve in the bottom of the oil separator. While the compressor is running, strained or filtered oil may also be added through the main suction strainer cap. The following optional lubrication system components are available:

- Dual oil filters
- Duplex oil strainer
- Auxiliary oil pump

1.6 THE ELECTRICAL CONTROL SYSTEM

The package is supplied with a complete electrical control system. See Figures 1-15 and 1-16. All normal running controls, capacity controls and protective controls are included.

The control system is completely wired, tubed and mounted to the package in a NEMA 1 enclosure mounted on rubber vibration isolators. The controls operate on a 115V, single phase, 60 hertz power supply of either 1500VA capacity for machines with an auxiliary oil pump or 500VA capacity for machines without an auxiliary oil pump.

The standard water-cooled and liquid injection cooled wiring diagrams are given in Figures 1-17 through 1-20. However, these diagrams are only typical: see the wiring diagram for your machine for specific details. The wiring diagram can be found inside the electrical control panel.

All Sullair Refrigeration wiring diagrams are drawn with the relays deenergized, with 115V power supplied and with system pressures ready to start. The motor overload and the ampere relay have to be field wired and this is shown in dashed lines in figures 1-17 through 1-20. Items shown with an asterisk in figures 1-17 through 1-20 are supplied by others.

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.

An amber indicating light shows whenever an increase load signal cannot be satisfied while the load limiting timer, 4TR is timing. Refer to Section 4.12 for adjustment of the system.

CAPACITY CONTROLS

The electric valve actuator (EVA) mounted on the shaft of the butterfly valve contains two AC motors. One AC motor at a time is energized to rotate (through a gear train) the valve shaft clockwise or counterclockwise according to the suction pressure as sensed by a dual pressure switch (P1/P2). The EVA is equipped with limit switches actuated by cams which establish the maximum and minimum capacity positions of the EVA.

Before the compressor can be started, the capacity control butterfly valve must be at minimum position, about five degrees open. Whenever the compressor is shut down for any reason other than power failure, the EVA automatically returns capacity control butterfly valve to the minimum position. If a power failure occurs, the capacity control butterfly valve will automatically return to the minimum position when power is restored to the EVA.

The capacity control system is connected through a timer (1TR) to prevent the compressor from loading 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 capacity control system has an "Auto-Manual" selector, providng the manual or automatic operation. In the "Manual" position either side of "Auto", push the button to attain the desired "Load" or "Unload" capacity control action.

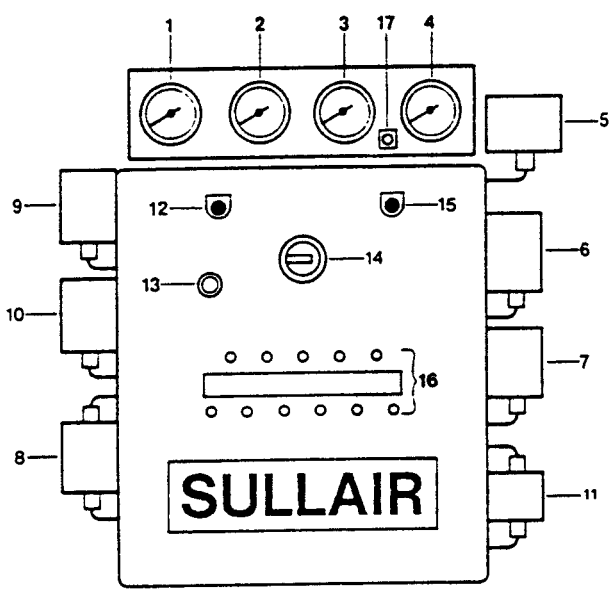
In the "Auto" position, the compressor capacity is controlled automatically from the suction pressure by a dual set point adjustable pressure switch (P1/P2). At the desired suction pressure which is midway between the two switch settings (or in the dead band) no control actions occurs and the compressor remains in a constant capacity position. This adjustable dead band is approximately 2 PSI (14 kPa).

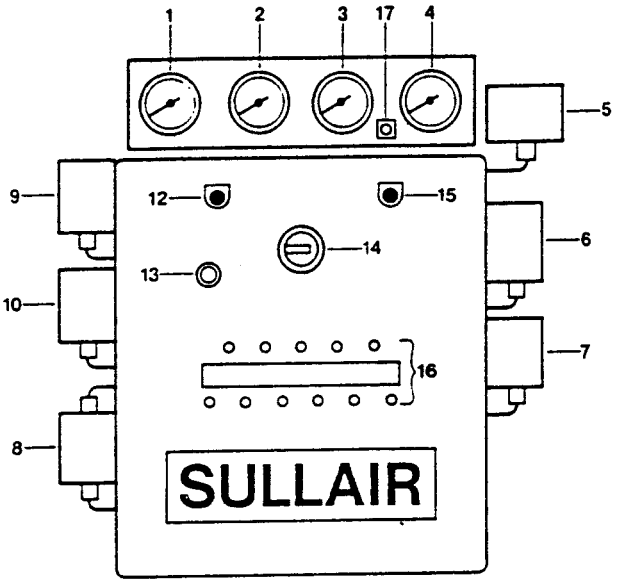
Above the high suction pressure set point, P2, the compressor loads. Below the low suction pressure set point, P1, the compressor unloads. Refer to Section 4.7 for adjustment of these two pressure settings.

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 stepwise fashion such that the "on" time adjustment varies

Figure 1-15 B25 AND B32 ELECTRICAL CONTROLS

B20 ELECTRICAL CONTROLS

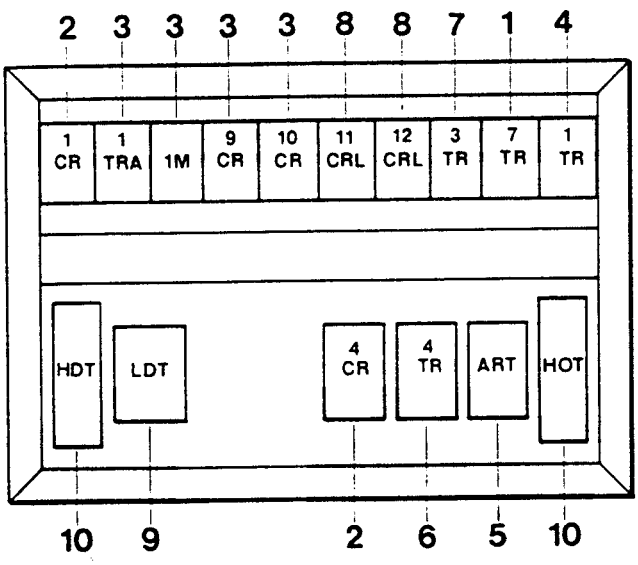


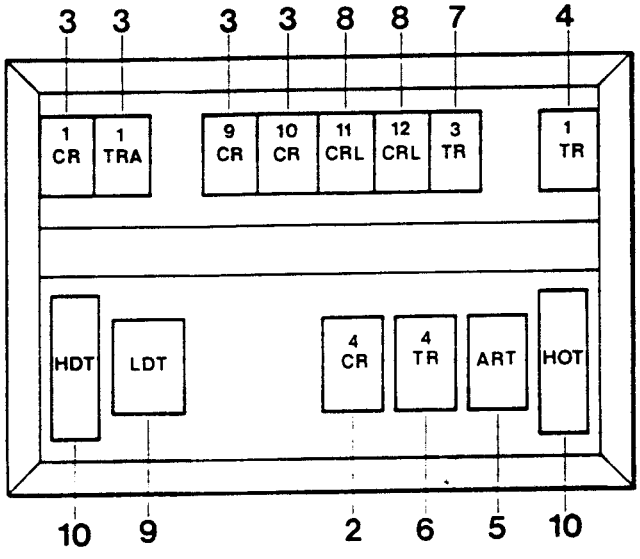


KEY NUMBER	DESCRIPTION
1	Suction pressure gauge (NH3) 30" Vac-150 PSIG
2	Discharge pressure gauge (NH3) 30" Vac-150 PSIG
3	Oil pressure gauge (NH3) 30" Vac-150 PSIG
4	Bearing oil temp. gauge (all machines)
5	P1/P2 switch, 20" Vac - 50 PSI U.E.
6	HSP switch, Penn 20" Vac - 100 PSI
7	LSP switch, Penn 20" Vac - 100 PSI
8	LOP switch, U.E. 5-70 PSI
9	HDP switch, Penn 50 - 450 PSI Man.
10	LIP switch, Penn 20" Vac-100PSI
11	SOP switch, Penn 0-70 PSI
12	Switch, selector -0- Push
13	Stop button
14	Hourmeter
15	Switch, Sel-Roto-Push 3 Pos.
16	Pilot lights lamp holder
	Lamp holders
	Resistor
	Bulb, lamp only
	Lens, red
	Lens, green
	Lens, amber
	Nameplate
17	Valve, 3 way ¼"

Figure 1-16 B25 And B32 ELECTRICAL CONTROLS

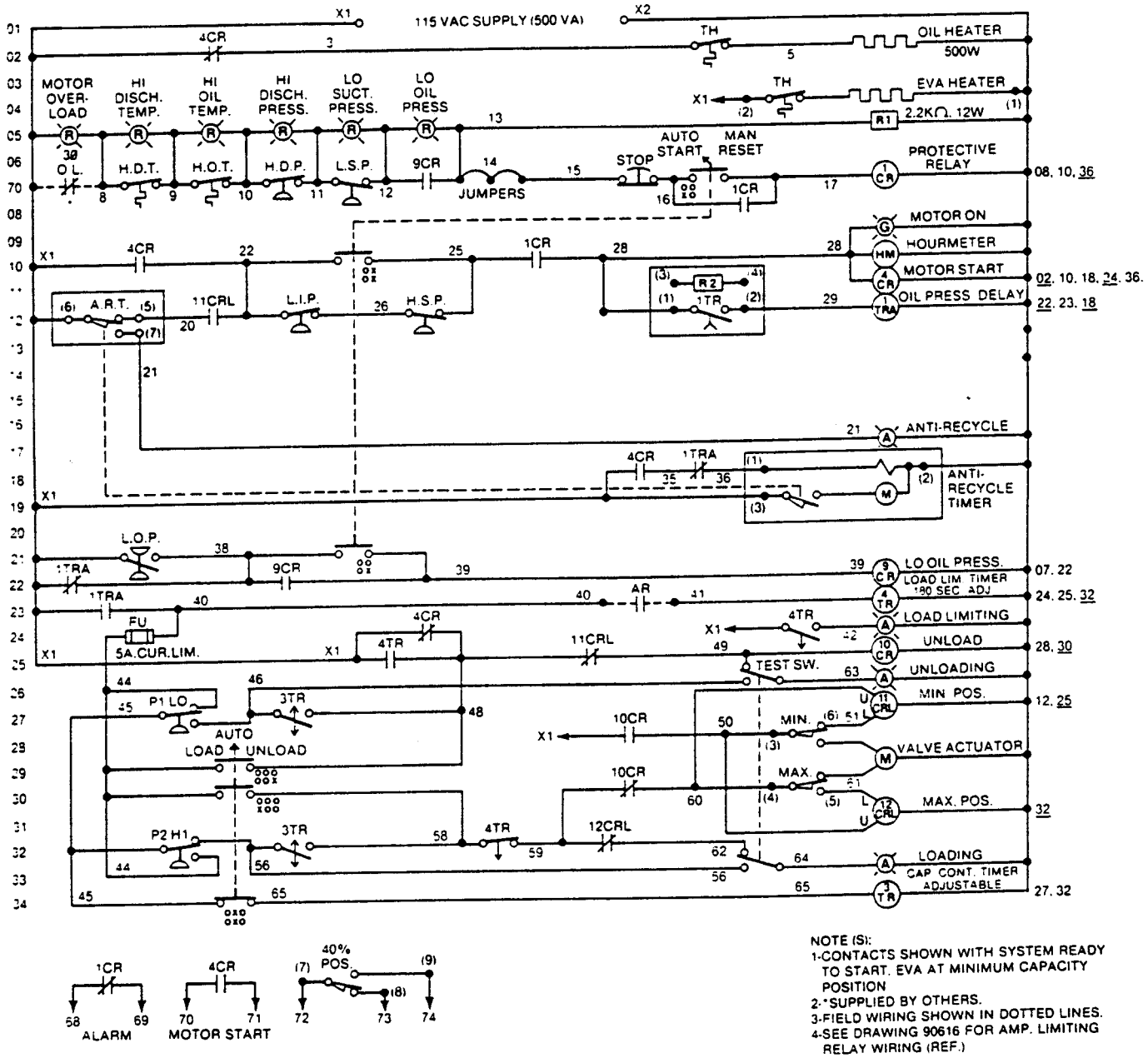
B20 ELECTRICAL CONTROLS





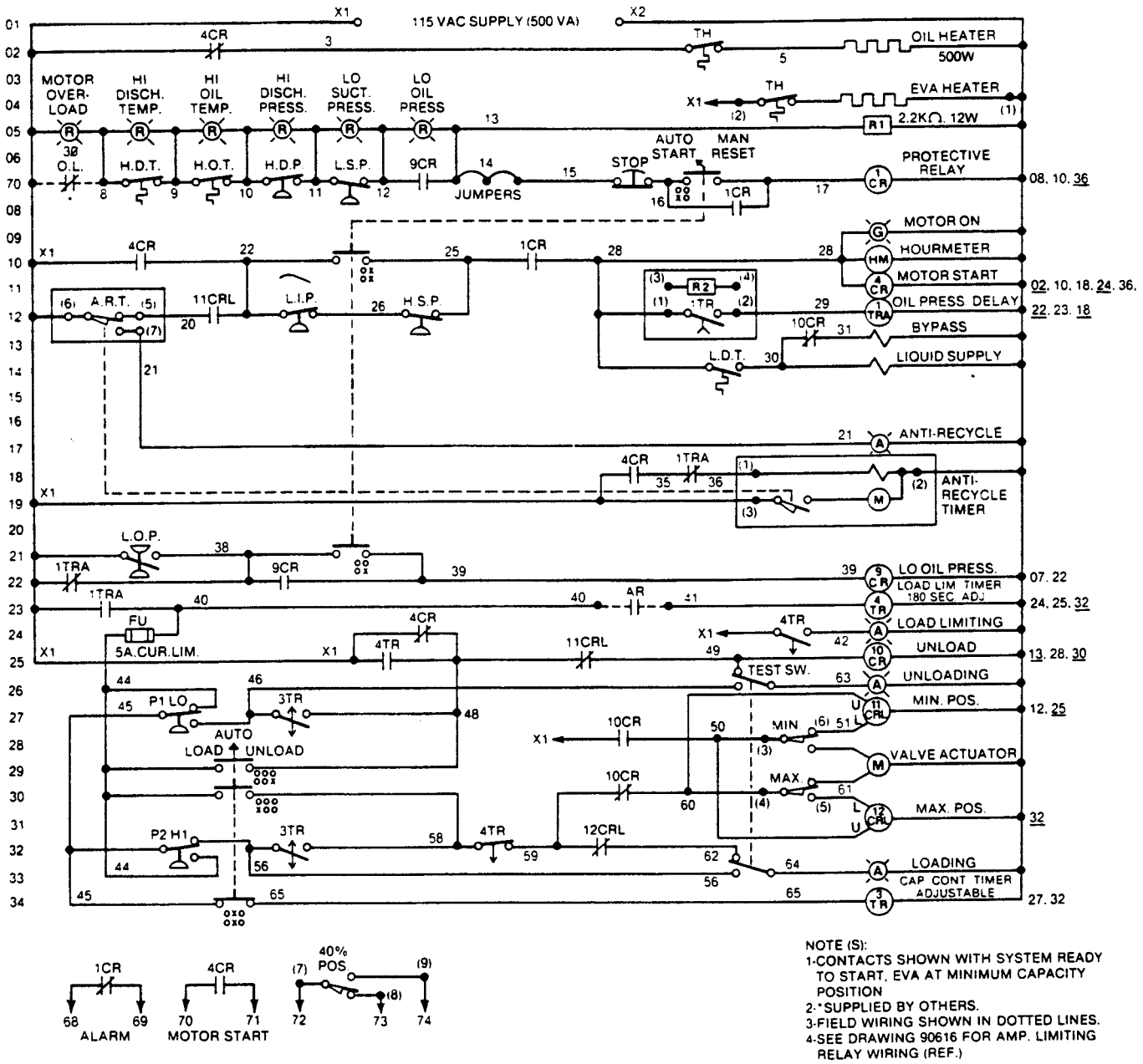
KEY NUMBER	DESCRIPTION
1	Timer relay, 7TR, 180 Sec., Potter Brumfield socket for 7TR, Potter Brumfield
2	Control relay, 1CR, 4CR, Allen Bradley 300V top deck for 4CR, Allen Bradley
3	Control relay (TRA, 1M, 3CR, 9CR, 10CR) Potter Brumfield control relay socket for 1TRA, 1M, 3CR, 9CR, 10CR
4	Timing relay, 1TR, Omnetics (Fixed Res) resistor required .68 Meg. ¼ Watt
5	Anti-recycle timer, 0-30 Min., Eagle
6	Timer 4TR, 2-60 Sec., Allen Bradley
7	Timing relay 3TR, Potter Brumfield socket for 3TR, Potter Brumfield
8	Latching relay, 11CRL, 12CRL
9	Oil temperature switch, or low discharge temperature switch (used on liquid injection only) probe, used with key No. 9
10	HDT HOT manual reset, Penn auto reset, Penn (option)

Figure 1-17 Wiring Diagram For Water-Cooled B20 Booster



NOTE (S):
1-CONTACTS SHOWN WITH SYSTEM READY TO START. EVA AT MINIMUM CAPACITY POSITION
2-*SUPPLIED BY OTHERS.
3-FIELD WIRING SHOWN IN DOTTED LINES.
4-SEE DRAWING 90616 FOR AMP. LIMITING RELAY WIRING (REF.)

Figure 1-18 Wiring Diagram For Liquid Injection Cooled B20 Booster



NOTE (S):
1-CONTACTS SHOWN WITH SYSTEM READY TO START, EVA AT MINIMUM CAPACITY POSITION
2-*SUPPLIED BY OTHERS.
3-FIELD WIRING SHOWN IN DOTTED LINES.
4-SEE DRAWING 90616 FOR AMP. LIMITING RELAY WIRING (REF.)

Figure 1-19 Wiring Diagram For Water-Cooled B25 and B32 Boosters

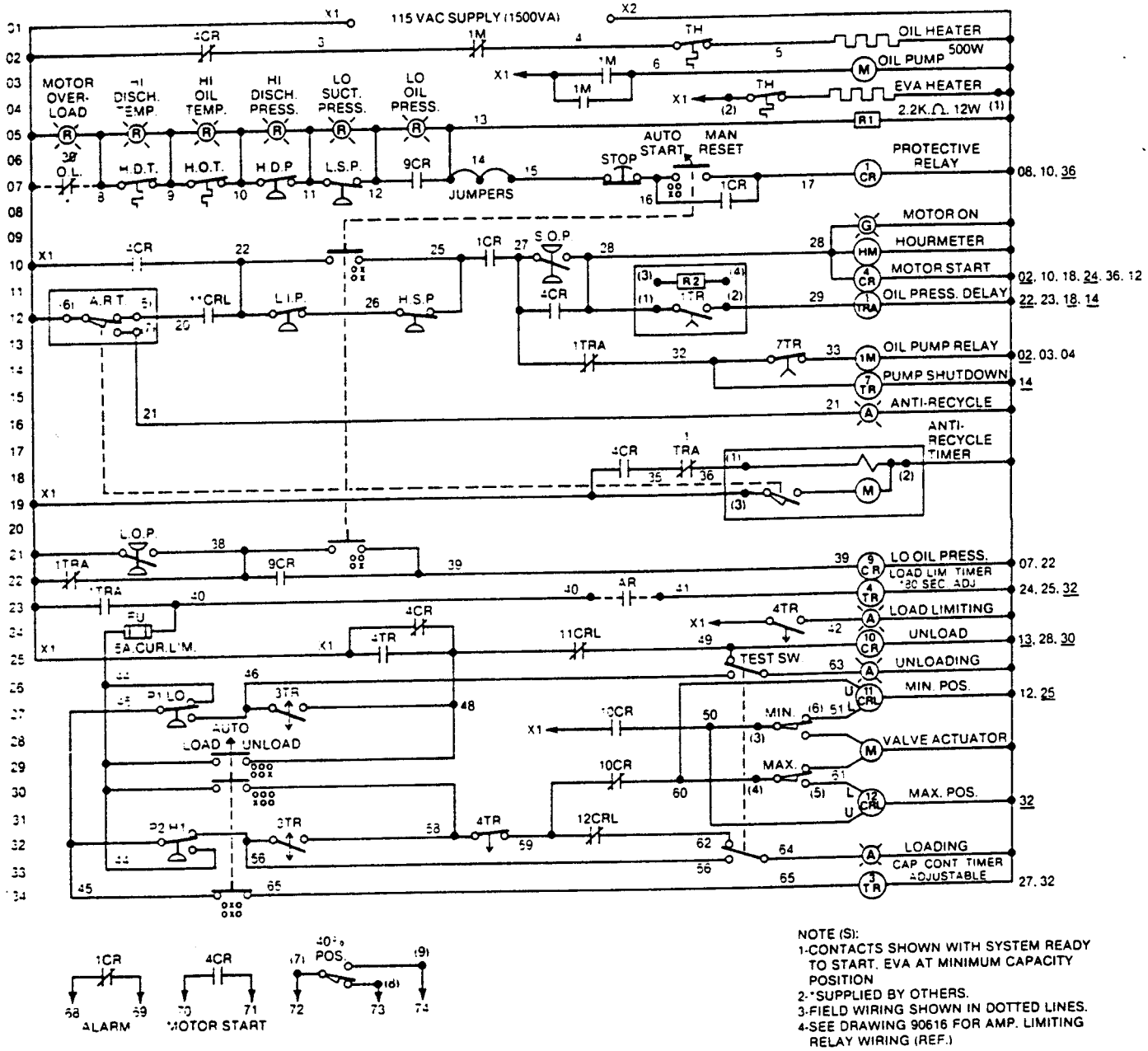
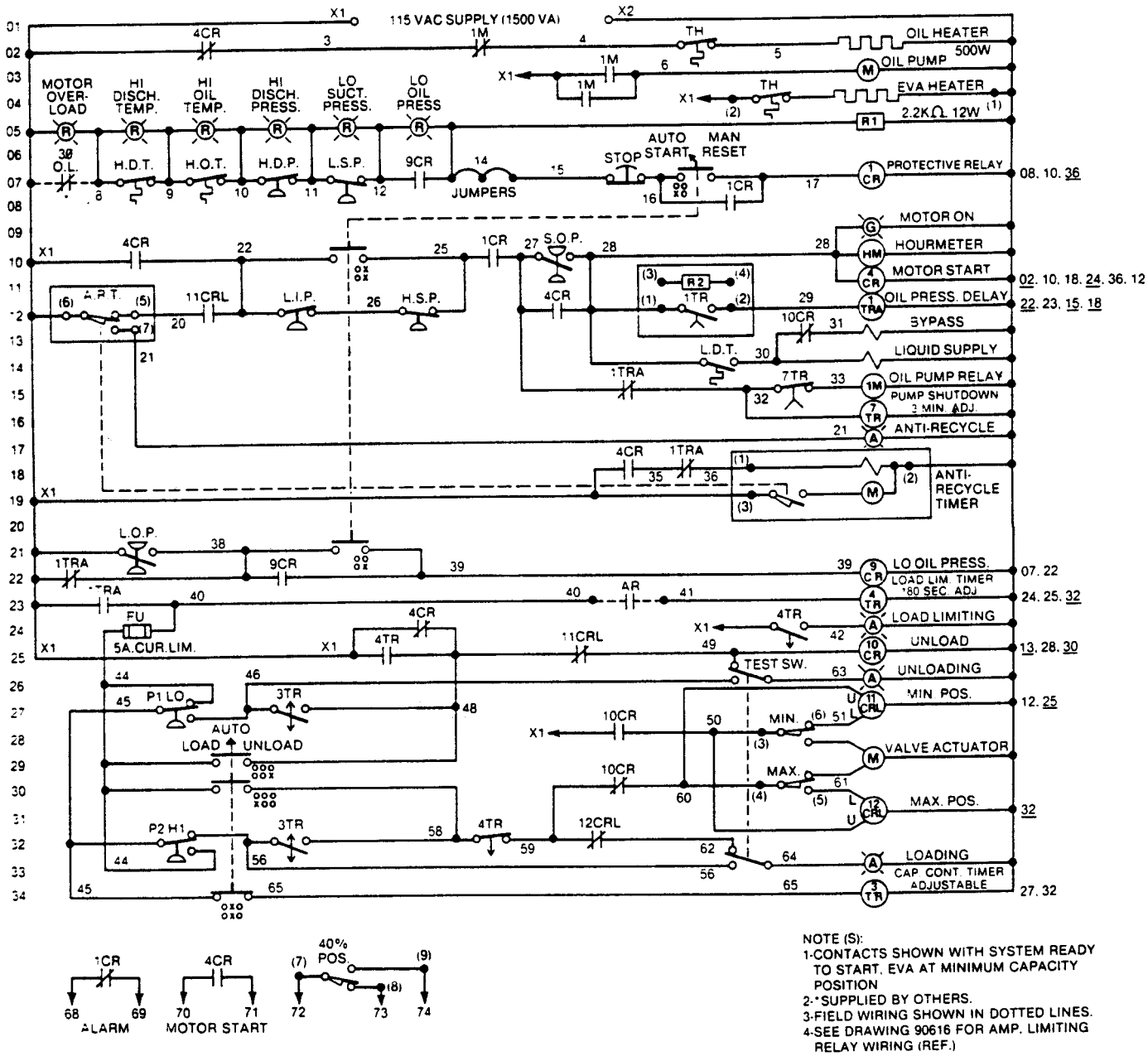


Figure 1-20 Wiring Diagram For Liquid Injection Cooled B25 and B32 Boosters



NOTE (S):
1-CONTACTS SHOWN WITH SYSTEM READY TO START. EVA AT MINIMUM CAPACITY POSITION
2-*SUPPLIED BY OTHERS.
3-FIELD WIRING SHOWN IN DOTTED LINES.
4-SEE DRAWING 90616 FOR AMP. LIMITING RELAY WIRING (REF.)

the length of percent capacity of each step and the "off" time adjustment varies the number of steps in a given amount of time. Refer to Section 4.7 for adjustment of this timer.

OPTIONS:
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.

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.

On machines equipped with an auxiliary oil pump, whenever a start is initiated, the auxiliary oil pump is started. When sufficient oil pressure has developed, the start-up oil pressure switch (SOP) trips and starts the compressor. If the oil pressure does not increase sufficiently within the time set on timer 7TR, the oil pump is shut down. To reset the timer and repeat the starting sequence, turn the start switch to the "Manual-Reset" position and push the button.

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

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 and that switch is manually reset, or whenever the control power is interrupted, or on a low oil pressure (LOP) switch shut down 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 when it is (depressed) pushed.

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 to allow the protective circuit and the protective relay, 1CR remains energized during shutdown. Refer to Section 4.9 for adjustment.

Low Discharge Temperature Switch

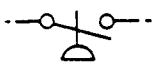
On refrigerant cooled machines only, the low discharge temperature switch (LDT) prevents over feed of refrigerant to the oil cooling system. If the discharge temperature drops below the set point on the low discharge temperature switch, the main liquid line solenoid valve closes and stops the refrigerant flow to the compressor. Refer to Section 4.6 (b) for adjustment.

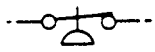
TABLE 1
TERMINOLOGY OF PRESSURE AND TEMPERATURE SWITCHES

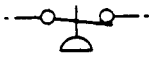
First Letter: High or Low
Second Letter: Description
Third Letter: Pressure, Temperature

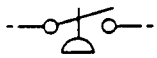
LSP:	Low Suction Pressure Shutdown/Alarm (Manual Reset)
HSP:	High Suction Pressure Start/Stop (Auto Reset)
LDP:	Low Discharge Pressure Start/Stop (Auto Reset)
HDP:	High Discharge Pressure Shutdown/Alarm (Manual Reset)
LOP:	Low Oil Pressure Shutdown/Alarm (Manual Reset)
SOP:	Start-Up Oil Pressure - Enables 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)

TABLE 2
GRAPHICS OF PRESSURE AND TEMPERATURE SWITCHES

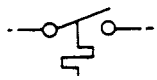

N.O.* No pressure applied or pressure lower than set point. Switch is reset. (Special case for HDP-LSP switch pressure

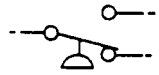

N.C.** higher than low set point *and* lower than high set point)

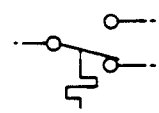

N.C. Pressure applied higher than set point. Switch is tripped. (Special case for HDP-LSP switch pressure higher than high


N.O. set point *or* lower than low set point)


N.C. Temperature lower than set point. Switch is reset.


N.O. Temperature higher than set point. Switch is tripped.


N.O. Some switches have a common with a double contact.
N.C.


N.O.
N.C.

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

PROTECTIVE CONTROLS

Low Oil Pressure Switch

The low pressure switch (LOP) consists of a pressure switch and a 10 second delay timer (1TR). During start-up, the low oil pressure switch is by passed 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 (9CR) 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 "Man-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 (172 kPa) differential. It is non adjustable in the field and removal of the seal constitutes abuse of the compressor under the terms of the warranty.

High Discharge Temperature (HDT), High Oil Temperature (HOT), High Discharge Pressure (HDP) and low Suction Pressure (LSP)

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 protective switch after shutdown and then the protective circuit must be manually reset by pushing the "Auto-Start". Refer to Section 3.15 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 this anti-recycle timer (ART) 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 the ART should be returned to the previous setting immediately.

Load Limit

The load limit relay prevents the motor overloading by unloading the compressor should the motor draw more than full load current. The load limiting system consists of a current transformer, adjustable current relay and a 0 to 3 minute adjustable timer, 4TR. When the relay senses the transformed current set point the compressor unloads until the excessive motor current is eliminated. The timer prevents the compressor loading until the set time has elapsed.

The "Auto-Start/Manual-Reset" selector switch is a four function switch and the capacity control Load/Auto/Unload" is a six function switch. In the wiring diagrams, figures 1-17 through 1-20, the contacts of these multi function push button switches are shown with the switch in the left hand, center and right hand positions and the lower line shows the contact with the push button depressed and the switch in the left hand, center and right hand positions. For example, to manually load the compressor, the capacity control selector switch should be turned to the "Load" position and the push button depressed. When the push button is released, the compressor stops loading.

SEQUENCING CONTROLS
Multiple machine sequencing may be accomplished by sequential settings of the high suction pressure switches (HSP) or as described in the C Series Operators Manual.

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 3.13 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 (red)
7. Low suction pressure (red)
8. Low oil pressure (red)
9. Load (amber)
10. Unload (amber)
11. Load limiting (amber)

The 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. The hour meter is connected across relay 4CR and the recorded time advances only when the motor is running.

Optional Meter Type Load Limit Relay

A meter type load limit relay is available for mounting in starter panel.

Area Classification

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

Central Control Panels

Central control panels and special electrical systems are available as options.

Section 2
SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS

Figure 2-1 and Tables 3 and 4 show the approximate dimensions, weights, and oil capacities for the Sullair "B" series rotary screw refrigeration compressor packages. Refer to the specific dimensional drawing and wiring diagram for exact details of the machine furnished.

2.2 MODEL AND SERIAL NUMBERS

Refer to Table 5.

The model number (e.g. B20LB30717-237-200) is found on a nameplate on the side of the control panel and explained in figure 2-2. The package serial number is located on the same nameplate as the model number and consists of a five to seven digit number (e.g. 056-00123). The compressor serial number is on a separate nameplate attached to either the top of the discharge end or the foot of the compressor (e.g. 80XD20-0012).

All three numbers are required to fully identify your screw compressor package to Sullair Refrigeration.

The wiring diagram number is on the Sullair logo inside the electrical control panel.

Figure 2-1 Package Dimensions

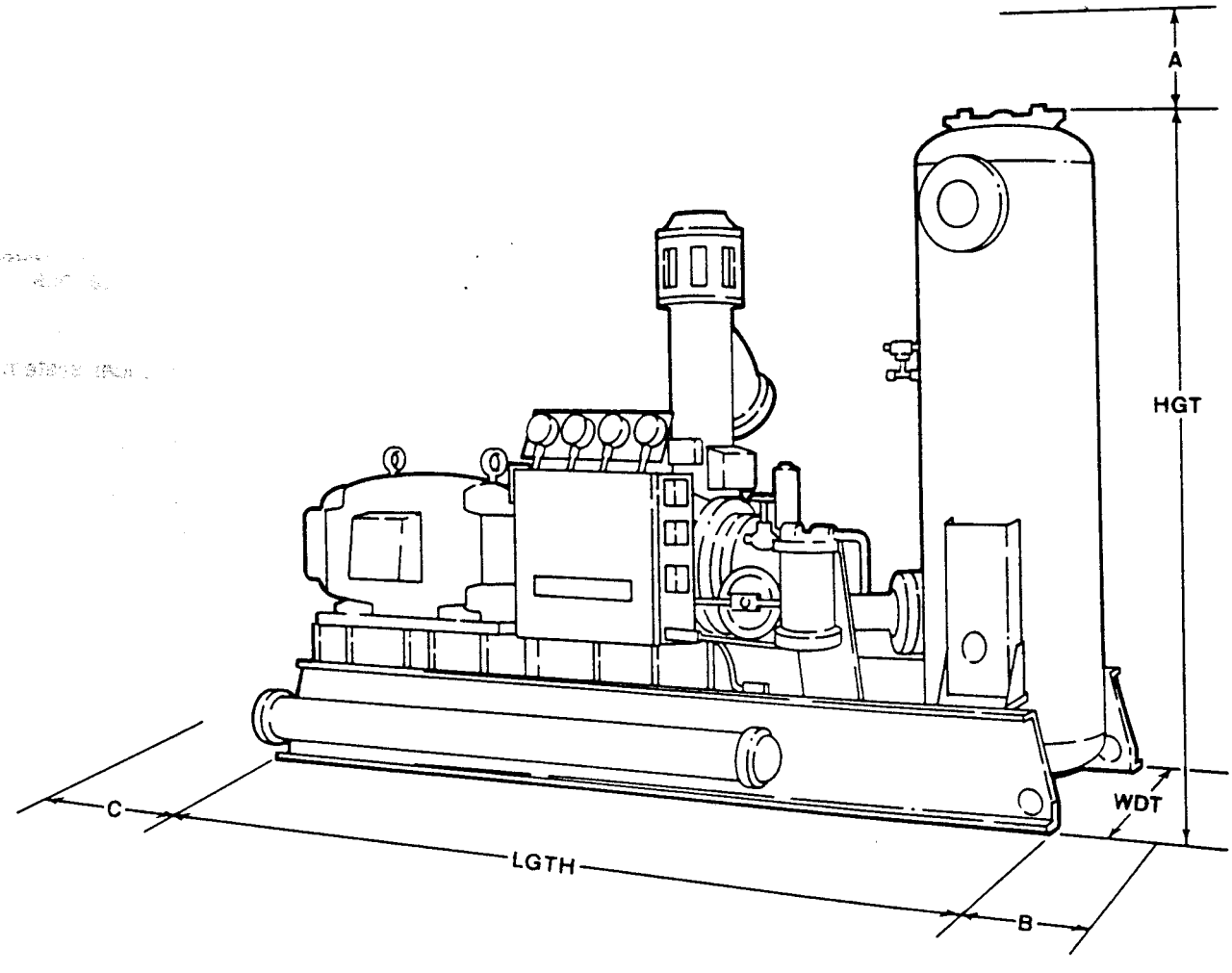


TABLE 3
PACKAGE DIMENSIONS

MODEL	DIMENSIONS									
	LENGTH		WIDTH		HEIGHT		A*		B*		C*	
	in	m	in	m	in	m	in	m	in	m	in	m
B20LB 400-418 Water-cooled	135	3429	49	1244.6	86	2184.4	32	812.8	98	2489.2	132	3352.8
B20LB 200-237 & 437-480 Water-cooled	135	3429	49	1244.6	92	2336.8	32	812.8	98	2489.2	132	3352.8
B20LB 400-418 Liquid Injection	122	3098.8	40	1016	86	2184.4	32	812.8	N/A		N/A	
B20LB 200-237 & 437-480 Liquid Injection	122	3098.8	40	1016	92	2336.8	32	812.8	N/A		N/A	
B32SB Water-cooled	150	3810	58	1473.2	110	2794	30	762	83	2108.2	127	3225.8
B32LB Watercooled	155	3937	58	1473.2	110	2794	30	72	83	2108.2	127	3225.8
B32SB Liquid Injection	143	3632.2	58	1473.2	110	2794	30	762	N/A		N/A	
B32LB Liquid Injection	149	3784.6	58	1473.2	110	2794	30	762	N/A		N/A	
B25LB Water-cooled	140	3556	59	1498.6	102	2590.8	26	660.4	57	1447.8	96	2438.4
B25LB Liquid Injection	135	3429	59	1498.6	102	2590.8	26	660.4	N/A		N/A	

A* Height needed to remove oil separator elements.
B** & C** Clearance for oil cooler tube cleaning (need only one as tube can be cleaned from either end). Does not apply to liquid injection oil cooling.

SPECIFICATIONS

TABLE 4
WEIGHTS AND CAPACITIES

MODEL	CONNECTIONS								APPROXIMATE WEIGHT WITH MOTOR***		NOMINAL OIL CHARGE	
	REFRIGERANT						WATER OIL COOLER					
	SUCTION*		DISCHARGE*		LIQUID**							
	in	mm	in	mm	in	mm	in	mm	lb	kg	gal	L
B20LB 400-418 Water-cooled	150		3	75	N/A		2 1/2	65	5900	2676	43	162.8
B20LB 200-237 & 437-480 Water-cooled	6	150	4	100	N/A		2 1/2	65	6050	2744	48	181.7
B20LB 200-237 Liquid Injection	6	150	3	75	3/4	20	N/A		5600	2540	30	113.6
B20LB 200-237 & 437-480 Liquid Injection	6	150	4	100	3/4	20	N/A		5750	2608	35	132.5
B32SB Water-cooled	8	200	6	150	N/A		2 1/2	65	8500	3856	50	189.3
B32LB Water-cooled	10	250	6	150	N/A		2 1/2	65	8750	3969	50	189.3
B32SB Liquid Injection	8	200	6	150	3/4	20	N/A		8200	3719	39	147.6
B32LB Liquid Injection	10	250	6	150	3/4	20	N/A		8525	3867	39	147.6
B25LB Water-cooled	8	200	5	125	N/A		2 1/2	65	7850	3561	68	257.4
B32LB Liquid Injection	8	200	5	125	3/4	20	N/A		7525	3413	58	219.6

* Valve sizes may vary according to the job application.
** Recommended customer minimum line size. Sullair liquid injection size from line to compressor connection is 3/4 in (20mm) for all machines.
*** Larger motors may increase weight 25%.

TABLE 5
MODEL NUMBER NOMENCLATURE

Rotor Diameter:
20, diameter 204mm
25, diameter 255mm
32, diameter 321mm

B — 20
Compressor Series

Type of Operation:
B, booster or low state

L — B
Rotor Length
L, rotor length / dia. = 1.65
S, rotor length / dia. = 1.15

Volume Ratio:
3.0 Low Compressor Ratio

717 — 30
Refrigerant:
012, R12
022, R22
717, ammonia

Gear Ratio:
11, 1.11
18, 1.18
37, 1.37
65, 1.65
80, 1.80

237 — 200
Motor Speed
2, Two Pole
4, Four Pole
Motor Power
200, Motor

SPECIFICATIONS

OPERATING LIMITS AND SWITCH SETTINGS

•• Anti Recycle Timer, Minimum (ART)	10 Minutes
100 to 199 HP (75 to 149 Kw)	12 Minutes
200 to 299 HP (150 to 224 Kw)	15 Minutes
300 to 399 HP (225 to 299 Kw)	20 Minutes
400 to 499 HP (300 to 374 Kw)	10 Minutes
• Oil Pressure Delay Timer (1TR)	
Oil Pressure, Above Suction Pressure	
Normal	45 PSI to 50 PSI (310 kPa to 345 kPa)
•• Minimum Starting (SOP)	10 PSI to 15 PSI (69 kPa to 103 kPa)
• Minimum Running (LOP)	40 PSI (276 kPA)
Maximum	60 PSI (414 kPa)
Oil Pressure Drop Across Filter, Maximum	30 PSI (207 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 (5.6°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 (54.4°C)
•• Oil Heater Thermostat (TH)	100°F (38°C) or 10°F (5.6 °C) above condensing temp. whichever is higher.
Discharge Pressure (Intermediate Pressure)	
•• Low (Compressor Start or Cut In) (LDP)	30 PSIG (207 kPag)
•• High (Compressor Stop or Cut Out) (LDP)	40 PSIG (276 kPag)
Maximum	150 PSIG (1.03 MPag)
•• Maximum (HDP)	20 PSI (138 kPa) below system relief valve or 100 PSIG (689 kPag) maximum.
Discharge Temperature	
•• Low, Liquid Injection Cooled (LDT)	105°F (40°C) or 10°F (5.6°C) above condensing temp. whichever is higher.
•• Maximum, Water Cooled (HDT)	195°F (90°C)
•• Maximum, Liquid Injection Cooled (HDT)	140°F (60°C)
Suction Pressure	
P1 Unload, Below Desired Suction Pressure	1 PSI to 2 PSI (7 kPa to 14 kPa)
P2 Load, Above Desired Suction Pressure	1 PSI to 2 PSI (7 kPa to 14 kPa)
Low (Compressor Stop or Cut Out), Below P1 Pressure (HSP)	5 PSI to 15 PSI (34 kPa to 103 kPa)
High (Compressor Start or Cut In), Above P2 Pressure (HSP)	2 PSI to 5 PSI (14 kPa to 34 kPa)
•• Minimum, Below Low Suction Pressure (LSP)	2 PSI to 5 PSI (14 kPa to 34 kPa)
Maximum	440 PSIG (276 kPag)
Suction Temperature	
Maximum Superheat, Ammonia R12 or R22	20°F (7°C)
Suction/Discharge Differential Pressure, Maximum	60 PSI (414 kPa)
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 (B20-200 Series, all B32, and all B25)	2900 RPM
Maximum (B20-200 Series, all B32, and all B25)	4000 RPM
Minimum (B20-400 Series)	1450 RPM
Maximum (B20-400 Series	2000 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).

2.4 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 5.5 for further details of oil analysis.

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 6 below.

TABLE 4
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 Special 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	35	-25	-32	-20	-29
Turmaco 68	300-350	63.7-68.3	49.0	7.0		-50	-46	-30	-34

Section 3
INSTALLATION

3.1 GENERAL

This section contains instructions for the proper installation of Sullair Refrigeration "B" Series Screw Compressors. All items in this section must be completed by those with installation responsibility before the Sullair Refrigeration Representative arrives for start-up.

3.2 START-UP SERVICE OUTLINE

Before the Sullair Refrigeration Representative arrives, the following must be completed in the order given.

1. The compressor is to be leveled securely, anchored to the foundation and grouted to assure stability of the coupling alignment as in Section 3.4.
2. All refrigeration piping is to be complete as in Section 3.5. Relief valves are to be properly vented.
3. The water piping is to be completed with the water valve installed for water-cooled machines as in Section 3.6.
4. The refrigerant piping is to be completed for the refrigerant cooled machines as in Section 3.7.
5. The system and the compressor package are to be pressure tested for leaks as in Section 3.8.
6. The system is to be evacuated to remove air and moisture as in Section 3.9.
7. The coupling is to be aligned within the specifications in Section 3.10. The Sullair Refrigeration Representative will check the coupling alignment before starting the compressor, so the coupling should not be reassembled after the alignment is completed.
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 as in Section 3.12.
10. The oil is to be warmed up as in Section 3.13.
11. The control panel is to be energized to check the protective switches and the capacity control as in Sections 3.14, 3.15 and 3.16.
12. The direction of rotation of the motor is to be checked as in Section 3.17.
13. The motor is to be lubricated as in Section 3.18.
14. Have available two dowel pins, drill and reamer for the motor. The motor will be dowel pinned by the customer after the alignment is checked by the Sullair Refrigeration Representative.

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

1. Check the general installation.
2. Check the coupling alignment. Customer will then dowel pin the motor.
3. Check all electrical protective controls.
4. Check capacity control actuator adjustment.
5. Start the compressor for the first time and adjust all the package valves and controls.
6. 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 to assure 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 frame 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.

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 complicate the alignment of the coupling.

In multiple machine installation of 350 HP (250 kW) or larger or 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.

Do not overtighten or pin the oil separators to the package frame, since thermal expansion of the discharge line must not be restricted.

Do not grout the package frame to the foundation at this stage. Grouting with an expanding grout around the entire base is necessary after the refrigerant piping is connected and the compressor and motor are roughly aligned (approximately 1/32 in (1mm) total indicated reading). The grouting will then minimize any base deflections that may affect the coupling alignment.

3.5 REFRIGERANT PIPING

All piping must conform to federal, state and local codes and good industrial practice (e.g. ANSI 31.5, ANSI/IIAR 74-2 and ASHRAE Systems Handbook). The customer must supply piping, fittings and equipment (in the dashed boxes in figures 1-2 through 1-14) up to the terminating connections on the Sullair package. The size and location of the refrigerant suction, discharge, liquid and Sullistage and water connections can be found on the dimensional drawing on the package. For standard machines, the size of

the connections is given in Table 4 and the location of the connections is given in figures 1-2 through 1-14.

The suction line and discharge line should be installed and supported such that there is no load exerted on the compressor frame from either static forces or vibration. External forces from the piping can distort the coupling alignment and cause major bearing and shaft seal problems.

GASKETED JOINTS

When using flanges, a 1/16 in (1.6 mm) fiber gasket should be used. Prior to tightening flange bolts the pipe to be connected should be in parallel alignment, and the bolt holes should be in line. Do not use flanges as a means of straightening pipe as they may stress adjacent compressors, valves and controls.

Flange bolts should be drawn up evenly when connecting flanges, to prevent flange breakage.

THREADED JOINTS

The use of litharge and glycerine for sealing threaded joints has been replaced by many commercially available compounds and sealing tapes designed for use with different refrigerants. Check for compatability, and follow instructions accompanying these compounds for method of application. Do not use excessive amounts or apply on female threads, because any excess could contaminate the system.

WELDED JOINTS

IMPORTANT

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.

3.6 COOLING WATER SUPPLY REQUIREMENTS

IMPORTANT

A water supply temperature of 85°F (30°C) or lower is required unless special design considerations have been made. The Sullair Selection Guide gives the procedure for calculating the required water flow rate. To design the water piping and select the pump, allow a minimum pressure drop through the oil cooler and the two-way valve of 20 PSI (150 kPa) unless checked by Sullair Refrigeration.

The oil cooler will require water supply and drain lines with a control valve that will regulate the water flow to maintain the oil temperature. Figures 3-1 and 3-2 show typical piping arrangements for two-way and three-way water valves for both the single oil cooler system and the two oil cooler system.

The two-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.

IMPORTANT

The bulb should be coated with aluminum paste or grease before inserting it into the bulbwell to improve heat transfer between the bulb and the oil.

Manual bypass valves are recommended to allow water supply to the cooler in case the water regulating valve becomes inoperative. A water solenoid valve is also recommended to stop the water flow upon shut down.

Optional three-way water regulating valves are available. If a three-way valve is used, a manual pressure balancing valve is recommended in addition to a manual bypass valve and a water solenoid valve.

The water supply to the cooler should be treated to minimize fouling of the oil cooler due to scale, corrosion, algae growth, dirt, etc. Additives, filtering and bleed-off should be used where necessary. If the water supply will not be reasonably treated, special consideration must be given to the oil cooler design (contact Sullair Refrigeration) and the water piping should be designed to maintain a high water velocity of approximately 10 ft/sec (3 m/s) to minimize fouling.

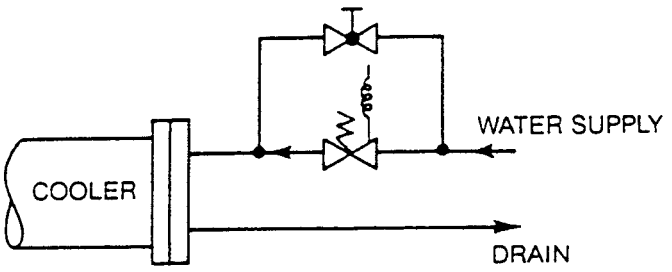
The alternative sources of cooling water for water-cooled machines are outlined below:

a) Open Circuit Recirculated Evaporative Condenser Pan Water

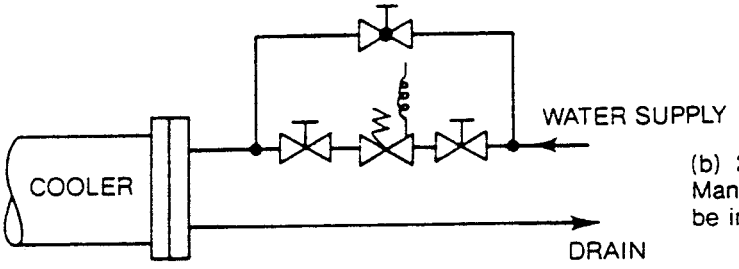
The most common source of cooling water for the oil cooler is from the evaporative condenser pan or a cooling tower pan. In most applications, the condenser size is the same as a comparable sized reciprocating compressor. Contact Sullair Refrigeration or your condenser (or cooling tower) supplier for specific recommendations on loads and sizing.

This source of cooling water has the advantages of the lowest operating cost and simplicity.

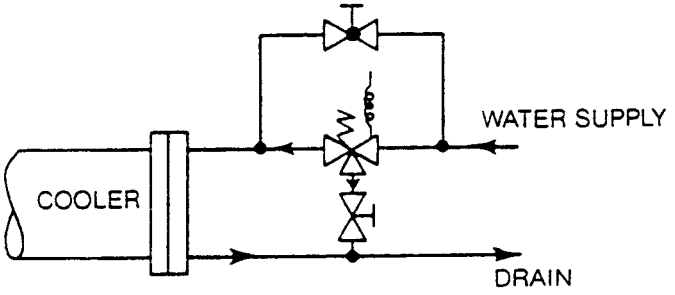
Figure 3-1 Recommended Water Piping Schematics For The Single Oil Cooler System



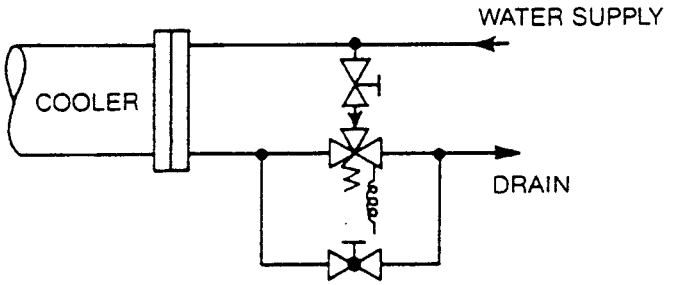
(a) 2-Way Valve With Manual Bypass Valve.



(b) 2-Way Valve With Maintenance Stop Valves And Manual Bypass Valve (Maintenance Stop Valves may also be included in Figures 3-1(c), 3-1(d), 3-2(b) and 3-2(c).

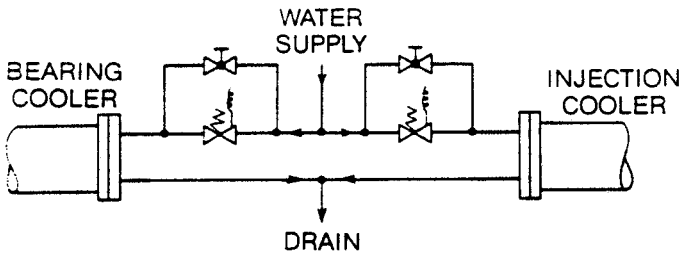


(c) 3-Way Diverting Valve With Balancing Valve And Manual Bypass Valve.

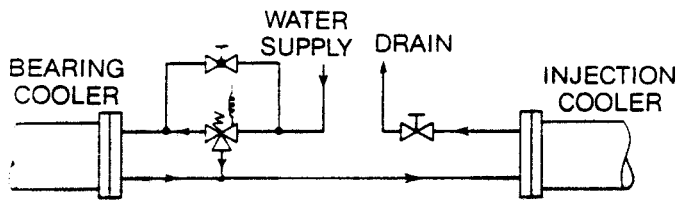


(d) 3-Way Mixing Valve With Balancing Valve And Manual Bypass Valve.

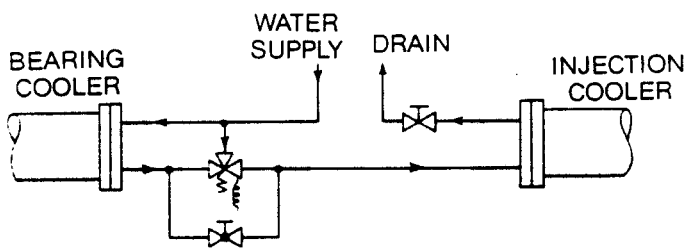
Figure 3-2 Recommended Water Piping Schematics For The Two Oil Cooler System



(a) Two 2-Way Valves With Two Manual Bypass Valves.



(b) One 3-Way Diverting Valve With Balancing Valve and Manual Bypass Valve.



(c) One 3-Way Mixing Valve With Balancing Valve and Manual Bypass Valve.

The disadvantages of this method are that the cooling water is contaminated with dissolved or suspended air-borne particles and pollution which causes excessive scale and fouls the oil cooler tubes and the potential for winter freeze up is great in the colder climates.

b) Closed Circuit Recirculated Evaporative Cooling

By using a circuit of the evaporative condenser and circulating a captive charge of coolant to the oil cooler, scale build up and fouling of the tubes is minimized and the winter freeze hazard is eliminated.

The disadvantage of this method is the expense of the evaporative cooler and oversized oil cooler.

c) Once Through Well or City Water

If a low-cost source of water is available, it is possible to cool the oil and return the warm water to a drain. Special consideration must be given to the oil cooler design if the water will not be treated and clean.

3.7 COOLING REFRIGERANT SUPPLY REQUIREMENTS

Figure 3-3 is a schematic of direct liquid injection oil cooling and the components and connections supplied with the Sullair package. For refrigerant cooling of Sullair Refrigeration compressors by direct liquid injection, a reliable source of high pressure liquid must be supplied to the compressor by the owner. The system must be such that the cooling liquid supply is always available to the compressor whether or not liquid is present in the high pressure receiver. A minimum of a five minute supply of liquid should be available to the compressor cooling system after the high pressure receiver is empty for any reason.

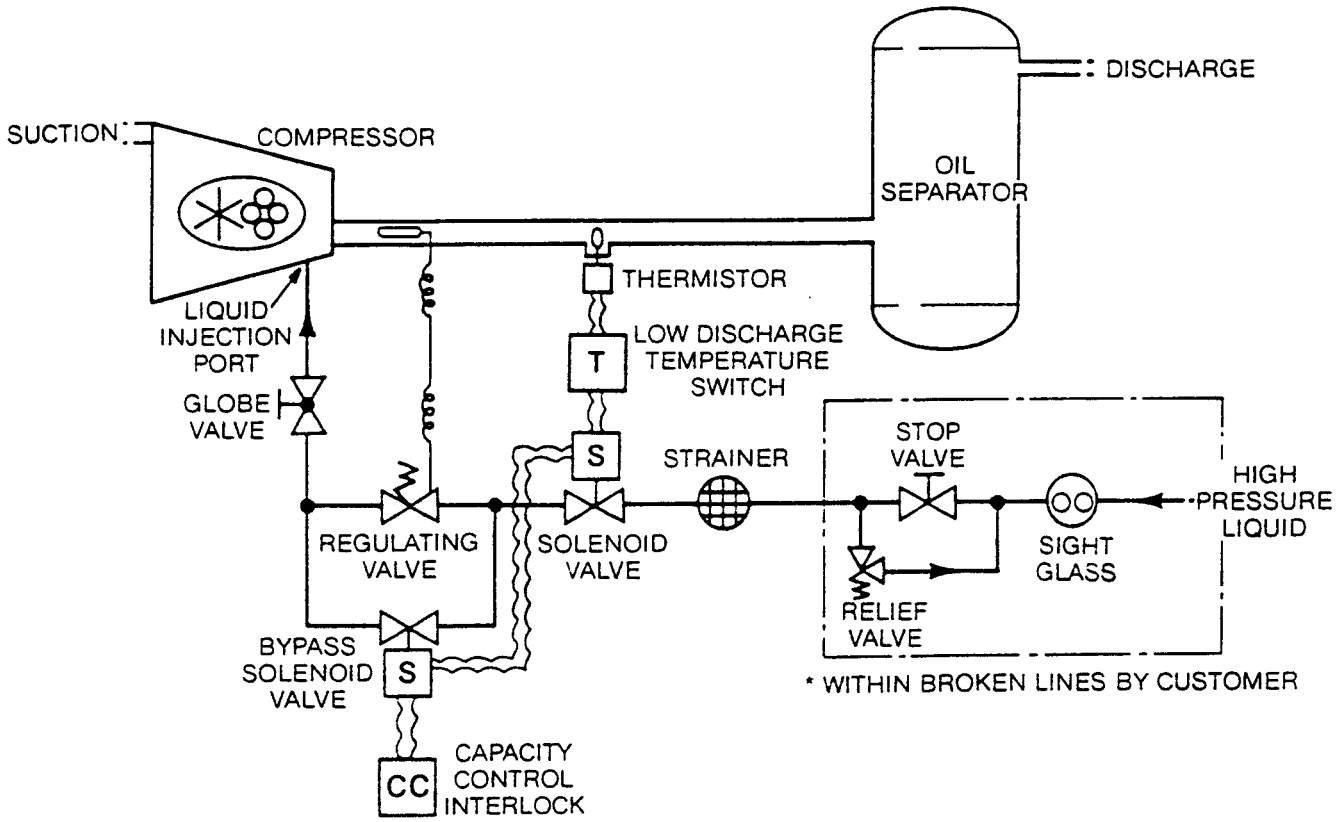
Table 7 gives line sizes and vessel sizes for the specific compressor. Note that the customer minimum line sizes are different from the Sullair line sizes. Contact Sullair Refrigeration for any additional information you may require.

Line lengths from the high pressure receiver to the compressor should be as short as possible to insure an adequate liquid supply at start-up. The piping must allow free venting of any vapor that may be created on shutdown.

To minimize evaporation of liquid in the supply line with consequent reduction in liquid flow through the refrigerant regulating valve, the line should be insulated if it passes through an area where the temperature is higher than the condensing temperature (eg in the open under the hot sun or inside warm rooms in cold climates).

Three refrigerant supply methods are shown in Figure 3-4.

Figure 3-3 Liquid Injection Piping



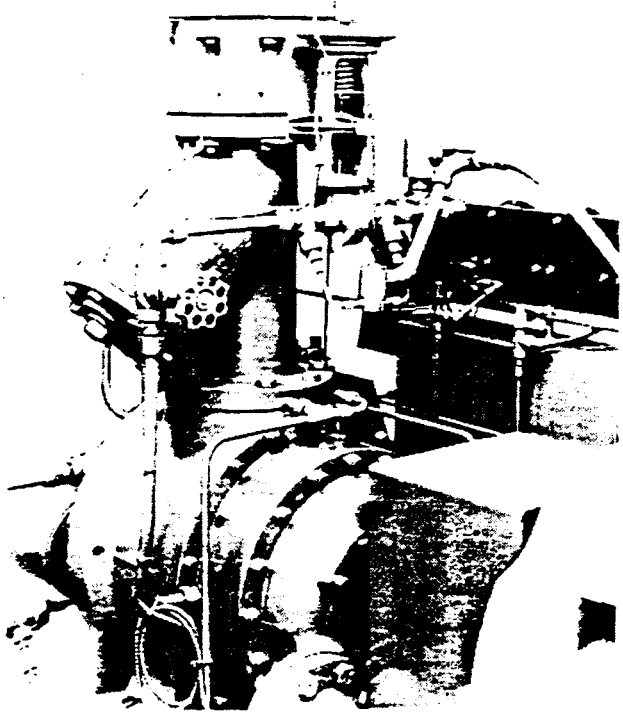
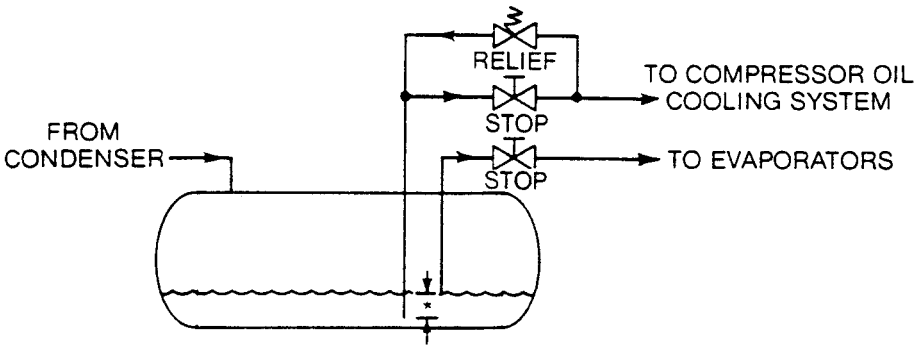
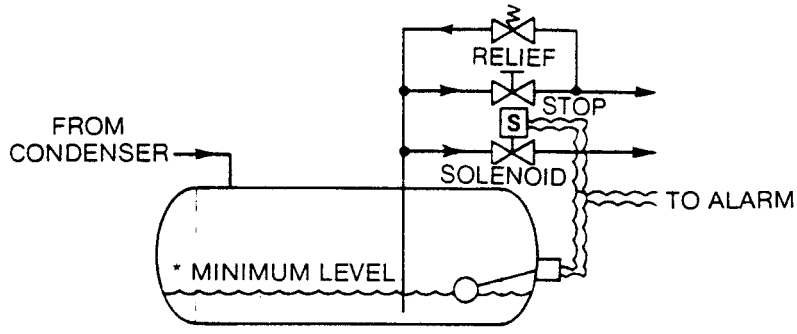


Figure 3-4 Refrigerant Supply Methods



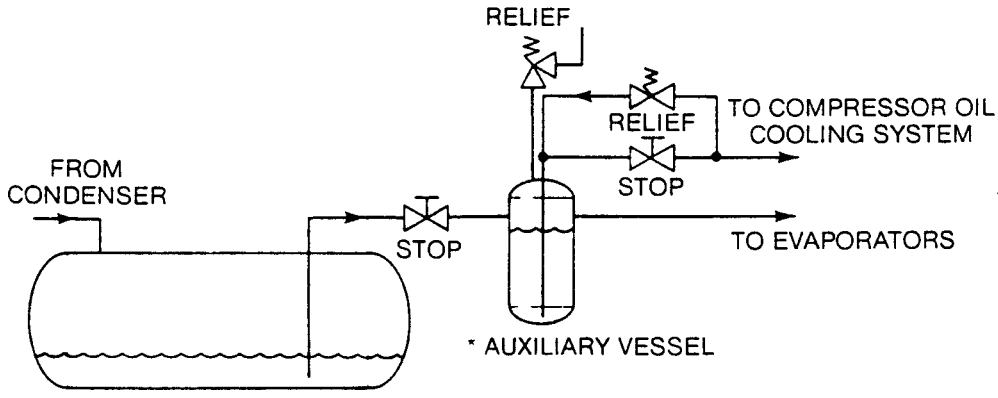
*Level difference to provide minimum of 5 minutes liquid supply for compressor oil cooling system.

(a) Modified High Pressure Liquid Receiver Method.



*Solenoid valve closes at this level. A minimum of 5 minutes liquid supply remains in the receiver for compressor oil cooling system.

(b) Level Control And Solenoid Valve Method.



*Auxiliary vessel sized to provide minimum of 5 minutes liquid supply for compressor oil cooling system.

(c) Auxiliary Vessel Method.

TABLE 7
LIQUID INJECTION PIPING

Model	Sullair Line Size		Customer Minimum* Line Size		Minimum Liquid Supply Volume	
	in	mm	in	mm	ft^3	L
B20LB400	3/4	20	1/2	15	1	30
B20LB411	3/4	20	1/2	15	1	30
B20LB418	3/4	20	1/2	15	1	30
B20LB437	3/4	20	1/2	15	1	30
B20LB465	3/4	20	1/2	15	1	30
B20LB480	3/4	20	1/2	15	1	30
B20LB200	3/4	20	1/2	15	1	30
B20LB211	3/4	20	1/2	15	1	30
B20LB218	3/4	20	1/2	15	1 1/2	40
B20LB237	3/4	20	1/2	15	1 1/2	40
B20LB265	3/4	20	1/2	15	1 1/2	40
B25LB	3/4	20	3/4	20	2	50
B32SB	3/4	20	3/4	20	3	80
B32LB	3/4	20	3/4	20	4	110

* Larger sizes should be used when the calculated pressure drop of the liquid flow (in the piping within the dashed lines of figure 3-3) exceeds 4 PSI (30 kPa)

System (A) consists of modifying the existing high pressure receiver or modifying the design of a new high pressure receiver such that two liquid supply lines are available; one to the evaporator and one for the cooling liquid supply. The connections must be situated such that the liquid will stop flowing to the evaporator before it stops flowing to the compressor. Again, a minimum of five minutes supply must be available to the compressor.

System (B) consists of a solenoid valve connected to the liquid supply line from the high pressure receiver to the evaporator. The solenoid valve is controlled by a level switch installed in the high pressure receiver and set such that the solenoid valve will close when the liquid level in the tank drops to a point where slightly more than five minutes of liquid remains in the tank.

System (C) consists of installing a small auxiliary high pressure vessel, sized to hold the five minute liquid supply.

.8 PRESSURE TEST

The Sullair Refrigeration package components have all been pressure tested prior to leaving the factory to the "Safety Code for Mechanical Refrigeration" ANSI B9.1 1977. 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 test should be done simultaneously with the system pressure test and system leak check.

Do not add oil to the package prior to pressure testing.

IMPORTANT

Whenever the compressor package is colder than the condensing temperature, admit only enough high pressure refrigerant to bring the package up to the test pressure given in Table 8 and then close the inlet valve. This minimizes the amount of liquid condensing in the package which could damage the compressor on start-up.

Before the system pressure test, check that the oil separator elements are seated correctly and that the gaskets are in the correct position. When the package is under pressure tighten the manhole cover gasket.

In the absence of an established pressure testing procedure, the following is a guide to good practice:

TABLE 8
MINIMUM DESIGN AND TEST PRESSURES

REFRIGERANT	LOW SIDE		HIGH SIDE			
			Water-Cooled		Air-Cooled	
	PSIG	kPag	PSIG	kPag	PSIG	kPag
R12	100	700	150	1000	200	1400
R22	150	1000	250	1700	300	2000
R717	150	1000	250	1700	300	2000

1. Open all the interconnecting valves between the low and high pressure sides. Open solenoid valves, pressure regulating valves, check valves and other control valves by means of their manual lifting stems.
2. Pressure test the entire system with dry nitrogen or dry air to the low side pressure given in table 8 or the setting of the pressure relief device protecting the low side.

IMPORTANT

If using an air compressor, an aftercooler must be used to reduce the moisture content.

3. Blow down the system and repair any leaks.
4. Again pressure test the entire system to the low side pressure as in step 2 but add 1% of the system refrigerant charge to aid leak detection.
5. If no leaks are found, record the pressure and the ambient temperature and hold the system pressurized for 12 hours (overnight). Note the system pressure and the ambient temperature after 12 hours. Correct the pretest pressure for temperature variation (as the absolute pressure is proportional to the absolute temperature) as in the example. If the pre-test temperature corrected pressure has not decreased by more than 0.5% of the test pressure the low side system can be considered leak free for refrigeration purposes.

For example, consider a low side ammonia system where the pretest pressure was 150 PSIG at an ambient temperature of 81°F and the test pressure reduced to 143.5 PSIG at an ambient temperature of 61°F. The pretest pressure is corrected for the temperature variation as follows:

$$Pc = \frac{(61 + 459)}{(81 + 459)} \times (150 + 14.7)$$

$$= 158.6 \text{ PSIA}$$
$$= 143.9 \text{ PSIG}$$

The minimum pressure of an acceptable leak free system is 99.5% of Pc which is 143.2 PSIG. As the system test pressure was 143.5 PSIG the low side is acceptable. (See 10 below for an SI unit example).

This assumes that the system air is at the same temperature as the ambient temperature and that the test mixture of air and refrigerant is a perfect gas.

6. Isolate the low side from the high side by closing all the interconnecting valves.
7. Pressure test the high side of the system with dry nitrogen or dry air and 1% of the system refrigerant charge to the high side pressure given in table 8 or the setting of the pressure relief device protecting the high side.
8. Blow down the high side and repair any leaks.
9. Again pressure test the high side to the high side pressure as in step 7.
10. If no leaks are found, record the pressure and the ambient temperature and hold the high side of the system pressurized for 12 hours (overnight). Note the system pressure and the ambient temperature after 12 hours and if the pressure has not decreased by more than 0.5% of the pretest temperature corrected pressure the high side can be considered leak free for refrigeration purposes.

For example, consider a high side ammonia system where the pretest pressure was 1700 kPag at an ambient temperature of 27°C and the test pressure reduced to 1635 kPag at an ambient temperature of 17°C. The pretest pressure is corrected for the temperature variation as follows:

$$Pc = \frac{(17 + 273)}{(27 + 273)} \times (1700 + 101)$$

$$= 1741 \text{ kPag}$$
$$= 1640 \text{ kPag}$$

The minimum pressure of an acceptable leak free system is 99.5% of Pc which is 1632 kPag. As the system test pressure was 1635 kPag the high side is acceptable. (See 5. above for an English unit example).

3.9 SYSTEM EVACUATION

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.

TABLE 9
PRESSURE – BOILING TEMPERATURE RELATION FOR WATER

Absolute Pressure				Boiling Temperature	
Micron (μm) of mercury	PSI	in. of mercury	Pa	°F	°C
100	0.00193	0.004	13.3	-40	-40
200	0.00385	0.008	26.6	-28	-33
500	0.00964	0.020	66.4	-12	-24
1000	0.0193	0.039	132.9	1	-17
2000	0.0385	0.078	265.8	14	-10
5000	0.0964	0.197	664	34	1
10000	0.193	0.393	1329	52	11

The system must be evacuated to remove both the air and the moisture. This evacuation can be done with a high vacuum pump capable of reducing the absolute pressure to 1000 microns (1000 μm = 1 mm) of mercury or less. As the internal pressure is reduced, the temperature at which the water boils (saturation temperature) is also reduced. As the water boiling temperature is lowered below the external ambient temperature, heat is transferred into the system and vaporizes the water which is removed by the vacuum pump. With high ambient temperatures, dehydration occurs more quickly. See Table 9.

Do not evacuate with oil in the separator as the oil prevents any trapped moisture from boiling off.

The following procedure is recommended.

1. Ensure all leaks have been corrected by pressure testing as in section 3.8.
2. Blow the system down to atmospheric pressure.
3. As many commercial vacuum pumps contain brass which is attacked by ammonia in the presence of moisture, remove any ammonia remaining in the system from the pressure test by adding dry nitrogen to a pressure of about 10 PSIG (70 kPag). Again blow the system down to atmospheric pressure.
4. Open all the interconnecting valves between the low and high pressure sides.
5. Install a vacuum gauge at the oil filter drain valve or some other convenient system connection. Open the drain valve.
6. Attach the vacuum pump by hose to the blowdown valve on the oil separator.
7. Open the blowdown valve.
8. Start the vacuum pump and evacuate the system to 1000 microns of mercury absolute pressure (0.0193 PSIA, 133 Pa). Depending on the internal volume of the system, the amount of air and water present, the ambient temperature and the size of the vacuum pump this may take from half an hour to ten hours. Should the ambient temperature be less than 32°F (0°C), evacuate the system to 200 microns of mercury absolute pressure (0.00385 PSIA, 27 Pa).
9. Close the blowdown valve.
10. Stop the vacuum pump.
11. Record the system absolute pressure.
12. Wait two hours and repeat steps 6, 7, 8, 9, 10 and 11.
13. Wait two hours and read the system absolute pressure again. If the pressure has not increased, dehydration is complete. If the pressure has increased repeat steps 6, 7, 8, 9, 10 and 11.
14. If the vacuum fails to hold after several dehydration attempts, check the system for leaks and again repeat steps 6, 7, 8, 9, 10 and 11.
15. Close the blowdown valve and the vacuum gauge valve.
16. Charge the system with refrigerant at the charging valve.

Even with the above procedure small amounts of moisture located a long way from the vacuum pump may be difficult to remove. A filter-drier (preferably with a replaceable element) should be installed in halocarbon systems in the liquid line downstream of the charging valve to remove this residual water. The circulating refrigerant brings the residual moisture to the drier. The filter drier element may have to be changed several times before the correct degree of dryness (as shown by a moisture indicator installed in the liquid line downstream of the filter-drier) is obtained.

3.10 COUPLING ALIGNMENT

The compressor is supplied leveled and secured to the package base frame with dowel pins. Do not loosen the bolts or disturb the compressor. Tighten

the compressor mounting bolts to the torque given in Table 12 in Section 6.3 as they may have loosened in shipment.

(a) Preparation for Alignment

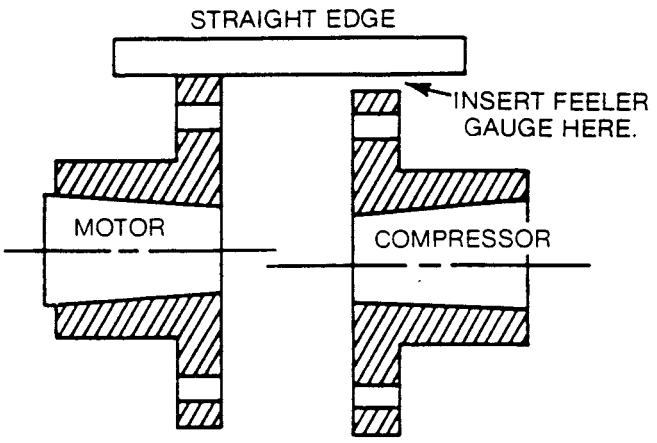
1. The compressor package should be leveled and securely anchored without base distortion as in section 3.4.
2. Have available a supply of *clean* shim stock in various thicknesses from 0.001 to 0.20 in (0.02 mm to 0.50 mm) and slotted to fit the motor mounting bolts.
3. Check to make sure the motor feet and the package mounting pads are free of dirt and burrs.
4. Remove the coupling spacer and flexible elements if fitted by removing the nuts, bolts, and thin and thick washers. Note the orientation of the thin and thick washers with the bevel facing the element pads.
5. Tie a wire through one bolt hole of each element pad to retain the original orientation of each element in the pad and to ensure that each element pad contains the same number of elements.
6. If the hubs are not mounted on the compressor shaft and the motor shaft, assemble the hubs as in Section 6.10.
7. Have a crowbar or other strong lever available to raise the motor for access to the shims.

(b) Preliminary Alignment

Refer to Figure 3-5.
Roughly align the motor to the compressor to get within dial indicator range (so the indicator is not damaged by being displaced out of its range) and to ensure that the motor shaft is lower than the compressor shaft (so that height increases are possible with shims).

1. Move the motor so the distance between the end of the compressor shaft and the end of the motor shaft is 5 inches (127 mm) for all models.
2. Place a straight edge across the top of the rim of one hub flange to the rim of the other. Measure the gap between the straight edge and the rim of the second coupling with a feeler gauge. Add or remove shims at each corner of the motor to raise or lower the motor by the measured amount so that the gap is reduced to about 1/32 inch (1 mm).
3. In a similar manner, measure the shaft offset from side to side and jack the motor from side to side to reduce the gap to about 1/32 inch (1 mm).
4. Loosen the motor mounting bolts and check that the motor feet are level by trying to rock the motor or move the shim packs by hand. Neither will be possible when the motor feet are level.

Figure 3-5 Preliminary Alignment



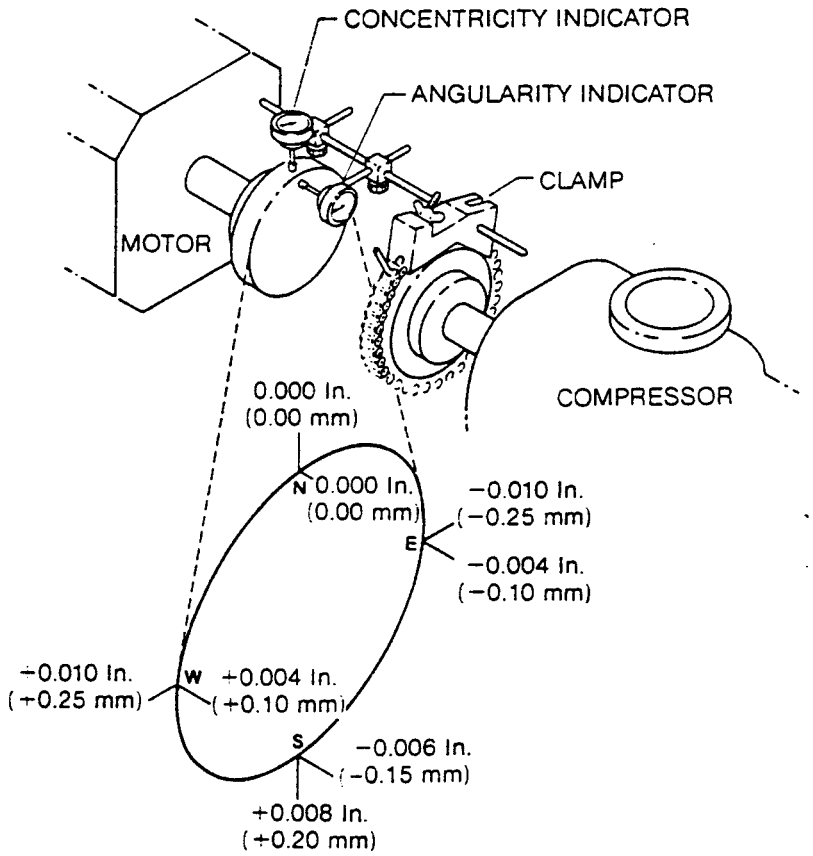
PLAN OR ELEVATION VIEW

5. Place expanding grout around the entire base channel flanges to ensure stability of the coupling alignment.

(c) Final Alignment

1. Attach two dial indicators together securely to either coupling hub using a chain block or a vise clamp as in Figure 3-6. Set one plunger on the top of the face of the opposite hub close to the rim or outside diameter (to measure the angularity) and set the other plunger on the top center of the rim (to measure the concentricity). Make sure that the plunger point is on a clean unpainted surface. Position both indicators such that their plungers are approximately half depressed to allow movement of the pointer in either direction.
2. Set both dial faces to zero as in position N in figure 3-6.
3. Make sure that the indicators are securely attached by rotating the compressor shaft and the motor shaft together 360 degrees or one complete revolution. The dial readings should return to zero. If the indicators do not return to zero check the mounting of the indicators and tighten the chain block or the vise clamps.

Figure 3-6 Final Alignment Procedure



4.

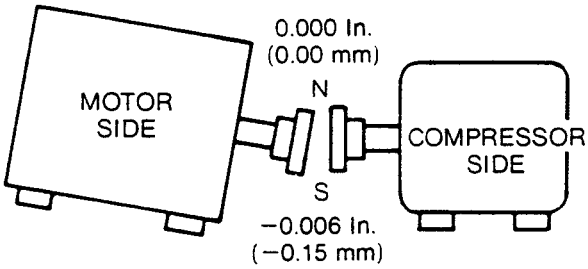
IMPORTANT

The *maximum allowable* coupling angularity or concentricity misalignment is 0.002 in (0.05 mm) total indicator reading (T.I.R.). The total indicator reading is obtained by subracting the lowest reading from the highest reading. Use care to observe the sign change when subtracting a negative reading eg:

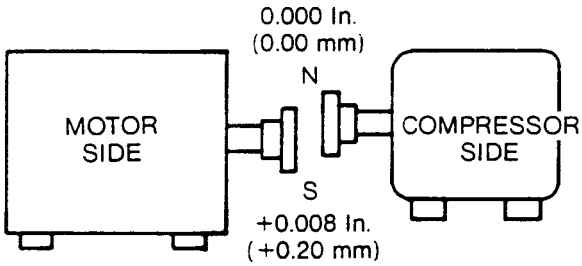
0.003 − (−0.002) = 0.005 and
0.003 − (+0.002) = 0.001

5. The adjustment for misalignment should be made in a specific sequence. The four positions of alignment described in Figure 3-7 are arranged in the recommended order.
6. The following example shows the recommended procedure for correcting coupling misalignment.
7. When making shim changes, use a small number of thick shims rather than a large number of thin shims to prevent excessive compression of the shim packs when the mounting bolts are tightened.
8. When making shim changes, change and secure one foot at a time. Tighten the bolt only enough to prevent the motor moving about while making shim changes. The next best procedure is to shim both inboard and outboard feet at the same time. This method helps to retain any correction already obtained.
9. Whenever shims are changed and the motor is moved, the mounting bolts should be tightened evenly in the sequence in Figure 3-8 to the same torque given in table 12 in section 6.3. This minimizes misalignment caused by the motor shifting when tightening the bolts and by the motor pads not being level.
10. Whenever shims are changed and the motor is moved and the mounting bolts are tightened. a continuing sequential record should be kept of each set of 8 indicator readings on a simple elliptical sketch as in figure 3-6.
11. Set both dial indicators to zero 0.000 in. (0.00 mm) in position N in figure 3-6. Rotate both the compressor shaft and motor snaft *together* in 90° or quarter turn steps

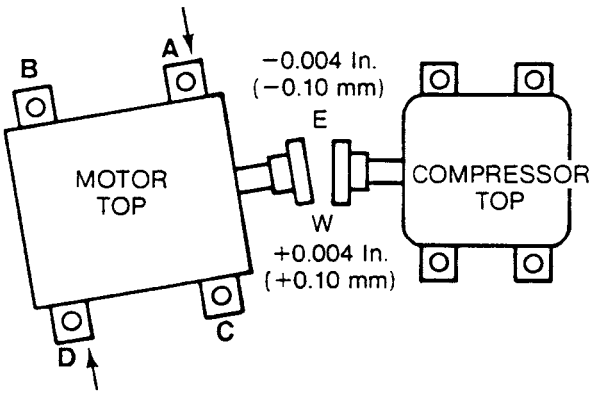
Figure 3-7 Alignment Sequence



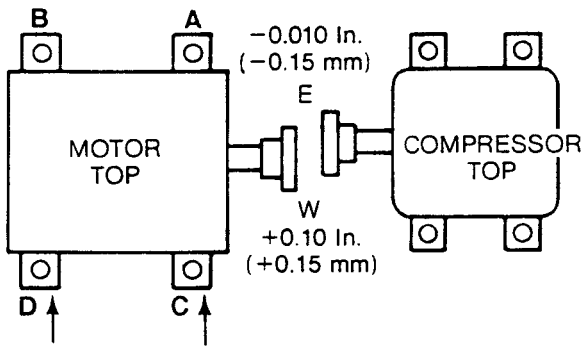
Step 1: Angularity in elevation—This alignment is adjusted with shims and is not readily lost in making the other adjustments.



Step 2: Concentricity in elevation—This alignment is also made with shims, but it cannot be made while there is angular misalignment in elevation.

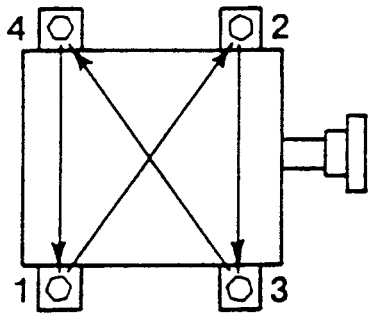


Step 3: Angularity in plan—This position can easily be lost if placed ahead of the two adjustments in elevation.



Step 4: Concentricity in plan—This adjustment cannot be made while there is still angular misalignment in plan, and can easily be lost if elevation adjustments are made.

Figure 3-8 Motor Mounting Bolts Tightening Sequence



and record both indicator readings at each 90° step. Turning both hubs together ensures that readings are recorded at the same point on each hub eliminating the effect of any irregularities on the rims or faces of the hubs. A mirror may assist in taking the readings. A sample set of readings is given in figure 3-6.

12. Never accept a single reading. Look for repeatability by rotating both shafts together several times and check that the reading remains the same.
13. The "angularity in elevation" misalignment from 0.000 in (0.00 mm) at point N to -0.006 in (-0.15 mm) at point S indicates that the rear of the motor is higher than the front in relation to the compressor. The T.I.R. is 0.006 in. (0.15 mm).
14. Calculate the distance to move the motor feet as follows:

    (a) Measure the angularity indicator plunger circle diameter (a little smaller than the coupling hub diameter) D, for example 6 inches (150 mm).
    (b) Measure the distance between the front and rear motor mounting bolts L, for example 30 inches (750 mm).
    (c) Let the angularity in elevation misalignment T.I.R. as measured in 13 above be M.
    (d) Let the shim thickness to be added or removed be S.
    (e) Then the shim thickness to be added or removed is calculated by dividing the bolt distance L, by the coupling diameter D, and multiplying the result by the misalignment, M.

15. $S = \frac{LM}{D}$

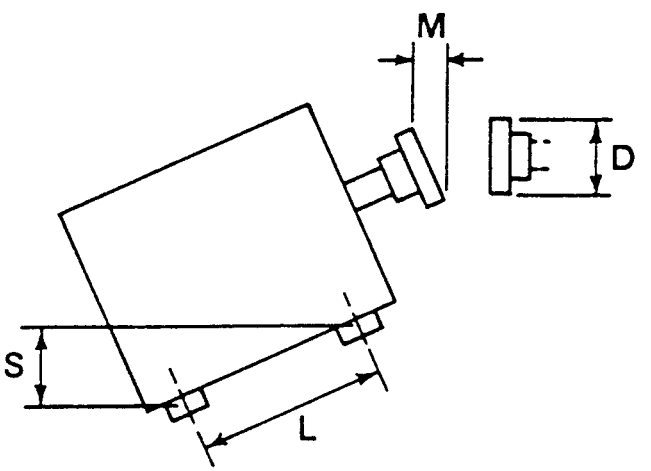
    $= \frac{30 \times 0.006}{6}$ $= \frac{750 \times 0.15}{150}$

    $= 0.030$ inches $= 0.75$ mm

    Remove 0.030 inch (0.75 mm) of shim from the two rear motor feet. Use a crowbar or other strong lever to raise the motor for access to the shims.

16. Tighten the mounting bolts to the torgue given in table 12 in section 6.3.
17. Recheck the angularity in elevation misalignment as in steps 11 to 14 above. Record all 8 dial indicator readings. Note that the motor shaft can be above or below the compressor shaft (i.e. not concentric) and this will not affect the angularity in elevation calculation. When this is checked the motor shaft is parallel in elevation to the compressor shaft, completing step 1 in figure 3-7.
18. The "concentricity in elevation" misalignment in figure 3-6 from 0.000 in (0.00 mm) at point N to 0.008 in (0.20 mm) at point S indicates that the motor is lower than the compressor. The T.I.R. is 0.008 in (0.20 mm).
19. The distance to move the motor feet is half of the concentricity in elevation misalignment T.I.R. This is 0.004 inch (0.10 mm) from 18 above.
20. Add 0.004 inch (0.10 mm) of shim to each of the four motor feet.
21. Tighten the mounting bolts to the torque given in table 12 in section 6.3.

Figure 3-9 Angularity Alignment



22. Recheck the concentricity in elevation misalignment and record all 8 dial indicator readings. When this is checked the motor shaft is both level and parallel in elevation to the compressor shaft, completing step 2 in figure 3-7. No more shims should need to be added or removed to the motor feet to complete the alignment.
23. The "angularity in plan" misalignment in figure 3-6 from -0.004 in (-0.10 mm) at point E to 0.004 in (0.10 mm) at point W indicates that the motor is displaced clockwise in plan in relation to the compressor. The T.I.R. is 0.008 in (0.20 mm).
24. Calculate the distance to move the motor feet in a similar manner to the "angularity in elevation" misalignment in step 14, except

M represents the "angularity in plan" misalignment T.I.R. and S is the distance the motor feet have to be moved from side to side.

25. $S = \frac{LM}{D}$

$= \frac{30 \times 0.008}{6}$ $= \frac{750 \times 0.20}{150}$

$= 0.040$ inches $= 1.0$ mm

Fit jack screws (supplied on most packages) to the frame at points A and D in figure 3-7. Bring the jack screw at point A in contact with the motor frame and turn the jack screws at point D in the direction of the arrow to move the motor rear feet 0.040 in (1.02 mm) clockwise when viewed from above.

26. Tighten the mounting bolts to the torque given in table 12 in section 6.3.
27. Recheck the angularity in plan misalignment and record all 8 dial indicator readings as in step 11 above. When this is checked the motor shaft is parallel to (in elevation and plan) and level with the compressor shaft, completing step 3 in figure 3-7.
28. The "concentricity in plan" misalignment in figure 16 from 0.010 in (0.25 mm) at point E to -0.10 in (-0.25 mm) at point W indicates that the motor is displaced in the direction of point W. The T.I.R. is 0.020 in (0.5 mm)
29. The distance to move the motor feet is half of the concentricity in plan misalignment T.I.R. This is 0.010 in (0.25 mm) from 28 above.
30. Fit jack screws to the frame at points C and D in figure 3-7. Bring both jack screws into contact with the motor frame and then turn them in the direction of the arrows to move both feet 0.010 in (0.25 mm).
31. Tighten the mounting bolts to the torque given in table 12 in section 6.3.
32. Recheck the concentricity in plan misalignment and record all 8 dial indicator readings as in step 11 above. If necessary, readjust the motor as outlined in the preceeding steps if either of the angularity or concentricity indicators exceeds the maximum allowable misalignment of 0.002 in (0.05 mm). When this is checked the motor shaft should be satisfactorily aligned within 0.002 in (0.05 mm) angularity and concentricity from top to bottom (elevation) and from side to side (plan) to the compressor shaft.
33. Reverse the checking procedure by adjusting both dial indicators to zero at point S. Again readjust the motor as in the preceeding steps.
34. Check the spacing between the motor shaft and the compressor shaft to make sure there is sufficient room to accept the coupling spacer. This should be $5 \pm 1/16$ inch (127 ± 1.6 mm) for all flexible disc models.
35. Finally tighten the motor mounting bolts in the sequence in figure 3-8 to the torque in table 12 in section 6.3.
36. Finally recheck the alignment as in step 32. If difficulty is experienced obtaining the alignment within the tolerance proceed to (d) below as the motor feet may not be sufficiently level.
37. Set the flange to flange spacing to the specified distance in Table 14 in Section 6.11. When setting coupling spacing on motors with sleeve bearings, it is mandatory that the motor armature be located on its magnetic center. Contact the motor manufacturer or Sullair Refrigeration for details.
38. Do not assemble the coupling and dowel pin the motor to the frame until the alignment has been verified by a Sullair Refrigeration Representative. The Sullair Refrigeration Representative will be available to supervise these operations, but the customer must supply the dowel pins, drill, reamer, drill bits and the labor.

(d) Leveling the Motor Feet

All motor support feet must be in the same plane. If they are not level it makes exact alignment difficult. If one foot is higher it stresses and springs the frame work and the motor or if badly out of level it can break the foot. Each time this foot is tightened it must be tightened to the same torque value, or a different indicator reading will result. The following procedure levels the motor feet in relation to the package base frame.

1. Tighten all mounting bolts evenly in the sequence in figure 3-8 to the torque in table 12 in section 6.3.
2. Attach a dial indicator plunger on the top center of the rim (to measure the concentricity) in position N on figure 3-6. Position the plunger so it is half depressed to allow movement of the pointer in either direction.
3. Set the dial face to zero.
4. Loosen one of the inboard feet and record the total movement on the indicator. Tighten the foot.
5. Loosen the adjacent inboard foot and record the total movement before tightening it.
6. If this reading is greater than the reading for the first foot, add shims to this second foot equal to the difference.
7. When the reading on the second foot is less than or equal to 0.003 in (0.08 mm) recheck the first foot. This will confirm that the inboard feet checked are level.
8. Repeat the procedure for the outboard pair of adjacent feet.
9. An acceptable reading on any foot is less than or equal to 0.003 in (0.08 mm) when three bolts are tight and one is loose.

10. Finally tighten the motor mounting bolts evenly in the sequence in figure 3-8 to the torque in table 12 in section 6.3.

3.11 ELECTRICAL CONNECTIONS

DANGER

Lethal shock hazard inside.

Disconnect all power at source, before opening or servicing.

WARNING

Use equipment grounding connector in accordance with the National Electrical Code, and all Federal, State, and Local Codes, to help avoid possible ground fault shock hazard.

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 or 1500 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.

B Series machines require a power supply of either 1500 VA for machines with an auxiliary oil pump, or 500 VA capacity for machines without an auxiliary oil pump.

WARNING

Disconnect all power at source, before attempting maintenance or adjustments.

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.

3.12 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 4.

Before charging any oil into the screw compressor package, see Section 2.4.

Sufficient oil should be charged into the oil separator reservoir to establish a level in the upper sight glass. See Table 4 for oil capacity.

Pump an additional two gallons (eight litres) of oil into the filter through the valve in the cover of the filter housing to ensure adequate lubrication during the initial start-up. Check that the bearings are prelubricated by loosening a nipple on the discharge journal bearing oil supply line at the compressor bearing and pump a small additional amount of oil until oil weeps at the loosened nipple. Make a final check by pumping further oil and noting the pressure increase on the oil pressure gauge.

3.13 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.

With power to the motor off, power supplied to the panel and the oil temperature below the thermostat setting of 100°F (38°C) verify that the oil heater is on by checking the current drawn. Alternatively check the heater element by noting the relative temperature of the separator at the element and the opposite side.

The machine should *never be* started until the oil is 68°F (20°C) or 10°F (5°C) above saturation temperature of the package pressure whichever is higher. Ideally, the temperature should be 80°F to 100°F (27°C to 38°C).

3.14 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.

IMPORTANT

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 or 1500 VA source should be obtained or the motor starter should be disconnected.

WARNING

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

3.15 PROTECTIVE SWITCH ADJUSTMENT AND CHECK

All switches are to be adjusted to values shown in section 2.3.

LOW OIL PRESSURE PROTECTIVE SWITCH (LOP) (Machines With Auxiliary Oil Pump)

With panel power on, simulate a start by pushing the start button . The auxiliary oil pump will start and build up pressure to 15 PSI (103 kPa) 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.

LOW OIL PRESSURE PROTECTIVE SWITCH (LOP) (Machines Without Auxiliary Oil Pump)

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 (HDP), LOW SUCTION PRESSURE (LSP), HIGH DISCHARGE TEMPERATURE (HDT) AND HIGH OIL TEMPERATURE (HOT) PROTECTIVE SWITCHES

To check the remaining protective switches, jumper both the low oil pressure switch (LOP), and the start-up oil pressure switch (SOP), then readjust or manually manipulate each protective switch after simulating a start and note whether the main control relay 4CR drops out. Also, check to assure that the appropriate pilot light on the panel door lights up.

ANTI-RECYCLE TIMER, MOTOR OVERLOAD AND LOAD LIMIT RELAY

Set the anti-recycle timer to the value in section 2.3 according to the motor power. Check that the correct motor overloads are installed for the motor nameplate full load current. The load limit relay has to be set as in section 4.12 after the compressor is running (and after the high discharge pressure (HDP) switch has been set).

3.16 CAPACITY CONTROL ELECTRIC VALVE ACTUATOR CHECK

With oil in the separator, the main motor disconnected, the low oil pressure (LOP) switch jumped, on machines so equipped, the auxiliary oil pump disconnected and the control system energized to simulate operation, the following items should be checked:

1. Remove the pointer/declutching override knob and remove the access cover.
2. Run the capacity control valve to the maximum or wide open position with the "Manual" load switch on the control panel.
3. Check that the butterfly valve is fully open and has not turned past the fully open position by noting that the flat surfaces on the valve stem are vertical.
4. If the valve does not fully open or turns past the open position, loosen the set screw on the maximum position cam (the bottom cam closest to the butterfly valve) and readjust the cam. Note that it may be necessary to remove the microswitch (es) for clearance to the cam set screw. Tighten the set screw.
5. Recheck the actuator setting for the maximum position.
6. Run the capacity control valve to the minimum or slightly open position (5° open) with the "Manual" unload switch on the control panel.
7. Check that the butterfly valve is in the minimum position by noting that the flat surfaces on the valve stem are approximately five degrees above the horizontal position. This corresponds to a butterfly valve position 85 degrees from the fully open position.
8. If the butterfly valve is not in the five degree open position, loosen the set screw on the minimum position cam (the second cam away from the butterfly valve) and readjust the cam. Note it may be necessary to remove the microswitch for clearance to the cam set screw. Tighten the set screw.
9. Recheck the actuator setting for the minimum position. Note that this minimum position setting must again be rechecked when the compressor is operating. If the valve is closed too much so that the flow is reduced excessively, the compressor will become noisy due to rotor rattle. The valve should be opened just enough to prevent this noise.
10. Replace the actuator cover.
11. Replace the pointer/declutching override knob. Be sure that the knob set screw engages the central clutch shaft.

To manually operate the valve without electrical system, proceed as follows:

All the pointer/declutching override knob all the way out and hold. Apply a wrench to the exposed flats on the actuator shaft and rotate to the desired butterfly valve position.

To re-engage, return the shaft to the original position of dis-engagement and release the declutching override knob.

IMPORTANT

The actuator should be manually operated only over the range for which it is set up to operate electrically. Operation beyond this range will totally disrupt indexing.

3.17 MOTOR ROTATION CHECK

Remove the coupling spacer if fitted.

Check to see that the motor turns freely by hand. 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 motor shaft coupling hub.

IMPORTANT

B20 GEAR DRIVE, ALL B25, ALL B32

The compressor shaft rotates clockwise when facing the compressor shaft end when the motor rotation is correct. Do not run the compressor in the reverse direction for more than one second. Failure to observe this caution could result in serious damage to the compressor.

IMPORTANT

B20 DIRECT DRIVE

The compressor shaft rotates counterclockwise when facing the compressor shaft and when the motor rotation is correct. Do not run the compressor in the reverse direction for more than one second. Failure to observe this caution could result in serious damage to the compressor.

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.

Check that the motor is correctly greased by removing the relief plug and running the motor for ten minutes. If excessively greased, the excess will run out of the open relief plug. Check the bearing temperatures and if high, add grease as in section 3.18.

Rotate the starting switch to the "Manual-Reset" position. Disconnect the power from the motor starter. Do not mount the coupling guard.

3.18 MOTOR LUBRICATION

Lubricate the motor to the instructions given in the motor manual supplied with the motor. The following lubricating instructions apply only to standard ball or roller bearing grease lubricated motors. Do not overgrease.

1. Clean the exterior of the motor.
2. Remove both the grease plug and the relief plug (if supplied).
3. If the grease has hardened, run a wire a short distance into the grease to break it up.
4. Regrease the motor with the grease shown on the motor nameplate or specified in the motor manual. Use a low pressure grease gun.
5. The bearing chamber should not be more than three quarters full.
6. Run the motor for ten minutes.
7. Replace the grease plugs.

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 COUPLING ALIGNMENT VERIFICATION

The Sullair Refrigeration Representative will verify that the coupling alignment has been achieved within the limits prescribed in Section 3.10. When alignment has been verified, it will be necessary for those with installation responsibility to dowel pin the motor, assemble the coupling spacer and mount the coupling guard. See Sections 3.10 and 6.10 for coupling instructions. The Sullair Refrigeration Representative will be available to supervise these operations, but the customer must supply the dowel pins, drill, reamer, drill bits and the labor.

4.3 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 2.3.
4. All protective switches verified for correct operation.
5. The oil in the separator sump is 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. Two gallons (eight litres) 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 on if refrigerant cooled.
10. Stop valves to the pressure gauges are open.
11. Suction and discharge valves open.
12. Coupling turns freely by hand.
13. Direction of motor rotation checked.
14. Motor bearings lubricated.
15. Capacity control actuator indicator at minimum.
16. Auxiliary start-up oil pump reconnected (if so required).
17. Capacity control valve verified for correct operation. See Section 3-16.
18. Capacity control butterfly valve stem flat surfaces 5° above horizontal (valve just open).
19. Capacity control selection switch in manual.
20. Starting switch in the "Manual-Reset" position.

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

4.4 INITIAL START-UP PROCEDURE

B20 GEAR DRIVE, ALL B25, ALL B32

IMPORTANT

The compressor shaft rotates clockwise when facing the compressor shaft end when the motor rotation is correct. Do not run the compressor in the reverse direction for more than one second. Failure to observe this caution could result in serious damage to the compressor.

B20 DIRECT DRIVE

IMPORTANT

The compressor shaft rotates counterclockwise when facing the compressor shaft and when the motor rotation is correct. Do not run the compressor in the reverse direction for more than one second. Failure to observe this caution could result in serious damage to the compressor.

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. On machines so equipped, the auxiliary oil pump will start automatically provided the suction pressure is above the "cut in" pressure on the unadjusted start/stop pressure switch (HSP) and the discharge pressure is below the "cut in" pressure set on the low discharge pressure switch (LDP).

On machines so equipped the auxiliary oil pump operates at startup to raise the oil pressure to 10 PSI to 15 PSI (69 kPa to 103 kPa) which closes the start up oil pressure switch (SOP) enabling the compressor to start. If the oil is above 105°F (40°C) the auxiliary oil pump may run for as long as 1 1/2 minutes before sufficient startup oil pressure is developed. If the auxiliary oil pump does not build up sufficient pressure within the time set on the auxiliary oil pump shutdown timer, 7TR, usually 3 minutes, the pump will stop and the start will have to be repeated. After the compressor has run for ten seconds the auxiliary oil pump shuts down automatically.

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. If the discharge pressure is above the "cut-in" pressure on the LDP switch, lower the discharge pressure by lowering the suction pressure of the high stage compressor (s).

If the discharge pressure is below the "cut-in" pressure on the LDP switch, and the motor still will not start, lower the "cut-in" setting on the LDP switch 5 PSIG (34 kPag) at a time to a minimum of 10 PSIG (69 kPag) until the auxiliary oil pump and the compressor start.

Immediately after starting, 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" gauge and the "Suction Pressure" gauge.

If the oil pressure does not increase to more than 40 PSI (276 kPa) within 10 seconds, the low oil pressure protective switch will stop the compressor. Check if the oil pressure relief line around the oil pump is warm indicating that the oil pressure relief valve if set too low and relieving too much oil. 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 relief valve (and/or 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 (if the machine is not equipped with an auxiliary pump), add 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 for the low oil pressure cause (Troubleshooting, Section 5.7).

IMPORTANT

Do not restart more than two times after stopping 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 (689 kPa) or more, loosen the locknut on the oil pressure relief valve (and/or the oil pressure regulating valve) and back out the adjustment screw to relieve the excessive oil pressure to approximately 75 PSI (517 kPa).

Restart the compressor and run for five minutes in the minimum load position. Watch all the gauges: The suction pressure slowly falls (if the load is not too great), the discharge pressure slowly rises, the discharge temperature slowly rises and the oil temperature slowly rises. The actual oil pressure at the oil manifold (oil pressure gauge reading minus the discharge pressure reading) slowly falls as the oil temperature increases.

The oil filter pressure drop can be found by subtracting the manifold oil pressure from the filter inlet oil pressure. Both the oil pressure after the oil filter (at the oil manifold) and the oil pressure before the oil filter (at the oil filter inlet) are read on the "Oil Pressure" gauge. The latter 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 30 PSI (207 kPa).

Continue to run the compressor and slowly load the machine by pressing the "Load" button in the capacity control switch intermittently. When the oil reaches its minimum operating temperature of 105°F (40°C), adjust the oil pressure relief and regulating valves as described under "Oil Pressure Adjustment", Section 4.5. Then stabilize the oil temperature by adjusting the controls as described under "Oil Temperature Adjustment", Sectiion 4.6. After the oil temperature has remained within the operating limits for fifteen minutes, make a final adjustment to the oil pressure if required.

4.5 OIL PRESSURE ADJUSTMENT

Before adjusting the oil pressure relief valve and 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.

1. Loosen the locknut on the relief valve and screw in the adjustment screw with an allen wrench as far as it will go.
2. Loosen the locknut on the oil pressure regulator and screw in the adjustment screw with an allen wrench until the oil pressure is 75 PSI (517 kPa) above the suction pressure.
3. Back out the adjustment screw on the oil pressure relief valve, while watching the oil pressure gauge, until the oil pressure begins to drop. This indicates the valve is starting to relieve and bypass oil at 75 PSIG (517 kPa). Tighten the locknut.

4. Back out the adjustment screw on the oil pressure regulator while watching the oil pressure and suction pressure gauges, until the oil pressure drops to 45 PSI to 50 PSI (310 kPa to 345 kPa) above suction pressure. Tighten the locknut.

4.6 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 main solenoid valve shutting off the supply of liquid refrigerant.

There is also a small bypass solenoid valve which opens and closes with the main liquid solenoid valve. It also closes independently of the main solenoid valve whenever the compressor unloads. It helps overcome the thermal inertia of the refrigerant regulating valve by anticipating the action of the regulating valve and maintaining a more even discharge temperature.

The oil and discharge temperature is sensed in the discharge line by a thermistor which acts through an electronic controller to control the liquid solenoid valve and bypass solenoid. Below 105°F, (40°C) the controller opens both the main liquid solenoid valve and the bypass solenoid valve.

Adjustment of the liquid feed low discharge temperature involves turning the white spindle on the electronic panel in the control panel almost fully counterclockwise. The range of the matched thermistor and controller is 100°F (38°C) in the full counterclockwise position to 375°F (190°C) in the full clockwise position.

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 (5Y in Figure 6-13) 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 as shown in Figure 3-3) and crack it open a quarter turn.
3. Turn the regulating valve adjusting wheel fully down (clockwise) to the jam nut (4Y in Figure 6-13) 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.

4.7 PRESSURE BASED ON/OFF CAPACITY CONTROLLER ADJUSTMENT

After satisfactory adjustment of the refrigeration system has been established with manual control, the automatic capacity control pressure controller, P1/P2 can be adjusted.

(a) SINGLE ADJUSTMENT CONTROLLER

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 7 below.

1. Utilize the test switch in the control panel to connect the load/unload pilot lights to the pressure switch (P1/P2) to bypass the on-off timer (3TR) so that the capacity control actuator cannot operate automatically.
2. To set the controller to the desired system control pressure, place the capacity control in the manual mode.
3. With the manual load/unload switch, vary the compressor capacity until the desired suction pressure is obtained. In some systems, it may be necessary to throttle the suction valve to achieve the desired pressure.
4. When the desired suction pressure is reached and remains stable, adjust the P1/P2 controller by turning the central adjustment screw in the appropriate direction so that neither the loading nor unloading lights are on. If the load light is on, turn the adjustment screw clockwise (from above). If the unload light is on, turn the adjustment screw counterclockwise (from above).
5. 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.
6. Return the test switch to its original position so the pilot lights indicate when the capacity controller is loading or unloading.
7. Place the compressor in the automatic capacity control mode. It will then modulate capacity as required to maintain the desired control suction pressure.

(b) DUAL ADJUSTMENT CONTROLLER

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 as in Steps 1 to 12 below.

1. Utilize the test switch in the control panel to connect the load/unload pilot lights to the pressure switch (P1/P2) to bypass the on/off timer (3TR) so that the capacity control actuator cannot operate automatically.
2. To set the controller to the desired system control pressure, place the capacity control in the manual mode.
3. With the manual load/unload switch, vary the compressor capacity until the desired suction pressure is obtained. In some systems, it may be necessary to throttle the suction valve to achieve the desired pressure.
4. Turn the low pressure switch P1 adjusting screw several turns counterclockwise (from above) so that the micro switch lowers toward its actuator pin. This ensures that the setting is well below the desired low pressure set point, as shown in Figure 4-1.
5. 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.
6. Manually load the machine 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 load pilot light should be off and the unload pilot light should be on.
7. 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 unload pilot light goes off. P1 is now correctly adjusted.
8. Manually unload the machine until the desired high pressure set point is indicated on the suction pressure gauge. In this condition, the load pilot light should be on and the unload pilot light should be off.
9. 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 load pilot light goes off. P2 is now correctly adjusted.

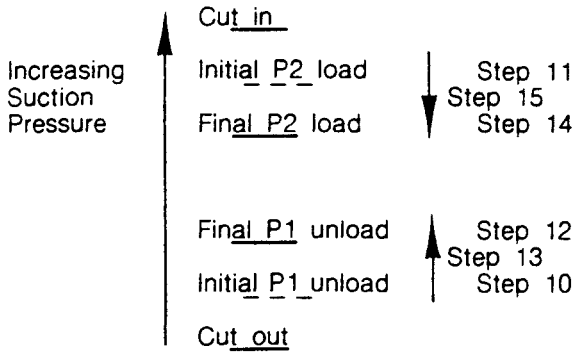
10.

IMPORTANT

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

11. Return the test switch to its original position so the pilot lights indicate when the capacity controller is loading or unloading.
12. Place the compressor in the automatic capacity control mode. It will then modulate capacity as required to maintain the desired control suction pressure.

Figure 4-1 Suction Pressure and Capacity Control Adjustment Steps



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.

4.8 OPTIONAL PRESSURE BASED PROPORTIONAL CAPACITY CONTROLLER ADJUSTMENT

After satisfactory adjustment of the compressor has been established with manual control, the automatic capacity control pressure proportional controller can be adjusted.

The proportional capacity control system consists of a pressure transducer (and its power supply) which converts the suction pressure signal into an electrical signal and a solid state electronic controller, which processes this signal and initiates corrective action based upon the difference between the desired suction pressure and the actual suction pressure (pressure error). The magnitude of the control action is proportional to the magnitude of this pressure error: the greater the pressure error, the longer time the controller remains on and the further the capacity control valve moves. This is shown in Figure 4-2.

Referring to Figure 4-3, the setting procedure for the pressure based proportional capacity controller is as follows:

1. Check connections between components and see that they are according to the wiring diagram.
2. Disconnect one of the 10V D.C. power supply leads going to the transducer.
3. Disconnect the pressure transducer from the system suction pressure and vent it to atmosphere so it senses 14.7 PSIA (101 kPaa).
4. Push down on the tab (1) to release the latch handle (2). Use the thumb spaces under the handle to pull the handle forward and up. The controller is moved forward by cams in the latch handle. Remove the controller from its housing.
5. Examine the left hand circuit board and make sure the red jumper is connected to point D and not point C. This increases the sensitivity and makes it much easier to find the zero output point indicated by neither the green loading light (7) nor the amber unloading light (6) coming on. (Do not confuse these circuit board points with the terminals C and D on the rear of the controller).
6. Turn the "Spread" control (on the front of the control under the metal cover plate (3)) with a screwdriver to full clockwise. This reduces the deadband to near zero.
7. Pull the "Set Point" knob (4) and turn it to 0.
8. Energize the controller and adjust the "Reset" control (on the front of the control under the metal cover plate (3)) with a screwdriver so that neither the green loading light nor the amber unloading light comes on. Since the cycle time is 15 seconds, wait at least that long to make sure neither the loading nor unloading light is going to come on.
9. Reconnect the 10V D.C. power supply to the pressure transducer. The amber unloading light should come on continuously.

Figure 4-2 Proportional Capacity Control

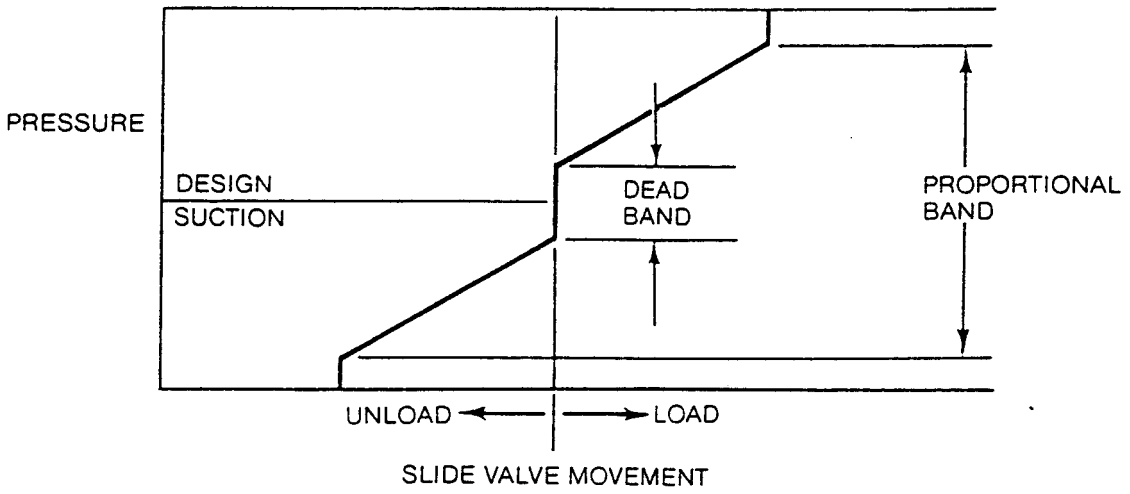
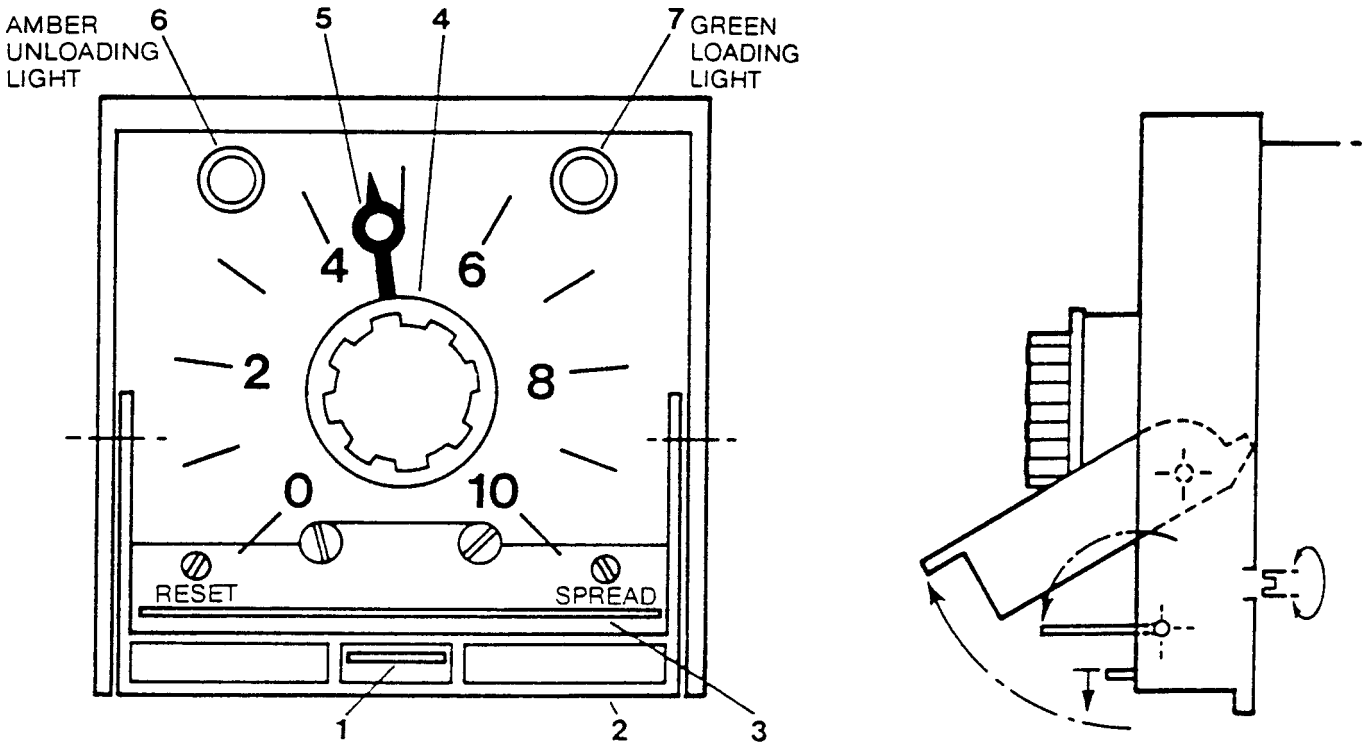


Figure 4-3 Pressure Proportional Capacity Controller



10. Pull the "Set Point" knob and turn it to 1.47. The 0-10 scale represents 0-100 PSIA so 1.47 represents 14.7 PSIA.
11. Adjust the power supply output voltage with a screwdriver until again neither the loading nor unloading light comes on.
12. Reconnect the pressure transducer to the system suction pressure.
13. Adjust the "Spread" control to achieve whatever deadband is required.

The system should need no further adjustments. The controller will now proportion the capacity control slide valve from a small movement to a large movement over a proportional band of about ± 3 PSI (± 20 kPa) from the suction pressure control set point. If this is too tight a proportional band, it can be increased to ± 10 PSI (± 70 kPa) by moving the red jumper from Point C to Point D.

Remember when setting the control point that the scale is PSI absolute times 10. So, for a control point of 20 PSIG (138 kPag) the setting would be (20 + 14.7) / 10 = 3.47 or for a control point of 200 kPag, the setting would be (200 + 101) / (10 x 6.895) = 4.37.

For servicing of the controller, refer to specific supplemental instructions available from Sullair Refrigeration.

4.9 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).

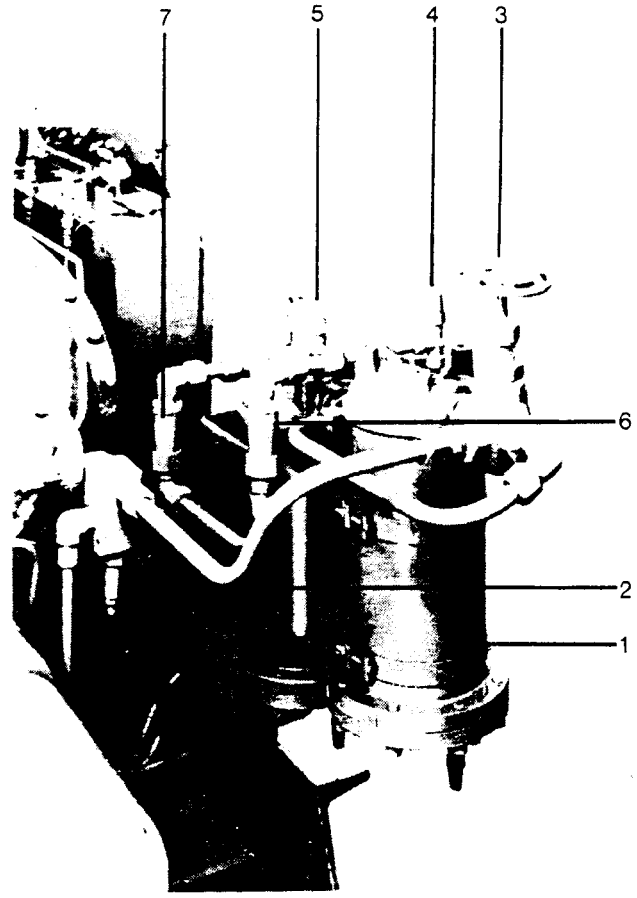
Set the "cut out" pressure adjustment at the pressure where it is desired to have the compressor automatically stop. This pressure should be set sufficiently below the pressure at which the capacity control calls for unloading, usually 5 PSI to 15 PSI (35 kPa to 100 kPa). If short cycling or frequent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

4.10 OPTIONAL DUAL OIL FILTER

Refer to Figure 4-4.
The optional dual oil filter consists of two single units (1,2) interconnected with a three way valve (3) to provide uninterrupted oil flow as shown in Figures 1-2 through 1-14. Provided the ambient temperature is below the normal oil temperature, the operating oil filter is warmer to the touch than the standby filter.

Figure 4-4 Dual Oil Filters



To direct the flow from the operating filter to the standby filter, turn the three way valve handle (3) *slowly* fully clockwise or fully counterclockwise.

Close the valve (4 or 5) to the oil pressure gauge and open the other valve (4 or 5).

The standby filter cartridge may be replaced (as in Section 6.4) with the compressor running provided the check valves (6,7) are in good condition.

4.11 OPTIONAL DUAL OIL STRAINER

Refer to Figure 6-8.
The optional dual strainer consists of two strainers in an integral unit interconnected by an internal three way valve to provide uninterrupted oil flow. The normal flow of oil is through the intake port, then through

THE FOLLOWING PAGES
ARE ADDED FROM THE C SERIES
MANUAL COVERING THE
NEWER
STYLE OIL FILTER
AND
OIL STRAINER

OPTIONAL DUAL OIL FILTER

Refer to Figures 5-4 and 5-5. In 1983, Sullair changed suppliers of dual filters. Changing of the filter element, or cartridge, is dependent on the type of filter installed on the package.

The newer dual filter is shown in Figure 5-4. It is a self-contained unit with an internal valve to provide uninterrupted oil flow.

Provided the ambient temperature is below the normal oil temperature, the operating oil filter is warmer to the touch than the standby filter.

To direct the flow from the operating filter to the standby filter, press the valve handle lock and turn the filter handle 180° clockwise or counterclockwise. The filter handle will snap into position in front of the filter being used.

The standby filter element may be replaced (as in Section 7.4) with the compressor running.

Figure 5-4 Dual Oil Filter - New Style

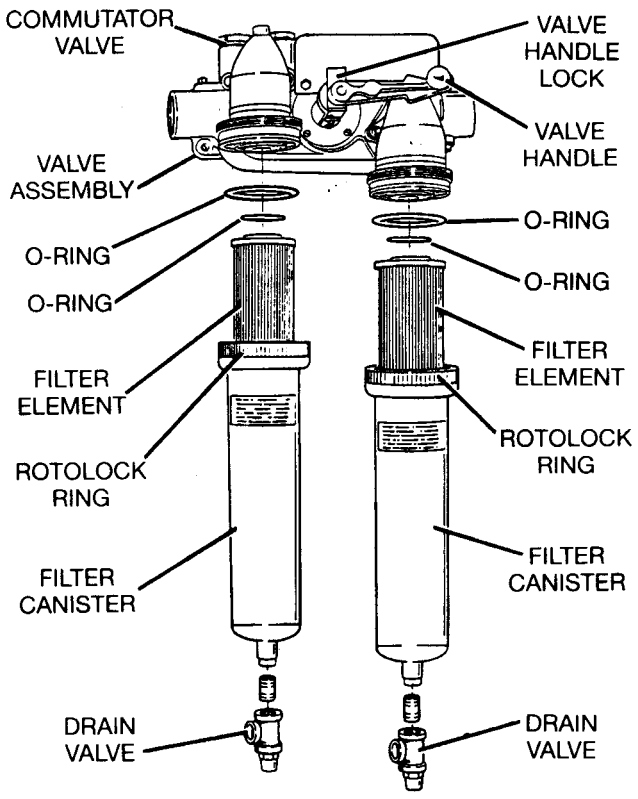
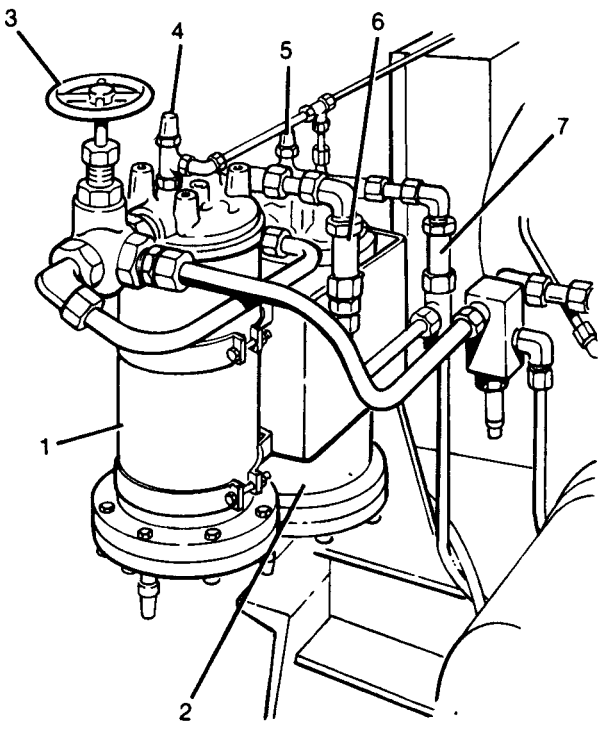


Figure 5-5 Dual Oil Filter - Old Style



The older style dual filter arrangement is shown in Figure 5-5 and consists of 2 (two) single unit (1&2) with a 3-way valve (3) to provide uninterrupted oil flow.

Provided the ambient temperature is below the normal oil temperature, the operating oil filter is warmer to the touch than the standby filter.

To direct the flow from the operating filter to the standby filter, turn the 3-way valve handle (3) slowly fully clockwise or fully counterclockwise.

Close the valve (4 or 5) to the oil pressure gauge and open the other valve (4 or 5).

The standby filter cartridge may be replaced (as in Section 7.4) with the compressor running provided the check valves (6&7) are in good condition.

See Section 7.4 (Oil Filter Element or Cartridge Replacement).

5.12 OPTIONAL DUAL OIL STRAINER

Refer to Figures 7-12 and 7-13. The optional dual strainer consists of two strainers in an integral unit interconnected by an internal 3-way valve to provide uninterrupted oil flow. The normal flow of oil is through the intake port, then through the upper port of the valve, through the inside of the strainer where all extraneous matter is trapped, through the bottom port of the valve and finally through the discharge port of the unit. To direct the flow from one strainer to the other, swing the valve handle to either of its extreme positions. The strainer in use is shown by the indicator which is cast as an integral part of the handle and which partially covers the strainer in use. The opposite chamber can then be opened and the strainer removed for cleaning. It is not necessary to drain the strainer chamber in order to remove the basket.

The dual strainers have tapered valve plugs which are adjusted at the factory. In operation, one side of the valve is exposed to the pressure developed on the chamber in use and the other side is exposed to a lower pressure. With the valve prop-

erly adjusted, there will be little, if any, equalization of pressure through the valve, and consequently, the pressure on one side will tend to press the tapered plug against the low pressure side. If the pressure is great enough, this pressure causes the valve to operate stiffly. To remedy this condition, a bypass line and stop valve are provided.

When it is desired to shift operation from one strainer to the other, open the valve in the bypass line so that the pressure in both chambers is equalized. Then swing the valve with the handle toward the strainer to be put in operation. The handle will move easily when the pressure is equalized.

⚠ WARNING

NEVER try to force the valve plug assembly through its cycle of operation. It should always move freely without extra leverage in addition to the valve handle.

Each valve plug is individually lapped on the valve seat to produce a leakproof fit. Therefore, never put any pressure on the top of the valve plug assembly as this could force the tapered plug more firmly onto its seat and damage the seat faces.

Refer to Section 7.11 to clean the strainers. Should the valve plug be jammed even after pressure equalization described above, refer to Section 7.11.

the upper port of the valve, through the inside of the strainer where all extraneous matter is trapped, through the bottom port of the valve and finally through the discharge port of the unit. To direct the flow from one strainer to the other, swing the valve handle to either of its extreme positions. The strainer in use is shown by the indicator which is cast as an integral part of the handle and which partially covers the strainer in use. The opposite chamber can then be opened and the strainer removed for cleaning. It is not necessary to drain the strainer chamber in order to remove the basket.

The dual strainers have tapered valve plugs which are adjusted at the factory. In operation, one side of the valve is exposed to the pressure developed on the chamber in use and the other side is exposed to a lower pressure. With the valve properly adjusted, there will be little, if any, equalization of pressure through the valve and consequently the pressure on one side will tend to press the tapered plug against the low pressure side. If the pressure is great enough this pressure causes the valve to operate stiffly. To remedy this condition, a by-pass line and stop valve are provided.

When it is desired to shift operation from one strainer to the other, open the valve in the by-pass line so that the pressure in both chambers is equalized. Then swing the valve with the handle toward the strainer to be put in operation. The handle will move easily when the pressure is equalized.

IMPORTANT

Never try to force the valve plug assembly through its cycle of operation. It should always move freely without extra leverage in addition to the valve handle.

Each valve plug is individually lapped on the valve seat to produce a leakproof fit. Therefore, never put any pressure on the top of the valve plug assembly as this could force the tapered plug more firmly onto its seat and damage the seat faces.

Refer to Section 6.9 to clean the strainers. Should the valve plug be jammed even after pressure equalization described above refer to Figure 6.14.

4.12 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 reducing high stage capacity slowly. 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.

4.13 ELECTRIC MOTOR

After the compressor has run for twenty minutes, check the motor bearings for temperature and noise. If high temperatures exist, remove the bearing relief plug and run for a further ten minutes. If excessively greased the excess will run out of the open relief plug. If the bearings are noisy, recheck the coupling alignment. Should these problems persist, consult the electric motor manual or contact Sullair Refrigeration.

4.14 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.

4.15 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).

Check the compressor shaft seal for excessive leakage of more than 10 drops per minute. If excessive, replace the seal as in Section 6.5.

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.

Section 4
OPERATION

Customer_____ Contractor_____

_____ _____

_____ _____

Persons Contacted_____ Persons Contacted_____

_____ _____

Phone_____ Phone_____

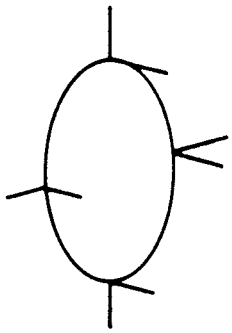
Telex _____ Telex _____

Identification (Section 2.2)

Package Model No._____ Package Serial No._____

Compressor Serial No._____ Wiring Diagram No._____

Oil Cooling: Liquid Injection/Water/DX



Coupling Alignment (Section 3.10)

TIR Concentricity_____in/mm
TIR Angularity_____in/mm
Coupling Spacing_____in/mm

Protective Switch Settings (Section 2.3)

Anti Recycle Timer_____min.

Low Oil Pressure 40 PSI/276 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

Control Switch Settings

Discharge Pressure: Cut In _____ PSIG/IN HG/kPag Cut Out_____PSIG/in HG/kPag

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. Auto Restart, 5TR_____min.

Sequencing Delay, 6TR _____min. Start Up Oil Pump Shutdown, 7TR_____min.

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

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_____%

E.V.A. Degrees of Butterfly Valve Travel from Maximum to Minimum_____

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.

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 (e.g. 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

TABLE 10
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 (at Manifold)	Po	PSIG/kPag						
Oil Temperature (at Manifold)	To	°F/°C						
Oil Pressure Minus Discharge Pressure	Po-Pd	PSI/kPa						
Oil Pressure (at Filter Inlet)	Pf	PSIG/kPag						
Oil Filter Pressure Drop	Pf-Po	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						

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 10.

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.

WARNING

Do not remove caps, plugs, or other components when compressor is running or pressurized.

Stop compressor and relieve all internal pressure before doing so.

IMPORTANT

Used or filtered oil should never be added to a refrigeration screw compressor under any circumstance. Use only new oil (as in Section 2.4) 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 suction strainer.

If the addition of oil becomes too frequent, a problem may have developed causing this excessive loss. See troubleshooting (Section 5.7) 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 cams.
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 coupling alignment.
10. Check low oil pressure protective switch.
11. Check high oil temperature protective switch.
12. Check high discharge temperature protective switch.
13. Restart and check all operating temperatures and pressures.

5.4 PROTECTIVE CONTROLS

The operation of all protective controls should be checked at least monthly (as in Section 3.15) as a protective switch failure can result in an expensive repair. It is especially important to regularly check the low oil pressure protective circuit for fusing of the switch or delay timer (1TR) contacts or failure of the delay timer coil. Carry out the following two checks after disconnecting the motor power supply but with power supplied to the control panel:

1. Simulate a start by pushing the start button to energize the main control relay 4CR. After ten seconds the delay timer 1TR will time out, de-energizing the main control relay and causing the low oil pressure circuit to light up the pilot light on the control panel.
2. Manually trip the low oil pressure switch and again simulate a start as in No. 1 above. After ten seconds the pilot light should not come on. Remove the manual trip and the pilot light will immediately light up. Note that the low oil pressure switch oil pressure differential 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.

5.5 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.

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 oil 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 2.4 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 a laboratory to perform the oil analysis. Sullair Refrigeration will submit an evaluation of the analysis to you.

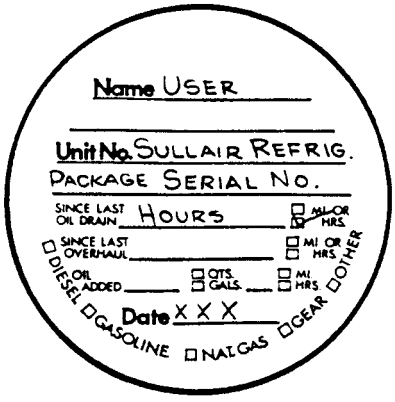
Included in the oil analysis kit from Sullair Refrigeration is:

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. Four oil sample bottles.
5. Three oil sample mailers (shipping boxes).

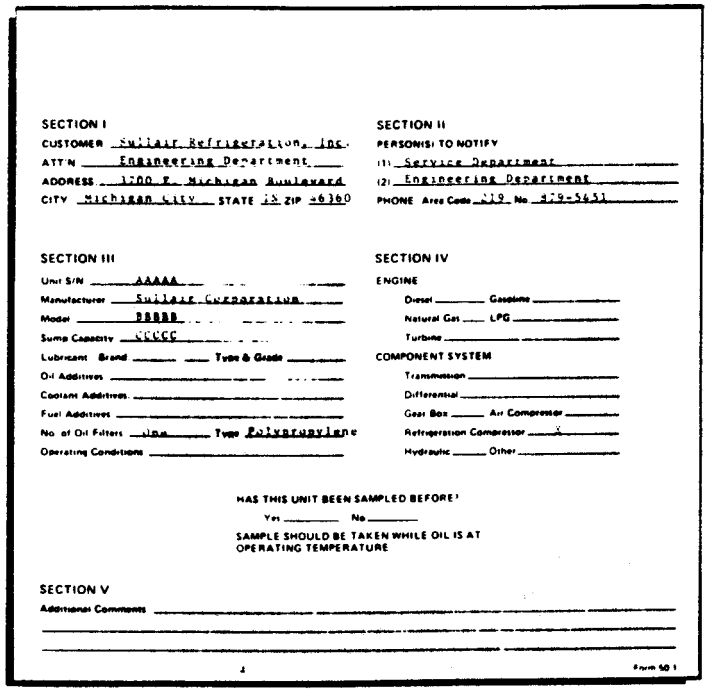
INSTRUCTIONS FOR SULLAIR'S OIL ANALYSIS SERVICE

1. Oil samples are to be drawn from the oil drain valve on the oil separator sump while the oil is warm.

Figure 5-1 Oil Sample Bottle Cap and Compressor Identification Record



OIL SAMPLE BOTTLE CAP


SECTION I
CUSTOMER Sullair Refrigeration, Inc.
ATT'N Engineering Department
ADDRESS 1700 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 Polyvarsylene
Operating Conditions ____

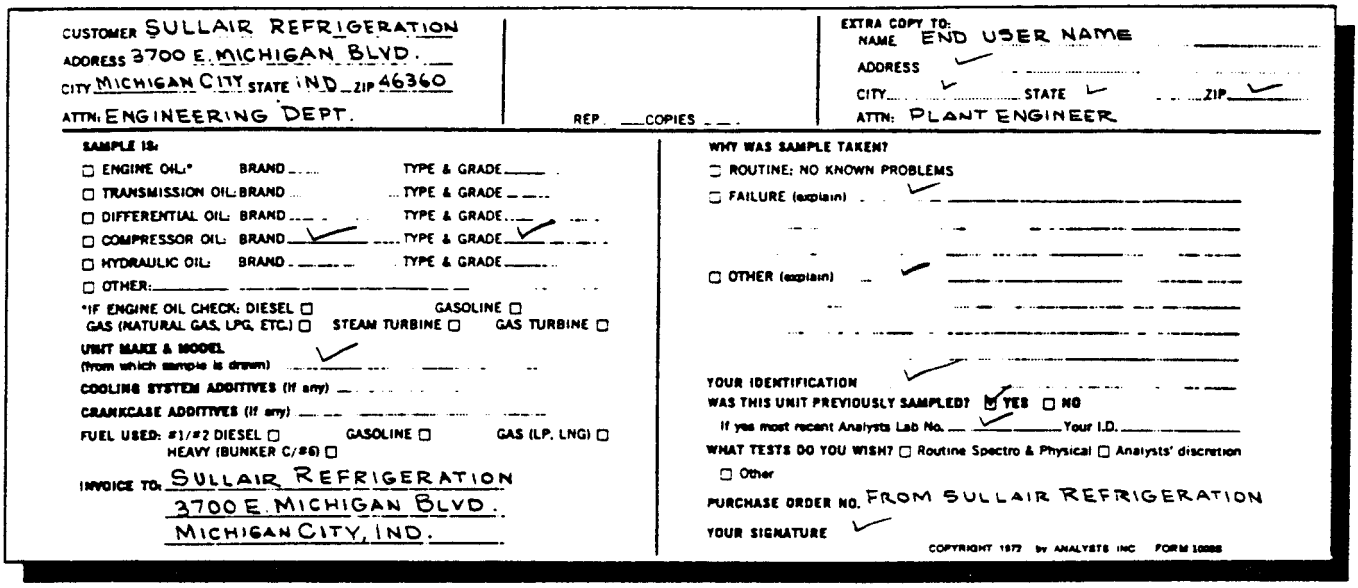
SECTION IV
ENGINE
Diesel ____ Gasoline ____
Natural Gas ____ LPG ____
Turbine ____
COMPONENT SYSTEM
Transmission ____
Differential ____
Gear Box ____ Air Compressor ____
Refrigeration Compressor X
Hydraulic ____ Other ____

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

SECTION V
Additional Comments ____

COMPRESSOR IDENTIFICATION RECORD

Figure 5-2 Oil Sample Data Sheet



CUSTOMER SULLAIR REFRIGERATION
ADDRESS 3700 E. MICHIGAN BLVD.
CITY MICHIGAN CITY STATE IND ZIP 46360
ATTN: ENGINEERING DEPT.
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 Analysis Lab No. Your I.D.
WHAT TESTS DO YOU WISH? ☐ Routine Spectro & Physical ☐ Analysts' discretion
☐ Other
PURCHASE ORDER NO. FROM SULLAIR REFRIGERATION
YOUR SIGNATURE
COPYRIGHT 1972 by ANALYSTS INC FORM 1000S

Some oil should be allowed to flow to a waste container before the sample bottle is filled to ensure a representative sampling.
2. 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.
3. Fill out the "Compressor Identification Record" (Form 50-1) as in Figure 5-1. Do not remove the backing paper from this tag.
4. Fill out one of the "Oil Sample Data Sheet"s (Form 1000S) as in figure 5-2.
5. 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.
6. 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.
7. 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.

8. Draw the *second* oil sample at 1000 hours of compressor operation.
9. The 1000 hour sample should be accompanied by a filled out Oil Sample Data Sheet and again mailed first class directly to the laboratory for prompt analysis.
10. 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 our designated lab, 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.

5.6 MAINTENANCE SCHEDULE

Table 11 is intended as a minimum maintenance schedule. Abnormal conditions may require more frequent action as determined by your daily log readings. (See Table 10). The yearly maintenance jobs should ideally be carried out before the start of the annual season.

TABLE 11
MAINTENANCE SCHEDULE

	OPERATION	SCHEDULING TIME PERIOD
1.	Check all operating indicators per 2.3 operating limits and switch settings.	
	Net Oil Pressure (Equals oil pressure gauge reading minus discharge 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 2.3 operating limits and switch settings, 3.14 electrical check and 3.15 protective switch check.	
	Low Oil Pressure Protective Switch	Monthly
	High Oil Temperature Protective Switch	Monthly
	High Discharge Temperature 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 5.5 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 30 PSI (206 kPa) or is less than 4 PSI (28 kPa)
	Clean Oil Strainers	Whenever oil is changed. (A good practice would be, anytime the machine is shut down or once a month to check for metal, etc., in the system).
4.	General Maintenance	
	Check Noise Level	Daily
	Check Capacity Control Actuator Cam Settings	Monthly
	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
	Check Coupling Alignment and Tighten Coupling Bolts	Yearly
	Tighten Motor and Compressor Mounting Bolts	Yearly

5.7 TROUBLESHOOTING

The information contained in the troubleshooting chart, Table 12, 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.

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, Table 12.

Should your problem persist after making these checks, contact the Sullair Refrigeration 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. Check all panel lights to assure they function. B. Recycle timer activated. Wait for timer to time out. C. No power supply to control circuit. Check power supply. D. Minimum position cam slipped. Readjust per Section 3.16 and tighten set screw. E. Minimum position micro switch on EVA defective. Replace. F. Auxiliary oil pump defective. Check motor is running in correct direction. Repair. G. Plugged oil strainer in auxiliary oil pump suction line. Clean. H. Start-up oil pressure switch out of adjustment or defective. Adjust or repair. I. High discharge (intermediate) pressure above low discharge pressure switch (LDP) "cut-in" setting. Lower suction pressure on high stage receivers. Check high stage compressors. Raise setting on LDP switch. J. High discharge (intemediate) pressure below low discharge pressure switch (LDP) "cut-in" setting. Motor torque insufficient to overcome pressure difference. Lower LDP switch "cut-in" setting 5 PSIG (34 kPag).
2. Compressor shuts down immediately after starting	A. Low oil pressure. See Symptom "3". B. The check valve after oil pump leaks excessively, allowing oil to drain from filter when compressor stops. The compressor oil pump cannot replace drained oil and build up pressure quickly enough before the low oil pressure protective switch stops the compressor. Replace check valve. C. High discharge pressure. Open discharge stop valves and check high stage compressors. D. Low suction pressure. Open suction valves. Check capacity control to see if it unloads automatically. E. High oil or discharge temperature. See Symptom "6" and Symptom "7".
3. Low oil pressure	A. Oil pressure relief valve and/or 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. Broken oil pump shear pin. This is indicated by zero oil pressure. Replace. F. Worn oil pump. Replace.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
3. Low oil pressure (continued)	G. In minimum position, discharge pressure too low for oil circulation. Check capacity control EVA motor shaft position from maximum to minimum and reset cams as in Section 3.16. H. 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 Symptom "11" items F to M. I. Water in oil. Change or install filter drier. J. 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 relief valve and/or oil pressure regulating valve out of adjustment or defective. Adjust or replace. B. Oil temperature too low. See Symptom "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 Symptom "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 Symptom "11". E. Oil in liquid refrigerant supply. Drain oil from liquid receiver. Check oil carryover from compressors. See Symptom "12".
7. High discharge temperature (water only)	A. High oil temperature. See Symptom "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.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
8. Low suction pressure	A. Excessive suction line pressure drop. Check system valves open. Clean suction strainer. B. Capacity control not modulating. See Symptom "10". C. Refrigerant charge low. Add refrigerant. D. Evaporators starving of refrigerant. Plugged liquid feed strainers. Clean.
9. High suction pressure	A. Additional refrigeration load added. Check heat loads. B. Capacity control not modulating. See Symptom "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 per Section 4.7 or replace. B. Timer 3TR out of adjustment or defective. Adjust per Section 4.7 or replace. C. Capacity control actuator out of adjustment. Adjust per Section 3.16. D. 5 amp fuse defective. Replace. E. No power at wire 40.1TRA contact on line 23 open. Relay 1TRA or timer 1TR faulty. Replace. Refer to Figures 1-17 through 1-20. F. One or both EVA motor(s) defective. Replace motor module(s). G. Capacity control EVA gears jammed or defective. Replace. H. Capacitor for capacity control EVA motors defective. Replace. I. Cam slipped. Reset per Section 3.16 and tighten set screw. J. Micro switch defective. 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 Symptom "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.

TROUBLESHOOTING

SYMPTOM	*PROBABLE CAUSE AND REMEDY*
11. Erratic oil temperature (liquid injection cooled only) (continued)	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 per 6.17 and Sullair Refrigeration. M. Sliding disc upside down in valve. Turn 180°. N. Low discharge temperature switch controlling discharge temperature instead of regulating valve. Adjust per section 4.6 (b).
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 elements 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 excess oil. 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 (41°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 with results. D. Any other persistant vibration or noise, contact Sullair Refrigeration.

5.8 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 (e.g. desiccant such as silica gel) inside the control panel and the electric valve actuator. 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 4.3 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. Two gallons (eight 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 B 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 surrounds 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 (e.g. 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

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 12. All fasteners (e.g., 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 (e.g., 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, e.g. grade 2 bolts have no slashes, Grade 5 bolts have three slashes and Grade 8 bolts have six slashes per Table 12. 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 30 PSI (200 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 (1) from the bottom plate on the filter body.
4. Remove the large center cap nut (2) and fiber washer (3).
5. Remove the bottom plate (4).
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.

INSTALLATION

IMPORTANT

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

TABLE 12
TIGHTENING TORQUES FOR THREADED BOLTS

Fastener Diameter inch	Pitch Thread inch	Tightening torques: Lbf ft in top line, N.m in bottom line — Grade 2 ** *Condition A	B	C	D	E	Grade 5 ** *Condition A	B	C	D	E	Grade 8 ** *Condition 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.

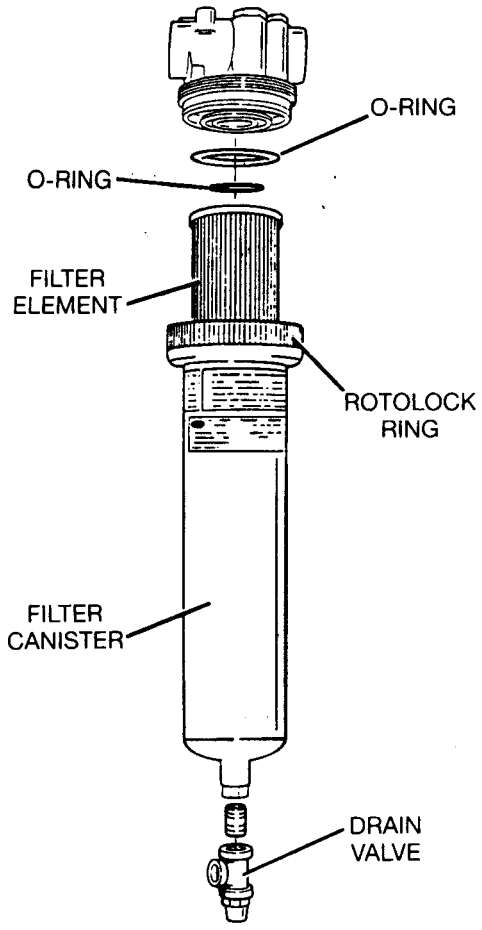
C) Lubricated with oil or grease.

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

E) Lubricated with loctite or sealants.

THE FOLLOWING PAGES
ARE ADDED FROM THE C SERIES
MANUAL COVERING THE
NEWER
STYLE OIL FILTER
AND

Figure 7-1 Oil Filter - New Style



replaced with a new filter cartridge or element. If the oil pressure drop is less than 4 PSID (28kPa), the filter may be defective and should be replaced immediately. In recent years, Sullair has used a new filter. If the filter needs to be replaced, locate the figure which represents the filter mounted on your package (refer to Figures 7-1 through 7-4).

SINGLE FILTER - NEW STYLE
Refer to Figure 7-1.

REMOVAL
1. Carry out the shutdown procedure Section 7.2.
2. Open the drain valve on the bottom of the filter to drain the filter oil and reduce pressure to atmospheric.
3. Loosen the filter canister by turning the rotolock ring. This can normally be turned by hand when the pressure inside the filter has been reduced to atmospheric pressure.
4. As the rotolock ring is turned, it will pry off the filter canister and the ejection spring will loosen the filter element.
5. Discard filter element and clean the filter canister.

INSTALLATION

NOTE

Ensure that the replacement element is Sullair P/N 250008-955 and is labeled.

1. Replace large o-ring.
2. Assemble the filter element into the filter canister with opening in filter element up. Make sure small o-ring is installed properly in the filter element.
3. Set assembly up to the filter manifold and make sure that filter element pushes ejector ring up as rotolock ring is tightened. Hand-tighten rotolock ring only.
4. Pump one (1) gallon (4 liters) of oil through the oil drain valve into the oil filter to replenish the filter chamber.
5. Shut the oil drain valve.
6. Open the compressor suction and discharge stop valves.
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 115V supply line.
10. Reconnect the starter to the electrical supply line.
11. Start the compressor.

SINGLE FILTER - OLD STYLE
Refer to Figure 7-2.

REMOVAL
1. Carry out the shut down procedure in Section 7.2.
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).

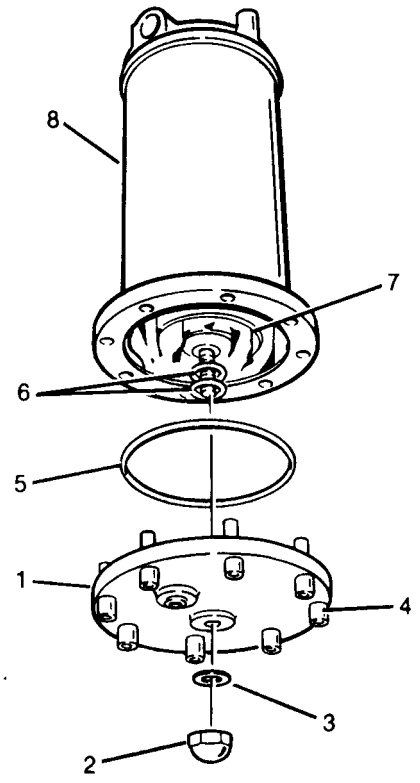
INSTALLATION

NOTE

Ensure that the replacement cartridge, Sullair P/N 042712, is labeled AF-450D-Y15.

1. The new 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 up into the filter body (8) with the central open tube (containing a trian-

Figure 7-2 Oil Filter - Old Style



gular support) inserted first. Push the cartridge frame (7) firmly up into the filter head 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 the new o-ring (5) on the groove in the bottom of the filter body, after smearing it with grease to keep it in place.
4. Place the bottom plate (1) on the filter bolt.
5. Install the hex socket screws (4) and tighten them evenly to 100 lb_fft. (135Nm).
6. Mount the fiber washer (3) on the filter bolt.
7. Install the large center cap nut (2) on the filter bolt and tighten it to 50 lb_fft. (70Nm).
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(s).
13. If the compressor is fitted with a Sullistage port, open the Sullistage stop valve.
14. Reconnect the control panel to the 115V supply line.
15. Reconnect the starter to the electric supply line.
16. Start the compressor.
17. After the compressor has run long enough for the oil to reach its normal operating temperature, adjust the oil pressure if necessary as explained in Section 5.5.

DUAL FILTER - OLD STYLE (OPTIONAL)
Refer to Figure 7-3.

The old style dual filter arrangement consists of two (2) filter housings, two (2) check valves and a 3-way valve.

The dirty filter element can be changed while the compressor is running.

⚠ CAUTION

Proceed carefully when opening filter while compressor is pressurized in the event the check valves or 3-way valve leak.

1. Rotate the 3-way valve so oil is flowing through the clean filter.
2. Remove and replace the filter cartridge as above for the single filter.

Figure 7-3 Dual Filter - Old Style

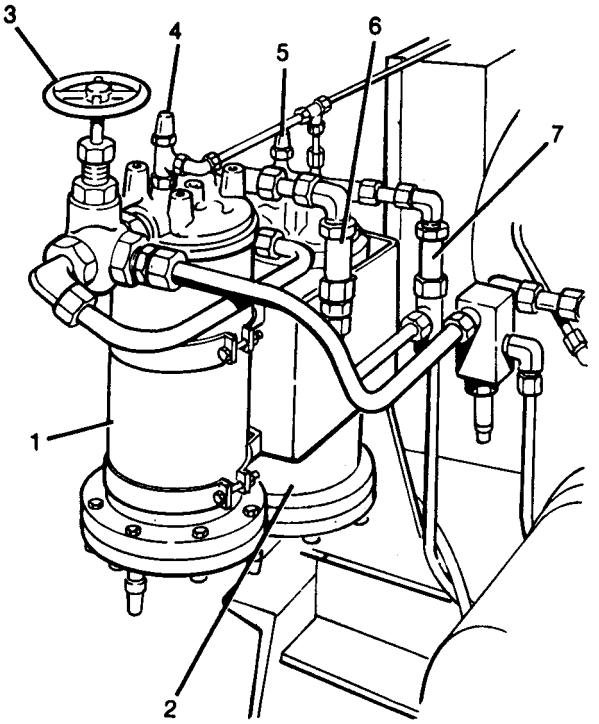
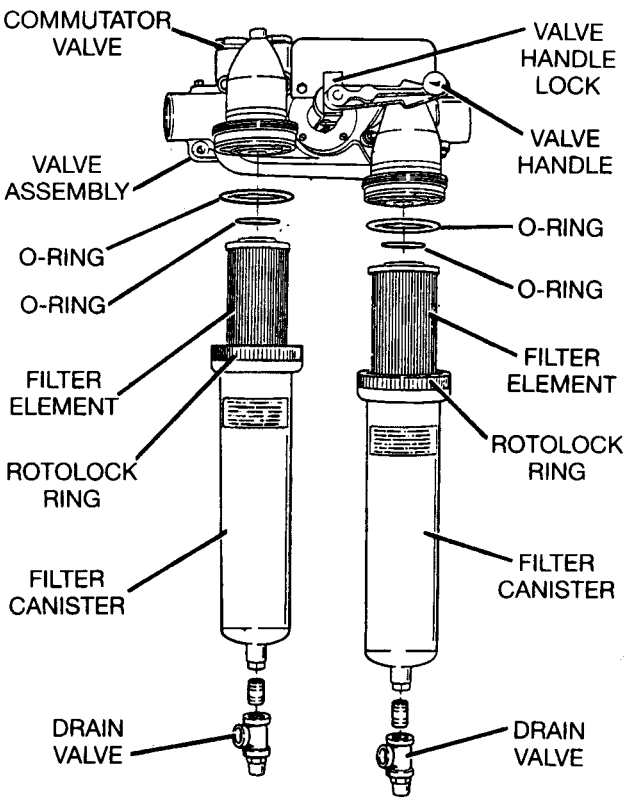


Figure 7-4 Dual Filter - New Style



DUAL FILTER - NEW STYLE (Optional)
Refer to Figure 7-4. If your compressor is equipped with the optional dual filter, the filter canister can be replaced while the compressor is running.

⚠ CAUTION

As compressor is pressurized, all steps must be performed with extreme caution in the event of leakage around the filter seals, and the resultant possibility of high pressure gas being present.

REMOVAL
1. Make sure commutator valve is open.
2. Slowly rotate valve handle to point to clean filter.
3. Close commutator valve.
4. Open the drain valve on the bottom of the dirty filter to drain the oil and reduce canister pressure to atmospheric.
5. Loosen the filter canister by turning the rotolock ring. This can normally be turned by hand when the pressure inside the filter has been reduced to atmospheric pressure.
6. As the rotolock is turned, it will pry off the filter canister and the ejector spring will loosen the filter element.
7. Discard the filter element and clean the filter canister.

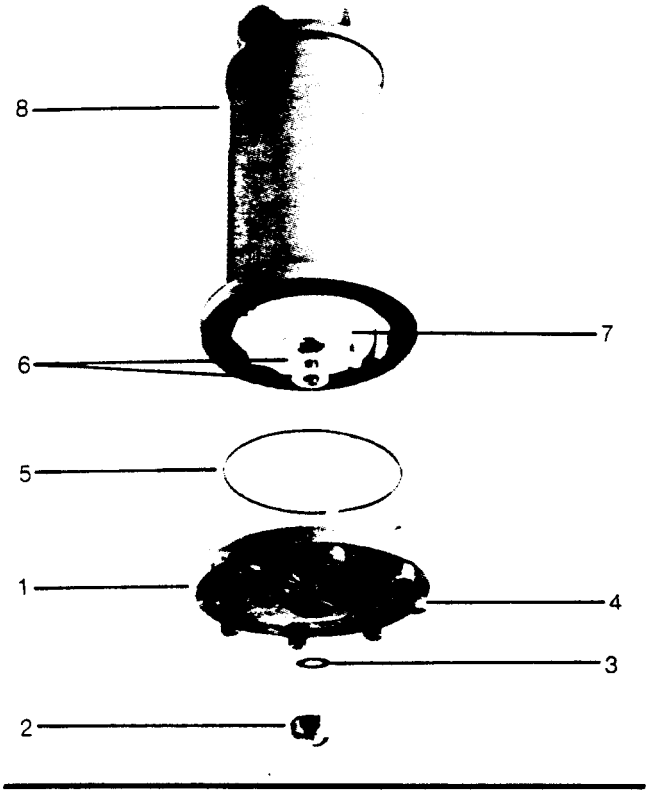
INSTALLATION

NOTE

Make sure that the replacement element is Sullair P/N 250008-955 and is labeled.

1. Replace large o-ring.
2. Assemble the filter element into the filter canister with opening in the filter element up. Make sure that the small o-ring is installed properly in the filter element.
3. Set the assembly up to the filter manifold and make sure that the filter element pushes the ejector ring up as the rotolock ring is tightened. Hand tighten the rotolock ring only.
4. Close the oil drain valve.
5. Slowly open the commutator valve to allow clean oil into the filter.

Figure 6-1 Oil Filter Cartridge Replacement



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 up into the filter body (8) with the central open tube (containing a triangular support) inserted first. Push the cartridge frame (7) firmly up into the filter head 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) on the groove in the bottom of the filter body, after smearing it with grease to keep it in place.
4. Place the bottom plate (1) on the filter body.
5. Install the hex socket screws (4) and tighten them evenly to 100 lb-ft (135 N.m).
6. Mount the fiber washer (3) on the filter body.
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 litres) 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.
17. After the compressor has run long enough for the oil to reach it's normal operating temperature, adjust the oil pressure if necessary as explained in Section 4.5.

6.5 SHAFT SEAL REPLACEMENT

The "B" Series Compressors are manufactured with either a single seal or a double seal. Contact Sullair Refrigeration with the package serial number, package model number, and compressor serial number to assure the proper shaft seal replacement kit is obtained.

6.6 SINGLE SEAL REPLACEMENT

Refer to Figure 6-2 and the shaft seal replacement instructions received with the shaft seal replacement kit.

REMOVAL (General)
1. Carry out the shutdown procedure in Section 6.2.
2. Remove the coupling guard, coupling spacer and coupling hub from the compressor shaft as in Section 6.10.
3. Disconnect the oil supply line from the shaft seal cover.
4. Loosen evenly the four bolts (12) between the shaft seal housing (11) and the inlet housing.
5. Remove the shaft seal housing (11). The sealant under the flange can be broken by prying underneath the housing flange with a screw driver.
6. Remove the seal (9) from the shaft. The neoprene seal (3) may be bonded to the shaft and will have to be broken loose by pushing the whole seal (9) further down the shaft. If tools are used take care not to scratch or damage the shaft. When the bond is broken the seal can be removed easily.
7. Remove the seat (7) from the shaft seal housing (11) by first removing the snap ring (8). Lay the machined edge of the shaft seal housing on a flat surface and push the seat (7) out of the shaft seal housing (11) by tapping on the exposed part of the seat (7) with a punch.

PREPARATION
1. Check the shaft for any burrs or sharp edges which could cut the seal when it is later slid over the shaft. Remove all burrs and break all sharp edges.

IMPORTANT

Be careful not to let any material get into the bearing area.

2. Inspect and clean the shaft where the seal is going to be mounted especially in the vicinity of the neoprene seal (3). Remove old carbon deposits with a light solvent (such as mineral or methylated spirits).
3. Clean all parts thoroughly. Wipe off any foreign material and use a light solvent to remove old carbon deposits.
4. Make sure the oil supply orifices in the shaft seal housing (11) are open and the threads are clean.
5. Oil the shaft and the inside of the neoprene seal (3) with clean refrigeration oil.

6. Check that the carbon face (1) is absolutely clean with no surface scratches.

INSTALLATION
1. Inspect the new seat (7) for any surface imperfections.
2. Check the bore of the seal cover for any burrs or nicks.

IMPORTANT

Always install a new seat (7) with a new seal assembly (9).

3. Install a new O ring (6) on the seat (7).
4. Oil the O ring (6) and the lapped surface with clean refrigeration oil.
5. Install the seat (7) into the bore of the seal housing (11) with the lapped surface facing the inside of the compressor. Make sure the seat (7) fits over pin (13).
6. Install the snap ring (8) using a pair of snap ring pliers.
7. Smear a film of Loctite 515 on the flange of the seal housing (11).
8. Install the seal (9) on the shaft until the tail section is past the shaft chamber.

IMPORTANT

The seal assembly must be started squarely over the shaft by hand force. If the seal assembly becomes locked on the shaft, remove and start again. Excessive force should not be necessary. Extreme caution must be exercised not to damage the lapped carbon surface and to keep it clean. Do not bend or tear the elastomers rings.

9. Mount the seal housing (11) over the shaft and line up the bolt holes. (There is only one correct position possible). Push the seal housing (11) squarely and slowly against the seal assembly (9) until the seal housing flange (11) contacts the inlet housing. Hold the housing in position with one hand, or an assistant, and tighten the bolts (12) diagonally and evenly to 80 lb-ft (108 Nm).

IMPORTANT

The seal housing must be held in position until the bolts are installed since releasing the seal housing may allow the spring force to push the neoprene seal out of position. If the neoprene seal grips the shaft while out of position, it will not allow the spring to exert the correct pressure between the lapped faces. This may result in seal failure within short period of time.

10. Connect the oil supply line to the shaft seal housing.
11. Pump one gallon (four liters) of oil into the oil filter to replenish the oil supply to the seal housing.
12. Turn the compressor shaft a few turns by hand.
13. Close the blowdown valve.
14. Open the suction stop valve slowly to pressurize the package.
15. Check to assure that the seal is not leaking.
16. Open the discharge stop valve.
17. If the compressor is liquid injection cooled, open the liquid injection stop valve.
18. Mount the coupling hub, coupling spacer and coupling guard (See Section 6.10).
19. Reconnect the control panel to the 115V supply line.
20. Reconnect the starter to the electric supply line.
21. Start the compressor.

6.7 OIL PUMP SERVICING

Refer to Figure 6-3 and the oil pump replacement instructions received with the oil pump replacement kit.

REMOVAL (GENERAL)
1. Carry out the shutdown procedure in Section 6.2.
2. Remove the connecting pipework on either side of the shaft driven oil pump (2).
3. Remove the shaft driven oil pump by removing the two bolts (8). The pump should come out with the drive hub (4) and connector (5) assembled.
4. If the shear pin (6) has broken, inspect the drive hub (4) and the connector (5) to determine if all the pieces of the shear pin are present.

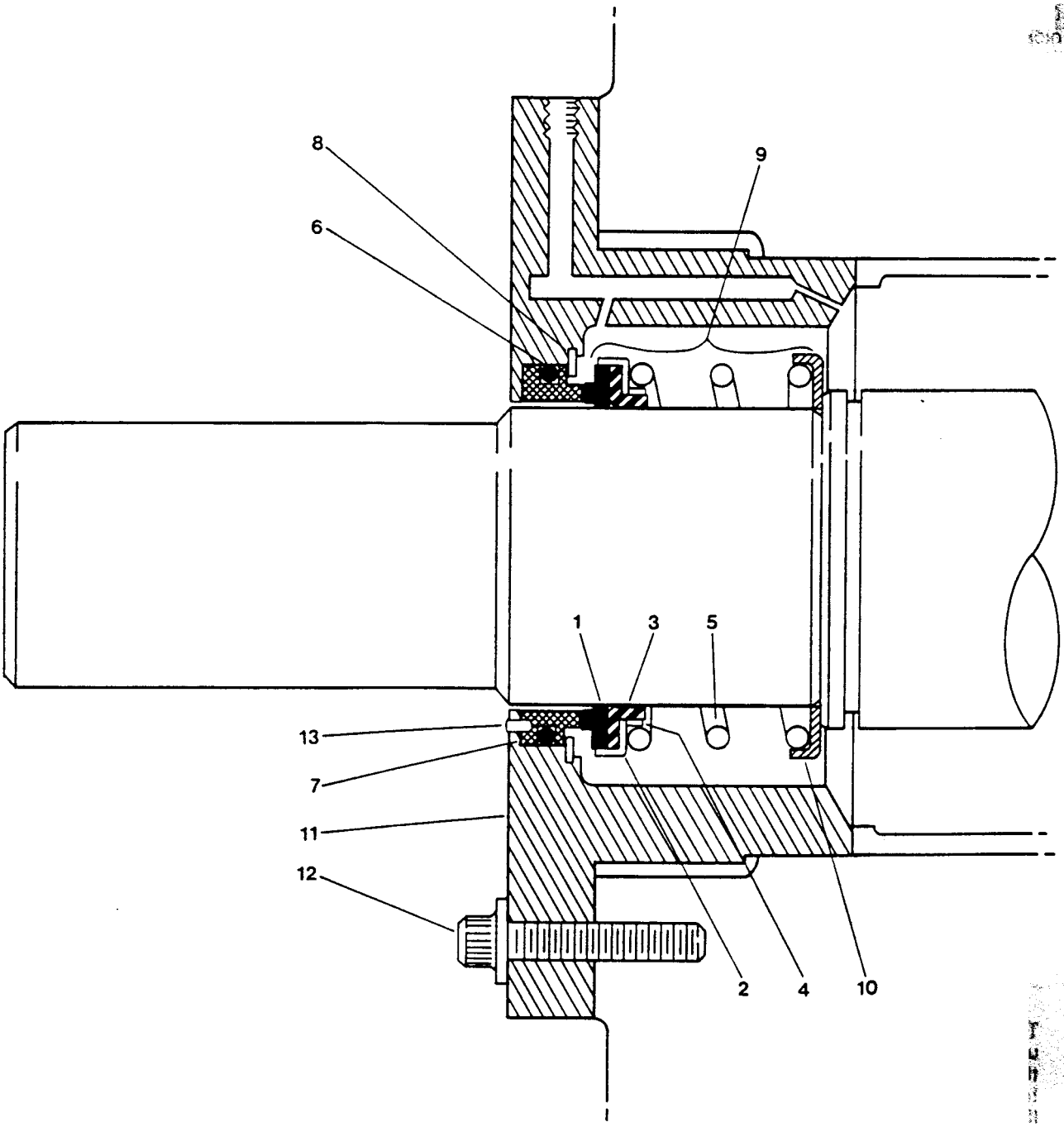
IMPORTANT

Missing pieces of the shear pin will require removal of the outlet cover from the compressor to recover the broken parts.

5. Use a suitable punch to remove an unbroken shear pin (6) from the drive hub (4) and connector (5).
6. Inspect the oil pump drive plate (1) on the end of the rotor to check that the dowel pin (7) is intact. If the dowel pin (7) is broken replace both the dowel pin and the oil pump drive plate (1).
7. Inspect all parts for wear and replace if necessary.

INSTALLATION (General)
1. Remove the screws from the seal housing on oil pump and remove the seal housing.
2. Pumps received with a seal must have the seal removed and replaced with a new seal Sullair Part No. 240146. Take care not to cut the shaft seal on the keyway.
3. Install the seal housing with screw lock adhesive Loctite 242 on the screws.
4. Install connector (5) to drive hub (4) using the shear pin (6).
5. Center punch drive hub (4) at shear pin hole on both ends to secure the shear pin (6).
6. Mount the drive hub (4) on the oil pump shaft near the end of the oil pump shaft. Use care to avoid interference. Do not tighten the drive hub set screws (3).
7. Assemble the oil pump (2) to the compressor adapter (10) without the O ring (9). Push fit by hand until firm to position the drive hub (4) on the oil pump (2) shaft.

Figure 6-2. General Configuration - Single Seal



8. Remove the oil pump (2) taking care not to move the drive hub (4) along the oil pump shaft.
9. Move the drive hub (4) 1/16 inch (1.6 mm) along the oil pump shaft towards the oil pump (2) and tighten the two drive hub set screws (3) to 9 lb-ft (12.2Nm). Check that there is a minimum gap of 1/32 inch (0.8mm) between the end of the oil pump (2) shaft and the connector (5).
10. Install new O ring (9) in the compressor adapter (10).
11. Install pump to compressor ensuring the connector (5) engaged dowel pin (7) properly.
12. Tighten bolts (8) evenly to 35 lb-ft (47Nm).
13. Reconnect the oil lines on either side of the oil pump (2).
14. Close the blowdown valve.
15. Open the suction stop valve and discharge stop valve.
16. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
17. Reconnect the control panel to the 115V supply line.
18. Reconnect the starter to the electric supply line.
19. Start the compressor.

6.8 LIQUID INJECTION REGULATING VALVE SERVICING

Refer to Section 6.17. The standard valve seat Cv sizes for the "B" Series valves are as follows:

MODEL	Cv
B20LB, All	.42
B25	.84
B32SB	.84
B32LB	.84

6.9 CAPACITY CONTROL BUTTERFLY VALVE SHAFT SEAL SERVICING

(General) Refer to Figure 6-4.
1. Carry out the shutdown procedure in Section 6.2.
2. Remove the four bolts, lockwashers and nuts (5) from actuator bracket (2) and actuator bracket plate (7) and remove the electric valve actuator (9) with actuator bracket attached.
3. Remove drive pin (4) from shaft coupling (3) and butterfly valve forward shaft (11) and remove shaft coupling (3).
4. Remove all bolts (not shown) from suction strainer flange to compressor.
5. Remove the butterfly valve asembly (8) from between suction strainer and compressor.

IMPORTANT

The butterfly valve assembly must be removed from compressor suction line before it can be serviced. Failure to do so will result in components falling into the compressor rotors.

6. Remove the four bolts and lockwashers (6) and the actuator bracket plate (7) from the butterfly valve assembly (8).
7. Remove the thrust washers (10) from the butterfly valve forward shaft (11).
8. Remove the butterfly valve retaining screw (12), the two bolts (13) and rear shaft retainer plate (14).
9. Remove the forward shaft (11), rear shaft (15), and butterfly valve plate (16).
10. Remove the four shafts seals (17).
11. Check the forward shaft (11), rear shaft (15) and their housings for any burrs or nicks, and repair as necessary.
12. Install four new shaft seals (17) with a light coating of grease.
13. Install forward shaft (11), butterfly valve plate (16), rear shaft (15), and retainer plate (14), with two bolts (13), the butterfly valve retaining screw (12) and new thrust washers (10).
14. Install the actuator bracket plate (7) with four bolts and lockwashers (6) to the butterfly valve assembly (8).
15. Remove the two body seals (18) and install two new body seals (18) with a light coating of grease.
16. Reinsert the butterfly valve assembly (8) into compressor suction line.

CAUTION

The word "inlet" is stamped on the machined surface of butterfly valve body. The "inlet" surface is to be directly against suction strainer flange face.

Use care to correctly align the assembly to prevent the butterfly valve plate (16) from binding as it is rotated through its full travel.

17. Install all bolts (not shown) into suction strainer flange and into compressor.
18. Install shaft coupling (3) onto butterfly valve shaft (11) using drive pin (3).
19. Install actuator bracket (2), with electric valve actuator (9) installed to actuator bracket plate (7) with four bolts, lockwashers and nuts (5).
20. Reverse the shutdown procedure in Section 6.2.

6.10 COUPLING SERVICING

The non lubricated flexible element shaft coupling requires no service other than alignment or replacement of the flexible elements.

Refer to Figures 6-6 and 6-7.

COUPLING REMOVAL
1. Carry out the shutdown procedure in section 6.2.
2. Remove the coupling guard.
3. Remove the coupling spacer (5) and flexible elements (4) by removing the nuts, bolts, and thin and thick washers. Note the orientation of the thick and thin washers with the bevel facing the element pads.
4. Tie a wire through one bolt hole of each element pad to retain the original orientation of each element in the pad and to ensure that each element pad contains the same number of elements.

REMOVAL OF HUB WITH TAPERLOCK BUSHING
1. Mark the hub, bushing and shaft with a felt pen to give the correct angular orientation for reassembly.
2. Remove all the screws from the hub.

Figure 6-3 General Configuration - Shaft Driven Oil Pump

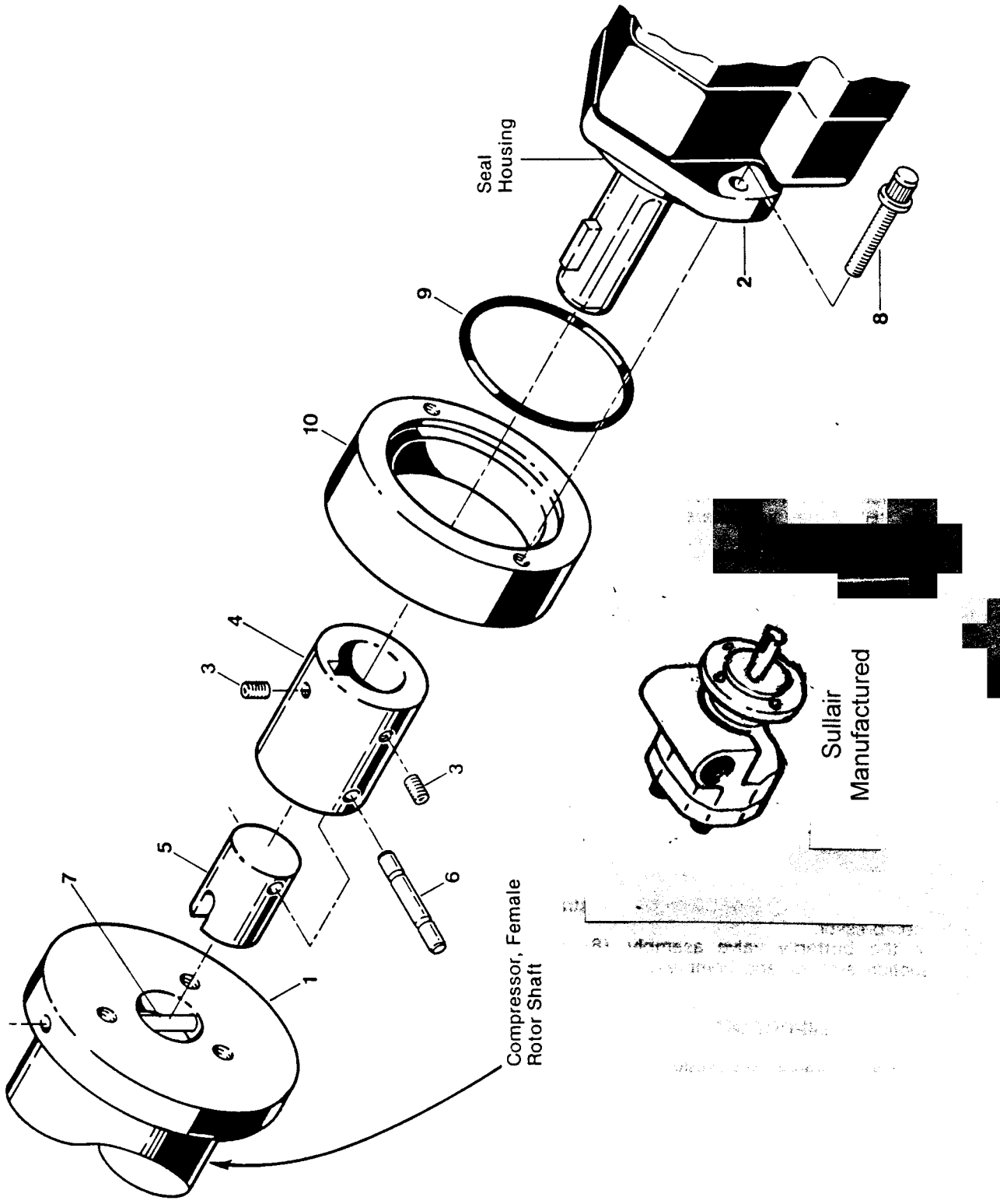
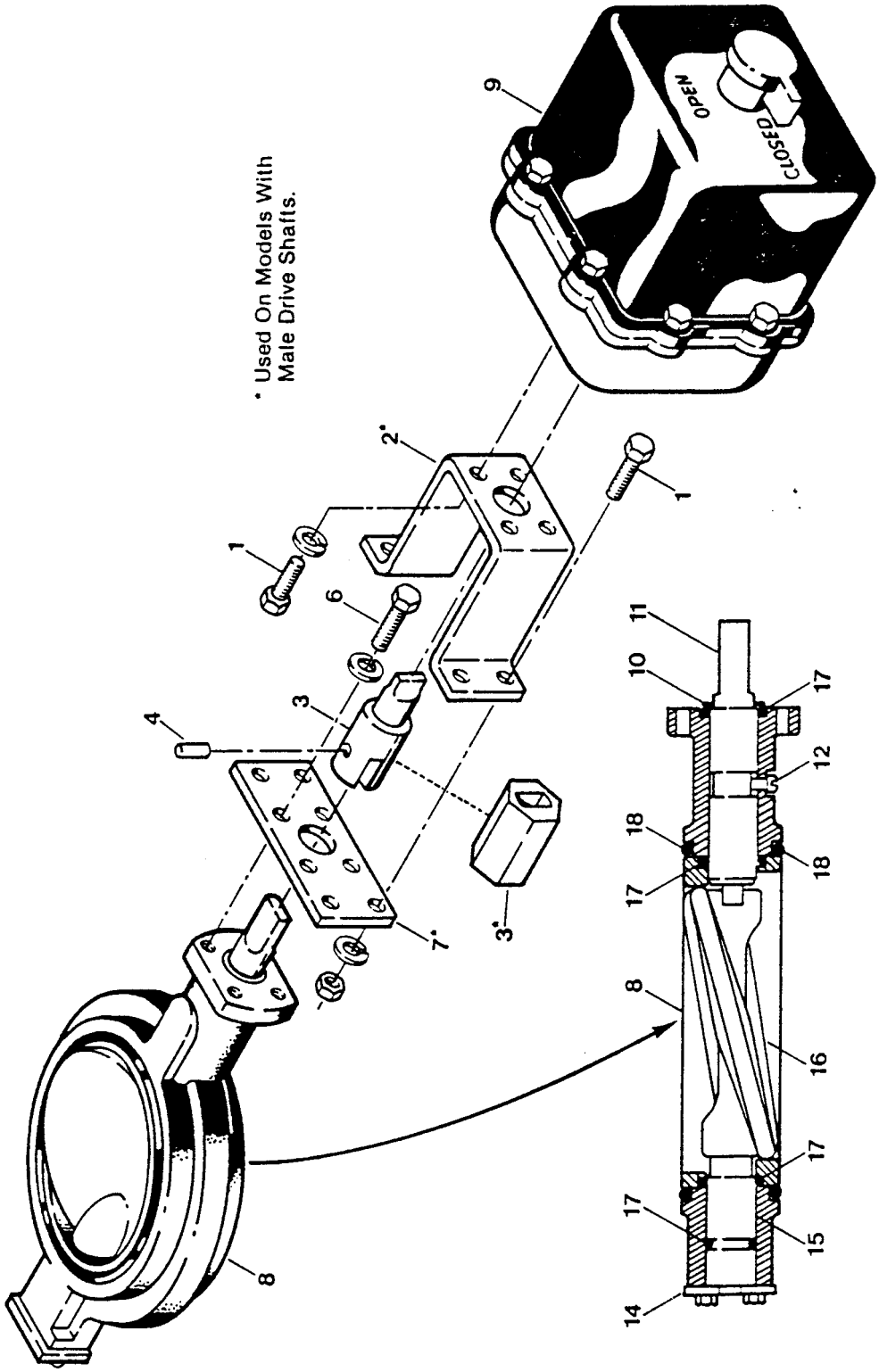
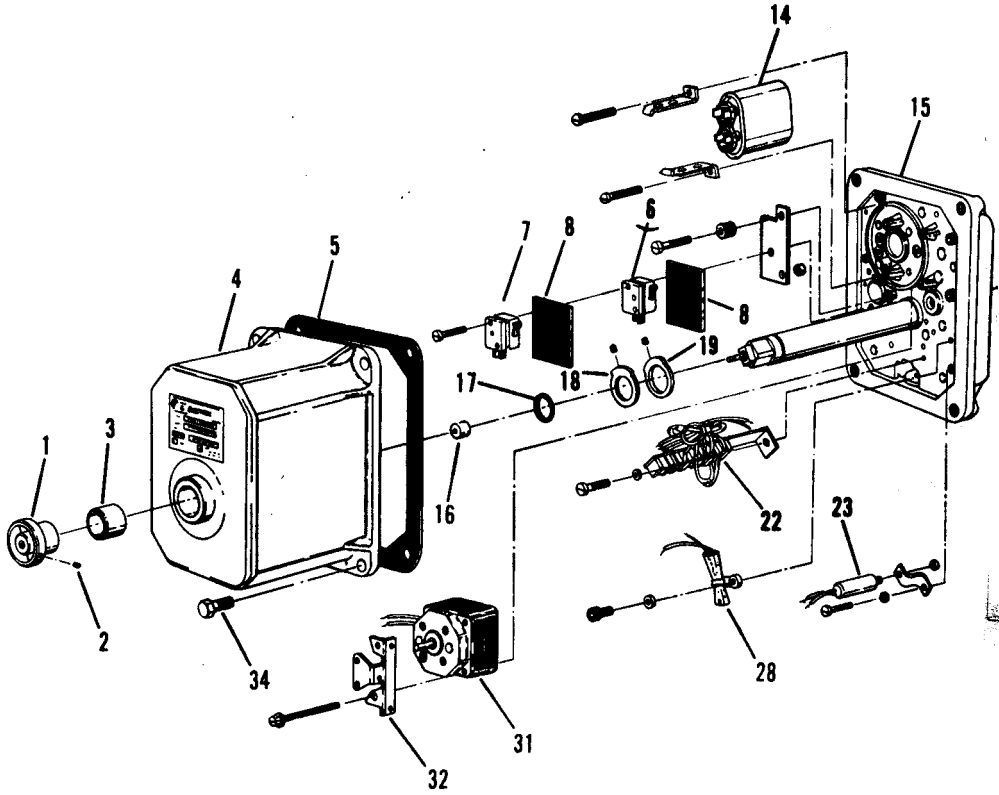


Figure 6-4 Capacity Control Butterfly Valve and Electric Valve Acutator



THE FOLOWING
PAGES ARE FOR THE NEWER STYLE
ACTUATOR
P/N 045630-002

Figure 6-8 Electric Valve Actuator



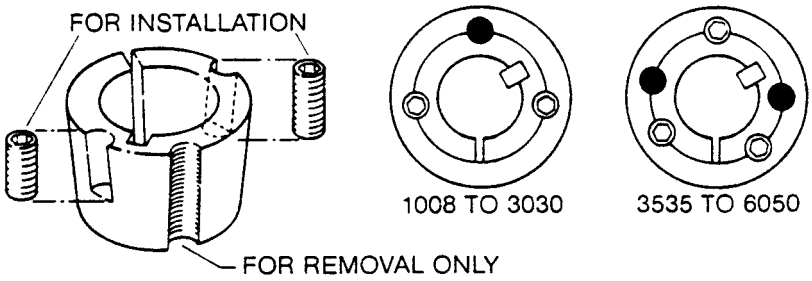
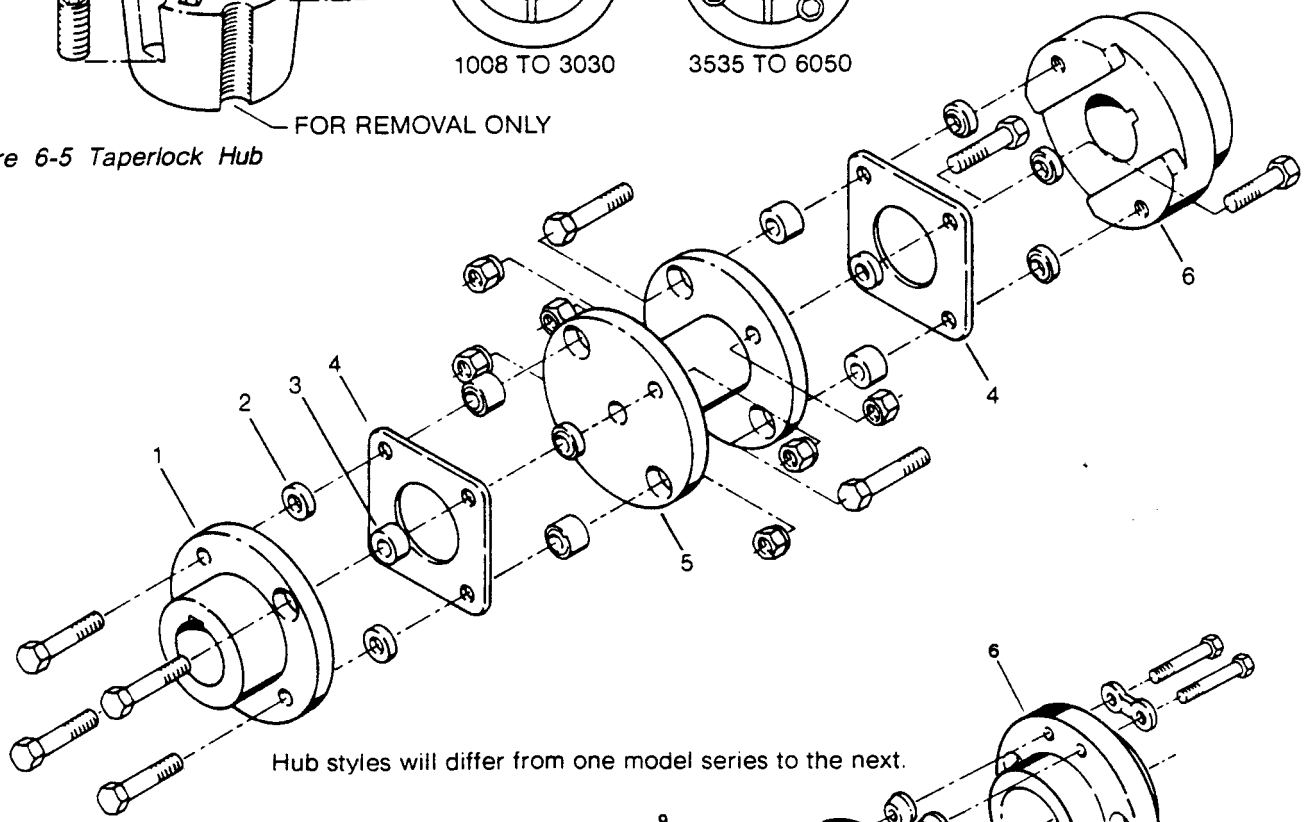


Figure 6-5 Taperlock Hub



Hub styles will differ from one model series to the next.

Figure 6-6 Formsprag Coupling

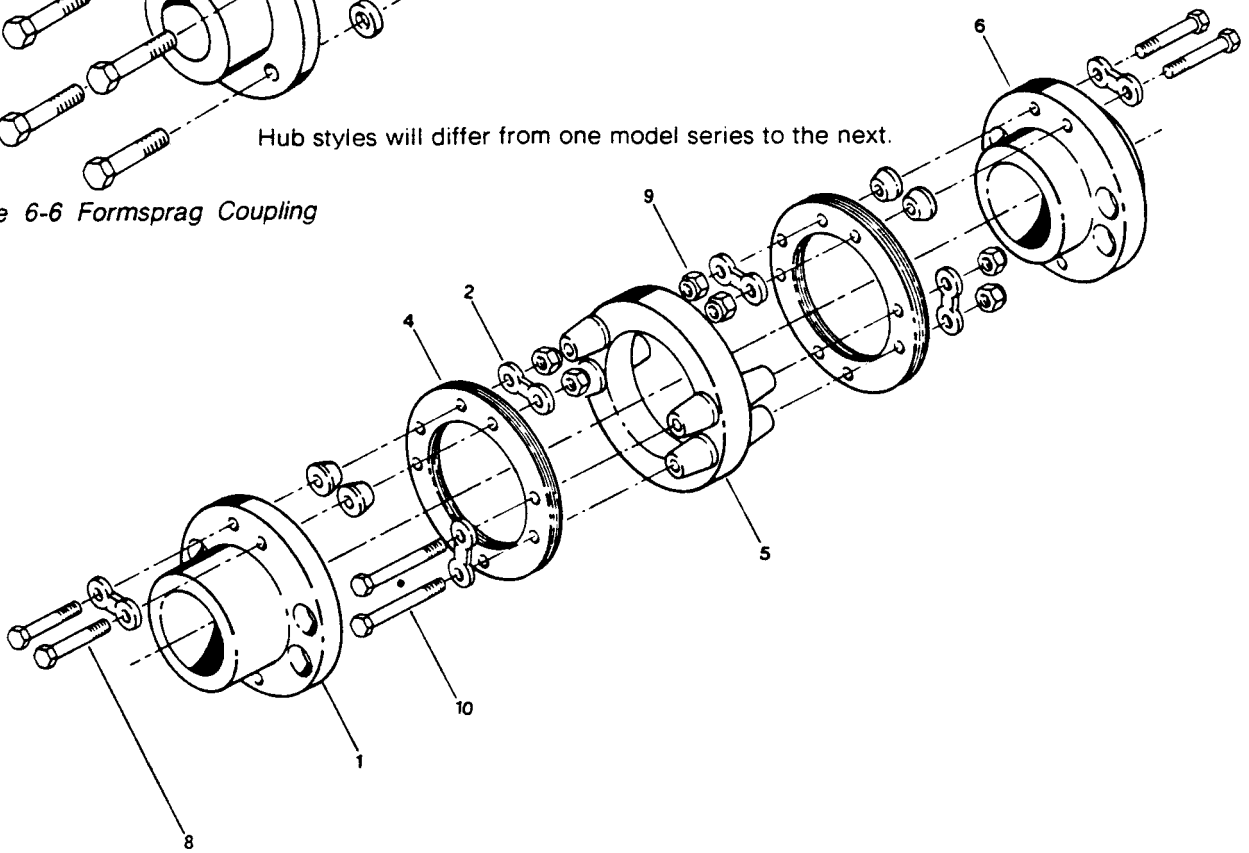


Figure 6-7 Thomas Coupling

3. Oil the thread and point of set screws, or if cap screws are used, oil their threads and under their heads.
4. Loosen the bushing in the hub by inserting screws in the holes that are threaded on the bushing side (as shown in Figure 6-5). Note that one screw in each hub is left over and is not used in this loosening operation.
5. If the bushing does not readily loosen, tap on the hub.

REMOVAL OF HUB WITHOUT TAPERLOCK BUSHING
1. Mark the hub and shaft with a felt pen to give the correct angular orientation for reassembly.
2. Remove the set screw from the hub if fitted.
3. Remove the motor hub by evenly pulling on the hub by hand or using a gear puller.
4. If the hubs were mounted with an interference fit, gently heat the hub evenly with a soft open flame to expand the hub and remove as in 2 above.

ASSEMBLY OF HUB WITH TAPERLOCK BUSHING
1. Clean the shaft including the keyway, the bore and the outside of the bushing and the bore of the hub (taking bushing from the hub if already assembled). Remove any oil, lacquer, dirt or burrs.
2. Place the bushing in the hub and match the half holes to make complete holes. Note each complete hole will be threaded on one side only.
3. Oil the thread and point of set screws, or if cap screws are used, oil their threads and under their heads.
4. Place screws loosely in the holes that are threaded on the hub side as shown in Figure 6-5.
5. Fit the key in the shaft keyway such that the end of the key is flush with the end of the shaft.
6. Make sure the bushing is free in the hub. Install the assembly onto the shaft and locate so that the distance between the two flanges is that given in Table 15, and the felt pen angular marks line up.
7. Tighten the screws alternately and evenly until pulled up tightly to the torque given in Table 13.
8. Tap against the large end of the bushing with a lead hammer to avoid damage. The screws can usually be turned a little more using the specified torque. Repeat this alternate hammering and retightening until the specified torque no longer turns the screws after hammering.

ASSEMBLY OF HUB WITHOUT TAPERLOCK BUSHING
1. Clean the shaft including the keyway and the bore of the hub. Remove any oil, lacquer, dirt or burrs.
2. Fit the key in the shaft keyway such that the end of the key is flush with the end of the shaft.
3. Mount the hub on the shaft. Alternatively, if the hubs have been bored for an interference fit, heat the hubs in an oil bath at 200°F (100°C) for 15 minutes and then quickly mount on the shaft.
4. Locate the hub such that the distance between the two hub flanges is that given in Table 14, and the felt pen angular marks line up.
5. Tighten the hub set screw if fitted.

COUPLING ALIGNMENT
1. Align the coupling as in Section 3.10.
2. Hold or support the coupling spacer and one element pad in position.
3. Insert the bolts through the washers and the element packing.

IMPORTANT

Ensure that both the thick and thin washers are oriented with the bevel or radius facing the element pack.

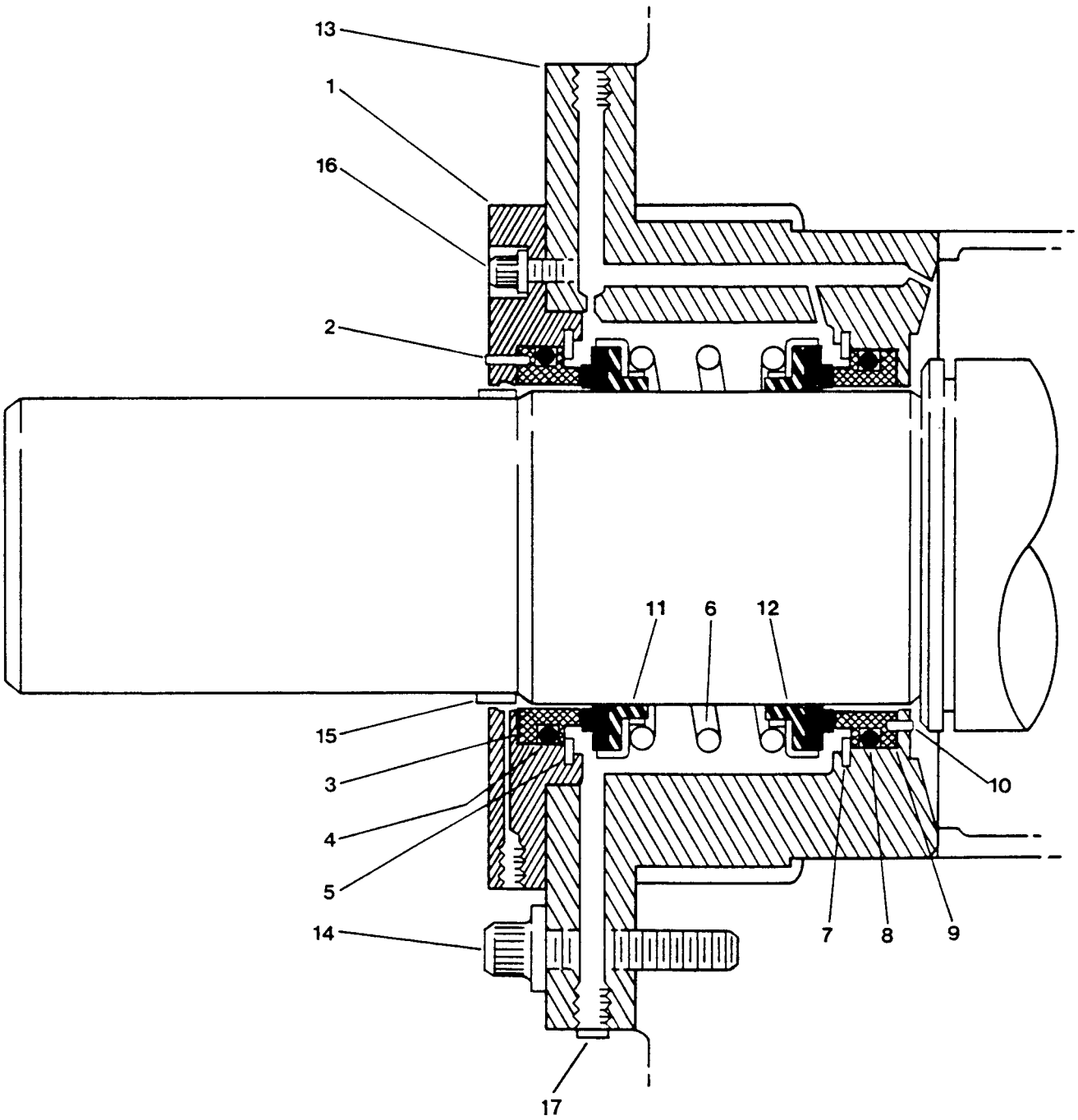
4. Alternately and evenly tighten each locknut to the torques given in Table 14. It is preferable to turn the locknut and not the bolt to prevent scoring of the fine turned bolt.
5. Install the coupling guard.
6. Close the blowdown valve.
7. Open the suction stop valve and discharge stop valve.
8. If the compressor is liquid injection cooled, open the liquid refrigerant stop valve.
9. If the compressor is fitted with a Sullistage port, open the Sullistage stop valve.
10. Reconnect the control panel to the 115 V supply line.
11. Reconnect the starter to the electric supply line.
12. Start the compressor.

6.11 DOUBLE SEAL REPLACEMENT

Refer to Figure 6-8 and the shaft seal replacement instructions received with the shaft seal replacement kit.

REMOVAL (General)
1. Carry out the shutdown procedure in Section 6-2.
2. Remove the coupling guard, coupling spacer and coupling hub from the compressor shaft as in Section 6-10.
3. Disconnect the oil supply line from the bearing retainer (13).
4. Disconnect the oil drain line from the shaft seal cover (1).
5. Remove the shaft spacer (15) from the shaft.
6. Loosen evenly the four bolts (16) between the shaft seal cover (1) and the male inlet bearing retainer (13).
7. Remove the shaft seal cover (1) from the male inlet bearing retainer (13).
8. Remove the snap ring (5) and the seat (3) from the shaft seal cover (1).
9. Remove the O ring (4) from the seat (3).
10. Remove the outboard seal (11) from the shaft. The neoprene seal (11) maybe broken loose by pushing the outboard seal (11) further down the shaft. When the bond is broken the seal (11) can be removed easily.
12. Remove the inboard seal (12) from the shaft.
13. Remove the snap ring (7) and the seat (9) from the bearing retainer (13). If this is difficult, remove the bearing retainer (13) from the inlet housing for better access.
14. Remove the O ring (8) from the seat (9).

Figure 6-8 General Configuration - Double Seal



PREPARATION
1. Check the shaft for any burrs or sharp edges which could cut the seals when they are later slid over the shaft. Remove all burrs and break all sharp edges.

IMPORTANT

Be careful not to let any material get into the bearing area.

2. Inspect and clean the shaft where the seals are going to be mounted especially in the vicinity of the neoprene seals (11, 12). Remove old carbon deposits with a light solvent (such as mineral or methylated spirits).
3. Check the bores of the seal cover and the bearing retainer for any burrs or nicks.
4. Make sure both the oil supply orifice and the oil drain line in the seal cover (1) are open and the threads are clean.
5. Oil the shaft, the bores of the seal cover (1) and the bearing retainer (13) and the inside of the neoprene seals (11, 12) with clean refrigeration oil.
6. Check that both carbon faces are absolutely clean with no surface scratches.

INSTALLATION
1. Inspect both new seats (3, 9) for any surface imperfections.

IMPORTANT

Always install two new seats with new seal assembly.

2. Install new O rings (4, 8) on the seats (3, 9).
3. Lightly oil the O rings (4, 8) and the lapped seat surfaces with clean refrigeration oil.
4. Install the seat (9) in the bearing retainer (13) making sure the groove in the seat fits over the drive pin (10).

IMPORTANT

Although the drive pin is only 1/4 inch (6.35mm) long, use care not to push it through the rear of the bearing retainer into the bearing.

5. Insert the snap ring (7) in the bearing retainer (13).
6. Install the inboard seal (12) on the shaft.

IMPORTANT

The seal assembly must be started squarely over the shaft by hand force. If the seal assembly becomes locked on the shaft remove and start again. Excessive force should not be necessary. Extreme caution must be exercised not to damage the lapped carbon surface and to keep it clean. Do not bend or tear the elastomers rings.

7. Install the spring (6).
8. Install the outboard seal (11). Note the item marked "important" in Statement 6 above.
9. Install the seat (3) in the seal cover (1) making sure the groove in the seat fits over the drive pin (2).
10. Insert the snap ring (5) in the seal cover (1).
11. Smear a film of Loctite 515 on the seal cover flange (1).
12. Mount the seal cover (1) over the shaft and line up the four bolt holes (there is only one correct position possible). Push the seal housing squarely and slowly against the seal assemblies until the seal cover (1) seats on the bearing retainer (13). Hold the housing in position with one hand, or an assistant, and tighten the bolts (16) diagonally and evenly to 80 lb-ft (108Nm).

IMPORTANT

The seal cover must be held in position until the bolts are installed since releasing the cover may allow the spring force to push the neoprene seals out of position, and will not allow the spring to exert the correct pressure between the lapped faces. This may result in seal failure within a short period of time.

13. Connect the oil supplyline to the bearing retainer (13).
14. Connect the oil drain line to the seal cover (1). Do not connect the oil drain line to the shaft seal neoprene connection (17) on the bottom of the bearing retainer (13) which is normally plugged.
15. Pump one gallon (four liters) of oil into the oil filter to replenish the oil supply to the seal housing.
16. Turn the compressor shaft a few turns by hand.
17. Close the blowdown valve.
18. Open the suction stop valve slowly to pressurize the package.
19. Check to assure that the seal is not leaking.
20. Open the discharge stop valve.
21. If the compressor is liquid injection cooled, open the liquid injection stop valve.
22. Mount the coupling hub, coupling spacer and coupling guard (See Section 6.10).
23. Reconnect the control panel to the 115V supply line.
24. Reconnect the starter to the electric supply line.
25. Start the compressor.

6.12 OIL PRESSURE RELIEF AND REGULATING VALVE SERVICING

Refer to Figures 6-9 and 6-10.

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.

TABLE 13 TAPERLOCK BUSHING TIGHTENING TORQUES

Bushing No.	Screws	Torque	
		lb_fin	N.m.
1008,1108	1/4" Set Screws	55	6
1210,1215,1310	3/8" Set Screws	175	20
1610,1615	3/8" Set Screws	175	20
2012	7/16" Set Screws	280	30
2517,2525	1/2" Set Screws	438	50
3020,3030	5/8" Set Screws	800	90
3535	1/2" Cap Screws	1,000	115

TABLE 14 COUPLING INSTALLATION DETAILS

Coupling	Compressor	Flange Center Distance		Tightening Torque		Usual Taperlock
Make	Model	in	mm	lb-ft	N.m.	Bush Number
Formsprag	B20 Gear Drive B25	5 ± 0.05	127 ± 1.2	40	55	2525
	B20 Direct Drive B32 All	5 ± 0.06	127 ± 1.4	80	110	3030
Thomas	B20 Gear Drive B25	4 7/8 ± 0.05	124 ± 1.2	95	130	2525
	B32 Direct Drive B32 All	5 7/8 ± 0.06	149 ± 1.4	175	240	3030

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.
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 2.3.
11. Adjust both the oil pressure relief valve and the oil pressure regulating valve as in Section 4.5.

6.13 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 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. A rotary brush is recommended.
10. Clean the heat exchanger and cooler head.
11. Mount both cooler heads with new gaskets. Tighten the cooler head bolts uniform diametrically staggered pattern.
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).

6.14 OIL STRAINER SERVICING

(A) SINGLE OIL STRAINER SERVICING

The strainers in standard packages are shown in Figures 1-5 through 1-14.

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 back flush the foreign matter the strainers into the lines. After reassembling the apparently clean strainers and running the compressor the strainers will again plug up.

1. Carry out the shutdown procedure in Section 6.2.

Figure 6-9 Oil Pressure Relief Valve

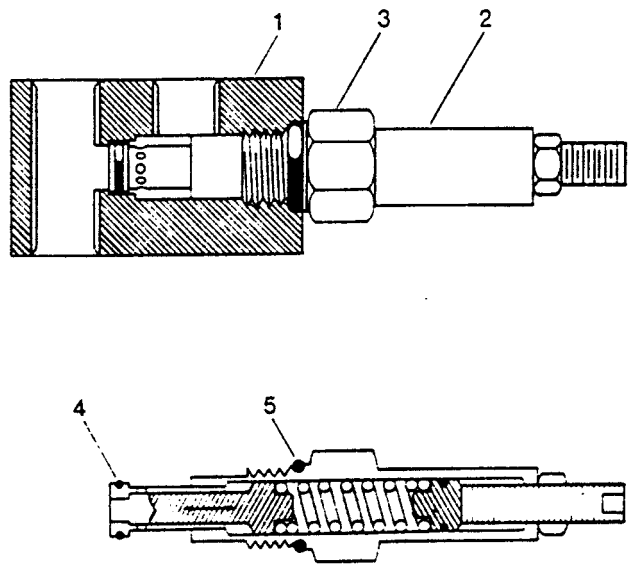
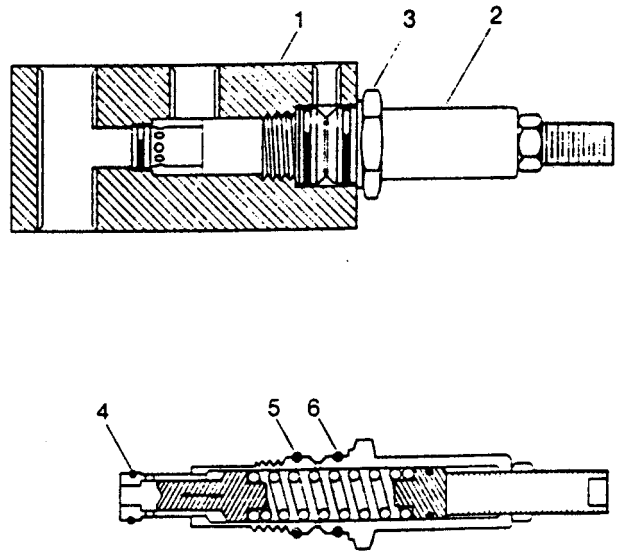


Figure 6-10 Oil Pressure Regulating Valve



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.

WARNING

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 (e.g. fibers) and clean the strainer with a light solvent (e.g. 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.
16. After the compressor has run long enough to reach its normal operating temperature, adjust the oil pressure if necessary as explained in Section 4.5.

(B) DUAL OIL STRAINER SERVICING

It is necessary to shut the compressor down as in Section 6.2 only to repack the valve stuffing box, as described below.

The dual strainers have tapered valve plugs which are factory assembled. In operation, one side of the valve is exposed to the pressure developed on the strainer chamber in use and the other side is exposed to a lower pressure. With the valve properly adjusted, there will be little, if any, equalization of pressure through the valve and consequently, the pressure on one side will tend to press the tapered plug against the low pressure side. If the pressure is great enough, this pressure causes the valve to operate rather stiffly. To remedy this condition, a by pass line and stop valve is provided.

When it is desired to shift operation of the strainer from one chamber to the other, open the valve in the by pass line so that the pressure in both chambers is equalized. Then swing the valve, using the handle provided, toward the chamber to be put in operation. The handle will move easily when the pressure is equalized. Finally, close the valve in the by-pass line before opening the cover of the strainer chamber.

IMPORTANT

Never try to force the valve plug assembly through its cycle of operation. It should at all times move freely without the aid of any additional leverage other than that provided through the mechanical advantage of the valve handle.

Each valve plug is individually lapped on the valve seat to produce a leak-proof fit. Therefore, never put any pressure on the top of the valve plug assembly as this could force the tapered plug more firmly on its seat and could result in damaging the seat faces.

Remove the strainer baskets as described below. It is possible, even after pressure equalization as described above, that the valve plug may be jammed at the valve seat faces because of unequal expansion of adjacent parts. Raise the plug slightly off its tapered seat by turning the lifting jack nut one third of a turn counterclockwise and turn the valve handle. If still jammed, adjust the valve plug.

ADJUSTMENT OF VALVE PLUG

Refer to Figure 6-11.

1. Turn the lifting jack nut (3) clockwise (from above) by hand. While doing this, continually move the valve handle from one position to the other. When the valve just begins to feel tight or snug, the valve is correctly positioned.
2. To determine whether or not the valve is bypassing liquid, remove the cover (6) of the strainer not in use and if the oil level continues to rise, turn the lifting jack nut clockwise until the oil level remains stationary.
3. Assemble the washer and turn the nut (14) tightly by hand so that the washer (13) does not rotate.
4. Back nut (14) off a quarter of a turn.
5. Block nut (14) with the locking nut (15).
6. Raise the valve plug slightly off its tapered seat by turning the lifting jack nut one third of a turn counterclockwise.
7. Turn the valve handle.

STRAINER BASKET REMOVAL AND INSTALLATION

1. Loosen the stud nuts (17) a few turns and carefully pry up the cover (6) to relieve the pressure. Do not remove the stud nuts until the chamber is depressurized.
2. Remove the stud nuts (17) and cover (6) of the strainer chamber not in use.
3. Lift out the strainer (9) and clean.
4. Clean the cover seat and cover.

THE FOLLOWING PAGES
ARE ADDED FROM THE C SERIES
MANUAL COVERING THE
NEWER

OIL STRAINER

7.9 THERMOSIPHON COOLER CLEANING

This cooler should never need cleaning under normal use. However, the refrigerant used for cooling will carry oil with it. This oil may tend to remain in the cooler as the refrigerant. Therefore this oil will have to be drained from the cooler on a periodic basis.

7.10 OIL STRAINER SERVICING

The strainers in standard packages are shown per the schematics (Figures 2–5, 2–6, and 2–7).

1. Carry out the shutdown procedure as in Section 7.2.

⚠ WARNING

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 blowdown 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 screw–in 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 screen from the recess in the plug 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 screen (e.g. fibers) and clean the strainer screen with a light solvent (e.g. mineral spirits).
6. Again, unscrew the plug by hand, and quickly insert the strainer screen into the plug recess. Renew the plug gasket, if necessary, and screw the plug into the strainer body. Tighten the plug.
7. While the compressor package is blown down, clean all of the oil strainers as in Steps 2 through 6.
8. Close the blowdown valve.
9. Open the suction stop valve slowly to prevent compressor shaft rotation and then open 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 Sullistage port, open the Sullistage stop valve.
13. Reconnect the control panel to the 115V supply line.
14. Reconnect the starter to the electric supply line.
15. Start the compressor.

DUAL OIL STRAINER SERVICING

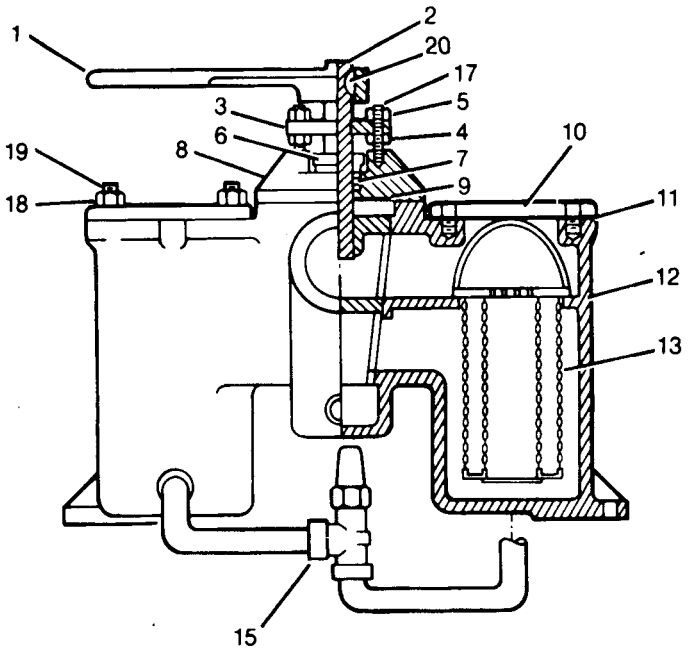
It is necessary to shut the compressor down as in Section 7.2 only to repack the valve stuffing box as described below. The dual strainers have tapered valve plugs which are factory assembled. In operation, one side of the valve is exposed to the pressure developed on the strainer chamber in use and the other side is exposed to a lower pressure. With the valve properly adjusted, there will be little, if any, equalization of pressure through the valve and consequently, the pressure on one side will tend to press the tapered plug against the low pressure side. If the pressure is great enough, this pressure causes the valve to operate rather stiffly. To remedy this condition, a bypass line and stop valves are provided.

When it is desired to shift operation of the strainer from one chamber to the other, open the valves in the bypass line so that the pressure in both chambers is equalized. Then swing the valve, using the handle provided, toward the chamber to be put in operation. The handle will move easily when the pressure is equalized. Finally, close the valve in the bypass line before opening the cover of the strainer chamber.

⚠ WARNING

NEVER try to force the valve plug assembly through its cycle of operation. It should at all times move freely without the aid of any additional leverage other than that provided through the mechanical advantage of the valve handle.

Figure 7-12 Dual Oil Strainer - Old Style



Each valve plug is individually lapped on the valve seat to produce a leakproof fit. Therefore, never put any pressure on the top of the valve plug assembly, as this could force the tapered plug more firmly onto its seat and could result in damaged the seat faces.

ADJUSTMENT OF VALVE PLUG (OLD STYLE ONLY)

Refer to Figure 7-12. Remove the strainer baskets as described below. It is possible, even after pressure equalization as described above, that the valve plug may be jammed at the valve seat faces because of unequal expansion of adjacent parts. Raise the plug slightly off its tapered seat by turning the lifting jack nut ⅓ of a turn counterclockwise and turning the valve handle. If still jammed, adjust the valve plug.

1. Loosen hex nuts (5) slightly and be sure the set screw in the handle hub (1) is tight. Place a piece of flat stock under the handle hub (1) and using locking flange stud (17) as a fulcrum, pry firmly so that the valve plug assembly (2) is lifted in a vertical direction while the valve housing casting is tapped with a hammer.
2. To readjust the valve, tighten hex nuts (5) evenly and a very little amount at a time. While doing this constantly, try the action of the valve plug assembly (2) by moving the valve handle (1) through its cycle of operation. When the valve action just begins to feel tight or snug, the valve is in its proper position.
3. To determine whether or not the valve is bypassing liquid, remove the cover (10) of the chamber not in use and if the level of the liquid in this chamber continues to rise, it will be necessary to further position the plug. Adjust until the liquid level remains stationary.
4. To hold the plug in position, bring the hex jam nuts (4) up against the underside of the locking flange (3).

STRAINER BASKET REMOVAL AND INSTALLATION - OLD STYLE

Refer to Figure 7-12.

1. Equalizing valve (15) must be closed.
2. Loosen the stud nuts (18) a few turns and carefully pry up the cover (10) to relieve the pressure. **DO NOT** remove the stud nuts until the chamber is depressurized.

⚠ CAUTION

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

3. Remove the stud nuts (18) and cover (10) of the strainer chamber not in use.
4. Lift out the strainer basket (13) and clean.
5. Clean the cover seat and cover (10).
6. Install the clean strainer basket (13).
7. Replace the cover (10) and stud nuts (18). As the studs are screwed down, the strainer basket handle is compressed, holding the strainer basket firmly in place.
8. Re-open equalizing valve (15) to recharge the cleaned strainer basket with clean oil.

⚠ CAUTION

Be sure equalizing valve is closed while removing basket.

STRAINER BASKET REMOVAL AND INSTALLATION - NEW STYLE

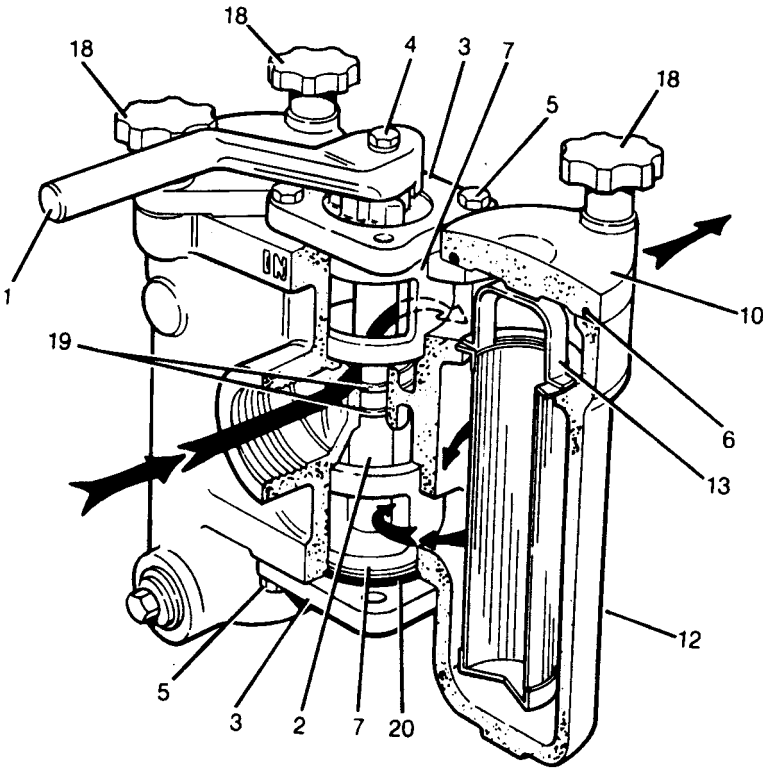
Refer to Figure 7-13.

1. Open equalizing valve at bottom of strainer to be removed.
2. Remove plug slowly from tee to relieve pressure from basket area.

⚠ CAUTION

Be sure valve at bottom of strainer that is being used is closed while removing basket that is not being used.

Figure 7-13 Dual Oil Strainer - New Style



3. Loosen knobs (18) a few times and carefully pry up the cover (10) to relieve the pressure. **DO NOT** remove the knobs until the chamber is depressurized.

⚠ CAUTION

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

4. Remove the knobs (18) and cover (10) of the strainer chamber not in use.
5. Lift out the strainer basket (13) and clean.
6. Clean the cover seat and cover (10) and o-ring groove.
7. Install the clean strainer basket (13) with clean o-ring (6).
8. Replace the cover (10) and knobs (18). As the knobs are screwed down, the strainer basket handle is compressed holding the strainer basket firmly in place.
9. Install plug into tee and tighten.
10. Open both valves in bottom of the strainer to re-charge cleaned strainer with clean oil.

PACKING REPLACEMENT (OLD STYLE ONLY)
Refer to Figure 7-12.

1. Carry out the shut down procedure in Section 7.2.
2. Remove the valve handle (1) and woodruff key (20).
3. Remove the hex nuts (5) or hex bolts (5). Remove the locking flange (3).
4. Remove the hex head capscrews (not shown) from the gland (6).
5. Remove the gland (6).
6. Remove old packing (7) and repack with a good grade of ¼" (6mm) square graphited asbestos valve stem packing.
7. Install the gland (6) and the hex head capscrews (not shown).
8. Install locking flange (3) and hex nuts (5).
9. Install woodruff key (20) and valve handle (1).
10. To start up the compressor, reverse the shut down procedure in Section 7.2.

O-RING REPLACEMENT (NEW STYLE ONLY)
Refer to Figure 7-13.

1. Carry out the shut down procedure in Section 7.2.
2. Remove the hex screw and washer (4). Remove the handle (1).
3. Remove the four hex screws (5). Remove the diverter cover (3) with o-ring at top of strainer assembly.
4. Remove top half of shaft (2) and top diverter plug (7).
5. Remove the hex screws (5). Remove the diverter cover (3) with o-ring at bottom of strainer assembly.
6. Remove bottom half of shaft (2) and bottom diverter plug (7).
7. Replace o-rings (19) on shaft (2) and o-rings (20) at diverter covers (3).
8. Install diverter plug (7) onto the bottom shaft (2) and onto the bottom diverter cover (3) and install into strainer assembly.
9. Install bottom diverter cover (3) with four hex screws (5) into bottom of strainer assembly.
10. Install top shaft (2) onto top diverter plug (7) with o-rings into top of strainer assembly.
11. Install top diverter cover (3) with the four hex screws (5) and hex screw and washer (4) onto top of strainer assembly.

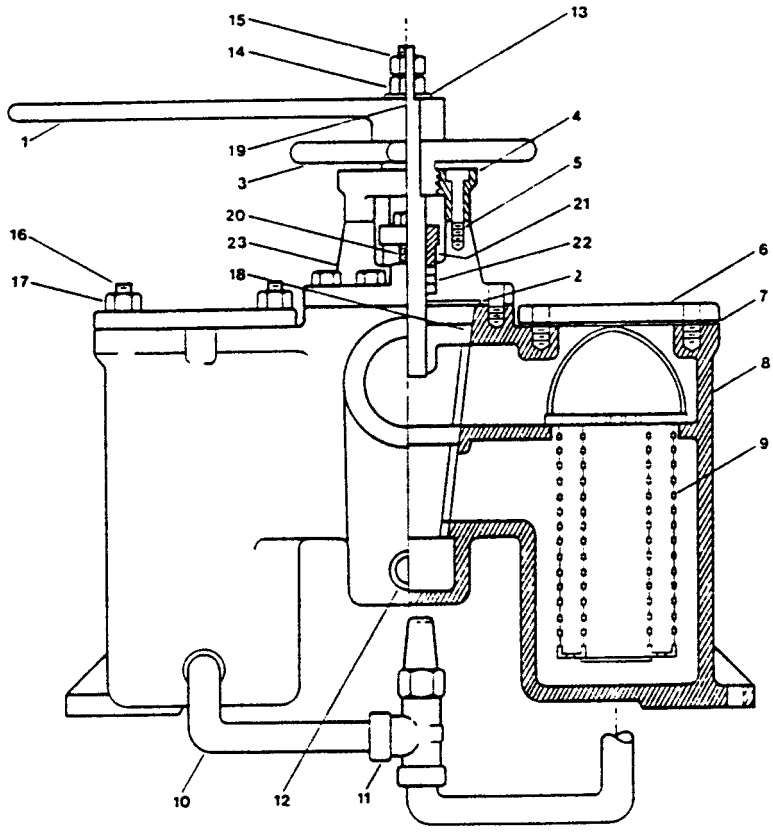
⚠ CAUTION

Top shaft must fit over and onto flats of bottom shaft for proper installation. Shaft projections must fit into slots of diverter plugs for proper installation. Bottom diverter plug must fit to bottom diverter cover for proper installation.

12. To start up the compressor, reverse the shut down procedure in Section 7.2.

7.11 OIL SEPARATOR ELEMENT SERVICING
Refer to Figure 7-14. On some early packages, this element was not replaceable.

Figure 6-11 Dual Oil Strainer



5. Replace the strainer.
6. Replace the cover and stud nuts. As the studs are screwed down the strainer handle is compressed which holds the strainer firmly in place.

PACKING REPLACEMENT
1. Carry out the shut down procedure in Section 6.2.
2. Remove the valve handle nuts and washer (13, 14 and 15).
3. Remove the valve handle (1).
4. Remove the lifting jack nut (3), lifting jack bridge cap screws (5) and the lifting jack bridge (4).
5. Remove the gland cap screws (20) and the gland (21).
6. Repack the stuffing box with 1/4 inch square (6 mm square) graphited asbestos packing.
7. To replace component parts, reverse the above disassembly procedure.
8. To start up the compressor, reverse the shut down procedure in Section 6.2.

6.15 OIL SEPARATOR ELEMENT SERVICING

Refer to Figure 6-12.

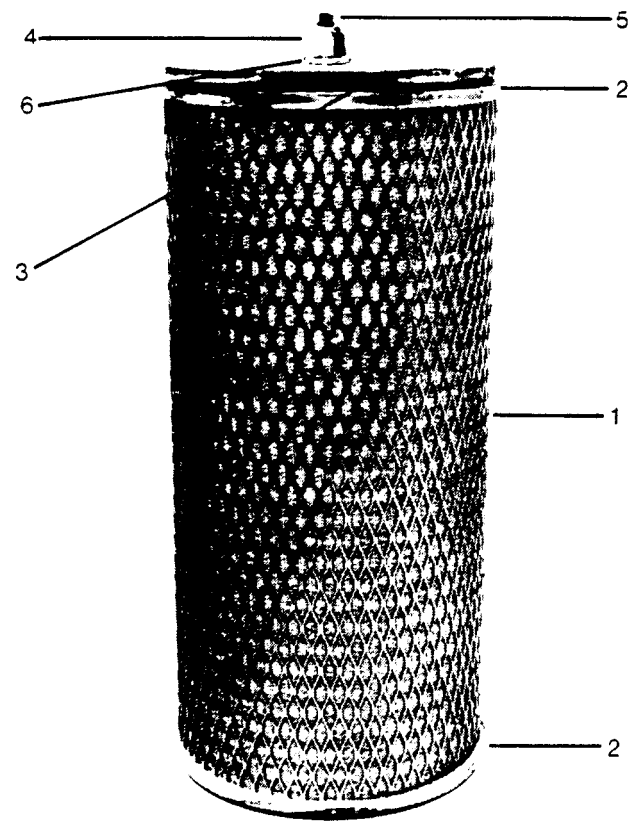
INSPECTION
1. Carry out the shut down procedure in Section 6.2.
2. Remove access cover on the top of the separator.
3. Inspect the element gaskets (2) for tightness. If the gaskets are blown on either end they must be replaced. If the gaskets had been replaced recently and they are blown again, the elements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

INSTALLATION

1. Cement new gaskets to the element using Loctite No. 404 (available from Sullair Refrigeration).
2. Replace element.
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.

Figure 6-12 Oil Separator Element



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.

6.16 AUXILIARY OIL PUMP SERVICING
Refer to Figure 6-13.

REMOVAL OF OIL PUMP
1. It is not necessary to shut the compressor down to service the auxiliary oil pump, provided the stop valve before the pump and the check valve after the pump are in good condition. If the valves are not in good condition, carry out the shut down procedure in Section 6.2.

DANGER

Do not touch the motor wiring unless the power is disconnected by removing the oil pump motor fuse in the control panel with an insulated puller.

2. Close the stop valve on the auxiliary pump inlet.
3. Remove the connecting pipework.
4. Remove the three bolts (18).
5. Withdraw the pump from the motor.

REPLACEMENT OF SHAFT SEAL
1. Unscrew the housing plug (10) with its O ring (9).
2. Remove the steel face (11) and O ring (12).
3. Remove the seal assembly (13, 14, 15, 16 and 17).
4. Clean the pump shaft (7) and the housing plug with solvent.
5. Inspect the new carbon face and ensure it is clean with no cracks, nicks or scratches. Also check the new steel face for scratches.
6. Mount the new seal assemble (13, 14, 15, 16 and 17) on the pump shaft.
7. Place a new O ring (12) on the replacement steel face (11). This may be already mounted on the new face.
8. Insert the steel face into the housing plug (10).
9. Immerse the steel face in some clean refrigeration oil.
10. Mount a new O ring (9) on the housing plug.
11. Screw the housing plug into the pump housing (6).

INSTALLATION OF THE OIL PUMP
1. Line up the delrin splined cap (19) on the pump shaft with the sintered iron splined coupling (21) and the delrin splined cap (20) on the motor shaft.
2. Mount the oil pump on the motor.
3. Install the mounting bolts (18).
4. Install the connecting pipework.
5. Open the stop valve on the pump inlet.
6. If the compressor was shut down, start up by reversing the shut down procedure in Section 6.2.

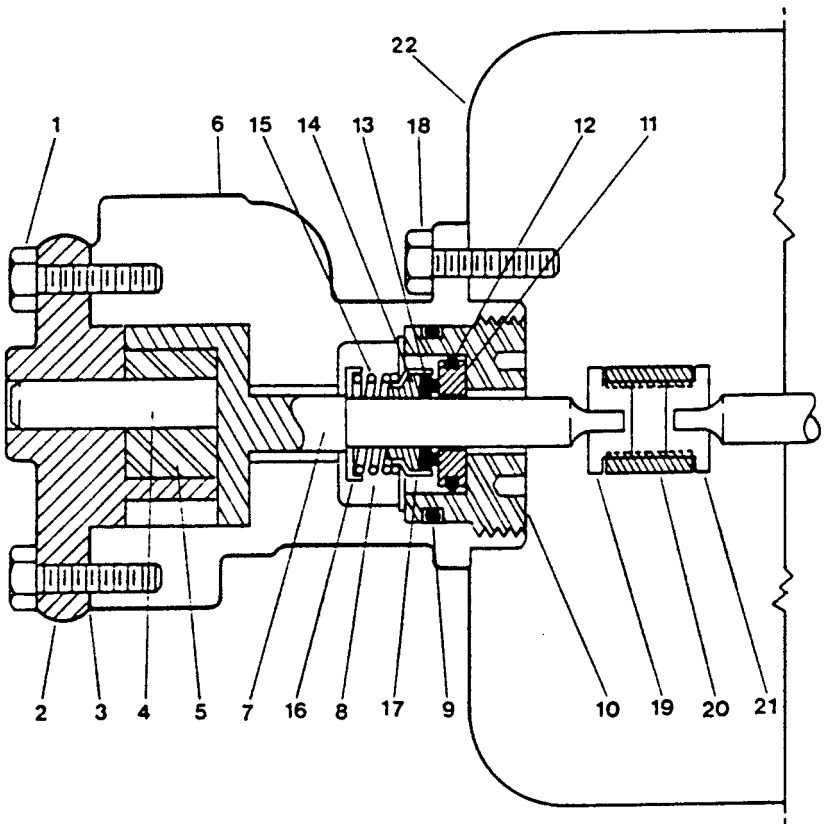
6.17 LIQUID INJECTION REGULATING VALVE SERVICING
Refer to Figure 6-14.

(A) THERMAL SYSTEM

The thermal system is a hermetically sealed unit consisting of a sensing bulb, capillary tubing, protective armor and an actuator assembly. This unit contains the thermostatic charge that operates the valve.

The thermal system can be tested with the valve in place by removing the bulb (1B) from the bulbwell (2B) and placing it in a container which can be heated with hot water or cooled with cold water. Note the bulb working temperature range is 80°F to 140°F (27°C to 60°C) and the maximum temperature that the thermal system will withstand without damage caused by a build up of excess pressure is 240°F (115°C).
Observe the valve stem while alternatively heating and cooling the bulb. A 10°F (5°C) bulb temperature change at the control temperature will cause the valve to fully stroke. An approximate 5°F (3°C) temperature change from a stable temperature will cause the valve to fully close or fully open the port. If the stem does not move, it is likely that the thermal system has lost its charge. As the thermal system is hermetically sealed, the thermal system must be replaced with a complete new system.

Figure 6-13 Auxiliary Oil Pump



(B) THERMAL SYSTEM REPLACEMENT

The thermal system can be replaced with the valve in place.

1. Stop the compressor with the stop button.
2. Turn the start button to the "Manual-Reset" position to prevent the compressor from starting automatically.
3. Remove the bulb (1B) from the bulbwell (2B) leaving the bulbwell mounted in the discharge pipe.
4. Remove the actuator assembly (1A) by rotating the adjusting wheel (5Y) downwards to release the spring compression and remove the four actuator screws (7Y).
5. Do not remove the adapter plate (4A).
6. To reassemble, place the replacement actuator assembly onto the valve yoke (1Y) and reinsert the four actuator screws (7Y).
7. Coat the bulb with aluminum paste or grease to improve the heat transfer.
8. Replace the bulb in the bulbwell turning the bulb so that the word "top" stamped on the adapter (3B) faces upward.
9. The valve stroke adjustment will not be affected if the above steps have been followed.

(C) REGULATING VALVE ISOLATION

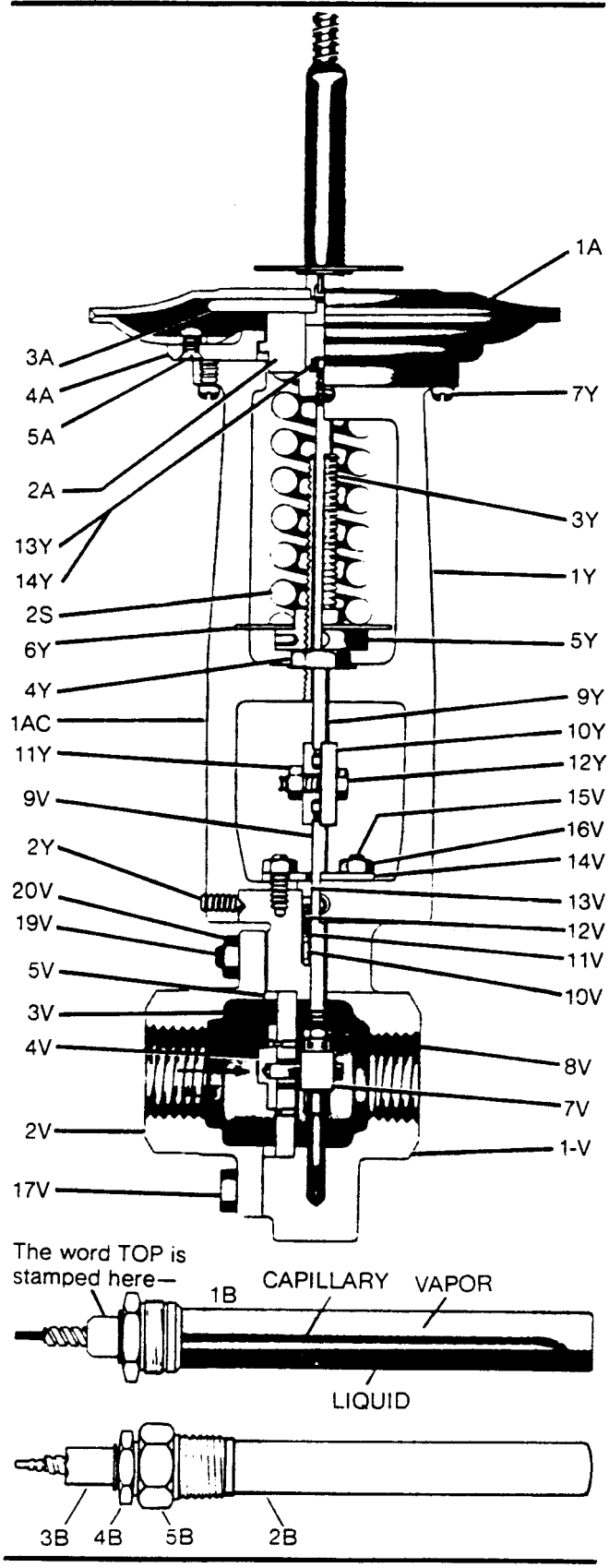
1. Stop the compressor with the stop button.
2. Turn the start button to the "Manual-Reset" position to prevent the compressor from starting automatically.
3. Close the globe valve and the stop valve on either side of the regulating valve.
4. Open the solenoid valve by removing the cap nut at the bottom of the solenoid valve and turn the jacking stem up towards the valve to lift the seat. If this is not done, liquid refrigerant can be trapped between the solenoid valve and the upstream stop valve.
5. Carefully loosen the solenoid strainer cap or a tube fitting to allow liquid refrigerant in the line to boil off.

WARNING

Be very careful to avoid being sprayed with liquid refrigerant.

6. After all the liquid refrigerant has evaporated, carefully remove the strainer cap. Leave the strainer open to the atmosphere all the time while working on the regulating valve.

Figure 6-14 Refrigerant Regulating Valve



(D) PACKING REPLACEMENT

The packing can be replaced with the valve and the thermal system in place.

1. Isolate the regulating valve as in (C) above.
2. Remove connector assembly (10Y).
3. Remove both packing flange nuts (16V).
4. Remove packing flange (14V) and packing follower (13V).
5. Should packing spring (10V) not eject packing set (12V) a slight amount of downstream pressure might be necessary to remove the packing set. Use care to avoid any liquid refrigerant that may be present.
6. Remove packing retainer (11V) and packing spring (10V).
7. Clean packing bore with solvent and blow out thoroughly.
8. Assemble in reverse order and tighten packing flange nuts (16V) so that packing follower (13V) bottoms out on top of valve body (N).
9. Engage valve stem (9V) and actuator stem (9Y) with connector (10Y). Tighten connector nut and bolt (11Y and 12Y).
10. No stroke adjustment is required.

(E) VALVE SEATS DISASSEMBLY

See table 15 for the standard valve seat Cv sizes. This number is stamped on the outlet side of the seat. Cv is defined as the flow of water in US gallons per minute across the fully opened valve for a pressure drop of 1 PSI.

1. Isolate the regulating valve as in (C) above.
2. Remove the tubing piece upstream from the regulating valve.

TABLE 15
STANDARD REFRIGERANT REGULATOR VALVE SEAT SIZES

MODEL	Cv
B20LB, ALL	.42
B25	.84
B32SB	.84
B32LB	.84

3. Note the scribe line on the side of the valve body and cap. Remove the cap screws (17V, 20V) and the cap (2V). Note that there is an index pin secured in the valve cap that fits into the index pin hole in the valve plate (3V). This index pin is on the same side as the scribe line on the valve cap and body and it positions the valve plate in the valve body.

IMPORTANT

The valve seats are lapped to a light band flatness. Maintenance of such tolerances is important for excellent control and tight shut-off. Do not use metallic objects in removing the seats. Improper handling of the seats will result in leakage and improper control.

4. Check the valve disc (4V) for a stamped arrow before removing. This arrow points to the scribed line and the index pin hole in the valve plate. Since the disc can be rotated 180° in some sizes without affecting the stroke adjustment, there may be no arrow on the valve disc. Remove the valve disc.
5. Remove the pressure ring (5V).
6. Remove the valve plate (3V).

IMPORTANT

Do not rotate the disc pin (7V) when disassembling, cleaning, or reassembling, since this affects the stroke adjustment of the valve.

7. Clean all the parts of the body and cap with solvent. The valve disc and plate then may be cleaned. If the parts are scarred they must be replaced. Do not attempt to relap them.
8. If no work has to be done on the disc pin, proceed to (H) to reassemble the valve seats.

(F) DISC PIN REPLACEMENT

1. Isolate the regulating valve as in (C) above.
2. Disassemble the valve seats as in (E) above.
3. Loosen the stem connector nut (11Y) and bolt (12Y) and remove connector assembly (10Y).
4. Back out the four allen head screws (2Y) which will allow the valve body (1V) to be separated from the valve yoke (1Y).
5. Loosen the stem locknut (8V) and rotate the disc pin counterclockwise, pulling the valve stem (9V) upward while doing so. Do not remove the valve stem completely but raise it sufficiently so that the disc pin may be removed by pulling up and out.
6. Replace the disc pin and reassemble in reverse order.
7. Adjust the stroke as in (G) below.

(G) VALVE STROKE ADJUSTMENT

1. Isolate the regulating valve as in (C) above.
2. Disassemble the valve seats as in (E) above.
3. Stroke the actuator stem (9Y) fully downwards by either loosening the spring (2S) completely and pulling down on the stem or heating the bulb so that the actuator (1A) moves the stem downwards.
4. Loosen the disc pin locknut (8V) and the stem connector bolt (12Y).
5. Reassemble the valve seats as in (H) below.
6. Orifices of the disc and plate must align perfectly in the full open position. Adjust the position of the disc on the plate by rotating the valve stem (9V) (clockwise to raise and counterclockwise to lower) until the seats are in the fully opened position. Note the stem will rotate in the stem connector if the connector bolt is loosened slightly. Proper positioning of the valve stem and actuator stem must be maintained during adjustment of the seats.

(H) VALVE SEATS REASSEMBLY

1. Disassemble the valve seats as in (E) above.
2. Place the valve plate in the body seat recess, ensuring that the index pin hole is on the same side as the scribe line on the valve body. Align the disc pin so that it is centered in the body bore and protrudes through the center slot of the valve plate.
3. Place the valve disc on the valve plate, engaging the disc pin. Be sure that the arrow which is stamped on the disc points to the scribe line on the valve body.
4. Note that the pressure ring has one lapped surface. In replacing the pressure ring, make certain that the lapped surface faces the valve plate.
5. Replace the valve cap. Note that the scribe line on the valve cap is aligned with the scribe line on the valve body and the index pin is aligned with the index pin hole in the valve plate. Normally, a slight rotation of the valve cap is sufficient to obtain proper alignment.
6. Install the cap screws and tighten uniformly diagonally from each other, to a torque of 9 lb-ft (12 Nm).

(I) VALVE INSTALLATION

1. Replace and tighten tube and fittings
2. Replace the strainer cap and tighten the cap bolts.
3. Return the solenoid valve to automatic operation by turning the jacking stem down away from the valve.
4. Coat the bulb with aluminum paste or grease to improve the heat transfer.
5. Install the bulb in the bulbwell, turning the bulb so that the word "top" (stamped on the adapter (3B)) faces upward.
6. Open the globe valve and the stop valve on either side of the regulating valve.
7. Check for refrigerant leaks around the disturbed valve and tubing.
8. Start the compressor.
9. Adjust the regulating valve per the setting procedure in Section 4.6(b).

6.18 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.

6.19 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.

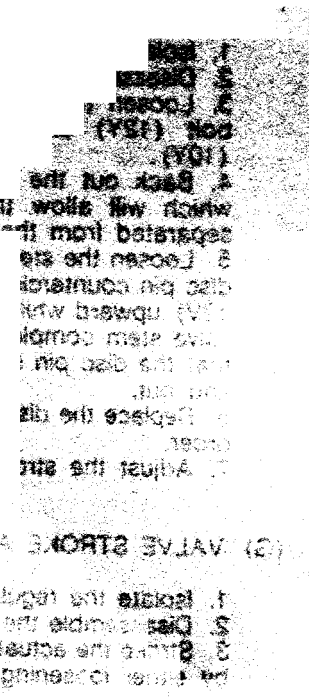
They will also assist in the ordering of the new unit and scheduling of Sullair Refrigeration Servicemen if required.

REMOVAL

1. Carry out the shut down procedure in Section 6.2.
2. Remove tubing in large sub-assemblies. 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 Figures 1-6 through 1-14 for standard units.
4. Follow the pressure test procedure, Section 3.8.
5. Follow the evacuation procedure, Section 3.9.
6. Follow the alignment procedure, Section 3.10.
7. Drain and discard all the oil from the package, by opening the drain valve on the bottom of the oil separator, and then removing drain plugs from the bottom of the oil cooler (if water cooled) and the bottom of the compressor stator (refer to Figure 1-3).
8. Flush the package with clean oil through the discharge temperature connection on the oil separator.
9. Replace the drain plugs, close the oil separator drain valve and charge the system with new oil as in Section 3.12.
10. Warm the oil, Section 3.13.
11. Check the electrical system, Section 3.14.
12. Check the protective switches, Section 3.15.
13. Check the capacity control, Section 3.16.
14. Follow the pre-start check up list, Section 4.3.
15. Follow the initial start-up procedure, Section 4.4.
16. Follow the initial maintenance procedures as for a new machine, Sections 5.2 and 5.3.



Section 7
WARRANTY

7.1 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.

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