450 XL Series Reciprocating Compressors

Installation, Operation & Service Manual



FRICK

FRICK INDIA LIMITED

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TABLE OF CONTENTS

Section	Description	Page Numbers
I	INSTALLATION	1 - 30
II	OPERATION	30 - 45
III	SERVICE	46 - 70
IV	SPARE PARTS	71 - 76
V	DO'S & DON'TS	77 - 79
VI	TROBLE SHOOTING	80 - 84
VII	ROUTINE MAINTENANCE SERVICE	85 - 86
VIII	CONDITIONS FOR NORMAL OPERATION	87 - 88
IX	DAILY OPERATING LOG SHEET	89 - 90
X	CONTROL WIRING DIGRAM	91 - 98
XI	FOUNDATION DRAWING	99 - 100

INSTALLATION

I. INTRODUCTION

Proper installation of the refrigeration compressor and its accessories is one of the most important aspects of system design. By performing the procedures in the following sections, you assure the optimum performance and efficiency of your 450XL series MultiCylinder Compressor

II. DELIVERY

All 450 XL series Compressors are thoroughly inspected and “run-in” by our factory to ensure all units are mechanically sound upon shipment. Since damage can occur during shipment, however, units should be thoroughly inspected upon arrival at the installation side. Immediately report any damage found to the transportation company and to the Frick India Factory.

III. LOCATING THE UNIT

Before anchoring the unit and connecting the refrigerant piping and electrical lines, there are several factors to consider.

A. Drains

Locate the unit near a floor drain. Since a considerable amount of water must be transported away when draining units with water cooled condensers (for repairs or seasonal shutdowns), a floor drain is important.

B. Ventilation

Proper ventilation is required for efficient operation. Heat generated by the compressor and its motor must be vented to avoid motor overheating and burn-out. If your 450XL series Compressor is installed in a large room that does not have abundant natural ventilation, mechanical ventilation is recommended.

Use a small unit cooler, in conjunction with inlet condenser water, where the fan operates when the compressor is running. Another possibility for units using an evaporative condenser, is to draw air for the evaporative condenser through the condenser room. Also, exhaust air from conditioned spaces is effectively utilized when passing it over the compressor and motor. The importance of adequate cooling cannot be overemphasized. Motors that occasionally operate at more than nameplate rating have a shorter life not sufficiently cooled.

For motors which operate within nameplate ratings, room temperatures can be a maximum of ten degrees greater than normal room temperature. Consult local codes for ventilation requirements.

C. Service Space

Provide adequate space around the unit for servicing and maintenance work. See Table 2 for overall dimensions. Clearances necessary for removing crankshafts are listed in Paragraph V.

IV. FOUNDATION

Frick India Ltd. maintains the highest standards in the design and manufacture of its Compressors. All rotating parts are balanced, and the weights of reciprocating parts calculated, to keep vibration to a minimum while the compressor is operating.

Some vibration will exist, however. Take precautions to prevent its transmission to the building structure, or noise problems may develop. Vibration is transmitted in two ways; through the base and foundation of the machine, and through the piping. The following detailed methods of installation insure a minimum of vibration transmission.

TABLE 1. 450XL SERIES COMPRESSOR DISPLACEMENT AND CONNECTION

Model	Compressor Cylinder Quantity	Dis-placement At max rpm (CFM)	Compressor connections (Line size-inches)			
			R-717		Halocarbon	
			Suction	Discharge	Suction (mm)	Discharge(mm)
450 XL SERIES	2	99.5	2 1/2" (63.5 mm)	2" (50.8 mm)	2 1/2 (63.5 mm)	2" (50.8 mm)
	4	199	3" (76.2 mm)	2 1/2 (63.5 mm)	3" (76.2 mm)	2 1/2 (63.5 mm)
	6	298	4" (101.6 mm)	3" (76.2 mm)	4" (101.6 mm)	3" (76.2 mm)
	8	298	4" (101.6 mm)	3" (76.2 mm)	4" (101.6 mm)	3" (76.2 mm)
	6 (2stg)	298	4" (101.6 mm)	3" (76.2 mm)	4" (101.6 mm)	3" (76.2 mm)
	8 (2 stg)	298	4" (101.6 mm)	3" (76.2 mm)	4" (101.6 mm)	3" (76.2 mm)

TABLE 2. 450 XL SERIES COMPRESSER DIMENSION WEIGHT

MODEL	COMP CYL QTY	*OVERALL DIMENSIONS						**SHIPPING WEIGHTS		
		V-BELT DRIVE			DIRECT DRIVE				UNIT WEIGHTS	
		L	W	H	L	W	H	BARE COMP	V-BELT DRIVE	DIRECT DRIVE
450 XL SERIES	2	69"	48"	50"	79"	41"	50"	1200	2000	1900
	4	74"	49"	52"	87"	42	52"	1600	2500	2400
	6	76"	56"	40"	93"	43"	41"	1900	3000	2900
	8	76"	56"	39"	96"	45"	39"	2200	3400	3300
	6	89"	48"	64"	89"	55"	64"	2600	3500	3300
	(2-Stage)									
	8 (2-Stage)	104"	77"	63"	132"	49"	64"	4700	6100	6100

NOTES:

* Unit length in inches, unit length dependent on size and make of motor.

** Unit weight in pounds, motor and starter not inculde in unit weights.

A. Dimensions are approximate and not to be used for construction. Certified prints will be furnished for this purpose

A. Ground Floor Installation

450 XL series Compressors are available with structural steel bases, or the customer may mount units on reinforced concrete foundations.

The Installation, illustrated in Figure 1, is recommended for the compressor that include a steel base. The raised concrete pad allows efficient cleaning while providing a level position. Regardless of method used, the unit must be level.

When placing the foundation on an existing concrete slab, the surface must be rough, thoroughly clean, dry and free of oil. Foundation bolts are to be anchored into the concrete slab, and must line up with the bolt holes on the structural steel base. If the floor is not of sufficient thickness, or if the subsoil has not been sufficiently compacted, an inertia pad will be required to support the unit and dampen any vibration.

NOTE:

For even smoother operation, once base is mounted on a concrete pad, encase base in concrete.

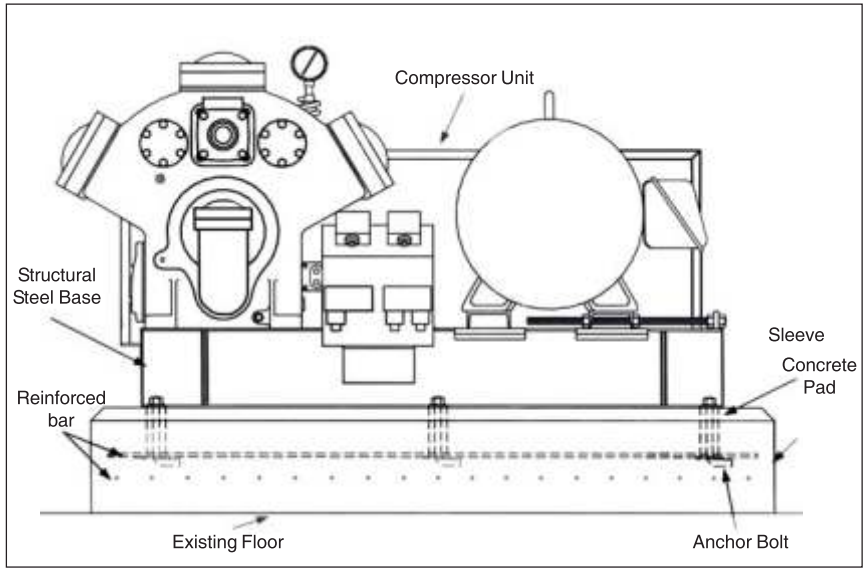


FIGURE1. TYPICAL GROUND FLOOR INSTALLATION OF 450 XLSERIES COMPRESSORS WITH STRUCTURAL STEEL BASE

B. Upper floor Installation

Install only the 2 through 8-cylinder 450 XL series Compressors on Upper floors. Upper Floor installations generally require using special vibration isolators to prevent transmission of the small residual vibration associated with machinery containing moving components to the building and to damp-out noise.

CAUTION

Three types of isolators are used- the first two types are used when mounting the structural steel base directly on isolators and the third when using a concrete pad along with the compressor unit. Follow proper adjustments for the type used.

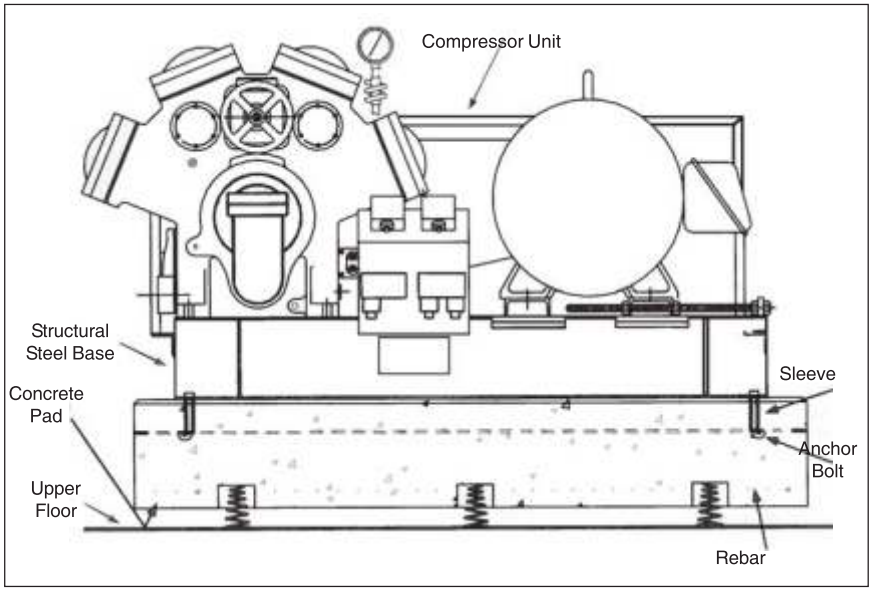


FIGURE 2. UPPER FLOOR INSTALLATION

C. Regardless of the type of isolators used, the springs should never be compressed to the point of being solid. Level adjustment of 3/4" (19.05 mm) is provided. Isolators are shipped assembled with correct springs. All springs are color coded. Use color chart furnished with isolator for spring identification. Type "W" acoustical friction pads are provided on the bottom to eliminate the need for bolting down on most installations.

1. ***Type "FLS" Vibration Isolators***

For ordinary commercial upper floor installations, the vibration can be absorbed adequately with type "FLS" vibration isolators. Such an installation, using only isolators, is accomplished by locating the bolt holes for the isolators, bolting the isolators down, making sure they are level and mounting the unit on the isolators.

2. ***Type "KIP-C" Vibration Isolators***

For more critical upper floor installations, it may be necessary to increase the static mass to further reduce the vibration amplitude. Figure 2 illustrates a practical method of accomplishing this.

Instructions for installing and adjusting the type :KIP-C" vibration isolators are as follows:

a) Place two layers of waterproof paper on sub-base where concrete foundation is to be poured.

b) Construct foundation formwork. See figure 4.

c) Place "KIP-C" mount housings (without spring elements) within formwork in accordance with foundation plan.

d) Drive nails through V-slots provided in "KIP-C" housings into formwork to keep housings in place.

e) Lay the necessary reinforcing steel in place within the formwork and locate anchor bolts for the equipment as required.

f) Pour concrete foundation, compacting thoroughly. Concrete is 137 lbs. per cu.ft. Concrete should be, at least, equal weight of the unit. In a 9" (228.6mm) high base, pour concrete in until the height is at least 4½" (114.3mm).

g) After foundation has set and cured, and formwork removed, set equipment in place on foundation.

h) Insert spring assemblies in place in "KIP-C" housings, checking carefully that assembly of proper capacity is set in each location. Spring assenblies can be identified by designation stamped on nameplate and / or colour code.

i) Center spring assembly under the washer in the top of the housing, and turn up adjustment bolt by hand until it seats within washer.

j) With wrench, take four complete turns, counterclockwise, on adjusting bolt of each mount. Repeat this procedure three additional times, making a total of sixteen turns on each bolt. Take additional turns as required to raise foundation ¾" (19.05mm) of sub-base.

k) Level foundation by taking additional turns on bolts of mounts at low side of corner.

l) If equipment requires extensive piping connections, it may be desirable to stabilize the foundation by inserting shims underneath while the piping work is done.

m) Piping should be independently supported, and brought to the equipment so pipe load is not placed on foundation.

n) After piping and electrical connections are made, shims may be knocked out and the equipment operated.

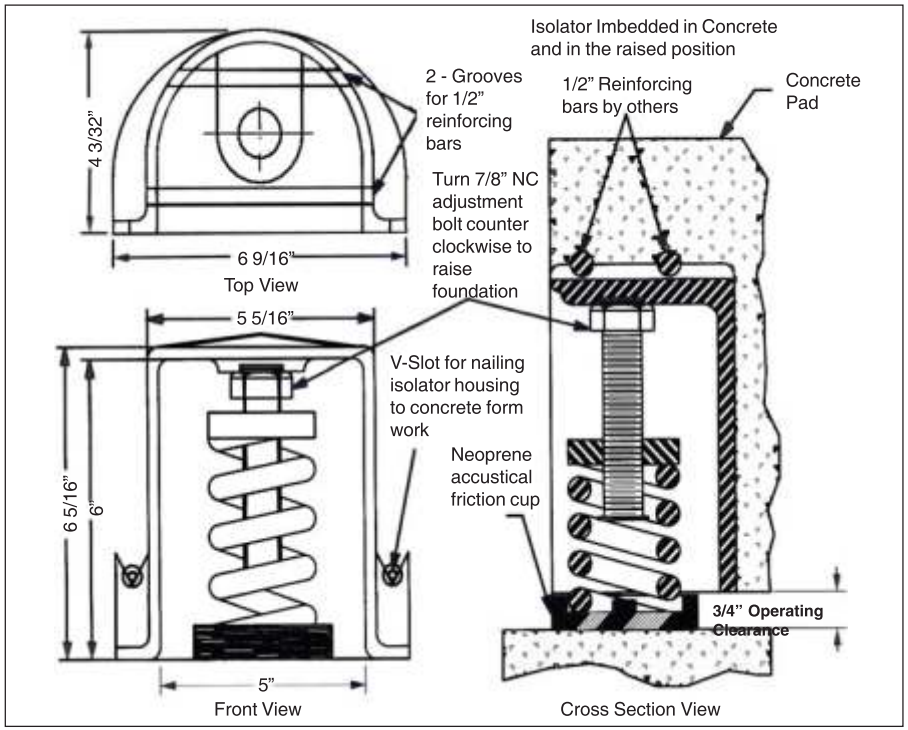


FIGURE 3. TYPE "KIP-C" VIBRATION ISOLATIONS

V. FORMS AND TEMPLATES

Prints showing foundation layouts are included with each unit. When locating the foundation, remember to allow adequate space for servicing the compressor and removing crankshaft. Consult Table 2 for overall dimensions. Crankshaft minimum allowances for the various machines are given in Table 3. These are minimum clearances in inches (millimeters) to remove crankshafts, measured from compressor frames.

TABLE3. CRANKSHAFT REMOVAL CLEARANCES

COMPRESSOR SIZE (cyl. qty.)	MODEL 400 SERIES	
	DRIVE END	PUMP END
2 thru 8	30" (762 mm)	22" (558.8 mm)

Use a form similar to that in Figure 4 to construct the concrete pad. Construct this form to withstand the weight of wet concrete. In addition, nail a 1" (25.4 mm) beveled strip around the top edge of the form to eliminate a sharp corner at the top of the pad.

Make the templates for locating the structural steel base anchor bolts from 1" (25.4 mm) to 6" (152.4 mm) boards. Accurately locate holes in the templates, and nail templates in place. Insert the anchor bolts with sleeves on them in the holes. Screw down the nuts until the sleeve is drawn up against the template.

Make this sleeve from a light weight metal shaped cylinder, to a diameter three times that of the anchor bolt. Place a washer of the same material at the bottom of the sleeve.

VI. CONSTRUCTION OF REINFORCED CONCRETE PAD

To construct a reinforced pad, place reinforcing steel rods in the concrete pad while it is being poured. Place layers of steel rods 6" (152.4 mm) apart with individual rods placed at a minimum of 6" (152.4 mm) from center to center. Position the layers in the pad to give a crosshatch effect (i.e. one layer placed lengthwise, the next crosswise, and so on). Keep the rod length about one inch less than the inside dimension of the form, so it is laid in place quickly and easily. To facilitate even spacing and quick placement, wire the rods together at 6"(152.4 mm) intervals using 6x6 wire mesh. There are variations for any given installation, but in all cases, the weight of the concrete pad should equal or exceed the weight of the compressor and drive. See Table 2 for approximate unit weights.

Extend the pad at least 6" (152.4 mm) beyond the outside of the structural steel base and at least 12" (304.8 mm) deep. Use base dimensions furnished with each compressor to locate all pad anchor bolts.

When constructing a concrete pad including vibration isolators, remember the form must be constructed and the concrete pad poured on a sub-base over which two layers of waterproof paper are place. This is so the pad is raised off the sub-base by isolators

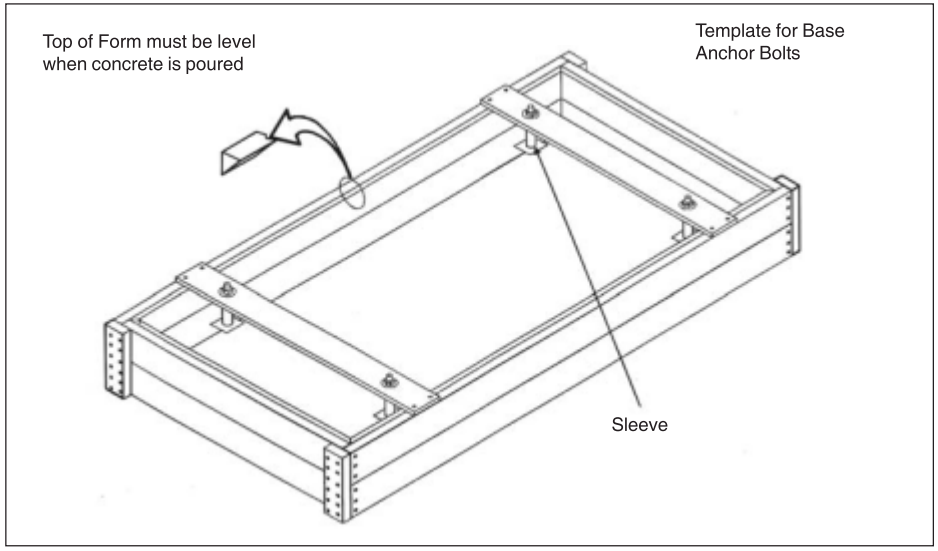


FIGURE4. CONCRETE PAD FORM

VII. CONCRETE

It is recommended the base be filled with concrete to increase vibration dampening.

The unit base must be grouted in place. Grouting ensures good contact between the base and foundation , allowing the foundation to stiffen the base as well as dampen any vibratory forces. The grout for filling the sleeves and leveling must be expanding grout rather than shrinking to provide a tighter bond.

VII. SETTING AND LEVELING UNIT ON CONCRETE PAD

Immediately before the compressor is set on the concrete pad, fill the sleeves on the anchor blots with grouting. In this way, the anchor bolts may be moved slightly, permitting final alignment with the base holes while eliminating the difficulty of filling the sleeves after the unit is in place.

When the compressor unit is placed on the concrete pad, check both lengthwise and crosswise to assure it is level. Use shims and wedges under the steel base to adjust the level of the unit if it is not satisfactory. Once the unit is perfectly level, it should be grouted in with a suitable tool for working the grunting into hard-to-get-at places.

Allow the grouting to harden completely, then tighten the anchor bolts. Recheck the unit alignment to insure its position has not changed.

XIV. DIRECT CONNECTED DRIVEN COMPRESSOR UNIT

CAUTION

IMPORTANT PRE-START OPERATION NOTICE

The drive coupling installed on your compressor is NOT completely aligned. Do NOT attempt to run until proper motor-coupling- compressor alignment is attained .Misalignment beyond specified limits causes excessive vibrations and premature failure of bearings, coupling and seal.

The same care in installing and aligning the flexible coupling used on direct connected 450 XL series Compressors should be exercised when installing a rigid flange coupling. To correctly install and align the coupling, see the insert to manufacturer" procedures. The Thomas Coupling Division type number must be known in order to use these aligning instructions. Some couplings are only identified with a Viter part number. In those cases. Use cross reference Table 3 to find the corresponding Thomas type number.

See Figure 5 for recommended direction of compressor rotation.

X. V-BELT COMPRESSOR UNIT

450 XL series Compressors equipped with "5V" (equivalent "SPB") V-belt drives are designed to meet necessary horse power requirements. They are furnished as a matched set of individual V-belts, or optionally (at added cost), as a banded (joined) unibelt.

The V-belt is one of the simplest and most dependable methods of trasmitting power from one machine to another. The drive, when properly installed, is quiet, relatively smooth operating, and practically maintenance free. Use of the correct tension in any V-belt drive is necessary to obtain the maximum service and capacity from the drive. Excessive tension will greatly decrease the service life of the V-belts while insufficient tension will not allow the V- belts to transmit maximum load.

CAUTION

Because equipment alignment could be disrupted during shipment, check drive alignment before start-up. Always follow proper V-belt tensioning procedures. See V-belt drive tag furnished with equipment.

TABLE 4. DRIVE COUPLING PART NUMBER CROSS REFERENCE

THOMAS COUPLING DIVISION TYPE	450 XL PART NUMBER				
	TAPER BORE HUB (COMPRESSOR)		CENTER MEMBER ASSEMBLY	STRAIGHT BORE HUB (MOTOR)	
	BORE DIMENSIONS (LARGE END)	PART NUMBER		BORE DIMENSIONS	PART NUMBER
201 DBZ-B	1.883" / 47.8 mm	1890A	1891A	1.375" / 34.9 mm 1.625" / 41.3 mm 1.875" / 47.6 mm Pilot hole	1896A 1896B 1896C 1896D
226 DBZ-B	1.883" / 47.8 mm	1890B	1891B	1.875" / 47.6 mm 2.125" / 5.4 mm 2.375" / 60.3 mm Pilot hole	1896E 1896F 1896G 1896H
262 AMR	1.992" / 50.6 mm	1890C	1891C	1.875" / 47.6 mm 2.125" / 5.4 mm 2.375" / 60.3 mm Pilot hole	1896J 1896K 1896L 1896M
312 AMR	1.992" / 50.6 mm 2.484" / 63.09 mm 2.984" / 75.79 mm	1890D 1890E 1890F	1891D	2.125"/ 54 mm 2.375" / 60.3 mm 2.875" / 73 mm Pilot hole	1896N 1890P 1896Q 1896R
350AMR	1.992" / 50.6 mm 2.492" / 63.3 mm 2.992" / 75 mm	1890G 1890H 1890J	1891F	2.125" / 54 mm 2.375" / 60.3 mm 2.875" / 73 mm Piolot hole	1896S 1896T 1896U 1896V
375 AMR	2.492" / 63.3 mm 2.992" / 76 mm	1890K 1890L	1891F	2.375" / 60.3 mm 2.875" / 73 mm 2.375" / 60.3 mm Pilot hole	1896W 1896X 1896Y 1896Z

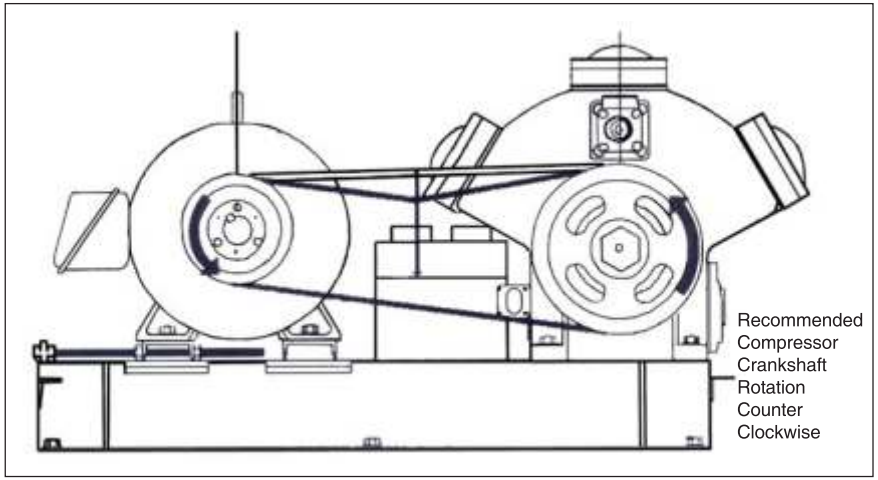


FIGURE 5. SHEAVES AND BELTS

A. V-Belt Installation

The motor of the v-belt driven compressor is mounted on a slide rail that enables movement of the motor toward or away from the compressor by loosening four adjusting screw lock nuts, eight guide clamp bolts and nuts, and turning the two adjustment screws. The proper method of installing v-belts is as follows:

1. Move the sheaves toward each other to each V-belt installation.

> **NOTE:**
>
> Mount the motor sheave as close as possible to the motor housing. Keeping the V-belt pull as close to the motor and compressor as possible gives the most rigid mounting, minimizing v-belt flopping.

2. Work V-belts around the sheaves by hand. On drives having more V-belt grooves in the sheaves than needed, use grooves closest to the motor and compressor. Make sure the V-belts are all slack on the same side of the drive preferably the bottom. Drive should pull tight across the top of flywheel. Never mix slack and tight sides as this could cause serious damage to the V-belts when tightening the drive. Never pry or "roll" V-belt onto the sheaves. This can cause serious tearing and damage to the V-belts.
3. Move the sheaves apart until the V-belts are snug.
4. The motor rails should be perpendicular to the base. Check compressor for soft foot and shim accordingly.
5. Check the motor and compressor shafts to make sure they are parallel. Check the flywheel and motor sheave with a straight edge, string or wire to be sure they are parallel, and in the same plane. See Figure 6. Fix any misalignment by moving the motor by means of adjusting screws.
6. Recheck drive and tension. Adjust, if necessary, after 2 to 4 hours and again after 24 to 48 hours of operation to compensate for initial stretch and wearing of the V-belts.
7. Make periodic checks of drive tension. Speed ratio and tension should be restored as necessary. The change in speed ratio from no load to full load should not exceed 1%.
8. Save used V-belts for emergency replacement, but never mix new and used V-belts on a drive.
9. Keep V-belts as free of dirt and oil as possible .Never paint V-grooves on flywheel or sheave.
10. Never use V-belt dressing on V-belts.

B. V-Belt Adjustment- General Comments

Tension usually is not critical but a few simple rules satisfy most requirements.

- Best tension for a V-belt drive is the lowest tension at which the V-belts will not slip under the highest load condition.
- Check tension frequently during the first day of operation.
- Too much tension shortens V-belt and bearing life.
- Keep V-belts and sheaves free of any foreign material, which may cause slip.
- If a V-belt slips, determine the cause for slippage and take corrective action.

C. Single "5v" (or SPB) V-Belt Adjustment

The method of checking single V-belt tension using numerical values is as follows.

1. After proper V-belt installation, measure the span in inches.
2. Use a spring scale at right angles to the center of the span. Apply enough force to deflect the V-belt 1/64th of an inch for every inch of span length and record the scale reading. The range of force should be 12 to 18 lbs.
3. Make sure equal tension exists on all V-belts in a set. Correct original tensions, as needed, by shifting the motor slightly. This point is very important. For example, on a four V-belt set drive, tension readings of 14, 13, 13, and 12 (although the average is 13 pounds) indicate misalignment and probable trouble. Drive horsepower capability can be reduced by as much as 50% if uniform V-belt tension is not attained. V-belts could slip, pop out of grooves or roll over.
4. Run the compressor at full load in the recommended direction. This direction tends to tighten rather than loosen the front bearing lock nut. This is extremely important if the locking compound is accidentally omitted. Be certain V-belts are not slipping. The belts will not slip when the correct tension has been applied.
5. After operating 2 to 4 hours, retension the drive to the high side of the normal required tension.
6. It is recommended that belt tension be checked 24 to 48 hours after initial installation.
7. Recheck the motor and compressor shafts and sheaves for alignment. If shafts or sheaves are not in alignment, V-belts tend to turn over in the grooves and wear unnecessarily fast, leading to noise and loss of transmission efficiency.

> **NOTE**
>
> Do not attempt to mix V-belts. Use only matched V-belts provided by manufacturers and always specify type and size of V-belts. Do not use uncoated belts.

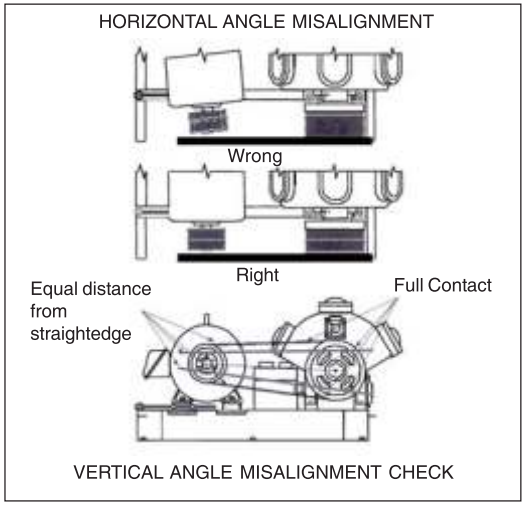


FIGURE 6. BELT ALIGNMENT

D. Banded (Joined) "5V" (or SPB) V-Belt Adjustment

To check banded "5V" V-belt tension, use the following methods.

1. *Method "A"*

Multiply the pounds of deflection force of 12 to 18 pounds by the number of V-belts in the band. Apply the tension tester to deflect the entire band. Place a small board or metal plate on the top of the band so all V-belts in the band are deflected a uniform amount. Place a straightedge across the sheaves to use as a reference for measuring deflections.

2. *Method "B"*

Move the sheaves closer together to facilitate installation of banded V-belts .Re move slack from V-belts. Measure the outside circumference of V-belt to the nearest 1/4" (6.35 mm). Multiply this reading by 0.0075 to 0.01, and add this amount by your circumference length. (Example: 80" x 1%= .8"+80"= 80.8")

E. V-Belt Removal For Servicing

Whenever it is necessary to remove V-belts for equipment servicing, follow the installation procedure outlined for the initial tensioning of the V-belts, whenever the belts are reinstalled.

XI. ACCESSORIES AND ASSOCIATED EQUIPMENT

A. Oil Separator

1. *General Description*

The oil separators of 450 XL Compressors are either the demister pad standard oil separator or the flanged coalescing element Super Separator.

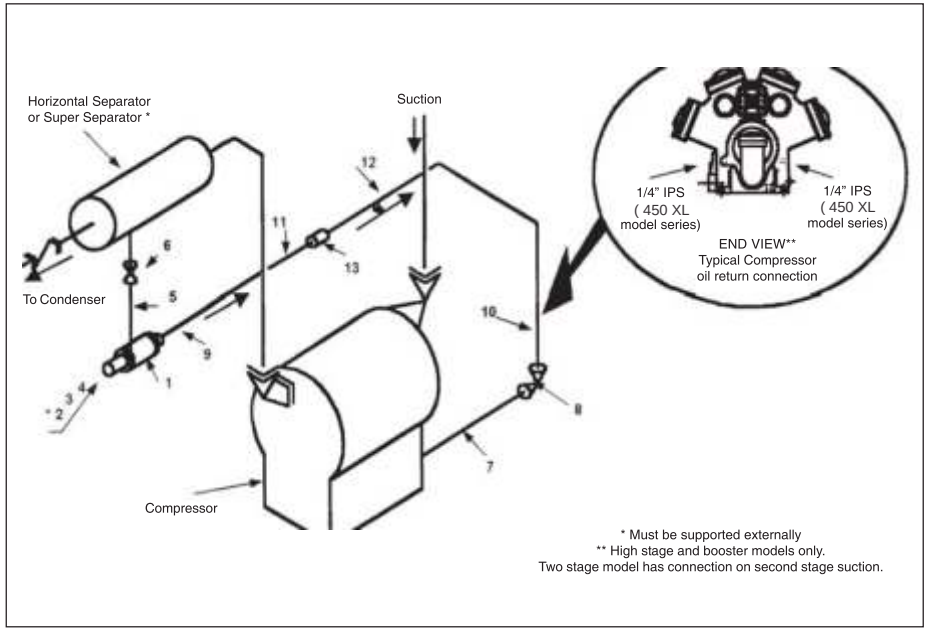
Both styles of oil separators are mounted on the compressor discharge line. The standard style oil separator can only be mounted in the horizontal position. The Super Separator style oil separator can be mounted in vertical or horizontal positions.

> NOTE:
>
> The separator should be installed with the flow in the direction of the arrow on the separator.

The separator and piping should be supported so no piping loads are transmitted through the compressor frame.

No initial oil charge is necessary for these separator types. Oil separators prevent oil from reaching the evaporator where it would impair efficiency. They are especially recommended for flooded system, low temperature applications, and any other installation where oil return from the low side may not be positive.

Horizontal Oil Separators are constructed for use with either steel pipe or copper tubing. The steel inlet and outlet connections are counterbored to form a socket so they will accept copper tubing. Cut off the counterbored portion when using this oil separator with steel pipe. The wall thickness of the counterbored portion is too thin for the discharge pressure involved.



	ITEM	DESCRIPTION	INSTALLATION KIT PART NO.
KEY	1.	External High Pressure Float Valve	
	2.*	Float Champer	KT1019 (Ammonia)
	3.	Inner Flange Gasket	Or
	4	3/8" x 1 1/4" Cap Screws (Qty. Six)	KT1018 (Halocarbon)
	5.	1/2" x 3" lg. Sch.160 Pipe Nipple	
	6.	1/2" Standard Screw End Valve	
	7.	1/4"x 2 1/2 lg. Sch. 80 Pipe Nipple	
	8.	1/4" Angle Screw End Valve	
	9.	1/4" O.D. X 1/4" FPT Compression Connector	KT1017 (Ammonia)
	10	1/4" O.D. X 1/4" MPT Compressor Connector	Or
	11.	1/4" O.D. X 10 ft. Steel Tubing (Qty. Two)	KT1016 (Halocarbon)
	12.	1/4" O.D. Tubing Clips (Qty.Six)	
	13.	1/4" O.D. X 1/4" O.D. Compression Union	

FIGURE 7. PIPING SCHEMATIC, TYPICAL OIL SEPARATOR INSTALLATION

2. ***Oil Separator Float Valve***

An external high pressure float valve is use in conjunction with the oil separator. A 1/4" (6.35 mm) line coming from the float valve returns oil to the compressor. On the 400 Series Compressors, oil is returned to the crankcase chamber on the pump end of the compressor.

NOTE

This float valve is designed to open when oil level in the float chamber rises. Make a visual check before installing in chamber. The word "TOP" is stamped on the outside of the float valve flange. Remove the tie wrap on float valve. This used to transport the valve. The float valve must be installed in the chamber as indicated on the flange. Proper positioning at installation will ensure trouble free operation later.

Connect the flat valve chamber and flat valve to the separator with tubing. Use the support plate to hold the float valve chamber. **DO NOT** support the float valve chamber by the tubing or pipe along the separator or weld on the separator or flat valve chamber. The float valve outlet should be in the horizontal plane.

B. Crankcase Heater

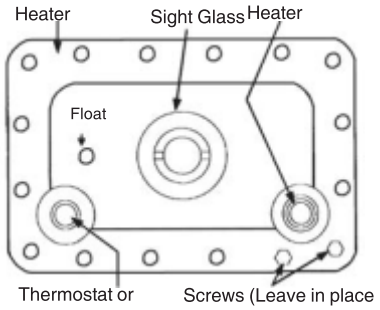
Three types of crankcase heaters are available for use with all 450 XI series Compressors. The first is a blanket heater cemented to the bottom of the compressor. It is primarily used in outdoor applications.

The second type is an immersion type heater. It is mounted in the crankcase handhole cover (on 450 XL series Compressors only). These heaters keep the crankcase and oil warm during the "off cycle, preventing refrigerant from condensing. When refrigerant condenses in oil during the "off" cycle, lubrication problems and "nuisance" oil failures are possible. The crankcase heater prevents this in most cases.

The third type is a cartridge type heater. It is mounted in the drive end of the frame on 300 Series 450 XL Compressors. When installing the heater, make electrical connections by removing the heater cover and inserting wires through the knock-out holes. Be sure the heater is on a separate circuit. **Never combine with other control circuits.**

NOTE

It is extremely important the heater be energized when the compressor is not operating, for compressor having a TRI-MICRO® filter with out internal bypass. The heater is equipped with a non-adjustable internal thermostat set at 100 ^{0} F (37.8^{0} C).



TYPICAL CRANKCASE HANDHOLE COVER - 450 COMPRESSOR MODEL SERIES

To install or replace a crankcase heater on a 450 XL Series Compressor already in service, pump down the compressor as described in the Service Section.

If heater is to be replaced, use appropriate lockout and tag out procedures and electrically disconnect the heater before removing oil. The oil drain valve at the lower end of the compressor should be opened and the oil allowed to drain out completely. Next (only on 450 XL Series Compressors), remove the handhole cover and substitute with a cover having a drilled and tapped hole for the heater.

Place the cover in a vise, making sure the two screws below the heater are left in place. If this is not done, the two screws can not be re-inserted into the holes due to interference of the installed heater. Insert the heater element through a tapped hole and tighten the fitting.

Position the heater so the electrical connections are in the correct orientation. Connect wires as explained previously, and replace the handhole cover.

Refill the crankcase with oil and return the compressor to service. It is not necessary to pump the compressor down and remove the oil to change the cartridge heater.

C. Oil Cooler

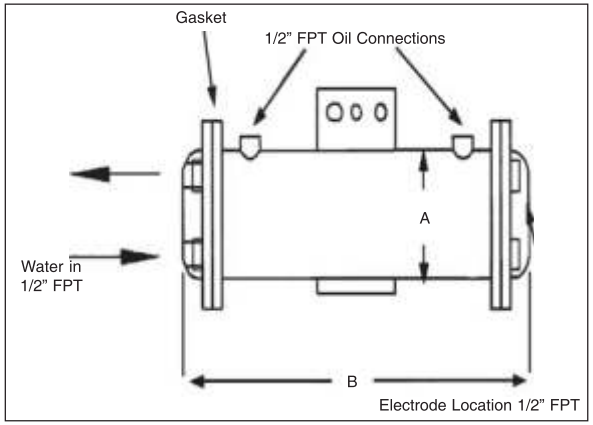
1. ***Introduction***

Multipass shell and tube oil coolers are furnished on many 450 XL Compressors, and are mounted at the pump end. Oil coolers prevent excess thinning of oil during operation, and decrease oil consumption. Cooler oil oxidizes less, reducing sludge deposits in the compressor.

Oil from the compressor pump enters the cooler, then the TRI-MICRO filter. Water enters on the tube side. It flows through the cooler, and is expelled to a drain or condenser sump.

NOTE

Water circuit through oil cooler and water cooled heads is in parallel. See "Operation" section



SHELL & TUBE OIL COOLER

STANDARD OIL COOLER APPLICATION

Quantity of cylinders	Oil cooler nominal Overall dimensions	
	"A"	"B"
2 and 6 Cyl 450 XL Series	2"	20" 508 mm
8 Cyl 450 XL Series	3"	20" 508 mm

2. Installation

a) *Strainers and Filter:*

We recommend the use of strainers when foreign matter is present in the water. Certain types of service require suitable filters to maintain standard efficiency.

b) *Piping Layouts:*

All water piping leading into the oil cooler should be of sufficient size to assure an adequate supply of water.

c) *Zinc Electrodes:*

All coolers designed for marine service are provided with one or more Zinc electrodes. Make sure all required electrodes are installed in the oil cooler prior to placing in service.

d) *Prevention of Gasket Leaks.*

Check all bolts for tightness before installing and oil cooler. Use caution when tightening bolts to prevent gasket surface damage.

3. *Operating Pressure*

All vilter shell and tube oil coolers are designed for 300 psig (2068.44 kPa) on both the oil and water sides.

4. *Inspection*

Because water contains a variety of chemicals in solution, and the water side of the cooler is continually exposed to those chemicals, inspect the condition of the tubes frequently, inspect the tube side for any evidence of corrosion, scaling or other fouling. If there is evidence of these problems, take steps to correct them immediately.

NOTE

Because 450XL Series Compressor has no control over field conditions of cooling water, The compressor, cannot assume liability for damage to the compressor or the system due to problems arising from corrosion, scaling or fouling.

5. *Service*

a) Temperature Control:

The function of the cooler is to maintain specified oil temperatures. When the temperature of the oil rises above normal, it is an indication some part of the temperature control system is not functioning properly, or a system or mechanical problem in the compressor. Inspect all manual and automatic control valves in the system for correct operation. Check all pressure gauges and thermostats. Inspect the water level to make sure proper flow through the cooler has been provided. Clean all strainers.

b) Disassembly and Cleaning:

If the temperature does not return to normal after adjustments are made, and the specified amount of cooling water is circulating through the tubes, inspect the cooler for foreign deposits.

When material accumulate in the cooler, cooling efficiency is impaired. Those materials should be removed. Remove all foreign substances from inside heads. Clean all gasket surfaces and install new gaskets wherever necessary. The type and condition of the water used and the operating conditions determine the cleaning periods. Using strainers in water lines extends the period between cleanings.

NOTE

The concentration of chemicals and temperature varies in sea water, and consequently, the disintegration of zinc electrodes will be more rapid under some conditions. This is especially true where water is warm. It is important zinc electrodes are inspected once every thirty days. The condition of the zinc electrodes at the time of inspection should govern the policy for future servicing. If zinc electrodes are corroded and coated with foreign material, electrodes effectiveness is either retarded or greatly reduced. Clean electrodes by wire brushing and scraping. If after cleaning, zinc electrodes are more than 50% disintegrated, they must be replaced. Make certain zinc electrodes are tightened to ensure good metal contact.

D. Water Cooled Cylinder Covers

Water cooled cylinder covers are furnished for some models of 450 XL Series Compressors. They are mounted on top of the standard cylinder covers. Maintain an adequate supply of water to the water cooled covers in order to prevent minerals in the water from depositing in lower and causing early fouling. When water is 80^0 F (23.7^0 C) or lower, the recommend quantity is 2 1/2 to 4 GPM (0.16 to 0.25 L/sec) for 2 thru 8 cylinder machines and 5 to 8 GPM (0.32 to 0.51 L/sec) for 12 and 16 cylinder machines, depending upon discharge temperature. (The 12 and 16 cylinder machine connections are actually 2,6 or 8 cylinder systems in parallel.) Table 6 shows the pressure drops through the cylinder covers for the recommended minimum and maximum flow rates.

If the necessary water pressure is not available, water connections should be configured in parallel and the quantity of water increased proportionally. A 1/2" (12.7mm) thermostatic water regulating valve should be provided in the inlet to control water flow and connect the outiet to an open drain or condenser sump.

A provision should be made to shut off the water the machine is stopped. The most positive way is to connect a solenoid water valve between the regulating valve and the valve between the regulating valve and the jacket inlet with electrical connections made so the solenoid is open when the compressor is running and closed when the compressor stops.

Regulate the water quantity to maintain a temperature of 100^0 F (37.8^0 C) off cylinder covers.

CAUTION

To avoid condensation of refrigerant in the compressor, turn off water flow through the heads during compressor shutdown.

TABLE 6. COMPRESSOR COOLING WATER FLOW RATES

COMPRESSOR SIZE	MAXIMUM		MINIMUM	
	GPM	Pressure Drop	GPM	Pressure Drop
2 CYL	4 0.25 l/sec	2.5 psi 17.2 kPa	$2^1/_2$ 0.16 l/sec	1.3 psi 9 kPa
4 CYL	4 0.25 l/sec	5 psi 34.5 kPa	$2^1/_2$ 0.16 l/sec	2.5 psi 17.2 kPa
6 CYL	4 0.25 l/sec	7.5 psi 51.7 kPa	$2^1/_2$ 0.16 l/sec	3.8 psi 26.2 kPa
8 CYL	4 0.25 l/sec	10 psi 68.9 kPa	$2\ ^1/_2$ 0.16 l/sec	6 psi 34.5 kPa
2 STG 6 CYL	4 0.25 l/sec	7.5 psi 51.7 kPa	$2^1/_2$ 0.16 l/sec	3.8 psi 26.2 kPa
2 STG 8 CYL	4 0.25 l/sec	10 psi 68.9 kPa	$2\ ^1/_2$ 0.16 l/sec	6 psi 34.5 kPa

NOTE

In order to further minimize the possibility of condensation, water flow through the cylinder cover is routed through the loaded cylinder banks first. This inlet to the loaded heads will always be on the side opposite the crankcase handhole cover.

E. Water Regulating Valve

A wide variety of water regulating valves are available for use with water cooled condensers. They maintain a constant condensing pressure and prevent waste of water.

Water regulating valves are installed at the water inlet of the condenser. There is a small capillary tube running from the valve to the discharge line of the compressor, the hot gas line, or the top of the condenser. When the pressure builds up on the high side of the system, it is transmitted through this capillary to the valve this acts against a spring, holding the valve closed.

Spring tension can be varied by means of an adjusting screw on the valve. When the valve is adjusted properly, it automatically opens and closes in response to the pressure on the high side of the system, maintaining a constant condensing pressure.

When cooling towers are used and no other positive means of regulating head pressure is provided, a water pressure regulating valve serves to regulate head pressure. Adequate head pressure is often important to provide proper refrigerant flow through expansion valves or float valves in order to maintain the suction pressure above the setting of the low pressure cut-out to prevent short cycling.

XII. SAFETY DEVICES

Plant safety requirements vary according to local ordinances. Research local codes before construction begins. In addition to devices for refrigerant control, safety devices are required for belt (full guards) and electrical equipment. (When required, a totally enclosed belt guard is available for 450 XL series Compressors)

NOTE

Make all arrangements for installation of electric power and inspection services by local authorities prior to construction, so all works is performed before the compressor trial run.

XIII. ELECTRICAL EQUIPMENT AND SPECIFICATIONS

Electric solenoid valves for liquid and solenoid lines used in automatic refrigeration systems should always be mounted outside of the refrigerated room, if possible, in all installations. If it is impossible to mount the electric valves outside the low temperature room, mount the valves so no moisture drips into them during defrosting periods or any other time. In fresh produce, banana storage rooms, considerable moisture is always present in the air. Under no circumstances should electrical equipment be mounted in the room or difficulties will be experienced within a short time in electrical wiring as well as control devices.

Mount thermostats outside of the refrigerated room. Only the remote bulb of the temperature controller is in the refrigerated space.

For proper electrical connections, color code all control circuits. All wires common to the same control wire starting from the motor starter, should be the same color. Where a temperature difference exists between various rooms in which the electric wiring is run, make provision for sealing off the conduits between such rooms. This is necessary to prevent condensation forming in the lower temperature room.

Connect control devices, such as electric valves, pressure switches, and thermostats with flexible conduit or “BX” armored cable, according to local electircal code. These flexible connections permit the devices removal with no difficulty. Locate these devices with sufficient head room to permit removal from the piping lines.

It is necessary for the electrical contractor to make additions as required for construction purposes when meeting local code requirements.

XIV. TESTING REFRIGERATION SYSTEM FOR LEAKS

Before proceeding with testing the system for leaks or evacuation of the system, please review all local laws and ordinances for information on the specific refrigerant used.

All the equipment are factory tested for leaks. After the equipment is leak-free, the unit is charged slightly above atmospheric pressure with a holding charge of nitrogen. This prevents impurities from entering the equipment during shipment. Upon receipt of the equipment, thoroughly check to see if a leak has developed. If a leak has developed, it should be repaired, tested, evacuated, and charged as described in the following pages.

One of the most important steps in installing a refrigeration system is testing for leaks. Testing ensures a tight system which will operate without loss of refrigerant. To test for leaks, pressurize the system. Do not use the compressor to build pressure as the compressor is not designed to pump air. Serious overheating and damage could result.

Test pressure for various refrigerants are listed in ASHRAE Standard 15 Code brochure entitled “Safety Code For Mechanical refrigerants”. These pressures usually suffice. Research local codes and ordinances before testing begins.

Determine the system tolerances for safety devices and relief valves. If the test pressure exceeds system tolerances, then remove valves and the appropriate devices:

- Plug all connections.
- All valves should be open except those leading to the atmosphere.
- Manually open all solenoids and pressure regulators.
- Open all bypass devices and proceed with testing.

Because of differences in characteristics of various refrigerants, two different testing methods are necessary.

A. Ammonia Systems

Dry nitrogen may be used to raise the pressure in an ammonia system to the proper level for the test. The gas may be put into the system through the charging valve or any other suitable opening.

Carbon Dioxide should NOT be used as a testing gas in a system in which ammonia is already dissolved in any moisture remaining. This will cause ammonium carbonate to precipitate when the **CO_2** is added. If heavy enough, this precipitate may cause the machine to freeze and clog the strainers.

A moisture of four parts water to one part liquid soap, with a few drops of glycerin added, makes a good testing solution. Apply this mixture with a one inch round brush at all flanges, threaded joints, and welds. Repair all visible leaks. If possible, leave the pressure on over night. A small pressure drop of 5 lbs. Over this period indicates a very tight system. Remember to note the ambient temperature as a change in temperature will cause a change in pressure.

After the system is thoroughly tested, open all valves on the lowest part of the system and arrange to carry the gas away from the compressor, so dirt or foreign particles cannot enter the working parts. The oil should then be charged into the compressor as described in Paragraph XVI of this section.

Charge a small amount of ammonia into the system. Pass a lit sulfur stick around all joints and connections. Any leaks will be indicated by a heavy cloud of smoke. If any leaks are observed during this test, they must be repaired and rechecked before the system can be considered tight and ready for evacuation.

B. Other Refrigerant Systems

Dry nitrogen may be used to raise the pressure to the proper level for testing.

When the proper pressure is attained, use a one inch round brush and test for leaks with a mixture of four parts water and one part liquid soap with a few drops of glycerin added. Apply to all flanges, threaded, soldered, or welded joints. Observe all welded joints and pipes. If a leak is present, the escaping gas causes the test solution to bubble. After all leaks are found and marked, relieve system pressure, and repair the leaks. Never attempt to repair soldered or welded joints while the system is under pressure. Defective joints should be opened and resoldered. Do not add more solder to the leaking joint. After all the joints are repaired and the system is considered “tight”, retest the system with refrigerant.

Attach a drum of refrigerant to the system and allow the gas to enter until a pressure of 5 psig (34.47 kPa) is reached. Remove the refrigerant drum and bring pressure to the recommended test level with oil pumped dry nitrogen. Check the system for leaks using an appropriate leak detector. Check all flanged, welded, screwed, and soldered joints, all gasket joints, and all parting lines on castings. If leaks are found, repair and recheck them before the system is considered tight. No repair should be made to welded or soldered joints while the system is under pressure.

C. Evacuating The System

A refrigeration system operates best when only refrigerant is present. Steps must be taken to remove all air, water, vapour and all other non-condensibles from the system before charging it with refrigerant. A combination of moisture and refrigerant, along with any oxygen in the system, can form acids or other corrosive compounds which corrode internal parts of the system.

To properly evacuate the system, and to remove all non-condensibles, air and water vapour, us a high vacuum bump capable of attaining a blanked off pressure of 50 microns or less. Attach this pump to the system and allow it to operate until system pressure is reduced some where below 1000 microns. Evacuation should not be done unless the room temperature is 60°F (15.6°C) or higher.

Attach vacuum gauge(s), reading in the 20 to 20,000 micron gauge range, to the refrigerant system. These gauge(s) should be used in conjuction with the high vacuum pump. The reading from these gauge(s) indicates when the system has reached the lowest absolute pressure required for complete system evacuation.

Connect the high vacuum pump into the refrigeration system by using the manufacturer’s instructions. Connect the pump both to the high side and low side of the system, to insure system evacuation. Attach the vacuum gauge to the system in accordance with the manufacturer’s instructions.

A single evacuation of the system does not satisfactorily remove all of the non-condensibles, air and water vapour. To do a complete job, a triple evacuation is recommended. When the pump is first turned on, bring system pressure to as low a vacuum level as possible, and continue operation for 5 to 6 hours.

Stop the pump and isolate the system. Allow the unit to stand at this vacuum for another 5 to 6 hours. After this time, break the vacuum and bring the system pressure up to 0 psig (0 kPa) with dry nitrogen.

To begin the second evacuation, allow the pump to operate and reduce the pressure again to within 50 to 1000 microns. After this reading is reached, allow the pump to operate 2 to 3 hours, stop the pump and let the system stand with this vacuum and again with dry nitrogen, raise the system pressure to zero.

For the third evacuation, follow the previous procedure with the pump operating until system pressure is reduced below the 1000 micron level. Run the pump an additional 6 hours and hold system for approximately 12 hours at low pressure. After this, again break the vacuum with dry nitrogen and allow the pressure in the system to rise slightly above zero pounds (psig). Install new drier cartridges and moisture indicators. Evacuate the system once more below the 1000 micron level, and charge with refrigerant designed for the system.

When properly evacuating the system as outlined above, the system is dry, oxygen-free and free of non-condensibles. The piping should not be insulated before the evacuation process is started. If moisture is in the system before evacuation, it will condense in low places and freeze. If this happens, it can be removed by gently heating the trap farthest away from the vacuum pump. This causes the ice to melt and water to boil. Water vapour collects in the next trap towards the vacuum pump. This process should be repeated untill all pockets of water have boiled off, and the vacuum pump has had a chance to remove all the water vapour from the system.

XV. COMPRESSOR OIL CHARGING

The company has made available to the field, hand-operated oil charging pumps. This pump is used in putting the original oil charge into the compressor crankcase as well as charging oil later during service operations. Using the pump eliminates the need for providing a vacuum on the compressor in order to charge oil into it.

After charging oil the charging valve on the compressor should be closed to relieve pressure on the oil charger check valve.

Reserve one to two gallons of the total compressor oil charge and charge into the compressor via the oil gauge connection just before initial start-up. Follow this same procedure after a compressor is shut down for an extended period of time. This helps eliminate “dry” start-up by forcing oil into small oil passage ways. Charging oil at this point is done as follows:

Remove the oil pressure gauge. Connect the oil charging hose (electric or manual) to the oil pressure gauge connection. Open the valve and begin charging. Continue charging until a sufficient amount of oil is charged. Disconnect charging hose, close valve and reassemble gauge and Stedy-Mount.

When several compressors are connected to a common system, it is recommended that oil equalizing connections between compressors be provided. This eliminates the possibility of oil build up in one compressor and insufficient oil in others.

Table 7. 450 XL series Compressor Crankcase Oil Charge

Cylinder quantity	Oil Charge (Ltrs.)	*Cylinder quantity*	Oil Charge (Ltrs.)
2	22	*8*	27
4	27	-	-
6	27	-	-

A. Oil for 450 XL Series Compressors

Due to the need for adequate lubrication Frick India recommends only the use of specific lubrications, designed specifically for 450 XL series Compressors. With the expensive research, we are able to offer refrigerant specific lubricating oil. Use of oil not specified or supplied by Frick india will void the compressor waranty.

XVI. SYSTEM REFRIGERANT CHARGING

After the system is leak-free and evacuation is complete, it is ready for charging. Prior to final charging, the entire operation of the refrigeration system should be inspected as outlined below:

A. Equipment Inspection

1. Low Side Equipment

a) Fans on air handling equipment running.

b) Pumps on water cooling equipment running.

c) Proper location and attachment of thermostatic expansion valve bulb to suction line.

d) Correct fan and pump rotation.

e) Evaporator pressure regulators and solenoid valves open.

f) Water pump and motor correctly aligned.

g) V-belt drives accurately aligned and tensioned.

h) Proper power voltages to motors.

2. Compressors

a) Correct oil level.

b) Voltage agrees with motor characteristics.

c) Properly sized motor fuses and heater.

d) V-belt drives aligned and couplings tight.

e) Direct drives aligned and couplings tight.

f) All suction and discharge valves open.

g) All gauges reading correctly.

3. Condenser

a) Water available at water cooled condensers and supply line valve open.

b) Water in sump of evaporative condenser and make-up water available.

c) Correct rotation of pump and fan motors.

d) V-belt drives aligned and tensioned correctly.

e) Pump, fans and motor lubricated.

4. Controls

a) controls at proper setting.

B. Refrigerant Charging

There are two methods of charging refrigerant into the system, through the “high side” or through the “low side”. High side charging is usually used for initial charging because this method fills the system much faster. Low side charging is usually reserved for adding only small amount of refrigerant after the system is in operation.

1. *High Side Charging - Initial Charging*

a) Connect a full drum of refrigerant to the liquid charging valve, following all applicable safety and venting law procedures.

b) Invert the refrigerant drum if drum is not equipped with “Liquid” and “Vapour” valves, and place in such a position the refrigerant can only enter the system. The vacuum in the system will draw in the refrigerant. It is important that during this operation the air handling units are running and water is circulating through the chillers. The low pressures in the system can cause the refrigerant to boil at a low temperature and possibly freeze the water if it is not kept circulating. Water freezing in a chiller can rupture the tubes and cause extensive damage to the system. It is desirable to charge the initial amount of refrigerant without water in the shell and tube equipment to eliminate the possibility of freeze up.

c) After some refrigerant has entered the system, carefully start the compressor. It is essential the compressor be allowed to pick up the load gradually and let it run for a few minutes at a time. During its intermittent operating period, the operator should check for the proper oil pressures and excessive heating at the bearings. In between running periods, allow the compressor to cool. The running periods may be gradually lengthened until the operator is sure no moving parts are heating excessively. The compressor may then be operated automatically.

CAUTION

Take care refrigerant does not flood into the compressor. Liquid slugging can cause considerable damage.

d) Continue charging refrigerant into the system until the design operating requirements are satisfied. Close the liquid charging connection. Open the liquid line valve allowing the system to operate normally. When enough refrigerant has been added, the liquid sight glass shows no bubbles. If these two conditions are not satisfied, add additional refrigerant.

e) When sufficient refrigerant is charged into the system, close the charging and drum valves. Then remove the drum from the system.

f) During the charging period, watch the gauge to ensure no operating difficulties. Check head pressure to make sure condensers are functioning properly.

Since it is usually necessary to use more than one drum when charging a system, follow procedures in paragraph (a) and (b) under the title “High Side Charging-initial charging”, when attaching a new drum. After charging, keep the refrigerant drums nearby for several days as it is sometimes necessary to add more refrigerant once the system “settles down”.

2. *Low Side Charging - Adding Refrigerant To Operating System*

Use low side charging on small systems only when adding a small amount of refrigerant. Unlike high side charging, where refrigerant is added as a liquid, in low side charging, refrigerant enters as a gas. This method is relatively slow. To charge refrigerant into the low side, use the following procedure:

a) Keep the refrigerant drum in an upright position. Close the valve to the suction gauge and remove the line to the suction valve. Attach a tee to the valve and reconnect the gauge to the tee. Connect the charging line, following all applicable safety and venting law procedures.

b) To charge gas into the compressor, throttle the valve to create a lower pressure in the compressor.

Open the drum valve marked “Vapor”, if drum is equipped with two valves. Then, open the gauge valve and refrigerant will draw out of the drum and into the compressor.

FOR HALOCARBON UNITS ONLY

During the charging process, the drum may get too cold. This prevents gas from boiling off fast enough. Heat can be applied to the drum. Place the drum in a pail of warm water not exceeding 125°F (51.7°C) or wrap the drum in burlap and pour hot water on it.

CAUTION

Direct flame or steam must Never be applied directly to the drum, as this can produce dangerous pressures in the drum.

c) Check the sight glass during charging. When the bubbles stop, close the drum valve. Next, close the suction valve and operate the system in the normal manner. Remove the refrigerant drum from the system and replace the gauge in its normal position.

XVII. THE INITIAL START

Before starting the compressor and putting the system into use, it is advisable to check certain items to assure proper operation.

A. Controls

check the setting of the dual pressure switch so the compressor starts at the desired suction pressure and the cut-out or differential is set low enough to prevent short cycling.The high pressure cut-out switch should be checked for proper setting.The cut-out set point for R22 is 275 psi (1806.07 kPa) and for R717 is 225 psi (1551.33 kPa).

Electrical interlocks, which are installed mainly for system component protection, should be checked to ensure they are functioning properly. All safety controls must always be wired into the compressor electrical circuit to ensure protection for the compressor.

Check the superheat setting of the thermostatic expansion valve. Take a temperature reading at the remote bulb of the valve and compare it with the temperature corresponding to the suction pressure. The bulb temperature should be about 10 degrees greater than suction temperature. If there is a large pressure drop in the low side of the system, the above method does not apply and the evaporator pressure should be determined from superheat and pressure drop.

Thermostats should be set for desired temperature.

The condenser water regulating valve should be adjusted to maintain the design head pressure. Open for increased flow in cases of high compressor head pressure and close for decreased flow in case of low head pressure.

B. Final Precautions.

The compressor suction valve, compressor discharge valve, condenser water shut-off valve, and other shut-off valves should be open.

Running parts of the compressor should have freedom of movement. Check this by turning the compressor input shaft over by hand. Solenoid valves should be mechanically connected and under electrical control. All gauges should be open and functional.

Oil level in the sight glass shows at least one half full.

Before initial compressor start-up, verify that the oil charging procedure is followed. If the procedure is followed, compressor start-up should commence as follows:

It is essential the compressor pick up the entire load gradually. It should be run for a few minutes and then stopped for a cooling off period. Lengthen each running period until the operator is sure no moving parts are heating up excessively. When the compressor operates with normal running temperatures, allow it to run for whatever length of time the load requires.

After the compressor is running, to provide quick response from the compressor unloader mechanism, set the oil relief valve to maintain 45 psi (310.27 kPa) net oil pressure in the 400 Series Compressors. Hold net oil pressure between 45 psi (310.27 kPa) and 50 psi (344.74 kPa) in the 400 Series Compressors.

NOTES

Net oil pressure is calculated by subtracting the compressor suction pressure from the oil pressure gauge reading while the compressor is running. The pressure is regulated by turning the adjusting valve stem. See Table 8 for location. To raise the oil pressure, turn the valve stem to the right or in. Turning the valve stem to the left, or out, decreases the oil pressure.

Table 8. Oil Pressure adjusting valve locations

Compressor	Valve Location
Model 450 XL Series	Front bearing Housing (Drive -Seal End)

CAUTION

When the Compressor has completed 24 hours of operation, remove and inspect the suction strainer bag. This bag is placed in the suction strainer to catch any foreign material present in the system at "start-up". If, when the bag is removed and inspected, there is an unusual amount of dirt, install a new bag. After another 24 hour period, remove and inspect the bag. Continue doing this until all traces of foreign material are removed from the system, The bag may then be thrown away. Whenever welding is performed on system pipping, a suction bag should be installed.

After discarding the bag, remove decal from the outside of the suction strainer cover and discard to avoid confusion. Decal is not needed if bag is not used. Clean the suction strainer after the first week of operation, the first month, and every six months after that. The best method of doing this is to remove it from the machine, knock the solids out, and wash it thoroughly with mineral spirits before replacing it in the machine.

XVIII. MAINTENANCE SUGGESTIONS

To insure the compressor against component malfunctions and system failure, a systematic preventive maintenance program is highly recommended. Performing the following steps at the prescribed intervals will keep the Compressor in optimum working condition.

A. Daily

clean the suction screen bag. Discontinue use when the bag remains clean. Reserve for system modifications or overhauls.

B. Weekly

1. Check system for leaks with a suitable leak detector for first week of operation
2. Check oil levels and oil condition.
3. Check oil pressures. Determine if oil filter needs changing.
4. Check refrigerant levels in vessels.
5. Check filters in air handling units.
6. Check low temperature coils for defrosting.
7. Check all gauge and temperature readings.

C. Monthly (Items 1 thru 7 and 8 thru 11)

8. Lubricate each piece of equipment in accordance with the manufacturer's instructions. As a general guide, bearings requiring oil should be given attention at least once a month, and those requiring grease at least once every six months.
9. Check drive for tightness and alignment. Direct drives should have coupling bolts tightened. V-belt drives should have correct tension.
10. Check cooling towers and evaporative condensers for scaling or algae. Check sprays and screens for clogging. Consult manufacturers of water treatment supplies for corrective measures of scaling and algae problems.
11. Check compressor oil coolers (when used) for any evidence of corrosion, scaling, or other fouling. See paragraph XI.C for maintenance and servicing.

D. Yearly (Items 1 thru 11 and 12 thru 21)

12. Check entire system thoroughly for leaks

13. Drain water from condensers, cooling towers and check tubes. Check carefully for damage by corrosion or scale.
14. Remove all rust from equipment, clean and paint.
15. Check motors and fans for shaft wear and end play.
15. Check motors and fans for shaft wear and end play.
16. Check operation and general condition of electrical controls.
17. Check all water strainers.
18. Check all V- belt drives. Replace worn V- belts and drive components.

CAUTION

Replace V-belts in matched sets only.

19. Check drains, to make sure water will flow away from equipment.
20. Drain and clean compressor crankcase. Flush oil circuit. Replace oil filter recharge. Recharge with new, clean, water-free oil.
21. Check and clean suction strainer.

E. System Leaks

Because of the demanding operational constraints of the 450 XL series Compressor (temperature variations, loosening of joints due to vibration, etc), the need to periodically test for leaks is a necessity. When any service operation is performed on the system, exercise care to make sure all opened flanges are replaced with a suitable thread filling compound, all packing glands on valve stems are tightened, and all valve caps are replaced. When operation is restored, all joints opened or any valves moved during the servicing should be checked for leaks.

F. Year-Round Operation

when refrigeration equipment is operated on a continuous years-round basis, a yearly examination of all internal compressor parts is recommended. While the highest material standards are maintained through the 450 XL Compressor line, continuous operation and any presence of grime may prove detrimental to the machine. To prevent shutdowns and/or possible breakdowns, your machine should be opened annually. The condition of the internal components should be fully inspected to determine if parts need replacement or repair.

G. Flushing The Oil Circuit

The oil circuit of the 450 XL Compressor is protected against dirt, grit and other foreign material by strainers and filters. Despite the filtering system, microscopic particles of foreign materials are carried through the lubrication system. These materials tend to settle in and clog the oil passages. We recommends the oil circuit in the crankshaft be flushed periodically. It should also be done whenever the machine is opened for repairs. Use mineral spirits or some other suitable refrigerant parts cleaner for flushing purposes. Since the flushing fluid is pumped under pressure, the use of the oil charger is recommended.

The machine should be pumped down for servicing, the oil taken out and the handhole cover removed. Remove the 1/4 (6.35 mm) pipe plug from the top of the seal chamber. Connect the oil charger to this opening. Pump the flushing solution through the seal chamber and into the crankshaft. Remove each of the pipe plugs in the crankshaft individually and operate the pump until the cleaner is flushed through the hole. Remove the plug, remove the next one and repeat the pumping procedure.

After the plugs are removed and these passages flushed, remove the bearing caps and connecting roads. Examine each of the oil passages to the connecting rods. Inspect the connecting rod bearings.

The preceding instructions enable a mechanic/technician to flush the shaft and passages on the 2 through 8 cylinder machines, and the drive end of the 12 and 16 cylinder machines. In order to flush the pump end of the shaft on the 12 and 16 cylinder machines, remove the connection to the center bearing and connect the pump there. Perform the flushing procedures in the same manner for this end of the shaft as for the other end. After the passage are flushed, open the connection on the bottom of the seal chamber and drain the flushing fluid out. Drain solvent from the crankcase and the interior surface of the machine. Replace the pipe fitting in the bottom of the seal chamber and fill the chamber with clean oil. Be sure to pump in enough oil to fill the passages in the crankshaft. Follow the procedure given earlier in this book. Remove the pump and replace the fitting in the top of the seal chamber.

Replace the crankcase cover and charge the machine with clean oil.

H. Crankshaft Seal oil leakage

In refrigeration compressors, a slight amount of oil leakage past the crankshaft seal is normal and acceptable. It lubricates the bellows and O-rings and cools mating rotating parts to provide less wear and longer life. Make provisions for collecting this oil.

I. Seasonal Operation

In instances where there is a seasonal operation of air conditioning systems, special considerations must be given to the equipment. Whenever equipment is shut down for any length of time, as over the winter, “pumpdown” the refrigerant and store it in the receiver. Only experienced refrigerant personnel should perform this operation.

Never fill the receiver to more than 80% of its capacity and after filling, it should be thoroughly checked for leaks.

When starting up a system after a seasonal shutdown, allow only enough refrigerant to enter the system to pressurize for leak testing.

Any leaks that may have developed during the shut down period may be found with a minimum of refrigerant loss. It is extremely important to check for leaks before a system is put back into operation. Be sure the system is sealed before the full supply of refrigerant is allowed to enter it .After the system has operated for several hours, another leak check should be made.

J. Service Contracts

Frick India offer a variety of maintenance, inspection, and repair services. Plans are available for almost any need. It is recommended that owners avail themselves of these services. Provisions for a service contract should be carefully considered by the plant management. This is especially important for owners of small plants, where qualified personnel are not available to perform the preventive maintenance, which is recommended.

OPERATION

I. COMBINATION UNLOADER AND CAPACITY CONTROL

A. Introduction

450 XL series MultiCylinder Compressors unloaders are supplied as oil actuated. Oil actuation is standard on all high stage compressors with 100% internal capacity reduction, all booster compressors and all two stage compressors. The method of unloading is determined by the solenoid valve connections; three tube connectors indicate a three way solenoid and oil unloading

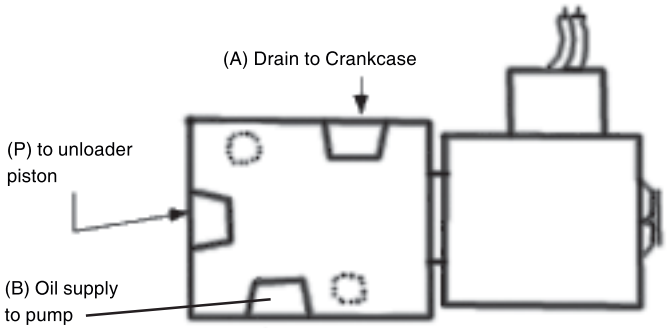
B. Oil Operated Unloader 450 XL Series, Single Stage, Booster, Integral Two-Stage

The mechanism is spring loaded and actuated by an unloader piston. When the suction and oil pressures are equalized on both sides of the piston, the yoke springs force the yoke, lift ring and lift pins upward. This lifts the suction valve plate, which unloads the bank of cylinders.

The capacity control system is incorporated in the compressor and is actuated by oil pressure. Pressure is conveyed to three-way solenoid capacity control valves, and is used for the operation of the unloader assembly. When the compressor is started, the solenoid valves are de-energized. Oil travels through the cylinder covers into the unloader cylinders, producing a pressure build up. Pressure is directed into the cylinder of the unloader mechanism which forces the unloader piston downward. The yoke arms of the unloader assembly lowers the lift pins and seats the suction valve plate.

The operation is complete and the cylinders are fully loaded.

To unload the cylinder, the solenoid valve energizes and bleeds off the pressure in the un loader cylinder. Oil flows through the solenoid valve and into the compressor crankcase.
The capacity control system typically operates two cylinders. When single cylinder unloading is required, the lift pins are omitted from one liner in a cylinder bank and the unloader mechanism unloads one cylinder. By controlling the sole noid valve in the line connected to the single cylinder unloader, the capacity reduction of all sizes of 450 XL series Compressors is obtained in one cylinder increments.
The minimum gas flow through a Compressor of any size should never be less than 25% of the maximum unless special precautions are taken to ensure proper cooling.



NOTE

Machines with 100% built-in capacity reduction require an oil cooler, crankcase thermometer and a timer to avoid running longer than 30 min utes unloaded, and a crankcase oil temperature thermostat if temperature exceeds 150°F (66.5°C).

The pressure differential between steps of capacity is limited by the minimum differential of the controlling device (i.e. pressure switch, microprocessor thermostat or other device). Standard compressors and condensing units are controlled by pressure switches.

Capacity reduction solenoid valves are con trolled electrically, and the device used to actuate the unloader solenoid valves are either temperature or pressure responsive depending upon the application type.

When standard unloading is used, capacity control solenoid valves are energized or de energized in series. Controls are single pole, single throw and closes on a pressure or temperature drop.

Single step unloading alternates the single and double cylinder unloading mechanics. The capacity controls are wired to allow the double cylinder solenoid valve to de-energize while the single cylinder is energized and vice versa.

II. FRICK CONTROLS (Electromechanical PLC)

A. Dual Pressure Switch

All 450 XL Series Compressors, except booster models and those controlled through microprocessors, are equipped with dual pressure switches. These switches protect the compressor from high excessive discharge pressures and excessively low suction pressures. The switches will open a set of contacts which stop the compressor whenever one of the previously mentioned conditions occur.

If the low pressure side contacts open, they close automatically when the pressure reaches a level sufficient for the cut-in setting. However, if the high side pressure contacts open, they must be reset manually. This is an indication of a major malfunction occurring in the system. The contacts cannot be reset until the pressure drops below the cut-in setting.

The cut-in and cut-out set points should be set on the low pressure side. On the high pressure side, set the cut-out point only. The differential between cut-in and cut-out is factory set at 5 psig (34.47 kPa). Refer to manufacturers instruction sheets for further information.

B. Oil Pressure Failure Switch

A standard feature on each 450 XL Series Compressor (except those controlled through a microprocessor) is an oil failure switch that measures useable pressure available for lubrication. If, or when, the oil pressure drops below the pre scribed levels, the pressure switch automatically shuts down the compressor. Useab oil pressure is a combination of the crankcase pressure

and oil pump pressure. The switch senses oil pressure by using a pair of bellows. The first bellows identifies oil pump pressure. Another bellows, which is connected directly opposite the first, measures crankcase oil pressure. Each switch has a 90 second time delay to prevent nuisance failures. If the failure switch detects any anomalies in the first 90 seconds, it will shut the compressor down. The switch must be manually reset after an oil failure.

C. High Pressure Switch

All booster compressors, models 2 through 8 cylinders are equipped with one high pressure switch. The switches open on high pressure and reset automatically when discharge pressure drops. Cut-out set points are adjustable but the differential is factory set.

D. Oil Filter Pressure Differential Switch (Optional)

This switch is installed on compressors equipped with the optional “warm start” oil protection sys tem. The switch is set to cut-out automatically when 40 psi (275.79 kPa) pressure differential is produced across the oil filter. The switch contact is normally closed when high oil pressure is not present.
When the 40 psi (275.79 kPa) oil pressure is produced across the filter, the contact opens and stops the compressor. If the compressor stops due to high filter differential, manually re set the filter oil differential switch before restarting the compressor. The switch reset button is located on the front of the control.

III. WARM START PROTECTION SYSTEM

CAUTION

Never attempt to start the 450 XL Series Compressor equipped with this system when the lube oil is too cold!

A. General Description

Some 450 XL Series Compressor incorporate an optional “warm start” oil protection system. This option features a differential oil pressure control across the inlet and outlet of a special Tri-Micro (micronic-type) oil filter.

Any effort to start a 450 XL Series Compressor equipped with this feature when the lubrication oil is cold and viscous can result in extreme oil pressure build-up and severe pump damage.
Before initial starting of the compressor, and/or after a scheduled maintenance check, turn on the crankcase heater for an extended time period. The heater should remain on until the oil temperature has reached 100°F (37.8°C) (set ting of thermostat equipped 450 Series crank case heater). The time frame for reaching the temperature will vary depending on the compressor location (indoors or outdoors). Special insulation may be necessary in unheated environments. Consult the factory.

B. Tri-Micro® Full-Flow Oil Filter And Differential Oil Pressure Switch

The Tri-Micro pressurized oil filter in the 450XL series Compressor is connected to a manual reset (in case you use this switch) differential oil pressure switch. The manual reset feature is provided to warn the operator when the oil filter element is dirty and to replace the recharge. Read the oil pressure differential across the Tri-Micro filter by alternately flipping the valve handle of the manual 3-way valve in opposite directions. Frick India strongly recommends the control selling on the filter oil pressure differential be checked by the operator prior to initial start-up of the compressor. Set the switch to provide a maximum of 40 psig (275.79 kPa) oil pressure differential across the filter.

IMPORTANT

On a new compressor, the filter element should be changed after 300 hours of break-in operation or whenever a gauge reading (taken on both sides of the filtering system) indicates a maximum pressure difference of 25 psig (172.37 kPa). Replace the filter element whenever the oil pressure drop across the filtering system reaches 25 psig (172.37 kPa), the compressor is opened for servicing, the filter is subjected to moisture, or whenever periodic oil checks reveal a gradual darkening of the oil.

IV. SETTING THE CAPACITY REDUCTION CONTROL

DUAL PRESSURE SWITCH (MP – 15AR)

450 XL series compressor is equipped with Dual pressure switches. These switches protect the compressor from high excessive discharge pressures & excessively low suction pressures. The switches will open a set of contacts, which stop the compressor wherever one of the previously mentioned conditions occur. If the low pressure side and high pressure side contacts open, they must be reset manually. The contact cannot be reset until the pressure drops below the cut in setting. The cut in (35 psig) & cut out (25 psig) set points should be set on the low pressure side and differential is variable between 8.52 to 85.2. On the high pressure side set the psig cut out (210 psig) point only and differential is fixed 42.6 psig.

OIL PRESSURE SWITCH BASED ON DIFFERENTIAL PRESSURE (MP-55A)

Oil pressure switch are designed for use as safety pressure controls on pressure lubricated refrigeration compressor. The control stops the compressor after a preset interval if the oil pressure fails. This control is equipped with a built-in thermal timing relay set for a fixed release time. The release time is the interval during which the differential pressure control allows the compressor to operate at too low on oil pressure. The differential pressure set value is (30 to 35psig).

SETTING THE CAPACITY REDUCTION CONTROLS (PRESSURE SWITCH)

When setting the pressure controls for capacity reduction and unloading, consider the operating conditions under varying loads, the capacity reduction controls maintain predetermined suction pressure & reduce machine capacity to suit the conditions under constant load conditions. The capacity reduction

Control is not used to any great extent to unload the compressor to facilitate starting.

Example:

SINGLE COMPRESSOR SYSTEM

To illustrate setting these controls on a fluctuating load, consider this case.

22ºF room with varying loads is maintained by a 6-cylinder compressor (three cylinder banks, one bank without capacity reduction)

Unloader control 'A' should be set to cut out at 32 psig, control 'B' at 30 psig and the low pressure action of the dual pressure section of the dual pressure switch should be set at 25 psig. These switches operate with a differential of 1.136 psig to 3.55 psig.

SIGNLE COMPRESSOR RANGE AND OPERATION

Low pressure switch	25 psig comp stop
Control 'B'	32.5 psig load
One bank cylinder	30 psig unload
Control 'A'	34.5 psig loaded
One bank of cylinder	32 psig unload

Note: Pressure shown above are for example purpose only. Pressure range and operating pressure must be based on actual system parameter.

Before starting the compressor keep the selector switch in manual or auto mode.

Manual Mode:

1. Before starting of compressor toggle switch TS1, TS2 & TS3 should be in ON position thus all the cylinder, which will be initially in unloaded condition.

2. When the compressor will reach at full speed switch OFF TS1 after 10 secs. This will de-energizes a solenoid valve SV1 then compressor will run at 33% load.

3. After 10 sec. Switch OFF TS2 this will de-energizes a solenoid valve (SV2) then compressor will run at 66% load.

4. After 10 sec. Switch OFF TS3, this will de-energizes the solenoid valve (SV3) then compressor will run at 100% i.e. fully loaded position.

5. As suction pressure decrease to 32 Psig with a drop of load switch ON TS3 this will energizes the SV3 and unload the cylinder bank. At this time compressor will run at 66% load.

6. As suction pressure decrease to 30 psig with a drop of load switch ON TS2, this will energizes the SV2 and unload the cylinder bank. At this stage compressor will run at 33%.

7. If the load decreases and suction pressure drop to 25 psig the low pressure switch will enable and shut down the compressor.**Auto mode:**

1. Before starting solenoid valve SV1, SV2 & SV3 will be energized through timer (TDR) thus all the cylinders which will be initially in unloaded condition automatically.

2. When the compressor will reach at full speed solenoid valve SV1 de-energized after preset time in TDR and compressor will run at 33% load.

3. Solenoid valve SV2 de-energized after preset time in TDR and then compressor will run at 66% load.

4. Solenoid valve SV3 de-energized after preset time in TDR & compressor will run at 100% load.

5. As suction pressure decrease to 32 Psig with a drop of the load, control 'A' energizes a solenoid valve (SV1) and unloads the cylinder bank then compressor will run at 66% load.

6. As suction pressure decrease to 30 Psig control 'B' energizes a solenoid valve (SV2) and unload the cylinder bank then compressor will run at 33% load.

7. If the load decrease and the suction pressure drop to 25 Psig the low-pressure switch will enable and shun down the compressor.

As load increase, suction pressure to 32.5 Psig control 'B' will operate and load the compressor. An increase in suction pressure to 34.5 loads the remaining cylinder bank and compressor will run at 100% load.

Two-Stage Compressor System (450 series only)

Two-stage compressors are supplied as standard with 100% unloaded Start. This is available for both the Six & Eight cylinder models.

Oil pressure supplied by the compressor operates the unloading mechanisms located inside the compressor. In order to insure positive action of the unloading mechanism, the oil pres sure on the machines should be at least 40 psi (275.79 kPa) above second stage suction pressure.

V. COMPRESSOR OIL SYSTEM

A. Description

The core of the 450 XL Series Compressor oiling system is an automatic, reversible gear type positive acting pump. The pump is compressor shaft driven. Oil is drawn into the pump through a fine mesh strainer from the crankcase reservoir.

The pump discharges oil through a pressurized micronic type filter into the seal end of the compressor. Oil enters the bottom of the seal chamber through an external connection and is flushed upward, under pressure, to provide the shaft seal with full flow cooling. Excess oil, by passed by relief, leaves at the top of the chamber.

Drilled oilways in the crankshaft conduct high pressure oil from the chamber to the various crankpin bearings. Cylinders are lubricated by oil thrown from the crankpin and wristpin oil bearing. The shaft roller bearings receive their oil through metering orifices in the bearing covers.

In a refrigeration system using Frick India 450 XL Compressors, an external pressure float valve is used in conjunction with a Frick India Standard oil separator to facilitate oil return. Oil is returned through a ¼" (6.35 mm) line directly into the crankcase of the compressor via NPT tapped boss on the suction end of the compressor frame.

B. Oil Regulating Valve (Adjustable Oil Relief)

The oil pressure regulating valve on the 450 XL Series Compressor is located in the front bearing housing of the machine. It consists of a spring loaded ball type valve positioned in the bearing housing. An adjusting screw regulates the pressure on the spring and ball. With less pressure on the ball, more oil bypasses the oil system and line pressure is low.

To adjust this valve, stop the compressor and remove the cap to expose the adjusting stem. Start the compressor and raise the oil pressure. To lower oil pressure, turn the screw counter clockwise.

NOTE
The stem is designed so it cannot be backed out, provided the stuffing box packing and packing nut are not removed.

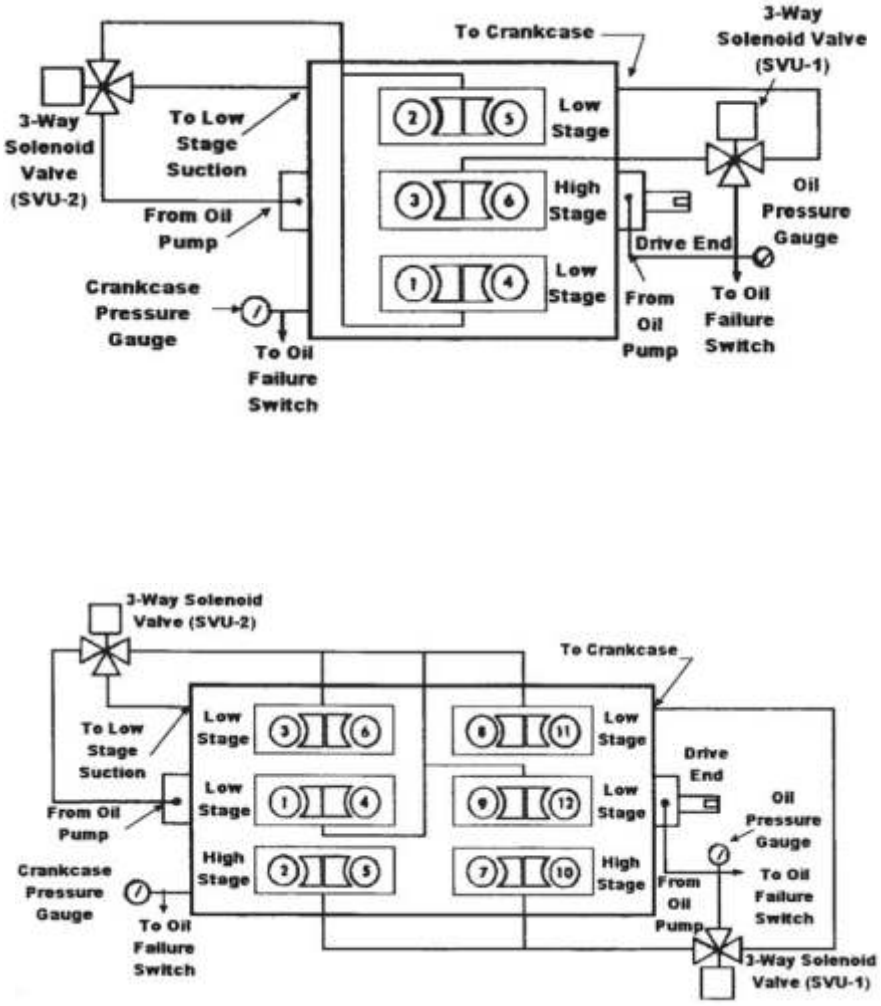
When oil pressure actuates the unloader mechanism, it is important to have net oil pres sure in excess of 45 pounds net, to provide quick response of the unloader arrangement.

C. 1st Stage Oil Drain Arrangement (Two Stage Compressors Only)

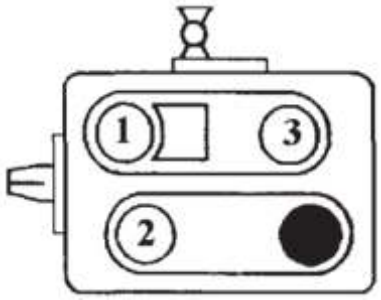
Automatic System (Optional)

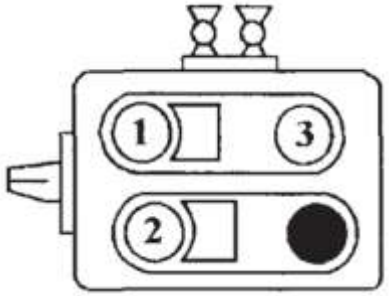
During compressor operation, any oil return with the suction gas usually accumulates in the 1 (low) stage suction manifold. Oil is drained automatically and returned to the compressor crankcase as follows:

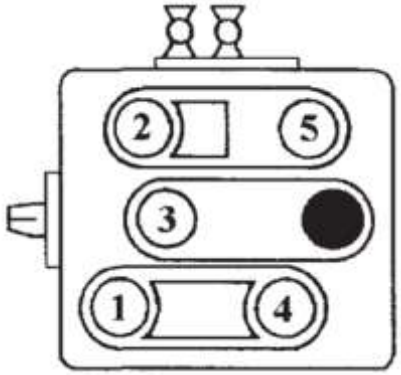
As the oil settles in the suction manifolds of the two outside banks of the compressor, it drains by gravity through a check valve into the oil reservoir. The equalizing line between the oil reservoir and the ft (low) stage suction is open through the three-way solenoid valve. When the oil level rises in the oil reservoir to the actuating level of the oil float switch, the solenoid valve is made to change ports. This action causes the oil reservoir's 1 (low) stage suction equalizing line to close and the line between the high stage discharge and oil reservoir to open. Simultaneously, the timer is energized. The discharge gas pushes the oil out of the reservoir, through a check valve and into the compressor crankcase. At the end of the time cycle, the solenoid valve reverts to the original position to allow for draining from the low stage suction. The cycle is continuously repeated as long as the compressor is running.

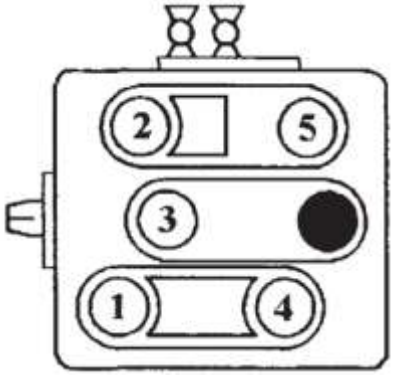


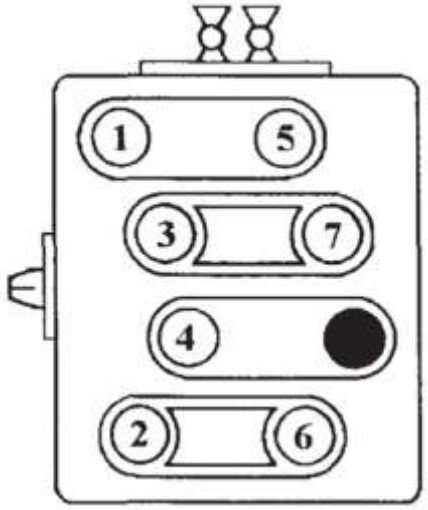
SCHEMATIC CAPACITY REDUCTION CONNECTIONSAND UNLOADER MECHANISM ARRANGEMENT - TWO STAGE COMPRESSOR ONLY

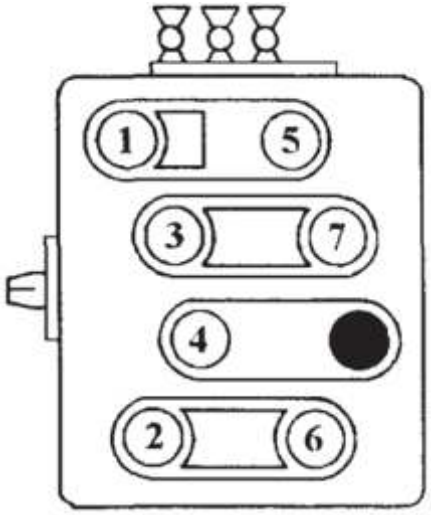

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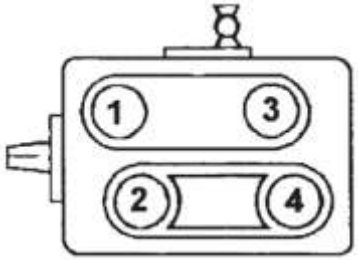

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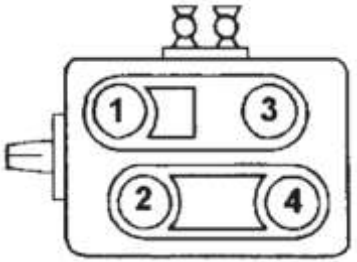

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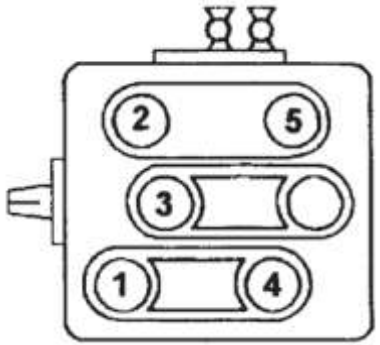

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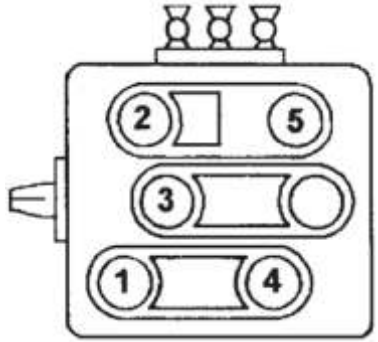

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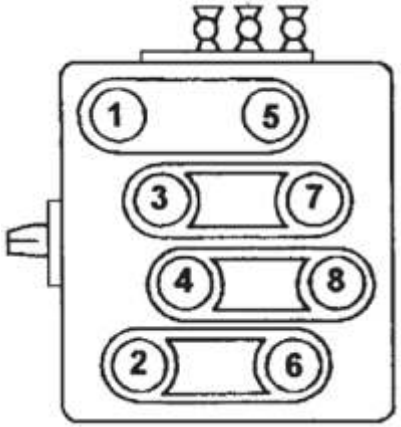

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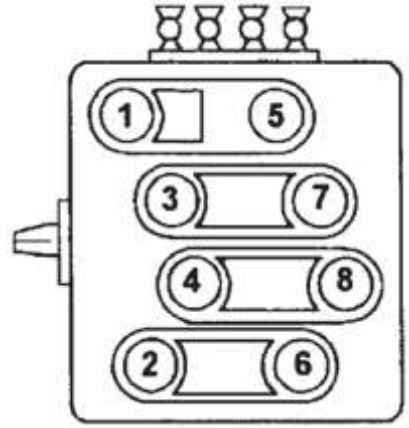

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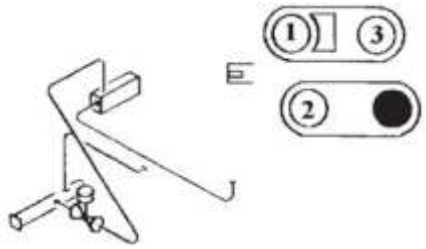

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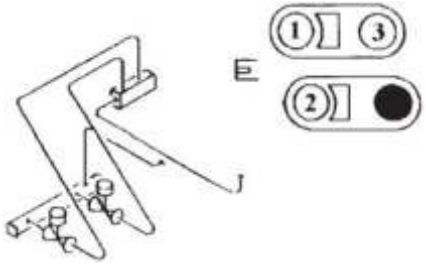

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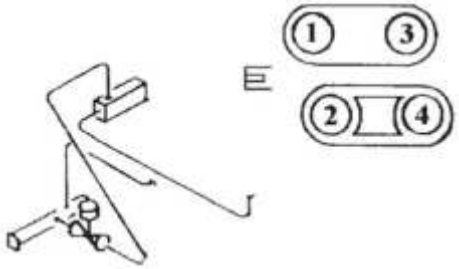

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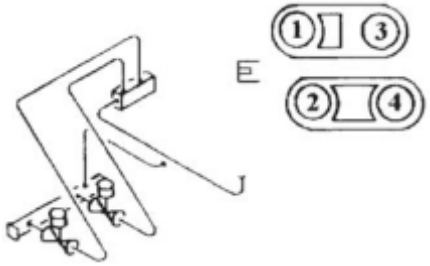

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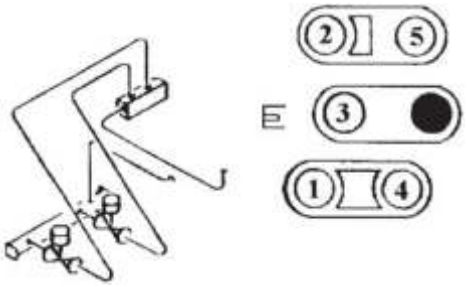

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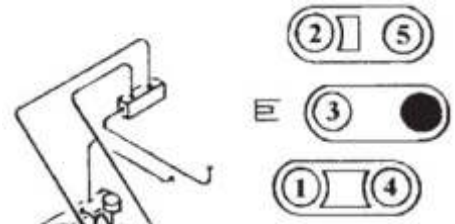

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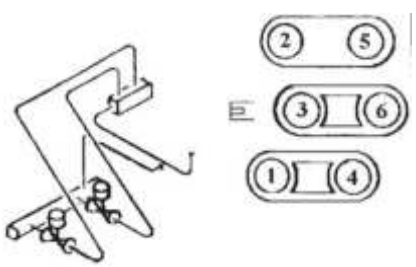

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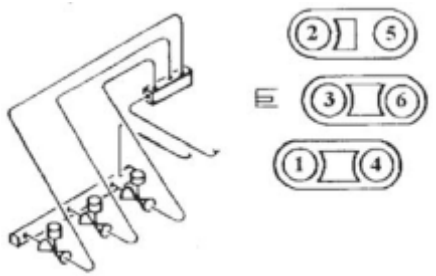

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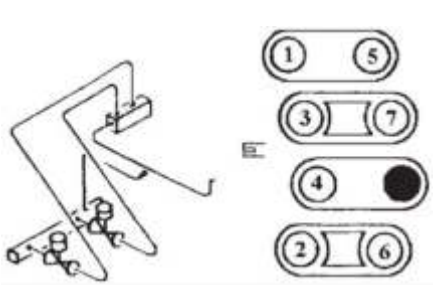

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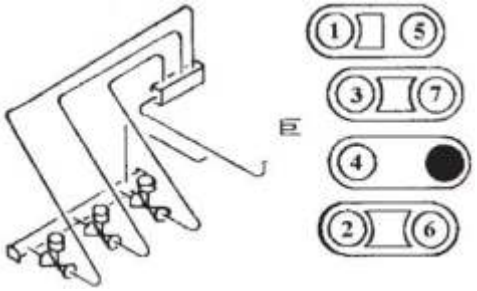

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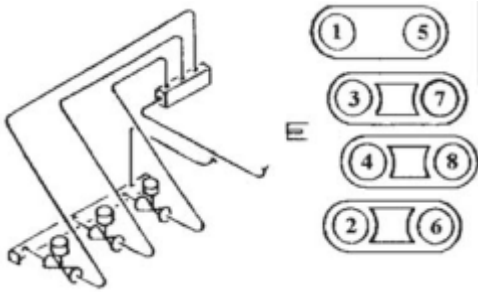

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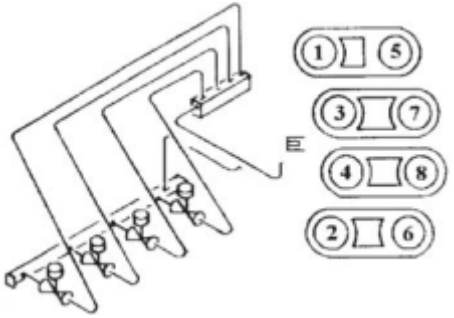

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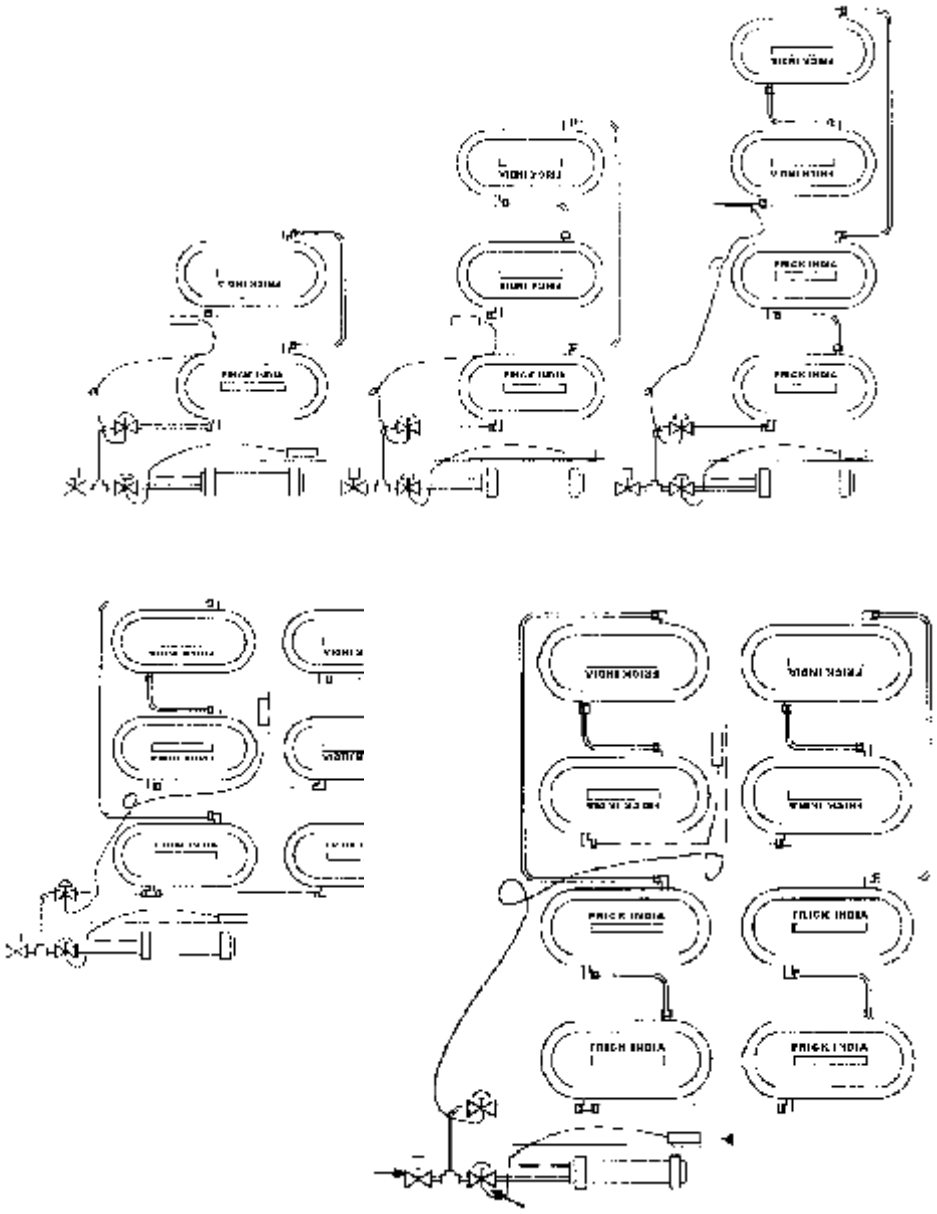

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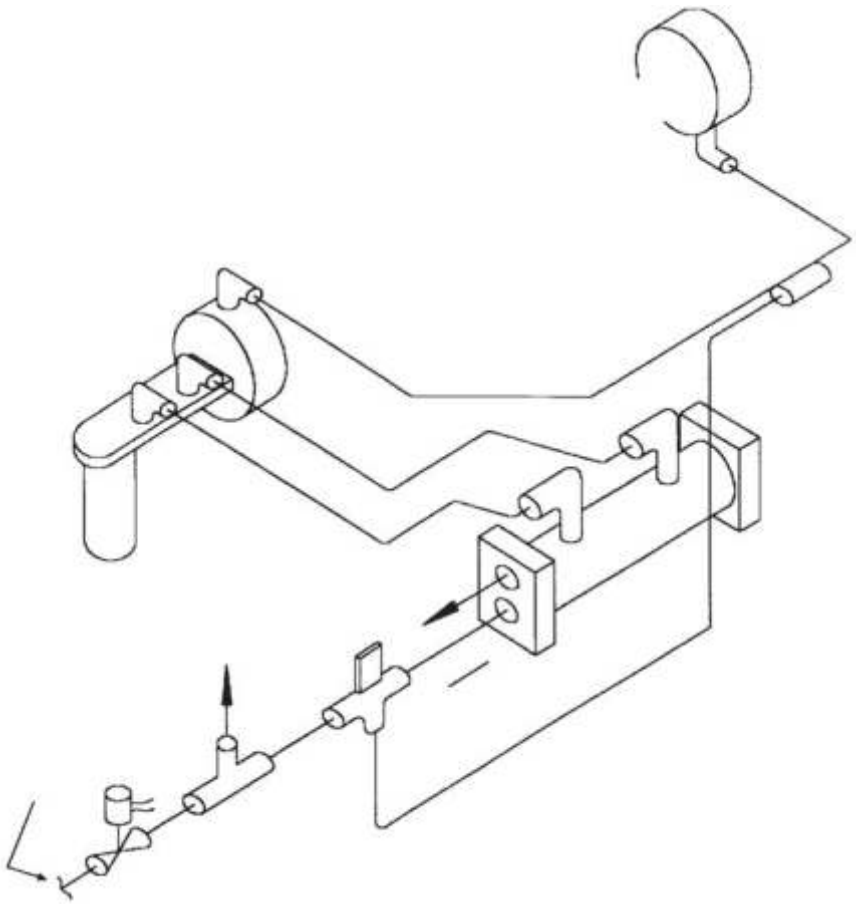

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450 XL WATER JACKET CONNECTIONS



450 XL WATER MODULATING VALVE CONNECTIONS

Frick India Multi Cylinder Compressor

TABLE : 450 XL Compressor Maximum Limits

Suction Superheat	(R717) 25°F (-3.9°C)	Discharge Pressure	350 PSIG (2413.18 kPa)
Compression Ratio	8:1 (R717) 10:1 (R290) 12:1 (R22)	Suction Pressure	150 PSIG (1034.22 kPa)
Pressure Differential	250 PSIG (1723.7 kPa)	Oil Temperature	150°F (65.5°C)
Discharge Temperature	300°F (148.9°C)	Direct Drive Motor H.P.	375 BHP (279.64 kW)

V-BELT DRIVE HORSEPOWER LIMITS		
SIZE	RPM (RAD/S)	MAX. BHP (kW)
452XL	1200 (125.43 rad/s)	195 (145.41 kW)
454XL	1130 (118.31 rad/s)	185 (137.95 kW)
456XL	1000 (104.7 rad/s)	165 (123.4 kW)
458XL	900 (94.23 rad/s) 810 (84.81 rad/s) 730 (76.43 rad/s) 1200 (125.64 rad/s)	145 (108.13 kW) 130 (96.94 kW) 120 (89.48 kW) 300 (223.71 kW)

NOTE :

Recommended operating oi temperature is 100°F to 130°F (37.8°C to 54.4°C).
Operating at or near maximum oil temperature could result in excessive wear.

SERVICE

I. GENERAL SERVICE INSTRUCTIONS

A. General Comments

When working on the compressor, care must be taken to ensure contaminants, such as water from melting ice or snow, dirt, and dust, DO NOT enter the compressor while it is being serviced. It is essential that all dust, oil or ice that has ac cumulated on the outside of the compressor be removed before servicing.

IMPORTANT

All gaskets, 0-rings, roll pins and lock washers must be replaced when servicing and reassem bling the compressor.

As an aid in servicing compressors, a tool kit is available and can be ordered as 450 XL Part No. KT067. This kit includes necessary wrenches as well as all the servicing tools pictured in this sec tion.

B. Preparation Of Compressor For Servicing

Remove all refrigerant from the compressor be fore servicing it. To properly evacuate the compressor, employ the following procedure:

Refrigerant 717 (Ammonia) Compressor

Shut down the unit, open the electrical disconnect switch and pull the fuses for the compressor motor to prevent the unit from starting. Put a lock on the disconnect switch and tag the switch to indicate maintenance is being performed.

Isolate the unit by manually closing the discharge stop/check valve. Close the liquid supply valves and open all solenoid valves to prevent liquid refrigerant from being trapped between the stop valves and solenoid valves. Allow the unit to equalize to suction pressure before closing the suction stop/check valve. After the unit has equalized to suction pressure, depressurize the unit by using a pump down compressor or other acceptable means.

Remove drain plugs from the bearing housings, compressor housing and discharge manifold. Drain the oil into appropriate containers.

To blow off the gas caught between the discharge valves and discharge stop valve, close the gauge valve, remove gauge, connect one end of a hose to gauge valve, and put the other end in a bucket of water. Open the valve slowly and the water will absorb any discharged ammonia.

CAUTION

Connect hose to the suction gauge connection in the same manner, and the water will absorb the rest of the ammonia. Do not leave hoses in the water if work has to stop and the frame is still warm. Cooling of the frame could siphon water back into the frame through the hose.

Halocarbon Refrigerant Compressor

The procedure for removing halocarbon refrigerant from a compressor is NOT the same as described for an ammonia compressor. To evacuate a compressor using halocarbon refrigerant, employ certified technicians to pump down the unit according to applicable laws and ordinances.

When the unit is pumped down, the temperature of the machine drops. Before opening the machine, allow it to warm up to room temperature. Opening the machine before it is warmed up produces condensation on the metal surfaces. Moisture is detrimental to compressor operation. It leads to system operating difficulties and rusting of parts.

Compressor Oil Removal

If service will be performed on unloader solenoids, oil filter change, suction or discharge valves, or crankshaft seal, the oil will not require removal, If it becomes necessary to open the crankcase, disconnect power to the heater and remove oil through the drain valve.

If a slight positive pressure is allowed to re main in the crankcase before compressor is opened, it will force the oil from the drain valve into a container of sufficient capacity. It is best to have reduced the pressure to 2 psig (13.79 kPa) to minimize the amount of foaming.

After the compressor has been serviced, do not reuse this oil. Even reconditioned oil contains contaminates that could cause compressor damage.

C. Preparation Of Compressor For Initial Start After Servicing

IMPORTANT

Frick India recommends charging 1 to 2 gallons of fresh oil into the compressor via the oil pressure gauge port in the front housing. This eliminates “dry start-up” by forcing oil into the passageways in the crankshaft, to the connecting rods, and having a good supply of oil for the shaft seal.

Add oil to crankcase, via drain valve, to within 1/2 of the sight glass in the handhole cover. Connect power to the crankcase heater, close all open valves, and check for leaks.

When oil has reached approximately 100°F (37.8°C), start the compressor and allow it to pull the load down gradually. Run the compressor for a few minutes, then stop for a cooling off period. Restart and run for a longer time. Stop and allow for a cooling off period again.

Lengthen each running period until it is deter mined no moving parts are heating up excessively.

When the compressor operates with normal running temperatures, allow it to run for whatever length of time the load requires. With new or re placement compressors, the suction bag should be removed after running for 24 hours or should be replaced with new one if found chocked. check for another 24 hrs. and repeat the process unless filter bag comes clean. Three filter bags provided separtely.

II. CYLINDER COVERS

NOTE

Before proceeding, refer to Paragraph I, “General Service Instructions”.

A. Disassembly

To remove the compressor cylinder covers, re move the capacity control lines and water lines (or liquid cooling lines, if any) from the covers that will be removed. Next, remove two screws that are opposite each other diagonally across the cover (i.e. two screws by water connections). Install two assembly studs into these holes and tighten them to thread bottom. Screw on nuts to within one thread of touching the cover. Remove the other screws. Slowly back the two nuts off and make sure the cover follows.

If the cover doesn't follow, **STOP. DO NOT** back off nuts more than one turn. Break the gasket seal and then continue cover removal.

The studs are long enough to relieve all the spring tension before the nuts are removed. Remember, the studs must not be turned out with the nuts. After all of the spring tension is re moved, the nuts can be removed, covers lifted off and head springs removed. It is best to keep all parts in the correct cylinder assignment. Invert the cover and place on work surface, placing each spring in its corresponding location in the cover.



Bearing & Cylinder covers assembly & disassembly Stud.

B. Assembly

Before replacing the cover on the compressor, inspect the gasket surfaces of the cover and compressor frame. Remove any debris adhering to either of these surfaces. Remove any burrs or rough edges from the mating surfaces to ensure a tight seal. Replace studs, if removed. Lightly lubricate both sides of the head gasket. Position the gasket over the studs and against the compressor frame in the correct orientation. Place the springs on top of the safety head yokes (rotating the spring until it stays on the yoke). Place the cover down over the studs and slowly lower on top of springs. When all pieces are in alignment, place the nuts on the studs and start to tighten. When the cover is secure within 11/4" (31.75 mm) of the gasket, install the rest of the screws so they come in contact with the cover. This will ensure they will not cross thread in the holes.

Do not tighten each screw separately, however. Alternate on opposing screws, until the cover is seated on the gasket. Remove the studs and replace with screws. Finish tightening the screws in an opposing pattern to the recommended torque values shown in Table 2, 3 or 4 (depending upon your compressor model). Re install the capacity control and head cooling lines, and check for leaks.

III. SUCTION AND DISCHARGE VALVE PLATES

NOTE

Before proceeding, refer to Paragraph I, "General Service Instructions".

A. Disassembly

To service valve plates in the compressor, re move the cylinder covers (refer to paragraph II.A). In cylinders without unloaders, the valve assemblies may be removed as soon as the covers are removed.On compressor cylinders equipped with unloaders, the unloader needs to be forced down before the valves are serviced. If the unloader remains up, the suction valve is forced off its seat, and will not seat and locate properly during reassembly. To hold the unloader mechanism down, remove the plug from the hole provided below oil line of unloader piston. Force the unloader piston down and insert a short (7.93 mm) diameter metal rod through the hole to restrain the piston. Use a wooden block to force the piston down to avoid scratching or damaging the top of the unloader piston. Once the piston is held down, the valve assemblies can be serviced.

1. 450, 450XL Compressor (Bullet Style)

Lift out the safety head yoke, which holds the safety head assembly in place. Invert the yoke to make sure all eight coil springs are intact within it. If any springs are bro ken, locate and remove pieces. Springs can be removed and replaced without tools. Since they are only finger tight in the bottom of the hole, they can be removed with a twisting, pulling motion.

After the safety yoke has been removed) lift out the ring plate discharge valve (refer to note below). Slip the safety head up and off the roll pin that guides it.

NOTE

Before removing valve plates, look for the word "TOP" etched on each plate and ring plate discharge valve. This denotes the unlapped upper face. If the etching is not clearly visible, dot the upper face of the valve plate with dye or tape. Do this sparingly. Any marking applied must be removed prior to reassembly.

The safety head contains four helical suction valve springs, which are identical to the eight discharge valve springs. These need to be kept separated. The suction valve can be lifted out.

B. Reassembly

450XL Series Compressor (Bullet Style)

Before assembling the valves, safety head and yoke, use a solvent to remove any dye, paint or tape you may have used as a marker.

Put the suction valve into their holes with the end that has two coils closely wound to wards the bottom of the hole and twist with the top of the finger. This will lock the spring in its hole. The springs are properly installed when the safety head can be inverted with out the springs falling out. Springs of all the same "hand" are used (wound the same way). This allows the valve to rotate during operation. When the valve rotates, the action tends to "heal" any small nicks or scratches on the valve or seal, and clean away any foreign material or dirt which may lodge between the valve and seat. This will also spread out the plate wear from the springs.

Place the suction valve into its cavity in the cylinder liner with the "top" facing up. The valve plate should rotate freely without binding. Replace the safety head assembly in the frame

IV. COMPRESSOR DRIVE TYPES

NOTE

Before proceeding, refer to Paragraph I, "General Instructions".

A. V-Belt Drive Compressors

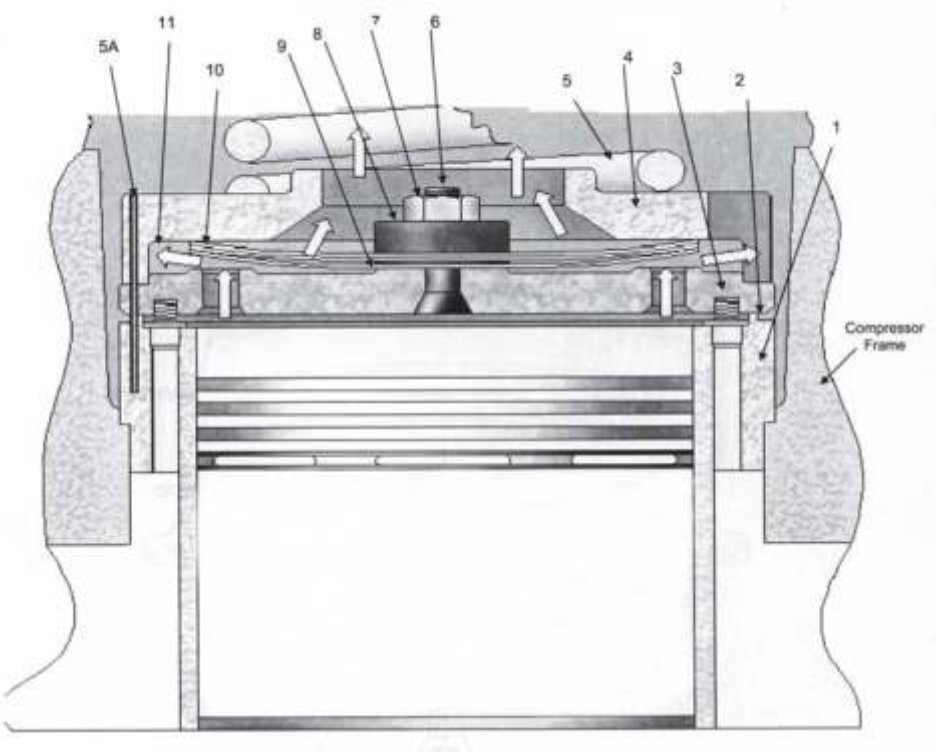
Belt Removal

Remove belt guard.

Loosen motor rail clamps. Remove tension on belts to provide enough slack to allow the belts to be removed from the drive without having to pry or roll the belts off.

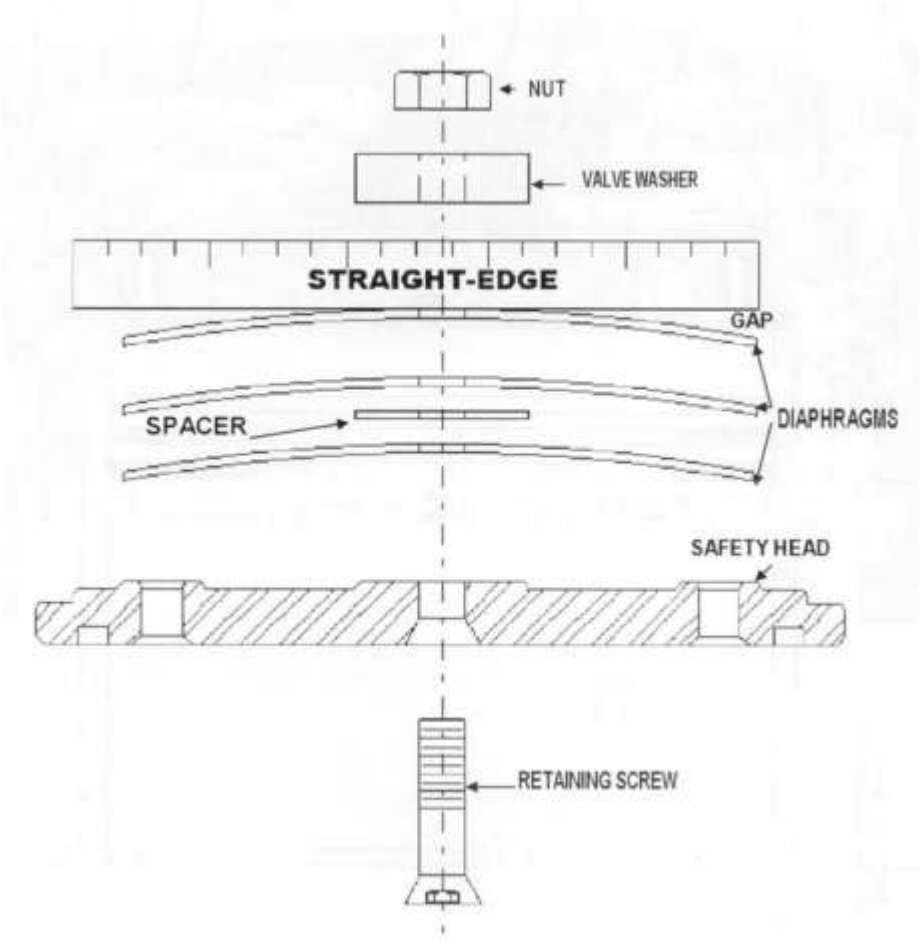
IMPORTANT

If belts are to be reused, mark the belts to orientation on the drive. The belts can now be removed.



ITEM NO.	ITEM NAME	ITEM NO.	ITEM NAME
1	Cylinder Liner	6	Retaining Screw
2.	Suction Valve Plate	7.	Hexagon Lockut
3.	Suction Valve Spring (4)	8	Valve washer
4.	Safety head Yoke	9.	Valve Spacer
5.	Safety Head Spring (4)	10.	Diaphragm Discharge Valves (3)
5A	Roll Pin (4)	11	Safety Head

UPPER CYLINDER CROSS SECTION
Low Stage - 2 Stage Compressors



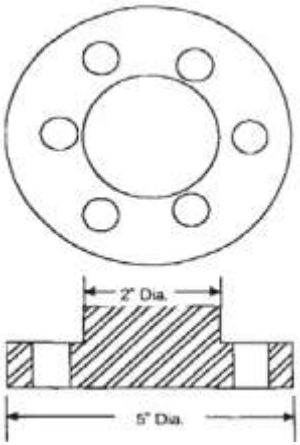
DISCHARGE DIAPHRAGM VALVE PLACEMENT
For Low Stage Discharge Valve- 2 Stage Compressors

Flywheel Removal

Remove flywheel screw holding the flywheel on the shaft.

Install flywheel puller on the flywheel. An al ternate tool can be fabricated from a 4W (107.95 mm) diameter steel plate, 1/2" (12.7 mm) thick with three equally spaced (17.46 mm) holes on a 31/2" (82.55 mm) or 3'I (98.43 mm) bolt circuit. See Figure 4. Also needed are several 1%" (44.45 mm) plate washers and three I8" (15.88 mm) x 1%" (44.45 mm) long screws. Place several washers against the end of the shaft so they extend past the flywheel hub.

Screw the plate to the flywheel and tighten the screws so the plate pulls tight against the washers. Tighten the screws evenly so they pull the flywheel. Apply pressure until the flywheel breaks free.



FLYWHEEL REMOVAL TOOL

Sheave Removal

Specific instructions for motor sheave maintenance are located after the Operation Section of this manual. These should be consulted for specific maintenance instructions.

Drive Inspection

Inspect the motor and compressor shafts, sheave bushing and flywheel for fretting corrosion or other wear. Fretting corrosion is the result of two metallic surfaces (a shaft and flywheel or bushing bore) having movement relative to one another. This is usually due to the incorrect tightening of drive components, use of oil or other anti- seize compounds, worn components, burrs or other imperfections not allowing the fly wheel and crankshaft to mate properly.

Signs of fretting corrosion are reddish brown powdery oxidation and wearing away of the surface of the shafts or drive component shaft bores. Minor fretting corrosion may be eliminated through light sanding after which the adequate contact area between the crankshaft and flywheel must be assured to prevent further fretting. Heavy fretting corrosion will require repair or replacement of the motor shaft or replacement of the compressor crankshaft and drive components. The flywheel or crankshaft should not be re-matched to eliminate the results of the fretting corrosion, as adequate clearances cannot be assured after re-machining.

The drive keys should fit tightly in their respective grooves and be free of damage. The keyways should also be free of chips and burrs that would not allow full contact of the key to the keyway.

The flywheel and sheave should be inspected for abnormal wear and damage. A groove wear gauge should be used to check condition of the sidewalls and width of the groove. Excessive wear is not permitted as this will lead to problems in achieving correct belt tension and loading, contributing to excessive belt and sheave wear.

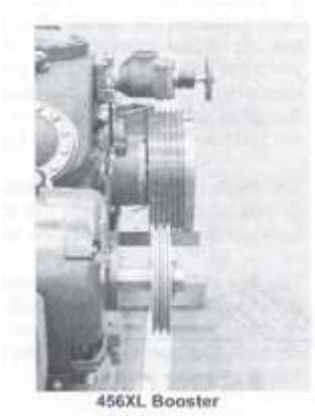
Clean any foreign matter that has accumulated in the grooves.

The sheave and pulley should be inspected for cracks and other damage that could affect the integrity of the drive components.

The sheave and pulley should be inspected for excessive run-out, indicating bent components. Bent pulleys or sheaves will wear the groove sidewalls unevenly, as the belt changes its angle of engagement as the pulley turns.

The groove bottom should also be checked for polishing, as this indicates the belt is not riding correctly in the groove. What has happened is the belt or groove has worn to the point the belt is actually rubbing on the bottom of the groove. This effectively changes the pitch diameter of the sheave or pulley for that groove, causing the belt to operate at a different speed than the rest. This will result in excessive heat and wear to the drive components.

When drive components are replaced, it is necessary to replace them with identical components. Due to operating conditions and the horsepower requirements of the compressors, the number of belts on a compressor package can vary from 2 through 10 belts and not all flywheel grooves will be filled.


456XL Booster


458XL High Stage

Drive belts should be inspected for abrasion, tearing, separation or checking that would indicate possible damage to drive components or alignment problems. They should also be inspected for sharp bends and kinks while they are slack as this indicates internal damage due to incorrect installation techniques. The belts can be cleaned at this time. Only soap and water should be used to clean the belts and other components. Belt dressing should never be used on drive components, as it will attack the elastomer used in construction of the belts.

IMPORTANT

Belts should always be changed in sets to minimize length variations between used and new belts. Note the match numbers on the belts. The same number must be on all belts in the set.

Drive Installation

If installation is new and the belts are being installed for the first time, the following items must be taken care of before the belts can be installed.

The compressor, motor and base should be level. This will help speed the alignment process of the unit if the shafts are level and in the same plane before starting the alignment process.

All piping must be finished and properly ported. Any piping stress must not be permitted to act on the compressor frame. base must be secured to the floor grouted.

The compressor should be checked for a soft foot and shimmed accordingly. Elimination of a soft foot in a belt drive compressor is essential to reduce vibration and misalignment problems.

The sheave and pulley should be checked for paint and foreign matter in the grooves. Any foreign material will cause a decrease in the horsepower transmitting ability of the belts and lead to accelerated wear of the belts, pulley and sheave.

If this is an existing installation, the motor and compressor shafts should be checked to see if they are level and in the same plane before starting the alignment process. If the compressor has been moved or if there is a complaint of excessive vibration, the compressor should be checked for a soft foot.

Absolutely no lubricants or anti-seize com pounds should be used in the installation of the motor sheave and bushing, or the crank shaft and flywheel. The bushing as supplied by the manufacturer should not have any lubricant applied to it or the sheave bore. The applied lubricant will be trapped between mating surfaces of the sheave and bushing, or bushing and shaft. When the components are tightened, the resulting hydraulic pres sure of the lubricant trapped between the mating surfaces will result in a cracked sheave or bushing. Lubricant or anti-seize is usually applied to the shaft for ease of disassembly. As the anti-seize is trapped when the pads are tightened, it will create a sliding layer between the pads. The parts are not free to move independent of each other while the unit is in operation, creating fretting corrosion. This results in excessive wear of the drive components and the possibility of the parts welding themselves together.

The belts can now be installed. The motor should be moved towards the compressor to facilitate the installation of the belts.

The belt closest to the compressor should be installed first. The belts should not be rolled or pried when installing them, as this will damage the cords in the belts and cause a failure in a shod time.

Drive Alignment

There are 3 different types of misalignment that are possible, more than one of which may be present at any onetime. These are:

- Horizontal angular
- Vertical angular
- Parallel

Although V-belt drives are somewhat tolerant to misalignment, the maximum amount of misalignment permitted is 1/16 of an inch per 12" of shaft, center to center distance. If this is exceeded, excessive drive, belt and bearing wear will result.

Horizontal angular misalignment results when the motor and compressor shafts are in the same horizontal plane, but not in the same vertical plane. A straight edge is held against the compressor pulley face. The distance from the straight edge to the motor sheave sides is compared. They should be the same. If they are not the same, adjust the motor to bring the sheave and pulley into alignment.

Vertical angular misalignment results when the motor and compressor shafts are in the same vertical plane, but not in the same horizontal plane. A straight edge is held against the compressor pulley face. The distance from the straight edge to the motor sheave at the top and bottom is compared. They should be the same. If the back of the motor is sitting low, the top of the sheave will be back further than the bottom of the sheave. The motor must be shimmed so the top and bottom of the sheave are in the same plane as the compressor pulley.

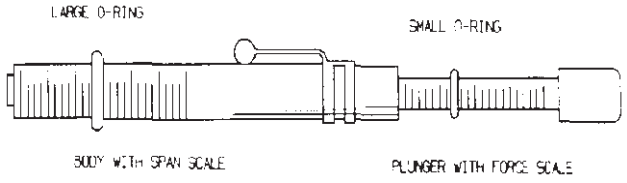
The last check is the parallel alignment. This check aligns the belt grooves of the pulley and sheave. The measurement is taken from a straight edge held at the outer rim to the edge of the first groove used on the compressor pulley (usually not all grooves are filled due to horsepower requirements). This is then compared to a measurement taken from the straight edge to the corresponding groove on the sheave. The sheave position is then adjusted to as sure the sheave is in line with the flywheel.

Belt Tension

Proper tension is essential to long belt life. An improperly tensioned belt will result in inefficient operation and excessive heat. The ideal tension is the least amount of tension at which the belt will not slip under the load.

Single 5V. V-belts

One device that provides the most accurate way of measuring the tension of the drive belts is a belt tension spring scale (Part No. 3072A) See Figure 6. This Device measures the amount of force needed to deflect the belt a given amount. The range of the readings should be between 12 to 18 lbs. The deflection should be / per inch of span. If the span of the belts from the sheave to the flywheel is 38 inches, the amount of deflection should be mm) and the tension required to should be between 12 to 18 lbs.



The belt tension spring scale is placed in the center of the belt span. The scale is then pushed down until the proper deflection is reached. The tension should then be read and recorded. The process is then repeated for the remaining belts.

If the tension is too low, the belts should be tightened evenly and rechecked.

The tension between belts should be within ±1 lbs. of each other. Inconsistent measurements indicate problems with alignment, belt length and/or wear of the drive components. The problem should be corrected before the unit is returned to service.

Banded 5V, V-belts

Due to their design, banded V-belts require special tensioning techniques in order to set the tension properly. There are two methods to check the tension of banded belts. They are as follows:

The first method utilizes a tension tester to measure the deflection. The number of belt bands in the belt is multiplied by the deflection force of 12 to 18 lbs. A board or metal plate is then placed across the bands to equalize the force as the tension tester is depressed on the board or plate.

A straight edge is positioned across the sheave and flywheel to use as a reference to measure the deflection of the belts.

The second method measures the amount of stretch as the belts are tightened to determine the tension of the belts. The banded belts are installed on the drive and rotated to get all the slack on the bottom side. The belts are then tightened to re move the slack from the belts. Measure the outside circumference to the nearest ¾" (6.35 mm). Multiply this reading by %% (0.0075) to 1% (0.01). Add this to the circumference reading. Elongate the belt to the new length.

EXAMPLE: 80"x 1% = 0.8" + 80"

B. Direct Drive Compressors

Coupling Removal

Remove the guard. Remove the bolts that extend through the coupling and remove the center member. Remove the bolts that hold the shim packs to coupling, and make note of location of the washers. Using one or two of these bolts through the shim pack will keep the shims in alignment.

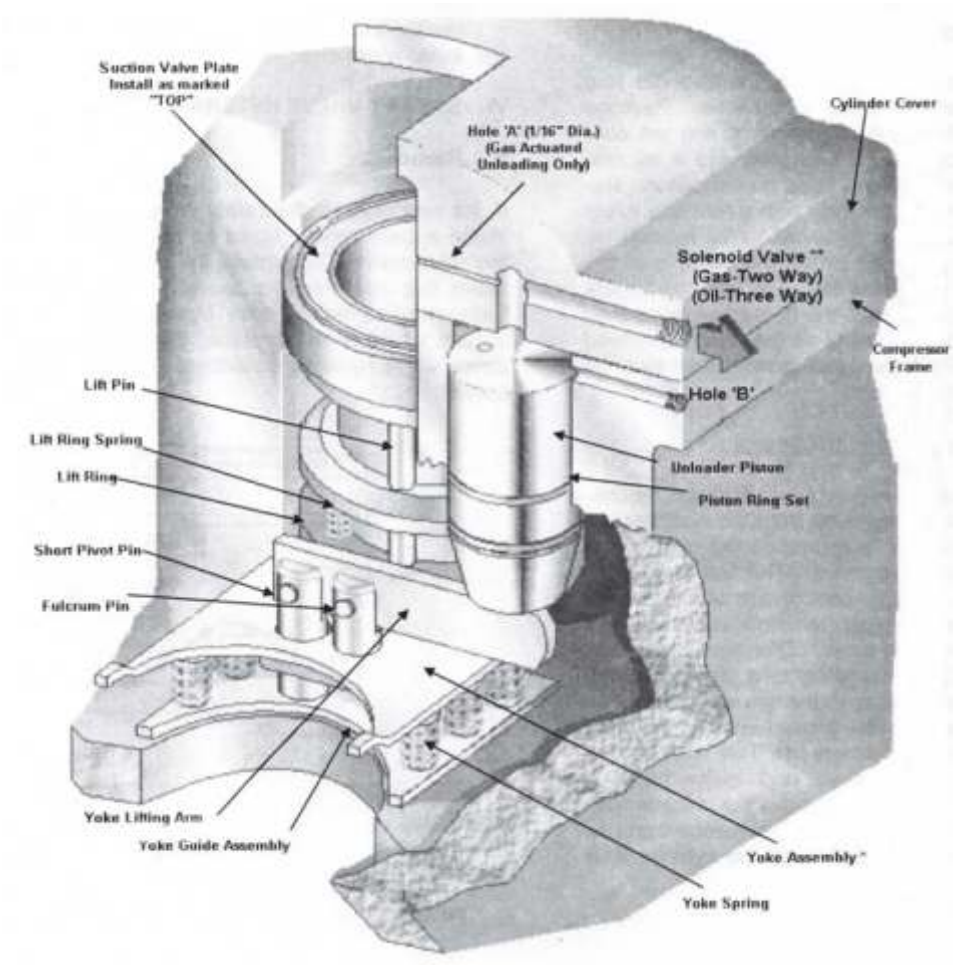
To remove the coupling from the crankshaft, remove the screw (and washer, if present). Try to lightly tap the coupling off the shaft, or apply heat to coupling. A puller can be constructed out of a flat steel bar with holes that match two holes in the coupling in a straight line past the center of the crank shaft. Make a hole in the center of the bar for a / (15.88 mm) bolt, thread the hole or weld a /8" (15.88 mm) nut inline with the hole. Bolt this bar loosely to holes in coupling. Place a solid washer or disc (a little smaller than end of the shaft) between the bar and in front of the tapped hole in the crankshaft. Using a '8" (15.88 mm) bolt, apply force to center crankshaft and a pulling force on the coupling.

Coupling Replacement

Inspect the compressor coupling bore and crankshaft to make sure they are clean and free of burrs. Apply anti-seize to shaft and coupling bore. Place the key on the shaft and slip on the coupling. Install the bolt (and washer, if required), and tighten.

Reassemble shim pack and center member in correct orientation. Tighten bolts and note distance between hubs per coupling manufacturer's bulletin. This bulletin is located in the Installation Section.

Recheck alignment, if necessary.



** COMPRESSOR APPLICATION NOTE
Gas Actuated Unloading is standard on:
High stage, except 100% internal CR oil
Actuated Unloading is standard on :
High stage with 100% internal CR
Boster
Both Stages of integral 2-stage

TYPICAL CAPACITY CONTROL MECHANISM ARRANGEMENT - 450 & 450 XL COMPRESSOR (NEW STYLE BULLET TYPE)

A. Bullet Type

Lift Pins, Ring and Springs Removal

In order to put the unloading mechanism back in the cylinder liner, place the lift pins with the springs around them in their holes. Place the lift ring on the pins with the smaller inside diameter facing top of the liner so it will slip over and cover the retainer when it is in place. Placing the liner on its side and holding the lift ring back against the pins and springs, slide the ring retainer over the liner into its groove.

Unloader Piston Removal

It is not necessary to remove or disturb the actuator mechanism or the cylinder liners to remove the unloader piston. There are two holes in the top of the unloader piston. One is threaded, the other is not. Use ½”-2ONC eyebolt in the center hole. Use the other hole to keep the piston from turning in the hole in the frame while doing this. Using the eyebolt as a handle, pull the piston out of its hole in the frame.

Unloader Piston Replacement

Before reinstalling piston, remove old ring set. Clean and inspect for wear. Replace piston if wear is excessive, a ring set con sisting of ‘FIFE” outer ring and a silicone rubber inner ring is used on the piston. Re place ring set carefully with a new one every time a piston is removed. With eyebolt re moved, place the piston into its hole in the frame. Compress the rings with the fingers and work them into the hole carefully so they are not nicked or cut as the piston is moved down. Push the piston down until it touches the yoke lifting arm.

Actuator Mechanism Removal

Before a capacity control actuator mechanism can be removed from the compressor, at least one of its corresponding cylinder liners must be removed. The first step in re moving capacity control actuator from the machine is to push the unloader piston down with a block of wood. Then take a piece of steel (in diameter) or a piece of wood, and insert it between the two vertical rods on the yoke assembly accommodating the short pivot pin and fulcrum pin. This will hold the assembly depressed and make handling much easier. Then remove the unloader piston as detailed above. The mechanism can then be removed through the cylinder liner hole in the frame.

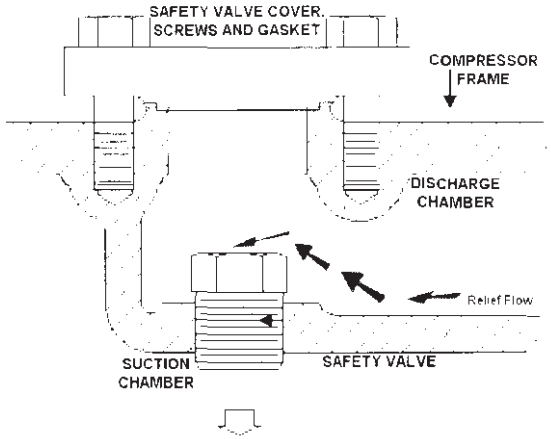
Actuator Mechanism Replacement

Compress the yoke assembly and place a small piece of wood or a 5 (7.94 mm) o.d. steel rod between the two vertical rods mentioned in paragraph 4. This keeps the yoke depressed for easier handling. Then place the mechanism into the frame through the cylinder liner opening and position it. Install unloader piston as detailed above. Depress the unloader piston with a block of wood and remove the rod or piece of wood used to hold the yoke assembly depressed.

V. SAFETY VALVE (INTERNAL RELIEF)

A. Removal

If, for any reason, the safety valve has relieved, install a new valve. Make no attempt to adjust the relief valve. To replace the safety valve, re move the cover on the top of the compressor frame marked “safety valve” by taking out the two screws which hold it in place. Then, remove the safety valve by using a standard 1 (44.45 mm) socket.



B. Replacement

Lightly oil the threads of the valve and screw the valve into place. Lightly oil a new gasket and place it on the frame. Position the cover and tighten it down.

VI. OIL PRESSURE ADJUSTMENT ASSEMBLY

A. Disassembly

The oil pressure adjustment assembly is located in the front bearing housing. It consists of a spring loaded ball positioned in a machined seat in the top of the front bearing housing. An adjusting screw turned in and out changes the amount of oil bypass, thus changing the oil pressure.

Remove the cap. A packing tool is required to remove the gland nut (Part No. A33781A).
After the gland nut has been removed, use a large screwdriver to turn the stem counter clock wise and remove it completely. The packing with 2 washers should also come out. Using a pencil magnet, pull out the spring and steel ball.

B. Reassembly

Clean the steel ball and place in the hole. Place the stainless steel spring on top of it. Screw the adjustment stem in the hole to get threads started. Place a washer over the end, then packing, then the other washer. The adjustment stem may have to be turned in so the packing nut can be installed and tightened. Adjustments of the oil pressure will have to be reset after start up. Replace the cap and gasket afterwards.

C. Adjustment

To provide quick response of the compressor unloader mechanism, it is recommended the oil pressure relief valve be set to maintain 40 psi (275.79 kPa) net oil pressure. Net oil pressure should be held at 35 psi (241.32 kPa) and 40 psi (275.79 kPa). Net oil pressure is calculated by subtracting the compressor suction pressure from the oil pressure gauge reading while the compressor is running.

VII. TRI-MICRO OIL FILTER

NOTE

Before proceeding, refer to Paragraph I, “Gen eral Service Instructions”.

A. Removal

To remove the oil filter, drain the tank by re moving the pipe plug on the bottom or side. Next remove one of the front screws. It can then be threaded back in at least 2 turns, or a %” (6.35 mm) longer screw can be used and also threaded in 2 turns. This will be the pivot point or hinge to swing the filter and tank out for ease of removal. By unscrewing the remaining 3 screws alternately, the tank will start to lower un til the first screw installed comes in contact with the filter adapter. Force the center tube top plate down and out of its connection hole while pivoting the filter tank. Now that the filter and center tube can be removed, disassemble the center tube by removing the bottom spring plate. Slide the old filter off and discard properly. The tube should be washed off and clean.

B. Replacement

Make sure to remove the used gasket of the fil ter adapter and install a new one. After cleaning the tank, reinstall the pipe plug in the drain. In stall it on its pivot screw. Add fresh oil to fill half the tank. Reassemble the new filter on the center tube. Slowly place the filter in the tank and allow the filter to absorb the new oil. Pivot the tank under the adapter and align the center tube in its hole. Start the remaining 3 screws than tighten the tank flange to the adapter. The proper placement of the mechanism, once in the frame, is having the curved sides of the bottom plate on the mechanism aligned between the lower liner bores.

VIII. OIL PUMP ASSEMBLY

NOTE

Before proceeding, refer to Paragraph I, “General Service Instructions”.

A. Removal

To remove the oil pump assembly, first remove the filter tank and adapter from the rear housing. Be prepared for a small amount of oil to drain from adapter. The pump will be exposed in the center and the outer pump housing will be covered by a gasket. Remove gasket. At the top right and bottom left, you will find tapped holes to aid in removing the pump, if necessary. The pump housing is approximately 11/2 (38.1 mm) thick, so it requires jack screws 2" (50.8 mm) or longer to release the inner gasket. Once loose, pull the oil pump straight back.

The oil pump is a factory built and tested component. It is furnished as a complete assembly only and cannot be serviced in the field.

B. Replacement

To replace the oil pump assembly, first rotate the crankshaft so the drive key is hanging from one of four screws through the rear bearing retainer. Make sure the small orifice plug in the rear housing (at the 12 o’clock position) is clear. Clean all gasket surfaces. Install gasket (Part No. 31899A), correctly aligning oil passage holes. Align pump shaft flats to match flats in pump drive key. The locating dowel pin in the rear housing should align with hole in the pump housing to the top-left-center.

Install the pump and seat it against the inner gasket. The outer surface of the pump should now be recessed approximately / (3.175 mm) to the rear bearing housing. Install gasket (Part No. 31900A), correctly aligning the holes. The slot in this gasket should be at the 9 o’clock position. Place the rubber seal gasket on the filter adapter, and reattach the filter assembly onto the rear housing. Install screws and tighten down evenly.

IX. PREPARATION FOR INTERNAL SERVICING

NOTE

Before proceeding, refer to Paragraph I, “General Service Instructions”.

A. Handhole Cover Removal

To work internally on the compressor, the hand- hole cover and crankcase oil will have to be re moved to gain access. The heater will have to be electrically disconnected at this time. Re member to shut the power off and lock it out. After disconnecting the wiring, loosen all but two screws on the upper corners of the cover. This helps support the cover during removal and pre vents damaging the heater. If the cover sticks to the frame, a slight tap with a lead or soft face hammer will free it.

Holding the cover in place, remove the two remaining screws, and pull the cover straight back away from the frame. Remove any gasket material from the cover and frame face. Also inspect and remove any burrs or rough edges from the mating surfaces to ensure a tight seal at time of reassembly.

B. Handhole Cover Replacement

Lightly lubricate both sides of a new gasket with refrigerant oil or general purpose grease. Place the gasket on the cover, and guiding in the heater, place the cover against the frame opening. While holding the cover and making sure the gasket is still in place, insert two screws in the lower row to help support the cover and keep the gasket from slipping out. Start the rest of the screws in their holes and continue to check gasket placement. Tighten screws evenly to the torque requirements in Table 2, 3 or 4 (depending upon compressor model). Connect the heater wiring and heater cover, add oil to crank case and turn on power to the heater to preheat the oil for operation of compressor.

X. CRANKSHAFT SEAL

NOTE

Before proceeding, refer to Paragraph I, “Gen eral Service Instructions”.

A. Oil Seal Leakage

In refrigeration compressors, a slight amount of oil leakage past the crankshaft seal is normal and desirable. A few drops per minute is reasonable. This leakage performs two important functions. It helps lubricate the neoprene bellows and 0-rings, and it helps cool mating rotating pads to provide less wear and longer life. A receptacle for collection is recommended.

B. Removal

The flywheel or coupling will have to be re moved. Detach the tubing line on the bottom of the front housing. Oil will drain from the seal chamber, be prepared to collect it. After the oil has drained, remove the 8 screws holding the cover. When removing the cover, caution should be taken because the front carbon seal might come off with the cover. At this time, if the seal is going to be reused, clean the surface of the shaft and avoid getting anything in the housing area.

Grab the front rubber bellows and pull forward. It should release. If not, Try by the tabs on the metal ring (alternating force from side to side) to remove it. Remove the large spring.

Next step is to remove the 3 screws in the retainer that hold the inner mirror seat. Put 2 of these screws in the tapped holes of the retainer. Rotate the retainer so screws are at 3 and 9 o'clock positions. Pull on the screws to aid in removing the retainer and the rest of the seal assembly. Clean out the seal chamber with suitable refrigeration parts cleaner. Afterwards, coat the area and crankshaft to keep them from rusting.

C. Installing A New Shaft Seal

Remove the mirror seats from the inner retainer and outer cover. The mirror face can be removed by tapping on back side that is exposed in each part. Make sure these parts are then cleaned. Place either on a flat surface with the recess up. Oil the 0-ring sealing area.

Take the mirror face (do not touch the mirrored surface), oil outer 0-ring and lay it in the cover or retainer with the mirror face upward. Using a very clean cloth or similar item, cover mirror face and, using palm of hand, set it in the recess. Repeat this assembly process for the other mirror face.

Frick recommends that if any part of a seal needs replacement, the entire shaft seal should be replaced with a new one.

Make sure the oil passage in the shaft is unobstructed. Install the inner retainer with face, flush in front housing, with the word at the top. Tighten down evenly with screws.

The shaft seal assembly is symmetrical. It can be installed in either direction. Spray oil on inner mirror face. Liberally coat oil on one of the bellows and carbon assemblies. Avoid coming in contact with carbon. Carefully slip the assembly on the shaft until the carbon touches the mirror face. Put the spring over the shaft and seal on the bellows assembly, and slide it onto the shaft to join up with the spring. With the new cover gasket in place, install the cover over the end of the shaft.

Push the cover all the way on, lining up the bolt holes so the drain is to the bottom. Tighten down the 8 screws evenly to the torque requirements in Table 2, 3 or 4 (depending upon compressor model).

XI. CONNECTING RODS AND PISTONS

NOTE

Before proceeding, refer to Paragraph I, "Gen eral Service Instructions".

A. Disassembly

After the cylinder covers, valves and handhole cover have been removed, the first step in re moving the piston and rod assembly is to re move the Palnut locknuts on the rod bearing bolts. Then, remove the plain nuts and slide the bearing cap off of the nuts. The Palnut locknut is not used with this type of locknut.

Handle the bearing cap carefully to avoid dam age to the bearing half insert. Push the rod and piston out through the top of the cylinder. Avoid possible mixing with components. Keep all parts together in relation to their position in the compressor. Connecting rods and rod caps are match marked to aid in reassembly. On reassembly, all parts must be installed in the same position in the compressor.

As soon as the parts are removed from the compressor, they should be thoroughly cleaned with a suitable refrigeration parts cleaner. Once the oil film is removed, the bare metal is subject to rust. This reaction can start immediately. Therefore, lubricate the surfaces of the parts lightly with clean compressor oil immediately after cleaning.

The tabs on the bearing half insert fit into the recess in the rod and rod cap, and the inserts can be slipped out without difficulty. To replace the rod bearings, it is necessary to change the inserts only and not the entire rod.

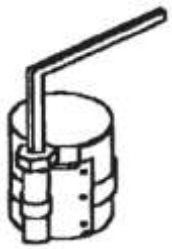
450XL Compressor Only

If the piston rings are to be removed, wrap a piece of thin shim stock around the piston. Work the rings carefully out of their grooves and onto the shim stock. They can then be worked down over the piston. Caution must be exercised to prevent breaking the rings.

The piston and connecting rod assembly should not be disassembled further. It is furnished only as a complete assembly and should not be worked on in the field.

B. Reassembly

All new compressors use three compression rings and one oil control ring. When replacing rings, use the ring expander. Check the grooves to make sure they are clean.



PISTON RING COMPRESSING TOOL

The easiest way to replace the rings on the piston is to wrap a thin piece of shim stock around the pistons and slide the ring over this. Do not force the rings when sliding them onto the shim stock. The rings are brittle and may snap. A tool is also available to aid in the installation of the rings.

Both compression and oil rings are marked to indicate the top of the ring. Install the compression rings with the identifying mark to the top of the pistons. Rotate the end gaps on each ring so they are not aligned on the piston.

Remove the piston assembly. Check the fit of the piston pin bushing for wear. The 440 and 450 have a different pin and piston design from the 450XL compressor. The 440 and 450 piston and piston pin bushing have a “slip” fit. When replacing the piston and bushing, the bushing must be reamed to the correct “slip” fit after installation into the rod to accommodate the new piston pin. The 450XL piston and piston pin bushing cannot be changed in the field due to tolerances. They must be purchased as a unit with the connecting rod and piston assembly.

DO NOT TRY TO ASSEMBLE WITHOUT PROPER TOOLS AND CALIBRATED TORQUE WRENCH

The piston pin should not slip easily into its hole, but it must not be driven down. ft may be necessary, however, to tap the pin lightly with a block of wood and a hammer. Be sure the hole in the rod pin bushing is aligned so the pin can slip through it. When the pin has been tapped in far enough, install the two piston pin lock rings, one at each end of the piston pin.

Two styles of bearing half inserts have been used in the compressor. One style has only the hole in the rod half to allow oil to travel up the rod. The second type has annular grooves to allow a continuous supply of oil.

CAUTION

The bearing inserts should never be spread open, by hand or any other means, to provide for a tighter fit in the rod.

If an inspection indicates the rod bearing surfaces are worn replace the bearing insert. Assemble bearing inserts by pressing them into place, making sure the notch in the rod is clear.

If the bearing insert does not properly fit in the rod and it falls out during assembly, either the bearing insert or the rod is worn or incorrectly made.

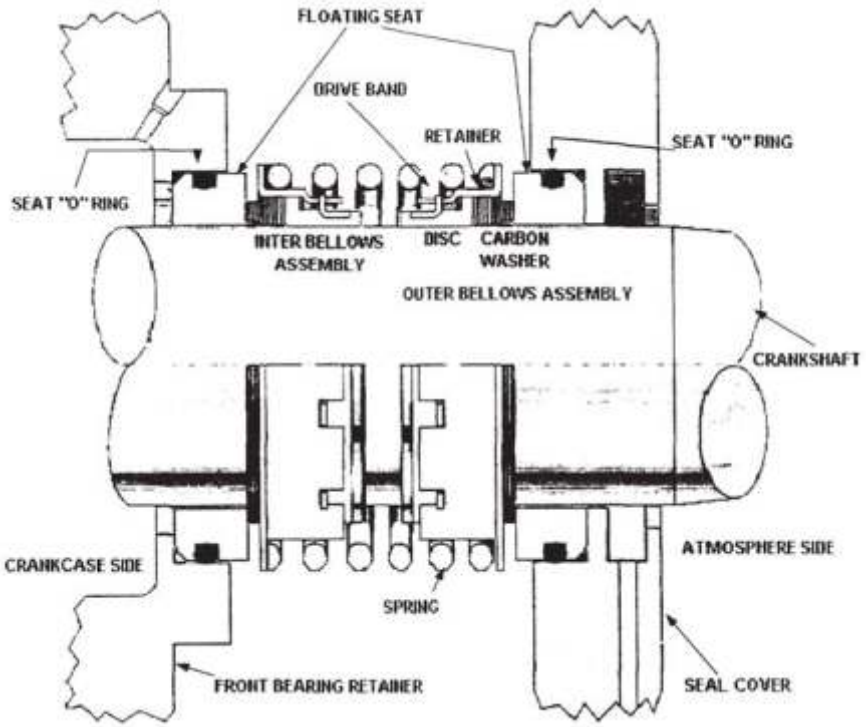
When installing the bearing insert into the connecting rod, make sure there is no oil on the connecting rod or the back side of the bearing insert.

If the original bearings have failed, check the crankshaft bearing surface. If there are slight imperfections due to bearing failure, remove by polishing with fine crocus cloth. Then, clean the bearing surface with suitable refrigeration cleaner and lubricate with clean compressor oil.

Lubricate the inside of the cylinder and the entire piston. The recommended method of installing the piston in the liner is with the use of a Piston Ring Compressor. Attach the oil line to the bottom of the front housing. Do not over tighten the nut. Rotate the shaft a few times to help the seal settle into position.



FRONT COVER ASSEMBLY AND DISASSEMBLY STUD



CRANKSHAFT SEAL ASSEMBLY

XII. CONNECTING RODS AND PISTONS

NOTE

Before proceeding, refer to Paragraph I, General Service Instructions".

A. Disassembly

After the cylinder covers, valves and handhole cover have been removed, the first step in re moving the piston and rod assembly is to re move the Palnut locknuts on the rod bearing bolts. Then, remove the plain nuts and slide the bearing cap off of the nuts. The palnut locknut is not used with this type of locknut.

Handle the bearing cap carefully to avoid dam age to the bearing half insert. Push the rod and piston out through the top of the cylinder. Avoid possible mixing with components. Keep all parts together in relation to their position in the compressor. Connecting rods and rod caps are match marked to aid in reassembly. On reassembly, all parts must be installed in the same position in the compressor.

As soon as the parts are removed from the compressor, they should be thoroughly cleaned with a suitable refrigeration parts cleaner. Once the oil film is removed, the bare metal is subject to rust. This reaction can start immediately. Therefore, lubricate the surfaces of the parts lightly with clean compressor oil immediately after cleaning.

The tabs on the bearing half insert recess in the rod and rod cap, and can be slipped out without difficulty. the rod bearings, it is necessary to inserts only and not the entire rod.

450XL Compressor Only

If the piston rings are to be removed, wrap a piece of thin shim stock around the piston. Work the rings carefully out of their grooves and onto the shim stock. They can then be worked down over the piston. Caution must be exercised to prevent breaking the rings.

The piston and connecting rod assembly should not be disassembled further. It is furnished only as a complete assembly and should not be worked on in the field.

B. Reassembly

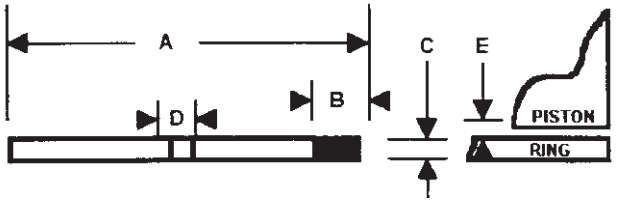
All new compressors use three compression rings and one oil control ring. When replacing rings, use the ring expander. Check the grooves to make sure they are clean.

Before inserting the piston into the cylinder, en sure the ring gaps are not in line and the match numbers on the rods are facing the right side of the machine when viewed from the driven end.

Push the piston down until the bearing insert seats on the crankshaft. Take the bottom half of the rod bearing insert and slip it into the rod cap. Make sure the rod cap is clean, so the insert can seat in the cap properly. Oil the insert with compressor oil, and place the cap on the rod with the matching number on the same side as those on the rod.

Connecting rod bolts are secured with one plain steel nut and one spring steel locknut (commonly referred to as a "Palnut"). The plain nut tightening torque should be listed in Table 2, 3 or 4 (depending upon compressor model). The torque wrenches should be set to the high side of the tightening torque range.As the rods, bearing inserts and crank pins are all machine to fine tolerances, no further adjustments are necessary.

After a plain nut has been placed on a rod bolt and torqued to the specified value, turn a Palnut to the rod bolt with the open end of the hexagon pointing away from the plain nut. The planut should be turned until mating parts are pulled togeter and actual tightening begins.



PISTON RING DIMENSIONS

DIMENSIONS	COMPRESSION RING	OIL RING
A	4.500	4.500
B	0.160 TO 0.170	0.170 TO 0.180
C	0.1230 TO 0.1240	0.1860 TO 0.1870
D	0.013 TO 0.0225	0.013 TO 0.023
E	0.002 TO 0.004	0.0015 TO 0.004

PISTON RING DIMENSIONS AND TOLERANCES

Final tightening and locking is then achieved by giving the palnut an additional 1/3 to 1/2 (maximum) turn. Although the plain steel nuts may be reused, new unused planuts must be used each time the connecting rods are reassembled to the crankshaft. If used Palnuts are installed , their locking features is lost and a loose rod connection may result. After each rod is installed , rotate the crankshaft by hand to make sure everything is free and there is no binding of the rotating parts.

CAUTION

Late model 450 XL compressors may push liners out.

XIII. CYLINDER LINERS

NOTE

Before proceedingsrefer to paragraph I, "General Service Instruction"

A. Removal

Once the piston and rod assemblies are removed, the liner can be extracted from the frames by means of Liner pulling tool (KT-257). This tool, or similar, is required for all 440/450 compressors and 2 stage compressors.

NOTE

If the cylinder bank has unloading, the unloader piston needs to be held down for ease in liner removal.

The lines in the 450Xl compressor have a looser fit into the frame. They can be removed by pulling from the bottom of the liner by hand.

NOTE

2-Stage liners have an extra groove without ring that seals the suction chamber from the crankcase.

B. Lift Rings for Unloading

There are two styiles of unloading lift ring assemblies.

450XL Lift Ring Assembly

Invert the liner and place on a flat surface. Locate the notched end of the snap ring that retains the lift ring, while pushing down on the lift ring in this area. Try the snap ring out of its groove and continue all the way around the liner.

Remove the snap ring, and slide the ring up and off the liner. Now the 8 pins and springs can be removed from the liner. Reverse the procedure to install a lift ring assembly on any 450XL liner.

C. Installation of Liners

Before the liner is installed, make sure the outer surface of the liner is clean and the seat area in the frame is free of foreign matter. If a new o ring is required, lubricate the 0-ring and frame seating area with refrigeration oil. Slide the liner into the frame and align with the bore. Roll pin on the top of the liner can be orientated so if an imaginary line is drawn to opposite pins, it forms the letter 'X". Seat the liner in the frame recess firmly by use of Cylinder Liner Tool (Part No. 33464A).
A similar tool can be constructed. Be sure to protect the liner tapped seats to prevent damage.

XIV. CRANKSHAFT

A. General

Removing the crankshaft from the compressor is basically the same for all units, regardless of size. Because of a center bearing on all compressors and the radius the 8 cylinder throws on the

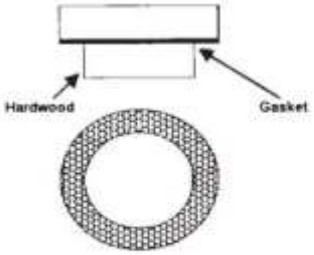


FIGURE 14. CYLINDER LINER ASSEMBLY TOOL

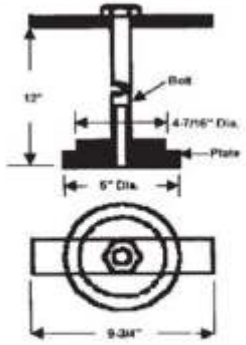


FIGURE 15. CYLINDER LINER REMOVAL TOOL

crankshaft, an extra step must be taken. A crankshaft may be removed from either end of the compressor. It is, how ever, easier to take the crankshaft out of the drive end of the frame. If the crankshaft is taken out of the pump end, the entire shaft seal must be removed.

B. Removal From Drive End

Remove any connections that will hinder the removal of the front bearing housing. When disconnecting the front oil line, be prepared to catch approximately 1 gallon of oil. Remove the shaft seal and inner retainer.

Replace the two 5/8" (15.88 mm) x 4" (101.6 mm) socket head screws with threaded studs to sup port the front housing during removal. Remove the 6 (168.28 mm) x 2" (50.8 mm) cap screws that hold the housing to the frame. Using the 4" (101.6 mm) socket head screws, insert them into the tapped holes on both sides of the housing to aid in the removal of the front housing from the frame and off the front bearing. During this process, the housing will have a tendency to hang up on the outer diameter of the bearing, thus pulling the entire shaft with it and possibly disengaging from the rear housing. Care must be taken to prevent this from happening. While the front housing is being removed, push on the crankshaft to be sure it is staying in the rear housing.

On a 458XL compressor, the rear housing will have to be removed, because the radius of the counterweight is larger than the radius of the front housing bore. Thus, the shaft will be hindered from coming straight out of the frame. Once the front housing is removed, the crankshaft should be blocked from inside the frame due to its weight. Adjust the blocking as the work proceeds so the crankshaft does not bump the front bore nor make any contact with the journals.

To aid in removal, a simple step can be added. Before removing the shaft from the rear housing, remove the rear bearing retainer and tap the center hole to 11/. (31.75 mm) NPT. Reinstall the retainer on the end of the crankshaft. A 1⅝" (31.75 mm) pipe can be threaded into it and used as an extension bar for handling the crank shaft during removal.

C. Removal From The Pump End

To pull the crankshaft from the pump end of the compressor, remove the pump cover filter adapter, the complete oil pump assembly and the rear bearing housing. The crankshaft does need to be blocked to prevent damage.

The shaft seal cover, shaft seal, and inner retainer will also have to be removed. All special notes apply to this method as well.

D. Reinstallation

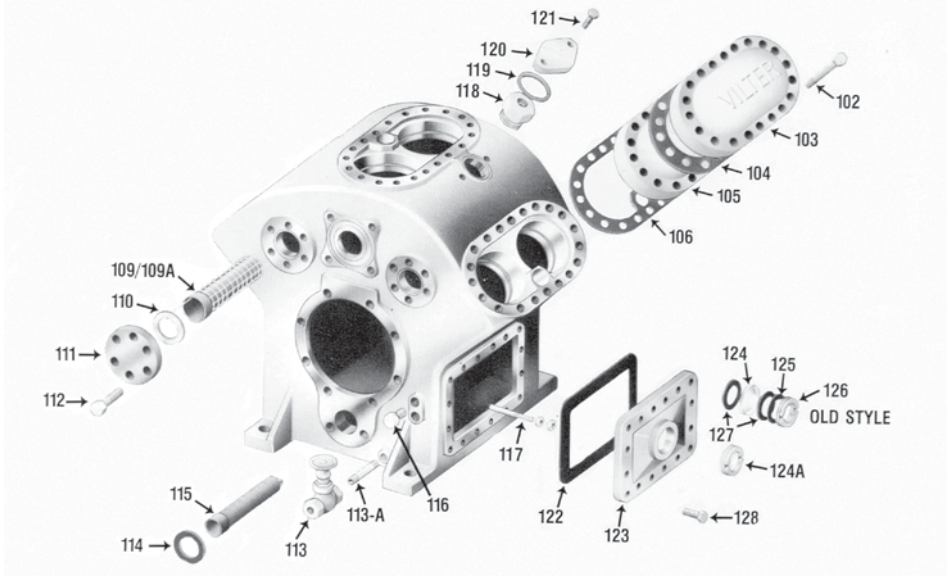
Whichever method was used to remove the crankshaft, extreme care is needed when placing the shaft back into the frame. Avoid any damage to the journals, and block the crankshaft once in position.

If the crankshaft was removed from the front end and the rear housing left in place with the oil pump, it is imperative the locating pin on the rear bearing align with the slot in the bottom of the rear housing bore. Also, the pump drive key must engage with the pump shaft. Align the hole in the bearing housing (for the oil feed connector tube) with hole in the frame. Screw the oil feed connector loosely on the end of the ½" (12.7 mm) threaded rod, and insert it into the hole. Push the tube into the bearing housing.

Unscrew the rod from the tube. Place the spring in the hole and screw in the "tee". Use thread sealant. Insert the taper pin in its hole. After placement, pin must be tightened. This expands the bearing housing so it fits tightly in the frame for quiet operation.

SPARE PARTS

Basic Frame & Covers

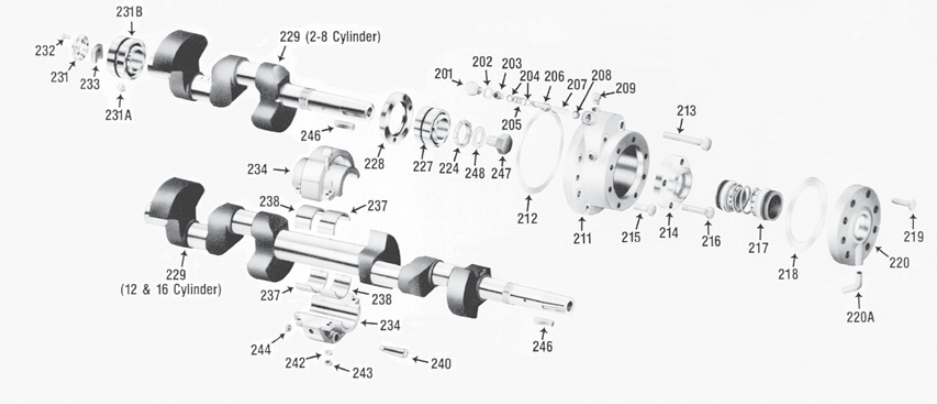


Ref. Number	450XL Part Number	Description
102	13152G	Screw, $^5/_8$" x 2½" Hex. Head Cap (Used w/o Water Jacket)
102	13152L	Screw, $^5/_8$" x 3½" Hex. Head Cap (Used with Water Jacket)
103	30299A	Cover, Water Jacket
104	33329A	Gasket, Water Jacket
105	*	Cover, Cylinder
106	33330A	Gasket, Cylinder Cover
109	*	Screen, Suction
109A	*	Bag, Suction Screen (Not Shown)
110	*	Gasket, Suction Screen/ Suction Tee Cover
111	*	Cover, Suction Screen; Cover Suction Tee
112	*	Screw, Hex. Head Cap
113	A13974B	Valve, ½" Oil Charge and Drain (Ammonia)
113	1956A	Valve, ½" Oil Charge and Drain (Halocarbon)

Ref. Number	450XL Part Number	Description
113A	13189G	Nipple, ½" x 4" Sch. 80 Pipe
114	31889A	Gasket. Crankcase Oil Screen
115	A31886A	Screen, Crankcase Oil
116	13264D	Plug, ½" Hex. Head Pipe
116	13264E	Plug, $^3/_4$" Hex. Head Pipe
117	A31936A	Pin Retaining Assembly For Crankcase Oil Screen
118	1721C	Safety Valve, Internal Relief
119	11323G	Gasket, 2" Flange
120	31954A	Cover, Safety Valve
121	13152E	Screw, $^5/_8$" x 2" Hex. Head Cap
122	31894A	Gasket, Handhole Cover
123	*	Cover, Handhole
124A	1484A	Glass, Oil Sight - 2"
124-127	-	Glass, Oil Sight - 3" (Old Style)
128	13153E	Screw, ½" x 1½" Hex. Head Cap

* Check your Operator's Manual for correct Part Number for your specific Compressor model.

Crankshaft & Front Bearing Cover



*Check your Operator's Manual for correct Part number for your specific compressor model. Splash shield included on crankshaft with bearing

Ref. No.	450XL Part Number	Description
201	30651B	Cap, Valve
202-208	KT486	Oil Relief Valve Kit
209	13264B	Plug, ¼" Pipe
209-211	-	Cover, Front Bearing Assy. for 2½" Shaft (Requires Oil Orifice In Item #214)
209-211	A36241A	Cover, Front Bearing Assy. for 3" Shaft (Requires Oil Orifice In Item #214)
212	31890A	Gasket, Bearing Cover
213	13159E	Screw, $^{5}/_{8}$" x 4" Socket Hd.
214	-	Retainer, Front Bearing (w/oil hole) for 2½" Shaft
214	33500A	Retainer, Front Bearing (w/oil hole) for 3" Shaft
215	13152E	Screw, $^{5}/_{8}$" x 2" Hex. Head
216	13153Q	Screw, ½" x 4" Hex. Head
217	-	Seal, 2½" Shaft Assembly
217	A33489A	Seal, 3" Shaft Assembly
218	-	Gasket 2½" Shaft Seal Cov.
218	33496A	Gasket 3" Shaft Seal Cov.
219	13153F	Screw, ½" x 1¾" Hex.Hd.
220	-	Cover, 2½" Shaft Seal
220	32564A	Cover, 3" Shaft Seal
220A	35078A	Tube, Oil Drain
224	-	Locknut, 2½" Shaft
224	KT367	Locknut, 3" Shaft

Ref. No.	450XL Part Number	Description
227	-	Front Bearing, 2½" Shaft
227	KT369	Front Bearing, 3" Shaft
228	-	Ring, 2½" Shaft, Front Bearing Retainer
228	33145A	Ring, 3" Shaft, Front Bearing Retainer
229	*	Crankshaft, Bare
224-244	*	Crankshaft with Bearings
231	31904A	Retainer, Rear Bearing
231A/ 231B	KT353	Rear Bearing and Lock Pin
232	1736G	Screw $^{5}/_{16}$" x 1 $^{1}/_{2}$" Hex.Hd.
233	33403A	Crank, Oil Pump Drive
234	A32163A	Case, Bearing Support
237	33508A	Bearing Half, Upper Right or lower left
238	33508B	Bearing Half, Upper left or Lower Right
240	33497A	Pin, Threaded Taper
242	13165F	Washer, $^{1}/_{2}$" Lock
243	1726E	Nut, $^{1}/_{2}$" Hex.
244	13253F	Nut, $^{9}/_{16}$", Hex.
246	-	Key, 2 $^{1}/_{2}$" Crankshaft
247	31956A	Screw, Flywheel Hub
248	33495A	Washer, 3"Shaft, Flywheel Hub Screw

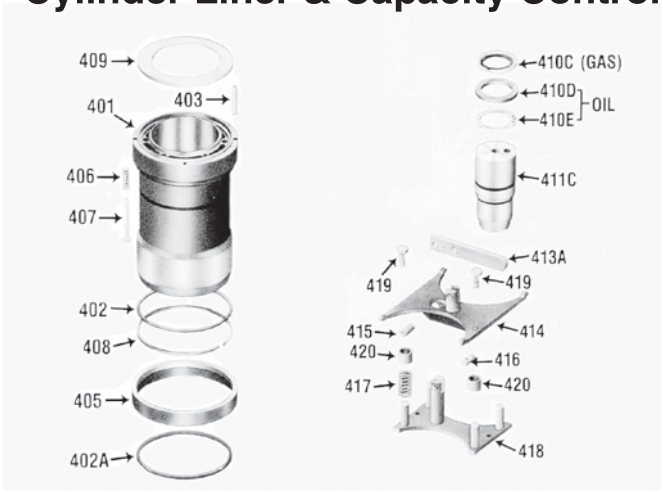
Rear bearing Cover & Filter assembly



Reference Number	450XL Part Number	Description
301-304	KT092	Rear Bearing Cover Assembly
305	31899A	Gasket, Oil Pump Body
306	A33480A	Oil Pump Assembly
307-323	-	Conversion Kit,Std. Tri Micro
307	31900A	Gasket, Oil Pump Cover
308	33320A	Gasket, Oil Pump and Rear Bearing Cover Seal
309	*	Cover, Oil Pump and Filter Head
310	A35240A	Tri-Micro Oil Filter Assembly with Bypass Relief
310	-	Tri-Micro Oil Filter Assembly w/o Bypass Relief
311	1448J	Spool, Internal with Bypass Relief
311	-	Spool, Internal w/o Bypass Relief
312	1448H	Seal, Spool End
313	1448K	Strainer Tube
314	1448L	Ring, Strainer Tube Retaining
315/321	1448C	Oil Filter Element with Gasket For use with Bypass Relief
315/321	-	Oil Filter Element with Gasket For use w/o Bypass Relief
316	1448M	Pressure Plate Assembly
317	1448N	Pressure Plate
318	1448P	"O" Ring Seal, Pressure Plate (Not Shown)
319	1448Q	Spring, Pressure Plate
320	13264A	Plug, $^{1}/_{8}$" Pipe
321	1448B	Gasket, Oil Filter Tank
322	A34623A	Filter Tank with Flange and Plug
323	1689G	Screw,$^{7}/_{16}$" x 2" Hex. Head Cap
325	31890A	Gasket, Bearing Cover
326	13152E	Screw, $^{5}/_{8}$" x 2" Hex. Head Cap
327	13153F	Screw, $^{1}/_{2}$" x 1 $^{3}/_{4}$" Hex. Head Cap

*Check your Operator's Manual for correct Part Number for Specific compressor model.

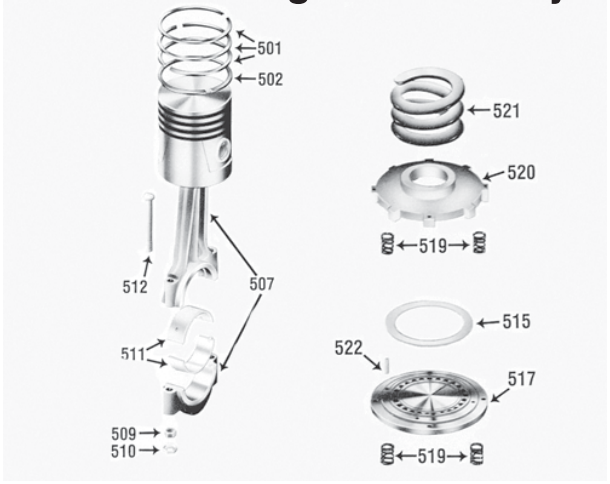
Cylinder Liner & Capacity Control



Reference Number	450XL Part Number	Description
401	34510A	Liner, Cylinder (Single Stage)
401	34710A	Liner, Cylinder (Integral Two-Stage)
402	33331A	Seal, "O" Ring, Upper
402A	33331K	Seal, "O" Ring, Lower (Integral Two-Stage)
403	1193Q	Pin, 1/8" x 1½" Roll
405	35071A	Ring, Lift
406	35069A	Spring, Lift
407	35070A	Pin, Lift
408	1971A	Retainer, Lift Ring
409	31909A	Plate, Suction Valve
410A[a]	-	Ring, Piston, Gas (Old style)
410B[a]	-	O-Ring, Oil (Old style)
410C[b]	2557A	Ring, Gas
410D[b]	2639A	Ring, Oil
410E	2638A	Retainer, Snap Ring, Oil
411A,410C[c]	-	Piston, Gas (Old Style)
411B, 410D / E [c]	-	Piston, Oil (Old Style)
411C[d]	35315A	Piston, Gas or Oil
412	-	Pin, Long Pivot
413[e]	-	Arm, Yoke Lifting (Old Style)
413A[e]	41725A	Arm, Yoke Lifting (New Style)
414	A33335A	Yoke Assembly, Std. Unloading
414	A33575A	Yoke Assembly, Single Cyl.Unloading
415	1193X	Pin, 3/8" x 11/16" Roll
416	33250B	Pin, Short Pivot
417	33686A	Spring, Unloader Yoke
418	A33347A	Yoke Guide, Std. Unloading
418	A33576A	Yoke Guide, Single Cyl. Unloading
419	1352D	Screw, 3/8" x 1" Hex Head Lock, Single Cyl. Unloading
420	33618A	Spacer, Sleeve, Single Cyl. Unloading

(a) 410A and 410B- Sold for replacement use only; will not fit present pistons.
(b) 410C and 410D-Not interchangable with old (410A and 410B).
(c) 411A and 411B- Present pistons cannot be used with old rings kit. KT034 contains 410C; KT364 contains 410D/E.
(d) 411C - New piston not interchangable with old (requires different frame). New piston has two grooves - top for gas and bottom for oil.
(e) 413 and 413A - Yoke lifting arms not interchangable.

Piston Connecting Rod & Safety Head



Reference Number	450XL Part Number	Description
501	31989M	Piston Ring, Compression
502	31989N	Piston Ring, Oil
503	-	Snap Ring, Piston Pin
501-505	-	Piston, Rings and Pin Kits
501-512	KT573	Piston, Rings and Connecting Rod Assembly
506-512	-	Connecting Rod with Bearings
506	-	Bushing, Piston Pin
507	See Kits Above	Connecting Rod
509	2027A	Nut, 3/8"-24 UNF, Hex.
510	2028A	Nut, 3/8" Lock
511	KT575	Bearing Set, Connecting Rod-Standard
511	-	Bearing Set, Connecting Rod-0.015" Undersize
511	-	Bearing Set, Connecting Rod-0.030" Undersize
512	31955A	Bolt, Connecting Rod
513-518	-	Safety Head Assembly-Ammonia
513-518	-	Safety Head Assembly-Halocarbon
513	-	Nut, 3/8" Lock Valve Retaining
514	-	Washer, Diaphragm Valve
515	-	Valve, Diaphragm Discharge
515	35080SS	Plate, Discharge Valve
516	-	Spacer, Diaphragm Valve
517	-	Safety Heads, Ammonia
517	-	Safety Heads, Halocarbon
517/522	A35082A	Safety Head & Pins Assembly-Ammonia
517/522	A35272A	Safety Head & Pins Assembly-Halocarbon
518	-	Screw, Valve Retaining-60° (Old Style)
518	-	Screw, Valve Retaining-82°
519	33803A	Spring, Valve
520	-	Yoke, Safety Head
520/522	KT543	Safety Head Yoke and Pin Kit
521	35252A	Spring, Safety Head
522	1712F	Pin, 3/16" x 11/16" Roll

Do's & Don'ts

Do's

- Run the compressor in its recommended direction of rotation i.e. Counter clockwise, while seeing through flywheel end.
- Replace V-belts in matched sets only.
- The suction filter in the compressor is equipped with a filter bag inside the suction screen. This bag is for catching the foreign material present in the system. Replace it with a clean bag after the first 24 hrs of operation & continue doing so untill all traces of foreign materials are removed from the system. Then remove the filter bag from the suction screen.
- Use only Frick India recommended compressor lube oil in the compressor
- Replace the faulty pressures gauges immediately.
- Take care; refrigerant does not flood into the compressor. Liquid slugging can cause considerable damage to the compressor.
  Stop the compressor immediatelly. Start the crankcase heater. Remove the boiled off ammonia gas out of the compressor then flush out the contaminated lub oil from the compressors crankcase and charge the fresh oil in the compressor.
- Replace initial oil filter cartirage after first 300 hrs of compressor operation. Further replace it every 1500 hrs or when oil begins to darken. This can be checked through differential pressure gauge installed over the filter tank if the pressure difference through the filter reaches 25 psig, change the filter.
  As the oil filter Assembly is provided with a bypass relief so replace the oil filter as soon as the differencial oil pressure reached 25 psig. Otherwise any further choking of oil filter leads to the opening of the bypass relief and dirty oil will start flowing to the compressor part.

  NOTE :

  In case the gauge is showing between 0-5 psig, after showing a pressure difference of 20 psig or above earlier, the filter may be a) Burst or b) bypassed.
  PI check filter immediatelly for Auto operation use a oil filter difference pressure switch when you install the compressor. The switch is an optional purchase.

  CAUTION
  This is a paper type oil filter, so never try to clean the filter by washing it. Always replace it with new one

- Check the oil temperature regularly in the oil temperature gauge provided at the bottom of oil cooler end of the compressor. Oil temperature should not rise beyond $60^{0}C$.
- Maintain the Log Sheet regularly & correctly fill up the parameters after every 4 hrs of running. (Format is given at the last page of this manual)
- Use only genuine Spare parts procured either from Frick India Factory or its nearest branch office.
- Do write to Frick India or your nearest branch office if you have any problem. Address and contact numbers are given at the back of this manual.

Don'ts

- Do not use the compressor as a vaccum pump for evacuating or pressure testing the system. Instead use a separate vaccum pump and air compressor.
- Do not attempt to run the compressor untill proper motor & compressor V-belts alignment is attained, otherwise this may cause popping & turning of V-belts, premature failure of belts, compressor bearings, seal etc.
- Do not let the compressor run without a minimum oil level of half of the oil indicator glass.
- Do not run the compressor with dirty oil. Check it after first 200 hrs of running. Drain the dirty oil & then make sure to clean the Crankcase from inside & the filter system completely before filling the new oil.
- Do not keep the compressor running if abnormal heating or sound in the compressor is noticed.
- Do not bypass compressor safety controls ie LP/HP/OP cutouts.

Trouble Shooting

Basic guide for diagnosing and correcting industrial refrigeration service problem :

First and foremost, safety must be stressed and safe operating practices followed , before and while doing any troubleshooting or service work. All local and national codes as well as company rules concerning safety, must be observed. Some of the more important safety steps that are often overlooked are :

a. Protective equipment such as eye protection, gloves hard hats etc., must be available and worn.
b. Fire extinguishers must be readily available, in good working order and adequate for the situations.
c. Gas masks should be handy and in good operating order.
d. Safety tags with such notations as “Danger” “Hands off” “Do not operate” and “Do not throw Switch” should be attached to valve, switches, starters and at other strategic locations when servicing or making repairs.
e. Install machinery guards properly, before operating machinery.

The above is only a short list and not intended to be all-inclusive.

It is assumed that only experienced , qualified personnel both in refrigeration and electrical will be using this guide. If the person or persons doing troubleshooting or service work are not qualified or if there are any questions, then there is one simple rule to follow and that is “DON’T ATTEMPT TROUBLESHOOTING OR SERVICE”. Wait to get the proper help.

The item contained on this list are written from the standpoint that the refrigerating equipment has been operating and all start-up problems have been corrected. Also, it is assumed that the system is an industrial refrigeration plant using open type reciprocating compressors.

Lastly, this guide is not intended to be all encompassing, but does serve as a brief checklist.

	PROBLEM	POSSIBLE CAUSE	REMEDY OR COMMENT
I.	COMPRESSOR WILL NOT START	A. No power to motor.	1 Check power to and from fuses; replace fuses if necessary. 2 Check starter contacts, connections, overloads and timer (if part winding start). Reset or repair as necessary. 3 Check power at motor terminals. 4 Repair wiring if damaged.
		B. Control circuit is open	1 Safety switches are holding circuit open. Check high pressure, oil failure and low pressure switches. Also check oil filter pressure differential switch if supplied. 2 Thermostat is satisfied. 3 Check control circuit fuses if blown; replace. 4 Check wiring for open circuit.
II.	MOTOR “HUMS” BUT DOES NOT START	A. Low voltage to motor.	1 Check incoming power for correct voltage. Call power company or inspect /repair power wiring.
		B. Motor shorted.	1 Check at motor terminals. Repair or replace as necessary.
		C. Single phase failure in three phase	1 Check power wiring circuit for component or power supply fuse failure.
		D. Compressor is seized due to damage or liquid.	1 Remove belts or coupling. Manually turn crankshaft to check compressor.
		E. Compressor is not unloaded.	1 Check unloader system.
III.	COMPRESSOR STARTS, BUT MOTOR CYCLES OFF ON OVERLOADS	A. Compressor has liquid or oil in cylinders.	1 Check compressor crankcase temperature. 2 Throttle suction stop valve on compressor to clear cylinders and act to prevent recurrence of liquid accumulation.
		B. Suction pressure is too high.	1 Unload compressor when starting. Use internal unloaders if present. 2 Install external by-pass unloader.
		C. Motor control.	1 Motor control located in hot ambient. 2 Low power voltage. 3 Motor overloads may be defective or weak. 4 Check motor control relay. 5 Adjust circuit breaker setting to full load amps.
		D. Bearings are “tight.”	1 Check motor and compressor bearings for temperature. Lubricate motor bearings.
		E. Motor is running on single phase power.	1 Check power lines, fuses, starter, motor etc., to determine where open circuit has occurred.
IV.	COMPRESSOR STARTS BUT SHORT CYCLES AUTOMATICALLY.	A. Low refrigerant charge.	1 Check and add if necessary.
		B. Driers plugged or saturated with moisture.	1 Replace cores.
		C. Refrigerant feed control is defective.	1 Repair or replace.
		D. No load.	1 To prevent short cycling, if objectionable, install pump-down circuit, anti-recycle timer or false load system.
		E. Unit is too large for load.	1 Reduce compressor speed. 2 Install false load system.
		F. Suction strainer blocked or restricted.	1 Check and clean or replace as necessary.
V.	MOTOR IS NOISY OR ERRATIC.	A. Motor bearing failure or winding failure.	1 Check and repair as needed.
		B. If electronic starter, check calibration on control elements.	1 Adjust as necessary.
VI.	COMPRESSOR RUNS CONTINUOUSLY BUT DOES NOT KEEP UP WITH THE LOAD	A. Load is too high	1 Speed up compressor or add compressor capacity. 2 Reduce load.
		B. Refrigerant metering device is underfeeding, causing the . compressor to run at too low a suction pressure	1 Check and repair liquid feed problems. 2 Check discharge pressure and increase if low.
		C. Faulty control circuit, may be low Pressure control or capacity controls.	1 Check and repair.

		D. Compressor may have broken valve plates.	1 Check compressor for condition of parts. This condition can usually be detected by checking compressor discharge temperature.
		E. Thermostat control is defective and keeps unit running.	1 Check temperatures of product or space and compare with thermostat control. Replace or readjust thermostat.
		F. Defrost system on evaporator not working properly.	1 Check and repair as needed.
		G. Suction bags in strainers are dirty and restrict gas flow.	1 Clean or remove.
		H. Hot gas bypass or false load valve stuck.	1 Check and repair or replace.
VII.	COMPRESSOR LOSES EXCESSIVE AMOUNT OF OIL	A. High suction superheat causes oil to vaporize.	1 Insulate suction lines. 2 Adjust expansion valves to proper super heat. 3 Install liquid injection (suction line de-superheating).
		B. Too low of an operating level in chiller will keep oil in vessel.	1 Raise liquid level in flooded evaporator (R12 systems only).
		C. Oil not returning from separator.	1 Make sure all valves are open. 2 Check float mechanism and clean orifice. 3 Check and clean return line.
		D. Oil separator is too small.	1 Check selection.
		E. Broken valves cause excessive heat in compressor and vaporization of oil.	1 Repair compressor.
		F. “Slugging” of compressor with liquid refrigerant that causes excessive foam in the crankcase.	1 “Dry up” suction gas to compressor by repairing evaporator. 2 Refrigerant feed controls are overfeeding. 3 Check suction trap level controls. 4 Install a refrigerant liquid transfer system to return liquid to high side.
VIII.	NOISY COMPRESSOR OPERATION.	A. Loose flywheel or coupling.	1 Tighten.
		B. Coupling not properly aligned.	1 Check and align if required.
		C. Loose belt.	1 Align and tighten per specs. 2 Check sheave grooves.
		D. Poor foundation or mounting.	1 Tighten mounting bolts, grout base or install heavier foundation.
		E. Check compressor with stethoscope if noise is internal.	1 Open, inspect and repair as necessary.
		F. Check for liquid or oil slugging.	1 Eliminate liquid from suction mains. 2 Check crankcase oil level.
IX.	LOW EVAPORATOR CAPACITY.	A. Inadequate refrigerant feed to evaporators.	1 Clean strainers and driers. 2 Check expansion valve superheat setting. 3 Check for excessive pressure drop due to change in elevation, too small of lines (suction and liquid lines). A heat exchanger may correct this.

			4 Check expansion valve size.
		B. Expansion valve bulb in a trap.	1 Change piping or bulb location to correct.
		C. Oil in evaporator.	1 Warm the evaporator, drain oil and install an oil trap to collect oil.
		D. Evaporator surface fouled.	1 Clean.
		E. Air or product velocity is too low.	1 Increase to rated velocity. 2 Coils not properly defrosting. 3 Check defrosts time. 4 Check method of defrost.
		F. Brine flow through evaporator may be restricted	1 Chiller may be fouled or plugged. 2 Check circulating pumps. 3 Check process piping for restriction.
X.	DISCHARGE PRESS--URE TOO HIGH	A. Air in condenser.	1 Purge non condensibles.
		B. Condenser tubes fouled.	1 Clean.
		C. Water flow is inadequate.	1 Check water supply and pump. 2 Check control valve. 3 Check water temperature.
		D. Air flow is restricted.	1 Check and clean : a. Coils b. Eliminators c. Dampers
		E. Liquid refrigerant backed up in condenser.	1 Find source of restriction and clear. 2 If system is overcharged, remove refrigerant as required. 3 Check to make sure equalizer (vent) line is properly installed and sized.
		F. Spray nozzles on evap condensers plugged.	1 Clean
XI.	DISCHARGE PRESS--URE TOO LOW.	A. Ambient air is too cold.	1 Install a fan cycling control system.
		B. Water quantity not being regulated properly through condenser.	1 Install or repair water regulating valve.
		C. Refrigerant level low.	1 Check for liquid seal, add refrigerant if necessary.
		D. Evap condenser fan and water switches are improperly set.	1 Reset condenser controls.
XII.	SUCTION PRESSURE TOO LOW.	A. Light load condition.	1 Shut off some compressors. 2 Unload compressors. 3 Slow down RPM of compressor. 4 Check process flows.
		B. Short of refrigerant.	1 Add if necessary.
		C. Evaporators not getting enough refrigerant.	1 Discharge pressure too low. Increase to maintain adequate refrigerant flow. 2 Check liquid feed lines for adequate refrigerant supply. 3 Check liquid line driers.
		D. Refrigerant metering controls are too small.	1 Check superheat or liquid level and correct as indicated.
XIII.	SUCTION PRESSURE TOO HIGH.	A. Low compressor capacity.	1 Check compressors for possible internal damage. 2 Check system load. 3 Add more compressor capacity.

Routine Maintenance Service

ROUTINE MAINTENANCE SERVICE

Assurance of receiving trouble-free, continuous service from a 450XL series Compressor depends on PROPER AND DEFINITE PERIODIC MAINTENANCE PROCEDURES, performed by a qualified service/maintenance mechanic trained in the field of refrigeration and air conditioning.

When other than routine problems arise, or if the correctional procedure requires pumping down and opening the system, or other complicated functions, it is strongly suggested that the nearest Frick Office be contacted for authorized service and assistance. This will ensure reliable and quick attention to the problem and a saving to you, the owner.

Close attention to, and faithful see of the following “routine maintenance chart” will largely eliminate any need for further service,

MAINTENANCE PROCEDURE	PERFORMANCE REGULARITY				
	DAILY	WEEKLY	MONTHLY	SEMI ANNUALLY	ANNUALLY
Check suction pressure	X				
Check discharge pressure	X				
Check Oil Pressure	X				
Check Oil diff pressure	X				
Check Oil Temp.	X				
Check oil level in gauge glass	X				
Check oil pressure at seal end of compressor.	X				
Check oil by sample in a clean glaas overnight, if sediment appears, change.		X			
Clean oil pump strainer,		1st week	Every 2000 to 2500 running hours		
Check condition of oil, clean crankcase and add fresh oil. Check motor lubrication.		1st week	Every 2000 to 2500 running hours		
Check suction temperature.	X				
Check discharge temperature.	X				
Check water jacket temperature by thermometer	X				
Clean suction scale trap	After 24 hour	After 1st week	After 2nd week	And until clean	
V-Belt drive check.	After several hours			X	
Check suction and discharge valves in compressor					X
Clean out water jackets.				X	
LP/HP/OP Cutouts					

Condition for Normal Operation

CONDITIONS OF NORMAL OPERATION

The term NORMAL OPERATION means a refrigeration system operating within the limits of design.

The following chart is designed to illustrate normal and proper conditions contingent upon accepted requirements of the system.

GAUGE OR CONTITION	READING OR CONDITIONAL STATE
Oil pressure gauge.	Should read a minimum of 45 psig above suction inlet pressure
Oil level (crank case)	Should be visible but more than3/4full in sight glass.
Oil pressure failure switch	Should be set 40 psig differential across oil filter.
Temperature of cooling water for compressor jackets and /or leaving oil cooler.	Water temperature leaving approximately 100^0F (37.8^OC)
Cylinder Head and Discharge line Temperature	Should not exceed 290^0F under any conditions, using any refrigerant. Average Maximums: For use with R-717=200^0F R-22 =170^0F R-12= 150^0F R-502=150^0F Note: Discharge temperature may vary up or down with the temperature of the suction gas. The above average is for ordinary conditions.
Compressor Crankcase oil temperature. than suction inlet gas temperature.	Normally not more than 60^0C
Safety Relief valve.	Factory set (NEVER ATTEMPT RE – ADJUSTEMENT).300psig differential.
Discharge Safety Temperature thermostat (optional)	AMMONIA APPLICATION-set to make at 240^0F and break at 275^0F.
Sound	Vilter “High Stage” compressors operating normally should emit a slight valve ticking sound.
Frost	Depending on ambient temperatures and low temperature operation, frost may appear on the suction line. However, frost should never appear beyond the suction valve.

Daily Operating Log Sheet

DAILY OPERATING LOG

The use of an operating log permits thorough analysis of the operation of a refrigeration system by those responsible for its maintenance and servicing. Continual observation and recording of gauge pressures, temperatures and other pertinent information enable the observer to do the following:

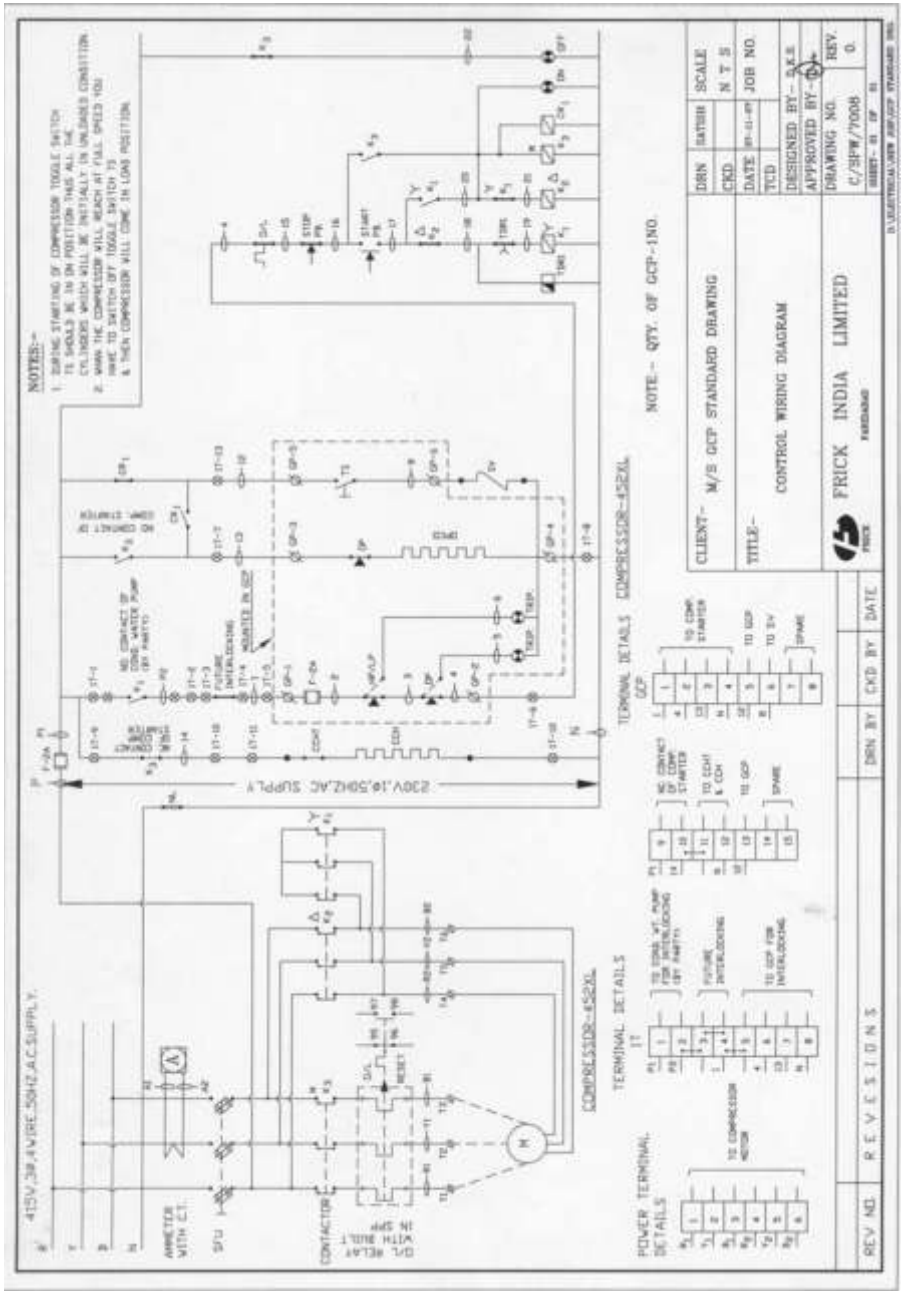
1. To be constantly and at all times familiar with the operation of the system.
2. To recognize immediately any deviations from normal operating conditions.
3. When recognizing any departure from normal operation, to rectify the condition at once, or shut down the system and service the components causing the malfunction.

The following suggested DAILY OPERATIONS LOG is designed for a basic refrigeration system, having a minimum of components. Depending on your particular size operation and refrigeration application, it may be necessary to expand the steps shown in the suggested log. The log is set up to satisfy a 20 hour type operation. If your particular plant operates at shorter intervals or on a single basis, change the frequency checks accordingly.

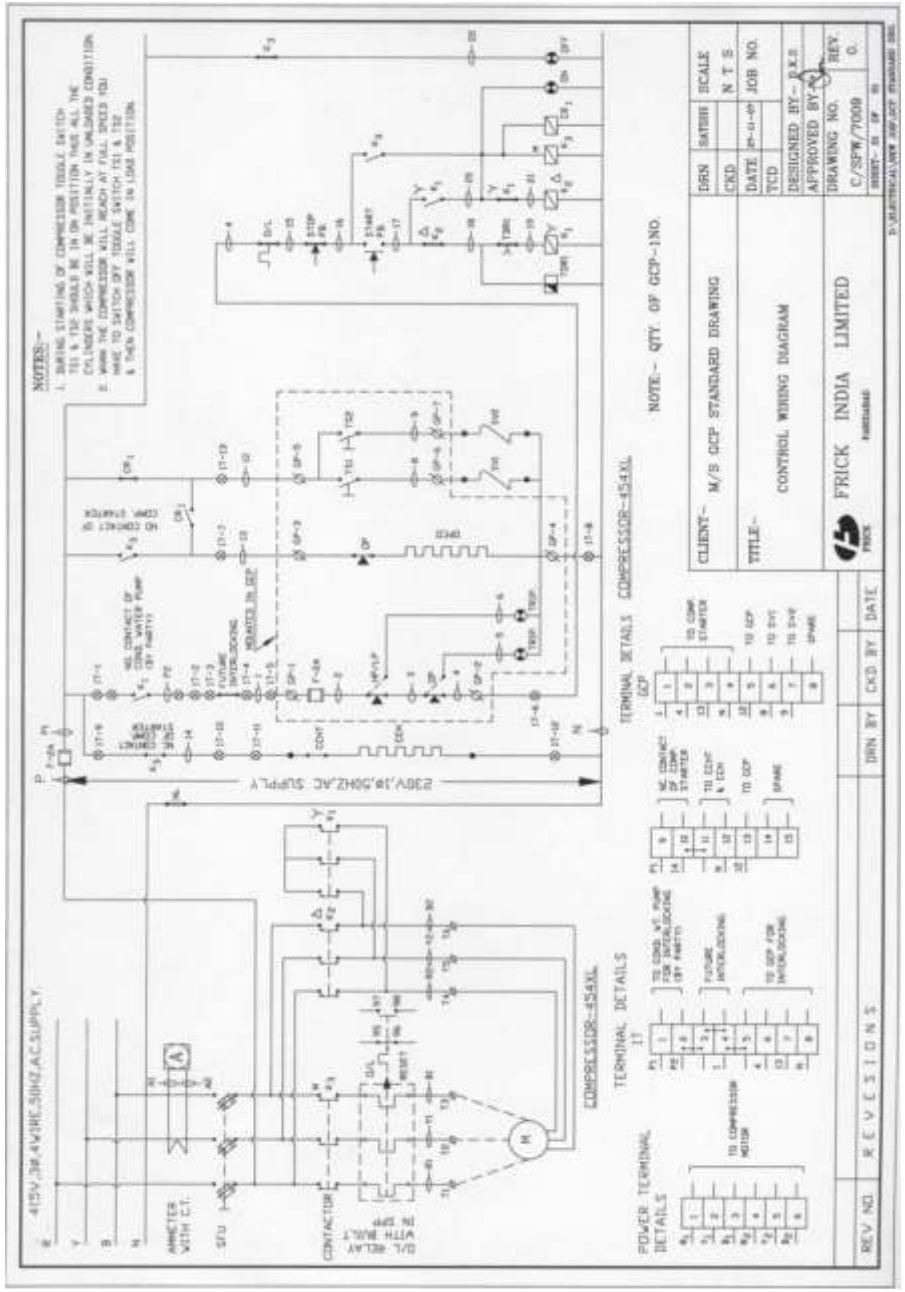
Machine Room No. or System Designing	**NORMAL Ranges**		**4-HOURLY RECORDINGS 20 hrs/day operation**					DATE.....
CHECK LIST	**From**	**To**	**4 AM**	**8AM**	**12 NOON**	**4PM**	**8PM**	**12PM**
1. Compressor Suction Pressure								
2. Compressor Discharge pressure								
3. Compressor Oil Pressure								
4. Oil Filter Diff. Pressure								
5. Compressor Motor Amps								
6. Compressor Suction Temperature								
7. Compressor Discharge Temperature								
8. Compressor Oil Temperature								
9. Crankcase Oil Level								
10. Condenser Water temperature (In)								
11. Condenser Water temperature (Out)								
12. Compressor Cooling Water (In)								
13. Compressor Cooling Water (Out)								
14. Receiver Liquid Temperature (In)								
15. Evaporator Gas Temperature (Out)								
16. Machine Room Ambient Temperature								
17. Out Ambient Temperature								
18. Outside Wet Bulb Temperature								
19. Voltage								

Control Wiring Diagram

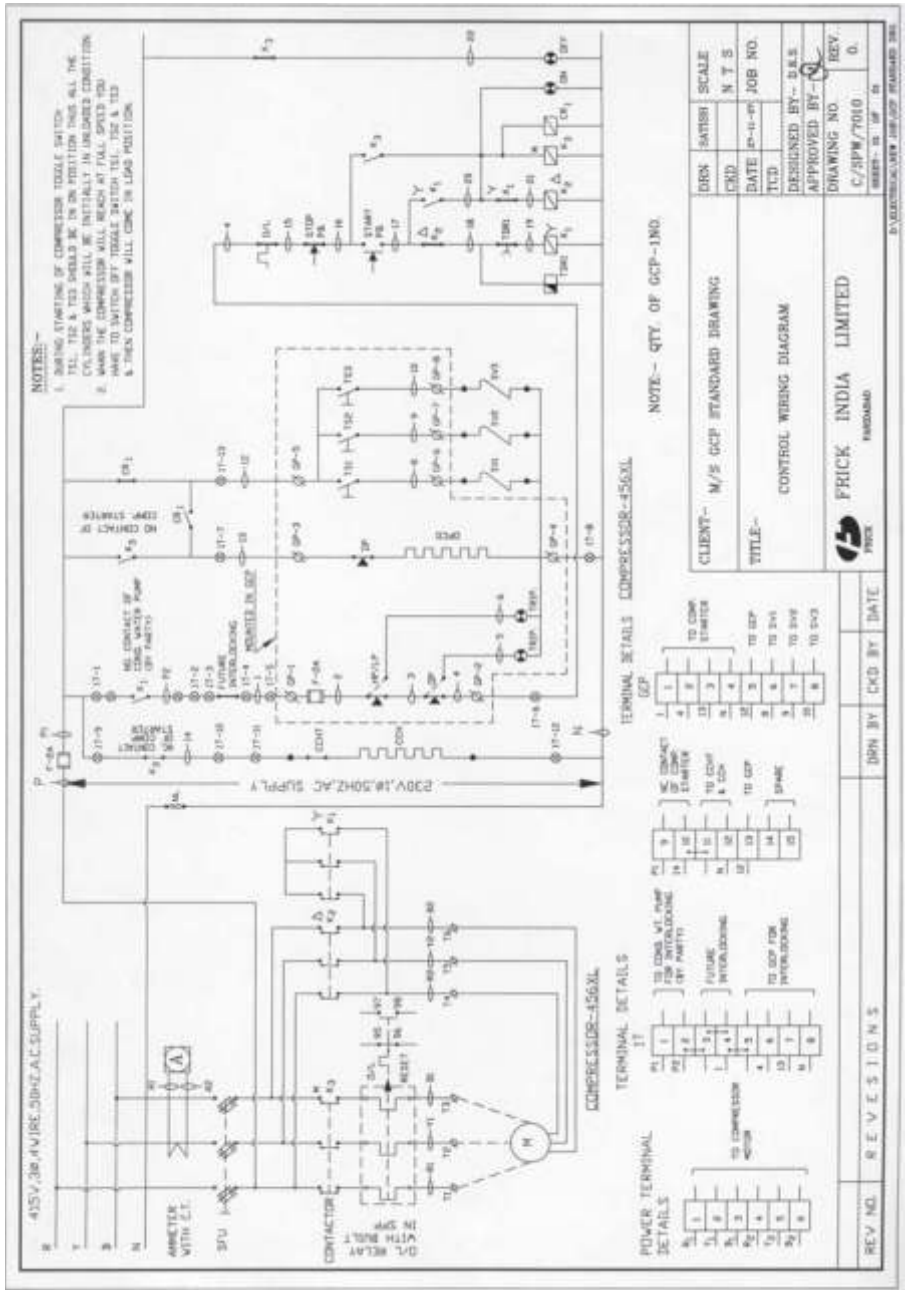
Control Wiring Diagram - 452XL



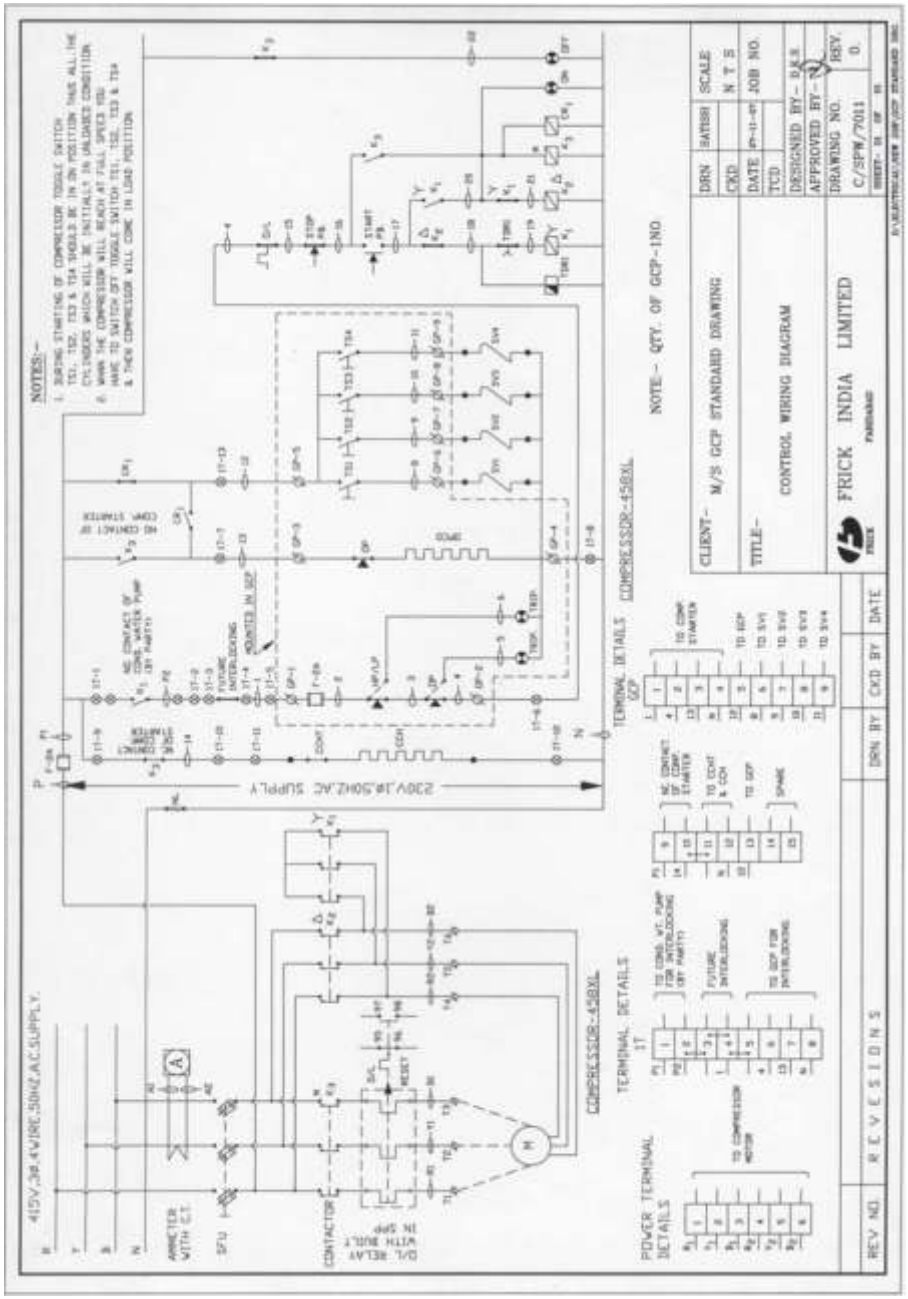
Control Wiring Diagram - 454XL



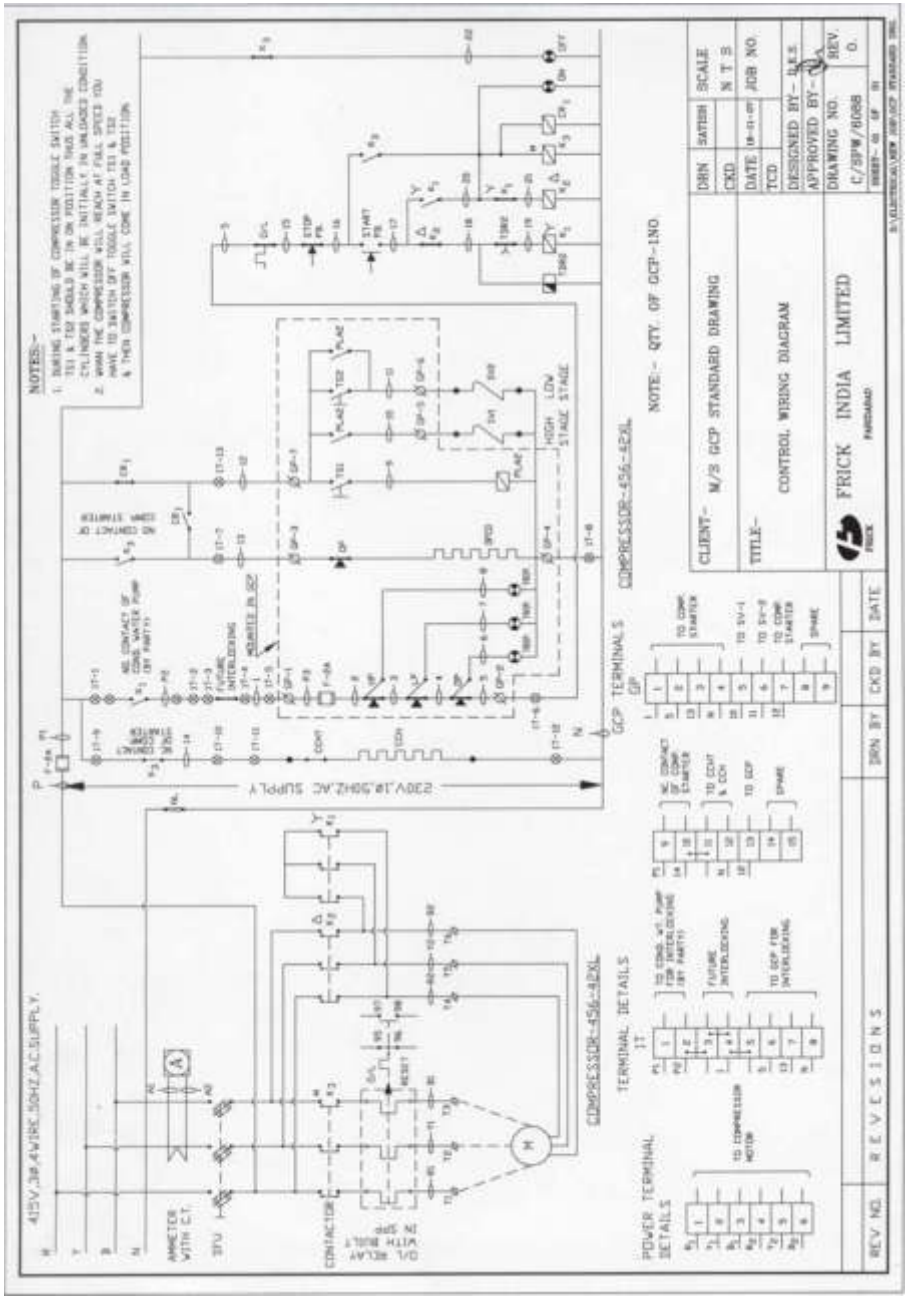
Control Wiring Diagram - 456XL



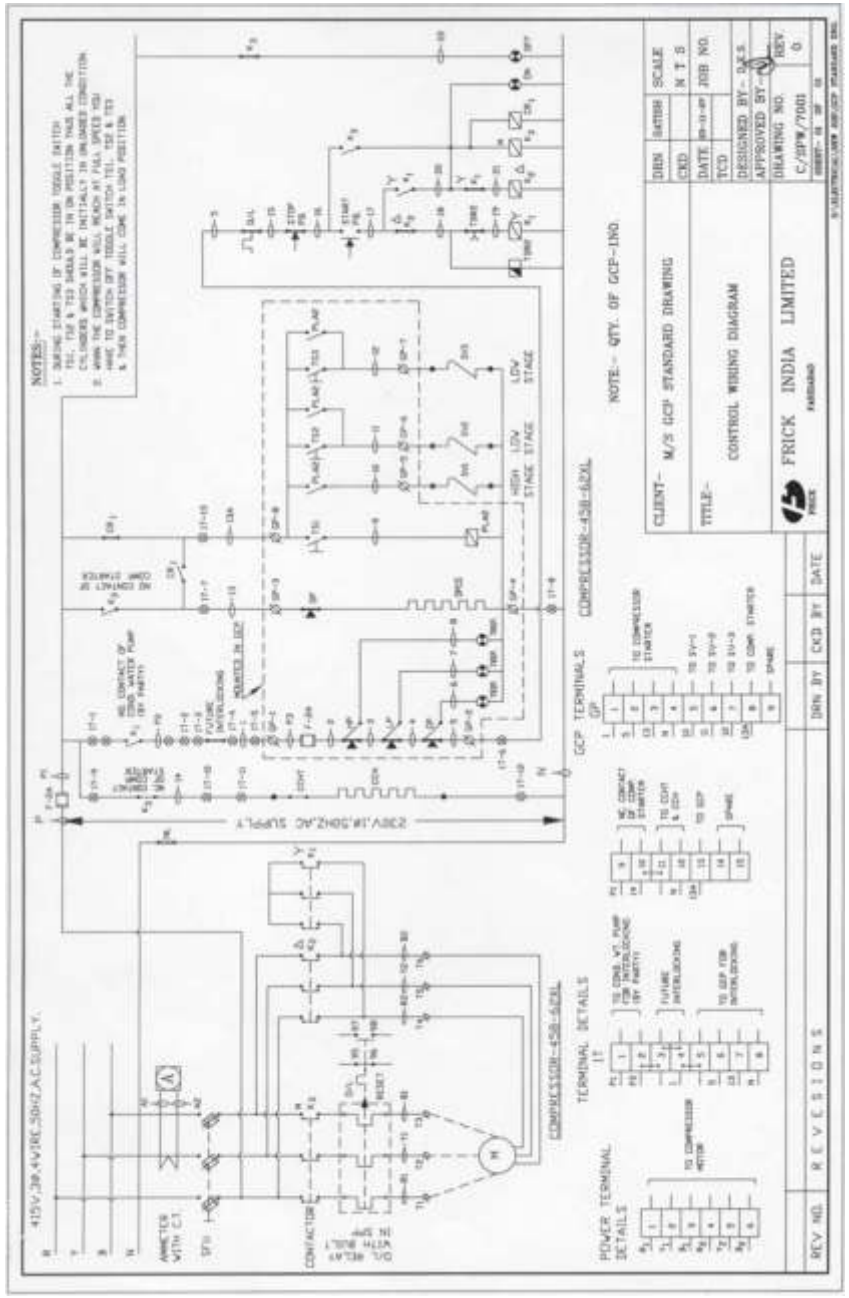
Control Wiring Diagram - 458XL



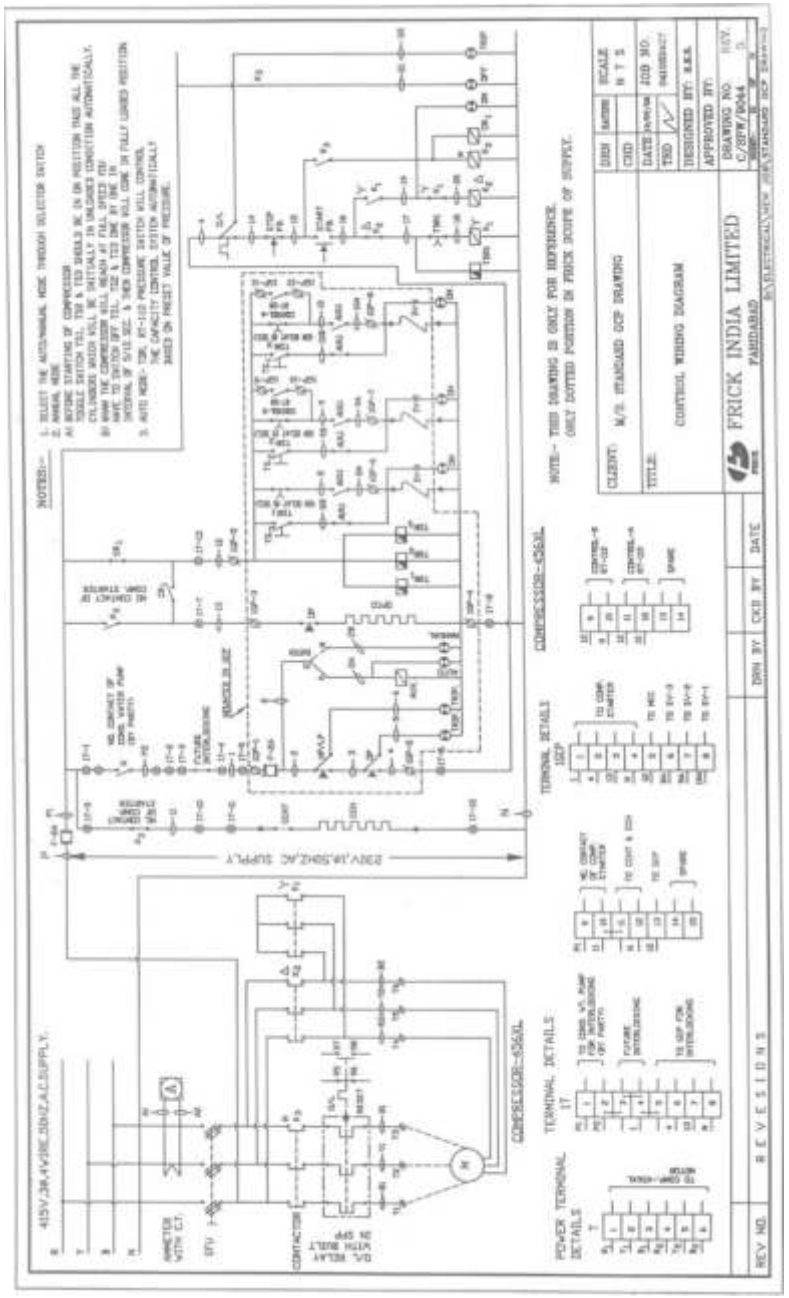
Control Wiring Diagram - 42XL



Control Wiring Diagram - 62XL



Control Wiring Diagram for Auto Control (eg. Model 456XL)



Foundation Drawing

Foundation Drawing

