INSTALLATION, OPERATION & MAINTENANCE INSTRUCTIONS

DISCONTINUED MODELS

LB161
LB162

LB361
LB361A

LB362
LB362A
LB362B

LB601
LB601A

LB602
LB602A

SAFETY DATA

This is a SAFETY ALERT SYMBOL.

When you see this symbol on the product, or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

DANGER

Warns of hazards that WILL cause serious personal injury, death or major property damage.

WARNING

Warns of hazards that CAN cause serious personal injury, death or major property damage.

CAUTION

Warns of hazards that CAN cause personal injury, or property damage.

NOTICE

Indicates special instruction which are very important and must be followed.

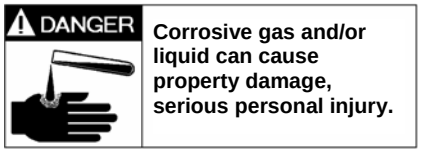
NOTICE

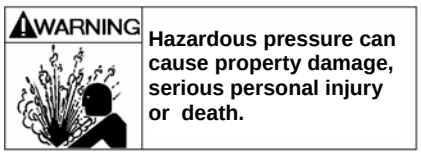
Blackmer compressors MUST only be installed in systems which have been designed by qualified engineering personnel. The system MUST conform to all applicable local and national regulations and safety standards.

These instructions are intended to assist in the installation and operation of Blackmer compressors and MUST be kept with the compressor.

Blackmer compressor service and maintenance shall be performed by qualified technicians ONLY. Service and maintenance shall conform to all applicable local and national regulations and safety standards.

For handling liquefied gas, it is recommended that NFPA Pamphlet 58 be consulted.





MODEL: LB _____ ID#: _____ SERIAL NO: _____

Before proceeding:

1. Note the nameplate data in the space provided above.
2. Obtain the appropriate parts lists for the model in question.

GENERAL INFORMATION

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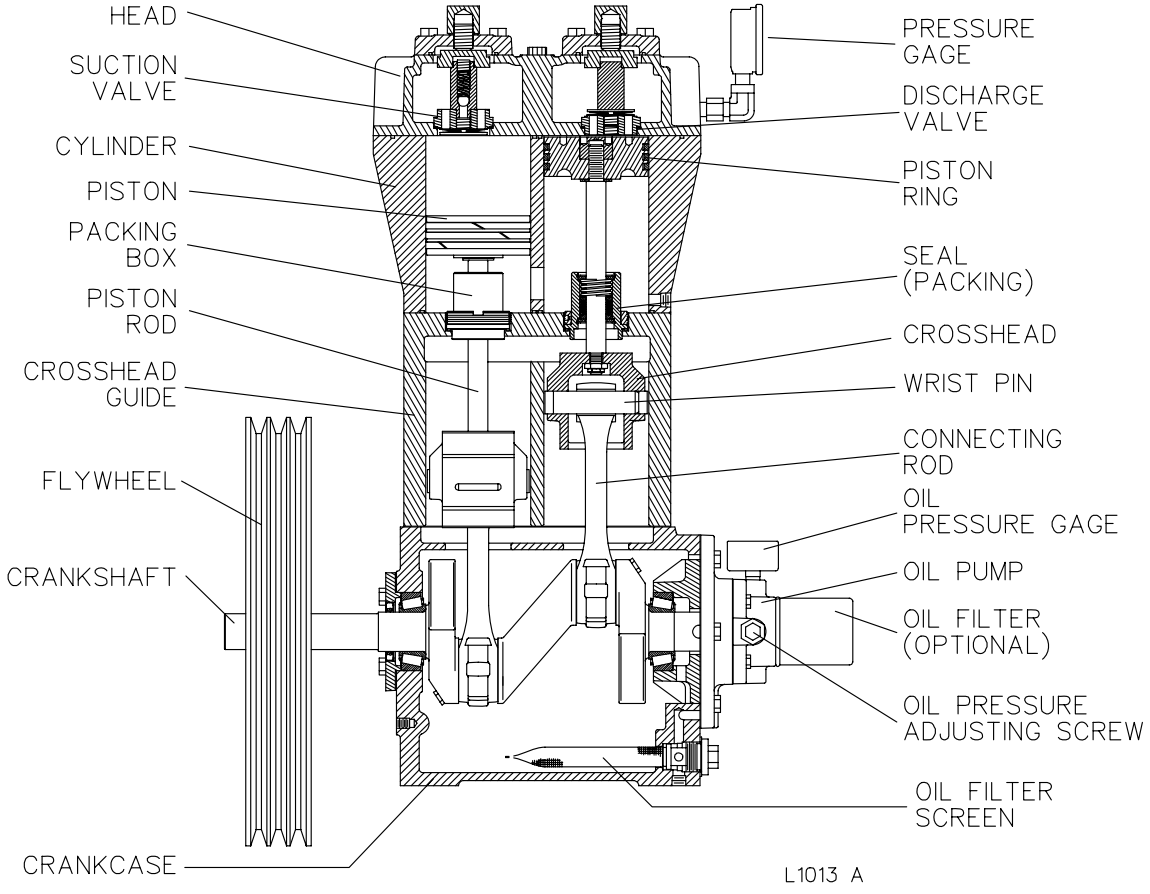


Figure 1 - Typical Compressor

GENERAL INFORMATION

The models listed are single-stage, vertical, air-cooled reciprocating style compressors with single acting cylinders.

Three basic sizes are offered with single or double seal arrangements available.

Single-Seal Models	**LB161**	**LB361** **LB361A**	**LB601** **LB601A**
Double-Seal Models	**LB162**	**LB362** **LB362A** **LB362B**	**LB602** **LB602A**
Minimum / Maximum RPM *	350 / 825	350 / 825	350 / 790
Displacement @ min rpm - CFM (m^3/hr) @ max rpm - CFM (m^3/hr)	 7.16 (12.2) 16.9 (28.7)	 15.3 (26.0) 36.0 (61.2)	 27.2 (46.3) 61.5 (104.5)
Max. BHP (kw)	7.5 (5.5)	15 (11)	30 (22)
MAWP - psia (kPa)	350 (2,413)		
Maximum Discharge Temperature	350°F (176°C)		

* Reduce maximum speeds by 9% for continuous duty operation.

Table 1 - Compressor Data

Model Version Differences:

Model	Cylinder to Head Seal		Packing Box Style	
	Flat Gasket	O-Ring	One-Seal	Two-Seals
LB161		X	X	
LB162		X	X	
LB361	X		X	
LB361A		X	X	
LB362	X		X	
LB362A	X			X
LB362B		X		X
LB601	X		X	
LB601A		X	X	
LB602	X		X	
LB602A		X		X

NAMEPLATE DATA

A nameplate is attached to the side of all Blackmer compressors showing the Model No., I.D. No., and Serial No. These numbers should be available when information or parts are needed for a particular unit.

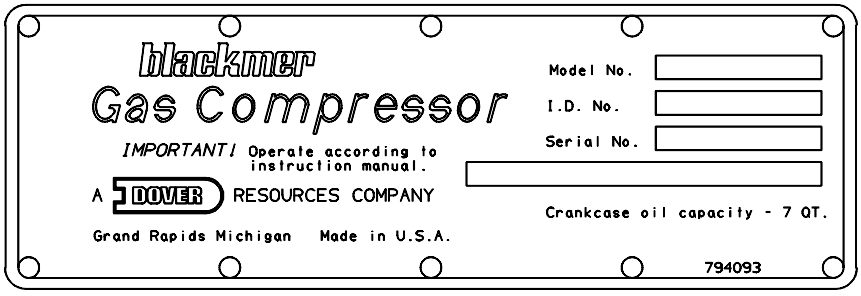
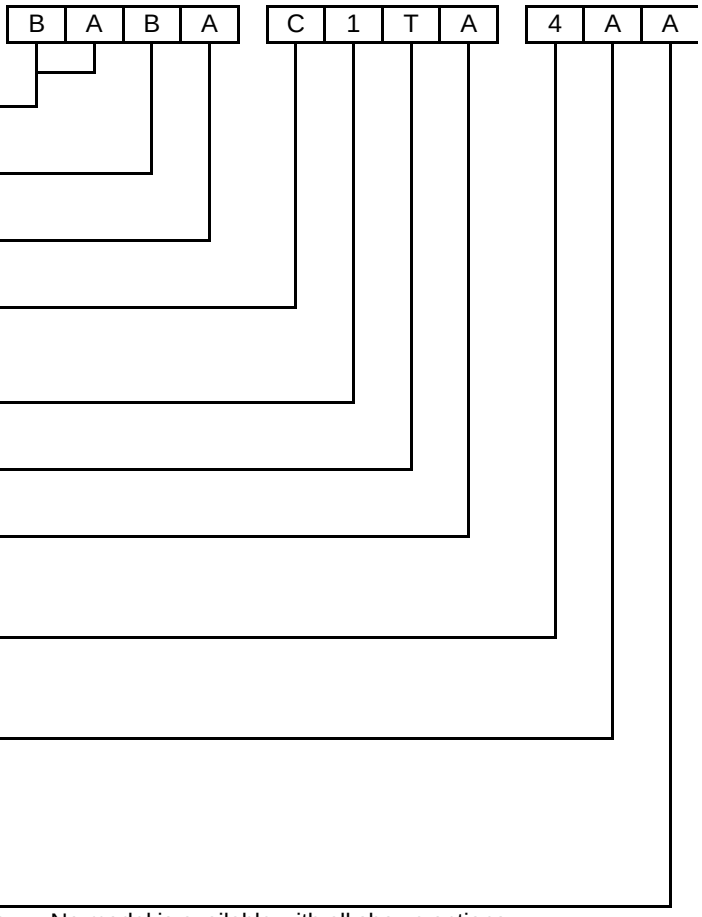


Figure 2 - Compressor Nameplate

The basic size and type of the compressor is indicated by "Model No." A suffix letter is used on most models to indicate the version.

An 11 character "I.D. No." identifies the construction of the compressor.
(Earlier models do not have an "I.D. No.")

GENERAL INFORMATION



VALVES	Code	Fields
Steel, w/ Liquid Relief	BA	1 & 2
O-RINGS		Field 3
Buna-N	B	
GASKETS		Field 4
Aluminum	A	
PISTON RINGS		Field 5
Carbon Filled PTFE	C	
SEAL (PACKING) ORIENTATION		Field 6
All Lips up	1	
SEAL MATERIAL		Field 7
PTFE	T	
CYLINDER & HEAD		Field 8
Ductile Iron	A	
GGG40.3 Ductile Iron	D	
PISTON RODS		Field 9
Chrome Plated Steel	1	
Black Surface Steel	4	
CRANKSHAFT & OIL FILTER		Field 10
Standard	A	
Extended Crankshaft	B	
Spin-on Oil Filter	C	
Ext. Crank / Oil Filter	D	
OTHER	A	Field 11

Note: A 'Z' in any field indicates a non-standard option. No model is available with all shown options.

Table 2 - ID Number Key

Serial No. 6 digits and a suffix letter indicating the year of manufacture.

Suffix	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P
Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994

Table 3 - Year of Manufacture

MAXIMIZING COMPRESSOR LIFE

Life of critical compressor components such as piston rings, valves and packing will vary considerably with each application, installation, and operating procedures. Premature failure of wear parts can often be attributed to one of the following causes:

1. **Excessive Temperatures**
   Primary causes are:
   - Operating at pressures other than those originally specified.
   - Handling a different gas than originally specified.
   - Clogged strainer or filter elements.
   - Line sizes too small, or other flow restrictions.
   - Excessive ambient temperature or suction gas temperature.
   - Valve problems. (See Foreign Material.)
   - Badly worn piston rings. (See Foreign Material.)

   Lower operating temperatures will increase valve and piston ring life significantly.

2. **Foreign Material**
   Solid particles in the gas stream will:
   - Rapidly wear the piston rings and score the cylinder wall.
   - Destroy the rod packing causing excessive leakage and score the piston rods.
   - Lodge in the valves causing loss of capacity and broken valve plates and springs.

   Liquid in the gas stream will:
   - Cause broken valve plates and springs.
   - Destroy the compressor if present in sufficient quantity.

   On new installations, the valves and piston rings should be inspected after the first few hundred hours of operation. This will give an early indication of any abnormal problems and allow for corrective action to be taken before a costly failure results. Although piston ring life will vary from application to application, wear will be fairly consistent on subsequent sets of rings.

INSTALLATION

LOCATION AND PIPING

Compressor life and performance can be significantly reduced when installed in an improperly designed system. Before starting layout and installation of the piping system, consider the following:

1. All piping must be leak free to a pressure of 1.5 times the maximum system pressure.

   NOTICE: If the system is to be hydro-statically tested, the compressor MUST be isolated. Liquid entering the compressor will cause damage and void the warranty.

2. A strainer should be installed in the inlet line to protect the compressor from foreign matter. A #30 mesh screen or finer is recommended. Strainers **must** be cleaned every 180 days, or more frequently if the system requires.
3. Expansion joints, placed within 36" (0.9 m) of the compressor, will compensate for expansion and contraction of the pipes.
4. Piping **must** be adequately supported to ensure that no piping loads are placed upon the compressor.
1. Both suction and discharge piping should slope down from the compressor. The compressor should not be placed at a low point in the piping system.

MOUNTING THE COMPRESSOR UNIT

A solid foundation reduces noise and vibration, and will improve compressor performance. On permanent installations, it is recommended the compressor be secured by anchor bolts as shown. This arrangement allows for slight shifting of position to accommodate alignment with the mounting holes in the base plate.

For new foundations, it is suggested that the anchor bolts be set in concrete. When compressors are to be located on existing concrete floors, holes should be drilled into the concrete to hold the anchor bolts.

To keep vibration at a minimum, in addition to a solid concrete foundation, it is important that the concrete be located on a stable soil foundation. The base should have complete contact along its entire length with the foundation. Visible separations can result in vibrations which are magnified in the upper part of the unit.

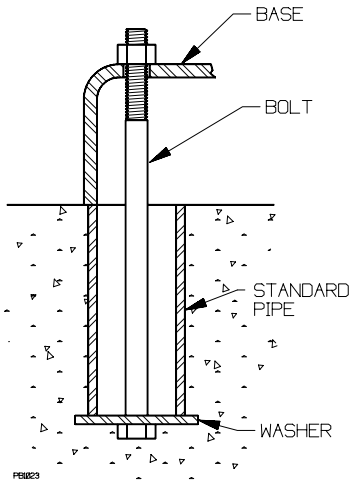


Figure 3 - Anchor Bolt

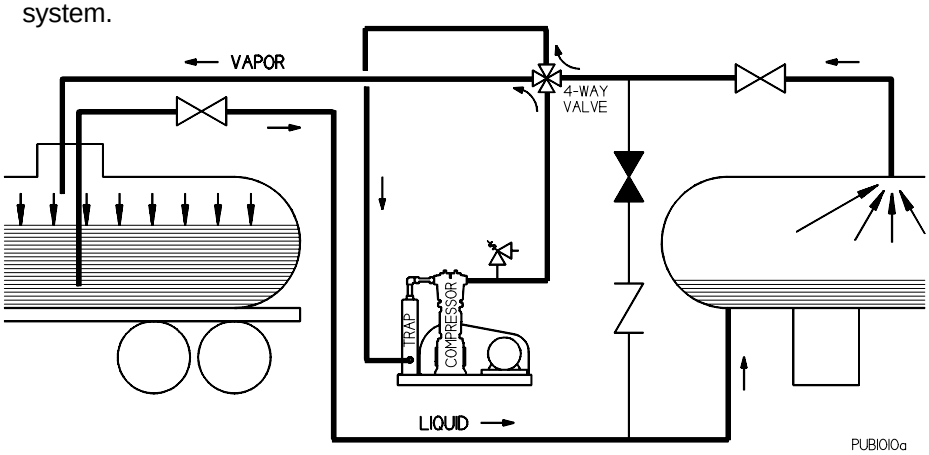


Figure 4 - Liquid Transfer Flow Schematic

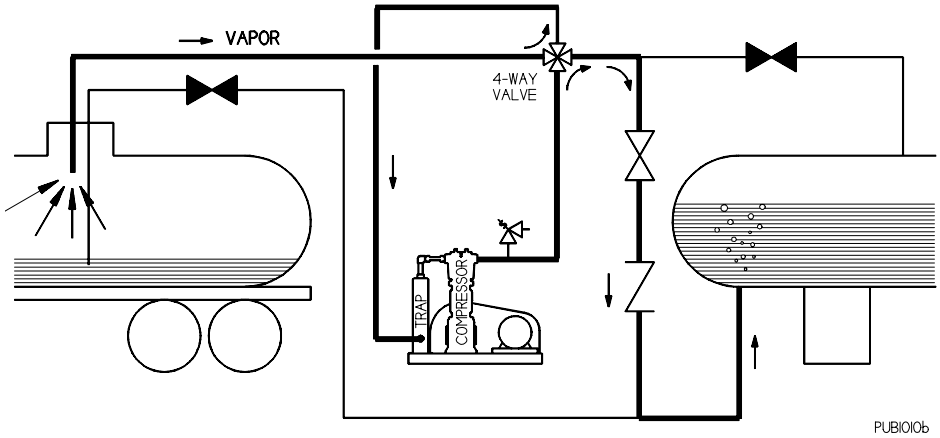


Figure 5 - Vapor Recovery Flow Schematic

INSTALLATION

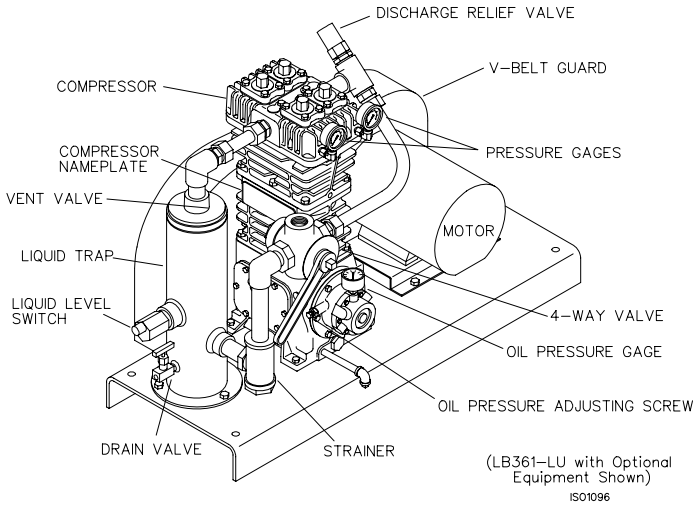
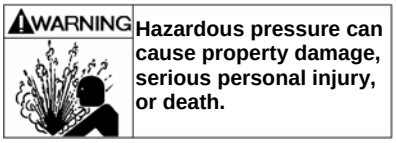


Figure 6 –
Typical Liquefied Gas Transfer Compressor



Hazardous pressure can cause property damage, serious personal injury, or death.

RELIEF VALVES

A relief valve of a type, material and pressure rating suitable to the installation, MUST be installed. The relief valve shall be installed in the discharge line between the compressor head and the first block valve.

Blackmer offers various relief valves for gas compatibility:

- Brass for LP-Gas service
- Aluminum for anhydrous ammonia
- Steel, A.S.M.E. code stamped for both services, and other applications.

4-WAY VALVES

Many liquefied gas compressors are used for both liquid transfer and vapor recovery operations. An optional 4-way valve is used to reverse the direction of flow through the system when changing from liquid transfer to vapor recovery. Both lubricated and nonlubricated models are available. Lubricated models should be lubricated every 6 months.

LIQUID TRAPS

Compressors handling gasses that contain condensates or other liquids MUST be protected from entry of the liquid.

NOTICE: Liquid in the compressor cylinder can cause destruction of the compressor.

Blackmer offers a variety of liquid traps. The most common variations include:

1. A non-code vessel fitted with a stainless steel float which will shut off the intake line to the compressor in the event of an excessive liquid level. A vacuum breaking valve is provided on the liquid trap head in case the trap closes and a vacuum develops between the compressor and the trap. A manual drain valve is provided.

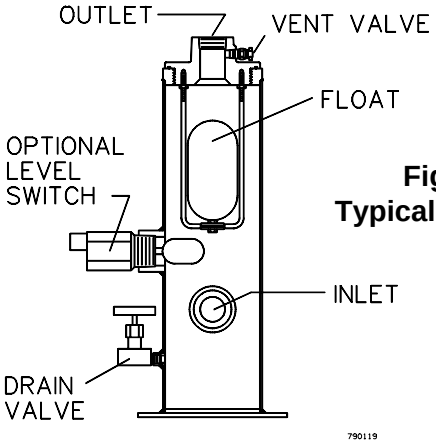


Figure 7 -
Typical Liquid Trap

2. The above trap is fitted with an additional port allowing for the use of an optional electric float switch which provides protection to the compressor by stopping the compressor when a high liquid level is present in the liquid trap. The electric float switch may be used with or without the mechanical float described above.
3. For additional protection, a larger ASME code stamped vessel is available. This liquid trap is typically fitted with one or two electric float switches for both a high liquid level shut down and alarm signal, a relief valve, and a manual drain valve. Level gauges and automatic drain systems are available options.

INSTALLATION

TEMPERATURE SWITCHES

Excessive discharge temperature is a leading cause of premature component failure and is often an early warning sign of impending problems.

Optional temperature switches should be installed with a thermowell as close to the compressor discharge as possible. The switch should be set to actuate at a temperature just above the maximum operating temperature of the compressor.

LOW OIL PRESSURE SWITCHES

Loss of crankcase oil pressure is a rare occurrence, but can result in costly damage. An optional low oil pressure switch set at about 15 psig (1 bar-g) may be installed to shut down the compressor in the event of a lubrication failure. A 10 second delay timer should be used to lock the low oil pressure switch out during compressor startup.

PRESSURE SWITCHES

Pressure switches may be installed in the suction or discharge gas stream as protective devices, for compressor control, or for other uses varying with each application and system design.

PRESSURE GAUGES

It is recommended that pressure gauges be installed in the discharge and inlet lines to verify actual suction and discharge pressures.

OPERATION

PRE-STARTUP CHECK LIST

Hazardous machinery. Failure to disconnect and lockout electrical power before performing service can cause severe personal injury.

1. After the compressor is installed in the system, a complete leak test MUST be performed on both the compressor and the piping.
2. Re-check the system piping and the piping supports to ensure that no piping loads are being placed on the compressor.
3. If V-belt driven, check the alignment of the motor and the compressor sheaves. The faces of the sheaves must be parallel.
4. Blackmer compressors are shipped from the factory without oil in the crankcase. Fill with a high quality non-detergent oil of the proper viscosity. See "Crankcase Lubrication" in this manual.
5. Check the electrical connections for proper wiring, grounding, etc.
6. With the power disconnected, remove the compressor nameplate. Squirt oil onto each crosshead while rotating the compressor by hand to verify smooth operation.

Hazardous machinery. Operation without adequate guards can cause severe personal injury.

7. Ensure that all guarding is properly installed.

STARTUP PROCEDURE

1. Start the compressor. Verify proper rotation direction.

   Oil pressure should register 25 psig (172 kPa) within 10 seconds.

   NOTICE: If proper oil pressure is not present, stop the compressor and correct the problem.

   Operating the compressor with low oil pressure will cause severe damage to the unit. Adjust if necessary. See "Setting the Oil Pressure" in this manual.
2. Verify that the suction and discharge pressures are within the expected ranges.

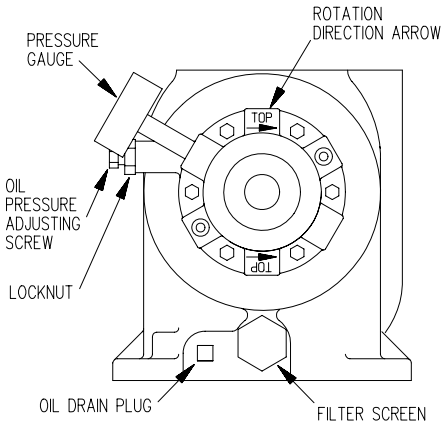
   NOTICE: Operating limits listed in the "Compressor Data" section must not be exceeded.
3. Check for leakage from the piping and equipment, and repair as necessary.
4. If the seals (packing) have just been replaced, the lower seal MUST be manually lubricated during the first 60 minutes of operation. See "Seal (Packing) Replacement" section. New compressors have had the packing broken in at the factory.
5. On newly rebuilt units, the valve hold down screws, valve cover plate bolts and cylinder head bolts MUST have their torque checked after 60 minutes running time. Also re-tighten all hold down bolts, flywheel bolts, etc. after 60 minutes running time. See Table 6 - "Bolt Torque."

OPERATION

ROTATION

The compressor rotation direction is indicated by the upper arrow (12 o'clock position) located on the face of the oil pump cover.

To reverse the rotation of the compressor, remove the capscrews in the oil pump cover and rotate the cover 180 degrees. In this position, the upper arrow on the oil pump cover will indicate rotation in the opposite direction. **NOTE:** The oil pump pressure gauge must also be removed and reinstalled in the upper gauge port.



MAINTENANCE

Hazardous pressure can cause property damage, serious personal injury or death.

1. Before work is started on the compressor make sure all pressure is bled off on both the suction and discharge.

2. When performing service or maintenance to the compressor, refer to the appropriate Blackmer Parts Lists for detailed views and identification of compressor parts.

NOTICE: Blackmer compressor service and maintenance shall be performed by qualified technicians only. Service and maintenance shall conform to all applicable local and national regulations and safety standards.

SERVICE SCHEDULE

	Daily	Weekly	Monthly	6 Months	Yearly
Overall Visual Check	X				
Check Crankcase Oil Pressure	X				
Check Suction Pressure	X				
Check Discharge Pressure	X				
Drain Distance Piece (Double-Seal Models)		X			
Drain Liquid From Accumulation Points		X			
Clean Compressor Cooling Fins		X			
Check Crankcase Oil Level *			X*		
Check V-Belt Tension			X		
Change Oil * and Optional External Oil Filter				X*	
Check Inlet Filter/Strainer Element				X	
Inspect Valves				X	
Lubricate 4-way Valve				X	
Lubricate Motor Bearings per Manufacturer's Suggestions				X	
Inspect Motor Starter Contact Points					X

* Change oil every 1,000 hours of operation (2,000 hours with optional external oil filter), or every 6 months which ever occurs first. If the oil becomes unusually dirty, change oil and external filter as often as needed to maintain clean oil.

Table 4 - Service Schedule

MAINTENANCE

TOOL LIST

Description	Used For:
Blackmer Wrench 790535	Valve Hold-down screw
Blackmer Packing Installation Tool 790536 for 160 and 360 Series Compressors 790538 for 600 Series Compressors	Rod-packing protection during installation.
3" Adjustable Spanner with 1/4" pins (Blackmer PN 790316)	Piston Nut, Piston, Packing Box Hold-down Ring
7/16", 9/16", 5/8" or 3/4" End Wrench	Oil pump cover, cylinder, crosshead guide
1-1/16" Wrench or Socket	Valve Caps
Allen Wrenches: 3/16", 1/4", 3/8"	Valves
Sockets: 7/16", 1/2", 9/16", 5/8", 3/4", 7/8"	Various
Internal Snap Ring Pliers	Seal Replacement
Feeler gauges or Depth Micrometer	Piston Clearance
Screwdriver, Flat Blade	Nameplate screws, Packing Installation
Pliers	
Rubber Mallet	
Arbor Press	Wrist Pin Removal
Bearing Puller	Crankshaft Bearings
Torque Wrench, 0 to 45 lb-ft range	Various
Hoist (useful)	Cylinder and Crosshead Guide

Table 5 - TOOL LIST

BOLT TORQUE FOR BLACKMER COMPRESSORS LBS-FT (Nm)

Size	Connecting Rod Bolt	Bearing Carrier	Bearing Cover Plate	Crankcase Inspection Plate	Crosshead Guide	Cylinder	Head	Valve Cover Plate	Valve Hold Down Screw
160	30 (40.7)	30 (40.7)	35 (47.5)	7 (9.5)	25 (33.9)	25 (33.9)	20 (27.1)	--	40 (54.2)
360	35 (47.5)	30 (40.7)	35 (47.5)	7 (9.5)	35 (47.5)	35 (47.5)	40 (54.2)	35 (47.5)	40 (54.2)
600	45 (61.0)	30 (40.7)	40 (54.2)	7 (9.5)	40 (54.2)	40 (54.2)	40 (54.2)	35 (47.5)	40 (54.2)

Table 6 - Bolt Torque

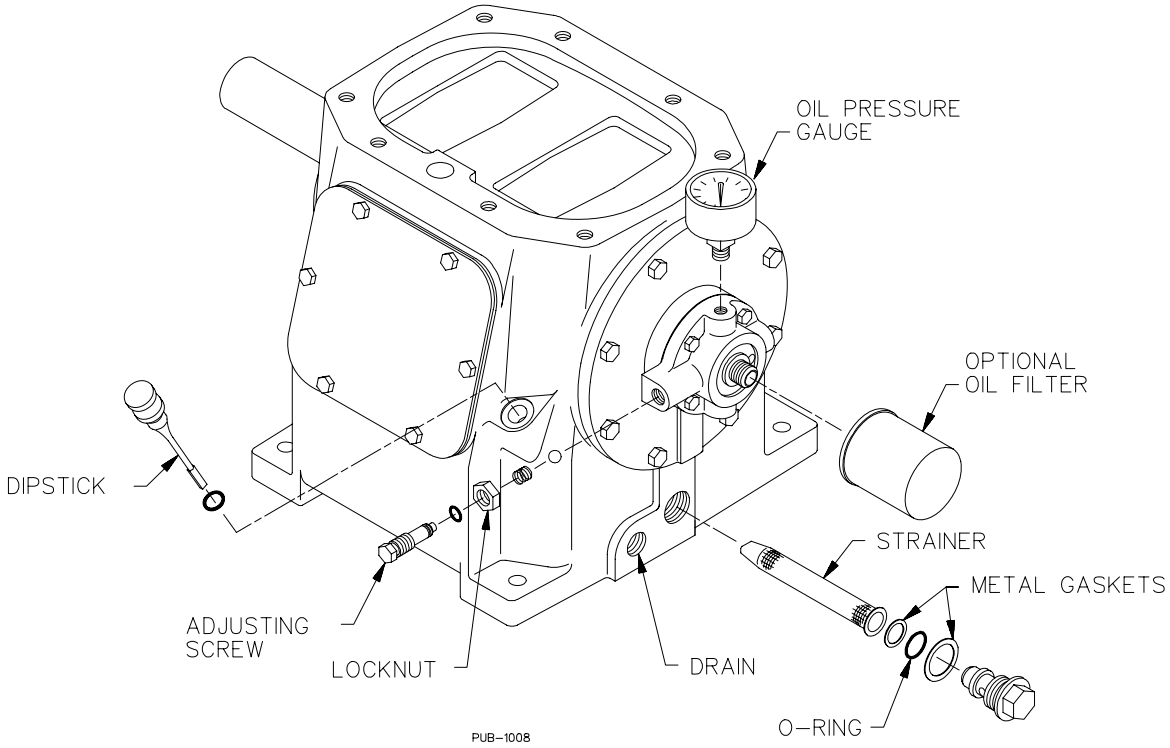


Figure 8 - Compressor Lubrication System

CRANKCASE LUBRICATION

Change the crankcase oil every 1,000 hours or 180 days, whichever is shorter. Under severe dusty or sandy operating conditions, the oil should be changed every 500 hours or every 90 days. When equipped with an optional spin-on oil filter, intervals between oil changes may double, but must not exceed 180 days.

A high quality non-detergent oil is recommended. Consult factory for special lubricating requirements.

Sizes	Quarts
160	2
360	3
600	6

Table 7 - Oil Capacity

Air Temperature	Oil Viscosity
Below 0°F (-18°C)	SAE 5W
0 to 32°F (-18 to 0°C)	SAE 10W
32 to 80°F (0 to 27°C)	SAE 20W
80°F (27°C) and above	SAE 30W

Table 8 - Oil Viscosity

Before changing the oil, bring the compressor up to normal operating temperature. Remove the crankcase drain plug and drain the oil into an adequately sized container. Remove the oil pickup screen and clean in a suitable solvent. When reinstalling the pickup screen, inspect the metal gasket and the O-ring for damage, replacing as necessary. If equipped, replace the optional external oil filter. See Figure 8.

SETTING THE OIL PRESSURE (see Figure 8)

The oil pressure should be about 25 psig (173 KPa).

1. Loosen the locknut.
2. Increase the pressure setting by turning the adjusting screw inward, CLOCKWISE.

   Decrease the pressure setting by turning the adjusting screw outward, COUNTER-CLOCKWISE.
3. Retighten the locknut.

COMPRESSOR DISASSEMBLY

Hazardous machinery. Failure to disconnect and lockout electrical power before performing service can cause severe personal injury.

Hazardous pressure can cause property damage or personal injury.

NOTICE: Before starting work on the compressor, make sure all pressure is bled off on both the suction and discharge.

1. Remove the center head capscrews from the cylinder head. Remove the outer cylinder head capscrews.
2. Remove the cylinder head assembly and cylinder head O-rings or gasket from the cylinder. The suction and discharge valve assemblies will come off with the cylinder head. For valve replacement instructions, refer to the "Valve Replacement" section of this manual.
3. Removal of the piston requires a 3" adjustable spanner wrench with 1/4" pins, such as Blackmer PN 790316.
   a. Rotate the flywheel by hand to bring a piston to top dead center of the cylinder.
   b. Remove the piston nut by turning the nut counterclockwise. (The nylon locking insert in the piston nut must be replaced during reassembly.)
   c. To remove the piston from the cylinder, turn it counterclockwise with the use of the adjustable spanner wrench. For removal and replacement of the piston rings, refer to the "Compressor Assembly" section.
   d. Remove the thrust washer and any shims. Keep the shims and piston together.
   e. Repeat these steps for the other piston.
4. Remove the cylinder capscrews.
5. Lift the cylinder and cylinder O-rings from the crosshead guide (or distance piece).
6. Packing Box Removal
   a. Using an adjustable spanner wrench, remove the packing box hold-down rings. (Replace the nylon locking inserts in the hold-down rings during reassembly.)
   b. Remove the packing box, O-rings and any spacers from each piston rod. Older double-seal models may have a distance piece and a second pair of packing boxes to remove as well.
   c. For disassembly of the packing boxes, refer to the "Seal (Packing) Replacement" section of this manual.
7. Remove the crosshead guide capscrews, and lift the crosshead guide and gasket from the crankcase.
8. To remove the connecting rod assemblies, with the crossheads attached, it may be necessary to drain the oil from the crankcase. The piston rod is permanently attached to the crosshead to form a single assembly. Do not attempt disassembly.
   a. Remove the inspection plate from the crankcase.
   b. Remove the locknuts from the connecting rod bolts. This will release the connecting rod cap (the lower half of the connecting rod) and the two halves of the bearing insert. The connecting rod and the connecting rod cap are marked with a dot on one side so that they can be properly aligned when reassembling.
   c. Lift the crosshead assembly and connecting rod off the top of the crankcase.

   NOTICE: The connecting rod parts are not interchangeable and must be reassembled with the same upper and lower halves. To avoid confusion, work on one connecting rod at a time, or mark the individual halves with corresponding numbers.
9. Remove the opposite connecting rod and crosshead assembly in the same manner.
10. Rest the crosshead assembly on a bench. Carefully drive the wrist pin and wrist pin plugs out of the crosshead and connecting rod using a suitable pin driver or an arbor press. Removal of the pin releases the crosshead assembly from the connecting rod.
12. If necessary, the wrist pin bushings can be replaced after the crossheads are removed. New bushings must be honed to the proper size after installation.
13. To replace the crankshaft bearings, the crankcase must be disassembled, and the crankshaft removed. Refer to the "Bearing Replacement" section of this manual.

Bushing I.D. Inches (mm)
0.8753 to 0.8756 (22.233 to 22.240)

Table 9 - Wrist Pin Bushing Dimensions

COMPRESSOR ASSEMBLY

Compressor assembly is generally the opposite of compressor disassembly. Before reassembling, clean each part thoroughly. Check all machined surfaces for burrs or roughness, and file lightly if necessary. **Replace any O-rings or gaskets that are removed or disturbed during service.**

1. **CRANKCASE ASSEMBLY**
   After replacing the crankshaft, bearing carrier, and bearing cover plate, the connecting rod and crosshead can be assembled in the crankcase. See the "Bearing Replacement" section.
   a. To attach the connecting rod to the crosshead assembly, first coat the wrist pin, the wrist pin bore in the crosshead assembly, and the wrist pin bushing in the connecting rod with grease.
   b. Start the wrist pin in the bore of the crosshead assembly and tap lightly until the pin begins to project through to the inside of the crosshead assembly.
   c. Slide the connecting rod up inside of the crosshead assembly and align the bushing with the wrist pin.
   d. Lightly tap the wrist pin through the connecting rod until it is centered in the crosshead assembly. The wrist pin should be snug in the crosshead assembly. The connecting rod should rotate freely on the wrist pin, but should not be loose.
   e. Dip the wrist pin plugs in grease and press them against the ends of the wrist pin.
   f. Place the bearing halves into each half of the connecting rod, aligning the bearing tangs with the slots in the connecting rod. Coat the bearing with grease.
   g. Set the top of the connecting rod over the crankshaft journal. Replace the connecting rod cap with the dots on the connecting rod and cap on the same side.
   h. Start the nuts on the connecting rod bolts and torque per Table 6 - "Bolt Torque."
   i. Follow this same procedure for the opposite connecting rod.
2. **CROSSHEAD GUIDE**
   a. Place the crosshead guide gasket on top of the crankcase.
   b. Lubricate the inside bore of the crosshead guide with light oil.
   c. Set the crosshead guide over the piston rods and the crossheads, and slowly lower it against the crankcase. Make certain that the crosshead assemblies are started straight in the bores of the crosshead guide to prevent binding when lowering the crosshead guide into position.
   d. Install the crosshead guide capscrews. DO NOT tighten.
3. Fill the crankcase with oil. Refer to the "Crankcase Lubrication" section. Squirt oil into the crankshaft, roller bearings, crankshaft journals, and crosshead assemblies to ensure proper lubrication at start up.
4. Attach the inspection plate and the inspection plate gasket to the crankcase.
5. **PACKING BOX ASSEMBLIES**
   Before installing the packing boxes into the crosshead guide, inspect the piston rods for scoring or roughness. Remove any burrs or sharp edges. Lubricate the piston rods and packing box O-rings with light oil. **Do not damage the packing when starting it over the rod.**

   Single-Seal Models
   a. Insert the packing box O-ring into the crosshead guide.
   b. Start the packing box assembly, short end down, over the piston rod and into the counter-bored hole of the crosshead guide.
   c. Install the packing box retainer ring, with new nylon locking inserts, and tighten securely.
   d. Repeat the above steps for the remaining packing box.

   Double-Seal Models with Two-Seal Boxes
   a. Insert the lower packing box O-ring into the crosshead guide.
   b. Start the packing box assembly, short end down, over the piston rod and into the crosshead guide.
   c. After the lower set of packing is started over the piston rod, make sure the oil deflector ring is properly aligned (with the flat side down) over the piston rod. Use the hole in the side of the packing box to center the deflector ring. Once the deflector ring is over the rod, the packing box can be fully inserted.
   d. Install the upper packing box O-ring on the end of the packing box.
   e. Place the packing box spacer ring over the O-ring.
   f. Install the packing box retainer ring, with new nylon locking inserts, and tighten securely.
   g. Repeat the above steps for the remaining packing box.

   Double-Seal Models with One-Seal Boxes
   Models LB162 and LB362 ONLY:
   a. Place a lower packing box assembly, long end down, over each piston rod and into the top of the crosshead guide.
   b. Place the oil deflector rings over the rods.
   c. Install the packing box O-rings into the crosshead guide (LB362) or the bottom of the distance piece (LB162).

d. Carefully place the distance piece over the rods and hand tighten to the crosshead guide.
e. Install the upper packing boxes (long end up) and O-rings onto the top of the distance piece.

Model LB602 ONLY

a. Place a lower packing box assembly, long end down, over each piston rod and into the top of the crosshead guide.
b. Install the packing box spacers into the top of the crosshead guide.
c. Install the upper packing boxes (long end up) with O-rings into the crosshead guide on top of the packing spacers.

6. Rotate the crankshaft by hand a few times, then uniformly tighten the crosshead guide (and distance piece) capscrews per Table 6 - "Bolt Torque."
7. Break in new packing per the "Seal (Packing) Replacement" section of this manual.
8. **CYLINDER ASSEMBLY**
   a. Install new O-rings in the bottom of the cylinder. A small amount of grease may be used to hold the O-rings in place during assembly.
   b. Set the cylinder over the piston rods and against the crosshead guide.
   c. Install cylinder capscrews. DO NOT tighten.
9. **PISTON RINGS**
   a. Place an expander in the top groove of the piston. Place an expander in the second groove with the break in this expander 180 degrees from the break of the top expander. Place the third expander in the bottom groove with its break in the same position as the top expander.
   b. Place piston rings in all three grooves of the piston. Align the breaks in the piston rings directly opposite the breaks in the corresponding expanders.
10. **PISTONS**
    a. Rotate the flywheel by hand to bring one piston rod to top dead center of the cylinder assembly.
    b. Set the thrust washer and one shim on the shoulder of the piston rod.
    c. With light pressure, squeeze the piston rings inward while threading the piston clockwise onto the rod. Tighten with the 3" adjustable spanner wrench.
    d. Follow this same procedure for the second piston.
    e. Rotate the crankshaft by hand a number of times to verify that the pistons are centered in the cylinder bores. Adjust the cylinder so that the pistons DO NOT touch the cylinder walls.
    f. Using an alternating pattern, torque the cylinder capscrews per Table 6 - "Bolt Torque."
11. **PISTON CLEARANCE**
    a. Rotate the flywheel by hand to bring one piston to the top.
    b. Measure the distance from the top of the piston to the top of the cylinder.
    c. If necessary, remove the piston and add or subtract shims accordingly.
    d. Install new nylon locking inserts in the piston retainer nuts.
    e. Thread the piston nut onto the piston rod and tighten securely with the spanner wrench.
    f. Follow this same procedure for the second piston.

LB161B	.010" to .025" (.254 to .635 mm)
LB162B	.015" to .030" (.381 to .762 mm)
LB361B	.020" to .035" (.508 to .889 mm)
LB362C	.025" to .040" (.635 to 1.016 mm)
LB601B	.020" to .035" (.508 to .889 mm)
LB602B	.030" to .045" (.762 to 1.143 mm)

Table 10 - Piston Clearance

12. **CYLINDER HEAD ASSEMBLY**
    If the valve assemblies have been removed from the cylinder head, refer to the "Valve Replacement" section of this manual.
    a. Place the cylinder head O-rings or gasket on top of the cylinder.
    b. Place the cylinder head assembly on top of the cylinder.
    c. Hand tighten the outer capscrews and center capscrews into the cylinder head.
    Gaskets MUST be used on the center capscrews of the LB161 and LB162 models.
    d. Uniformly torque the cylinder head capscrews per Table 6 - "Bolt Torque."
13. Rotate the compressor by hand to verify that it turns freely. Ensure that the pistons are not hitting the cylinder head assembly.
14. Follow all procedures listed in the "Pre-Startup Check List" and "Startup Procedure" sections of this manual.
15. Start the compressor and bring to normal operating temperature. Stop the compressor, allow it to cool and retorque the valve hold down screws per Table 6 -"Bolt Torque."

VALVE REPLACEMENT

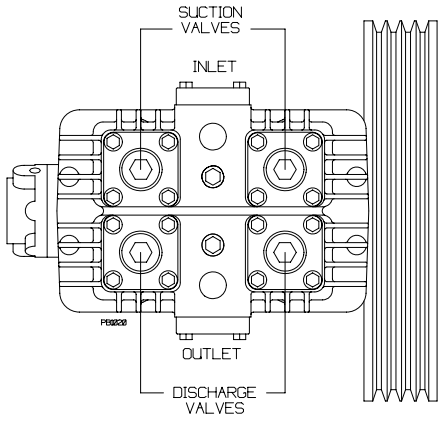


Figure 9 - Valve Location

Suction and discharge valves MUST be installed in the correct cylinder head locations. See Figure 9.

MODELS LB161 or LB162 - see Figure 10.

1. Remove the valve cap and O-ring or gasket from the valve being serviced.

2. Remove the valve hold down screw with a spanner wrench, such as Blackmer PN 790535.

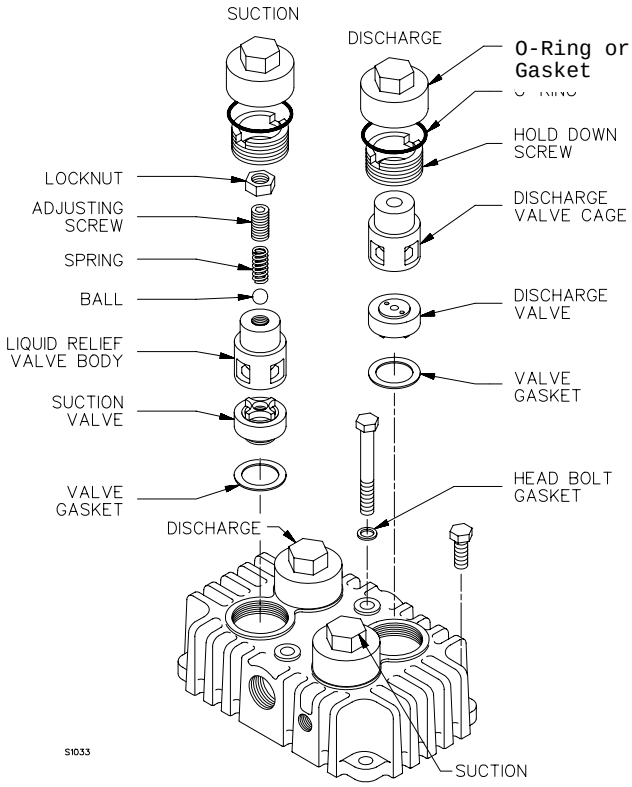


Figure 10 - LB161 or LB162 Valves

3. Suction valve - Remove the liquid relief valve body, valve assembly and gasket. DO NOT drop the liquid relief ball and spring into the head interior.

4. Discharge valve - Remove the discharge valve cage, valve assembly and gasket.

5. Inspect the valve for wear or breakage.

6. Ensure that the old gasket is removed, then install a new valve gasket.

7. To reinstall the suction valves:
   a. Install the valve assembly in the cylinder head. Ensure the correct orientation and location of the valve.
   b. Center the liquid relief body on the valve assembly.
   c. Install the hold down screw and tighten per Table 6 - "Bolt Torque."
   d. Drop the liquid relief ball and the liquid relief spring into the opening of the liquid relief body.
   e. Insert the liquid relief adjusting screw and adjust clockwise until the top of the screw is approximately 3/8" (9.5 mm) above the top of the liquid relief body. Add the locknut and tighten securely.

8. To reinstall the discharge valves:
   a. Install the valve assembly in the cylinder head. Verify the correct valve orientation and location.
   b. Center the valve cage on the valve assembly.
   c. Install the hold down screw and tighten per Table 6 - "Bolt Torque."

9. Install the valve cap and O-ring or gasket. A little oil or grease on the O-ring will help hold it in place during installation.

10. After replacing the valves, rotate the flywheel by hand to check for interference between the pistons and the valves.

11. After 60 minutes running time, remove the valve cap and retorque the hold down screw. Replace the valve cap and O-ring.

VALVE REPLACEMENT

SERIES LB361, LB362, LB601 or LB602

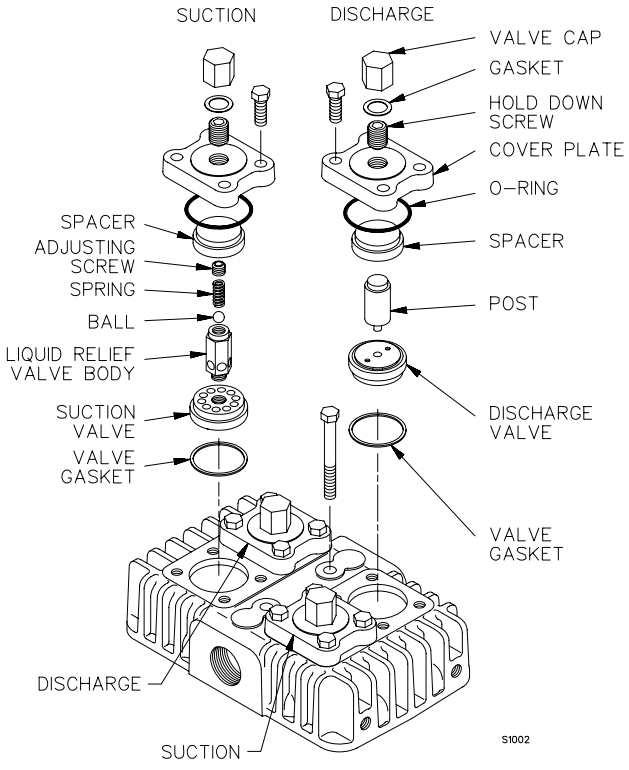


Figure 11 -
LB361, LB362, LB601 & LB602 Valves

1. Remove the valve cap and gasket from the valve being serviced.

2. **Remove** the valve hold down screw with an allen wrench.

3. Remove the valve cover plate capscrews then lift off the cover plate and O-ring.

4. Suction valves: remove the spacer, suction valve assembly and valve gasket.

5. Discharge valves: remove the spacer, post, discharge valve, and valve gasket.

6. Inspect the valve for wear or breakage. Repair or replace as necessary.

7. To reinstall the suction valves:
   a. Adjust the liquid relief valve adjusting screw clockwise until the screw is flush with the top of the liquid relief valve body, or no more than 1/16" (1.6 mm) above the top of the liquid relief valve body.
   b. Ensure that the old gasket is removed, then install a new valve gasket.
   c. Install the valve assembly with the liquid relief valve upward. Verify the correct valve orientation and location.
   d. Install the valve spacer.
   e. Ensure the valve hold down screw is removed from the cover plate, then place the cover plate and new O-ring in position.
   f. Install the valve cover plate capscrews and tighten per Table 6 - "Bolt Torque."
   g. Install and tighten the hold down screw per Table 6 - "Bolt Torque."
   h. Install the valve cap with a new gasket.

8. To reinstall the discharge valves:
   a. Ensure that the old gasket is removed, then install a new valve gasket.
   b. Install the valve assembly with the plug downward. Verify the correct valve orientation and location.
   c. Install the valve post, small end first.
   d. Install the valve spacer.
   e. Ensure the valve hold down screw is removed from the cover plate, then place the cover plate and new O-ring in position.
   f. Install the valve cover plate capscrews and tighten per Table 6 - "Bolt Torque."
   g. Install and tighten the hold down screw per Table 6 - "Bolt Torque."
   h. Install the valve cap with a new gasket.

9. After replacing the valves, rotate the flywheel by hand to check for interference between the pistons and the valves.

10. After 60 minutes running time, remove the valve cap and retorque the hold down screw. Replace the valve cap and gasket.

SEAL (PACKING) REPLACEMENT

1. Follow steps 1 through 6 of the "Compressor Disassembly" section of this manual.

2. Remove the upper and lower retainer ring from the packing box being serviced. Disassemble the packing box and discard the old packing sets and packing springs.

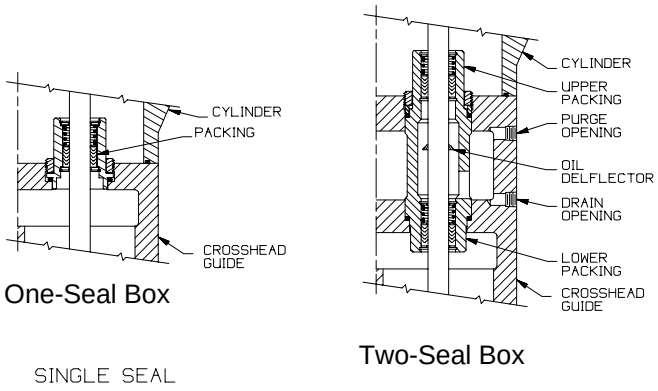


Figure 12 - TYPE 1 Seal Orientation

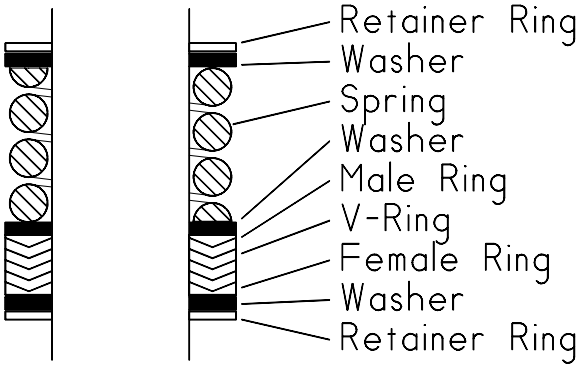


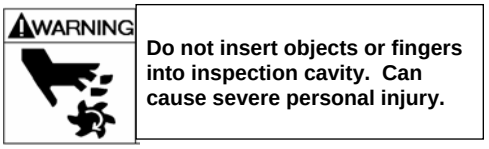
Figure 13 - Typical Seal Assembly

3. Clean the packing box in a suitable solvent. Inspect the bore for wear, roughness, or corrosion. Clean or replace as necessary.

4. Ensure that the 6th digit of the Compressor ID number is a "1", indicating a TYPE 1 packing arrangement. See "Nameplate Data" in this manual. Refer to Figures 12 and 13 for proper TYPE 1 component location and orientation.

5. **Single-Seal Packing Boxes**
   a. Install the lower retainer ring.
   b. Install the packing rings, spring, washers, and the upper retainer ring. To ease installation on the second retainer ring, use a screwdriver handle and press on the last washer to compress the seal spring slightly.

6. **Two-Seal Packing Boxes**
   a. Install the inner retainer ring of the lower packing.
   b. Install the packing rings, spring, washers, and the second retainer ring. To ease installation on the second retainer ring, use a screwdriver handle and press on the last washer to compress the seal spring slightly.
   c. Insert the oil deflector ring through the top of the packing box, flat side down, into the cavity between the upper and lower packing. The oil deflector ring will be positioned between the two sets of packing.
   d. Install the upper packing set starting with the inner retainer ring.



7. The lower packing MUST be manually lubricated with oil several times during the first 60 minutes of compressor operation. This will prevent overheating of the piston rods and potential damage to the packing material.
   To lubricate the packing:
   a. Remove the inspection plate from the crosshead guide.
   b. **Stop** the compressor approximately every 5 minutes to allow adequate cooling of the piston rods.
   c. Using a small oil can, lubricate the piston rods each time the compressor is **stopped**.

8. Proceed according to steps 5 through 15 of the "Compressor Assembly" section.

BEARING REPLACEMENT

NOTICE: When replacing the bearings, the entire bearing assembly, including the bearing cup and the bearing cone, must be replaced.

1. Follow steps 1 through 12 of the "Compressor Disassembly" section.

2. Remove the Oil Pump per the section titled "Oil Pump Replacement."

3. Remove the flywheel.

4. Remove the bearing carrier and gasket from the outboard end of the crankcase. The outboard bearing cup will come off with the bearing carrier and will need to be removed with a bearing removal tool.

5. Remove the key from the crankshaft and slide the crankshaft through the outboard end of the crankcase. The bearing cones can then be removed with a bearing puller.

6. Remove the bearing cover plate from the inboard end of the crankcase. The inboard bearing cup is pressed into the crankcase and can be removed with the use of a bearing removal tool.

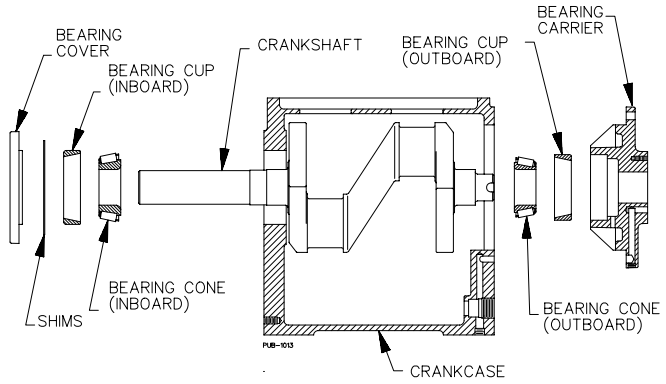


Figure 14 - Bearing Locations

a. Grease the outer edges of the bearing cups.
b. Referring to Figure 14 for the proper orientation, carefully press the inboard bearing cup into the crankcase until it is flush with the outer surface of the crankcase.
c. Note the proper orientation and carefully press the outboard bearing cup into the bearing carrier assembly.
d. Press a bearing cone onto each end of the crankshaft with the tapered end outward. The bearing race should rest against the shoulder on the crankshaft.
e. Lubricate the bearings with grease.

8. Install the crankshaft through the outboard end of the crankcase.

9. With the oil pump assembly removed, install the bearing carrier and new gasket. The bolt hole positions ensure proper orientation. Tighten the bolts evenly per Table 6 - Bolt Torque."

10. If the bearings have not been replaced, reinstall the inboard bearing cover plate using the existing shim set. If the bearings have been replaced, use a **thicker** set of shims.

11. Rotate the crankshaft by hand to verify free movement of the shaft.
    a. If the crankshaft has an excessive amount of end play, too many shims have been used. Lateral crankshaft movement (end play) between the bearings should be 0.0015 to 0.0030" (0.038 to 0.076 mm) . If necessary, remove shims until the end play is within tolerance.
    b. If the crankshaft binds, or will not turn, not enough shims have been used pushing the bearing cup too tight against the bearing cone. Remove the crankshaft from the crankcase and drive the inboard bearing cup out toward the inboard side of the crankcase. Reinstall the crankshaft and the bearing cover plate using additional shims as required.

12. Install the oil pump per the "Oil Pump Replacement" section of this manual.

13. Reassemble the compressor according to the "Compressor Assembly" section.

OIL PUMP REPLACEMENT

1. Remove the oil pump cover bolts and the oil pump cover.

2. Remove the cover O-ring, oil pump ring and shaft assembly.

3. Clean, inspect and replace parts as necessary.

4. Place the oil pump shaft assembly (complete with oil pump rotor, key, retainer ring and new shaft O-ring) into the bearing housing. If the bearing housing is bolted to the crankcase, the slot in the end of the oil pump shaft must align with the pin in the end of the crankshaft.

5. Place the oil pump ring over the rotor. Place the cover O-ring into the bearing carrier (do **not** place it on the oil pump cover).

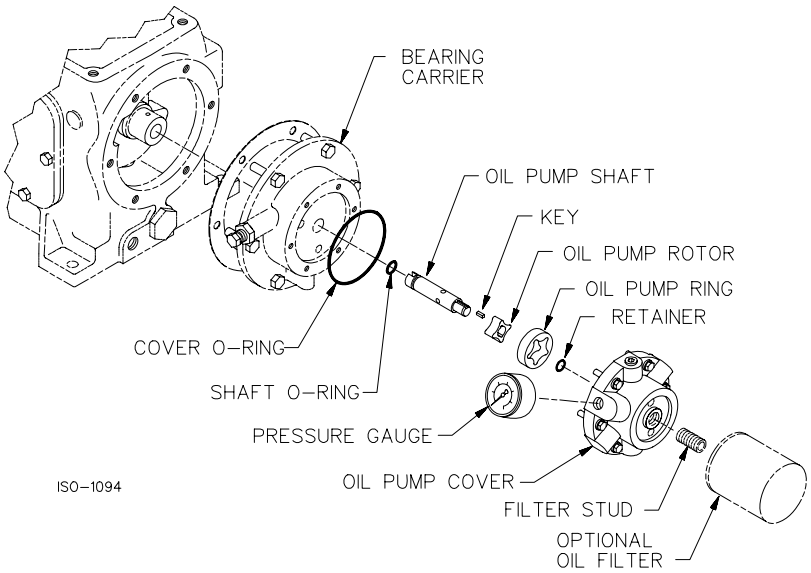


Figure 15 - Oil Pump

6. Orient the oil pump cover with the upper direction arrow (the one labeled 'TOP') for the proper crankshaft rotation direction.

7. Tighten the oil pump cover bolts by hand.

   NOTE: If the pump cover cannot be drawn flush with the bearing carrier by hand, either the oil pump shaft or other parts are not properly aligned. DO NOT USE A WRENCH AT THIS POINT AS THE OIL PUMP WILL BE DAMAGED IF INSTALLED INCORRECTLY.

8. Once the oil pump cover is secured by hand, the bolts may be evenly tightened per the Bolt Torque Table.

9. Verify that the proper plugs are installed in the oil pump cover per the above sketches.

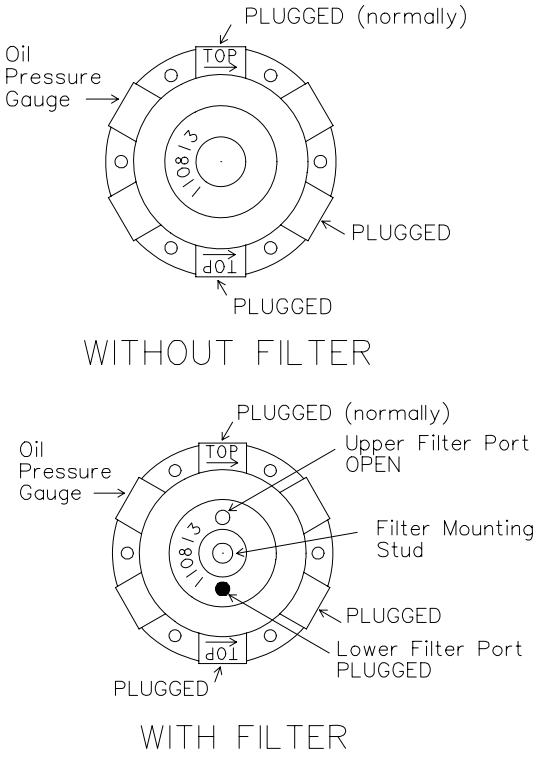


Figure 16 - Oil Pump Cover

EXTENDED STORAGE PROCEDURES

If a compressor is not to be put into service for some time, or if a compressor is to be taken out of service for an extended period, the following procedures should be taken.

1. Fill the crankcase with rust inhibiting oil. (New compressors are shipped from the factory without oil.) Squirt oil on the piston rods and crossheads through the nameplate opening. Loosen the V-belts to relieve the load on the bearings. Rotate the compressor by hand a few times to distribute the oil.

2. Plug all openings and purge the compressor with an inert gas such as nitrogen or **dry** air at about 50 psig (3.5 bar-g). This may be done at the factory if requested. Leave the compressor pressurized to prevent air or moisture from entering the unit.

   NOTICE: Tag the unit with a warning that it is pressurized.

3. If a purge gas is not available, fog oil into the compressor suction while rotating the unit. Then plug all openings to keep out moisture, insects, etc.

4. Turn the flywheel by hand a few revolutions once a month to distribute the oil.

5. Store the unit under a plastic wrap on its wooden shipping base up off the ground. If the unit was boxed for export shipment, leave it in its box. An indoor or covered storage area is preferable.

6. When the compressor is to be put in service, vent the remaining purge gas and change the crankcase oil. See the "Pre-Startup Checklist" and "Startup Procedure" sections in this manual.

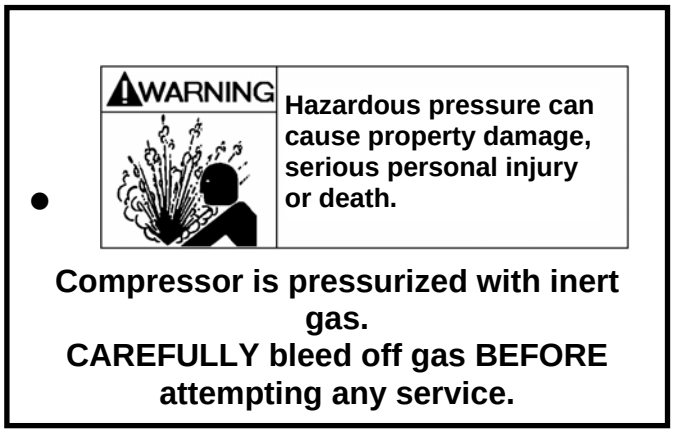


Figure 17 - Pressurized Compressor Tag

TROUBLESHOOTING

PROBLEM	STEP	PROBABLE CAUSE	WHAT TO CHECK	IF PROBLEM STILL EXISTS GO TO STEP ...
Low Transfer Rate	1	4-Way Valve Leaking (when equipped)	Lubricate with a stick lubricant compatible with material being transferred.	2
	2	Worn or Broken Piston Rings	Check condition of rings by restricting discharge line. If pressure increases slowly, rings are probably faulty.	3
	3	Plugged Strainer	Clean screen as necessary.	4
	4	Compressor Valve Faulty	Remove and inspect for broken or worn springs, discs, or bodies.	5
	5	Liquid Relief Valves Need Adjusting	Adjust per instructions in "Valve Replacement."	6
	6	Compressor Drive Slipping	Tighten belts, check for sheared keys, loose keys or loose flywheel.	7
	7	Piping Improperly Designed or Installed	Use proper pipe sizes.	8
No Flow	8	Liquid Trap Full	Drain liquid trap through drain valve. Relieve vacuum through bleeder valve on top of liquid trap.	9
	9	Excess Flow Valves Slugged	Stop the compressor to let the excess flow open. Installation of a valved bypass line between the suction and discharge lines my be necessary.	6 & 7
Knocks or Other Noises	10	Loose Valves	Tighten valve hold-down screws.	11
	11	Worn Internal Parts	Inspect through inspection plates and repair as necessary.	4
No Oil Pressure	12	Oil Pump Relief Valve Not Properly Set.	Set oil pump relief valve.	13
	13	Oil Pump Not Working	Check the Oil Pump drive tab or stop pin for damage.	14
	14	Low Oil Level	Check and fill as necessary	15
	15	Dirty Inlet Strainer	Clean Inlet Strainer	
Gas Leaking from Crankcase Breather	16	Faulty/Worn Packing	Replace Packing.	17
	17	Piston Rod Scored	Replace crosshead assemblies and packing.	18
	18	Improper Seal Arrangement	See "Seal Arrangements."	19
Shake or Vibration	19	Improper Mounting	Ensure base is supported full length. See "Mounting the Compressor."	20
	20	Nonfunctioning Valves	Replace or repair valves.	

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