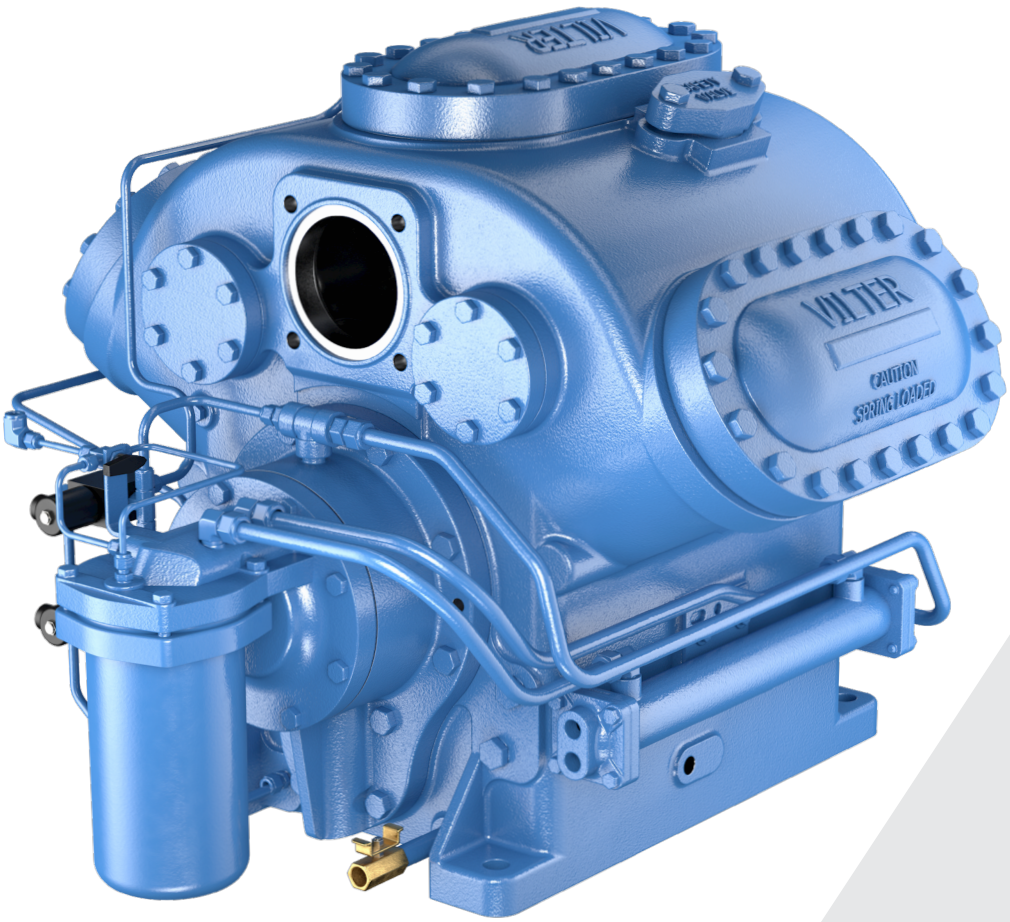
400 VMC Series Compressor

Installation, Operation and Maintenance Manual



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NOTE

This manual only covers VMC models 440 and 450XL series reciprocating compressors.

For VMC models 450, 460 series and Two-Stage compressors, please refer to manual 35391B Rev. 1a (5/14);

For VMC models 320, 330 and 340 series compressors, please refer to manual 35391J Rev. 0;

For VMC models 350 series compressors, please refer to manual 35391K Rev. 0

Standard VILTER™ Warranty Statement

What is covered & how long it is covered: Subject to the other terms of this Warranty Statement, Seller warrants to its direct purchasers (and to no others) that the Products it manufactures will be free from defects in material and workmanship under normal use, regular service and maintenance. This warranty only applies when such defect appears in the Products within 12 months ("m") from the date such Products are placed in service and when such Products are returned to and received by Seller within 18m from the date of manufacture by Seller ("12m/18m"), except that defects in the following Products different than 12m/18m are covered by the number of months indicated below if returned to Seller within the following number of months ("m Ship") from shipment by Seller—

Product	Compressor Type		
	Reciprocating Compressors	VSS / VSM Refrigeration Compressors	VSG / VSSG Gas Compressors
New Unit	24m Ship	24m Ship	12m/18m
Compressor (New Unit Only)	24m Ship	60m Ship	12m/18m
New Bareshaft Compressor	24m Ship	24m Ship	12m/18m
Remanufactured Compressor	12m/18m	12m/18m	12m/18m
Any Engineered to Order (ETO) packaged system (including Heat Pumps and Process Chillers) not described above carry the 12m/18m warranty.			
VSS / VSM single screw compressors installed and shipped on New Units carry an internal Product component warranty of 5 years from shipment date and a warranty of 15 years from shipment date for compressor bearings only. Does not include actuator motors and shaft seals.			
Vilter™ Genuine OEM Parts, retrofit Vission 20/20 and MicroVission panels, retrofit PLC panels and any other supplied equipment not described above carry a 12m warranty from shipment date.			
New Vapor Recovery Units ("VRU Units") and its Compressors carry the standard 12m/18m warranty—all other VRU parts carry a 6 m warranty from shipment date.			

What is not covered: This warranty does not extend to any losses or damages due to misuse; corrosion; accident; abuse; neglect; normal wear and tear; negligence (other than Seller's); unauthorized alteration; use beyond rated capacity; acts of God; war or terrorism; unsuitable power sources or environmental conditions; operation with refrigerants or lubricants which are not suitable for use with the Product; improper installation, repair, handling, maintenance or application; substitution of parts not approved by Seller; or any other cause not the fault of Seller. This warranty is only applicable to Products properly maintained and used according to Seller's instructions, the use of genuine Vilter™ replacement parts and recommended oil in all repairs, and when Buyer has demonstrated adherence to a scheduled maintenance program as detailed in the applicable operating manual. The Buyer must use Vilter approved oil only and provide oil analysis results to Vilter. To the extent the Buyer has supplied specifications, information, representation of operating conditions or other data to Seller in the selection or design of the Products and the preparation of Seller's quotation, and in the event that actual operating conditions or other conditions differ from those represented by Buyer, any warranties or other provisions contained herein which are affected by such conditions will be null and void. Seller does not warrant that the Products comply with any particular law or regulation not explicitly provided in the Product specifications, and Buyer is responsible for ensuring that the Products contain all features necessary to safely perform in Buyer's and its customers' plants and operations. If the Products are for a gas compression application, this warranty does not apply if the Products are operated in conjunction with a gas with an H_2S level above 100 PPM.

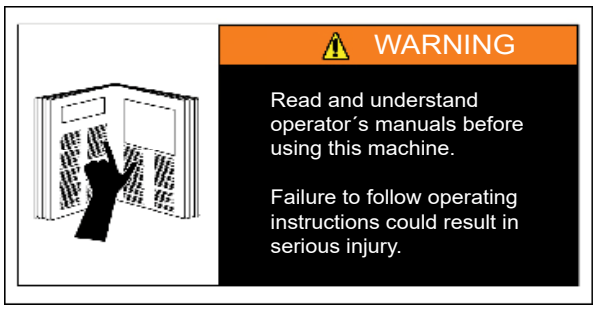
Third Party Motors & Starters: Motors and starters or Motor & Starter Parts purchased by Seller from a third party for resale to Buyer or for incorporation into Seller's Product will carry only the warranty extended by the original manufacturer ("OEM"). Motor manufacturer warranties cover only the repair or replacement of the motor, and do not cover removal and installation charges, incidental charges associated with the removal and installation process, loss of product, or shipping to and from the manufacturer or approved shop. The individual motor manufacturer warranty terms can be found on the manufacturer's associated websites.

Other limitations: Seller will not be liable under the above warranty if Buyer is in default of its payment obligations to Seller under any purchase order or credit agreement. Except with Seller's written permission given after receipt of Buyer's request within 60 days of an event, Seller will not be responsible for costs of dismantling, lost refrigerant, reassembling, repair labor and expenses, travel cost or transporting the Product. Products repaired or replaced under this warranty will be warranted for the unexpired portion of the warranty applying to the original Products. Buyer agrees that all instructions and warnings supplied by Seller will be passed on to those persons who use the Products. Products are to be used in their recommended applications and all warning labels adhered to the Products by Seller must be left intact. Any technical advice furnished by Seller before or after delivery in regard to the use, application or suitability of the Products may not be construed as an express warranty unless confirmed by Seller in writing, and Seller assumes no obligation or liability for the advice given or results obtained—all advice given and accepted at Buyer's sole risk.

Exclusive Remedy: Within (10) ten days after Buyer's discovery of any warranty defects within the warranty period, Buyer will notify Seller of such defect in writing. Seller will, at its option and as Buyer's exclusive remedy, repair, correct, or replace F.O.B. point of manufacture, or issue credit or refund the purchase price for, that portion of the Products found by Seller to be defective. Failure by Buyer to give such written notice within the applicable time period will be deemed an absolute and unconditional waiver of Buyer's claim for such defects. Buyer assumes all other responsibility for any loss, damage, or injury to persons or property arising out of, connected with, or resulting from the use of the Products, either alone or in combination with other products/components. If so required, Products or parts for which a warranty claim is made are to be returned transportation prepaid to Seller's factory. T**HE FOREGOING CONSTITUTES THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF ANY WARRANTY HEREUNDER.**

SOLE WARRANTY: THE WARRANTIES ABOVE CONSTITUTE SELLER'S SOLE AND EXCLUSIVE WARRANTIES WITH RESPECT TO THE PRODUCTS AND ARE IN LIEU OF AND EXCLUDE ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHETHER OR NOT THE PURPOSE OR USE HAS BEEN DISCLOSED TO SELLER IN SPECIFICATIONS, DRAWINGS OR OTHERWISE, AND WHETHER OR NOT SELLER'S PRODUCTS ARE SPECIFICALLY DESIGNED AND/OR MANUFACTURED BY SELLER FOR BUYER'S USE OR PURPOSE.

LIMITATION OF LIABILITY: SELLER SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE AND THE REMEDIES OF BUYER HEREIN ARE EXCLUSIVE. IN NO EVENT, REGARDLESS OF THE FORM OF THE CLAIM OR CAUSE OF ACTION (WHETHER BASED IN CONTRACT, INFRINGEMENT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL SELLER'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXCEED THE PRICE PAID BY BUYER FOR THE SPECIFIC PRODUCTS OR PORTION OF THE PRODUCTS PROVIDED BY SELLER GIVING RISE TO THE CLAIM OR CAUSE OF ACTION, AND BUYER SHALL INDEMNIFY AND HOLD HARMLESS SELLER FOR ANY DAMAGES INCURRED BY SELLER IN EXCESS THEREOF. BUYER AGREES THAT IN NO EVENT SHALL SELLER'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXTEND TO INCLUDE INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES. The term "consequential damages" includes loss of anticipated profits, business interruption, loss of use, revenue, reputation and data, costs incurred, including for capital, fuel, power and loss or damage to capital or equipment. Buyer agrees that all instructions and warnings supplied by Seller will be passed on to those persons who use the Products. Seller's Products are to be used in their recommended applications and all warning labels adhered to the Products by Seller are to be left intact.



READ CAREFULLY BEFORE INSTALLING AND STARTING YOUR COMPRESSOR.

The following instructions have been prepared to assist in installation, operation and removal of Vilter 400 Series Reciprocating Compressors. Following these instructions will result in a long life of the compressor with satisfactory operation.

The entire manual should be reviewed before attempting to install, operate, service or repair the compressor.

Only qualified personnel shall operate, install and maintain the equipment.

Qualified personnel shall be accredited by a local regulatory agency, which requires that they are continually scrutinized by an organization whose sole mission is to establish, maintain and assure that the highest industry standards are set and met in a continuous and ongoing basis. The credentials shall address topics ranging from plant safety, operating concepts and principles and operations through the basics of refrigeration compliance and PSM (Process Safety Management) requirements.

Follow local workplace occupational safety and health regulations.

A compressor is a positive displacement machine. It is designed to compress gas. The compressor must not be subjected to liquid carry over. Care must be exercised in properly designing and maintaining the system to prevent conditions that could lead to liquid carry over. Vilter Manufacturing is not responsible for the system or the controls needed to prevent liquid carry over and as such Vilter Manufacturing cannot warrant equipment damaged by improperly protected or operating systems.

Vilter reciprocating compressor components are thoroughly inspected at the factory. However, damage can occur in shipment. For this reason, the equipment should be thoroughly inspected upon arrival. Any damage noted should be reported immediately to the Transportation Company. This way, an authorized agent can examine the unit, determine the extent of damage and take necessary steps to rectify the claim with no serious or costly delays. At the same time, the local Vilter representative or the home office should be notified of any claim made.

All inquires should include the Vilter sales order number, compressor serial and model number. These can be found on the compressor name plate on the compressor.

All requests for information, services or parts should be directed to:

Vilter Manufacturing LLC
Customer Service Department
5555 South Packard Ave
Cudahy, WI 53110 USA
Telephone: 1-414-744-0111, Fax:1-414-744-3483
E-mail: info.vilter@copeland.com, Website- www.Copeland.com/Vilter

Equipment Identification Numbers:
Vilter Order Number: _____Compressor Serial Number: _____
Vilter Order Number: _____Compressor Serial Number: _____

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EC Declaration of Incorporation

We hereby declare that the following machinery is intended to be incorporated into other machinery, and must not be put into service until the relevant machinery into which it is to be incorporated has been declared in conformity with the essential requirements of the Machinery Directive 2006/42/EC.

Machine Description:	*Industrial Compressor*
Make:	*Vilter*
Type:	*Reciprocating Compressor - 400 VMC Series*
Model Size:	*442, 444, 446, 448, 448HD, 4412, 4416*
	452XL, 454XL, 456XL, 458XL, 4512XL, 4516XL.
	446 2-Stage, 456XL 2-Stage, 4512XL 2-Stage.
Manufactured by:	Vilter Manufacturing, LLC.

The following transposed harmonised European Standards have been used:

EN ISO 12100-1: 2010	- Safety of Machinery - General principles for design-Risk assessment and risk reduction.
EN ISO 13857: 2008	- Safety of Machinery - Safety distances to prevent danger zones being reached by the upper and lower limbs.
EN349:1993 + A1: 2008	- Safety of Machinery - Minimum gaps to avoid crushing hazards.
EN ISO 13850: 2015	- Safety of Machinery - Emergency stop equipment - Principles for design.
IEC/EN60204-1 (2016)	- Safety of Machinery - Electrical equipment of machines - Specification for general requirements.

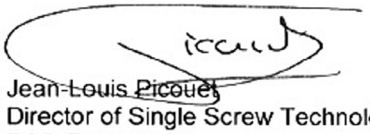
A technical construction file for this machinery is retained at the following address:

Vilter Manufacturing, LLC.
5555 South Packard Avenue
P.O. Box 8904, Cudahy
Wisconsin 53110-8904, USA

Vilter's Authorized Representative in Europe is Emerson S.R.L., company No J12/88/2006, Emerson 4 Street, Parcul Industrial Tetarom II, Cluj-Napoca 400638, Romania. For product compliance destination sales questions in Europe, contact the Regulatory Compliance Department: europeproductcompliance@emerson.com (+40 374 132 000).

In Great Britain, it is Emerson Process Management Ltd., Company No 00671801, Meridian East, Leicester, LE19 1UX, United Kingdom. For product compliance destination sales questions contact the Regulatory Compliance Department: ukproductcompliance@emerson.com (+44 11 6282 23 64).

Signed for and on behalf of Vilter Manufacturing, LLC.:



Jean-Louis Picouet
Director of Single Screw Technology
R&D Engineering

Last update: September 2021

Vilter Manufacturing, LLC.
5555 South Packard Avenue t P.O. Box 8904 t Cudahy, Wisconsin 53110-8904
001-414- 744-0111 t FAX: 001-414-744-3483

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How To Use This Manual

This manual contains instructions for 400 series reciprocating compressors. It has been divided into eight sections and appendices:

Section 1: General Information

Section 2: Theory of Operation

Section 3: Installation

Section 4: Operation

Section 5: Maintenance & Service

Section 6: Troubleshooting

Section 7: Warranty

Section 8: Spare Parts

Appendices

Appendix A: Torque Specifications

Appendix B: Vilter Oil

Appendix C: Vilter Oil Charger

Appendix D: Vilter Stedy-Mount®

Appendix E: Wood's Sure-Grip® QD Bushings

Appendix F: Johnson Controls P28 and P128 Series Lube Oil Controls with Built-in Time Delay Relay

Appendix G: PENN P70, P72, and P170 Series Controls for High Pressure Applications

Appendix H: Danfoss Pressure Switch, Differential Pressure Switch, RT

Appendix I: Danfoss Differential Pressure Switch Type MP 54, 55 and 55A

Appendix J: Danfoss Pressure Switch Type KP

Appendix K: Hansen HCK1 Piston-Type Check Valves

Appendix L: Rexnord Thomas® Disc Couplings

Appendix M: Super Separator General Dimensions and Mounting Positions

Appendix N: Oil Return Line Piping

NOTE:

The symbol ‹ at the bottom of every page:

Click the symbol ‹ . It will take you back to your previous page.

It is highly recommended that the manual be reviewed prior to servicing system parts.

Figures and tables are included to illustrate key concepts.

Safety precautions are shown throughout the manual. They are defined as the following:

NOTICE - Notice statements are shown when there are important information that shall be followed. Not following such notices may result in void of warranty, serious fines, serious injury and/or death.

WARNING - Warning statements are shown when there are hazardous situations, if not avoided, will result in serious injury and/or death.

CAUTION - Caution statements are shown when there are potentially hazardous situations, if not avoided, will result in damage to equipment.

NOTE - Notes are shown when there are additional information pertaining to the instructions explained.

Additional Important Notes

- Due to continuing changes and unit updates, always refer to the www.Copeland.com/Vilter website to make sure you have the latest manual.
- Any suggestions of manual improvements can be made to Vilter Manufacturing at the contact information on page iii.

Reciprocating Compressor Model Designations

The compressor unit model designation can be found on the nameplate. For nameplate location, see Component Identification on section page 1-4.

Refrigerant [3]
A - Ammonia (R-717)
E - R-134A
H - R-404A
J - R410A
M - R-22
P - R-290 (Propane)
R - R1270 (Propylene)
Z - R-507

Compressor Unit Type
B - Booster
K - High-stage
KX - High suction pressure
S - Swing - high-stage/ booster

Control Voltage
1 - 115 VAC
2 - 230 VAC
3 - 24 VDC
9 - Other

Cooling Size
S - Standard[1]
J - Jumbo
D - Dual
N - None

Other Features
X1 - Special connectors
X2 - Class I, Div. 2
X3 - Class I, Div. 1

A – 11 – S – 458XL – B – T* – 1 – W – J – Y – X1

Speed Designator
06 - 1060 RPM
10 - 1000 RPM
11 - 1130 or 1150[2] RPM
12 - 1200 RPM
73 - 730 RPM
76 - 1176 RPM
78 - 780 RPM
80 -798 RPM
83 - 830 RPM
86 - 1286 RPM
87[2] - 870 RPM
88 - 880 RPM
93 - 930 RPM
95 - 950 RPM
96 - 960 RPM (50 hz)

Compressor Series
44_ or 45_ XL or 448HD
Where _ indicates the number of cylinders (2, 4, 6, 8, 12 or 16)

Drive
B - Belt drive
D - Direct drive
W - VFD with direct drive

Coolant Type
W - Water-cooled
R - Refrigerant-cooled
A - Seawater-cooled
N - None

Cooling Jacket
Y - Yes
N - None

Notes-

(1): For 8-, 12-, and 16-cylinder compressors, the standard is Jumbo.

(2): For Direct Drive Units.

(3): See T sheet T00546 for more refrigerants choices.

*

6. Unloading % Code							
		2	4	6	8	12	16
S	Standard	None	*50%*	33/66 %	25/50 %	33/66 %	25/50 %
T	Option 1	50%	25/50/75 %	33/66 /100%	25/50/75/100 %	33/66/100%	25/50/75/100 %
U	Option 2	100%	50/100%		25/50/75 %		25/50/75 %
V	Not Standard						

System Unit Identification

Reciprocating compressors are provided in different levels of assemblies:

Level 1 - Bare Shaft Compressor

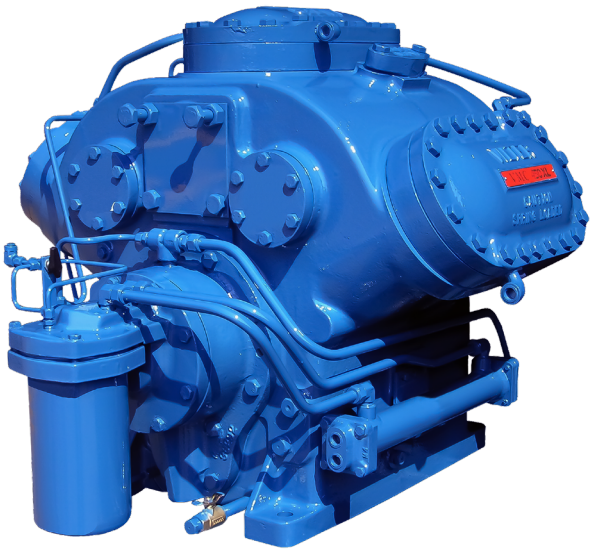
The standard level 1 450XL Bare Shaft Compressor includes the following:

1. Compressor, arranged for standard unloaded starting.
2. Suction strainer with suction screen bag
3. Internal safety relief valve
4. Unloader solenoid valves(s) (specify control voltage)
5. Water/Refrigerant cooled oil cooler
6. Tri Micro oil filter with 3-way manual valve mounted on filter housing
7. 535 watt crankcase heater (specify control voltage)
8. Crankcase oil thermometer

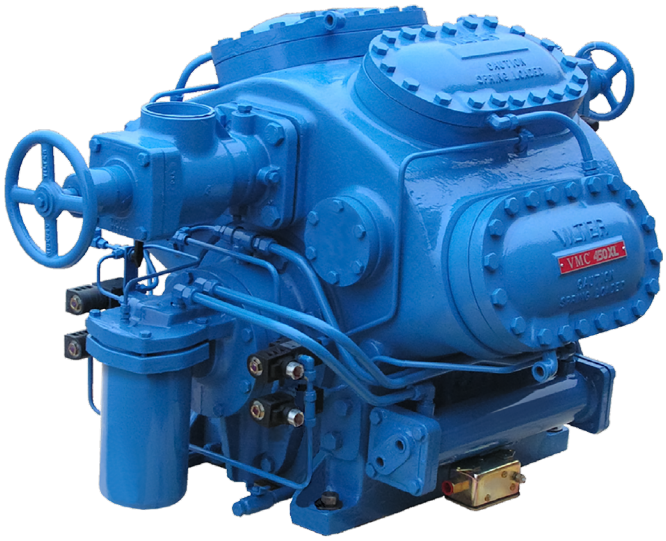
Level 2 - Bare Shaft Compressor

The standard level 2 450XL Bare Shaft Compressor includes the following:

1. Level 1 components
2. Suction and discharge stop valves
3. Bracket mounted pressure control assembly with capacity reduction switches. (Shipped loose)
4. Suction and discharge gauges with Stedy-Mounts and liquid filled oil pressure indicator (shipped loose)
5. Flywheel (belt-driven) or drive coupling (direct drive)



456XL Bare Compressor
- Level 1



458XL Bare Compressor
- Level 2

Level 3 - Compressor Unit

The standard level 3 450XL Compressor includes the following:

1. Level 2 components
2. Steel base
3. Motor

4a. For belt driven (B) units:

- Motor sheave and bushing
- V-belts
- Belt guard
- Motor rails

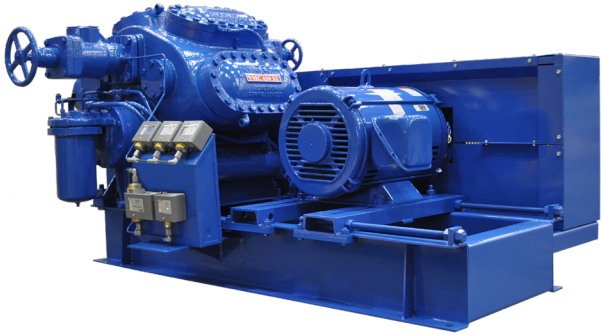
4b. For direct drive (D) units:

- Coupling guard

Packaged Unit

A package may include the following:

1. Level 3 components
2. Separator
3. Pressure Transducers
4. Micro-controller



458XL Compressor Unit (Belt Drive)
- Level 3

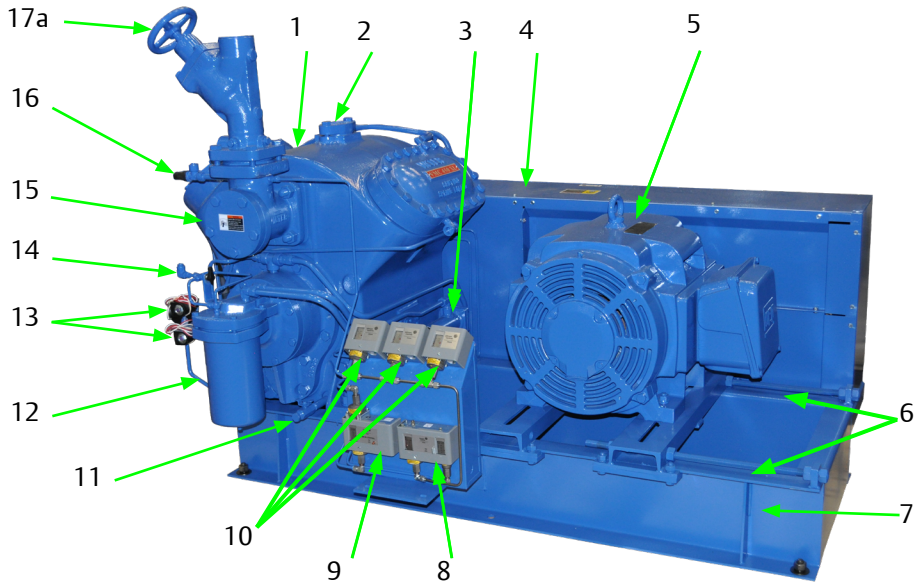
458XL Compressor Unit (Direct Drive)
- Level 3

458XL Compressor Packaged Unit (Belt Drive)

Bare Compressor Major Component Identification

Below are typical components that can be found on a bare reciprocating compressor.

1 - Compressor
2 - Internal Relief Valve Cover
3 - Oil Cooler (Water Cooled)
4 - Belt Guard (Belt Drive Units Only)
5 - Motor
6 - Rails (Belt Drive Units Only)
7 - Skid Base
8 - Dual Pressure Switch (Suction and Discharge Pressures)
9 - Pressure Switch (Oil Pressure)
10 - Unloader Pressure Controls
11 - Oil Drain (Crankcase)
12 - Oil Filter (Tri Micro)
13 - Solenoid Valves (Unloader)
14 - Oil Pressure Indicator Connection
15 - Suction Strainer Cover
16 - Suction Pressure Indicator Connection
17a - Suction Stop Valve
17b - Suction Stop Valve
18 - Crankcase Oil Heater (560 Watt)
19 - Oil Level Sight-glass
20 - Oil Temperature Indicator
21 - Coupling Guard (Direct Drive Units Only)



454XL Compressor Unit (Belt Drive)

- High Stage Unit with 25%, 50% and 75% Capacity Reduction and Cutouts

458XL Compressor Unit (Direct Drive)

- Micro-processor controlled (no pressure switches installed)

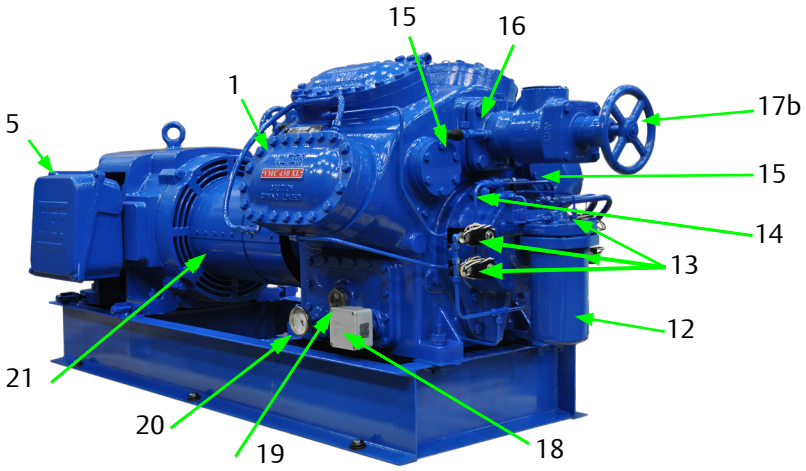
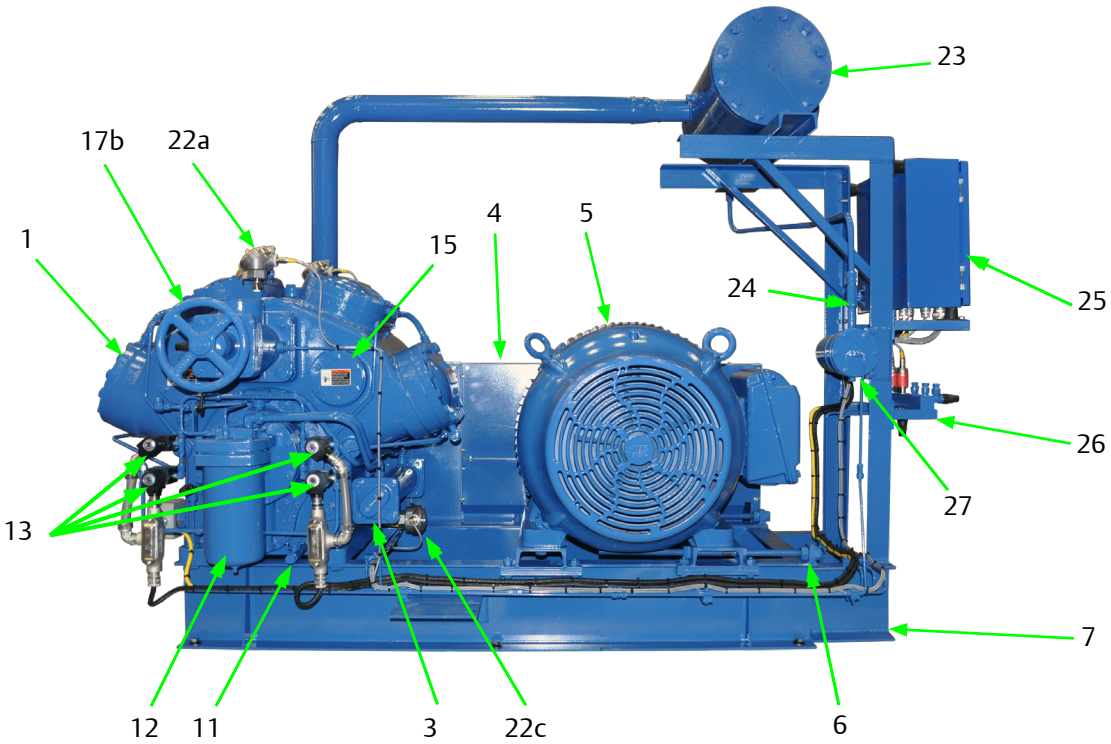


Figure 1-1. Refrigeration Compressor Unit and Package Components (1 of 3)

Component Identification (Continued)

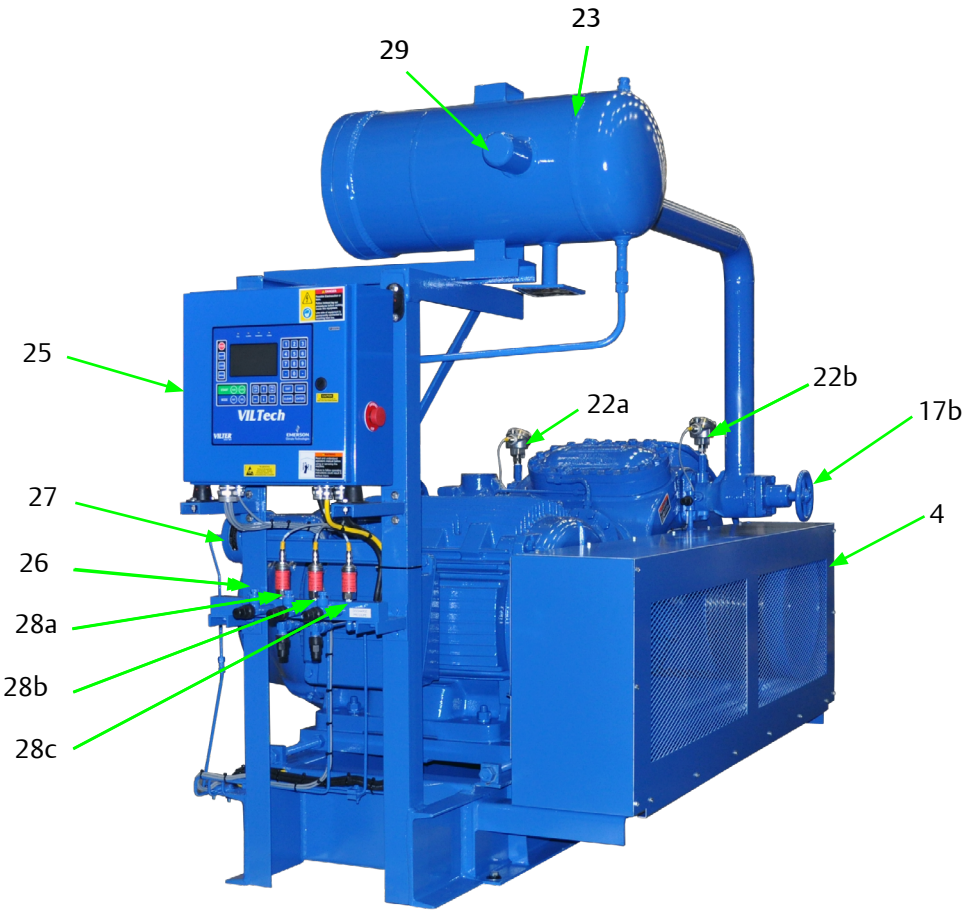
1 - Compressor
2 - Internal Relief Valve Cover
3 - Oil Cooler (Water Cooled)
4 - Belt Guard (Belt Drive Units Only)
5 - Motor
6 - Rails (Belt Drive Units Only)
7 - Skid Base
8 - Dual Pressure Switch (Suction and Discharge Pressures)
9 - Pressure Switch (Oil Pressure)
10 - Unloader Pressure Controls
11 - Oil Drain (Crankcase)
12 - Oil Filter (Tri Micro)
13 - Solenoid Valves (Unloader)
14 - Oil Pressure Indicator Connection
15 - Suction Strainer Cover
16 - Suction Pressure Indicator Connection
17a - Suction Stop Valve
17b - Suction Stop Valve
18 - Crankcase Oil Heater (535 Watt)
19 - Oil Level Sight-Glass
20 - Oil Temperature Indicator
21 - Coupling Guard (Direct Drive Units Only)
22a - RTD with Transmitter (Suction)
22b - RTD with Transmitter (Discharge)
22c - RTD with Transmitter (Oil)
23 - Oil Separator
24 - Shut-off Valve (Oil Return)
25 - VILTech or MicroVission Micro-controller
26 - Block and Bleed Assembly
27 - Float Valve (Oil Return)
28a - Pressure Transducer (Suction)
28b - Pressure Transducer (Discharge)
28c - Pressure Transducer (Oil)
29 - Discharge Connection (Oil Separator)



458XL Compressor Packaged Unit (Belt Drive)
- Micro-processor controlled (no pressure switches installed)

Figure 1-1. Refrigeration Compressor Unit and Package Components (2 of 3)

Component Identification (Continued)



458XL Compressor Packaged Unit (Belt Drive)

- Micro-processor controlled (no pressure switches installed)

Figure 1-1. Refrigeration Compressor Unit and Package Components (3 of 3)

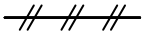
Control and Instrument Identification

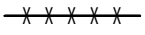

Discrete Instrument, Field Mounted


Discrete Instrument, Remote, Mount, Normally Accessible to Operator

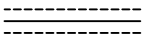

Discrete Instrument, Local Rack Mounted, Normally Accessible to Operator

Line Type Designations


Pneumatic Signal


Capillary Tube

Customer Field Piping


Insulation

Compressor Unit Flow Descriptions

Reference Figure 2-1 for refrigerant and oil flow descriptions. This is a typical reciprocating refrigeration system with R717.

Refrigerant Flow

High pressure heat-laden R717 vapor is discharged from the reciprocating compressor (004-C-100) into the oil separator (004-V-100) where refrigeration oil is separated from the refrigerant discharge vapor. The recovered oil is then returned to the compressor crankcase via an oil float valve (FV-100) mounted within a small pressure vessel. This ensures only oil and not refrigerant vapor is returned to the compressor crankcase.

A check valve (CV-100) is provided between the oil separator (004-V-100) and the condenser (not shown) to prevent refrigerant vapor from migrating back to the oil separator during shutdown periods. Vapor migration and condensation of R717 refrigerant into liquid which can return to the compressor crankcase via the oil return line has the potential to cause compressor damage.

In order to accommodate a range of process glycol heat load conditions, the package system is equipped with several systems to adjust system capacity. In this example, the compressor is equipped with three solenoid valves (XV-100, XV-101 & XV-102) which are activated by the package controller (VILTech or MicroVission) to provide steps of cylinder unloading to match capacity requirements.

Oil Life and Oil Flow

Oil in the refrigeration system serves three primary purposes. They are compressor lubrication, sealing clearances between moving parts, and heat removal resulting from heat of compression and friction. Oil flow is driven by a mechanical gear pump (004-P-100) located inside the reciprocating compressor (004-C-100). The following lists the path taken by the oil starting at the crankcase:

1. Oil flow through the compressor starts in the crankcase. The oil enters the oil system through a large mesh strainer screen.
2. The oil is then drawn through the mechanical gear pump (0047-P-100).
3. After the oil leaves the pump, it enters the shell & tube oil cooler (004-E-100).
4. After leaving the oil cooler it enters the micro oil filter head (004-U-100), the oil around the outside of the filter element which filters out the impurities in the oil.
5. As it leaves the filter it flows forward to the rear bearing housing of the compressor (004-C-100). At this point it supplies oil to the rear bearing through a metering orifice and to the front bearing housing.
6. If the compressor is equipped with oil unloading the oil is supplied from a tee on the top of the rear housing to the oil solenoids.

This is a continuous cycle as long as the compressor is running.

Controls

If equipped with a VILTech or MicroVission control panels, their main function is to control the refrigeration system from the data that they receive from the sensors around the unit. Typically, these Vilter control panels are installed on reciprocating compressor packages. For additional information, refer to VILTech operating manual (35391VT) or MicroVission operating manual (35391MV).

NOTE

VMC compressor packages equipped with a VILTech or MicroVission control panel do not have control switches installed.

Temperature Elements and Pressure Transmitters and Indicators

Temperature elements (TE), temperature Indicator (TI), pressure transducers (PT) and pressure Indicator (PI) are instruments used to measure temperatures and pressures at specific locations on the compressor unit. Temperature elements are installed on the compressor suction and discharge pipes. A temperature Indicator is installed on the crankcase to measure oil temperature. Pressure transducers are mounted on the block and bleed assembly to measure pressures at the suction and discharge compressor connections. The block and bleed assembly is located underneath the control panel. A pressure indicator is also installed to measure oil pressure from the crankcase.

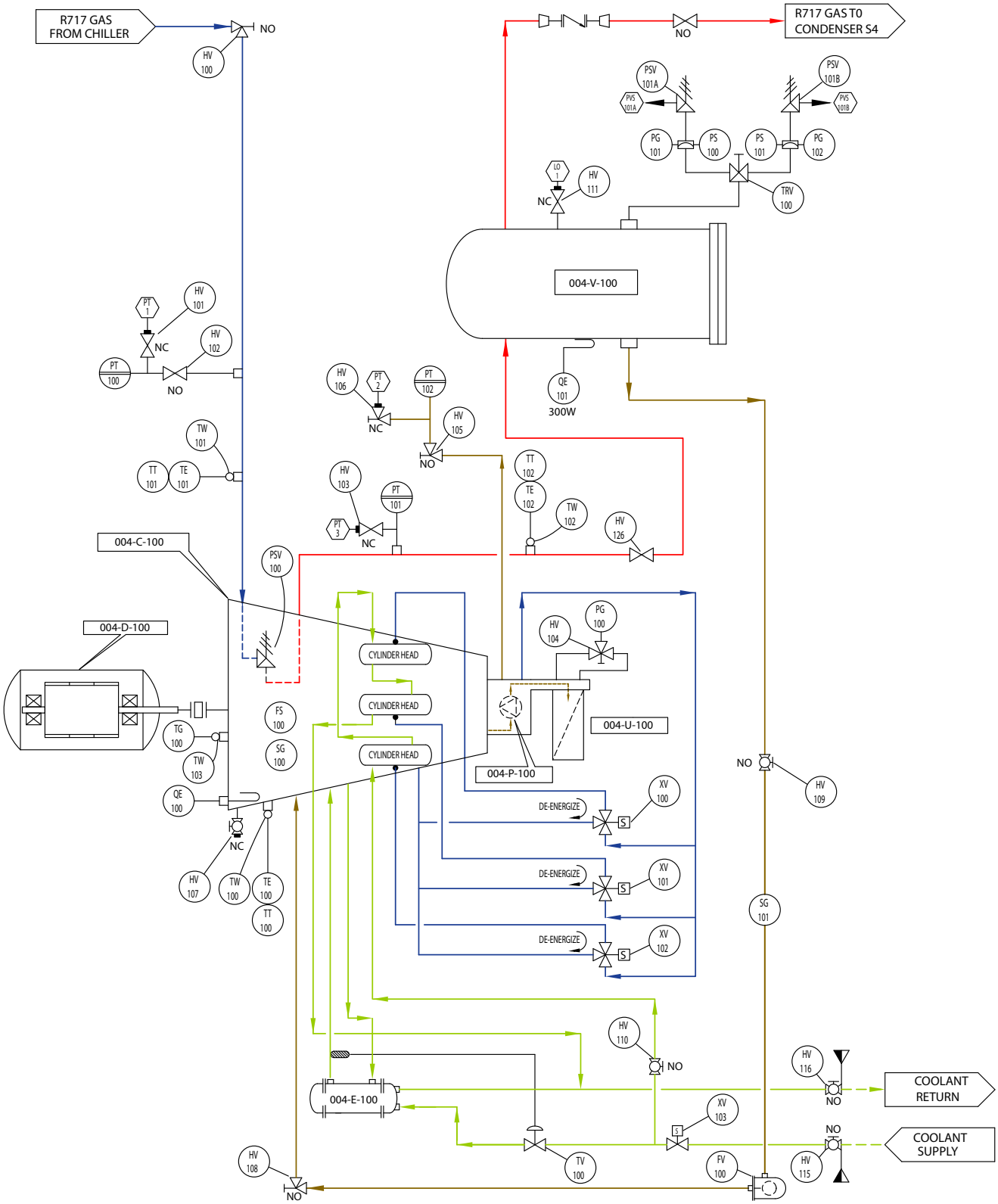


Figure 2-1. Refrigeration Compressor Unit P&ID

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 Vilter VMC MultiCylinder Compressor.

Only qualified personnel shall operate, install and maintain the equipment.

Follow local workplace occupational safety and health regulations.

Delivery Inspection

All equipment supplied by Vilter are thoroughly inspected at the factory to ensure all units are mechanically sound upon shipment. However, damage can occur in shipment. For this reason, first verify that all unit components and parts have been received per the packing slip and bill of lading. Second, the units should be thoroughly inspected for visible damage upon arrival, especially tubing, instrumentation, piping, prior to off-loading.

Any damage noted should be photographed and reported immediately to the transportation company. This way, an authorized agent can examine the unit, determine the extent of damage and take necessary steps to rectify the claim with no serious or costly delays. At the same time, the local Vilter representative or the home office should be notified of any claims made within ten (10) days after its discovery. Refer to below and long term storage for additional recommendations.

Compressor Unit Inspections Prior to Storage and Installation

The compressor unit must be inspected prior to installation since components could have come loose and/or damaged during shipment or moving.

- Check for loose bolts, particularly the compressor and motor mounting nuts.
- Check for bent or damaged components. The compressor unit should have also been inspected prior to off-loading, see Delivery Inspection.
- If provided, check that the nitrogen pressure is still holding pressure. The pressure Indicator is located at the discharge bleed valve on the block and bleed assembly. Any leaks must be fixed and the system purged and re-charged with dry nitrogen.

Recommended On-site Tools

The tools recommended to have on site are important for troubleshooting, inspections and compressor unit operation. Besides general mechanic tools, these tools are recommended:

- Manual Oil Pump (KT009)
- Infrared Heat Gun
- Torque Wrenches (with ranges from 0 to 600 ft-lbs)
- Sockets and wrenches up to 2-1/2" (63.5 mm)
- Voltmeter

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.

NOTE

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

Service Tools

Tool kit – 400 VMC Compressor – all items listed below and various snap-on sockets and T-handles. Part No.: KT067.

Table 3-1. 440VMC SERVICE MAINTENANCE TOOL KIT - KT067

Position	Item number	Quantity	Item name
001	1996A*	1.00	TOOL 400VMC SET W/STEEL BOX
002	2412A	1.00	EXPANDER PRS8 PISTON RING
003	1420A/42444A	1.00	TOOL 400 PISTON RING COMPRESSOR
004	KT523	1.00	STUD 440 COVER CYL 5/8&NUT PAIR
005	KT524	1.00	STUD 400 COVER FRONT 5/8-NC PAIR
006	KT525	1.00	TOOL 400 CYLINDER LINER INSTALL
007	KT526	1.00	TOOL 400 FLYWHEEL REMOVAL
008	KT527	1.00	TOOL 440 CYLINDER LINER REMOVAL
009	33463A	2.00	TOOL 400 SHAFT SEAL REMOVAL
010	2040A	1.00	TOOL 9/16 PALNUT SOCKET WN280562
011	33781A	1.00	TOOL 400 PACKING NUT WRENCH

Note- *: See Table 3-2 for details of 1996A

Table 3-2. 1996A TOOL SET - For 440 VMC Tool Kit (Part No. KT067)

VPN	Description
1996B	Handle, Sliding “T”, 17-1/2” long, 3/4" drive
1996C	Socket, Regular 12-Point, 1-3/4" opening, 3/4" square drive
1996D	Adapter, 3/4" square female & 1" square opening
1996E	Socket, 1" square drive, extra heavy duty, 2-3/8" opening
1996F	Ratchet, Reversible, 10-1/2" long, 1/2" square drive
1996G	Adapter, 1/2" square female & 3/8" square male
1996J	Socket, 3/8" square drive, thin wall, 12-point, 1/2" opening
1996K	Socket, 3/8" square drive, thin wall, 12-point, 9/16" opening
1996L	Impact Socket, 3/8" square drive, thin wall, 12-point, 3/4" opening
1996M	Socket, 1/2" square drive, thin wall, 12-point, 7/8" opening
1996N	Socket, 1/2" square drive, thin wall, 12-point, 15/16" opening
1996P	Hex Bit Socket w/ Short Bit, 3/16" bit, 3/8" square drive
1996Q	Hex Bit Socket w/ Short Bit, 7/32” bit, 3/8” square drive
1996U	Wrench, Adjustable Hook Spanner, 2” to 4-3/4” dia.
1996W	Metal Case, 23-1/4” x 7-1/2” (16-651) x 9-1/4” (16-653)
1996X	Adaptor, 3/4" square female & 1/2" square male

1. 1996A 400VMC Tool Set with Steel Box Part No. 1996A (KT627) (See table 3-2)

1a. Socket Set, Ratchet and Extensions

Part No. 1996B to 1996X except 1996U & 1996W (See Table 3-2 for details)

1b. Spanner Wrench

Part No. 1996U (See Table 3-2)

1c. Toolbox - 23¼" lg. X 7½" wide x 9¼" deep with tote tray.

Part No. 1996W (See Table 3-2).

2. Piston Ring Spreader

Simplifies installation of piston rings while insuring minimum breakage and distortion. Pressure on handles evenly expands ring so that it will slip over the piston and into the groove.

Part No. 2412A

3. Piston Ring Compressor

Eases installation of pistons into cylinder liners by compressing the rings. Pistons can then be easily tapped into the liners.

VPN: 42444A

OR

VPN: 1420A

4. Set Of Front Cover and Cylinder Cover Assembly and Disassembly Studs

Safely removes or installs cylinder covers against the tension of the safety head springs. Also used as jack screws to force the front cover outward.

Part No. 33461A (Stud) and 1726G (Nut) (KT523)

5. Set of Front Cover Assembly and Disassembly Studs

These are guide rod studs used with the above set of studs to remove the front cover. (Both sets of studs required to remove cover.)

Part No. 33462A (KT524)

6. Cylinder Liner Assembly Tool

A turned hardwood and gasketed block which is placed upon the liner and tapped with a babbitt hammer to ease the liner into the cylinder.

Part No. A33464A (KT525)

7. Flywheel Removal Tool

Bolted to the flywheel and cap screws. As the cap screws are screwed in, the flywheel is forced loose from the tapered end of the crankshaft.

Part No. A33465A (KT526)

8. Cylinder Liner Removal Tool

This tool removes cylinder liners when a 12" lg. Machine bolt is slowly screwed into a flat steel bar.

Part No. A33466A (KT527)

9. Shaft Seal Disasembly Tool

Facilitates simple removal of the inner bellows of the shaft seal.

Part No. 33463A

10. Palnut Socket

A 3/8" square drive socket with a shallow hex head for connecting rod palnut.

Part No. 2040A

11. Oil Pressure Relief Packing Nut Wrench

Part No. A33781A

VMC Compressor Displacement and Connection Pipeline Sizes

Please see Table 3-3 for details.

Table 3-3. Vilter VMC Compressor Displacement and Connections

Model	Number of Cylinders	Displacement at max RPM (CFM)	Compressor Connections (line size - inches)	
			Suction	Discharge
440 Series	2	78	2 1/2" (63.5 mm)	2" (50.8 mm)
	4	155	3" (76.2 mm)	2 1/2" (63.5 mm)
	6	232	4" (101.6 mm)	3" (76.2 mm)
	8	309	4" (101.6 mm)	3" (76.2 mm)
	12	464	5" (127 mm)	(2) 3" (76.2 mm)
	16	619	6" (152.4 mm)	(2) 3" (76.2 mm)
450XL Series	2	99.5	2 1/2" (63.5 mm)	2" (50.8 mm)
	4	199	3" (76.2 mm)	2 1/2" (63.5 mm)
	6	298	4" (101.6 mm)	3" (76.2 mm)
	8	398	4" (101.6 mm)	3" (76.2 mm)
	12	597	5" (127 mm)	(2) 3" (76.2 mm)
	16	796	6" (152.4 mm)	(2) 3" (76.2 mm)

Table 3-4. Vilter VMC Compressor Dimensions and Weights

Model	Number of Cylinders	*Overall Dimensions						**Shipping Weights		
		V-Belt Drive			Direct Drive			Bare Compressor	Unit Weight	
		L	W	H	L	W	H		V-Belt Drive	Direct Drive
400 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
	12	83"	80"	59"	129"	51"	60"	3600	5000	5000
	16	84"	80"	63"	129"	51"	64"	4000	5500	5500

Notes-

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

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

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

Rigging and Lifting of Compressor Unit

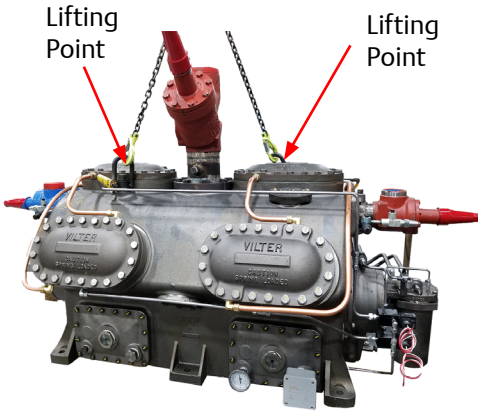
WARNING

When rigging and lifting a compressor unit, use proper lifting device capable of lifting and maneuvering the weight and size of the compressor unit. Use only qualified personnel and additional personnel and lifting equipment (i.e. spreader bar) as required. Failure to comply may result in death, serious injury and/or damage to equipment.

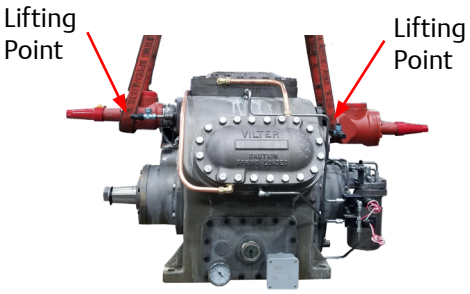
Qualified personnel shall operate rigging and lifting equipment. Ensure that the lifting device is capable of lifting the weight of the bare compressor or compressor unit, refer to Only the supplied Vilter General Assembly (GA) drawing or Table 3-4.

Recommended Tools

- Round Sling, 2 in x 6 ft (12,800 lbs) (Qty. 2 Minimum)
- Round Sling, 2 in x 8 ft (12,800 lbs) (Qty. 2 Minimum)
- Lifting Device capable of lifting weight of compressor



(a) VMC 4512XL Bare Compressor



(b) VMC 456XL Bare Compressor

Lifting

Vilter 8-, 12-, and 16-cylinder compressor frames have a boss built into the housing bored to accept a threaded stud for the use of lifting eye and/or shackle bolts. Vilter strongly encourages the use of these to lift the bare compressors. See Figure 3-1(a).

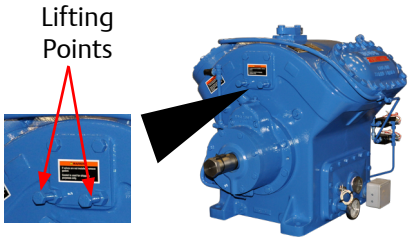
On frames where this option is not available, follow the illustrated method of lifting as below:

For bare compressors, lift from the suction and discharge Valves, See Figure 3-1(b). If no valves are installed, lift from the bolts supplied at those connections, See Figure 3-1(c).

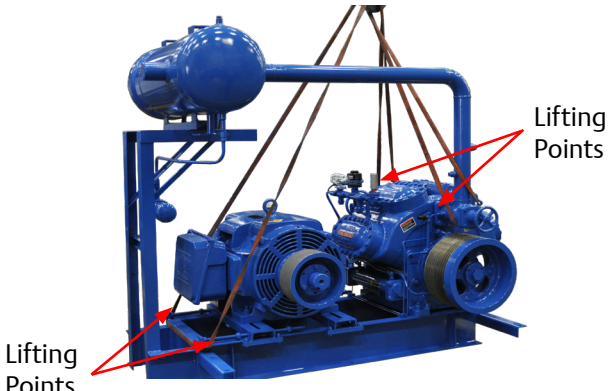
For all compressor units, lift from suction and discharge valves and Bottom of skid, See Figure 3-1(d).

- Ensure that the lifting device is not obstructed by any parts of the compressor unit to prevent damage to components.
- Ensure the sling is not pressed against any corners of the skid.
- Lift slowly, check for proper sling contact and even lift of the compressor.
- Ensure there is plenty of space to maneuver the compressor and a clear path to its location.

Use lifting straps. Lift from skid, suction valve and discharge valve as shown in the image below. Evenly distribute weight so the unit remains level when lifted. Keep lifting straps clear of components to prevent damage.



(c) VMC 444 Bare Compressor



(d) VMC 458XL Compressor Packaged Unit

Figure 3-1. Rigging and Lifting Points

Long Term Storage Recommendations

The procedure described is a general recommendation for long term storage (over one month of no operation) of Vilter compressor units. It is the responsibility of the installation firm and end user to address any unusual conditions. Use the supplied Long Term Storage Log sheet to help with record keeping, see next page.

Refer to document T25116 for more details.

Warranty of the system remains in effect as described on the Terms and Conditions of your order.

Compressor Unit

The following are recommendations regarding long term storage:

- If the unit is designed for indoor duty, it must be stored in a heated building.
- If the unit is designed for outdoor duty and is to be stored outdoors, a canvas tarp is recommended for protection until installation. Adequate drainage should be provided. Place wood blocks under the base skid so that water does not collect inside the base perimeter or low spots in the tarp.
- All compressor stop valves are to be closed to isolate the compressor from the remainder of the system. All other valves, except those venting to atmosphere, are to be open. The unit can be shipped with dry nitrogen holding charge of approximately 5 psi above atmospheric pressure. It is essential that the nitrogen holding charge be maintained.
- The nitrogen or clean dry gas holding charge in the system and compressor are to be monitored on a regular basis for leakage. If not already installed, it is required that a gauge is to be added to help monitor the nitrogen holding charge pressure. If a drop in pressure occurs, the source of leakage must be found and corrected. The system must be evacuated and recharged with dry nitrogen to maintain the package integrity.
- Cover all bare metal surfaces (coupling, flange faces, etc) with rust inhibitor.
- If equipped with a control panel, desiccant is to be placed in the control panel. If the panel is equipped with a space heater, it is to be energized. Use an approved electrical spray-on corrosion inhibitor for panel components (relays, switches, etc).
- All pneumatic controllers and valves (Fisher, Taylor, etc) are to be covered with plastic bags and sealed with desiccant bags inside.

Compressor Motor

The following are general recommendations. Refer to specific motor manufacturer instructions for storage recommendations.

- Remove the condensation drain plugs from those units equipped with them and insert silica-gel into the openings. Insert one-half pound bags of silica-gel (or other desiccant material) into the air inlets and outlets of drip-proof type motors.

NOTE

Bags must remain visible and tagged, so they will be noticed and removed when the unit is prepared for service.

- Cover the motor completely to exclude dirt, dust, moisture, and other foreign materials.
- If the motor can be moved, it is suggested that the entire motor be encased in a strong, transparent plastic bag. Before sealing this bag, a moisture indicator should be attached to the side of the motor and several bags of silica-gel desiccant be placed inside the bag around the motor. When the moisture indicator shows that the desiccant has lost its effectiveness, replace desiccants.
- Whenever the motor cannot be sealed, space heaters must be installed to keep the motor at least 10°F above the ambient temperature.
- Rotate motor and compressor shafts several revolutions (approximately 6) per month to eliminate flat spots on the bearing surfaces. For motors utilizing anti-friction bearings, the shaft should be rotated once every 30 days by hand at 30 RPM for 15 seconds in each direction. Bearings should also be re-lubricated at 2-year intervals using the grease specified on the motor lubrication nameplate.

Long Term Storage Log

Company: _____

Serial Number: _____ Sales Order Number: _____

Name (Please Print): _____ Initial: _____

Date (M/D/Y):

☐	PSIG	Nitrogen Pressure - Current
☐	PSIG	Nitrogen Pressure - Recharged (If pressure is low, identify and fix leak prior to recharging, see Compressor Unit Leak Check procedure in Section 5 of the compressor manual)

Nitrogen Leak Location (Briefly explain nature of leak):

☐ Compressor Shaft (Rotate shafts at least 6 revolutions)

☐ Motor Shaft (Rotate shafts at least 6 revolutions)

☐ Motor Bearings Greased

☐ Bare Metal Surfaces (Check all bare metal surfaces for rust and ensure they are covered with rust inhibitor)

☐ Desiccants (Are desiccants still effective? If not, replace. Check control panel, motor, pneumatic controllers and valves)

☐ Cover Bags/Tarp (Ensure bags and tarps are not torn and are sealed over components correctly, replace if damaged)

☐ Valves (Stop valves are in closed position so the compressor unit is isolated. All other valves, except those venting and draining to atmosphere are to be open)

☐ Space Heater & Panel Components (Ensure space heater is energized and panel components are rust-free)

Name (Please Print): _____ Initial: _____

Date (M/D/Y):

☐	PSIG	Nitrogen Pressure - Current
☐	PSIG	Nitrogen Pressure - Recharged (If pressure is low, identify and fix leak prior to recharging, see Compressor Unit Leak Check procedure in Section 5 of the compressor manual)

Nitrogen Leak Location (Briefly explain nature of leak):

☐ Compressor Shaft (Rotate shafts at least 6 revolutions)

☐ Motor Shaft (Rotate shafts at least 6 revolutions)

☐ Motor Bearings Greased

☐ Bare Metal Surfaces (Check all bare metal surfaces for rust and ensure they are covered with rust inhibitor)

☐ Desiccants (Are desiccants still effective? If not, replace. Check control panel, motor, pneumatic controllers and valves)

☐ Cover Bags/Tarp (Ensure bags and tarps are not torn and are sealed over components correctly, replace if damaged)

☐ Valves (Stop valves are in closed position so the compressor unit is isolated. All other valves, except those venting and draining to atmosphere are to be open)

☐ Space Heater & Panel Components (Ensure space heater is energized and panel components are rust-free)

Clear Form

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 VIlter VMC compressor is installed in a large room that does not have abundant natural ventilation mechanical ventilation is recommended.

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

C. Servicing Space

Provide adequate space around the unit for servicing and maintenance work, see Table 3-4 for overall dimensions. Clearances necessary for removing crankshafts are listed in Table 3-5.

Table 3-5. Crankshaft Removal Clearances

Compressor Size (Cyl. Qty.)	Drive End, IN (MM)	Pump End, IN (MM)
2 thru. 8	30" (762)	22” (559)
12 & 16	60” (1524)	52” (1320)

Foundation

Vilter Reciprocating compressor units are medium to high vibration machines. As such, the foundation has a major influence on mitigating vibration from a reciprocating compressor. A sound foundation maintains motor alignment and proper elevation, and is therefore required. Provided are recommendations for the foundation and anchoring of the compressor unit. The Vilter foundation supports the entire operating weight of the unit and is suitable for years of continuous duty. Included are specifications for concrete, rebar, aggregate, anchors and grout.

Considerations Prior to Starting

Consult professionals, such as building inspectors, structural engineers, geotechnical engineers and/or construction contractors prior to starting. Below are a few points to consider:

Site Characteristics:

- Soil information
- Site drainage
- Wind data
- Seismic zone
- Ingress and egress
- Power and power lines

Site Layout:

- Plant elevations, grading, drainage and erosion
- Accessibility to compressors for service
- Location of surrounding buildings
- Property lines and roadways
- Power
- Fire safety

NOTE

Always check with a safety engineer before proceeding.

Safety:

- Arranging equipment with adequate access space for safe operation and maintenance
- Wherever possible, arrange equipment to be served by crane. If not feasible, consider other handling methods
- Make all valves and devices safely accessible
- Use special bright primary color schemes to differentiate service lines
- Lightning protection for outdoor installations
- Relief valve venting

Foundation Materials

Materials needed to build the foundation are forms, concrete, sand, rebar, wire, grout, anchor bolts, expansion board, and shims. A set of concrete forms will need to be acquired; generally, these can be rented or constructed from dimensional lumber. There should be enough 4,000 psi concrete with one inch aggregate to build the foundation. Also, there should be enough sand to provide a base of compacted sand four inches thick for the foundation to rest on. The rebar required is ASTM 615, grade 60, for sizes see Table 3-6. Wires will also be needed to tie the rebar together. The recommended grout is Masterflow 648CP high performance non-shirk grout to provide at least a 1" thick pad under the entire perimeter of the skid. The recommended anchors are 5/8" Diameter HILTI HAS SS threaded rod for outdoor installations or HAS-E rods for indoor installations. Anchor bolts shall have a three inch projection and 60% of the concrete thickness embedded into the foundation. The required adhesive is HIT-ICE/HIT/HY 150 anchoring system. There should be enough one inch expansion boards to go around the perimeter of the foundation. Finally there should be enough shim stock and extra anchor bolt nuts to level the compressor unit.

Building the Foundation

Use the Vilter General Arrangement (GA) and foundation drawings to help secure a building permit and foundation construction. The Vilter GA drawing will have the necessary dimensions required to determine the overall foundation size and where to locate the compressor unit on the foundation. It will also show the dimensions required to form up the housekeeping piers that the compressor unit rests on. The Vilter foundation drawing lists the necessary information to construct a suitable foundation. It includes the rebar requirements and locations. It also shows anchor bolt locations, grouting and the concrete specifications. Using the Vilter GA drawing, Vilter foundation drawing and the information from site characteristics, site layout and safety studies will provide enough data to allow building the foundation to proceed. As a guide the following table has been provided, see Table 3-6.

The foundation is to be cast and permanently exposed against the earth. Therefore, if constructing on an existing floor, typically indoors, the floor will need to be broken up to get to the earth. If starting from undisturbed soil, it must be also be prepared accordingly. In either case, these are some check points to consider:

- Check the depth of your frost line to ensure the foundation extends below it.
- Ensure the foundation rests entirely on natural rock or on solid earth, but never on a combination of both
- Check the ability of the soil to carry the load
- Check wet season and dry season soil characteristics for static loading limits and elasticity
- Check local codes for Seismic Design requirements

Once the site has been excavated and prepared, place four inches of sand down on the bed where the foundation will rest. The sand must be compacted before placing the forms and rebar. After the sand is compacted, use the Vilter GA drawing to construct the forms for the foundation. With forms in place, install expansion boards on the inside of the forms.

NOTE

If drainage is desired, the foundation can be sloped to allow drainage of oil and water. A pitch of 1/16" or greater per foot should be used to allow proper drainage.

Next, place your rebar in the forms as per the Vilter foundation drawing. When all rebars are in place the concrete can be poured. The concrete must then be trolled level and a surface texture etched in place. Leave the concrete to cure for at least 28 days.

For additional samples of compressor units and foundation dimensions, see Figure 3-3.

Compressor Unit Installation

Once the foundation has cured, the compressor unit can be placed on the foundation. With the appropriate material handling equipment, lift the compressor unit by locations shown on the Vilter GA drawing and slowly place it on the foundation. As per the Vilter GA drawing, ensure the compressor unit is correctly placed on the foundation. Once placed, use the top surface of the compressor base to level the compressor unit. Place shims under the compressor unit as needed, until it is leveled, see Figure 3-2.

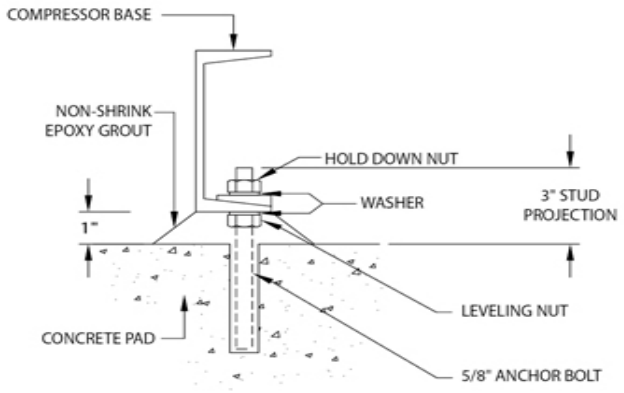


Figure 3-2. Concrete Pad and Compressor Unit Installation Detail

NOTE

If drainage holes are to be created, place 1”x 1”x 2” (LxWxH) blocks halfway between each anchor hole and/or in the direction of drainage flow. These can be knocked out once the grout has been cured. Shim the compressor unit until leveled as necessary.

Select the correct drill bit and drill thru the anchor bolt hole in the compressor base to the depth called for on the Vilter foundation drawing. Finally using the HILTI instructions, put your anchor bolts in place and wait for them to cure. Then place the nuts on the anchor bolts to finger tight and prepare to grout.

Additional concrete can be added into the compressor base for increased vibration dampening. Ensure to fill enough concrete but still allow compressor and motor mounting bolts to be removed if required.

Leveling and Grouting

The unit should be level in all directions. Wet the concrete pad according to the grout manufacturer’s directions. Mix a sufficient amount of grout. The grout must be an expanding grout rather than shrinking to provide a tighter bond. Follow the manufacturer’s recommendations for setting, precautions, mixing, grout placement, finishing and curing.

NOTE

The grout must be worked under all areas of the compressor base with no bubbles or voids.

If the grout is created with an outside chamfer, this will allow oil and water to run off of the base. Once the grout has cured, torque the anchor bolts as per HILTI instructions.

Operation and Performance

The foundation was designed for:

- Outside environment severe exposure
- Ambient temperature -10˚F to 105˚F
- Unit weight 20,000 lbs
- 1800 RPM
- Soil bearing capacity 1,500 lbs/sq.ft.
- Wind speed 120 MPH
- Exposure factor D
- Wind importance factor 1.15
- Concrete poured on and permanently cast against the earth

General Design Requirements

The compressor foundation is designed to:

- Maintain the compressor in alignment and at proper elevation
- Minimize vibration and prevents its transmission to other structures
- Provide a permanently rigid support
- Provide sufficient depth to dampen vibrations

Table 3-6. Foundation and Rebar Specifications

Compressor Unit	Foundation Specifications			Rebar Specifications (ASTM 615, Grade 60)				
	Width	Depth	Length	Rebar Size Long Axis	Rebar Size Short Axis	No. of Layers of Rebar Each Axis	No. of Rebar Long Axis Per Layer	No. of Rebar Short Axis Per Layer
2 & 4 CYL BD	53”	15”	78”	5	5	2	5	5
2 & 4 CYL DD	51”	14”	79”	4	5	2	5	4
6 & 8 CYL BD	57”	19”	86”	5	5	2	5	5
6 & 8 CYL DD	58”	18”	88”	5	6	2	5	5
12 & 16 CYL BD	66”	24”	88”	5	6	2	5	5
12 & 16 CYL DD	60”	19”	124”	4	7	2	7	5

Note: BD = Belt Drive; DD = Direct Drive

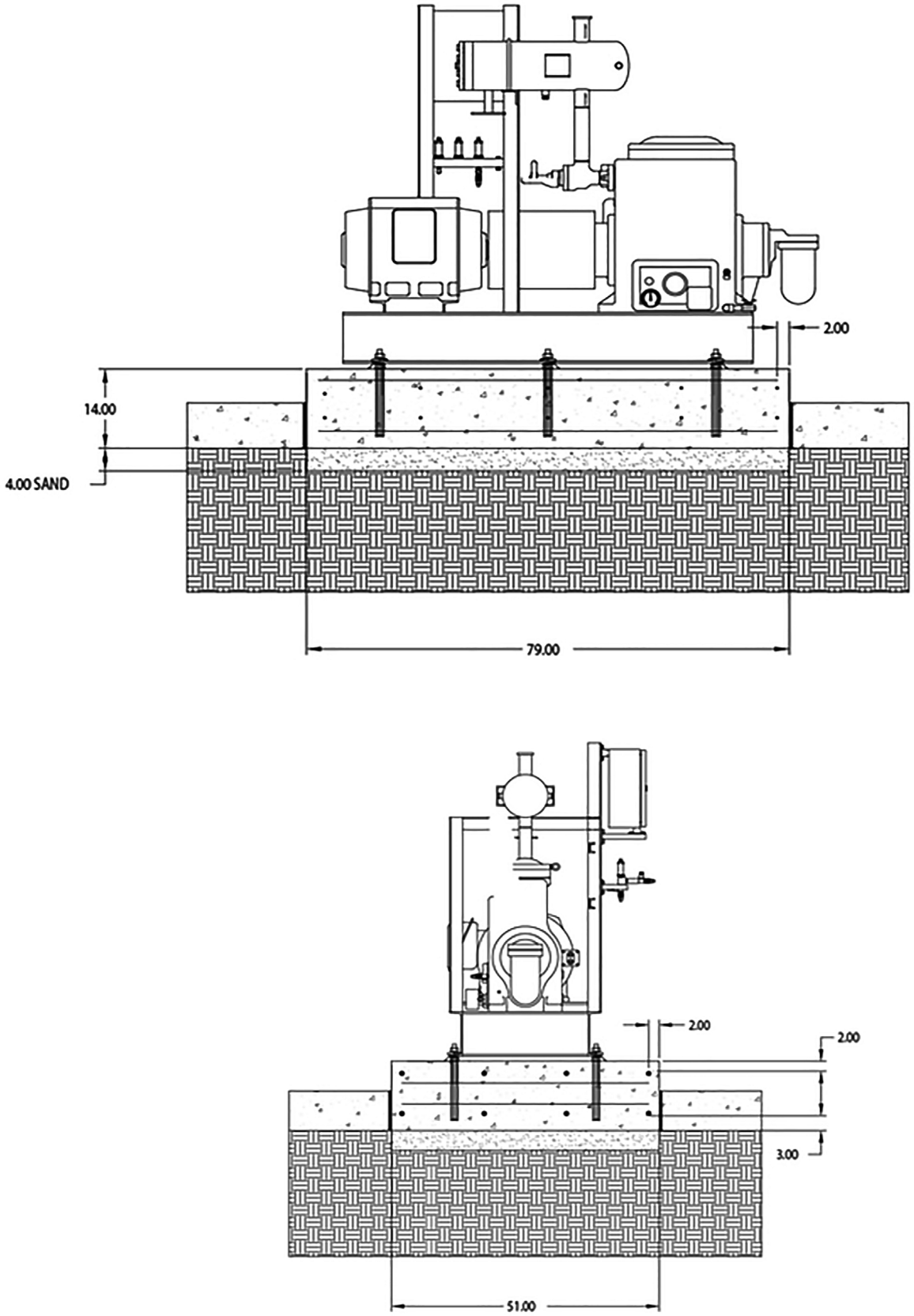


Figure 3-3. Compressor Unit and Foundation Dimensions – 2 Cylinder (1 of 6)

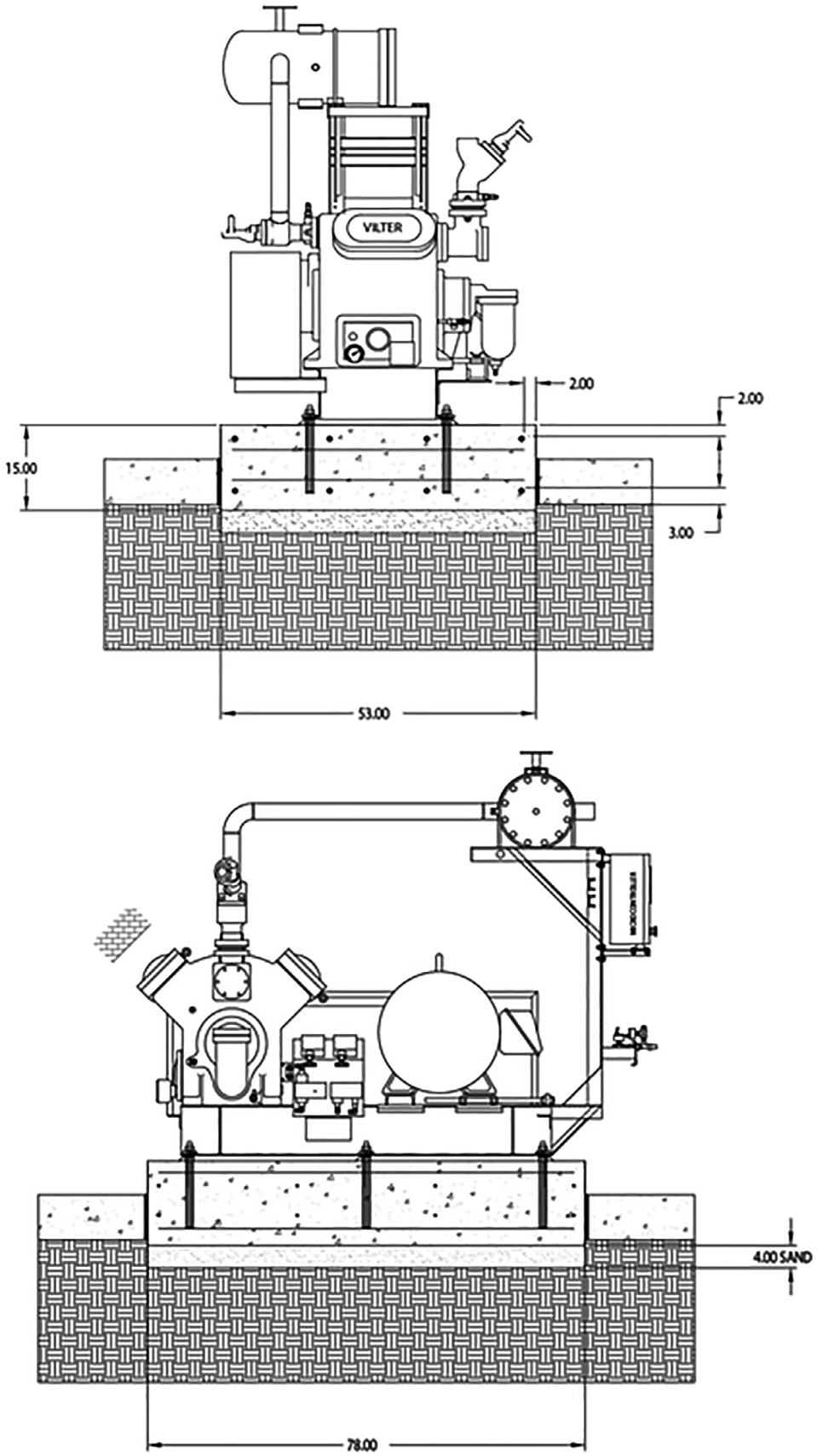


Figure 3-3. Compressor Unit and Foundation Dimensions – 4 Cylinder (2 of 6)

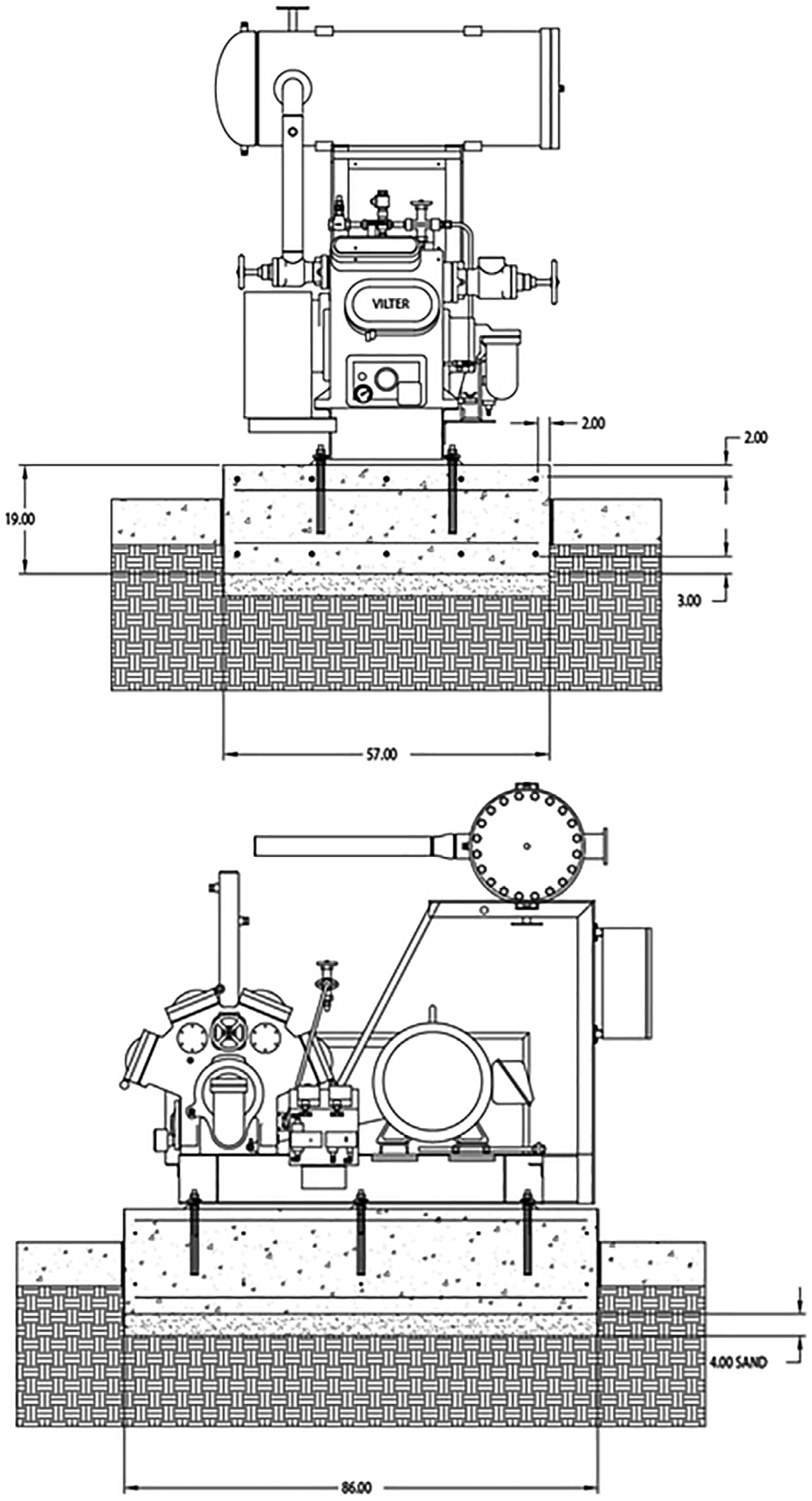


Figure 3-3. Compressor Unit and Foundation Dimensions – 6 and 8 Cylinder (3 of 6)

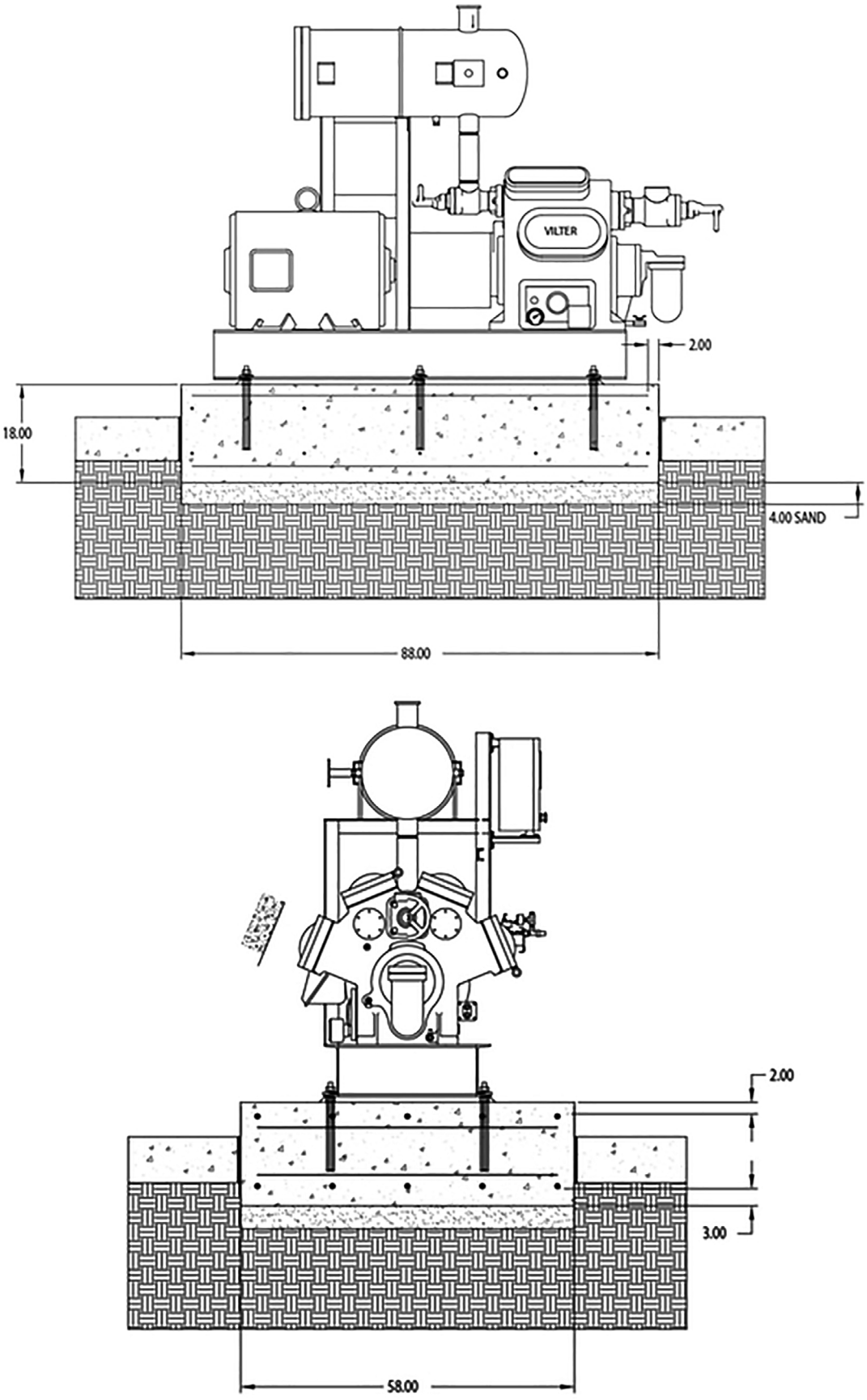


Figure 3-3. Compressor Unit and Foundation Dimensions – 6 and 8 Cylinder (4 of 6)

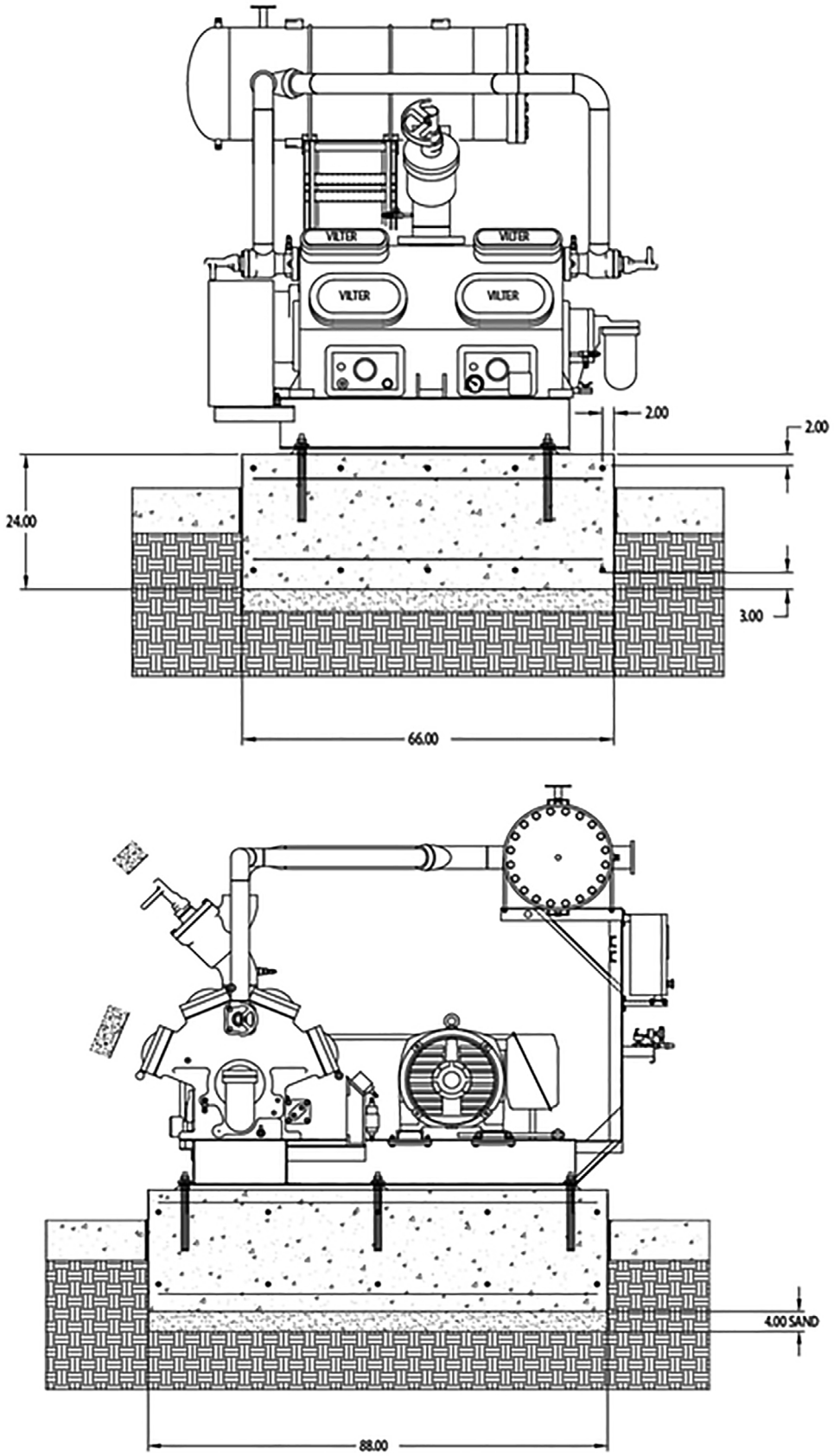


Figure 3-3. Compressor Unit and Foundation Dimensions – 12 and 16 Cylinder (5 of 6)

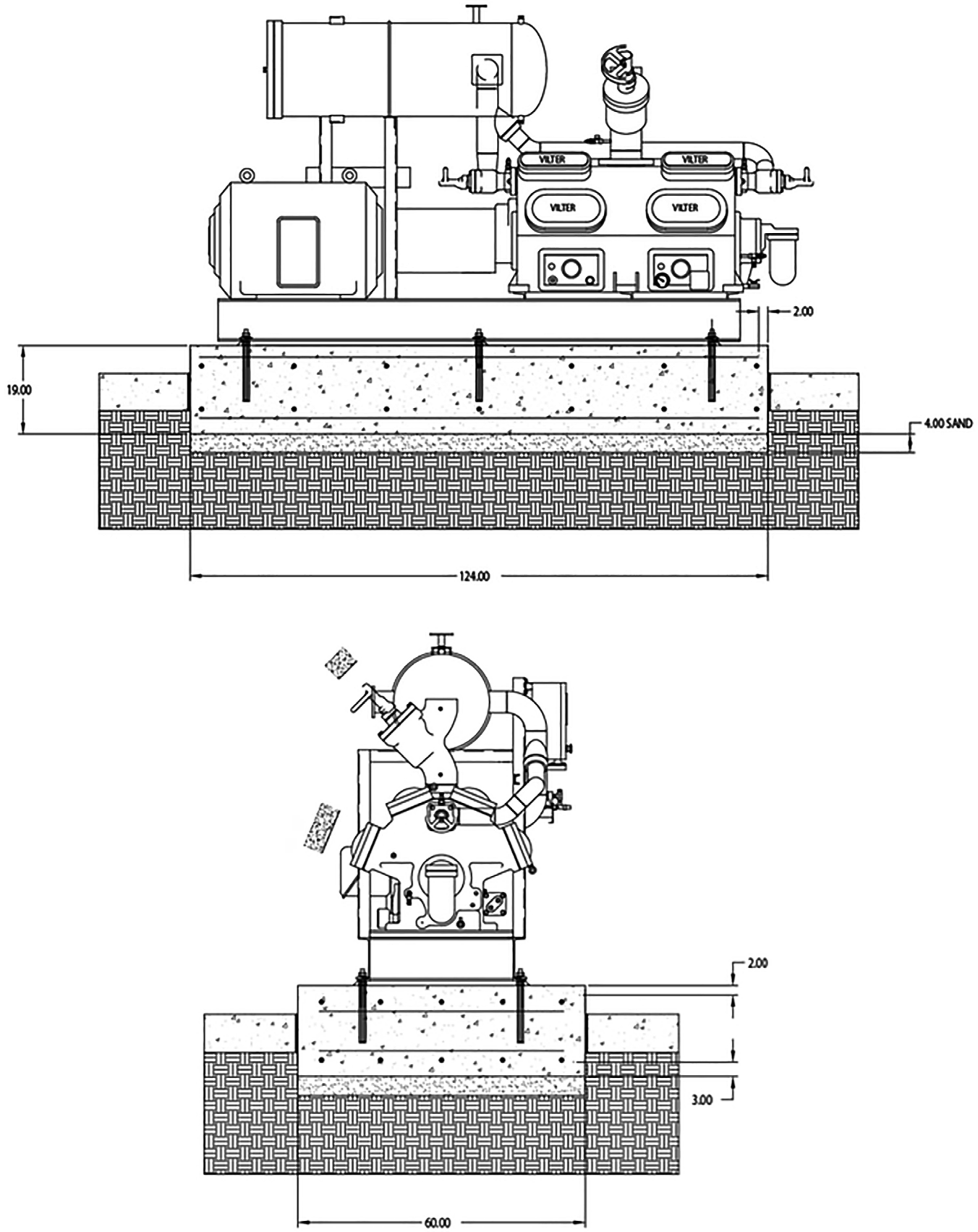


Figure 3-3. Compressor Unit and Foundation Dimensions – 12 and 16 Cylinder (6 of 6)

Ground Floor Installation

Vilter VMC compressors are available with structural steel bases, or the customer may mount units on reinforced concrete foundations.

This installation (see Figure 3-4) is recommended for VMC´s 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.

NOTE

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

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.

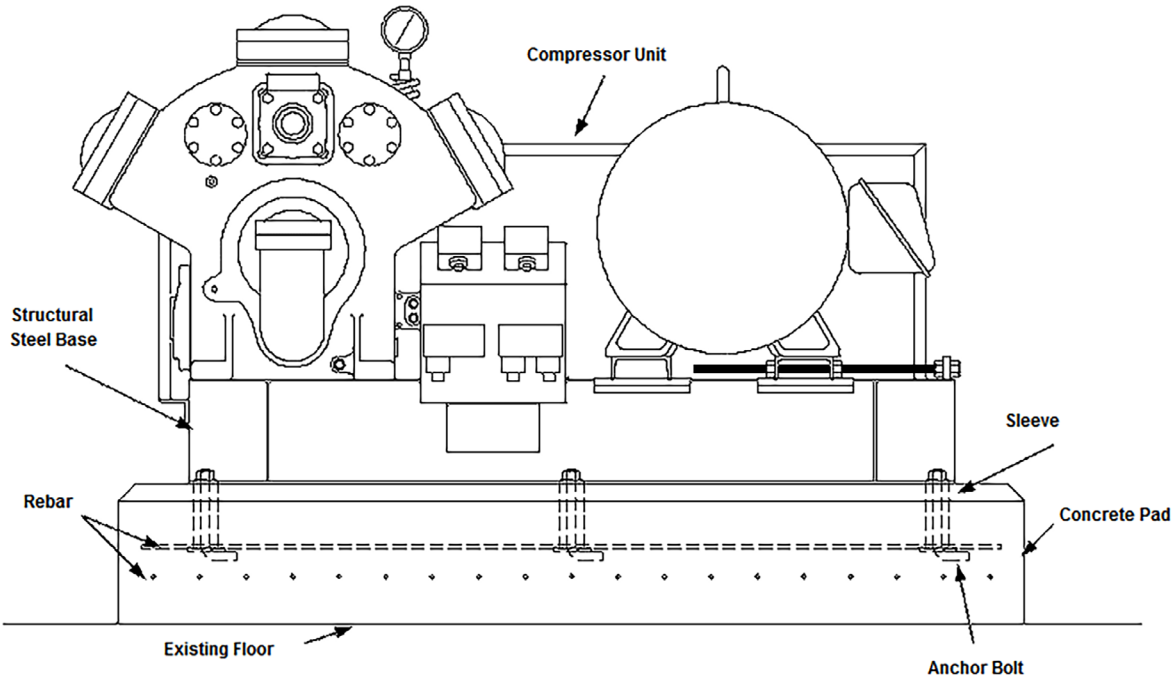


Figure 3-4. Typical Ground Floor Installation (VMC Compressors with Structural Steel Base)

Compressor and Motor Connections

1. Direct Drive

CAUTION

The drive coupling installed on your compressor is NOT completely aligned. DO NOT attempt to run unit until proper motor-coupling-compressor alignment is attained. Misalignment beyond specified limits causes excessive vibrations and premature failure of bearings, coupling and seal. Failure to comply will result in damage to equipment.

The same care in installing and aligning the flexible coupling used on direct connected VMC Compressors should be exercised when installing a rigid flange coupling. To correctly install and align the coupling, see manufacturer's procedures.

The Thomas Coupling Division type number must be known in order to use these aligning instructions. Some couplings are only identified with a Vilter part number. In those cases, use cross reference Table 3-7 to find the corresponding Thomas type number.

See Figure 3-5 for recommended direction of compressor rotation.

2. V-Belt

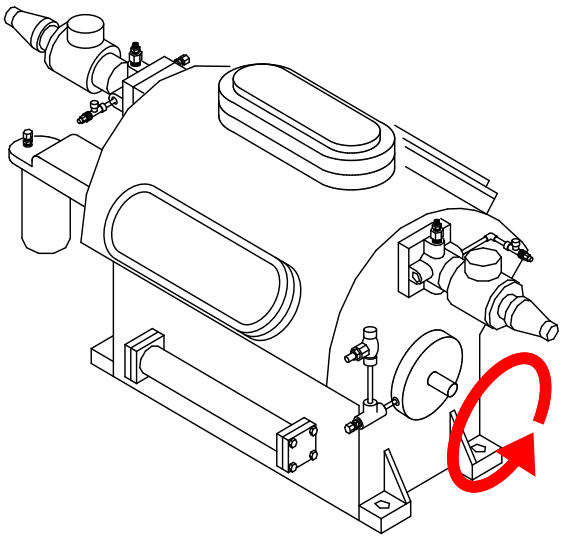
CAUTION

Because equipment alignment could be disrupted during shipment, check drive alignment before start-up. Always follow proper V-belt tensioning procedures. Failure to comply will result in damage to equipment.

Compressor units equipped with "5V" V-belt drives are designed to meet necessary horsepower 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 transmitting 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.

See Figure 3-6 for recommended direction of compressor rotation.



Recommended Compressor Crankshaft Rotation (*Counterclockwise*)

Figure 3-5. Recommended Compressor Crankshaft Rotation (Bare Shaft Compressor)

Table 3-7. Drive Coupling Part Number Reference

Rexnord/ TB Woods Coupling Division Type	Vilter Part Number				
	Taper Bore Hub (Compressor)		Center Member Assembly	Straight Bore Hub (Motor)	
	Bore Dimensions (Large End)	Part Number		Bore Dimensions	Part Number
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 1896P 1896Q 1896R
350 AMR	1.992” / 50.6 mm 2.492” / 63.3 mm 2.992” / 76 mm	1890G 1890H 1890J	1891E	2.125” / 54 mm 2.375” / 60.3 mm 2.875” / 73 mm Pilot 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 3.375” / 85.73 mm Pilot hole	1896W 1896X 1896Y 1896Z

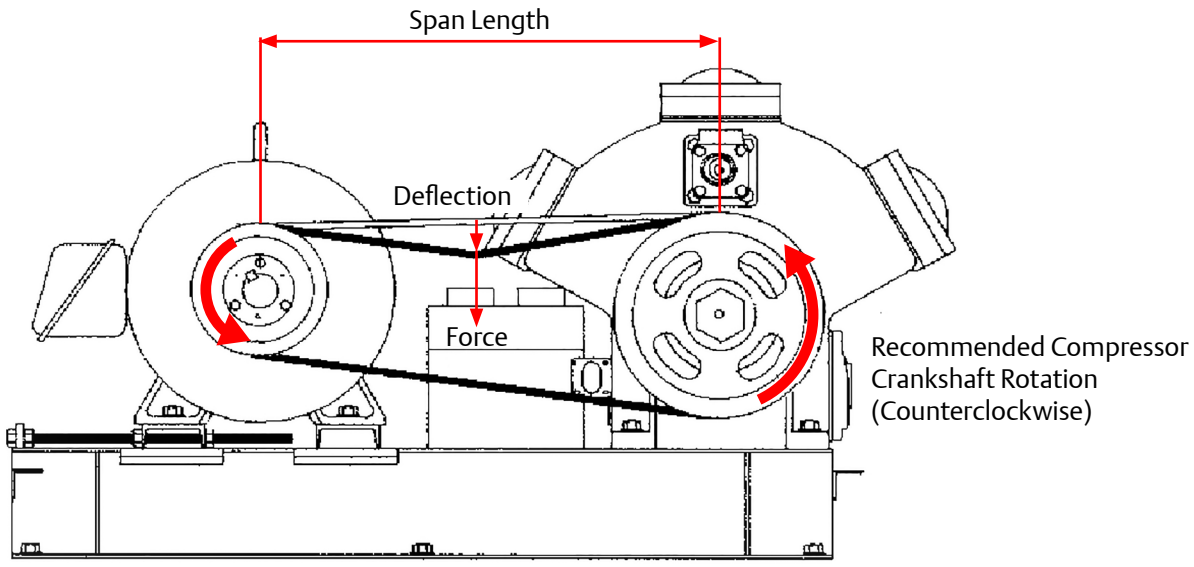


Figure 3-6. Recommended Compressor Crankshaft Rotation (Unit)

V-Belt Initial Installation

CAUTION

Because equipment alignment could be disrupted during shipment, check drive alignment before start-up. Always follow proper V-belt tensioning procedures. Failure to comply will result in damage to equipment.

For belt driven compressors, the motor is mounted on slide rails which allows the motor to move along the rails for tightening and loosening the V-belt.

Moving the Motor

To move motor, loosen four nuts securing motor rails to skid base. Then turn the two adjustment screws to move the motor.

Installation

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 the 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-belts 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 3-7. 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.

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.

Single "5V" 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, re-tension the drive to the high side of the normal required tension.
6. It is recommended that belt tension be checked 24 to 48 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.

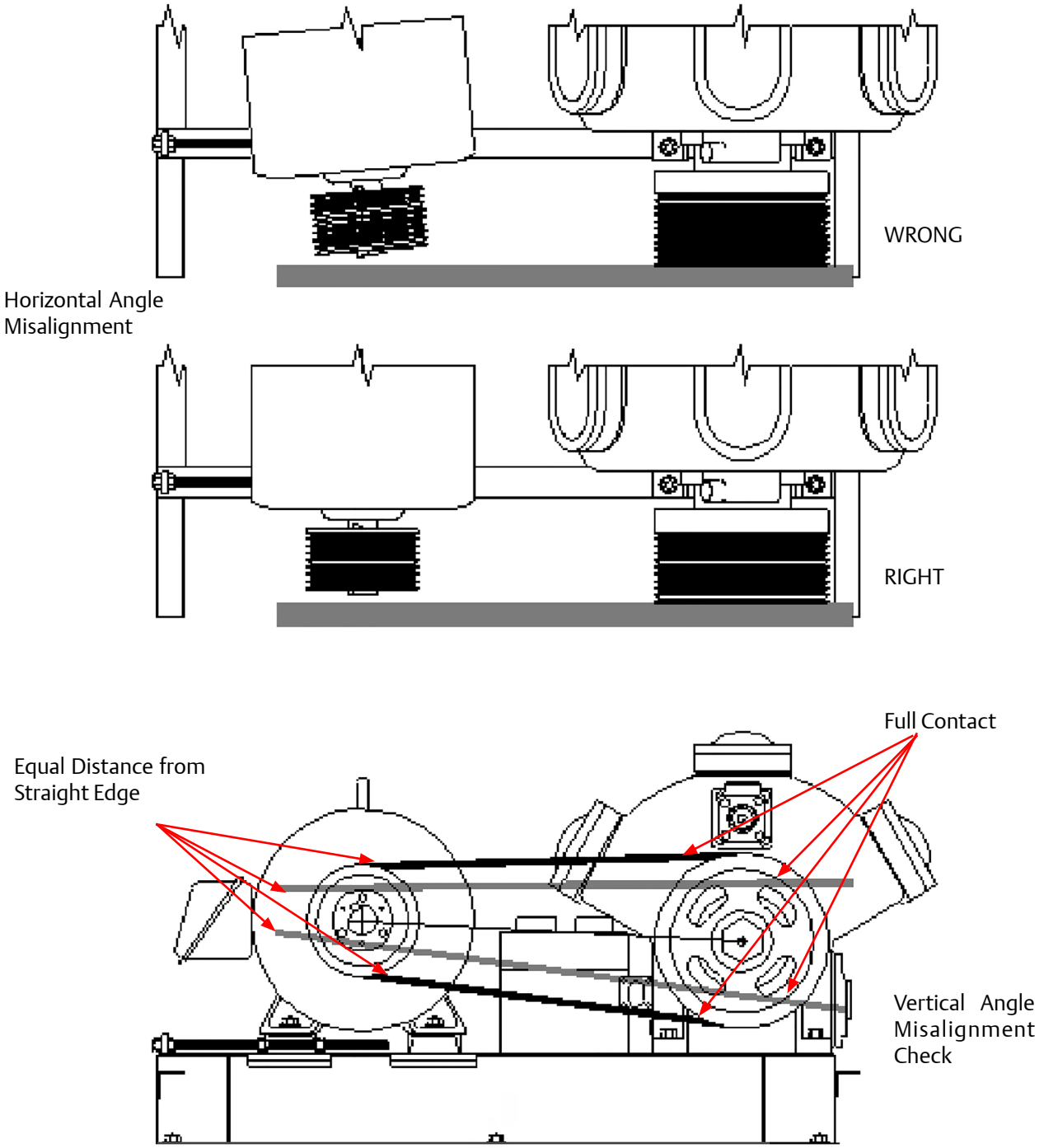


Figure 3-7. Belt Alignment

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.

Banded (Joined) "5V" V-Belt Adjustment

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

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 straight edge across the sheaves to use as a reference for measuring deflections.

Method B

Move the sheaves closer together to facilitate installation of banded V-belts. Remove 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% = 0.8" + 80" = 80.8"

V-Belt Removal for Servicing

Whenever it's 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 re-installed.

Using Non -Vilter Oils

CAUTION

Do not mix oils. Failure to comply may result in damage to equipment.

NOTICE

Vilter does not approve non-Vilter oils for use with Vilter compressors. Use of oils not specified or supplied by Vilter will void the compressor warranty.

Due to the need for adequate lubrication, Vilter recommends only the use of Vilter lubricants, designed specifically for Vilter compressors. Use of oil not specified or supplied by Vilter will void the compressor warranty.

Please contact your local Vilter representative or the Home Office for further information.

Oil Separator

The oil separators for VMC Compressors are either the demister pad standard oil separator or the flanged coalescing element Super Separator™.

Both styles of oil separators are mounted in the compressor discharge line. The standard style oil separator can only be mounted in the horizontal position, see Figure 3-8 for details. The Super Separator style oil separator can be mounted in vertical or horizontal position, see Figure 3-9 for details. For more info, please refer to Appendix M.

NOTE

The separator has an arrow to indicate the direction of flow, to help during installation.

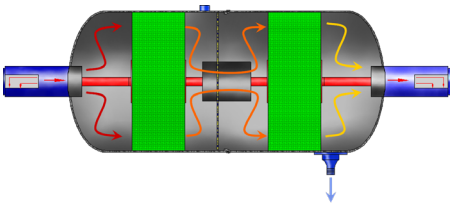


Figure 3-8. Standard Oil Separator

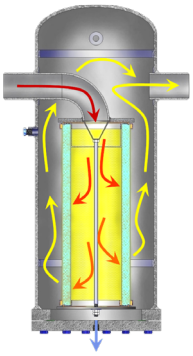


Figure 3-9. Super Oil Separator

The separator and piping should be supported so no piping loads are transmitted through the compressor frame. Please refer to Appendix N for more info on Oil Return Line Piping.

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 systems, low temperature applications, and any other installation where oil return from the low side may not be positive.

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

Oil Separator Float Valve

An external high pressure float valve is used in conjunction with the oil separator, see Figure 3-10 for details. A 1/4" (6.35 mm) line coming from the float valve returns oil to the compressor, see Table 3-8 and Appendix N for more info.

On the 400 series compressors, oil is returned to the crankcase 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 float chamber. The word "TOP" is stamped on the outside of the float valve flange. **Remove the tie wrap on the float valve. This is used to transport the valve.** The float valve must be installed in the float chamber as indicated on the flange. Proper positioning at installation will ensure trouble free operation later.

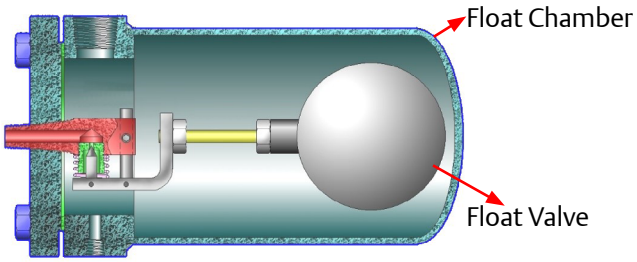


Figure 3-10. Oil Separator Float Valve

Connect the float valve chamber and float 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 float valve chamber. The float valve outlet should be on the horizontal plane.

Table 3-8. Installation Kits for Typical Oil Separator Installation

Item	Description	Installation Kit Part No.
1	External High Pressure Float Valve	KT1018
2	Float Chamber	
3	Inner Flange Gasket	
4	3/8" X 1 1/4" Cap Screws (quantity of 6)	
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	KT1016
8	1/4" Angle Screw End Valve	
9	1/4" O.D. x 1/4" FPT Compression Connector	
10	1/4" O.D x 1/4" MPT Compression Connector	
11	1/4" O.D x 10 ft Steel Tubing (quantity of 2)	
12	1/4" O.D Tubing Clips (quantity of 6)	
13	1/4" O.D x 1/4" O.D Compression Union	

Crankcase Handhole Cover

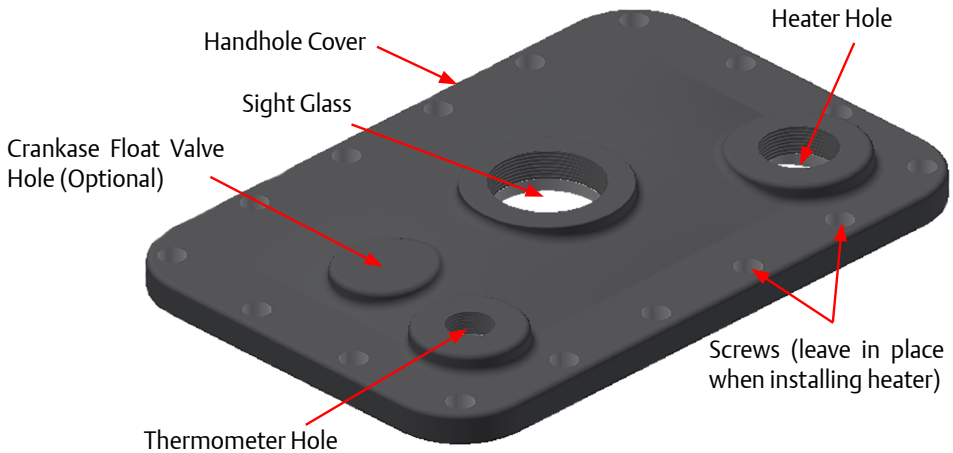


Figure 3-11. Typical Crankcase Handhole Cover - 400 VMC Compressors

Crankcase Heater

Three types of crankcase heaters are available for use with all Vilter VMC Compressors. The first one 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 400 Series VMC Compressors only). These heaters keep the crankcase and oil warm during the "off" cycle, preventing refrigerant from condensing. Figure 3-11 shows a typical crankcase handhole cover for a 400 VMC Compressor.

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.

NOTE

It is extremely important the heater be energized when the compressor is not operating, for compressors having a TRI-MICRO™ filter without internal bypass. The heater is equipped with a non-adjustable internal thermostat set at 100 °F (37.8°C).

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.**

Oil Cooler

Multipass shell and tube oil coolers are furnished on many VMC 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.

Figure 3-12 shows a diagram of a shell and tube oil cooler, and Table 3-9 has the dimensions according to number of cylinders.

NOTE

Water circuit through oil cooler and water cooled heads is in parallel. See the Operation Section.

Installation

- Strainers and Filter: Vilter recommends the use of strainers when foreign matter is present in the water. Certain types of service require suitable filters to maintain standard efficiency.
- Piping Layouts: All water piping leading into the oil cooler should be of sufficient size to assure an adequate supply of water.

Table 3-9. Standard Oil Cooler Application

Number of Cylinders (400 Series)	Oil Cooler Nominal Overall Dimensions	
	A	B
2 to 16	---	20" (508 mm)

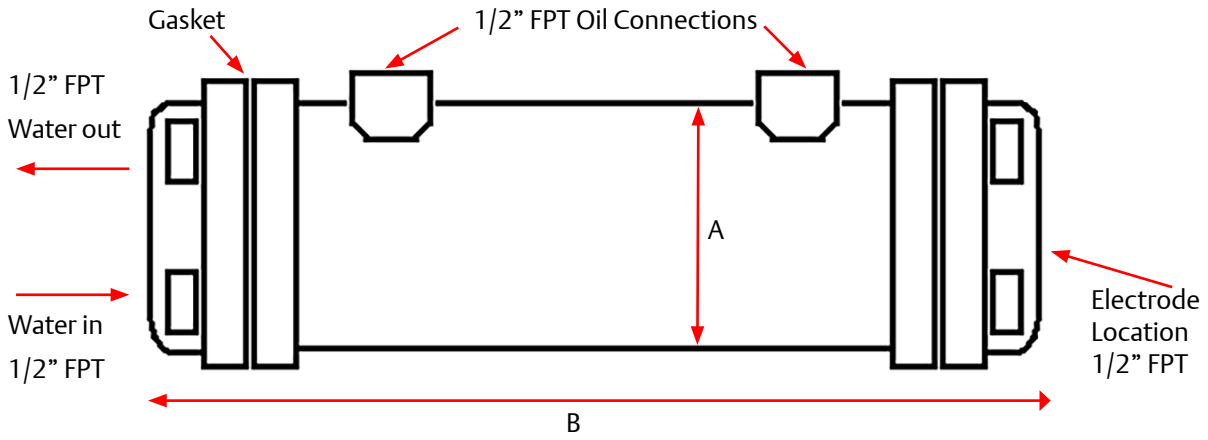


Figure 3-12. Shell and Tube Oil Cooler

Table 3-10. Compressor Cooling Water Flow Rates

Compressor Size	Maximum				Minimum			
	GPM		Pressure Drop		GPM		Pressure Drop	
2 Cylinders	4	(0.25 l/sec)	2.5 psi	(17.2 KPa)	2 1/2	(0.16 l/sec)	1.3 psi	(9 KPa)
4 Cylinders	4	(0.25 l/sec)	5 psi	(34.5 KPa)	2 1/2	(0.16 l/sec)	2.5 psi	(17.2 KPa)
6 Cylinders	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 Cylinders	4	(0.25 l/sec)	10 psi	(68.9 KPa)	2 1/2	(0.16 l/sec)	6 psi	(34.5 KPa)
12 Cylinders	8	(0.50 l/sec)	7.5 psi	(51.7 KPa)	5	(0.32 l/sec)	3.8 psi	(26.2 KPa)
16 Cylinders	8	(0.50 l/sec)	10 psi	(68.9 KPa)	5	(0.32 l/sec)	5.0 psi	(3.8 KPa)

- 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.
- Prevention of Gasket Leaks: Check all bolts for tightness before installing any oil cooler. Use caution when tightening bolts to prevent gasket surface damage.
- Operating Pressure: All Vilter shell and tube oil coolers are designed for 300 psig (2068.44 kPa) on both the oil and water sides.
- 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 Vilter has no control over field conditions of cooling water, Vilter cannot assume liability for damage to the compressor or the system due to problems arising from corrosion, scaling or fouling.

Refer to Section 5 for Oil Cooler servicing.

Water Cooled Cylinder Covers

Water cooled cylinder covers are furnished for some models of Vilter VMC 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 the covers and causing early fouling. When-water is 80°F (26.7°C) or lower, the recommended quantity is 2½ 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 3-10 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 ½" (12.7 mm) thermostatic water regulating valve should be provided in the inlet to control water flow and connect the outlet to an open drain or condenser sump.

A provision should be made to shut off the water when the machine is stopped. The most positive way is to connect a solenoid water 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°F (37.8°C) off cylinder covers.

CAUTION

To avoid condensation of refrigerant in the compressor, turn off water flow through the heads during compressor shutdown. Failure to comply will result in damage to equipment.

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.

Table 3-11. Vilter Part Numbers for Oil Drums and Pumps

Refrigerant	R-22 (HCFC)	R-134a (HFC)	R-404a (HFC)	R-290 (HC)	R-507 (HFC)	R-717 (NH3)
Oil 5 GAL VPN	3100A	3106C	3106C	3098A	3106C	2939A
OIL 55 GAL VPN	3100B	3106D	3106D	3098B	3106D	2939B

Pump	VPN
Manual Oil Pump	KT009
Motor Driven Oil Pump	A40849A
Motor Driven Explosion Proof Oil Pump	A40849C

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.

Table 3-12. Compressor Crankcase Oil Charge

Number of Cylinders	OIL CHARGE (GALLONS) 400 SERIES COMPRESSOR
2	5
4	7
6	7
8	7
12	14
16	14

Compressor Oil Charging

WARNING

Avoid skin contact with oil. Wear rubber gloves and a face shield when working with oil. Failure to comply may result in serious injury or death.

CAUTION

Do not put oil under vacuum. Use an oil pump to charge oil.

NOTICE

Failure to follow these instructions will result in bearing damage and compressor seizing and will void any and all warranties that may apply.

Vilter has made available three models of oil charging pumps: manual, motor-driven, and explosion proof motor-driven (see Table 3-11). All these pumps can be used to put the original oil charge into the compressor crankcase as well as charging oil later during service operations. Using any of these pumps eliminates the need to provide a vacuum on the compressor to charge oil into it.

Both the hand operated Vilter oil pump and the Vilter motor-driven pumps attach quickly and easily to a 5 gallon container. Once connected to the container, it can be left alone until it is empty.

The Vilter motor-driven pump clamps to the top of the can with the dip tube extending down into the can. Once the motor-driven oil pump has been mounted on the top of the can, the can and oil pump may be moved around as a single assembly by the carrying handles on top of the motor driven oil pump. This too, can be left alone until the can is empty.

All oil pumps are equipped with a length of hose with a female half of a quick connector mounted on it. The female half is easily and quickly snapped onto the male half of the connector, which is attached to the oil charging valve on the compressor crankcase.

If more than one compressor is used, the recommendation would be to purchase extra male halves of the quick connectors, and install them on each machine. This makes it easy to connect either of the two pumps to the oil charging valve and charge the required amounts of oil into the compressor crankcase.

Initial Compressor Oil Charging

You can follow these charging steps with any of the pumps:

1. Attach the female half of the connector to the male half.
2. Open the oil charging valve to the compressor crankcase.
   - In the case of the hand-operated oil pump, operate the pump manually until such time as sufficient oil is pumped into the crankcase. Using the hand operated oil pump, approximately 8 full strokes are needed to force 1 pint of oil into the crankcase.
   - In case you are using the Vilter motor-driven oil pumps, after the two halves of the quick connector are connected, and the oil charging valve is opened, turn on the Oil pump motor with the switch and allow it to operate until sufficient oil has been pumped into the compressor.
3. After charging oil with any of the oil pumps, the charging valve on the compressor would be closed to relieve pressure on the oil pump check valve and quick connector. With the Vilter motor-driven oil pump, take care not to operate the pump unless the oil charging valve on the crankcase is open.

If a motor driven oil pump is allowed to operate with this valve closed, enough pressure might build up to rupture the pumping hose or cause damage to the pump. The pump motor is protected by means of an automatic cut-out switch mounted in the motor. However, do not allow the motor to cycle repeatedly on this cut-out device or damage to the motor will result. For the correct oil charge for your compressor, see Table 3-12.

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 VMC Compressors)

NOTE

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

Electrical Equipment and Recommendations

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 or 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, according to local electrical code. These flexible connections permit the device removal with no difficulty. Locate these devices with sufficient head room to permit removal from the piping lines.

The wiring diagram shown in this manual is only a typical schematic. It is necessary for the electrical contractor to make additions as required for construction purposes when meeting local code requirements.

Testing Refrigeration System for Leaks

CAUTION

Do not hydro test compressor unit. Failure to comply may result in damage to equipment.

CAUTION

The compressor unit along with other system units contain many components with various pressure ratings. Pressure relief protection provided considers the design pressure of a system components. Before replacing a pressure relief valve with a relief valve having a higher pressure setting, all system components must be evaluated for acceptability.

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

Vilter equipment is factory tested for leaks. After the equipment is leak-free, the unit is charged slightly above atmospheric pressure with a holding charge of nitrogen upon request. 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 on 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 pressures for various refrigerants are listed in ASHRAE Standard 15 Code brochure entitled "Safety Code For Mechanical Refrigeration". 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.

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. Adjust the pressure regulator on the bottle to prevent over-pressurization. Do not exceed the pressure rating on the vessel with the lowest pressure rating.

Carbon Dioxide should **NOT** be used as a testing gas in a system where 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 strainer.

A mixture of four parts water to one part liquid soap, with a few drops of glycerin added, makes a good 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 so the gas will float away from the compressor. This prevents any dirt or foreign particles from entering the compressor and contaminating the working parts. The oil should then be charged into the compressor.

Charge a small amount of ammonia into the system and pressurize the system to its respective design pressure. 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.

Other Refrigerant Systems

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

When the proper pressure is attained, test for leaks with the soap mixture previously described. After all leaks are found and marked, relieve the system pressure and repair the leaks. Never attempt to repair soldered or welded joints while the system is under pressure. Soldered joints should be opened and re soldered.

Do not simply add more solder to the leaking joint. After all the joints have been repaired and the system is considered "tight" the system may be tested with refrigerant. Attach a drum of the refrigerant to be used in the system and allow the gas to enter until a pressure of 5 psig is reached.

Remove the refrigerant drum and bring the pressure to the recommended test level with dry nitrogen or CO_2. Then check the entire system again for leaks, using a halide torch or electronic leak detector. Be sure to check all flanged, welded, screwed and soldered joints, all gasketed joints, and all parting lines on castings. If any leaks are found, they must be repaired and rechecked before the system can be considered tight again, remembering that no repair should be made to welded or soldered joins while the system is under pressure.

Evacuating the System

CAUTION

Insure that a proper leak test has been completed before starting an evacuation.

A refrigeration system operates best when only refrigerant is present. Steps must be taken to remove all air, water, vapor, and all other non-condensables 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 that corrode internal parts of the system.

To properly evacuate the system, and to remove all non-condensables, air and water vapor, use a high vacuum pump 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 somewhere below 1000 microns. Evacuation should not be done unless the room temperature is 60 °F 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 conjunction with the high vacuum pump. The reading from the gauge(s) indicates when the system has reached the low 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-condensable, air and water vapor. 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 by bringing the system pressure up to 0 psig with dry nitrogen.

To begin the second evacuation, allow the pump to operate and reduce the pressure again to within 500 to 1000 microns. After this reading is reached, allow the pump to operate 2 or 3 hours. Stop the pump and let the system stand with this vacuum. Again using 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 the 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. Vacuum the system once more below the 1000 micron level and charge using the refrigerant designed for the system.

When properly evacuating the system as outlined above, the system is dry, oxygen-free and free of non-condensables. The piping should not be insulated before the evacuation process is started. If moisture is in the system before evacuating, it condenses in low places and freezes. 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 vapor collects in the next trap towards the vacuum pump. This process should be repeated until all pockets of water have been boiled off, and the vacuum pump has had a chance to remove all the water vapor from the system.

System Refrigerant Charging

After the system is leak-free and evacuation has been completed, the entire operation of the refrigeration system should be inspected before charging.

A. Low Side Equipment

4. Fans on air handling equipment running.
5. Pumps on water cooling equipment running.
6. Proper location and attachment of thermostatic expansion valve bulb to suction line.
7. Correct fan and pump rotation.
8. Evaporator pressure regulators and solenoid valves open.
9. Water pumps and motors correctly aligned.
10. Belt drives correctly aligned and tensioned.
11. Proper voltage to motors.

B. Compressors

1. Proper oil level.
2. Voltage agrees with motor characteristics.
3. Properly sized motor fuses and heaters.
4. Direct drivers aligned and couplings tight.
5. All suction and discharge valves open.
6. All transducers and RTDs calibrated and reading correctly.

C. Condensers

1. Water available at water cooled condensers and supply line valve open.
2. Water in receiver of evaporative condenser and makeup water available.
3. Correct rotation of pump and fan motors.
4. Belt drives aligned and tensioned correctly.
5. Pump, fans and motors lubricated.

D. Controls

Controls should be at the initial set points. See microprocessor manual for further information.

Initial High Side Charging - Initial Charging

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

CAUTION

Ensure compressor unit has been charged with the correct amount of oil prior to initial refrigerant charging. Failure to comply may result in damage to equipment.

CAUTION

Do not apply flame or steam directly to drum, as this can produce dangerously high pressures inside drum. Failure to comply may result in damage to equipment.

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 as filling of the system is much faster. Low side charging is usually reserved for adding only small amounts of refrigerant after the system is in operation.

High side charging of refrigerant into the system is accomplished as follows:

1. Connect a full drum of refrigerant to the liquid charging valve. This valve is generally located in the liquid line immediately after the king or liquid line valve. Purge the air from the charging line.
2. Invert the refrigerant drum if the drum is not equipped with “Liquid” and “Vapor” valves, and place in such a position so the liquid refrigerant only can enter the system. Close the liquid line or king valve, if it is not already closed. Open the “Liquid” charging valve slowly to allow refrigerant to enter the system. The vacuum in the system will draw in the refrigerant.
3. It is important that during this operation air handling units be running and water is circulating through the chillers. The low pressures on the system can cause the refrigerant to boil at 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 would be desirable to charge the initial amount of refrigerant without water in the shell and tube equipment to eliminate the possibility of freeze up.
4. After some refrigerant has entered the system, the compressor unit starting procedure may be followed, see Starting procedure in Section 4.
5. Continue charging refrigerant into the system until the proper operating requirements are satisfied. Then, close the liquid charging connection and open the liquid line valve allowing the system to operate normally. To check that enough refrigerant has been added, the liquid sight glass should show no bubbles, and there will be a liquid seal in the receiver. If these two conditions are not satisfied, additional refrigerant must be added.
6. When sufficient refrigerant has been charged into the system, close the charging and drum valves. Then remove the drum from the system.
7. During the charging period, observe the gauge carefully to insure no operating difficulties. Watch head pressures closely to make sure the condensers are functioning properly.

8. Since it is usually necessary to use several drums when charging a system, follow the procedures in steps 1 and 2 when attaching a new drum. After charging, the refrigerant drums should be kept nearby for several days as it is sometimes necessary to add more refrigerant as the system settles down.

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:

1. 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.
2. 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

Do not apply flame or steam directly to drum, as this can produce dangerously high pressures inside drum. Failure to comply may result in damage to equipment.

3. 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.

The Initial Start

WARNING

Only qualified personnel shall install, start, operate and maintain the equipment. Failure to comply may cause damage to the workers and the system.

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

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 the 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.

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 (detailed in Section 3) is followed. If the procedure is followed, compressor start-up should consider the following points:

- Its essential for the compressor to 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.

Table 4-1 shows the net oil pressure values to provide quick response from the compressor unloader mechanism, once the compressor is running.

NOTE

Net oil pressure is calculated by subtracting the compressor suction pressure from the oil pressure indicator reading while the compressor is running. The pressure is regulated by turning the adjusting valve stem. See Table 4-1 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 4-1. Pressure Adjusting Valve Locations and Net Oil Pressures

Compressor Model	Valve Location	Relief Valve Net Oil Pressure	Hold Net Oil Pressure
400 Series	Front Bearing Housing (Drive-Seal End)	45 psi (310.27 kPa)	Between 45 psi (310.27 kPa) and 50 psi (344.74 kPa)

CAUTION

When the compressor has completed 24 hours of operation, remove and inspect the suction strainer bag, which is placed to catch any foreign material present in the system at start-up. If, when the inspection of the removed bag shows an unusual amount of dirt, install a new bag. After another 24 hour period, remove and inspect the bag again. 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 piping, 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.

CAUTION

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.

VMC Compressor Operation

Combination Unloader and Capacity Control

Vilter Multi-Cylinder Compressors (VMC) 400 Series cylinder unloaders are supplied as oil actuated. Oil actuation is standard on all high stage compressors with 100% internal capacity reduction, all booster compressors.

Automatic Controls

If equipped with a VILTech or MicroVission control panels, their main function is to control the refrigeration system from the data that they receive from the sensors around the unit. Typically, these Vilter control panel are installed on reciprocating compressor packages. For additional information, refer to VILTech operating manual (35391VT) or MicroVission operating manual (35391MV).

1. Dual Pressure Switch

All VMC 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 manufacturer's instruction sheets for further information.

2. Oil Pressure Failure Switch

A standard feature on each Vilter VMC Compressor (except those controlled through a microprocessor) is an oil failure switch that measures usable pressure available for lubrication. If, or when, the oil pressure drops below the prescribed levels, the pressure switch automatically shuts down the compressor. Usable 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 pre-vent 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.

3. High Pressure Switch

All booster compressors, models 2 through 8 cylinders are equipped with one high pressure switch. Twelve and sixteen cylinder machines have two switches because of the double dis-charge arrangement. 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.

On the twelve and sixteen cylinder high stage machines, a single high pressure switch is used for the second discharge. The high pressure side of the dual pressure switch is connected to the other discharge. The high pressure switch has the same manual reset feature as the high pressure side of the dual pressure switch. Refer to the manufacturer's instructions located in this manual.

4. Capacity Control

This control operates the unloaders and has a single pole double throw action. A rise in pressure will signal an increase in capacity. The unloader control opens the contacts from red to blue colored terminals and closes the contacts from red to white colored terminals. This

de-energizes the unloader solenoid valve and loads the compressor. The opposite action occurs when the pressure drops.

The differential of the control is fixed at approximately 2.5 psi (17.24 kPa) and is not adjustable. Set the control to close the contacts from red to white at the desired capacity control cut-in pressure. Once the single pointer is set at the correct pressure setting, the differential is subtracted from this setting. The resulting value is the point at which the contacts close from red to blue.

Warm Start Protection System

CAUTION

Do not start a VMC Compressor equipped with a warm start protection system when the lubrication oil is cold and viscous. Any attempt will result in extreme oil pressure build-up and severe pump damage. Failure to comply will result in damage to equipment.

General Description

Some Vilter VMC Compressors incorporate an optional "warm start" oil protection system.

Any effort to start a VMC 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, make sure the oil temperature has reached 100°F (37.8°C). 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.

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.

Setting the Capacity Reduction Control

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 and 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.

1. Single Compressor System

NOTE

Pressures shown below are for example purposes only. Pressure ranges and operating pressures must be based on actual system parameters.

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

A 30°F (-1.1°C) room with varying loads is maintained by a 6-cylinder VMC Compressor (three cylinder banks, one bank without capacity reduction).

- Unloader control 'A' should be set to cut-out at 20 psig (137.9 kPa)
- Control 'B' at 19 psig (131.00 kPa)
- Low pressure action of the dual pressure section of the dual pressure switch should be set at 18 psig (124.11 kPa).

These switches operate with a differential of 6 to 50 psig (41.37 to 344.74 kPa). The range and operation are shown in Table 4-2.

When the compressor is started, balanced pressures exist between the high side and low side, and the two banks of cylinders are unloaded. It is assumed the compressor has been shut down a sufficient length of time for the pressure to equalize. After a short period, the pressure differential should be sufficient to operate the capacity reduction mechanism and the two banks of cylinders are loaded.

- As suction pressure decreases to 20 psig (137.9 kPa) with a drop off of the load, control 'A' energizes a solenoid valve, and unloads the cylinder bank.
- As suction pressure decreases to 19 psig (131.00 kPa), control 'B' energizes a solenoid and unloads the cylinder bank.
- If the load decreases and the suction pressure drops to 18 psig (124.11 kPa), the low pressure switch will enable and shut down the compressor.

- When suction pressure increases to 23 psig (158.58 kPa), the compressor starts and one cylinder bank operates fully loaded (bank without capacity reduction). The two remaining cylinder banks are unloaded.
- If the load increases suction pressure to 24 psig (165.48 kPa), control 'B' will operate and load a cylinder bank. An increase in suction pressure to 25 psig (172.37 kPa) loads the remaining cylinder bank. At this point, the compressor is operating at full capacity.

The preceding example describes a rapidly fluctuating load. In the case of loads that remain constant for long durations, the compressor could operate with one bank of cylinders cycling between loaded and unloaded position.

2. Dual Compressor System

NOTE

Pressures shown below are for example purposes only. Pressure ranges and operating pressures must be based on actual system parameters.

When two VMC Compressors operate on one load, Vilter recommends both machines operate together.

- Port (P) to (B) open when valve is de-energized.
- Port (P) to (A) open when valve is energized.

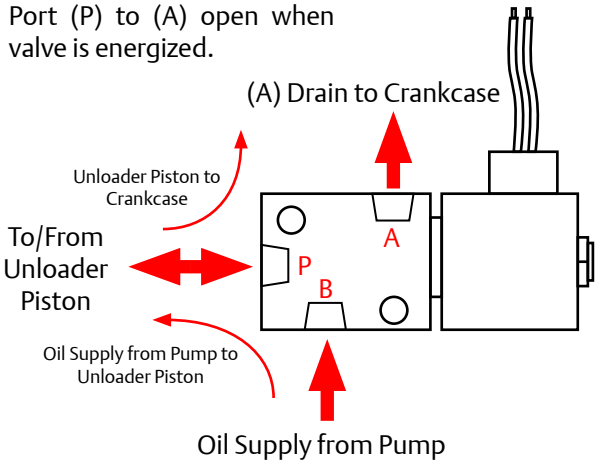


Figure 4-1. Typical Oil Unloading Solenoid Valve

As an example, two 6-cylinder VMC Compressors are running automatically on widely varying loads. Set the switches and controls as shown in Table 4-3.

- Assume the compressors have shut down because the suction pressure has dropped to its cut-out setpoint.
- When suction pressure increases to 20 psig (137.9 kPa), the low pressure switch starts compressor 2. One bank is loaded. The two remaining cylinder banks are unloaded.
- When pressure rises to 21 psig (144.79 kPa), compressor 1 starts with two cylinder banks unloaded.
- With an increase in suction pressure to 22 psig (151.69 kPa), control 'D' of compressor 2 loads a cylinder bank.
- A rise to 23 psig (158.58 kPa) loads bank 2 of compressor 1.
- As pressure rises to 24 psig (165.48 kPa), bank 1 of compressor 1 loads. At this point, both compressors are operating at full capacity.

A load decrease reduces the capacity of each compressor inversely:

- Bank 1, compressor 1 unloads at 20 psig (137.9 kPa)
- Bank 1, compressor 2 unloads at 19 psig (131.00 kPa)
- Bank 2, compressor 1 at 18 psig (124.11 kPa)
- Bank 2, compressor 2 at 27 psig (186.16 kPa)
- If suction pressure drops below 16 psig (110.32 kPa), compressor 1 shuts down.
- If suction pressure drops below 15 psig (103.42 kPa), compressor 2 shuts down.

Table 4-2. Single Compressor Range and Operation

Controls	Setpoints	Operation
Dual Pressure Switch	23 psig (158.58 kPa)	Compressor Starts
Low Pressure Switch	18 psig (124.11 kPa)	Compressor Stops
Control 'B'	24 psig (165.48 kPa)	Loaded
One Bank of Cylinders	19 psig (131.00 kPa)	Unloaded
Control 'A'	25 psig (172.37 kPa)	Loaded
One Bank of Cylinders	20 psig (137.90 kPa)	Unloaded

Compressor Oil System

The core of the VMC 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, bypassed by relief, leaves at the top of the chamber.

Drilled oil ways 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 wrist pin oil bearing. The shaft roller bearings receive their oil through metering orifices in the bearing covers.

In a refrigeration system using Vilter VMC Compressors, an external pressure float valve is used in conjunction with a Vilter 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.

Table 4-3. Dual Compressor Range and Operation

Compressor 1		
Controls	**Setpoints**	**Operation**
Low Pressure Switch	21 psig (144.79 kPa)	Compressor Starts
	16 psig (110.32 kPa)	Compressor Stops
Control 'B' (Bank 2)	23 psig (158.58 kPa)	Loaded
	18 psig (124.11 kPa)	Unloaded
Control 'A' (Bank 1)	25 psig (172.37 kPa)	Loaded
	20 psig (137.90 kPa)	Unloaded

Compressor 2		
Controls	**Setpoints**	**Operation**
Low Pressure Switch	20 psig (137.90 kPa)	Compressor Starts
	15 psig (103.42 kPa)	Compressor Stops
Control 'D' (Bank 2)	22 psig (151.69 kPa)	Loaded
	17 psig (117.21 kPa)	Unloaded
Control 'C' (Bank 1)	24 psig (165.48 kPa)	Loaded
	19 psig (131.00 kPa)	Unloaded

Oil Regulating Valve (Adjustable Oil Relief)

The oil pressure regulating valve (See Figure 4-2) on the 400 Series VMC 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.

Adjust the oil pressure regulating valve to maintain a minimum of 45 to 50 psig (310.27 to 344.74 kPa) net oil pressure for 400 Series Compressors (oil pressure minus crankcase pressure equals net oil pressure).

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.

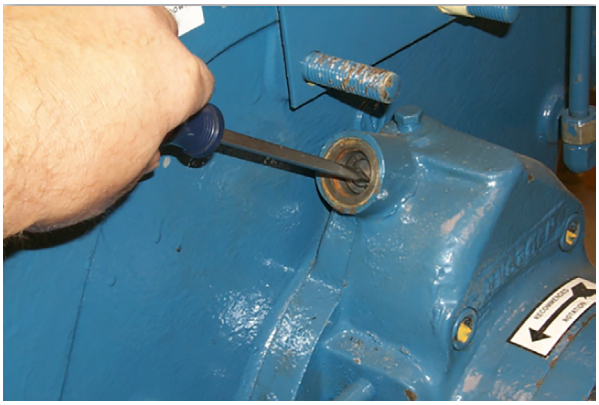


Figure 4-2. Oil Pressure Regulating Valve Adjustment

Compressor Loading/Unloading Diagrams

Use Figure 4-3 to interpret compressor loading and unloading diagrams.

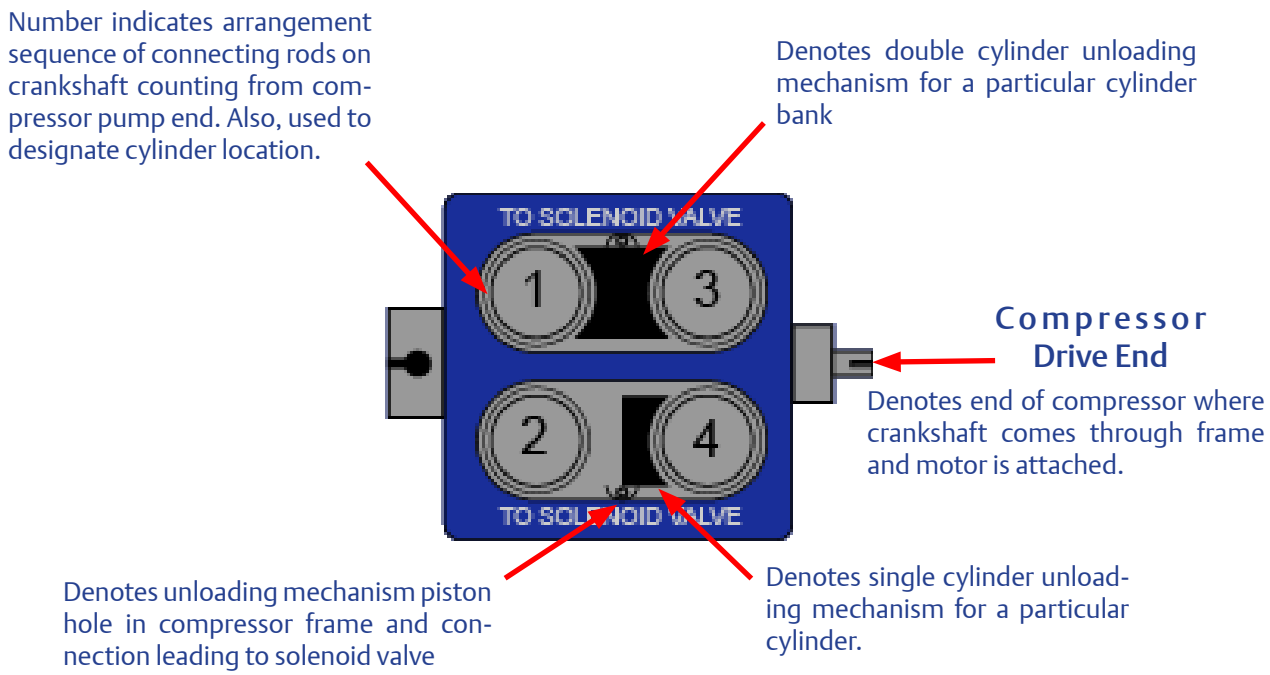


Figure 4-3. Compressor Loading/Unloading Key Schematic

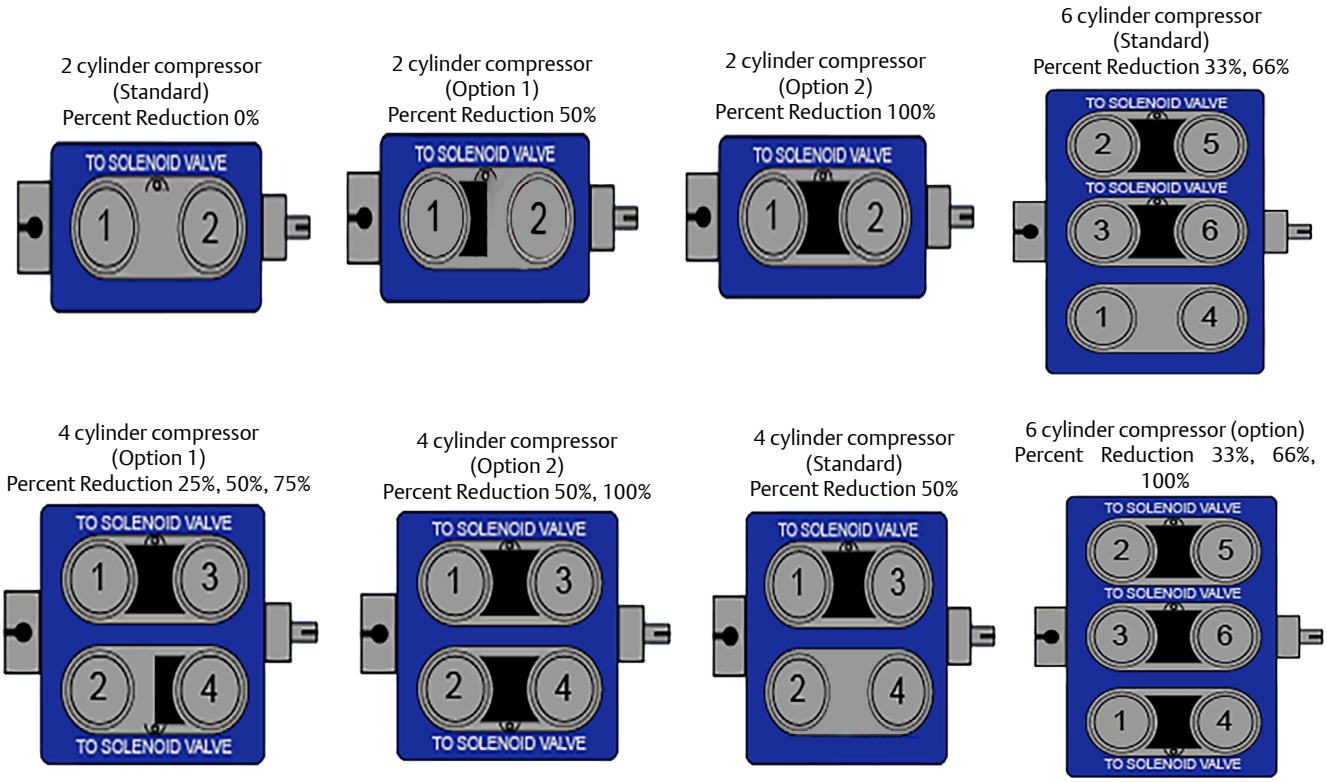


Figure 4-4. High Stage 2-Thru-6 Cylinder for 400 Series Compressor Capacity Reduction Arrangement Typical Schematic

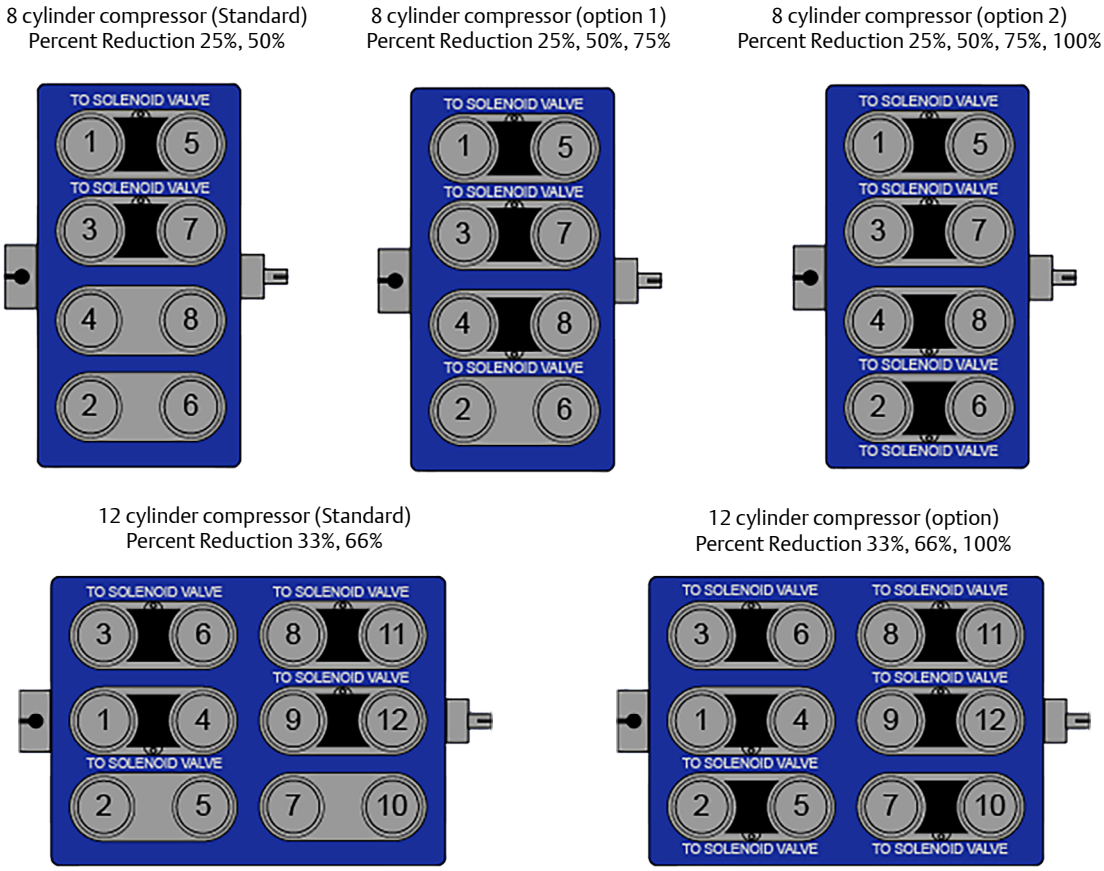


Figure 4-5. High Stage 8 and 12 Cylinder Compressor for 400 Series Capacity Reduction Arrangement Typical Schematic

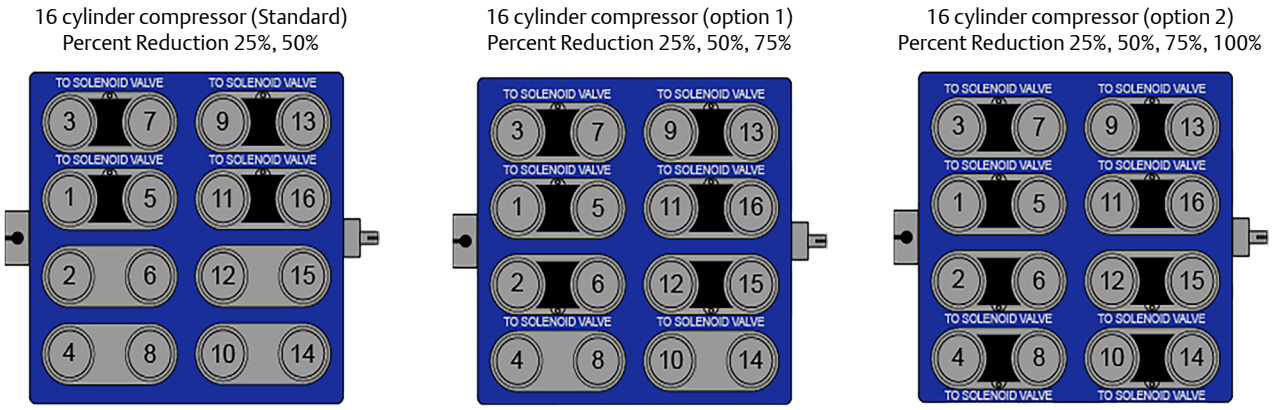


Figure 4-6. High Stage 16 Cylinder Compressor for 400 Series Capacity Reduction Arrangement Typical Schematic

440 VMC Compressors Application Guidelines

Maximum Limits	
Pressure Differential	175 PSI (1.20 MPa)
Discharge Temperature	300˚F (149°C)
Discharge Pressure	350 PSI (2.41 MPa)
Suction Pressure	150 PSI (1.03 MPa)
Oil Temperature	150˚F (66°C)
Direct Drive Motor Horsepower	300 HP (223.7 kW)

Suction Superheat	
R-12, R-134A (actual gas temp.)	65˚F (18°C)
R-22, R-507, R-404A	25˚F (14°C)

Compression Ratio	
R-12, R-22, R-134A, R-717	8 : 1
R-502, R-507, R-404A & R-290	10 : 1

NOTE
Recommended operating Oil Temperature is 100˚F (38°C) to 130˚F (54°C). Operating at or near maximum oil temperature could result in excessive wear.

Table 4-4. 440 VMC Compressors V-Belt Drive Horsepower Limits

Compressor		Maximum Motor	
Size	RPM	HP	kW
442, 444, 446, & 448	1200	100	74.6
	1130	100	74.6
	1000	100	74.6
	900	75	55.9
	810	75	55.9
	730	60	44.7
448HD, 4412, & 4416	1200	150	111.8
	1130	125	93.2
	1000	100	93.2
	900	100	93.2
	810	75	74.6
	730	75	74.6

Table 4-5. Minimum 440 Compressor Speed and Motor RPM

Cylinders	Motor RPM	Minimum Compressor RPM	Minimum RPM with External Oil Pump
2	870	350	200
4	1150	480	
6 & 8	1150	540	
12 & 16	1750	730	

450XL VMC Compressors Application Guidelines

Maximum Limits	
Suction Superheat	25˚F (14° C)
Pressure Differential	250 PSI (1.72 MPa)
Discharge Temperature	300˚F (149° C)
Discharge Pressure	350 PSI (2.41 MPa)
Suction Pressure	150 PSI (1.03 MPa)
Oil Temperature	150˚F (66° C)

Compression Ratio	
R-134A	10 : 1
R-717	8 : 1
R-290	10 : 1
R-22	12 : 1
R-507	14 : 1
R-404A	14 : 1

Direct Drive Motor Horsepower	
VMC 450XL	375 HP (279.6 kW)

NOTE
Recommended operating Oil Temperature is 100˚F (38°C) to 130˚F (54°C). Operating at or near maximum oil temperature could result in excessive wear.

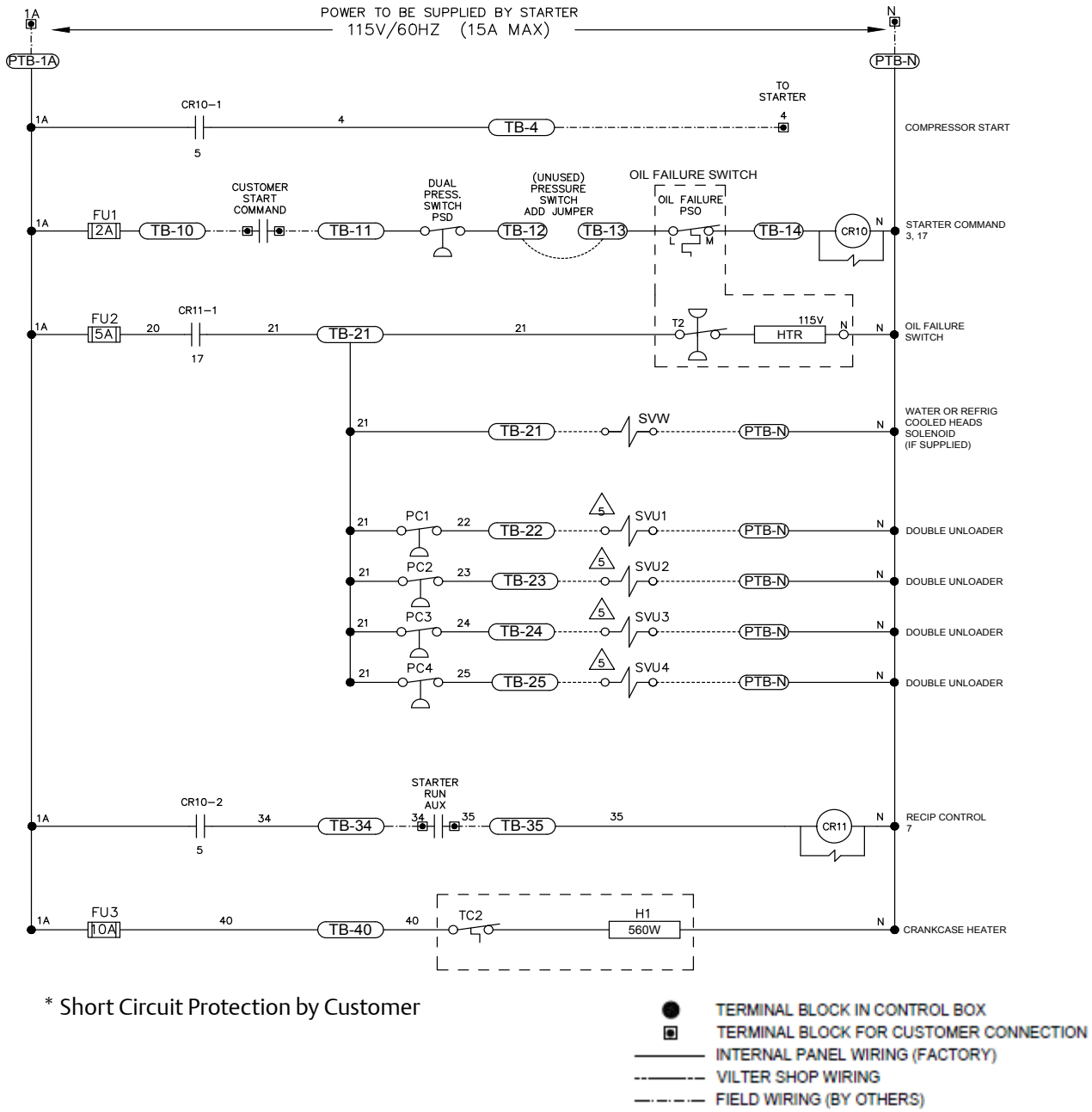
Table 4-6. 450XL VMC Compressors V-Belt Drive Horsepower Limits

Compressor		Maximum Motor	
Size	RPM (rad/s)	HP	kW
452XL, 454XL, 456XL, & 458XL	1200 (125.43 rad/s)	200	149.1
	1130 (118.31 rad/s)	200	149.1
	1000 (104.7 rad/s)	150	111.8
	900 (94.23 rad/s)	150	111.8
	810 (84.81 rad/s)	125	93.2
	730 (76.43 rad/s)	125	93.2
4512XL & 4516XL	1200 (125.64 rad/s)	300	223.7
	1130 (118.31 rad/s)	300	223.7
	1000 (104.7 rad/s)	250	186.4
	900 (94.23 rad/s)	200	149.1
	810 (84.81 rad/s)	200	149.1
	730 (76.43 rad/s)	150	111.8

Table 4-7. Minimum 450XL Compressor Speed and Motor RPM

Cylinders	Motor RPM	Minimum Compressor RPM	Minimum RPM with External Oil Pump
2	870	350	200
4	1150	480	
6 & 8	1150	540	
12 & 16	1750	730	

Typical Electrical Schematic for a Reciprocating Compressor



* Short Circuit Protection by Customer

- TERMINAL BLOCK IN CONTROL BOX
- TERMINAL BLOCK FOR CUSTOMER CONNECTION
- INTERNAL PANEL WIRING (FACTORY)
- VILTER SHOP WIRING
- FIELD WIRING (BY OTHERS)

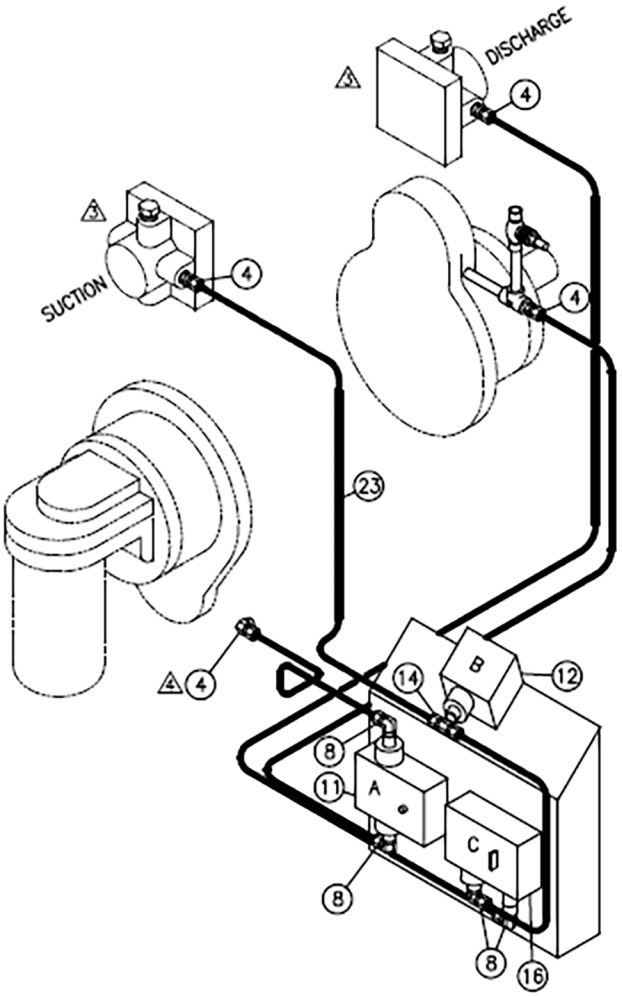
Notes-

1. Wiring PER NEMA 12.
2. Control Wiring #14 AWG, JIC Color Code Unless Otherwise Noted.
3. Use Copper Wire With An Insulation Temperature Rating of 60 C Minimum.
4. All Connections To The Panel Must Be Made With Flexible Conduit.

Figure 4-7. Typical Electrical Schematic for a 4516XL Reciprocating Compressor with 25,50,75,100% Unloading

Reciprocating Compressor Pressure Control Connections

Please refer to Figure 4-8 and 4-9 for details.



Pressure Control Key

A = Oil Pressure Failure Cutout

B = Unloader Pressure Control (Capacity Reduction Switch)

C = Dual Pressure Control

- High Pressure Cutout Is Manual Reset
- Low Pressure Cutout Is Auto. Reset

D = High Pressure Cutout With Manual Reset

E = Low Pressure Cutout With Manual Reset

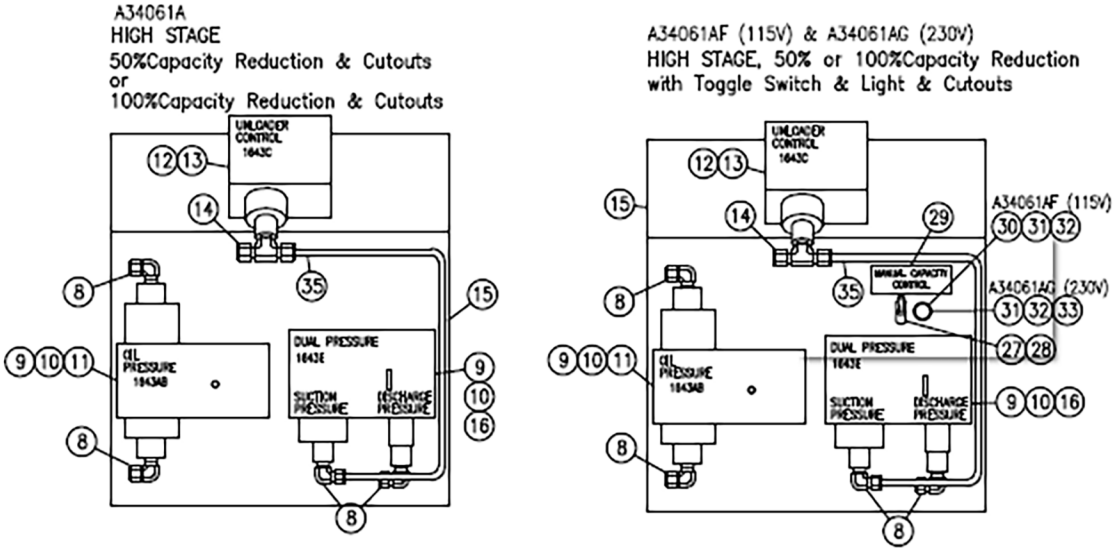
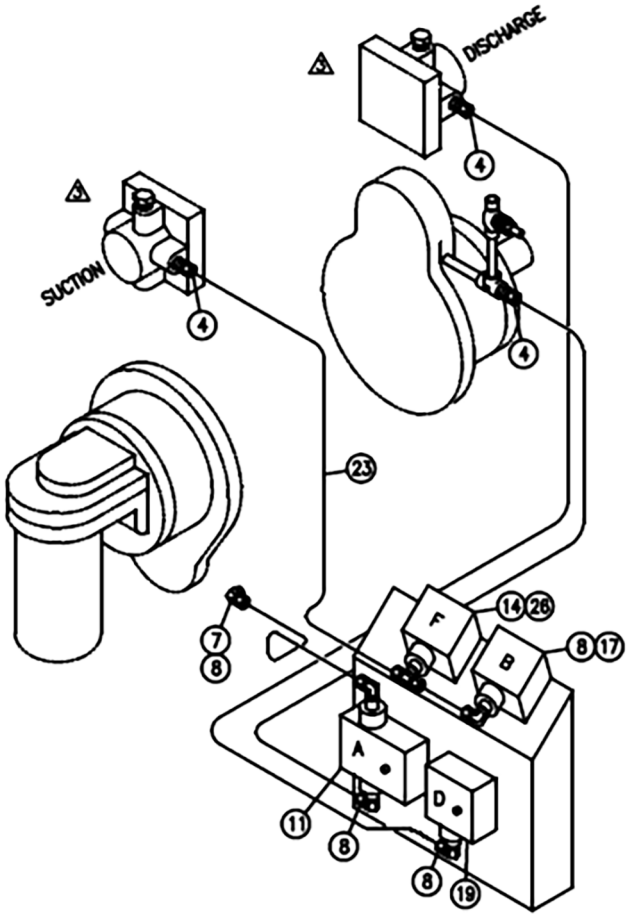


Figure 4-8. 442/452XL High Stage Compressor Pressure Control Connections



Pressure Control Key

A = Oil Pressure Failure Cutout

B = Unloader Pressure Control (Capacity Reduction Switch)

C = Dual Pressure Control

- High Pressure Cutout Is Manual Reset
- Low Pressure Cutout Is Auto. Reset

D = High Pressure Cutout With Manual Reset

E = Low Pressure Cutout With Manual Reset

F = Low Pressure Cutout With Auto. Reset

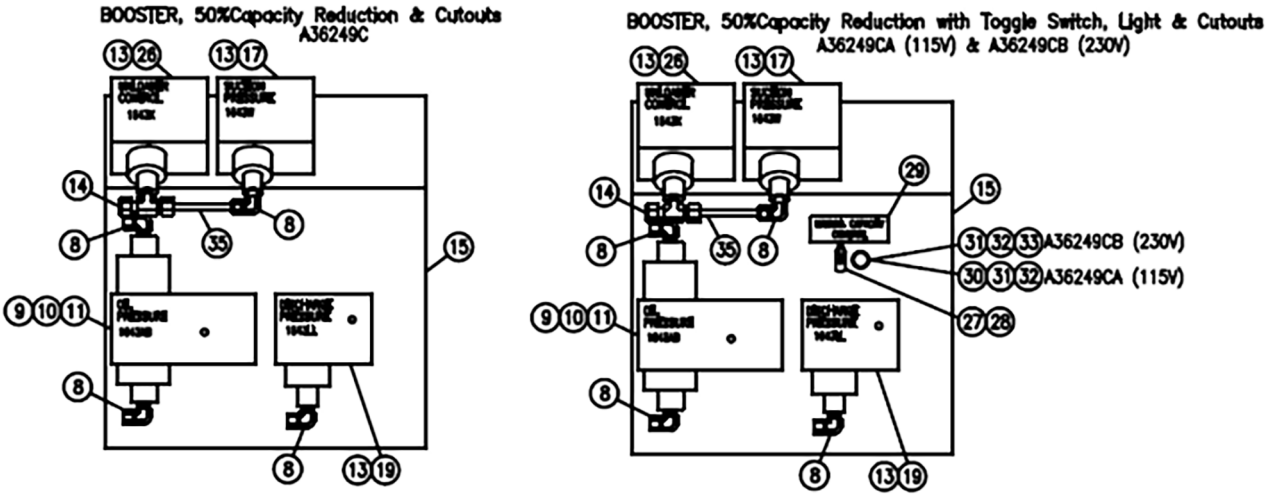


Figure 4-9. 442/452XL Booster Compressor Pressure Control Connections

400 VMC Compressor Water Jacket Connections

Refer to Figures 4-10 to 4-12 for details.

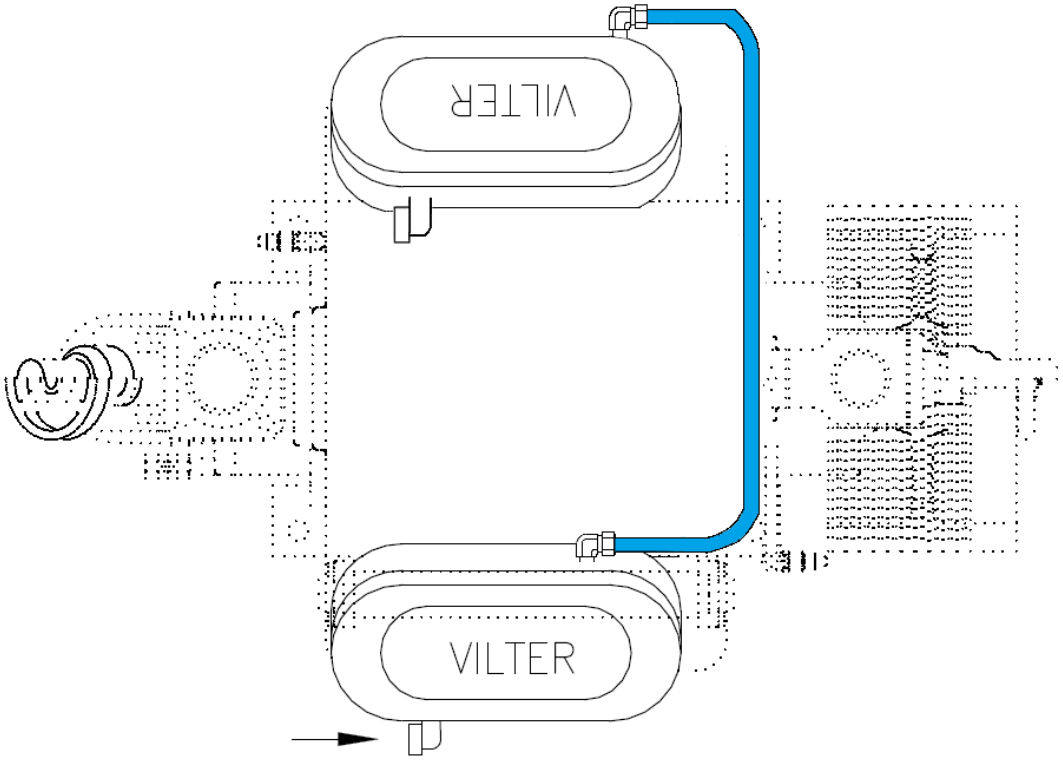


Figure 4-10. Water Jacket Connections (4 cylinders)

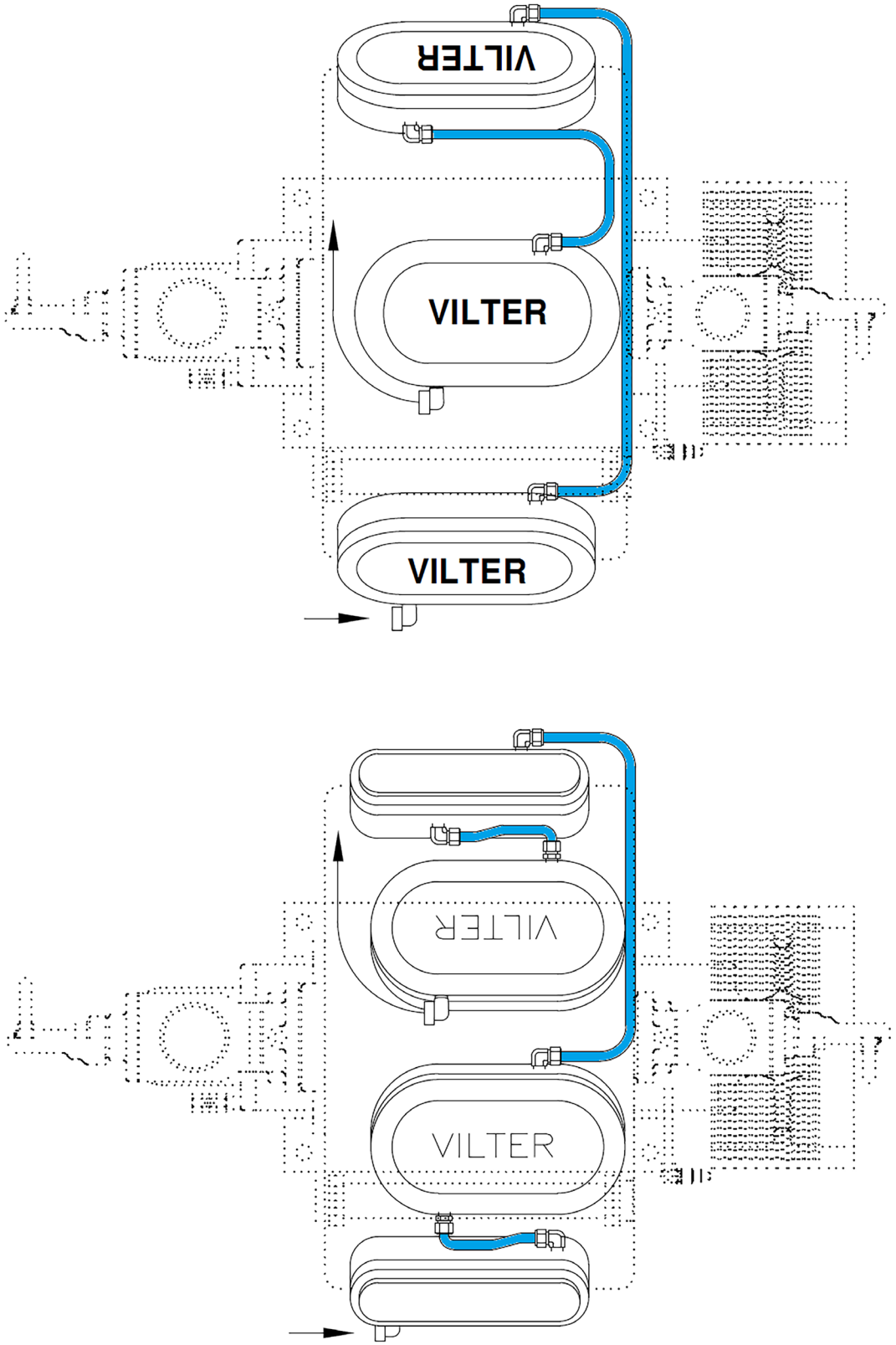


Figure 4-11. Water Jacket Connections (6 & 8 cylinders)

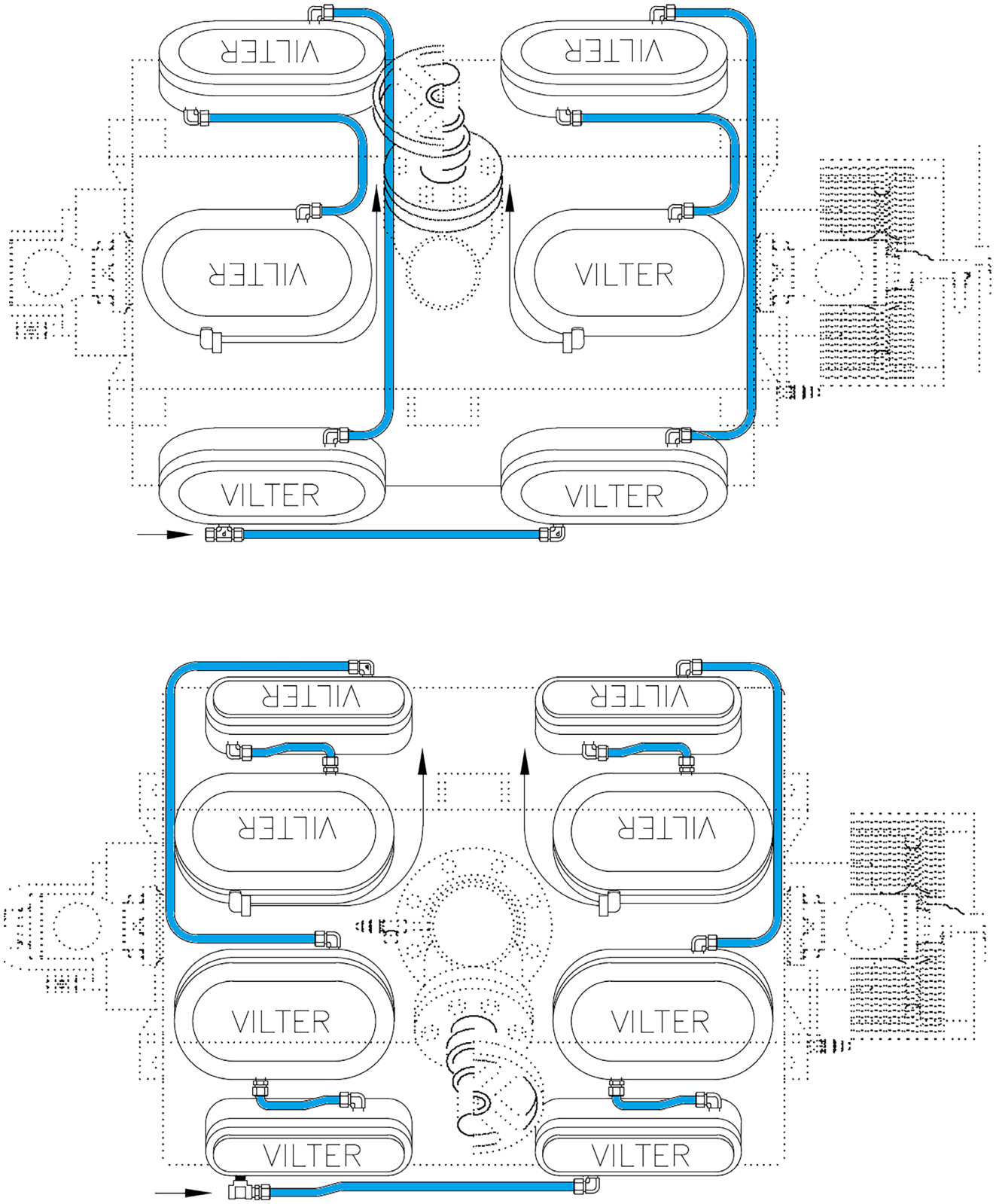
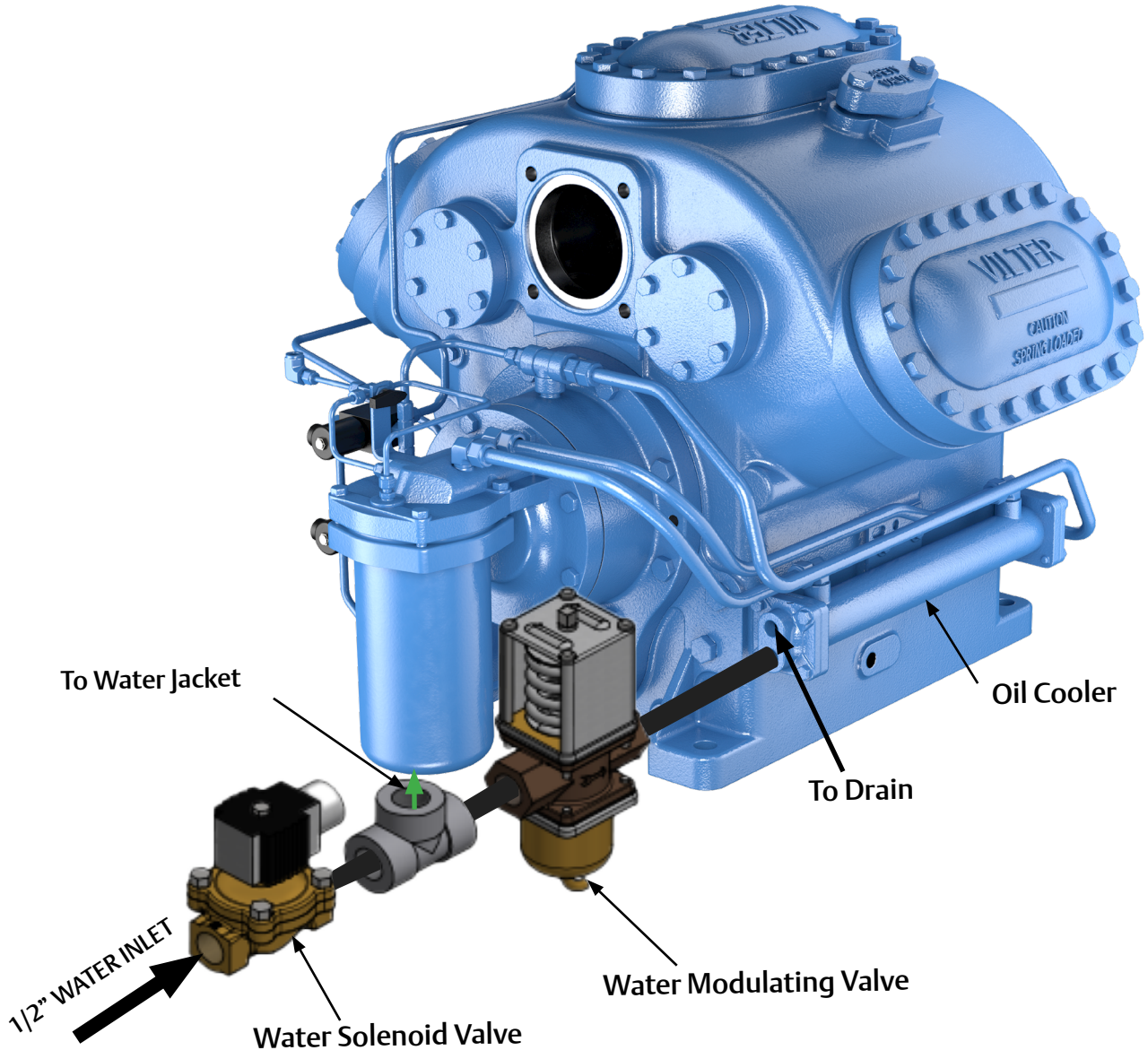


Figure 4-12. Water Jacket Connections (12 & 16 cylinders)

Water Valve Connections

See Figure 4-13 for details of the water valve connections for oil cooler and/or water jackets.

See Figure 4-14 for details of the water valve connections with additional water modulating valve for water jackets.

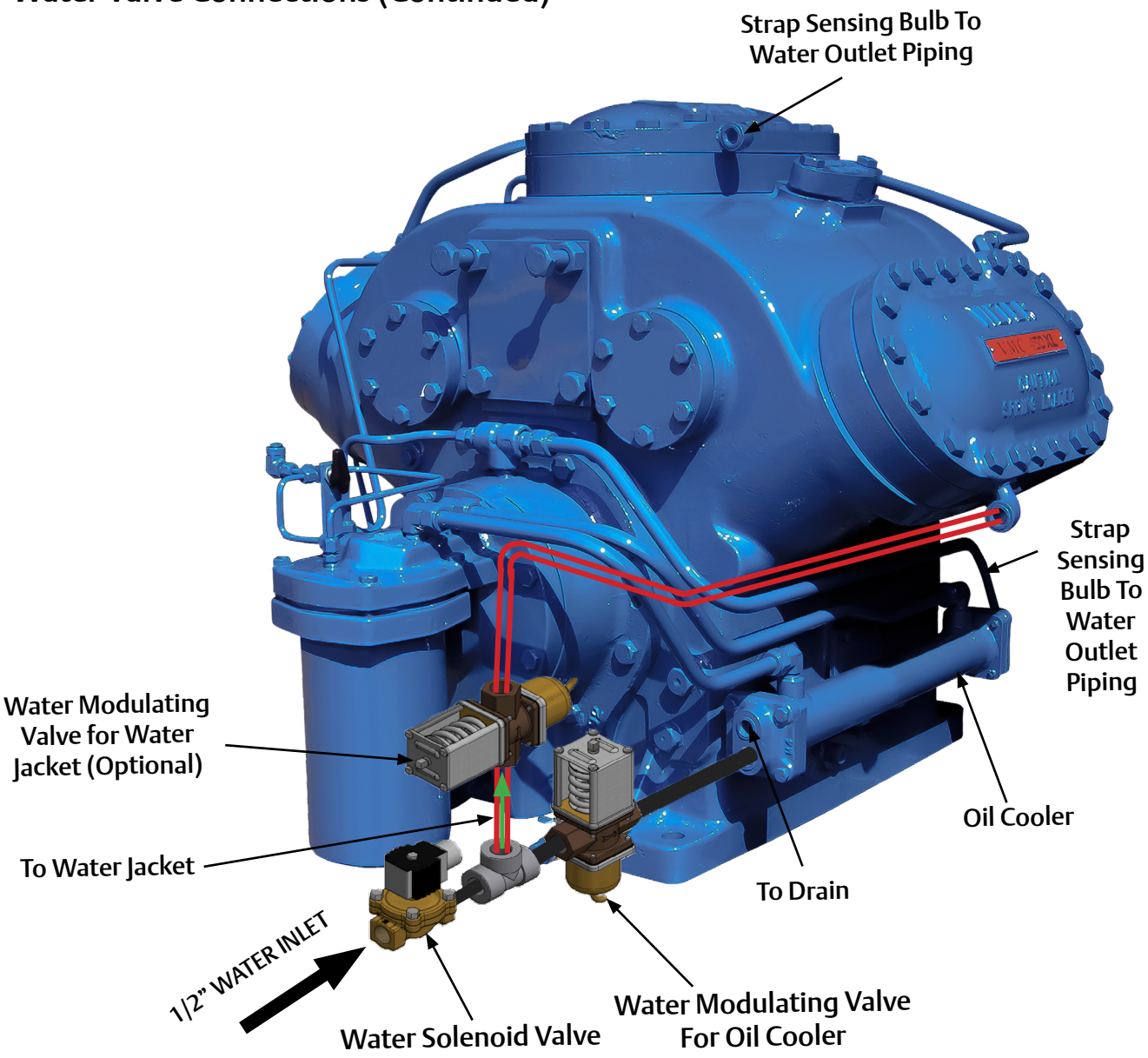


Notes-

1. Set Modulating Valve To Maintain a 110° to 125° F Oil Temperature.
2. Max. Crankcase Oil Temperature Is 150° F.
3. Max. Water Inlet Temperature Is 80° F.
4. Max. Water Flow Is 4 GPM.

Figure 4-13. Water Valve Connections

Water Valve Connections (Continued)



Notes-

1. Set Modulating Valve To Maintain a 110° to 125° F Oil Temperature.
2. Max. Crankcase Oil Temperature Is 150° F.
3. Max. Water Inlet Temperature Is 80° F.
4. Max. Water Flow Is 4 GPM.

Figure 4-14. Water Valve Connections With An Additional Water Modulating Valve for Water Jacket

Service/Maintenance Schedule

Follow this table for maintaining and servicing the compressor unit at hourly intervals.

Table 5-1. Service/Maintenance Schedule

Group	Inspection/ Maintenance * *	Service Interval (Hours) * (Based on dry clean gas)													
		200	5,000	10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	110,000	120,000
Unit	Suction Screen	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Coupling Alignment and Integrity	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	V-Belt Drive Alignment and Integrity	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Water Line Strainers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Liquid Line Strainers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Control Calibration	Electromechanical Pressure Controls	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Transducers	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	RTDs	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Compressor	Oil Change[1]		R	R	R	R	R	R	R	R	R	R	R	R	R
	Flush Oil Circuit				R		R		R		R		R		R
	Oil Analysis[2]		S	S	S	S	S	S	S	S	S	S	S	S	S
	Oil Filter[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	Inspect Compressor[4]		I	I	I	I	I	I	I	I	I	I	I	I	I

I = Inspect S = Sample R = Replace

(1) The oil should be changed at these intervals, unless oil analysis results exceed the allowable limits. The frequency of changes will depend on the system cleanliness.

(2) Oil analysis should be done at these intervals as a minimum; the frequency of analysis will depend on system cleanliness.

(3) The oil filter on a minimum must be changed at these intervals or annually if not run continuously. However, the oil filter must be changed if the oil filter differential exceeds 25 psi or if the oil analysis requires it.

(4) To prevent possible breakdowns, the compressor should be opened and the condition of the valves, valve seats, liners and connecting rod bearings should be checked and excessively worn parts should be replaced. The crankshaft bearing float should be checked at the same time.

Daily records should be kept on suction, discharge, oil pressures & temperatures.

Preventive Maintenance, Checks and Services

WARNING

Only qualified personnel shall install, start, operate and maintain the equipment. Failure to comply may cause damage to the workers and the system.

Careful checking of a refrigeration system for leaks and proper operation of all components upon installation will start the system on its way to a long life of satisfactory service. To ensure the desired trouble-free operation, however, a systematic maintenance program is a prerequisite. The following PMCS is suggested in addition to the Maintenance/Service Schedule.

Daily

1. Check oil levels.
2. Check all pressure and temperature readings.
3. Clean the suction screen bag. Discontinue use when the bag remains clean. Reserve for system modifications or overhauls.

Weekly

(Items 1 thru 3 above plus 4 thru 9)

4. Check the refrigeration system for leaks with a suitable leak detector.
5. Check oil pressures and review microprocessor log and log sheets. Determine if oil filter needs changing.
6. Check refrigerant levels in vessels.
7. Check filters in air handling units
8. Check low temperature coils for defrosting.
9. Check all gauge and temperature readings.

Monthly

(Items 1 thru 9 above plus 10 thru 14)

10. 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.
11. Check drives for tightness and alignment. Direct drives should have coupling bolts tightened. V-Belt drives should have correct tension.
12. Check calibration and operation of all controls, particularly safety controls.
13. 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 if scaling or algae are present.
14. Check oil cooler for any evidence of corrosion, scaling or other fouling.

Annually

(Items 1 thru 14 plus 15 thru 27)

15. Check entire system thoroughly for leaks.
16. Drain water from condensers, cooling towers and check tubes. Check carefully for damage by corrosion or scale.
17. Remove all rust from equipment, clean and paint.
18. Grease valve stems and threads for the valve caps.
19. Flush out sediment, etc. from water circuits.
20. Clean all oil strainers.
21. Check and clean suction strainer.
22. Check motors and fans for shaft wear and end play.
23. Check operation and general condition of microprocessor and other electrical controls.
    - Check fuses in the MicroVission panel.
    - Check for loose wiring connections in the MicroVission panel.
    - Check relay and contact operation for relays in the MicroVission panel.
    - Verify set points in the MicroVission.
24. Clean all water strainers.
25. Check all V-Belt drives. Replace worn V-Belts and drive components.

CAUTION

Replace V-belts in matched sets only.

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

Year-round Operation

When refrigeration equipment is operated on a continuous year-round basis, a yearly examination of all internal compressor parts are recommended. While the highest material standards are maintained through the Vilter 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.

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, “pump-down“ 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

Service Contracts

Vilter Distributors 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. If a Vilter Distributor is not available in your area, contact the Vilter Manufacturing

Home Office. 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 might not be available to perform the recommended preventive maintenance.

General Service Instructions

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 accumulated on the outside of the compressor be removed before servicing.

All gaskets, O-rings, roll pins and lock washers must be replaced when servicing and reassembling the compressor.

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

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

Preparation of Compressor For Servicing

Remove all refrigerant from the compressor before servicing it. To properly evacuate the compressor, employ the following procedures, depending on your refrigerant.

Refrigerant 717 (Ammonia) Compressor

1. 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.
2. Isolate the unit by manually closing the discharge stop/check valve.
3. Close the liquid supply valves and open all solenoid valves to prevent liquid refrigerant from being trapped between the stop valves and solenoid valves.
4. 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.
5. Remove drain plugs from the bearing housings, compressor housing and discharge manifold. Drain the oil into appropriate containers.
6. 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.
7. 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 or CO_2 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 remain 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.

Table 5-2. Components of the Upper Cylinder Cross Section

Item Number	Item Name
1	Cylinder Liner
2	Suction Valve Plate
3	Suction Valve Spring (4)
4	Safety Head Yoke
5	Safety Head Spring (4)
5A	Roll Pin (4)
6	Valve Retaining Screw
7	Hexagon Lock Nut
8	Valve Washer
9	Valve Spacer
10	Diaphragm Discharge Valves (3)
11	Safety Head

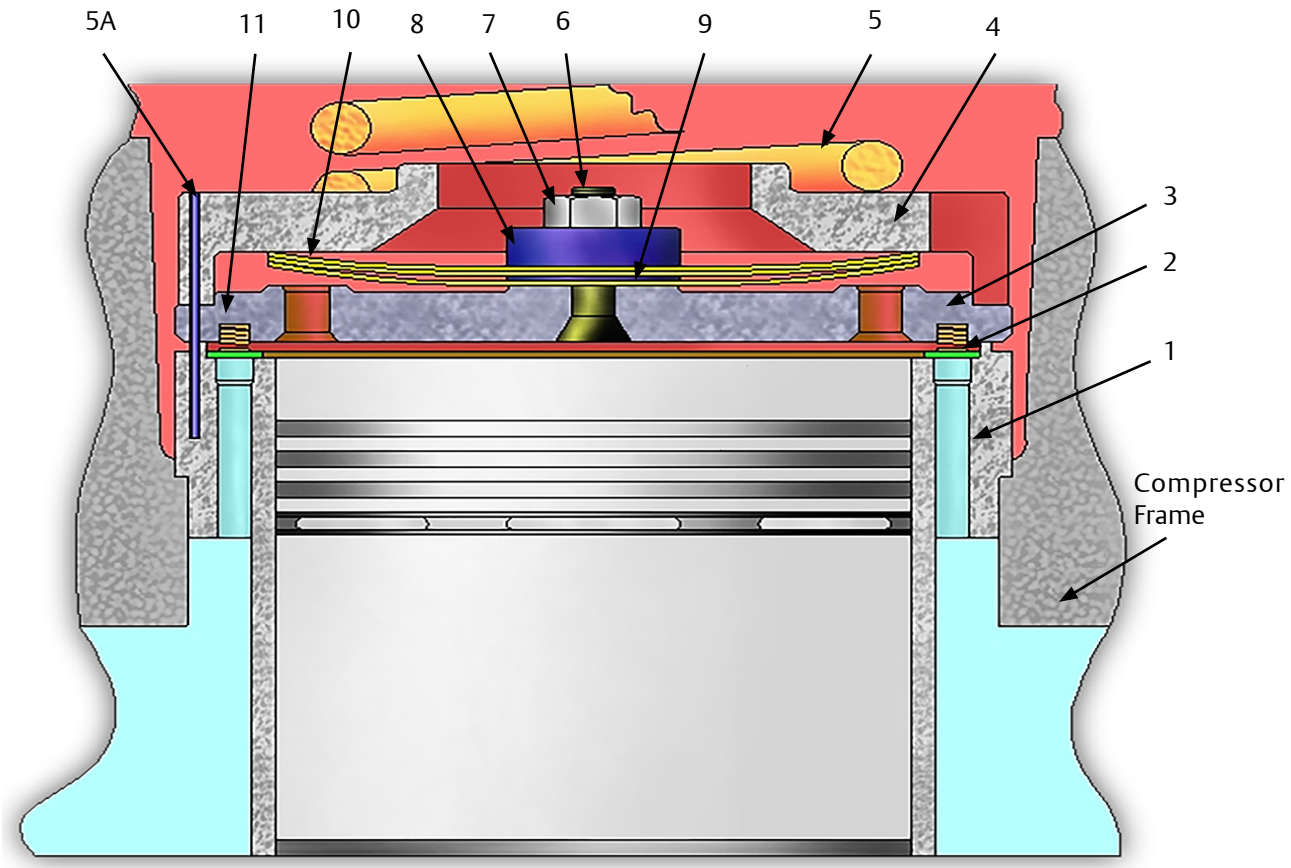


Figure 5-1. Upper Cylinder Cross Section

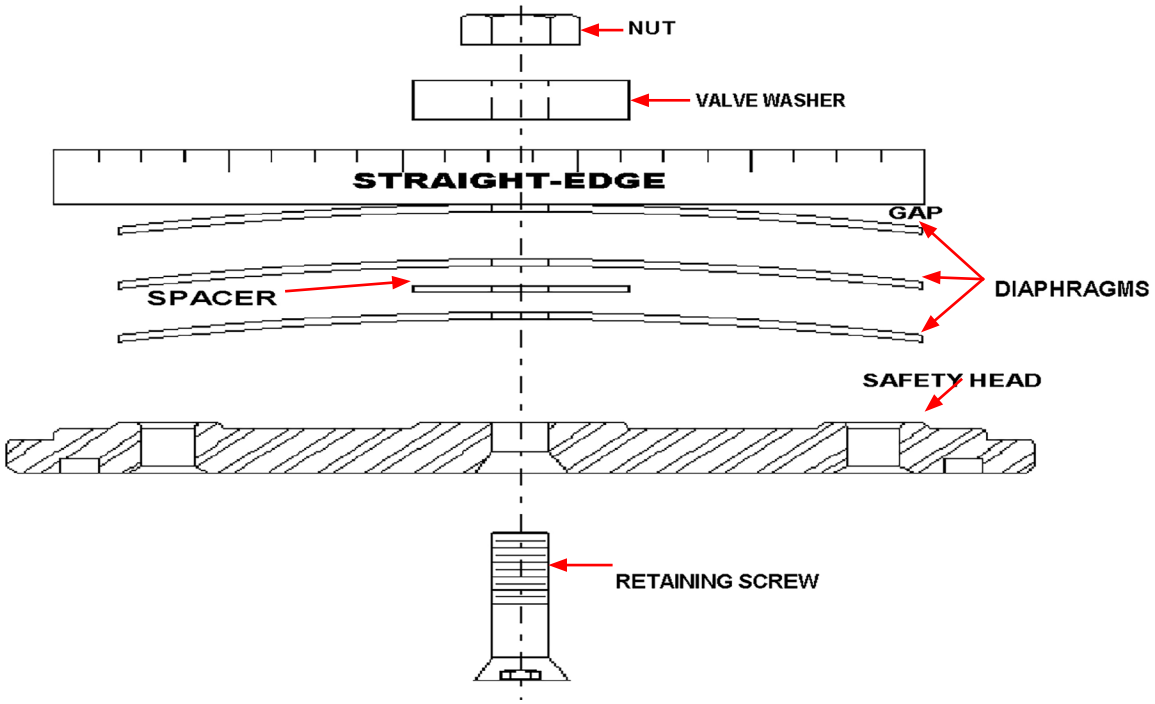


Figure 5-2. Discharge Diaphragm Valve Placement

Oil System Components

Checking for Leaks

Because of the demanding operational constraints of the VMC compressor (temperature variations, loosening of joints due to vibration, etc), there's a need for periodical leak testing. 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.

Flushing the Oil Circuit

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4 and "Preparation for Internal Servicing" on pages 5-19 to 5-20.

The oil circuit of a Vilter Reciprocating 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. Vilter 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 Vilter oil charger pump is recommended in this procedure.

1. The machine should be pumped down for servicing, the oil taken out and the handhole cover removed.
2. Connect the Vilter oil charger to this opening, and pump the flushing solution through the seal chamber and into the crankshaft.
3. Remove each of the pipe plugs in the crankshaft individually and operate the pump until the cleaner is flushed through the hole.
4. Remove the plug, remove the next one and repeat the pumping procedure.
5. After the plugs are removed and these passages flushed, remove the bearing caps and connecting rods.
6. Examine each of the oil passages to the connecting rods.
7. Inspect the connecting rod bearings.

By following the preceding instructions, a mechanic or technician would be able 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.

Once the passages have been flushed:

1. Open the connection on the bottom of the seal chamber and drain the flushing fluid out.
2. Drain solvent from the crankcase and the interior surfaces of the machine.
3. 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.
4. Follow the System Refrigerant Charging procedure found in Section 3.
5. Remove the pump and replace the fitting in the top of the seal chamber.
6. Replace the crankcase cover and charge the machine with clean oil.

DANGER

Sampling often releases hot fluid under high velocity/pressure.

1. **Hot fluid can cause severe burn injuries.**
2. **Skin penetration from high-pressure fluid can occur, causing severe injury, gangrene and/or death. If this happens, immediately contact an experienced medical practitioner.**
3. **Hot fluid escaping to the atmosphere can ignite if it comes into contact with an ignition source. This can lead to severe property damage.**

Oil Sampling

WARNING

When working with LFG, NG or other dangerous or flammable gases, ensure there are adequate ventilation and vapor detectors. Refer to national fire and building codes. Failure to comply may result in serious injury or death.

WARNING

Improper selection or application of fluid diagnostic products can cause serious injury or damage. The user is solely responsible for making the final selection of products to ensure that the overall system performance and safety requirements are met. These include reviewing fluid compatibility with materials and seals.

WARNING

Avoid skin contact with any condensate or oil. Wear rubber gloves and a face shield when working with condensate or oil. Failure to comply may result in serious injury or death.

Recommendations

1. Make sure you are aware of the risks associated with the fluid being sampled or worked with. Check with the manufacturer.
2. If you have not been trained to sample, service, repair, or troubleshoot a pressurized fluid system, especially a hydraulic system, you are at risk of suffering an accident. Seek the proper training before proceeding.

Installation of the Oil Sampler Valve

1. Lubricate the threads (1/4”-18 NPT) with Teflon tape.
2. Tighten to the max. torque 25 ft-lbs (34 N-m). Use 11/16” open wrench. Avoid over tightening.

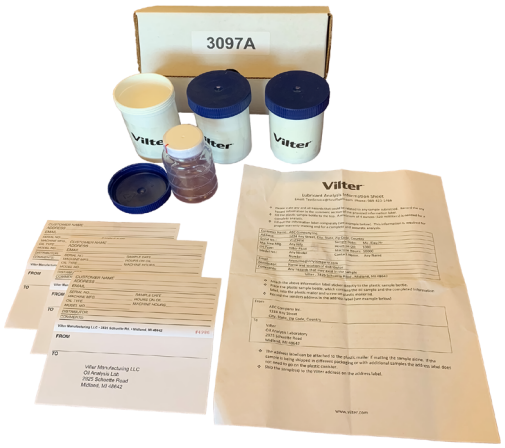


Figure 5-3. Oil Analysis Kit (VPN 3097A)

Pre-Sampling

Use the Vilter Oil Analysis Kit (VPN 3097A) to collect an oil sample for analysis, see Figure 5-3.

Once the sample has been taken, the label must be filled out and pasted on the bottle, and both must be placed inside the mailing tube and sealed with the pre-addressed mailing label.

Below are a few points to remember when taking a sample:

- Sample running compressor units, not cold units. Sample after minimum 30 minutes of compressor operating time.
- Sample after the oil filter.
- Sample according to the sampling procedure below.
- Ensure sampling valves and devices are thoroughly flushed prior to taking a sample.
- Ensure samples are taken as scheduled in the Maintenance and Service Schedule.
- Send samples to the oil analysis lab immediately after sampling, do not wait 24 hours.

Sampling Procedure

THE SAMPLING PRESSURE RANGE IS LIMITED BETWEEN 5 TO 750 PSI (0.03 – 5.17 MPa). IF THE OPERATING PRESSURE IS ABOVE 750 PSI (5.17 MPa), THE OIL SAMPLING MUST BE DONE WHEN THE COMPRESSOR IS NOT RUNNING AND ENSURE THE SYSTEM PRESSURE IS WITHIN THE 5 TO 750 PSI (0.03 – 5.17 MPa) SAMPLING RANGE.

A 1/4" NPT oil sampling valve is provided on the oil drainage tee (See Figure 5-4) for some models. If your unit doesn't come with one, you can call Vilter Customer Service to order one (VPN: 3709A).

1. Unthread the oil sampling valve cap. For valve #3709A, you also need to turn the knurled locknut clockwise, see Figure 5-4 (b).

NOTE

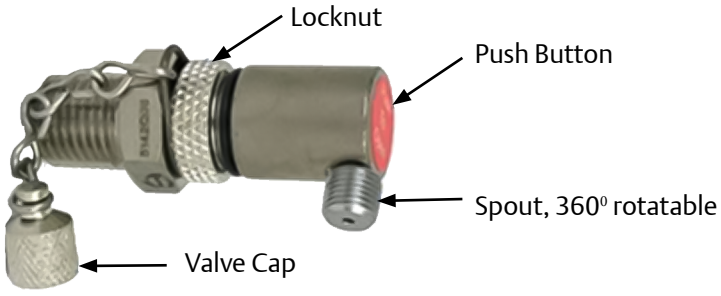
DO NOT remove the valve from the piping or filter housing.

2. Remove the cap of the oil analysis bottle and position it carefully under the valve spout. (Make sure the valve spout is rotated to the downward position) **SLOWLY AND VERY CAREFULLY** press the "PUSH BUTTON" with your finger to open the valve, and release the button to close it, see Figure 5-6.

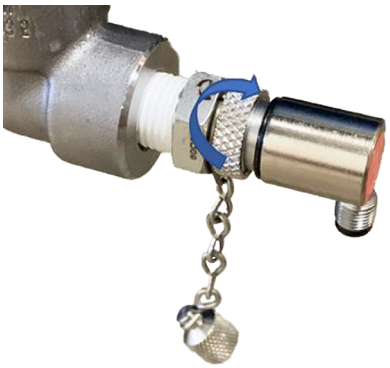
WARNING

If the valve is opened too rapidly, a foamy pressurized jet of oil will gush out and splash outside the container.

3. In most cases there will be foam in the oil, so you must fill the bottle up to the top and then wait for the foam to dissipate. Repeat this step as many times as necessary (around 4 to 6 times) until the clear oil level reaches ¾ full, see sequence in Figure 5-6.



(a). Oil Sampler Valve (VPN#3709A) for Ammonia and Refrigerants Compressors



(b). Valve shown ready for oil sampling

(c). Valve shown in lockout position

Figure 5-4. Oil Sampling Valve (VPN #3709A) For Ammonia and Refrigerant Compressors

Button being pressed, valve open

Button released, valve closed

Figure 5-5. Operating the Oil Sampling Valve

4. After all the foam dissipates, tighten the sample bottle cap.
5. Tighten the oil sampling valve cap.
6. Back seat the knurled locknut by turning it counter-clockwise. This is to prevent any accidental release, see Figure 5-4 (c).
7. Attach the filled sampling information label to the bottle and mail the sample out to the oil analysis lab immediately.

NOTE

Missing information from the sampling label may result in longer turnaround time as the laboratory will need to request the info before the sample can be tested.

Oil Sample Analysis Report

NOTE

A copy of the oil analysis report is also sent to Vilter. See Appendices for a sample of the oil analysis report.

An oil analysis report will show the physical properties of the oil, such as:

- Water content
- Viscosity
- Acid number
- Particle count
- Antioxidant level
- Wear metals
- Contaminating/additive metals

Figure 5-6. Stages of the Oil Sample Taking Process

Crankshaft Seal

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

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 O-rings, and it helps cool mating rotating parts to provide less wear and longer life. A receptacle for collection is recommended.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-4 to 5-5.

Removal

1. The flywheel or coupling will have to be removed. When removing the flywheel or hub, make sure the key slot is at the "top", it is not recommended to turn the crankshaft any more; the 3 screws that hold the inner mirror face won't align-up with the retainer behind the inner bearing.
2. Detach the tubing line on the bottom of the front housing. Oil will drain from the seal chamber, be prepared to collect it.
3. 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.
4. 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.
5. Grab the front rubber bellows and pull forward. It should release. If not, pry by the tabs on the metal ring (alternating force from side to side) to remove it.
6. Remove the large spring.
7. 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.
8. Clean out the seal chamber with suitable refrigeration parts cleaner. Afterwards, coat the area and crankshaft to keep them from rusting.

Installing a New Shaft Seal

1. 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.
2. Oil the O-ring sealing area.
3. Take the mirror face (do not touch the mirrored surface), oil outer O-ring and lay it in the cover or retainer with the mirror face upward.
4. 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[1].

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

5. Make sure the oil passage in the shaft is unobstructed. Install the inner retainer with mirror face, flush in front housing, with the word “TOP” at the top.
6. Tighten down evenly with the 3 screws.
7. The shaft seal assembly is symmetrical. It can be installed in either direction. Spray oil on inner mirror face.
8. Liberally coat oil on one of the bellows and carbon assemblies.
9. Avoid coming in contact with carbon. Carefully slip the assembly on the shaft until the carbon touches the mirror face.
10. Put the spring over the shaft and seal on the bellows assembly, and slide it onto the shaft to join up with the spring.
11. With the new cover gasket in place, install the cover over the end of the shaft.
12. Push the cover all the way on, lining up the bolt holes so the drain is to the bottom.
13. Tighten down the 8 screws evenly to the torque requirements in Table 5-3 or 5-4 (depending upon compressor model).

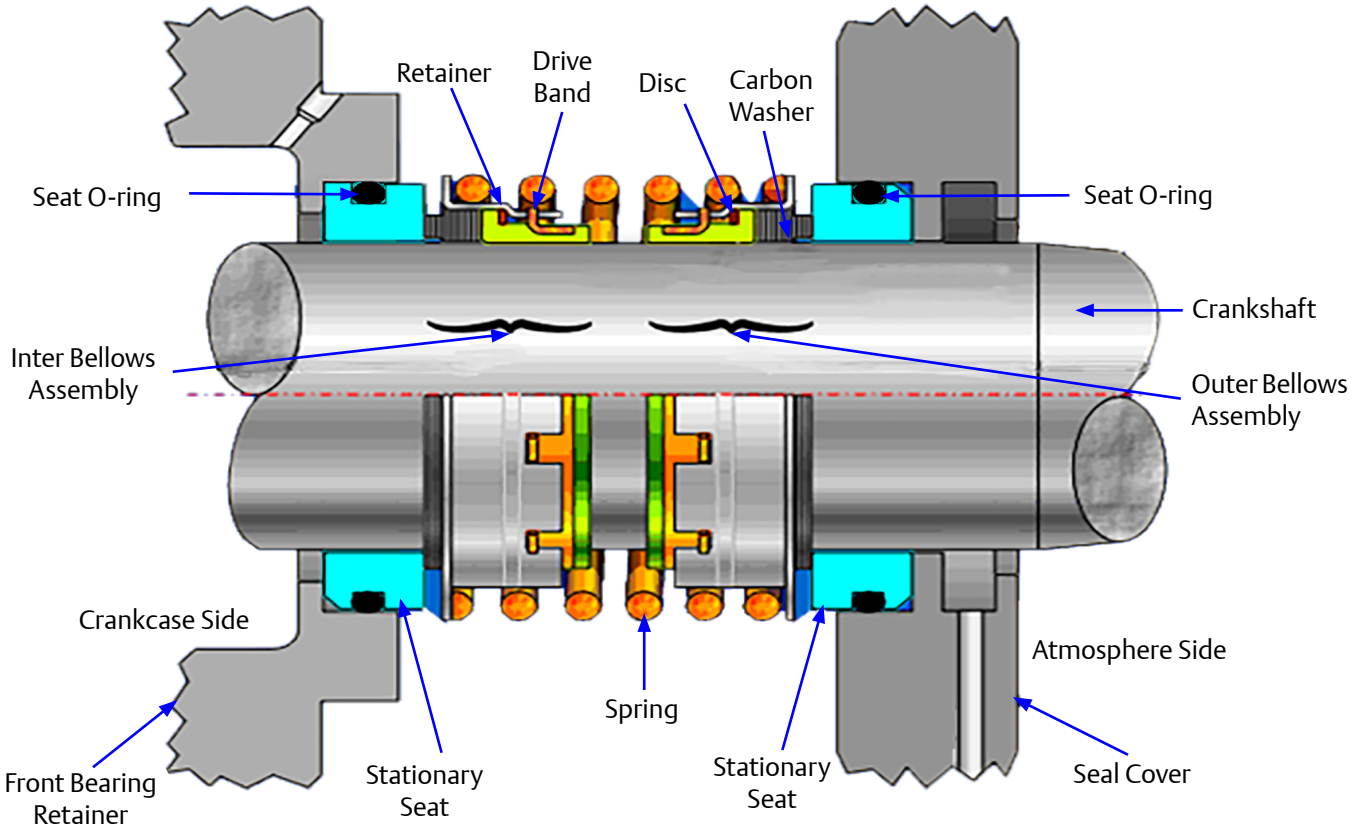


Figure 5-7. Crankshaft Seal Assembly

Cylinder Covers

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

Disassembly

1. To remove the compressor cylinder covers, remove the capacity control lines and water lines (or liquid cooling lines, if any) from the covers that will be removed.
2. Remove two screws that are opposite each other diagonally across the cover (i.e. two screws by water connections).
3. Install two assembly studs (see figure below) into these holes and tighten them to thread bottom. The studs are long enough to relieve all the spring tension before the nuts are removed

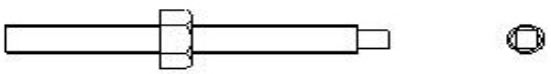


Figure 5-8. Disassembly

4. Screw on nuts to within one thread of touching the cover.
5. Remove the other screws.
6. 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. Remember, the studs must not be turned out with the nuts.
7. Break the gasket seal and then continue cover removal.
8. After all of the spring tension is removed, the nuts can be removed, covers lifted off and head springs removed. It is best to keep all parts in the correct cylinder assignment.
9. Invert the cover and place on work surface, placing each spring in its corresponding location in the cover.

Assembly

1. Before replacing the cover on the compressor, inspect the gasket surfaces of the cover and compressor frame.
2. Remove any debris adhering to either of these surfaces.
3. Remove any burrs or rough edges from the mating surfaces to ensure a tight seal.
4. Replace studs, if removed.
5. Lightly lubricate both sides of the head gasket.
6. Position the gasket over the studs and against the compressor frame in the correct orientation.
7. Place the springs on top of the safety head yokes (rotating the spring until it stays on the yoke).
8. Place the cover down over the studs and slowly lower on top of springs.
9. When all pieces are in alignment, place the nuts on the studs and start to tighten. When the cover is secure within 1¼" (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.
10. Do not tighten each screw separately, however. Alternate on opposing screws, until the cover is seated on the gasket.
11. Remove the studs and replace with screws.
12. Finish tightening the screws in an opposing pattern to the recommended torque values shown in Table 5-3 or 5-4 (depending upon compressor model).

WARNING

Torque the head to the recommended torque values shown in Table 5-3 or 5-4. Failure to comply may result in serious injury, death and/or damage to equipment.

13. Reinstall the capacity control and head cooling lines, and check for leaks.

Suction and Discharge Valve Plates

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

Disassembly

To service valve plates in the compressor, remove the cylinder covers (refer to procedure above). 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 'B' in the frame. Force the unloader piston down and insert a short 5/16" (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.

440 Compressor (Mushroom Style)

Refer to Figure 5-9.

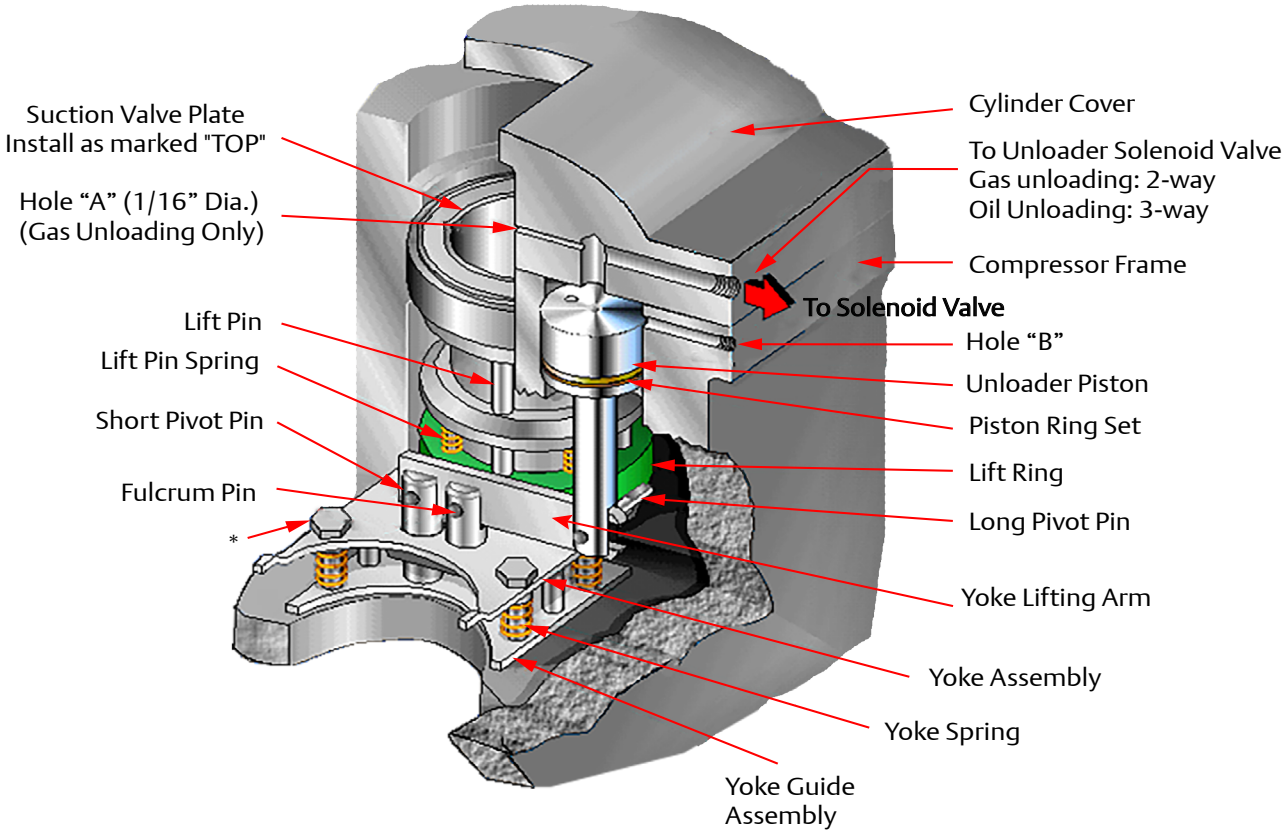
Disassembly

1. Lift out the safety head yoke, which holds the safety head assembly in place.
2. When the yoke is out, lift out the safety head assembly and suction valve plate.
3. To disassemble the safety head assembly, remove the locknut on the valve retaining screw.
4. Lift off the washer, two diaphragm valves, spacer and last diaphragm valve.
5. Turn the safety head assembly over and remove the valve retaining screw.
6. Remove the helical suction valve springs from their sockets with a twisting, pulling motion.

Reassembly

Before reassembling the safety head assembly, the “top” of the discharge diaphragm valve must be determined.

1. Place a straight edge on the diaphragms to reveal the dome. Diaphragms are installed with the dome on top.



* Yoke assembly is bolted down on one end as shown on the two cylinder and two-stage compressor capacity control mechanism. All other compressors do not use these bolts.

Use this illustration for:

Oil Actuated Unloading

- Booster
- High Stage

Figure 5-9. Typical Capacity Control Mechanism Arrangement - 440 Compressor (Old Style Mushroom Type)

2. All pieces of the safety head assembly should be clean and lightly lubricated with compressor oil before reassembly.
3. To reassemble the safety head assembly, insert the valve retaining screw in the safety head.
4. Place one of the domed discharge diaphragm valves on the screw, making sure the dome is up.
5. Next, place the thin spacer on the screw.
6. Follow it with the two remaining diaphragms, both having the dome on top.
7. Place the thicker washer and nut on the valve retaining screw.
8. Tighten the nut to the torque value listed in Table 5-3 or 5-4 (depending upon compressor model).
9. Place the suction valve springs into the holes with the end that has two coils wound towards the bottom of the hole, and twist.
10. The springs lock in place. When the springs are properly installed, the safety head can be inverted without the springs falling out.
11. Place the suction valve plate in the cavity of the cylinder liner with the side marked "TOP" facing up.
12. Ensure the valve plate rotates freely, without binding.
13. Replace the safety head assembly in the frame. Be sure no debris or foreign material is on any parts.
14. Replace safety yoke on top of the safety head assembly.

All replacement parts are drilled. They are interchangeable with original parts. All replacement cylinder liner kits have roll pins. Discard roll pins if new liner is being used with old safety head and safety head yoke.

The old style frames have built-in guide lugs which serve the same purpose as the roll pins. Replace safety springs and cylinder covers on the compressor.

NOTE

Compressors with serial numbers 7000 and higher have 4 holes drilled through the safety head and safety head yoke into the cylinder liner, to accommodate roll pins.

15. After replacing the cylinder cover, return the unloader mechanism to its operating position by removing the metal rod from the hole in the frame. This allows the piston to rise.
16. Put the plug back into the hole (hole 'B') in the frame and reconnect the unloader lines.

450XL Compressor (Bullet Style)

Refer to Figure 5-10.

Disassembly

1. Lift out the safety head yoke, which holds the safety head assembly in place.
2. Invert the yoke to make sure all eight coil springs are intact within it. If any springs are broken, 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.
3. 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.

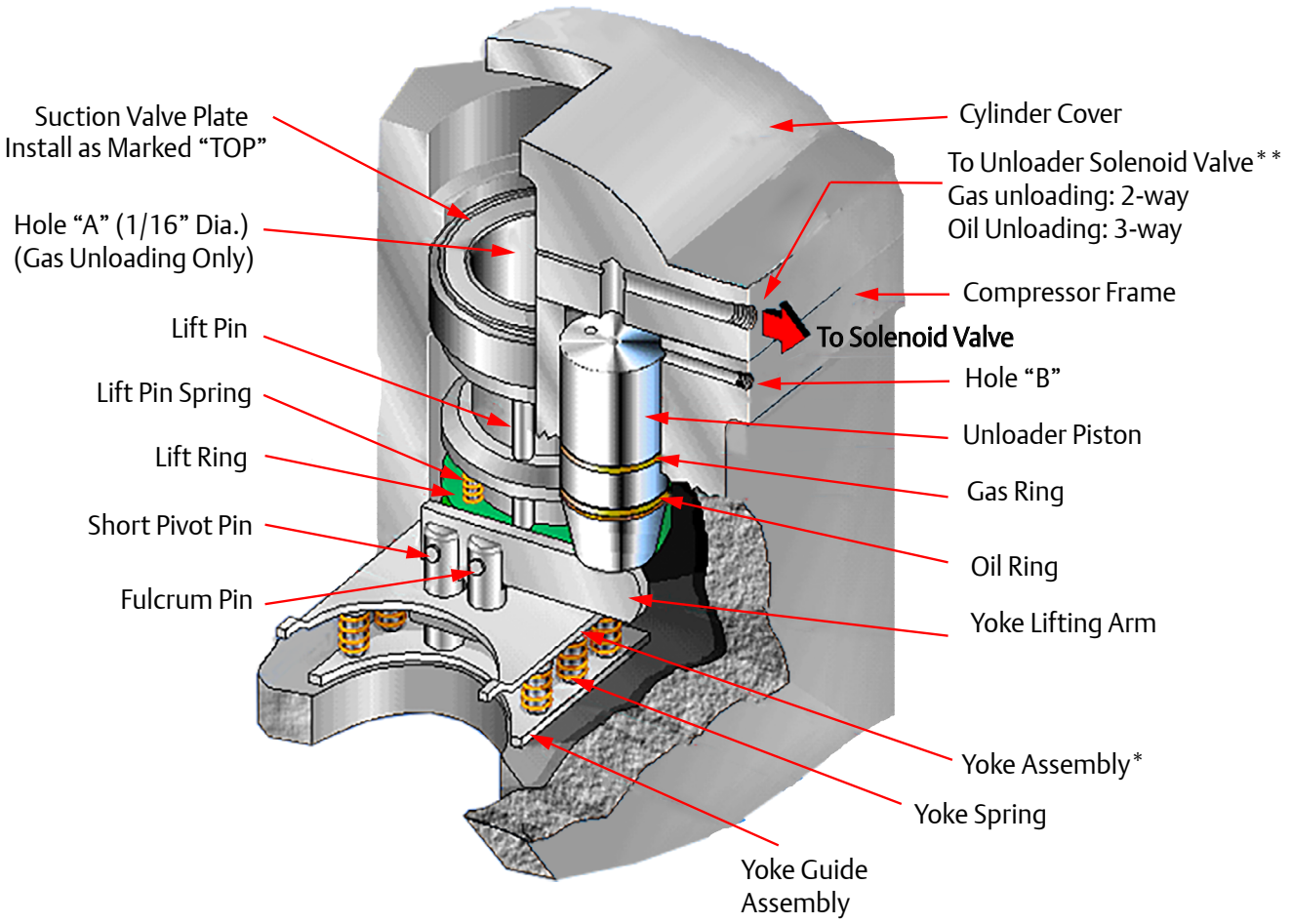
NOTE

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.

Reassembly

1. 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.
2. Put the suction valve springs into their holes with the end that has two coils closely wound towards 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 without 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.
3. 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.



** Compressor Application Note

- Oil Actuated Unloading is standard on:
- High Stage with 100% internal CR
- Booster
- Both Stages of integral 2-Stage

* Yoke assembly is bolted down on one end, as shown, on all compressor banks equipped with optional single cylinder unloading. All other compressors do not use these bolts.

Figure 5-10. Typical Capacity Control Mechanism Arrangement - 450XL Compressors (New Style Bullet Type)

Compressor Drive Types

NOTE
Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4

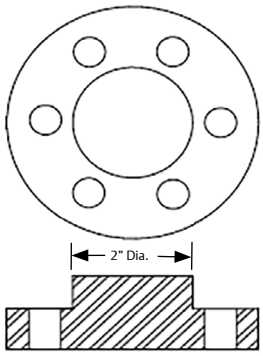
V-Belt Drive Compressors

Belt Removal

1. Remove belt guard.
2. Loosen motor rail clamps.
3. 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.
4. If belts are to be reused, mark the belts to orientation on the drive.
5. The belts can now be removed.

Flywheel Removal

1. Remove flywheel screw holding the flywheel on the shaft.
2. Install flywheel puller on the flywheel.
3. An alternate tool can be fabricated from a 4½" (107.95 mm) diameter steel plate, ½" (12.7 mm) thick with three equally spaced 11⁄16" (17.46 mm) holes on a 3 ½" (82.55 mm) or 3 ⅞" (98.43 mm) bolt circle. See below:



4. Also needed are several 1¾" (44.45 mm) plate washers and three 5/8" (15.88 mm) x 1¾" (44.45 mm) long screws. Place several washers against the end of the shaft so they extend past the flywheel hub.
5. 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.

Sheave Removal

Specific instructions for motor sheave maintenance are located in the Appendices 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 flywheel 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.

CAUTION

Wear gloves while inspecting sheaves, to avoid cuts caused by burrs, chips or sharply worn pulley edges.

Sheave grooves should be kept smooth and uniform. 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, since dust, oil and any foreign matter could cause pitting.

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. If the sheave walls are allowed to “dish out”, the bottom shoulder will wear the belts quickly, by chewing on their bottom corners:

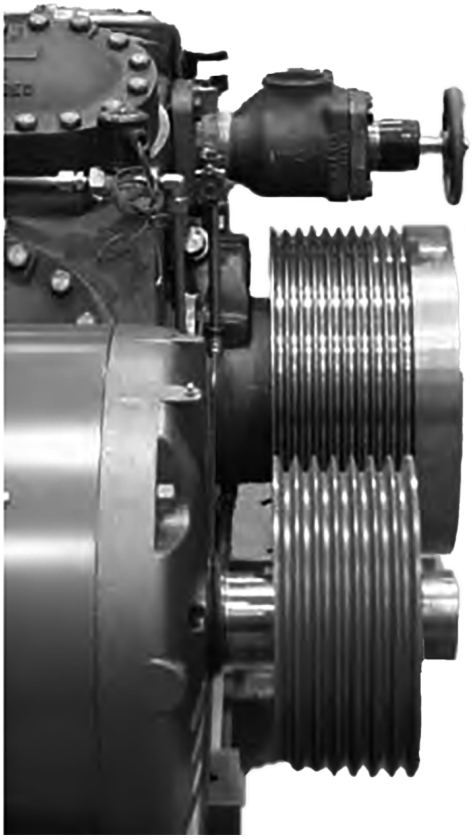
The groove bottom should also be checked for polishing, as this indicates the belt is not riding correctly in the groove. What has happened is the belt or groove has worn to the point the belt is actually rubbing on the bottom of the groove. This effectively changes the pitch diameter of the sheave or 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.

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.

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.

456XL Booster



458XL High Stage

Figure 5-11. Unit Belting Requirements Due to Horsepower

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 supported. Any piping stress must not be permitted to act on the compressor frame. The base must be secured to the floor and 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 compounds should be used in the installation of the motor sheave and bushing, or the crankshaft 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 pressure 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 parts are tightened, it will create a sliding layer between the parts. 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 short time.

Drive Alignment

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

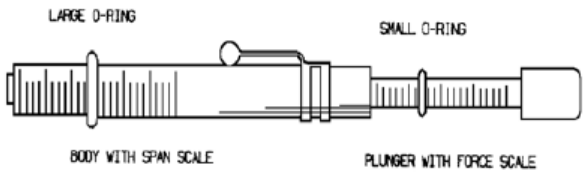
The last check is the parallel alignment. This check aligns the belt grooves of the pulley and sheave. The measurement is taken from a straight edge held at the outer rim to the edge of the first groove used on the compressor pulley (usually not all grooves are filled due to horsepower requirements). 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 assure 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 (Vilter Part No. 3072A), see below:



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 1/64" 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 19/64" (7.54 mm) and the tension required to achieve it 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 remove the slack from the belts. Measure the outside circumference to the nearest ¼" (6.35 mm). Multiply this reading by ¾% (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" = 80.8"

Direct Drive Compressors

Coupling Removal

1. Remove the guard.
2. Remove the bolts that extend through the coupling and remove the center member.
3. 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.
4. 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.
5. 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 crankshaft. Make a hole in the center of the bar for a 5/8" (15.88 mm) bolt, thread the hole or weld a 5/8" (15.88 mm) nut in-line with the hole.
6. Bolt this bar loosely to holes in coupling.
7. 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 5/8" (15.88 mm) bolt, apply force to center crankshaft and a pulling force on the coupling. See Appendix L for more details.

Coupling Replacement

1. Inspect the compressor coupling bore and crankshaft to make sure they are clean and free of burrs.
2. Apply anti-seize to shaft and coupling bore.
3. Place the key on the shaft and slip on the coupling.
4. Install the bolt (and washer, if required), and tighten.
5. Reassemble shim pack and center member in correct orientation.
6. Tighten bolts and note distance between hubs per coupling manufacturer's bulletin. This bulletin is located in the Appendix Section.
7. Recheck alignment, if necessary. See Appendix L for more details.

Capacity Control

Old Style (Mushroom Type)

Lift Pins, Ring and Springs Removal

The valve lifting mechanism consists of:

- Lift pins
- Lift ring
- Lift springs

All assembled to the cylinder liner.

Follow these steps to remove these parts from the cylinder liner:

1. Place the liner on a flat surface in an upright position.
2. Rotate the lift ring slightly until the four semi-circular notches line up with the lift pins, and slide the ring down off the liner.
3. Lift the pins out of the top of the liner.
4. In order to put the unloading mechanism onto the cylinder liner, set the lift ring on a flat surface with the guides for the lift springs facing up.
5. Next, place the cylinder liner inside the lift ring.
6. Drop the four lift pins into their holes in the liner with the notched ends of the pins facing down and the flat side facing out.
7. Lift the rings so the semicircular notches slide over the pins.
8. Then, rotate the lift ring so the springs fit into their holes in the cylinder liner.

Unloader Mechanism Removal

Follow these steps to remove the capacity control unloader mechanism from the machine:

1. Push the unloader piston down with a block of wood. This holds the assembly depressed and makes handling much easier.
2. Push the assembly away from the unloader piston until the notch in the yoke lifting arm slides free of the flats on the long pivot pin.
3. Then, remove the mechanism through the liner hole in the top of the frame. Remove the long pivot pin from the shaft of the piston.
4. Now slide the piston out of the cylinder and slip the ring or rings off the piston, taking care not to break any.

NOTE

Gas actuated unloader pistons have two grooves and use four metal piston pins. Oil actuated unloader pistons have one groove and use a rubber piston ring (O-ring).

Unloader Mechanism Replacement

Oil Actuated Unloader Piston:

1. Clean the piston thoroughly and place the O-ring on it. Work the O-ring on carefully to avoid breaking or excessively stretching it.
2. Liberally coat piston and O-ring, as well as cylinder bore, with compressor oil.
3. Place the piston in the cylinder and compress the O-ring to work it into the cylinder.
4. Next, insert the long pivot pin into its hole in the piston shaft and position it so the flats will receive the slot of the yoke lifting arm. The end of the pin is machined flat so the installer can see the position of the inner flat.
5. Compress the yoke assembly and place a piece of 5/16" (23.81 mm) o.d. steel rod under the rear of the lifting rod. This keeps the yoke depressed for easier handling.
6. Place the yoke into the frame through the cylinder opening and position it so the slot on the yoke lifting arm registers with the flats on the long pivot pin.
7. Depress the piston with a block of wood, and remove the rod or piece of wood used to hold the yoke assembly depressed.
8. Then, center the assembly between the two cylinder liner holes.

New Style (Bullet Type)

Lift Pins, Ring and Springs Removal

1. In order to put the unloading mechanism back in the cylinder liner, place the lift pins with the springs around them in their holes.
2. 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.
3. 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 unloader 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 ¼"-20NC 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

1. Before reinstalling piston, remove old ring set.
2. Clean and inspect for wear. Replace piston if wear is excessive.
3. A ring set consisting of "PTFE" outer ring and a silicone rubber inner ring is used on the piston. Replace ring set carefully with a new one every time a piston is removed.
4. With eyebolt removed, place the piston into its hole in the frame.
5. 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.
6. Push the piston down until it touches the yoke lifting arm.

Unloader Mechanism Removal

Before a capacity control unloader mechanism can be removed from the compressor, at least one of its corresponding cylinder liners must be removed.

1. The first step in removing capacity control unloader from the machine is to push the unloader piston down with a block of wood.
2. Then take a piece of steel (5/16" 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.
3. Then remove the unloader piston as detailed above. The mechanism can then be removed through the cylinder liner hole in the frame.

Unloader Mechanism Replacement

1. Compress the yoke assembly and place a small piece of wood or a 5/16" (7.94 mm) O.D. steel rod between the two vertical rods mentioned in Unloader Mechanism Removal. This keeps the yoke depressed for easier handling.
2. Then place the mechanism into the frame through the cylinder liner opening and position it.
3. Install unloader piston as detailed above.
4. Depress the unloader piston with a block of wood and remove the rod or piece of wood used to hold the yoke assembly depressed. Then center the mechanism between the two cylinder liner holes.

Safety Valve (Internal Relief)

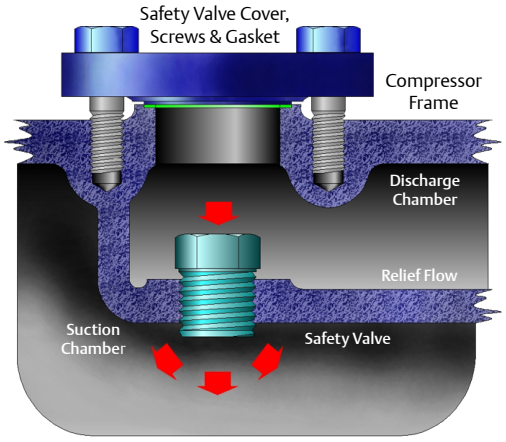
NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

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, follow these steps:

5. Remove the cover on the top of the compressor frame marked "safety valve" by taking out the two screws which hold it in place.
6. Then, remove the safety valve by using a standard 1¾" (44.45 mm) socket.



NOTE

Safety Valve is set at a differential pressure of 300 PSIG (2069 kPa). Maximum discharge temperature is 300°F (150°C).

Replacement

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

Oil Pressure Adjustment Assembly

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.

1. Remove the cap. A packing tool is required to remove the gland nut (Vilter Part No. 33781A).
2. After the gland nut has been removed, use a large screwdriver to turn the stem counterclockwise and remove it completely. The packing with 2 washers should also come out.
3. Using a pencil magnet, pull out the spring and steel ball.

Reassembly

1. Clean the steel ball and place in the hole.
2. Place the stainless steel spring on top of it.
3. Screw the adjustment stem in the hole to get threads started.
4. Place a washer over the end, then packing, then the other washer.
5. 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.
6. Replace the cap and gasket afterwards.

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 indicator reading while the compressor is running.

Tri-Micro Oil Filter

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

NOTE

Before proceeding, refer to “General Service Instructions” on pages 5-3 to 5-4.

Removal

1. To remove the oil filter, drain the tank by removing the pipe plug on the bottom or side.
2. Next remove one of the front screws. It can then be threaded back in at least 2 turns, or a ¼” (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.
3. By unscrewing the remaining 3 screws alternately, the tank will start to lower until the first screw installed comes in contact with the filter adapter.
4. Force the center tube top plate down and out of its connection hole while pivoting the filter tank.
5. Now that the filter and center tube can be removed, disassemble the center tube by removing the bottom spring plate.
6. Slide the old filter off and discard properly. The tube should be washed off and cleaned.

Replacement

1. Make sure to remove the used gasket of the filter adapter and install a new one.
2. After cleaning the tank, reinstall the pipe plug in the drain. Install it on its pivot screw.
3. Add fresh oil to fill half the tank. Reassemble the new filter on the center tube.
4. Slowly place the filter in the tank and allow the filter to absorb the new oil.
5. Pivot the tank under the adapter and align the center tube in its hole.
6. Start the remaining 3 screws then 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.

Oil Pump Assembly

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

Removal

To remove the oil pump assembly, follow these steps:

1. Remove the filter tank and adapter from the rear housing. Be prepared for a small amount of oil to drain from adapter.
2. The pump will be exposed in the center and the outer pump housing will be covered by a gasket.
3. Remove gasket.
4. At the top right and bottom left, you will find tapped holes to aid in removing the pump, if necessary.
5. The pump housing is approximately 1½" (38.1 mm) thick, so it requires jack screws 2" (50.8 mm) or longer to release the inner gasket.
6. 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.

Replacement

To replace the oil pump assembly, follow these steps:

1. Rotate the crankshaft so the drive key is hanging from one of four screws through the rear bearing retainer.
2. Make sure the small orifice plug in the rear housing (at the 12 o'clock position) is clear.
3. Clean all gasket surfaces. Install gasket (Vilter Part No. 31899A), correctly aligning oil passage holes.

4. 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.
5. Install the pump and seat it against the inner gasket. The outer surface of the pump should now be recessed approximately 1/8" (3.175 mm) to the rear bearing housing.
6. Install gasket (Vilter Part No. 31900A), correctly aligning the holes. The slot in this gasket should be at the 9 o'clock position.

7. Place the rubber seal gasket on the filter adapter, and reattach the filter assembly onto the rear housing.
8. Install screws and tighten down evenly.

Preparation for Internal Servicing

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

Handhole Cover Removal

To work internally on the compressor, follow these steps:

1. Remove the hand hole cover and crankcase oil to gain access.
2. The heater will have to be electrically disconnected at this time.
3. Remember to shut the power off and lock it out.
4. After disconnecting the wiring, loosen all but two screws on the upper corners of the cover. This helps support the cover during removal and prevents damaging the heater. If the cover sticks to the frame, a slight tap with a lead or soft face hammer will free it.
5. Holding the cover in place, remove the two remaining screws, and pull the cover straight back away from the frame.
6. Remove any gasket material from the cover and frame face.
7. Also inspect and remove any burrs or rough edges from the mating surfaces to ensure a tight seal at time of reassembly.

Handhole Cover Reassembly

1. Lightly lubricate both sides of a new gasket with refrigerant oil or general purpose grease.
2. Place the gasket on the cover, and guiding in the heater, place the cover against the frame opening.
3. 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.
4. Start the rest of the screws in their holes and continue to check gasket placement.
5. Tighten screws evenly to the torque requirements in Table 5-3 or 5-4 (depending upon compressor model).
6. Connect the heater wiring and heater cover, add oil to crankcase and turn on power to the heater to preheat the oil for operation of compressor.

Torque Specifications

Refer to the following tables for torque specifications.

Table 5-3. Torque Specifications - VMC Model 440

Item No.	VPN	Bolt Size	Grade	Required Torque	Application
102	13152L	5/8 x 3½	2	95 Ft. Lb.	Head Bolt with H_2O Jacket
102	13152G	5/8 x 2½	2	95 Ft. Lb.	Head Bolt without H_2O Jacket
112	13152C	5/8 x 1½	2	95 Ft. Lb.	Suction Screen Cover
112	13152D	5/8 x 1¾	2	95 Ft. Lb.	Suction Screen Cover
112	2796E	½ x 1½	5	75 Ft. Lb.	Suction Screen Cover
112	2796EJ	½ x 1¼	5	75 Ft. Lb.	Suction Screen Cover
121	13152E	5/8 x 2	2	95 Ft. Lb.	Safety Valve Cover
128	2796E	½ x 1½	5	75 Ft. Lb.	Handhole Cover
201	17355A			20 Ft. Lb.	Cap, Valve
209	13264B	Plug, ¼ Hex. Pipe Plug		20 Ft. Lb.	
210	13264C	Plug, 3/8 Hex. Pipe Plug		35 Ft. Lb.	
213	13159E	5/8 x 4	5	100 Ft. Lb.	Front Bearing Cover
215	13152E	5/8 x 2	2	100 Ft. Lb.	Front Bearing Cover
216	2796EV	½ x 4	5	75 Ft. Lb.	Front Bearing Retainer
219	2976EL	½ x 1¾	5	75 Ft. Lb.	Shaft Seal Cover
224	KT366				Nut 440 Lock Small Crank Ret Comp
232	1736G	5/16 x 1½	2	11 Ft. Lb.	Rear Bearing Retainer
232	13160D	5/16 x 1	2	11 Ft. Lb.	Rear Bearing Retainer
236	11396D				(See Item 243)
243	1726E	½" Nut	2	50 Ft. Lb.	Center Bearing Support- Half Bolt (Used on Item 236 ½ x 1 ¾ Bolt VPN 11396D)
244	13253F	9/16" Nut	2	65 Ft. Lb.	Center Bearing Tapered Pin
247	31956A	1 x 1⅞	2	250 Ft. Lb.	Flywheel Hub
302	2606A	¾" Hex Socket Pipe Plug		75 Ft. Lb.	
323	2796DM	7/16 x 2	2	30 Ft. Lb.	Oil Filter Shell
326	13152E	5/8 x 2	2	100 Ft. Lb.	Rear Bearing Cover
327	2796EL	½ x 1¾	5	75 Ft. Lb.	Oil Pump Cover
341	13152E				Same as 326
342	2796EL				Same as 327
419	1352D	3/8 x 1		20 Ft. Lb.	Yoke Assembly
509	2027A	3/8-24 Nut	8	*	Conn. Rod Cap
510	2028A	3/8 Palnut		*	Conn. Rod Cap w/Nut Lock
513	1776B	3/8" Locknut	5	25 Ft. Lb.	Discharge Valve Retaining
510A	1472A	3/8" Locknut	3	15-18 Ft. Lb.	Discharge Valve Retaining
518	31964A	3/8 x 1⅜	3	15-18 Ft. Lb.	Use with 510A
518	1527B	3/8 x 1½	3	20-25 Ft. Lb.	Use with 513

Note- *: Refer to 'Connecting Rod Nuts Tightening Instructions', Tables 5-5 & 5-6.

Table 5-4. Torque Specifications - VMC Model 450XL

Item Number	VPN	Bolt Size	Grade	Required Torque	Application
102	13152L	5/8 x 3½	2	95 Ft. Lb.	Cylinder Head
112	13152E 2796E	5/8 x 2 ½ x 1½	2 5	95 Ft. Lb. 75 Ft. Lb.	Suction Screen Cover
116	13264E 13264D	¾" Hex Pipe Plug ½" Hex Pipe Plug		75 Ft. Lb. 50 Ft. Lb.	Plug
121	13152E	5/8 x 2	2	95 Ft. Lb.	Safety Valve Cover
125	2796E	½ x 1½	5	75 Ft. Lb.	Handhole Cover
201	17355A			20 Ft. Lb.	Valve Cap
209	13264B	¼" Hex Pipe Plug		20 Ft. Lb.	Front Bearing Cover
210	13264C	3/8" Hex Pipe Plug		35 Ft. Lb.	Front Bearing Cover
213	13159E	5/8 x 4	5	100 Ft. Lb.	Front Bearing Cover
215	13152E	5/8 x 2	2	100 Ft. Lb.	Front Bearing Cover
216	2796EV	½ x 4	5	75 Ft. Lb.	Front Bearing Retainer
219	2796EL	½ x 1¾	5	75 Ft. Lb.	Shaft Seal Cover
224	KT 367				Bearing Locknut
232	1736G	5/16 x 1½	2	11 Ft. Lb.	Rear Bearing Retainer
236	13153F	½ x 1¾			Machine Bolt
243	1726E	½" Nut	2	50 Ft. Lb.	Bearing Support Half
244	2796EL	9/16" Nut	2	65 Ft. Lb.	
247	31956A	1 x 1 7/8	2	250 Ft. Lb.	Flywheel Hub
323	2796DM	7/16 x 2	2	30 Ft. Lb.	Oil Filter Shell
334	13152E	5/8 x 2	2	95 Ft. Lb.	Rear Bearing Cover
335	2796EL	½ x 1¾	5	75 Ft. Lb.	Oil Pump
419	1352D	3/8 x 1		20 Ft. Lb.	Yoke Assembly
504	2027A	3/8 x 24 Nut	8	*	Connection Rod Cap
505	2028A	3/8" Palnut		*	Connection Rod Cap

Note-

*: Refer to 'Connecting Rod Nuts Tightening Instructions', Tables 5-5 & 5-6.

Table 5-5. Plain Nuts Torque

Connecting Rod Assembly	Torque Value
A33171A (Aluminum)	18 to 21 ft. lb. (24 to 28 Nm)
A31045D (Steel)	30 to 35 ft. lb. (41 to 48 Nm)
A34762A (Steel)	30 to 35 ft. lb. (41 to 48 Nm)

Table 5-6. Lock Nuts Torque

Adaptor Part No.	Drive	Overall Dimension	Torque Limit Setting	Use w/Rod
2287A	3/8"	1 3/8"	19 ft. lb. (26 Nm)	A33171A
2287B	½"	1 5/8"	33 ft. lb. (45 Nm)	A31045D OR A34762A

Connecting Rods and Pistons

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

Disassembly

After the cylinder covers, valves and handhole cover have been removed, follow these steps:

1. Remove the Palnut® locknuts on the rod bearing bolts to remove the piston and rod assembly.
2. 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.
3. Handle the bearing cap carefully to avoid damage 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.
4. 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.
5. 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.

440 VMC Compressors Only

1. To remove the rod from the piston, take out the piston pins.
2. Remove the spring locks from the pin hole on each side of the piston and slide out the pins. If this cannot be accomplished by hand, it may be necessary to force the pin out with a brass rod and hammer.
3. Be careful not to damage spring lock grooves. To remove the piston rings, use the ring expander. Caution should be exercised to prevent the rings from scoring the piston.

450XL VMC Compressor Only

1. If the piston rings are to be removed, wrap a piece of thin shim stock around the piston.
2. 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.

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.

3. 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.
4. 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.
5. Remove the piston assembly.

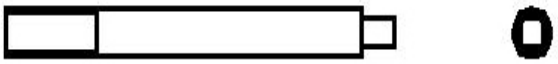
6. Check the fit of the piston pin bushing for wear. The 440 has a different pin and piston design from the 450XL compressor. The 440 piston and piston pin bushing have a "slip" fit. When replacing the piston and bushing, the bushing must be reamed to the correct "slip" fit after installation into the 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. The piston pin should not slip easily into its hole, but it must not be driven down. It 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.
7. 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.

8. 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.
9. 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.
10. 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.
11. 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 Compressing Tool, see image below.
12. 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.

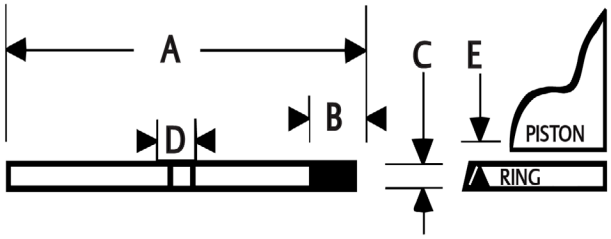


The front cover assembly and disassembly stud is shown above.

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 5-3 or 5-4 (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.

See Table 5-7 for piston ring dimensions and tolerances, according to image below:



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 Palnut should be turned until mating parts are pulled together and actual tightening begins.

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 Palnuts must be used each time the connecting rods are reassembled to the crankshaft. If used Palnuts are installed, their locking feature 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.

Table 5-7. Piston Ring Dimensions and Tolerances

Dimension	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

Cylinder Liners

WARNING

Follow local lock-out/tag-out procedure. Failure to comply may result in serious injury, death and/or damage to equipment.

WARNING

Avoid skin contact with any liquid refrigerant or oil. Wear rubber gloves and a face shield when working with liquid refrigerant or oil. Failure to comply may result in serious injury or death.

WARNING

When working with refrigerants, ensure there is adequate ventilation and refrigerant vapor detectors as per ASHRAE standards. Failure to comply may result in serious injury or death.

WARNING

At shutdown, open any other valves that may trap liquids to prevent serious injury and/or damage to equipment.

NOTICE

Recover or transfer all refrigerant vapor in accordance with local ordinances before opening any part of the package unit to atmosphere.

CAUTION

Late model VMC compressors may push liners out.

NOTE

Before proceeding, refer to "General Service Instructions" on pages 5-3 to 5-4.

Removal

Once the piston and rod assemblies are removed, the liner can be extracted from the frame by means of a Vilter Liner Pulling Tool (KT257). This tool, or similar, is required for all 440 compressors.

NOTE

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

The liners 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.

Lift Rings For Unloading

There are two styles of unloading lift ring assemblies.

440 Lift Ring Assembly

1. Rotate the lift ring to align the notches with the pins. The springs will follow.
2. The lift ring will then drop to the bottom of the liner.
3. Note the position of each lift pin. They will have to be returned to that position for reassembly.
4. Push the lift pins up and out of the top of the liner to remove them. The assembly of the lift ring is the reverse order of disassembly.
5. Place the lift ring on a flat surface with the notches facing up.
6. Put the liner in the center of the ring, and place a spring on each roll pin in the ring.
7. Install a lift pin in each of the 4 slots along the outside of the liner.
8. The flat on the bottom of the lift pin should be flush to the diameter of the liner.
9. Lift the ring up the liner, and engage all four lift pin slots in the notches on the ring.
10. Rotate the ring so the four springs engage in the holes of the lift ring stop.

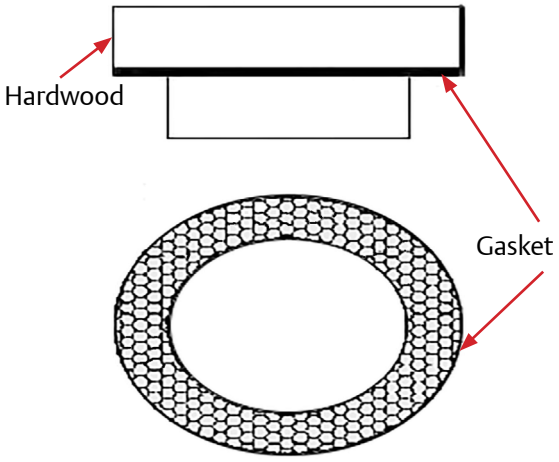
450XL Lift Ring Assembly

1. Invert the liner and place on a flat surface.
2. Locate the notched end of the snap ring that retains the lift ring, while pushing down on the lift ring in this area. Pry the snap ring out of its groove and continue all the way around the liner.
3. 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.
4. Reverse the procedure to install a lift ring assembly on any 450XL liner.

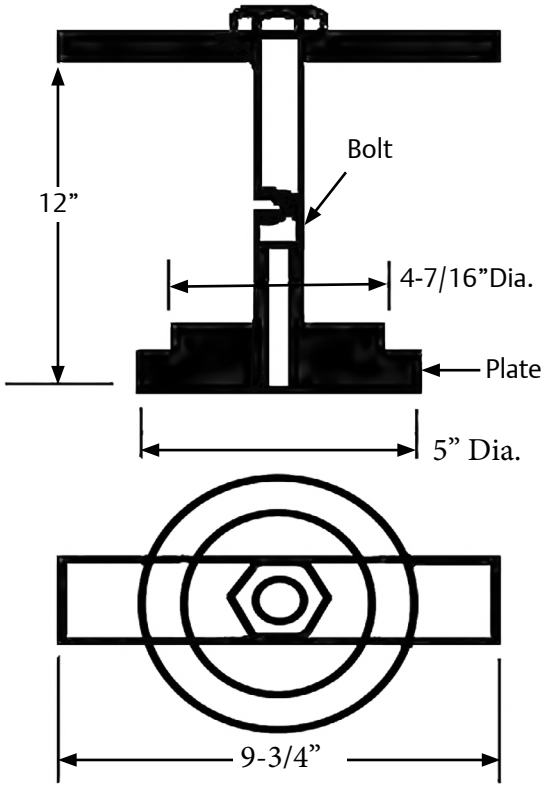
Installation of Liners

1. 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.
2. If a new O-ring is required, lubricate the O-ring and frame seating area with refrigeration oil.
3. 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".

4. Seat the liner in the frame recess firmly by use of Vilter Cylinder Liner Tool (Vilter Part No. 33464A). A similar tool can be constructed. Be sure to protect the liner lapped seats to prevent damage.



See the cylinder liner removal tool below:



Crankshaft

General

Removing the crankshaft from the compressor is basically the same for all units, regardless of size. Because of a center bearing on all 12 and 16 cylinder compressors and the radius the 8 cylinder throws on the crankshaft, an extra step must be taken. A crankshaft may be removed from either end of the compressor. It is, however, 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.

Removal From Drive End

1. 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.
2. Remove the shaft seal and inner retainer.
3. Replace the two 5/8” (15.88 mm) x 4” (101.6 mm) socket head screws with threaded studs to support the front housing during removal.
4. Remove the 65/8” (168.28 mm) x 2” (50.8 mm) cap screws that hold the housing to the frame.
5. 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 and 4516XL 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.

On a 12 or 16 cylinder compressor, the center bearing must be freed. Follow these steps for the removal:

1. Remove the oil circuit piping tee in the middle of the oil cooler side on the frame.
2. Slip out the spring behind the tee with a piece of wire.
3. Secure a ½”-13NCx10” long rod. Screw this into the threads in the end of the oil feed connector tube.
4. Remove the tube from the frame with a slight pull on the rod.

After the tube is taken out, separate the nut from the taper pin in the center bearing and tap the pin out of its hole. This releases the center bearing and allows the crankshaft to be removed.

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:

1. Before removing the shaft from the rear housing, remove the rear bearing retainer and tap the center hole to 1¼" (31.75 mm) NPT.
2. Reinstall the retainer on the end of the crankshaft. A 1¼" (31.75 mm) pipe can be threaded into it and used as an extension bar for handling the crankshaft during removal.

Removal From 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 and on all 12 and 16 cylinder compressors, the center bearing needs to be freed.

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

Servicing the Center Bearing (12 and 16 Cylinders)

The center bearing on this compressor is a split sleeve type bearing much like connecting rod bearings.

1. To disassemble the bearing, remove the four bolts holding the halves of the center bearing housing together.
2. The bearing inserts are snapped into place and can readily be removed by pushing them out by hand.
3. Clean the bearing housing thoroughly before installing new inserts.
4. Snap the inserts into place.
5. Lubricate the bottom half with refrigeration oil, and position it on the crankshaft.
6. Do the same to the upper half, and locate it using the dowel pins provided.
7. When aligned, bolt the halves together and tighten with a torque wrench to the values listed in Tables 5-4 or 5-5 (depending upon compressor model).

NOTE

If oil dams are present on the center housing, they will need to be reinstalled if only changing the insert bearing. The current center housing does not require these dams.

Re-installation

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.

1. 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.
2. If the unit is 12 or 16 cylinder, the center bearing must be guided into place.
3. Align the hole in the bearing housing (for the oil feed connector tube) with hole in the frame.
4. Screw the oil feed connector loosely on the end of the ½" (12.7 mm) threaded rod, and insert it into the hole.
5. Push the tube into the bearing housing.
6. Unscrew the rod from the tube.
7. Place the spring in the hole and screw in the "tee".
8. Use thread sealant.
9. Insert the taper pin it its hole.
10. After placement, pin must be tightened. This expands the bearing housing so it fits tightly in the frame for quiet operation.

Modification to Front Bearing Retainer and Front Bearing Cover After Compressor Serial Number 21354 (440 Compressor only)

Compressors below serial number 21355 were furnished with the front bearing cover assemblies:

- A30294A (no longer available) for 2, 4, 6 and 8 cylinders
- A32162A for 12 and 16 cylinders

Front bearing retainers:

- 38115A for 2, 4, 6 and 8 cylinder
- 33500A for 12 and 16 cylinders (without the oil hole).

Former front bearing retainers (31885A or 33500A) without oil holes cannot be used with current bearing cover assemblies A36240A and A36241A. There is no provision for oil to get to the bearings.

If the front bearing cover is being replaced, a current front bearing retainer must be ordered also, unless one of these current styles is already being used. If a current front bearing retainer is used with former style cover having an oil hole, remove orifice in cover and replace with solid 1/8" (3.2 mm) flush pipe plug.

See Figure 5-12 for location and description of oil hole in current bearing retainer.

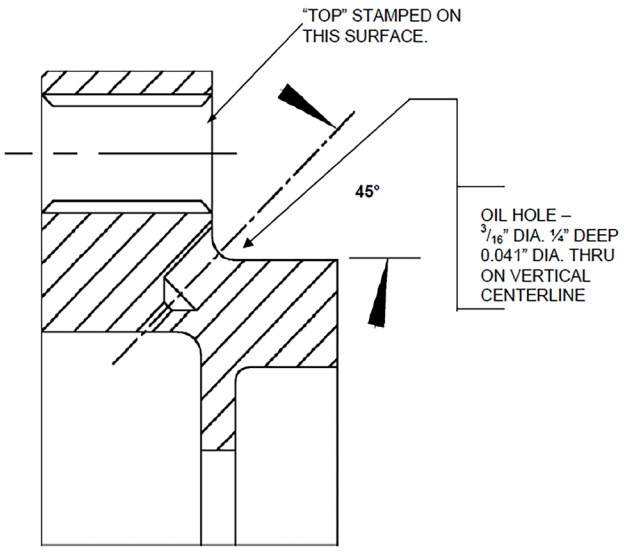


Figure 5-12. Retainer Partial Vertical Cross-Section

Connecting Rod Nuts Tightening Instructions for VMC Compressors

All VMC Compressors connecting rod bolts use a plain nut with a spring steel locknut ("Palnut©") combination.

Plain Nuts

Plain nuts may be re-used. Torque the plain nuts according to Table 5-5.

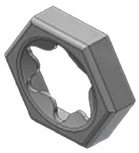
Lock Nuts

New, unused locknuts ("Palnuts") must be used each time the connecting rods are serviced. After the plain nut is torqued to the specified value (see Table 5-5), assemble the Palnut to the rod bolt with the open end of the hexagon pointing away from the hex, plain nut.

CAUTION

OPEN END MUST POINT AWAY FROM PLAIN NUT. If palnut is installed the other way, it will not lock and will eventually work loose, during operation.

Turn the Palnut until the mating parts are pulled together and tightening begins. Final tightening and locking of the Palnut is achieved by an additional 1/3 to 1 /2 (maximum) turn. Order spare Palnuts by Vilter part number 2028A.



Socket

A special, shallow hexagon socket is available for easier assembly. This socket is 7/8" in diameter, 2¼" long and has a 3/8" square socket drive. The socket is specially made for this type of nut, allowing more convenient gripping and tightening of the Palnut. Order Vilter part number 2040A.

Torque Limit Adaptor

Also available is a torque limit adaptor. This lightweight, compact, rugged, and square male drive tool is factory set to a predetermined torque value. Use with any socket driving device. The adaptor allows the accurate torquing of the plain nut to the specified value in the confined crankcase space. One adaptor is needed for each different connecting rod. Order by part number listed in Table 5-6.

Table 5-8. Factory Running Dimensions, Tolerances, Clearances and Allowable Wear Limits (1 of 3)

Item	Part Name	Compressor Size	Dimension	Tolerance	Clearance	Maximum Allowable Wear
1	Crankshaft Main Brg. Journal: Drive End	2, 4, 6, 8	2.8145" Dia.	+0.000" -0.001"	-0.0015 0.0000	NONE
		8 HD, 12, 16, 450XL –ALL	3.1895" Dia.	+0.000" -0.001"	-0.0020 -0.0005	
	Pump End	ALL	2.8140" Dia.	+0.000" -0.001"	-0.0015 0.0000	
2	Main Bearing I.D.: Drive End	2, 4, 6, 8	2.8125" Dia.	+0.0005" -0.0000"	PRESS FIT ONTO SHAFT	NONE
		8 HD, 12, 16, 450XL - ALL	3.1875" Dia.			
	Pump End	ALL	2.8125" Dia.	+0.0005" -0.0000"		
	End Play Bench	ALL	0.008"	+/-0.001"		NONE
	Mounted	2,4,6,8	0.0073" 0.0002"	0.0071"	0.0073" 0.0002"	0.009" Max. End Play
		8 HD, 12, 16 450XL - ALL	0.0074" 0.0008"	0.0068"	0.0074" 0.0008"	
1	Crankshaft Crank Pin: Std. Size	ALL Except 450XL	2.874" dia.	+0.000" -0.001"	0.0015 to 0.0036	0.002"
	0.015" U.S.	ALL Except 450XL	2.859" dia.			
	0.030" U.S.	ALL Except 450XL	2.844" dia.			
	Std. Size	450XL ALL Models	3.124" dia.			
	0.015" U.S.	450XL (ALL)	3.109" dia.			
	0.030" U.S.	450XL (ALL)	3.094" dia.			
3	Connecting Rod I.D.: With Large End Bearings Installed	ALL Except 450XL	2.8755" dia.	+0.0011" -0.0000"		0.001"
		450XL	3.1255" dia.			
	With 0.015" U.S. Bearings Installed	ALL Except 450XL	2.8605" dia.			
		450XL	3.1105" dia.			
	With 0.030" U.S. Bearings Installed	ALL Except 450XL	2.8455" dia.			
		450XL	3.0955" dia.			
4	Shell Bearing Thickness: Std.	ALL	0.0750"	+0.0000" -0.0003"	NONE (Bearing To Rod)	0.0005"
	0.015" U.S.		0.0825"			
	0.030" U.S.		0.0900"			
3	Connecting Rod: Width	ALL	0.994" 0.993"	0.001"		0.001" No Scuffing
	Side Clearance		0.006" Each rod	+0.001"		

Table 5-8. Factory Running Dimensions, Tolerances, Clearances and Allowable Wear Limits (2 of 3)

Item	Part Name	Compressor Size	Dimension	Tolerance	Clearance	Maximum Allowable Wear
1	Crankshaft Center Bearing O.D.	12, 16	3.999" Dia.	+0.000" -0.001"	0.0020" to 0.0046" Theoretical Vertical	0.002"
4	Shell Bearings I.D.		4.0010" Dia.	+0.0026 -0.0000		0.0005"
	Thickness		0.1255" Dia.	+0.0000 -0.0003		
5	Piston O.D.	ALL	4.4955" * Dia.	+0.000" -0.001"	0.0045" to 0.0065"	0.001"
6	Cylinder Bore		4.500" Dia.	+0.001" -0.000"	0.0045" to 0.0065"	0.005"
	O.D.		5.9965" Dia. 5.9955" Dia.	0.001"	0.0035" to 0.0055" (loose)	NONE
7	Frame Bore		6.000" Dia.	+0.001" -0.000"	0.0035" TO 0.0055" (loose)	NONE
5	Piston Pin: Bore	ALL (Except 450XL)	1.1250" Dia. 1.1248" Dia.	0.0002"	Finger Tight (Dry)	Drops Thru
		450XL (ALL)	1.1241" Dia. 1.1238" Dia.	0.0003"	Tight 0.0007" 0.0012"	NONE
	Pin Dia.	ALL	1.1250" Dia.	+0.0000" -0.0002"	See Above Pin Bore	0.0005"
3	Connecting Rod Pin Bushing (I.D.)	ALL	1.1257" Dia. 1.1254" Dia.	0.0003"	0.0004" to 0.0009"	0.001"
8	Rings Piston End Gap: Compression		0.013"-0.025"	0.012"	Measured In a 4.500" Bore	0.025"
	Oil (Solid)		0.013"-0.023"	0.010"		0.025"
	Oil (Flex)					
	Oil (Rails)					
	Fit in Groove: Compression		0.002"/0.004"	0.002"	Measured in Piston Groove	0.002"
	Oil (Solid)		0.0015"/0.004"	0.0025"		
	Oil (Flex) with Rails					

Note-

*: Dimension does not apply to assembled 450XL piston on connecting rod (piston shrink fit to wrist pin).

Table 5-8. Factory Running Dimensions, Tolerances, Clearances and Allowable Wear Limits (3 of 3)

Item	Part Name	Compressor Size	Dimension	Tolerance	Clearance	Maximum Allowable Wear
9	Suction Valve Thickness	ALL	0.061”	+/- 0.003”	NONE	NONE
6	Cylinder Valve Seat: Height		0.036” to 0.026”	0.010”	NONE	NONE (Lapped – Flat to Seat)
	To Top of Liner		0.134” to 0.132”	0.002”		
	Piston Top To Bottom of Safety Head		0.035” 0.012”	0.023”	0.012”	0.010” Minimum Must be measured
10	Discharge Valve Thickness	440 ALL	0.0295”	+/-0.0025	NONE	NONE
		450XL Plate	0.040”	+/-0.002”		
		450XL Diaphragm	0.0295”	+/-0.0025"		
	Height of Discharge Valve Seat	ALL	0.031”	+/-0.010”		Measured from Head to Rail 0.005” Minimum Height
11	Oil Pump Axial Clearance (#2 Pump)	ALL	0.003” 0.006”	0.003”	0.003” 0.006”	0.002”

Crankcase Heater

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.**

To install or replace a crankcase heater on a 400 Series Compressor already in service, follow these steps:

1. Pump down the compressor as described in the service section.
2. If heater is to be replaced, use appropriate lock-out/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.
3. Next (only on 400 Series VMC Compressors), remove the handhole cover and substitute with a cover having a drilled and tapped hole for the heater.
4. 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 cannot be reinserted into the holes due to interference of the installed heater.
5. Insert the heater element through a tapped hole and tighten the fitting.
6. 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.

Figure 5-13. Oil Pressure Indicator

Using Non-Vilter Oils

CAUTION

Do not mix oils. Failure to comply may result in damage to equipment.

NOTICE

Vilter does not approve non-Vilter oils for use with Vilter compressors. Use of oils not specified or supplied by Vilter will void the compressor warranty.

Due to the need for adequate lubrication, Vilter recommends only the use of Vilter lubricants, designed specifically for Vilter compressors. Use of oil not specified or supplied by Vilter will void the compressor warranty.

Please contact your local Vilter representative or the Home Office for further information.

Charging Oil During Normal Operation

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

Charging oil at this point is done as follows:

1. Remove the oil pressure indicator and Stedy-Mount, Figure 5-13 on the left.
2. Connect the oil charging hose (electric or manual) to the oil pressure indicator connection.
3. Open the valve and begin charging.
4. Continue charging until a sufficient amount of oil is charged.
5. 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. Due to the need for adequate lubrication Vilter recommends only the use of Vilter lubricants, designed specifically for Vilter compressors. With the extensive research Vilter has performed, we are able to offer refrigerant specific lubricating oils. The use of oil not specified or supplied by Vilter will void the compressor warranty.

Oil Cooler

Temperature Control

The function of the oil cooler is to maintain specified oil temperatures. When the temperature of the oil rises above normal, this is an indication that some part of the temperature control system is not functioning properly, or of the presence of a system or mechanical problem in the compressor. Follow these steps to identify causes:

1. Inspect all manual and automatic control valves in the system for correct operation.
2. Check all pressure indicators and thermostats.
3. Inspect the water level to make sure proper flow through the cooler has been provided.
4. Clean all strainers.

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, take these considerations into account:

- Inspect the cooler for foreign deposits. When materials 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 whenever 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 inspections should govern the policy for future servicing. If zinc electrodes are corroded and coated with foreign material, electrode 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.

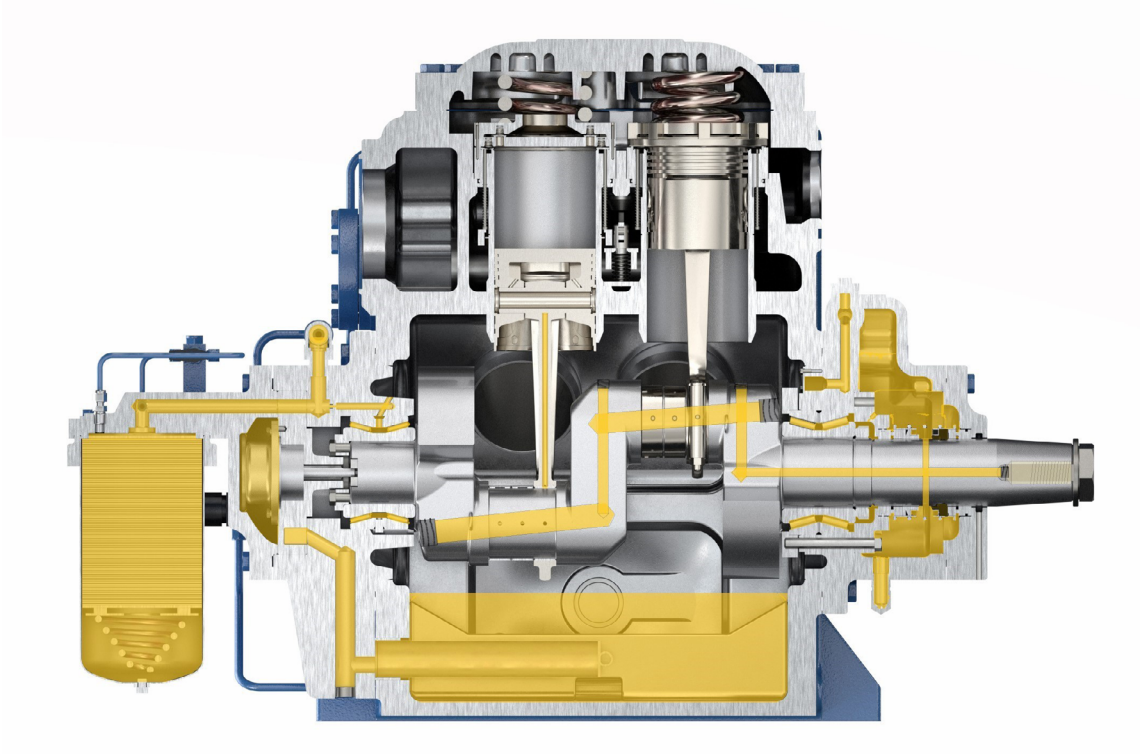


Figure 5-14. Typical 400 Series Compressor Vertical Cross-Section and Lubrication System

Compressor Unit Leak Check After Servicing

The compressor unit must be checked for leaks after servicing to ensure a tight system. For additional leak testing information, refer to Chapter VI of ASME B31.3 Process Piping Code.

CAUTION

Do not hydro test compressor unit. Failure to comply may result in damage to equipment.

1. If servicing the compressor unit was completed, proceed to Step 2. Otherwise, isolate the compressor unit from the house system, see Compressor Unit Isolation procedure.
2. Open all shut-off valves, check valves, control valves and solenoid valves in the system to be tested.
3. Slowly pressurize compressor unit through suction oil charging port with dry nitrogen.
4. Using appropriate soap solution, check for leaks on joints and connections of the serviced component.
5. If leaks are found, depressurize system and fix leaks. Repeat steps 3 and 4 until all leaks are fixed.
6. Evacuate from suction oil charging port.
7. Close all valves previously opened in the system. Remove tags as per the local lock-out/tag-out procedure.
8. Turn the motor and oil pump disconnect switches to the ON position.
9. Return compressor unit to service.

Preparation of Compressor For Initial Start After Servicing

WARNING

Only qualified personnel shall install, start, operate and maintain the equipment. Failure to comply may cause damage to the workers and the system.

Vilter recommends charging 1 to 2 gallons of fresh oil into the compressor via the oil pressure indicator 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.

1. Add oil to crankcase, via drain valve, to within 1/2 of the sight glass in the hand hole cover.
2. Connect power to the crankcase heater, close all open valves, and check for leaks.
3. When oil has reached approximately 100°F (37.8°C), start the compressor and allow it to pull the load down gradually.
4. 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.
5. Lengthen each running period until it is determined 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 replacement compressors, the suction bag should be removed after running for 24 hours.

CAUTION

If, when the inspection of the removed suction strainer bag shows an unusual amount of dirt, install a new bag. After another 24 hour period, remove and inspect the bag again. 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 piping, 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.

Troubleshooting Guide - General Problems and Solutions

Refer to the following tables for Troubleshooting Guide - General Problems and Solutions.

Table 6-1. Troubleshooting Guide - General Problems and Solutions (1 of 3)

Problem	Reason	Solution
Shaft seal not working properly	A. Installed incorrectly	Re-install the shaft seal.
	B. Water in oil, or just plain moisture in refrigerant (R22)	Install “dryer cores” to remove the moisture from system.
	C. O-rings broken in seal mirror faces.	Replace shaft seal.
	D. Inner retainer not seated flat	Replace shaft seal.
No oil pressure reading	A. Oil pump shaft broken off.	Replace shaft
	B. Pump turns both ways, pump not free to turn.	Remove pump; check if shaft turns by hand. If “jammed”, replace the pump.
	C. Pump not getting primed.	1. Fill oil filter housing with refrigerant oil. 2. Start compressor and watch oil gauge (should give reading), if the compressor is working.
	D. Too much liquid in crankcase oil.	Drain crankcase to ¾ of the sight glass when compressor is off.
	E. Gaskets installed wrong	Re-check the gaskets to make sure all the passages are not blocked.
	F. 3 location holes not on “top” of oil pump	Make sure the word “TOP” is pointing upwards.
Oil level switch issues	No LED is on when the sensor is in the medium.	No supply to the sensor or defective cable/plug. Check the power supply or replace the power supply cable.
	No output (3 x green LED are on but the output signal is not active)	Check if the sensor’s output matches the control’s input; if it is a NO or NC respectively. See the output charge instructions. Create alignment between the sensor and control so that the two are identical.
	No contact activation (3 x green LED are not on, even though liquid should activate the sensor)	There may be dirt between the electronic housing and the mechanical housing. Separate the two parts and clean the spring tip.
	Delay in sensor activation	Can be caused by a gas pocket that displaces the liquid. Install the sensor so that the gas pockets cannot displace the liquid
	Output and 3xLED are activated constantly, even though liquid is not in contact with the sensor.	Threaded sleeves are installed with negative slope so that liquid can collect in the threaded sleeves which activate the sensor. Place the threaded sleeves according to the instructions. See installation.

Table 6-1. Troubleshooting Guide - General Problems and Solutions (2 of 3)

Problem	Reason	Solution
Low discharge pressure	A. Instrument reading error	Compare readings using an equivalent instrument.
	B. Unloading system defective	
	C. System Leakage	
Vibration	A. Inadequate pipe support	Check supports and add if necessary
	B. Unloaders not working properly	
High Cylinder Temperature	A. Instrument reading error	Compare readings using an equivalent instrument
	B. System´s discharge pressure is high	
	C. Wrong speed	
Capacity loss	A. Suction Filter is plugged or intake line is blocked	If this is the case, the compressor will unload and the suction pressure would fall under atmospheric
	B. Unloader is stuck	If the unloader is stuck, it might be holding a suction valve open, and the gas compression is not being performed.
	C. Gasket failing at valve seat, cylinder head or intercooler	
	D. System pressure is above rated pressure	Check valves to make sure they´re working properly.
	E. Faulty valves	Check valves to make sure they´re working properly.
Knocking noise from cylinders when idle	A. Loose pistons	
	B. Insufficient head clearance	
	C. Piston-to-cylinder bore clearance too big	
Knocking noise from cylinders when loaded	A. Broken piston rings	Replace
	E. Loose piston	
	F. Valves are loose/broken	
	G. Moisture carryover or liquid slug	
Low Oil Pressure	A. Low Oil Level	Check level and add oil if necessary
	B. Pump is faulty	Check oil pump and it´s power supply.
	C. High Oil temperature	Check oil temperature and adjust
	D. Filter strainer is dirty	Replace/clean filter cartridge
	E. Header´s relief valve is faulty	Replace valve
	F. Worn bearings	Replace bearings
High Oil Pressure	A. Header´s relief valve is faulty	Replace valve
	B. Oil is cold	Check oil temperature and adjust
	C. Setting for the pressure regulating valve is too high	Check the setting and change to accommodate working conditions
	D. Restricted oil line	

Table 6-1. Troubleshooting Guide - General Problems and Solutions (3 of 3)

Problem	Reason	Solution
Too much oil is being used	A. Crankcase oil level is too high	
	B. Oil pressure is too high	
	C. Piston rings and/or cylinder wearing	
High Discharge Temperature	Clean piping	
	Replace valves/rings	

Warranty Claim Processing

This section explains how the warranty claim is processed and to help clear any questions that may arise prior to contacting customer service. For additional warranty information, refer to the Terms and Conditions of your order. Vilter™ contact information can be found on page iii.

1. The warranty process starts with contacting a Vilter Service and Warranty (S&W) department representative. *Ensure to have the original Vilter sales order number for the equipment available to better assist you.*
2. Our Vilter S&W representative will confirm if the equipment is within the warranty time frame as described in the warranty statement.

If the equipment (Part/Compressor/Compressor Motor) is within the warranty time frame, proceed to the following section regarding the type of equipment:

Process For Returning Products Covered By the Warranty

STEP 1. To return a defective Product or part under this warranty, you will need to provide the Vilter™ compressor order number on all submitted documents.

For a parts warranty request, you will also need to provide:

- The Vilter™ serial number of the compressor;
- A detailed and accurate description of the issue;
- A valid purchase order for the new part(s)—you must pay the freight;
- One copy of Return Merchandise Authorization (RMA) sent to you for your records;
- One copy of RMA sent to you to include in the return shipment of parts back to Vilter™ for warranty consideration.

STEP 2. Return the parts (freight prepaid) to:

VILTER MANUFACTURING CORPORATION
5555 South Packard Avenue
Cudahy, WI 53110-8904

STEP 3. Upon receipt of the returned part(s), Vilter™ will complete a timely evaluation of the part(s).

STEP 4. You will be contacted with Vilter's decision once the final report is completed.

STEP 5. If approved, the approved warranty will be credited (excluding freight) to your account. Vilter™ will retain the returned part(s) for final disposition. If a warranty request is not approved, you will be provided with a written response and the parts will be held for 30 days. After such time, Vilter™ will dispose of the parts. If you wish to have the part(s) returned, you will need to contact Vilter™ and the part(s) will be returned freight collect.

Procedure For Parts Not Manufactured By Vilter™

Although Vilter™ does not provide any warranty for parts and products that are not manufactured by Vilter™, Vilter™ does pass through any manufacturer's warranty to you (to the maximum extent permitted by the manufacturer). Vilter™ will work with you in facilitating your warranty claim with the manufacturer.

To facilitate your warranty claim, please follow the following four steps:

STEP 1. Determine if the part or product is within the OEM's warranty.

STEP 2. If the defective part or product is not a motor, send a description containing the specifications of the part/product and the defect to:

Service.Vilter@Copeland.com

If the defective part or product is a motor or starter, please complete the form on the next page and return it to:

Service.Vilter@Copeland.com.

STEP 3. Vilter™ will communicate with you, if necessary, to ascertain additional information and will reasonably assist with the OEM to determine the part/product's warranty status.

COPELAND

VILTER™

Motor Warranty Procedure

To facilitate your warranty claim, please follow the steps outlined below:
1. Determination if motor is within the OEM warranty.
2. Please complete the following and return to Service.Vilter@Copeland.com, along with a picture of the motor's nameplate.
3. Vilter will assist with the motor OEM to determine the motor's warranty status.

Model: _____
Serial Number: _____
Manufacturer: _____
Run Hours: _____

Start Date: _____/_____/____
Month Day Year

Grease Type: _____

Starter Type:
- ☐ Soft Start
- ☐ Across the Line
- ☐ VFD

Alignment Data Available:	☐ Yes, please include with information	☐ No
Lubrication Records Available:	☐ Yes, please include with information	☐ No
Vibration Report:	☐ Yes, please include with information	☐ No

Describe Motor Symptoms:

4. If the motor falls within the OEM's warranty time frame:
- The motor will need to be taken to a manufacturer approved shop for diagnosis. Vilter can help with locating motor shops that are manufacturer approved in your area. The shop will diagnose the root cause, submit a report to the OEM, and the motor OEM will make the determination of warranty coverage.
- If warranty is approved, the OEM will either have the motor repaired by the motor shop or send a new replacement motor to the site.

Note: Motor warranty is a "pass thru warranty" as stated in Vilter Manufacturing's standard warranty statement which means that the original motor OEM is the provider of the warranty. Vilter does assist with the expediting of the claim but any dispensation of warranty is provided solely by the motor OEM.
Motor manufacturer warranty covers only repair or replacement of the motor. It does not cover removal and installation charges, incidental charges associated with the removal and installation process, loss of product or shipping to and from the manufacturer or approved shop. This is standard motor manufacturer warranty policy regardless of brand or application. If the end user requires additional information regarding warranty coverage, the individual motor manufacturer warranty terms can be found on their associated websites.

STEP 4. For defective motor or starter claims, if the motor or starter falls within the OEM's warranty time frame:

- The motor or starter will need to be taken to a manufacturer approved shop for diagnosis. Vilter™ can help you locate motor shops in your area that are manufacturer approved. The shop will diagnose the root cause, submit a report to the OEM, and the motor OEM will make the determination of warranty coverage.
- If a warranty claim is approved, the OEM will either have the motor or starter repaired by the motor shop or send a new replacement motor to the site.

On-Site Service Support

If on site support is required, contact a Vilter S&W department representative to start this process.

Warranty does not cover labor or expenses.

1. A quote, a service rate sheet, and the service terms and conditions will be provided.
2. Submit a PO.
3. Schedule the service visit.

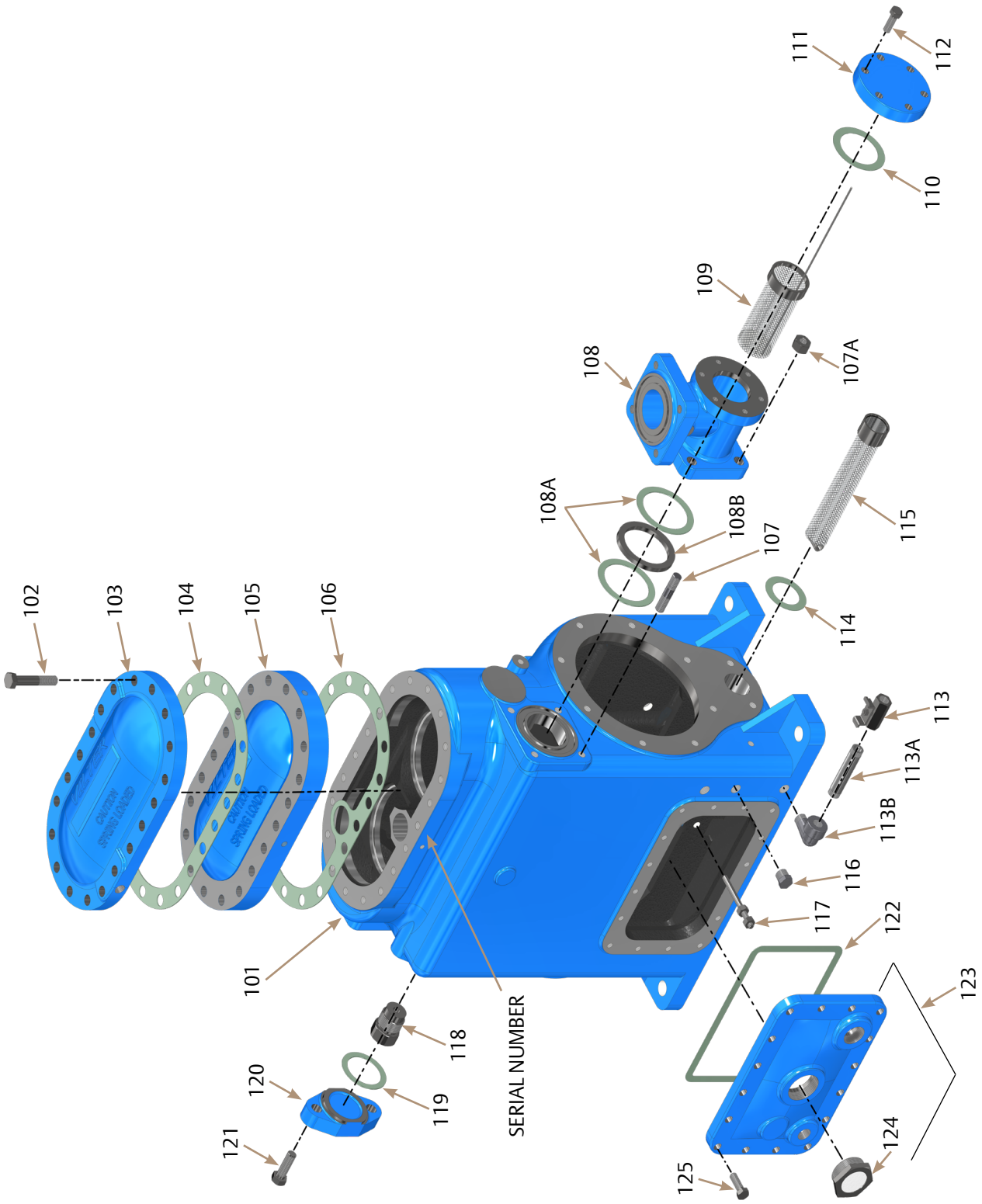
450XL® VMC Compressors
Replacement Parts List

NOTE
Except where noted in the description column, part listed apply to all 450XL High Stage, Booster, and Two-Stage Compressors

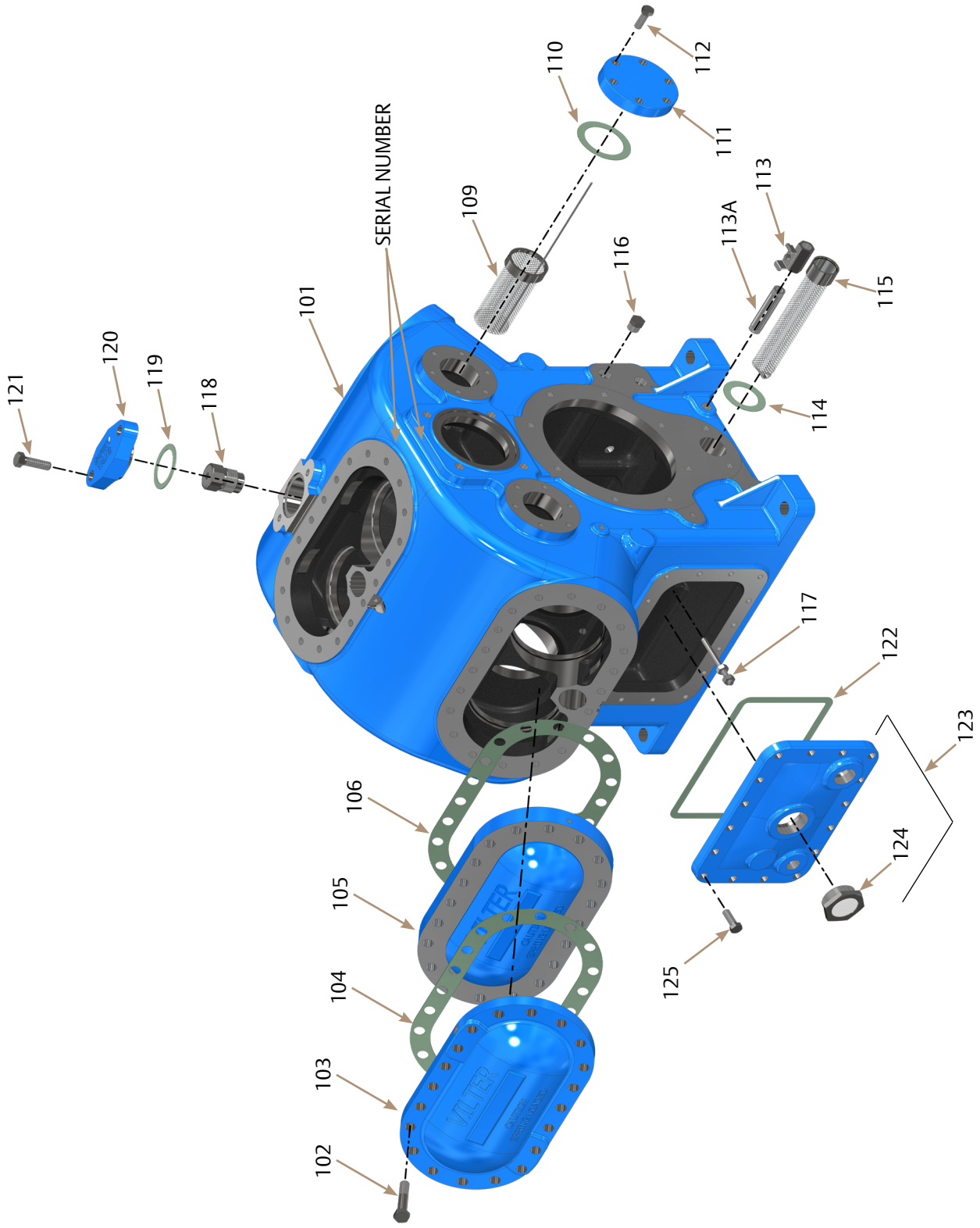
Refer to the Custom Manual
Spare Parts Section for Specific Applications

Please have your Model # and Sales Order # available when ordering.
These are found on the compressor's Name Plate.

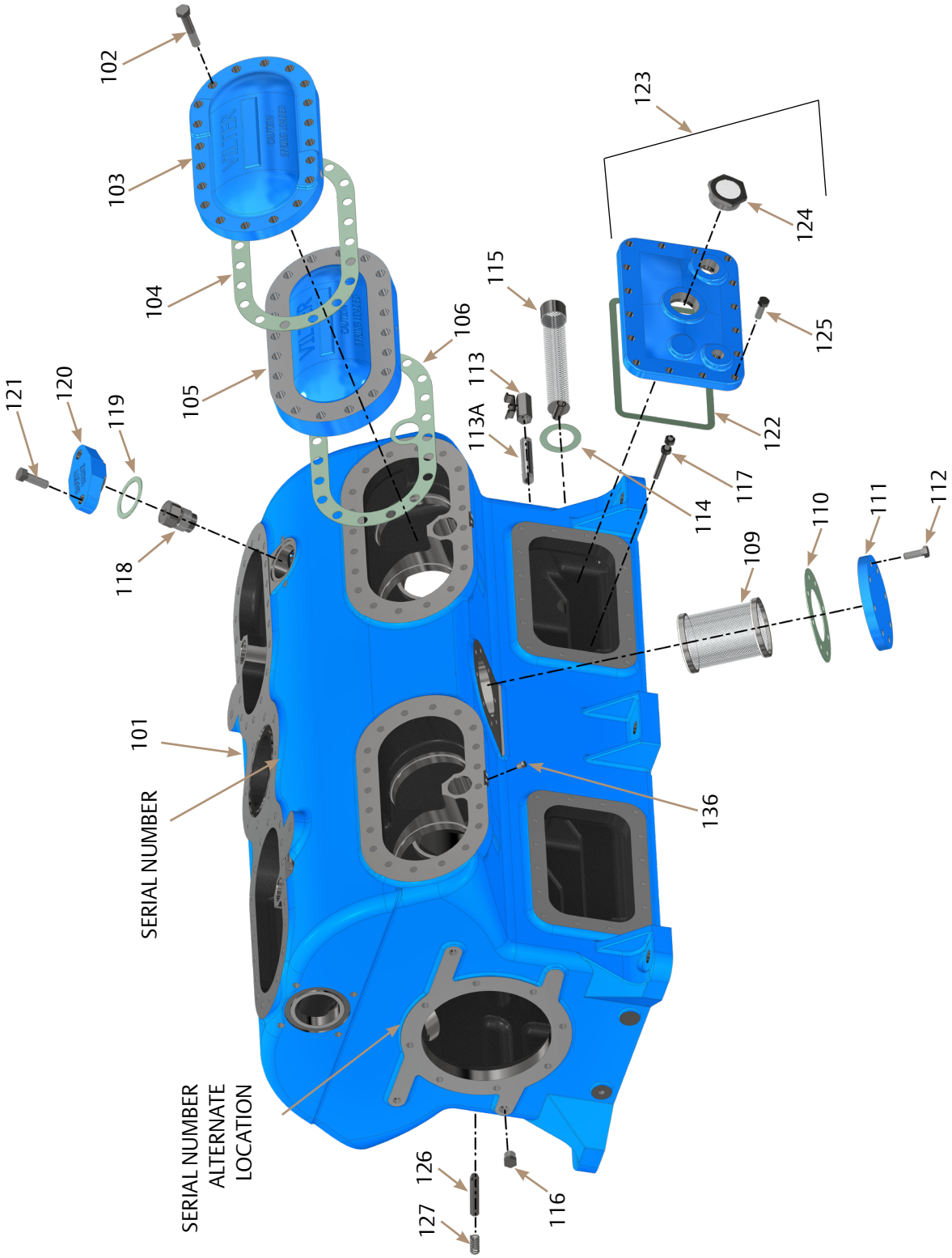
450XL® VMC Compressors
2 Cylinder Basic Frame Replacement Parts



450XL® VMC Compressors
4, 6 and 8 Cylinder Basic Frame Replacement Parts



450XL® VMC Compressors
12 and 16 Cylinder Basic Frame Replacement Parts



450XL® VMC Compressors
Basic Frame Replacement Parts
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
101	Frame	1	1	1	1	1	1	+
102	Screw, 5/8" x 3 3/4" Hex Head Cap (used with water jacket)	4	8	12	16	24	32	13152M
102	Screw, 5/8" x 3½" Hex Head Cap (Used with Water Jacket)	16	32	48	64	96	128	13152L
102	Screw, 5/8" x 2½" Hex Head Cap (Used when Water Jacket not used)	20	40	60	80	120	160	13152G
103	Cover, Water Jacket (Ammonia and R22)	1	2	3	4	6	8	30299A
104	Gasket, Water Jacket (Ammonia and R22)	1	2	3	4	6	8	33329A
105	Cover, Cylinder							
	Banks w/o Capacity Reduction (Right)	--	1	--	2	--	4	A30332A
	Banks w/Capacity Reduction (Oil Act.) (Right)	--	1**	--	2**	--	4**	30332B
	Banks w/o Capacity Reduction (Left)	1	--	1	--	2	--	A30364A
	Banks w/Capacity Reduction (Oil Act.) (Left)	1**	--	2**	--	4**	--	30364B
	Banks w/o Capacity Reduction (Two-Stage) (Left)	--	--	3	--	6	--	A30364A
106	Gasket, Cylinder Cover	1	2	3	4	6	8	33330A
107	Stud, 5/8" x 3" (shown only on 2 cylinder)	8	4	4	4	8	8	13156D
107	Stud, ¾" x 3¼" (not shown)	--	4	4	4	--	--	13157D
107A	Nut, 5/8-11NC-2B							1726G
107A	Nut, ¾-10NC-2B	--	4	4	4	--	--	1726H
108 (108A is Gasket & 108B is Steel Ring)	Tee, Suction (++)							
	2½" x 2½"	1	--	--	--	--	--	30319A plus 13156D (8)
	3½" x 3"	--	1	--	--	--	--	32417B plus 13156D (4) & 13157D (4)
109	Suction Screen	--	1	--	--	--	--	A32428A
109	Suction Screen	1	--	2	2	--	--	A32428D
109	Suction Screen	--	--	--	--	2	2	A32565A
109-A	Bag, Suction Screen (not shown)	--	1	--	--	--	--	A33474A
109-A	Bag, Suction Screen (not shown)	1	--	2	2	--	--	A33474B
109-A	Bag, Suction Screen (not shown)	--	--	--	--	2	2	A33474G
110	Gasket, Suction Screen Cover	1	--	2	2	--	--	31892A

Notes-

A: Unless otherwise indicated, quantities shown are for compressors with standard capacity reduction, and may vary if compressor is equipped with other versions. See Application Notes.

**: Items shown are for compressors with optional oil unloading or optional single cylinder unloading. See Application Notes.

+: Part Number on application.

++: May not be shown, or only shown typically on one illustration.

450XL® VMC Compressors
Basic Frame Replacement Parts
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
110	Gasket, Suction Screen Cover	--	--	--	--	2	2	33493A
110	Gasket, Suction Cover	--	1	--	1	--	--	11323J
111	Cover, Suction Screen	1	--	2	2	--	--	31893A
111	Cover, Suction Screen	--	--	--	--	2	2	33492A
111	Cover, Suction Screen	--	1	--	1	--	--	13706A
112	Screw, 5/8" x 2" Hex Head Cap	--	5	--	5	--	--	13152E
112	Screw, ½" x ½" Hex Head Cap	6	--	12	12	16	16	2796E
113	Valve, ½" Oil Charge and Drain (Ammonia)	1	1	1	1	1	1	1956H
113	Valve, ½" Oil Charge and Drain (Halocarbon)	1	1	1	1	1	1	1956H
113A	Nipple, ½" x 4" Sch. 80 Pipe	1	1	1	1	1	1	13189G
113B	Elbow, ½" 90deg Street	1	--	--	--	--	--	1735C
114	Gasket, Crankcase Oil Screen	1	1	1	1	1	1	31889A
115	Crankcase Oil Screen Assembly	1	1	1	1	1	1	A31886A
116++	Plug, ¾" Hex Head Pipe (not shown on 12 & 16)	1	1	1	1	1	1	13264E
116++	Plug, ½" Hex Head Pipe (not shown on 2 thru 8)	1	1	1	1	1	1	13264D
117	Pin Assembly, Crankcase Oil Screen Retaining	1	1	1	1	1	1	A31936A
118	Safety Valve (Internal Relief)	1	1	1	1	2	2	1721C
119	Gasket, 2" Flange	1	1	1	1	2	2	11323G
120	Cover, Safety Valve	1	1	1	1	2	2	31954A
121	Screw, 5/8" x 2" Hex Head Cap	2	2	2	2	4	4	13152E
122	Gasket, Handhole Cover (Chain)	1	1	1	1	2	2	35382A
122	Gasket, Handhole Cover (Strip)	1	1	1	1	2	2	31894A
123 & 124	Handhole Cover and 2" Sight Glass Assy With openings for:							
	560W NEMA 1 & 7 Htr., F.V. & Therm.	1	1	1	1	1	1	A33034G
	560W NEMA 1 & 7 Heater and Therm.	1	1	1	1	1	1	A33034L
123	Cover, Handhole (with openings)	1	1	1	1	1	1	Order Assy
123A	Cover, Handhole (without openings) (not shown)	--	--	--	--	1	1	33034B
124	Glass, Oil Sight – 2"	1	1	1	1	1	1	2366R
125	Screw, ½" x 1½" Hex Head Cap	16	16	16	16	32	32	2796E
126	Tube, Oil Feed Connector	--	--	--	--	1	1	33494A
127	Spring	--	--	--	--	1	1	31789A
135	Hex Head Plug Long Shank Unloader Hold Down	--	--	1	--	2	--	35166A
136	Hex Head Plug Short Unloader Hold Down	1	2					13264A

Notes-

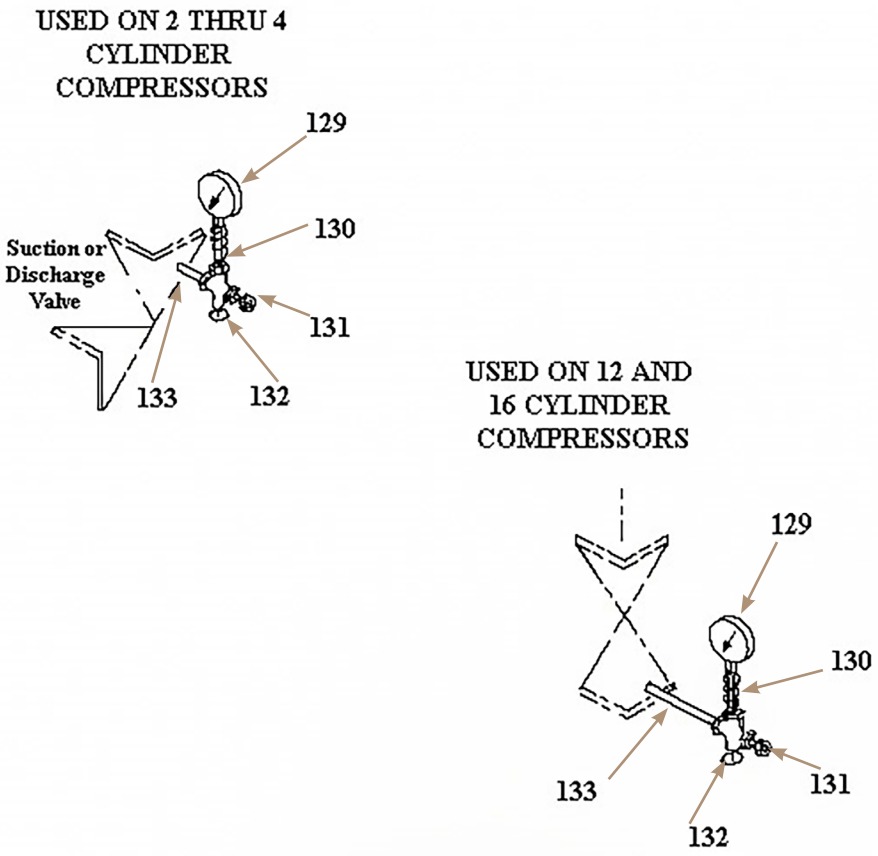
A: Unless otherwise indicated, quantities shown are for compressors with standard capacity reduction, and may vary if compressor is equipped with other versions. See Application Notes.

**: Items shown are for compressors with optional oil unloading or optional single cylinder unloading. See Application Notes.

+: Part Number on application.

++: May not be shown, or only shown typically on one illustration.

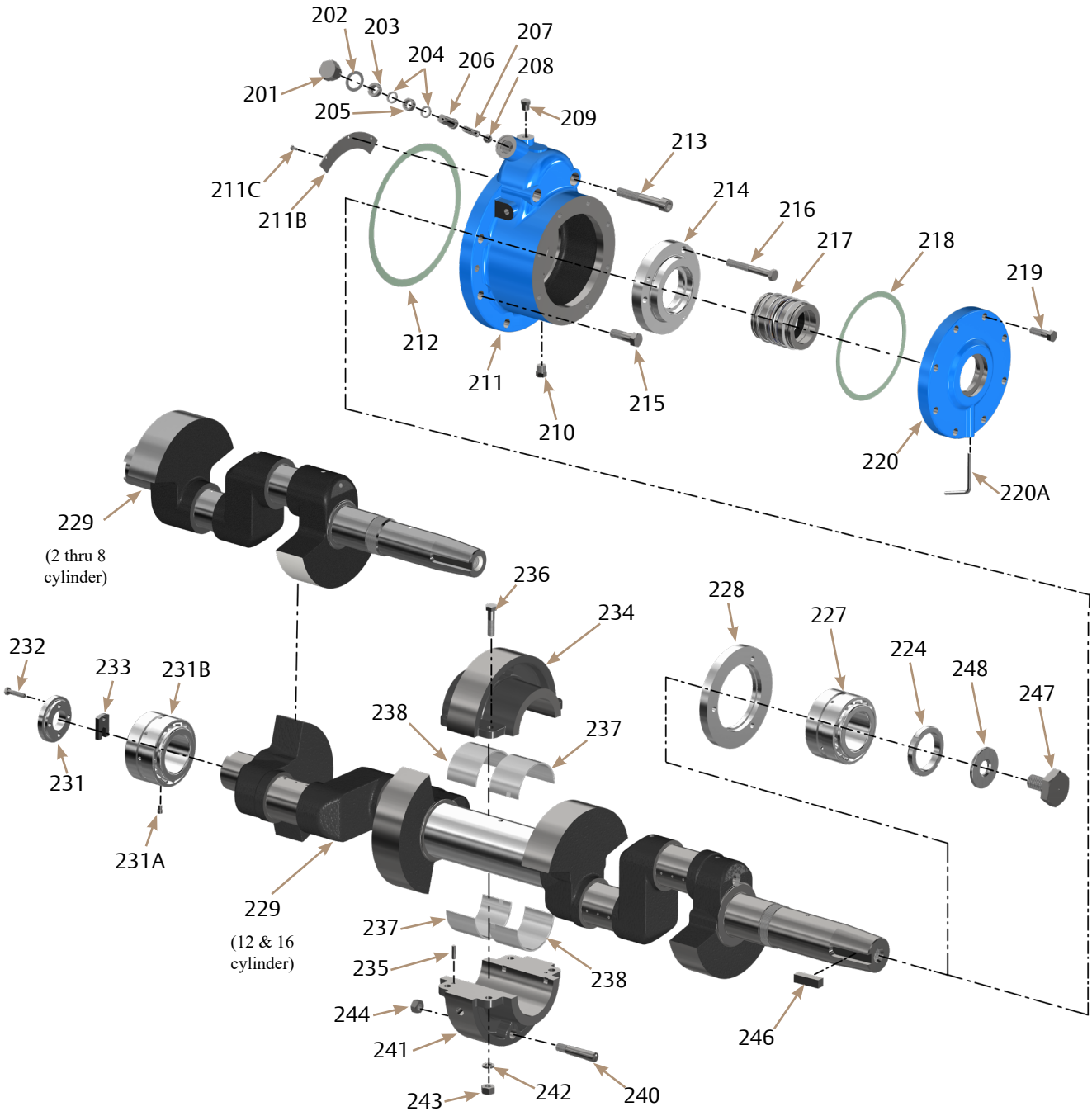
450XL® VMC Compressors
Discharge/Suction Gauge Replacement Parts



450XL® VMC Compressors
Discharge/Suction Gauge Replacement Parts

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
128	Heater, Electric Crankcase Oil, 115V (not shown)	1	1	1	1	2	2	2069J
128	Heater, Electric Crankcase Oil, 230V (not shown)	1	1	1	1	2	2	2069K
129	Gauge, Discharge, 300 PSI	1	1	1	1	2	2	1204E
129	Gauge, Suction, 150 PSI	1	1	1	1	1	1	1204C
130	Stedy-Mount®	2	2	2	2	3	3	A17311SS
131	Connector, ¼" MPT x ¼" O.D. Compression	2	2	2	2	3	3	13229D
133	Nipple ¼" x 4" Sch. 80 Pipe	2	2	2	2	3	3	13181G
134	Thermometer, Crankcase Oil (not shown)	1	1	1	1	1	1	1467G

450XL® VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts



450XL® VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
201 thru 211	Front Bearing Cover and Relief Valve Assy	1	1	1	1	1	1	A32566A
201	Cap, Valve	1	1	1	1	1	1	17355A
202 thru 208	Oil Relief Valve Kit	1	1	1	1	1	1	KT486
202	Gasket, Valve Cap	1	1	1	1	1	1	30651C
203	Nut, Packing	1	1	1	1	1	1	31048A
204	Washer	2	2	2	2	2	2	31048D
205	Packing, 7/8" O.D. x 39/64" I.D. x 3/8"	1	1	1	1	1	1	31048E
206	Stem, Valve	1	1	1	1	1	1	31048C
207	Spring	1	1	1	1	1	1	31048F
208	Ball, 5/8" dia. Steel	1	1	1	1	1	1	13155K
209 thru 211	Front Bearing Cover Assembly	1	1	1	1	1	1	A36241A
209	Plug, ¼" Hex Head Pipe	1	1	1	1	1	1	13264B
210	Plug, 3/8" Hex Head Pipe	1	1	1	1	1	1	13264C
211	Cover, Front Bearing	1	1	1	1	1	1	Order Assy
211B	Shield, Splash	1	1	1	1	1	1	35274A
211C	Screw, Hexagon Hd. No. 10-32 x 3/8" long	3	3	3	3	3	3	2583A
212	Gasket, Bearing Cover	1	1	1	1	1	1	31890A
213	Screw, 5/8" x 4" Hex Socket Head Cap	2	2	2	2	2	2	13159E
214	Retainer, Front Bearing (with Oil Hole)	1	1	1	1	1	1	33500A
215	Screw, 5/8" x 2" Hex Head Cap	6	6	6	6	6	6	13152E
216	Screw, ½" x 4" Hex Head Cap	3	3	3	3	3	3	2796EV
217 & 218	Seal and Gasket Kit	1	1	1	1	1	1	KT509
217	Seal, Rotary Shaft Assembly	1	1	1	1	1	1	A33489A
218	Gasket, Shaft Seal Cover	1	1	1	1	1	1	33496A
219	Screw, ½" x 1¾" Hex Head Cap	8	8	8	8	8	8	2796EL
220 & 220A	Cover and Tube Assembly, Shaft Seal	1	1	1	1	1	1	A32564A
220A	Drain Tube	1	1	1	1	1	1	35078A
224 thru 233	Crankshaft and Bearings Assembly *	1	--	--	--	--	--	A34555HX
	Crankshaft and Bearings Assembly *	--	1	--	--	--	--	A34555KX
	Crankshaft and Bearings Assembly *	--	--	1	--	--	--	A34555LX
	Crankshaft and Bearings Assembly *	--	--	--	1	--	--	A34555BX
224 thru 244 less items 234, 235 and 241	Crankshaft and Bearings Assembly Kit *	--	--	--	--	1	--	KT588
	Crankshaft and Bearings Assembly Kit *	--	--	--	--	--	1	KT589
224	Locknut and Retaining Compound Kit	1	1	1	1	1	1	KT367
227	Front Bearing and Retaining Compound Kit	1	1	1	1	1	1	KT369

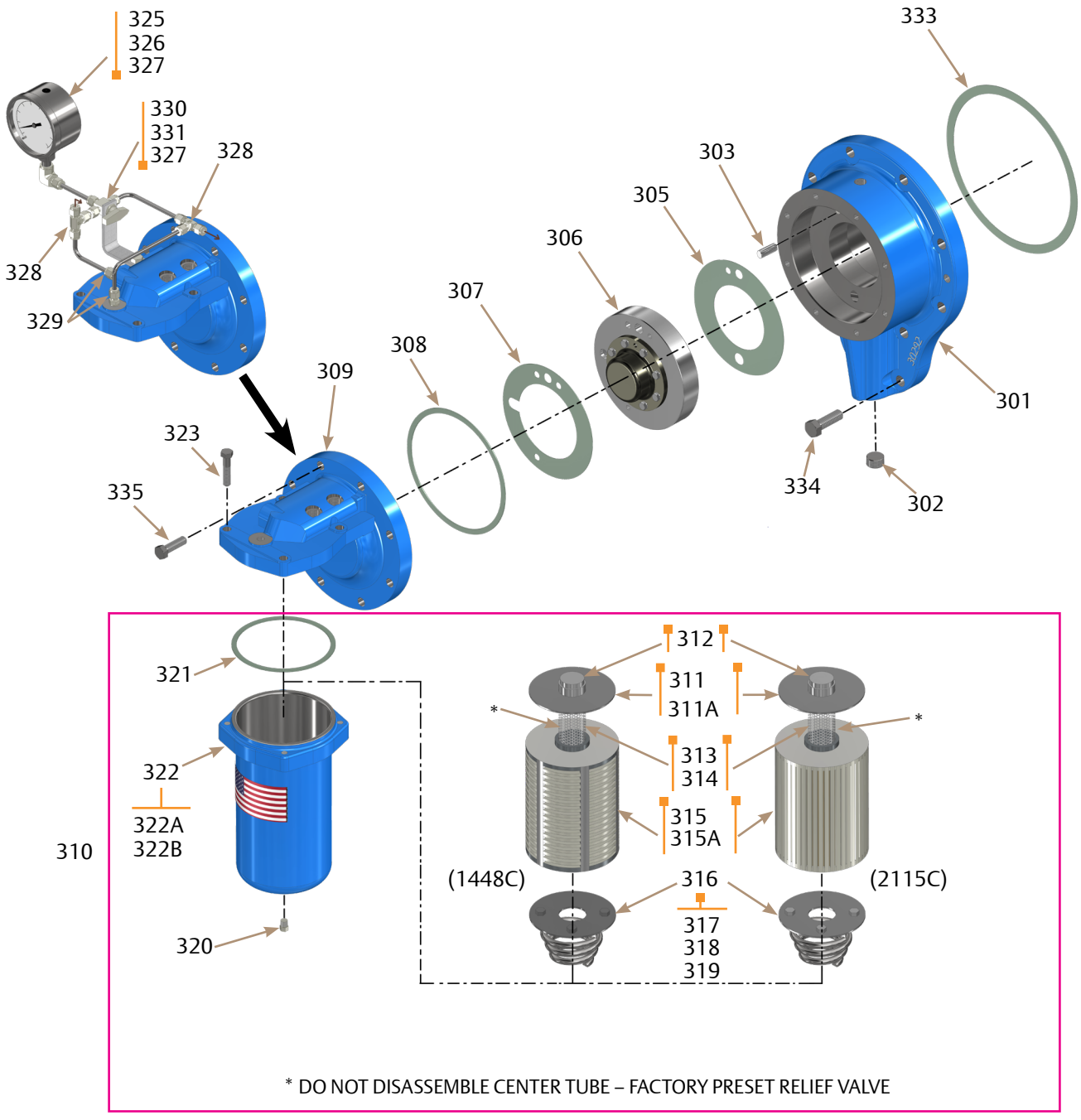
450XL® VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
228	Ring, Front Bearing Retainer	1	1	1	1	1	1	33145A
229	Crankshaft and Retaining Compound Kit *	--	--	--	--	--	--	See Assembly Above
229A	Plug, 1/8" Pipe, Hex Socket Head (not shown)	3	3	3	3	5	5	2606B
229B	Plug, ¾" Pipe, Hex Socket Head (not shown)	2	2	2	2	4	4	2606A
231	Retainer, Rear Bearing	1	1	1	1	1	1	31904A
231A & 231B	Rear Bearing and Lock Pin Kit	1	1	1	1	1	1	KT353
232	Screw, 5/16" x 1½" Hex Head Cap	4	4	4	4	4	4	1736G
233	Crank, Oil Pump Drive	1	1	1	1	1	1	33403A
234	Cap, Bearing Support	--	--	--	--	1	1	**
235	Pin, ¼" x 1" Dowel	--	--	--	--	2	2	2868B **
236	Bolt, ½" x 2" Machine	--	--	--	--	4	4	2796R **
237	Bearing, Upper Right Half or Lower Left Half	--	--	--	--	2	2	33508A
238	Bearing, Upper Left Half or Lower Right Half	--	--	--	--	2	2	33508B
240	Pin, Threaded Taper	--	--	--	--	1	1	33497A
241	Case, Bearing Support	--	--	--	--	1	1	**
242	Washer, ½" Spring Lock	--	--	--	--	4	4	13165F
243	Nut, ½" Hex	--	--	--	--	4	4	1726E **
244	Nut, 9/16" Hex	--	--	--	--	1	1	13253F
246	Key, Crankshaft	1	1	1	1	1	1	33505B
247	Screw, Flywheel Hub	1	1	1	1	1	1	31956A
248	Washer, Flywheel Hub Screw	1	1	1	1	1	1	33495A
249	Gauge, Oil Pressure, 300 PSI	1	1	1	1	1	1	1204E
250	Stedy-Mount®	1	1	1	1	1	1	A17311SS
251	Valve, ¼" Screw End Globe	1	1	1	1	1	1	3031J
252	Nipple, ¼" x 7" Sch. 80 Pipe	1	1	1	1	1	1	13181M
253	Connector, ¼" MPT x ¼" O.D. Compression	1	1	1	1	1	1	13229D
254	Tee, ¼"	1	1	1	1	1	1	1098B
255	Nipple, ¼" x 2" Sch. 80 Pipe	1	1	1	1	1	1	13181C

Notes-

**: Matched set with pins, sold as assembly A32163A. Shown in five parts to illustrate disassembly.

450XL® VMC Compressors
Rear Bearing Cover Replacement Parts



450XL® VMC Compressors
Rear Bearing Cover Replacement Parts
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
301 THRU 304 & 333	Rear Bearing Cover Assembly Kit	1	1	1	1	1	1	KT092
301	Cover, Rear Bearing	1	1	1	1	1	1	Order Kit
302	Plug, ¾" Hex Socket Head Pipe	1	1	1	1	1	1	2606A
303	Pin, 3/8" x 1" Dowel	1	1	1	1	1	1	2868H
304	Orifice, Oil Metering (not shown)	1	1	1	1	1	1	33361A
305	Gasket, Oil Pump Body	1	1	1	1	1	1	31899A
306	Oil Pump Assembly	1	1	1	1	1	1	KT519A
307	Gasket, Oil Pump Cover	1	1	1	1	1	1	31900A
308	Gasket, Oil Pump and Rear Bearing Cover Seal	1	1	1	1	1	1	33320A
309	Cover, Oil Pump and Filter Head (R12 & R502)	1	1	1	1	1	1	34565A
309	Cover, Oil Pump and Filter Head (R717 & R22)	1	1	1	1	1	1	34760AB
310 ***	Filter Assy., Complete (without Bypass Relief)	1	1	1	1	1	1	A35241A
310 **	Filter Assy., Complete (with Bypass Relief)	1	1	1	1	1	1	A35240A
311 ***	Spool Assembly (without Bypass Relief)	1	1	1	1	1	1	2046A
311A, 312, 313 & 314	Spool – Strainer Tube Assembly	1	1	1	1	1	1	1448U
311A, 312 thru 314 & 315A thru 319 & 321	Filter Assembly (without Shell)	1	1	1	1	1	1	1448T
311A **	Spool Assembly (with Bypass Relief)	1	1	1	1	1	1	1448J
312	Seal, Spool End	1	1	1	1	1	1	1448H
313	Strainer Tube	1	1	1	1	1	1	1448K
314	Ring, Retaining	1	1	1	1	1	1	1448L
315 ***	Recharge (for A35241A & 2046A) (w/o Bypass) †	1	1	1	1	1	1	2115C † or KT645 (6 pack)
315A **	Recharge (for A35240A & 1448J) (with Bypass) †	1	1	1	1	1	1	1448C † or KT645 (6 pack)
316	Pressure Plate Assembly	1	1	1	1	1	1	1448M
317	Pressure Plate	1	1	1	1	1	1	1448N
318	'O' Ring Seal, Pressure Plate	1	1	1	1	1	1	1448P
319	Spring, Pressure Plate	1	1	1	1	1	1	1448Q
320	Plug, Steel Hexagon Head 1/8" Pipe	1	1	1	1	1	1	13264A
321	Gasket, Oil Filter Head	1	1	1	1	1	1	1448B
322	Filter Shell with Flange and Plug	1	1	1	1	1	1	A34623A

Notes-

**: Filter with bypass relief is standard. These items are used.

***: Filter without bypass relief is optional. When supplied, these items are used.

†: Replacement recharge also includes gasket 1448B (Item 321).

450XL® VMC Compressors
Rear Bearing Cover Replacement Parts
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
322A	Flange, Oil Filter Tank	1	1	1	1	1	1	35125A
322B	Tank, Oil Filter	1	1	1	1	1	1	34623A
323	Screw, Hexagon Head Cap 7/16" x 2"	4	4	4	4	4	4	2796DM
324 ***	Instruction/Nameplate (for use with A35241A) (not shown)	1	1	1	1	1	1	40680AJ
324 **	Instruction/Nameplate (for use with A35240A) (not shown)	1	1	1	1	1	1	40680AT
325	Gauge, 2½", 0-300 PSI, Oil Filter (Liquid FIlled)	1	1	1	1	1	1	2047A
326	Elbow, ¼" 90° Female Compression	1	1	1	1	1	1	1892B
327	Tubing, ¼" O.D. Steel	3 ft.	3 ft.	3 ft.	3 ft.	3 ft.	3 ft.	3509A
328 ***	Tee, ¼" Compression	2	2	2	2	2	2	13239C
329	Connector, ¼" MPT x ¼" O.D. Compression	2	2	2	2	2	2	13229D
330	Valve, 3-Way, Oil Filter	1	1	1	1	1	1	2030A
331	Bracket, Valve	1	1	1	1	1	1	35106A
333	Gasket, Bearing Cover	1	1	1	1	1	1	31890A
334	Screw, 5/8" x 2" Hexagon Head Cap	10	10	10	10	10	10	13152E
335	Screw, ½" x 1¾" Hexagon Head Cap	8	8	8	8	8	8	2796EL

Notes-

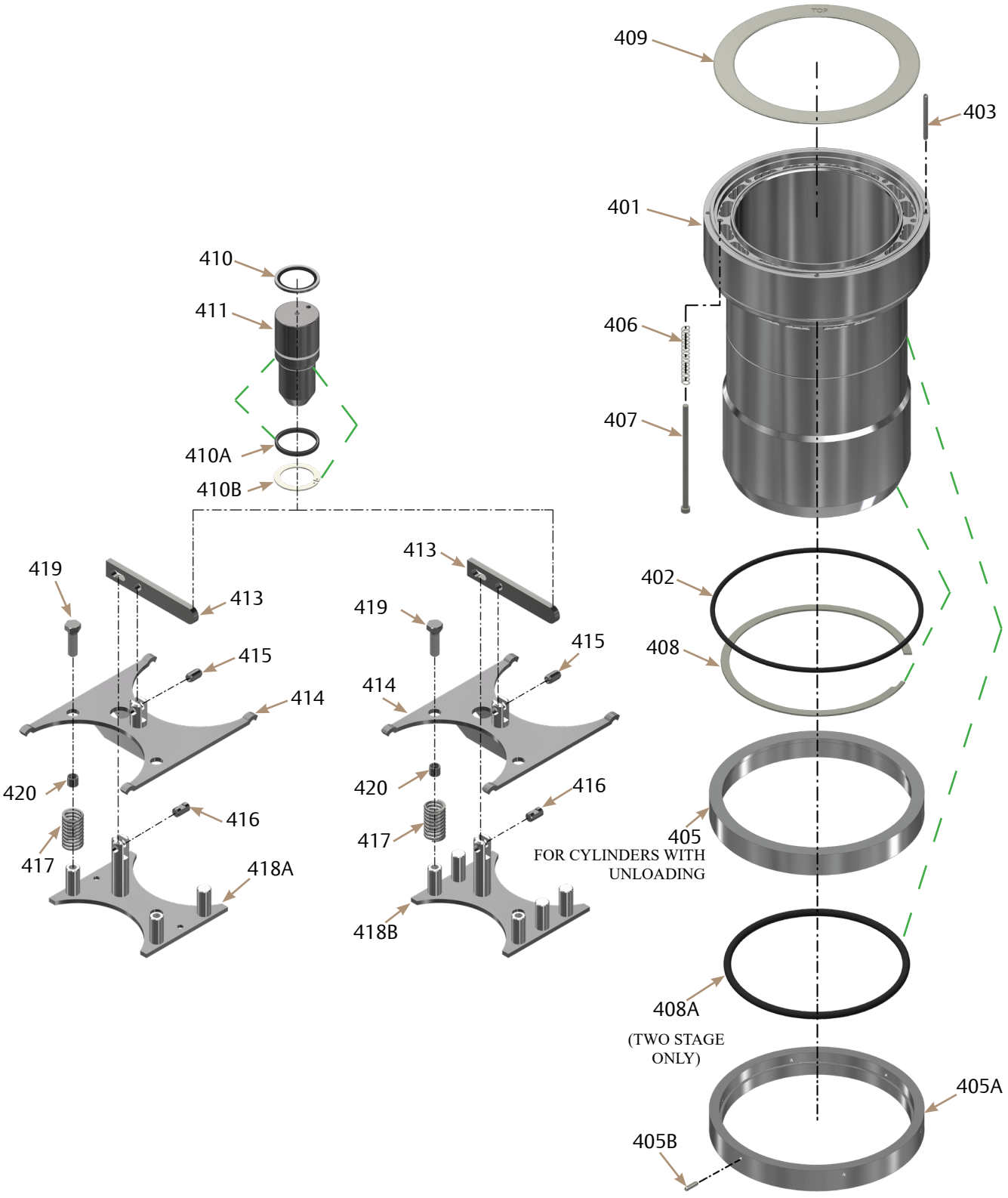
**: Filter with bypass relief is standard. These items are used.

***: Filter without bypass relief is optional. When supplied, these items are used.

†: Replacement recharge also includes gasket 1448B (Item 321).

AR: As Required.

450XL® VMC Compressors
Cylinder Liner and Capacity Control Replacement Parts



450XL® VMC Compressors
Cylinder Liner and Capacity Control Replacement Parts
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
401, 402 & 403	Cylinder Liner Assembly (for cylinder without unloading)	2(1**)	2	2	4	4	8	KT475
401, 402 thru 408	Cylinder Liner Assembly (for cylinder with unloading)	-(1**)	2	4	4	8	8	KT476
401A, 402, 403 & 408A	Cylinder Liner Assembly (Two-Stage only) (for cylinder without unloading)	--	--	6(3**)	--	12(6**)	--	A35108D
	Single Cylinder Liner without Unloading		1					A35108B
401A, 402, thru 408A	Single Cylinder		3					A35108A
	Liner with Unloading	--	--	-(3**)	--	-(6**)	--	A35108C
401	Liner, Cylinder	2	4	6	8	12	16	34510A
401A	Liner, Cylinder (Two-Stage only)	--	--	6	--	12	--	34710A
402	Seal, 'O' Ring (upper)	2	4	6	8	12	16	2176BH
403	Pin, Roll, 0.125" dia. x 1½" lg.	8	16	24	32	48	64	1193Q
405	Ring, Lift	-(1**)	2	4(3**)	4	8(6**)	8	35071A
405A +	Ring, Lift	1	2	4	4	8	8	35380A
405B +	Pin, Roll	4	4	4	4	4	4	1193SS
406	Spring, Lift	-(8**)	16	32(24**)	32	64(48**)	64	35069A
407	Pin, Lift	-(8**)	16	32(24**)	32	64(48**)	64	35070A
408	Retainer, Lift Ring	-(1**)	2	4(3**)	4	8(6***)	8	1971A
408A	Seal, 'O' Ring (lower – Two-Stage only)	--	--	6	--	12	--	2176BL
409	Plate, Suction Valve	2	4	6	8	12	16	31909A or KT646 (12 pieces)
410A/B & 411	Piston & Rings Assy., Cap Red (Oil †)	-(1**)	1	2(3**)	2	4(6**)	4	A35315BX
410 & 411	Piston & Rings Assy., Cap Red (Gas †)	-(1**)	1	2(3**)	2	4(6**)	4	A35315CX
410	Ring Set (PTFE & rubber)	-(1**)	1	2(3**)	2	4(6**)	4	2557A
410A	Seal, Unload Piston (Oil only)	1	1	1	1	1	1	2639A
410B	Ring, Retaining Unload Piston (Oil only)	1	1	1	1	1	1	2638A

Notes-

**: Two cylinder high stage and 6 & 12 cylinder Two-Stage Compressor only: Unloading is NOT standard. When supplied as an option, single cylinder unloading is provided on 50% of the cylinders. These items and quantities in ( ) are then used. Also, for single cylinder unloading, the yoke assembly (Part Number A33575A) and two pins on the Yoke Guide Assembly (Part Number A33576A) have drill and tapped holes to accommodate screw (Item 419) and spacers (Item 420).

***: Parts quantities are listed for standard unloading only (except 2 cylinder and two-stage, see note **). Standard unloading on compressors with 2 cylinders is none; 4 cylinders is 50%; 6 cylinders is 33 & 66%; 8 cylinders is 25 & 50%; 12 cylinders is 33 & 66%; 16 cylinders is 25 & 50%; and two-stage is none. See Operation Section for other unloading options.

† Actuation type present on your compressor can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. Gas unloading was considered standard on all high-stage compressors, except those with 100% capacity reduction. Oil unloading is standard on high-stage compressors with 100% capacity reduction, all boosters and two-stage compressors with capacity reduction.

+ If a single cylinder unloader mechanism serviced uses pivot bolts to hold down one half of the mechanism, it should be replaced by 405A and 405B.

450XL® VMC Compressors
Cylinder Liner and Capacity Control Replacement Parts
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
411	Piston, Unloader (Gas or Oil)	-(1**)	1	2(3**)	2	4(6**)	4	Order Assy
413 thru 418	Complete Capacity Control Mechanism Assembly 4 thru 16 cylinder compressors (Low Suction R717 and all Booster)	--	1	2	2	4	4	A41788BX
	Capacity Control Mechanism Assembly (High Suction)	1	1	2	2	4	4	A35304AX
413	Arm, Yoke Lifting	-(1**)	1	2(3**)	2	4(6**)	4	41725A
414	Yoke Assembly (2 Cylinder and Two-Stage only)	-(1**)	--	-(3**)	--	-(6**)	--	A33575A
414	Yoke Assembly	--	1	2	2	4	4	A33335A
415	Pin, 3/8" x 11/16" lg. Roll	-(1**)	1	2(3**)	2	4(6**)	4	1193X
416	Pin, Short Pivot	-(1**)	1	2(3**)	2	4(6**)	4	33250B
417	Spring, Unloader Yoke	-(4**)	4	8(12**)	8	16(24**)	16	33686A
418A	Yoke Guide Assembly	--	1	2	2	4	4	A33347A
418B	Yoke Guide Assembly	--	1	2	2	4	4	A35248A
419	Screw, 3/8" x 1" Cap Lock	2*	2	--	--	--	--	1352D
420	Spacer, Sleeve	2*	2	--	--	--	--	33618A

Notes-

**: Two cylinder high stage and 6 & 12 cylinder Two-Stage Compressor only: Unloading is NOT standard. When supplied as an option, single cylinder unloading is provided on 50% of the cylinders. These items and quantities in ( ) are then used. Also, for single cylinder unloading, the yoke assembly (Part Number A33575A) and two pins on the Yoke Guide Assembly (Part Number A33576A) have drill and tapped holes to accommodate screw (Item 419) and spacers (Item 420).

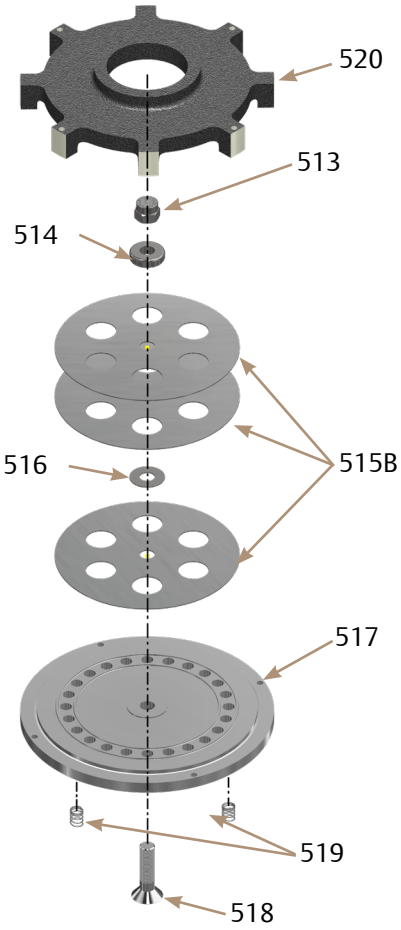
***: Parts quantities are listed for standard unloading only (except 2 cylinder and two-stage, see note **). Standard unloading on compressors with 2 cylinders is none; 4 cylinders is 50%; 6 cylinders is 33 & 66%; 8 cylinders is 25 & 50%; 12 cylinders is 33 & 66%; 16 cylinders is 25 & 50%; and two-stage is none. See Operation Section for other unloading options.

†: Actuation type present on your compressor can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. Gas unloading was considered standard on all high-stage compressors, except those with 100% capacity reduction. Oil unloading is standard on high-stage compressors with 100% capacity reduction, all boosters and two-stage compressors with capacity reduction.

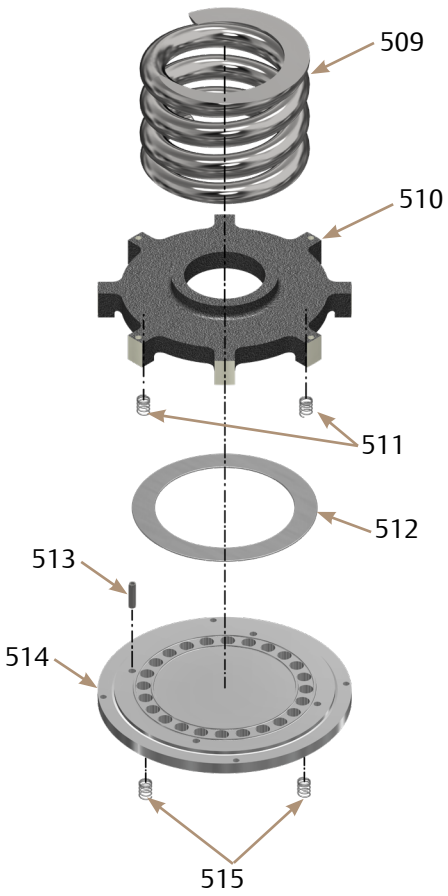
+: If a single cylinder unloader mechanism serviced uses pivot bolts to hold down one half of the mechanism, it should be replaced by 405A and 405B.

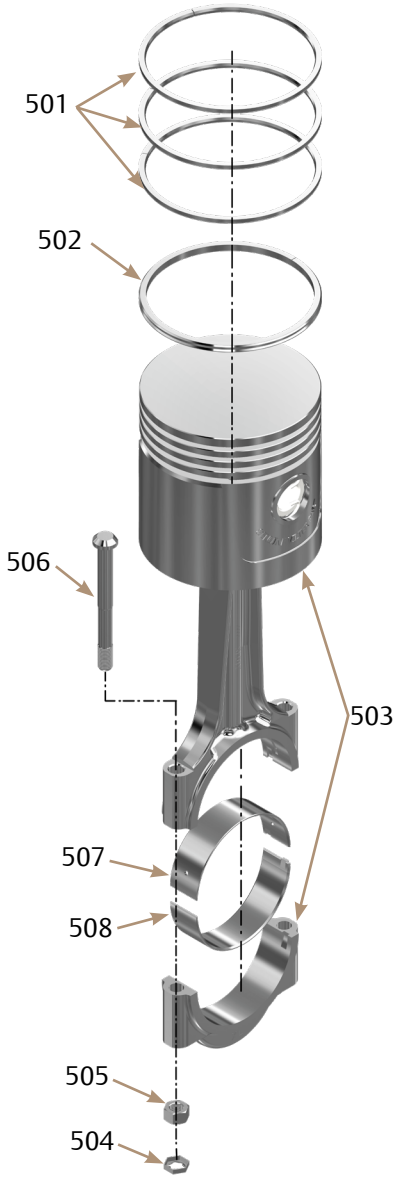
450XL® VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts

Booster & 2 Stage Low Side



High Stage





450XL® VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
501 thru 508	Piston Rings and Connecting Rod Assy Kit	2	4	6	8	12	16	KT573 **
501	Piston Ring, Compression	6	12	18	24	36	48	31989M or KT649 (24 pieces/8 piston)
502	Piston Ring, Oil	2	4	6	8	12	16	31989N or KT650 (8 pieces)
503	Piston and Connecting Rod Assy	2	4	6	8	12	16	**
504, 507 & 508	BEARING 450XL CON-ROD STD SET	2	4	6	8	12	16	KT575
	BEARING 450XL 0.015 UNDERSIZE SET							KT399A
	BEARING 450XL 0.030 UNDERSIZE SET							KT399B
504	Lock Nut, 3/8", Connecting Rod	4	8	12	16	24	32	2028A
505	Nut, Plain Hex 3/8"-UNF	4	8	12	16	24	32	2027A
506	Bolt, Connecting Rod	4	8	12	16	24	32	31955A
507	Bearing Half, Connecting Rod (upper)	2	4	6	8	12	16	Order KT575
508	Bearing Half, Connecting Rod (lower)	2	4	6	8	12	16	Order KT575
509	Spring, Safety Head	2	4	6	8	12	16	35252A
510	Safety Head Yoke Kit (includes 4 of item 513)	2	4	6	8	12	16	KT543
520	Booster - Safety Head Yoke	2	4	6	8	12	16	31941B
	2-Stage Low side - Safety Head Yoke	--	--	4	--	8	--	31941B
511	Spring, Valve	16	32	48	64	96	128	33803A or KT648A
512	Plate, Discharge Valve	2	4	6	8	12	16	35080SS or KT647XL (12 pieces)
513 & 514	Safety Hd. & Pins Assy (Ammonia and Halocarbon) (Std.)	2	4	6	8	12	16	A35082A
	Safety Hd. & Pins Assy (2- Stage High Side Comp.)	--	--	2	--	4	--	
	Safety Hd. & Pins Assy (#) (Ammonia and Halocarbon) (High Suction)	2	4	6	8	12	16	A35272A
	Safety Hd. & Pins Assy (2- Stage High Side Comp.)	--	--	2	--	4	--	
513	Pin, Roll, 3/16" dia. x 11/16" lg. †	8	16	24	32	48	64	1712F
514	Safety Head-STD.XL	2	4	6	8	12	16	***
515	Spring, Valve	8	16	24	32	48	64	33803A or KT648 (100 pieces)
515B	Valve, Diaphragm Discharge (Booster)	6	12	18	24	36	48	31939B or KT647 (12 pieces/ 4 safety heads)
	2-Stage Low Side	--	--	12	--	24	--	

Notes-

**: Piston, wrist pin and connecting rod sold only as a kit.

***: Shown for disassembly purposes only, order assembly.

†: Install with pin's outside longitudinal seam facing outside diameter of safety head.

#: This Safety Head and Pins Assembly is used on standard Halocarbon and High Suction Pressure Ammonia Compressors. High Suction Pressure Compressors are identified with an 'X' in the serial number. Also used in 2- Stage High Side Halo Compressors.

450XL® VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
513 thru 518	Safety Hd. & Disch Valve Assy (R314A, R404A) (Std.)	2	4	6	8	12	16	A32695C
	Safety Hd. & Disch Valve Assy (Booster) (R717, R22, R290 , R314A, R404A, R507)	2	4	6	8	12	16	
	2- Stage Low Side-Safety Head- Ammonia	--	--	4	--	8	--	
	Safety Hd. & Disch Valve Assy (R314A, R404A) (High Suction)	2	4	6	8	12	16	A32695D
	2- Stage Low Side- Safety Head- Halo	--	--	4	--	8	--	
	Safety Hd. & Disch Valve Assy (R507) (Std.)	2	4	6	8	12	16	A32695F
	Safety Hd. & Disch Valve Assy (R507) (High Suction)	2	4	6	8	12	16	A32695E
519	Spring, Valve (Booster)	8	16	24	32	48	64	33803A or KT648 (100 pieces)
	2- Stage Low Side	--	--	16	--	32	--	

Notes-

** Piston, wrist pin and connecting rod sold only as a kit.

*** Shown for disassembly purposes only, order assembly.

† Install with pin's outside longitudinal seam facing outside diameter of safety head.

This Safety Head and Pins Assembly is used on standard Halocarbon and High Suction Pressure Ammonia Compressors. High Suction Pressure Compressors are identified with an 'X' in the serial number. Also used in 2- Stage High Side Halo Compressors.

450XL® VMC Compressors
Recommended Spare Parts List
(1 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
118	Valve, Internal Relief	1	1	1	1	1	1	1721C
217 & 218	Rotary Shaft Seal Assembly	1	1	1	1	1	1	KT509
306	Oil Pump Assembly	1	1	1	1	1	1	A33480A (KT519A)
315	Recharge, Oil Filter (Gasket 1448B included) (for use with 2046A & A35241A) (w/o bypass)	1	1	1	1	1	1	2115C
315	Recharge, Oil Filter (Gasket 1448B included) (for use with A35240A & 1448J) (with bypass)	1	1	1	1	1	1	1448C or KT645 (6 pack)

Notes-

A: The above listing includes the minimum selection and quantity of recommended spare parts. All items listed do not necessarily apply to every compressor, because of type, size or optional features. Items should be selected for each individual compressor as they apply.

**: When capacity reduction is supplied.

#: This Safety Head and Pins Assembly is used on standard Halocarbon and High Suction Pressure Ammonia Compressors. High Suction Pressure Compressors are identified with an 'X' in the serial number. Also used in 2- Stage High Side Halo Compressors.

450XL® VMC Compressors
Recommended Spare Parts List
(2 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
401 thru 404	Cylinder Liner Assembly Kit (for cylinder without unloading)	1	1	2	2	2	2	KT475
	Cylinder Liner Assembly Kit (for cylinder without unloading, Two-Stage)	--	--	1	--	1	--	A35108D
401 thru 408	Cylinder Liner Assembly Kit (for cylinder with unloading)	1	1	2	2	2	2	KT476
	Cylinder Liner Assembly Kit (for cylinder with unloading, Two-Stage) **	--	--		--		--	A35108C
409	Plate, Suction Plate	2	4	6	8	12	16	31909A
413 thru 420	Capacity Control Assembly Two Cylinder and Two-Stage Compressor ** (High Suction)	1	--	1	--	1	--	A35304AX
	Capacity Control Assembly 4 thru 16 Cylinder Compressors	--	1	1	1	1	1	A41788BX
501 thru 508	Piston, Rings and Connecting Rod Assembly Kit	1	1	2	2	2	2	KT573
501	Piston Ring, Compression	6	12	18	24	36	48	31989M or KT649 (24 pieces/8 piston)
502	Piston Ring, Oil	2	4	6	8	12	16	31989N or KT650 (8 pieces)
504, 507 & 508	BEARING 450XL CON-ROD STD SET	2	4	6	8	12	16	KT575
	BEARING 450XL 0.015 UNDERSIZE SET							KT399A
	BEARING 450XL 0.030 UNDERSIZE SET							KT399B
511, 515 & 519	Spring, Valve	24	48	72	96	144	192	33803A or KT648 (100 pieces)
512	Plate, Discharge Valve	2	4	6	8	12	16	35080SS
513 & 514	Safety Hd. & Pins Assy (R717, R22, R290) (Std.)	2	4	6	8	12	16	A35082A
	Safety Hd. & Pins Assy (2- Stage High Side Comp.)	--	--	2	--	4	--	
	Safety Hd. & Pins Assy (#) (R717, R22, R290) (High Suction)	2	4	6	8	12	16	A35272A
	Safety Hd. & Pins Assy (2- Stage High Side Comp.)	--	--	2	--	4	--	

Notes-

A: The above listing includes the minimum selection and quantity of recommended spare parts. All items listed do not necessarily apply to every compressor, because of type, size or optional features. Items should be selected for each individual compressor as they apply.

**: When capacity reduction is supplied.

#: This Safety Head and Pins Assembly is used on standard Halocarbon and High Suction Pressure Ammonia Compressors. High Suction Pressure Compressors are identified with an 'X' in the serial number. Also used in 2- Stage High Side Halo Compressors.

450XL® VMC Compressors
Recommended Spare Parts List
(3 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
513 thru 518	Safety Hd. & Disch Valve Assy (R314A, R404A) (Std.)	2	4	6	8	12	16	A32695C
	Safety Hd. & Disch Valve Assy (Booster) (R717, R22, R290 , R314A, R404A, R507)	2	4	6	8	12	16	
	2- Stage Low Side-Safety Head- Ammonia	--	--	4	--	8	--	
	Safety Hd. & Disch Valve Assy (R314A, R404A) (High Suction)	2	4	6	8	12	16	A32695D
	2- Stage Low Side- Safety Head- Halo	--	--	4	--	8	--	
	Safety Hd. & Disch Valve Assy (R507) (Std.)	2	4	6	8	12	16	A32695F
	Safety Hd. & Disch Valve Assy (R507) (High Suction)	2	4	6	8	12	16	A32695E
--	Gasket Kit, Complete	1	--	--	--	--	--	KT041
	Gasket Kit, Complete	--	1	--	--	--	--	KT043
	Gasket Kit, Complete	--	--	1	--	--	--	KT045
	Gasket Kit, Complete	--	--	--	1	--	--	KT049
	Gasket Kit, Complete	--	--	--	--	1	--	KT051
	Gasket Kit, Complete	--	--	--	--	--	1	KT055

Notes-

A: The above listing includes the minimum selection and quantity of recommended spare parts. All items listed do not necessarily apply to every compressor, because of type, size or optional features. Items should be selected for each individual compressor as they apply.

**: When capacity reduction is supplied.

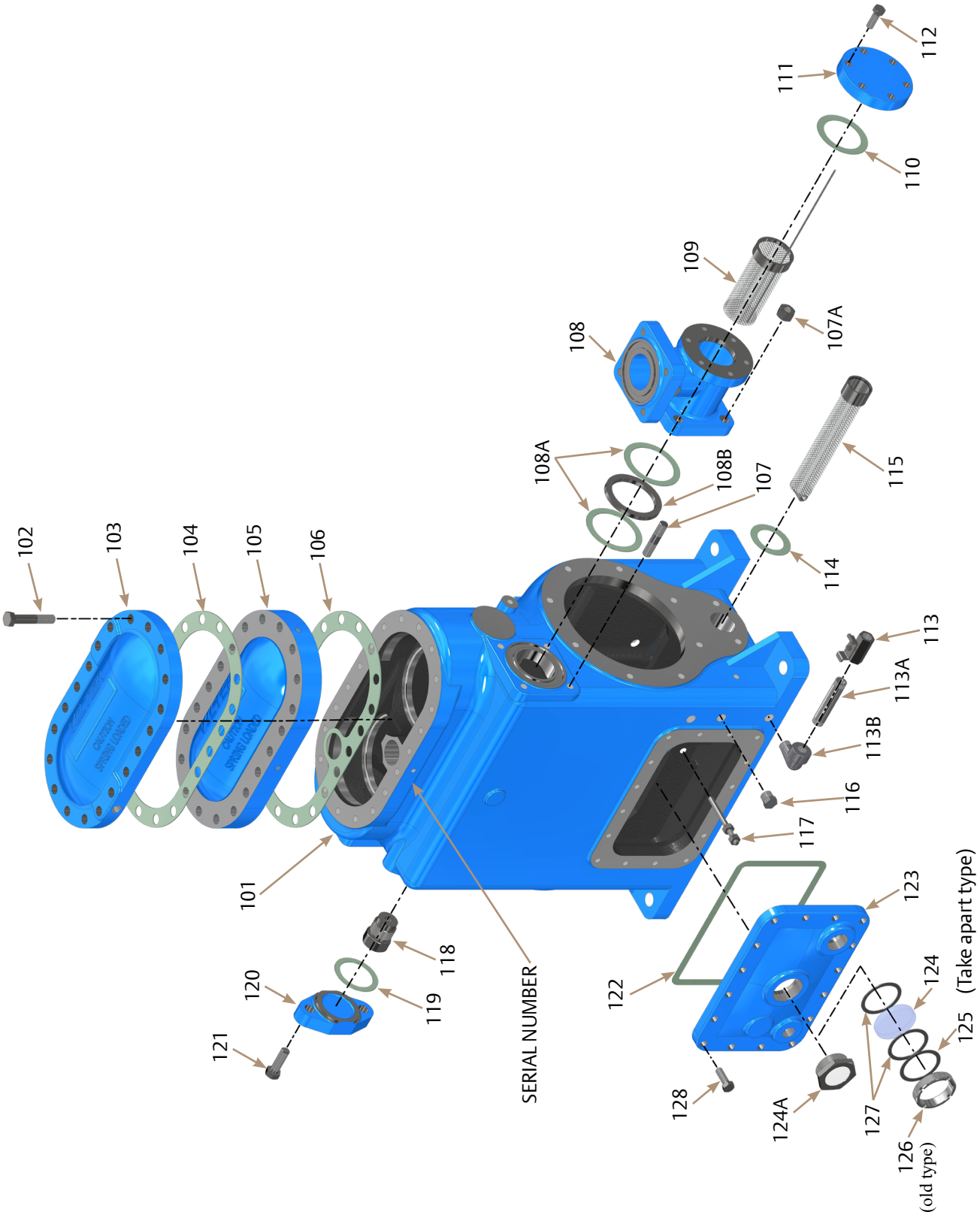
#: This Safety Head and Pins Assembly is used on standard Halocarbon and High Suction Pressure Ammonia Compressors. High Suction Pressure Compressors are identified with an 'X' in the serial number. Also used in 2- Stage High Side Halo Compressors.

440 VMC Compressors
Replacement Parts List

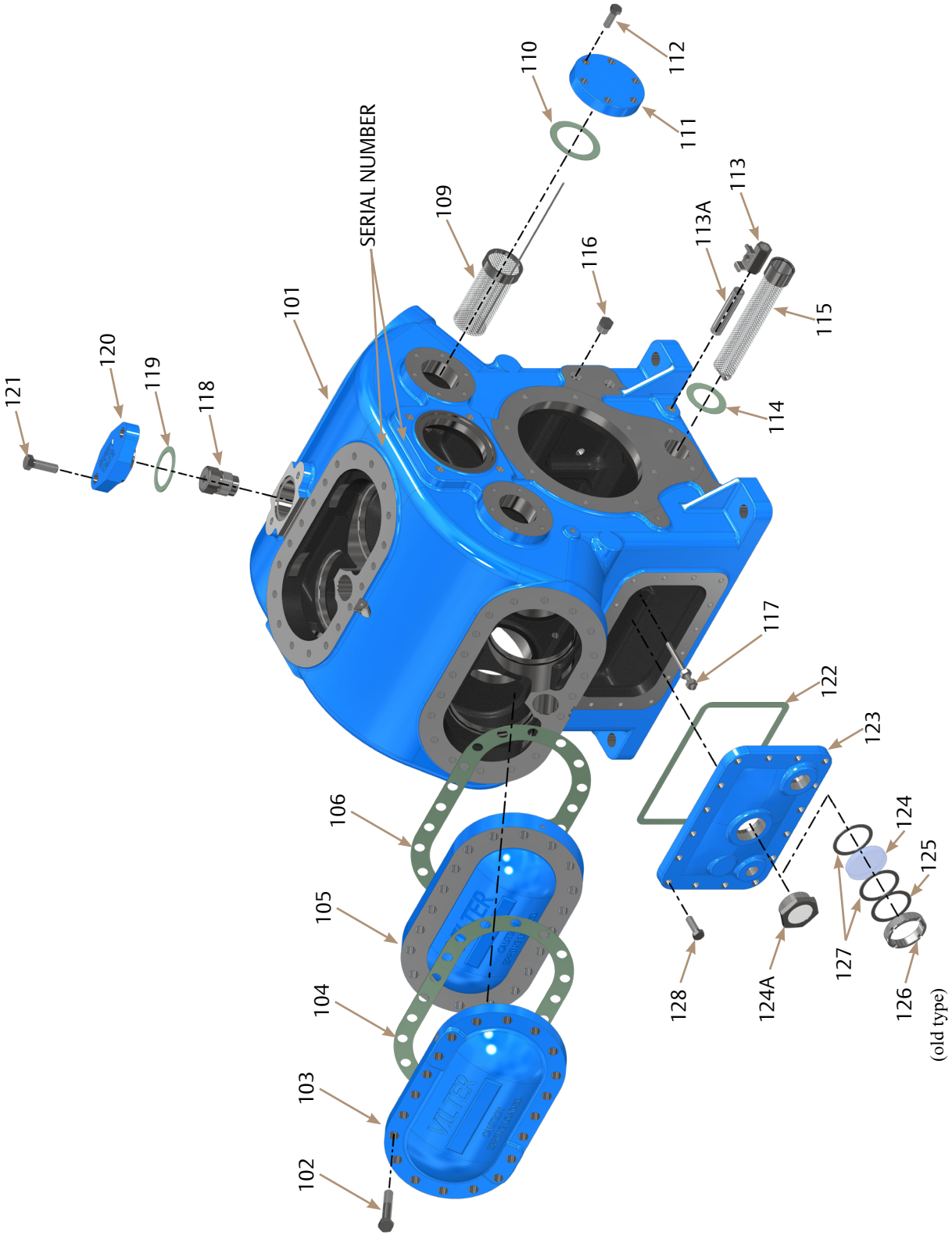
Refer to the Custom Manual
Spare Parts Section for Specific Applications

Please have your Model # and Sales Order # available when ordering.
These are found on the compressor's Name Plate.

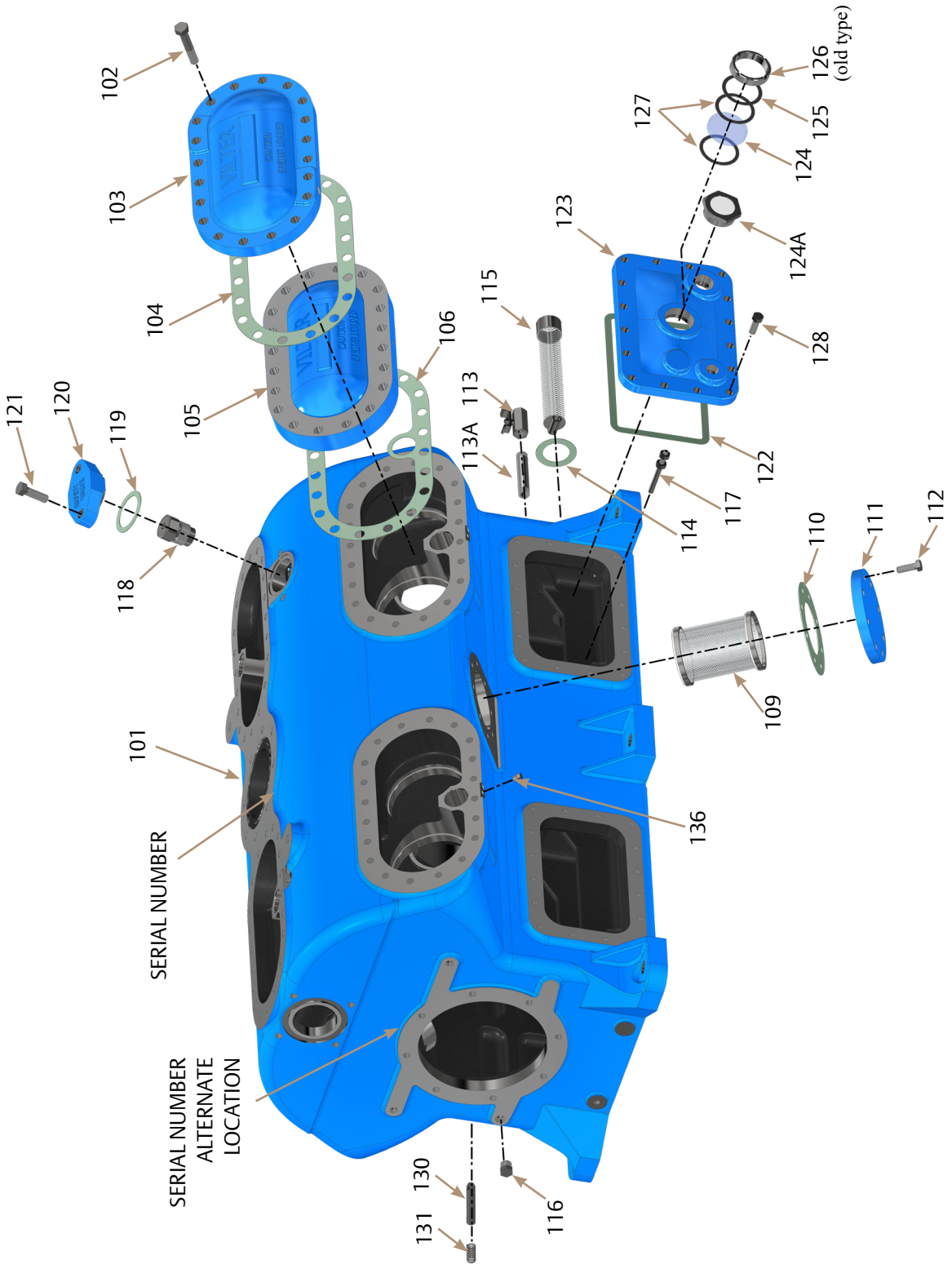
440 VMC Compressors
Basic Frame Replacement Parts For 2 Cylinder VMC Compressors



440 VMC Compressors
Basic Frame Replacement Parts 4, 6 and 8 Cylinder VMC Compressors



440 VMC Compressors
Basic Frame Replacement Parts 12 and 16 Cylinder VMC Compressors



440 VMC Compressors
Basic Frame Replacement Parts For All VMC Compressors
(1 of 4)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
101	Frame	1	1	1	1	1	1	1	1			*
102	Screw, 5/8" x 3½"Hex Head Cap (Used with Water Jacket)	20	40	60	80	120	160	20	40	0	Present	13152L
102	Screw, 5/8" x 2½" Hex Head Cap (Used witout Water Jacket)	20	40	60	80	120	160	40	80	0	Present	13152G
103	Cover, Water Jacket (Amm & R22)	1	2	3	4	6	8	1	2	0	Present	30299A
104	Gasket, Water Jacket (Amm & R22)	1	2	3	4	6	8	1	2	0	Present	33329A
105	Cover, Cylinder * *											
	Without Capacity Reduction (Right)	--	1	--	2	--	4	--	--	0	Present	A30332A
	With Capacity Reduction, Oil Type (Right)	--	1†	--	2†	--	4†	--	--	0	Present	30332B
	Without Capacity Reduction (Left)	1	--	1	--	2	--	3	6	0	Present	A30364A
	With Capacity Reduction, Oil Type (Left)	1†	--	2†	--	4†	--	2†	6†	0	Present	30364B
	With Capacity Reduction, Two-Stage (Left)	--	--	--	--	--	--	1†	--	0	Present	30364F
106	Gasket, Cylinder Cover	1	2	3	4	6	8	3	6	0	Present	33330A
107	Stud, 5/8" x 3" (shown only on 2 cyl.)	8	4	4	4	8	8	4	8	0	Present	13156D
107	Stud, ¾" x 3¼" (not shown)	--	4	4	4	--	--	4	--	0	Present	13157D

Notes-

*: Part Number on application.

**: Quantities shown are for compressors with standard capacity reduction, and will vary if compressor is equipped with additional steps of capacity reduction.

†: Items shown are for compressors with optional oil unloading or optional single cylinder unloading.

***: 6 cylinder compressors with serial numbers below 21937 (oil unloading) and 30039 (gas unloading) are equipped with a suction elbow and two suction screens (VPN A32428D) located behind the suction screen covers on the frame. 6 cylinder compressors with serial numbers 21937 (oil unloading), and 30039 (gas unloading) and above are equipped with a suction tee (VPN A36254 series) and a single suction screen (VPN 35215A) located in the suction tee. 8 cylinder compressors with serial numbers below 21937 (oil unloading) and 30039 (gas unloading) are equipped with a suction tee (VPN 32010) and three suction screens, one in the tee and two behind the suction screen covers on the frame. 8 cylinder compressors with serial numbers 21937 (oil unloading), and 30039 (gas unloading) and above, are equipped with suction tee (VPN A36254 series) and a single suction screen (VPN A35215A) located in the suction tee.

440 VMC Compressors
Basic Frame Replacement Parts For All VMC Compressors
(2 of 4)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
108	Tee, Suction											
	2½ " x 2½" (all)	1	--	--	--	--	--	--	--	0	Present	30319A
	3½" x 2½" (Ammonia)	--	1	--	--	--	--	--	--	0	Present	32417B
	3½" x 3" (Halocarbon)	--	1	--	--	--	--	--	--	0	Present	32417B
108A	Gasket 4-3/16 X 3-5/16 Flange 2-1/2	1	--	--	--	--	--	--	--	--	--	11323H
108B	Joint Ring 2-1/2 Male	1	--	--	--	--	--	--	--	--	--	13151H
109	Screen, Suction (Right & Left Side)	1	--	2	2	--	--	2	--	0	***	A32428D
	Screen, Suction	--	1	--	--	--	--	--	--	0	Present	A32428A
	Screen, Suction (Center)	--	--	--	1	--	--	--	--	0	***	A32428C
	Screen, Suction	--	--	--		2	2		1	0	Present	A32565A
	Screen, Suction (R.H. Side, 8 cyl., 75% Cap. Red.)	1	--	2	3	--	--	2	--	0	***	A32428D
	Screen, Suction	--	--	1	1	--	--	1	--	***	***	A35215A
109-A	Bag, Suction Screen (not shown)	--	1	--	--	--	--	--	--	0	Present	A33474A
	Bag, Suction Screen (not shown)	1	--	2	2	--	--	2	--	0	***	A33474B
	Bag, Suction Screen (not shown)	--	--	--	--	2	2	--	1	0	Present	A33474G
	Bag, Suction Screen (not shown)	--	--	1	1	--	--	1	--	***	***	A35234A
110	Gasket, Suction Screen Cover	1	--	2	2	--	--	2	--	0	***	31892A
	Gasket, Suction Screen Cover	--	--	--	--	2	2	--	1	0	Present	33493A
	Gasket, Suction Tee Cover	--	1	--	--	--	--	1	--	0	***	11323J
111	Cover, Suction Screen	1	--	2	2	--	--	2	--	0	Present	31893A
	Cover, Suction Screen	--	--	--	--	2	2	--	1	0	Present	33492A
	Cover, Suction Tee (for VPN 32010)	--	1	--	--	--	--	--	--	0	***	13706A

Notes-

**: Quantities shown are for compressors with standard capacity reduction, and will vary if compressor is equipped with additional steps of capacity reduction.

†: Items shown are for compressors with optional oil unloading or optional single cylinder unloading.

***: 6 cylinder compressors with serial numbers below 21937 (oil unloading) and 30039 (gas unloading) are equipped with a suction elbow and two suction screens (VPN A32428D) located behind the suction screen covers on the frame. 6 cylinder compressors with serial numbers 21937 (oil unloading), and 30039 (gas unloading) and above are equipped with a suction tee (VPN A36254 series) and a single suction screen (VPN 35215A) located in the suction tee. 8 cylinder compressors with serial numbers below 21937 (oil unloading) and 30039 (gas unloading) are equipped with a suction tee (VPN 32010) and three suction screens, one in the tee and two behind the suction screen covers on the frame. 8 cylinder compressors with serial numbers 21937 (oil unloading), and 30039 (gas unloading) and above, are equipped with suction tee (VPN A36254 series) and a single suction screen (VPN A35215A) located in the suction tee.

440 VMC Compressors
Basic Frame Replacement Parts For All VMC Compressors
(3 of 4)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
112	Screw, 5/8" x 1½" Hex. Head Cap	--	5	--	5	--	--	--	--	0	***	13152C
	Screw, 5/8" x 1¾" Hex. Head Cap *	--	--	6	6	--	--	6	--	***	***	13152D
	Screw, ½" x 1½" Hex. Head Cap	6	--	12	12	--	--	12	--	0	Present	2796E
	Screw, ½" x 1¼" Hex. Head Cap	--	--	--	--	16	16	--	16	0	Present	2796EJ
113	Valve, ½" Oil Charge & Drain (Ammonia)	1	1	1	1	1	1	1	1	0	Present	1956H
	Valve, ½" Oil Charge & Drain (Halo.)	1	1	1	1	1	1	1	1	0	Present	1956H
113A	Nipple, ½" x 4" Sch. 80 Pipe	1	1	1	1	1	1	1	1	0	Present	13189G
113B	Elbow, ½" 90deg Street	1	--	--	--	--	--	--	--	--	--	1735C
114	Gasket, Crankcase Oil Screen	1	1	1	1	1	1	1	1	0	Present	31889A
115	Crankcase Oil Screen Assembly	1	1	1	1	1	1	1	1	0	Present	A31886A
116	Plug, ¾" Hex. Head Pipe (not shown on 12 & 16)	1	1	1	1	1	1	1	1	0	Present	13264E
	Plug, ½" Hex. Head Pipe (not shown on 2 thru 8)	1	1	1	1	1	1	1	1	0	Present	13264D
117	Pin Retaining Assy, Crankcase Oil Screen	1	1	1	1	1	1	1	1	0	Present	A31936A
118	Safety Valve (Internal Relief)	1	1	1	1	2	2	--	--	0	Present	1721B
118A	Valve, Crankcase Check (not shown)	--	--	--	--	--	--	2	2	--	--	A33568A ‡
119	Gasket, 2" Flange	1	1	1	1	2	2	--	--	0	Present	11323G
120	Cover, Safety Valve	1	1	1	1	2	2	--	--	0	Present	31954A

Notes-

*: Part Number on application.

**: Quantities shown are for compressors with standard capacity reduction, and will vary if compressor is equipped with additional steps of capacity reduction.

†: Items shown are for compressors with optional oil unloading or optional single cylinder unloading.

***: 6 cylinder compressors with serial numbers below 21937 (oil unloading) and 30039 (gas unloading) are equipped with a suction elbow and two suction screens (VPN A32428D) located behind the suction screen covers on the frame. 6 cylinder compressors with serial numbers 21937 (oil unloading), and 30039 (gas unloading) and above are equipped with a suction tee (VPN A36254 series) and a single suction screen (VPN 35215A) located in the suction tee. 8 cylinder compressors with serial numbers below 21937 (oil unloading) and 30039 (gas unloading) are equipped with a suction tee (VPN 32010) and three suction screens, one in the tee and two behind the suction screen covers on the frame. 8 cylinder compressors with serial numbers 21937 (oil unloading), and 30039 (gas unloading) and above, are equipped with suction tee (VPN A36254 series) and a single suction screen (VPN A35215A) located in the suction tee.

440 VMC Compressors
Basic Frame Replacement Parts For All VMC Compressors
(4 of 4)

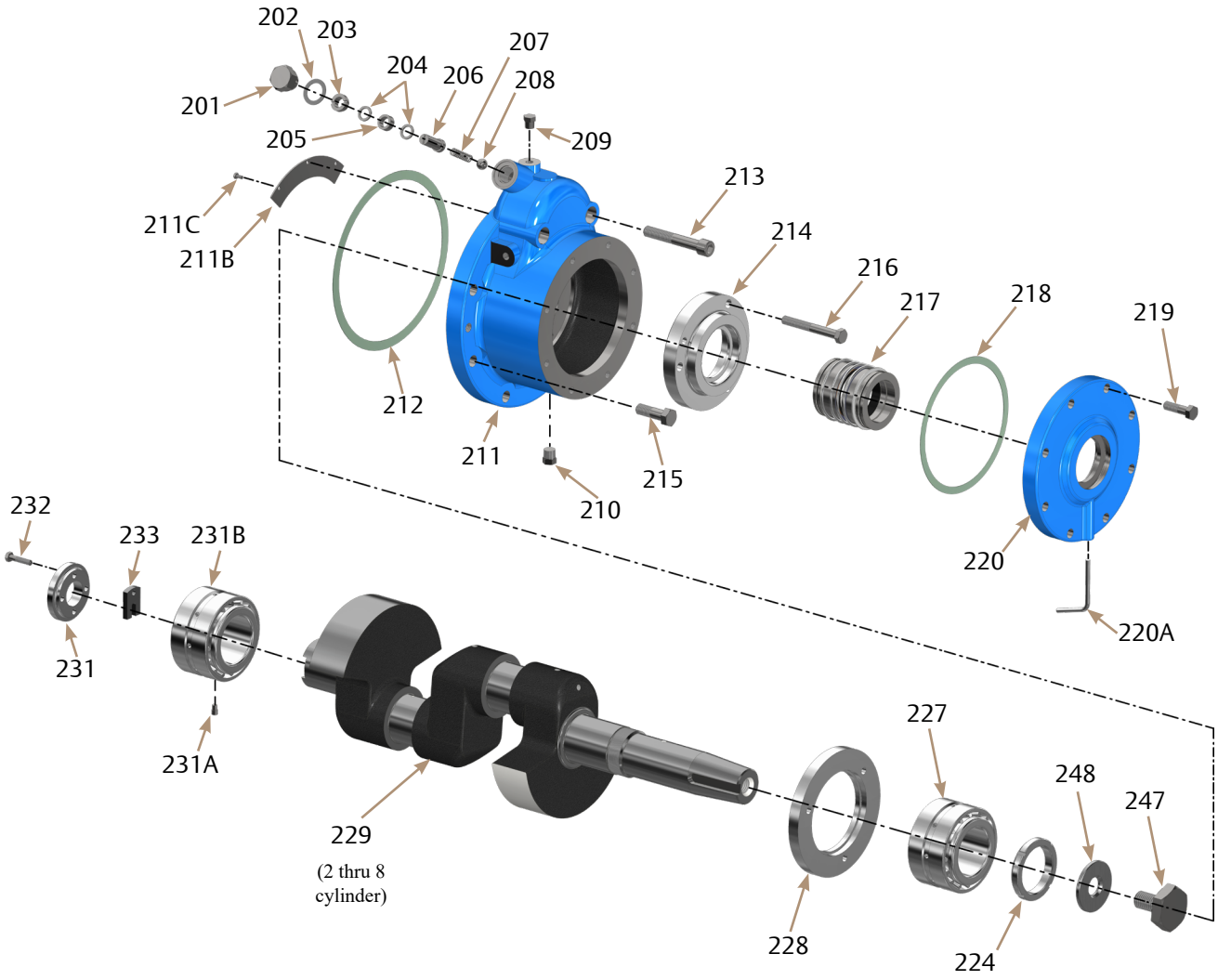
ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
121	Screw, 5/8" x 2" Hex. Head Cap	2	2	2	2	4	4	--	--	0	Present	13152E
122	Gasket, Handhole Cover	1	1	1	1	2	2	1	2	0	Present	31894A
123 & 124A	Handhole Cover and 2" Sight Glass Assy With openings for:											
	560W NEMA 1&7 Htr, F.V. & Therm	1	1	1	1	1	1	1	1	0	Present	A33034G
	300W NEMA 1&7 Htr, F.V. & Therm	1	1	1	1	1	1	1	1	0	Present	A33034GA
	560W NEMA 1&7 Heater & Therm	1	1	1	1	1	1	1	1	0	Present	A33034L
	300W NEMA 1&7 Heater & therm	1	1	1	1	1	1	1	1	0	Present	A33034LA
	560W NEMA 1&7 Heater & Float Valve	1	1	1	1	1	1	1	1	0	Present	A33034G
	560W NEMA 1&7 Heater	1	1	1	1	1	1	1	1	0	Present	A33034L
123	Cover, Handhole (with openings)	1	1	1	1	1	1	1	1	0	Present	Order Assy
123A	Cover, Handhole (without openings)	--	--	--	--	1	1	--	1	0	Present	33034B
124A	Glass, Oil Sight – 2"	1	1	1	1	1	1	1	1	13050	Present	1484A
124 +	Glass, Oil Sight – 3"	1	1	1	1	1	1	1	1	0	13049	31212A
125 +	Washer, Oil Sight Glass – 3"	1	1	1	1	1	1	1	1	0	13049	31636A
126 +	Lock, Oil Sight Glass – 3"	1	1	1	1	1	1	1	1	0	13049	31211A
127 +	Gasket, Oil Sight Glass – 3"	2	2	2	2	2	2	2	2	0	13049	31226A
128	Screw, ½" x 1½" Hex. Head Cap	16	16	16	16	32	32	16	32	0	Present	2796E
130	Tube, Oil Feed Connector	--	--	--	--	1	1	--	1	0	Present	33494A
131	Spring	--	--	--	--	1	1	--	1	0	Present	31789A

Notes-

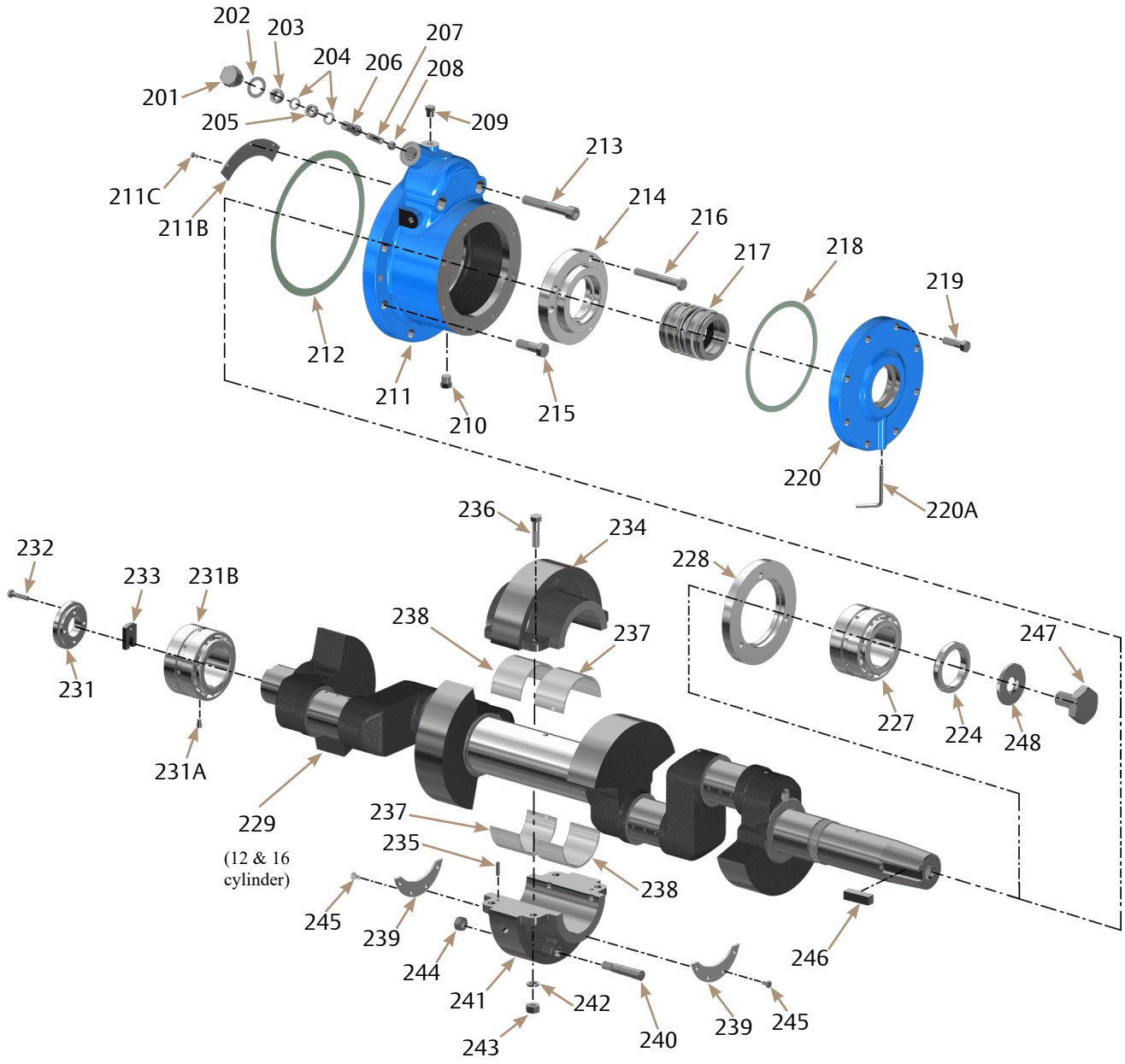
‡: For use on compressors without external oil drain arrangement.

+: The crankcase cover for the 3" sight glass is not available, but these sight glass parts can still be supplied.

440 VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
2 Thru 8 Cylinder Compressors



440 VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
12 and 16 Cylinder Compressors



440 VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
(1 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
The following complete crankshaft sub-assemblies are available for all 440 VMC Compressors with aluminum pistons for 1000 RPM compressors from serial number 3068 thru present and for 1200 RPM compressors from serial number 1660 thru present. x												
201 thru 208	Oil Relief Valve Kit											KT486
201 Thru 211A	Front Brg. Cover & Relief Valve Assy.	1	1	1	1	--	--	1	--	0	Present	A31121A
	Front Brg. Cover & Relief Valve Assy.	--	--	--	--	1	1	--	1	0	Present	A32566A
201	Cap, Valve	1	1	1	1	1	1	1	1	0	Present	17355A
202	Gasket	1	1	1	1	1	1	1	1	0	Present	30651C
203	Nut, Packing	1	1	1	1	1	1	1	1	0	Present	31048A
204	Washers	2	2	2	2	2	2	2	2	0	Present	31048D
205	Packing, 7/8" O.D. x 39/64" I.D. x 3/8"	1	1	1	1	1	1	1	1	0	Present	31048E
206	Stem, Valve	1	1	1	1	1	1	1	1	0	Present	31048C
207	Spring	1	1	1	1	1	1	1	1	0	Present	31048F
208	Ball, 5/8" Dia. Steel	1	1	1	1	1	1	1	1	0	Present	13155K
209 thru 211A	Front Bearing Cover Assembly †††	1	1	1	1	--	--	1	--	See †††	Present	A36240A
	Front Bearing Cover Assembly †††	--	--	--	--	1	1	--	1	See †††	Present	A36241A
209	Plug, ¼" Hex. Head Pipe	1	1	1	1	1	1	1	1	0	Present	13264B
210	Plug, 3/8" Hex (not used after 12/81)	1	1	1	1	1	1	1	1	0	Present	13264C
211	Cover, Front Bearing	1	1	1	1	--	--	1	--	0	Present	**
211	Cover, Front Bearing	--	--	--	--	1	1	--	1	0	Present	**
211A	Orifice, Oil Metering	1	1	1	1	1	1	1	1	0	21354	33361A
211B & 211C	Splash Oil Shield W/Bolts											A35274A
211B	Shield, Splash (Oil Relief Outlet Hole)	1	1	1	1	1	1	1	1	0	Present	35274A
211C	Screw, Rd Hd No. 10-32 x 3/8" Lg.	3	3	3	3	3	3	3	3	0	Present	1332C
212	Gasket, Bearing Cover	1	1	1	1	1	1	1	1	0	Present	31890A
213	Screw, 5/8" x 4" Hex, Socket Head Cap	2	2	2	2	2	2	2	2	0	Present	13159E
214	Retainer, Front Bearing (w/oil hole)†††	1	1	1	1	--	--	1	--	See †††	Present	31885A

Notes-

**: Sold only in Front Bearing Cover Assembly.

***: Crankshafts for Cast Iron Piston for these machines are no longer available. Use current crankshaft and convert the compressor to aluminum pistons.

†††: Compressors below serial number 21355 were furnished with the no longer available front bearing cover assemblies A30294A (2,4,6, and 8 cylinders) or A32162A (12 and 16 cylinders), and front bearing retainer 31885A (2,4,6, and 8 cylinders) or 33500A (12 and 16 cylinders) without the oil hole. Former front bearing retainers (31885A or 33500A) without oil holes cannot be used with current front bearing cover assemblies A36240A (2,4,6, and 8 cylinders) and A36241A (12 and 16 cylinders), as there is no way for oil to get to the bearing. If front bearing cover is being replaced, a current front bearing retainer (31885A or 33500A with oil hole) must be ordered also, unless one of these current styles is already being used. If a current front bearing retainer, (31885A or 33500A, both with oil hole) is used with former style cover (A30294A or A32162A) having an oil hole, remove orifice in cover (A30294A or A32162A) and replace with solid 1/8" pipe plug.

440 VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
(2 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
214	Retainer, Front Bearing (w/oil hole)†††	--	--	--	--	1	1	--	1	See †††	Present	33500A
215	Screw, 5/8" x 2" Hex Head Cap	6	6	6	6	6	6	6	6	0	Present	13152E
216	Screw, ½" x 4" Hex Head Cap	3	3	3	3	3	3	3	3	0	Present	2796EV
217	Seal, Rotary Shaft Assembly	1	1	1	1	--	--	1	--	0	Present	KT508
217	Seal, Rotary Shaft Assembly	--	--	--	--	1	1	--	1	0	Present	KT509
218	Gasket, Shaft Seal Cover	1	1	1	1	--	--	1	--	0	Present	31897A
218	Gasket, Shaft Seal Cover	--	--	--	--	1	1	--	1	0	Present	33496A
219	Screw, ½" x 1¾" Hex Head Cap	8	8	8	8	8	8	8	8	0	Present	2796EL
220	Cover, Shaft Seal	1	1	1	1	--	--	1	--	0	Present	31044A
220	Cover, Shaft Seal	--	--	--	--	1	1	--	1	0	Present	32564A
220A	Tube, Oil Drain	1	1	1	1	1	1	1	1	0	Present	35078A
224 thru 233	Complete Crankshaft Assy (1200 RPM)											
	For Aluminum Pistons *	1	--	--	--	--	--	--	--	1660	Present	A32574A
	For Aluminum Pistons *	--	1	--	--	--	--	--	--	1660	Present	A32574B
	For Aluminum Pistons *	--	--	1	--	--	--	1	--	1660	Present	A32574C
	For Aluminum Pistons *	--	--	--	1	--	--	--	--	1660	Present	A32574D
224 thru 245 (less items 225, 226, 230, 234, 235 & 241)	Complete Crankshaft Assembly Kit											
	1000 or 1200 RPM, for Aluminum Pistons	--	--	--	--	1	--	--	1	0	Present	KT068
	1000 or 1200 RPM for Aluminum Pistons	--	--	--	--	--	1	--	--	0	Present	KT069
224††	Locknut and Retaining Compound Kit	1	1	1	1	--	--	1	--	0	Present	KT366 ++
224††	Locknut and Retaining Compound Kit	--	--	--	--	1	1	--	1	0	Present	KT367 ++
227 ‡	Front Bearing and Retaining Compound Kit	1	1	1	1	--	--	1	--	0	Present	KT368
227	Front Bearing and Retaining Compound Kit	--	--	--	--	1	1	--	1	0	Present	KT369
228	Ring, Front Bearing Retainer	1	1	1	1	--	--	1	--	0	Present	33144A
228	Ring, Front Bearing Retainer	--	--	--	--	1	1	--	1	0	Present	33145A

Notes-

*: Please call Vilter for assistance regarding serial numbers below 1660.

‡: This bearing is interchangeable with the bearing (Part No. A31988A) originally used on the 2, 4, 6 and 8 cylinder compressors. A spacer is incorporated as an integral part of this bearing, eliminating the use of shims and a bearing lock. When installing this bearing, do not use the shims (Item No. 230) and bearing lock (Item No. 226).

††: Supplied as a kit, includes retaining compound for bearing locknut. Retaining compound also available separately; order Part No. KT365.

++: When ordering a crankshaft bearing locknut (Item 224) for a compressor with Serial No. 9,999 and below, also order crankshaft bearing lockwasher (Item 225). See *.

440 VMC Compressors
Crankshaft and Front Bearing Cover Replacement Parts
(3 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
229A	Plug, Pipe, 1/8", Hex Socket Head (Not Shown)	5	5	5	5	8	8	5	8	0	Present	2606B
231	Retainer, Rear Bearing †	1	1	1	1	1	1	1	1	0	Present	31904A
231A 231B	Rear Bearing and Lock Pin Kit	1	1	1	1	1	1	1	1	0	Present	KT353
231A	Pin, Bearing Lock +	1	1	1	1	1	1	1	1	4233	Present	33678A
231B	Bearing, Rear Crankshaft	1	1	1	1	1	1	1	1	0	Present	A33509A or KT353
232	Screw, 5/16" x 1" Hex. Socket Head Cap	4	4	4	4	4	4	4	4	See †		13160D
232	Screw, 5/16" x 1½" Hex. Head Cap.	4	4	4	4	4	4	4	4			1736G
233	Crank, Oil Pump Drive	1	1	1	1	1	1	1	1	0	Present	33403A
234	Cap, Bearing Support *	--	--	--	--	1	1	--	1	0	Present	*
235	Pin, ¼" x 1" Dowel *	--	--	--	--	2	2	--	2	0	Present	2868B
236	Bolt, ½" x 2" Machine	--	--	--	--	4	4	--	4	0	Present	2796R
237	Bearing Half, Upper Right or Lower Left	--	--	--	--	2	2	--	2	0	Present	33508A
238	Bearing Half, Upper Left or Lower Right	--	--	--	--	2	2	--	2	0	Present	33508B
239	Oil Dam, Center Bearing ††	--	--	--	--	2	2	--	2	0	Present	33498A
240	Pin, Threaded Taper	--	--	--	--	1	1	--	1	0	Present	33497A
241	Case, Bearing Support *	--	--	--	--	1	1	--	1	0	Present	*
242	Washer, ½" Spring Lock	--	--	--	--	4	4	--	4	0	Present	13165F
243	Nut, ½" Hex	--	--	--	--	4	4	--	4	0	Present	1726E
244	Nut, 9/16" Hex	--	--	--	--	1	1	--	1	0	Present	13253F
245	Screw, ¼" x ½" Hex. Head Cap ††	--	--	--	--	8	8	--	8	0	Present	2796AC
246	Key, Crankshaft	1	1	1	1	--	--	1	--	0	Present	31994B
246	Key, Crankshaft	--	--	--	--	1	1	--	1	0	Present	33505B
247	Screw, Flywheel Hub	1	1	1	1	1	1	1	1	0	Present	31956A
248	Washer, Flywheel Hub Screw	--	--	--	--	1	1	--	1	0	Present	33495A

Notes-

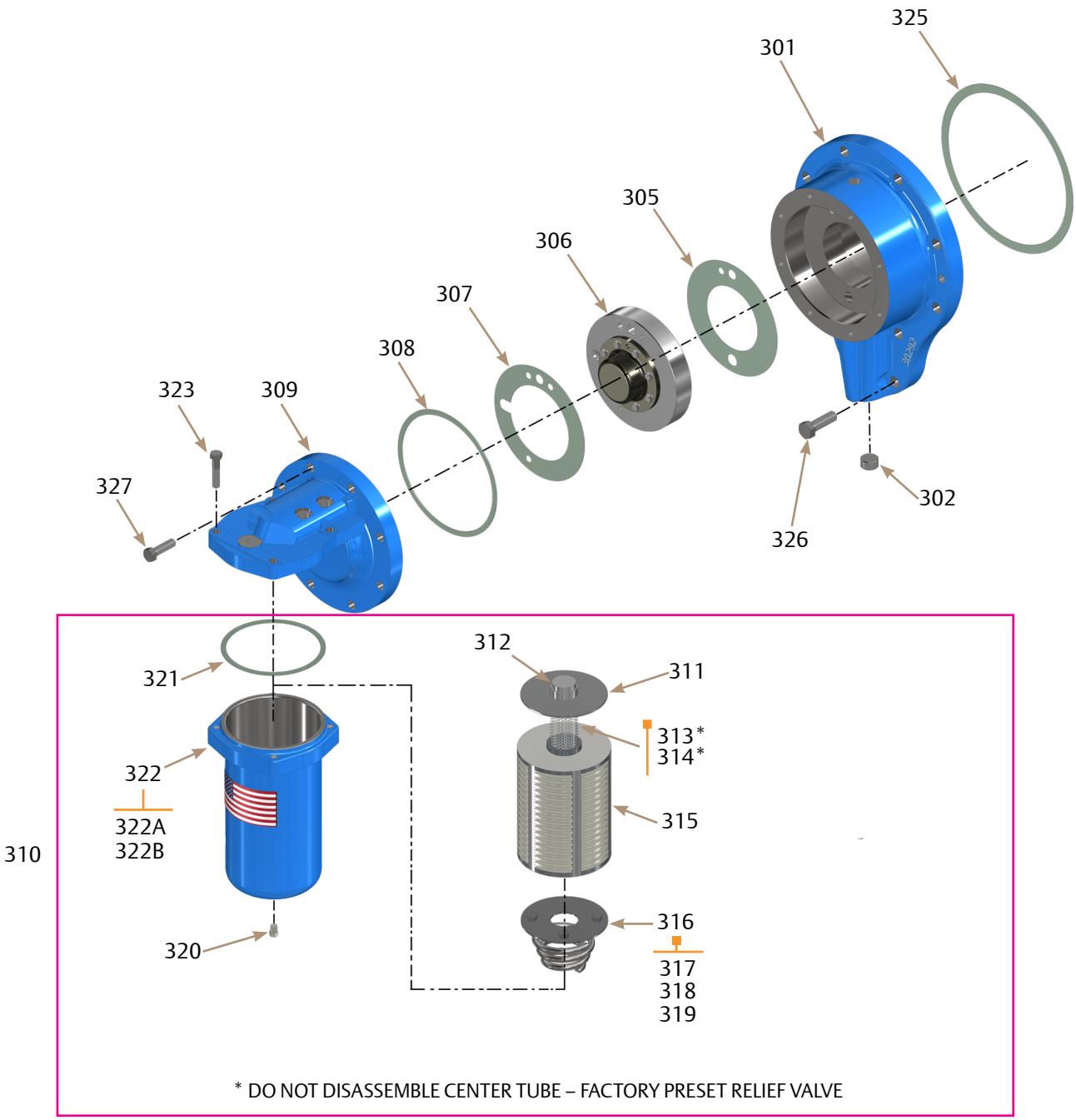
*: Matched set with pin, sold as assembly A32163A. Shown in three parts to illustrate disassembly.

+: A bearing lock pin (Item 231A) is used to keep outer face of bearing (Item 231B) from turning. If compressor does not have groove in bottom of rear bearing cover (Item 301), make a notch with a ¼" deep radius and 1 ⅛" long to accommodate pin in cover.

†: Mounting holes on retainer (Item 231) were changed from counterbored holes to plain, straight-thru holes. Use replacement screw, part number 13160D, on the former retainer with counterbored holes. Use replacement screw, part number 1736G, on current retainer with straight-thru holes.

††: Dams (Item 239) and screws (Item 245) are not needed when using VILTER's patented joined crankshafts. In this design version (introduced in 1980) two 6 cylinder or two 8 cylinder crankshafts are joined by a sleeve to form an inseparable 12 cylinder or 16 cylinder crankshaft. This specially machined sleeve eliminates the dams. This design is completely interchangeable with the former design.

440 VMC Compressors
Rear Bearing Cover Replacement Parts Compressors with Standard Tri-Micro® Filter



440 VMC Compressors
Rear Bearing Cover Replacement Parts
(Compressors with Standard Tri-Micro® Filter)
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
301 Thru 304	Rear Bearing Cover Assembly Kit	1	1	1	1	1	1	1	1	0	Present	KT092
301	Cover, Rear Bearing	1	1	1	1	1	1	1	1	0	Present	**
302	Plug, ¾" Hex. Socket Head Pipe	1	1	1	1	1	1	1	1	0	Present	2606A
303	Pin, 3/8" x 1" Dowel (not shown)	1	1	1	1	1	1	1	1	0	Present	2868H
304	Orifice, Oil Metering (not shown)	1	1	1	1	1	1	1	1	0	Present	33361A
305	Gasket, Oil Pump body	1	1	1	1	1	1	1	1	0	Present	31899A
306	Oil Pump Assembly	1	1	1	1	1	1	1	1	0	Present	KT519A
307 Thru 324	Conversion Kit, Std. Tri-Micro	1	1	1	1	1	1	1	1	0	13374	KT361A & B +
307	Gasket, Oil Pump Cover	1	1	1	1	1	1	1	1	0	Present	31900A
308	Gasket, Oil Pump and Rear Bearing Cover Seal	1	1	1	1	1	1	1	1	13375	Present	33320A
309	Cover, Oil Pump and Filter Head (Used when Oil Cooler not used)	1	1	1	1	1	1	1	1	13375	Present	34565A
309	Cover, Oil Pump and Filter Head (Used when Oil Cooler is used)	1	1	1	1	1	1	1	1	13375	Present	34760AB
310	Filter Assy, Complete (Tri-Micro) (Items 311 thru 322B)	1	1	1	1	1	1	1	1	13375	Present	A35240A
311, 312, 313 & 314	Spool – Strainer Tube Assembly	1	1	1	1	1	1	1	1	13375	Present	1448U
311, 312 Thru 314 & 315 Thru 319 & 321	Filter Assembly (without shell)	1	1	1	1	1	1	1	1	13375	Present	1448T
311	Spool Assembly (with bypass relief)	1	1	1	1	1	1	1	1	13375	Present	1448J
312	Seal, Spool End	1	1	1	1	1	1	1	1	13375	Present	1448H
313	Strainer Tube	1	1	1	1	1	1	1	1	13375	Present	1448K
314	Ring, Retaining	1	1	1	1	1	1	1	1	13375	Present	1448L
315	Recharge (Gasket 1448B included)	1	1	1	1	1	1	1	1	13375	Present	1448C or KT645 (6 pieces)
316	Pressure Plate Assembly (Items 317, 318 and 319)	1	1	1	1	1	1	1	1	13375	Present	1448M
317	Pressure Plate	1	1	1	1	1	1	1	1	13375	Present	1448N
318	'O' Ring Seal, Pressure Plate	1	1	1	1	1	1	1	1	13375	Present	1448P

Notes-

A: "Tri-Micro" is a registered trademark of Vilter Manufacturing Corporation.

**: The rear bearing cover is sold only in Kit KT092.

+: When Kit KT256 is ordered, the overall length of the existing oil pump (Item 306) on the compressor should be checked. If the length from the end of the pump shaft to the end of the pump boss measures 5 7/32", a new oil pump must be ordered with Kit KT256.

440 VMC Compressors
Rear Bearing Cover Replacement Parts
(Compressors with Standard Tri-Micro® Filter)
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
319	Spring, Pressure Plate	1	1	1	1	1	1	1	1	13375	Present	1448Q
320	Plug, Steel Square Head Pipe, 1/8”	1	1	1	1	1	1	1	1	13375	Present	13264A
321	Gasket, Oil Filter Head	1	1	1	1	1	1	1	1	13375	Present	1448B
322	Filter Shell with Flange and Plug (Items 320, 322A and 322B)	1	1	1	1	1	1	1	1	13375	Present	A34623A
322A	Flange, Oil Filter Tank	1	1	1	1	1	1	1	1	13375	Present	35125A
322B	Tank, Oil Filter	1	1	1	1	1	1	1	1	13375	Present	34623A
323	Screw, Hex. Head Cap 7/16” x 2”	4	4	4	4	4	4	4	4	13375	Present	2796DM
324	Instruction/Name Plate (not shown)	1	1	1	1	1	1	1	1	13375	Present	40680AT
325	Gasket, Bearing Cover	1	1	1	1	1	1	1	1	0	Present	31890A
326	Screw, 5/8” x 2” Hex. Head Cap	10	10	10	10	10	10	10	10	0	Present	13152E
327	Screw, ½” x 1¾”Hex Head Cap	8	8	8	8	8	8	8	8	0	Present	2796EL

Notes-

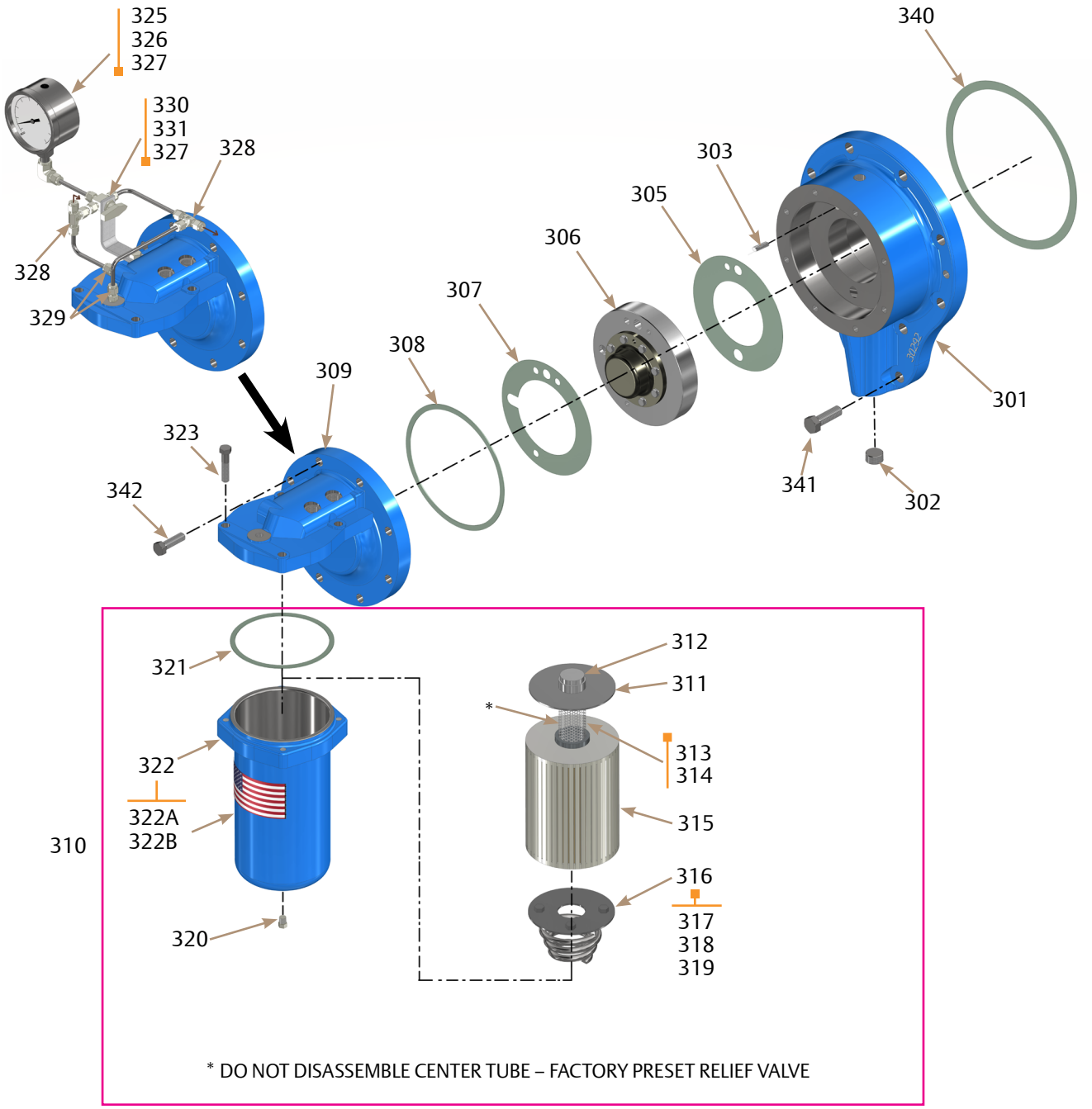
A: “Tri-Micro” is a registered trademark of Vilter Manufacturing Corporation.

**: The rear bearing cover is sold only in Kit KT092.

+: When Kit KT256 is ordered, the overall length of the existing oil pump (Item 306) on the compressor should be checked. If the length from the end of the pump shaft to the end of the pump boss measures 5 7/32”, a new oil pump must be ordered with Kit KT256.

440 VMC Compressors
Rear Bearing Cover Replacement Parts
Compressors with Tri-Micro® Filter Option

Typical arrangement



440 VMC Compressors Rear Bearing Cover Replacement Parts Compressors with Tri-Micro® Filter Option (1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
301	Cover, Rear Bearing	1	1	1	1	1	1	1	1	0	Present	30292A **
302	Plug, ¾" Hex Socket Head Pipe	1	1	1	1	1	1	1	1	0	Present	2606A
303	Pin, 3/8" x 1" Dowel (not shown)	1	1	1	1	1	1	1	1	0	Present	2868H
304	Orifice, Oil Metering (not shown)	1	1	1	1	1	1	1	1	0	Present	33361A
305	Gasket, Oil Pump Body	1	1	1	1	1	1	1	1	0	Present	31899A
306	Oil Pump Assembly	1	1	1	1	1	1	1	1	0	Present	KT519A
307 Thru 339	Conversion Kit, Special (improved) Tri-Micro Oil Filter, 120 volts	1	1	1	1	1	1	1	1	0	Present	KT361A +
	Conversion Kit, Special (improved) Tri-Micro Oil filter, 240 volts	1	1	1	1	1	1	1	1	0	Present	KT361B +
307	Gasket, Oil Pump Cover	1	1	1	1	1	1	1	1	0	Present	31900A
308	Gasket, Oil Pump and Rear Bearing Cover Seal	1	1	1	1	1	1	1	1	0	Present	33320A
309	Cover, Oil Pump and Filter Head	1	1	1	1	1	1	1	1	0	Present	34565A
310	Filter Assembly, Complete (Tri-Micro)	1	1	1	1	1	1	1	1	0	Present	A35241A
311	Spool Assembly (without bypass relief)	1	1	1	1	1	1	1	1	0	Present	2046A
312	Seal, Spool End	1	1	1	1	1	1	1	1	0	Present	1448H
313	Strainer Tube	1	1	1	1	1	1	1	1	0	Present	1448K
314	Ring, Retaining	1	1	1	1	1	1	1	1	0	Present	1448L
315	Recharge (Gasket 1448B included)	1	1	1	1	1	1	1	1	0	Present	2115C
316	Pressure Plate Assembly	1	1	1	1	1	1	1	1	0	Present	1448M
317	Pressure Plate	1	1	1	1	1	1	1	1	0	Present	1448N
318	'O' Ring Seal, Pressure Plate	1	1	1	1	1	1	1	1	0	Present	1448P
319	Spring, Pressure Plate	1	1	1	1	1	1	1	1	0	Present	1448Q
320	Plug, Steel Square Head Pipe 1/8"	1	1	1	1	1	1	1	1	0	Present	1190A
321	Gasket, Oil Filter Head	1	1	1	1	1	1	1	1	0	Present	1448B
322	Filter Shell with Bolt Ring	1	1	1	1	1	1	1	1	0	Present	A34623A

Notes-

AR: As required. Cut to suit when assembling.

•: Not shown here, cover replaces item 123. Thermometer and heater mount on crankcase handhole cover so oil temperature can be monitored and raised to 100°F (thermostat setting) before starting compressor. If an attempt is made to start with cold oil, the filter pressure differential switch will stop compressor.

**: The rear bearing cover is sold only in Kit KT092.

+: When Kit KT361A & B is ordered, the overall length of the existing oil pump (Item 306) on the compressor should be checked. If the length from the end of the pump shaft to the end of the pump boss measures 5 7/32", a new oil pump must be ordered with Kit KT361A & B.

440 VMC Compressors
Rear Bearing Cover Replacement Parts
Compressors with Tri-Micro® Filter Option
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
323	Screw, Hex Head Cap 7/16" x 2"	4	4	4	4	4	4	4	4	0	Present	2796DM
324	Instruction/Nameplate	1	1	1	1	1	1	1	1	0	Present	40680AJ
325	Gauge, 2½", 0-300 PSI, Oil Filter	1	1	1	1	1	1	1	1	0	Present	2047A
326	Elbow, ¼" 90° Female Compression	1	1	1	1	1	1	1	1	0	Present	1892B
327	Tubing, ¼" O.D. x 5 ft. Steel	AR	AR	AR	AR	AR	AR	AR	AR	0	Present	3509L
328	Tee, ¼" Compression	2	2	2	2	2	2	2	2	0	Present	13239C
329	Connector, ¼"MPT X ¼"O.D. Compression	3	3	3	3	3	3	3	3	0	Present	13229D
330	Valve, 3-Way, Oil Filter	1	1	1	1	1	1	1	1	0	Present	2030A
331	Bracket, Valve	1	1	1	1	1	1	1	1	0	Present	35106A
332	Elbow, ¼" 90° Male Compression	1	1	1	1	1	1	1	1	0	Present	13375D
333	Control, Pressure Differential	1	1	1	1	1	1	1	1	0	Present	1643V
334	Screw, 10-32 x 3/8" Long, Round Head	2	2	2	2	2	2	2	2	0	Present	1332C
335	Washer, Lock, 3/16"	2	2	2	2	2	2	2	2	0	Present	13165A
336	Washer, Flat, 3/16"	4	4	4	4	4	4	4	4	0	Present	13265A
337*	Cover, Crankcase Handhole	1	1	1	1	1	1	1	1	0	Present	A33034L
338*	Thermometer, Crankcase Oil	1	1	1	1	1	1	1	1	0	Present	1467G
339*	Heater, 535W, 115V Electric Crankcase	1	1	1	1	1	1	1	1	0	Present	2069J
339*	Heater, 535W, 230V Electric Crankcase	1	1	1	1	1	1	1	1	0	Present	2069K
340	Gasket, Bearing Cover	1	1	1	1	1	1	1	1	0	Present	31890A or KT092
341	Screw, 5/8" x 2" Hex Head Cap	10	10	10	10	10	10	10	10	0	Present	13152E
342	Screw, ½" x 1¾" Hex Head Cap	8	8	8	8	8	8	8	8	0	Present	2796EL

Notes-

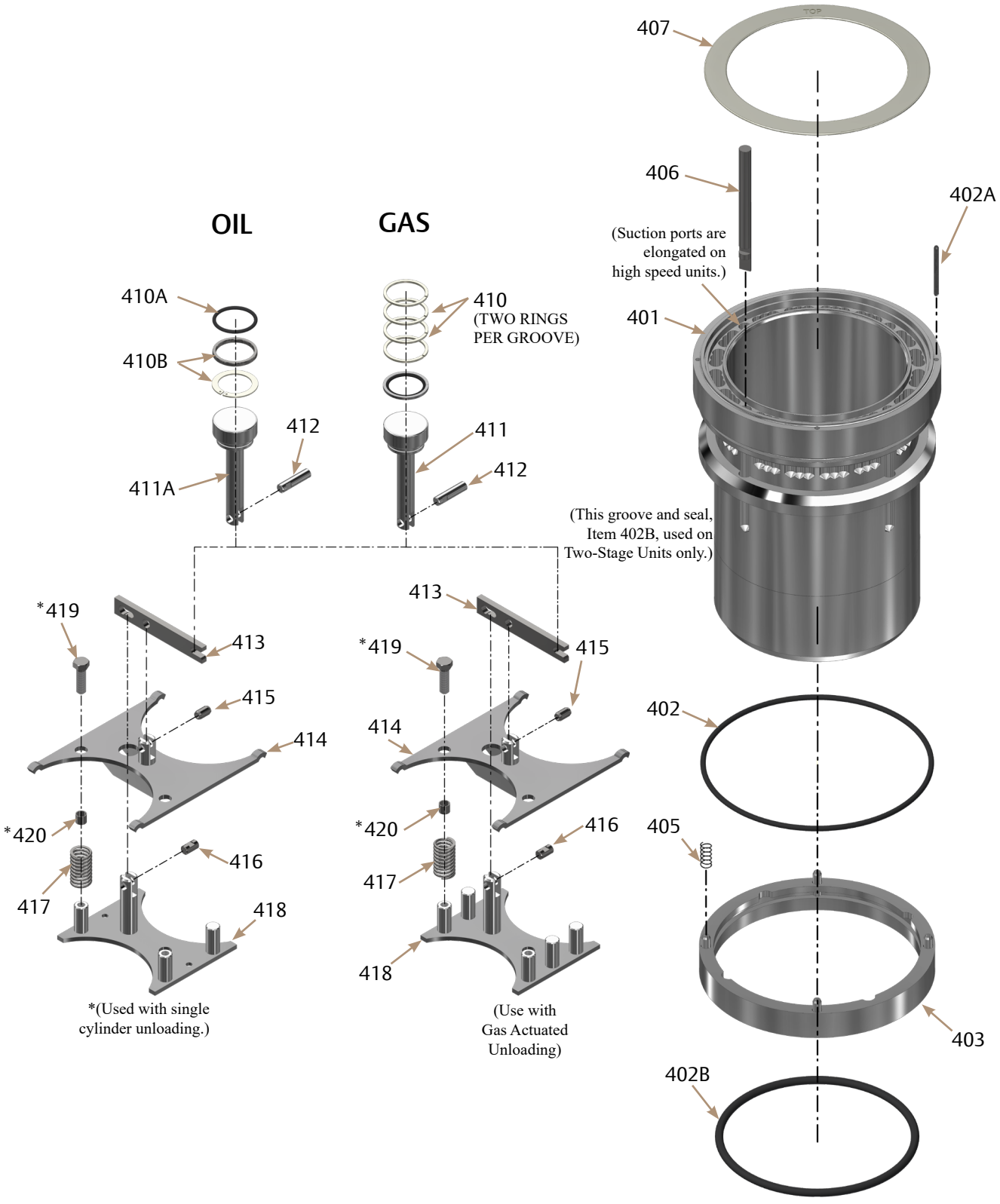
AR: As required. Cut to suit when assembling.

•: Not shown here, cover replaces item 123. Thermometer and heater mount on crankcase handhole cover so oil temperature can be monitored and raised to 100°F (thermostat setting) before starting compressor. If an attempt is made to start with cold oil, the filter pressure differential switch will stop compressor.

**: The rear bearing cover is sold only in Kit KT092.

+: When Kit KT361A & B is ordered, the overall length of the existing oil pump (Item 306) on the compressor should be checked. If the length from the end of the pump shaft to the end of the pump boss measures 5 7/32", a new oil pump must be ordered with Kit KT361A & B.

440 VMC Compressors
Cylinder Liner and Capacity Control Replacement Parts



440 VMC Compressors
Cylinder Liner and Capacity Control Replacement Parts
1200 RPM High Stage and Two-Stage Compressors
(Serial Number 3638 to as indicated) * *
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
401 Thru 406	Cylinder Liner Kit (w/Unload-Std.)	1*	2	4	4	8	8	--	--	3638	Present	KT072
	Cylinder Liner Assy (w/unload-Hi Suct#)	--	2	4	4	8	8	--	--	3638	Present	A31194B
	Cylinder Liner Kit (w/Unloading)	--	--	--	--	--	--	3*	6*	3638	14203	KT072
	Cylinder Liner Assy (w/Unloading)	--	--	--	--	--	--	3*	6*	14204	Present	A33179B
401 Thru 402A	Cylinder Liner Kit (w/o Unloading)	2	2	2	4	4	8	--	--	3638	Present	KT071
	Cylinder Liner Kit (w/o Unloading)	--	--	--	--	--	--	6	12	3638	14203	KT071
	Cylinder Liner Kit (w/o Unloading)	--	--	--	--	--	--	3*	6*	3638	14203	KT071
	Cylinder Liner Kit (w/o Unloading)	1*	--	--	--	--	--	--	--	3638	Present	KT071
401 Thru 402B	Cylinder Liner Assy (w/o Unloading)	--	--	--	--	--	--	6	12	14204	Present	A33179A
	Cylinder Liner Assy (w/o Unloading)	--	--	--	--	--	--	3*	6*	14204	Present	A33179A
401	Liner, Cylinder	2	4	6	8	12	16	--	--	3638	Present	32687A
	Liner, Cylinder	--	--	--	--	--	--	6	12	3638	14203	32687A
	Liner, Cylinder	--	--	--	--	--	--	6	12	14204	Present	33179A
402	Seal, 'O' Ring (Upper)	2	4	6	8	12	16	6	12	3638	Present	2176BH
402A ++	Pin, Roll	8	16	24	32	48	64	24	48	7000	Present	1193Q
402B	Seal, 'O' Ring (Lower)	--	--	--	--	--	--	6	12	14204	Present	2176BL
402	Lift Ring & Post Assy (Std)	1*	2	4	4	8	8	3*	6*	3638	Present	A33351A
403	Lift Ring & Post Assy (Hi-Suct #)	--	2	4	4	8	8	--	--	3638	Present	A33351A
405	Spring, Lift	4*	8	16	16	32	32	12*	24*	3638	Present	33352A
406	Pin, Lift	4*	8	16	16	32	32	12*	24*	3638	Present	33350A
407	Plate, Suction Valve	2	4	6	8	12	16	6	12	3638	Present	31909A or KT646 (12 pieces)

Notes-

*: These items are used on Two-Stage and 2 cylinder compressors only when equipped with unloading. For single cylinder unloading, the yoke assembly (Item 414) and the two pins on the yoke guide assembly (Item 418) have drilled and tapped holes to accommodate screws (Item 419) and spacers (Item 420).

**: Please call Vilter regarding replacement parts for 1200 RPM compressors with serial numbers below 3638.

***: Spring part number was 33353A and quantity was 6. Replace all springs in the assembly.

+: Actuation type can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. For serial numbers above these, see page 8-46 and 8-47.

++: Four "roll pin" holes are drilled thru the safety head and safety head yoke into the cylinder liner. Drilled replacement parts are interchangeable with undrilled parts. Discard roll pins from kits if new liner is used with former style safety head, safety head yoke and frame with built-in guide lugs.

#: High suction compressors are identified by an "X" in the serial number.

440 VMC Compressors
Cylinder Liner and Capacity Control Replacement Parts
1200 RPM High Stage and Two-Stage Compressors
(Serial Number 3638 to as indicated) * *
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
410B, 411A & 412	Piston Kit, Cap. Red. (Oil Actuated+)	1*	1	2	2	4	4	3*	6*	19247	22799	KT364
410	Piston Ring (Steel For Gas Actuated)	4*	4	8	8	16	16	12*	24*	30000	32499	31989L
410A	'O' Ring (Rubber-For 0.187" Groove)	1*	1	2	2	4	4	3*	6*	19247	22673	2176AX
410B	Ring Set (PTFE-For 0.120" Groove)	1*	1	2	2	4	4	3*	6*	22674	22799	2557A
411/ 411A	Piston, Unloader (Gas or Oil)	1*	1	2	2	4	4	3*	6*	--	--	Order Kit
412	Pin, Long Pivot	1*	1	2	2	4	4	3*	6*	3638	22799	33250C
413 Thru 420	Cap Cont Mech Assy (Std-Single) +	1*	--	--	--	--	--	3*	6*	150	22799	A33577A
	Cap Cont Mech Assy (Std-Double) +	--	1	2	2	4	4	--	--	150	22799	A33354A
	Cap Cont Mech Assy (Hi-Suct #) +	--	1	2	2	4	4	--	--	150	22799	A35253A
413	Arm, Yoke Lifting	1*	1	2	2	4	4	3*	6*	150	22799	33338A
414	Yoke Assembly (Std-Single)	1*	--	--	--	--	--	3*	6*	150	22799	A33575A
414	Yoke Assembly (Std-Double & Hi Suct)	--	1	2	2	4	4	--	--	150	22799	A33335A
415	Pin, 3/8" x 11/16" lg. Roll	1*	1	2	2	4	4	3*	6*	150	22799	1193X
416	Pin, Short Pivot	1*	1	2	2	4	4	3*	6*	30000	32499	33250B
417***	Spring, Unloader Yoke (Std)	4*	4	8	8	16	16	12*	24*	30000	32499	33686A
417	Spring, Unloader Yoke (Hi-Suct #)	6	6	12	12	24	24	--	--	30000	32499	33686A
418	Yoke Guide Assembly (std-single)	1*	--	--	--	--	--	3*	6*	30000	32499	A33576A
418	Yoke Guide Assembly (std-double)	--	1	2	2	4	4	--	--	30000	32499	A33347A
418	Yoke Guide Assembly (Hi Suct #)	--	1	2	2	4	4	--	--	30000	32499	A35248A
419	Screw, 3/8" x 1" Cap Lock	2*	--	--	--	--	--	6*	12*	30000	32499	1352D
420	Spacer, Sleeve	2*	--	--	--	--	--	6*	12*	30000	32499	33618A

Notes-

*: These items are used on Two-Stage and 2 cylinder compressors only when equipped with unloading. For single cylinder unloading, the yoke assembly (Item 414) and the two pins on the yoke guide assembly (Item 418) have drilled and tapped holes to accommodate screws (Item 419) and spacers (Item 420).

**: Please call Vilter for replacement parts for 1200 RPM compressors with serial numbers below 3638.

***: Spring part number was 33353A and quantity was 6. Replace all springs in the assembly.

+: Actuation type can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. For serial numbers above these, see page 8-46 and 8-47.

++: Four "roll pin" holes are drilled thru the safety head and safety head yoke into the cylinder liner. Drilled replacement parts are interchangeable with undrilled parts. Discard roll pins from kits if new liner is used with former style safety head, safety head yoke and frame with built-in guide lugs.

#: High suction compressors are identified by an "X" in the serial number.

440 VMC Compressors Cylinder Liner and Capacity Control Replacement Parts 1000 RPM High Stage and Two-Stage Compressors and 1200 RPM Booster Compressors (1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
401 Thru 406	Cylinder Liner Kit (w/unloading)	1*	2	4	4	--	--	--	--	0	Present	KT072
	Cylinder Liner Kit (w/unloading)	--	--	--	--	8	8	--	--	2656	Present	KT072
	Cylinder Liner Kit (w/unloading)	--	--	--	--	--	--	3*	6*	0	14203	KT072
	Cylinder Liner Kit (w/unloading)	--	--	--	--	--	--	3*	6*	14204	Present	A33179B
401 Thru 402A	Cylinder Liner Kit (w/o unloading)	2	2	2	4	--	--	--	--	0	Present	KT071
	Cylinder Liner Kit (w/o unloading)	--	--	--	--	4	8	--	--	2656	Present	KT071
	Cylinder Liner Kit (w/o unloading)	1*	--	--	--	--	--	--	--	0	Present	KT071
	Cylinder Liner Kit (w/o unloading)	--	--	--	--	--	--	3*	6*	0	14203	KT071
	Cylinder Liner Kit (w/o unloading)	--	--	--	--	--	--	6	12	0	14203	KT071
401 Thru 402B	Cylinder Liner Assy (w/o unloading)	--	--	--	--	--	--	3*	6*	14204	Present	A33179A
	Cylinder Liner Assy (w/o unloading)	--	--	--	--	--	--	6	12	14204	Present	A33179A
401	Liner, Cylinder	2	4	6	8	--	--	--	--	0	Present	32687A
	Liner, Cylinder	--	--	--	--	12	16	--	--	0	2655	A32609A
	Liner, Cylinder	--	--	--	--	12	16	--	--	2656	Present	32687A
	Liner, Cylinder	--	--	--	--	--	--	6	12	0	14203	32687A
	Liner, Cylinder	--	--	--	--	--	--	6	12	14204	Present	33179A
402	Seal, 'O' Ring (upper)	2	4	6	8	12	16	6	12	0	Present	2176BH
402A++	Pin, Roll	8	16	24	32	48	64	24	48	7000	Present	1193Q
402B	Seal, 'O' Ring (Lower)	--	--	--	--	--	--	6	12	14204	Present	2176BL
403	Lift Ring & Spring Post Assembly	1*	2	4	4	--	--	3*	6*	160†	Present	A33351A
403	Lift Ring & Spring Post Assembly	--	--	--	--	8	8	--	--	2656	Present	A33351A
405	Spring, Lift	4*	8	16	16	--	--	12*	24*	160†	Present	33352A
405	Spring, Lift	--	--	--	--	16	16	--	--	0	2655	33428A
405	Spring, Lift	--	--	--	--	32	32	--	--	2656	Present	33352A
406	Pin, Lift	4*	8	16	16	--	--	12*	24*	150†	Present	33350A
406	Pin, Lift	--	--	--	--	32	32	--	--	2656	Present	33350A
407	Plate, Suction Valve	2	4	6	8	--	--	6	12	0	Present	31909A

Notes-

*: These items are used on Two-Stage and 2 cylinder compressors only when equipped with unloading. For single cylinder unloading, the yoke assembly (Item 414) and the two pins on the yoke guide assembly (Item 418) have drilled and tapped holes to accommodate screws (Item 419) and spacers (Item 420).

***: Spring part number was 33353A and quantity was 6. Replace all springs in the assembly.

+: Actuation type can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. For serial numbers above these, see page 8-46 and 8-47.

++: Four "roll pin" holes are drilled thru the safety head and safety head yoke into the cylinder liner. Drilled replacement parts are interchangeable with undrilled parts. Discard roll pins from kits if new liner is used with former style safety head, safety head yoke and frame with built-in guide lugs.

#: High suction compressors are identified by an "X" in the serial number.

†: Refer to Home Office for compressor with serial numbers below 150.

440 VMC Compressors Cylinder Liner and Capacity Control Replacement Parts 1000 RPM High Stage and Two-Stage Compressors and 1200 RPM Booster Compressors (2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
407	Plate, Suction Valve	--	--	--	--	12	16	--	--	0	2655	33422A
407	Plate, Suction Valve	--	--	--	--	12	16	--	--	2656	Present	31909A
408	Springs, Valve (Helical) (not shown)	--	--	--	--	48	64	--	--	0	2655	33803A or KT648 (100 pieces)
410B 411A 412	Piston Kit, Cap Red (Oil Actuated+)	1*	1	2	2	4	4	3*	6*	19247	22799	KT364
410A	'O' Ring (Rubber-for 0.187" Groove)	1*	1	2	2	4	4	3*	6*	19247	22673	2176AX
410B	Ring Set (PTFE-for 0.120" Groove)	1*	1	2	2	4	4	3*	6*	22674	22799	2557A
411/ 411A	Piston, Unloader (gas or oil)	1*	1	2	2	4	4	3*	6*	--	--	Order Kit
412	Pin, Long Pivot	1*	1	2	2	4	4	3*	6*	150†	22799	33250C
413 Thru 420	Capacity Control Mechanism Assembly	1*	--	--	--	--	--	3*	6*	150†	22799	A33577A or A35253A (High Suction)
	Capacity Control Mechanism Assembly	--	1	2	2	4	4	--	--	150†	22799	A33354A
413	Arm, Yoke Lifting	1*	1	2	2	4	4	3*	6*	150†	22799	33338A
414	Yoke Assembly	1*	--	--	--	--	--	3*	6*	150†	22799	A33575A
414	Yoke Assembly	--	1	2	2	4	4	--	--	150†	22799	A33335A
415	Pin, 3/8" x 11/16" lg. Roll	1*	1	2	2	4	4	3*	6*	150†	22799	1193X
416	Pin, Short Pivot	1*	1	2	2	4	4	3*	6*	30000	32499	33250B
417***	Spring, Unloader Yoke	4*	4	8	8	16	16	12*	24*	30000	32499	33686A
418	Yoke Guide Assembly	1*	--	--	--	--	--	3*	6*	30000	32499	A33576A
418	Yoke Guide Assembly	--	1	2	2	4	4	--	--	30000	32499	A33347A
419	Screw, 3/8" x 1" Cap Lock	2*	--	--	--	--	--	6*	12*	30000	32499	1352D
420	Spacer, Sleeve	2*	--	--	--	--	--	6*	12*	30000	32499	33618A

Notes-

*: These items are used on Two-Stage and 2 cylinder compressors only when equipped with unloading. For single cylinder unloading, the yoke assembly (Item 414) and the two pins on the yoke guide assembly (Item 418) have drilled and tapped holes to accommodate screws (Item 419) and spacers (Item 420).

***: Spring part number was 33353A and quantity was 6. Replace all springs in the assembly.

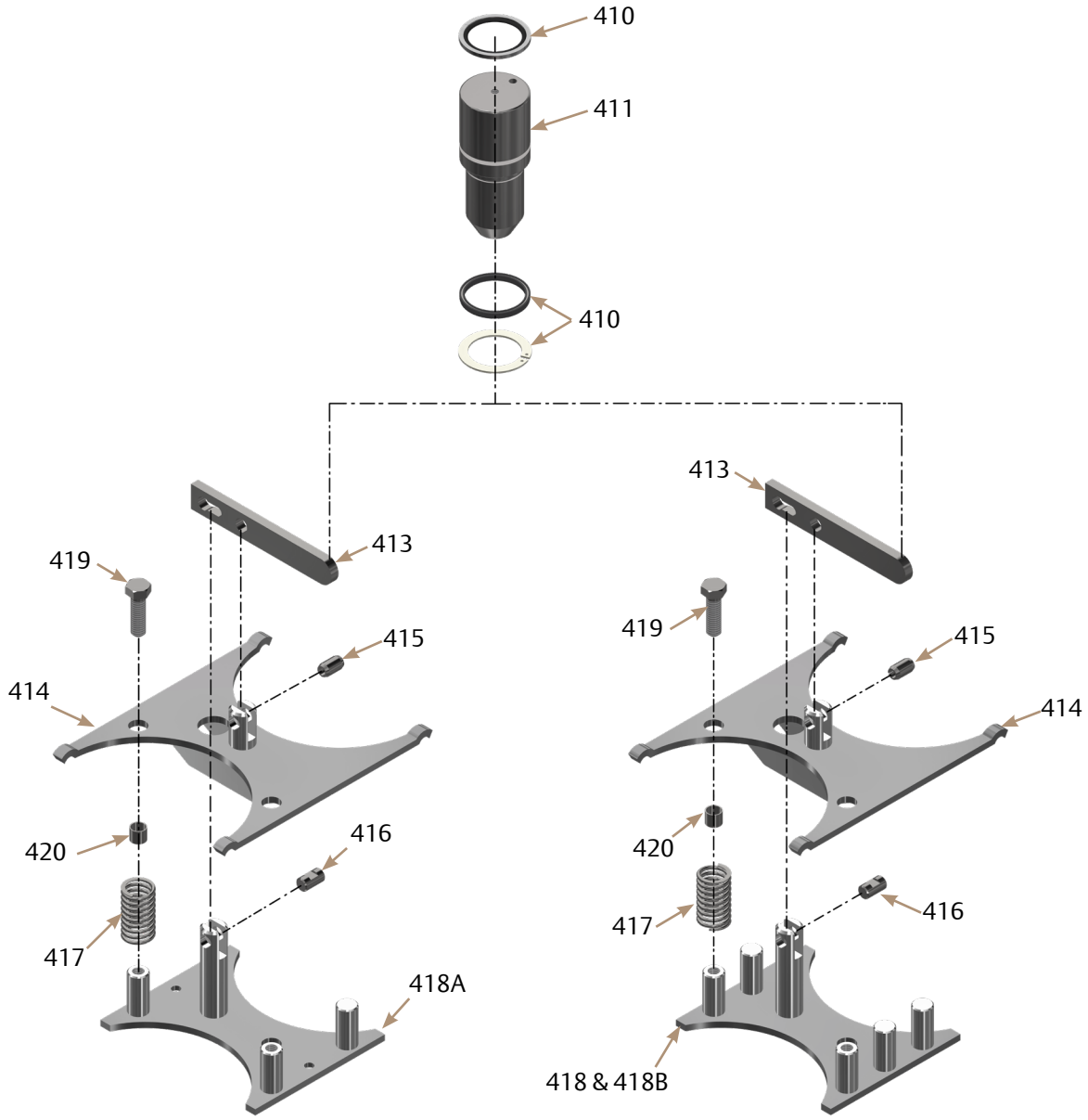
+: Actuation type can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. For serial numbers above these, see page 8-46 and 8-47.

++: Four "roll pin" holes are drilled thru the safety head and safety head yoke into the cylinder liner. Drilled replacement parts are interchangeable with undrilled parts. Discard roll pins from kits if new liner is used with former style safety head, safety head yoke and frame with built-in guide lugs.

#: High suction compressors are identified by an "X" in the serial number.

†: Refer to Home Office for compressor with serial numbers below 150.

440 VMC Compressors
Capacity Control Mechanism Assembly (†) Replacement Parts
Version Used Beginning with Serial Number: 32,500 For Gas Unloading 22,800 For Oil Unloading (++)



440 VMC Compressors
Capacity Control Mechanism Assembly (†) Replacement Parts
Version Used Beginning with Serial Number: 32,500 For Gas Unloading 22,800 For Oil Unloading (++)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS						Part Number
		2	4	6	8	12	16	
410 & 411	Piston & Rings Assy., Cap Red (Gas or Oil +)	-(1*)	1	2(3*)	2	4(6*)	4	A35315BX (Oil) A35315CX (Gas)
410	Ring Set (PTFE and rubber)	-(1*)	1	2(3*)	2	4(6*)	4	2557A
411	Piston, Unloader (Gas or Oil)	-(1*)	1	2(3*)	2	4(6*)	4	35315A
413 Thru 420	Complete Cap Control Mech Assy							
	(High Suction – Single Cylinder)	-(1*)	--	-(3*)	--	-(6*)	--	A35305AX
	(Standard– Single Cylinder)	-(1*)	--	-(3*)	--	-(6*)	--	A41787AX
	(Standard – Double Cylinder)	- -	1	2	2	4	4	A41788BX
	(High Suction – Double Cylinder)	--	1	2	2	4	4	A35304AX
413	Arm, Yoke Lifting	-(1*)	1	2(3*)	2	4(6*)	4	41725A
414	Yoke Assy (Standard – Single Cylinder)	-(1*)	--	-(3*)	--	-(6*)	--	A33575A
414	Yoke Assy (Standard – Double Cylinder)	--	1	2	2	4	4	A33335A
414	Yoke Assy (High Suct-Single Cylinder)	-(1*)	--	-(3*)	--	-(6*)	--	A35247A
414	Yoke Assy (High Suct-Double Cylinder)	--	1	2	2	4	4	A33335A
415	Pin, 3/8” x 11/16” lg. Roll	-(1*)	1	2(3*)	2	4(6*)	4	1193X
416	Pin, Short Pivot	-(1*)	1	2(3*)	2	4(6*)	4	33250B
417	Spring, Unloader Yoke (Standard)	-(4*)	4	8(12*)	8	16(24*)	16	33686A
417	Spring, Unloader Yoke (High Suction)	-(6*)	6	12(18*)	12	24(36*)	24	33686A
418A	Yoke Guide Assy (Std-Single Cylinder)	-(1*)	--	-(3*)	--	-(6*)	--	A33576A
418	Yoke Guide Assy (Hi Suct-Single Cyl)	-(1*)	--	-(3*)	--	-(6*)	--	A35249A
418B	Yoke Guide Assy (Hi Suct-Double Cyl)	--	1	2	2	4	4	A35248A
419	Screw, 3/8” x 1” Cap Lock	-(2*)	--	-(6*)	--	-(12*)	--	1352D
420	Spacer, Sleeve	-(2*)	--	-(6*)	--	-(12*)	--	33618A

Notes-

*: These items are used on Two-Stage and 2 cylinder compressors only when equipped with unloading. For single cylinder unloading, the yoke assembly (Item 414) and the two pins on the yoke guide assembly (Item 418) have drilled and tapped holes to accommodate screws (Item 419) and spacers (Item 420).

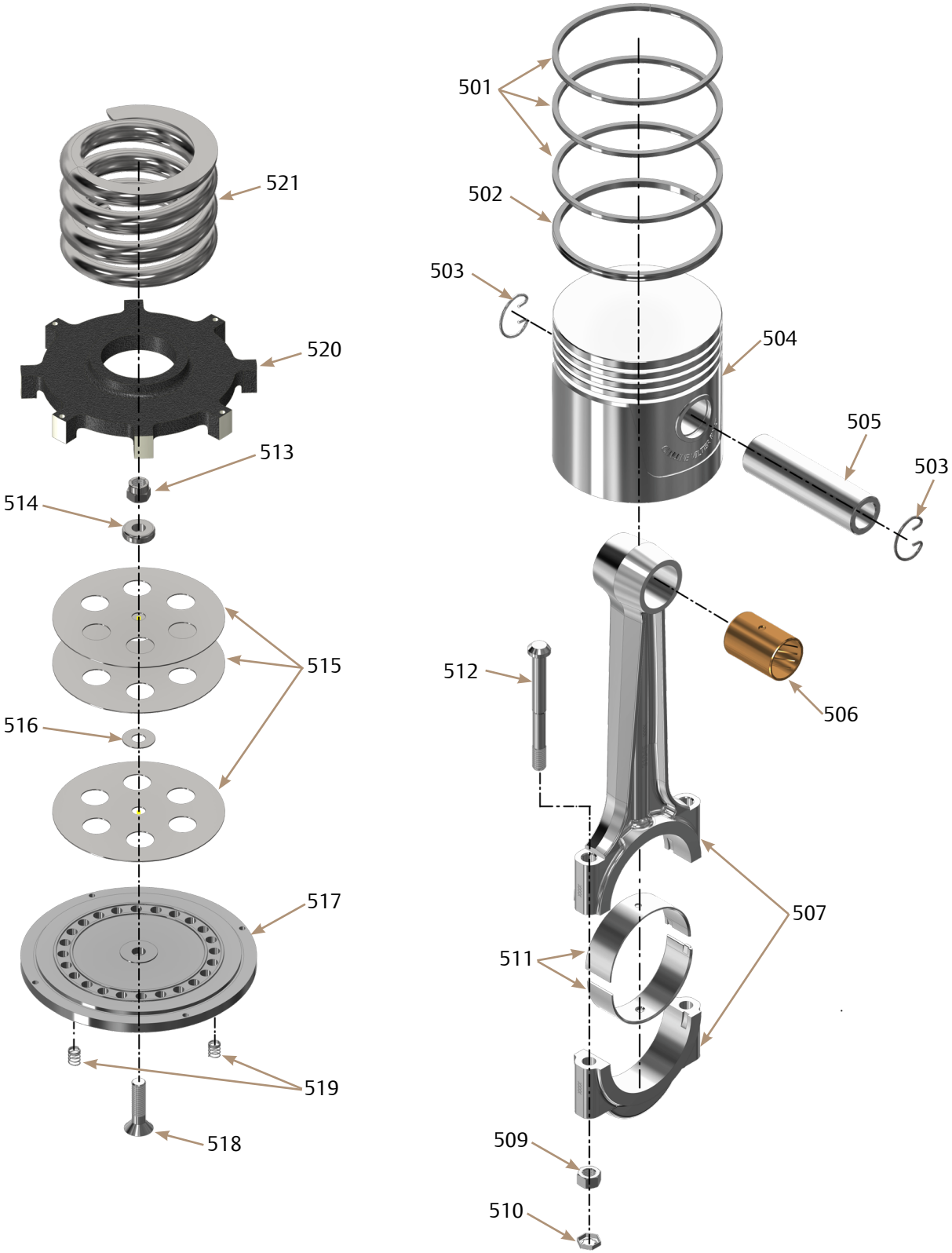
**: Two cylinder high stage and 6 & 12 cylinder Two-Stage Compressor only: Unloading is NOT standard. When supplied as an option, single cylinder unloading is provided on 50% of the cylinders. These items and quantities in ( ) are then used. Also, for single cylinder unloading, the yoke assembly (Part Number A33575A) and two pins on the Yoke Guide Assembly (Part Number A33576A) have drill and tapped holes to accommodate screw (Item 419) and spacers (Item 420).

+: Actuation type can be determined by checking unloading solenoid valve – oil uses three-way valves, gas uses two-way valves. For serial numbers below this see pages 8-41 to 8-45.

++: Four “roll pin” holes are drilled thru the safety head and safety head yoke into the cylinder liner. Drilled replacement parts are interchangeable with un-drilled parts. Discard roll pins from kits if new liner is used with former style safety head, safety head yoke and frame with built-in guide lugs.

#: High suction compressors are identified by an “X” in the serial number.

440 VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts



440 VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
1200 RPM High Stage and Two-Stage Compressors
Serial Number 3638 to Present
(1 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
501 Thru 505	Piston (Flat, AL) Rings and Pin Kit	2	4	6	8	12	16	6	12	3638	Present	KT213
501 Thru 512	Piston (Flat, AL) & Connecting Rod Assembly Kit	2	4	6	8	12	16	6	12	3638	Present	KT478
501	Piston Ring, Compression	6	12	18	24	36	48	18	36	3638	Present	31989M or KT649 (24 pieces/8 piston)
502	Piston Ring, Oil	2	4	6	8	12	16	6	12	3638	Present	31989N ** or KT650 (8 pieces)
503	Snap Ring, Piston Pin	4	8	12	16	24	32	12	24	3638	Present	33244A
504 & 505	Piston and Pin Assembly	2	4	6	8	12	16	6	12	3638	Present	Order Kit
506 Thru 512	Connecting Rod Assembly with Bearings Kit	2	4	6	8	12	16	6	12	3638	Present	KT463
510 & 511	Bearing Half & Lock Nut Kit (std size)	2	4	6	8	12	16	6	12	3638	Present	KT512
	Bearing Half & Lock Nut Kit (undersize)	2	4	6	8	12	16	6	12	3638	Present	KT513
506	Bushing, Piston Pin	2	4	6	8	12	16	6	12	3638	Present	31896B #
507	Connecting Rod and Cap	2	4	6	8	12	16	6	12	3638	Present	Order Kit
509	Nut, Plain, Hex 3/8”-24UNF	4	8	12	16	24	32	12	24	3638	Present	2027A
510	Nut, Lock, 3/8”-24NF	4	8	12	16	24	32	12	24	3638	Present	2028A

Notes-

*: Please contact Vilter for replacement parts for compressors having serial numbers below 3638.

**: These oil rings do not require expanders. Do not use expanders. They may cause excessive wear.

#: Replacement bushing must be reamed after installation to properly accommodate piston pin.

++: Replaces bearing half with groove. If compressor has standard size bearings with groove, order 31957B-Std. Size bearing half. If crankshaft is groove undersize, order KT513 or KT513A bearing half set with locknuts with no groove.

If you are replacing insert bearings on a crankshaft that used grooved insert bearing, then the same insert bearing should be ordered and installed. These grooved insert bearings are VPN 31957ST. They are not available in kit form, so palnuts need to be ordered also.

If you are replacing insert bearing on a crankshaft that used grooved insert bearing and you are having the journals turned down to accept either 0.015” or 0.030” undersized insert bearing, then and only then should you change to the solid insert bearing with a single hole.

The 0.015” undersized bearing is VPN 41726ST or KT 513A.

The 0.030” undersized bearing is VPN 35214ST or KT 513.

†: When ordering safety head (Item 517) for machines with serial number below 13491 – Item 518 (1527B) must also be ordered. Screw hole was changed from a 60° hole to an 82° hole.

AL: Aluminum Pistons.

440 VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
1200 RPM High Stage and Two-Stage Compressors
Serial Number 3638 to Present
(2 of 2)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
510 & 511	Bearing Set, Conn Rod (w/o Groove)											
	Standard Size ++	2	4	6	8	12	16	6	12	3638	Present	KT512
	0.015" Undersize	2	4	6	8	12	16	6	12	3638	Present	KT513A
	0.030" Undersize	2	4	6	8	12	16	6	12	3638	Present	KT513
512	Bolt, Connecting Rod	4	8	12	16	24	32	12	24	3638	Present	31955A
513 Thru 518	Safety Head Assembly, Ammonia (for Helical Springs)	2	4	6	8	12	16	6	12	3638	Present	A32695C
	Safety Head Assembly, R12 and R22 (for Helical Springs)	2	4	6	8	12	16	6	12	3638	Present	A32695D
513	Nut, Lock, 3/8" Valve Retaining	2	4	6	8	12	16	6	12	3638	Present	1776B
514	Washer, Diaphragm Valve	2	4	6	8	12	16	6	12	3638	Present	31990B
515	Valve, Diaphragm Discharge	6	12	18	24	36	48	18	36	3638	Present	31939B or KT647 (12 pieces/ 4 safety heads)
516	Spacer, Diaphragm Valve	2	4	6	8	12	16	6	12	3638	Present	31990A
517 †	Safety Head, Ammonia (for Helical Springs)	2	4	6	8	12	16	6	12	3638	Present	33531B
517 †	Safety Head, R12 and R22 (for Helical Springs)	2	4	6	8	12	16	6	12	3638	Present	33532B
518	Screw, Valve Retaining (60°)	2	4	6	8	12	16	6	12	3638	13490	31964A
518 †	Screw, Valve Retaining (82°)	2	4	6	8	12	16	6	12	13491	Present	1527B
519	Springs, Valve (Helical)	8	16	24	32	48	64	24	48	3638	Present	33803A or KT648 (100 pieces)
520	Yoke, Safety Head	2	4	6	8	12	16	6	12	3638	Present	31941B
521	Spring, Safety Head	2	4	6	8	12	16	6	12	3638	Present	31882A

Notes-

*: Please contact Vilter for replacement parts for compressors having serial numbers below 3638.

**: These oil rings do not require expanders. Do not use expanders. They may cause excessive wear.

#: Replacement bushing must be reamed after installation to properly accommodate piston pin.

++: Replaces bearing half with groove. If compressor has standard size bearings with groove, order 31957B-Std. Size bearing half. If crankshaft is groove undersize, order KT513 or KT513A bearing half set with locknuts with no groove.

If you are replacing insert bearings on a crankshaft that used grooved insert bearing, then the same insert bearing should be ordered and installed. These grooved insert bearings are VPN 31957ST. They are not available in kit form, so palnuts need to be ordered also.

If you are replacing insert bearing on a crankshaft that used grooved insert bearing and you are having the journals turned down to accept either 0.015" or 0.030" undersized insert bearing, then and only then should you change to the solid insert bearing with a single hole.

The 0.015" undersized bearing is VPN 41726ST or KT 513A.

The 0.030" undersized bearing is VPN 35214ST or KT 513.

†: When ordering safety head (Item 517) for machines with serial number below 13491 – Item 518 (1527B) must also be ordered. Screw hole was changed from a 60° hole to an 82° hole.

AL: Aluminum Pistons.

440 VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
1000 RPM High Stage and Two-Stage Compressors
and 1200 RPM Booster Compressors
(1 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
501 Thru 505	Piston (Flat,AL) Rings & Pin Kit	2	4	6	8	--	--	6	12	3068	Present	KT213
	Piston (Flat,AL) Rings & Pin Kit	--	--	--	--	12	16	--	--	2656	Present	KT213
501 Thru 512	Piston (Flat,AL) & Conn Rod Assy Kit	2	4	6	8	--	--	6	12	3068	Present	KT478
	Piston (Flat,AL) & Conn Rod Assy Kit	--	--	--	--	12	16	--	--	2656	Present	KT478
501	Piston Ring, Compression	6	12	18	24	36	48	18	36	0	Present	31989M or KT649 (24 pieces/8 piston)
502	Piston Ring, Oil	2	4	6	8	12	16	6	12	0	Present	31989N ** or or KT650 (8 pieces
503	Snap Ring, Piston Pin	4	8	12	16	24	32	12	24	0	Present	33244A
506 Thru 512	Connecting Rod Assy with Bearings Kit	2	4	6	8	12	16	6	12	0	Present	KT463
510 & 511	Bearing Half & Lock Nut Kit (Std. Size)	2	4	6	8	12	16	6	12	0	Present	KT512
	Bearing Half & Lock Nut Kit (Under-size)	2	4	6	8	12	16	6	12	0	Present	KT513
506	Bushing, Piston Pin	2	4	6	8	12	16	6	12	0	Present	31896B #
507	Connecting Rod and Cap	2	4	6	8	12	16	6	12	0	Present	Order Kit
509	Nut, Plain, Hex 3/8”-24UNF	4	8	12	16	24	32	12	24	0	Present	2027A
510	Nut, Lock, 3/8” Connecting Rod	4	8	12	16	24	32	12	24	0	Present	2028A

Notes-

*: The latest design for cast iron flat top pistons utilizes a set of three compression rings (Part No. 31989M) and can be used in a compressor having cast iron pistons with two compression rings.

**: These oil rings do not require expanders. Do not use expanders. They may cause excessive wear.

#: Replacement bushing must be reamed after installation to properly accommodate piston pin.

++: Replaces bearing half with groove. If compressor has standard size bearings with groove, order 31957B-Std. Size bearing half. If crankshaft is groove undersize, order KT513 or KT513A bearing half set with locknuts with no groove.

+: 1000 RPM high stage and VMC booster compressors with Serial No.’s 2198 and below have volute springs, with the exception of Serial Nos. 2160, 2163, 2168, 2169, 2182, 2183, 2184, 2185, and 2186, which have helical springs. All 1000 RPM high stage and VMC booster compressors with Serial Nos. 2199 and above have helical springs. The old type volute springs are available. However, the safety head for volute springs is not available. If a replacement safety head for volute springs is needed, it will be necessary to purchase the helical spring as well as the safety head for helical springs. When this conversion is made, it is not necessary to make the conversion on all cylinders of the compressors. It may be well to do so to eliminate confusion in the future.

A. Abbreviation C.I. = Cast Iron Pistons; Al = Aluminum Pistons.

440 VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
1000 RPM High Stage Compressors and Two-Stage and 1200 RPM Booster Compressors
(2 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
511	Bearing Half, Conn. Rod (w/o Groove)											
	Standard Size	2	4	6	8	12	16	6	12	0	Present	KT512 ++
	0.015" Undersize	2	4	6	8	12	16	6	12	0	Present	KT513A
	0.030" Undersize	2	4	6	8	12	16	6	12	0	Present	KT513 ++
512	Bolt, Connecting Rod	4	8	12	16	24	32	12	24	0	Present	31955A
513 Thru 518	Safety Head Assembly, Ammonia											
	(for Helical Springs)	2	4	6	8	--	--	6	12	2199+	Present	A32695C
	(for Helical Springs)	--	--	--	--	12	16	--	--	2656	Present	A32695C
513 Thru 518	Safety Head Assembly, R12 and R22											
	(for Helical Springs)	2	4	6	8	--	--	6	12	2199+	Present	A32695D
	(for Helical Springs)	--	--	--	--	12	16	--	--	2656	Present	A32695D
513	Lock Nut, 3/8", Valve Retaining	2	4	6	8	--	--	6	12	0	Present	1776B
513	Lock Nut, 3/8", Valve Retaining	--	--	--	--	12	16	--	--	2656	Present	1776B
514	Washer, Diaphragm Valve	2	4	6	8	--	--	6	12	0	Present	31990B
514	Washer, Diaphragm Valve	--	--	--	--	12	16	--	--	2656	Present	31990B
515	Valve, Diaphragm Discharge	6	12	18	24	--	--	18	36	0	Present	31939B or KT647 (12 pieces/ 4 safety heads)
515	Valve, Diaphragm Discharge	--	--	--	--	36	48	--	--	2656	Present	31939B or KT647 (12 pieces/ 4 safety heads)
516	Spacer, Diaphragm Valve	2	4	6	8	--	--	6	12	0	Present	31990A

Notes-

†: When ordering safety head (Item 517) for machines with serial number below 13491 – Item 518 (1527B) must also be ordered. Screw hole was changed from a 60° hole to an 82° hole.

+: 1000 RPM high stage and VMC booster compressors with Serial No.'s 2198 and below have volute springs, with the exception of Serial Nos. 2160, 2163, 2168, 2169, 2182, 2183, 2184, 2185, and 2186, which have helical springs. All 1000 RPM high stage and VMC booster compressors with Serial Nos. 2199 and above have helical springs. The old type volute springs are available. However, the safety head for volute springs is not available. If a replacement safety head for volute springs is needed, it will be necessary to purchase the helical spring as well as the safety head for helical springs. When this conversion is made, it is not necessary to make the conversion on all cylinders of the compressors. It may be well to do so to eliminate confusion in the future.

440 VMC Compressors
Piston and Connecting Rod Assembly and Safety Head Replacement Parts
1000 RPM High Stage and Two-Stage Compressors
and 1200 RPM Booster Compressors
(3 of 3)

ITEM	DESCRIPTION	QUANTITY REQUIRED PER COMPRESSOR NUMBER OF CYLINDERS								Serial Number		Part Number
		SINGLE STAGE						TWO-STAGE		From	Thru	
		2	4	6	8	12	16	6	12			
516	Spacer, Diaphragm Valve	--	--	--	--	12	16	--	--	2656	Present	31990A
517 †	Safety Head (for Helical Springs) Ammonia	2	4	6	8	--	--	6	12	2199+	Present	33531B
517 †	Safety Head (for Helical Springs) Ammonia	--	--	--	--	12	16	--	--	2656	Present	33531B
517 †	Safety Head (for Helical Springs) R12 & R22	2	4	6	8	--	--	6	12	2199+	Present	33532B
517 †	Safety Head (for Helical Springs) R507	2	4	6	8	--	--	6	12	2199+	Present	33532D
517 †	Safety Head (for Helical Springs) R12 & R22	--	--	--	--	12	16	--	--	2656	Present	33532B
517 †	Safety Head (for Helical Springs) R507	--	--	--	--	12	16	--	--	2657	Present	33532D
518	Screw, Valve Retaining (60°)	2	4	6	8	--	--	6	12	2656	13490	31964A
518 †	Screw, Valve Retaining (82°)	2	4	6	8	--	--	6	12	13491	Present	1527B
518	Screw, Valve Retaining (60°)	--	--	--	--	12	16	--	--	2656	13490	31964A
518 †	Screw, Valve Retaining (82°)	--	--	--	--	12	16	--	--	13491	Present	1527B
519	Springs, Valve (Volute)	8	16	24	32	--	--	--	--	0+	2198	31915A
519	Springs, Valve (Helical)	8	16	24	32	48	64	24	48	2199+	Present	33803A or KT648 (100 pieces)
520	Yoke, Safety Head	2	4	6	8	--	--	6	12	0	Present	31941B
520	Yoke, Safety Head	--	--	--	--	12	16	--	--	2656	Present	31941B
521	Spring, Safety Head	2	4	6	8	12	16	6	12	0	Present	31882A

Notes-

†: When ordering safety head (Item 517) for machines with serial number below 13491 – Item 518 (1527B) must also be ordered. Screw hole was changed from a 60° hole to an 82° hole.

+: 1000 RPM high stage and VMC booster compressors with Serial No.'s 2198 and below have volute springs, with the exception of Serial Nos. 2160, 2163, 2168, 2169, 2182, 2183, 2184, 2185, and 2186, which have helical springs. All 1000 RPM high stage and VMC booster compressors with Serial Nos. 2199 and above have helical springs. The old type volute springs are available. However, the safety head for volute springs is not available. If a replacement safety head for volute springs is needed, it will be necessary to purchase the helical spring as well as the safety head for helical springs. When this conversion is made, it is not necessary to make the conversion on all cylinders of the compressors. It may be well to do so to eliminate confusion in the future.

Torque Specifications

Refer to the following tables for torque specifications.

Table A-1. Torque Specifications (ft-lbs)

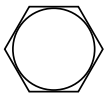
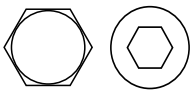
TYPE BOLT	HEAD MARKINGS	NOMINAL SIZE NUMBERS OR INCHES									
		#10	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"	7/8"
SAE GRADE 2 COARSE (UNC)			5	10	18	29	44	63	87	155	150*
SAE GRADE 5 COARSE (UNC)			8	16	28	44	68	98	135	240	387
SAE GRADE 5 FINE (UNF)				16							
SAE GRADE 8 COARSE (UNC)			11	22	39	63	96	138	191	338	546
SOCKET HEAD CAP SCREW (ASTM A574) COARSE (UNC)		5	13	26	46	73	112	155	215	380	614
Notes:	1) Torque values on this sheet are not to override those given on the individual drawings.										
	2) When using loctite, the torque value on this sheet are only accurate if bolts are tightened immediately after loctite is applied.										
	* The proof strength of Grade 2 bolts is less for sizes 7/8 and above and therefore the torque values are less than smaller sizes of the same grade.										

Table A-2. Torque Specifications for 17-4 Stainless Steel Fasteners (ft-lbs)

TYPE BOLT/NUT	HEAD MARKINGS	NOMINAL SIZE NUMBERS OR INCHES								
		#10	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"
Hex & Socket Head Cap Screws		3	8	14	25	40	60	101	137	245
Nut		-	8	-	25	-	-	-	-	-

NOTE

Continue use of red loctite #271 (VPN 2205E) on currently applied locations. Use blue loctite #243 (VPN 2205F or 2205G) on all remaining locations.

Oil Analysis Report

OIL SERVICES LABORATORIES
www.oil-services-lab.com

PRODUCT ANALYSIS REPORT

No Action Required

Report Date:	3/4/2013
Report Number:	*********
Customer	Customer
Comp. Mfr.	Vilter
Oil Type	VILTER METHANE 100
Serial Number	****-***
Model Number	VSG-1801
Hrs. on Fluid	6049
Hrs. on Machine	11239
Sample Date	Feb 21, 2013
Receive Date	Mar 01, 2013
I.D. #	*********

Customer Name
Customer Address

Evaluation:

The fluid is in good condition. Sample again in 6 months.

Physical Properties Results *

Sample Date (Lube Hours)	Feb 21, 2013 (6049)	Oct 19, 2012 (4809)	Jul 26, 2010 (5190)
Water by Karl Fischer (ppm)	19.5	147.7	41.4
Viscosity 40 C (cSt)	64.23	64.47	66.00
TAN Total Acid #	0.077	0.106	0.080
ISO Code	21/20/16	21/19/16	21/19/14

Spectrochemical Analysis

Wear Metals (ppm)			
Silver (Ag)	0	0	0
Aluminum (Al)	0	0	0
Chromium (Cr)	0	0	0
Copper (Cu)	0	0	0
Iron (Fe)	0	0	0
Nickel (Ni)	0	0	0
Lead (Pb)	0	0	0
Tin (Sn)	0	0	0
Titanium (Ti)	0	0	0
Vanadium (V)	0	0	0
Contaminant/Additive Metals (ppm)			
Barium (Ba)	0	0	0
Calcium (Ca)	0	0	0
Magnesium (Mg)	0	0	0
Molybdenum (Mo)	0	0	0
Sodium (Na)	0	0	0
Phosphorus (P)	0	0	0
Silicon (Si)	0	0	0
Zinc (Zn)	0	0	0

Thank you for this opportunity to provide technical assistance to your company. If you have any questions about this report, please contact us at 1-800-637-8628, or fax 1-989-496-2313 or email us at tslab@oil-services-lab.com

CC List

Accuracy of recommendations is dependent on representative oil samples and complete correct data on both unit and oil

* Property values should not be construed as specifications

Storage Guidelines For Vilter B and Fl Type Lubricants

Vilter Type B and FL lubricants are ester-based fluids and are hygroscopic by nature. This means that they absorb water moisture from the surrounding environment. Compared to mineral based lubricants which are typically saturated with water at less than 100 PPM, ester based lubricants become saturated with water at approximately 2,500 PPM.

High water moisture levels cannot be tolerated in the refrigeration systems where ester based lubricants are utilized and require specific handling and storage guidelines, in addition to the normal precautions for system dehydration prior to system start-up.

All Vilter lubricants are manufactured to meet strict requirements to ensure minimal water moisture content as shipped. The following guidelines are provided for the end-user of the equipment as a means to minimize the water content of lubricants in storage.

Guidelines

- Use a suitable dehydration process for the complete refrigeration system to ensure that the system as a whole is completely dry and water free. This can be accomplished by the use of vacuum pumps and checked by a vacuum gauge to ensure that a suitable micron value has been reached, and maintained.
- Store all lubricant containers in a dry environment. Do not expose the lubricant to the atmosphere by opening the container until the compressor sump or separator is ready to be charged.
- Keep the lubricant in its original container. Some plastic containers allow water moisture to pass through the container itself.
- If possible, use container sizes appropriate to the compressor charge to avoid leaving partially filled containers open for long period of times. Vilter B Type lubricant is available in 5 and 55 gallon containers.
- Refrigeration systems using ester based lubricants will require suitable high capacity moisture filter/driers to maintain low total moisture content in the refrigerant and lubricant.

Compatibility and Miscellaneous

- Vilter Type B lubricant has been extensively tested with many of the components in a refrigeration system. Elastomers, driers, etc. for use with HFCs have demonstrated no adverse effects when tested for hardness, swelling and brittleness.
- Vilter Type B lubricant cannot be used in conjunction with a mineral based oils CFC and HCFC refrigerants typically have used mineral oil; however, mineral oils are not miscible with HFCs. The performance of a refrigeration system is optimized when the lubricant is allowed to be miscible with the refrigerant to aid in the oil return to the compressor. If the oil used in an HFC refrigeration system does not provide oil return capability, the oil will tend to accumulate in the evaporator reducing the overall system capacity.
- CFC and HCFC refrigerants should not be used with Vilter Type B lubricant since these types of refrigerants greatly reduce the viscosity of ester based lubricants, resulting in inadequate compressor lubrication.

Table B-1 Oil Recommendations for Standard Warranty Coverage Reciprocating Compressors Only

Vilter Oil Type	717	HCL-68	F-68	FL-100	B-68 (AW) Recip Only	HC-68
ISO Grade	68	68	68	100	68	68
@ 100°F (cSt)	77	75.7	65.67	76.4	71	67.2
Viscosity Index	100	132	79	115	114	168
Spec. Gravity	0.867	0.835	0.876	0.96	0.957	0.989
Density lbm/gal, 60°F	7.4	6.95	7.3	8.26	8.02	8.25
Flash Point - °F	440	525	295	558	266	425
Fire Point - °F	475	570	315	633	296	465
Pour Point - °F	-38.2	-67	-31	Pending	-15	-55
Floc Point - °F	-25	NA	-75	NA	NA	NA
Refrigerant Type	R-717	R-717, R-22, R-1270	R-22	R-22	R-134a, R-507, R-404A, R-407C, R-410A	R-290

Table B-2 Cross Reference Index

Vilter Part No.	Oil Type	Vilter Lube Type	Container Size	Applications
2939A	HMO	R717	5 gallon pail	R-717 (Ammonia)
2939AFG	HMO	717FG	5 gallon drum	R-717 (Ammonia) Food Grade
2939B	HMO	R717	55 gallon pail	R-717 (Ammonia)
2939BFG	HMO	717FG	55 gallon drum	R-717 (Ammonia) Food Grade
3098A	PAG	HC-68	5 gallon pail	R-290
3098B	PAG	HC-68	55 gallon drum	R-290
3099A	PAG	HC-100	5 gallon pail	Hydrocarbon
3100A	Naphthenic	VILTER D	5 gallon pail	R-22, R-123 & R-414A
3100B	Naphthenic	VILTER D	55 gallon drum	R-22, R-123 & R-414A
3101A	POE	FL-100	5 gallon pail	R-22
3101B	POE	FL-100	55 gallon drum	R-22
3103A	PAO	HCL-68	5 gallon pail	Ammonia
3103B	PAO	HCL-68	55 gallon drum	Ammonia
3103C	PAO	HCL-15	5 gallon pail	R-717
3105A	BLEND	F-68	5 gallon pail	R-22, R-123 & R-502
3105B	BLEND	F-68	55 gallon drum	R-22, R-123 & R-502
3106A	POE	B-68	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3106B	POE	B-68	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3106C	POE	B-68 AW	5 gallon pail	Blends
3106D	POE	B-68 AW	55 gallon drum	Blends
3107A	POE	B-120	5 gallon pail	R-134A, R-404A, R-407C, R-410A
3107B	POE	B-120	55 gallon drum	R-134A, R-404A, R-407C, R-410A
3456A	POE	LT-32	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A)
3456B	POE	LT-32	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A)
3595A	HMO	NH3-100-CI	5 gallon pail	Ammonia
3595B	HMO	NH3-100-CI	55 gallon drum	Ammonia
3603B	POE	B-68AWAF	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3603C	POE	B-68AWAF	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3603D	POE	B-100AWAF	55 gallon drum	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3603E	POE	B-100AWAF	5 gallon pail	All HFC applications (including R-134a, R-404A, R-407C, R-410A, R-507)
3643A	PAO	XG 105-100	5 gallon pail	Hydrocarbon/natural gas
3643B	PAO	XG 105-100	55 gallon drum	Hydrocarbon/natural gas
3653A	POE	POE-100	5 gallon pail	Air Compressor Lubricant
3653B	POE	POE-100	55 gallon drum	Air Compressor Lubricant

Notes- POE: Polyol Ester. HMO: Hydro Treated Mineral Oil. PAO: Polyalfaolefin.
PAG: Poly Alkylglycols. AB: Alkylbenzene.

Appendix C
Vilter Oil Charger

For Easy Adding Of Crankcase Oil....
Use Vilter Oil Charger
It's Ideal For Reciprocating and Screw Compressors

Vilter Manual Oil Charger

Is adding oil to the compressor crankcase a “headache” for you? Are you tired of the oil mess on the floor and worrying about oil contamination and air getting into the compressor? If so, how would you like one simple hand pump that will:

A. Introduce oil into the crankcase quickly, cleanly, and efficiently.

B. Charge oil separators.

C. Charge oil lines and the seal chamber before starting the compressor.

D. Flush the oilways in the crankshaft.

Vilter has offered such a pump, called the Oil Charger, since 1957.

With this simple easy-to-operate pump it takes only about 16 strokes to add a quart of oil. In addition, with the Vilter Oil Charger there is:

1. No interference with compressor operation because the oil can be added any time, as long as the crankcase pressure is below 100 psi.
2. No danger of air being drawn into the compressor because the oil lines from the supply can to the crankcase always remain completely filled after priming.
3. No oil drips on the floor when connecting or dis connecting the lines because the quick coupler instantly Shuts off both the charging hose and crankcase adapter connection.
4. No inconvenience in pouring oil from container to container because the oil is pumped directly from the refinery sealed can to the compressor.
5. No oil contamination during storage because the seal cap protects the hose coupler end and the oil can remains closed after the pump is attached.

The Vilter Oil Charger is perfect for use with Vilter VMC® reciprocating compressors as well as Vilter Single Screw and Twin Screw compressors; in fact, for any refrigeration compressor with a closed crankcase. It can also be used for other applications such as adding oil to the seal chamber on liquid pumps. Multiple compressor installations are no problem since extra adapters are available.

The Vilter Oil Charger offers many outstanding construction features. The cylinder is made of steel hydraulic fluid line tubing for easier pumping and no oil leakage. The two plunger cups are of die formed Neoprene, and fit the cylinder exactly for high pressure pumping. The hose is of reinforced Neoprene with a working pressure of 125 psi. The quick coupler is all steel, not brass, and designed for refrigeration service. The check valves are also of all steel construction. In short, each component is designed for easy operation and a long working life.

The Vilter Oil Charger can make your job a lot easier, so call your nearby Vilter District Office or Distributor today.

It takes only a few seconds to make the coupler connections and begin pumping, The oil charger is suitable for reciprocating and rotary screw compressors

Manual Oil Charger (Vilter P/N: KT009)

Vilter Motor Driven Oil Charger

The addition of oil to a compressor crankcase under pressure is usually accomplished in either one of two different ways. One means is to pipe an oil can containing a fine mesh screen to the oil drain valve. The suction valve is then closed creating a partial vacuum and the oil drain valve is cracked to draw oil into the crankcase. The biggest disadvantage of this method is the disruption of the system which results when the suction valve is closed. Great care must also be taken to prevent the contamination of the oil or the entrance of air into the compressor during the operation. In addition, continued use of this procedure results in untidy engine room floors.

The other alternative is to use a hand pump to charge the oil into the crankcase. This is a considerable improvement since it does not disrupt the system, keeps air from entering the crankcase, prohibits any contamination of the oil and eliminates the untidiness of the operation. However, it can be a strenuous and time consuming procedure, particularly when a large charge has to be added to a crankcase or an oil separator.

But there is a third method of charging oil into a compressor under pressure - an extremely effective method requiring an absolute minimum of effort and time.

It's through the use of the Vilter Motor Driven Oil Charger. With the flick of a switch, oil is delivered from a refinery sealed can into the crankcase at the rate of 1½ gallons per minute against a maximum discharge pressure of 100 psi. At this rate, a Vilter reciprocating compressor crankcase can be filled in less than 5 minutes.

A motor driven pump is mounted on a bracket assembly which enables it to be easily attached to a 5 gallon can of compressor lubricant simply by tightening a thumb screw. The bracket is also formed to provide a convenient carrying handle for movement throughout the compressor room. Connection to the compressor is just as rapid since a quick coupling two-way shut-off attachment is used. This means no opportunity for oil drips on the floor. When the coupling is snapped apart, both the charging hose and the adapter connection in the crankcase are instantly shut off.

The Vilter Motor Driven Oil Charger has been designed to give many years of trouble-free service. A 1/2 H.P., 115 volt motor is used to drive the pump. An on-off switch is located in the motor terminal block and an 8 ft. long cord and plug set is furnished. The motor can also be supplied for 220 volt operation if desired.

Suction and discharge hoses are of reinforced Neoprene with a working: pressure of 125 psi. The quick coupler is all steel, designed for refrigeration service.

The Vilter Motor Driven Oil Charger is ideal for use with Vilter VMC® reciprocating compressors, as well as Vilter Single Screw and Twin Screw compressors. In fact, it can be used on any refrigeration compressor having a closed crankcase.

It is especially appropriate for multiple compressor installations. Extra adapter kits, which include a bushing, nipple and the plug portion of the coupling, are available to enable the operating engineer to install a set in the oil charging valve of each compressor. As a result, a tedious, messy job that used to require hours to perform, is quickly and effectively finished in minutes.

Contact your nearby Vilter District Office or Distributor. He is prepared to give you immediate service and will be happy to provide any additional information you may require.

Charge 1½ gallons of Crankcase Oil a minute with the Vilter Motor Driven Oil Charger

Motor Driven Oil Charger
(Vilter P/N: A40849A)

Appendix D
Vilter Stedy-Mount®
(New Improved All Stainless Steel “Pulse Control” Model)

Stedy-Mount® - VPN A17311SS

Temperature and Pressure Application Range

Stedy-Mounts are factory-tested for service within an ambient temperature range of -50°F to +150°F, and are suitable for system temperatures up to 300°F and system pressures up to 300 psig. For applications from 300 to 7000 psig, consult the Vilter Home Office.

If you want to use the Stedy-Mount for applications under pressure limitations governed by Codes other than ANSI/ASHRAE 15 Safety Code For Mechanical Refrigeration, Vilter will be glad to test the Stedy-Mount for your specific pressure requirement.

Installation and Servicing

Before installing, the Stedy-Mount should be checked to make sure the coil spring has not been compressed.

THE FULL BENEFITS OF A STEDY-MOUNT INSTALLATION WILL NOT BE ACHIEVED IF THE FITTINGS STRIKE EACH OTHER DURING OPERATION.

It is of extreme importance that the upper and lower coil fittings be separated by a space of 5/16" when the Stedy-Mount stands free, before the gauge is screwed into place.

Since this 5/16" space is enclosed within the Neoprene damper and is not visible, it cannot be measured directly. However, it can be checked by measuring the overall free length of the unit. If the Stedy-Mount measures exactly 3" overall, the air gap or space between fittings is exactly 5/16" as required.

If there is less than 5/16" air gap or free movement, the fittings can be pulled apart by hand to slightly overstretch the coil and then compressed again to obtain the required air gap (or 3" overall free unit length). When heavier gauges are used, it may be necessary to slightly increase the air gap by overstretching the coil to allow more than a 5/16" air gap.

Because periodic recalibration is necessary for all types of pressure gauges, it is suggested that the Stedy-Mount be installed downstream of a globe valve to facilitate safe removal of the pressure gauge.

Materials Of Construction

The "standard" VSM-1 Vilter Stedy-Mount consists of:

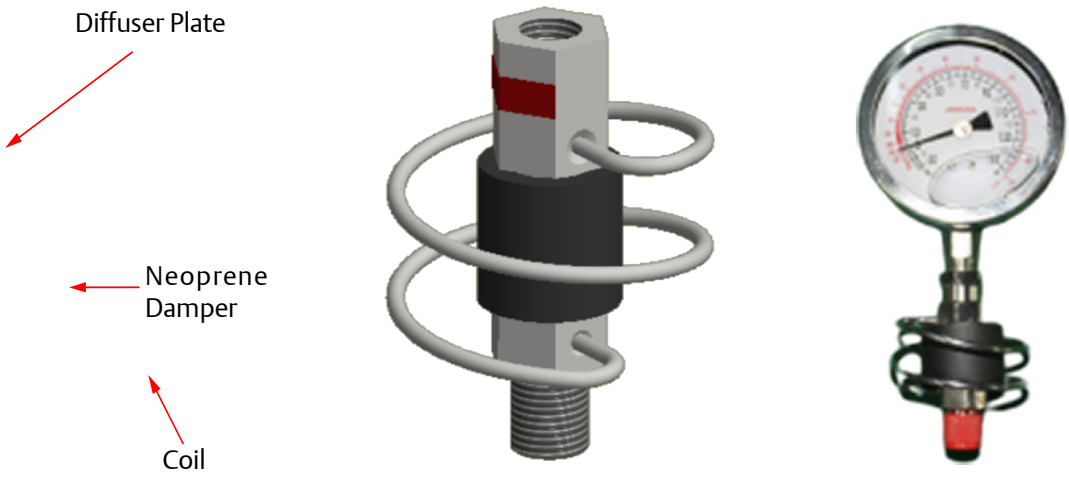
1 - Lower Coil Fitting - 304 stainless steel for ¼" FPT connection.

1- Upper Coil Fitting - 304 stainless steel for ¼" MPT connection.

1 - Spiral Tube Coil - 304 stainless steel.

1 - Damper - Neoprene (Oil resistant).

1 - Diffuser - 316 stainless steel.



Gauge Sizes and Weights

Because the Stedy-Mount converts the gauge into a free-standing, free-floating body, certain size and weight limitations must be applied in order not to convert the unit into a top-heavy system in which the gauge would topple over. To some extent, gauge sizes and weights are dependent on the make and pattern of the gauge.

Generally speaking, pressure gauges of 3½" dia. or less and weigh up to 2½ lbs., or 4½" dia., weighing up to 2 lbs., can be accommodated by the Stedy Mount. This is providing that the Top Heavy Moment of the weight of the gauge is within the 30 to 140 range. TOP HEAVY MOMENT is the product of the weight of the gauge (ounces) times the distance (inches) from the center of gravity of the gauge to the top of the Stedy-Mount. The center of gravity of the gauge must be low enough so the system does not lose its vertical stability.

Table D-1. Stedy-Mount Specifications

VPN	Gauge Connection	Stedy-Mount Pipe Size	Top Heavy Mount Range (Oz.-In.)
A17311SS	1/4"	1/4"	30 - 140

Appendix E
Wood's Sure-Grip® QD Bushings

Wood's Sure-Grip® QD Bushings

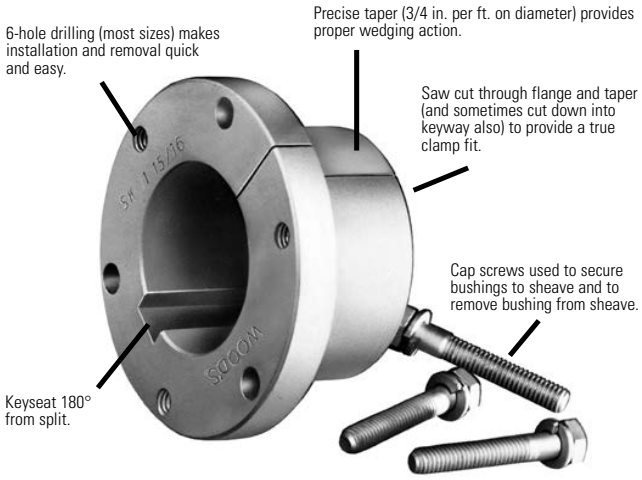
A1

- **Provide a True Clamp Fit**
- **Are Easy to Install and Remove**
- **Permit Four-Way Mounting**

Sure-Grip® Bushings

Features

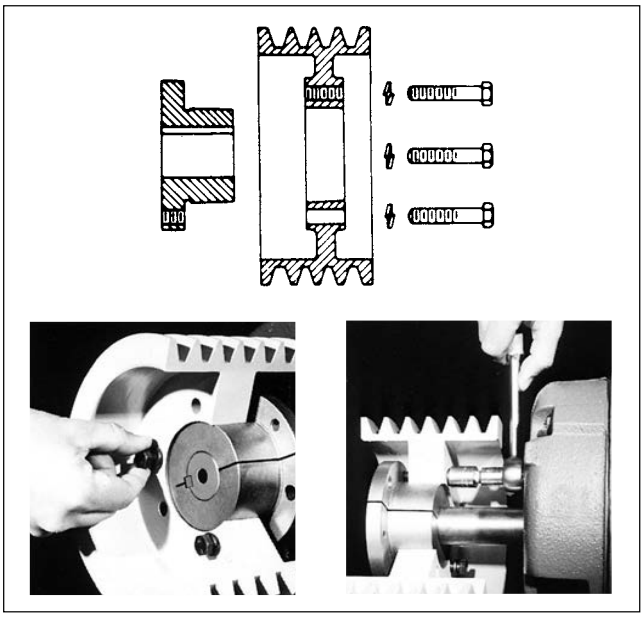
Sure-Grip® "Quick Detachable" bushings are easy to install and remove. They are split through flange and taper to provide a true clamp on the shaft that is the equivalent of a shrink fit. All sizes except JA and QT have a setscrew over the key to help maintain the bushing's position on the shaft until the cap screws are securely tightened. Sure-Grip bushings have a very gradual taper (3/4-inch taper per ft. on the diameter) which is about half the inclined angle of many other bushings. The result is the Sure-Grip securely clamps the shaft, with twice the force of those competitive bushings, to provide extreme holding power.



Versatile Sure-Grip bushings permit the mounting of the same mating part on shafts of different diameters, and the mounting of different sheaves on the same shaft using the same bushing. Their interchangeability extends through sheaves, pulleys, timing pulleys, sprockets, flexible and rigid couplings, made-to-order items by Wood's, and to product lines of several other mechanical power transmission manufacturers.

Sure-Grip bushings are manufactured with the drilled and tapped holes located at a precise distance from the keyseat; thus, a wide mating part having a bushing in each end can be mounted on a common shaft with the two keyways in line. This feature not only facilitates installation but also permits both bushings to carry an equal share of the load.

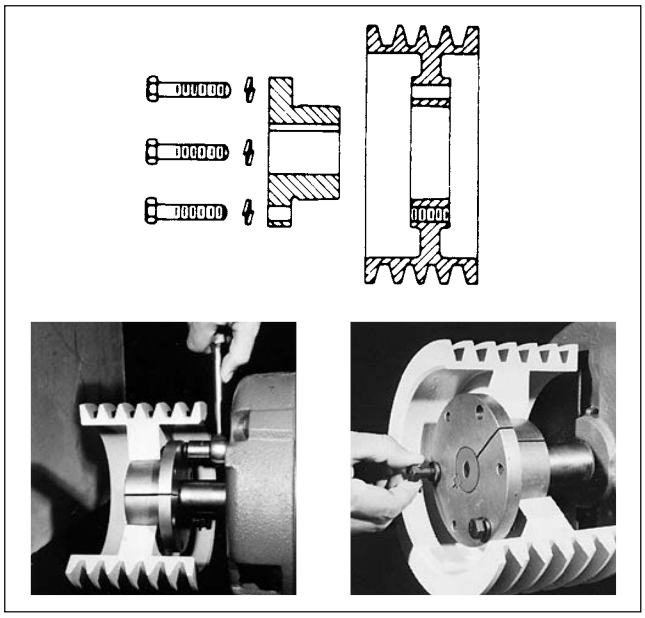
STANDARD MOUNTING



1. Cap screws from outside through drilled holes in the mating part and into threaded holes in the bushing flange located on the inside of the assembly. Or the complete assembly reversed on the shaft and;

2. Cap screws from inside through drilled holes in the mating part and into threaded holes in the bushing flange located on the outside of the assembly.

REVERSE MOUNTING



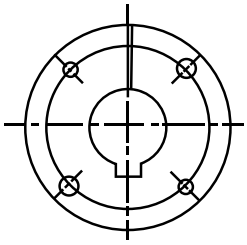
3. Cap screws from inside through drilled holes in the bushing flange located on the inside of the assembly and into threaded holes in the mating part.

4. Cap screws from outside through drilled holes in the bushing flange located on the outside of the assembly and into threaded holes in the mating part.

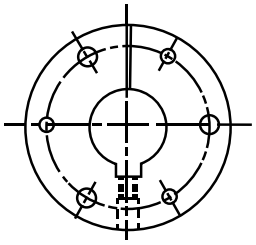
Sure-Grip® Bushings

Dimensions

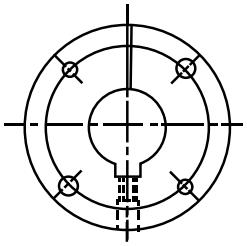
Sure-Grip bushings are designed to transmit the rated torque capacity listed in the table below when the cap screws are tightened as indicated. The bushings are stocked in all popular bore sizes, including metric bores, within the bore range for a particular bushing.



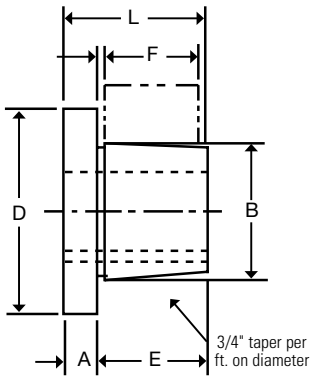
Bushing
QT



Bushings
JA to J inclusive w/
Setscrew
Except JA



Bushings
M to S inclusive
w/Setscrew



SURE-GRIP BUSHING
TORQUE RATINGS AND DIMENSIONS

Bush.	Torque Capacity (In.-Lbs.)	(Note 1) Max. Bore	(Note 2) Max. Bore	DIMENSIONS IN INCHES						Bolt Circle	Cap Screws Required
				A	B	D	E	F*	L		
QT	1,750	1-1/2	30	1/4	1.625	2-1/2	1	7/8	1-1/4	2	2-1/4 x 1
JA	1,750	1-1/4	23	5/16	1.375	2	11/16	9/16	1	1-21/32	3 - #10 x 1
SH	3,500	1-5/8	36	3/8	1.871	2-11/16	7/8	13/16	1-1/4	2-1/4	3-1/4 x 1-3/8
SDS	5,000	1-15/16	42	7/16	2.1875	3-3/16	7/8	3/4	1-5/16	2-11/16	3-1/4 x 1-3/8
SD	5,000	1-15/16	42	7/16	2.1875	3-3/16	1-3/8	1-1/4	1-13/16	2-11/16	3-1/4 x 1-7/8
SK	7,000	2-1/2	56	1/2	2.8125	3-7/8	1-3/8	1-1/4	1-7/8	3-5/16	3-5/16 x 2
SF	11,000	2-15/16	63	1/2	3.125	4-5/8	1-1/2	1-1/4	2	3-7/8	3-3/8 x 2
E	20,000	3-1/2	78	3/4	3.834	6	1-7/8	1-5/8	2-5/8	5	3-1/2 x 2-3/4
F	40,000	3-15/16	90	13/16	4.4375	6-5/8	2-13/16	2-1/2	3-5/8	5-5/8	3-9/16 x 3-5/8
J	55,000	4-1/2	105	1	5.1484	7-1/4	3-1/2	3-3/16	4-1/2	6-1/4	3-5/8 x 4-1/2
M	125,000	5-1/2	130	1-1/4	6.500	9-1/8	5-1/2	5-3/16	6-3/4	7-7/8	4-3/4 x 6-3/4
N	150,000	6	140	1-1/2	7.000	10	6-5/8	6-1/4	8-1/8	8-1/2	4-7/8 x 8
P	250,000	7	160	1-3/4	8.250	11-3/4	7-5/8	7-1/4	9-3/8	10	4 - 1 x 9-1/2
W	375,000	8-1/2	200	2	10.437	15	9-3/8	9	11-3/8	12-3/4	4 - 1-1/8 x 11-1/2
S	625,000	10	240	3-1/4	12.125	17-3/4	12-1/2	12	15-3/4	15	5 - 1-1/4 x 15-1/2

* Mating hub length.
1. MAX INCH BORE WITH KEYSEAT.
2. MAX MM BORE WITH STANDARD KEYSEAT.

See pages E–5 to E–6 for Bore and Keyseat information and weights.

SURE-GRIP® BUSHINGS

Bore and Key Seat Dimensions

Sure-Grip Bushings are available from stock with all the bores and keyseats listed below. In some cases, as the bore increases in diameter, a shallow keyseat is provided—due to insufficient metal thickness. When this happens, Wood's furnishes the correct rectangular key to suit at no charge. This does not affect the bushing's ability to transmit the load. The rectangular key, or flat key as some call it, fits into the standard keyway in the shaft.

DIMENSIONS (In Inches)

Product No.	Bore	Key Seat	Wt. (*)
QT BUSHINGS			
QTMPB	7/16	No KS	.6
QT12	1/2	1/8 x 1/16	.6
QT9/16	9/16	1/8 x 1/16	.6
QT58	5/8	3/16 x 3/32	.6
QT11/16	11/16	3/16 x 3/32	.6
QT34	3/4	3/16 x 3/32	.6
QT13/16	13/16	3/16 x 3/32	.6
QT78	7/8	3/16 x 3/32	.6
QT15/16	15/16	1/4 x 1/8	.6
QT1	1	1/4 x 1/8	.6
QT1116	1-1/16	1/4 x 1/8	.6
QT118	1-1/8	1/4 x 1/8	.6
QT1316	1-3/16	1/4 x 1/8	.6
QT114	1-1/4	1/4 x 1/8	.6
QT1516	1-5/16	5/16 x 1/16	.6
QT138	1-3/8	5/16 x 1/16	.6
QT1716	1-7/16	3/8 x 1/16	.6
QT112	1-1/2	3/8 x 1/16	.6
JA BUSHINGS			
JAMPB	1/2	No KS	.8
JA12	1/2	1/8 x 1/16	.8
JA9/16	9/16	1/8 x 1/16	.8
JA58	5/8	3/16 x 3/32	.8
JA11/16	11/16	3/16 x 3/32	.8
JA34	3/4	3/16 x 3/32	.8
JA13/16	13/16	3/16 x 3/32	.8
JA78	7/8	3/16 x 3/32	.8
JA15/16	15/16	1/4 x 1/8	.8
JA1	1	1/4 x 1/8	.8
JA1116	1-1/16	1/4 x 1/16	.8
JA118	1-1/8	1/4 x 1/16	.8
JA1316	1-3/16	1/4 x 1/16	.8
JA114	1-1/4	1/4 x 1/32	.8
SH BUSHINGS			
SHMPB	7/16	No KS	1.1
SH12	1/2	1/8 x 1/16	1.1
SH9/16	9/16	1/8 x 1/16	1.1
SH58	5/8	3/16 x 3/32	1.1
SH11/16	11/16	3/16 x 3/32	1.0
SH34	3/4	3/16 x 3/32	1.0
SH13/16	13/16	3/16 x 3/32	1.0
SH78	7/8	3/16 x 3/32	1.0
SH15/16	15/16	1/4 x 1/8	1.0
SH1	1	1/4 x 1/8	.9

* Approximate weight in lbs.

Product No.	Bore	Key Seat	Wt. (*)
SH BUSHINGS (continued)			
SH1116	1-1/16	1/4 x 1/8	.9
SH118	1-1/8	1/4 x 1/8	.9
SH1316	1-3/16	1/4 x 1/8	.8
SH114	1-1/4	1/4 x 1/8	.8
SH1516	1-5/16	5/16 x 5/32	.7
SH138	1-3/8	5/16 x 5/32	.7
SH1716	1-7/16	3/8 x 1/16	.7
SH112	1-1/2	3/8 x 1/16	.6
SH1916	1-9/16	3/8 x 1/16	.6
SH158	1-5/8	3/8 x 1/16	.5
SH11116	1-11/16	No KS	.5
SDS BUSHINGS			
SDSMPB	7/16	No KS	1.7
SDS12	1/2	1/8 x 1/16	1.7
SDS9/16	9/16	1/8 x 1/16	1.7
SDS58	5/8	3/16 x 3/32	1.6
SDS11/16	11/16	3/16 x 3/32	1.6
SDS34	3/4	3/16 x 3/32	1.6
SDS13/16	13/16	3/16 x 3/32	1.6
SDS78	7/8	3/16 x 3/32	1.5
SDS15/16	15/16	1/4 x 1/8	1.5
SDS1	1	1/4 x 1/8	1.5
SDS1116	1-1/16	1/4 x 1/8	1.4
SDS118	1-1/8	1/4 x 1/8	1.4
SDS1316	1-3/16	1/4 x 1/8	1.4
SDS114	1-1/4	1/4 x 1/8	1.3
SDS1516	1-5/16	5/16 x 5/32	1.3
SDS138	1-3/8	5/16 x 5/32	1.2
SDS13838KS	1-3/8	3/8 x 3/16	1.2
SDS1716	1-7/16	3/8 x 3/16	1.2
SDS112	1-1/2	3/8 x 3/16	1.1
SDS1916	1-9/16	3/8 x 3/16	1.1
SDS158	1-5/8	3/8 x 3/16	1.0
SDS11116	1-11/16	3/8 x 3/16	1.0
SDS134	1-3/4	3/8 x 1/8	1.0
SDS11316	1-13/16	1/2 x 1/8	.9
SDS178	1-7/8	1/2 x 1/16	.9
SDS11516	1-15/16	1/2 x 1/16	.8
SDS2	2	No KS	.7
SD BUSHINGS			
SDMPB	7/16	No KS	2.1
SD12	1/2	1/8 x 1/16	2.1
SD9/16	9/16	1/8 x 1/16	2.1
SD58	5/8	3/16 x 3/32	2.1
SD11/16	11/16	3/16 x 3/32	2.0

MPB Bushings are unsplit.

Product No.	Bore	Key Seat	Wt. (*)
SD BUSHINGS (continued)			
SD34	3/4	3/16 x 3/32	2.0
SD13/16	13/16	3/16 x 3/32	2.0
SD78	7/8	3/16 x 3/32	1.9
SD15/16	15/16	1/4 x 1/8	1.9
SD1	1	1/4 x 1/8	1.8
SD1116	1-1/16	1/4 x 1/8	1.8
SD118	1-1/8	1/4 x 1/8	1.7
SD1316	1-3/16	1/4 x 1/8	1.7
SD114	1-1/4	1/4 x 1/8	1.6
SD1516	1-5/16	5/16 x 5/32	1.6
SD138	1-3/8	5/16 x 5/32	1.5
SD13838KS	1-3/8	3/8 x 3/16	1.5
SD1716	1-7/16	3/8 x 3/16	1.4
SD112	1-1/2	3/8 x 3/16	1.4
SD1916	1-9/16	3/8 x 3/16	1.3
SD158	1-5/8	3/8 x 3/16	1.2
SD11116	1-11/16	3/8 x 3/16	1.2
SD134	1-3/4	3/8 x 1/8	1.1
SD11316	1-13/16	1/2 x 1/8	1.1
SD178	1-7/8	1/2 x 1/16	1.0
SD11516	1-15/16	1/2 x 1/16	.9
SD2	2	No KS	.8
SK BUSHINGS			
SKMPB	7/16	No KS	3.6
SK12	1/2	1/8 x 1/16	3.6
SK9/16	9/16	1/8 x 1/16	3.6
SK58	5/8	3/16 x 3/32	3.6
SK11/16	11/16	3/16 x 3/32	3.5
SK34	3/4	3/16 x 3/32	3.5
SK13/16	13/16	3/16 x 3/32	3.5
SK78	7/8	3/16 x 3/32	3.4
SK15/16	15/16	1/4 x 1/8	3.4
SK1	1	1/4 x 1/8	3.3
SK1116	1-1/16	1/4 x 1/8	3.3
SK118	1-1/8	1/4 x 1/8	3.2
SK1316	1-3/16	1/4 x 1/8	3.2
SK114	1-1/4	1/4 x 1/8	3.1
SK1516	1-5/16	5/16 x 5/32	3.1
SK151638KS	1-5/16	3/8 x 3/16	3.1
SK138	1-3/8	5/16 x 5/32	3.0
SK13838KS	1-3/8	3/8 x 3/16	3.0
SK1716	1-7/16	3/8 x 3/16	2.9
SK112	1-1/2	3/8 x 3/16	2.9
SK1916	1-9/16	3/8 x 3/16	2.8
SK158	1-5/8	3/8 x 3/16	2.7
SK11116	1-11/16	3/8 x 3/16	2.6
SK134	1-3/4	3/8 x 3/16	2.5
SK13412KS	1-3/4	1/2 x 1/4	2.5

(Continued—next page)

Sure-Grip® Bushings

Bore and Key Seat Dimensions

DIMENSIONS (In Inches)

Product No.	Bore	Key Seat	Wt. (*)
SK BUSHINGS (continued)			
SK11316	1-13/16	1/2 x 1/4	2.4
SK178	1-7/8	1/2 x 1/4	2.4
SK11516	1-15/16	1/2 x 1/4	2.3
SK2	2	1/2 x 1/4	2.2
SK2116	2-1/16	1/2 x 1/4	2.1
SK218	2-1/8	1/2 x 1/4	2.0
SK2316	2-3/16	1/2 x 1/8	2.0
SK214	2-1/4	1/2 x 1/8	1.9
SK21458KS	2-1/4	5/8 x 1/8	1.9
SK2516	2-5/16	5/8 x 1/16	1.8
SK238	2-3/8	5/8 x 1/16	1.7
SK2716	2-7/16	5/8 x 1/16	1.6
SK212	2-1/2	5/8 x 1/16	1.5
SK2916	2-9/16	No KS	1.3
SK258	2-5/8	No KS	1.1
SF BUSHINGS			
SFMPB	1/2	No KS	5.1
SF12	1/2	1/8 x 1/16	5.1
SF58	5/8	3/16 x 3/32	5.0
SF34	3/4	3/16 x 3/32	5.0
SF78	7/8	3/16 x 3/32	4.9
SF15/16	15/16	1/4 x 1/8	4.8
SF1	1	1/4 x 1/8	4.8
SF1116	1-1/16	1/4 x 1/8	4.7
SF118	1-1/8	1/4 x 1/8	4.7
SF1316	1-3/16	1/4 x 1/8	4.6
SF114	1-1/4	1/4 x 1/8	4.5
SF1516	1-5/16	5/16 x 5/32	4.5
SF138	1-3/8	5/16 x 5/32	4.4
SF13838KS	1-3/8	3/8 x 3/16	4.4
SF1716	1-7/16	3/8 x 3/16	4.3
SF112	1-1/2	3/8 x 3/16	4.2
SF1916	1-9/16	3/8 x 3/16	4.2
SF158	1-5/8	3/8 x 3/16	4.1
SF11116	1-11/16	3/8 x 3/16	4.0
SF134	1-3/4	3/8 x 3/16	3.9
SF11316	1-13/16	1/2 x 1/4	3.8
SF178	1-7/8	1/2 x 1/4	3.7
SF11516	1-15/16	1/2 x 1/4	3.6
SF2	2	1/2 x 1/4	3.5
SF2116	2-1/16	1/2 x 1/4	3.4
SF218	2-1/8	1/2 x 1/4	3.3
SF2316	2-3/16	1/2 x 1/4	3.2
SF214	2-1/4	1/2 x 1/4	3.1
SF21458KS	2-1/4	5/8 x 5/16	3.1
SF2516	2-5/16	5/8 x 3/16	3.1
SF238	2-3/8	5/8 x 3/16	3.0
SF2716	2-7/16	5/8 x 3/16	2.9
SF212	2-1/2	5/8 x 3/16	2.8
SF2916	2-9/16	5/8 x 1/16	2.6
SF258	2-5/8	5/8 x 1/16	2.5
SF21116	2-11/16	5/8 x 1/16	2.4
SF234	2-3/4	5/8 x 1/16	2.2
SF278	2-7/8	3/4 x 1/16	1.8
SF21516	2-15/16	3/4 x 1/32	1.7

Approximate weight in lbs.

Product No.	Bore	Key Seat	Wt. (*)
E BUSHINGS			
EMPB	7/8	No KS	10.8
E78	7/8	3/16 x 3/32	10.8
E15/16	15/16	1/4 x 1/8	10.8
E1	1	1/4 x 1/8	10.7
E118	1-1/8	1/4 x 1/8	10.6
E1316	1-3/16	1/4 x 1/8	10.5
E114	1-1/4	1/4 x 1/8	10.4
E1516	1-5/16	5/16 x 5/32	10.3
E138	1-3/8	5/16 x 5/32	10.2
E13838KS	1-3/8	3/8 x 3/16	10.2
E1716	1-7/16	3/8 x 3/16	10.1
E112	1-1/2	3/8 x 3/16	10.0
E1916	1-9/16	3/8 x 3/16	9.9
E158	1-5/8	3/8 x 3/16	9.8
E11116	1-11/16	3/8 x 3/16	9.7
E134	1-3/4	3/8 x 3/16	9.6
E11316	1-13/16	1/2 x 1/4	9.4
E178	1-7/8	1/2 x 1/4	9.3
E11516	1-15/16	1/2 x 1/4	9.2
E2	2	1/2 x 1/4	9.0
E2116	2-1/16	1/2 x 1/4	8.9
E218	2-1/8	1/2 x 1/4	8.8
E2316	2-3/16	1/2 x 1/4	8.6
E214	2-1/4	1/2 x 1/4	8.5
E21458KS	2-1/4	5/8 x 5/16	8.5
E2516	2-5/16	5/8 x 5/16	8.3
E238	2-3/8	5/8 x 5/16	8.1
E2716	2-7/16	5/8 x 5/16	8.0
E212	2-1/2	5/8 x 5/16	7.8
E2916	2-9/16	5/8 x 5/16	7.6
E258	2-5/8	5/8 x 5/16	7.5
E21116	2-11/16	5/8 x 5/16	7.3
E234	2-3/4	5/8 x 5/16	7.1
E21316	2-13/16	3/4 x 3/8	7.2
E278	2-7/8	3/4 x 3/8	7.1
E21516	2-15/16	3/4 x 1/8	6.9
E3	3	3/4 x 1/8	6.7
E318	3-1/8	3/4 x 1/8	6.3
E3316	3-3/16	3/4 x 1/8	6.0
E314	3-1/4	3/4 x 1/8	5.8
E3516	3-5/16	7/8 x 1/16	5.7
E338	3-3/8	7/8 x 1/16	5.5
E3716	3-7/16	7/8 x 1/16	5.2
E312	3-1/2	7/8 x 1/16	4.7
F BUSHINGS			
FMPB	1	No KS	17.9
F1	1	1/4 x 1/8	17.9
F118	1-1/8	1/4 x 1/8	17.7
F1316	1-3/16	1/4 x 1/8	17.6
F114	1-1/4	1/4 x 1/8	17.5
F138	1-3/8	5/16 x 5/32	17.2
F1716	1-7/16	3/8 x 3/16	17.1
F112	1-1/2	3/8 x 3/16	16.9
F1916	1-9/16	3/8 x 3/16	16.8
F158	1-5/8	3/8 x 3/16	16.7

MPB Bushings are unsplit.

Product No.	Bore	Key Seat	Wt. (*)
F BUSHING (continued)			
F134	1-3/4	3/8 x 3/16	16.3
F178	1-7/8	1/2 x 1/4	16.0
F11516	1-15/16	1/2 x 1/4	15.8
F2	2	1/2 x 1/4	15.6
F2116	2-1/16	1/2 x 1/4	15.4
F218	2-1/8	1/2 x 1/4	15.2
F2316	2-3/16	1/2 x 1/4	15.0
F214	2-1/4	1/2 x 1/4	14.8
F21458KS	2-1/4	5/8 x 5/16	14.8
F2516	2-5/16	5/8 x 5/16	14.5
F238	2-3/8	5/8 x 5/16	14.3
F2716	2-7/16	5/8 x 5/16	14.1
F212	2-1/2	5/8 x 5/16	13.9
F2916	2-9/16	5/8 x 5/16	13.7
F258	2-5/8	5/8 x 5/16	13.4
F21116	2-11/16	5/8 x 5/16	13.2
F234	2-3/4	5/8 x 5/16	12.9
F21316	2-13/16	3/4 x 3/8	12.6
F278	2-7/8	3/4 x 3/8	12.3
F21516	2-15/16	3/4 x 3/8	12.1
F3	3	3/4 x 3/8	11.8
F318	3-1/8	3/4 x 3/8	11.2
F3316	3-3/16	3/4 x 3/8	10.9
F314	3-1/4	3/4 x 3/8	10.6
F3516	3-5/16	7/8 x 3/16	11.0
F338	3-3/8	7/8 x 3/16	10.6
F3716	3-7/16	7/8 x 3/16	10.3
F312	3-1/2	7/8 x 3/16	10.0
F358	3-5/8	7/8 x 3/16	9.4
F31116	3-11/16	7/8 x 3/16	9.0
F334	3-3/4	7/8 x 3/16	8.7
F378	3-7/8	1 x 1/8	8.1
F31516	3-15/16	1 x 1/8	7.7
F4	4	No KS	6.9
J BUSHINGS			
JMPB	1-7/16	No KS	28.1
J1716	1-7/16	3/8 x 3/16	28.1
J112	1-1/2	3/8 x 3/16	28.0
J1916	1-9/16	3/8 x 3/16	27.8
J1116	1-11/16	3/8 x 3/16	27.4
J134	1-3/4	3/8 x 3/16	27.2
J178	1-7/8	1/2 x 1/4	26.7
J11516	1-15/16	1/2 x 1/4	26.5
J2	2	1/2 x 1/4	26.3
J218	2-1/8	1/2 x 1/4	25.8
J2316	2-3/16	1/2 x 1/4	25.6
J214	2-1/4	1/2 x 1/4	25.3
J2516	2-5/16	5/8 x 5/16	25.0
J238	2-3/8	5/8 x 5/16	24.7
J2716	2-7/16	5/8 x 5/16	24.5
J212	2-1/2	5/8 x 5/16	24.2
J258	2-5/8	5/8 x 5/16	23.6
J21116	2-11/16	5/8 x 5/16	23.3
J234	2-3/4	5/8 x 5/16	23.0
J278	2-7/8	3/4 x 3/8	22.2

Appendix F
Johnson Controls P28 and P128 Series Lube Oil Controls with Built-in Time Delay Relay

Master Catalog 125
Pressure Controls Section **P**
Product/Technical Bulletin P28
Issue Date 0498

P28 and P128 Series Lube Oil Controls with Built-in Time Delay Relay

The P28 and P128 Series Lube Oil Controls provide dependable and economical oil pressure cut-out for pressure-lubricated refrigeration compressors. The field-adjustable pressure differential of these controls provides compressor operation according to the manufacturer's specifications. The P28 and P128 controls operate by measuring the net lube oil pressure and de-energizing the compressor if the pressure falls below the differential setpoint.

Manual or automatic reset models are available with factory set and sealed time delays of 30, 45, 60, 90, or 120 seconds (all time delays may not be available on all models). The P128 is the same control as the P28 but with 1/4 inch male flare pressure connections.

Figure 1: P128AA

Features and Benefits	
Built-in Time Delay Relay with Ambient Compensation	Minimizes timing fluctuations due to temperature variations
Trip-free Manual Reset	Provides manual reset that cannot be overridden by pressing and holding the reset button
Replaceable Time Delay Relay Assembly	Allows easy field replacement of the time delay relay and terminal board
Available with Runlight and Alarm Terminals	Allows the control to be wired for normal oil pressure runlight signals and shutdown alarm circuits for remote monitoring of oil pressure status

Introduction

WARNING: **Personal injury hazard.** All P28 and P128 controls are designed as lubrication protection controls. Failure of the P28 or P128 could allow the refrigeration compressor to be damaged in a way that may not be apparent upon visual inspection. Follow proper procedures and the compressor manufacturer's instructions, as well as any warning signs on or around the equipment, when discharging and disassembling the compressor.

Environmental damage hazard. If leakage of sensed media (such as refrigerant or oil) can be harmful to the environment, or hazardous in any way, user must provide for proper containment.

The P28 and P128 controls measure the net oil pressure available to circulate oil throughout a pressure-lubricated refrigeration system. The net oil pressure is the difference between the oil pressure at the pump discharge and the refrigerant pressure in the compressor crankcase.

Example: If the oil pressure pump discharge reading is 90 psi (621 kPa) and the crankcase pressure is 70 psi (483 kPa), the net oil pressure is 20 psi (138 kPa).

The P28 and P128 have a built-in time delay relay. This relay allows the oil pressure to build up for the time delay period before the compressor trips. This also prevents nuisance lockouts due to intermittent loss of oil pressure. The time delay relay is a "trip free" device. The manual reset cannot be overridden by pressing and holding the reset button.

Manual reset models are available with time delays of 30, 45, 60, 90, or 120 seconds. Automatic reset models are available with a 90-second time delay. The time delay relay is compensated to minimize the effect of ambient temperature variations. However, the time delay relay will be affected by voltage variations.

Dimensions

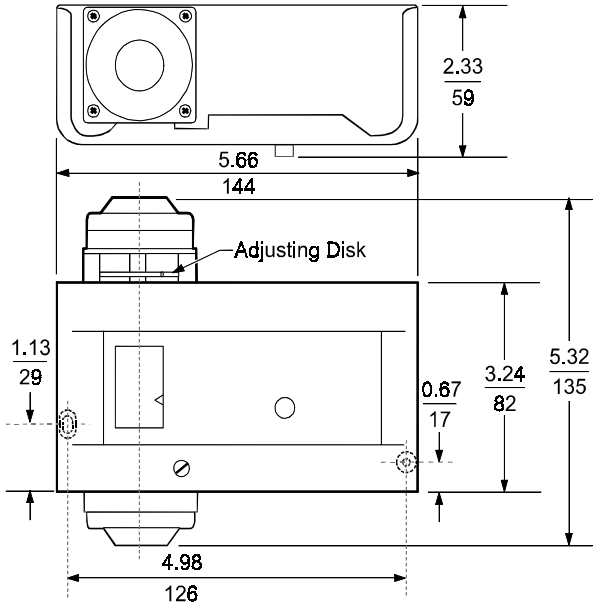


Figure 2: P28 or P128 Dimensions (in./mm)

Operation

When the compressor starts, the timer is energized because the net oil pressure of the system is zero. During normal operation, the net oil pressure should build up to the pressure switch's cut-out setting (scale setting) plus the switch differential (3 to 5 psi [21 to 34 kPa]) within the required time delay, causing the time delay relay to de-energize.

If the net oil pressure does not rise to the cut-out pressure setting plus the switch differential within the required time delay, the time delay relay trips and stops the compressor.

If the net oil pressure drops below the cut-out pressure setting during the compressor's run cycle, the time delay relay energizes. If the net oil pressure returns within the time delay, the time delay relay de-energizes and the compressor continues to operate normally. If the net oil pressure does not return within the time delay, the control shuts down and locks out the compressor.

Example: Net oil pressure (oil pump pressure minus crankcase pressure) required to the bearings is 9 psi (62 kPa). The control scale setting should be 9 psi (62 kPa). The switch differential is 5 psi (34 kPa). Upon initial start of the compressor, the time delay relay energizes. If the net oil pressure does not build up to 14 psi (97 kPa), or the scale setting (9 psi) plus the switch differential (5 psi), during the time delay, the control breaks the circuit to the compressor. If the pressure of 14 psi (97 kPa) is reached during the time delay, the time delay relay de-energizes and the compressor continues to operate normally.

Installation

Mounting

⚠ CAUTION: **Equipment damage hazard.**

- A P28AN or P28DN control used for ammonia service must be mounted separately from the electrical cabinet. An ammonia leak could damage the electrical circuitry.
- Do not use Johnson Controls/Penn Ecosafe® hose tubing in applications with ammonia or other corrosive refrigerants. Corrosion could cause tube breakage and refrigerant leakage.
- Use **only** the mounting screws supplied with the control. Damage to internal components may occur if other screws are used.

The P28 and P128 controls are not position sensitive and can be mounted in any position.

Use the two mounting screw holes located on the back of the control case to mount the control directly to a wall or panel board. Mount the control so that the pressure connections on the bellows are above the crankcase liquid level of the equipment being controlled.

Note: When mounting the control to a compressor is required, a mounting bracket (Part No. 271-51) is available.

Pressure Connections

⚠ CAUTION: **Equipment damage hazard.**

- Avoid sharp bends or kinks in the capillary or tubing to avoid damage to the capillary.
- Coil and secure excess capillary or tubing. Because harmonic vibration can break the capillary or tubing, some slack must be provided.
- Do not allow the capillary or tubing to rub against metal surfaces where friction can cause damage.
- When using a control with 1/4 in./ 6.4 mm tubing, a pulsation damper must be used. Pulsation can cause excessive wear and damage the control.

1. Purge all tubing and lines before connecting the pressure control.
2. Connect the oil pressure line pump discharge to the pressure connector labeled "OIL."
3. Connect the crankcase pressure line to the pressure connector labeled "LOW."
4. Coil and secure excess capillary or tubing to avoid vibration.

Wiring

⚠ WARNING: **Shock hazard.** Disconnect all power supplies before making wiring connections to avoid electrical shock or damage to the equipment.

- Make all wiring connections using copper conductors only.
- Wire in accordance with National Electric Code and local regulations. For maximum electrical rating of the control, see the label inside the control cover.
- Use the terminal screws furnished (8-32 x 1/4 in. binder head). Substitution of other screws may cause faulty connections.

See Figures 3 through 10 for typical wiring diagrams or refer to the compressor manufacturer's specifications.

When the P28 or P128 control is supplied with a Terminal 3, it may be wired to operate a runlight for indicating when there is sufficient net oil pressure. When the control is supplied with a Terminal A, it can be wired to operate a shutdown alarm or signal for indicating when the compressor has tripped.

For applications using a 208V control circuit, it is suggested that one leg of the 208V circuit and a neutral or ground wire be used as a 120V source to power the time delay relay.

When a P28 or P128 is installed on a 440 or 550 VAC system, use an external step-down transformer to provide either 120 or 240V to the pilot and time delay relay circuits. The transformer must be of sufficient volt ampere capacity to operate the motor starter and the time delay relay. Table 1 presents the power requirements for the P28 or P128 time delay relay. Table 2 presents the electrical ratings.

Table 1: Electrical Power Required for Time Delay Relay

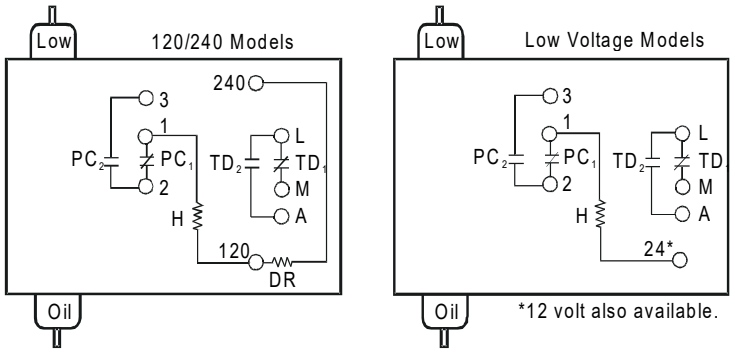
Timing in Seconds	Voltage	
	12, 24, or 120V	240V
30, 45, 60, 90, or 120	15 VA	30 VA

Table 2: Electrical Ratings--Pilot Duty

Time Delay Relay Circuit	Pilot Circuit	Alarm Circuit*	Crankcase Heater** (Terminal 1)	Runlight** (Terminal 3)
120/240 VAC	750 VA, 120/240 VAC	10W Tungsten, 120/240 VAC	10 Ampere, 120 VAC 5 Ampere, 240 VAC	10W Tungsten
24 VAC/VDC 12 VAC/VDC	125 VA, 24 VAC 57.5 VA, 24 VDC	125 VA, 24 VAC 57.5 VA, 24 VDC	--	10W Tungsten

* Must be the same voltage as the pilot circuit.

** Must be the same voltage as the time delay relay circuit.



PC_1 - Pressure actuated contacts. Open on increase in pressure difference between oil and low pressure conntectors. Makes and breaks time delay heater circuit.

PC_2 - Contacts close simultaneously when PC_1 contacts open (runlight circuit).

TD_1 - Time delay relay. Contacts open after time delay interval if pressure dfference between oil and low pressure connectors is not established or maintained.

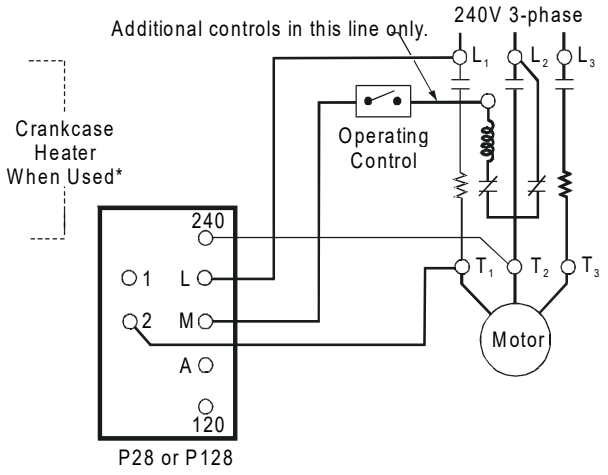
TD_2 - Contacts close simultaneously when TD_1 contacts open (alarm circuit).

DR - Voltage dropping resistor used in dual voltage models.

H - Heater for time delay relay.

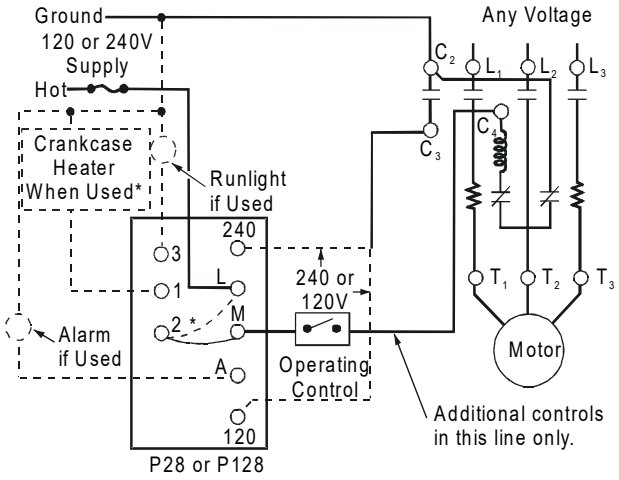
Connect Terminals L and M as a single pole switch.
Connect Terminals 2 and 240 or 120 to energize circuit only when motor starter is closed.

Figure 3: P28 or P128 Internal Wiring Circuit, Showing Alarm Circuit and Runlight Terminals



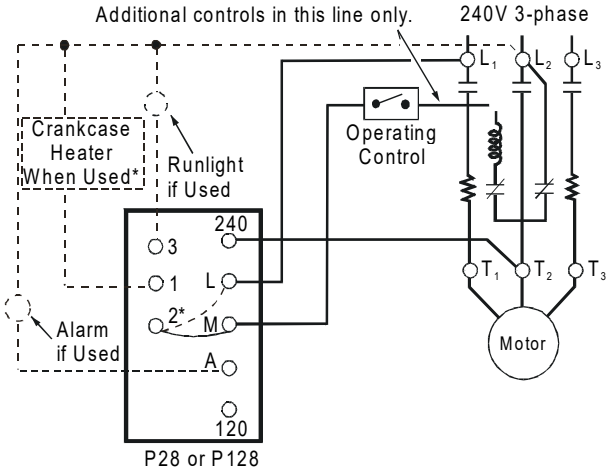
*Crankcase heater cannot be cycled with this hookup. See Figure 5.

Figure 4: P28 or P128 Used on a 240V System with 240V Magnetic Starter Coil



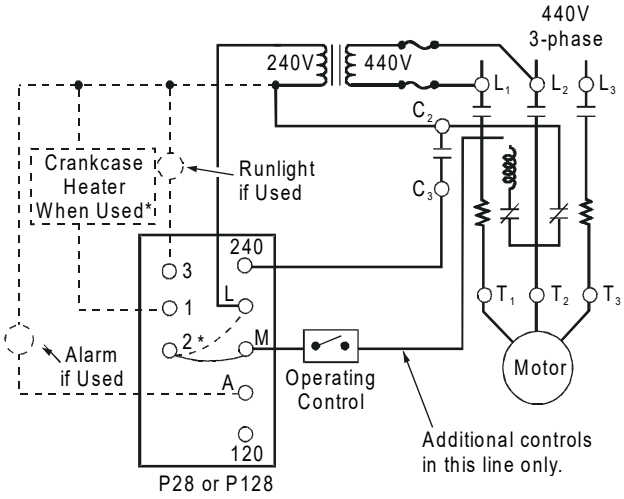
*When crankcase heater is used, disconnect jumper from 2 to M and reconnect from 2 to L.

Figure 6: P28 or P128 Where Separate Supply is Provided for Control Circuit (Jumper between 2 and M [or L] must be field installed.)



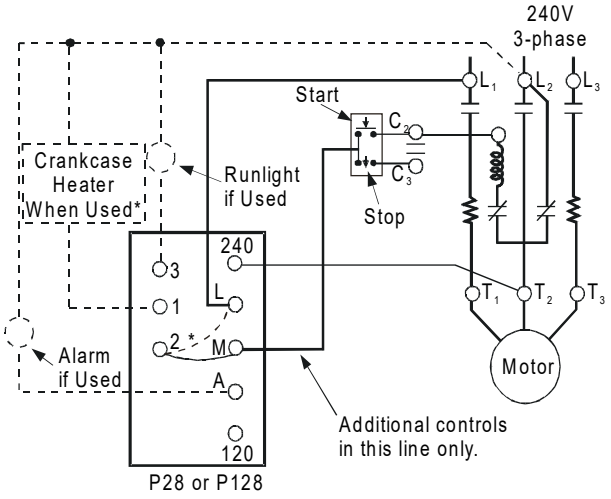
*When crankcase heater is used, disconnect jumper from 2 to M and reconnect from 2 to L.

Figure 5: P28 or P128 Wired for 3-wire Control (Jumper between 2 and M [or L] must be field installed.)



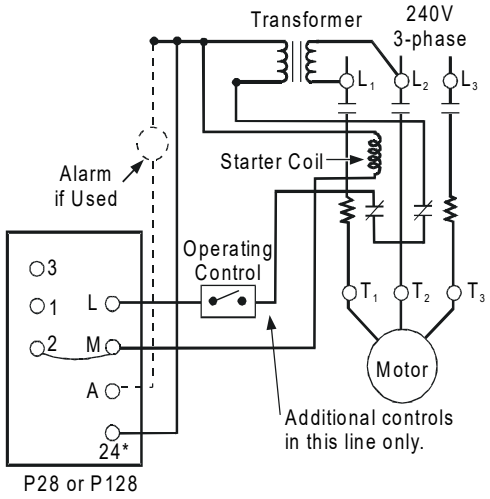
*When crankcase heater is used, disconnect jumper 2 to M and reconnect 2 to L. Also, make sure that control circuit transformer has sufficient output for additional load.

Figure 7: P28 or P128 Wired for 440V Supply and 240V Magnetic Start Coil (Also for 550V Using Proper Transformer) (Jumper between 2 and M [or L] must be field installed.)



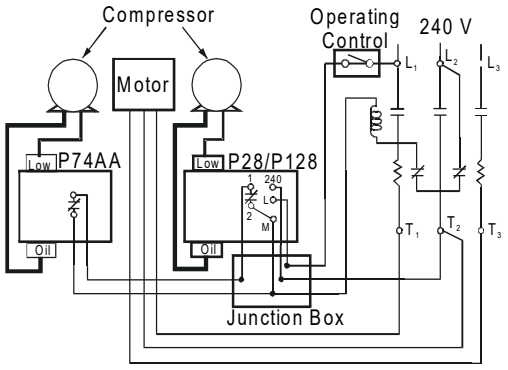
*When crankcase heater is used, disconnect jumper from 2 to M and reconnect 2 to L.

Figure 8: P28 or P128 Where Manual "Start-Stop" Pushbutton Station is Used (Jumper between 2 and M [or L] must be field installed.)



*12 volt also available.

Figure 9: P28 or P128 Where 24V Control Circuit Power is from a Step-down Transformer (Jumper between 2 and M must be field installed.)



Note: This system would provide shutdown on low lube oil pressure in either of two compressors operated by the common motor.

Figure 10: P28 or P128 and P74AA Wired for an Oil Pressure Control System Where One Motor Operates Two Compressors

Adjustments

The P28 and P128 controls are shipped with a cut-out pressure differential of 9 psi (62 kPa). However, the controls can be adjusted according to the compressor manufacturer's specifications.

Note: When the controls are shipped as an accessory to the compressor unit, time delay and cut-out pressure are set to manufacturer's specifications. Replacement controls should duplicate the manufacturer's specifications.

CAUTION: **Equipment damage hazard.** To avoid damage to the compressor, obtain the compressor manufacturer's net oil bearing pressure specifications as soon as possible. If necessary, reset the cut-out pressure difference to the manufacturer's specifications.

When the manufacturer's specifications are not known, proceed as follows to set the cut-out pressure differential:

1. With the compressor running, read the oil pressure and the crankcase pressure.

2. Subtract the crankcase pressure reading from the oil pressure pump discharge reading. This is the net oil pressure to the bearings.

3. Set the cut-out pointer 6 to 8 psi (41 to 55 kPa) below the established running net oil pressure with the Adjusting Disk using a standard screwdriver.

   To increase the cut-out pressure, turn the Adjusting Disk counterclockwise. To decrease, turn clockwise.

   To raise the pressure differential, turn the Adjusting Disk (see Figure 2) to the left when viewing the front of the control. Turn the adjusting disk to the right to lower the pressure differential.

Test for Shutdown

Immediately after installing, and at regular intervals thereafter, the time delay relay should be tested to verify that all circuits are operating correctly.

> ⚠ WARNING: **Shock hazard.** Disconnect power from the control before testing for shutdown to avoid electrical shock or damage to the equipment.

To test for shutdown:

1. Remove power from the control and remove the control cover.

2. Connect a jumper between Terminals 1 and 2. See Figure 3 for terminal locations.

   Note: If the control is mounted on a condensing unit where air from auxiliary equipment (blowers or fans) may strike the control, the control cover should be replaced before proceeding to Step 3.

3. Apply power to start the compressor. The time delay relay should trip after the time interval and stop the compressor.

4. Remove power from the control and remove the jumper between Terminals 1 and 2.

5. Replace the cover on the control and apply power.

6. Manually reset the time delay relay if required.

Checkout Procedure

Before leaving the installation, observe at least three complete operating cycles to be sure that all components are functioning correctly.

Fungus Proofing

Fungus proofing can be supplied at extra cost when specified. Conforms to government specifications MIL-V-173A.

Repairs and Replacement

Field repairs must not be made, except for replacement of the time delay relay assembly. For a replacement control or time delay relay assembly, contact the nearest Johnson Controls representative or Refrigeration Application Engineering at 414-274-5535.

Table 3: Replacement Time Delay Relay Assemblies

Part Number	Voltage	Reset Type	Timing in Seconds	Alarm Circuit
RLY13A-600R	120/240 VAC	Manual	60	No
RLY13A-602R	120/240 VAC	Manual	90	No
RLY13A-603R	120/240 VAC	Manual	90	Yes
RLY13A-608R	120/240 VAC	Automatic	90	No
RLY13A-609R	24 VAC/VDC	Manual	120	No
RLY13A-610R	120/240 VAC	Manual	30	No
RLY13A-616R	120/240 VAC	Manual	120	No
RLY13A-617R	120/240 VAC	Manual	45	No

Ordering Information

Table 4: Ordering Information

Series Part Number	Pressure Connections*	Reset Type	Refrigerant	Time Delay Relay Voltage	Alarm Terminal	Runlight Terminal
P28AA	Style 13, Style 5, or Style 15	Manual	Non-corrosive All-range	120/240 VAC	No	No
P128AA	Style 5	Manual	Non-corrosive All-range	120/240 VAC	No	No
P28AN	Style 15	Manual	Ammonia	120/240 VAC	No	No
P28DA	Style 13	Manual	Non-corrosive All-range	120/240 VAC	Yes	Yes
P28DN	Style 15	Manual	Ammonia	120/240 VAC	Yes	Yes
P28GA	Style 13	Automatic	Non-corrosive All-range	120/240 VAC	No	No
P28NA	Style 13 or Style 5	Manual	Non-corrosive All-range	24 VAC/VDC	No	No
P28PA	Style 5	Manual	Non-corrosive All-range	24 VAC/VDC	No	No

* Style 5 connections are 1/4 in. / 6.4 mm SAE male flare connectors (no capillary tubing). Style 13 connections are 36 in. / 914 mm capillary tubing and 1/4 in. / 6.4 mm flare nut. Style 15 connections are 1/4 in. / 6.4 mm female National Pipe Thread connectors.

Specifications

Product	P28 and P128 Series Lube Oil Controls with Built-in Time Delay Relay
Power Requirements	See Tables 1 and 2.
Pressure Specifications	Adjustable Cut-out Pressure Difference: 8 to 70 psi (55 to 483 kPa)* Maximum Differential: 70 psi (483 kPa) Maximum Working Pressure: 250 psig (1724 kPa) on the high side Maximum Overpressure: 325 psi (2240 kPa) oil and low side pressure **The time delay relay is de-energized 3 to 5 psi (21 to 34 kPa) above the cut-out scale setting.*
Pressure Switch Units	Enclosed Dust-protected Pennswitch
Ambient Operating Conditions	32 to 104°F / 0 to 40°C
Material	Case: 0.062 in. / 1.6 mm Galvanized Steel Cover: 0.028 in. / 0.7 mm Cold Rolled Steel (plated and painted)
Mounting	Flat Surface or with a Universal Mounting Bracket (Part No. 271-51)
Wiring Terminal	Large 8-32 x 1/4 in. Binder Head Screws
Agency Listings	UL Guide No. SDFY; File SA516** CSA Class No. 1222 01; File LR948** ***Most models. Contact Johnson Controls for a complete listing.*
Dimensions (H x W x D)	5.66 x 5.32 x 2.09 in. / 144 x 135 x 53 mm
Shipping Weight	3.0 lb / 1.36 kg

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult the local Johnson Controls Refrigeration Application Engineering at (414) 274-5535. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

JOHNSON CONTROLS

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FAN 125
Master Catalog
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Appendix G
PENN P70, P72, and P170 Series Controls for High Pressure Applications

Master Catalog 125
Pressure Controls Section **P**
Product/Technical Bulletin P70
Issue Date 0318

P70, P72, and P170 Controls for High Pressure Applications

The P70, P72, and P170 controls for high pressure applications are designed primarily for high pressure cut-out control, head-pressure control, and condenser fan cycling control on commercial refrigeration and air conditioning applications. Some models are UL® (Underwriters Laboratories) Listed as refrigeration pressure limiting controls.

Controls are available in several pressure ranges and are compatible with most common refrigerants. They may also be used on other non-corrosive fluid applications. Ammonia compatible models are also available.

Several different electrical ratings and switch configurations are available. The P72 models provide direct control of 208-240 volt single-phase motors up to 3 hp, and 208-220 volt 3-phase motors up to 5 hp.

Figure 1: P70CA-2 High Pressure Cutout Control

Features and Benefits	
❑ **All Steel Case and Cover**	Provides long lasting, rugged protection for internal components
❑ **"Sight-Set" Calibrated Pressure Adjustment**	Displays a visible pressure scale, fully adjustable through the range without removing the cover (on NEMA 1 enclosure models)
❑ **Manual Reset Lockout Option**	Provides "trip-free" lockout that cannot be overridden or reset until pressure returns to specified level
❑ **A Variety of Pressure Connection Styles Available**	Allows greater flexibility when mounting control and adapting pressure connections to field application requirements

Application

P70, P72, and P170 Series controls for high pressure applications are designed primarily to provide high-side pressure control on commercial refrigeration and air conditioning applications.

IMPORTANT:	Except for those models listed as *Refrigeration Pressure Limiting Controls*, the P70, P72, and P170 Series controls for high pressure applications are intended to control equipment under normal operating conditions. Where failure or malfunction of the P70, P72, and P170 pressure controls could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory systems) intended to warn of or protect against failure or malfunction of the P70, P72, and P170 pressure controls must be incorporated into and maintained as part of the control system.

- **P70C, P70D P170C and P170D models** with Single-Pole Single-Throw (SPST) Open-high switch action are the most popular models, and are typically used for high-pressure cutout. The **C models** are automatic reset. The **D models** have a manual reset lockout mechanism. Some **P70C, P70D P170C and P170D models** are UL Listed as refrigeration pressure limiting controls.
- **P70A and P170A models** are available with SPST Open-low switch action, and typically are used for condenser fan cycling control.
- **P70 and P170 models** with Single-Pole Double-Throw (SPDT), or 4-wire, 2-circuit switch action allow users to install alarm devices or other control circuits.
- **P72 models** have a Double-Pole Single-Throw (DPST) switch with load-carrying contacts that can provide direct control of 208-240 V single-phase motors up to 3 hp, and 208-220 V 3-phase motors up to 5 hp. Refer to Table 8.

Controls are available in several pressure ranges and are compatible with most common refrigerants. They may also be used on air, water and other non-corrosive fluid applications. Ammonia compatible models are also available.

⚠ CAUTION:	**Equipment Damage Hazard.** Ammonia is very corrosive to copper and brass components. On ammonia applications, **only** ammonia-compatible control models and pressure connections must be used. The pressure control must be mounted separately from the electrical cabinet and all electrical piping sealed to prevent ammonia from migrating to electrical components.

The **Manual Reset Lockout** mechanism does not allow the pressure control to automatically reset after the control has cut out, providing shutdown capability for unmonitored equipment. See *Manual Reset Operation.*

NEMA 1 enclosures are standard on most models. **NEMA 3R enclosures** are also available.

Operation

A pressure-actuated bellows on the control is connected to a pressure tap on the controlled equipment by a capillary or a field-installed hose (except ammonia models). The bellows responds to equipment pressure changes and operates a snap-action electrical switch.

Dimensions

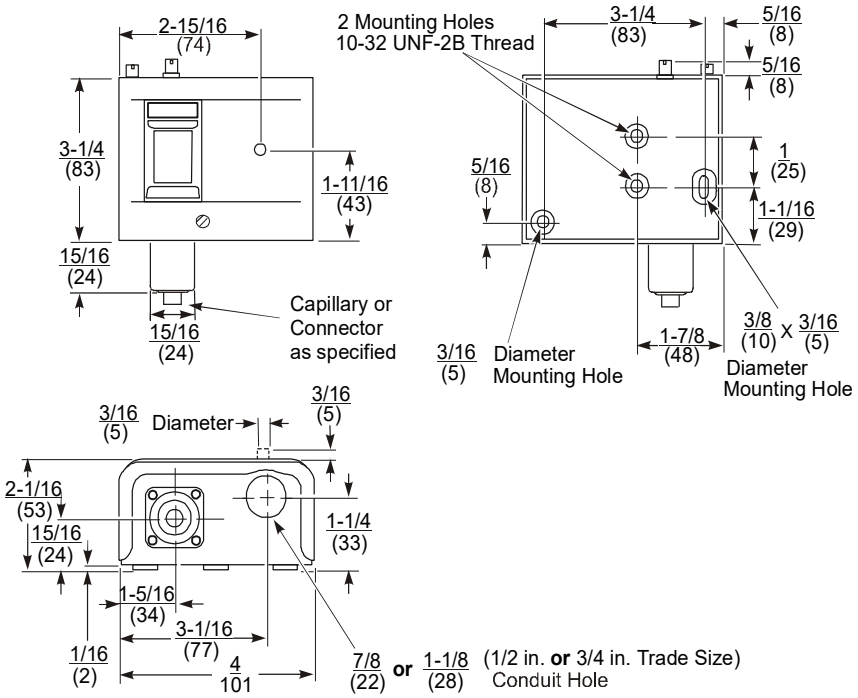


Figure 2: Dimensions for High Pressure Controls with NEMA 1 Enclosure, in. (mm)

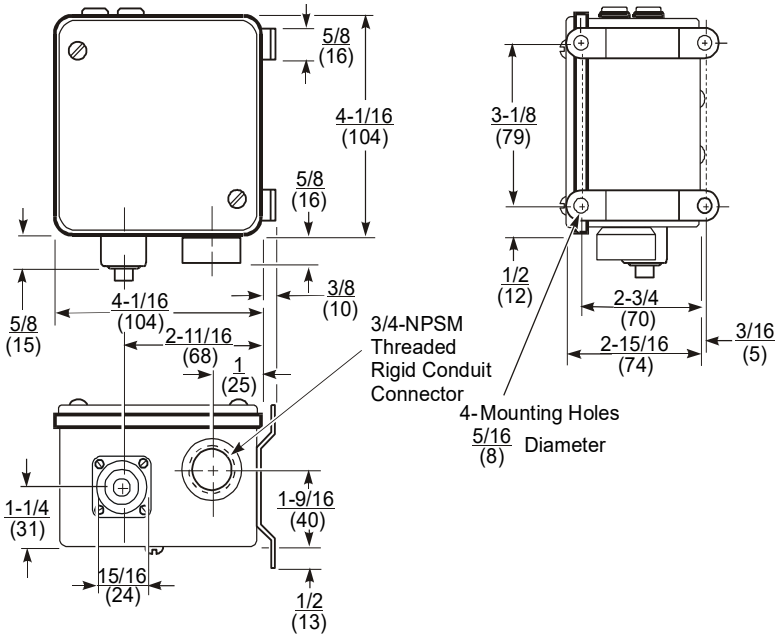


Figure 3: Dimensions for High Pressure Controls with NEMA 3R Enclosure, in. (mm)

Note: These dimensions are nominal and are subject to accepted manufacturing tolerances and application variables.

Mounting

Mount the control in an accessible position, where the control and pressure connection line will not be subject to damage.

CAUTION:	**Equipment Damage Hazard.** Mount the pressure control upright and level. Position the pressure connection line to allow drainage away from control bellows. Pressure tap points must be located on the top side of the refrigerant lines. This reduces the possibility of oil, liquids, or sediment accumulating in the bellows, which could cause control malfunction.

Controls with NEMA 1 enclosures may be mounted on flat, horizontal, or vertical surfaces.

Use two screws or bolts through the two outer holes on the back of the control case when mounting control directly to a flat vertical surface.

Use the two inner holes with the Universal Mounting Bracket (and screws supplied) when mounting the control to a flat horizontal surface.

IMPORTANT:	Use **only** the mounting screws provided with the Universal Mounting Bracket to avoid damaging internal components. Do not warp control case when mounting control to uneven surface.

Controls with NEMA 3R enclosures are designed to be mounted in a level, upright position with the bellows and conduit connection facing down. All gaskets must be in place. Mounting NEMA 3R enclosures in any position other than upright and level may trap water in the enclosure and submerge internal control components.

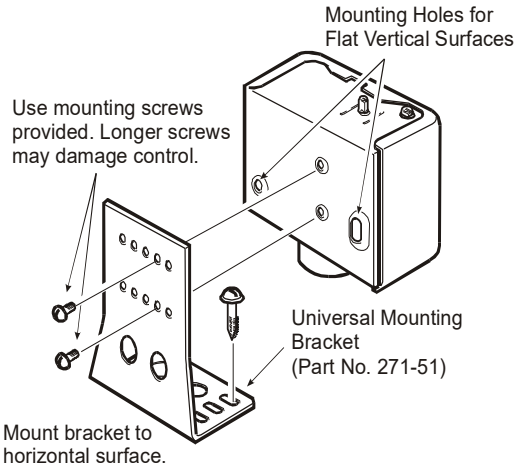


Figure 4: Mounting the P70, P72, and P170 High Pressure Control with NEMA 1 Enclosure

Pressure Connections

P70, P72, and P170 high pressure controls are connected to the controlled equipment by a capillary or flexible hose (except ammonia models). These controls are available with a variety of pressure connection styles. See Figure 10 for pressure connection styles.

Follow these guidelines when installing pressure connection lines.

IMPORTANT:	If these controls are installed on equipment that contain hazardous or regulated materials, such as refrigerants or lubricants, the installer and user should observe all regulations governing the handling and containment of those materials.

Avoid Sharp Bends in the Capillary Tube

Sharp bends can weaken or kink capillary tubes, which may result in leaks or restrictions.

Allow for Slack in the Capillary Tube

Leaving a little slack in the capillary tube helps dampen mechanical vibration that can weaken or damage capillary tubes.

Coil and Secure Excess Capillary Tubing

Carefully loop any excess capillary tubing into smooth, circular coils (approximately 3 in. diameter). Securely fasten the coiled tubing.

Avoid Contact Between the Capillary Tubing and Sharp or Abrasive Objects

Vibration of sharp or abrasive objects in contact with capillary tubes can result in leaks.

Do Not Overtighten Flare Nuts on Pressure Connection Line Fittings

Overtightening flare connections may damage the threads on the flare nuts or flare connectors, and may result in leaks. Do not exceed 9 ft-lb (12 N-m) of torque when tightening brass flare connections.

Avoid Severe Pressure Pulsation at Pressure Connections

Install pressure connection lines to pressure tap points away from the compressor, to minimize the effects of pressure pulsation from reciprocating compressors.

IMPORTANT:	After installing control, evacuate control and pressure connection lines in accordance with applicable EPA and other regulations, to remove air, moisture, and other contaminants.

Wiring

P70, P72, and P170 controls for high pressure applications are available with several switch options and electrical ratings. Check the label inside the control cover for model number, switch action, and electrical rating. (See to Table 1 for switch action and models.)

Check the wiring terminal designations on the control switch-block and refer to the following guidelines and applicable wiring diagrams, when wiring the control.

WARNING:	**Risk of Electrical Shock.** Disconnect power supply before making electrical connections to avoid possible electrical shock or equipment damage.

IMPORTANT:	Use terminal screws furnished in the switch block. Using other terminal screws will void the warranty and may damage the switch.

IMPORTANT:	Make all wiring connections in accordance with the National Electrical Code and all local regulations. Use copper conductors only. Do not exceed the control's electrical rating.

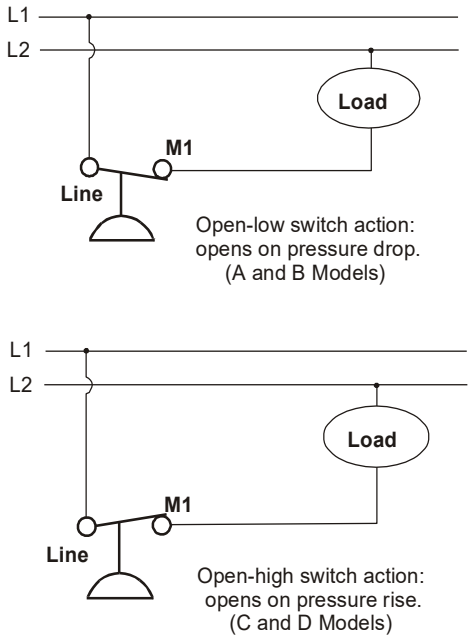


Figure 5: Typical Wiring for SPST Switch (P70A, B, C, D and P170A, C, D Models)

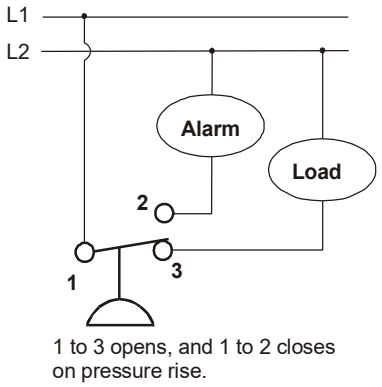
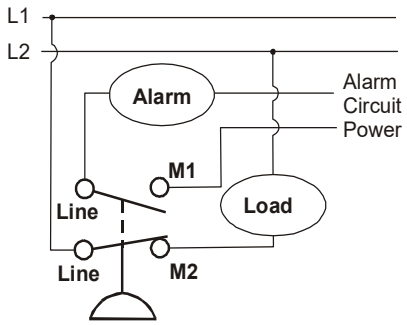
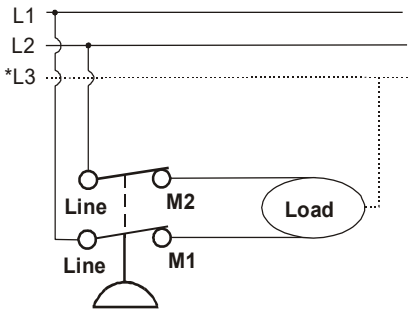


Figure 6: Typical Wiring for SPDT Switch (P70E, F Models)



Main circuit (Line to M2) opens and auxiliary circuit (Line to M1) closes on pressure rise.

Figure 7: Typical Wiring for 4-wire 2-circuit Switch used for a High Pressure Cutout Application with an Alarm Circuit (P70J, K, and P170K Models)



Line to M1, and Line to M2 open on pressure rise.

*(L3 is third supply line in 3-phase applications.)

Figure 8: Typical Wiring for DPST Switch (P72C, and D Models)

Table 1: Single Pressure Controls Switch Action, Low Event, High Event, and Models

Switch and Action	Low Event	High Event	Models
Single-Pole Single-Throw (SPST) Open-low	Cut Out (Opens Line to M1)	Cut In (Closes Line to M1)	P70A, P70B, P170A
Single-Pole Single-Throw (SPST) Open-high	Cut In (Closes Line to M1)	Cut Out (Opens Line to M1)	P70C, P70D, P170C, P170D
Single-Pole Double-Throw (SPDT)	Opens 1 to 2 and closes 1 to 3	Closes 1 to 2 and Opens 1 to 3	P70E, P70F
4-Wire, 2-Circuits, 1-NO, 1-NC Open-low	Cut Out (Opens M2 to Line and Closes M1 to Line)	Cut In (Closes M2 to Line and Opens M1 to Line)	P70G, P70H
4-Wire, 2-Circuits, 1-NO, 1-NC Open-high	Cut In (Closes M2 to Line and Opens M1 to Line)	Cut Out (Opens M2 to Line and Closes M1 to Line)	P70J, P70K, P170K
Double-Pole Single-Throw (DPST) Open-low	Cut Out (Opens M1 to Line and M2 to Line)	Cut In (Closes M1 to Line and M2 to Line)	P72A, P72B
Double-Pole Single-Throw (DPST) Open-high	Cut In (Closes M1 to Line and M2 to Line)	Cut Out (Opens M1 to Line and M2 to Line)	P72C, P72D

Adjustments

Adjustment of the P70, P72, and P170 high pressure controls vary, depending on the model. The following guidelines and diagrams illustrate the procedures for adjusting these controls. Refer to the product label inside the control cover for model number and switch action. Refer to Table 1 for switch action, low event, and high event for the various control models.

High Pressure Cutout - Automatic Reset

High pressure cutout controls with automatic reset have a scaleplate that displays the CUT IN and CUT OUT setpoints. (See the visible scale on the control.) Turning the range screw adjusts the CUT IN and CUT OUT setpoints up or down simultaneously, while maintaining a constant pressure differential. Turning the differential screw adjusts only the low event on the left side of the scale, and changes the pressure differential between the CUT IN and CUT OUT pressures.

High Pressure Cutout - Manual Reset Lockout

High pressure cutout controls with the Manual Reset Lockout option have a scaleplate that displays the CUT OUT setpoint. There is no pointer for the CUT IN setpoint. (See the visible scale on the control.)

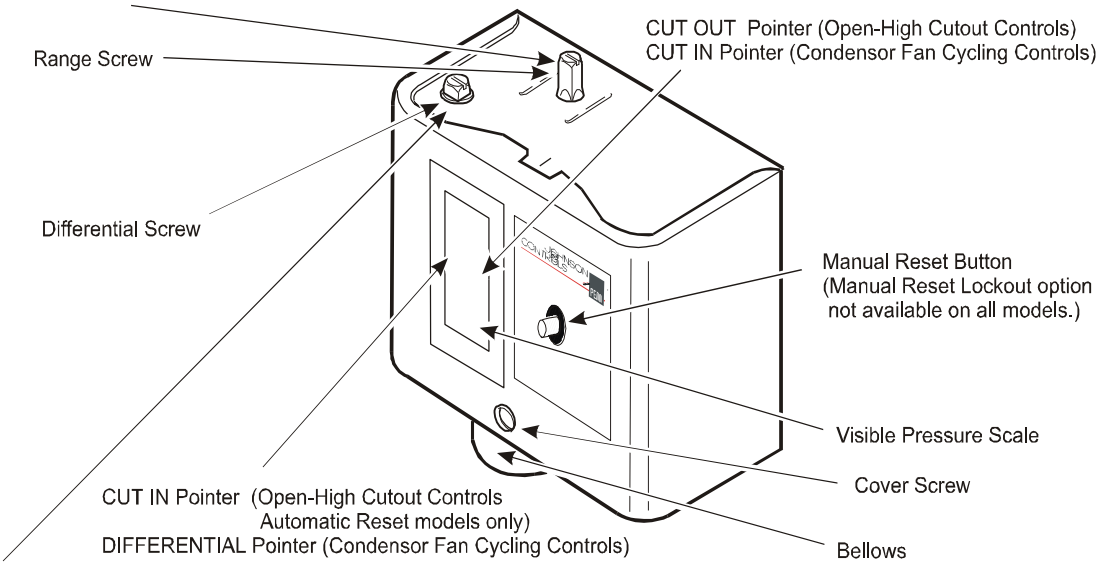
Turning the range screw adjusts the CUT OUT setpoint on the right side of the scale. There is no differential screw on Manual Reset Lockout models.

Condenser Fan Cycling - Open-low Switch Action

Condenser fan cycling pressure controls have a scaleplate that displays the CUT IN setpoint and DIFFERENTIAL setting. (See visible scale on the control.) Turning the range screw adjusts the CUT IN setpoint on the right side of the scale. Turning the differential screw adjusts the DIFFERENTIAL setting on the left side, which changes the resulting cutout pressure.

IMPORTANT:	Do not adjust pointers beyond the highest or lowest indicator marks on the control's pressure scale. Adjusting pointers beyond indicator marks may damage screw threads and cause inaccurate control operation

Step 1. Set high event by adjusting range screw.
Open-High Cutout Controls: Turn screw clockwise to raise CUT OUT.
Condenser Fan Cycling Controls: Turn screw clockwise to lower CUT IN.



Step 2. Adjust the differential screw.
Open-High Cutout Controls (Automatic Reset only): Turning the differential screw changes the CUT IN setpoint. Turn screw clockwise to lower CUT IN setpoint.
Condensor Fan Cycling Controls: Turning the differential screw changes the differential setting. Turn screw clockwise to increase DIFFERENTIAL.

Figure 9: Adjusting P70, P72, and P170 Controls for High Pressure Applications

IMPORTANT:	Use the pressure control settings recommended by the manufacturer of the controlled equipment. Do not exceed the pressure ratings of the controlled equipment or any of its components when checking pressure control operation or operating the controlled equipment.

IMPORTANT:	After installing and adjusting pressure control, and before leaving installation, cycle the controlled equipment several times (at least three) at normal operating conditions. Use reliable pressure gauges to verify proper control settings and equipment operation.

Manual Reset Operation

Pressure controls with the Manual Reset option, lock out when they reach cut out pressure and must be manually reset by the user to restart the controlled equipment. The manual reset mechanism is “trip-free” and cannot be overridden by blocking or tying the reset button down.

On equipment with locked out controls, first determine and remedy the cause of the lockout, and allow the sensed pressure to drop at least 70 psig below the CUT OUT setpoint. Then, press and release the reset button on the front of the control to restore operation of the controlled equipment.

Ordering Information

P70, P72, and P170 controls for high pressure applications are available in a variety of standard and non-standard models. Table 2 lists the standard models available through most Johnson Controls/PENN Authorized Distributors.

Table 3 is a model identification matrix that depicts all the potential P70, P72, and P170 control models. Not all control models depicted in Table 3 are manufactured and available. Figure 10 illustrates the pressure connection styles available on P70, P72, and P170 control models.

Contact your Johnson Controls/PENN Authorized Representative for availability and price.

Table 2: Standard P70, P72, and P170 Controls for High Pressure Applications

Code Number	Switch Action	Range psig (kPa)	Differential psi (kPa)	Pressure Connection
Condenser Fan Cycling Controls (for Non-Corrosive Refrigerants)				
P70AA-118	SPST Open-low	100 to 400 (690 to 2758)	Minimum 35 (241) Maximum 200 (1379)	36 in. Capillary with 1/4 in. Flare Nut
P70AA-2		0 to 150 (0 to 1034)	Minimum 12 (83) Maximum 70 (482)	
P72AA-27	DPST Open-low	100 to 400 (690 to 2758)	Minimum 35 (241) Maximum 200 (1379)	
P170AA-118	SPST Open-low			1/4 in. Male Flare Connector
All Range Controls (for Non-Corrosive Refrigerants)				
P70CA-2*	SPST Open-high	50 to 500 (345 to 3448)	Minimum 60 (414) Maximum 150 (1034)	1/4 in. Male Flare Connector
P70CA-3*				36 in. Capillary with 1/4 in. Flare Nut
P70DA-1*			Manual Reset Lockout	
P70KA-1	4-wire, 2-circuit Line-M1 Close-high Line-M2 Open-high			
P72CA-2*	DPST Open-high		Minimum 60 (414) Maximum 150 (1034)	
P72DA-1*			Manual Reset Lockout	
P170CA-3*	SPST Open-high		Minimum 60 (414) Maximum 150 (1034)	1/4 in. Male Flare Connector
P170DA-1*			Manual Reset Lockout	
P170KA-1	4-wire, 2-circuit Line-M1 Close-high Line-M2 Open-high			
Ammonia Compatible Models				
P70AA-119	SPST Open Low	50 to 300 (345 to 2068)	Minimum 20 (138) Maximum 120 (827)	1/4 in. SS Female NPT
P70CA-5*	SPST Open-high	50 to 500 (345 to 3448)	Minimum 60 (414) Maximum 150 (1034)	
P70DA-2*			Lockout (requires manual reset)	

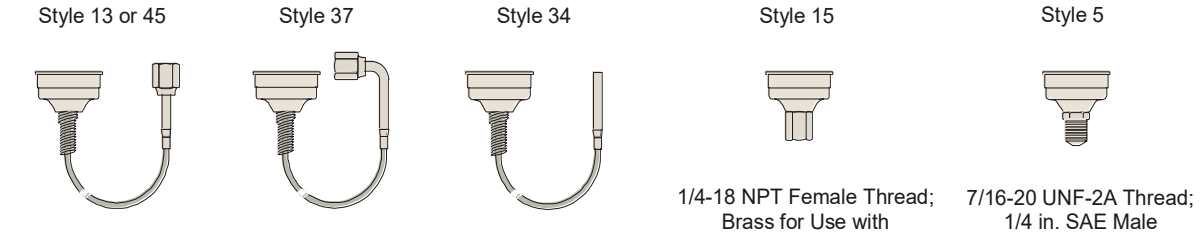
*Models (Code Number) that are UL Listed as refrigeration pressure limiting controls.

Note: See *Dimensions* and *Specifications* for additional model information including Maximum Working Pressure and Maximum Over-pressure ratings.

Table 3: P70, P72, and P170 Single Pressure Control Identification Chart

P70	Various pressure connection styles available on many models (See Figure 10.)		
P170	1/4 in. male flare pressure connection only (Style 5, see Figure 10.)		
P72	DPST switch only, 3/4 in. conduit opening on most models, (E, F, G, H, J, and K, models not available)		
	A	SPST switch (DPST in P72), Open-low, automatic reset	
	B	SPST switch (DPST in P72), Open-low, manual reset lockout	
	C	SPST switch (DPST in P72), Open-high, automatic reset	
	D	SPST switch (DPST in P72), Open-high, manual reset lockout	
	E	1 hp SPDT switch (n/a in P72), automatic reset	
	F	1/4 hp SPDT switch (n/a in P72), automatic reset	
	G	4-wire, 2-circuit switch (n/a in P72), main switch Open-low, automatic reset	
	H	4-wire, 2-circuit switch (n/a in P72), main switch Open-low, manual reset lockout	
	J	4-wire, 2-circuit switch (n/a in P72), main switch Open-high, automatic reset	
	K	4-wire, 2-circuit switch (n/a in P72), main switch Open-high, manual reset lockout	
		A	NEMA 1 enclosure, no adjustment knob
		B	NEMA 1 enclosure, with adjustment knob
		C	No enclosure, no adjustment knob
		D	No enclosure, with adjustment knob
		E	NEMA 3R enclosure, no adjustment knob
		G	NEMA 3R enclosure, no adjustment knob, 1/2 in. conduit
		H	NEMA 1 enclosure, no adjustment knob, 1/4 in. quick connects
		J	NEMA 1 enclosure with adjustment knob, 1/4 in. quick connects
		N	NEMA 1 enclosure no adjustment knob, transportation application
		P	NEMA 1 enclosure with adjustment knob, transportation application
		S	NEMA 3R enclosure, no adjustment knob, transportation application

Note: Not all combinations shown on this chart are available. To verify product availability and for quantity orders of non-standard items, please contact Refrigeration Application Engineering at (414) 524-5535.



*Note: Style 5, 1/4 in. SAE Male Flare Connector may require a copper flare saver gasket, which must be purchased separately.

Figure10: Pressure Connections Styles Available on P70, P72, and P170 Controls

Electrical Ratings

Table 4: SPST Electrical Ratings (P70A, B, C, and D, and P170A, C, and D Models)

	Standard Single-Phase Ratings			Hermetic Compressor Single-Phase Ratings
	120 VAC	208 VAC	240 VAC	208/240 VAC
Motor Horsepower	1.5	3	3	--
Motor Full-Load Amperes	20	18.7	17	20
Motor Locked-Rotor Amperes	120	112.2	102	120
Non-Inductive Amperes	22	22	22	--
Pilot Duty	125 VA at 120 to 600VAC; 57.5 VA at 120 to 300 VDC			

Table 5: SPDT Electrical Ratings 1hp Switch (P70E Models)

	Standard Single-Phase Ratings			
	120 VAC	208 VAC	240 VAC	277 VAC*
Motor Full Load Amperes	16.0	9.2	8.0	7.0
Motor Locked Rotor Amperes	96.0	55.2	48.0	42.0
Non-Inductive Amperes	16.0	9.2	8.0	--
Pilot Duty	125 VA at 120 to 600 VAC			125 VA at 24 to 600 VAC

* Rating for P70EC models only.

Table 6: SPDT Electrical Ratings 1/4 hp Switch (P70F Models)

	Standard Single-Phase Ratings		
	120 VAC	208 VAC	240 VAC
Motor Full Load Amperes	6.0	3.3	3.0
Motor Locked Rotor Amperes	36.0	19.8	18.0
Non-Inductive Amperes	6.0	6.0	6.0
Pilot Duty	125 VA at 24 to 240 VAC		

Table 7: 4-wire, 2-circuit Electrical Ratings (P70G, H, J, and K, and P170K Models)

	Standard Single-Phase Ratings							
	Line-M2 (Main Contacts)				Line-M1 (Auxiliary Contacts)			
	120 VAC	208 VAC	240 VAC	277 VAC	120 VAC	208 VAC	240 VAC	277 VAC
Motor Full Load Amperes	16.0	9.2	8.0	--	6.0	3.3	3.0	--
Motor Locked Rotor Amperes	96.0	55.2	48.0	--	36.0	19.8	18.0	--
Non-Inductive Amperes	16.0	9.2	8.0	7.2	6.0	6.0	6.0	6.0
Pilot Duty (for both sets of contacts)	125 VA at 24 to 600 VAC; 57.5 VA at 120 to 300 VDC							

Table 8: DPST Electrical Ratings (P72A, B, C, and D Models)

	Standard Ratings					Hermetic Compressor Ratings	
	120 VAC 1Ø	208 VAC 1Ø	240 VAC 1Ø	208 VAC 3Ø	220 VAC 3Ø	208 VAC 1Ø	240 VAC 1Ø
Motor Horsepower	2	3	3	5	5	--	--
Motor Full-Load Amperes	24	18.7	17	15.9	15	24	24
Motor Locked-Rotor Amperes	144	112.2	102	95.4	90	144	144
AC Non-Inductive Amperes	24	24	24	24	24	--	--
DC Non-Inductive Amperes	3	0.5	0.5	0.5	0.5	--	--
Pilot Duty	125 VA at 120 to 600VAC; 57.5 VA at 120 to 300 VDC						

Specifications

Product	P70, P72, and P170 Controls for High Pressure Applications			
Switch Action	**P70, P170:** SPST; 4-wire/2-circuit; or SPDT PENN switch			**P72:** DPST
Pressure Connection	**P70, P72 Standard Models** Various connections available See Figure 10.	**P170 Standard Models** 1/4 in. SAE male flare See Figure 10.		**Ammonia Compatible Models** 1/4 in. stainless steel female NPT connection See Figure 10.
Maximum Working Pressure	For 0-150 psig range: 150 psig (1034 kPa)	For 50-300 psig range: 300 psig (2068 kPa)	For 100-400 psig range: 400 psig (2758 kPa)	For 50-500 psig range: 500 psig (3448 kPa)
Maximum Overpressure	For 0-150 psig range: 525 psig (3620 kPa)	For 50-300 psig range: 400 psig (2758 kPa)	For 100-400 psig range: 475 psig (3275 kPa)	For 50-500 psig range: 525 psig (3620 kPa)
Ambient Temperature	50 to 104°F (10 to 40°C)			
Case and Cover	NEMA 1 Enclosures: case is galvanized steel; cover is plated and painted steel. NEMA 3R Enclosures: case and cover are plated and painted steel.			
Dimensions (H x W x D)	NEMA 1 Enclosure: 3-1/4 x 4 x 2-1/16 in. (83 x 101 x 53 mm) NEMA 3R Enclosure: 4-11/16 x 4-1/16 x 2-15/16 in. (104 x 104 x 74 mm)			
Approximate Shipping Weight	Individual (NEMA 1): 2.4 lb (1.08 kg); Bulk pack (NEMA 1, multiples of 25 controls): 60 lb (27.2 kg)			
Agency Listings	For information on specific items, contact the Refrigeration Application Engineering Group at (414) 524-5535.			
Accessories	271-51 Universal Mounting Bracket (supplied with standard controls)			

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, contact the Refrigeration Application Engineering Group at (414) 524-5535. Johnson Controls shall not be liable for damages resulting from misapplication or misuse of its products.

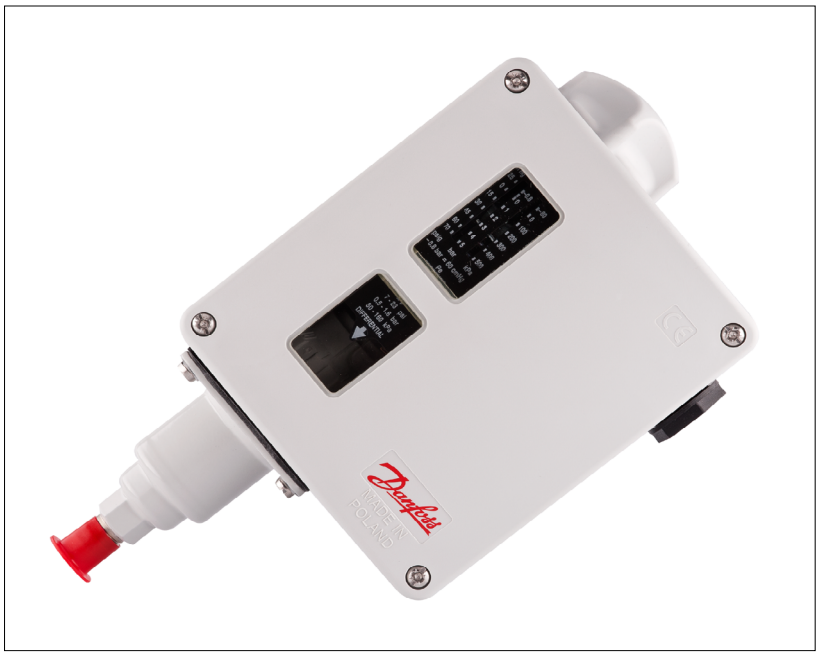
Building Technologies & Solutions
507 E. Michigan Street, Milwaukee, WI 53202

Appendix H
Danfoss Pressure Switch, Differential Pressure Switch, RT

ENGINEERING TOMORROW

Data sheet

Pressure switch, Differential pressure switch
RT



An RT pressure switch contains a pressure operated single-pole changeover contact, the position of which depends on the pressure in the inlet connection and the set scale value.
The RT series includes pressure switches for general applications within industrial and marine refrigeration.
The RT series also includes differential pressure switches, pressure switches for neutral zone regulation, and special pressure switches with gold-plated contact surfaces for PLC applications.

Features

- Versions with enclosure IP66
- Wide regulating range
- Wide range of units for industrial and marine applications
- Suitable for alternating and direct current (AC and DC)
- Interchangeable contact system
- Special versions for PLC applications
- Safety Integrity Level:
  SIL 2 according to IEC 61508

Data sheet | Pressure switch, Differential pressure switch, type RT

Approvals

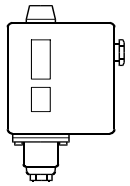
RT 1	RT 1A	RT 1AL	RT 5A	RT 6W, RT 6B, RT 6S	RT 6AW, RT 6AB, RT 6AS	RT 30AW, RT 30AB, RT 30AS	RT 36B, RT 36S	RT 117	RT 117L	RT 200	RT 200L	RT 260A	RT 262A	
•				•		•		•		•				Germanischer Lloyd, GL
								•		•				Det Norske Veritas, DNV
								•		•				Bureau Veritas, BV
•	•							•		•		•	•	Registro Italiano Navale, RINA
•	•	•	•	•	•	•	•	•	•	•	•	•	•	Russian Maritime Register of Shipping, RMRS
•	•		•					•		•				Nippon Kaiji Kyokai, NKK
								•		•		•	•	Korean Register of Shipping, KRS
•	•	•	•	•	•	•	•	•	•	•	•	•	•	CE marked according to 60947-4, -5
				•	•	•	•							CE marked acc. to PED 97/23/EC category IV, safety equipment and EN 12263
•	•	•	•	•	•	•	•	•	•	•	•	•	•	China Compulsory Certificate, CCC

Technical data

Cable connection	2 × Pg 13.5 Cable diameter 6 – 14 mm
Enclosure	IP66 to EN 60529 / IEC 529, except for versions with ext. reset which are IP54
Ambient temperature	-50 – 70 °C for pressure control housing
Switches	See “Ordering, switches” (below)
Solid / stranded	0.2 – 2.5 mm^2
Flexible, without ferrules	0.2 – 2.5 mm^2
Flexible, with ferrules	0.2 – 1.5 mm^2
Tightening torque	max. 1.5 Nm
Rated impulse voltage	4 kV
Pollution degree	3
Short circuit protection, fuse	10 Amp
Insulation	400 V

Data sheet | Pressure switch, Differential pressure switch, type RT

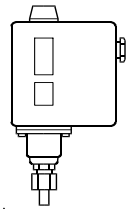
Ordering



For R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D
For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

Pressure	Type	Regulation range [bar]	Differential Δp [bar]	Reset	Max. working pressure PS [bar]	Max. test pressure P_e [bar]	Code no. Connection ¼ in flare	Code no. Connection G 3/8 A [1]
Low	RT 1	-0.8 – 5	0.5 – 1.6	Auto.	22	25	**017-524566**	–
		-0.8 – 5	0.5	Man. (Min.)	22	25	**017-524666**	–
	RT 200	0.2 – 6	0.25 – 1.2	Auto	22	25	–	**017-523766**
High	RT 117	10 – 30	1 – 4	Auto	42	47	–	**017-529566**

[1]) BSP ext. thread, ISO 228-1.



Safety – Pressure switches for
R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R507A, R717 *)
For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

Pressure	Type	Regulation range [bar]	Differential Δp [bar]	Reset	Max. working Pressure PS [bar]	Max. test pressure P_e [bar]	Code no. Connection Cutting ring ø6 mm	Code no. Connection G 3/8 A [1] + weld nipple ø6.5/10 mm
Low	RT 1A	-0.8 – 5	0.5 – 1.6	Auto	22	25	**017-501966**	**017-500166**
		-0.8 – 5	0.5	Man. (Min.)	22	25	**017-502766**	**017-500266**
		-0.8 – 5	1.3 – 2.4	Auto	22	25	–	**017-500766**
High	RT 5A	4 – 17	1.2 – 4	Auto	22	25	**017-505266**	**017-504666**
		4 – 17	1.3	Man. (Max.)	22	25	**017-506166**	**017-504766**

[1]) BSP ext. thread, ISO 228-1.
*) *Only for RT 1A, RT 5A.*

Safety pressure switches with EN 12263 approval and CE marked acc. PED (Pressure Equipment Directive) *)
R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R507A, R717 **)
For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

Pressure	Type	Regulation range [bar]	Differential (fixed) Δp [bar]	Reset [bar]	Max. working pressure PS [bar]	Max. test pressure P_e [bar]	Code no. Connection ¼ in flare	Cutting ring ø6 mm	G 3/8 A [1] + weld nipple ø6.5/10 mm	G ½ A [1]
High	RT 6W	5 – 25	3.0	Auto	34 [3]	38	017-503166	–	–	–
	RT 6B	10 – 28	1.0 [4]	Man. (Max.)	34 [3]	38	017-503466	–	–	–
	RT 6S	10 – 28	1.0 [4]	Man. (Max.)	34 [3]	38	017-507566	–	–	–
High	RT 30AW [2]	1 – 10	0.8	Auto	22	25	–	–	–	**017-518766**
	RT 30AB [2]	1 – 10	0.6 [4]	Man. (Max.)	22	25	–	–	–	**017-518866**
	RT 30AS [2]	1 – 10	0.4 [4]	Man. (Max.)	22	25	–	–	–	**017-518966**
High	RT 6AW	5 – 25	3.0	Auto	34 [3]	38	–	**017-513166**	**017-503266**	–
	RT 6AB	10 – 28	1.5 [4]	Man. (Max.)	34 [3]	38	–	**017-513366**	**017-503566**	–
	RT 6AS	10 – 28	1. 5 [4]	Man. (Max.)	34 [3]	38	–	**017-514666**	**017-507666**	–

*) Meets the requirements in VBG 20 on safety equipment and excess pressures.
W=Wächter (pressure control).
B= Begrenzer (pressure control with external reset).
S= Sicherheitsdruckbegrenzer (pressure control with internal reset).
A rupture in the bellows system of the unit will cause the compressor to stop.

**) Only for RT 6AW, RT 6AB, RT 6AS, RT 30AW, RT 30AB, RT 30AS.

[1]) BSP ext. thread, ISO 228-1.
[2]) Approved for PED also acc. to EN12953-9 and EN12922-11.
[3]) Max. working pressure acc. to PED is limited to 28 bar.
[4]) Max.

Data sheet | Pressure switch, Differential pressure switch, type RT

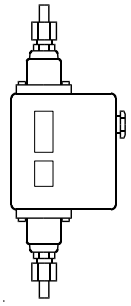
Ordering
(continued)

Pressure switches with adjustable neutral zone for
R22, R134a, R404A, R407A, R407C, R407F, R507A, R717 *)
For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

Pressure	Type	Regulation range [bar]	Differential Δp [bar]	Adjustable neutral zone NZ Δp [bar]	Max. working Pressure PS [bar]	Max. test pressure P_e [bar]	Code no.	
							Connection	
							Cutting ring ø6 mm	G 3/8 A [1] + weld nipple ø6.5/10 mm
Low	RT 1AL	-0.8 – 5	0.2	0.2 – 0.9	22	25	**017L001666**	**017L003366**
	RT 200L	0.2 – 6	0.25	0.25 – 0.7	22	25	–	**017L003266** [2]
High	RT 5AL	4 – 17	0.35	0.35 – 1.4	22	25	**017L001766** [2]	**017L004066**
	RT 117L	10 – 30	1.0	1 – 3.0	42	47	–	**017L004266** [2]

[1]) BSP ext. thread, ISO 228-1.
[2]) Without nipple.
*) Only for RT 1AL, RT 5AL.

Differential pressure switches for
R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R507A, R717
For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.



Type	Regulation range [bar]	Differential Δp [bar]	Operating range for LP bellows [bar]	Max. working Pressure PS [bar]	Max. test pressure P_e [bar]	Code no.	
						Connection	
						Cutting ring ø6 mm	G 3/8 A [1] + weld nipple ø6.5/10 mm
RT 260A	0.5 – 4	0.3	-1 – 18	22	25	**017D001466**	**017D002166**
	0.5 – 4	0.3	-1 – 18	22	25	–	**017D002266**[2])
	0.5 – 6	0.5	-1 – 36	42	47	**017D001566**	**017D002366**
	1.5 – 11	0.5	-1 – 31	42	47	**017D001666**	**017D002466**
RT 262A	0.1 – 1.5	0.1	-1 – 9	11	13	**017D001366**	**017D002566**
RT 265A [3]	1 – 6	0.5	-1 – 36	42	47	–	**017D007266**

[1]) BSP ext thread, ISO 228-1.
[2]) Man. (Max.) reset.
[3]) Filter monitor: Alarm Δp = 0.8 bar, cut-out Δp = 1 bar (factory setting).

Differential pressure switches with adjustable neutral zone for
R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R507A, R717
For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

Type	Regulation range [bar]	Differential Δp [bar]	Adjustable neutral zone NZ [bar]	Operating range for LP bellows [bar]	Max. working pressure PS [bar]	Max. test pressure P_e [bar]	Code no.
							Connection
							G 3/8 A [1] + weld nipple ø6.5/10 mm
RT 262 AL	0.1 – 1.5	0.1	0.1 – 0.33	-1 – 9	11	13	**017D004366**

[1]) BSP ext thread, ISO 228-1.

Data sheet | Pressure switch, Differential pressure switch, type RT

Ordering
(continued)

Switches [1])

Contact system versions	Contact system	Description	Contact load	Code no.
With automatic reset	 SPDT	Single-pole changeover switch with terminal board proof against leakage current. Fitted in all standard versions of type RT. Snap action changeover contacts.	Alternating current [2]) Ohmic: AC 1 = 10 A, 400 V Inductive: AC 3 = 4 A, 400 V AC 15 = 3 A, 400 V Direct current DC 13 = 12 W, 220 V	**017-403066**
With manual (max.) reset	 SPDT	For manual reset of unit after contact changeover on rising pressure. For HP units prepared for reset facility.		**017-404266**
With manual (min.) reset	 SPDT	For manual reset of unit after contact changeover on falling pressure. For LP-units prepared for reset facility.		**017-404166**
With automatic reset, gold-plated	 SPDT	Single-pole changeover switch with gold plated (oxide-free) contact surfaces. Increases cut-in reliability on alarm and monitoring systems, etc. Snap action changeover contacts. Terminal board proof against leakage current.	Alternating current [2]) Ohmic: AC 1 = 10 A, 400 V Inductive: AC 3 = 2 A, 400 V AC 15 = 1 A, 400 V Direct current DC 13 = 12 W, 220 V	**017-424066**
Cuts in two circuits simultan-eously	 SPST	Single-pole changeover switch that cuts in two circuits simultaneously on rising pressure. Snap action changeover contacts. Terminal board proof against leakage current.	Alternating current [2]) Ohmic: AC 1 = 10 A, 400 V Inductive: AC 3 = 3 A, 400 V AC 15 = 2 A, 400 V Direct current DC 13 = 12 W, 220 V [3])	**017-403466**
With non-snap action changeover contacts	 SPDT	Single-pole changeover switch with non-snap action changeover contacts.	Alternating or direct current 25 VA, 24 V	**017-018166**

[1]) RT pressure switches meet the conditions of EN 60947-2-9.
[2]) Max. starting current (L.R.) = 7 × AC 3.
[3]) If current is led through the contacts 2 and 4, i.e. terminals 2 and 4 connected but not terminal 1, the max. permissible load is increased by 90 W, 220V.

The switches are shown in the position they assume on falling pressure, i.e. after downward movement of the RT main spindle.

The setting pointer of the switch shows the scale value at which contact changeover occurs on falling pressure.

An exception is RT with switch code no. 017-404266 with Man. reset, where the setting pointer shows the scale value at which contact changeover occurs on rising pressure.

Special versions

RT can be supplied with special switches as follows.

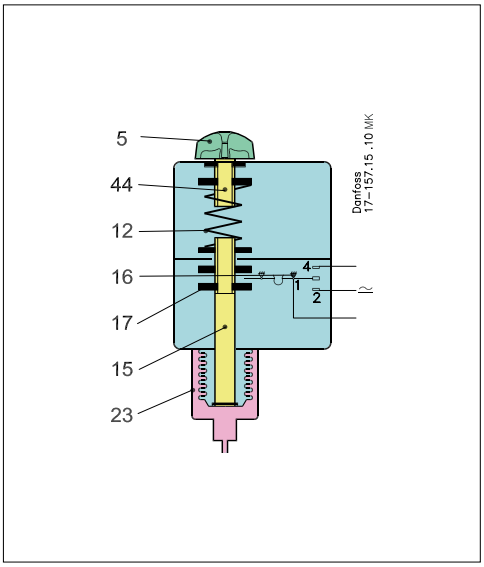
When ordering, please state:
1. Type
2. Code no. of standard unit
3. Code no. of special switch

Data sheet | Pressure switch, Differential pressure switch, type RT

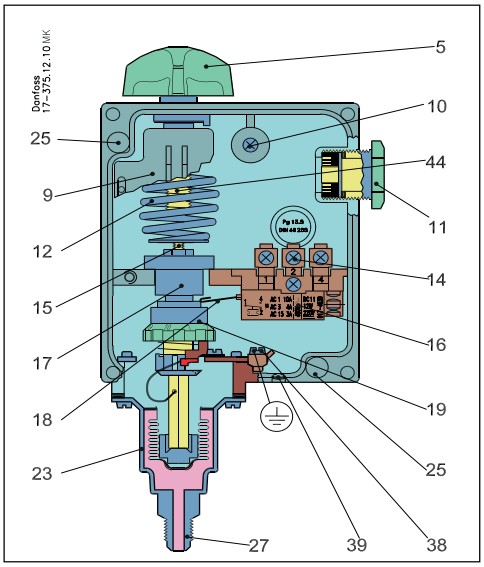
Design / Function

5. Setting knob
9. Regulation range scale
10. Loop terminal
11. Pg 13.5 screwed cable entry
12. Main spring
14. Terminals
15. Main spindle
16. Switch
17. Guide bush
18. Contact arm
19. Differential setting nut
23. Bellows element
25. Fixing hole
27. Connection
38. Earth terminal
39. Blow-out disc
44. Pressure setting spindle

Pressure switch, type RT



Pressure switch, type RT



The bellows in the RT pressure switch is connected to the low or high pressure side of the controlled system via the connection.

By turning the setting knob (5) the main spring (12) can be set to balance the pressure in the bellows.

A rise in pressure compresses the bellows and moves the main spindle (15) upwards until spring and bellows pressure are in equilibrium.
The main spindle (15) is fitted with a guide bush (17) and a differential pressure setting nut (19) that together transfer the main spindle movement to the switch (16).

The RT 6W, RT 6B, RT 6S, RT 6AW, RT 6AB, RT 6AS, RT 30AW, RT 30AB, RT 30AS, RT 36B, RT 36S are equipped with a double bellows (an outer bellows and a regulating bellows).

These units have been tested and approved by TÜV (Technischer Überwachungs Verein, Germany) according to EN 12263.

General for EN 12263 approved units.

1. The units are equipped with a double bellows system. When pressure in the plant exceeds the set value, the unit will automatically stop the plant.
   The double bellows system prevents loss of system charge in the event of bellows rupture.
2. Versions with designation W or AW cut again automatically when the pressure has fallen to the set value minus the differential.
3. Versions with designation B or AB are cut manually with the external reset button. This is possible when the pressure has fallen to the set value minus differential.
4. Versions with designation S or AS can be cut in manually with the internal reset arm when the pressure has fallen to the set value minus differential.

As laid down by EN 12263 requirements, if a rupture occurs in the regulating bellows of the unit, the refrigerating system compressor will be stopped and can only be restarted when the pressure control has been replaced.

A rupture in the outer bellows will cause the cut-out pressure of RT 36 to fall 2.5 bar, and the cut-out pressure of RT 6 and RT 30 to fall 4.5 bar under the set value. This means that the unit cuts out at normal condensing pressure and thus provides a fail-safe function.

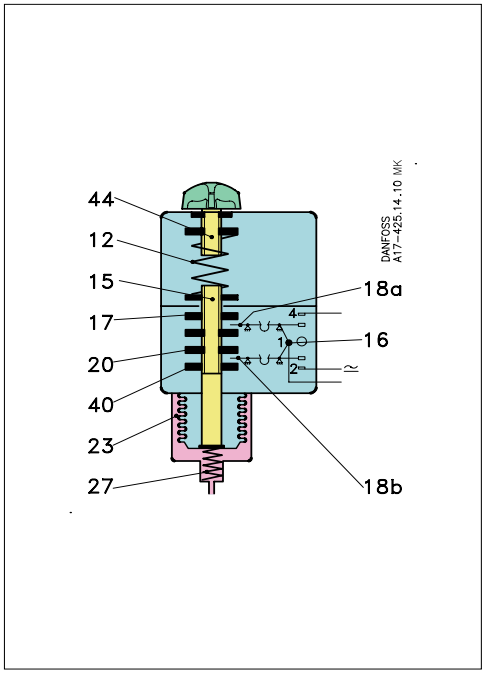
All RT pressure switches, including those which are EN 12263 approved, operate independently of changes in the ambient temperature around the control housing. Therefore the set cut-out pressure and differential are held constant provided the permissible ambient temperatures are not exceeded.

Data sheet | Pressure switch, Differential pressure switch, type RT

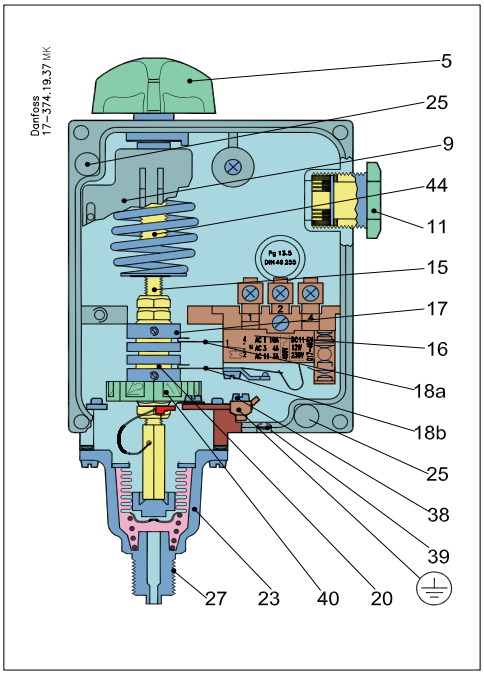
Design / Function
(continued)

5. Setting knob
9. Regulation range scale
11. Pg 13.5 screwed cable entry
12. Main spring
15. Main spindle
16. Switch
17. Upper guide bush
18. 18a, 18b. Contact arm
20. Lower guide bush
23. Bellows element
25. Fixing hole
27. Connection
38. Earth terminal
39. Blow-out disc
40. Neutral zone setting nut
44. Pressure setting spindle

Pressure switch with adjustable neutral zone, type RT L

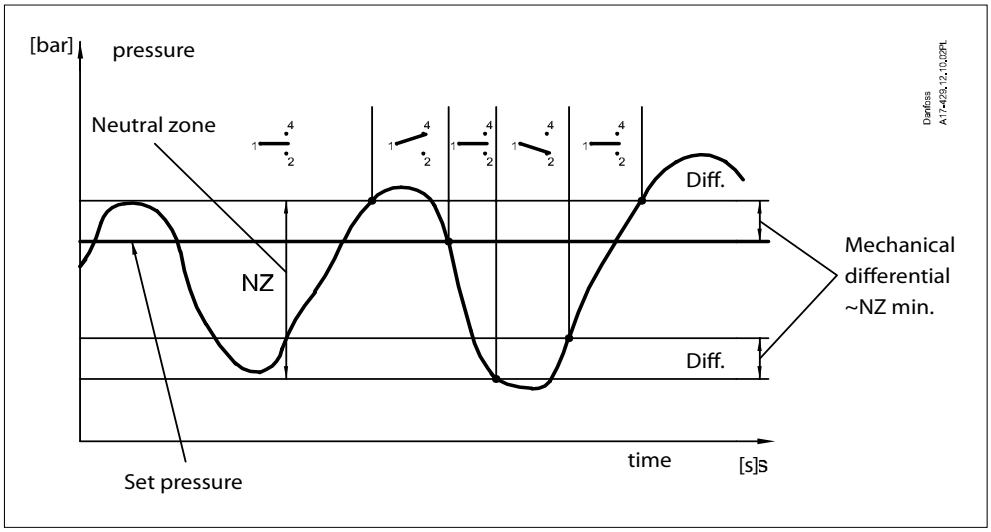


Pressure switch, type RT L



RT L pressure switches are fitted with a switch with an adjustable neutral zone. This enables the units to be used for floating control. The neutral zone switch contact arms (18a) and (18b) are operated by the spindle guide bushes (17) and (20).

The upper guide bush (17) is fixed while the lower guide bush (20) can be moved up or down by the setting nut (40). In this way the neutral zone can be varied between a minimum value (equal to the mechanical differential of the unit) and a maximum value (depending on the type of RT unit).

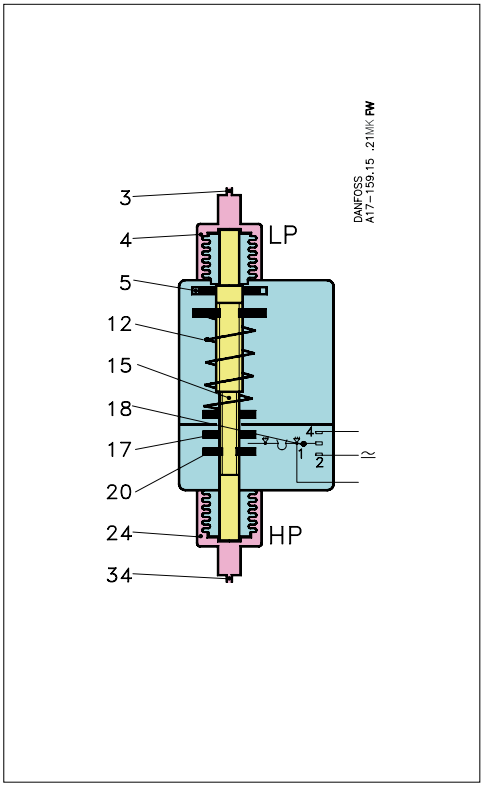


Data sheet | Pressure switch, Differential pressure switch, type RT

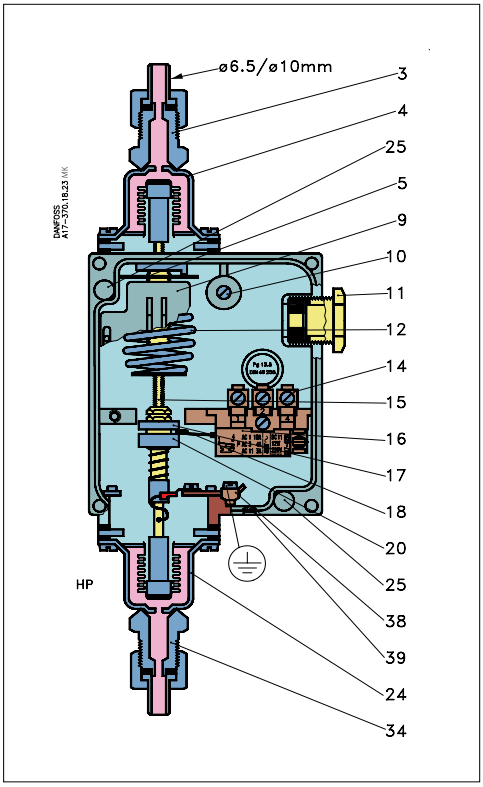
Design / Function
(continued)

3. LP connection
4. LP bellows element
5. Setting disc
9. Regulation range scale
10. Coil clamp
11. Pg 13.5 screwed cable entry
12. Main spring
14. Terminals
15. Main spindle
16. Switch
17. Upper guide bush
18. Contact arm
20. Lower guide bush
24. HP bellows element
25. Fixing hole
34. HP connection
38. Earth terminal
39. Blow-out disc

Differential pressure switch, type RT



Differential pressure switch, type RT



An RT differential pressure switch contains a single-pole changeover switch that makes or breaks depending on the pressure differential between two counteracting bellows elements (LP and HP).

Differential pressure switches are used primarily as protection against too low a differential pressure across liquid circulation pumps.
A secondary application is the safeguarding of lubricating oil pressure in refrigeration compressors.

The function of the pressure switch is conditional only on the differential pressure, i.e. the difference in pressure between the two counteracting bellows, whereas it is independent of the absolute pressure on both bellows.
The bellows (4) and (24) are respectively connected to the LP port (lowest pressure) and the HP port (highest pressure).

The main spring (12) can be set for different differential pressures by the setting disc (5).
If the differential pressure between highest and lowest pressures falls, the spindle (15) moves downwards and via the upper guide bush (17), actuates the switch contact arm (18). The reverse function occurs if the differential pressure rises.

Data sheet | Pressure switch, Differential pressure switch, type RT

Terminology

Floating control
A form of delayed control where the correcting element (e.g. valve, damper, or similar) moves towards one extreme position at a rate independent of the magnitude of the error when the error exceeds a definite positive value, and towards the opposite extreme position when the error exceeds a definite negative value.

Hunting
Periodic variations of the controlled variable from the fixed reference.

Neutral zone
The interval between the make points of the two contacts.

"Snap function"
A certain contact force is maintained until the irrevocable "snap" is initiated. The time during which the contact force approaches zero is thus limited to a very few milliseconds. Therefore contact bounce cannot occur as a result of, for example, slight vibrations, before the cut-out point.

Contact systems with "Snap function" will change over even when micro-welds are created between the contacts during cut-in. A very high force is created during cut-out to separate the contacts. This force immediately shears off all the welds. Thus the cut-out point of the unit remains very accurate and completely independent of the magnitude of the current load.

Setting

RT with automatic reset – LP
The knob is used to set the lowest pressure at which the contact system must be activated (cut-out or cut-in).
This value can be read on the main scale of the unit.
The differential roller must be used to set the differential.
Highest activating pressure = lowest activating pressure + set differential.

RT with manual reset – LP
RT pressure switches RT 1 and RT 1A are obtainable in versions with min. reset. When the pressure falls to the setting value the pressure control cuts out.

Manual reset becomes possible when the pressure in the bellows system has risen to a value corresponding to the set value + the differential.

On falling pressure the follower activates the contact system arm and the contact changes over.

The scale is calibrated so that the scale value corresponds to contact changeover on falling pressure.

RT with automatic reset – HP
The knob can be used to set the lowest pressure at which the contact system must be activated (cut-out or cut-in).
This value can be read on the main scale of the unit.
The differential must be set with the differential roller. Highest activating pressure = lowest activating pressure + set differential.

RT with manual reset – HP
Pressure switch RT 5A is obtainable with max. reset. When the pressure has risen to the set value the pressure control cuts out.

Manual reset only becomes possible when the pressure has fallen to a value corresponding to the set pressure minus the differential.

The differential roller is then used as a follower. On rising pressure the differential roller activates the contact system arm and the contact changes over.

The scale is calibrated so that the scale values correspond to contact changeover on rising pressure, which is opposite to RT units with automatic reset.

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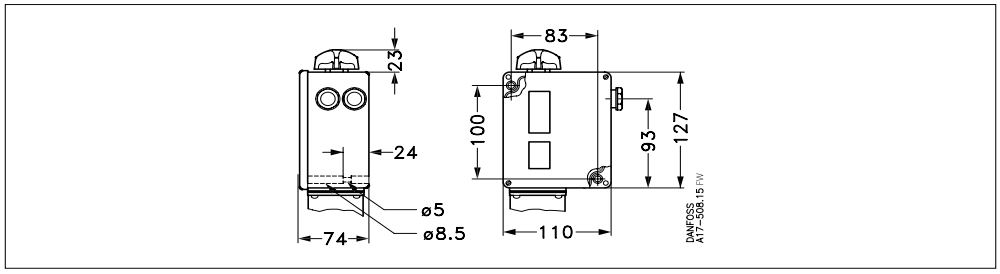
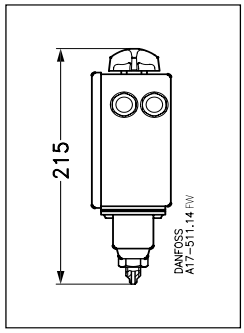
Dimensions [mm] and weight [kg]

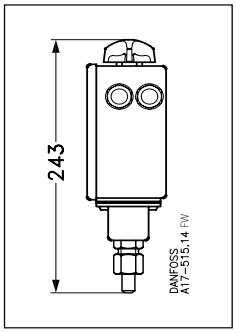
RT pressure switch housing



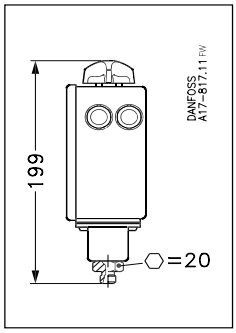
RT 1



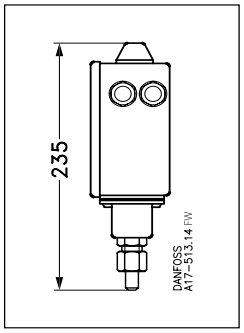
RT 1A, RT 1AL



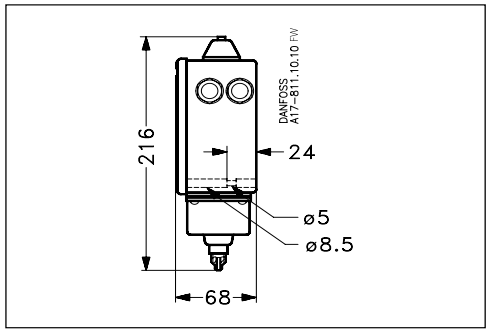
RT 1A, RT 1AL



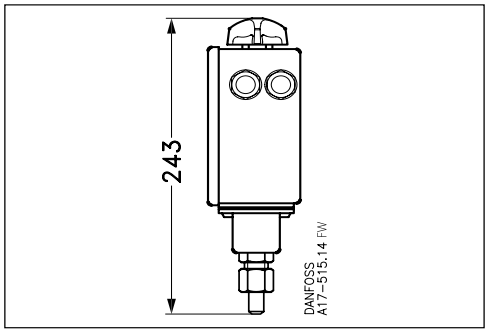
RT 6A



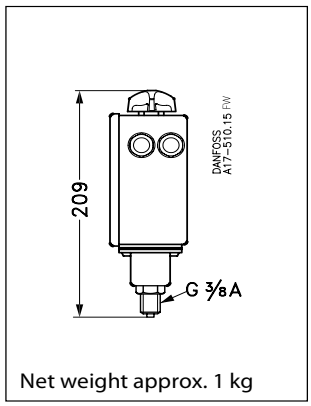
RT 6, RT 36



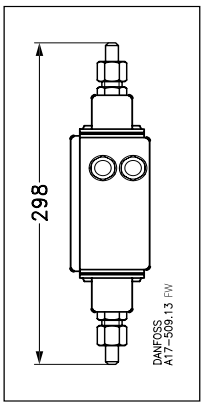
RT 30A



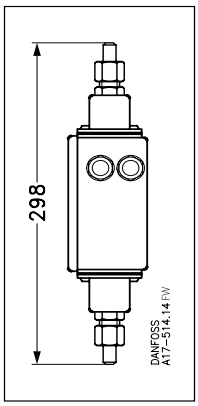
RT 117, RT 117L, RT 200, RT 200L



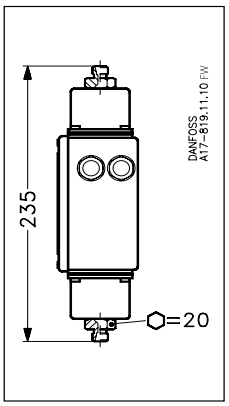
RT 260A



RT 262A



RT 260A, RT 262A



Appendix I
Danfoss Differential Pressure Switch Type MP 54, 55 and 55A

ENGINEERING TOMORROW

Data Sheet

Differential pressure switch Type **MP 54, 55** and **55A**

MP 54 and **MP 55** are used in refrigerating systems using HCFC and non-flammable HFC refrigerants.

MP 54 and MP 55 oil differential pressure switches are used as safety switches to protect refrigeration compressors against low lubricating oil pressure.

If the oil pressure fails, the oil differential pressure switch stops the compressor after a certain time period.

MP 54 and MP 55 are used in refrigerating systems using HCFC and non-flammable HFC refrigerants.

MP 55A is used in refrigerating systems with R717. MP 55A can also be used in systems with HCFC and non-flammable HFC refrigerants.

MP 54 has a fixed differential pressure setting. It also incorporates a thermal time relay with a fixed release time setting.

MP 55 and MP 55A have adjustable differential pressure and are available both with and without thermal time relay.

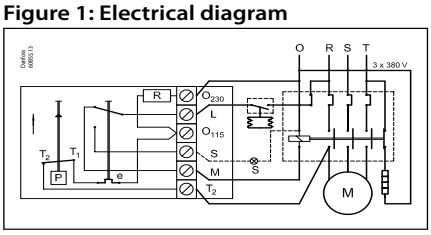
Features

- Wide regulating range
- Can be used for deep freeze, refrigeration and air conditioning plant
- Can be used for HCFC and non-flammable HFC refrigerants
- Electrical connection at the front of the unit
- Suitable for both alternating and direct current (AC and DC)
- Screwed cable entry for cables from 6 – 14 mm diameter
- Small contact differential

Differential pressure switch, Type MP 54, 55 and 55A

Functions

Figure 1: Electrical diagram



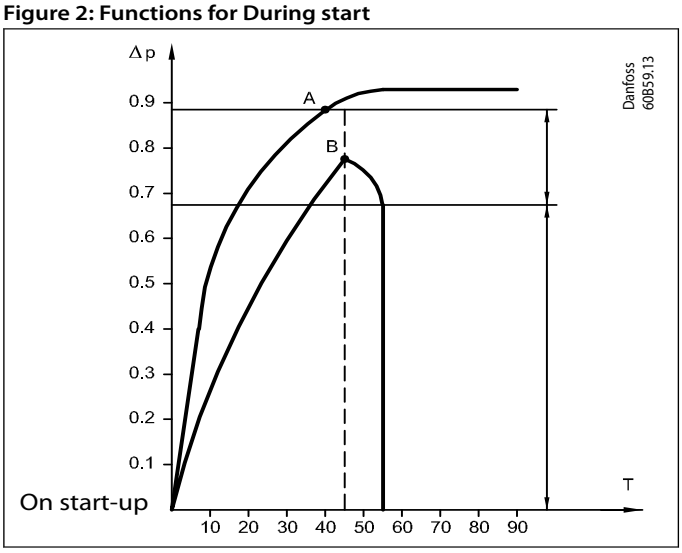
If there is no oil pressure on starting, or if the oil pressure falls below the set pressure during operation, the compressor will stop after the release time has elapsed.

The electrical circuit is divided into two completely separate circuits: a safety circuit and an operational circuit.

The timer (e) in the safety circuit is activated when the effective lubricating oil pressure, the oil differential pressure (the difference between the oil pump pressure and suction pressure), is lower than the set value.

The timer is deactivated when the oil differential pressure is more than the set value plus the contact differential.

Figure 2: Functions for During start



The two diagrams below explain the terms "oil differential pressure" and "contact differential". Both have to be considered when using oil differential pressure switches.

The first diagram shows the function of the differential switch during start; the second shows the function of the switch during operation.

Pos. A: Normal start-up

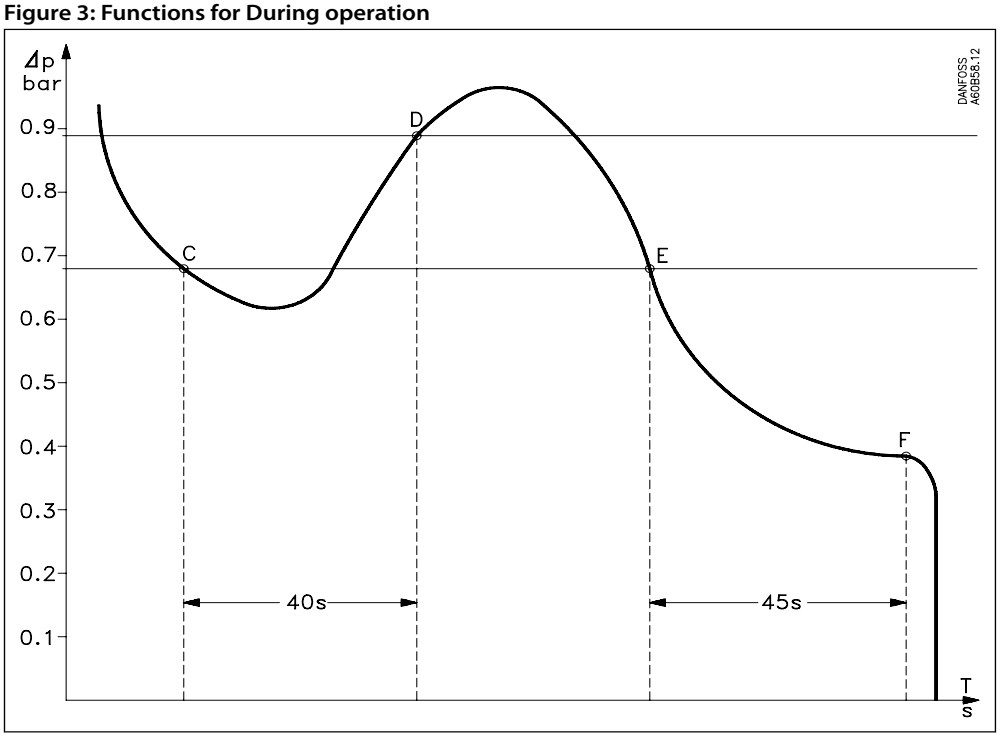
The lubricating oil pressure is built up during start to the set/fixed differential plus the contact differential, before the timer cuts out (in this example, after 45 seconds).

At point A contacts T1-T2 open and timer (e) is stopped, i.e. normal lubricating oil conditions for the compressor have been established.

Pos. B: The lubricating oil pressure does not reach the set/fixed differential plus the contact differential before the timer period elapses. At point B the timer cuts out operational circuit L-M and the compressor stops. If a signal source is connected to terminal S, it will be activated. Restart can only be performed after about 2 minutes by activation of the reset button, provided the cause of the fault has been determined.

Differential pressure switch, Type MP 54, 55 and 55A

Figure 3: Functions for During operation



Pos. C: The lubricating oil pressure falls during operation to a value lower than the set/fixed differential. At point C, safety circuit T1-T2 cuts in and the timer is activated.

Pos. D: The lubricating oil pressure reaches the set/fixed differential plus the contact differential before the timer period elapses. At point D, safety circuit T1-T2 cuts out and the timer is stopped, i.e. normal lubricating oil conditions for the compressor have been established.

Pos. E: The lubricating oil pressure falls to a value lower than the set/fixed differential during operation. At point E, safety circuit T1-T2 cuts in and the timer is activated.

Pos. F: The lubricating oil pressure remains lower than the set/fixed differential. At point F the timer cuts out operational circuit L-M and the compressor stops. If a signal source is connected to terminal S, it will be activated. Restart can only be performed after about 2 minutes by activation of the reset button, provided the cause of the fault has been determined.

After start-up

It is important that a function check should be made to ensure that the differential pressure control is operating as it should.

This check can be made by pressing the test device (inside the unit on the left hand side).

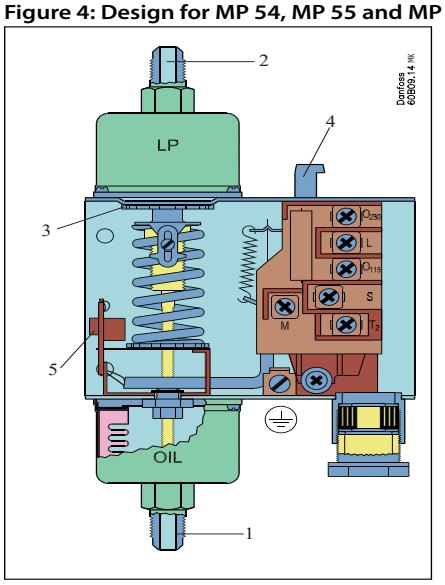
When the test device is pressed down and held in this position, the compressor motor should stop after the release time determined by the time relay has elapsed.

Differential pressure switch, Type MP 54, 55 and 55A

Product specification

Design and Materials

Figure 4: Design for MP 54, MP 55 and MP 55A



1	Connection to pressure side of lubrication system, OIL
2	Connection to suction s ide of refrigeration plant, LP
3	Setting disk (MP 55 and MP 55A)
4	Reset button
5	Test device

The operation of the pressure switch relies only on the differential pressure, i.e. the difference in pressure between the two counteracting bellows, whereas it is independent of the absolute pressure acting on both bellows.

The MP 55 and 55A can be set for different differential pressures by the setting disc (3).

The set differential pressure can be read from the internal scale.

The MP 54 has a fixed differential and has no pressure setting disc.

The factory-set differential pressure is stamped on the front plate of the switch.

Table 1: Materials in contact with the medium

Unit type	Material
MP 54 MP 55	Stainless steel 19/11, no. 1.4306 to EN 10088 Cold forming steel, no. 1.0338, EN 10139 Free cutting steel, no. 1.0718, EN 10277
MP 55A	Stainless steel 19/11, no. 1.4306 to EN 10088 Cold forming steel, no. 1.0338, EN 10139 Free cutting steel, no. 1.0401, EN 10277-2

Technical data

Table 2: Technical data for MP 54, MP 55 and MP 55A

Features	Specifications
Control voltage	230 V or 115 V AC or DC
Permissible voltage variation	-15 – 10%
Max. working pressure	PS/MWP = 17 bar
Max. test pressure	P_e = 22 bar
Ambient temperature The time relay is temperature-compensated in the range	-40 – 60 °C
Screwed cable entry	P_g 13.5
Cable diameter	6 – 14 mm
Max. bellows temperature	100 °C
Switch differential max. Δp [bar]	0.2

Differential pressure switch, Type MP 54, 55 and 55A

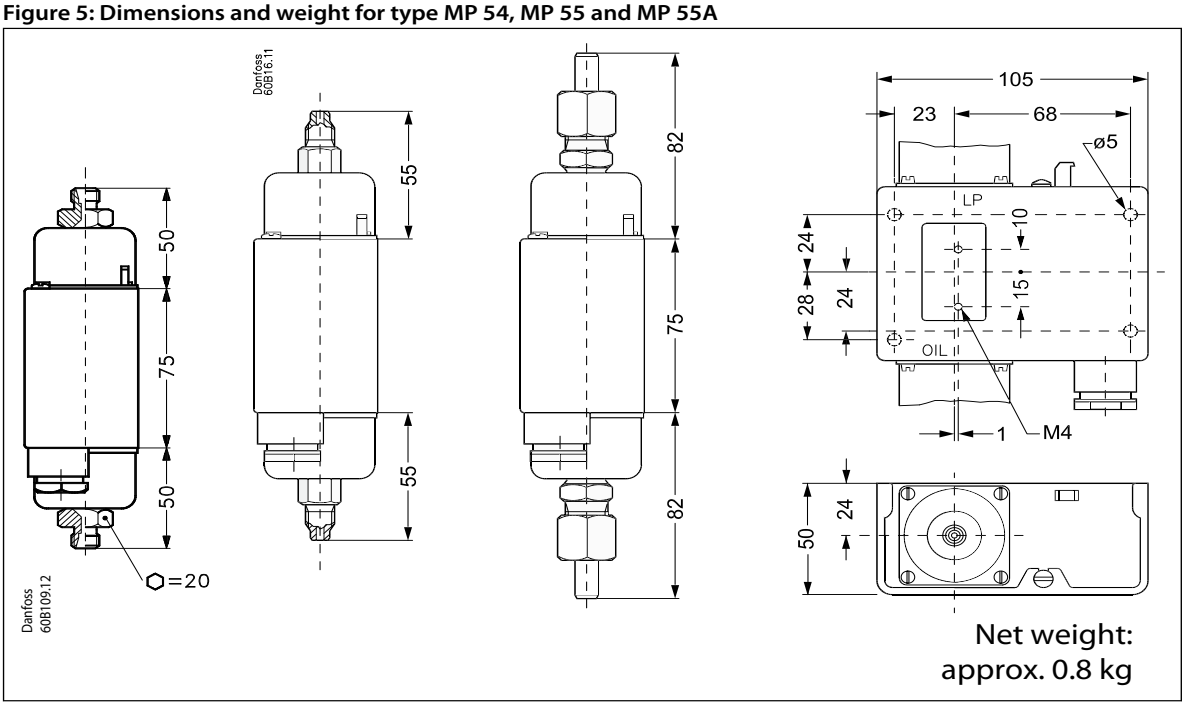
Features		Specifications
Enclosure		IP20 to EN 60529 / IEC 60529
Contact loads	MP with time relay (contacts M-S)	AC15 = 2 A, 250 V
		DC13 = 0.2 A, 250 V
	MP without time relay	AC15 = 0.1 A, 250 V
		DC13 = 12 W, 125 V
Wire dimensions	solid / stranded	0.2 – 1.5 mm^2
	flexible, without ferrules	0.2 – 1.5 mm^2
	flexible, with ferrules	0.2 – 1 mm^2
Tightening torque		max. 1.2 Nm
Rated impulse voltage		4 kV
Pollution degree		3
Short circuit protection, fuse		2 A
Insulation		250 V

Terminology

Differential range
The pressure difference between LP and OIL connections within which the switch can be set to operate.
Scale reading
The differential between the oil pump pressure and the pressure in the crankcase that exists at the moment the contact system cuts in current to the time relay on falling oil pressure.
Operating range
The pressure range on the LP connection within which the switch can operate.
Contact differential
The pressure rise above the set differential pressure (scale reading) necessary to cut off current to the time relay.
Release time
The period for which the differential pressure switch allows the compressor to run with too low an oil pressure during start-up and operation.

Dimensions and weight

Figure 5: Dimensions and weight for type MP 54, MP 55 and MP 55A



Differential pressure switch, Type MP 54, 55 and 55A

Ordering

Figure 6: MP 55E

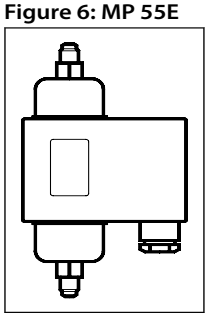


Table 3: For R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R448A, R449A, R450A, R452A, R507A, R513A

Type	Differential Δp	Operation range, LP side	Relay release time	Code no.		
				Connection		
	[bar]	[bar]	[s]	¼ in Flare	1 m cap.tube ¼ in ODF solder	M12 x 1.5 with 6 mm cutting ring
MP 54	0.65	-1 – 12	0[1]	060B029791	-	-
	0.65	-1 – 12	45	060B016691	-	-
	0.9	-1 – 12	60	060B016791	-	-
	0.65	-1 – 12	90	060B016891	-	-
	0.65	-1 – 12	120	060B016991	-	-
MP 55	0.3 – 4.5	-1 – 12	45	060B017091	060B013391	-
	0.3 – 4.5	-1 – 12	60	060B017191	-	-
	0.3 – 4.5	-1 – 12	60	060B017891 [2]	-	-
	0.3 – 4.5	-1 – 12	90	060B017291	-	-
	0.3 – 4.5	-1 – 12	120	060B017391	-	-
	0.3 – 4.5	-1 – 12	0[1]	060B029991	-	-

[1] MP without time relay. Versions without time relay are for applications where an external time relay is required – perhaps with a different release time than the one specified
[2] With glow lamp that remains on during normal operation.

Table 4: For R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R448A, R449A, R450A, R452A, R507A, R513A, R717*)

Type	Differential Δp	Operation range, LP side	Relay release time	Code no.	
				Connection	
	[bar]	[bar]	[s]	G ⅜ A supplied with ø6.5 / ø10 mm weld nipple	M12 ×1.5 with 6 mm cutting ring
MP 55A	0.3 – 4.5	-1 – 12	45	060B017491	060B018291
	0.3 – 4.5	-1 – 12	60	060B017591	060B018391
	0.3 – 4.5	-1 – 12	60	060B017991[3]	-
	0.3 – 4.5	-1 – 12	90	060B017691	060B018491
	0.3 – 4.5	-1 – 12	120	060B017791	060B018591
	0.3 – 4.5	-1 – 12	0 [4]	060B029891[4]	060B029691

[3] With glow lamp that remains on during normal operation
[4] MP without time relay. Versions without time relay are for applications where an external time relay is required – perhaps with a different release time than the one specifed

*) only for MP 55A

For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

NOTE:
If the operational light goes out, the compressor should not run longer than the release time

Differential pressure switch, Type MP 54, 55 and 55A

Certificates, declaration and approvals

The list contains all certificates, declarations, and approvals for this product type. Individual code number may have some or all of these approvals, and certain local approvals may not appear on the list.

Some approvals may change over time. You can check the most current status at danfoss.com or contact your local Danfoss representative if you have any questions.

Table 5: Certificates, declaration and approvals

Document type	Approval authority
UA declaration (EMCD/LVD)	LLC CDC EURO TYSK
EU declaration LVD	Danfoss
Manufacturer declaration for China ROHS	Danfoss
Electrical safety certificate	CCC
Marine safety certificate	DNV GL/RINA

Appendix J
Danfoss Pressure Switch Type KP

ENGINEERING TOMORROW

Data Sheet

Pressure switch Type **KP**

The KP pressure switches can be used as safety switches against too low a suction pressure and / or too high a discharge pressure in refrigeration and air conditioning systems. They can also be used to start / stop compressors and fans for air-cooled condensers.

They are available in both single and dual versions and include a single pole double throw (SPDT) switch.

Features:

- Ultra-short bounce time thanks to snap-action function (reduces wear to a minimum and increases reliability)
- Available with gold-plated contacts
- SPDT switch design Offers open or close switching action on pressure rise or fall
- Fail safe double bellows Prevent refrigerant loss and system contamination - standard on KP 7 and KP 17 pressure switches
- Convenient manual trip feature To test electrical contact function - no tools needed
- Pressure wire connectors For easy electrical wiring
- No spade or lug terminals required
- Integral 1⁄2 NPSM swivel cable connector Allows direct attachment of 1⁄2 in male pipe thread connector
- Lockplate Prevents tampering with range and differential settings
- Universal mounting hole patterns

Pressure switch, Type KP

Product specification

Technical data

Table 1: Technical data

Features	Values
Ambient temperature	-40 – 149 °F (175 °F for maximum 2 hours)
Maximum working pressure	LP: MWP = 245 psig
	HP: MWP = 465 psig
Maximum test pressure	LP: p_e = 285 psig
	HP: p_e = 510 psig
Switch	Single pole changeover switch (SPDT)
Contact load	120 V AC: 16 FLA, 96 LRA
	240 V AC: 8 FLA, 48 LRA
	240 V DC: 12 W pilot duty
Terminal D, dual switches	240 V, 50 VA

Cable entry
Integral 1⁄2 in female NPSM swivel cable connector allows direct attachment of 1⁄2 in male pipe thread connector.

Enclosure
~NEMA 1
This grade of enclosure is obtained when the units **without** top cover are mounted on a flat surface or bracket. The bracket must be fixed to the unit so that all unused holes are covered.

~ NEMA 2
This grade of enclosure is obtained when the units **with** top cover are mounted on a flat surface or bracket. The bracket must be fixed to the unit so that all unused holes are covered

Table 2: Materials in contact with the medium

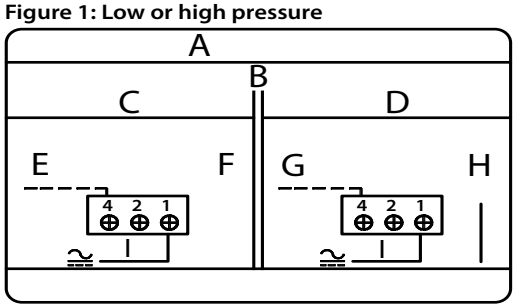
Control type	Material
KP 1, KP 2, KP 5, KP 7, KP 15, KP 17, KP 25	Tin bronze, no. CW452K, EN 1652 Nickel plated free cutting steel, no. 1.0737 / 1.0718 to EN 10277
KP with cap. tube	Copper SF-Cu, no. 2.0090 to DIN 1787

Electrical wiring

Table 3: Electrical wiring

Load	Signal option	Bellows movement on pressure rise	Bellows movement on pressure drop
			

Figure 1: Low or high pressure

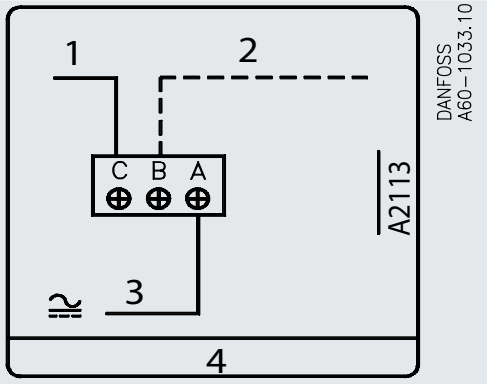


Danfoss
AK01.102.10

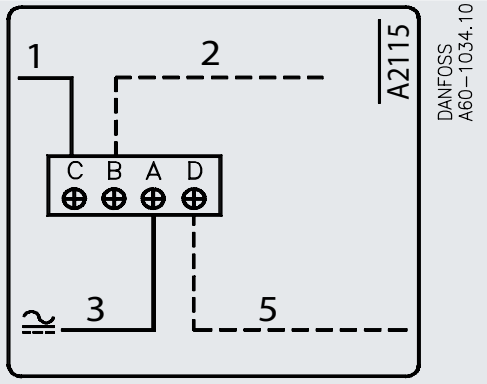
A	SPDT - signal pole double throw
B	Pressure / Temperature
C	Rise
D	Drop
E	Load Cut-in (term.1-4)
F	Load Cut-out (term.1-2)
G	Load Cut-out (term.1-4)
H	Load Cut-in (term.1-2)
I	Line

Pressure switch, Type KP

Dual (low and high) pressure, LP signal

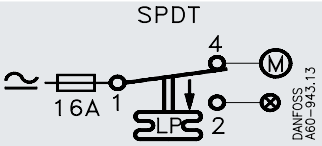


Dual (low and high) pressure, LP and HP signal

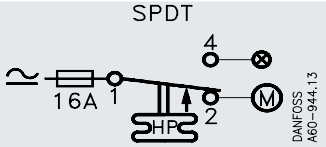


1.	Load
2.	LP - signal option
3.	Line
4.	Wiring instruction
5.	HP - signal option

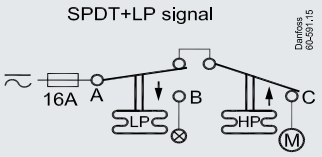
Low pressure, LP: KP 1 and KP 2



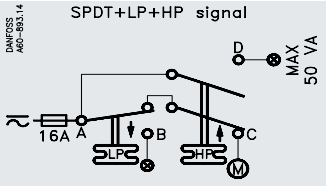
High pressure, HP: KP 5, KP 7W and KP 7B



Dual (low and high) pressure: KP 15, KP 17W, KP 17B and KP 25



Dual (low and high) pressure: KP 15, KP 17W, KP 17B and KP 25

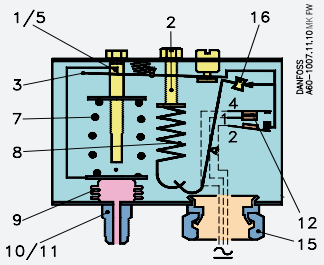
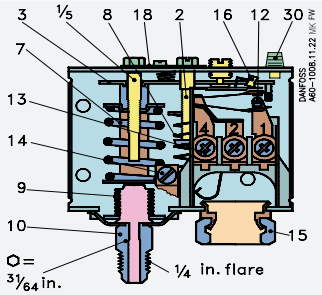
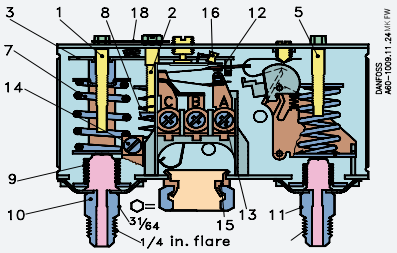
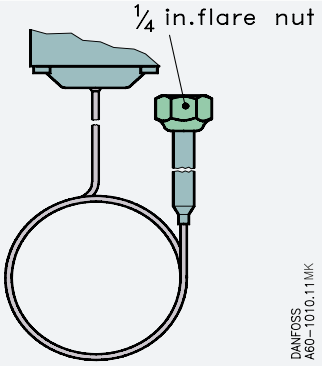


Metric conversions
1 psi = 0.07 bar
5⁄9 (t_1 °F - 32) = t_2 °C

Pressure switch, Type KP

Design

Table 4: Design

Pressure switch, type KP	KP 1, KP 2, KP 5
	
KP 15, KP 25 flare	**KP 1, KP 2, KP 5, KP 15, KP 25, KP 7W, KP 7B, KP 17W, capillary tube**
	

1.	Low pressure setting spindle, (LP)	**12.**	Switch
2.	Differential setting spindle	**13.**	Terminals
3.	Main arm	**14.**	Earth terminal
5.	High pressure setting spindle, (HP)	**15.**	Cable entry
7.	Main spring	**16.**	Tumbler
8.	Differential spring	**18.**	Locking plate
9.	Bellows	**19.**	Arm
10.	LP connection	**30.**	Reset button
11.	HP connection		

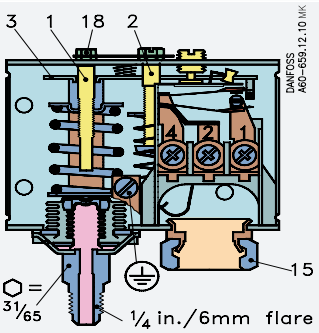
The switch in the KP has a snap-action function where the bellows move only when the cut-in or cut-out value is reached.

The bellows are connected to the low or high pressure side of the system through connection (10) or (11).

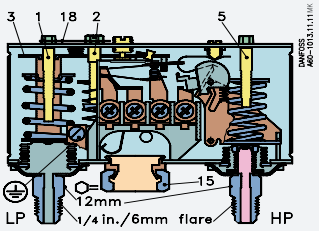
The design of the KP gives the following advantages:
- high contact load
- ultra-short bounce time
- high resistance to pulsation
- vibration resistance up to 4 g in the range 0 – 1000 Hz
- long mechanical and electrical life

Pressure switch, Type KP

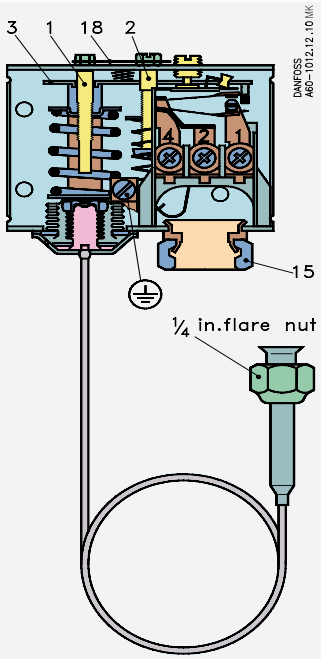
KP 7W (KP 7B), flare



KP 17W (KP 17B), flare



KP 7W (KP 7B), capillary tube



1.	Pressure setting spindle, (LP)	**5.**	Pressure setting spindle, (HP)
2.	Differential setting spindle	**15.**	Cable entry
3.	Main arm	**18.**	Locking plate

The KP with designations W or B have been tested and approved by TÜV (Germany) in accordance with EN 12263.

Versions with designation W will cut in automatically when the pressure has fallen to the setpoint minus the differential.

Versions with designation B can be cut in manually using the external reset button when:
KP 1 – the pressure has increased to 10 psi above the setpoint.
KP 7 – the pressure has fallen 58 psi below the setpoint.

KP 7 and KP 17 are equipped with fail-safe double bellows; a regulation bellows and an outer bellows. The double bellows system protects against loss of system charge in the event of a bellows rupture.

A rupture in the outer bellows will cause the control to trip approximately 43 psi lower than the actual control setting. This features provides a warning without a loss of charge.

All KP pressure switches, including those which are PED-approved, operate independently of changes in the ambient temperature around the control housing. Therefore the set cut-out pressure and differential are kept constant provided the permissible ambient temperatures are not exceeded.

Terminology

Reset
1.Manual reset: Units with manual reset can only be reset during operation by activation of the reset button.
2.Automatic reset: After operational stop, these units reset automatically.

Maximum working pressure
The Maximum working pressure is determined by the pressure that can be safely allowed in the refrigerating system or any of the units within it. The maximum working pressure is designated MWP.

Pressure switch, Type KP

Test pressure
The test pressure is the pressure used in strength tests and / or leakage tests on refrigerating systems or individual parts in systems. The test pressure is designated Pe.

"Snap function"
A certain contact force is maintained until irrevocable "snap" is initiated. The time during which the contact force approaches zero is thus limited to a very few milliseconds. Therefore contact bounce cannot occur as a result of, for example, slight vibrations, before the cut-out point. Contact systems with "Snap function" will change over even when micro-welds are created between the contacts during cut-in. A very high force is created during cut-out to separate the contacts. This force immediately shears off all the welds. Thus the cut-out point of the unit remains very accurate and completely independent of the magnitude of the current load.

Setting

Pressure switches with automatic reset – LP: Set the LP start pressure on the "CUT-IN" scale (range scale). One rotation of the low pressure spindle ~10 psi. Set the LP differential on the "DIFF" scale. One rotation of the differential spindle ~ 3 psi. The LP cut-out pressure is the LP cut-in pressure minus the differential.

NOTE:
The LP cut-out pressure must be above absolute vacuum pe = 30 in Hg. If compressor will not stop at low cut-out pressure, check whether the differential value is set at too high a value!

Metric conversions 1 psi = 0.07 bar

Pressure switches with automatic reset – HP: Set the HP cut-out pressure on the "CUT-OUT" scale. One rotation of the HP spindle ~ 33 psi. Set the HP differential on the "DIFF" scale.

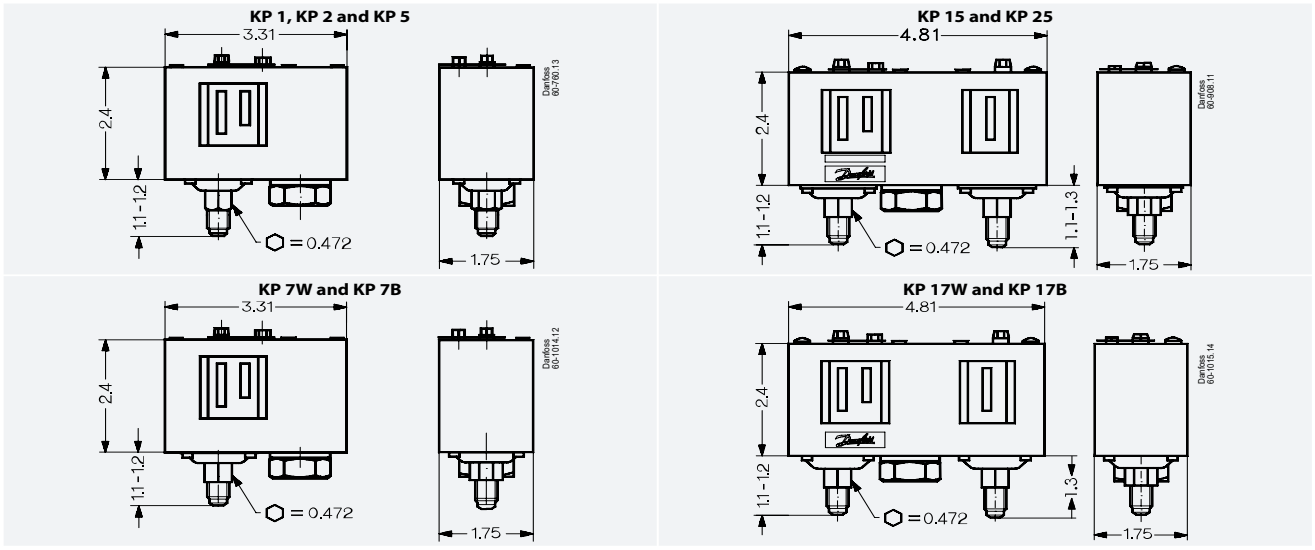
One rotation of the differential spindle ~ 4 psi. The HP cut-in pressure is the HP cut-out pressure minus the differential. Pressure switches with manual reset. Set the cut-out pressure on "CUT-OUT" scale (range scale). Low pressure controls can be manually reset when the pressure is equal to the cut-out pressure plus the differential.

High pressure switches can be manually reset when the pressure is equal to the cut-out pressure minus the differential.

Cut-in and cut-out pressures for both the LP and HP sides of the system should always be checked with an accurate pressure gauge.

Dimensions [in] and weight [lb]

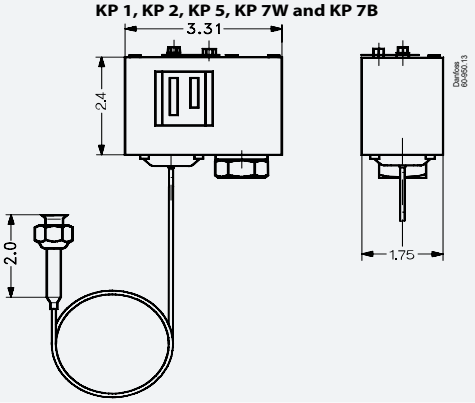
Table 5: Flare connection



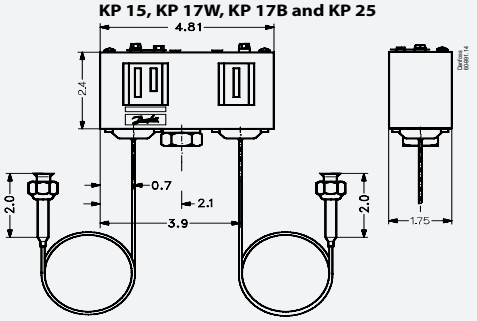
Pressure switch, Type KP

Table 6: Capillary tube connection

KP 1, KP 2, KP 5, KP 7W and KP 7B



KP 15, KP 17W, KP 17B and KP 25

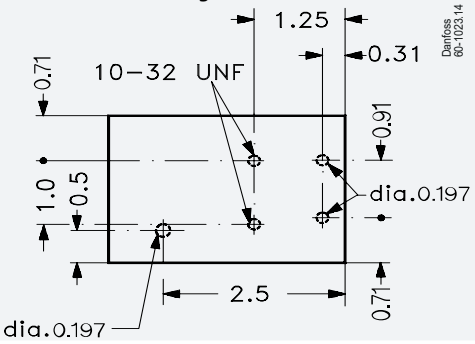


Net weight:
KP 1, KP 2, KP 5 and KP 7:
approx. 0.7 lbs.
KP 15, KP 17 and KP 25:
approx. 1.1lbs.

Metric conversions:
1 in = 25.5 mm
1 lb = 0.454 kg

Table 7: KP switches, rear side

Single switches



Dual switches

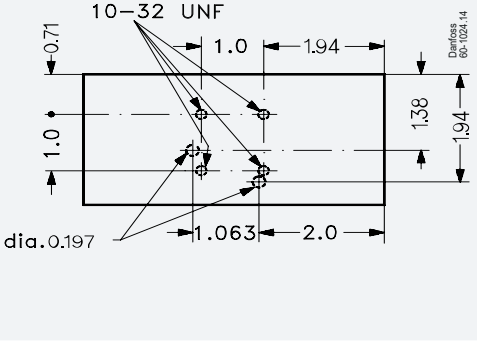
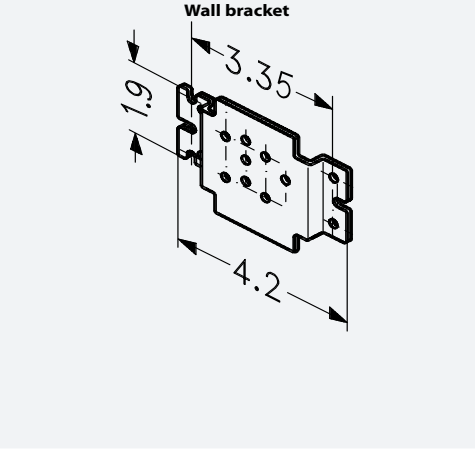
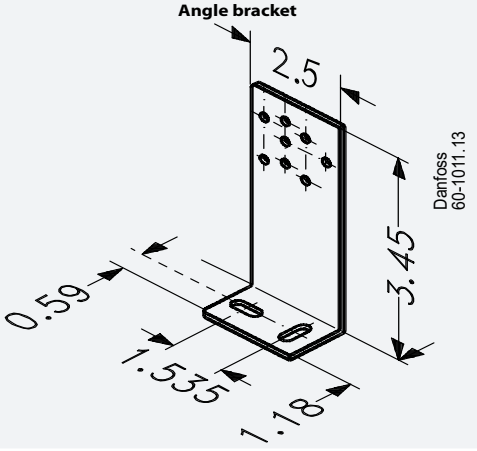


Table 8: Bracket dimensions

Wall bracket



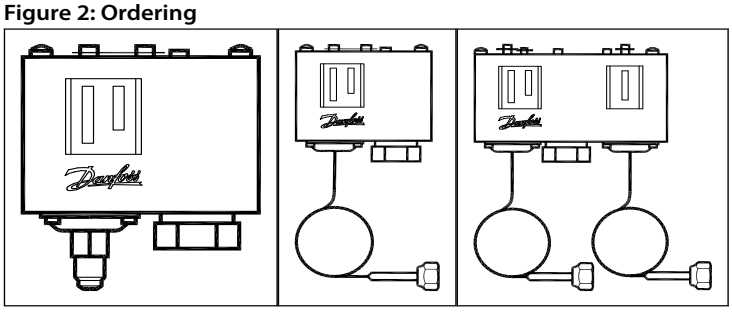
Angle bracket



Pressure switch, Type KP

Ordering

Figure 2: Ordering



For R22, R134a, R404A, R407A, R407C, R407F, R422B, R422D, R448A, R449A, R450A, R452A, R507A, R513A

For complete list of approved refrigerants, visit www.products.danfoss.com and search for individual code numbers, where refrigerants are listed as part of technical data.

Table 9: Ordering

Type	Pressure	Low pressure (LP)		High pressure (HP)		Reset		Contact functio	Code no.	
		Regulating range	Differential Δp	Regulating range	Differential Δp	Low pressure	High pressure		connection	
		[inHg] [psig]	[psi]	[psig]	[psi]	[LP]	[HP]		1/4 in flare	Cap. tube w. 1/4 in flare nut 36 in
KP 1	Low	6 in – 108	10 – 58	–	–	Auto	–	SPDT	060-200191	–
KP 1	Low	6 in – 108	10 – 58	–	–	Auto	–	SPDT	–	060-205191
KP 1	Low	27 in – 100	10	–	–	Man. (Min.)	–	SPDT	–	060-205291[1]
KP 2	Low	6 in – 50	6 – 32	–	–	Auto	–	SPDT	–	060-206391
KP 5	High	–	–	115 – 465	25 – 85	–	Auto	SPDT	060-201491	–
KP 5	High	–	–	115 – 465	25 – 85	–	Auto	SPDT	–	060-206491
KP 7W[2]	High	–	–	115 – 465	58 – 140	–	Auto	SPDT	060-200391	–
KP 7W [2]	High	–	–	115 – 465	58 – 140	–	Auto	SPDT	–	060-205391
KP7B [2]	High	–	–	115 – 465	58	–	Man. (Max.)	SPDT	060-200491	–
KP7B [2]	High	–	–	115 – 465	58	–	Man. (Max.)	SPDT	–	060-205491
KP 15	Dual	6 in – 108	10 – 58	115 – 465	58	Auto	Auto	SPDT/w. L P signal	060-200891	–
KP 15	Dual	6 in – 108	10 – 58	115 – 465	58	Auto	Auto	SPDT/w. L P signal	–	060-205891
KP 15	Dual	6 in – 108	10 – 58	115 – 465	58	Auto	Man. (Max.)	SPDT/w. L P signal	–	060-205991
KP 15	Dual	6 in – 108	10 – 58	115 – 465	58	Man. (Min.)	Man. (Max.)	SPDT/w. L P signal	–	060-206091
KP 15	Dual	6 in – 108	10 – 58	115 – 465	58	Auto	Auto	SPDT/w. LP + HP signal	–	060-203191
KP 15	Dual	6 in – 108	10 – 58	115 – 465	58	Auto	Man. (Max.)	SPDT/w. LP + HP signal	060-202691	–
KP 17W [2]	Dual	6 in – 108	10 – 58	115 – 465	58	Auto	Auto	SPDT/w. LP + HP signal	–	060-202991

[1] With dial knob
[2] With fail safe double bellows

Metric conversions

1 psi = 0.07 bar
5⁄9 (t_1 °F - 32) = t2 °C

Pressure switch, Type KP

Certificates, declarations, and approvals

The list contains all certificates, declarations, and approvals for this product type. Individual code number may have some or all of these approvals, and certain local approvals may not appear on the list.

Some approvals may change over time. You can check the most current status at danfoss.com or contact your local Danfoss representative if you have any questions.

Table 10: Certificates, declarations, and approvals

Document type	Approval authority
UL certificate	UL
EAC document	EAC
EU declaration	Danfoss
CCC declaration	Danfposs
Quality - Assurance Certificate	TUV
Marine safety certificate	DNV G L ,LR and BV
Manufacturer declaration for China ROHS	Danfoss

Appendix K
Hansen HCK1 Piston-Type Check Valves

HANSEN

Bulletin C449c
JUL 2006

2" HCK1 Piston-Type Check Valve

Specifications, Applications, Service Instructions & Parts

HCK1, HCK1W PISTON-TYPE CHECK VALVE 3/4" THRU 6" (20 mm THRU 150 mm)

Flanged
3/4" thru 4"
FPT, SW, WN, ODS
for refrigerants

INTRODUCTION

These flanged, heavy-duty, piston-type check valves control the flow of refrigerant. Valves open wide for flow in the direction of the arrow on the valve body. Valves close tight when flow reversals occur. The piston design minimizes pulsations.

Valves open when inlet pressure exceeds outlet pressure (1 psid [.07 bar] minimum), thereby lifting the piston/seat assembly and allowing flow through the valve. When inlet pressure and outlet pressure are equalized, the weight of the piston/seat assembly causes the valve to close. If outlet pressure exceeds inlet pressure, the outlet pressure acting on top of the piston/seat also helps seat the valve closed.

Also available, Type HCK4 in-line check valves and Type SCK combination stop/check valves; contact Hansen.

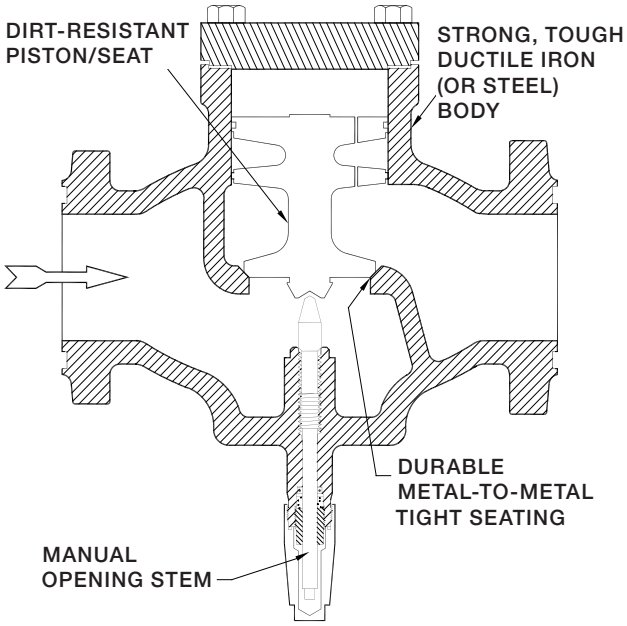
ADVANTAGES

This normally closed valve requires very little pressure drop to operate. Valve sizes ¾" thru 1¼" have spring-assisted closing. Valve sizes 1½" thru 6" have a special, spool-type, dirt-resistant piston/seat. A manual opening stem allows positive opening during servicing or troubleshooting the system.

APPLICATIONS

The HCK1 piston-type check valve prevents reverse flow of refrigerant in liquid, discharge, suction, and hot gas lines. It is an ideal valve where constant pulsating of gas or liquid is present, or where a manual opening of the valve is desirable. This valve is suitable for ammonia, R22, R134a, CO2 and other common refrigerants.

KEY FEATURES



MATERIAL SPECIFICATIONS

Body:

¾" thru 4": Ductile iron ASTM A536.

5" & 6": Cast steel

Piston/Seat:

¾" thru 1¼": Stainless steel with Teflon® seat

1½" thru 6": Ductile iron, ASTM A536

Closing Spring: Stainless steel (¾" thru 1¼" only)

Gaskets: Nonasbestos, graphite composite

Stem: Plated steel

Cover: Steel

Stem Seal: O-ring plus graphite composite packing

Companion Flanges: Forged steel

Safe Working Pressure: 400 psig (27 bar), 600 psig (40 bar) CO2

Operating Temperature: –25°F to +250°F (–32°C to +121°C)

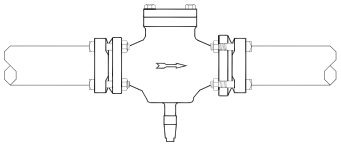
SIZING

The same care should be taken when sizing check valves as with any other type of control valve. Check valves should be sized so that the valve is fully open under all normal operating conditions. Also, the check valve port size is not always the same as the line size. This is particularly true for gas flow in compressor discharge lines and hot gas lines. Under some conditions, the port size of a properly-selected check valve can be one or two sizes smaller than the line.

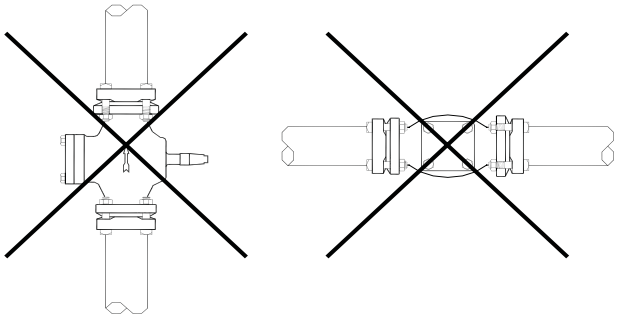
The pressure drop across the HCK1 check valve should normally be 2 to 5 psi under full load conditions. In addition, the pressure drop across the check valve at normal minimum load should be determined. For the Hansen HCK1 check valve, a minimum of 1 psi at minimum load is required to ensure that the valve is fully open during all normal flow conditions.

INSTALLATION

Protect the interior of the valve from dirt and moisture during storage and installation. The valve must be installed upright in a horizontal line. The arrow on the valve body should be in the normal direction of refrigerant flow. The system should be free of dirt, weld slag, and rust particles. Install the valve in an accessible location for servicing. Do not install a check valve at the inlet of a solenoid valve or regulator with electric shut-off. Do not install a check valve at the inlet of an outlet regulator where liquid may be trapped between the valves. Check valves in general, when installed, should be at the outlet of control valves to avoid trapping refrigerant between the valves.



CORRECT



INCORRECT

CAPACITIES

(1 Ton= 12,000 Btu/hr= 3.517 kW= 3042 kcal/hr)

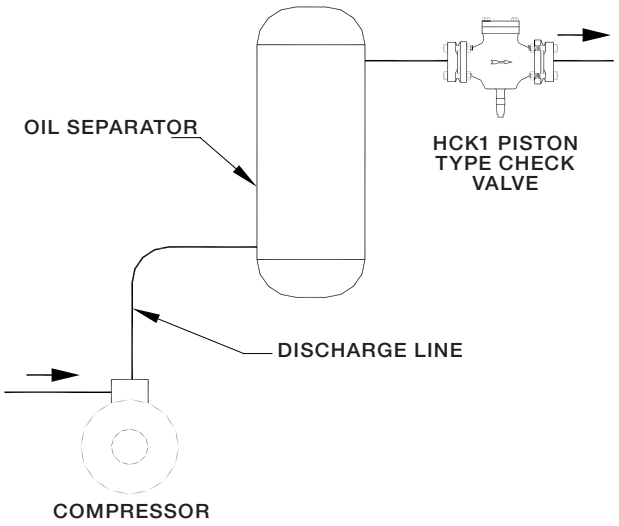
REFRIG	APPLICATIONS			PORT SIZE (mm)									
	DESCRIPTION		ΔP	3/4" (32)	1" (32)	1-1/4" (32)	1-1/2" (40)	2" (50)	2-1/2" (65)	3" (80)	4" (100)	5" (125)	6" (150)
R717	Discharge Line		2 psi	22	29	44	128	150	242	343	750	952	1224
			5 psi	34	45	69	200	234	378	535	1173	1487	1912
	Compressor Sideport		2 psi	12	16	25	72	84	136	193	–	–	–
			5 psi	19	25	38	110	129	209	296	–	–	–
	Liquid Line	TONS	2 psi	209	274	425	1227	1435	2322	3289	7203	–	–
		GPM	2 psi	14	18	29	83	97	157	222	486	–	–
R22	Discharge Line		2 psi	7.5	9.8	15	44	52	83	118	259	328	422
			5 psi	12	16	24	70	82	133	189	414	525	675
	Compressor Sideport		2 psi	4.7	6.2	9.6	27	32	52	74	–	–	–
			5 psi	7.2	9.5	15	42	50	80	114	–	–	–
	Liquid Line	TONS	2 psi	48	63	97	282	330	534	756	1656	–	–
		GPM	2 psi	9.9	13	20	58	68	110	156	342	–	–
Cv (Kv)				8 (7)	10.5 (9)	16.3 (14)	47 (40)	55 (47)	89 (76)	126 (108)	276 (236)	350 (300)	450 (385)

2 psi = 0.14 bar 5 psi = 0.35 bar 1 U.S. GPM (gallons per minute) = 0.227124 m3/hr

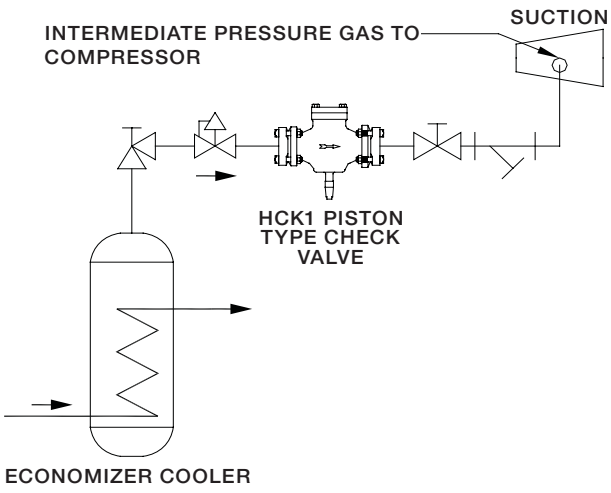
Discharge line capacities based on +86°F (+30°C) condenser, +140°F (+60°C) discharge, and +15°F (–9.4°C) evaporator.
Compressor sideport capacities based on +20°F (–6.7°C) economizer and +86°F (+30°C) condensing.
Liquid line capacities based on +20°F (–6.7°C) liquid and +5°F (–15°C) evaporator, with no flashing through valve. To convert to +86°F (+30°C) liquid, multiply values in table by 0.9. To convert R22 capacities to R134a, multiply tons in table by 0.92 (accuracy within 8%). GPM correction factors for temperatures between –40°F (–40°C) and +40°F (+4.4°C) are negligible.

TYPICAL APPLICATIONS

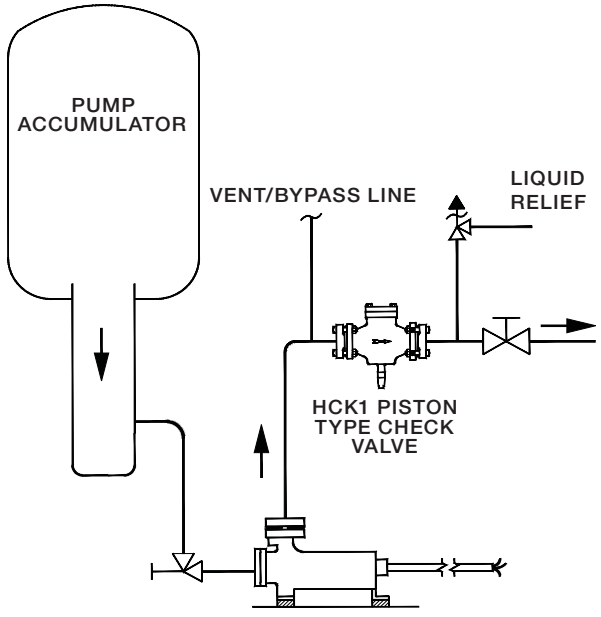
DISCHARGE LINE



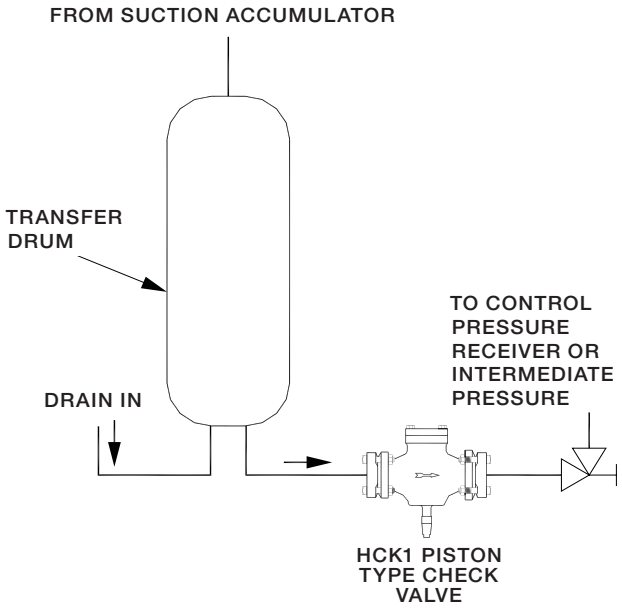
COMPRESSOR SIDEPORT



PUMP DISCHARGE LINE



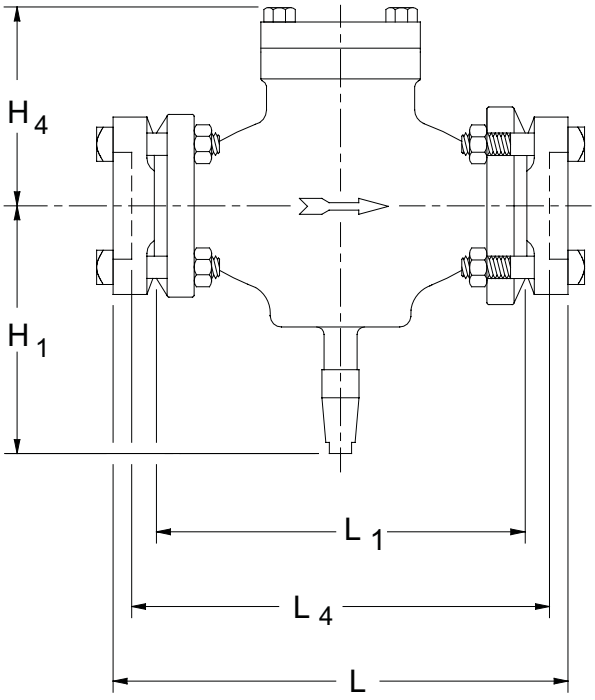
TRANSFER SYSTEM



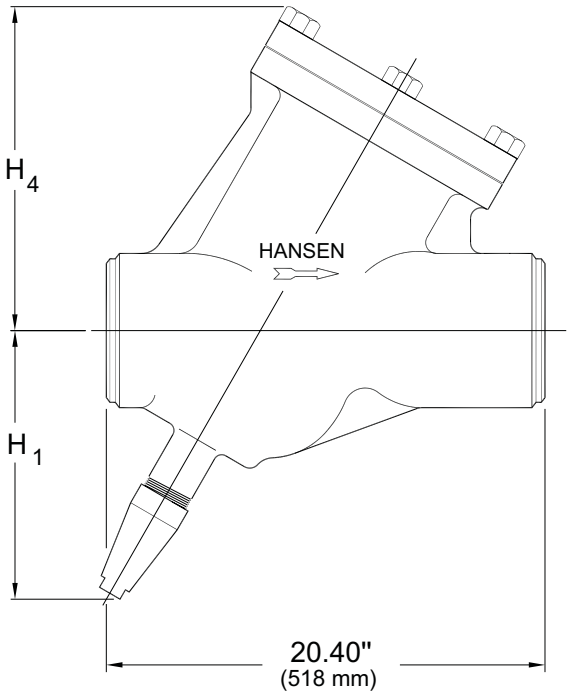
The above are schematic drawings of fictional refrigeration systems to show Hansen product applications in a system. These drawings should not be used for design or construction.

INSTALLATION DIMENSIONS

3/4" thru 4"
(20 mm thru 100 mm)



5" & 6"
(125 mm thru 150 mm)

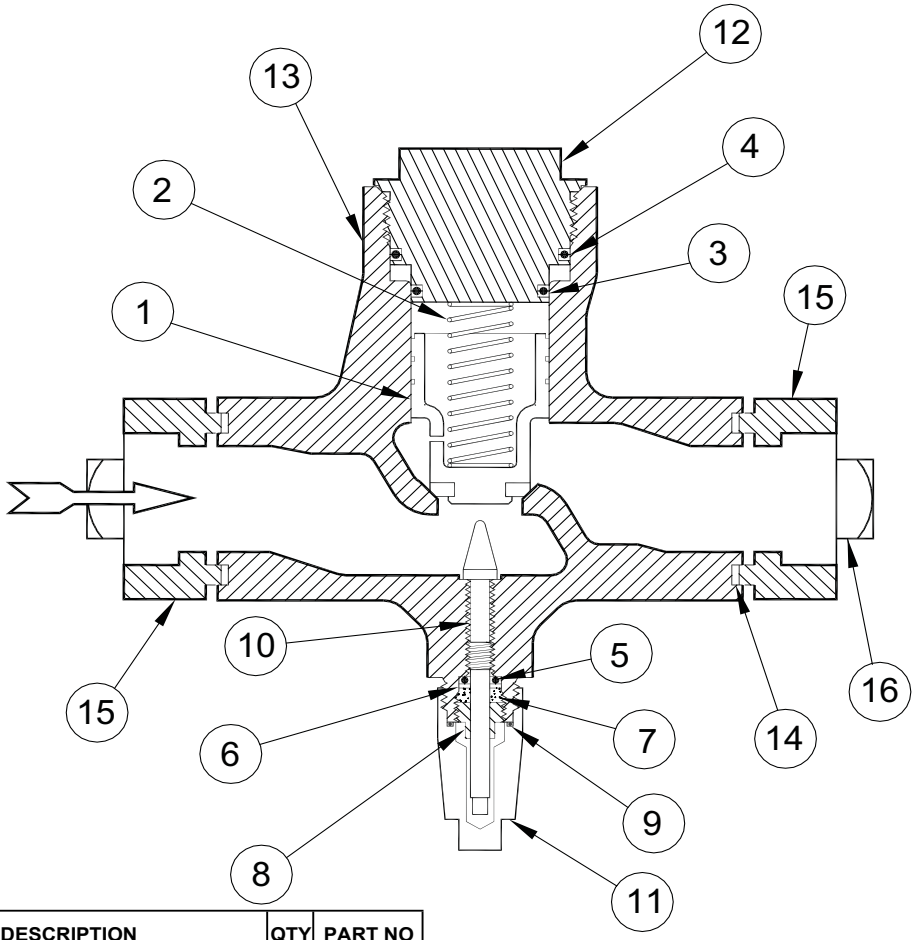


PORT SIZE (mm)	DIMENSIONS (mm)						
	H_1	H_4	L		L_1*	L_4	W**
			FPT, SW	WN, ODS			
3/4", 1" (20), (25)	4.21" (107)	8.99" (228)	8.20" (208)	8.94" (227)	6.19" (157)	7.20" (183)	4.50" (114)
1-1/4" (32)	4.21" (107)	8.99" (228)	8.20" (208)	8.94" (227)	6.19" (157)	7.20" (183)	4.50" (114)
1-1/2", 2" (40), (50)	7.12" (107)	5.34" (136)	12.39" (315)	13.39" (340)	9.88" (251)	10.89" (277)	4.50" (114)
2-1/2" (65)	8.06" (205)	6.10" (155)	13.01" (330)	14.03" (356)	9.88" (251)	11.01" (280)	5.62" (143)
3" (80)	8.38" (213)	6.56" (167)	15.38" (391)	16.40" (417)	12.25" (311)	13.38" (340)	6.50" (165)
4" (100)	9.88" (251)	7.38" (187)	17.01" (432)	20.51" (521)	14.12" (359)	15.01" (381)	8.06" (205)
5" (125)	12.13" (308)	14.34" (364)	–	–	20.40" (518)	–	12.75" (324)
6" (150)	12.13" (308)	14.34" (364)	–	–	20.40" (518)	–	12.75" (324)

*L1 is the flange face-to-face dimension.
** W dimension is the maximum width of the valve.

HCK1 PARTS LIST

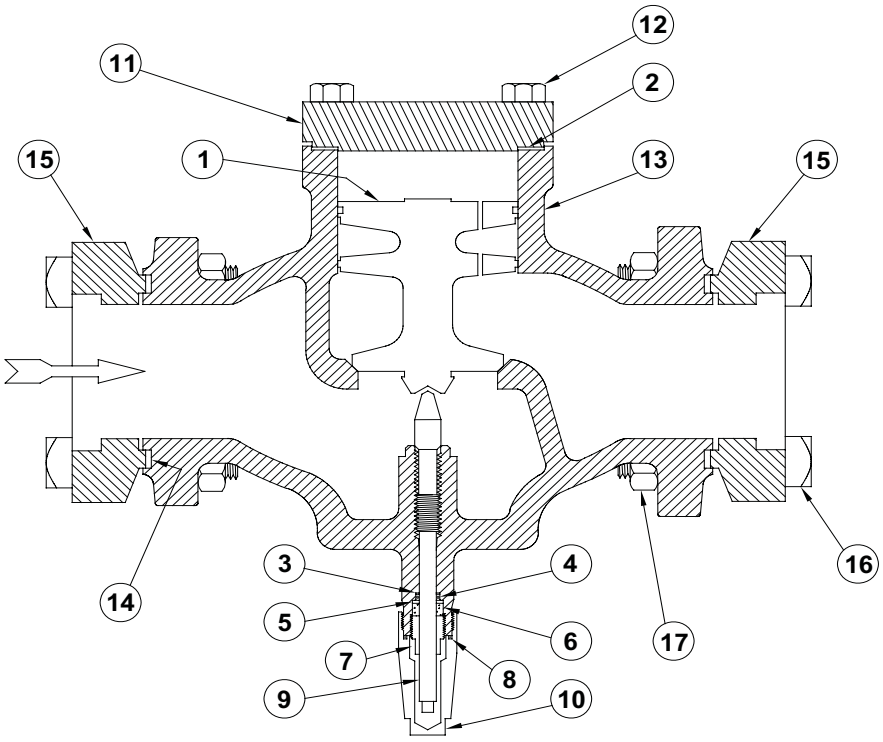
3/4” thru 1-1/4” (20 mm thru 32 mm)



ITEM	DESCRIPTION	QTY	PART NO
	Piston/Seat Kit 3/4"		**70-1019**
	Piston/Seat Kit 1"		**70-1026**
	Piston/Seat Kit 1-1/4"		**70-0166**
	Above kits consist of:		
1a	Piston/Seat 3/4"	1	70-0166
1b	Piston/Seat 1"	1	70-0163
1c	Piston/Seat 1-1/4"	1	70-0167
2	Closing Spring	1	70-0155
3	Cover O-Ring, Lower	1	70-0130
4	Cover O-Ring, Upper	1	70-0131
	Gasket Kit 3/4", 1", 1-1/4"		**70-1017**
	Above kit consists of:		
3	Cover O-Ring, Lower	1	70-0130
4	Cover O-Ring, Upper	1	70-0131
5	Stem O-Ring	1	70-0010
6	Stem Washer	1	70-0026
7	Packing	1	70-0025
8	Packing Nut	1	70-0019
9	Seal Cap O-Ring	1	70-0011
14	Flange Gasket	2	70-0132
11	Seal Cap	1	50-0411
9	Seal Cap O-Ring	1	70-0011
10	Stem	1	70-0128
12	Cover	1	70-0307
13a	Body 3/4", 1"	1	70-0369
13b	Body 1-1/4"	1	70-0369
15	Flange (various)	2	FACTORY
16	Bolt (5/8"-11x2-3/4")	4	70-0339
17	Nut (5/8"-11)	4	70-0136

HCK1 PARTS LIST

1-1/2” thru 4” (40 mm thru 100 mm)

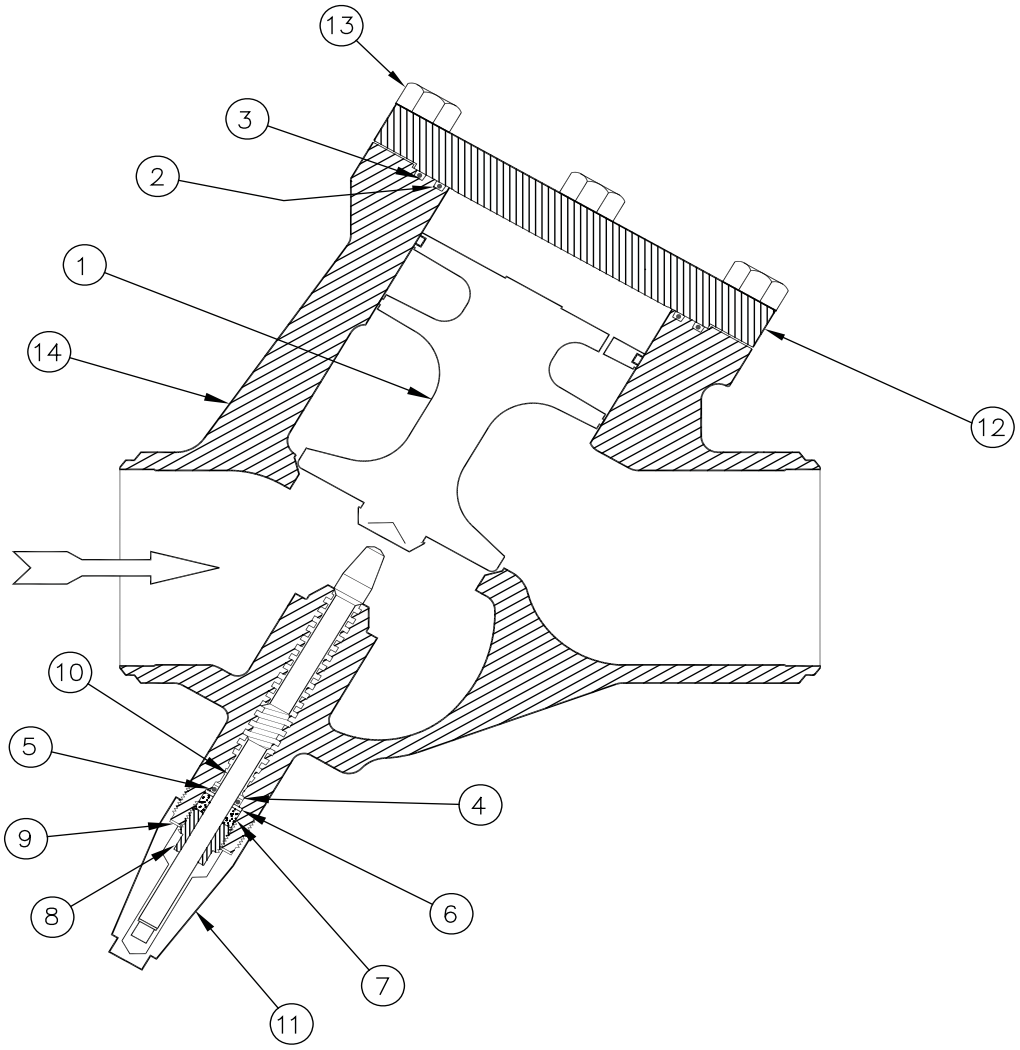


ITEM	DESCRIPTION	QTY	PART NO
	Piston/Seat Kit 1-1/2", 2"		**75-1065**
	Piston/Seat Kit 2-1/2"		**75-1066**
	Piston/Seat Kit 3"		**?**
	Piston/Seat Kit 4"		**75-1067**
	Above kits consist of:		
1a	Piston/Seat 1-1/2", 2"	1	75-0282
1b	Piston/Seat 2-1/2", 3"	1	75-0281
1c	Piston/Seat 4"	1	75-0244
2a	Cover Gasket 1-1/2", 2"	1	75-0196
2b	Cover Gasket 2-1/2", 3"	1	75-0128
2c	Cover Gasket 4"	1	75-0234
	Gasket Kit 1-1/2", 2"		**75-1007**
	Gasket Kit 2-1/2", 3"		**75-1008**
	Gasket Kit 3"		**75-1009**
	Gasket Kit 4"		**75-1017**
	Above kit consists of:		
2a	Cover Gasket 1-1/2", 2"	1	75-0196
2b	Cover Gasket 2-1/2", 3"	1	75-0128
2c	Cover Gasket 4"	1	75-0234
3a	Back-up Washer 1-1/2",2",2-1/2",3"	1	75-0245
3b	Back-up Washer 4"	1	50-0351
4a	Stem O-Ring 1-1/2",2",2-1/2",3"	1	50-0179
4b	Stem O-Ring 4"	1	50-0253
5a	Stem Washer 1-1/2",2",2-1/2",3"	1	50-0046
5b	Stem Washer 4"	1	50-0247
6a	Packing 1-1/2",2",2-1/2",3"	1	50-0045
6b	Packing 4"	1	50-0248
7a	Packing Nut 1-1/2",2",2-1/2",3"	1	50-0013
7b	Packing Nut 4"	1	50-0251
8a	Seal Cap O-Ring 1-1/2",2",2-1/2",3"	1	50-0432
8b	Seal Cap Gasket 4"	1	50-0270
14a	Flange Gasket 1-1/2", 2"	2	75-0138
14b	Flange Gasket 2-1/2"	2	75-0125
14c	Flange Gasket 3"	2	75-0137
14d	Flange Gasket 4"	2	75-0253

ITEM	DESCRIPTION	QTY	PART NO
9a	Stem 1-1/2", 2", 2-1/2"	1	75-0118
9b	Stem 3"	1	75-0135
9c	Stem 4"	1	75-0242
10a	Seal Cap 1-1/2",2",2-1/2",3"	1	75-0139
10b	Seal Cap 4"	1	50-0260
11a	Cover 1-1/2", 2"	1	75-0107
11b	Cover 2-1/2", 3"	1	75-0121
11c	Cover 4"	1	75-0243
12a	Cover Bolts 1-1/2", 2"	4	75-0175
12b	Cover Bolts 2-1/2", 3"	4	65-0057
12c	Cover Bolts 4"	4	75-0291
13a	Body 1-1/2"	1	75-0197
13b	Body 2"	1	75-0197
13c	Body 2-1/2"	1	75-0221
13d	Body 3"	1	75-0198
13e	Body 4"	1	75-0238
15	Flange (various)	2	FACTORY
16a	Flange Bolt 1-1/2",2"(5/8"-11x3-1/4")	8	70-0135
16b	Flange Bolt 2-1/2",3"(3/4"-10x3-3/4")	8	75-0202
16c	Flange Bolt 4"(7/8"-9x4")	8	75-0279
17a	Flange Nut 1-1/2",2"(5/8"-11)	8	70-0136
17b	Flange Nut 2-1/2",3"(3/4"-10)	8	75-0210
17c	Flange Nut 4"(7/8"-9)	8	75-0280

HCK1W PARTS LIST

5” & 6” (125 mm thru 150 mm)



ITEM	DESCRIPTION	QTY	PART NO
1	Piston/Seat Kit 5" & 6"	1	75-1135
2	Cover O-Ring, Inner, 5" & 6"	1	75-0605
3	Cover O-Ring, Outer 5" & 6"	1	75-0606
4	Back-up Washer	1	50-0324
5	Stem Seal O-Ring	1	50-0293
6	Stem Washer	1	50-0299
7	Packing	1	50-0290
8	Packing Nut	1	50-0292
9	Seal Cap Gasket	1	50-0315
10	Stem	1	75-0584
11	Seal Cap	1	50-0304
12	Cover	1	75-0583
13	Cover Bolts	4	75-0604
14a	Body 5"	1	75-0638
14b	Body 6"	1	75-0639

SERVICE AND MAINTENANCE

Failure to Close: The manual opening stem is turned in, mechanically holding the piston/seat open. Dirt may be lodged between the piston/seat and the valve piston wall.

Failure to Open: The pressure difference is not high enough. Inlet pressure must be at least 1 psi above outlet pressure. Adjacent shut-off valves or control valves are not open. Dirt may be lodged between the piston/seat and valve piston wall.

Manual Operation: If it is necessary to manually hold open the HCK1 valve, remove the seal cap cautiously. There may be a small amount of refrigerant trapped in it. Turn the manual opening stem inward (clockwise) as far as possible. The piston/seat is then mechanically held open. The valve cannot close until the manual opening stem is turned out (counter-clockwise).

If it is necessary to remove or disassemble the valve for servicing, be sure it is completely isolated from the refrigeration system and all refrigerant is removed (pumped out to zero pressure). Be sure to follow refrigeration system safety procedures and read the Caution section in this bulletin. To inspect valve interior, slowly loosen the screwed cover or four cover bolts equally, being careful to avoid any refrigerant which may still remain. Remove the piston/seat. Then clean and inspect for burrs and damage to the seating surfaces. Slight marks and burrs can often be removed by hand with emery paper or by power lapping. Damaged parts should be replaced. Lightly lubricate the main valve interior bore with refrigerant oil, and install the piston/seat and closing spring (a closing spring is used in ¾" - 1¼" valves only). Replace the cover, gasket and bolts (1½" 6"). Carefully check the entire valve for leaks before restoring the valve to service.

CAUTION

Hansen valves are only for refrigeration systems. These instructions must be completely read and understood before selecting, using or servicing Hansen valves. Only knowledgeable, trained refrigeration mechanics should install, operate, or service these valves. Stated temperature and pressure limits should not be exceeded. Bonnets, solenoid tubes, etc. should not be removed from valves unless system has been evacuated to zero pressure. Must also see Safety Precautions in current List Price Bulletin and Safety Precautions Sheet supplied with product.

WARRANTY

All Hansen products, except electronics, are guaranteed against defective materials or workmanship for one year F.O.B. factory. Electronics are guaranteed against defective materials or workmanship for 90 days F.O.B. factory. No consequential damages or field labor is included.

ORDERING INFORMATION

PORT SIZE (mm)	FLANGE STYLE AND SIZES		
	CONNECTIONS AVAILABLE		
	SW, WN, FPT		ODS
	STD	ALSO	STD
3/4" (20)	3/4"	1", 1-1/4"	7/8"
1" (25)	1"	3/4", 1-1/4"	1-1/8"
1-1/4" (32)	1-1/4"	1", 3/4"	1-3/8"
1-1/2" (40)	1-1/2"	2"	1-5/8"
2" (50)	2"	1-1/2"	2-1/8"
2-1/2" (65)	2-1/2"	3"	2-5/8"
3" (80)	3"	–	3-1/8"
4" (100)	4"	–	4-1/8"
5" (125)**	5" BW	–	–
6" (150)**	6" BW	–	–

* ¾", 1", and 1¼" valves are 2-bolt design.
**5" & 6" are integral butt weld only, Type HCK1W.

To Order: Specify Type HCK1 (or HCK1W), port size, flange connection style and size.

TYPICAL SPECIFICATIONS

"Piston-type check valves shall be ductile iron or steel bodied, normally closed, with a manual opening stem, as manufactured by Hansen Technologies Corporation or approved equal."

HANSEN
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USA · Asia · Europe · India · Latin America · Middle East

Appendix L
Rexnord Thomas® Disc Couplings

REXNORD

Thomas® Disc Couplings • Installation and Maintenance
Type CMR & AMR • Sizes 225 - 750 with Tpack™ (Page 1 of 11)

This is the Original Document in English Language

Figure 1 - Thomas CMR and AMR Couplings

1. General Information

1.1. Thomas CMR and AMR Couplings with Tpacks are designed to provide a mechanical connection between the rotating shafts of mechanical equipment, using flexible disc elements to accommodate inherent misalignment while transmitting the power and torque between the connected shafts.

1.2. These instructions are intended to help you install and maintain your Thomas CMR and AMR Tpack couplings. Please read these instructions prior to installing the coupling, and prior to maintenance on the coupling and connected equipment. Keep these instructions near the coupling installation and available for review by maintenance personnel. For special engineered couplings, Rexnord may provide an engineering drawing containing installation instructions that take precedence over this document.

1.3. Rexnord Industries, LLC owns the copyright of this material. These Installation and Maintenance instructions may not be reproduced in whole or in part for competitive purposes.

1.4. Symbol descriptions:

STOP Danger of injury to persons.

Damages on the machine possible.

Pointing to important items.

Hints concerning explosion protection.

2. Safety and Advice Hints

STOP **DANGER!**

2.1. Safety should be a primary concern in all aspects of coupling installation, operation, and maintenance.

2.2. Proper lockout-tag out procedures must be followed to safeguard against unintentional starting of the equipment.

2.3. Because of the possible danger to person(s) or property from accidents which may result from improper use or installation of these products, it is extremely important to follow the proper selection, installation, maintenance and operational procedures.

2.4. All personnel involved in the installation, service, operation, maintenance, and repair of this coupling and the connected equipment must read, understand, and comply with these Installation and Maintenance instructions.

PRECAUTION! For this coupling to meet the ATEX requirements, you must precisely follow these installation and maintenance instructions, and the supplement form 0005-08-49-01. This supplement outlines the ATEX requirements. If the operator does not follow these instructions, the coupling will immediately be considered non-conforming to ATEX.

2.5. All rotating power transmission products are potentially dangerous and can cause serious injury. They must be properly guarded in compliance with OSHA, ANSI, ATEX, European machine safety standards and other local standards. It is the responsibility of the user to provide proper guarding.

2.6. For ATEX requirements the guard must have a minimum of 12.7 mm (1/2 inch) radial clearance to the coupling ouutside diameter “A” (see Figure 3 and Table 3) and allow for proper ventilation.

2.7. Make sure to disengage the electrical power and any other sources of potential energy before you perform work on the coupling.

2.8. Do not make contact with the coupling when it is rotating and/or in operation.

2.9. All work on the coupling must be performed when the coupling is at rest with no load.

2.10. Do not start or jog the motor, engine, or drive system without securing the coupling components. If the equipment is started with only a hub attached, the hub must be properly mounted and ready for operation, with the key and set screw (if included) fastened. When the full coupling assembly is started, all fasteners and hardware must be completely and properly secured. Do not run the coupling with fasteners.

2.11. The coupling may only be used in accordance with the technical data provided in the Thomas catalog for Type CMA and AMR Tpack couplings. Modifications and alterations to the coupling are not permissible.

⚠ **CAUTION: Air driven wrenches for assembly are not permitted to avoid the potential of excessive speed and heat build up that may lead to thread damage during assembly.**

2.12. All spare parts for service or replacement must originate from or be approved by Rexnord Industries, LLC.

3. Components and Part Numbers

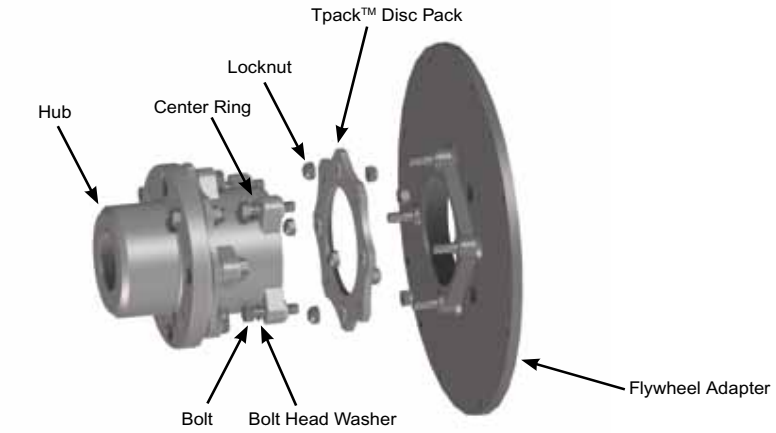


Figure 2 - Thomas Series CMR TPack Coupling Components (AMR Coupling uses a Hub at each end, with no Flywheel Adapter)

Thomas CMR and AMR Tpack couplings may be delivered from the factory assembled (for shipment only) or not assembled. If assembled, the locknuts are not fully tightened. Examine the parts to assure there is no visible damage. If the coupling is assembled, remove the locknuts, bolts, and bolt head washers that attach the hub(s) to the disc packs. Remove the hub(s). Leave the disc packs attached to the center ring and the flywheel adapter (when used). Prior to operation the disc pack locknuts will be tightened to the specifications shown in Table 4.

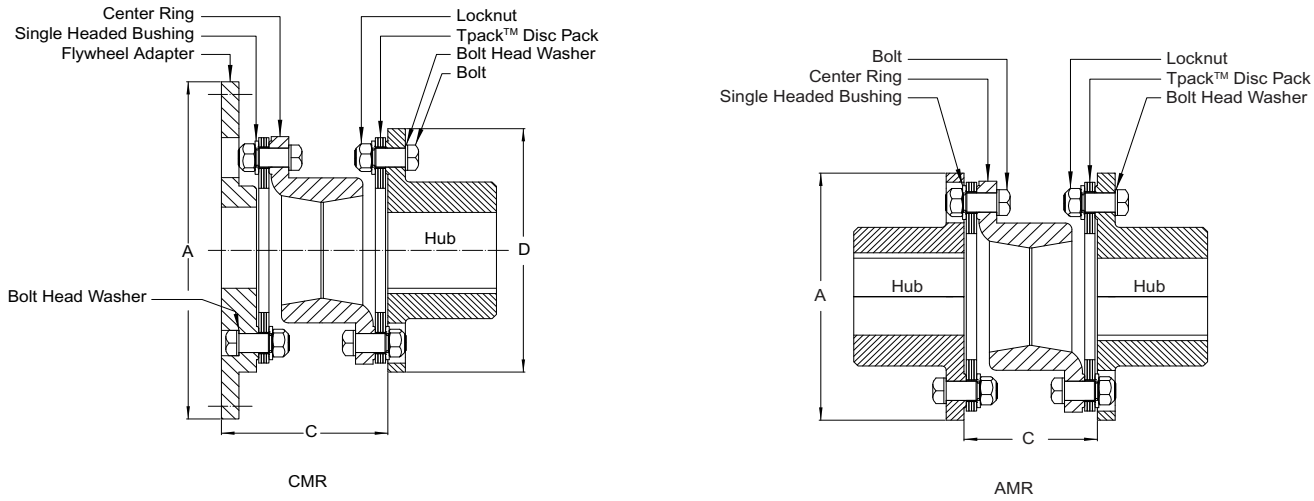


Figure 3 - Thomas CMR and AMR TPack Cross Sectional View of Components

Table 1 - Parts Numbers and Quantity Required

Size of AMR/CMR Coupling	Flywheel Adapter	Hub Rough Bored	Center Ring (1 per Coupling)	Tpack™ Disc Pack Tomaloy		Parts Kit – Consists of Tpacks, Locknuts and Washers for One Coupling**			
		Part No.	Part No.	Part No.	Qty.	Parts Kit Part No.	Bolts Qty.	Locknuts Qty.	Washers Qty.
225	One per coupling. Made to customer's specifications.	622050	320960	586056	2	588014	16	16	16
262		322047	720826	586058	2	588015	16	16*	16
312		021395	720752	585913	2	588016	16	16*	16
350		721392	820897	586059	2	588017	16	16	16
375		921797	921373	586060	2	588018	16	16	16
425		221838	321377	586062	2	588019	16	16	16
450		122088	121376	586063	2	588020	16	16*	16
500		321936	920941	586065	2	588021	16	16*	16
550		021647	930642	586066	2	588022	16	16*	16
600		120943	937205	586067	2	588023	16	16*	16
700		621073	830400	586068	2	588024	16	16*	16
750		622262	130597	586069	2	588025	16	16*	16

* These locknuts are cadmium plated.
**Use this kit when replacing original Thomas round, non-unitized disc packs (non-Tpack) with a Tpack disc pack. It includes the special bolt head washers as shown in Figures 2, 3, 9 and 10.

4. Hub Mounting

DANGER!

Be sure to disengage the electrical power and any other sources of energy before you perform work on the hub and coupling assembly.

4.1. Examine the coupling assembly to insure there is no visible damage.

4.2. Clean the hub bores and shafts using lint free cloth. Remove any nicks or burrs.

4.3. When assembled, the key(s) should have a close side-to-side fit in the keyway in both the hub and shaft, with a slight clearance over the top of the key.

CAUTION: When heating hubs is required, use of an oven is preferred and an open flame is not recommended. If flame heating is considered mandatory, it is important to provide uniform heating to avoid distortion and excessive temperature. A thermal stick (crayon marker) applied to the hub surface will help determine the hub temperature.

DANGER!

Touching hot hubs causes burns and blistering. Wear safety gloves to avoid contact with hot surfaces.

5. Straight Bore with Clearance/Slip Fit –

CAUTION: Clearance/Slip Fits are not recommended for use with AMR/CMR couplings when the application includes reversing torque loads, in which AMR/CMR couplings are generally applied.

5.1. Install the key(s) in the shaft.

5.2. Check to be sure that the set screw(s) in the hub does not protrude into the keyway and/or the bore. If needed, loosen the set screw to provide clearance during assembly.

5.3. Slide the hub up the shaft to the desired axial position.

5.4. Assemble and tighten the set screw(s), using a calibrated torque wrench, to the values shown in Table 2.

ATTENTION! Never use two set screws with one on top of the other in the same tapped hole.

Table 2 - Set Screw Tightening Torque

Set Screw Thread Size				Internal Hex Size		Set Screw Thread Size				Internal Hex Size
Inch	In-lb	ft-lb	Nm	inch		Inch	In-lb	ft-lb	Nm	inch
1/4-20	66	6	7	1/8		3/8-16	240	20	27	3/16
1/4-28	76	6	9	1/8		3/8-24	276	23	31	3/16
5/16-18	132	11	15	5/32		1/2-13	600	50	68	1/4
5/16-24	144	12	16	5/32		1/2-20	660	55	75	1/4

6. Straight Bore with Interference Fit –

6.1. Accurately measure the bore and shaft diameters to assure proper fit.

6.2. Install the key(s) in the shaft.

6.3. Heat the hub in an oven until the bore is sufficiently larger than the shaft.

6.4. 350°F (177°C) is usually sufficient for carbon steel hubs. Do not exceed 500°F (260°C).

6.5. Higher temperatures may be required for higher interference fit levels where alloy steel hubs may be encountered. A general rule to consider is that for every 160°F increase in temperature, steel will expand 0.001 inch for every inch of shaft diameter (or .029 mm/100°C). When calculating temperatures, also consider additional expansion to provide clearance and allow for a loss of heat and subsequent shrinkage during the handling process.

6.6. With the hub expanded, install it quickly on the shaft to the desired axial position. A pre-set axial stop device can be helpful.

7. Taper Bore –

7.1. Check for acceptable contact pattern between the hub and the shaft.

7.2. Put the hub on the shaft, keeping the keyways (if existing) aligned.

7.3. Lightly tap the face of the hub with a soft mallet. The resultant position will provide a starting point for the hub axial draw up.

7.4. Use a depth micrometer to measure the distance from the shaft end to the hub face, as shown in Figure 4. Record the dimension.

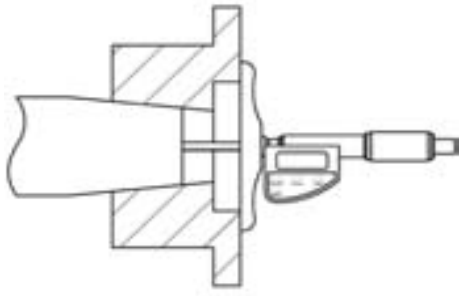


Figure 4 - Shaft end to hub face measurement example.

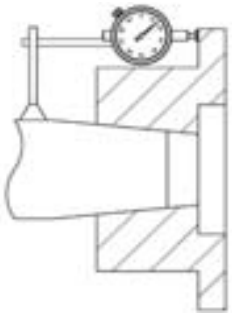


Figure 5 - Dial indicator placement for axial draw measurement example.

7.5. Mount a dial indicator to read axial hub advancement, as shown in Figure 5. Alternatively, the indicator can be positioned to contact the end of the hub. Set the indicator to “zero”.

7.6. Remove the hub and install the key(s) in the shaft.

7.7. Heat the hub in an oven until the bore is sufficiently larger than the shaft.

7.8. 350°F (177°C) is usually sufficient for carbon steel hubs. Do not exceed 500°F (260°C).

7.9. Higher temperatures may be required for higher interference fit levels where alloy steel hubs may be encountered. A general rule to consider is that for every 160°F increase in temperature, steel will expand 0.001 inch for every inch of shaft diameter (or .029 mm/100°C). When calculating temperatures, also consider additional expansion to provide clearance and allow for a loss of heat and subsequent shrinkage during the handling process.

7.10. With the hub expanded, install it quickly on the shaft to the “zero” set point. Continue to advance the hub up the taper to the desired axial position, as defined by the customer. Use the indicator as a guide only. A pre-set axial stop device can be helpful.

7.11. Inspect the assembly to verify that the hub is properly positioned. Consult Rexnord if necessary.

8. Shaft Alignment –

8.1. Move the equipment into place.

ATTENTION! Soft Foot – The equipment must rest flat on its base. If one or more feet of the machine are shorter, longer, or angled in some way to prevent uniform contact (a condition commonly known as “soft foot”) it must now be corrected.

ATTENTION! To improve the life of the coupling, the shafts must be aligned to minimize deflection of the flexing elements. Shaft alignment is required in the axial, parallel, and angular directions, with each of these values not to exceed the recommended installation limits shown in Table 3. Shaft alignment can be measured using various established methods, including Laser Alignment, Reverse Dial Indicator, and Rim and Face. Refer to Rexnord bulletin 538-214 “Coupling Alignment Fundamentals” for instructions regarding shaft alignment.

8.2. Move the connected equipment to achieve acceptable alignment. When well aligned, the disc packs will be centered and approximately parallel to their mating flange faces and the flexing elements will have little visible waviness when viewed from the side.

8.3. Table 3 shows recommended installation limits for Parallel, Angular, and Axial alignment.

8.4. The “Parallel Misalignment” value (P) is the offset between the centers of the hubs, as shown in Figure 6.

8.5. When Parallel Offset is measured by rotating the hubs with dial indicators as shown in Figure 7, the total indicated reading (TIR) should be divided by (2) to calculate “P”.

8.6. It should be noted that parallel offset measured on the hub surfaces includes misalignment of the equipment shafting plus any variation (TIR) in the hub bore indicating surface. This may be helpful to consider during problem solving for alignment difficulties.

8.7. The “Angular Misalignment” value is the maximum difference between the measurements X and Y taken at opposite ends of the hub flanges, as shown in Figure 8.

Figure 6 - Parallel Misalignment “P”

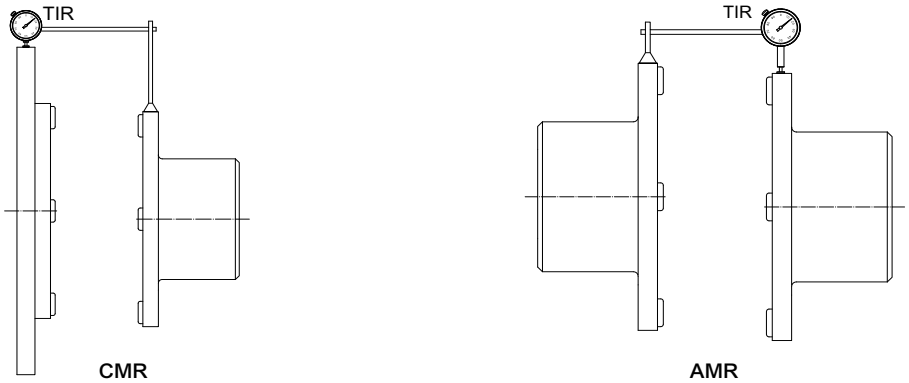


Figure 7 - Parallel Misalignment “TIR” (Total Indicated Reading)

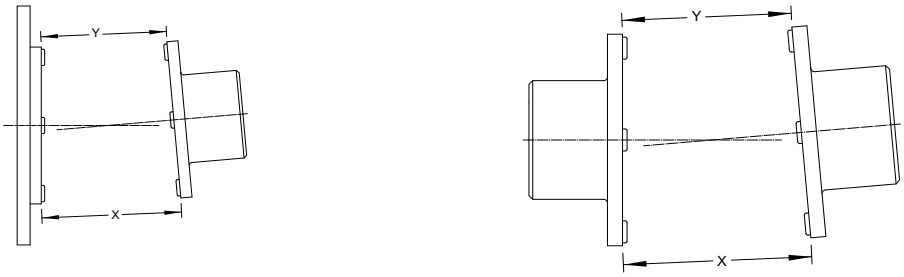


Figure 8 - Angular Misalignment "X-Y"

ATTENTION! If the driver or driven equipment alignment tolerances are more stringent than our recommendations, the driver or driven equipment tolerances should be used. Also, be sure to compensate for thermal movement in the equipment. The coupling is capable of approximately four times the shaft misalignment tolerances shown in Table 3. However, close alignment at installation will provide longer service with smoother operation.

Table 3 - Installation Alignment Values

Thomas AMR/CMR Coupling Size	Hub Flange Diameter CMR = "D" AMR = "A"		Dimension "C"				Recommended Installation Limits****									
							Maximum Coupling Parallel Misalignment AMR and CMR Maximum Measurement Between Hubs Defined in one of two ways				Angular Misalignment Between Hubs Maximum (X-Y) ***				"C" Dimension Tolerance +/-	
			CMR		AMR		Parallel Alignment Total Indictor Reading (TIR)*		Parallel Offset "P" **		AMR		CMR			
	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
225	6.00	152.4	3.87	98.3	2.99	75.9	0.006	0.15	0.0030	0.08	0.012	0.30	.002 inch per Inch of "A Diameter	.002 mm per mm of "A Diameter	0.009	0.23
262	6.88	174.8	4.47	113.5	3.51	89.2	0.007	0.18	0.0035	0.09	0.014	0.36			0.011	0.28
312	8.12	206.2	5.34	135.6	4.14	105.2	0.008	0.20	0.0040	0.10	0.016	0.41			0.013	0.33
350	9.12	231.6	5.89	149.6	4.58	116.3	0.009	0.23	0.0045	0.11	0.018	0.46			0.014	0.36
375	10.06	255.5	6.62	168.1	5.18	131.6	0.010	0.25	0.0050	0.13	0.020	0.51			0.016	0.41
425	11.00	279.4	7.18	182.4	5.55	141.0	0.011	0.28	0.0055	0.14	0.022	0.56			0.017	0.43
450	11.88	301.8	7.68	195.1	5.93	150.6	0.012	0.30	0.0060	0.15	0.024	0.61			0.018	0.46
500	13.44	341.4	8.75	222.3	6.81	173.0	0.014	0.36	0.0070	0.18	0.027	0.69			0.021	0.53
550	15.00	381.0	9.89	251.2	7.70	195.6	0.015	0.38	0.0075	0.19	0.030	0.76			0.023	0.58
600	16.75	425.5	10.89	276.6	8.45	214.6	0.017	0.43	0.0085	0.22	0.033	0.84			0.026	0.66
700	18.94	481.1	12.48	317.0	9.66	245.4	0.019	0.48	0.0095	0.24	0.038	0.97			0.029	0.74
750	20.62	523.7	13.54	343.9	10.54	267.7	0.021	0.53	0.0105	0.27	0.041	1.04			0.031	0.79

* Parallel misalignment measured by rotating the hubs with a dial indicator on the outside hub diameter.
** Parallel offest "P" is equivalent to one-half of the TIR measurement using dial indicators.
*** Subtract Measurement Y from Measurement X to obtain Angular Misalignment dimension.
**** During installation and/or operation, do not exceed the maximum misalignment capacity of 1/3°per disc pack.
Refer to Rexnord Bulletin 538-214 "Coupling Alignment Fundamentals" for more details regarding alignment methods and procedures.

9. Final Assembly –

DANGER!

When handling the coupling, components may sometimes slip and fall. To prevent loss of fingers or injury avoid inserting fingers into any fastener holes.

ATTENTION! All bolt threads must be lubricated prior to assembly. A clean motor oil is recommended. Do not use lubricants containing molybdenum disulfide or greases.

ATTENTION! With the coupling in good alignment, the bolts should fit through the holes in the flanges and the disc packs. See Figure 1.

CMR – WHEN THE FLYWHEEL ADAPTER IS USED WITH ONE HUB

9.1. If the coupling arrived assembled (for shipment only), the Tpack disc packs, center ring, hub, and flyweel adapter are still attached. Remove the locknuts, bolts, and bolt head washers that attach the Tpack disc packs. Remove the locknuts and Tpack disc packs from the center ring, but do not remove the bolts and bolt head washers.

9.2. Place the center ring on a workbench.

9.3. If the coupling is not preassembled, place a bolt head washer on each bolt and install eight bolts with a bolt head washer through all eight bolt holes in the radial extensions in the center ring, as shown in Figure 9.

9.4. Slide a Tpack disc pack over the four bolts on the end that will mate to the flywheel adapter so that the single headed bushings in the Tpack are opposite the center ring bosses as shown in Figure 9. Use caution to ensure that bolt head washer and Tpack disc pack are not assembled incorrectly as shown in the incorrect methods in Figure 9.

ATTENTION! When assembling bolts through the Tpack disc pack, make sure the single headed bushing in the Tpack engages the body ground diameter of the bolt.

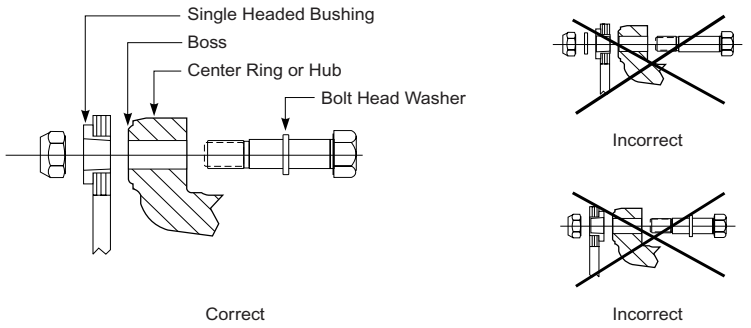


Figure 9 - Correct and Incorrect Assembly of the Bolt and Bolt Head Washer with the Center Ring and the TPack Disc Pack Bushing.

DANGER!

The bolt head washer must be placed under the bolt head so that it is between the bolt head and the flange, as shown in the correct method of Figure 9. If it is placed on the bolt after the single headed bushing, it could become trapped between the locknut and the bolt body. This could prevent the locknut from fully clamping the disc pack which could result in looseness and fracture of the bolted joint.

9.5. Lubricate the bolt threads with clean motor oil. Install four locknuts, and slightly tighten them using an alternating progressive pattern making sure the disc pack is not distorted and all the bolts are fully seated. Tighten each locknut to the appropriate torque value shown in Table 4, using an incremental torque in a progressive alternating pattern.

9.6. Make sure that the bolts and bolt head washers in the other end of the center ring do not fall out before mounting the flywheel adapter.

9.7. Mount the flywheel adapter to the disc pack, by inserting four bolts with bolt head washers through the holes in the back side of the flywheel adapter, as shown in Figure 10. Seat the bolt heads and washers in the slots provided and then install the bolts through the remaining four single headed bushings in the disc pack.

Table 4 - Locknut Tightening Torques

Series 52 Coupling Size	Hub Flange Diameter CMR = "D" AMR = "A"		Tightening Torque for Steel Locknut (For Stainless Steel see Note 3)				Bolt Head
			Thread Size	Torque		Wrench Hex Size Inch	Wrench Hex Size Inch
	Inch	mm	Inch	Ft-Lb*	Nm		
225	5.69	144.5	5/16-24 UNF	25	34	1/2	1/2
262	6.63	168.4	3/8-24 UNF	30*	41*	9/16	5/8
312	7.81	198.4	7/16-20 UNF	40*	54*	11/16	11/16
350	8.69	220.7	1/2-20 UNF	95	129	3/4	13/16
375	9.69	246.1	9/16-18 UNF	130	176	7/8	15/16
425	10.50	266.7	5/8-18UNF	175	237	15/16	1-1/16
450	11.31	287.3	11/16-16 UNF	150*	203*	1-1/8	1-1/8
500	12.88	327.2	3/4-16 UNF	190*	258*	1-1/4	1-1/4
550	14.44	366.8	7/8-14 UNF	255*	346*	1-7/16	1-7/16
600	16.00	406.4	1-14 UNS	335*	454*	1-5/8	1-5/8
700	18.25	463.6	1-1/8-12 UNF	425*	576*	1-13/16	1-13/16
750	19.81	503.2	1-1/4-12 UNF	560*	759*	2	2

* These locknuts are cadmium plated. Do not use any lubricant other than clean motor oil.

1. These torque values are approximate for bolts with threads lubricated with clean motor oil. The locknuts are prevailing torque type and some resistance will be felt. If thread galling is suspected, immediately stop and contact Rexnord.
2. Bolts should be held stationary while the locknuts are tightened to the values shown. Do not tighten the fastener by rotating the bolt.
3. Air driven wrenches for fastener assembly are not permitted (heat build up may lead to thread damage during assembly).

ATTENTION! On sizes 225 through 750 the bolt heads will protrude from the back side of the adapter, as shown in Figure 10. If this interferes with the mounting of the adpater to the flywheel, contact Rexnord for bolts with modified bolt heads. Table 5 shows the amount of bolt head protrusion as well as the circumscribed diameter over the bolt heads.

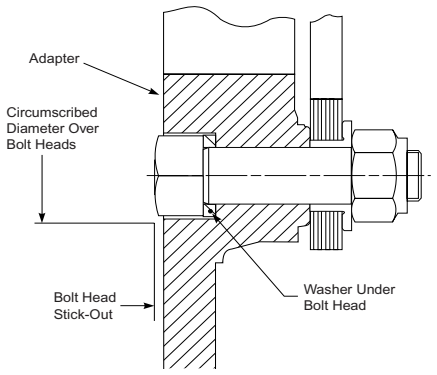


Figure 10 - Bolt assembly into adapter

Table 5 - Bolt Head Protrusion and Circumscribed Diameter Over Bolt Heads

Size of AMR/CMR Coupling	Bolt Head Protrusion		Circumscribed Diameter Over Bolt Heads	
	Inch	mm	Inch	mm
225	0.030	0.76	5.33	135.4
262	0.060	1.52	6.15	156.2
312	0.080	2.03	7.22	183.4
350	0.100	2.54	8.19	208.0
375	0.110	2.79	9.09	230.9
425	0.140	3.56	9.85	250.2
450	0.150	3.81	10.55	268.0
500	0.190	4.83	11.95	303.5
550	0.230	5.84	13.41	340.6
600	0.270	6.86	14.88	378.0
700	0.310	7.87	16.84	427.7
750	0.350	8.89	18.31	465.1

9.8. Lubricate the bolt threads with clean motor oil. Install four locknuts, and slightly tighten them using an alternating progressive pattern making sure the disc pack is not distorted and all the bolts are fully seated. Tighten each locknut to the appropriate torque value shown in Table 4, using an incremental torque in a progressive alternating pattern.

9.9. The disc pack, when installed, should look flat and parallel with the mating adapter and the center ring bosses (located around the bolt holes on the radial extensions of the center ring).

9.10. With the hub mounted and the "C" length set per the allowable dimension and tolerance range shown in Table 3, put the subassembly (flywheel adapter, disc pack, and center ring) into place between the equipment flywheel and hub.

9.11. Push the end of the four bolts on the hub end, so that they do not extend beyond the bosses on the face of the center ring. This will provide clearance during assembly.

9.12. Bolt the adapter to the flywheel in the manner prescribed by the manufacturer.

9.13. Prepare to install the remaining Tpack disc pack by rotating the hub or center ring so that the hub bolt holes are centered between the radial extensions from the center ring.

ATTENTION! It may help with the installation of the second Tpack disc pack to compress the Tpack disc pack on the flywheel adapter side. Use clamps to squeeze the center ring toward the flywheel adapter or a pry bar on the first end to push the center ring toward the flywheel adapter.

9.14. Install the remaining Tpack discpack between the center ring and hub.

9.15. Align the Tpack disc pack with the bolt holes in the radial extensions of the center ring so that the single headed bushings in the Tpack are opposite the center ring bosses as shown in Figure 9. Use caution to ensure that bolt head washer and Tpack disc pack are not assembled incorrectly as shown in the incorrect methods in Figure 9.

9.16. Push the four bolts in the center ring through the Tpack single headed bushings and the clearance holes in the hub. It may be helpful to align and push one bolt first, and then pivot the Tpack disc pack to align and push the other bolts.

9.17. Place a bolt head washer on each of four bolts, and insert one bolt with the bolt head washer through each of the four bolt holes in the hub, and through the single headed bushing in the Tpack disc pack, as shown in Figures 2 and 3.

9.18. Remove any clamps or pry bars used to compress the disc pack assembly.

9.19. Lubricate the threads on all eight bolts with clean motor oil.

9.20. Install locknuts onto the bolts and slightly tighten all eight locknuts using an alternating progressive pattern making sure the disc pack is not distorted and all the bolts are fully seated.

9.21. Make the final coupling alignment check at this time.

9.22. Tighten all eight locknuts to the appropriate torque value shown in Table 4, using an incremental torque in a progressive alternating pattern.

9.23. It is recommended that all locknuts have their tightening torque checked after several hours of operation, per Table 4.

AMR – WHEN TWO HUBS ARE USED

9.24. If the coupling arrived assembled, the Tpack disc packs are still attached to the center ring. Remove the locknuts and Tpack disc packs from the center ring, but do not remove the bolts and bolt head washers.

9.25. Push the end of the eight bolts, so that they do not extend beyond the bosses on the face of the center ring. This will provide clearance during assembly.

9.26. With the hubs mounted and the span length “C” set, position the center ring between the two hubs. Care should be taken when handling the center ring.

9.27. Support the center ring on wood blocks, with nylon straps from a hoist, or some other convenient way. It may help to support the end that is not being worked on, by pushing the bolts through the center ring bolt holes and into the hub flange bolt holes. This will hold the parts in line at that end.

9.28. Rotate the hub or center ring so that the hub bolt holes are centered between the bolt holes in the radial extensions from the center ring. (This will position the clearance holes in the hub with the radial extension and bolt holes of the center ring.)

9.29. If not already preassembled, place a bolt head washer on each bolt and install eight bolts with a bolt head washer into all eight bolt holes in the radial extensions in the center ring, as shown in Figure 9. To provide clearance during assembly, the bolt threads should not extend beyond the bosses on the face of the center ring,

9.30. Slide a Tpack disc pack between the center ring and the hub so that the single headed bushings in the Tpack are opposite the center ring bosses as shown in Figure 9.

9.31. Push four bolts with the bolt head washer through the bolt hole in the center ring, through the Tpack disc pack single headed bushing, and through the clearance hole in the hub. It may be helpful to align and push one bolt first, and then pivot the Tpack disc pack to align and push the other bolts.

DANGER!

The bolt head washer must be placed under the bolt head so that it is between the bolt head and the flange, as shown in Figure 9. If it is placed on the bolt after the single headed bushing, it could become trapped between the locknut and the bolt body. This could prevent the locknut from fully clamping the disc pack which could result in looseness and fracture of the bolted joint.

9.32. Place a bolt head washer on each of four bolts, and insert one bolt with the bolt head washer through each of the four bolt holes in the hub, and through the single headed bushing in the Tpack disc pack, as shown in Figures 2 and 3. Lubricate the threads on all eight bolts with clean motor oil.

9.33. Install locknuts onto the bolts and slightly tighten all eight locknuts using an alternating progressive pattern making sure the disc pack is not distorted and all the bolts are fully seated.

9.34. Use caution to ensure that bolt head washers and Tpack disc pack are not assembled incorrectly as shown in the incorrect methods in Figure 9.

9.35. Tighten all eight locknuts to the appropriate torque value shown in Table 4, using an incremental torque in a progressive alternating pattern.

9.36. Proceed to the other end to install the remaining Tpack disc pack. Support the center ring and retract the support bolts, if used.

9.37. Rotate the hub or center ring so that the hub bolt holes are centered between the bolt holes in the radial extensions from the center ring. (This will position the clearance holes in the hub with the radial extension and bolt holes of the center ring.)

☞ **ATTENTION!** It may help with the installation of the second Tpack disc pack to compress the first installed Tpack using clamps to squeeze the center ring toward the first Tpack and hub flange, or use a pry bar on the first end to push the center ring toward the hub flange.

9.38. Install the remaining Tpack discpack between the center ring and hub.

9.39. Align the Tpack disc pack with the bolt holes in the radial extensions of the center ring so that the single headed bushings in the Tpack are opposite the center ring bosses as shown in Figure 9. Use caution to ensure that bolt head washer and Tpack disc pack are not assembled incorrectly as shown in the incorrect methods in Figure 9.

9.40. Push the four bolts in the center ring through the Tpack single headed bushings and the clearance holes in the hub. It may be helpful to align and push one bolt first, and then pivot the Tpack disc pack to align and bush the other bolts.

9.41. Place a bolt head washer on each of four bolts, and insert one bolt with the bolt head washer through each of the four bolt holes in the hub, and through the single headed bushing in the Tpack disc pack, as shown in Figures 2 and 3.

9.42. Remove any clamps or pry bars, if they were used to compress the disc pack assembly.

9.43. Lubricate the threads on all eight bolts with clean motor oil.

9.44. Install locknuts onto the bolts and slightly tighten all eight locknuts using an alternating progressive pattern making sure the disc pack is not distorted and all the bolts are fully seated.

9.45. Make the final coupling alignment check at this time.

9.46. Tighten all eight locknuts to the appropriate torque value shown in Table 4, using an incremental torque in a progressive alternating pattern.

9.47. It is recommended that all locknuts have their tightening torque checked after several hours of operation, per Table 4.

9.48. For further help with the installation or alignment, consult Rexnord.

10. Disc Pack Replacement –

⚠ **CAUTION: CMR/AMR Sizes 225 through 750 use the Tpack™ unitized disc pack. If original Thomas round nonunitized (not a Tpack) disc packs are being replaced by the Tpack disc packs, the original thick beveled washers must be discarded. Use of the thick beveled washers with the Tpack disc pack could cause insufficient thread engagement, preventing the locknut from fully clamping the disc pack which could result in looseness and fracture of the bolted joint.**

10.1. If it becomes necessary to replace the disc packs, it can be done as follows.

10.2. Support the center ring at the hub end of the coupling, remove all locknuts on this end.

10.3. Back out and remove all but one bolt. It may be necessary to tap the ends of the bolts with a soft hammer to start them out.

10.4. Pivot the disc pack to move it from the center of the coupling assembly.

10.5. Remove the last bolt and slide the disc pack out.

FOR THE CMR COUPLING

10.6. Remove the bolts that hold the flywheel adapter to the flywheel. Be sure to support the center ring assembly when taking out the last bolts.

10.7. Remove the adapter, disc pack, and center ring assembly and put it on a bench.

10.8. Remove all the locknuts, washers, and bolts that hold the center ring to the disc pack. Remove the center ring.

10.9. Remove the remainder of the locknuts, washers, and bolts.

10.10. Replace parts as necessary. Recheck alignment using the procedure defined in Section 8.0, Shaft Alignment.

10.11. Reassemble using the procedure described in Section 9.0, Final Assembly.

FOR THE AMR COUPLING

10.12. Disassemble the other end, by repeating the disassembly procedure at the beginning of this section.

10.13. Be sure to support the center ring when taking out the last bolts.

10.14. Remove the center ring.

10.15. Replace parts as necessary. Recheck alignment using the procedure defined in Section 8.0, Shaft Alignment.

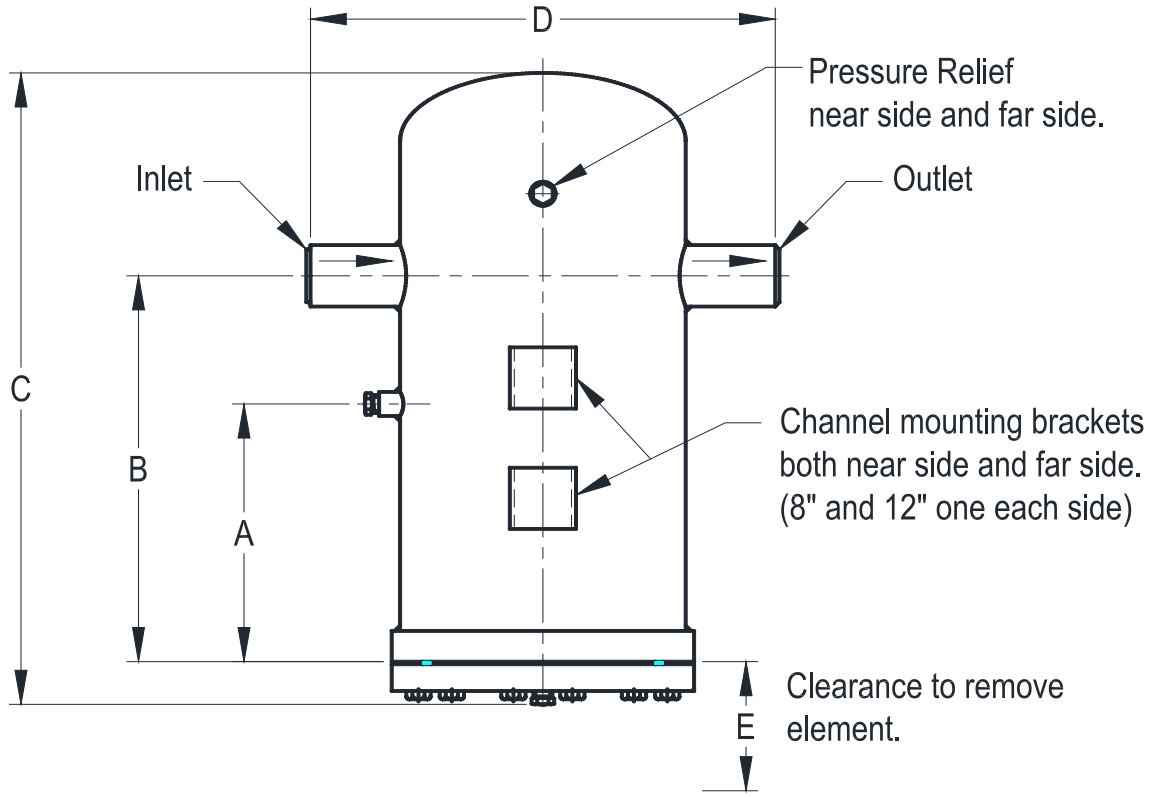
10.16. Reassemble using the procedure described in Section 9.0, Final Assembly.

10.17. It is recommended that all locknuts have their tightening torque checked after several hours of operation, per Table 4.

10.18. For spare replacement part numbers, see Table 1.

Appendix M
Super Separators General Dimensions & Mountings

General Dimensions for Bottom Flanged Super Seperators

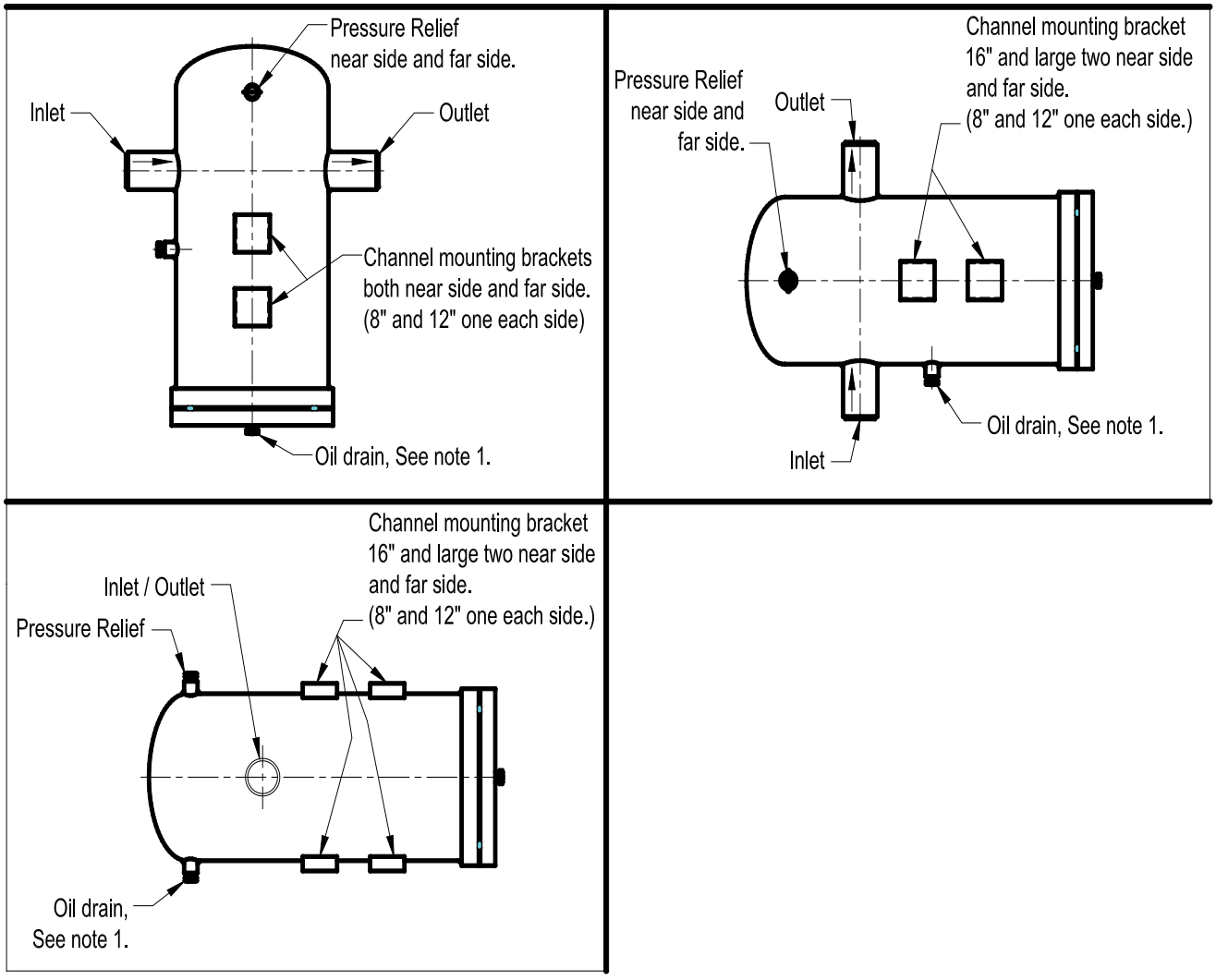


Part Number	Part Number (Heat Treated)	Part Number (With Spot X-ray)	O.D.	Design Pressure PSI	Inlet & Outlet Size	A	B	C	D	E	Weight Lbs.
A68005A	A68005AH	A68005ASX	8-5/8	370	2	13-5/16	22-7/8	28-3/4	16-5/8	13	135
A68005B	A68005BH	A68005BSX	12-3/4	370	2-1/2	12-1/16	18-1/16	30	20-3/4	11	220
A68005C	A68005CH	A68005CSX	16	370	3	24-3/4	35	43-5/8	24	23	495
A68005D	A68005DH	A68005DSX	20	370	4	39	51-7/16	61-3/16	28	34	735
A68005E ▲	A68005EH ▲	A68005E ▲	24	370	5	40-9/16	53-3/16	64-3/16	32	34	985
A68005F	A68005FH		8-5/8	370	2-1/8 ODS	13-5/16	19-5/16	28-3/4	16-5/8	13	135
A68005G ▲	A68005GH ▲	A68005G ▲	24	400	5	39	53-1/4	64-5/16	32-1/2	34	985

Notes:

1. For Super Separator mounting positions see next page.
2. All drains and pressure relief connections are 3/4" FPT.
3. ▲ 24" Super Separators A68005E, EH, G, and GH are Spot X-rayed as a requirement of Vilter's ASME design.
4. Code of Design and Construction: ASME Section VIII, Division 1.

Super Separators Mounting Positions



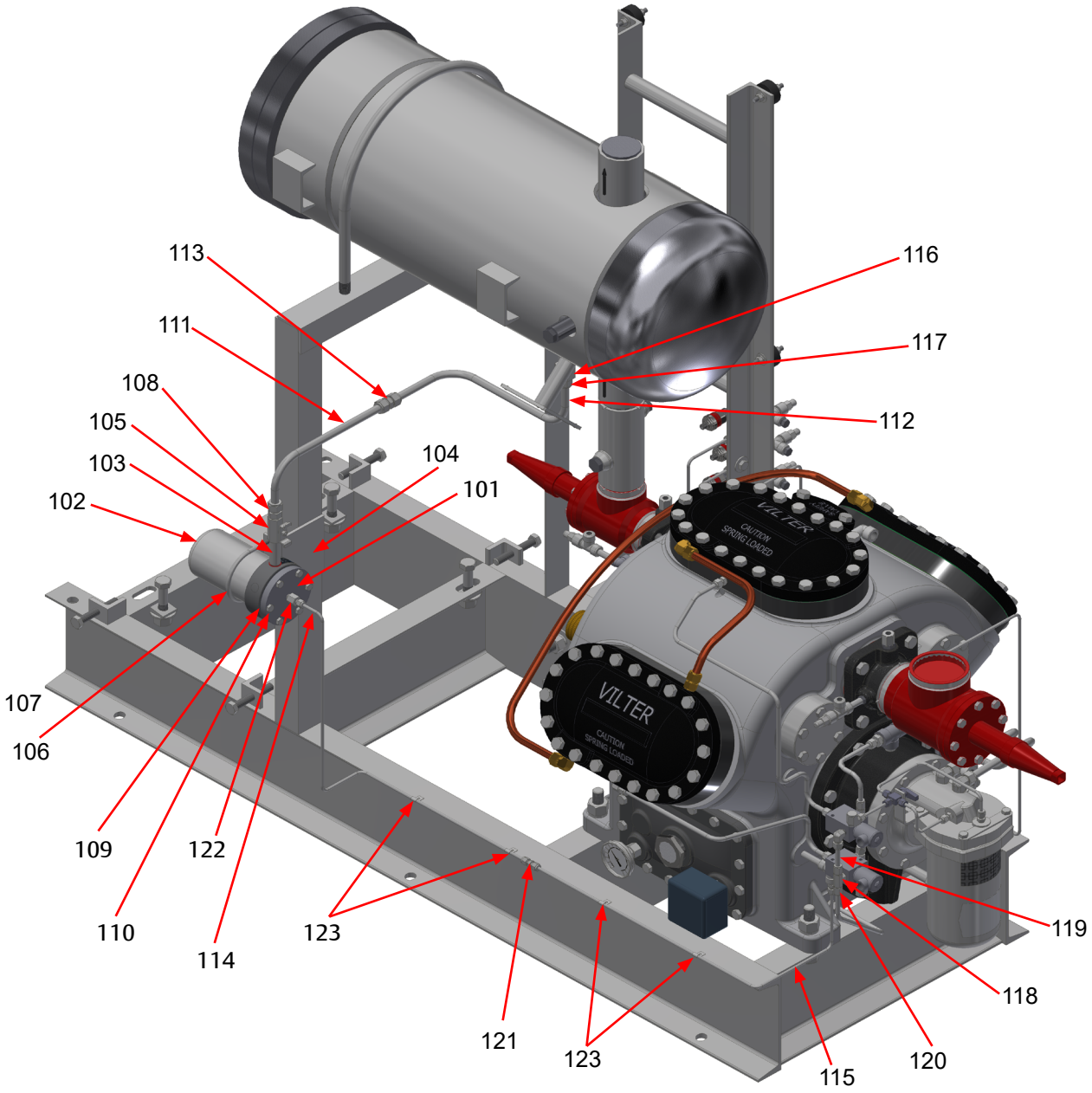
Notes:

1. Do not mount oil return float valve assembly directly to the vessel coupling. The float chamber must be supported externally to eliminate the possibility of drain line breakage due to vibration. Do not rely on the refrigerant piping alone for support.

Appendix N
Oil Return Line Piping

Oil Return Line Piping

Super Oil Separator® with External High Pressure Float Valve & Accessories



Notes:

1. 400 Series Compr.: Return Oil Into Crankcase Chamber Thru Frame On Pump End.
2. Before Putting The Float Under Pressure Open It And Verify The Float Arm Is Not Secured With A Zip-Tie. (These Prevent Damage During Hipping).
3. Support float chamber externally. Do not rely only on piping. The position of the float chamber should be above the conduit box of the motor.

Table N-1. Bill of Material

ITEM	QTY	PART NUMBER	DESCRIPTION	CUT LENGTH
101	1	A66999A	VALVE HP FLOAT BALL ASSY	
102	1	A67000A	CHAMBER HP FLOAT VALVE 400#	
103	1	1749B	NIPPLE 1/2X3 PIPE SCH160 SMLS	3 in
104	1	15660A	BRACKET FLOAT VALVE SUPPORT	
105	1	1956H	VALVE 1/2 BALL STEEL BODY W/VENT	
106	1	2120L	U-BOLT 3-1/2 ELECTRO GALV 3/8- 16 ROD	
107	2	1726C	NUT 3/8- 16NC -2B HEX HVY PLAIN	
108	1	13229X	CONNECTOR 5/8ODTX1/2MPT COMPRESSION	
109	1	65544A	GASKET 3-11/16X3-1/8 FLANGE FLOAT	
110	6	2796CJ	SCREW 3/8-16NCX1-1/4 CAP HEX HD GR5	
111	1	3509D	TUBING 5/8X.049 STEEL SMLS	13 5/16 in
112	1	3509D	TUBING 5/8X.049 STEEL SMLS	19 5/16 in
113	1	1458G	UNION 5/8OD TUBING	
114	1	3509A	TUBING 1/4X.035 STEEL SMLS	34 3/8 in
115	1	3509A	TUBING 1/4X.035 STEEL SMLS	33 1/2 in
116	1	13193D	NIPPLE 3/4X3 PIPE SCH80 SA106 GRB	3 in
117	1	3081JEEA	CONNECTOR 5/8ODX3/4FPT FEMALE STL P	
118	1	3031C	VALVE 1/4 ANG FPT SC	
119	1	13181D	NIPPLE 1/4X2-1/2 PIPE SCH80 SMLS	2 1/2 in
120	1	13229D	CONNECTOR 1/4ODTX1/4MPT COMPRESSION	
121	1	1458C	UNION 1/4OD TUBING	
122	1	1468A	CONNECTOR 1/4ODTX1/4FPT FEMALE	
123	4	1253A	CLIP 1/4 JIFFY	

About Vilter

Vilter is a technology leader in energy-efficient, environmentally conscious solutions in its industry. The 150-year history of the Vilter brand tells a rich story of perseverance and drive to cultivate continuous innovation within the industrial refrigeration and gas compression industries. Vilter offers unprecedented efficiency, productivity and reliability in cooling, recovery, and compression. It combines best-in-class technology with proven engineering and design to create quality products and latest solutions for customers worldwide.

About Copeland

Vilter Manufacturing LLC is a business segment of Copeland, a global leader in providing sustainable climate solutions for customers in industrial, commercial and consumer markets around the world. Copeland combines category-leading brands in compression, controls, software and monitoring for heating, cooling and refrigeration. With best-in-class engineering and design and the broadest portfolio of modulated solutions, we're not just setting the standard for compressor leadership; we're pioneering its evolution. Combining our technology with our smart energy management solutions, we can regulate, track, and optimize conditions to help protect temperature-sensitive goods over land and sea, while delivering comfort in any space. Through energy-efficient products, regulation-ready solutions, and expertise, we're revolutionizing the next generation of climate technology for the better. For more information please visit

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