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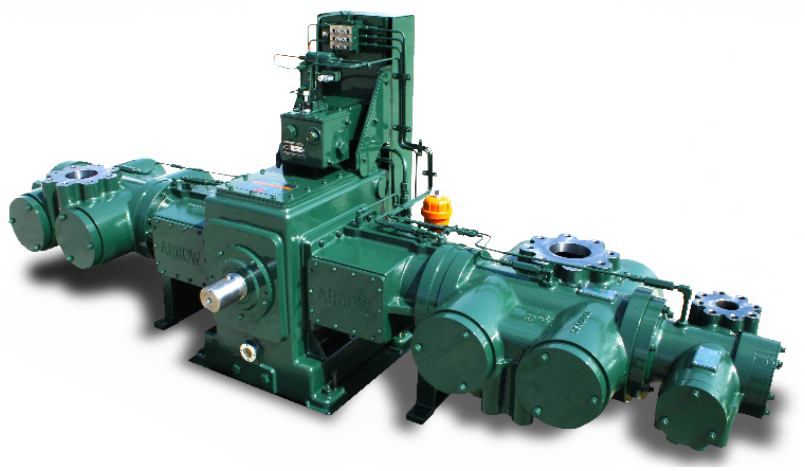
VRS-2

OPERATIONS MANUAL



ARROW ENGINE™
ENGINES & COMPRESSION

ARROW ENGINE COMPANY
2301 E. Independence St., Tulsa, OK 74110
www.arrowengine.com

VRS2-OM-JAN2024

VRS-2

OPERATIONS MANUAL

Very Reliable Super Compressor
Two-throw

VRS2-OM-JAN2024

2301 E. Independence St.

Tulsa, OK 74110

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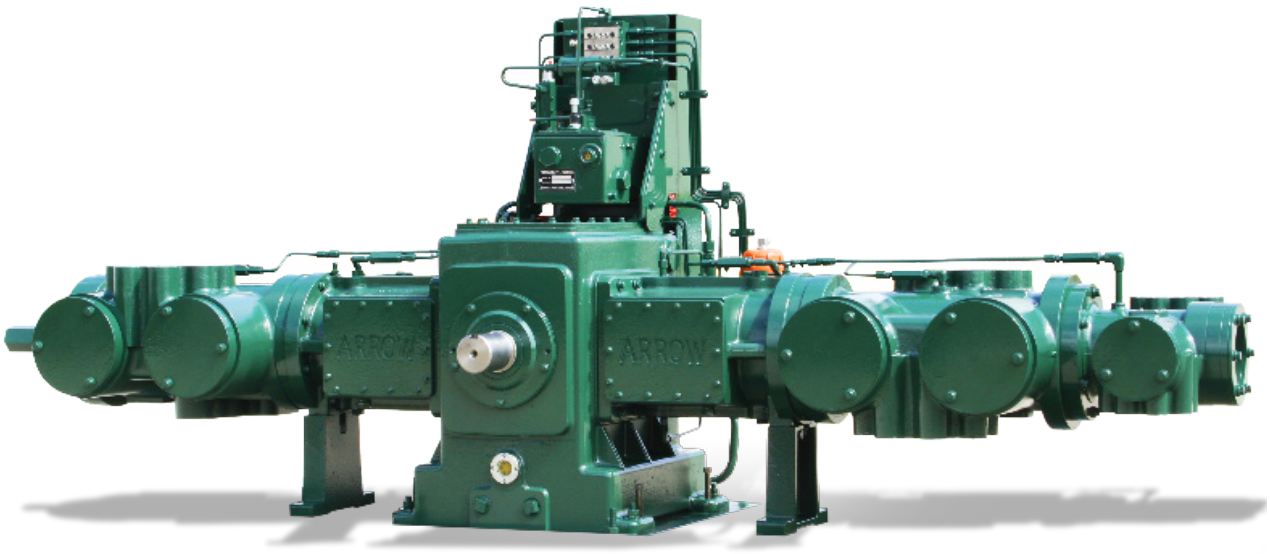
2 INTRODUCTION



2.1 Purpose of this Manual

This manual is designed to provide information, specifications, maintenance, and instructions regarding the Arrow Engine VRS-2 gas compressor.

This manual provides design specifications standards for the VRS-2 gas compressor at time of publication of this material. If you have any questions regarding any of this material, please contact your packager. If they are unable to assist, you may always contact Arrow Engine at 1-800-331-3662.

This manual provides design specifications for standard current production equipment at the date of publication. Do not exceed information plate ratings for the VRS-2 Compressor.

3 DESIGN SPECIFICATIONS

3.1 Arrow Engine VRS-2 Compressor Overview

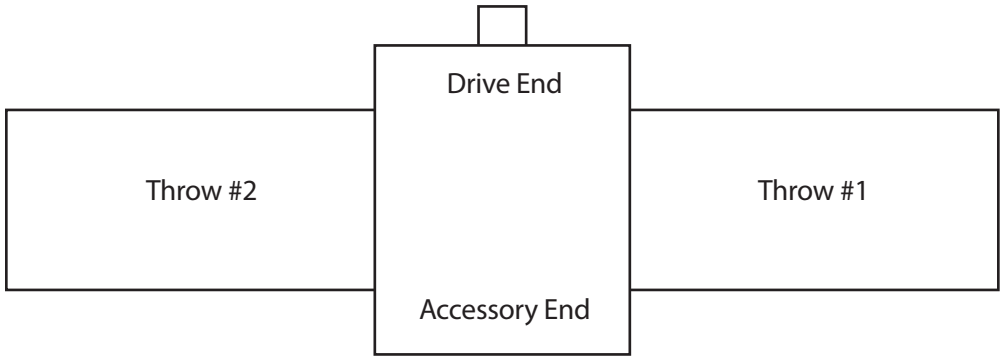
The Arrow VRS-2 is a two-throw separable reciprocating gas compressor. The horizontally opposed cylinders are accurately balanced for smooth running and long-lasting durability at 1,800 RPM. Unlike many other reciprocating compressors, the VRS-2 has a unique three-throw crankshaft configuration that eliminates opposing cylinder off-set and the vibration associated with traditional designs.

The absolute alignment of opposing cylinders provides perfectly balanced weight distribution and symmetry. The elimination of vibration associated with horizontal couple inherent with traditional designs, along with state-of-the-art engineering design and rugged construction, make the VRS-2 a truly balanced, high-performance, durable compressor specifically designed for continuous operation at high speed. The 1,800 RPM speed design, 275 horsepower rating and 20,000-pound combined rod load capability make the VRS-2 a perfect fit for direct coupling with today's higher speed gas engines.

The Arrow VRS-2 can be packaged for single, two-stage, and three-stage applications with cylinder size from 1.125" to 10". Cylinders are air-cooled which reduces packaging and maintenance costs. As a standard feature, cylinders have a variable volume clearance pocket for flexibility and adjustment to allow accurate fits for changing field conditions.

The use of a pressurized lubrication system, highly efficient Hoerbiger valves, industry proven accessories, innovative engineering design, and close attention to quality make the Arrow VRS-2 gas compressor unequaled in the industry.

3.1.1 Compressor Frame Nomenclature



3.2 Compressor Frame Specifications

VRS-2 COMPRESSOR FRAME SPECIFICATIONS	
STROKE	3 inches (76.2 mm)
SPEED, RPM (MAXIMUM)	1,800 RPM
PISTON SPEED	900 ft/min (4.57 m/s)
NUMBER OF THROWS	2
HORSEPOWER	275 HP (205 kw)
PISTON ROD DIAMETER	1.125 inches (28.575 mm)
CRANKSHAFT DIAMETER	2.75 inches (69.85 mm)
HEIGHT - BOTTOM TO CRANKSHAFT	13 inches (330.2 mm)
MAXIMUM WIDTH	100 inches (2.54 m)
MAXIMUM LENGTH	33 inches (0.838 m)
APPROXIMATE WEIGHT WITH CYLINDERS	2500 lbs. (1133.95 kg)
ROD LOAD - TENSION	10,000 lbs. (4535.9 kg)
ROD LOAD - COMPRESSION	10,000 lbs. (4535.9 kg)
ROD LOAD COMBINED	20,000 lbs. (9071.8 kg)
OIL PUMP CAPACITY	4 GPM (15 LPM)
OIL HEAT REJECTION	3750 BTU/hr. (945 Kal/HR)
OIL SUMP CAPACITY	4 gal. (15 L)

Table 3.1. VRS-2 Compressor Specifications

COMPONENTS	INCHES (mm)
CRANKSHAFT MAIN BEARING DIAMETER	3.937 (99.999)
CRANK PIN DIAMETER	3.125 (79.375)
MAIN BEARING TYPE	Spherical Roller
CONNECTING ROD LENGTH CL-CL	8.375 (212.725)
CONNECTING ROD BEARING WIDTH (SINGLE)	1.745 (44.323)
CONNECTING ROD BUSHING WIDTH (SINGLE)	2.125 (53.975)
CONNECTING ROD BOLTS (SINGLE)	(FOUR) 1/2”
CONNECTING ROD BEARING WIDTH (DOUBLE)	1.370 (34.798)
CONNECTING ROD BUSHING WIDTH (DOUBLE)	1.125 (28.575)
CONNECTING ROD BOLTS (DOUBLE)	(TWO) 1/2”
CROSSHEAD SURFACE	5.50 X 4.0 (139.7 x 101.6)
FLOATING CROSSHEAD PIN DIAMETER	2.499 (63.475)
PISTON ROD DIAMETER	1.125 (28.575)

Table 3.2. VRS-2 Compressor Components

MATERIALS	
FRAME	Class 40 Gray Iron
CRANKSHAFT	Forging With Induction Hardened Journals
CONNECTING RODS	Forging
CONNECTING ROD BEARINGS	Tri-Metal
CROSSHEADS	65-45-12 Ductile Iron with Babbitt
CROSSHEAD PINS	SAE 8620
CROSSHEAD PIN BUSHINGS	SAE 660 Bronze
PISTON RODS	SAE 4140 Induction Hardened
PACKING RINGS	Carbon Filled Teflon with Cast Iron Backup Rings
PISTON	Ductile Iron or Anodized Aluminum
PISTON RINGS	Carbon Filled Teflon
CYLINDERS	80-55-06 Ductile Iron

Table 3.3. VRS-2 Compressor Materials

CLEARANCES (AS NEW)		
	CLEARANCE	
DESCRIPTION	INCHES	mm
Crankshaft Thrust (End Play)	0.004 to 0.020	0.102 to 0.508
Crankshaft Pin to Connecting Rod Bearing	0.0015 to 0.0040	0.038 to 0.102
Connecting Rod Thrust (Side)	0.007 to 0.016	0.178 to 0.406
Connecting Rod Bushing to Crosshead Pin	0.0014 to 0.0031	0.0356 to 0.079
Crosshead to Crosshead Pin	0.0015 to 0.0025	0.038 to 0.064
Crosshead to Guide (Feeler Gauge)	0.007 to 0.011	0.178 to 0.279
Piston End Clearance - Crank End (Double-acting)	30% of Total Clearance - 0.050 (approx.)	1.270 (approx.)
Piston End Clearance - Head End (Double-acting)	70% of Total Clearance - 0.093 (approx.)	2.362 (approx.)
Piston End Clearance - Crank End (Steeple Cylinder)	30% of Total Clearance - 0.063 (approx.)	1.600 (approx.)
Piston End Clearance - Head End (Steeple Cylinder)	70% of Total Clearance - 0.093 (approx.)	2.362 (approx.)
Maximum Acceptable Piston Rod Run-out - Vertical	0.002	0.051
Maximum Acceptable Piston Rod Run-out - Horizontal	0.001	0.025

Table 3.4. VRS-2 Compressor Clearances

ARROW VRS-2 DOUBLE-ACTING CYLINDER DATA							
BORE IN.	FLANGE SIZE IN/RATING	VALVE TYPE	LIFT AREA SUCT/DISCH SQ/IN.	VALVE LIFT SUCT/DISCH IN.	ADDED CLEARANCE/ MAXIMUM %	MAWP PSI	RDP PSI
2.5	1.5″/900#	42 CRE	0.82/0.59	.055/.039	44 W/HEAD SPACERS	2250	2025
2.5 HP	1.5″/1500#	42 CRE	0.59/0.47	.039/.031	44 W/HEAD SPACERS	2750	2475
3.0	1.5″/900#	42 CRE	0.82/0.59	.055/.039	40 W/HEAD SPACERS	2250	2025
3.0 HP	1.5″/1500#	42 CRE	0.59/0.47	.039/.031	40 W/HEAD SPACERS	2750	2475
3.5	2″/600#	60 CRE	1.90/1.43	.063/.047	56 W/VVCP	1270	1150
4.0	2″/600#	60 CRE	1.90/1.43	.063/.047	42 W/VVCP	1270	1150
4.5	2.5″/600#	70 CRE	2.25/1.69	.063/.047	52 W/VVCP	1100	990
5.0	2.5″/600#	70 CRE	2.25/1.69	.063/.047	42 W/VVCP	1100	990
5.5	3″/300#	88 CRE	3.88/3.09	.079/.063	52 W/VVCP	635	575
6.0	3″/300#	88 CRE	3.88/3.09	.079/.063	44 W/VVCP	635	575
6.5	4″/300#	98 CRE	4.31/3.44	.079/.063	59 W/VVCP	500	450
7.0	4″/300#	98 CRE	4.31/3.44	.079/.063	52 W/VVCP	500	450
7.5	4″/300#	105 CRE	5.83/4.67	.079/.063	59 W/VVCP	350	315
8.0	4″/300#	105 CRE	5.83/4.67	.079/.063	52 W/VVCP	350	315
9.5	6″/150#	98 CRE (2/corner)	4.31/3.44	.079/.063	100 W/VVCP	250	225
10.0	6″/150#	98 CRE (2/corner)	4.31/3.44	.079/.063	96 W/VVCP	250	225

NOTE: HP= Special high-pressure rated cylinders

Table 3.5. VRS-2 Compressor Double-acting Cylinder Data

ARROW VRS-2 STEEPLE CYLINDER DATA							
BORE SACE X SAHE IN	FLANGE SIZE IN/RATING	VALVE TYPE	LIFT AREA SUCT/DISCH SQ/IN.	VALVE LIFT SUCT/DISCH IN.	ADDED CLEARANCE MAXIMUM %	MAWP PSI	RDP PSI
2.5/1.375	1.5″/1500# X 1.5″ SPECIAL FLG.	42 CRE/42 CRE 46030 OR 40030	.59/.59 .152/.164	.039/.039 .039/.031	0 0	2750/6000	2475/ 5400
3.0/1.375	1.5″/1500# X 1.5″ SPECIAL FLG.	42 CRE/42 CRE 46030 OR 40030	.59/.59 .152/.164	.039/.039 .039/.031	0 0	2750/6000	2475/ 5400
3.5/2.25	2.0″/600# X 1.5″/1500#	60 CRE 42 CRO	1.90/1.43 0.76/0.65	.063/.047 .055/.047	26 WITH HEAD SPACERS	1270/2550	1150/ 2025
4.0/2.25	2.0″/600# X 1.5″/1500#	60 CRE 42 CRO	1.90/1.43 0.76/0.65	.063/.047 .055/.047	26 WITH HEAD SPACERS	1270/2250	1150/ 2025
4.5/2.50	2.5″/600# X 1.5″/1500#	70 CRE 42 CRO	2.25/1.69 0.76/0.65	.063/.047 .055/.047	26 WITH HEAD SPACERS	1100/2250	990/ 2025
4.5/3.0	2.5″/600# X 1.5″/900#	70 CRE 60 CRO	2.25/1.69 1.64/1.23	.063/.047 .063/.047	26 WITH HEAD SPACERS	1100/1500	990/ 1350
4.5/3.5	2.5″/600# X 1.5″/900#	70 CRE 60 CRO	2.25/1.69 1.64/1.23	.063/0.47 .063/.047	26 WITH HEAD SPACERS	1100/1500	990/ 1350
5.0/2.50	2.5″/600# X 1.5/1500#	70 CRE 42 CRO	2.25/1.69 0.76/0.65	.063/.047 .055/.047	26 WITH HEAD SPACERS	1100/2250	990/ 2025
5.0/3.0	2.5″/600# X 1.5″/900#	70 CRE 60 CRO	2.25/1.69 1.64/1.23	.063/.047 .063/.047	26 WITH HEAD SPACERS	1100/1500	990/ 1350
5.0/3.5	2.5″/600# X 1.5″/900#	70 CRE 60 CRO	2.25/1.69 1.64/1.23	.063/.047 .063/.047	26 WITH HEAD SPACERS	1100/1500	990/ 1350
5.5/3.0	3.0″/300# X 1.5″/900#	88 CRE 60 CRO	3.88/3.09 1.64/1.23	.079/.063 .063/.047	26 WITH HEAD SPACERS	635/1500	575/ 1350
5.5/3.5	3.0″/300# X 1.5″/900#	88 CRE 60 CRO	3.88/3.09 1.64/1.23	.079/.063 .063/.047	26 WITH HEAD SPACERS	635/1500	575/ 1350
6.0/3.0	3.0″/300# X 1.5″/900#	88 CRE 60 CRO	3.88/3.09 1.64/1.23	.079/.063 .063/.047	26 WITH HEAD SPACERS	635/1500	575/ 1350
6.0/3.5	3.0″/300# X 1.5″/900#	88 CRE 60 CRO	3.88/3.09 1.64/1.23	.079/.063 .063/.047	26 WITH HEAD SPACERS	635/1500	575/ 1350
6.5/4.0	4.0″/300# X 2.0″/600#	98 CRE 70 CRO	4.31/3.44 2.12/1.60	.079/.063 .063/0.47	26 WITH HEAD SPACERS	500/1000	450/ 900
6.5/4.5	4.0″/300# X 2.0″/600#	98 CRE 70 CRO	4.31/3.44 2.12/1.60	.079/.063 .063/.047	26 WITH HEAD SPACERS	500/1000	450/ 900
7.0/4.0	4.0″/300# X 2.0″/600#	98 CRE 70 CRO	4.31/3.44 2.12/1.60	0.79/.063 .063/.047	26 WITH HEAD SPACERS	500/1000	450/ 900
7.0/4.5	4.0″/300# X 2.0″/600#	98 CRE 70 CRO	4.31/3.44 2.12/1.60	0.79/0.63 .063/.047	26 WITH HEAD SPACERS	500/1000	450/ 900

Table 3.6. VRS-2 Compressor Steeple Cylinder Data

3.3 Piston Ring Side Clearance and End Gap

The standard side clearance in inches (mm) for the VRS-2 Compressor piston rings, when new, is shown in the following tables:

NEW CONVENTIONAL PISTON RING SIDE CLEARANCE		
NOMINAL WIDTH	**ACTUAL GROOVE WIDTH inches (mm)**	**TEFLON ONE-PIECE inches (mm)**
1/4 (6.35)	0.250 to 0.252 (6.35 to 6.4008)	0.005 to 0.009 (0.127 to 0.2286)
3/8 (9.53)	0.375 to 0.377 (9.525 to 9.5758)	0.007 to 0.011 (0.1778 to 0.2794)

Table 3.7. VRS-2 Compressor Piston Ring Side Clearance

NEW RIDER RING PISTON RING SIDE CLEARANCE		
NOMINAL WIDTH	**ACTUAL GROOVE WIDTH inches (mm)**	**TEFLON ONE-PIECE inches (mm)**
1/2 (12.7)	0.500 to 0.502 (12.70 to 12.7508)	0.008 to 0.013 (0.2032 to 0.3302)
3/4 (19.05)	0.750 to 0.752 (19.05 to 19.1008)	0.014 to 0.019 (0.3556 to 0.4826)

Table 3.8. VRS-2 Compressor New Rider Ring Piston Ring Side Clearance

PISTON TO BORE CLEARANCE AND CONVENTIONAL PISTON RING END GAP FOR DOUBLE-ACTING AND STEEPLE CYLINDERS		
BORE DIAMETER (INCHES)	**PISTON TO BORE CLEARANCE (INCHES)**	**PISTON RING END GAP - TFE NEW MIN. - MAX. (INCHES)**
1.375	0.007 to 0.009	0.015 to 0.021
2.5	0.031 to 0.034	0.034 to 0.044
3.0	0.030 to 0.033	0.042 to 0.052
3.5	0.030 to 0.033	0.049 to 0.059
4.0	0.030 to 0.034	0.056 to 0.068
4.5	0.030 to 0.034	0.063 to 0.077
5.0	0.030 to 0.034	0.070 to 0.086
5.5	0.045 to 0.049	0.077 to 0.095
6.0	0.045 to 0.049	0.084 to 0.102
6.5	0.045 to 0.049	0.091 to 0.110
7.0	0.045 to 0.049	0.098 to 0.120
7.5	0.045 to 0.049	0.105 to 0.129
8.0	0.045 to 0.049	0.112 to 0.136
9.5	0.045 to 0.049	0.133 to 0.163
10.0	0.045 to 0.049	0.140 to 0.172

Table 3.9. Piston to Bore Clearance and Conventional Piston Ring End Gap for Double-acting and Steeple Cylinders

3.4 Fastener Tightening Torque

The following tables list the fastener tightening torque values required for proper assembly of the Arrow VRS-2 Compressor. All threads need to be cleaned and free from burrs and nicks.

Torque values are based on the use of petroleum type lubricants used on threads and seating surfaces.

FASTENER TIGHTENING VALUES			
FASTENER	**NOMINAL SIZE, INCH - TPI**	**TYPE**	**TORQUE**
CONNECTING ROD CAP SCREW	1/2 - 20	12 Point - Grade 8	90 ft.-lbs. (122 Nm)
CROSSHEAD PIN THROUGH BOLT - LOCK NUT	3/8 - 16	Hex - Flexloc	25 ft.-lbs. (34 Nm)
FRAME TO CYLINDER - SCREW	1/2 - 13	12 Point - Grade 8	82 ft.-lbs. (111 Nm)
ECCENTRIC CHAIN IDLER CLAMP - SCREW	1/4 - 20	12 Point - Grade 8	109 in.-lbs. (16 Nm)
IDLER SPROCKET - SCREW	3/8 - 24	12 Point - Grade 8	30 ft.-lbs. (55 Nm)
ROD PACKING - SCREW	1/2 - 13	12 Point - Grade 8	45 ft.-lbs. (61 Nm)
PISTON NUT	7/8 - 14	Arrow Design	330 ft.-lbs. (447 Nm)
CROSSHEAD JAM NUT	2 - 14	Arrow Design	255 ft.-lbs. (346 Nm)
RUPTURE DISC - BLOW OUT FITTING CAP	1/4 - Nom. Tube	Hex - Tube Fitting	36 in.-lbs. (4 Nm)*
VALVE COVER/CYLINDER HEAD/VVCP - SCREW	1/2 - 13	12 Point - Grade 8	82 ft.-lbs. (111 Nm)
STEEPLE CYLINDER TO CYLINDER - SCREW	1/2 - 13	12 Point - Grade 8	82 ft.-lbs. (111 Nm)
DIVIDER BLOCK VALVE - SCREW	1/4 - 28	Socket Head	109 in.-lbs. (16 Nm)
* Because the aluminum disk may be damaged if tightened to tight, Arrow recommends to hand-tighten and then 1/8 turn with a wrench for proper tightening.			

Table 3.10. VRS-2 Compressor Fastener Tightening Values

VALVE ASSEMBLY FASTENERS – TIGHTENING VALUES		
CYLINDER SIZE (INCHES)	**CENTER BOLT SIZE (INCHES)**	**TORQUE VALUE (ft.-lbs.)**
2.25 - 3.0	1/4 - 28 UNF	8 - 10
3.5 - 4.0	5/16 - 24 UNF	13 - 15
4.5 - 5.0	3/8 - 24 UNF	18 - 21
5.5 - 6.0	1/2 - 20 UNF	32- 38
6.5 - 10.0	1/2 - 20 UNF	32- 38

Table 3.11. VRS-2 Compressor Valve Assembly Fasteners – Tightening Values

3.5 Torque Procedures

Listed here are procedures to aid you with proper torque technique. These procedures will allow faster and more accurate tightening as well as to ensure that the proper torque is being applied.

These are general guidelines to assist you in the proper use and techniques of the torque wrench.

1. Check to be sure your torque wrench is calibrated properly and is being used by a qualified individual. This will ensure that proper tightening torque for all critical parts is achieved.
2. Because torque wrenches are not accurate over their entire range, check to determine what range the torque wrench is accurate.
3. When tightening with a torque wrench NEVER jerk the wrench. Apply steady slow force to the torque wrench. When jerking a torque wrench the amount of torque applied can be as much as one and a half times the amount indicated on the wrench.
4. Always finalize tightening with a torque wrench. NEVER tighten the fastener with a ratchet or impact wrench and then check the torque with a torque wrench.
5. Never double tap the torque wrench. This action will cause the torque wrench to make the torque on the bolt more than what is set. If you need to check the setting, release all pressure on the torque wrench and slowly apply a steady force until a click is felt.
6. After the tightening is complete return the torque wrench to its lowest setting. If the torque wrench is left in a high setting, the spring will become stressed and the torque wrench will become inaccurate over time.
7. The torque wrench should not be used to break fasteners loose. This could cause the torque wrench to lose calibration.

3.6 Bolting

Bolts used with the VRS-2 Compressor have been selected based on Arrow's strength, sealing, and locking requirements. Proper bolting must be used and tightened to the values found listed in Table 3.4, Fastener Tightening Values. This information provides assistance in the identification of bolts used in the Arrow VRS-2 Compressor.

If there are questions about replacing bolts or bolting question, please contact your packager or Arrow. Arrow supplied replacement bolting is recommend.

3.7 Safety Information

CAUTION

SEVERE INJURY AND PROPERTY DAMAGE CAN OCCUR IF COMPRESSOR IS NOT COMPLETELY VENTED BEFORE LOOSENING SCREWS, FLANGES, HEADS, VALVES, VALVE COVERS OR PACKING. REFER TO THE ARROW VRS-2 COMPRESSOR OPERATIONS AND MAINTENANCE MANUAL BEFORE ANY REPAIR OR MAINTENANCE IS STARTED.

CAUTION

SUCTION AND DISCHARGE VALVES MUST BE INSTALLED CORRECTLY AND IN THEIR PROPER LOCATION OR SEVERE PERSONAL INJURY AND PROPERTY DAMAGE CAN OCCUR. REFER TO THE VRS-2 COMPRESSOR OPERATIONS AND MAINTENANCE MANUAL FOR PROPER VALVE INSTALLATION INSTRUCTIONS.

CAUTION

NOISE GENERATED BY THE VRS-2 COMPRESSOR CAN CAUSE HEARING INJURY. ARROW RECOMMENDS WEARING THE PROPER HEARING PROTECTION WHEN THE COMPRESSOR IS RUNNING.

CAUTION

HOT GAS TEMPERATURES FROM CYLINDER AREA AS WELL AS HIGH FRICTION AREAS OF THE UNIT CAN CAUSE BURNS. WEAR THE PROPER INSULATED CLOTHING WHEN AROUND THE COMPRESSOR. SHUT DOWN THE UNIT AND ALLOW FOR COOLING BEFORE PERFORMING ANY MAINTENANCE TO THESE AREAS.


1
ARROW
COMPRESSOR PRODUCTS
1-800-331-3662
10
ARROW
GENUINE PARTS
7
4
8
5
9
2
6
3

3.8 Recommended Special Tools

Special tools may be ordered as follows:

1. Tool box (a complete set of recommended tools)
2. Individual recommended tools
3. Individual optional tools
4. Combination of individual recommended tools and individual optional tools

SPECIAL TOOLS AND TOOL BOX					
			QUANTITY		
NO.	PART NO.	DESCRIPTION	STD. ISSUE	REC. TOOL	OPT. TOOL
	VRS29400A	TOOL BOX (INCLUDES ALL OF THE FOLLOWING)			
1	VRC29400CB	TOOL BAG, ARROW COMPRESSION PRODUCTS		1	
2	VRC21140	ADAPTOR, BAR-OVER, CRANKSHAFT	1	1	
3	VRC29490	PISTON NUT ADAPTOR		1	
4	VRC29492	PISTON ROD ENTERING SLEEVE		1	
5	VRS29482	OIL SEAL ENTERING SLEEVE		1	
6	VRC29496	2” JAM NUT WRENCH		1	
7	VRC29499	PISTON JAM NUT BAR		1	
8	VRC29463	TOOL, VALVE INSTALLATION, 2.25 - 4.0” CYLS.		1	
9	VRC29464	TOOL, VALVE INSTALLATION, 4.5 - 8.0” CYLS.		1	
10	VRS28310	FILTER, OIL FRAME		1	

4 COMPRESSOR START-UP

4.1 Maximum Allowable Working Pressure

All Arrow VRS-2 Compressor cylinders have a Maximum Allowable Working Pressure (MAWP). This MAWP is stamped on every name plate.

Arrow cylinders are tested to a hydrostatic test pressure of 1 1/2 times the MAWP.

CAUTION: *Operating conditions must NOT exceed the cylinder Maximum Allowable Working Pressure (MAWP).*

API SPEC 11P* (paragraph 1.10.5) – RDP

Rated Discharge Pressure (RDP) is defined as the highest pressure required to meet the conditions specified by the purchaser for the intended service. Arrow Cylinder Data Sheets list the RDP (Rated Discharge Pressure), which is the recommended continuous pressure the equipment should be designed to operate. RDP is 90% of the MAWP (Maximum Allowable Working Pressure).

4.2 Relief Valve Settings

It is the responsibility of the packager to provide relief valves for every stage of the compression operation in compliance with API SPEC 11P*, Paragraph 7.20.3.

4.3 Filling the Main Oil System Sump

Filling the sump of the main oil system must be done prior to start-up.

1. Remove breather and fill compressor sump through side cover (side cover with the breather hole).
2. Check sight glass on drive end. Oil level at start-up should be in the middle of the sight glass. Be careful NOT to overfill THE SUMP. The crankshaft will dip into the oil, churn it, and make it difficult to pump and control the proper level of oil if sump is overfilled.

   It may be necessary to add additional oil to bring the level of oil to the middle of the sight glass if you are starting with a dry or new filter.

   NOTE: After the compressor is running, it may be necessary to add oil to bring up the oil level to one-half the height of the sight glass; however, it must never exceed two-thirds height, while the compressor is running during normal operations.
3. When the sump is filled to the proper level, install and tighten the breather by hand. Tightening by hand will help when removing the breather at a later date.

4.4 Cylinder Lubricator Pump Adjustment at Start-up

To be sure that the cylinder lube pump system is set to the correct break-in rate, refer to the cylinder lubricator plate located on the side of the force-feed lube reservoir or refer to section 6.10.2, Divider Blocks. An indicator pin on the divider block shows the rate at which the block is cycling.

To make adjustments to the rate, screw DOWN the feed regulator adjustment to DECREASE the rate, screw UP the feed regulator adjustment to INCREASE the rate. Adjust screw upward to twice the normal rate to set the break-in rate.

Run at this setting for 200 hours of operation. The lubricator adjustment may then be reduced (screw DOWN the feed regulator adjustment) to the normal operating rate.

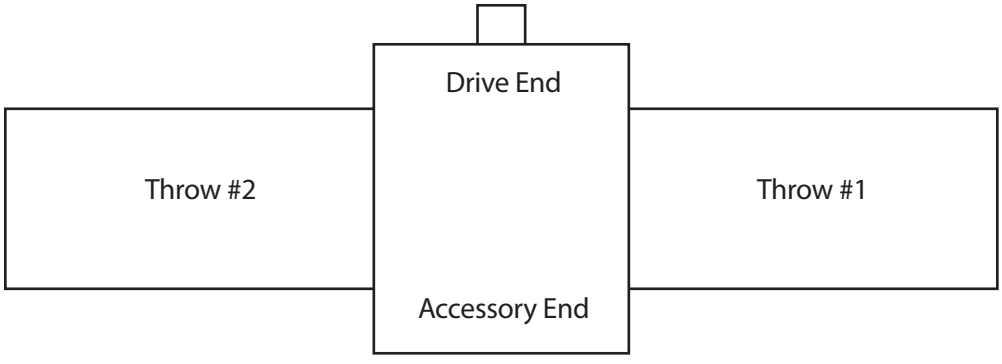
NOTE: Remember this simple rule when making adjustments: UP IS UP (screw upward to increase rate) and DOWN IS DOWN (screw downward to decrease rate).

Tighten lock nut securely after adjustments have been made to the feed regulator screw.

NOTE: If lock nut is not tightened properly it can vibrate loose and lube rate will not be at the desired setting.

4.5 VRS-2 Compressor Start-up Checklist

COMPRESSOR GENERAL INFORMATION				
Compressor Model			Serial No.	
Cylinder Serial No.				
Driver			Rated Speed	
Packager			Packager Unit No.	
Date Packager Shipped			Start-up Date	
Serviceman			Customer	
Location			Field Contact	
Field Telephone No.			Unit Location	
Frame Oil - Make			Grade	
Cylinder Oil - Make			Grade	
NOTES / COMMENTS:				



4.5.1 Pre-Start-up Checklist

Compressor Model	Serial No.

	YES	NO
1. Are the correct Arrow parts book, technical manual, special tools, and spares available?		
2. Have the design limitations for the compressor model such as rod load, maximum and minimum speed, discharge temperature been checked?		
3. Have the design operating conditions been determined?		

Pressure, PSIG (kPa): Suction	Discharge
Temperature, °F (°C): Suction	Discharge
Maximum RPM	Minimum RPM

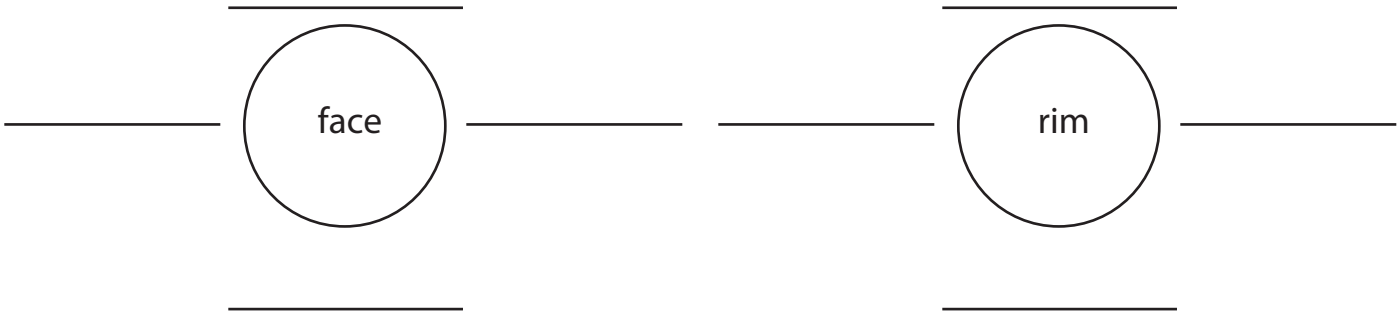
	YES	NO
4. Soft Foot Check: Have the compressor feet and crosshead guide supports been shimmed so that the machine is not twisted or bent?		
5. Have bottom crosshead clearances on all corners been checked? Max. 0.0015" (0.0381 mm) feeler inserted to 1/2" (12.7 mm) Max. depth.		

6. Record top crosshead minimum feeler clearance below:

THROW No. 1	2

	YES	NO
7. Have the piping and supports been checked to be sure they do not bend or stress compressor?		
8. Have the coupling bolt torque values been rechecked?		
9. Has the compressor to driver alignment been checked? Maximum allowable 0.005" (0.127mm) TIR		

10. Record coupling dial indicator readings in inches at the 3, 6, 9, 12 o'clock positions on the lines provided.



	YES	NO
11. Has the crankshaft end-play clearance been checked?		
Record frame end-play clearance here:	inches (mm)	
	YES	**NO**
12. Have piston end clearances been checked with feeler gauges?		
THROW No.	**1**	**2**
HE		
CE		
	YES	**NO**
13. Has the frame been filled with oil to the proper level?		
14. Has proper oil been added if extreme ambient conditions exist or special gases are compressed?		
15. Is the compressor frame oil level control working and set at the proper level?		
16. Is the frame oil supply isolation valve open?		
17. Does the frame low level shutdown work?		
18. Has the recommended oil filter element been installed?		
19. Is the oil filter element and all lube oil piping primed with oil?		
20. Is the low oil pressure shutdown installed and tubed correctly to the down-stream side of the oil filter?		
21. Does the low oil pressure shutdown work?		

	YES	NO
22. Does unit have an oil cooler? Maximum compressor inlet oil temperature is not to exceed 250°F (121°C).		
23. Is the frame oil temperature shutdown installed, set and working?		
24. If oil is cooled, is there a temperature control valve?		
25. Is the frame breather element clean?		
26. Is the cylinder lubricator box filled with oil?		
27. Is the cylinder lubricator system primed?		
28. Is the cylinder lubrication system no flow shutdown installed and working?		
29. Is the cylinder lubrication overpressure indicator installed? Check rupture disc for color. Aluminum is standard @ 2350 PSI.		
30. Has the lubricator instruction plate or Divider Block selection and cycle time (section 6.10.2) been checked for proper lube feed rate?		
31. Is there a working vibration shutdown mounted on the compressor?		
32. Are the primary and secondary packing vents and the distance piece vents open, and when necessary, tubed off of the skid or out of the building?		
33. Is there some method of suction pressure control?		
34. Are the suction pressure, inter stage pressure and discharge pressure shut-downs set and working?		
35. Are the safety relief valves installed and set to protect cylinders and piping for each stage of compression?		
36. Are the gas discharge temperature shutdowns installed, set and working?		
37. Have the gas suction lines been blown out to remove water, slag, dirt, etc?		
38. Have temporary screens been installed at cylinder suction?		
39. Has the machine been rolled with the starter to make sure it is free? The oil pressure should come up noticeably while rolling on the starter.		
40. For engine driven units, has the machine been rolled with the starter to make sure it is free? The oil pressure should come up noticeably while rolling on the starter.		
41. Does the driver rotation match the compressor rotation?		

	YES	NO
42. For machines compressing a combustible gas, have the piping and compressor been purged to remove all air?		
43. Have the start-up instructions for other equipment on the package been followed?		
44. Has the Packager's representative performed the required review of the Packager's Start-up and Operating Instructions for the unit with the unit operator?		

4.5.2 After Start-up Checklist

Compressor Model:	**Serial No:**	
	YES	**NO**
1. Did the oil pressure come up immediately?		
2. Any strange noises or shaking in the compressor or piping?		
3. Is low oil pressure shutdown set at 25 PSIG?		
4. Are the high discharge gas temperature shutdowns set at approximately 10% above normal discharge temperature? 325°F (163°C) to a maximum of 350°F (177°C).		
5. Is the divider block cycle indicator pin moving, and have you set lubricator for proper break-in flow rate?		
6. Are there any oil leaks? If so, where?		
7. Are the scrubber dumps and high level shutdowns working?		
8. Are the scrubbers removing all liquids from the gas?		
How often do the scrubbers dump?	min	
9. Are there sands or oxides in the gas?		
10. Is the overspeed shutdown set?		
11. Are rod packing sealing properly?		
12. Have all safety functions been tested to ensure shutdown of unit upon malfunction?		

	YES	NO
11. Has the crankshaft end-play clearance been checked?		
Record frame end-play clearance here:	inches (mm)	
	YES	**NO**
12. Have piston end clearances been checked with feeler gauges?		
THROW No.	**1**	**2**
HE		
CE		
	YES	**NO**
13. Has the frame been filled with oil to the proper level?		
14. Has proper oil been added if extreme ambient conditions exist or special gases are compressed?		
15. Is the compressor frame oil level control working and set at the proper level?		
16. Is the frame oil supply isolation valve open?		
17. Does the frame low level shutdown work?		
18. Has the recommended oil filter element been installed?		
19. Is the oil filter element and all lube oil piping primed with oil?		
20. Is the low oil pressure shutdown installed and tubed correctly to the down-stream side of the oil filter?		
21. Does the low oil pressure shutdown work?		
22. Does unit have an oil cooler? Maximum compressor inlet oil temperature is not to exceed 250°F (121°C).		
23. Is the frame oil temperature shutdown installed, set and working?		
24. If oil is cooled, is there a temperature control valve?		
25. Is the frame breather element clean?		
26. Is the cylinder lubricator box filled with oil?		

	YES	NO
27. Is the cylinder lubricator system primed?		
28. Is the cylinder lubrication system no flow shutdown installed and working?		
29. Is the cylinder lubrication overpressure indicator installed? Check rupture disc for color. Aluminum is standard @ 2350 PSI.		
30. Has the lubricator instruction plate or Divider Block selection and cycle time (section 6.10.2) been checked for proper lube feed rate?		
31. Is there a working vibration shutdown mounted on the compressor?		
32. Are the primary and secondary packing vents and the distance piece vents open, and when necessary, tubed off of the skid or out of the building?		
33. Is there some method of suction pressure control?		
34. Are the suction pressure, inter stage pressure and discharge pressure shutdowns set and working?		
35. Are the safety relief valves installed and set to protect cylinders and piping for each stage of compression?		
36. Are the gas discharge temperature shutdowns installed, set and working?		
37. Have the gas suction lines been blown out to remove water, slag, dirt, etc?		
38. Have temporary screens been installed at cylinder suction?		
39. Has the machine been rolled with the starter to make sure it is free? The oil pressure should come up noticeably while rolling on the starter.		
40. For engine driven units, has the machine been rolled with the starter to make sure it is free? The oil pressure should come up noticeably while rolling on the starter.		
41. Does the driver rotation match the compressor rotation?		
42. For machines compressing a combustible gas, have the piping and compressor been purged to remove all air?		
43. Have the start-up instructions for other equipment on the package been followed?		
44. Has the Packager's representative done the required review of the Packager's Start-up and Operating Instructions for the unit with the unit operator?		

4.6 Compressor Maintenance

4.6.1 General Information

The main components of the frame assembly are: the frame, crosshead guides, crankshaft and bearings, connecting rods, chain drive system and crossheads. Drilled oil passages deliver lubrication to the running gear.

A top cover and crosshead guide side covers provide ample accessibility for inspecting and removing internal components of the VRS-2 Compressor.

Cleanliness is important. Use lint-free cloths to wipe clean the frame and all the working parts during any maintenance on the compressor. It is important to keep the frame covered when the access panels are removed during maintenance. Covering the frame will help keep dust and dirt out. If any components have been removed, it is important that you protect these parts from anything that might damage the running surfaces.

Whenever the compressor has been dismantled, gaskets at non-pressure positions are to be inspected before reusing. If a gasket is found to be damaged or compromised it MUST be replaced before restarting the compressor. Gaskets and O-rings at pressure locations in the compressor should be replaced. When replacing the gaskets, always apply anti-seize lubrication to both sides of the gasket for easy removal at a later time.

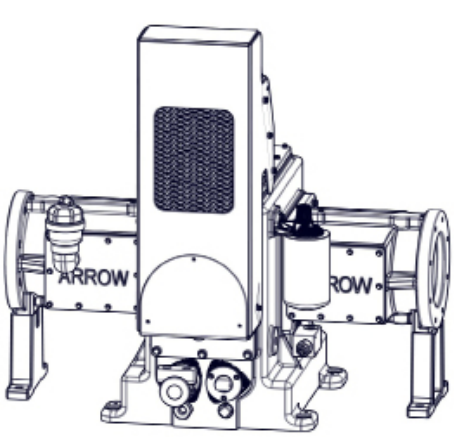
When conducting major overhauls on the compressor, drain and flush the compressor frame.

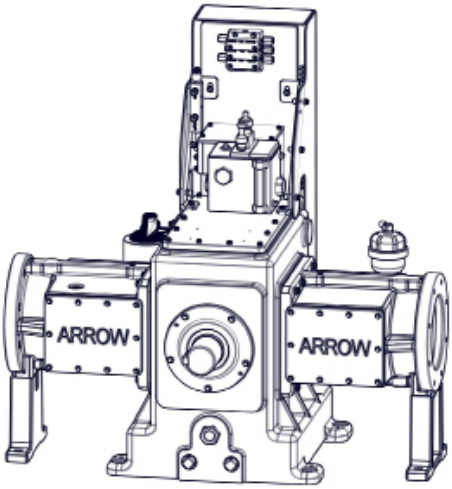
CAUTION: *to prevent personal injury be sure that the compressor crankshaft cannot be turned by the driver or compressor cylinder gas pressure during maintenance or repair. On engine driven compressors, lock the fly-wheel. On electric motor-driven compressors, the driver switch gear must be locked out during maintenance or repair.*

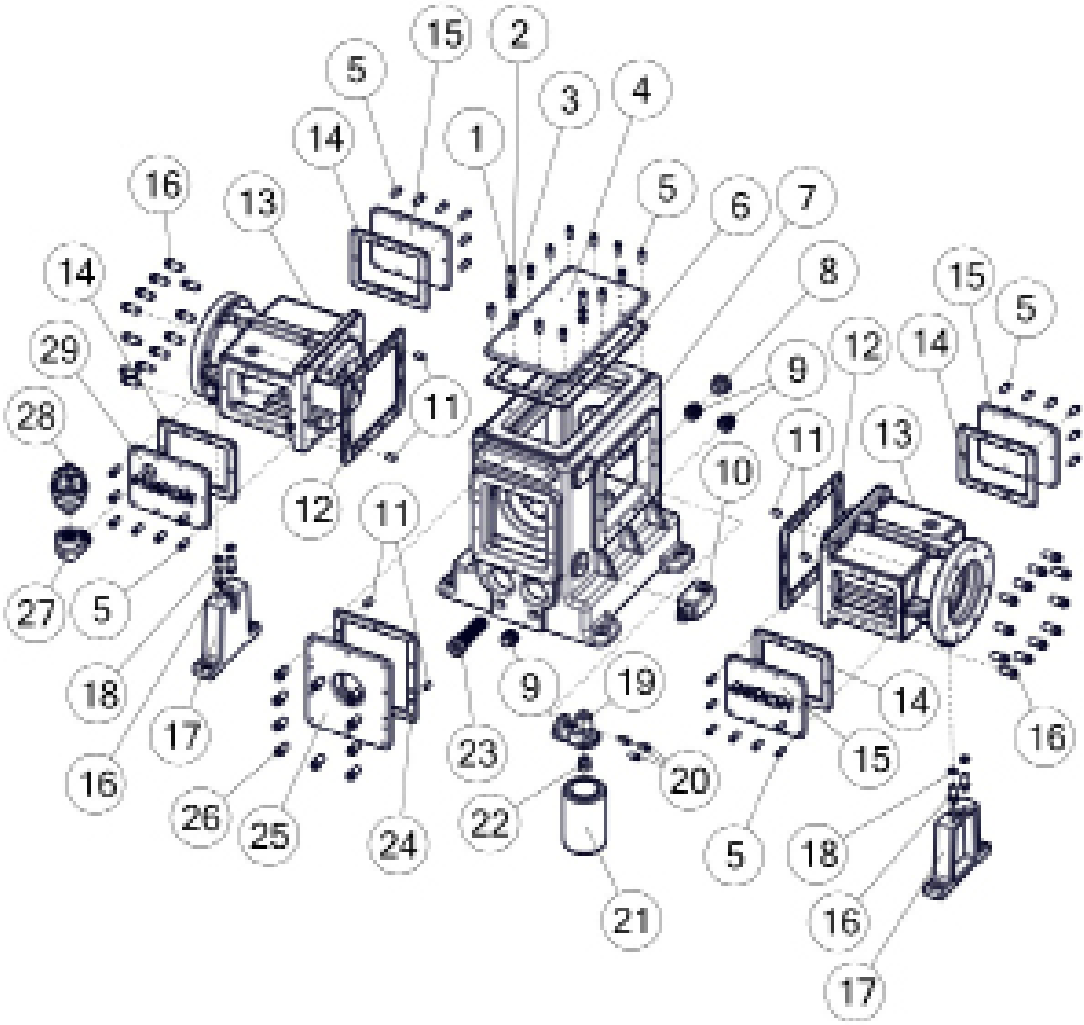
Before starting any maintenance or repairing any of the compressor parts, relieve all pressure from the compressor cylinders. See the packager's instructions for complete venting of the system.

CAUTION: *When maintenance is complete, air must be totally eliminated from the entire system before operation. This will avoid a potentially explosive air/gas mixture from occurring.*

4.7 Frame Parts – Frame, Covers, Gaskets, Oil Strainer, Sight Glass, and Plugs







Frame Parts

NO.	PART NO.	DESCRIPTION	QTY	REC. SPARE PARTS 6 MOS	1 YR	2 YRS
1	7A-5/16-18X1 1/4	CAPSCREW HEX HEAD	2			
2	VRS21336	WASHER, LOCK, 5/16"	2			
3	VRS21335	WASHER, FLAT, 5/16"	2			
4	VRC21310	COVER PLATE, FRAME TOP	1			
5	VRC21327	SCREW 12-POINT 5/16 -18 X 1	52			
6	VRS21315	GASKET, COVER PLATE, FRAME TOP	1	1	1	1
7	VRS21020	FRAME TWO-THROW VRS-2 COMPRESSOR	1			
8	VRS21400	SIGHTGLASS, FRAME OIL LEVEL	1			
9	VRC21519	PLUG, PIPE, 1"-NPT	3			
10	VRC28350	VALVE, RELIEF, OIL PRESSURE	1			1
11	VRS21506	PIN DOWEL DISTANCE PIECE	6			
12	VRS22221	GASKET, DIST PC TO FRAME	2	2	2	2
13	VRS22220	DISTANCE PIECE, VRS-2	2			
14	VRS21325	GASKET, COVER PLATE, FRAME SIDE	4	4	4	4
15	VRS21320	COVER PLATE, DISTANCE PIECE SIDE	3			
16	VRC25067	SCREW, 12-POINT 1/2 - 13 X 1-1/4	28			
17	VRS22230	SUPPORT, DISTANCE PIECE	2			
18	VRC25025	WASHER, LOCK, 1/2" HIGH COLLAR	4			
19	VRC28320	BRACKET, MOUNTING, FRAME OIL FILTER	1			
20	VRC28327	SCREW 12-POINT 5/16 - 18 X 3/4	3			
21	VRS28310	FILTER, OIL, FRAME	1	2	2	2
22	VRS28325	ADAPTER, BRACKET, FILTER	1			
23	VRC28340	STRAINER, OIL, FRAME (1" NPT)	1			
24	VRS28015	GASKET, COVER PLATE HOUSING	1	1	1	1
25	VRS28010	COVER PLATE, HOUSING, LUBE OIL DRIVE	1			
26	VRC21117	SCREW, 12-POINT 3/8-16X1	10			
27	VRC21419	ELBOW, 1-1/4", STREET 90	1			
28	VRC21410	BREATHER, FRAME VENT	1			1
29	VRS21321	COVER PLATE, DISTANCE PIECE SIDE, WITH BREATHER	1			

4.8 Frame Assembly – Cleaning and Inspecting the Frame

1. Inspect the frame making sure it is free from chips and burrs.
2. Use a cleaning solvent to flush out debris and blow air through the oil passages to make sure all debris has been removed.
3. Clean the frame making sure the area is free from dirt and metal shavings. Dirt or metal shavings can cause lock up and serious damage to the compressor.
4. Inspect the frame for imperfections and defects.

4.8.1 Serial Number Location

1. Serial number is stamped on machined flat surface on the left side of the accessory-end of the frame.

4.9 Oil Strainer Installation

The oil strainer (VRC28340) is located on the accessory side of the frame below the oil level.

Oil Strainer (VRC28340)

Installation

1. Coat the threads of the oil strainer with a Teflon sealant.
2. Slide the oil strainer through the hole just below and to the left of the crankshaft on the accessory side of the frame.
3. Tighten with wrench.

NOTE: The oil strainer should be removed and cleaned using the proper solvents whenever oil is changed.

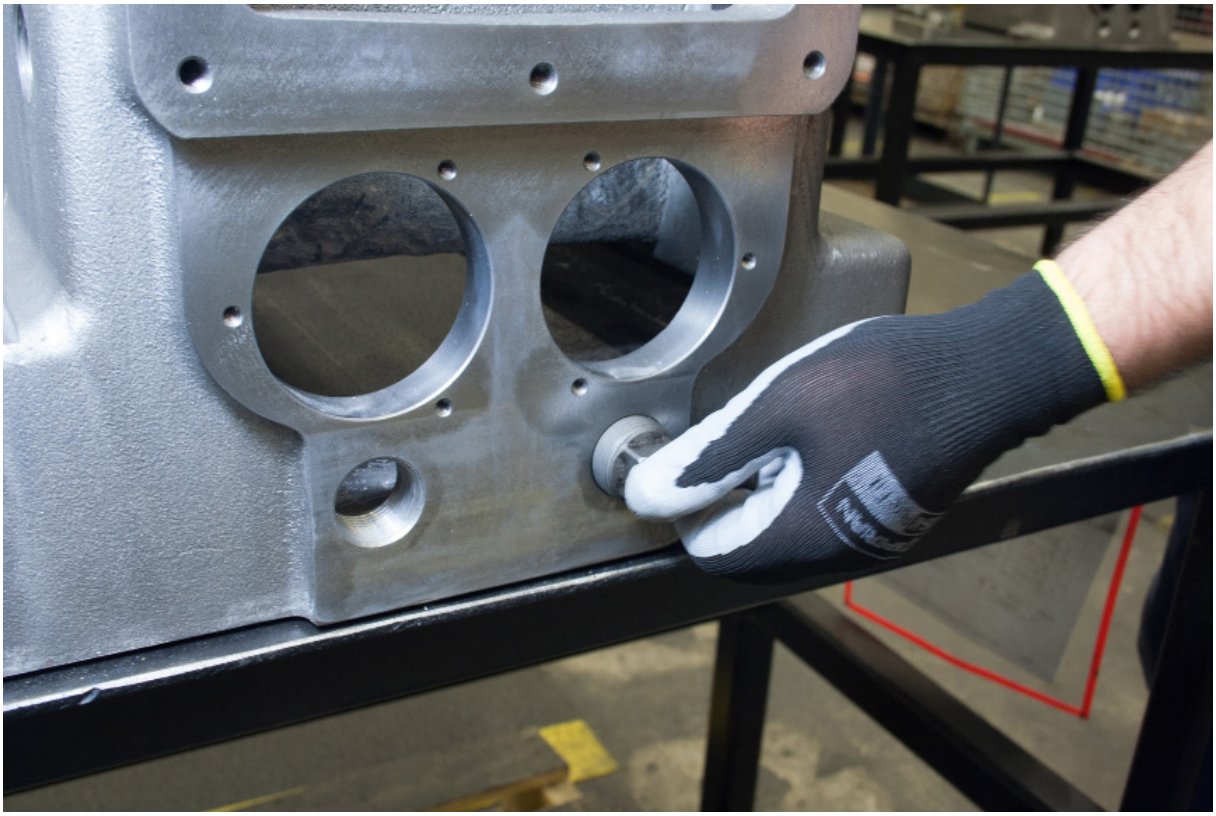
4.10 Sight Glass Installation

The sight glass (VRC21400) is located on the drive side of the frame. The sight glass allows the operator to see the oil level within the compressor. Oil level should be in the center of the sight glass.

Installation

1. Coat the threads of the sight glass with a Teflon sealant.
2. Insert the sight glass and tighten with wrench.

4.11 Plug installation

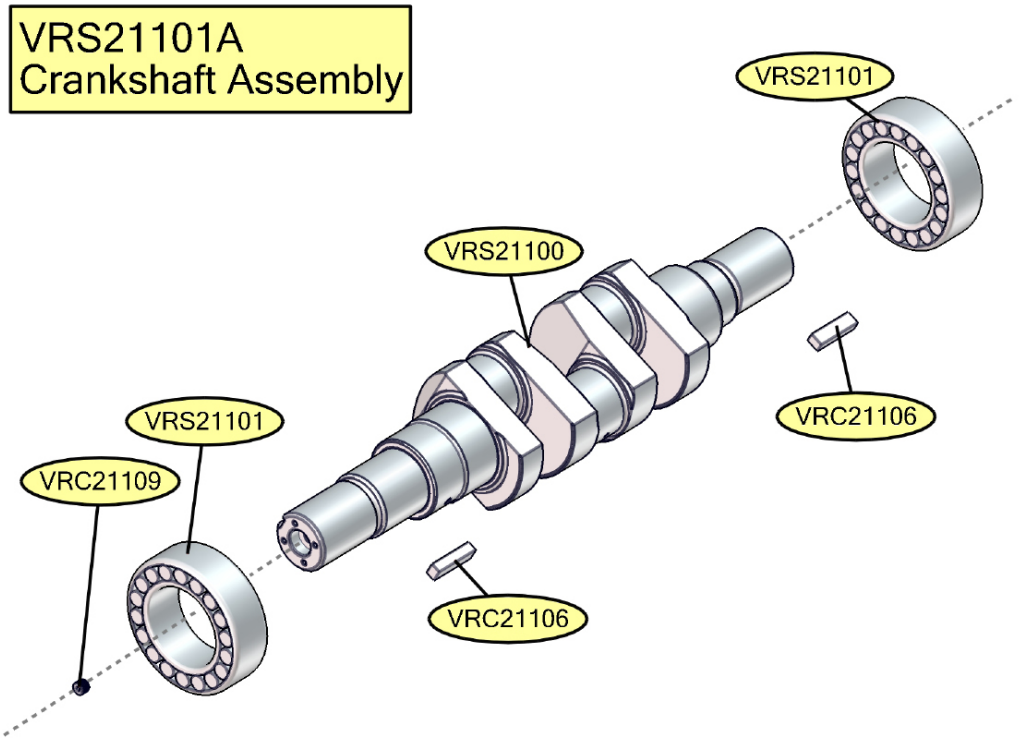


There are three 1” NPT plugs (VRS21519) to be mounted on the frame. Two plugs on the drive-end of the frame and one on the accessory-end.

Instruction

1. Coat the threads of the plugs with Teflon sealant.
2. Insert the plugs in the frame and tighten with wrench.

4.12 Crankshaft Parts

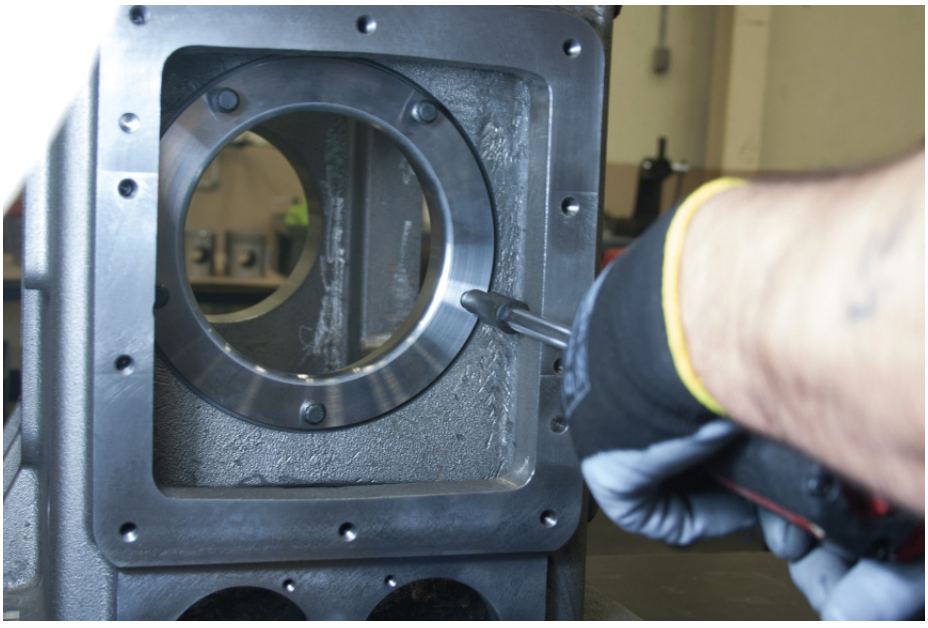


CRANKSHAFT ASSEMBLY						
NO.	PART NO.	DESCRIPTION	QTY.	REC. SPARE PARTS		
				6 MOS	1 YR	2 YRS
VRS21101A	VRS21101A	CRANKSHAFT, VRC-2, ASSEMBLY WITH MAIN BRGS	1			1
	VRS21106	KEY, CRANKSHAFT	2			
	VRS21101	BEARING, CRANKSHAFT MAIN	2			
	VRS21100	CRANKSHAFT, VRS-2 COMPRESSOR	1			
	VRC21109	PLUG, CRANKSHAFT 1/4” NPT	1			

4.13 Install Accessory-end Bearing Retainer

1. Insert bearing retainer (VRS21120) into accessory-end of frame.

2. Install (6) retainer screws (VRC21117) and tighten in a crisscross pattern.



4.13.1 Spherical Roller Bearings Installation

The spherical roller bearings are heated prior to installation on the crankshaft. Arrow recommends purchasing a new crankshaft assembly with spherical roller bearings (VRS21101A) installed.

IMPORTANT*:* This is a difficult procedure and may result in damage to the crankshaft. Arrow recommends using a professional repair facility to perform this procedure.

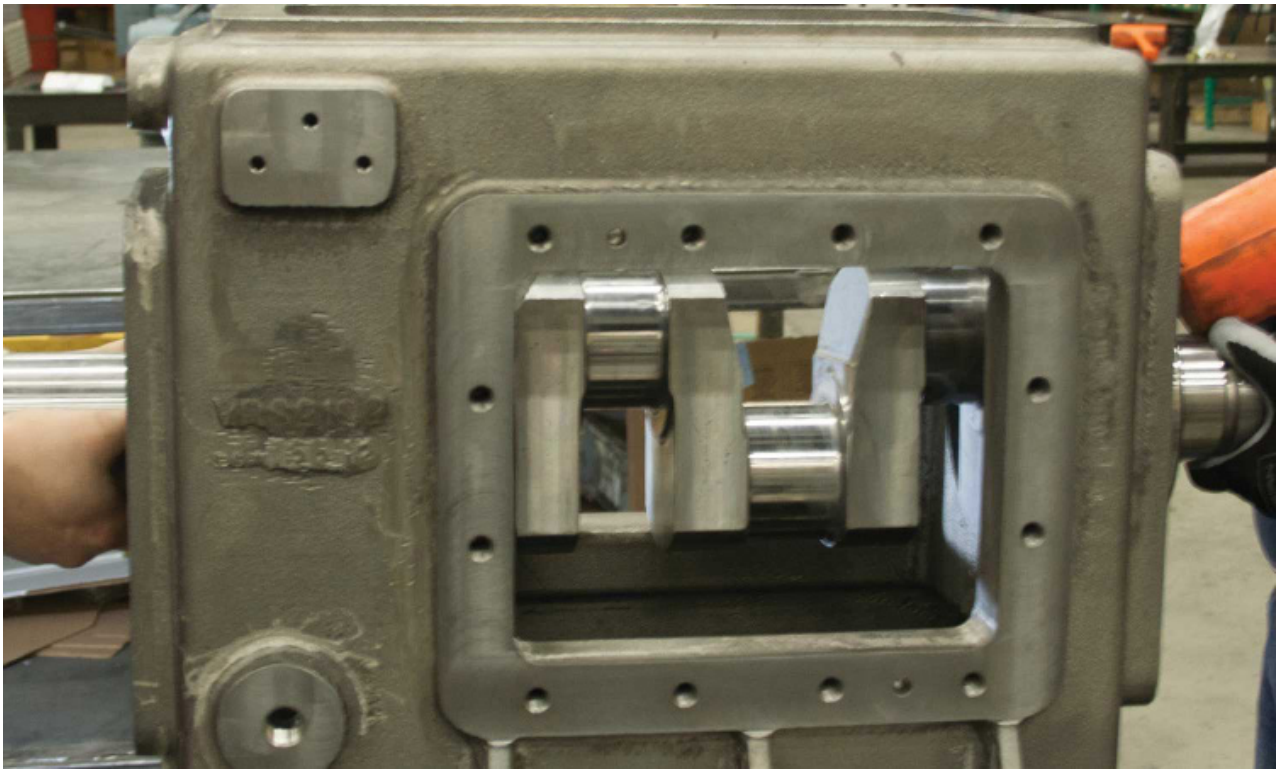
Arrow offers crankshaft assemblies with spherical roller bearings (VRS21101A) installed and recommends the purchase of the crankshaft assemblies rather than trying to repair or replace the bearings yourself.

4.14 Crankshaft Preparation

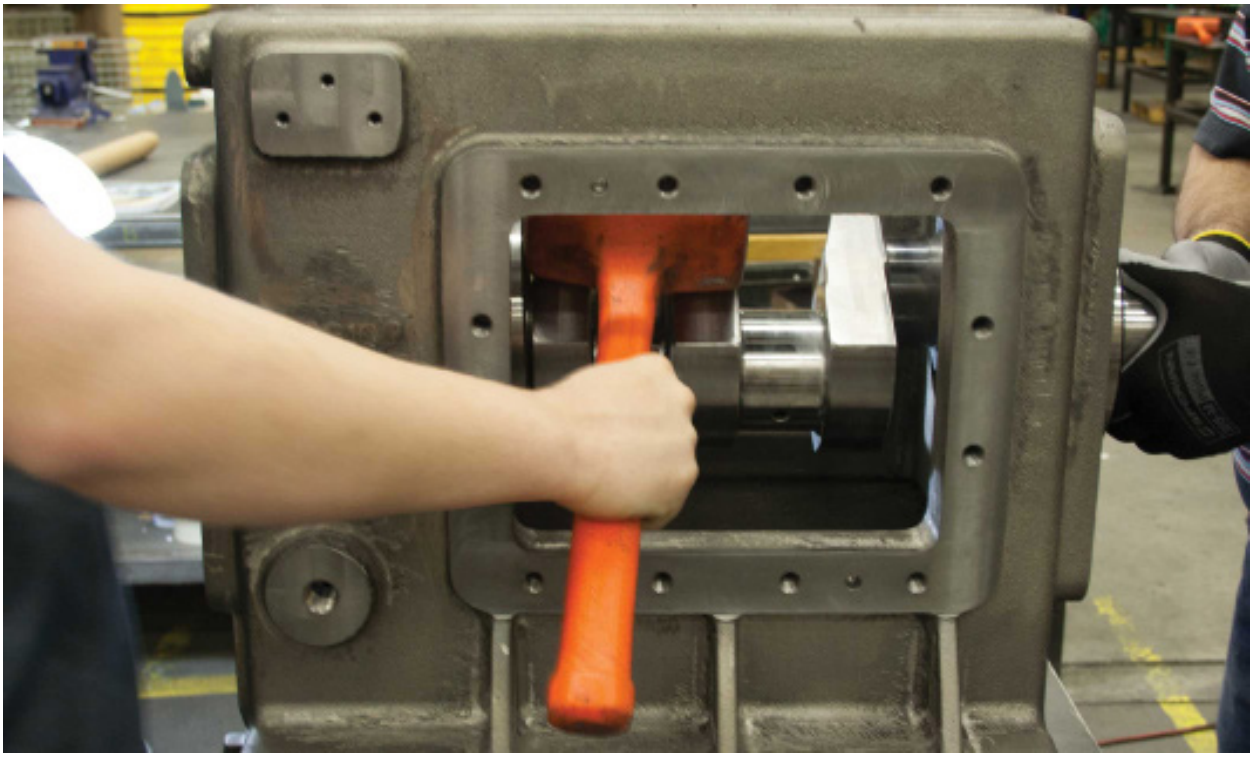
1. Clean crankshaft making sure all surfaces are free from dirt and metal shavings.
2. Use a cleaning solvent to flush out debris and blow air through the oil passages to make sure all debris has been removed.
3. Inspect the crankshaft main bearings making sure they are clean and free from metal chips and shavings. Dirt or metal shavings can cause lock up and serious damage to the compressor.
4. Inspect crankshaft for imperfections and defects.

4.14.1 Crankshaft Reassembly and Installation

1. Install the crankshaft by hand horizontally. Insert the accessory end of the crankshaft into the frame through the drive side until the accessory end of the crankshaft appears on the accessory side of the frame. The crankshaft can be installed from either side.

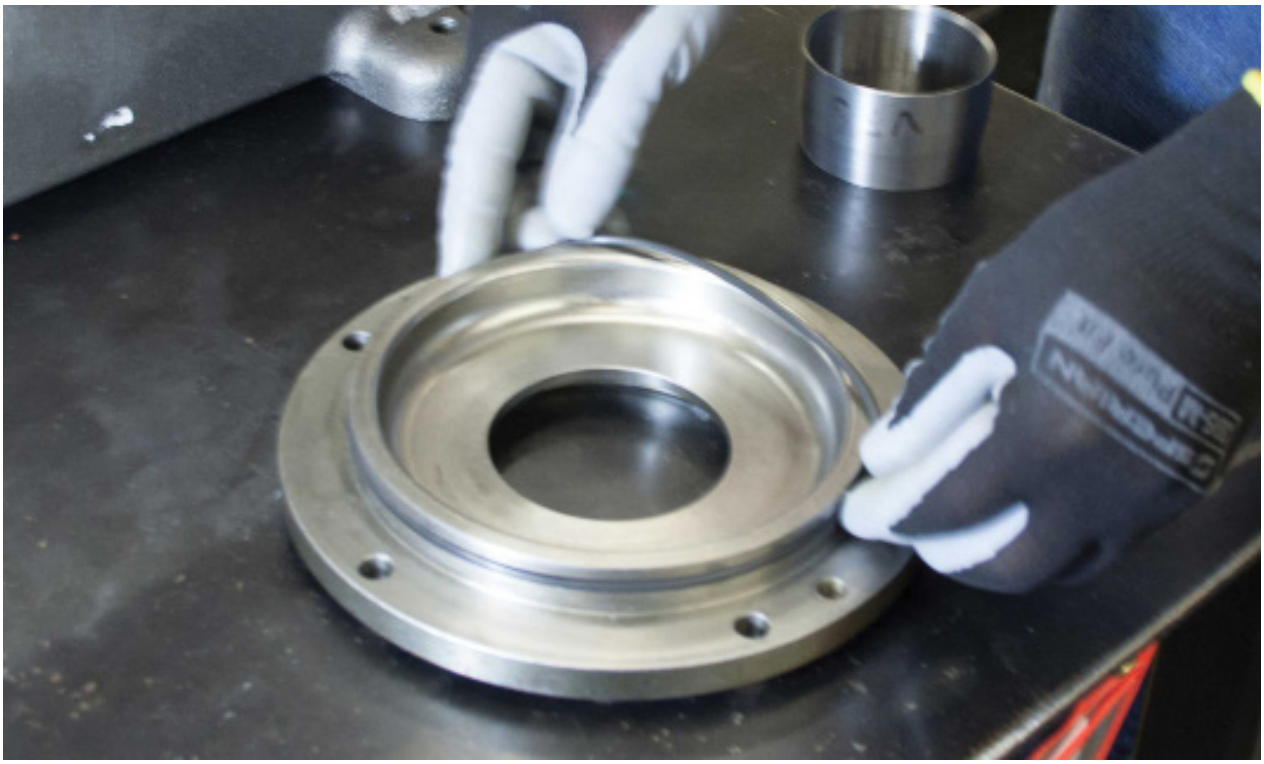


2. This is a tight fit and may require lightly tapping with a soft-blow rubber mallet to seat the main bearings in the bearing housing.



4.14.2 Install oil seal in bearing retainer

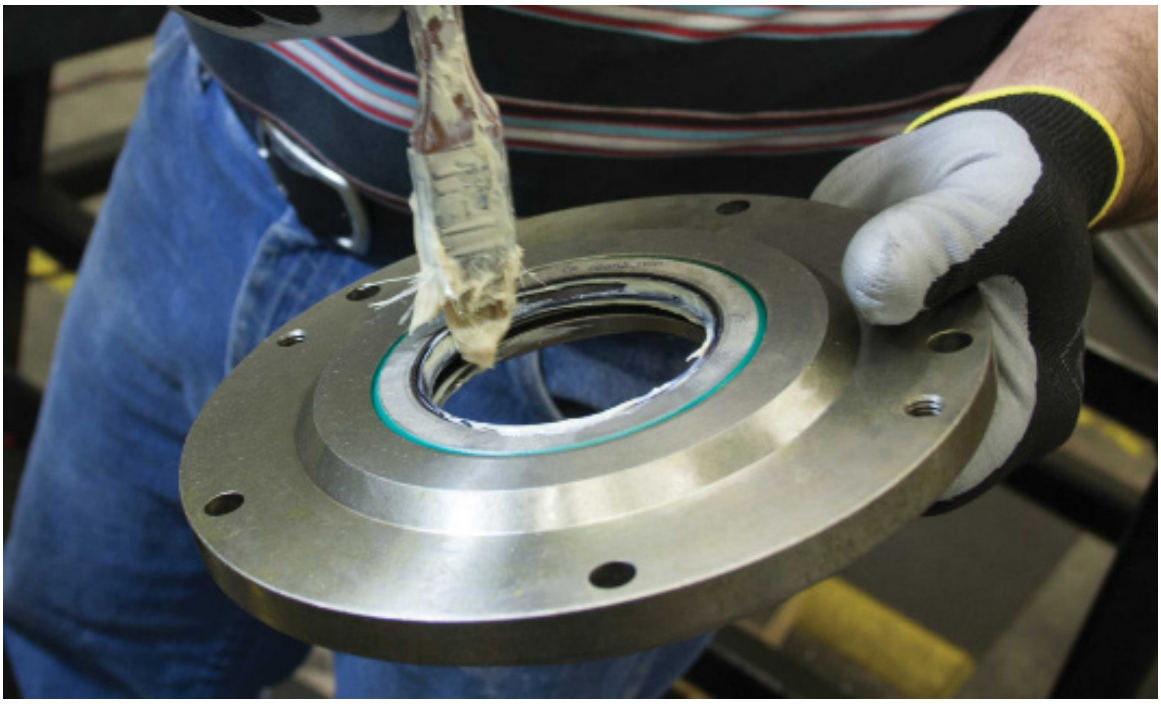
1. Place retainer O-ring (VRS21114) in O-ring groove of bearing retainer (VRS21120).



2. Press oil seal (VRS28024) into retainer with a bench press, or a block and mallet.

3. Press until seal fully seats in the retainer and seal lip is toward the inside of the retainer.

4. Apply lubricant to the oil seal and O-ring.

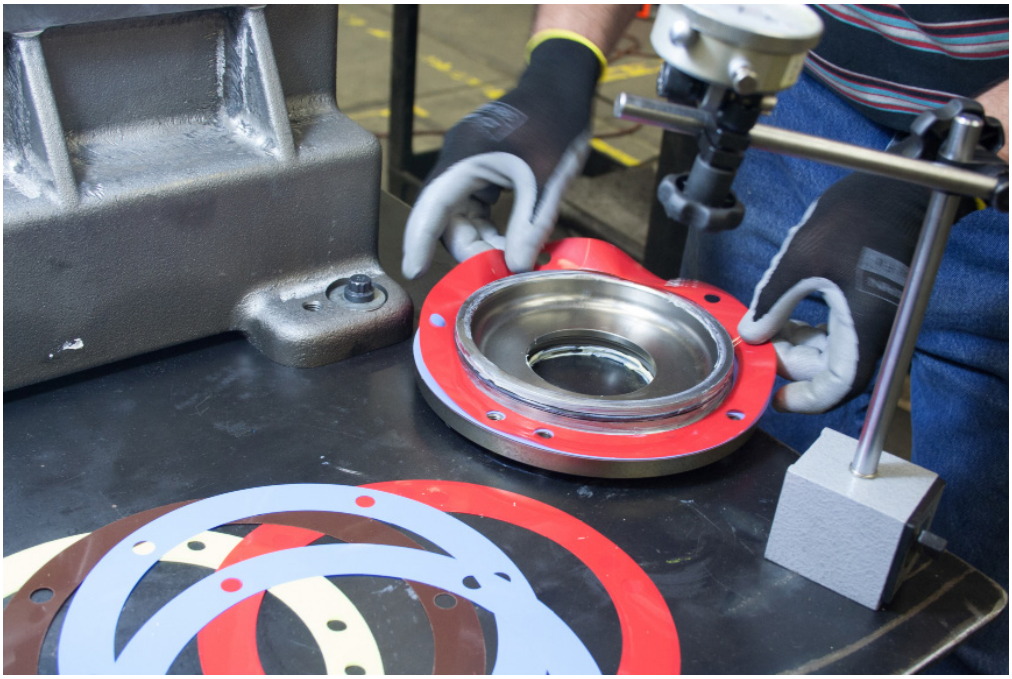


4.14.3 Install Bearing Retainer

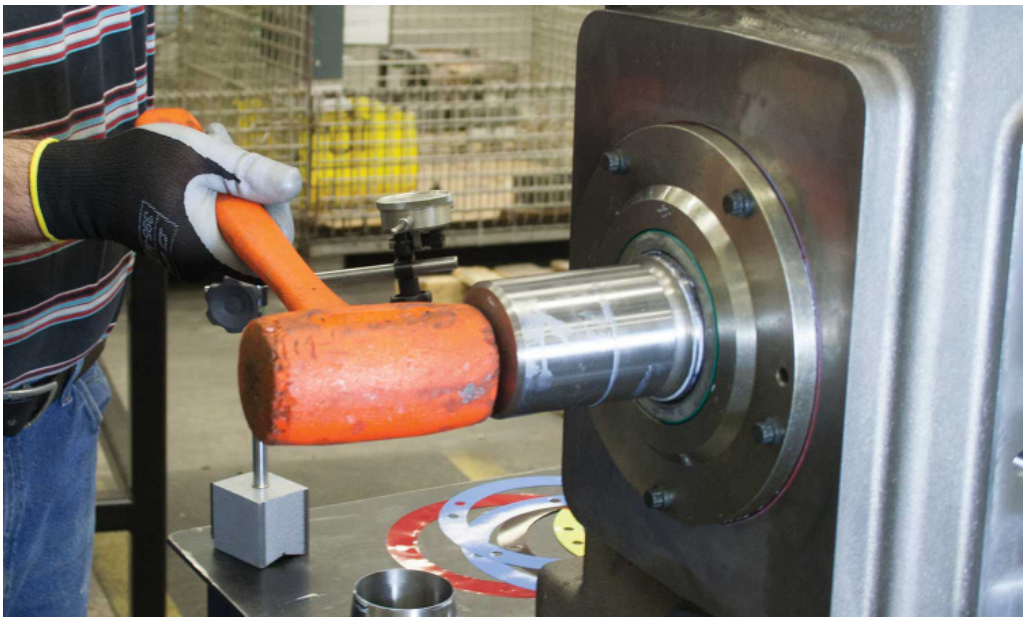
1. Put shim pack (VRS21119) on retainer. After checking crankshaft end-play it may be necessary to add or remove shims.

Shim packs contain the following shims:
(3) .002-inch thick red shims
(3) .005-inch thick blue shims
(2) .010-inch thick brown shims
(1) .020-inch thick yellow shim

2. Start by putting (1) red, (1) blue, and (1) brown shim under the retainer and install retainer by tightening the (5) retainer screws (VRC21117)

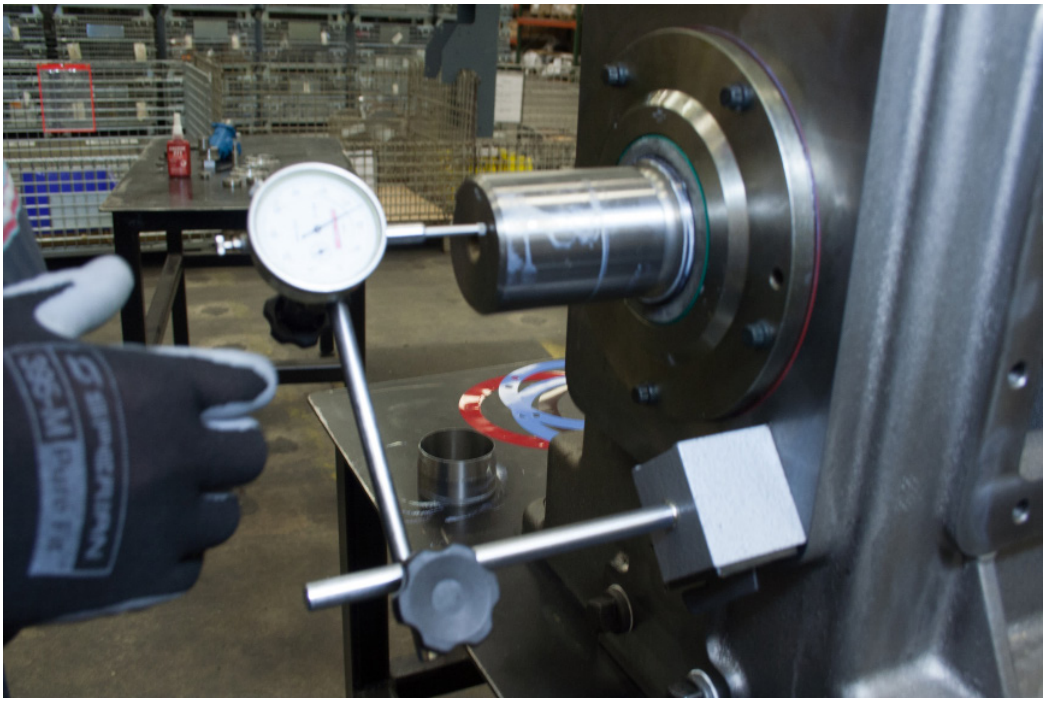


3. Tap crankshaft with a mallet on both ends to seat it well in the frame.



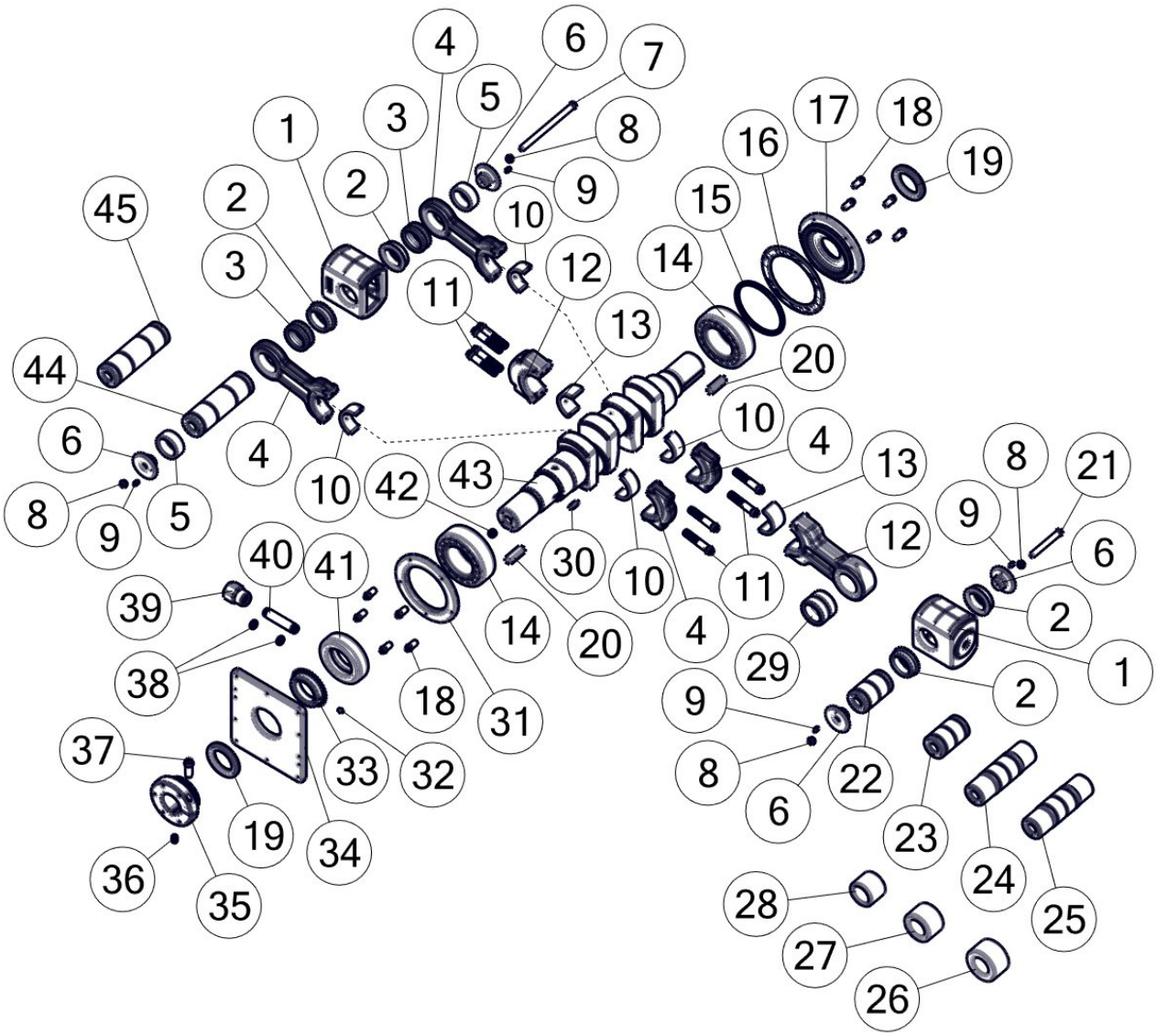
4.14.4 Crankshaft End-play Check Procedure

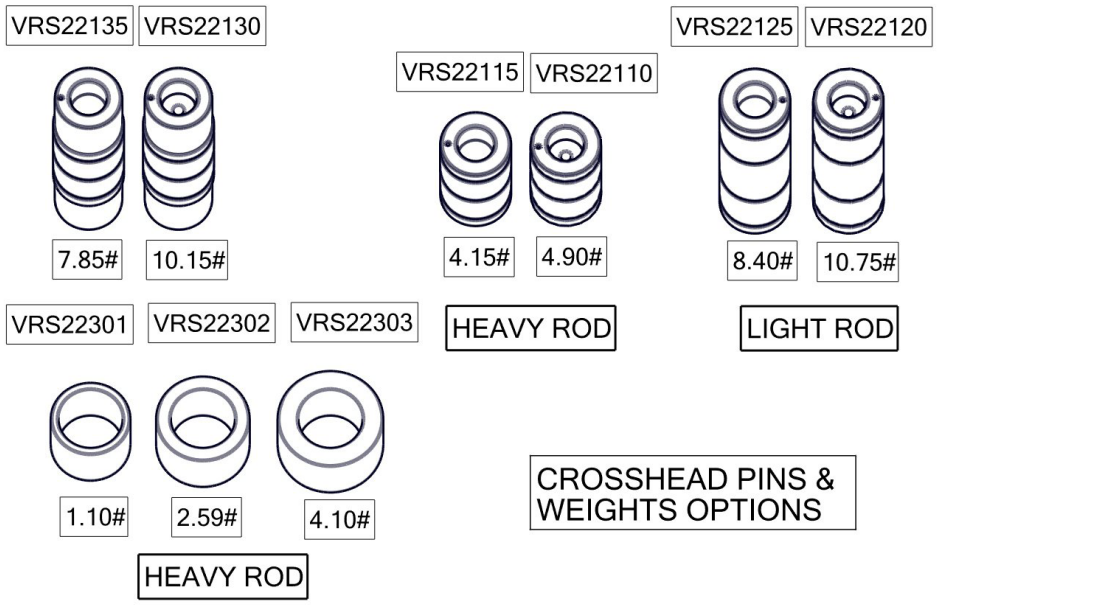
1. Set dial indicator base on the end of the frame with dial indicator touching the end of the crankshaft.



2. Push or tap crankshaft all the way to the far end of the frame set dial indicator to "0" and pull or tap crankshaft all the way to the opposite end.
3. After checking the end-play reading on the dial indicator, add or remove shims as needed to achieve end-play of 0.004" to 0.020".
4. Repeat end-play check procedure until end-play is within specified range.

4.14.5 Crankshaft, Crosshead, and Connecting Rod Parts





SINGLE AND DOUBLE CONNECTING ROD ASSEMBLY

ITEM NO.	PART NO.	DESCRIPTION	QTY.	REC. SPARE PARTS		
				6 MOS	1 YR	2 YRS
1	VRS22000A	CROSSHEAD ASSEMBLY (WITH BUSHINGS AND BABBIT)	2			2
2	VRS22002	BUSHING CROSSHEAD (INCLUDED WITH CROSSHEAD)	4			
3	VRS21222	BUSHING CONNECTING ROD LIGHT (INCLUDED WITH ROD)	2			
4	VRS21220	ROD, CONNECTING, LIGHT ASSY. WITH BUSHING AND SCREWS	2			2
5	VRS22420	SPACER PIN CROSSHEAD LONG	2			2
6	VRS22200	CAP, RETAINER, CROSSHEAD PIN	4			4
7	VRS22128	BOLT CROSSHEAD PIN RETAINER LONG	1			1
8	VRC22119	NUT 3/8-16 NYLOK	4		4	4
9	VRC22206	PIN ROLL, 1/8X1/2	4			4
10	VRS21221	BEARING CONNECTING ROD LIGHT, SET	2		2	
11	VRS21217	SCREW CONN ROD CAP 12-POINT 1/2"X3-1/4" (INCLUDED W/ROD)	8			
12	VRS21210	ROD, CONNECTING, HEAVY ASSY. WITH BUSHING AND SCREWS	1			1
13	VRS21211	BEARING CONNECTING ROD HEAVY PAIR	1		1	
14	VRS21101	BEARING, CRANKSHAFT MAIN	2			2
15	VRS21114	O-RING RETAINER DRIVE-END	1			1
16	VRS21119	SHIM PACK RETAINER DRIVE-END	1			1
17	VRS21110	RETAINER, BEARING, DRIVE-END	1			
18	VRC21117	SCREW 12-POINT 3/8 - 16 X 1	10			
19	VRS28024	SEAL, OIL, CRANKSHAFT	2	1		2
20	VRC21106	KEY, CRANKSHAFT, ACCESSORY-END	2			2
21	VRS22118	BOLT, CROSSHEAD PIN RETAINER, SHORT	1			1
22	VRS22110	PIN CROSSHEAD SHORT HEAVYWEIGHT 4.90 LBS*	1			
23	VRS22115	PIN CROSSHEAD SHORT LIGHTWEIGHT 4.15 LBS*	1			
24	VRS22135	PIN CROSSHEAD LONG BALANCE LIGHTWEIGHT 7.85 LBS*	1			
25	VRS22130	PIN CROSSHEAD LONG BALANCE HEAVYWEIGHT 10.15 LBS*	1			
26	VRS22303	WEIGHT, CROSSHEAD PIN 2@8.20 LBS EACH**	2			
27	VRS22302	WEIGHT, CROSSHEAD PIN 2@5.18 LBS EACH**	2			
28	VRS22301	WEIGHT, CROSSHEAD PIN 2@2.20 LBS EACH**	2			
29	VRS21212	BUSHING CONNECTING ROD HEAVY (INCUDED WITH ROD)	1			
30	VRC28206	KEY SQ 1/4 X 1/4 X 1.24 ROUND-END	1			2
31	VRS21120	RETAINER, BEARING, ACCESSORY-END	1			
32	VRC28239	SETSCREW 5/16 - 18 X 1/2 CUP PNT	1			
33	VRS28248	SPROCKET, CRANKSHAFT DRIVE	1			1
34	VRS28010	COVERPLATE, HOUSING/SEAL RETAINER	1			
35	VRS28425	SHEAVE BELT, CYLINDER LUBE PUMP	1			
36	VRC28429	SETSCREW 3/8 - 16 X 3/4 CUP PNT	1			1
37	VRC25017	SCREW 12-POINT 1/2 - 13 X 1-3/4	1			
38	VRS28104	O-RING SLINGER OIL TUBE	2		2	2
39	VRS28130	FITTING, OIL SLINGER TUBE	1			
40	VRS28110	TUBE, OIL, SLINGER	1			
41	VRS28100	SLINGER, OIL, LUBE DRIVE	1			1
42	VRC21109	PLUG, FLUSH 1/4 NPT	1			
43	VRS21100	CRANKSHAFT, VRS-2 COMPRESSOR	1			1
44	VRS22120	PIN CROSSHEAD LONG HEAVYWEIGHT 10-75 LBS*	1			
45	VRS22125	PIN CROSSHEAD LONG LIGHTWEIGHT 8.40 LBS*	1			

* Pins are determined as required to balance opposing throw according to cylinder configuration.

** Weights to be determined by cylinder configuration.

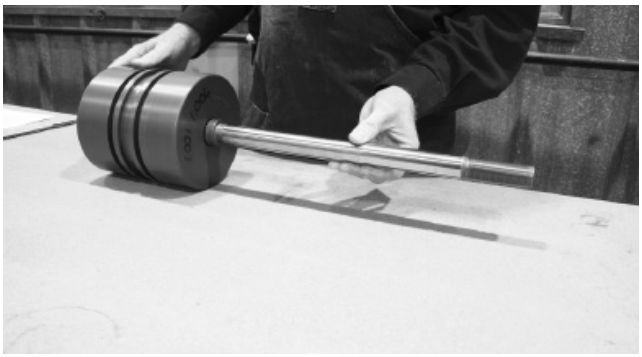
4.15 Piston and Piston Rod Assembly Preparation

1. Clean the piston making sure the all surfaces are free from dirt and metal shavings.
2. Clean piston rod and remove any excessive corrosion inhibitor oil from the threaded area.
3. Inspect both piston and rod making sure both are clean and free from debris and metal shavings.

4.15.1

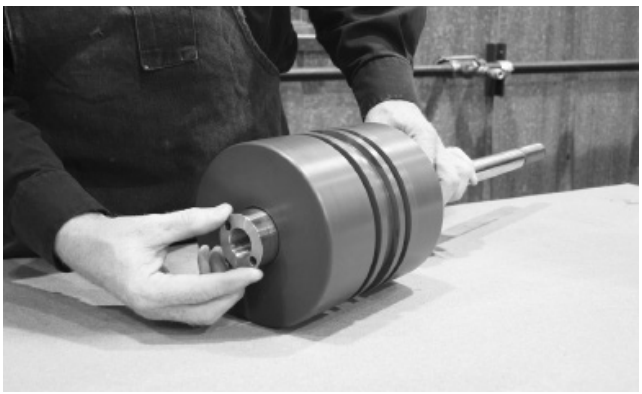
NOTE: Dirt in this area will cause excessive packing ware and cylinder bore abrasion damage.

1. Place the piston on its side and insert the piston rod in the piston. The piston rod should be inserted through the piston's smallest hole end.
2. Carefully insert the piston rod until it bottoms out.



3. Thread the piston nut (VRC24919) on to the counter bore of the piston.

NOTE: DO NOT lubricate the piston nut threads.



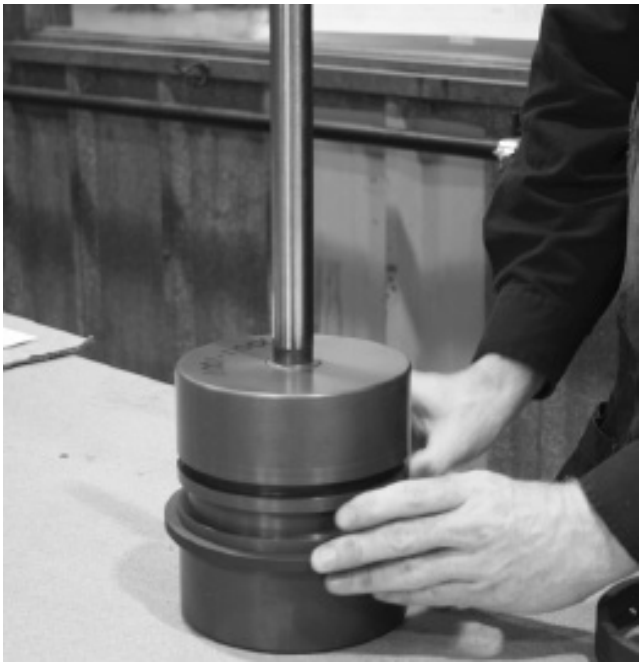
4. Thread the piston nut by hand. Then using the piston nut adapter tool (VRC29490), insert the pins of the adapter into the holes of the piston nut.

5. Insert the piston rod into the rod clamp (VRC29494) and place both into a vise and tighten firmly.

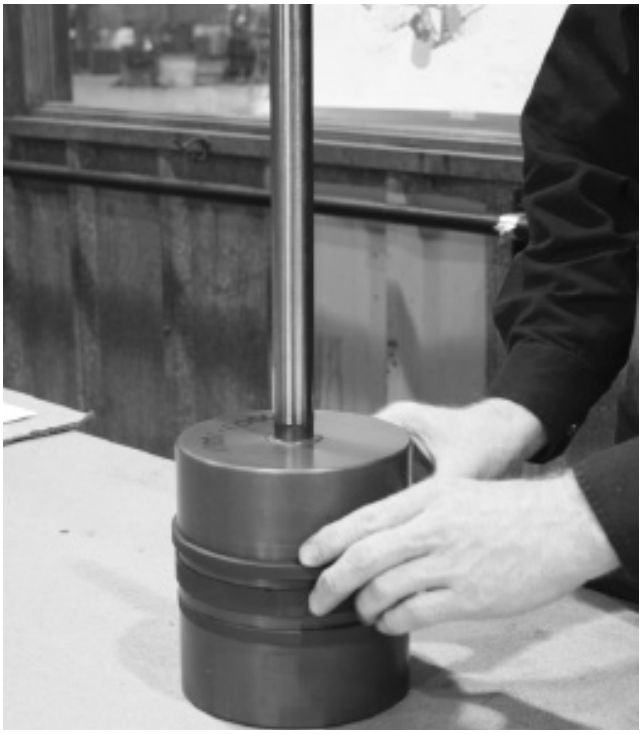
6. Using a 1” socket and torque wrench, torque the piston nut to 330 ft.-lbs.

7. Remove piston rod and piston from vise.
8. Remove piston rod clamp by tightening the set screws to open the jaws of the clamp.
9. Install piston rings. Stand the piston and rod assembly on the end. Expand the ring with your fingers and slide the ring over the piston to the ring land. (Some pistons may have more rings.)

10. Next install the rider band by expanding the band with your fingers and sliding it over the piston inserting it in the rider groove.



11. Slide the remaining piston rings over the piston on to the remaining ring grooves. (Some pistons may have a second ring.)

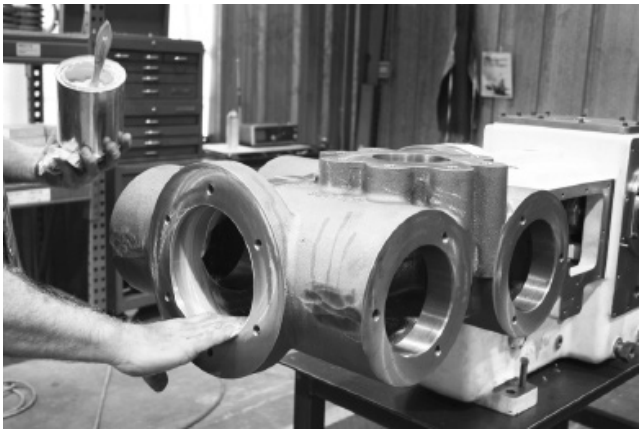


NOTE: Make sure you stagger the gaps of the rings and rider band. You do not want the ring gaps to line up.

4.15.2 Piston and Piston Rod Installation

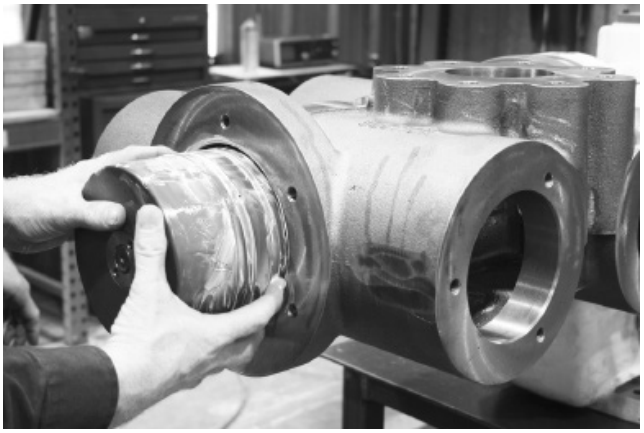
After the piston and piston rod assembly is complete and the cylinder has been mounted on the frame, you may install the piston rod assembly into the cylinder.

1. Liberally apply lubricant to the piston and piston rod assembly. The piston rings should be included in this lubrication process.
2. Liberally apply lubricant in the cylinder bore.



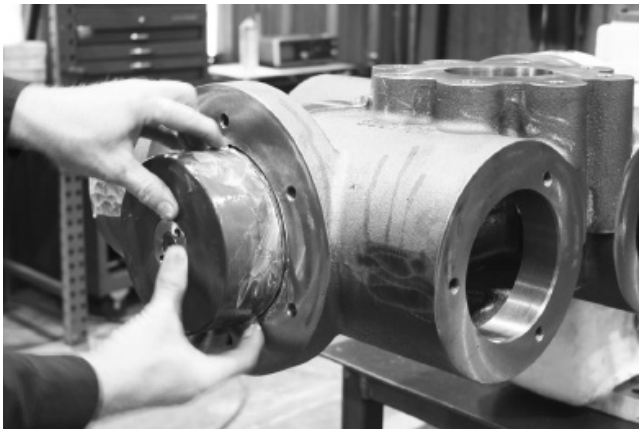
3. Install the piston rod assembly with piston rings into the cylinder. The threaded crosshead end of the rod is 1/8″ (3 mm) smaller than the inside diameter of the packing. It's preferred to use an entering sleeve. This piston rod entering sleeve tool (VRC29492) is available from Arrow.

4. Stagger the piston ring gaps and then compress the piston rings with your fingers as you slide the piston rod assembly into the cylinder. Be careful not to pinch your fingers.

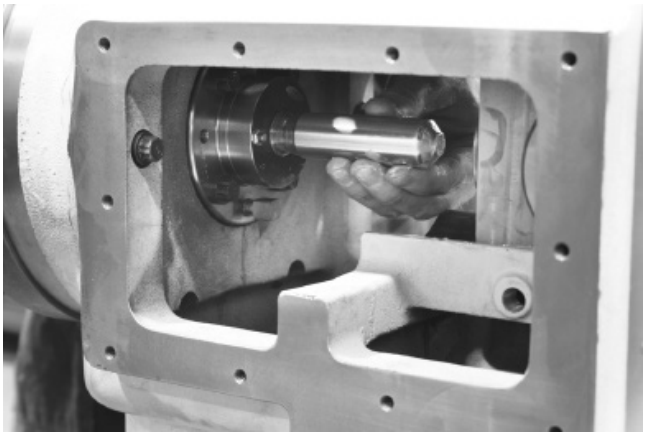


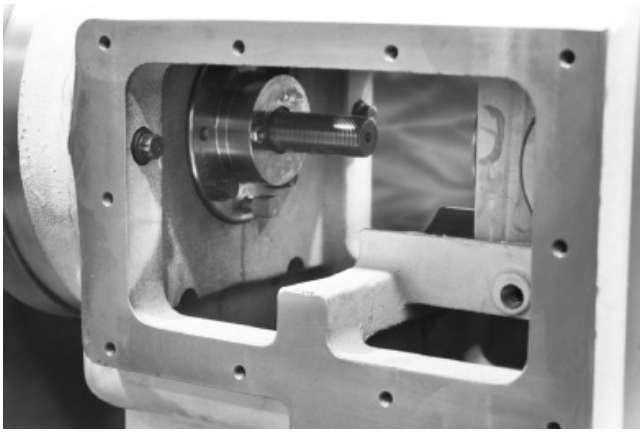
5. While your fingers are compressing the piston rings, carefully insert the piston and piston rod assembly into the cylinder bore (the cylinder is normally mounted to the frame prior to this step).

6. Make sure the crosshead is all the way back of its throw.

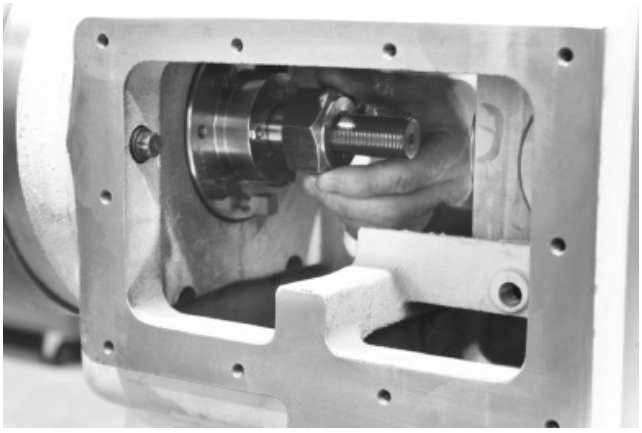


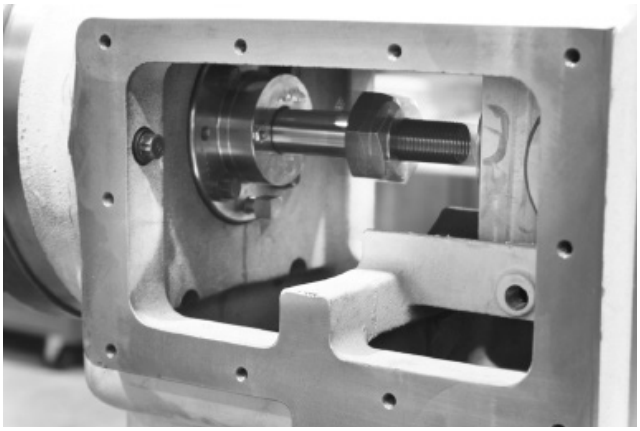
7. Remove entering sleeve tool from rod.





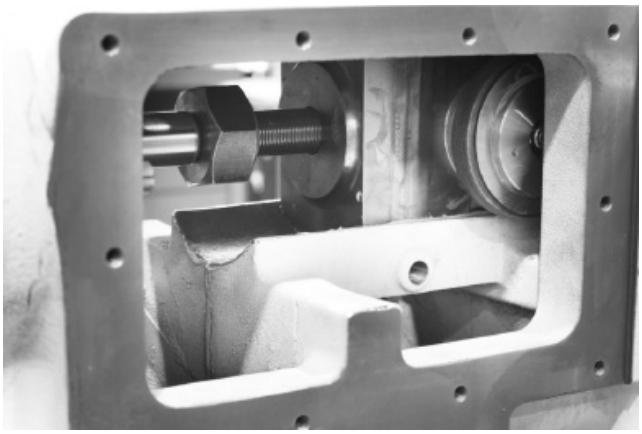
8. Install piston rod jam nut (VRC24909) or other extra heavy nuts as required for proper balancing on the piston rod. Make sure that the raised flat surface of the nut will be against the crosshead.





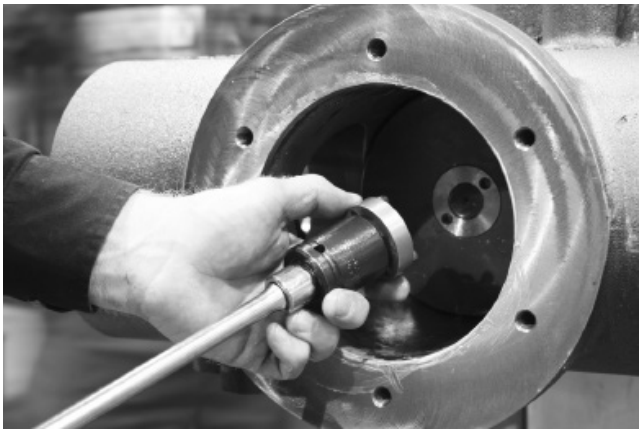
NOTE: Screw piston rod jam nut to end of thread.

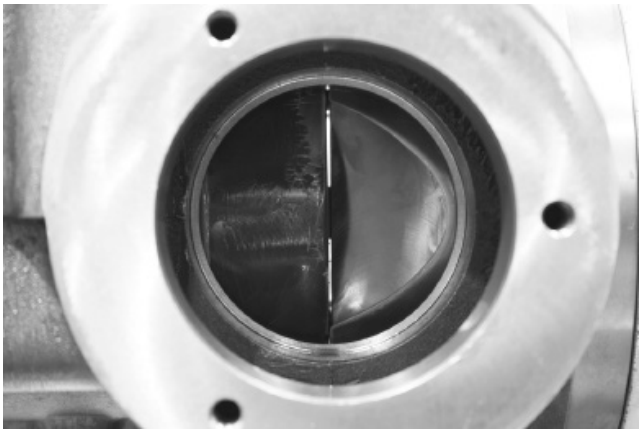
9. Continue to insert piston and piston rod assembly until it begins to thread into crosshead.



10. Using the piston nut adapter tool (VRC29490) screw the piston and piston rod assembly into the crosshead while the crosshead is all the way to the back of its throw.

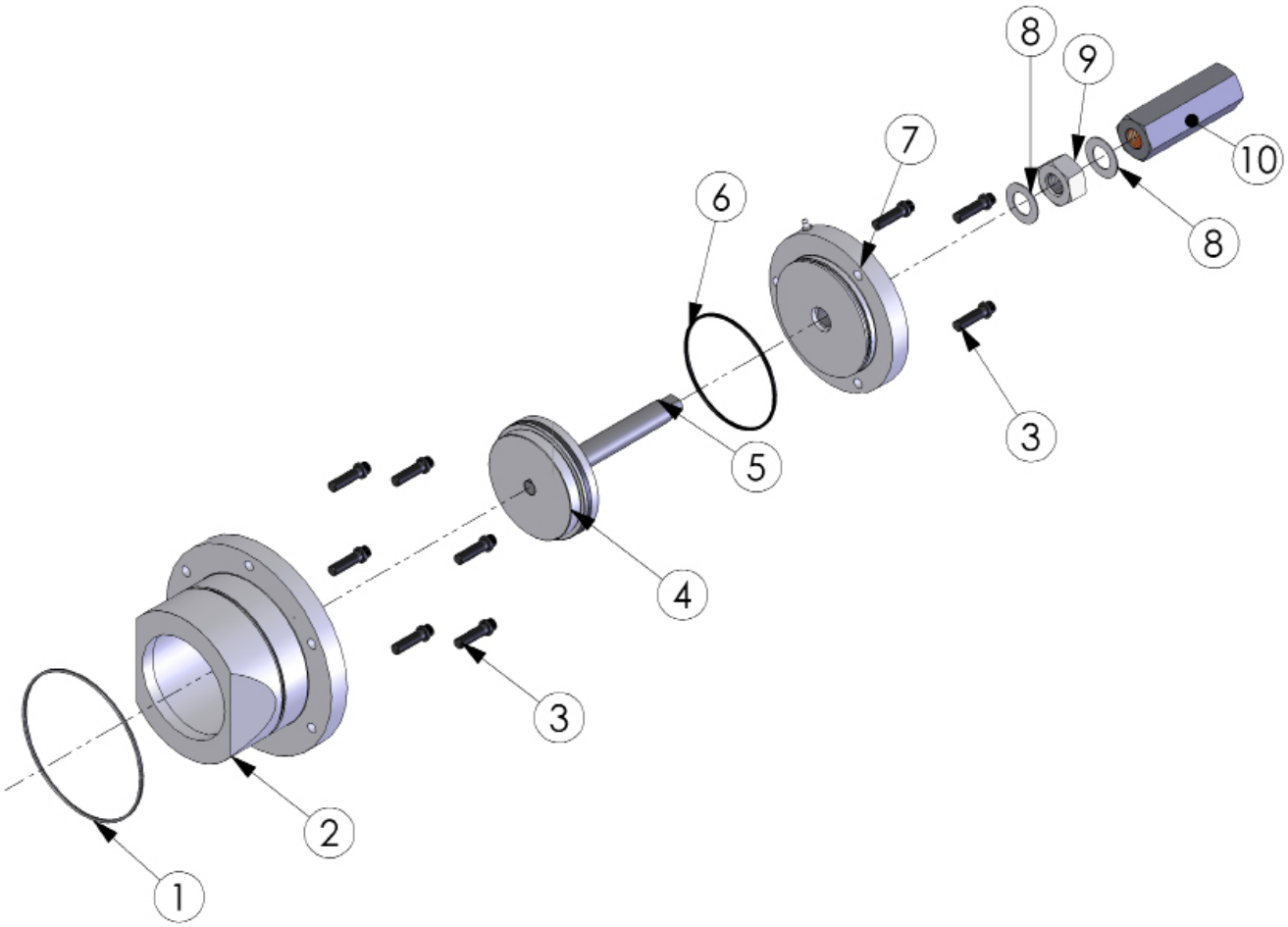
NOTE: Continue this process until the crank-end of the piston is approximately 0.050” from the crank-end head.





After assembly and installation of the outer head/VVCP pocket, refer to section 4.15.12, Setting Final Piston Clearance.

4.15.3 VVCP- Variable Volume Clearance Pocket



VVCP - VARIABLE VOLUME CLEARANCE POCKET			
NO.	PART NO.*	DESCRIPTION	QTY.
1	VRC2XXXX*	O-RING, HEAD, CRANK AND OUTER END CYLINDER BORE	1
2	VRC2XXXX*	POCKET, OUTERHEAD, X.X INCH VVCP	1
3	VRC2XXXX*	SCREW, VVCP POCKET AND COVER	9
4	VRC2XXXX*	PISTON, X.X - X.X INCH VVCP	1
5	VRC2XXXX*	STEM, VVCP ADJUSTING	1
6	VRC2XXXX*	O-RING, POCKET COVER, X.X - X.X INCH VVCP	1
7	VRC2XXXX*	COVER POCKET, X.X - X.X INCH VVCP	1
8	VRC2XXXX*	GASKET, VVCP ADJUSTING STEM COVER	2
9	VRC2XXXX*	NUT, JAM, VVCP ADJUSTING STEM	1
10	VRC2XXXX*	COVER, VVCP ADJUSTING STEM	1

* For specific size and part number, see the VRS-2 Compressor Parts Manual.

4.15.4 VVCP Installation – Assembly of the Adjustment Stem to the Piston

NOTE: This assembly (VVCP adjustment stem) may be purchased as an assembly from Arrow with no assembling required.

The part number for the assembly is a "Piston and Stem Assembly" using VVCP piston part number followed by an "A".

1. Insert VVCP adjusting stem (VRC27100) into the flat end of the piston so that the stepped end piece is opposite of the stem.

2. Using a 3/16" drill bit, drill a 3/16" hole half way into the piston and half way into the stem.
3. Insert spring pin (VRC27106) into the hole just drilled.

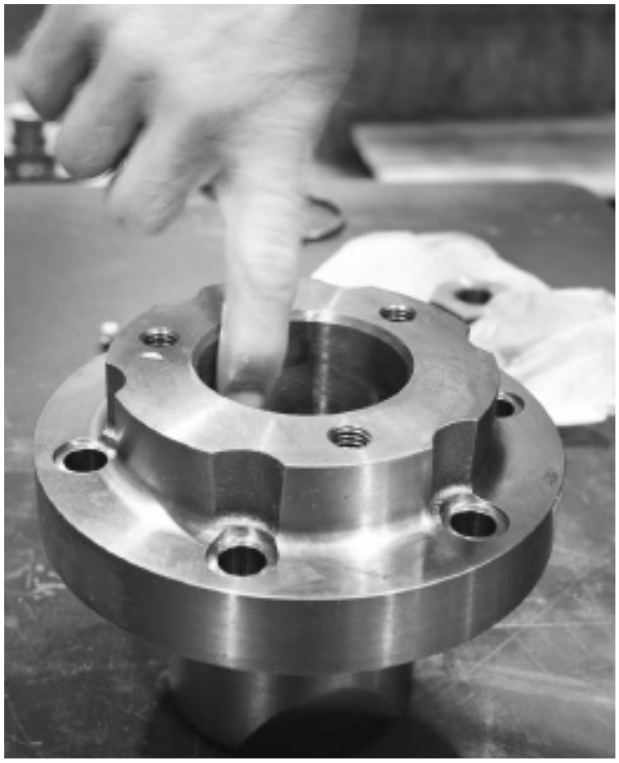
4. Insert the piston ring by sliding the ring over the piston onto the ring groove.

5. Lubricate O-ring.

6. Insert O-ring onto the ring groove in the VVCP pocket cover.

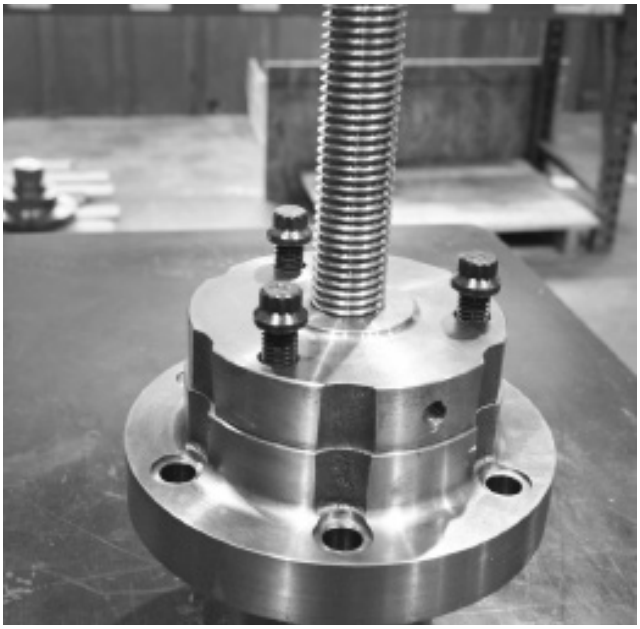
7. Screw the adjusting stem into the VVCP pocket cover in the end that has the O-ring groove.

8. Liberally lubricate the piston, piston ring, and VVCP pocket.

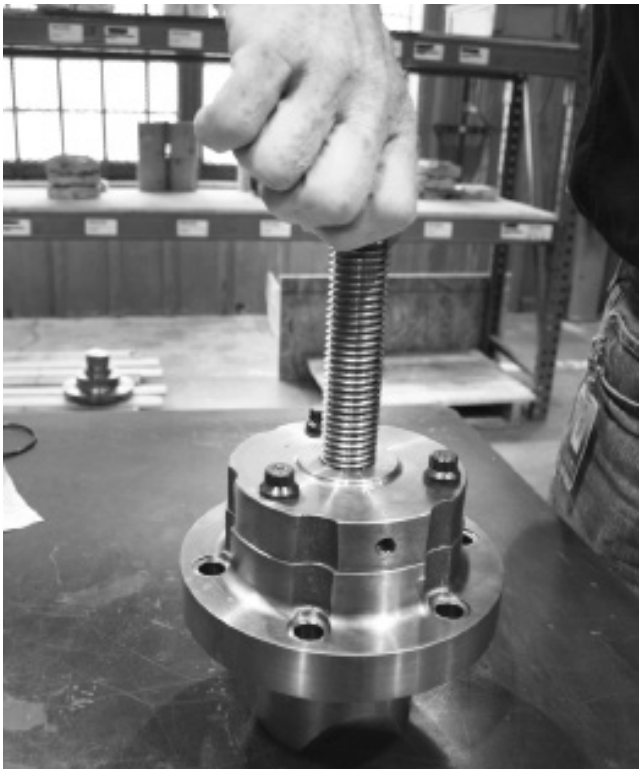


9. Insert the piston carefully into the VVCP pocket making sure the piston ring and O-ring insert evenly into the VVCP pocket.

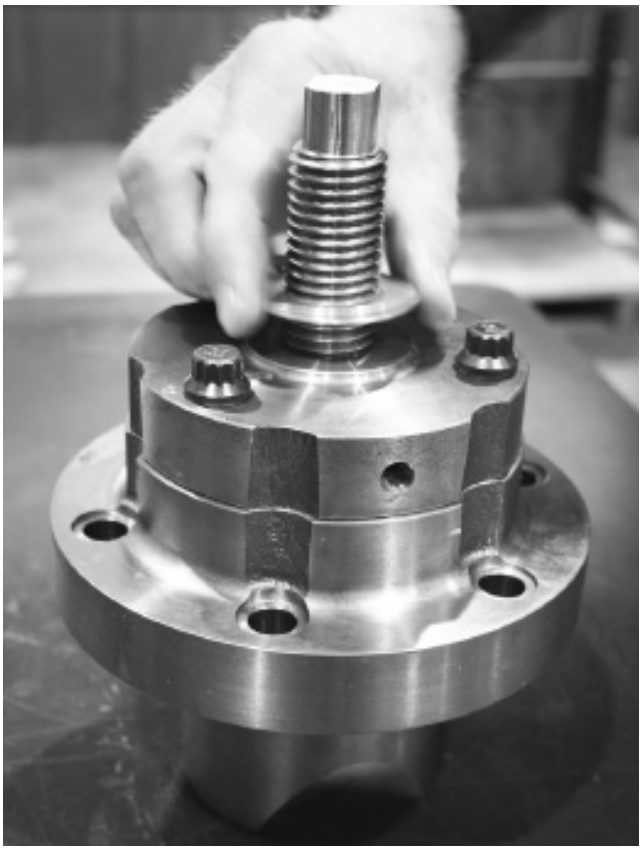
10. Insert three VVCP pocket cover screws (VRC25017) and torque to 82 ft.-lbs.



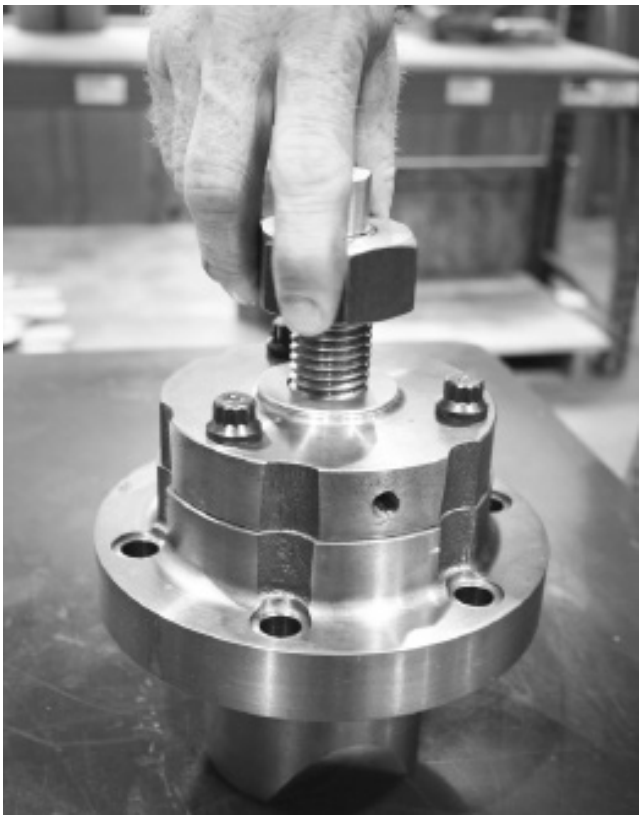
11. Run the adjusting stem all the way into the VVCP pocket until the piston seats at the bottom of the VVCP pocket (at base clearance).



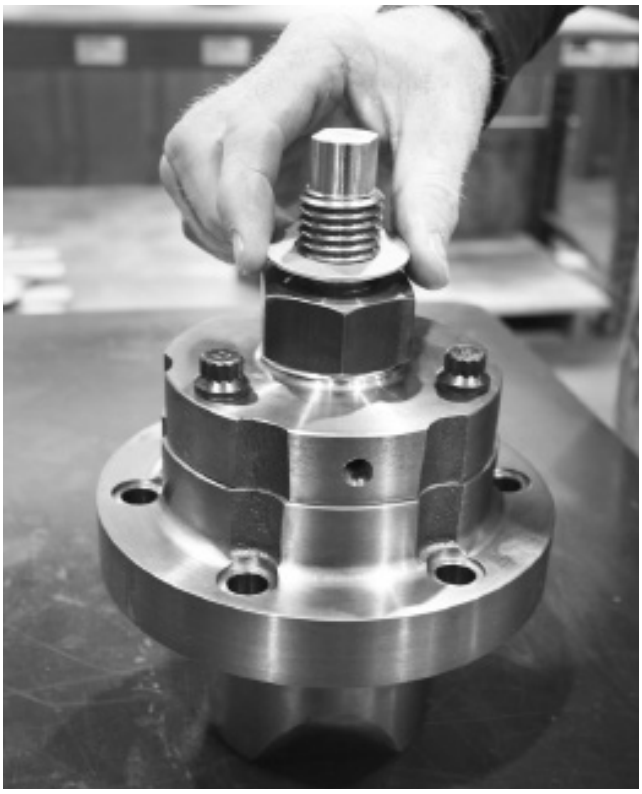
12. Insert the first of two VVCP adjusting stem cover gaskets (VRC27105).



13. Insert VVCP adjusting stem jam nut (VRC27103).



14. Insert second VVCP adjusting stem cover gasket (VRC27105).



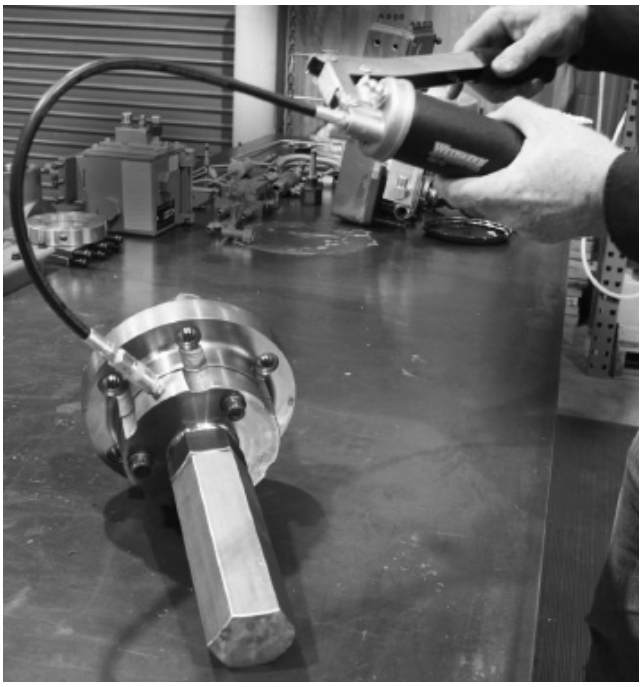
15. Install VVCP adjusting stem cover (VRC27101).

16. Lubricate the crank-end outer head O-ring (VRC27101).

17. Insert the O-ring in the O-ring groove in the head end of the VVCP pocket.

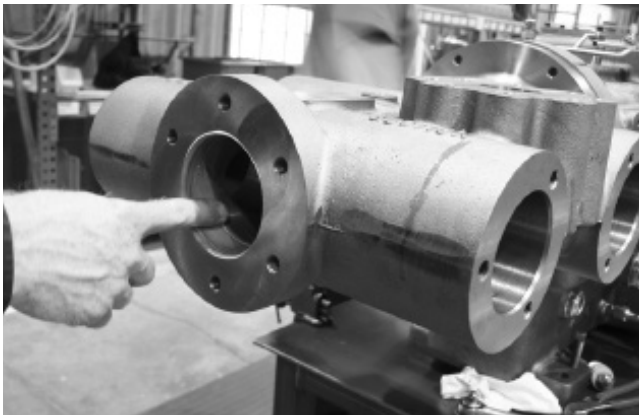
18. Insert VVCP grease zerk (VRC27109) into the hole located in the VVCP pocket cover.

19. Using a grease gun, full the VVCP with grease via the grease zerk.



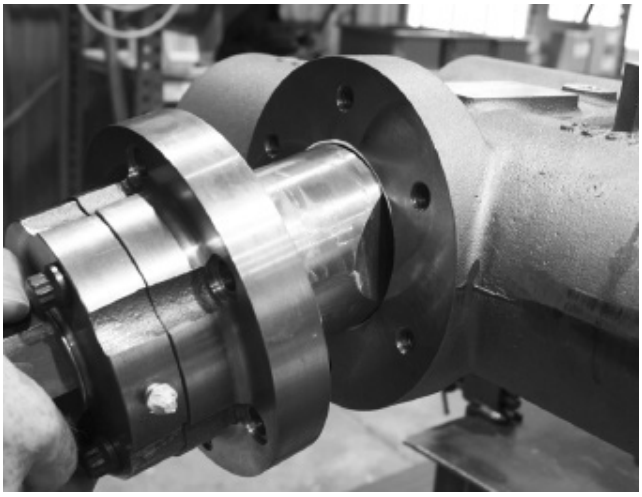
4.15.5 Installing VVCP to the Cylinder

1. Apply grease to the cylinder head bore.



2. Insert VVCP into cylinder making sure the flats on the VVCP head align with valve ports.

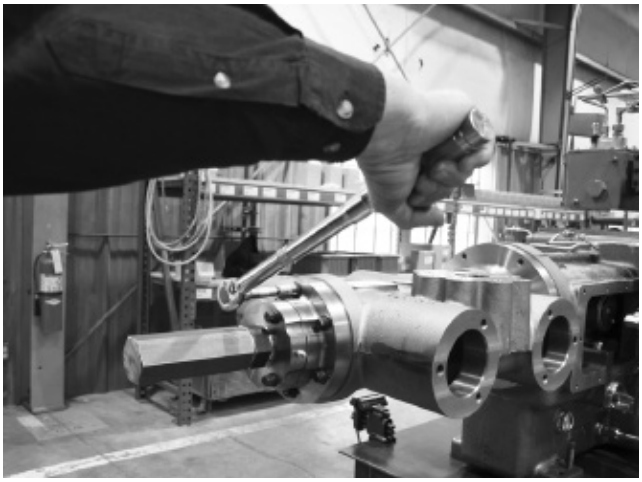
NOTE: You may use a rubber hammer or mallet to help with inserting the head into the cylinder.



3. Push the VVCP into the cylinder.

4. Insert six (6) VVCP pocket cover screws (VRC25017) into the holes in the VVCP and attach to the cylinder.

5. Torque screws to 82 ft.-lbs.



4.15.6 VVCP Removal

1. Remove VVCP from the cylinder by unscrewing the six (6) VVCP pocket cover screws.
2. Pull the VVCP from the cylinder after all the pocket cover screws are removed.

CAUTION: *Make sure that the head is loose and the cylinder has been properly vented and all pressure and trapped gas is relieved.*

4.15.7 VVCP Disassembly

1. Remove the O-ring in the O-ring groove from the head end of the VVCP pocket.
2. Remove the VVCP adjusting stem cover.
3. Remove the VVCP adjusting stem cover gasket.

NOTE: This would be the gasket that would be inserted SECOND during the VVCP assembly and installation process.

4. Remove VVCP adjusting stem jam nut.
5. Remove VVCP adjusting stem cover gasket. This would be the gasket that would be inserted FIRST during the VVCP assembly and installation process.
6. Unscrew the three VVCP pocket cover screws.
7. Remove the piston and cover from the VVCP pocket.
8. Unscrew the adjusting stem from the VVCP pocket cover.
9. Remove O-ring from the ring groove in the VVCP pocket cover.
10. Remove the piston ring that is seated in the ring groove on the piston.

4.15.8 VVCP Adjustments

CAUTION: *VVCP clearance volume should only be changed with the compressor STOPPED!*

VVCP clearance volume should only be change with the compressor stopped. Refer to the performance run for the specific field operating conditions for the percentage of clearance required to set the VVCP. Consult the table below for VVCP clearance specifications.

Most Arrow Variable Volume Clearance Pockets have three inches of total travel on a stem that has seven threads per inch, therefore, it takes 21 turns to go from base clearance to 100% total added clearance available.

It is recommended that you start at base clearance (stem screwed all the way in) and count the number of turns out until desired clearance is achieved. Refer to the table below or the VRC-SIM compressor sizing program output for the required number of turns.

VVCP CLEARANCE			
CYLINDER SIZE (INCHES)	MAXIMUM ADDED CLEARANCE %	% CLEARANCE PER TURN	MAXIMUM NUMBER OF TURNS
3.5″	56.7%	2.7%	21
4.0″	42.0%	2.0%	21
4.5″	52.5%	2.5%	21
5.0″	42.0%	2.0%	21
5.5″	52.5%	2.5%	21
6.0″	44.1%	2.1%	21
6.5″	58.8%	2.8%	21
7.0″	52.5%	2.5%	21
7.5″	58.8%	2.8%	21
8.0″	52.5%	2.5%	21
9.5″	100.0%	3.6%	28
10.0″	96.0%	3.4%	28

The VVCP piston ring is not designed to be gas tight, but to allow a nearly balanced gas pressure for ease of VVCP adjustment with the cylinder pressurized. Gas pressure behind the VVCP piston normally vents when the cylinder is vented.

If gas is trapped behind the piston the VVCP can be adjusted when the cylinder is pressurized, but will be difficult to turn when the cylinder is vented.

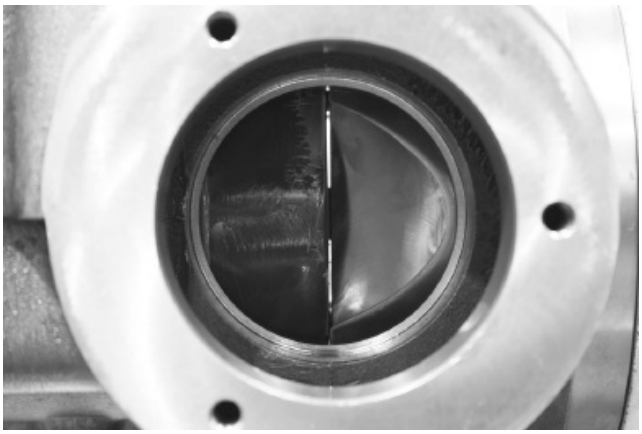
4.15.9 Adjust VVCP Volume

CAUTION: *Volume adjustments are NOT to be made while the compressor is running.*

1. Remove the VVCP adjustment stem cover (VRC27101).
2. Loosen the stem jam nut (VRC27103) so that the stem (VRC27100) is free to turn.
3. Turn the stem with a wrench on the flats of the stem.
4. Refer to Table above, VVCP Clearance, for the number of turns required to achieve the percentage clearance required for specific operating conditions.
5. After making the appropriate VVCP adjustment, tighten the jam nut and replace the adjusting stem cover.

4.15.10 Setting Initial Piston Clearance (Crank-end Head)

1. Using long feeler gauges, insert .050 feeler gauge between piston and crank-end head. Continue to screw the rod into the crosshead until .050 clearance is achieved. The crosshead must be all the way to the back of its throw at this time.



2. Tighten the piston rod jam nut using a 2" open end wrench.

NOTE: Bring crosshead to the end of its throw allowing access with the wrench to tighten the piston rod jam nut.

NOTE: The objective is to achieve 70% of total clearance at the head-end and 30% of total clearance at the crank-end.

3. Turn crankshaft to make sure all installed parts are free and moving properly.

NOTE: Piston clearance should be checked again after installing outer-end head.

4. Replace the crosshead side covers and tighten all screws. Before installing side covers apply anti-seize lubricant to the gaskets. This will help when removing them later during maintenance.

4.15.11 Outer Head/VVCP Pocket Assembly to Cylinder

1. Clean and lubricate liberally the outer head and O-ring.
2. Insert the outer head O-ring into the O-ring groove.

3. Carefully work the outer-end head into the cylinder paying special attention to make sure the flat surfaces face the valve ports in the cylinder.

NOTE: You may use a rubber hammer or mallet to help with inserting the head into the cylinder

4. Insert the 12-POINT. screws into the outer end head and torque to 82 ft.-lbs..

4.15.12 Setting Final Piston Clearance (Outer Head/VVCP Installed)

1. With the outer head/VVCP installed, rotate the crankshaft until the piston is at the end of its throw.
2. Insert feeler gauge through the valve port to determine what the clearance is between the piston and outer end head. Add this clearance to the actual clearance measured on the crank-end and determine the total clearance as the sum of these two values. Make sure that you have approximately 70% of the total clearance on the outer head end and approximately 30% of the total clearance on the crank end head.
3. After final adjustment is made tighten the piston rod jam nut as tight as possible, or to the specified torque of 255 ft.-lbs.
4. Replace the crosshead side covers and tighten all screws.

NOTE: Before installing side covers apply anti-seize lubricant to the gaskets. This will help when removing them later during maintenance.

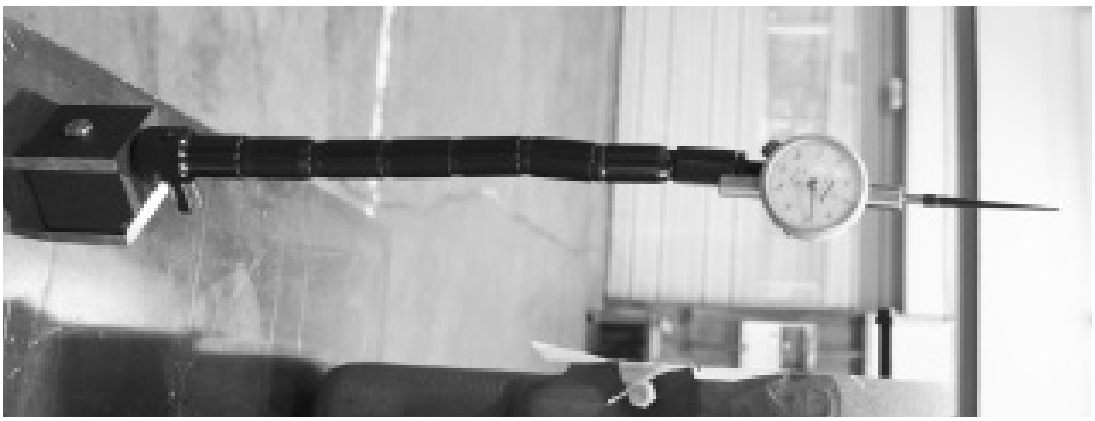
5. Replace the valve seat gaskets, valve assemblies, the retainers and valve covers. Tighten all valve cover screws evenly to the proper torque value of 82 ft.-lbs..

4.15.13 Piston Rod Run-out

It is important to check piston run-out after installing a new unit, relocating a unit or when performing any maintenance that could affect piston run-out.

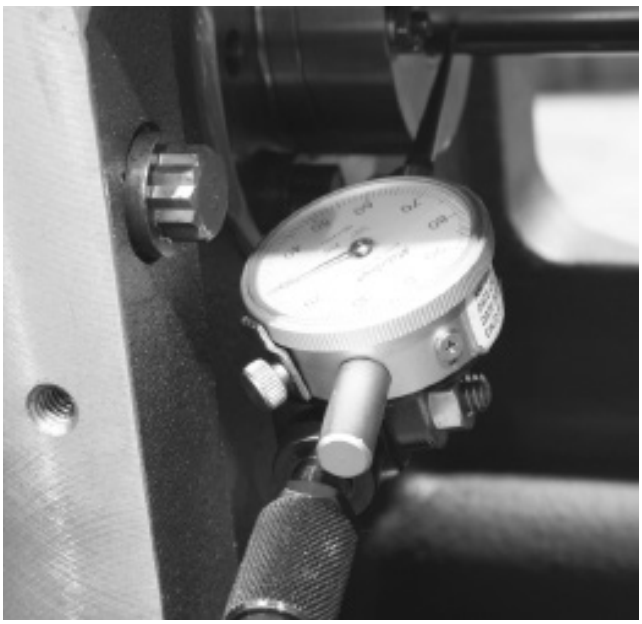
4.15.14 Horizontal Piston Rod Run-out Reading

1. Position the dial indicator PARALLEL to the flexible arm (see picture for illustration).



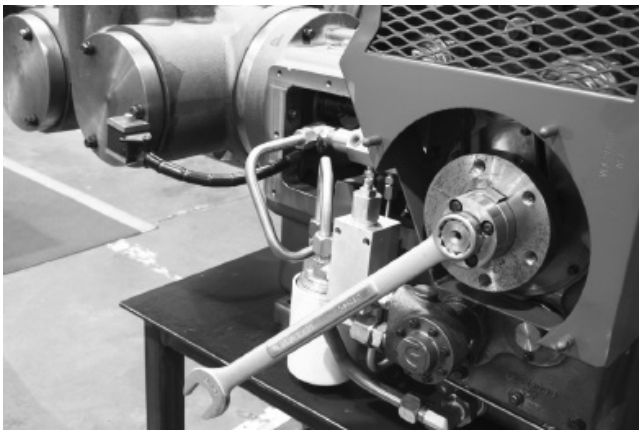
2. Using the magnetic base with flexible arm dial indicator, position the magnetic base on the valve cover on the ACCESSORY SIDE of the frame and position the dial indictor so that the indicator is touching the side of the rod close to the packing case.

NOTE: An extra long extension on the dial indicator will make it easier to read the dial.



3. Once the dial indicator is in the proper position and is zeroed out, check to make sure the dial indicator is not touching anything that might give an incorrect reading.

4. Using the crankshaft adapter tool and a 1-1/16” wrench, turn the crankshaft counter-clock wise one full turn (360°).

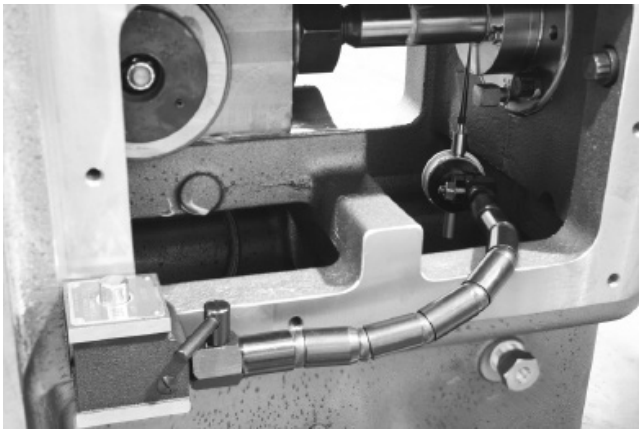


5. While the rod completes a full stroke, observe the dial indicator and record the highest reading. This reading is the maximum HORIZONTAL rod run-out reading (see Table 3.4, Maximum Acceptable Piston Rod Run-out Readings).

4.15.15 Vertical Piston Rod Run-out Reading

1. Position the dial indicator PERPENDICULAR to the flexible arm.

2. Position the magnetic base and attach it to the area where the side cover is placed on the DRIVE SIDE of the frame.



3. With the magnetic base attached, position the dial indicator on the bottom side of the rod and zero out the dial indicator.

4. From the accessory side of the frame and using the crankshaft adapter tool and 1-1/16 wrench, turn the crankshaft one full turn (360°).

5. While the rod completes a full stroke, observe the dial indicator and record the highest reading. This reading is the maximum VERTICAL rod run-out reading (see Table 3.4, Maximum Acceptable Piston Rod Run-out Readings).

MAXIMUM ACCEPTABLE PISTON ROD RUN-OUT READINGS		
DIRECTION	**INCHES**	**(mm)**
VERTICAL	0.002	(0.0508)
HORIZONTAL	0.001	(0.0254)

If the piston rod run-out readings are not within acceptable limits after maintenance or replacing worn or damaged parts and correcting any misalignment, the piston rod should be replaced.

4.15.16 Piston Rings

The VRS-2 Compressor cylinders use one-piece angle-cut carbon filled Teflon piston rings.

4.15.17 Determining Ring Wear

Arrow recommends replacing rings when the end gap has increased three times the new dimension (see Table 3.9, Piston to Bore Clearance and Conventional Piston Ring End Gap for Double-acting and Steeple Cylinders).

To measure the end gap, with piston removed, insert the ring in the cylinder bore in the area of piston ring travel. Expand the ring so that it is snug against the inside of the cylinder bore and measure the ring gap.

NOTE: Excessive ring gap may be an indication of cylinder bore wear.

4.15.18 Piston Ring Removal

Take care when handling the piston rings. Despite the piston rings toughness, rings should still be considered fragile when removing them from the piston. Always handle them with clean tools and hands so as to protect the rings from dirt, nicks, marring and bending.

1. Pull the piston out of the cylinder until the first ring clears the cylinder.
2. Place fingers in the ring gap and gently pull gap apart just enough to expand the ring so that it clears the ring land. Carefully remove the rings from the piston.

Use these procedure to remove all remaining piston rings and rider band.

4.15.19 Rider Bands

The VRS-2 Compressor cylinders use two one-piece straight-cut carbon filled Teflon rider bands.

4.15.20 Determining Rider Band Wear

Because the rider band does not work as a seal ring, end gap is not a concern. The rider band projection beyond the outer diameter of the piston is important. Rider band projection can be checked by measuring the piston to cylinder bore clearance at the bottom of the bore. This is done without removing the piston from the cylinder.

Replace the rider band before it becomes worn. A worn rider band will allow the piston to touch the cylinder bore and cause damage to the piston and to the cylinder bore. For acceptable piston to bore clearance see Table 3.9, Piston to Bore Clearance and Conventional Piston Ring End Gap for Double-acting and Steeple Cylinders.

4.15.21 Piston Ring(s) Installation

1. Place the rings over the grooves in the piston. Compress the one-piece carbon filled Teflon rings by hand.
2. With the rings fully compressed in the grooves of the piston, insert the piston rod and piston into the cylinder.

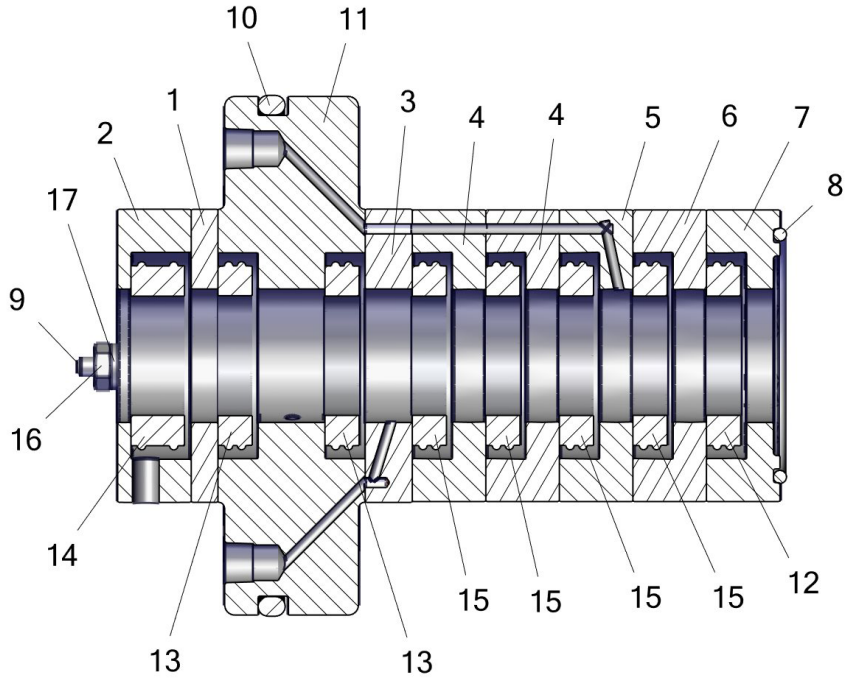
NOTE: Ring gaps are to be staggered around the piston, rather than in line.

3. Continue by following the procedures found in section 4.15.2, Piston and Piston Rod Installation.

Rider Band Installation

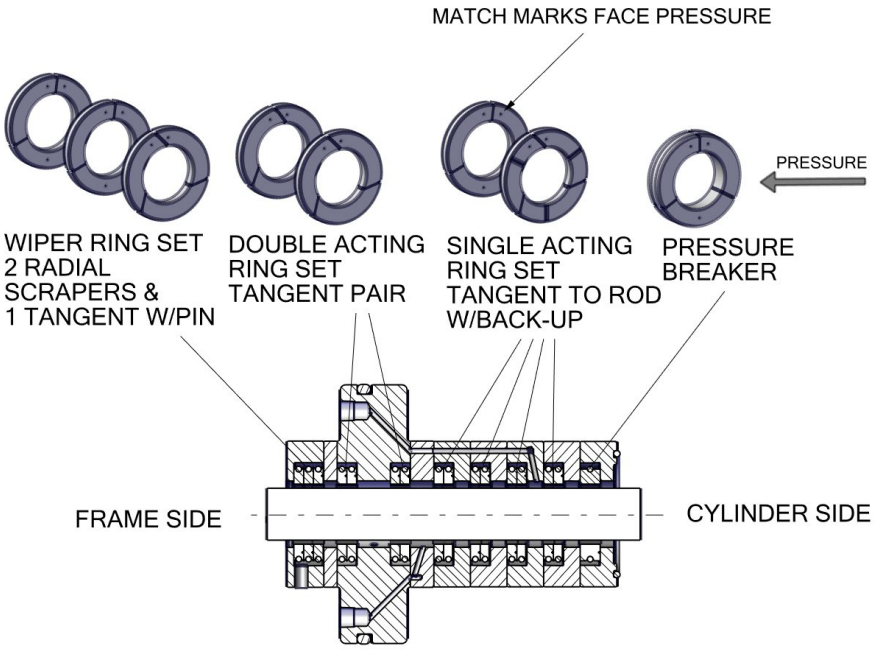
The procedure for installing the rider ring is exactly like the procedure for installing the piston ring. The rider bands are used on all Arrow cylinders.

4.16 Pressure Packing, Piston Rod



PACKING CASE			
NO.	PART NO.	DESCRIPTION	QTY.
1	VRC23321	SPACER, PACKING CASE	1
2	VRC23351	CUP, PACKING, WIPER	1
3	VRC23311	SPACER, PRIMARY VENT	1
4	VRC23241	CUP, PACKING, CENTER	2
5	VRC23231	CUP, PACKING, LUBE	1
6	VRC23221	CUP, PACKING, PLAIN	1
7	VRC23211	CUP, PACKING, BOTTOM	1
8	VRC23106	GASKET, WIRE, PACKING CASE NOSE	1
9	VRC23118	STUD, PACKING CASE	3
10	VRC23104	O-RING, PACKING CASE MOUNTING FLANGE	1
11	VRC23201	FLANGE, PACKING CASE	1
12	VRC23411	RING, PACKING, PRESSURE BREAKER	1
13	VRC23431	RING, PACKING, DOUBLE-ACTING	2
14	VRC23441	RING, PACKING, WIPER	1
15	VRC23421	RING, PACKING, SINGLE-ACTING	4
16	VRC23109	NUT, LOCK, PACKING CASE STUD	3
17	VRC23001A	CASE, PACKING ASSEMBLY	1

4.16.1 Piston Rod Packing Ring Arrangement



IMPORTANT: Packing rings are to be installed with the punch mark pointing toward the pressure side.

Frame Side	Wiper Ring (1) Set of (3) (VRC23441)	Double-acting Ring Set (2) (VRC23431)	Primary Vent	Single Acting Ring Sets (3) (VRC23421)	Oil Supply	Single Acting Ring Set (1) (VRC23421)	Pressure Breaker Ring (VRC23411)	Pressure Side

Arrow part numbers for ordering renewal ring kits are:

VRC23501- Ring Kit, Packing Renewal with parts (include O-ring, nose gasket, nuts, and washers)

VRC23551- Ring Kit, Packing Renewal (rings only)

4.16.2 Piston Rod Pressure Packing Removal

1. Remove the piston and piston rod.
2. Disconnect the lube oil line from the top of the packing case and primary vent line from the bottom of the packing case.
3. Remove the four (4) screws that hold the pressure packing case to the cylinder.
4. Do not remove the small nuts from the studs. These studs hold the entire packing case together so it can be removed as an assembly.
5. Pull the entire pressure packing case out into the crosshead guide. It will come out through the side opening. The pressure packing case may now be taken to a clean place for disassembly.
6. Set the pressure packing on a clean surface. Three (3) long tie studs hold the pressure packing case together. The stud holes are not equally spaced. This prevents the stack of parts from being aligned incorrectly. Remove the stud nuts and pressure packing; the pressure packing can be unstacked. It is recommended that you replace lock-washers, O-ring and nose gasket each time the pressure packing is serviced.
7. Parts kits are available from Arrow for this. Contact your Arrow sales representative for more information regarding the parts kits. See section 4.16.1, Piston Rod Packing Ring Arrangement for part numbers.
8. Ring wear can be determined by placing the assembled rings on the piston rod. Check end gap clearance. If the ends knock against each other, or nearly hit, they should be replaced.
9. Any wire edges on the rings due to wear should be filed off allowing all matching edges to be square.
10. If necessary, replace aluminum gasket prior to reassembling. Be careful not to scratch the sides of the gasket groove when removing the old gasket.
11. It is important to be sure that all parts are cleaned thoroughly before reassembly.
12. Refer to the packing case drawing, section 4.16, for proper orientation of packing rings. Arrow Pressure Packing Replacement kits are available.

4.16.3 Piston Rod Pressure Packing Reassembly and Installation

1. Be sure to refer to the exploded view drawing of the pressure packing assembly (see section 4.16, Pressure Packing, Piston Rod and section 4.16.1, Piston Rod Packing Ring Arrangement). A pressure packing assembly drawing is also included in each pressure packing renewal kit.
2. When installing a new set of rod packing rings in an existing packing case, the case parts need to be inspected for wear. Cups should be smooth and flat on the back side where the rod packing rings must seal. If the grooves have worn or tapered, they should be re-ground or re-lapped. It is rarely necessary to alter the crosshead side of the cups, however, if this is found necessary, care must be taken so that the correct side clearance is not destroyed or compromised.
3. Before a packing case is installed, it should be disassembled and cleaned using an appropriate solvent.
4. Make sure that each rod packing ring and cup is properly positioned and the rings are liberally coated with a clean lubricant before reassembly. Examining all the parts for nicks or burrs is

important. Imperfections such as these can interfere with the free movement of the rod packing ring in the cup. Extreme care should be taken with rod packing rings made of soft material like Teflon. It is also important to carefully handle and install the wiper rings as to prevent damage to the scrapping edges.

5. Parts should be laid out on a table so that they can be properly installed in the proper progression. Each in its correct position and their rod packing rings with their proper faces toward the pressure.

6. Regarding new installations, it is important to clean all dirt that may have accumulated in the lines and in the compressor. If you do not inspect and clean the lines, dirt and other foreign material will lodge in the packing and become destructive to the compressor.

7. Prior to installing the packing case into the cylinder, the end cup wire gasket (VRC23106) must be inspected for nicks or any other damage that could cause leaks in service. It is a good practice if you are in doubt, to replace the wire gasket with a new one.

8. Clean and inspect the gasket surface in the packing counter bore on the crank end of the cylinder for scratches before you install the packing case into the cylinder.

9. Reinstall the complete packing case assembly making sure the oil supply point is on top. Pull the packing into place by using the packing case screws (VRC23107).

10. Reinstall the piston and piston rod.

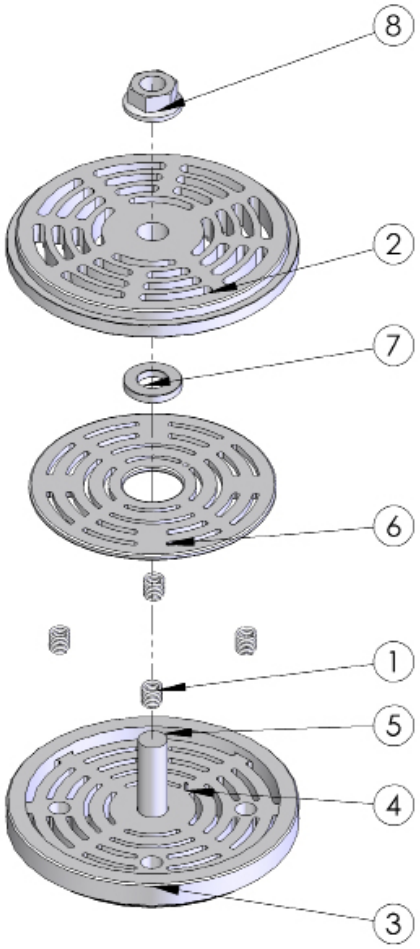
11. After the crosshead jam nut has been tightened, tighten the rod packing screws evenly to the recommended torque of 45 ft.-lbs. This procedure will ensure that the pressure packing comes up square on its nose gasket.

12. Retighten the small packing case stud nuts. Reinstall the tubing connections for the oil supply and primary vent. Be careful not to cross-thread the fittings.

NOTE: After installing the new pressure packing rings, refer to section 6.9, Filling and Operating the Lubrication System, for instructions for priming the cylinder lube system.

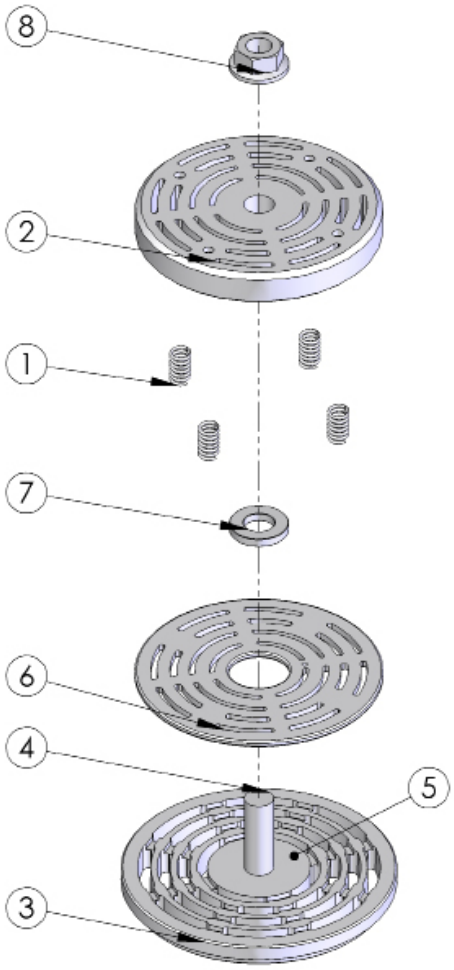
For normal lubrication rates that are recommended for a normal running compressor, see section 6.10.2, Divider Blocks. Break-in lube rates are twice the normal rates or one-half the normal indicator pin cycle time. For fitting and tubing connections refer to section 6.8, Tubing and Distance Piece Venting.

4.17 Valves



SUCTION VALVE			
NO.	PART NO.*	DESCRIPTION	QTY.
1	VRC2XXXX*	SPRING, CLOSING, VALVE	3-6
2	VRC2XXXX*	SEAT, VALVE, SUCTION	1
3	VRC2XXXX*	GUARD, VALVE, SUCTION	1
4	VRC2XXXX*	PIN, LOCATING, VALVE	1
5	VRC2XXXX*	BOLT, CENTER, VALVE	1
6	VRC2XXXX*	PLATE, VALVE, SUCTION	1
7	VRC2XXXX*	RING, GUIDE, VALVE	1
8	VRC2XXXX*	NUT, LOCK, VALVE	1

* Part numbers are specific to each model valve depending on what size cylinder they are for. The springs can be light, medium, or heavy depending on the operating conditions. Contact Arrow Engine Company for replacement parts.



DISCHARGE VALVE			
NO.	**PART NO.***	**DESCRIPTION**	**QTY.**
1	VRC2XXXX*	SPRING, CLOSING, VALVE	3-6
2	VRC2XXXX*	GUARD, VALVE, DISCHARGE	1
3	VRC2XXXX*	SEAT, VALVE, DISCHARGE	1
4	VRC2XXXX*	BOLT, CENTER, VALVE	1
5	VRC2XXXX*	PIN, LOCATING, VALVE (PART NOT SHOWN)	1
6	VRC2XXXX*	PLATE, VALVE, DISCHARGE	1
7	VRC2XXXX*	RING, GUIDE, VALVE	1
8	VRC2XXXX*	NUT, LOCK, VALVE	1

* Part numbers are specific to each model valve depending on what size cylinder they are for. The springs can be light, medium, or heavy depending on the operating conditions. Contact Arrow Engine Company for replacement parts.

4.17.1 Removing Valves

CAUTION: *Before removing any valve cover, be sure that ALL pressure from the compressor cylinder has been vented.*

Pressure must be completely vented from both the suction and discharge passages of the cylinder.

1. Slightly loosen all the screws on each valve cover. With all the screws loosened, the cover should stay in its original position. If there are signs of the cover pushing out on its own STOP IMMEDIATELY! You must take steps to completely vent the cylinder before proceeding. (See CAUTION above)
2. After the pressure from the cylinder has been discharged, remove the valve cover screws.
3. Remove the valve. Remove the valve by hand or uses a valve tool that threads on to the valve center screw.

NOTE: The size of the valve tool will depend on the size of the cylinder. See table below for the different sized valve installation tools and part number.

VALVE INSTALLATION TOOL SIZE TABLE

PART NO.	TOOL, VALVE INSTALLATION
VRC29463	2.25" - 4.0" CYLINDERS 1/4" AND 5/16" THREADS
VRC29464	4.5" - 10.0" CYLINDERS 3/8" AND 1/2" THREADS

4. The valve seat gasket will remain in the pocket. The gasket may fall into the gas passage. The gasket should be replaced after several uses or each time the valves are replaced.

Valve Maintenance

Arrow Engine Company does not have a compressor valve repair facility. Arrow does stock and sell new Hoerbiger replacement valves and valve repair kits. Valve repair kits can be ordered by finding the appropriate valve part number in the VRS-2 Replacement Parts manual and then substituting the "A" suffix (used to designate a complete valve assembly) with a "K" suffix (used to designate a valve repair kit).

For valve repair, contact your local authorized Hoerbiger valve repair facility. For assistance locating an authorized Hoerbiger valve repair facility in your area please contact customer service at Hoerbiger Corporation of America Inc. at 1-800-327-8961 or contact Arrow Engine Company for a referral.

4.17.2 Valve Reassembly In Cylinder

1. The 1/32" (0.8 mm) thick soft metallic flat gasket should be coated with an anti-seize lubricant. It then can be inserted into the valve pocket. Be careful not to let the gasket fall into the gas passage.
2. Using the valve tool insert the valve and the retainer into the pocket together.
3. Inspect the valve cover O-ring for any cuts, gashes or splits and replace it if necessary. Lubricate the O-ring and the nose of the valve cover.
4. Insert the cover and tighten the screws evenly to the recommended torque of 82 ft.-lbs.. If the assembly is correct, the distance from the underside of the cover to the valve boss surface on the cylinder will be approximately 1/8" (3 mm).

NOTE: Be certain all parts, gasket faces, and mating surfaces are absolutely clean and always use clean oil on all the threads before reinstalling screws.

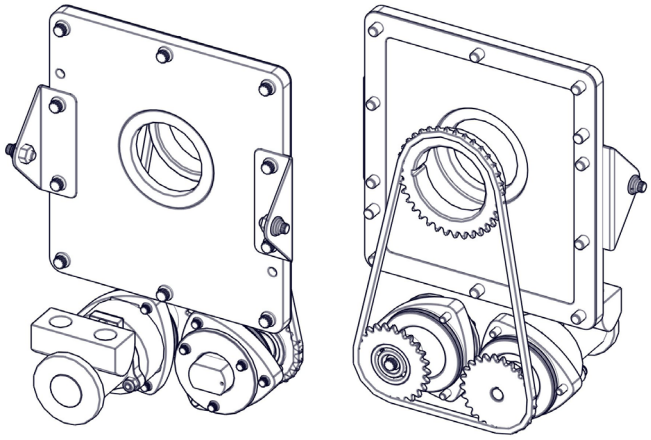
4.17.3 Screw Tightening for Valve Covers

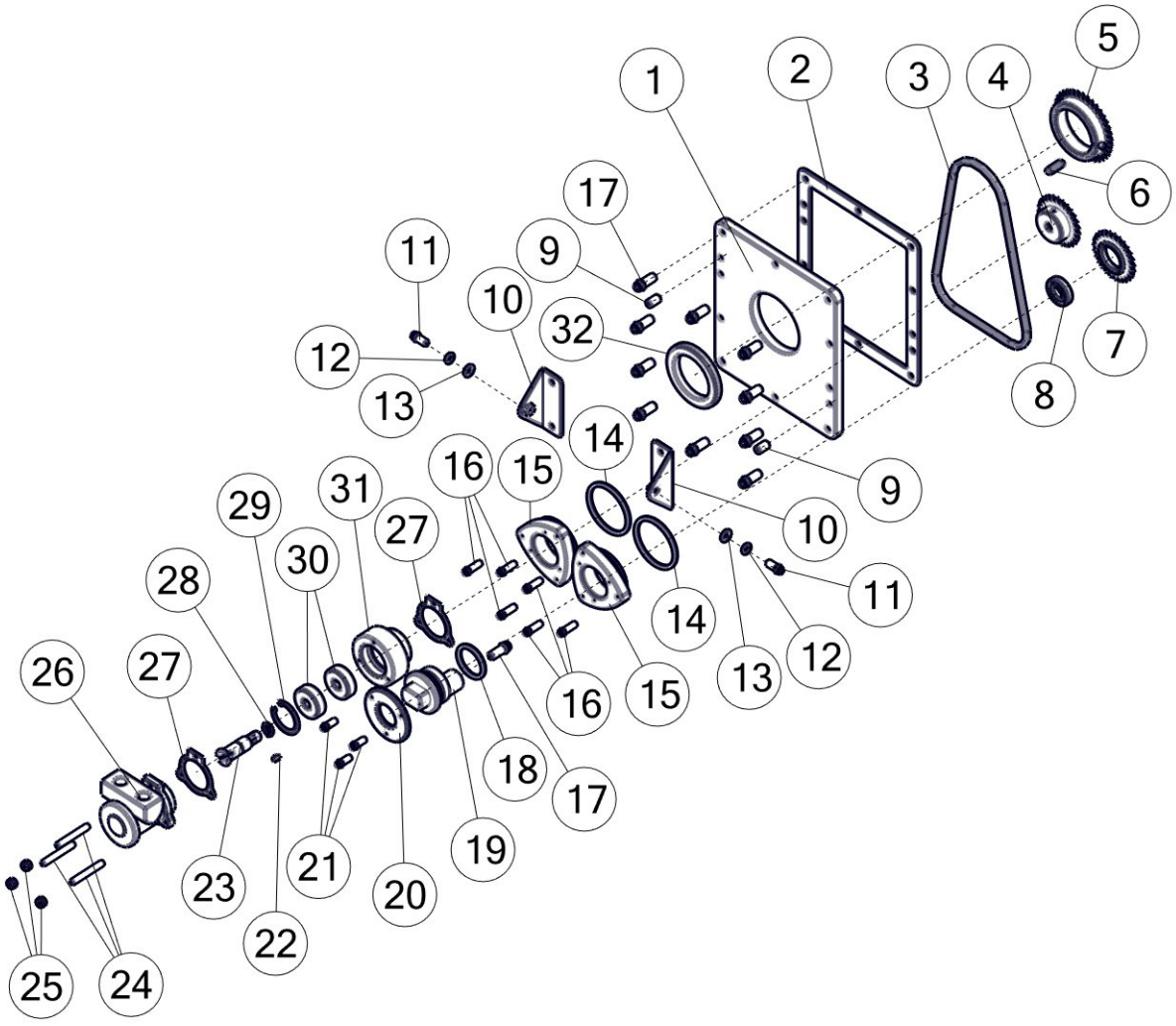
Proper tightening technique is essential for sealing of the valve covers. It is important to draw the screws upward to full torque in even and gradual steps.

1. Install the valve assembly with the flat gasket and valve retainer, in the valve pocket.
2. Lubricate threads and screws with petroleum type lubricant and install screws. Do not use anti-seize compounds on the valve cover screws. Tighten each screw until snug using a crisscross pattern.
3. Next tighten each screw to full torque, moving across from screw to screw, in a crisscross pattern.

CAUTION: *Severe personal injury and property damage can result if valve cover screws are not installed to the proper torque of 82 ft.-lbs..*

4.18 Lubrication System Installation Chain Drive





LUBRICATION SYSTEM – CHAIN DRIVE

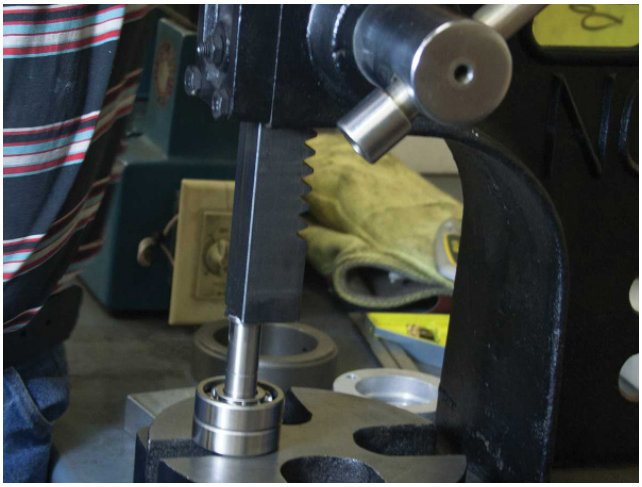
NO.	PART NO.	DESCRIPTION	QTY.	REC. SPARE PARTS		
				6 MOS	1 YR	2 YRS
1	VRS28010	COVER PLATE, HOUSING/SEAL RETAINER	1			
2	VRS28015	GASKET, COVER PLATE, HOUSING	1	1	1	1
3	VRS28200	CHAIN DRIVE ENDLESS RIVETED 86LINKS	1		1	1
4	VRS28232	SPROCKET, DRIVE, FRAME OIL PUMP	1		1	1
5	VRS28248	SPROCKET, CRANKSHAFT DRIVE	1			1
6	VRC28206	KEY SQ 1/4 X 1/4 X 1.24 RND END	1			
7	VRS28220	SPROCKET, IDLER, CHAIN (25 TEETH)	1	1	1	1
8	VRS28251	BEARING, IDLER SPROCKET	1			
9	VRS21506	DOWEL PIN 3/8 X 3/4	2			
10	VRS28482	SUPPORT BELT GUARD	2			
11	VRC28327	SCREW 12-POINT 5/16 - 18 X 3/4	2			
12	1A-5/16	LOCKWASHER PLATED	2			
13	1N-5/16	WASHER FLAT SAE PLATED	2			
14	VRC25504	O-RING, 3.250 OD .125 W	2			2
15	VRS28252	BUSHING, ADAPTER IDLER	2			
16	VRC28557	SCREW 12-POINT 1/4 - 20 X 1	6			
17	VRC21117	SCREW 12-POINT 3/8 - 16 X 1	11			
18	VRS28254	O-RING IDLER CHAIN	1		1	1
19	VRS28250	IDLER, CHAIN, FRAME OIL PUMP	1			
20	VRS28253	CLAMP, IDLER CHAIN	1			
21	VRC28027	SCREW 12-POINT 1/4 - 20 X 3/4	3			
22	104A-#3	KEY WOODRUFF 1/8X1/2	1			
23	VRS28332	SHAFT, PUMP MOUNT, FRAME OIL	1			
24	VRC28337	STUD, PUMP MOUNT, 1/4-20 x 2.5", DBL END	3			3
25	VRC28559	NUT NYLOK 1/4 - 20	3			3
26	VRC28301	PUMP, OIL, FRAME- WITH TANG SHORT SHAFT	1	1	1	1
27	VRC28305	GASKET, PUMP, FRAME OIL	2	1	1	2
28	VRC28334	RING, RETAINING, SMALL,SHAFT, PUMP MOUNT	1			1
29	44999E	SNAP RING FOR THE HW123804	1			1
30	VRC28333	BEARING, SHAFT, PUMP MOUNT	2			2
31	VRC28331	MOUNT, PUMP, FRAME OIL	1			
32	VRS28024	SEAL, OIL, CRANKSHAFT	1	1		2

1. Install pump adapter bushing O-ring (VRS28252) in O-ring groove of both pump adaptor bushings.

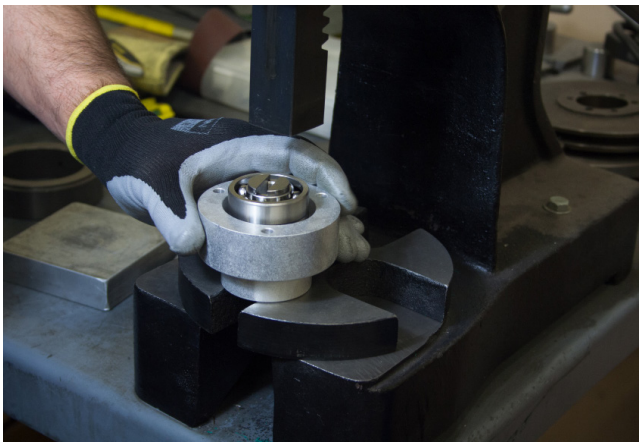
2. Apply loc-tite to the pump mount studs (VRC28337) and screw them into the pump adaptor bushings.

4.18.1 Assemble the frame oil pump mount assembly

1. Insert pump mount shaft (VRS28332) into (2) shaft bearings (VRC28333) and using a bench press, press shaft all the way into the bearings.



2. Place shaft and bearings into pump mount fixture (VRC28331) and press in using a bench press.



3. Using snap-ring pliers, insert the large retaining ring (VRC28335) in the bearing end of the mount assembly.

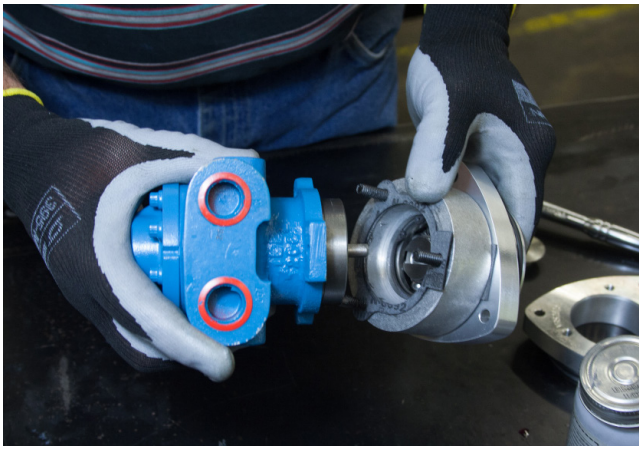
4. Using snap-ring pliers, insert the small retaining ring (VRC28334) in the shaft end of mount assembly.

5. Check to make sure shaft rotates freely in mount assembly.

6. Apply light coat of loc-tite nickel anti-seize lubricant on gasket area and place gasket (VRC28305) over studs.

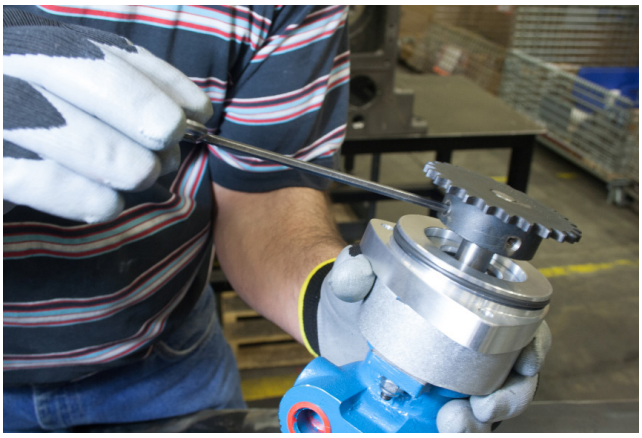
7. Press woodruff key (VRC28236) into key slot in the pump mount shaft. It may be helpful to use pliers or a vise to press the key in.

8. Apply anti-sieze lubricant to gasket surface area and insert oil pump (VRC28301) in pump mount so that it lines up with the gasket.



9. Screw on (3 pump mount nuts (VRC28489) and tighten them.

10. Install pump drive sprocket (VRS28232) so the shoulder on the sprocket is facing toward the pump and sprockets and chain can align properly. Tighten the two sprockets set screws with an Allen wrench.

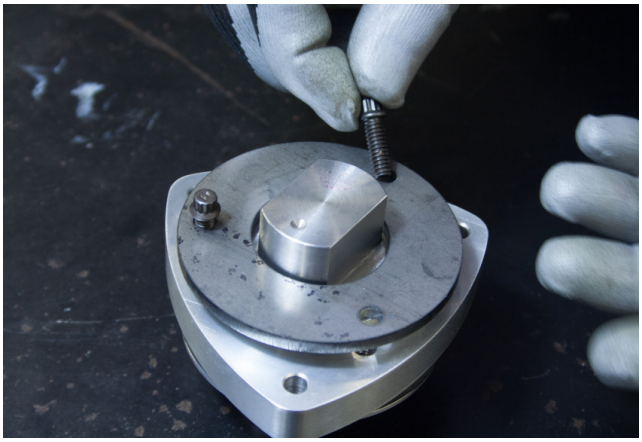


4.19 Chain Idler Assembly

1. Apply lubricant to the O-ring groove of the chain idler (VRS28250) and slip on the idler O-ring (VRS28254).

2. Insert the idler into the second adaptor bushing (VRS28252).

3. Install the idler clamp (VRS28253) and (3) idler clamp screws (VRS28257) and tighten them finger tight.



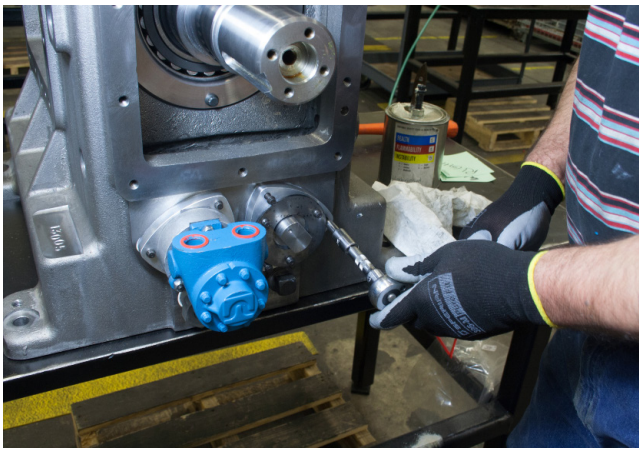
4. On the end of the idler shaft install the idler sprocket (VRS28220) using the idler sprocket retainer (VRS28255) and the idler sprocket screw (VRC21117) and tighten.

4.20 Pump Assembly and Chain Idler Assembly Installation

1. Apply lubricant to pump assembly O-ring and slide into lower left opening on the accessory end of the frame. Install so that pump inlet and outlet parts are facing upward.

2. Insert (3) mounting screws (VRC28557) and tighten them.

3. Apply lubricant to chain idler assembly O-ring and slide into lower right opening. Insert mounting screws and tighten.



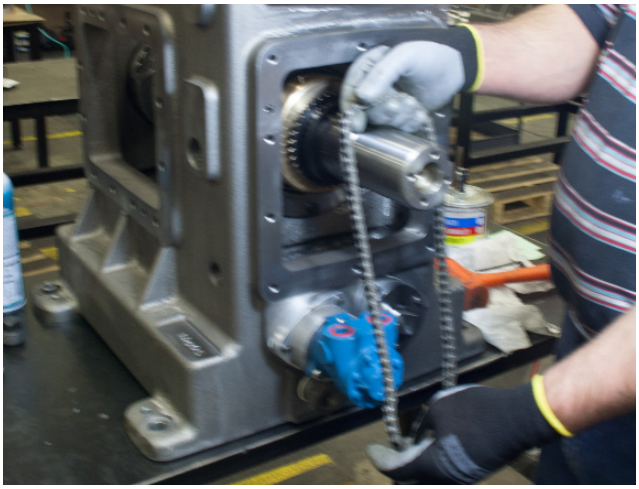
4.21 Lubrication System Installation Chain Drive

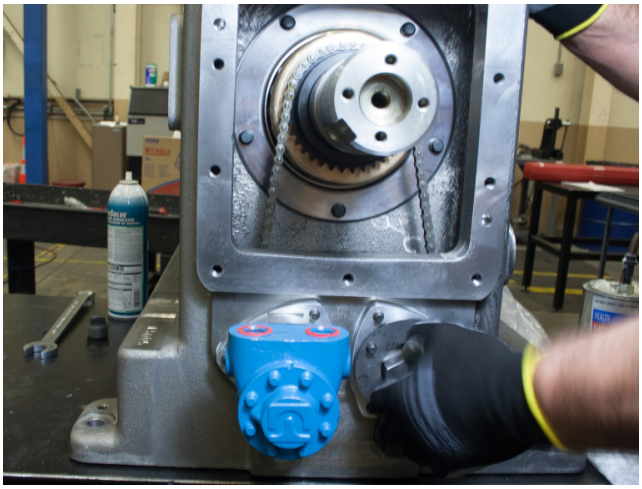
1. Apply lubricant to oil slinger ring (VRS28100) and slip on crankshaft. This can be installed either way.

2. Install crankshaft key (VRC28226) in key way and then slide drive sprocket (VRS28248) on crank shaft with sprocket shoulder facing away from the slinger ring.

3. This is a tight fit so it may require tapping the sprocket with a rubber mallet to fully seat the sprocket against the shoulder on the crankshaft. When sprocket is fully seated tighten the sprocket set screw with an Allen wrench.

4. Slip pump drive chain (VRS28200) over the crankshaft. Move chain idler adjustment so that chain is at its most slack point. Slip chain over the other two sprockets and adjust eccentric idler.





5. With the screws on the idler clamp loosened adjust idler so that the chain has about 1/2" slack/ movement.

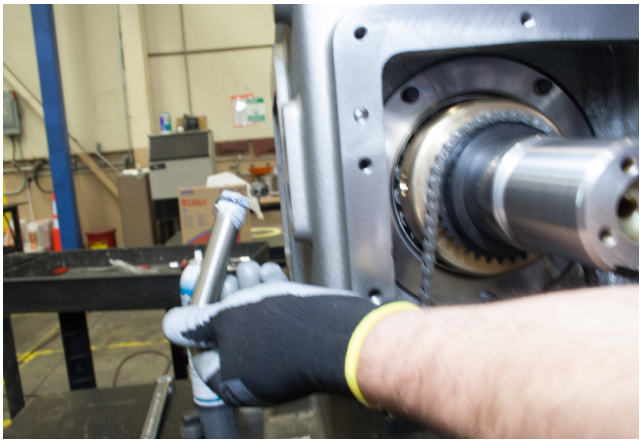
CAUTION: *It is better to have a little extra slack in the chain than to have too little slack. Running the chain too tight can cause premature wear and failure of the chain idler bearing.*

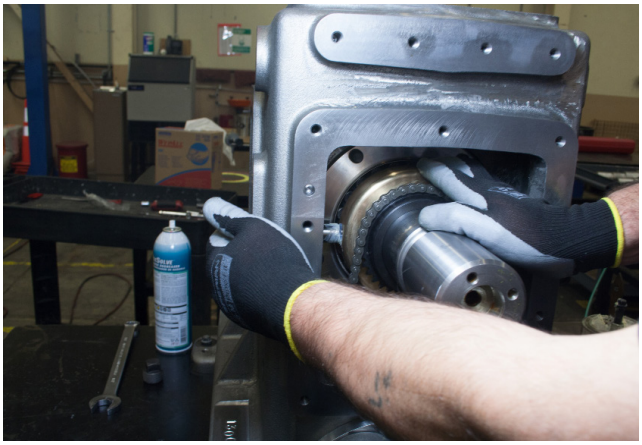
6. Rotate the crankshaft several revolutions while feeling the chain tension and making sure there are no tight spots throughout a complete revolution.

NOTE: A 1" port plugged with a 1" pipe plug is provided on the side of the frame for checking and maintaining the appropriate chain tension.

7. Fit the two oil slinger tube O-rings (VRS28104) into the O-ring groves on the ends of the oil slinger tube (VRS28110) and apply lubricant.

8. Insert the oil slinger tube through the opening in the side of the frame and into the hole in the side of the oil slinger ring.

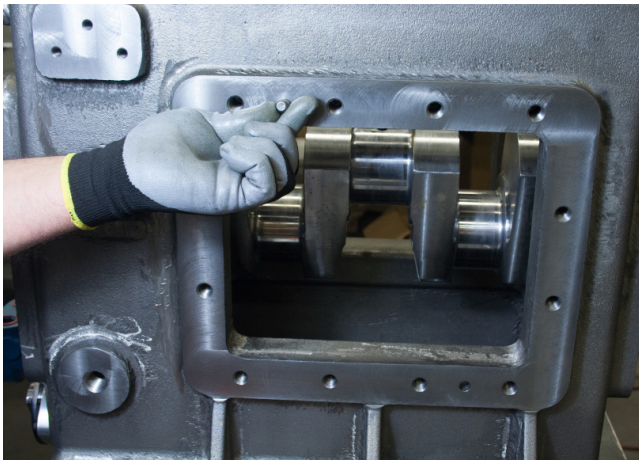




9. Apply anti-sieze to the threads of the oil slinger tube fitting (VRS28130) and thread it into the hole in the side of the frame being care full that the tube and O-ring slide into the fitting without damaging the O-ring

10. Tighten the oil slinger tube fitting and install the 1” NPT pipe plug (VRC21519) in the chain inspection part.

11. Install the six dowel pins (VRS21506) in the two dowel pin holes at the accessory-end of the frame and in the two dowel holes in each side of the frame where the distance pieces are mounted.

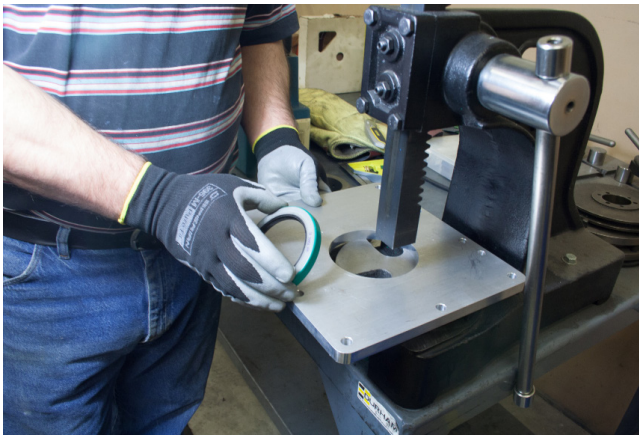


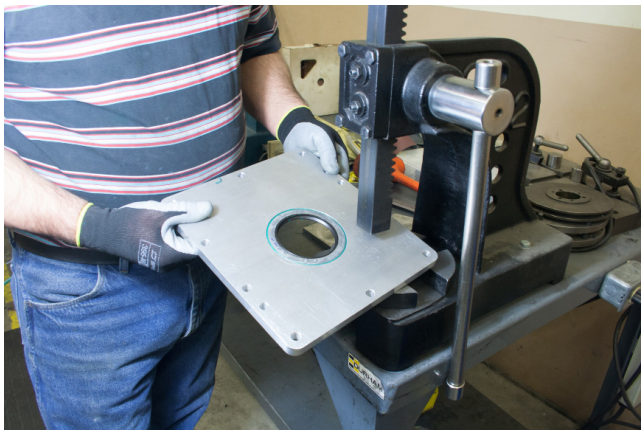
4.22 Oil Seal Installation

1. Clean and prepare the housing cover plate/seal retainer (VRS28010) to install the crankshaft oil seal.

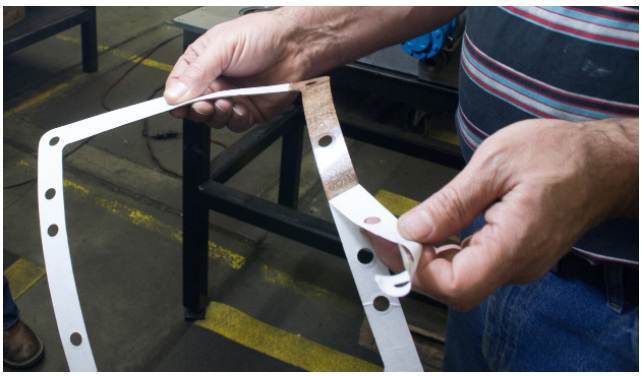
NOTE: Check the bolt-hole pattern of the cover plate to make sure the seal is installed from the front of the cover plate.

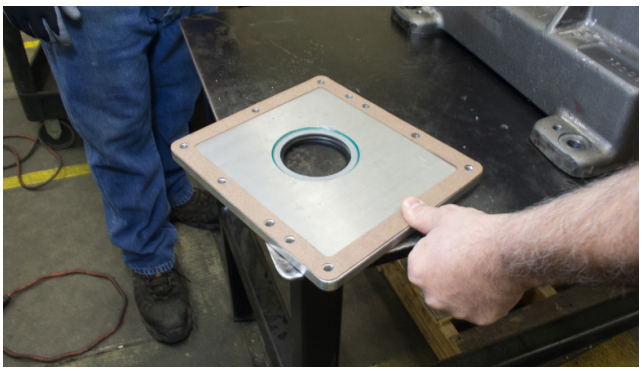
2. Press oil seal (VRS28024) into the housing cover plate using a bench-press or a hammer and block to tap in seal straight and evenly until it is flush with the cover plate.



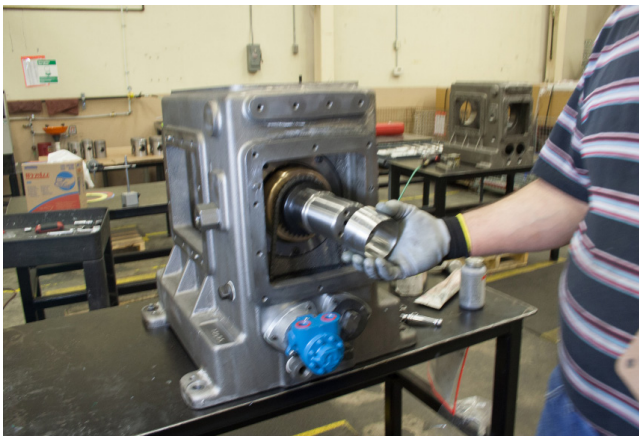


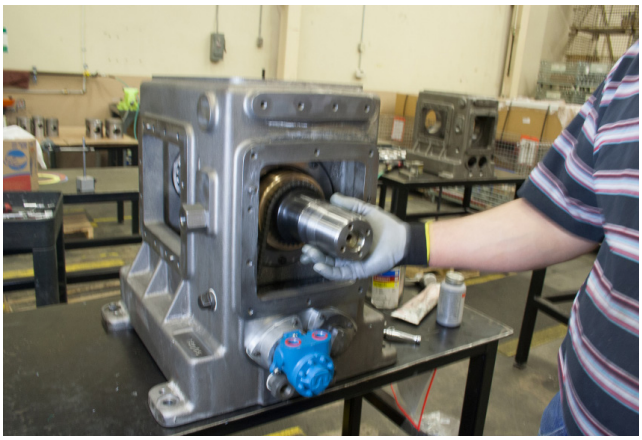
3. Remove the paper backing from cover plate gasket (VRS28015) and adhere it to the back of the cover plate.



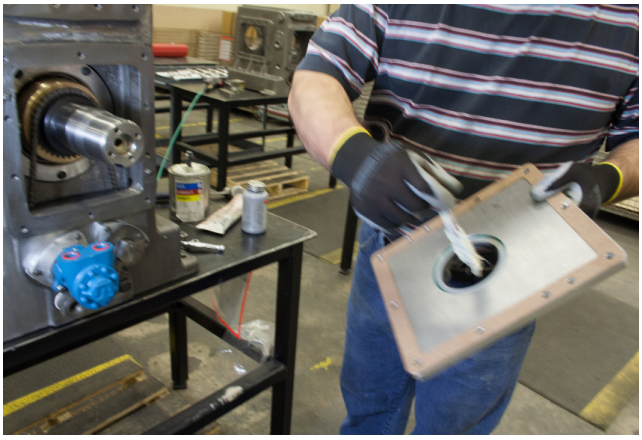


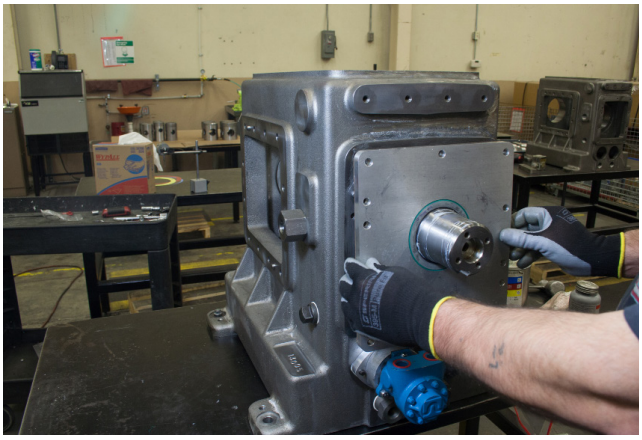
4. Slip the special oil seal entering sleeve tool (VRS29482) over the crankshaft.



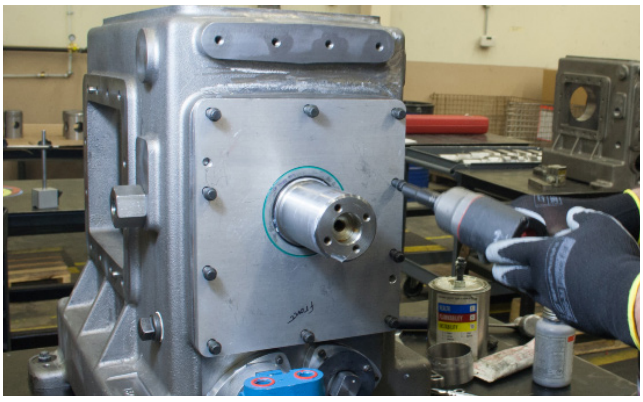


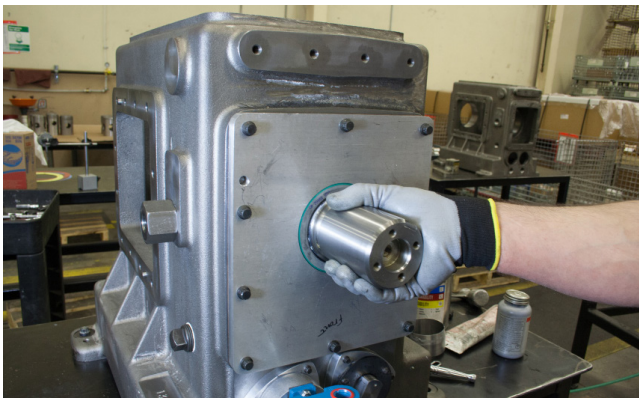
5. Apply a light coat of lubrication to the oil seal and slide the seal and cover plate into position.





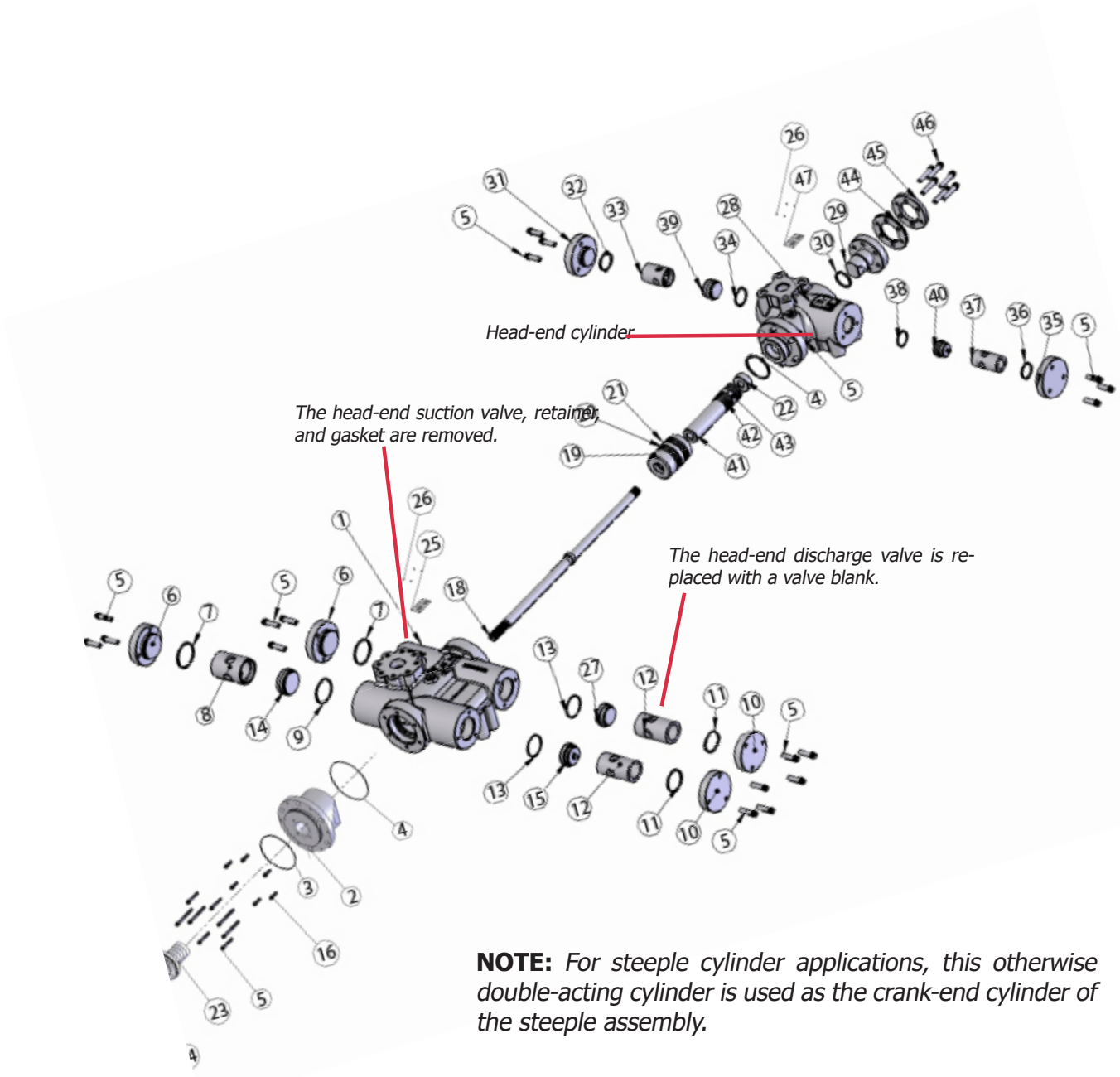
6. Tighten the cover plate screws (VRC21117) and check to make sure the crankshaft still rotates freely.





5 CYLINDER ASSEMBLY

5.1 Steeple Cylinder Parts



NOTE: *For steeple cylinder applications, this otherwise double-acting cylinder is used as the crank-end cylinder of the steeple assembly.*

TYPICAL STEEPLE CYLINDER				REC. SPARE PARTS		
NO.	PART NO.	DESCRIPTION	QTY.	6 MOS	1 YR	2 YRS
	VRS25143A	CYLINDER, STEEPLE, 4.5" SAHE × 6.5" SACE ASSEMBLY				
1	VRS25650	CYLINDER, 6.5" DA	1			
2	VRS25651	HEAD, CRANK END, 6.5" CYLINDER	1			
3	VRC25262	O-RING, HEAD, CRANK-END TO FRAME	1	1		1
4	VRC25652	O-RING, HEAD, CRANK AND OUTER END, 6.5" CYL.	2	1	1	2
5	VRC25077	SCREW, VALVE COVER	32			
6	VRS25653	COVER, VALVE, SUCTION, 6.5", 7.0", 9.5", & 10.0" CYL.	2			
7	VRS25654	O-RING, COVER, SUCTION VALVE, 6.5", 7.0", 9.5", AND 10.0" CYLINDER	2	2	2	2
8	VRS25656	RETAINER, VALVE, SUCTION, 6.5" CYLINDER	1			
9	VRS25655	GASKET, SUCTION VALVE SEAT, 6.5", 7.0", 9.5", AND 10.0" CYLINDER	1	1	1	1
10	VRS25703	COVER, VALVE, DISCHARGE, 6.5", 7.0", 9.5", AND 10.0" CYLINDER	2			
11	VRS25704	O-RING, COVER, DISCHARGE, 6.5", 7.0", 9.5", AND 10.0" CYLINDER	2	2	2	2
12	VRS25658	RETAINER, VALVE, DISCHARGE, 6.5" CYLINDER	2			
13	VRS25705	GASKET, DISCHARGE, VALVE SEAT, 6.5", 7.0", 9.5", AND 10.0" CYLINDER	2	2	2	2
14	VR-S26715A	VALVE, SUCTION, 6.5", 7.0", 9.5", AND 10.0" CYLINDER, MEDIUM *	1	1		1
15	VR-S26725A	VALVE, DISCHARGE, 6.5", 7.0", 9.5", AND 10.0" CYLINDER, MEDIUM *	1	1		1
16	VRC25067	SCREW, HEAD, CRANK-END, 12-POINT	6			
17	VRC24909	NUT, JAM, PISTON ROD **	1			1
18	VRC24115	ROD, PISTON, 4.0"-4.5" SAHE × 6.5"-7.0" SACE	1			1
19	VRC24659	PISTON, 6.5" SACE STEEPLE CYLINDER, AL	1			1
20	VRC24651	RING, 6.5" PISTON	2		2	2
21	VRC24652	BAND, RIDER, 6.5" PISTON	1		1	1
22	VRC24919	NUT, PISTON	1			1
23	VR-C23001A	CASE, PACKING ASSEMBLY ***	1			1
24	VRC23107	SCREW, PACKING CASE, 12-POINT	4			
25	VRS25110	NAMEPLATE, VRS CYLINDER	1			
26	VRC21606	PIN, NAMEPLATE	8			
27	VRS26799	BLANK, VALVE, DISCHARGE, 6.5"-7.0" SACE CYLINDER	1			
28	VRC25143	CYLINDER, STEEPLE 4.5" SAHE × 6.5" SACE	1			
29	VRC27145	HEAD, 4.5" SAHE CYLINDER	1			
30	VRC25452	O-RING, HEAD, CRANK OUTER-END, 4.5" SAHE CYL.	1	1	1	1

TYPICAL STEEPLE CYLINDER				REC. SPARE PARTS		
NO.	PART NO.	DESCRIPTION	QTY.	6 MOS	1 YR	2 YRS
31	VRC25453	COVER, VALVE, SUCTION, 4.5”-5.0” CYLINDER AND 4.0”-4.5” SAHE	1			
32	VRC25454	O-RING, COVER, SUCTION VALVE, 4.5”-5.0” CYLINDER AND 4.0”-4.5” SAHE	1	1	1	1
33	VRC25165	RETAINER, VALVE, SUCTION, 4.5” SAHE CYLINDER	1			
34	VRC25455	GASKET, SUCTION VALVE SEAT, 4.5”-5.0” CYLINDER AND 4.0”-4.5” SAHE	1	1	1	1
35	VRC25503	COVER, VALVE, DISCHARGE, 4.5”-5.0” CYLINDER AND 4.0”-4.5” SAHE	1			
36	VRC25504	O-RING, COVER, DISCH. VALVE, 4.5”-5.0” CYLINDER AND 4.0”-4.5” SAHE	1	1	1	1
37	VRC25185	RETAINER, VALVE, DISCHARGE, 4.5” SAHE CYLINDER	1			
38	VRC25505	GASKET, DISCH. VALVE SEAT, 4.5”-5.0” CYLINDER AND 4.0”-4.5” SAHE	1	1	1	1
39	VR-C26215A	VALVE, SUCTION, 4.0” AND 4.5” SAHE CYLINDER MEDIUM *	1	1		1
40	VR-C26225A	VALVE, DISCHARGE, 4.0” AND 4.5” SAHE CYLINDER MEDIUM *	1	1		1
41	VRC24415	PISTON, 4.5” SAHE × 6.5”-7.0” SACE STEEPLE CYLINDER, AL	1			1
42	VRC24451	RING, 4.5” PISTON	4		4	4
43	VRC24452	BAND, RIDER, 4.5” PISTON	1		1	1
44	VRC27146	SPACER, 4.0”-4.5” SAHE HEAD, 1/4”	1			
45	VRC27147	SPACER, 4.0”-4.5” SAHE HEAD, 1/2”	1			
46	VRC25027	SCREW, CYL. TO FRAME, SHORT AND STEEPLE HEAD	6			
47	VRC25100	NAMEPLATE, VRS CYLINDER	1			
* Actual site gas conditions may require LIGHT or HEAVY valve springs.						
** A heavier jam nut may be used if required for balancing. See section 4.15.						
*** Packing case ring kits are available. See section 4.16.						

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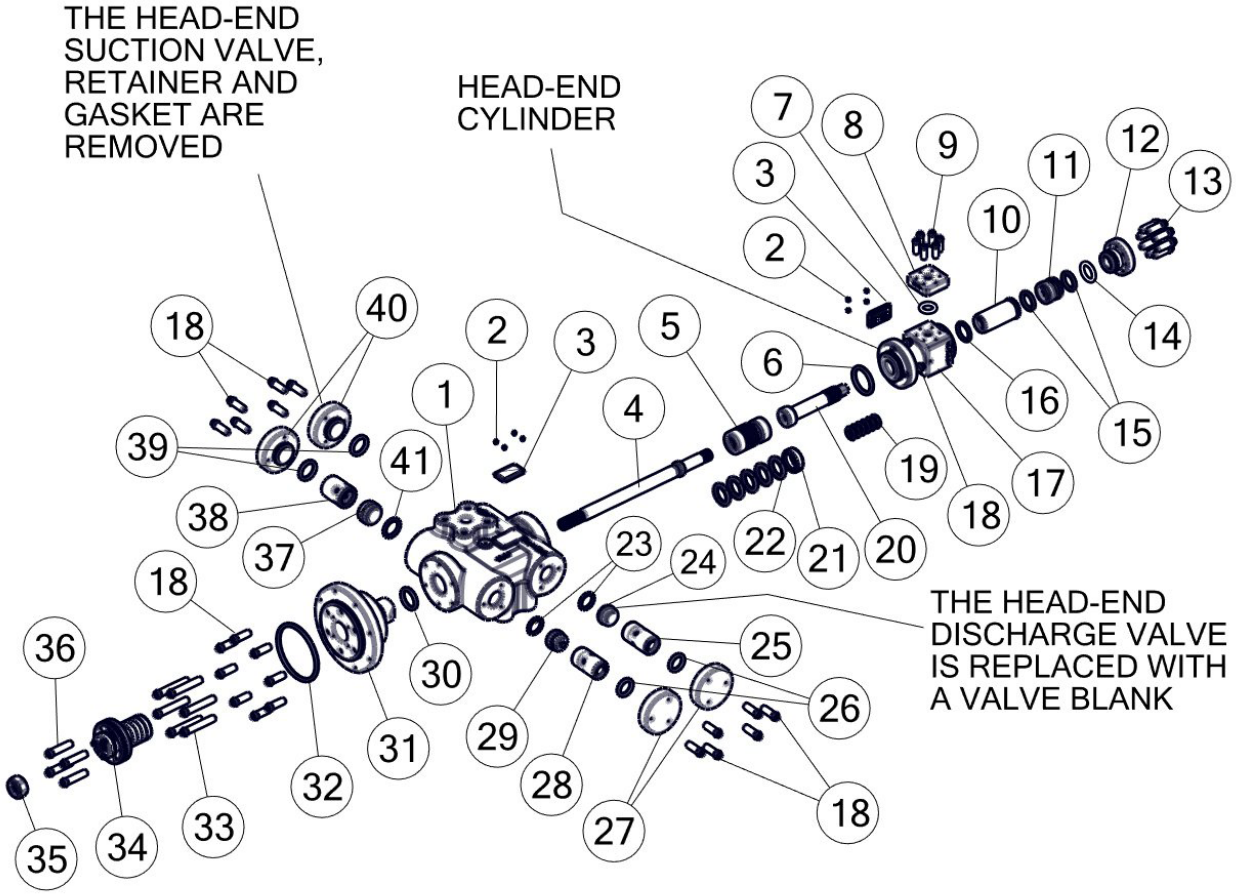
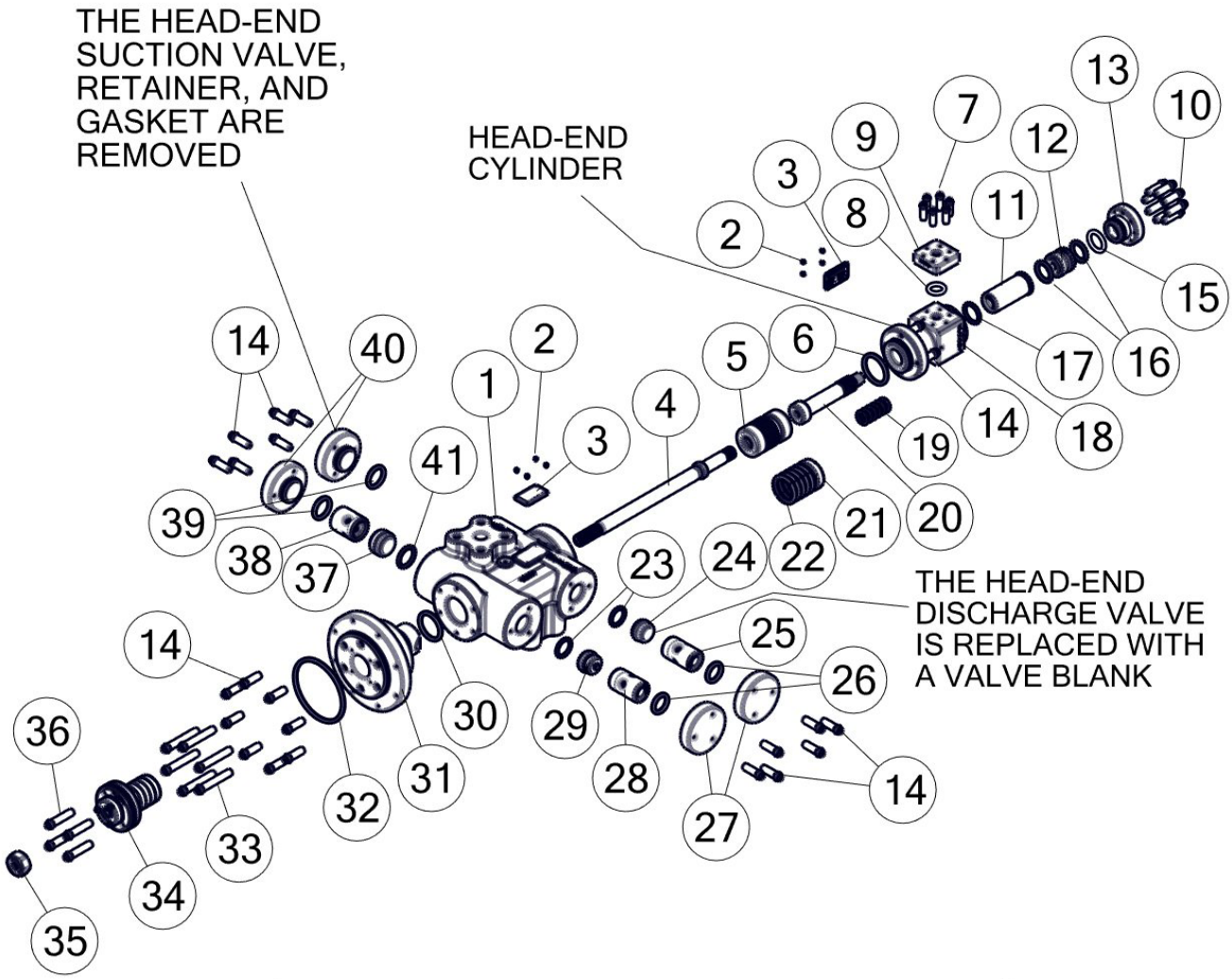
2.5 × 1.375-inch Steeple Cylinder Parts



NOTE: FOR STEEPLE CYLINDER APPLICATIONS, THIS OTHERWISE DOUBLE ACTING CYLINDER IS USED AS THE CRANK-END CYLINDER OF THE STEEPLE ASSEMBLY

2.5 × 1.375 STEEPLE CYLINDER				REC. SPARE PARTS		
NO.	PART NO.	DESCRIPTION	QTY.	6 MOS	1 YR	2 YRS
1	VRC25260	CYLINDER, 2.5" SACE, MODIFIED HEAD	1			
2	B577A	PIN, NAMEPLATE	8			
3	VRS25110	NAMEPLATE, VRS CYLINDER	2			
4	VRC24130	ROD, PISTON, 2.5-3.0" PISTONS	1			1
5	VRC24259	PISTON, 2.5" SACE X 1.375" SAHE STEEPLE CYLINDER, CI	1			1
6	VRC25504	O-RING, 3.250 OD .125 W	1	1	1	1
7	VRCC5127	O-RING, SUCTION FLANGE, 1.125-1.375	1	1	1	1
8	VRCC5126	FLANGE, SUCTION, 3/4" NPT, 1.125-1.375	1			
9	VRC28467	SCREW 12-POINT 3/8-16 X 1-1/4	6			
10	VRCC5141	LINER, CYLINDER 1.375" SAHE	1			
11	VRCC6125A	VALVE, CONCENTRIC, 1.125-1.375	1	1		1
12	VRCC5128	FLANGE/RTR, DISCHARGE, 3/4" NPT, 1.125-1.375	1			
13	VRC28257	SCREW 12-POINT 3/8-16 X 1-1/2	8			
14	VRCC5124	O-RING WITH PARBAK, DISCHARGE FLANGE, 1.125-1.375	1	1	1	1
15	VRCC5125	GASKET, VALVE SEAT & TOP, 1.125-1.375	2	1	1	1
16	VRCC5122	GASKET, LINER, CYLINDER, 1.125-1.375	1	1	1	1
17	VRCC5120	CYLINDER, STEEPLE, 1.125-1.375	1			
18	VRC25077	SCREW 12-POINT 1/2-13 X 2	24			
19	VRCC4141	RING, 1.375" CNG PISTON, BUTT CUT	6		6	6
20	VRCC4140	PISTON, CNG, 1.375" SAHE	1			
21	VRC24252	BAND, RIDER, 2.5 INCH PISTON	1		1	1
22	VRS24251	RING, 2.5 INCH PISTON	5		4	4
23	VRC25305	GASKET, DISCHARGE VALVE SEAT, 2.5-3.0" CYLINDER	2	2	2	2
24	VRC26399	BLANK, VALVE, DISCHARGE, 2.25-3.0" SACE CYLINDER	1			
25	VRC25258	RETAINER, VALVE, DISCHARGE, 2.5" DA CYLINDER	1			
26	VRC25304	O-RING, COVER, DISCHARGE VALVE, 2.5-3.0" CYLINDER	2	2	2	2
27	VRC25303	COVER, VALVE, DISCHARGE, 2.5-3.0" CYLINDER	2			
28	VRC25258SP	RETAINER, VALVE, DISCHARGE, 2.5" SP CYLINDER	1			
29	VRS26347A	VALVE, DISCHARGE, 2.5-3.0" CYLINDER PC, HEAVY	1	1		1
30	VRC25252	O-RING, HEAD, 2.5 INCH CYLINDER	1	1	1	2
31	VRS25251	HEAD, CRANK END, 2.5" CYLINDER	1			
32	VRC25262	O-RING, HEAD, CRANK-END 2.5 CYLINDER	1	1		1
33	VRS41217	SCREW 12-POINT 1/2-13 X 4-1/4	6			
34	VRC23001A	CASE, PACKING, ASSEMBLY	1			1
35	VRC24909	NUT, JAM, PISTON ROD	1			1
36	VRC23107	SCREW 12-POINT 1/2-13 X 3	4			
37	VRS26335A	VALVE, SUCTION, 2.5-3.0" CYLINDER, PC, MEDIUM	1	1		1
38	VRC25256SP	RETAINER, VALVE, SUCTION, 2.5" SP CYLINDER	1			
39	VRC25254	O-RING, COVER, SUCTION VALVE, 2.5-3.0" CYLINDER	2	2	2	2
40	VRC25253	COVER, VALVE, SUCTION, 2.5-3.0" CYLINDER	2			
41	VRC25255	GASKET, SUCTION VALVE SEAT, 2.5-3.0" CYLINDER	1	1	1	1

3.0 × 1.375-inch Steeple Cylinder Parts



NOTE: FOR STEEPLE CYLINDER APPLICATIONS, THIS OTHERWISE DOUBLE ACTING CYLINDER IS USED AS THE CRANK-END CYLINDER OF THE STEEPLE ASSEMBLY

3.0 × 1.375 STEEPLE CYLINDER				REC. SPARE PARTS		
NO.	PART NO.	DESCRIPTION	QTY.	6 MOS	1 YR	2 YRS
1	VRC25310	CYLINDER, 3.0" SACE, MODIFIED HEAD	1			
2	B577A	PIN, NAMEPLATE	8			
3	VRS25110	NAMEPLATE, VRS CYLINDER	2			
4	VRC24130	ROD, PISTON, 2.5-3.0" PISTONS	1			1
5	VRC24312	PISTON, 3.0" SACE X 1.375" SAHE STEEPLE CYLINDER, CI	1			1
6	VRC25504	O-RING, 3.250 OD .125 W	1	1	1	1
7	VRCC5127	O-RING, SUCTION FLANGE, 1.125-1.375	1	1	1	1
8	VRCC5126	FLANGE, SUCTION, 3/4" NPT, 1.125-1.375	1			
9	VRC28467	SCREW 12 PT 3/8-16 X 1-1/4	6			
10	VRCC5141	LINER, CYLINDER 1.375" SAHE	1			
11	VRCC6125A	VALVE, CONCENTRIC, 1.125-1.375	1	1		1
12	VRCC5128	FLANGE/RTR, DISCHARGE, 3/4" NPT, 1.125-1.375	1			
13	VRC28257	SCREW 12-POINT 3/8-16 X 1-1/2	8			
14	VRCC5124	O-RING WITH PARBAK, DISCHARGE FLANGE, 1.125-1.375	1	1	1	1
15	VRCC5125	GASKET, VALVE SEAT AND TOP, 1.125-1.375	2	1	1	1
16	VRCC5122	GASKET, LINER, CYLINDER, 1.125-1.375	1	1	1	1
17	VRCC5120	CYLINDER, STEEPLE, 1.125-1.375	1			
18	VRC25077	SCREW 12-POINT 1/2-13 X 2	24			
19	VRCC4141	RING, 1.375" CNG PISTON, BUTT CUT	6		6	6
20	VRCC4140	PISTON, CNG, 1.375" SAHE	1			
21	VRC24302	BAND, RIDER, 3.0 INCH PISTON	1		1	1
22	VRS24301	RING, 3.0 INCH PISTON	5		4	4
23	VRC25305	GASKET, DISCHARGE VALVE SEAT, 2.5-3.0" CYLINDER	2	2	2	2
24	VRC26399	BLANK, VALVE, DISCHARGE, 2.25-3.0" SACE CYLINDER	1			
25	VRC25308	RETAINER, VALVE, DISCHARGE, 3.0" CYLINDER	1			
26	VRC25304	O-RING, COVER, DISCHARGE VALVE, 2.5-3.0" CYLINDER	2	2	2	2
27	VRC25303	COVER, VALVE, DISCHARGE, 2.5-3.0" CYLINDER	2			
28	VRC25308SP	RETAINER, VALVE, DISCHARGE, 3.0" SP CYLINDER	1			
29	VRS26347A	VALVE, DISCHARGE, 2.5-3.0" CYLINDER PC, HEAVY	1	1		1
30	VRC25262	O-RING, HEAD, 3.0 INCH CYLINDER	1	1	1	2
31	VRS25301	HEAD, CRANK END, 3.0" CYL	1			
32	VRC25302	O-RING, HEAD, CRANK-END, 3.0" CYLINDER	1	1		1
33	VRS41217	SCREW 12-POINT 1/2-13 X 4-1/4	6			
34	VRC23001A	CASE, PACKING, ASSEMBLY	1			1
35	VRC24909	NUT, JAM, PISTON ROD	1			1
36	VRC23107	SCREW 12-POINT 1/2-13 X 3	4			
37	VRS26335A	VALVE, SUCTION, 2.5-3.0" CYLINDER, PC, MEDIUM	1	1		1
38	VRC25306SP	RETAINER, VALVE, SUCTION, 3.0" SP CYLINDER	1			
39	VRC25254	O-RING, COVER, SUCTION VALVE, 2.5-3.0" CYLINDER	2	2	2	2
40	VRC25253	COVER, VALVE, SUCTION, 2.5-3.0" CYLINDER	2			
41	VRC25255	GASKET, SUCTION VALVE SEAT, 2.5-3.0" CYLINDER	1	1	1	1

5.2 Steeple Piston and Cylinder Removal

When removing a piston from a steeple cylinder, it will be necessary to first remove the outboard head-end cylinder.

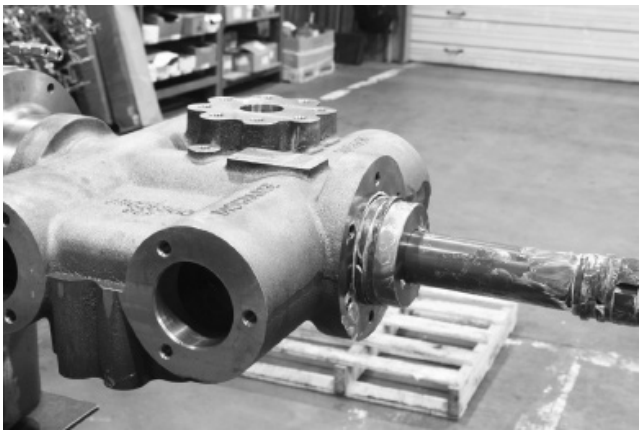
For further instructions, simply REVERSE the Steeple Cylinder Assembly and Installation procedures found in section 5.2.1.

For piston rod removal and disassembly, see section 5.3, Steeple Cylinder – Piston and Rod Disassembly.

5.2.1 Steeple Cylinder Assembly and Installation – Mounting Crank-end and Head-end Cylinders

NOTE: The crank-end cylinder is actually a double-acting cylinder converted to be use as the crank-end cylinder of the steeple.

1. Attach crank-end cylinder to frame.
2. After the crank-end cylinder is attached to the frame, the steeple piston and rod assembly MUST be installed prior to attaching the head-end cylinder to the crank-end cylinder. If the steeple piston and piston rod is NOT assembled, and is not installed, YOU MUST assemble the steeple piston and piston rod at this point and install it on the crank-end cylinder.



NOTE: If you have not assembled the steeple piston and piston rod, see section 5.4, Steeple Cylinder – Piston and Rod Assembly and Installation.

3. Liberally lubricate both the crank-end cylinder bore and the head-end cylinder bore before installing.
4. Attach the head-end cylinder to the head-end of the crank-end cylinder.

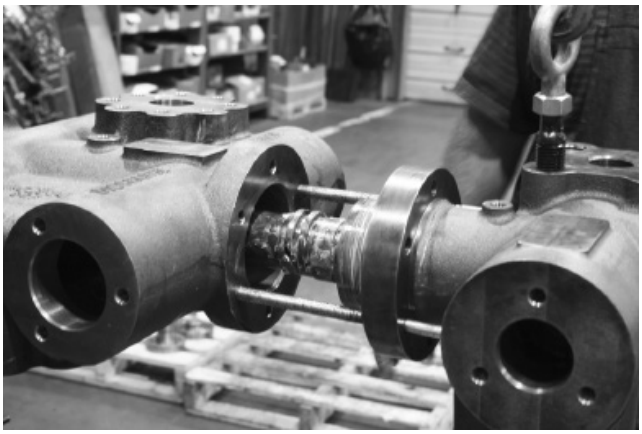
NOTE: If available, use alignment studs to make attachment to the crank-end cylinder easier.

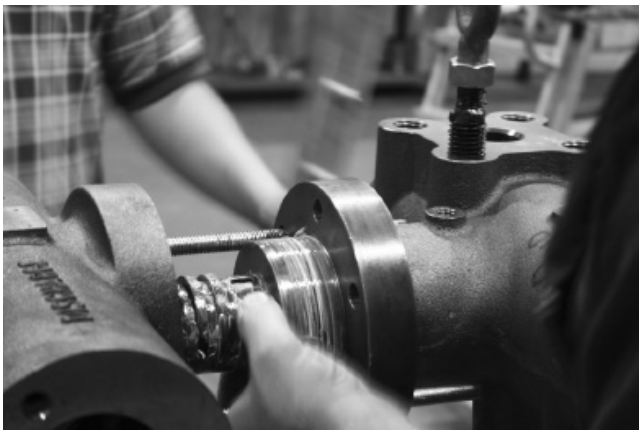
The alignment studs used are NOT necessary for attaching the head-end cylinder to the head-end of the crank-end cylinder, but is mentioned here as an aid.

Insert the head-end cylinder so that the cylinder lube hole is at the top.

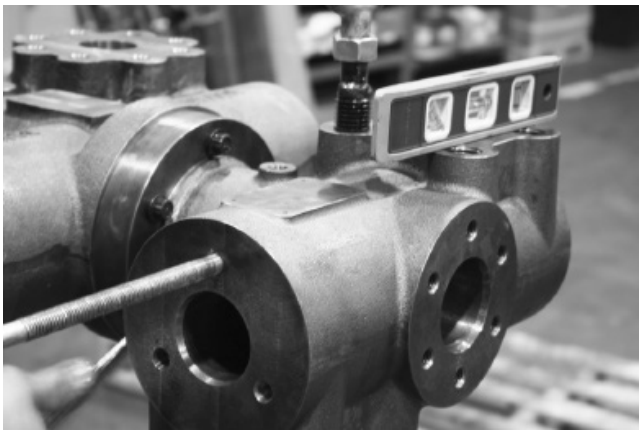
IMPORTANT: Support the head-end cylinder during removal and installation so that no excessive weight is exerted on the piston and piston rod. Excessive weight to the piston rod can cause bending and damage the rod.

5. Ease the head-end cylinder toward the crank-end cylinder and carefully install the head-end cylinder. While installing the head-end cylinder compress the piston rings of the head-end (smaller) piston with your fingers and slide the cylinder onto the piston. Be careful not to pinch your fingers.





6. After installing the head-end cylinder and before tightening fasteners, check level for both the head-end cylinder and the crank-end cylinder. Place a level on the suction flange making sure that the suction flanges on both cylinders are level.



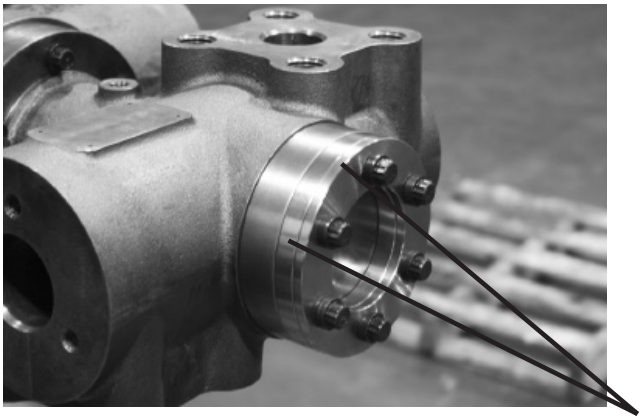
7. Check piston rod run-out (see sections 4.15.13, 4.15.14, and 4.15.15, Piston Rod Run-out).

8. Prepare the moveable head by liberally lubricating the O-ring.

9. Insert the moveable head into the head-end of the head-end cylinder making sure that the flats are in line with the valve ports.

10. Prior to installing screws, place the two head spacers on the outside of the head (for base clearance) and attach to the head with the screws.

NOTE: If added clearance is required, insert the appropriate spacer or spacers underneath the moveable head.



11. Torque all fasteners to 82 ft.-lbs. using a crisscross torque pattern.

12. Arrow's two smallest double-acting cylinders and all of the head-end steeple cylinders have the capability of adding clearance using spacers under the cylinder head. Cylinders are shipped with an assortment of 1/4" and 1/2" spacers installed on the outside of the cylinder head.

13. To add clearance, remove the cylinder head and move the appropriate number of spacers from outside the head to under the head and install the head back on the cylinder.

14. Note that the 1/2" spacers are treated as two 1/4" spacers. Therefore, if the application calls for two 1/4" spacers, this can physically be done with one 1/2" spacer. Refer to Table 5.2, Spacer Clearance, for the percent (%) clearance added with each 1/4" spacer increment.

SPACER CLEARANCE			
CYLINDER SIZE (INCHES)	MAXIMUM ADDED CLEARANCE %	% CLEARANCE PER 1/4 (inch) SPACER	MAXIMUM NUMBER OF SPACERS
2.5 DA	44.0	8.8	5
3.0 DA	40.0	8.0	5
2.25 SAHE	26.4	8.8	3
2.5 SAHE	26.4	8.8	3
3.0 SAHE	25.8	8.6	3
3.5 SAHE	25.8	8.6	3
4.0 SAHE	25.8	8.6	3
4.5 SAHE	25.8	8.6	3

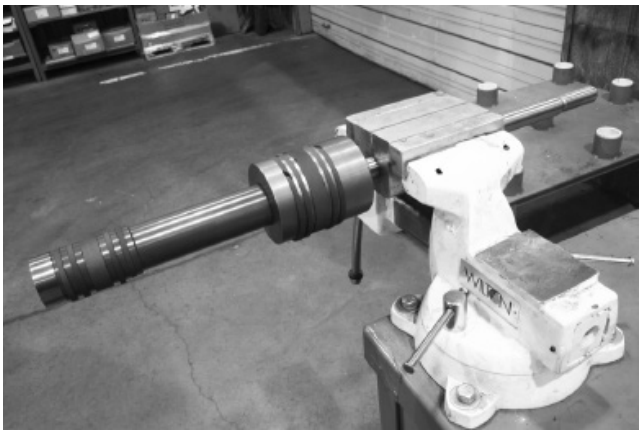
Table 5.2. Spacer Clearance

5.3 Steeple Cylinder – Piston and Rod Disassembly

The same piston and rod clamp (VRC29494) that was used in the double-acting piston and piston rod disassembly and assembly can be used with the steeple piston and piston rod.

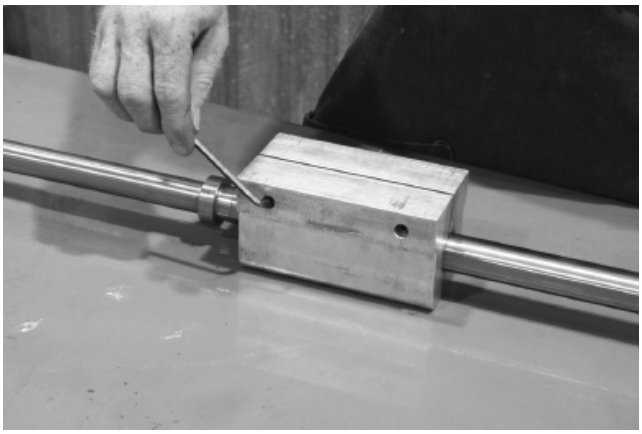
1. Clamp the steeple piston and rod assembly in the piston rod clamp device. This device will properly hold the rod in place and prevent any damage to the rod. Follow these instructions for using the piston rod clamp:
2. Open the jaws of the rod clamp device by TIGHTENING the set screws.
3. Slide the clamp onto the steeple piston rod as close as possible to the piston. Close the jaws of the clamp by loosening the set screws.

4. Back off the set screws but do NOT remove.
5. Insert the clamp into a large vise so that the pressure is applied to the shoulder of the clamp.



6. Loosen the piston nut (VRC24919) using the piston nut adaptor tool (VRC29490) and a 1” socket wrench.
7. Remove the pistons (both large and small piston) from the rod. The pistons will slip off the end of the rod.
8. Remove the clamp from the vise.

9. Tighten the set screw in the clamp to open the jaws.
10. Remove the clamp from the rod.



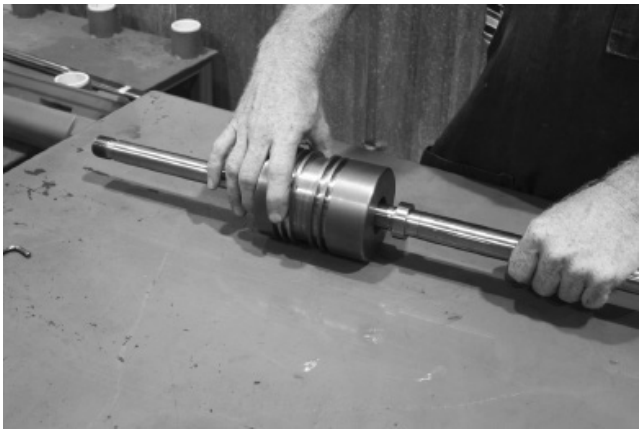
5.4 Steeple Cylinder – Piston and Rod Assembly and Installation

Preparation

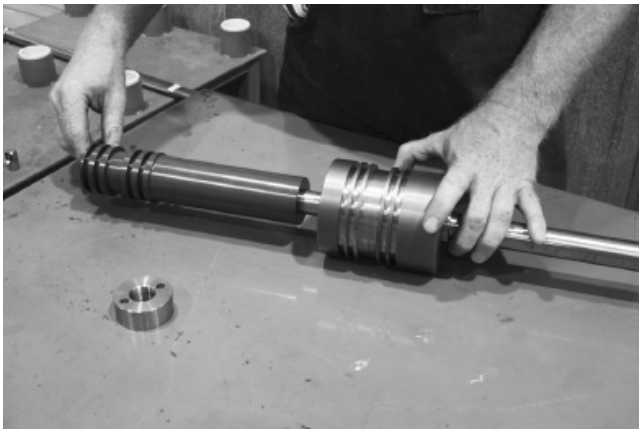
1. Clean the piston making sure that all surfaces are free from dirt and metal shavings.
2. Clean piston rod and remove any excessive corrosion inhibitor oil from the threaded area.
3. Inspect both piston and rod making sure both are clean and free from debris and metal shavings. Dirt and debris in this area will cause excessive packing wear and cylinder bore abrasion damage.

5.4.1 Steeple Piston and Rod Assembly

1. Place the piston on its side. Starting with the larger piston, insert the piston rod in the large piston. The piston rod should be inserted through the large piston's smallest counter sunk hole.
2. Carefully insert the piston rod until it bottoms out.



3. After inserting the large piston, insert the smaller piston on the same end of the rod.



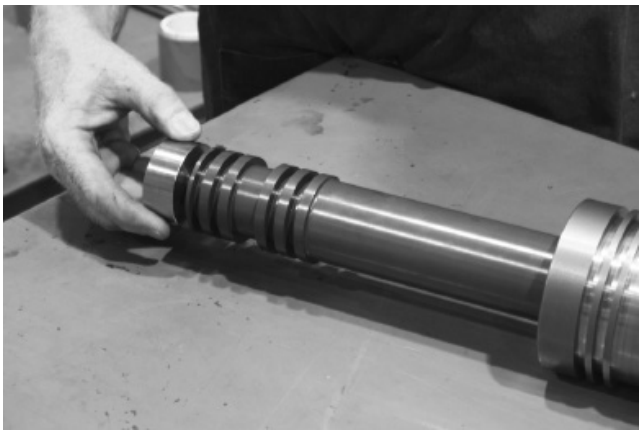
NOTE: Insert the smaller piston with ring lands toward the end of the rod.

4. Thread the piston nut (VRC24919) onto the piston rod. Do NOT lubricate the piston nut threads.

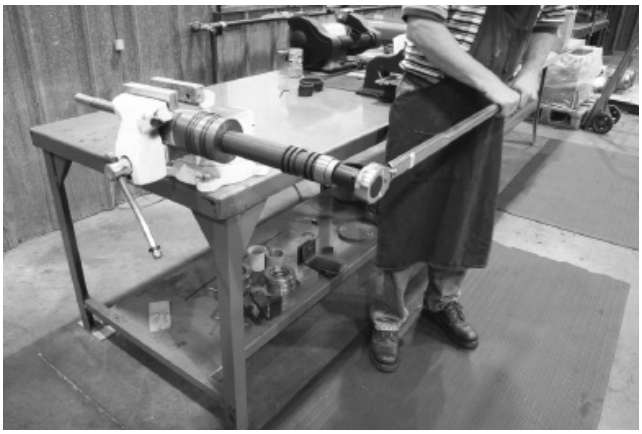
NOTE: Use piston nut VRC24911 on 2.25 pistons ONLY.

5. Thread the piston nut by hand. Then, using the piston nut adapter tool, insert the pins of the adapter tool into the holes of the piston nut.

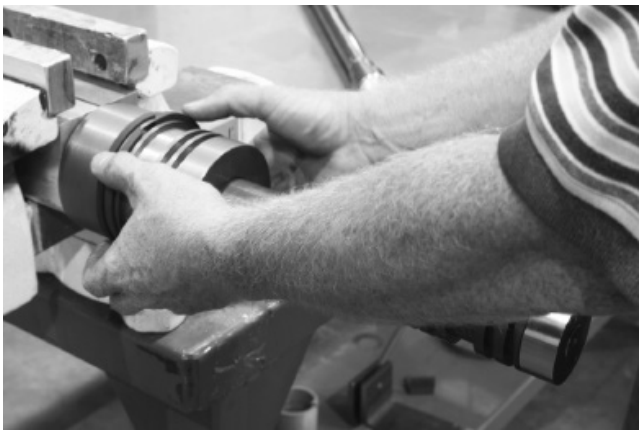
6. Insert the piston rod into the rod clamp and place both into a vise and tighten.



7. Using a 1" socket and torque wrench, torque the piston nut to 330 ft.-lbs.



8. While the piston rod assembly is still in the clamp and vise, insert the 2 piston rings on the large piston



9. Insert the rider band on the center groove of the large piston.
10. Insert the remaining two piston rings on the large piston.

11. Repeat the same procedure for inserting the piston rings and rider band for the smaller piston.
12. Stagger all piston ring gaps approximately 180° apart. The piston ring gaps should NOT be lined up.

5.4.2 Steeple Piston and Rod Installation

1. Liberally apply lubricant to the pistons of the steeple piston and rod assembly.
2. Liberally apply lubricant in the crank-end cylinder bore.

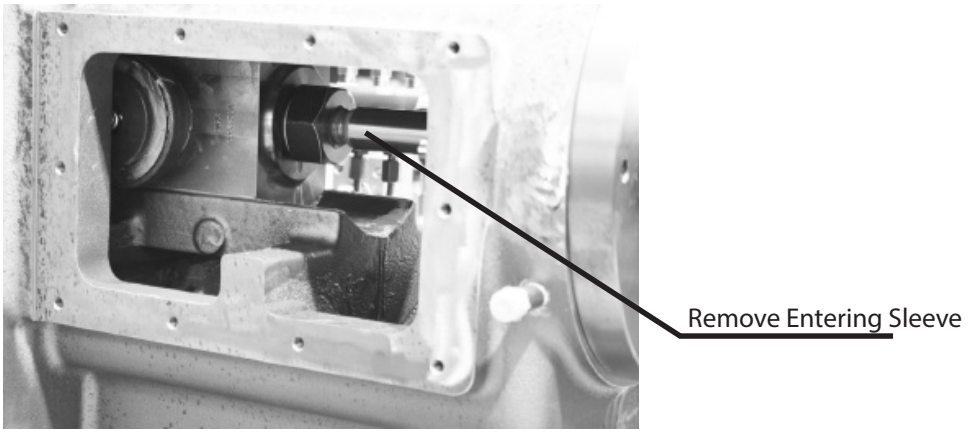
3. Insert the steeple piston and rod assembly (with piston rings) into the crank-end cylinder.

NOTE: The threaded crosshead end of the rod is 1/8" (3mm) smaller than the inside diameter of the packing however, it is recommend to use the piston rod entering sleeve (VRC29492) for this particular installation procedure.

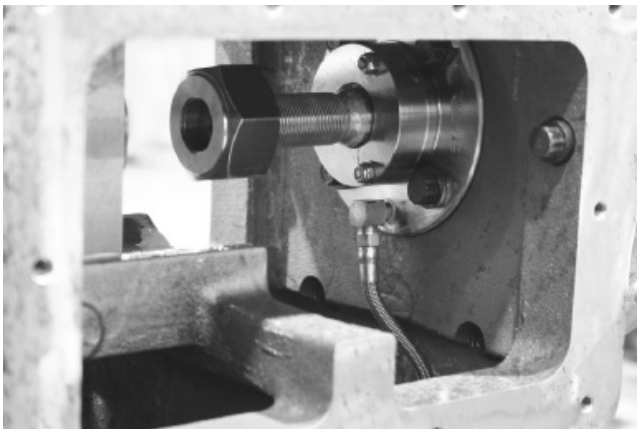
4. Compress the piston rings with your fingers as you carefully slide the piston rod assembly into the crank-end cylinder. Be careful not to pinch your fingers.

5. Make sure the crosshead is all the way back of its throw.

6. Remove the entering sleeve tool from the piston rod.



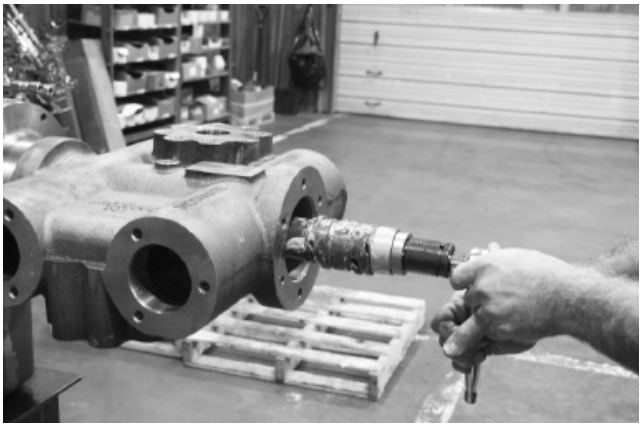
7. Install the piston rod jam nut (VRC24909) on the steeple cylinder piston rod. Make sure that the raised flat surface of the nut will be against the crosshead.



8. Screw the piston rod jam nut to the end of the threads.

9. Continue to turn the piston and rod assembly until it begins to thread into the crosshead.

10. Using the piston nut adaptor tool (VRC29490) screw the piston rod assembly into the crosshead while the crosshead is all the way to the back of its throw.



NOTE: Continue screwing in the piston rod assembly until the piston is approximately 1/16" from the crank-end head (see section 4.15.10, Setting Initial Piston Clearance).

5.5 Steeple Cylinders – Valve Removal

CAUTION: *Before removing any valve cover, be sure that ALL pressure from the compressor cylinder has been vented. The pressure must be completely vented from both the suction and discharge passages of the cylinder.*

1. Slightly loosen all the screws on each valve cover. With all the screws loosened, the cover should stay in its original position. If there are signs of the cover pushing out on its own STOP IMMEDIATELY! You MUST take proper steps to completely vent the cylinder before proceeding (see CAUTION above).
2. After the pressure from the cylinder has been discharged, remove the valve cover screws.
3. Remove the valve. Remove the valve by hand or use a valve tool which attaches to the valve center bolt.

NOTE: The thread size of the valve tool will depend on the size of the valve. See the table below for the different sized valve installation tools and part numbers.

VALVE INSTALLATION TOOL SIZE	
PART NO.	**TOOL, VALVE INSTALLATION**
VRC29463	2.25" - 4.0" CYLINDERS 1/4" AND 5/16" THREADS
VRC29464	4.5" - 10.0" CYLINDERS 3/8" AND 1/2" THREADS

4. The valve seat gasket may remain in the pocket or the gasket may fall into the gas passage. The gasket should be replaced after several uses or each time the valves are replaced.

5.5.1 Steeple Cylinder – Valve Selection

Arrow uses Hoerbiger manufactured valves. Depending on the pressure conditions of the specific application, it may be necessary to change the valve springs to lighter or heavier springs.

Contact your Arrow representative for assistance regarding valve and spring selection.

5.5.2 Steeple Cylinder – Valve Reassembly

1. The 1/32" (0.8 mm) thick soft metallic flat gasket should be coated with an anti-seize lubricant. It can then be inserted into the valve pocket. Be careful not to let the gasket fall into the gas passage.
2. Using the valve tool insert the valve and the retainer into the pocket together.
3. Insert the cover and tighten the screws evenly to the recommended torque of 82 ft.-lbs.. If the assembly is correct, the distance from the underside of the cover to the cylinder will be approximately 1/8" (3 mm).

NOTE: Be certain all parts, gasket faces, and mating surfaces are absolutely clean.

4. Install the suction and discharge valves in the crank-end of the crank-end cylinder.
5. Leave the suction valve gasket, and retainer out of the suction valve port, and put a blank valve in the discharge valve port of the head-end of the crank-end cylinder.
6. Insert valves into the head-end cylinder.
7. Insert one suction and one discharge valve in the head-end cylinder of the steeple cylinder

5.5.3 Steeple Cylinder – Valve Covers

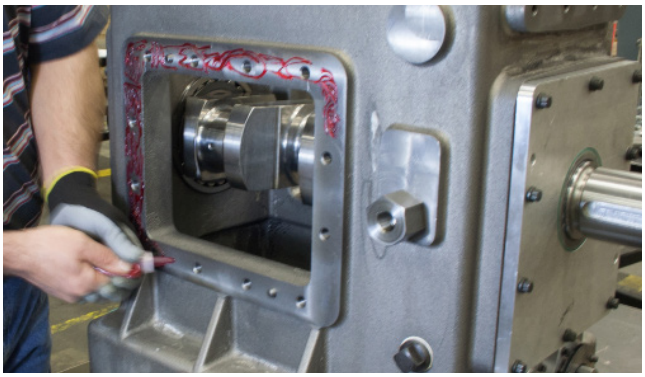
Proper tightening technique is essential for sealing of the valve covers. It is important to draw screws upward to full torque in even and gradual steps.

1. Install the valve assembly with the flat gasket and valve retainer, in the valve pocket.
2. DO NOT use anti-seize compounds on the valve cover screws. Tighten each screw until snug using a crisscross torque pattern.
3. Next tighten each screw to full torque of 82 ft.-lbs.

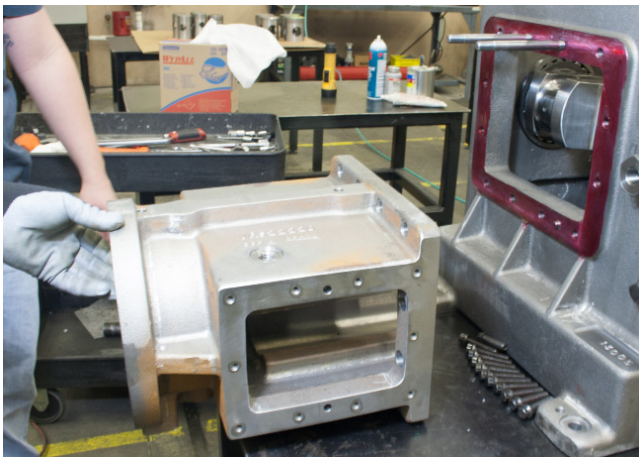
CAUTION: *Severe personal injury and property damage can result if valve cover screws are not installed to the proper torque of 82 ft.-lbs..*

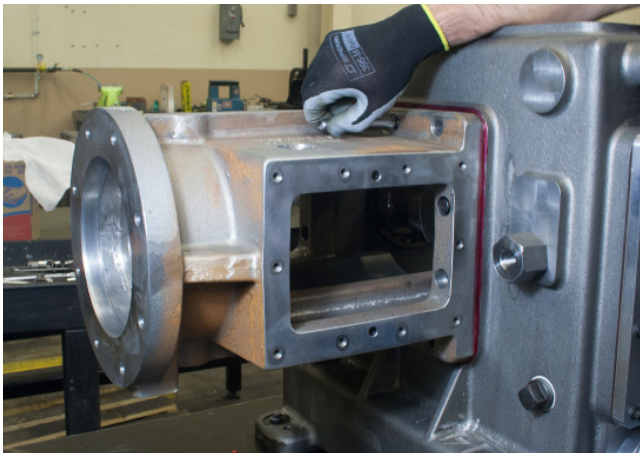
5.6 Distance Piece Installation

1. Apply loctite 518 gasket eliminator to the frame to form a gasket seal a thin layer is all that is required.

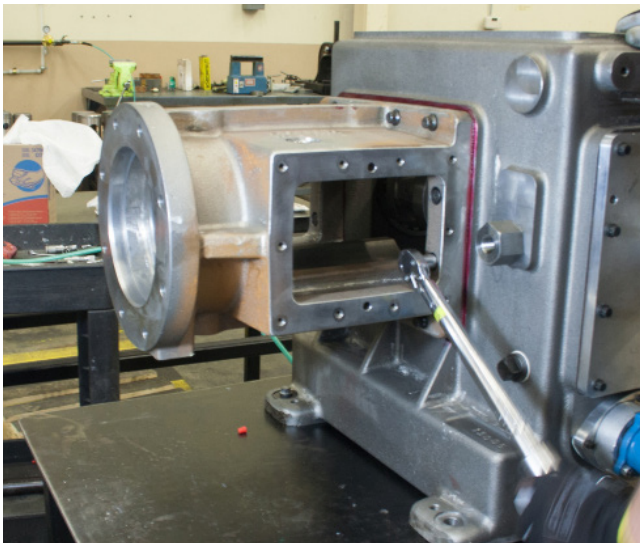


2. Two studs may be used as alignment bolts to help with fitting the distance piece (VRS22220) up against the frame.





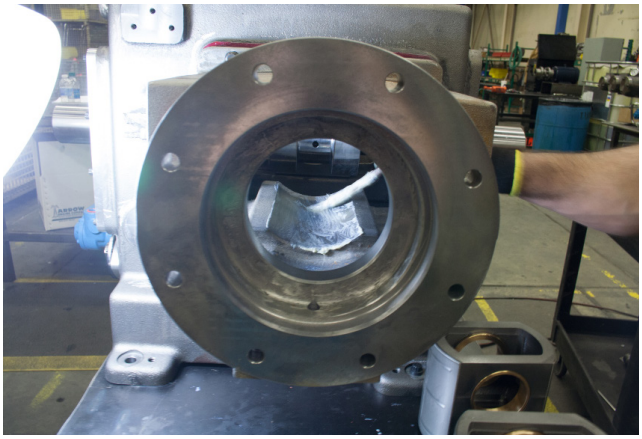
3. Insert distance piece to frame screws (VRC25077) and tighten them in a crisscross pattern to a torque of 82 ft.-lbs.



5.6.1 Connecting Rod Installation

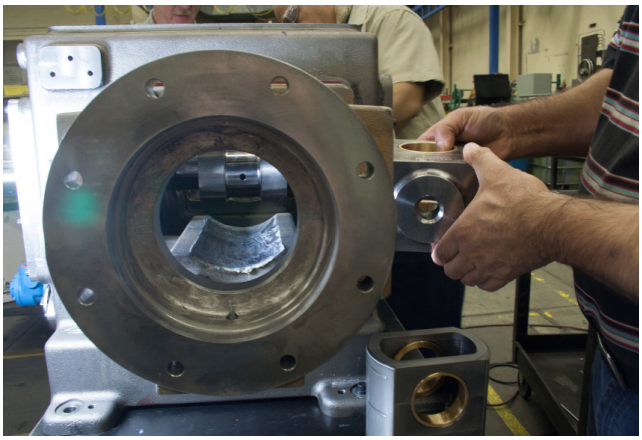
1. Clean and inspect the two lightweight connecting rod assemblies (VRS21220A) and the one heavy-weight connecting rod assembly (VRS21210A).

2. Clean and inspect crosshead slides and then apply lubricant to the bottom and top slide surface.



3. Clean and inspect the two crossheads (VRS22000A) and apply lubricant to the bottom and top crosshead surfaces.

4. Insert the crosshead sideways through the distance piece door and then rotate crosshead into position in the crosshead slides.



5. Inspect connecting rod bearing surface and the rod cap bearing surface to make sure no dirt gets under the rod bearings.

6. Place the rods in the frame so that the match marks on the rod cap end of the rod are on top and can be seen for proper alignment of the match marks on the rod cap to the rod.

7. Insert the heavy connecting rod bearing (VRS21211) in the heavy connecting rod and the two light connecting rod bearings (VRS21221) in the light connecting rods.

NOTE: Avoid touching the bearing surfaces as much as possible and wipe the bearing surfaces clean before applying lubricant and installing them on the crankshaft.

8. Insert conning rods through the top of the frame and into the crosshead area on the appropriate throw.

NOTE: The two light rods and the one heavy rod can be installed on either throw. Orientation is determined by designating which throw is to be the first stage and the parts required to balance the reciprocating weights. (Consult Arrow Compressor Products for the balancing requirements of your specific cylinder configuration.)

9. Fit rod caps to the connecting rods making sure the cap is installed back on its matching rod. Caps are matched marked to the rods with identifying marks. It is necessary that the marks on one side of the cap matches the marks on one side of the matching rod.

10. Install the connecting rod cap screws (VRS21217) and tighten them to a torque of 90 ft.-lbs. wiggle the rod on the crankshaft journal to make sure it floats freely and is not binding up on the journal.

5.6.2 Crosshead Pin Installation

1. Clean and inspect the crosshead pins.

NOTE: There are a variety of crosshead pins available in different weights and lengths depending on whether additional weight is needed to balance the reciprocating weight.

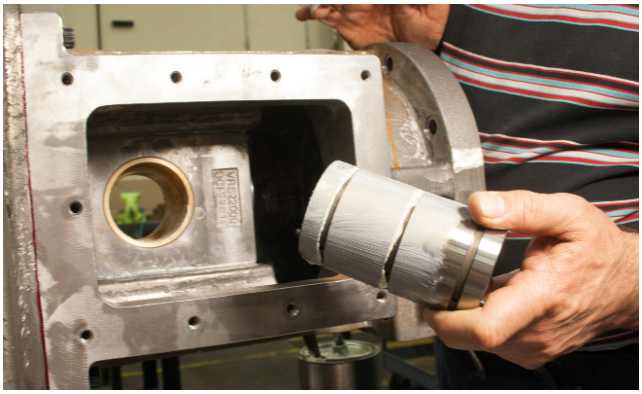
2. All VRS-2 Compressors are balanced so that the reciprocating weight of the opposing throws is less than 1 pound.

NOTE: See the VRS-2 Parts Book section 3.5,Crankshaft, Crosshead, and Connecting Rod Parts, for the various crosshead pin options.

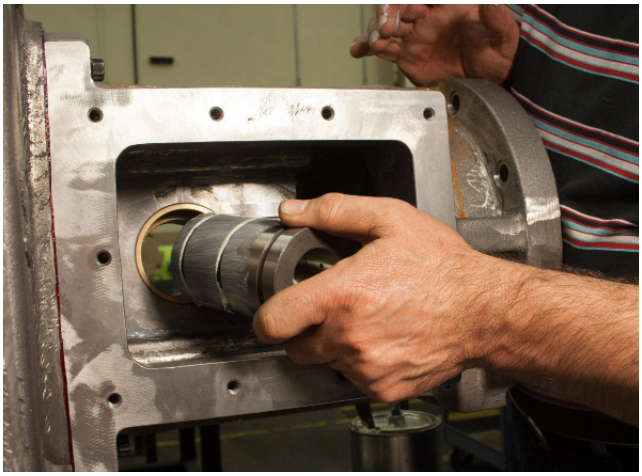
(Consult Arrow Compressor Products for the balancing requirements of your specific cylinder configuration.)

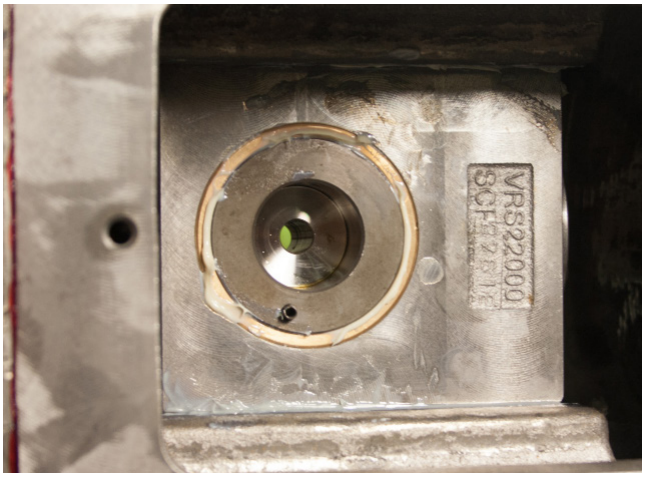
3. Insert the crosshead cap roll pins (VRS22206) in the ends of the crosshead pins and lightly tap them in with a hammer until they fully seat in.

4. Apply lubricant to the crosshead pin and insert it into the crosshead and the bushing-end of the connecting rod.

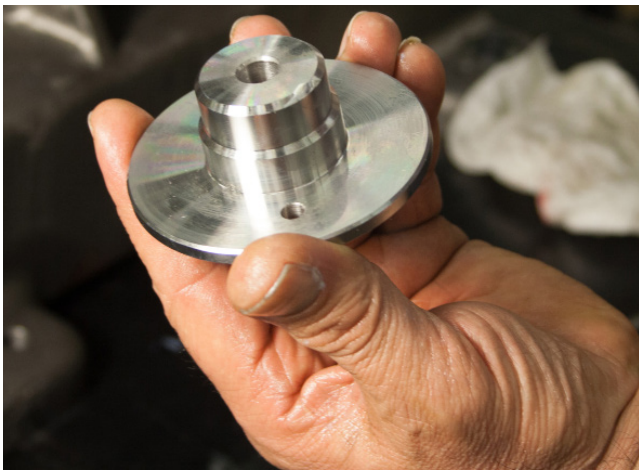


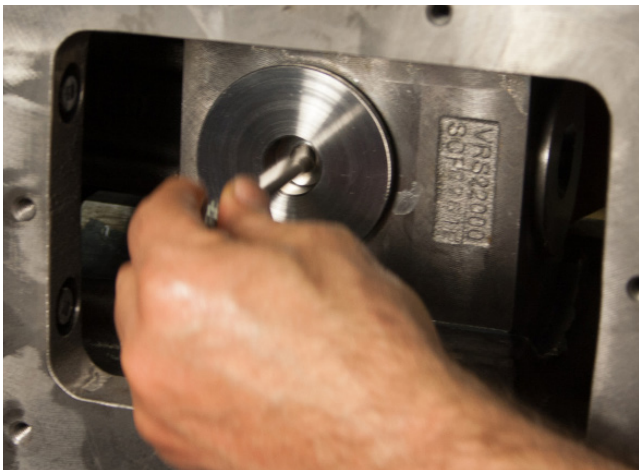
5. On the single heavy rod throw the connecting rod will be inside the crosshead.



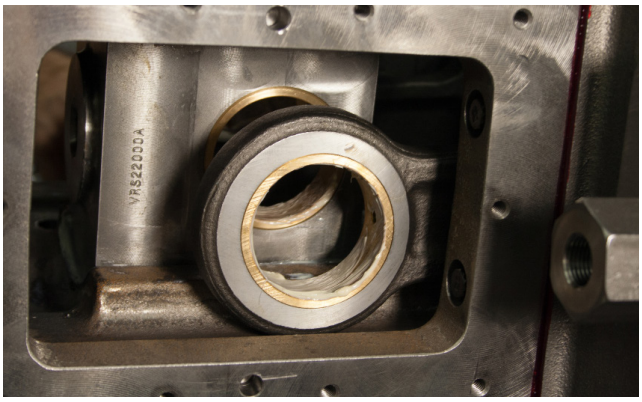


6. Place crosshead retainer cap (VRS22200) on both ends of the pin insert the short crosshead pin retainer stud (VRS22118) and tighten the crosshead pin retainer stud nuts (VRC22119) to a torque of 25 ft.-lbs.

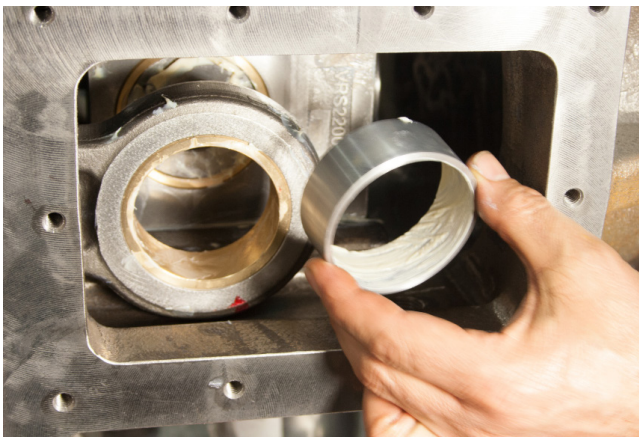




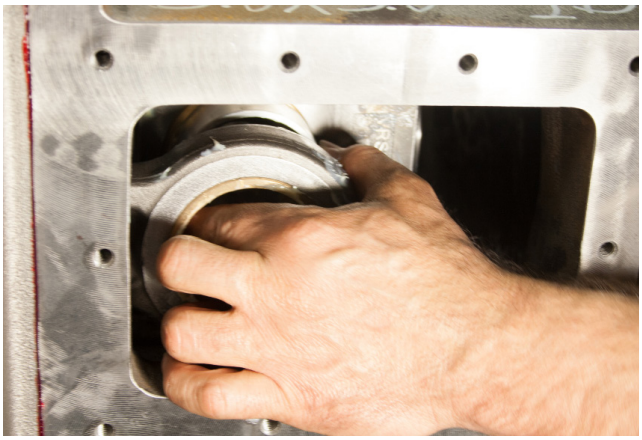
7. On the double light rods throw the connecting rods will be on the outside of the crosshead.

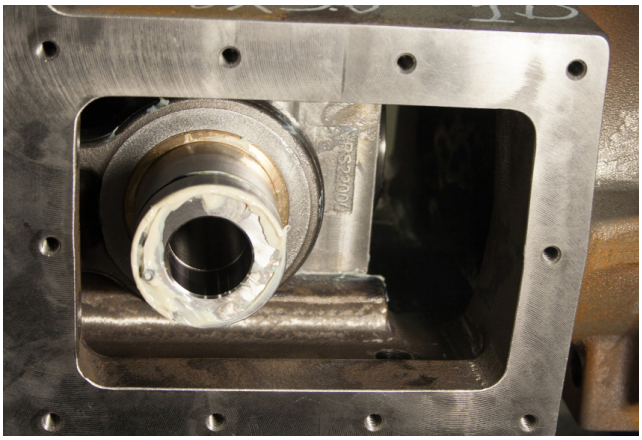


8. Insert the two crosshead pin spacers (VRS22420) between the connecting rods and the crosshead.

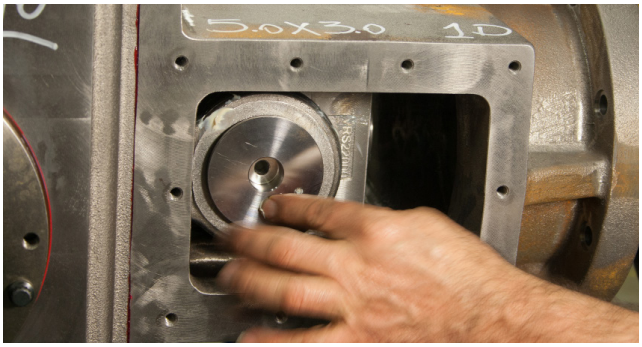


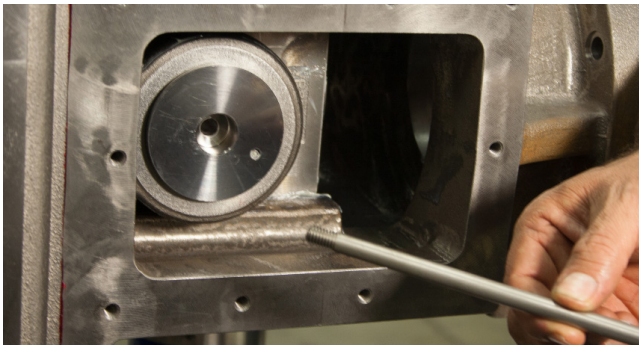
9. Apply lubricant to the crosshead pin and insert it through the rod, spacer, crosshead, spacer, and the second rod while holding all these parts in alignment.



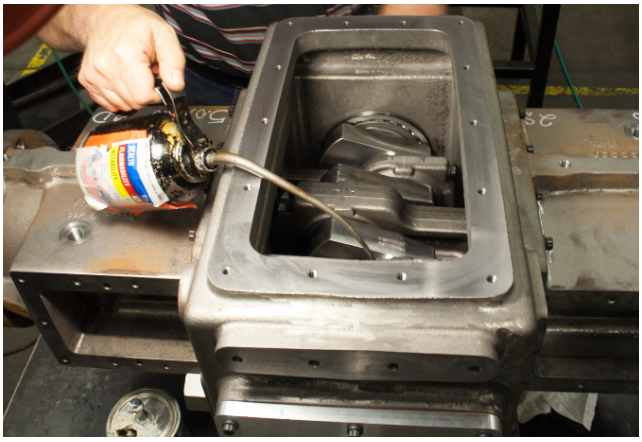


10. Place crosshead retainer caps on both ends of the pin insert the long crosshead pin retainer stud (VRS22128) and tighten the crosshead pin retainer stud nuts to a torque of 25 ft.-lbs.

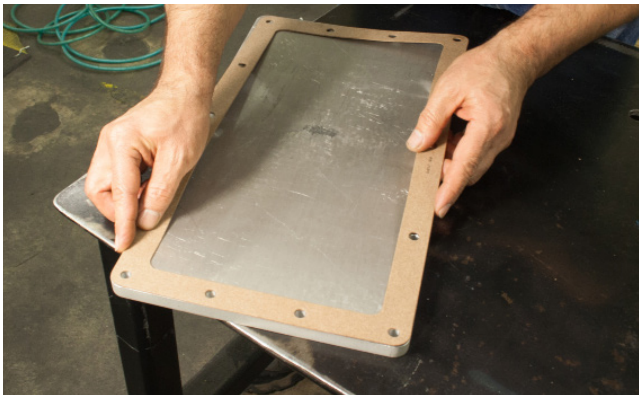




11. Apply oil to the main bearings and connecting rod bearings and rotate the crankshaft to make sure it is rotating freely.



12. Remove the paper backing from the frame top cover gasket (VRS21315) and adhere the gasket to the bottom of the frame top cover (VRS21310)

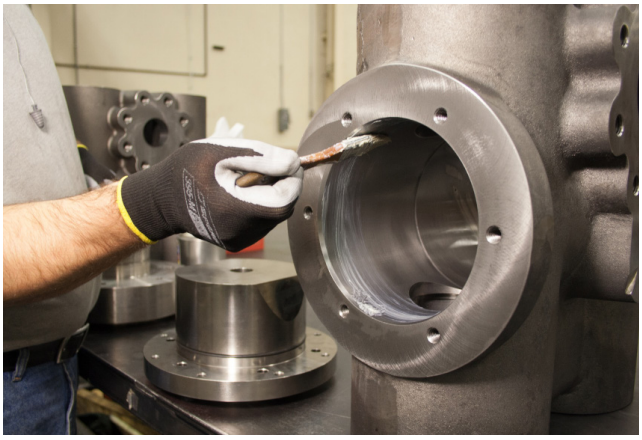


NOTE: The top of the cover plate is identified by the nameplate holes and or nameplate which is located on the top and drive-end of the cover plate.

13. Apply some never-sieze to the gasket insert the top cover screws (VRC21327) and tighten them.

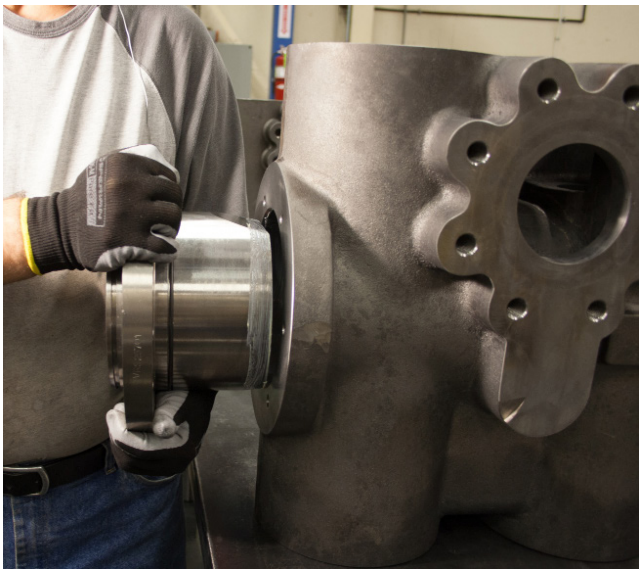
5.7 Cylinder Assembly and Installation

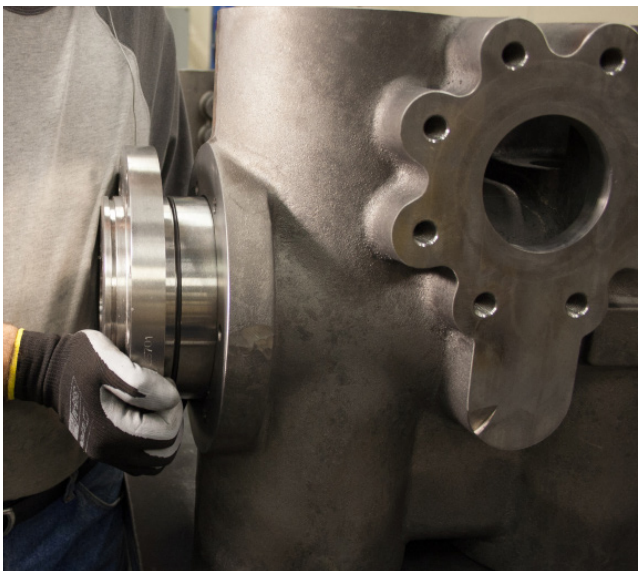
1. Apply lubricant to the inside bore of the cylinder and to the cylinder head and head O-ring.



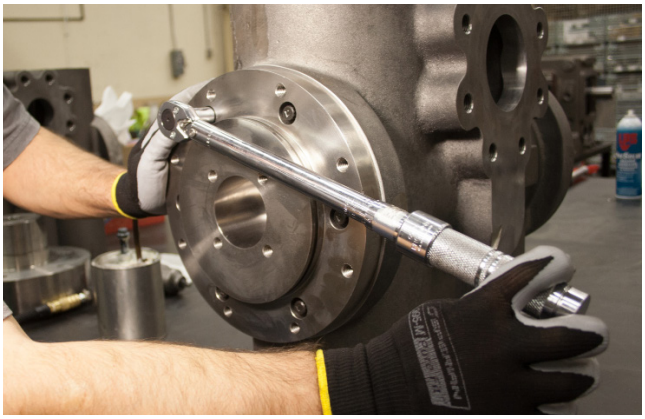
2. Slide the crank-end cylinder head into the crank-end of the cylinder bore with the flats on the head aligned with the valve ports.

NOTE: Be careful to avoid damage to the O-ring and pinching your fingers as the head is fully inserted into the cylinder.

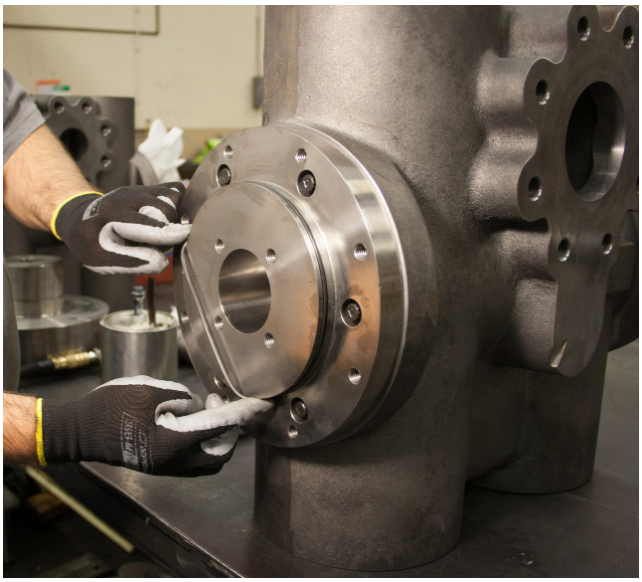




3. Insert crank-end head screws (VRC25067) in head and tighten in a crisscross pattern to a torque of 82 ft.-lbs.



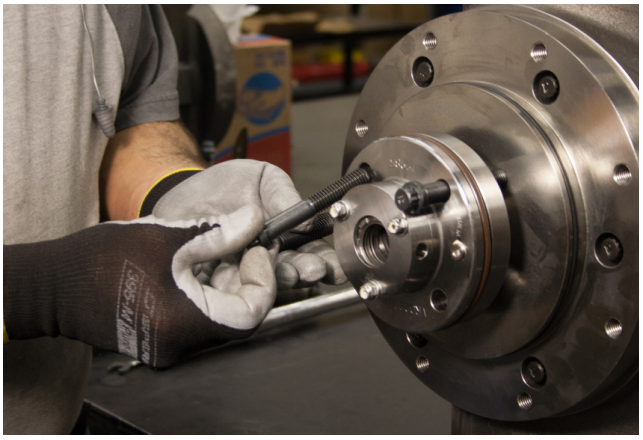
4. Insert O-ring in the O-ring groove in the cylinder head.



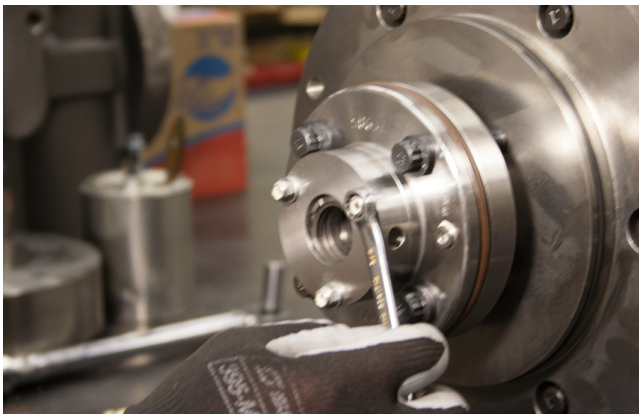
5. Prepare the packing case assembly (VRC23001A) for installation by first loosening the stud nuts enough that the packing cups can move slightly and align as the packing case is inserted in the crank-end cylinder head.

6. Make sure the packing case nose gasket is in place and that the packing case is installed with the lube connection on the top and the vent connection on the bottom.

7. Insert the four packing case screws (VRC23107) and tighten them evenly in a crisscross pattern to a torque of 45 ft.-lbs.



8. The nuts on the packing case studs can now be tightened.

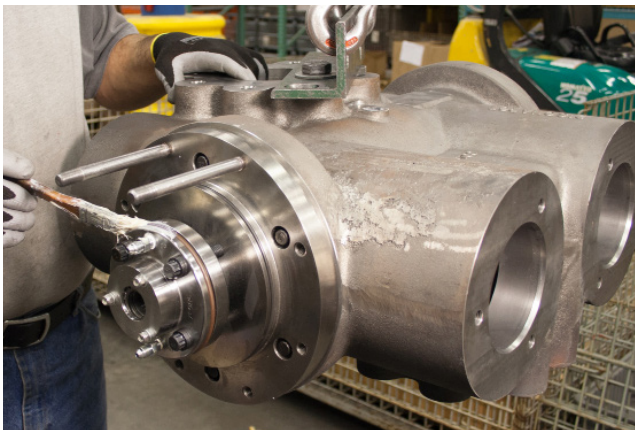


9. Remove the plugs in the "lube" and "vent" connections.

10. Apply loctite 592 thread sealant to the two hose to packing fittings (VRC28878) and thread them into the "lube" and "vent" ports.
11. Tighten the lube fitting until opening of fitting (lube hole) faces to the right.
12. Tighten the vent fitting until opening of fitting (lube hole) faces down.

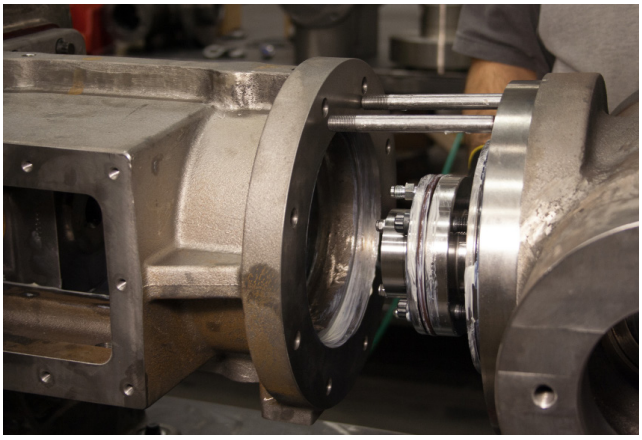
5.8 Cylinder to Frame Installation

1. Using appropriate lifting equipment lift cylinder up toward the distance piece. Apply lubricant to the cylinder head O-ring and packing case O-ring.

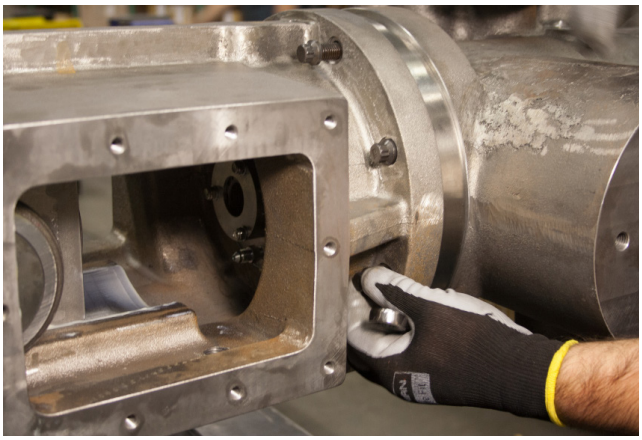


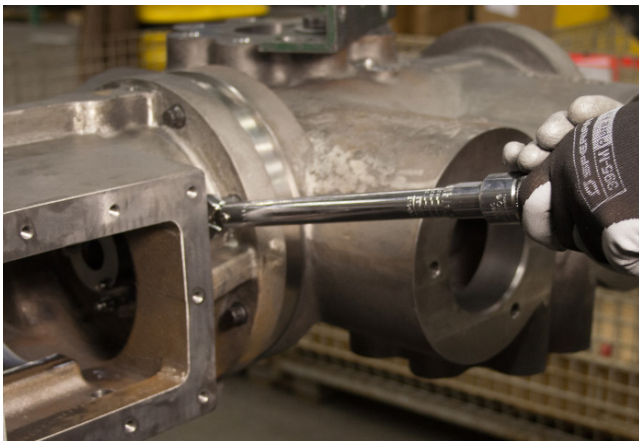
2. Apply lubricant to the opening in the distance piece and insert cylinder into the distance piece.

NOTE: Two 1/2" -13 studs can be used to help with alignment during the installation process.



Install the cylinder to distance piece screws and tighten them in a crisscross pattern to torque of 82 ft.-lbs.

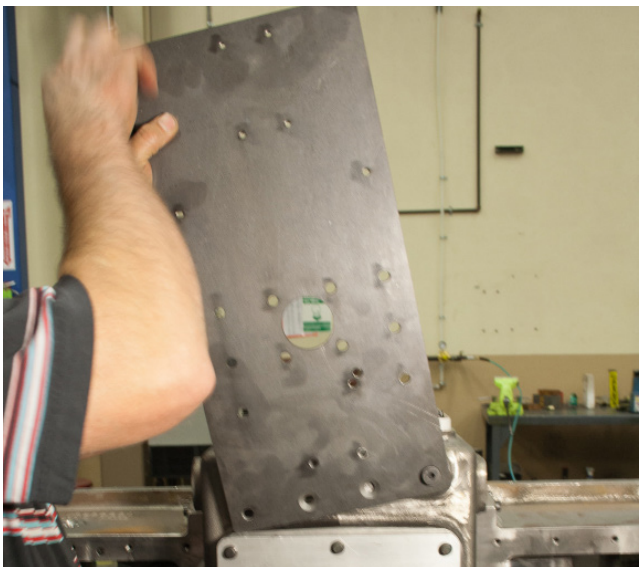


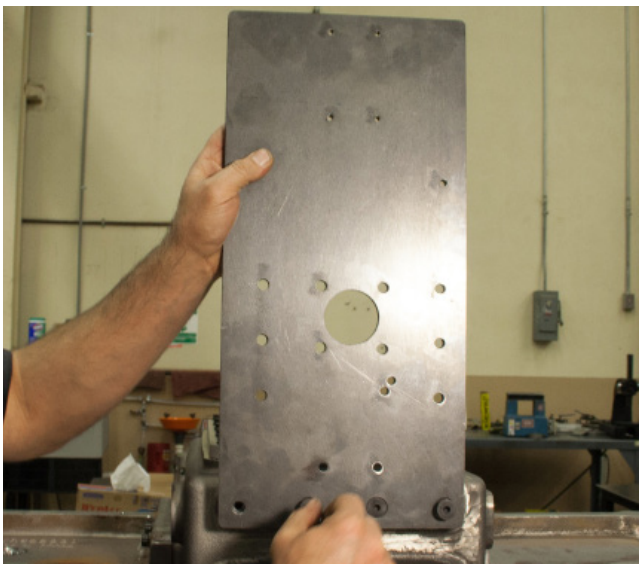


6 LUBRICATION SYSTEM INSTALLATION

6.1 Belt Drive

1. Locate the cylinder lube pump mounting plate (VRS28550) at the top accessory end of the frame so that the mounting holes on the bottom of the plate line up with the mounting holes in the frame.

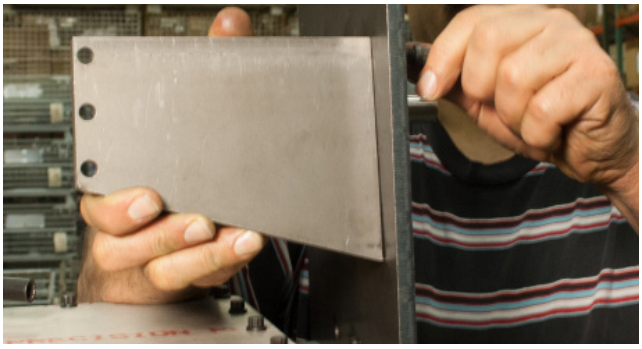


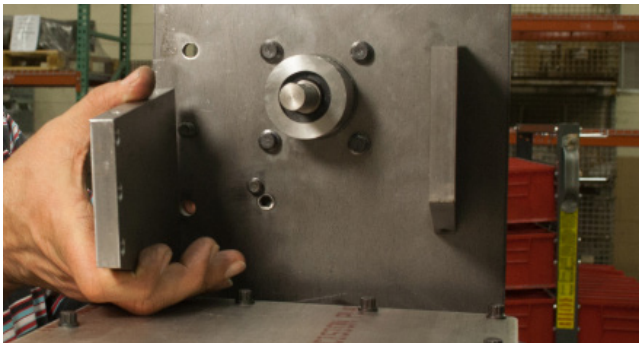


2. Insert and tighten three flat socket screws (VRS21117) in the counter sunk mounting holes.

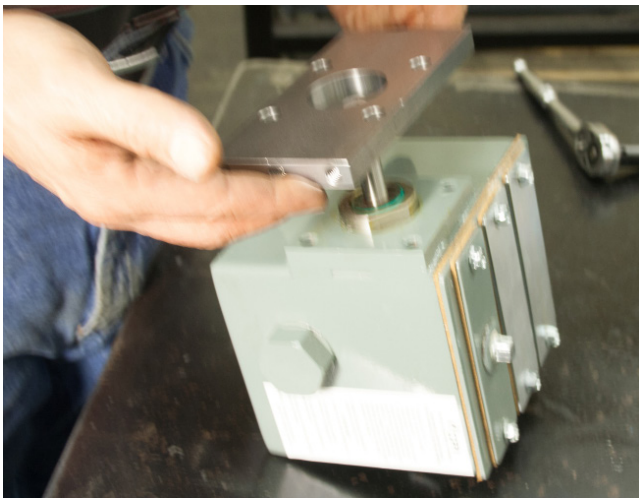
3. Install the flange and integral bearing shaft assembly (VRC28565A) using four retainer screws (VRC28427) inserted from the back side of the mounting plate and tighten them.

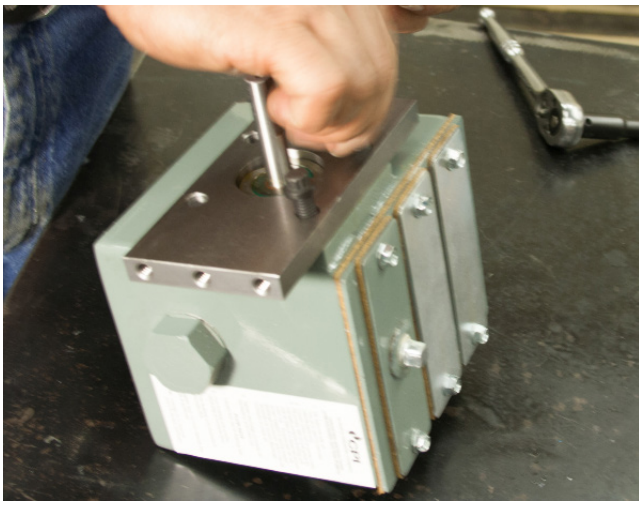
4. Fasten the pump support side plates (VRC28571) to the pump mounting plate with six side plate screws (VRC21327)



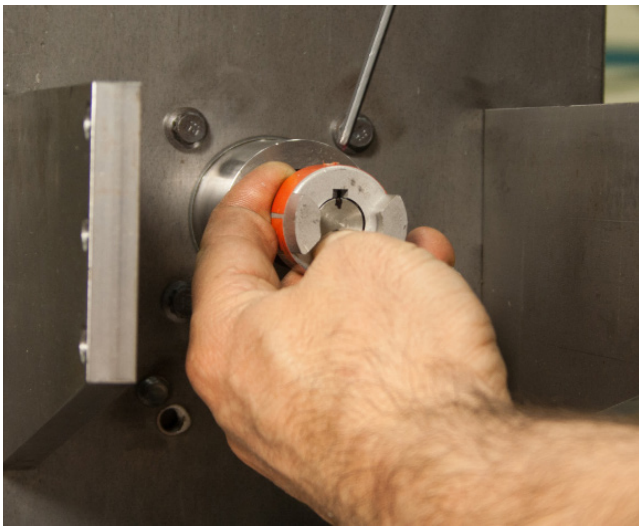


5. Fasten the pump support end plate (VRC28572) to the cylinder lube pump (VRC28530) with four mount plate screws (VRC21117)

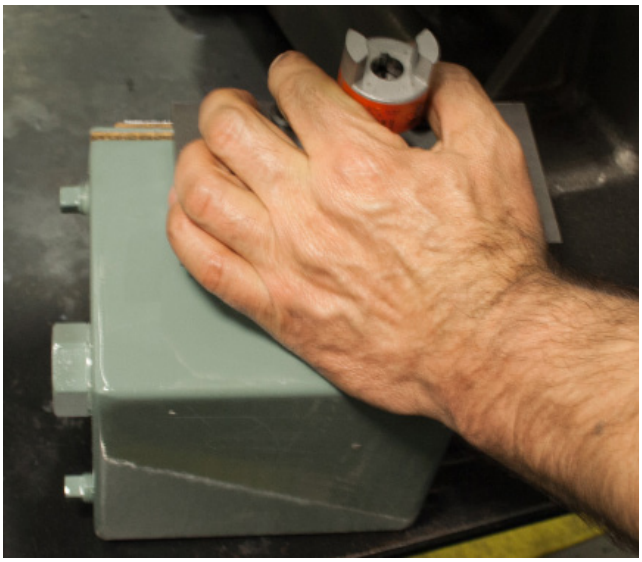




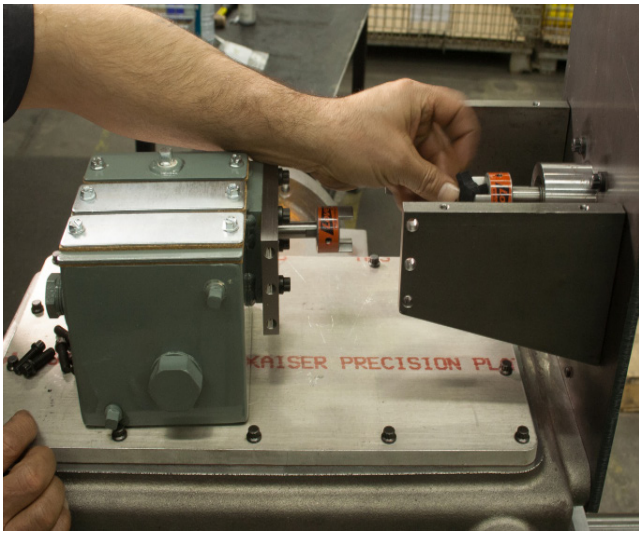
6. Prepare the love joy lube oil pump shaft coupling (VRS28573) for installation by first separating the two halves. Install one half to the integral bearing shaft and tighten the set screw.



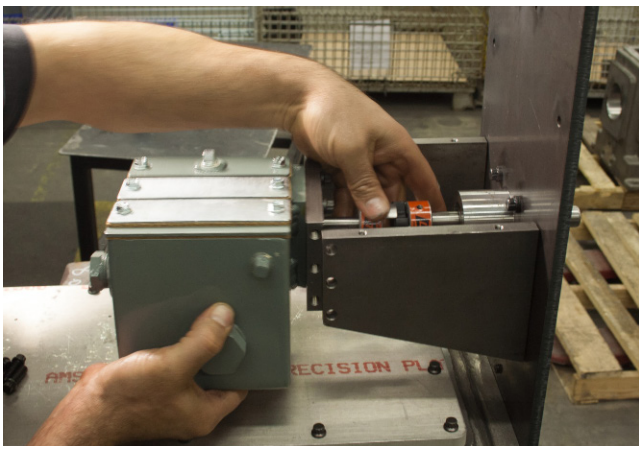
7. Install the other half of the lube pump reservoir shaft and tighten the setscrew.

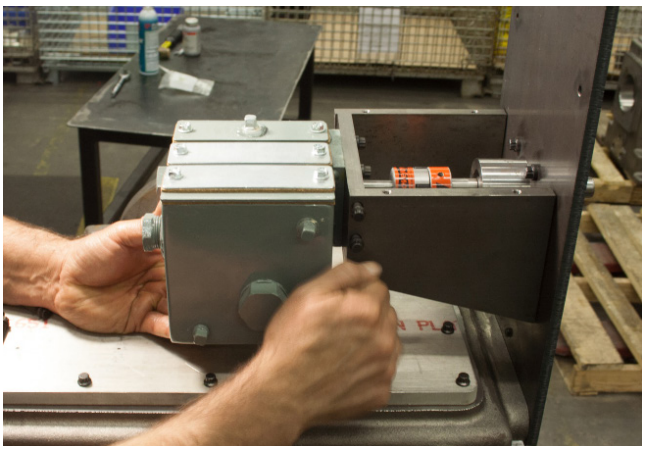


8. Insert the elastomer coupling element in the jaws of the coupling.



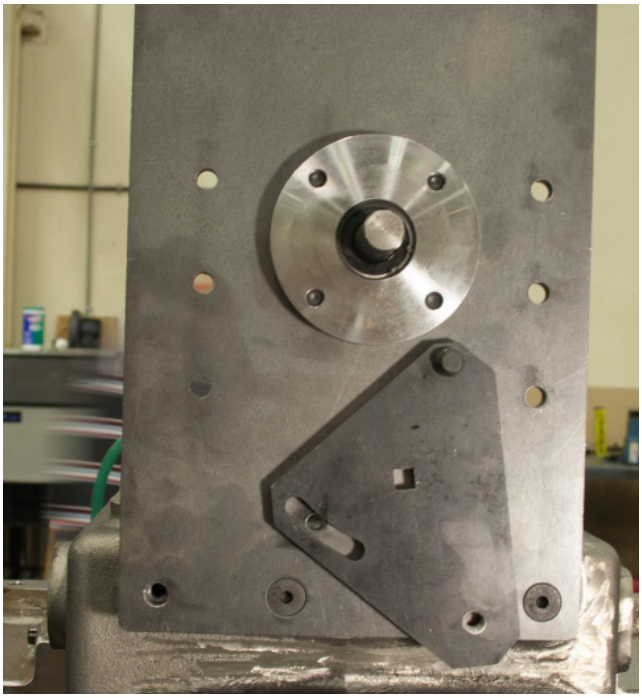
9. Hold reservoir in place and insert six side plates screws (VRC21327) to attach the end plate to the side plates.

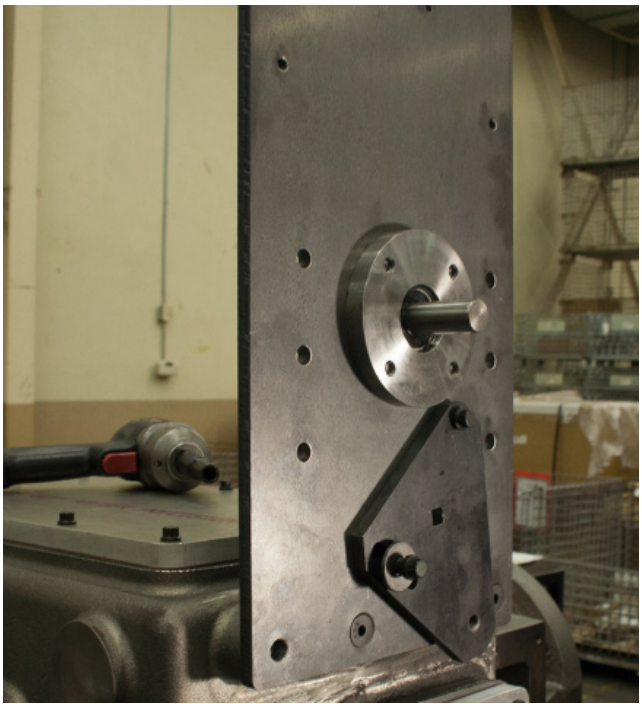




10. Attach the pump support top plate (VRC28570) with four top plate screws (VRC28017)

11. Install the belt tensioner adjusting plate (VRC28472) to the pump mounting plate with a tensioner screw (VRC21117) at the top and a tensioner screw and flat washer (VRS28476) in the elongated hole in the tensioner plate.





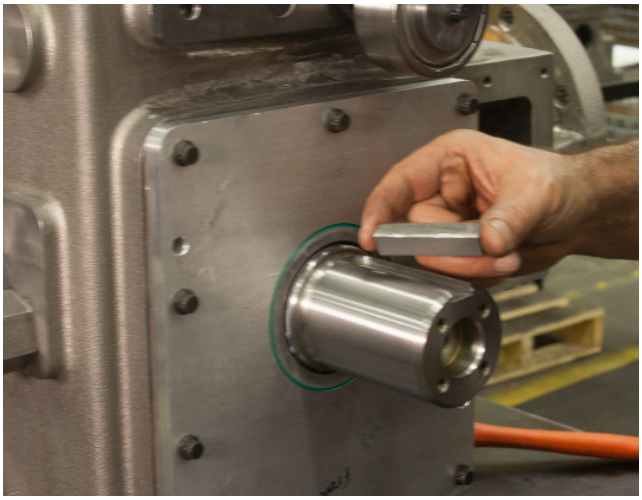
12. Insert setscrew (VRC28239) in the lube pump driven belt sheave (VRC28465) slip the sheave over the integral bearing shaft and tighten the setscrew.

13. Insert the belt tensioner sleeve (VRC28471) into the belt tensioner bearing (VRC28470) and using a bench press or hammer and block press the sleeve into the bearing.

14. Insert screw (VRC28477) into the tensioner sleeve and bearing.

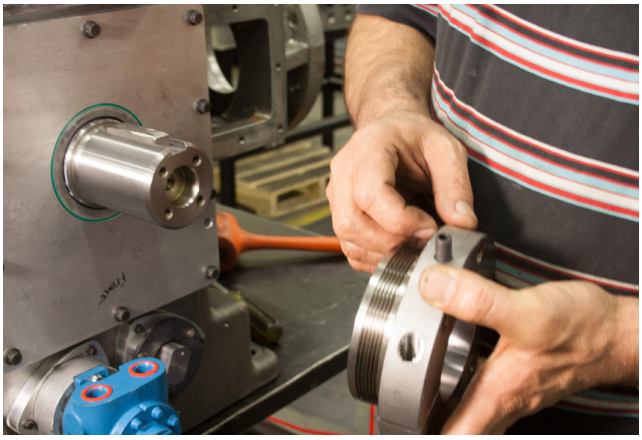
15. Put the belt tensioner washer (VRC28475) behind the tensioner bearing and attach this assembly to the bottom hole of the belt tensioner adjusting plate.

16. Insert the crankshaft key (VRC21106) in the key way of the crankshaft.

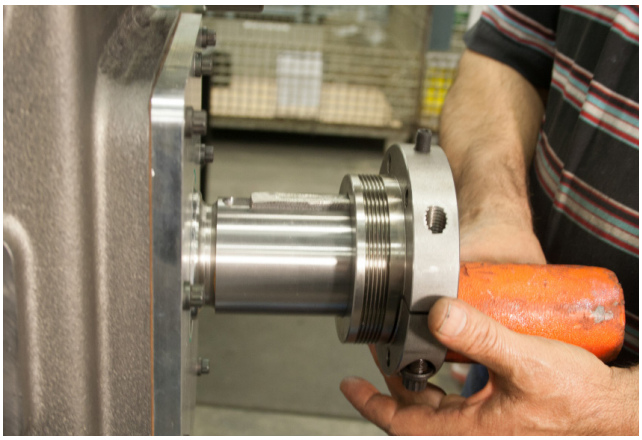


NOTE: Some dressing of the key may be necessary to achieve a good snug fit.

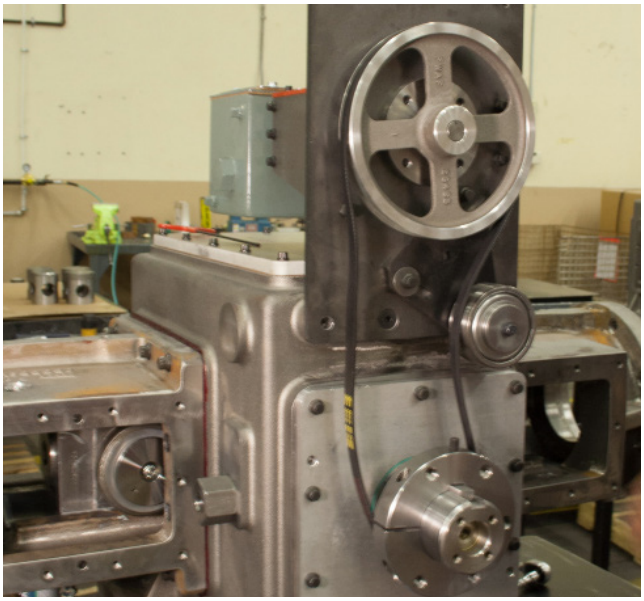
17. Prepare the lube pump drive belt sheave (VRS28425) for installation by inserting the setscrew (VRC28429) and the sheave screw (VRC25017) but do not tighten them yet.



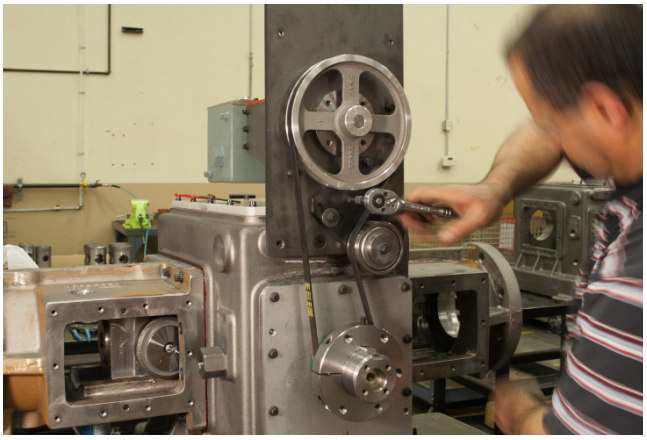
18. Slip the drive sheave over the crankshaft, with the grooved belt sheave toward the frame. This may require lightly tapping the sheave with a rubber mallet.



19. Place the cylinder lube pump drive belt (VRS28400) over the drive sheave and driven sheave.

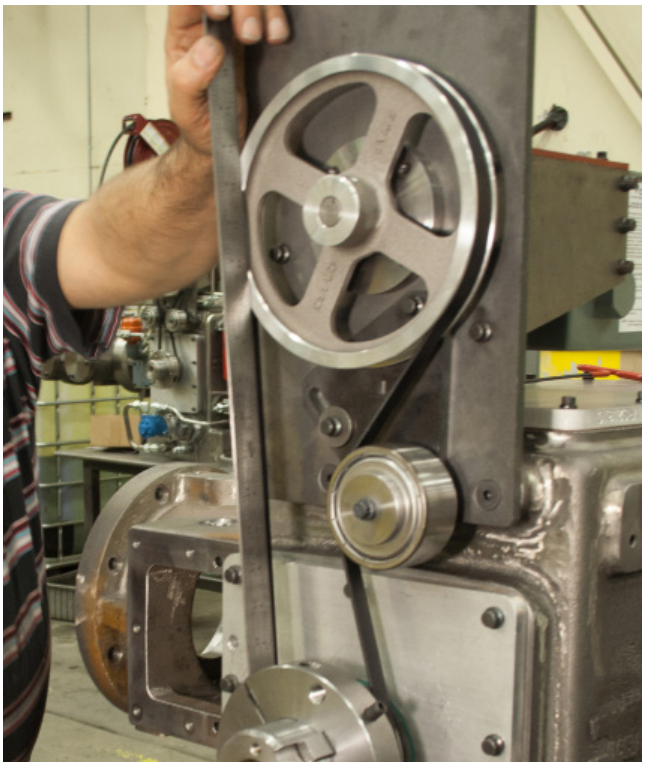


20. Using the square hole in the belt tensioner adjusting plate insert a 3/8” drive wrench and use it to apply tension to the belt, then tighten the adjustment screw.

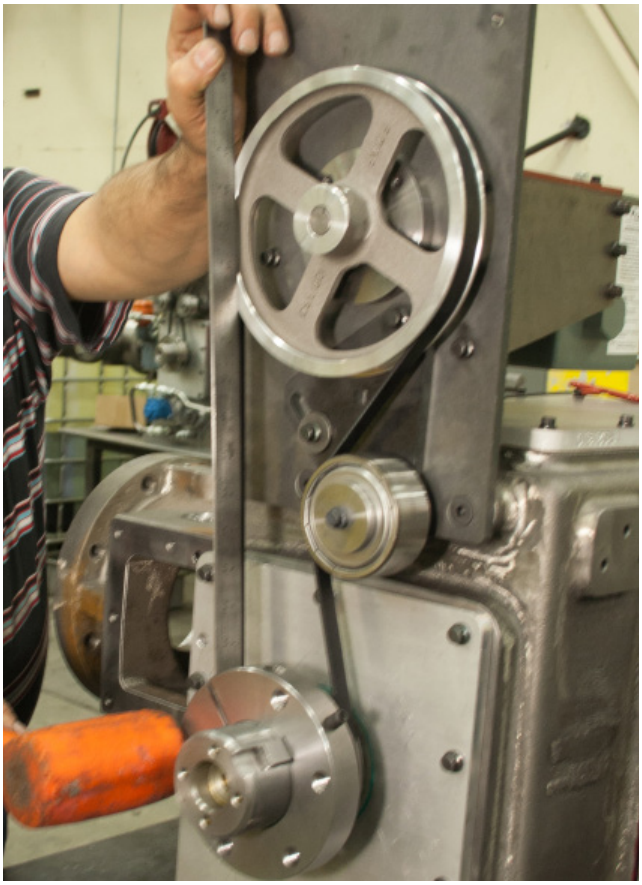


6.2 Adjusting Belt Alignment and Tension

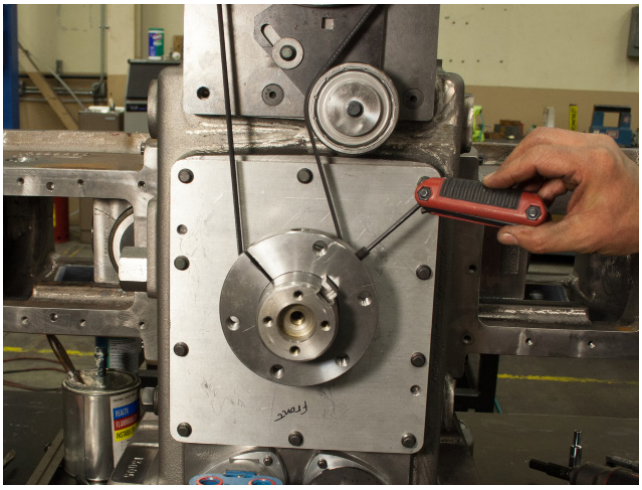
1. Check the alignment of the belt sheaves by placing a straight edge on the face of the driven sheave and checking the gap between the straight edge and the belt. Make sure the gap is consistent the entire length of the belt.



2. Using the drive sheave to make adjustments, move the drive sheave in or out on the crankshaft until proper alignment has been achieved.

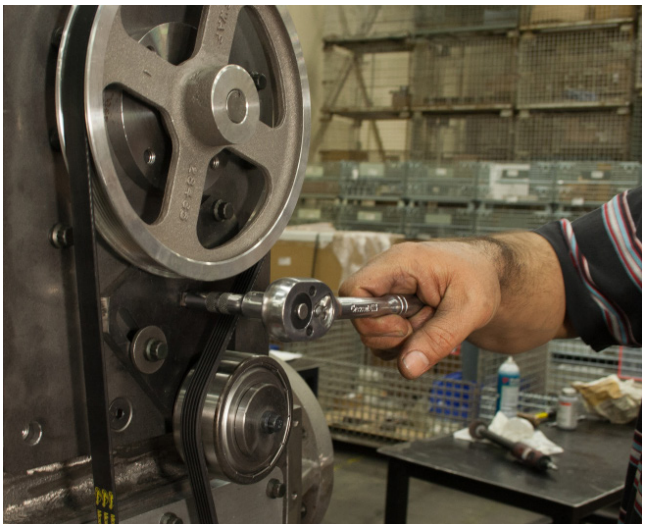


3. When alignment is completed, tighten the drive sheave setscrew over the key, and the sheave screw.

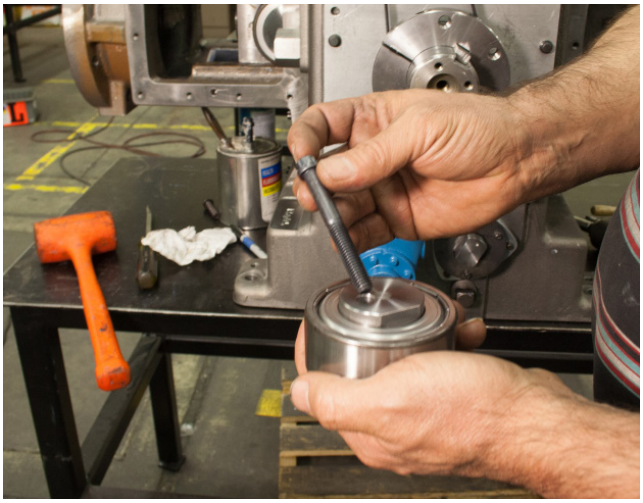
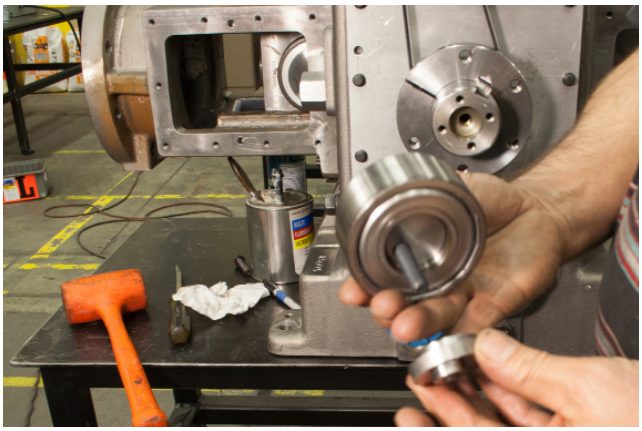
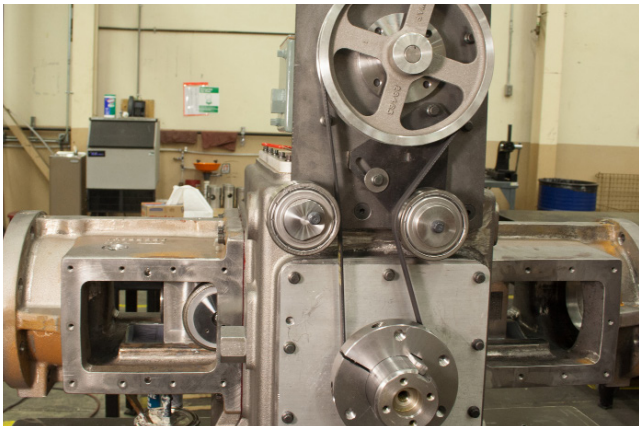


4. Check the belt tension on the slack side by holding a straight edge on the outside diameter of the drive and driven sheave (adjacent to the belt) and with a ruler, push the belt in and measure the amount of slack in the belt. Belt tension should be such that when applying about 10 pounds of pressure to the center of the slack side of the belt, there will be approximately 1/4” movement or slack.

5. Make final adjustments of the belt tensioner adjusting plate and tighten the adjustment set screw.



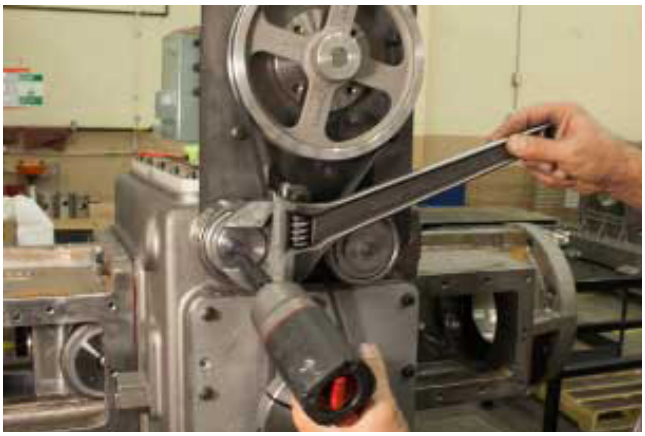
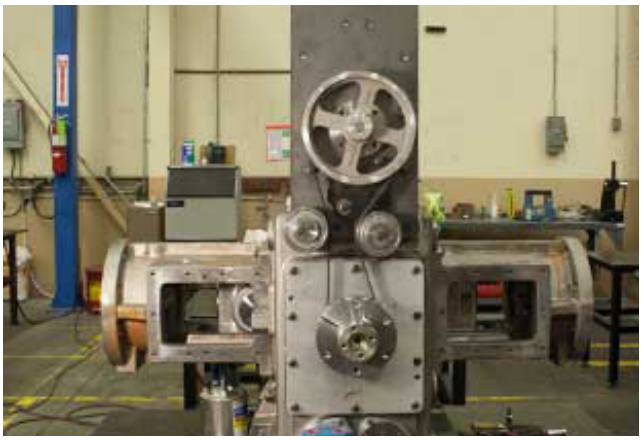
6. Insert the belt eccentric idler sleeve (VRC28474) into the belt idler bearing (VRC28470) insert the idler bearing screw (VRS28067) in the front, or sleeve end, and put the belt eccentric idler spacer (VRC28473) on the back side so that the protrusion on the spacer fits into the hole in the mounting plate.

7. Position idler by using the eccentric adjuster and apply only slight pressure to the belt. The idler bearing should be able to turn by hand.

NOTE: It is not intended for the idler bearing to apply tension to the belt, it is simply touching it to eliminate belt flutter.

8. After idler position has been set using a wrench to make adjustments, tighten the set screw.

6.3 Lubrication System Overview

Proper lubrication is critical for long life and proper functionality of a compressor.

Maximum allowable oil temperature into the VRS-2 Compressor frame is 250°F (121°C), thus proper lubrication will help the compressor run efficiently with minimum friction and wear.

Below are a few ways proper lubrication helps the compressor perform optimally:

- **Reduces friction** – Reducing the friction within a compressor and decreases the amount of energy it takes to run the compressor and reduces the heat a compressor creates while performing.
- **Reduces wear and tear** – Reducing wear and tear prolongs the life of the compressor and all of the compressor's working parts. Proper lubrication reduces maintenance and repair costs.
- **Lubrication cools rubbing surfaces** – This extends the life of the constantly moving and rubbing parts within the compressor. It also removes heat build-up caused by these rubbing parts.
- **Prevents corrosive build up** – Prevents rust and lessens corrosion on surfaces and friction heat.
- **Seals and reduces impurities** – Improves piston and packing ring(s) seals and flushes away impurities from moving parts.
- **Decreases shock and vibration** – Shocks and vibrations are softened reducing noise and vibration thus extending the life of the compressor and its parts.

Lubricants most often used in compressors are petroleum based oils and synthetic fluids. Lubricant additives are used to better the viscosity index, slow down oxidation, lower the lubricant pour point, slow down rust accumulations, help improve detergency, provide anti-wear protection, supply extreme pressure protection, reduce gas dilution, enhance "wetability", prevent washing away of lubricants due to water, wet or saturated gas within the gas stream.

- **Viscosity index** is the measure of the ability of oil to resist breakdown caused by increase oil temperature.
- **Lubricity** is a the measure of the degree of lubrication.
- **Wetability** is the measure of the lubricant's ability to adhere to a metal surface.

6.3.1 Petroleum-based Oils

Two types of petroleum based oils, also called mineral oils, are Paraffinic and Napthenic.

Paraffinic has better resistance to thinning at greater temperatures than napthenic. Paraffinic also has a higher wax content than napthenic.

Napthenic allows for better flow of lubricant and is better for cold start-ups. It has a lower resistance to thinning at higher temperatures compared to Paraffinic. Napthenic has lower life/oxidation stability and leaves soft carbon deposits or residues on discharge valves and other moving parts.

6.3.2 Synthetic Lubricants

Synthetic oils or lubricants are oils consisting of chemical compounds which were not originally present in the petroleum product but were artificially made from other compounds. The synthetic lubricants can be substituted for petroleum based lubricants. When synthetics are substituted for petroleum based lubricants it generally provides superior mechanical and chemical properties over those found in the tra-

ditional mineral oils. Synthetics also assist with energy savings, reduced lubricant usage and increased compressor life which results in decreased equipment maintenance and compressor downtime.

Synthetics usually are designed for better viscosity, increased oxidation resistance, better lubricity, lower volatility, and greatly decreases operating temperatures. Some synthetic lubricants can be used in the compressor frame. Please consult with your lubrication supplier for more information regarding the use of these lubricants in the compressor frame.

- **Synthesized Hydrocarbons** – polyalphaolefins (PAO) may be used as compressor lubricants
- **Organic Esters** – diesters and polyolesters
- **Polyglycols** – polyalkylene glycols (PAG), polyethers, polygylcolethers, and polyalkylene glycol ethers.

Cylinder oils are a special compound of lubricants created for use in compressor cylinders. The compounds used can be a petroleum or synthetic base. These lubricants are created to enhance oil film strength and to offset the affects of water, wet gas and solvents that might be present in the gas.

6.3.3 Compressor Frame Lubricants

Arrow Engine Company recommends a good quality mineral oil which provides the proper lubrication, heat removal, oxidation prohibitors, prevents rust and corrosion build-up, and decreases wear and tear from day-to-day operation.

When compressing clean, dry, pipeline quality gas, the oil Arrow recommends for the VRS-2 Compressor should be a SAE 30-weight (ISO 100 grade) oil for normal operation.

Arrow Engine Company typically uses an Industrial Oils Limited "Hi-TeK TAGE GEO SAE 30" oil in the compressor frame, cylinder lubrication system and engines.

The maximum viscosity of lubrication oil for cold ambient temperature starting is 15,000 SUS (3300 cSt), typically 40°F (4°C) for SAE 30-weight (ISO 100 grade) oil, or 55°F (13°C) for SAE 40-weight (ISO 150 grade) oil.

The minimum viscosity at operating temperature is 60 SUS (10 cSt).

Low ash or no ash oils are recommended as high ash oils can increase maintenance requirements. Any additives used must not be corrosive or damaging to lead or copper based bearing material.

The frame driven oil pumps use a spring loaded regulating valve (VRC28350) to maintain oil pressure. The system pressure can be raised or lowered by adjusting the valve. Discharge side of the lube oil filter is set for 50 PSIG. If the lubrication oil pressure drops below 40 PSIG, the cause should be found immediately. Low lube oil pressure shutdown, set at 35 PSIG, is required for compressor protection.

Minimum lube oil operating temperature is 150°F (66°C). This is the minimum temperature required to eliminate water vapor. The VRS-2 Compressor is equipped with a simplex, spin-on filter.

The VRS-2 Compressor frame lubricating oil should be changed at regular maintenance cycles of six months or 4,000 hours. More frequent oil changes may be necessary if the compressor is operating in a extremely dirty environment or if the oil supplier recommends it. Oil sampling should be done on a regular basis to verify the oil integrity for continued service. Decreasing or increasing the viscosity grade below or higher to the original oil viscosity will require a complete oil change. Viscosity testing should be performed at 212°F (100°C).

6.3.4 Cylinder and Packing Lubrication Requirements

Requirements for cylinder lubrication will vary with operating conditions and the make up of the gas that is to be compressed. Arrow Engine Company recommends using the same oil as used in the compressor frame when compressing sweet natural gas, although other oils may be suitable.

Just as lack of lubrication can damage the compressor, over lubrication can cause operational issues and compressor damage as well. Excessive lubrication can cause oil carryover into the gas stream and thus increase the amount of deposits in the valves and gas passages. Valve plate breakage and packing failure are symptoms of over lubrication. The excessive lubrication will force the packing rings to lift off the rod just enough to form a leak path. Increased gas leakage results in packing and rod over heating.

If symptoms indicate lack of lubrication; first verify that the cylinder lubrication pumps are operating properly, confirm that the distribution block cycle time matches cycle times shown in section 6.10.2, Divider Blocks. Double check all tubing and fittings making sure they are tight and no leakage is present. Do not forget to check the fittings inside the compressor frame.

To set the proper cylinder lubrication pump flow rate, the cycle time indicator on the distribution block is to be observed. Time the cycle from flash to flash as observed on the magnetic cycle indicator assembly.

NOTE: The pumps can become inconsistent when set too low. When adjusting the cylinder lubrication pump, set for the appropriate cycle time, DO NOT set the pumps at too low a flow rate.

The cylinder lubrication pumps should be able to deliver twice the normal required lube rate for the break-in period. Read the information on lubricators provided in this manual for further details.

NOTE: The lubrication recommendation given in this manual are to be used as guidelines. If the recommended lubricants or flow rates DO NOT appear to work properly, the flow rates and/or lubricant type may need to be changed. Please contact the lubricant supplier for specific lubricant recommendations.

Warranty of component failures which occur while using lubricants which do not meet these specifications mentioned in this manual will be subject to review on a case by case basis.

6.4 Lubrication System Assembly and Installation Introduction

Installation of the VRS-2 Compressor lubrication system is a detailed task that is made up of two main installation procedures , the chain drive system and the belt drive system. to help ease the installation process, we have broken down the installation procedures for the lube system into these two main procedures and their associated sub-topics and procedures that make up the entire lubrication system.

Lubrication System Installation Procedure Outline

1. **The Frame Lubrication (Chain Drive) System Installation**

- The Chain Idler Assembly
- Sprocket Alignment
- Chain Tensioner Adjustment
- Frame Oil Pump Tubing
- Oil Pressure Relief Valve Installation
- Frame Oil Strainer to Pump Tubing Assembly
- Relief Valve to Sump Tubing Assembly
- Relief Valve to Filter Inlet Tubing Assembly

2. **The Cylinder Lubrication (Belt Drive) System Installation**

- Lube Pump/Integral Bearing Shaft/Cylinder Lube Pump Mounting Flange installation
- Belt Tensioner Assembly
- Belt Tensioner Bearing
- Belt Tensioner Assembly Installation
- Idler Bearing Assembly Installation

6.4.1 Frame Lubricating System (Chain Drive) – Description

The frame lubrication system supplies oil to the internal frame running gear such as the crankshaft, connecting rods, crosshead pins and crossheads. The cylinder's lubrication originates from the cylinder lubrication system (see section 6.5 for information on Cylinder Lubrication System). Sight glass on the drive side of the frame displays the oil level in the sump. The proper oil level is when the oil is in the center of the sight glass. It is important that the oil level does NOT exceed two-thirds of the sight glass or over lubrication can occur.

Frame lubrication is drawn from the sump through the suction strainer into the oil pump that is mounted on the accessory side of the compressor frame. The pump's discharge is piped to an oil-pressure relief valve (VRC28350) used to regulate the oil pressure. Oil flows to the oil filter (VRS28310) mounted on the accessory end of the frame.

Oil then flows from the filter to the six-port manifold (VRC28120) and then to the oil slinger system (VRS28100).

Oil then travels to the crankshaft, connecting rods, and crosshead pin. Oil also flows from the six-port manifold to the crosshead guides.

6.5 Cylinder Lubrication System (Belt Drive)

6.5.1 Description

The cylinder lubrication system provides oil to the compressor cylinders and piston rod packing. The cylinders have top lubrication injection points. Oil is supplied to the suction side of the force-feed lubricator pump directly from the frame lube oil system.

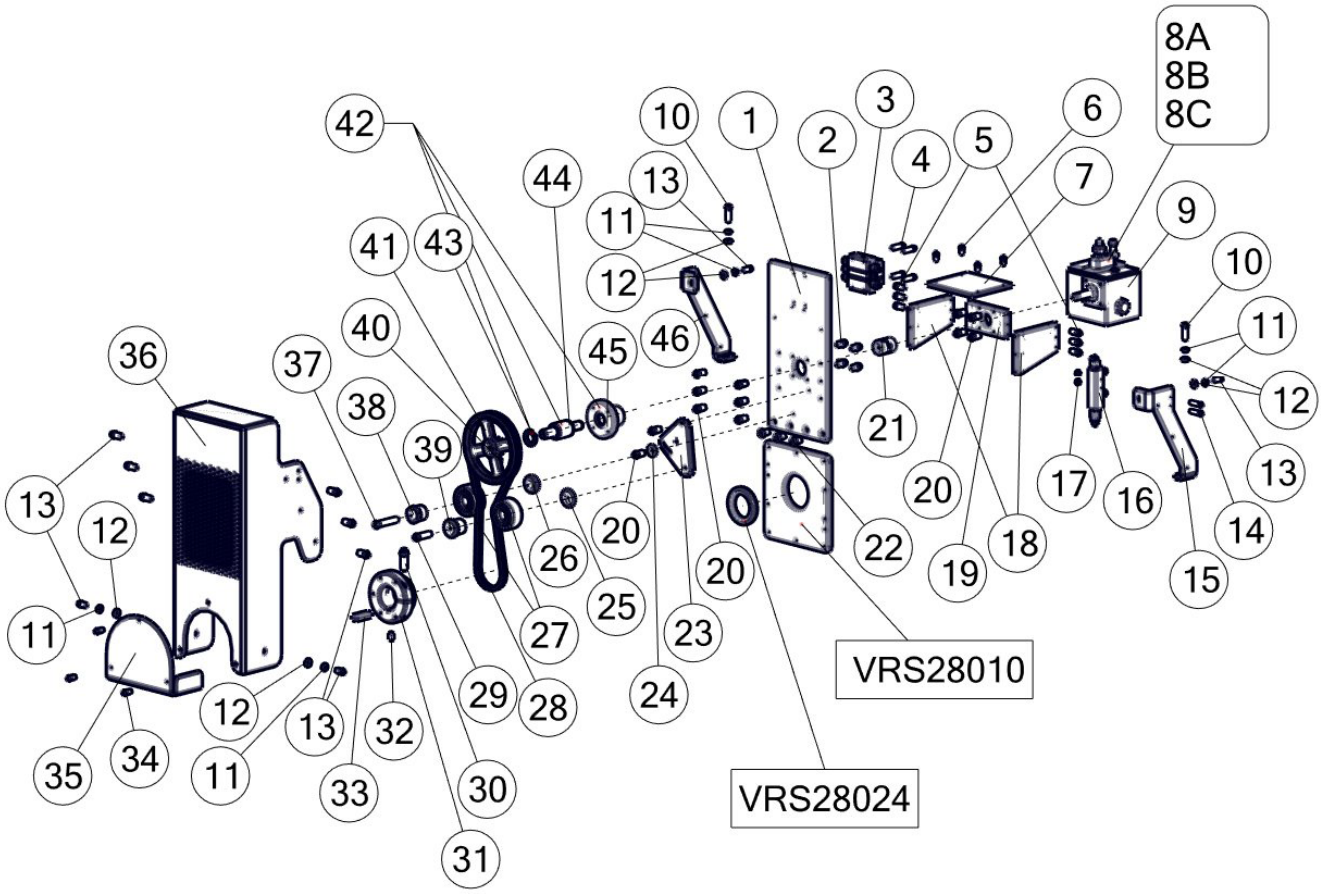
The lubricator has its own oil reservoir to lubricate the worm gear and cam. This reservoir is self-contained and is not fed by the lube oil system. The sight glass located on the reservoir side will show the oil level in the lubricator reservoir.

There is a purge port (VRC28630) check valve in the manifold in the discharge line of the force-feed lubricator pump through which the system may be primed. Next in the manifold is a overpressure indicator (VRC28610) with a blow-out disc (VRC28611). If there is any blockage within the system, the pressure build-up will rupture the disc. Venting the system through the blow-out disc will cause the no-flow shutdown switch to activate.

The oil travels to the distribution block where each of the outlets has a check valve to prevent oil from clogging the block. Here, the lubricant is allocated to provide the amounts needed to the cylinders and packing.

Some of the oil to the packing moves through to the cylinders, but the majority of it is drained out through the oil drain fitting on the bottom of the packing case and through the flexible hose assembly terminating at a fitting in the frame, and to be run to an appropriate location by others.

6.6 Lubrication System – Belt Drive

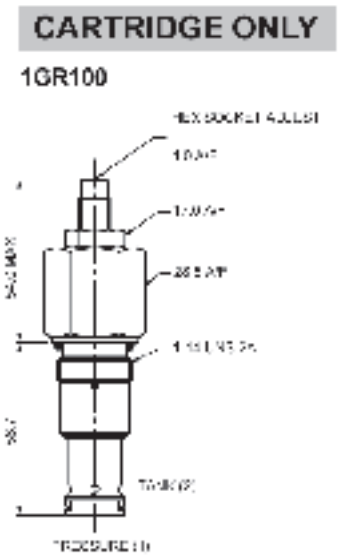


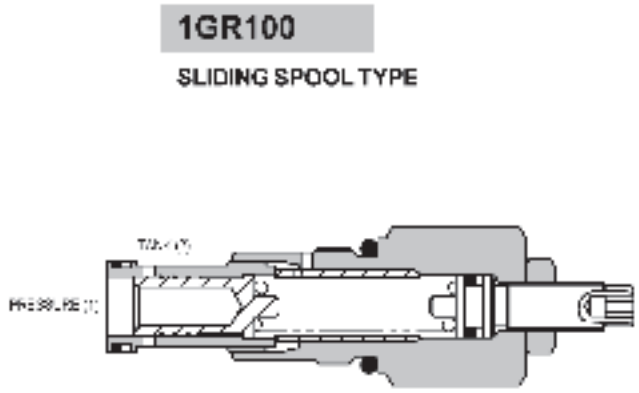
LUBRICATION SYSTEM – BELT DRIVE

ITEM NO.	PART NO.	DESCRIPTION	QTY.	REC. SPARE PARTS 6 MOS	1 YR	2 YRS
1	VRS28550	PLATE MOUNTING CYLINDER LUBE PUMP	1			
2	VRC28427	SCREW 12-POINT 3/8 - 16 X 3/4	4			
3	VRC286XX	BLOCK, DIVIDER, CYLINDER LUBE OIL **	1			
4	VRC28607	SCREW 12-POINT 1/4 - 20 X 1-1/2	4			
5	VRC21327	SCREW 12-POINT 5/16 -18 X 1	6			
6	VRC28017	SCREW 12-POINT 1/4 - 20 X 5/8	4			
7	VRC28570	PLATE, TOP, PUMP SUPPORT	1			
8A	VRC28510	PUMP, OIL, CYLINDER LUBE, 3/16" CPI	1*		1	1
8B	VRC28512	PUMP, OIL, CYLINDER LUBE, 1/4" CPI	1*		1	1
8C	VRC28514B	PUMP OIL CYLINDER LUBE 3/8" GRACO	1*		1	1
9	VRC28530B	RESERVOIR PUMP CYLINDER LUBE (WITHOUT PUMP)	1			
10	7A-5/1618X11/4	CAPSCREW HEX HEAD	2			
11	1A-5/16	LOCKWASHER PLATED	6			
12	1N-5/16	WASHER FLAT SAE PLATED	6			
13	VRC28327	SCREW 12-POINT 5/16 - 18 X 3/4	10			
14	VRC28727	SCREW SOCKET HEAD 10 - 32 X 1-1/2	2			
15	VRS28551	SUPPORT, PLATE MOUNTING RIGHT	1			
16	VRC28720	SWITCH, NO-FLOW SAFETY	1			
16A	VRC28721	SWITCH, NO-FLOW SAFETY, EXPLOSION-PROOF	1			
17	VRC28728	NUT 10-32N NYLOK	2			
18	VRC28571	PLATE, SIDE, PUMP SUPPORT	2			
19	VRC28572	PLATE, END, PUMP SUPPORT	1			
20	VRC21117	12D-3/816X1	12			
21	ASA-1653	COUPLING; L070 HUB 1/2 AND 5/8 WITH SPIDER	1			
22	12D-3/816X1	SCREW FLAT SOCKET MACH	3			
23	VRC28472	PLATE, ADJUSTING, BELT TENSIONER	1			
24	VRC28476	WASHER FLAT 3/8	1			
25	VRC28475	WASHER FLAT 1-7/8 X 13/32 X 0.041	1			
26	VRC28473	SPACER, IDLER, ECCENTRIC, BELT	1			
27	VRC28470	BEARING, IDLER AND TENSIONER, BELT	2		1	2
28	VRS28400	BELT, DRIVE, CYLINDER LUBE PUMP	1	1	1	1
29	VRC28477	SCREW 12-POINT 3/8 - 16 X 2	1			
30	VRC25017	SCREW 12-POINT 1/2 - 13 X 1-3/4	1			
31	VRS28425	SHEAVE BELT, CYLINDER LUBE PUMP	1			
32	VRC28429	SETSCREW 3/8 - 16 X 3/4 CUP PNT	1			
33	VRC21106	KEY, CRANKSHAFT, ACCESSORY-END	2			
34	9A-1/428X3/4	CAPSCREW SOCKET HEAD	3			
35	VRS28481	COVER, ACCESSORY DRIVE BELT GUARD	1			
36	VRS28480	GUARD, BELT CYLINDER LUBE PUMP	1			
37	VRS28067	SCREW, 12-POINT 3/8 - 16 X 3	1			
38	VRC28474	SLEEVE, IDLER, ECCENTRIC	1			
39	VRC28471	SLEEVE, TENSIONER, BELT	1			
40	VRC28239	SETSCREW 5/16 - 18 X 1/2 CUP PNT	1			
41	VRC28465	SHEAVE, BELT, CYLINDER LUBE PUMP	1			
42	VRC28565A	FLANGE AND INTEGRAL, BEARING SHAFT ASSEMBLY	1			1
43	VRC28583	SNAP RING H0-150, 1.660 OD	1			
44	VRC28581	BEARING, INTEGRAL, LUBE OIL PUMP	1			
45	VRC28560	FLANGE, MOUNTING, CYLINDER LUBE PUMP	1			
46	VRS28552	SUPPORT, PLATE MOUNTING LEFT	1			

* Refer to section 6.10.2, Divider Blocks, for required pump size.
** Refer to section 6.10.2, Divider Blocks, for required block part number.

6.7 Frame Oil Pressure Relief Valve (Typical*)





6.7.1 Relief Valve Specifications

RELIEF VALVE SPECIFICATIONS	
RATE FLOW	40 US GPM (150 litres/min)
MAXIMUM SETTING	600 PSI (40 bar)
CARTRIDGE MATERIAL	Working parts hardened and ground steel. External surfaces zinc-plated
BODY MATERIAL	Standard aluminium
MOUNTING POSITION	Unrestricted
TORQUE CARTRIDGE INTO CAVITY	44 ft.-lbs. (60 Nm)
WEIGHT	0.7 lbs. (0.31 kg)
RECOMMENDED FILTRATION LEVEL	BS5540/4 Class 18/13 (25 micron nominal)
OPERATION TEMPERATURE	- 4˚F (- 20˚C) to 194˚F (90˚C)
LEAKAGE	15 milliliters/min nominal
NOMINAL VISCOSITY RANGE	5 to 500 cSt

NOTE: Figures based on Oil Temperature = 140˚F (60˚C) and Viscosity = 40 cSt.

6.7.2 Relief Valve Features

The 1GR100 series relief valve is a stable and quiet operating valve. The cartridge construction give it maximum flexibility in mounting which offers good repeatability and re-seat.

6.7.3 Relief Valve Operation

The relief valve is held closed by the spring until pressure on the piston overcomes the valve setting, allowing relief flow to the tank through a ring of the radial holes.

6.7.4 Adjusting Frame Oil Pressure

Loosen the lock nut on the oil pressure relief valve (VRC28350) and move the adjusting screw upward to decrease pressure and downward to increase pressure using a 5/32” Allen wrench or hex socket.

After making the necessary adjustment, tighten the lock nut with a 11/16” wrench.

6.7.5 Lube Oil Pressure

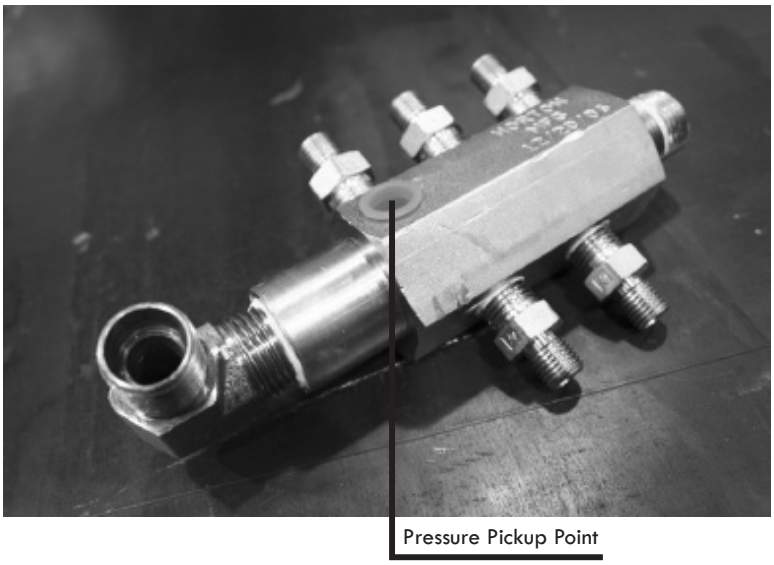
Normal pressure on the discharge side of the frame oil filter is set a the factory at 50 PSI at 1,800 RPM. If oil pressure drops below 25 PSI, find the cause immediately and correct the problem.

*These are typical specifications for the oil pressure relief valve. Various brands of valves are used, and specifications may vary slightly depending on brand provided at time of order. All valves provided have the same connections and are interchangeable.

6.7.6 Low Oil Pressure Shutdown

The low oil pressure shutdown is normally mounted by the packager and is supplied to the customers specifications. Arrow Engine provides an oil pressure pickup point on the six-port manifold (VRC28120).

The compressor must have a working low oil pressure shutdown.



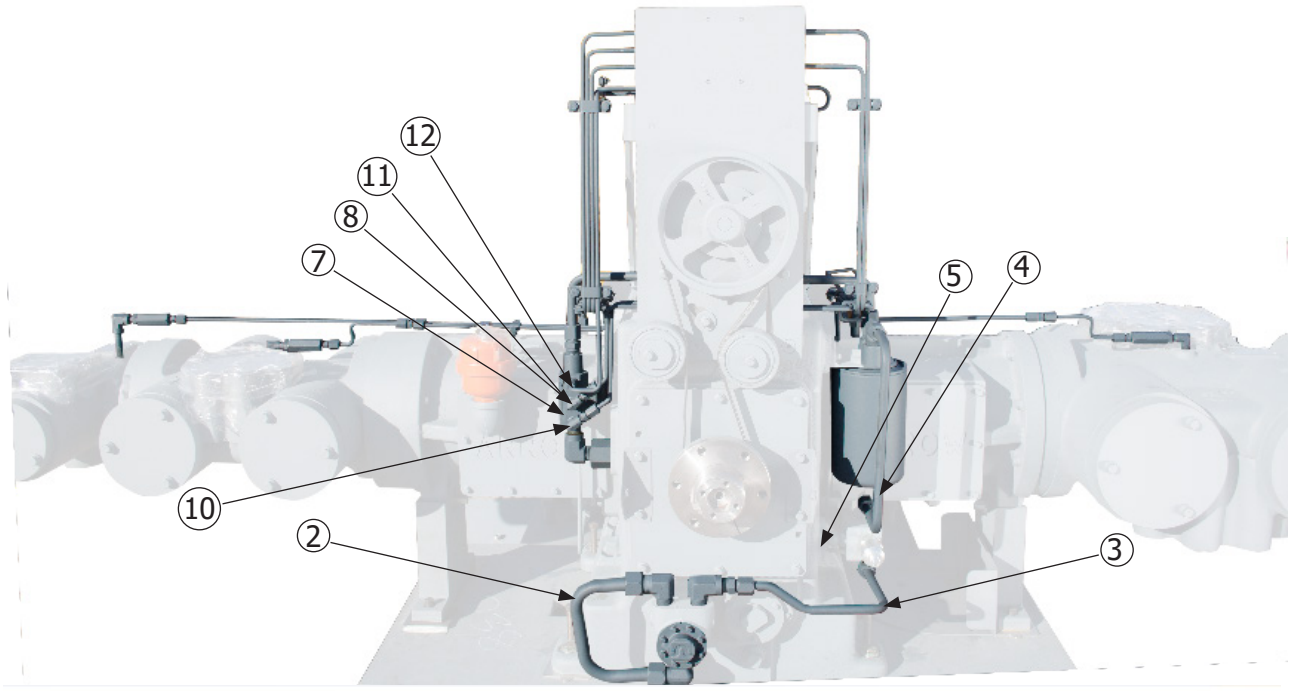
IMPORTANT*:* Never attempt to add oil to the frame through the breather hole while the compressor is running. This will cause oil foaming and unnecessary no flow shutdowns in the force-feed lubrication system.

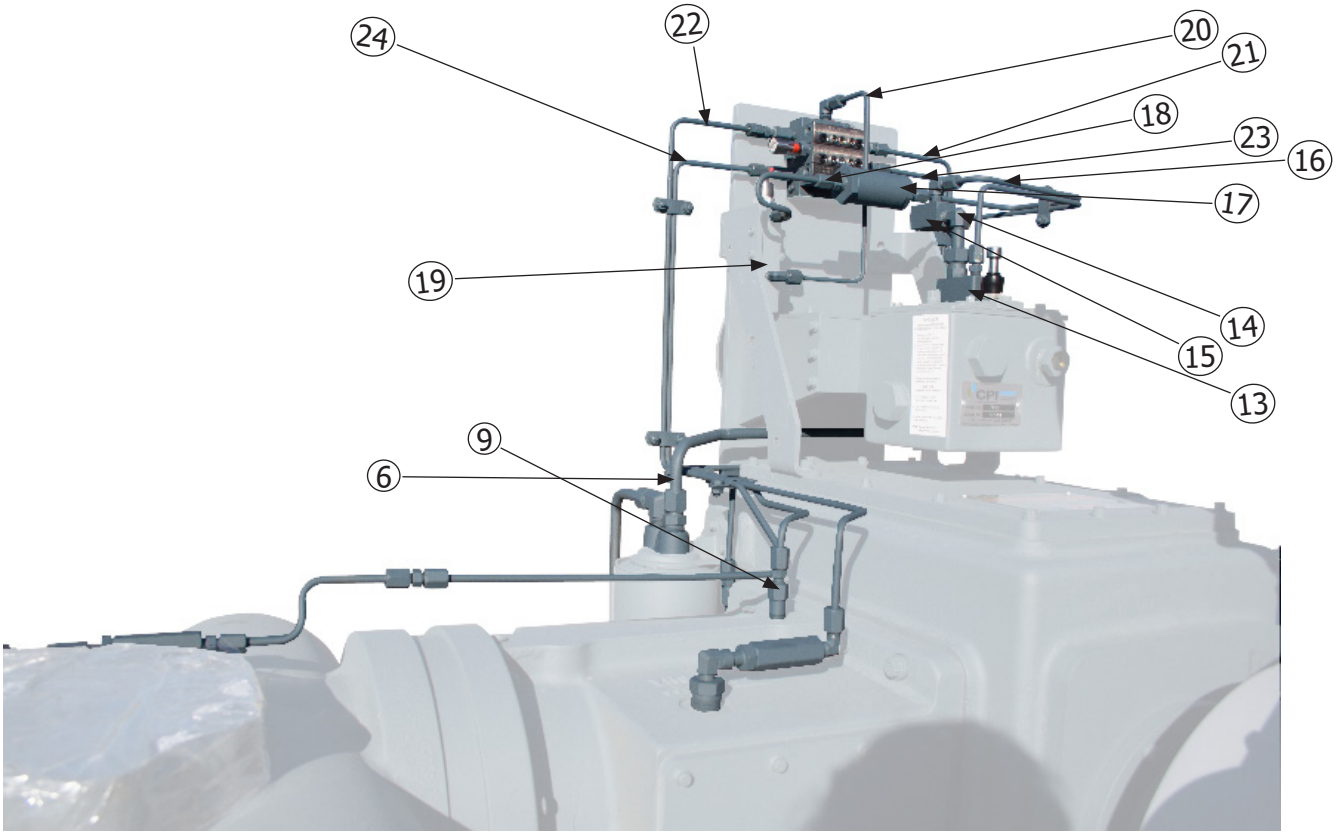
Because the cylinder lubrication system is constantly using oil from the frame, a working frame oil level controller is necessary. This must be designed to allow oil travel into the frame from an overhead tank at all ambient temperature conditions.

NOTE: The cylinder lube system must have a blow-out disc between the cylinder lubricator and the no-flow shutdown. The cylinder lube system must have a no-flow shutdown. (These are normally provided with Arrow compressors.)

Shutdown must be enabled to activate within three to five minutes after disruption of lubrication flow.

6.8 Tubing and Distance Piece Venting





LUBRICATION SYSTEM TUBING			
	PART NO.	**DESCRIPTION**	**QTY.**
1	VRS28800A	TUBING AND FITTINGS KIT COMPLETE	1
1A	VRC28802	CLAMP, TUBING, 2 TUBE (WITH SCREWS AND NUTS)	4
1B	VRC28803	CLAMP, TUBING, 3 TUBE (WITH SCREWS AND NUTS)	4
1C	VRC28804	CLAMP, TUBING, 4 TUBE (WITH SCREWS AND NUTS)	1
2	VRS28810A	TUBING ASSEMBLY, STRAINER TO PUMP	1
2A	VRC28871	FITTING, 1/2" 14 NPT × 3/4" TUBE 90	2
2B	VRS28875-13.2	TUBING, 3/4" 304SS, 13.2" LONG	1
3	VRS28801A	TUBING ASSEMBLY, PUMP TO RV	1
3A	VRS28854	FITTING, 1/2" MNPT X 1/2" FNPT TUBE 90	1
3B	VRC28851	FITTING, 1/2" 14NPT X 1/2" TUBE STR.	1
3C	VRS28850-14.9	TUBING, 1/2" 304SS, 14.9" LONG	1
3D	VRC28815	FITTING, 3/4" 16SAE O-RING X 1/2" TUBE 90	1
4	VRS28811A	TUBING ASSEMBLY, RV TO FILTER INLET	1
4A	VRC28815	FITTING, 3/4" 16SAE O-RING X 1/2" TUBE 90	1
4B	VRS28850-18.7	TUBING, 1/2" 304SS, 18.7" LONG	1
4C	VRC28853	FITTING, 1/2" 14NPT X 1/2" TUBE 90	1
5	VRS28812A	TUBING ASSEMBLY, RV TO SUMP	1
5A	VRC28801	FITTING, 1/2" 14NPTF X 3/4" 16SAE O-RING	1
6	VRS28813A	TUBING ASSEMBLY, FILTER OUTLET TO 6 PORT MANIFOLD	1
6A	VRC28851	FITTING, 1/2" 14NPT X 1/2" TUBE STR.	2
6B	VRS28850-23.3	TUBING, 1/2" 304SS, 23.3" LONG	1
7	VRC28120	MANIFOLD, 6 PORT, CUSTOM	1
7A	VRS28854	FITTING, 1/2" MNPT X 1/2" FNPT TUBE 90	1
8	VRS28830A	TUBING ASSEMBLY, #2 PORT TO THROW 1 CROSSHEAD, TOP	1
8A	VRC28866	FITTING, 1/8" NPTF X 1/4" NPTM 90	1
8B	VRC28823	FITTING, 1/8" 27NPT X 1/4" TUBE STR.	2
8C	VRS28825-38.6	TUBING, 1/4" 304SS, 38.6" LONG	1
8D	VRC28835	FITTING, ORIFICE, .094"	1
9	VRS28831A	TUBING ASSEMBLY, #4 PORT TO THROW 2 CROSSHEAD TOP	1
9A	VRC28866	FITTING, 1/8" NPTF X 1/4" NPTM 90	1
9B	VRC28823	FITTING, 1/8" 27NPT X 1/4" TUBE STR.	2
9C	VRS28825-14.8	TUBING, 1/4" 304SS, 14.8" LONG	1
9D	VRC28823	FITTING, 1/8" 27NPT X 1/4" TUBE STR.	2
9E	VRC28835	FITTING, ORIFICE, .094"	1

LUBRICATION SYSTEM TUBING			
	PART NO.	**DESCRIPTION**	**QTY.**
10	VRS28832A	TUBING ASSEMBLY, #1 PORT TO CYLINDER LUBE PUMP	1
10B	VRC28821	FITTING, 1/4" 18NPT X 1/4" TUBE STR.	1
10C	VRC28890	FITTING, CHECK VALVE	1
10D	VRS28825-36.3	TUBING, 1/4" 304SS, 36.3" LONG	1
10E	VRC28823	FITTING, 1/8" 27NPT X 1/4" TUBE STR.	1
11	VRS28833A	TUBING ASSEMBLY, #5 PORT TO THROW 2 CROSSHEAD BOTTOM	1
11A	VRC28826	FITTING, 1/4" 18NPT X 1/4" TUBE 90	1
11B	VRS28825-16.9	TUBING, 1/4" 304SS, 16.9" LONG	1
11C	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1
11D	VRC28835	FITTING, ORIFICE, .094"	1
12	VRS28834A	TUBING ASSEMBLY, #3 PORT TO THROW 1 CROSSHEAD BOTTOM	1
12A	VRC28866	FITTING, 1/8" NPTF X 1/4" NPTM 90	1
12B	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1
12C	VRS28825-34.0	TUBING, 1/4" 304SS, 34.0" LONG	1
12D	VRC28827	FITTING, UNION 1/4" X 1/4" TUBE STR.	1
12E	VRS28825-21.0	TUBING, 1/4" 304SS, 21.0" LONG	1
12F	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1
12G	VRC28835	FITTING, ORIFICE, .094"	1
13	VRC285XX*	PUMP, OIL, CYLINDER LUBE (SEE SECTION 6.6 FOR PUMPS AVAILABLE AND SECTION 6.10.2 FOR SIZE REQUIRED)	1
14	VRC28847	FITTING, MANIFOLD 1/8" 27NPTM X 1/4" 18NPTM 90	1
15	VRC28640	MANIFOLD, LUBE PUMP, CUSTOM	1
16	VRS28840A	TUBING ASSEMBLY, LUBE PUMP MANIFOLD TO IN-LINE FILTER	1
16A	VRC28826	FITTING, 1/4" 18NPT X 1/4" TUBE 90	1
16B	VRS28825-18.0	TUBING, 1/4" 304SS, 18.0" LONG	1
16C	VRC28821	FITTING, 1/4" 18NPT X 1/4" TUBE STR.	1
17	VRC28710*	FILTER, LUBE OIL, IN-LINE, 10 MICRON	1
17A	VRC28711*	ELEMENT, FILTER, 10 MICRON	1
*Part is NOT included in the "Tubing and Fittings Complete" kit. Part must be ordered separately.			

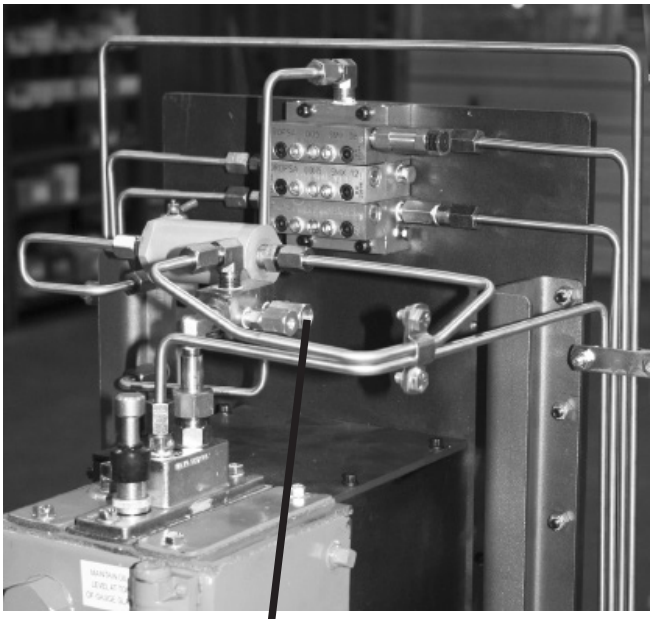
LUBRICATION SYSTEM TUBING			
	PART NO.	**DESCRIPTION**	**QTY.**
18	VRS28841A	TUBING ASSEMBLY, IN-LINE FILTER TO NO-FLOW SWITCH	1
18A	VRC28821	FITTING, 1/4" 18NPT X 1/4" TUBE STR.	1
18B	VRS28825-10.0	TUBING, 1/4" 304SS, 10.0" LONG	1
18C	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1
19	VRC28720*	SWITCH, NO-FLOW SAFETY	1
20	VRS28842A	TUBING ASSEMBLY, NO-FLOW SWITCH TO DIVIDER BLOCK	1
20A	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1
20B	VRS28825-17.0	TUBING, 1/4" 304SS,17.0" LONG	1
20C	VRC28826	FITTING, 1/4" NPT X 1/4" TUBE 90	1
21	VRS28860A	TUBING ASSEMBLY, DIVIDER BLOCK TO THROW 2 CYLINDER	1
21A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	2
21B	VRS28825-47.0	TUBING, 1/4" 304SS, 47.0" LONG	1
21C	VRC28827	FITTING, UNION 1/4" X 1/4" TUBE STR.	1
21D	VRS28825-8.0	TUBING, 1/4" 304SS, 8.0" LONG	1
21E	VRC28730*	VALVE, CHECK, LUBE OIL, 1/8" NPT	1
21F	VRC28866	FITTING, 1/8" NPTF X 1/4" NPTM 90	1
22	VRS28861A	TUBING ASSEMBLY, DIVIDER BLOCK TO THROW 1 CYLINDER	1
22A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	2
22B	VRS28825-39.0	TUBING, 1/4" 304SS, 39.0" LONG	1
22C	VRC28827	FITTING, UNION 1/4" X 1/4" TUBE STR.	1
22D	VRS28825-8.0	TUBING, 1/4" 304SS, 8.0" LONG	1
22E	VRC28730*	VALVE, CHECK, LUBE OIL, 1/8" NPT	1
22F	VRC28866	FITTING, 1/8" NPTF X 1/4" NPTM 90	1
23	VRS28862A	TUBING ASSEMBLY, DIVIDER BLOCK TO PACKING LUBE, THROW 2	1
23A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1
23B	VRS28825-28.0	TUBING, 1/4" 304SS, 28.0" LONG	1
23C	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1
23D	VRC28730*	VALVE, CHECK, LUBE OIL, 1/8" NPT	1
23E	VRC28867	FITTING, 1/8" NPTF X 1/8" NPTM 90	1
23F	VRC28876	FITTING, PACKING, CUSTOM 1/2" 14NPT X 7/16-20	1
23G	VRS28877	HOSE, FLEX ASSEMBLY , PACKING LUBE	1
23H	VRS28878	FITTING, HOSE TO PACKING, 7/16" JICM X 1/8"NPTM STR.	1
*Part is NOT included in "Tubing and Fittings Complete" kit. Part must be ordered separately.			

LUBRICATION SYSTEM TUBING

NO.		PART NO.	DESCRIPTION	QTY.
	24	VRS28863A	TUBING ASSEMBLY, DIVIDER BLOCK TO PACKING LUBE THROW 1	1
VRC28863A	24A	VRC28823	FITTING, 1/8" NPT × 1/4" TUBE STR.	2
	24B	VRS28825-49	TUBING, 1/4" 304SS, 49" LONG	1
	24C	VRC28730*	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1
	24D	VRC28867	FITTING, 1/8" NPTF × 1/8" NPTM 90	1
	24E	VRC28876	FITTING, PACKING, CUSTOM 1/2" 14 NPT × 7/16-20	1
	24F	VRS28877	HOSE, FLEX ASSEMBLY, PACKING LUBE	1
	24G	VRS28878	FITTING, HOSE TO PACKING, 7/16" JICM x 1/8" NPTM STR.	1
	25	VRS28870A	TUBING ASSY., PACKING VENT, THROW 1 AND 2 (NOT SHOWN)	2
VRC28870A	25A	VRS28878	FITTING, HOSE TO PACKING, 7/16" JICM x 1/8" NPTM STR.	2
	25B	VRS28887	HOSE, FLEX ASSEMBLY, PACKING	2
	25C	VRC28876	FITTING, PACKING, CUSTOM 1/2" 14 NPT x 7/16-20	2
	26	VRS28880A	ASSEMBLY, DISTANCE PIECE VENT, THROW 1 AND 2	2
	26A	VRC28839	FITTING, REDUCER BUSHING, 1/4" 18 M × 1/8" 27 F (NOT SHOWN)	2
	26B	VRC28888	CAP, VENT (NOT SHOWN)	2
	26C	VRC28826	FITTING, 1/4" NPT x 1/4" TUBE 90	2
	27	VRC28610*	INDICATOR, OVERPRESSURE, LUBE OIL (NOT SHOWN)	1
	27A	VRC28611*	DISC, RUPTURE, OVERPRESSURE (2350 PSI) (MAY BE ORDERED SEPARATELY)	1
28		VRC28630*	PORT, PURGE, 1/8" NPT (SEE SECTION 6.9)	1

* Part is NOT included in the "Tubing and Fittings Complete" kit. Part must be ordered separately.

6.9 Filling and Operating the Lubrication System

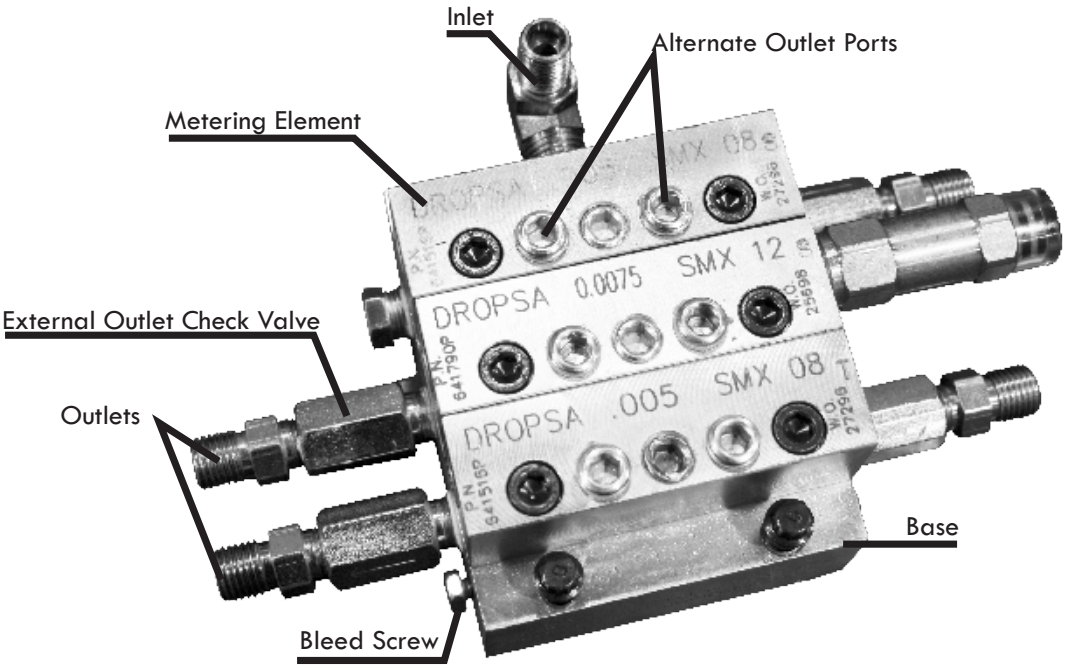


1. Loosen tubing connection at the inlet and all outlets of the divider block.
2. Install a hand priming pump (VRC29480) into the purge port check valve at the pump outlet.
3. Operate the hand priming pump until clean air free lubricant appears at the inlet of the divider valve. Then re-tighten the tubing connection at the inlet and operate the hand priming pump to purge air from the divider valve. When air free lubricant is observed at all outlets re-tighten tube connections.

NOTE: When operating hand priming pump (steps 1-3) gauge pressure should not exceed 300-500 PSI unless you encounter air pockets which will increase pressure. Once air is expelled, the gauge should drop back.

4. Loosen tubing connections at all injection point check valves.
5. Operate the hand priming pump until clean air free lubricant appears at the inlet of all injection point check valves. Then retighten all tubing connections at all injection point check valves.
6. Remove hand priming pump from purge port check valve at the lubricator pump outlet.
7. It is necessary to prime the lubricator pump before the oil line from the day tank or crankcase is connected. Clean air free lubricant must be observed at the pump inlet.
8. Fill the lubricator reservoir with oil to 1" from top of gauge glass (Do not fill to top). This oil is used to lubricate the internal parts only. Occasionally oil level will increase due to seepage from pump which is not uncommon; when the reservoir level is observed near the top of the gauge glass remove drain plug and drop level.
9. The system should now be completely filled with clean air free lubricant and ready for start-up.

6.10 Divider Block



6.10.1 Divider Block Overview

The divider block is made up of three valve blocks fastened to a section of the base plate. O-rings are used to seal the valve blocks and the base plate and base plate sections. The divider valves are used in a single line progressive lubrication system that distributes lubrication.

Check valves at the inlets of all lube points should be installed.

Metering pistons contained within the valve blocks release a set amount of lubricant with each cycle. These valve blocks can be single or twin. Outlets must be plugged if not used when singling or cross porting.

The use of a by-pass block maybe used on the base plate. This allows the addition or deletion of lubrication points without disconnecting or disturbing any lubrication system tubing. When using a by-pass block, both outlets must be plugged.

The valve and by-pass blocks are attached to the base plate which sets on the piece of equipment needing to be lubricated. The base plate contains divider block's inlet and outlet connections, interconnected pathways and built-in check valves. Lubricant piping both to and from the divider valve is connected to the base plate.

The base plate consists of one inlet block, three intermediate blocks, one end block and three tie rods. The gasket plate seals are included with the base plate segments. The valve block capacity of each base plate is dependent upon the number of intermediate blocks in the base plate. There must be a minimum of three working valves on each valve and base plate assembly.

6.10.2 Divider Block Technical Data and Cycle Time

DIVIDER BLOCKS		
PART NO.	**DESCRIPTION**	**QTY.**
SINGLE STAGE/ SINGLE CYLINDER		
VRC28614	BLOCK, DIVIDER, 1 STAGE, 1 CYLINDER, 2.25-4.0 USE WITH 3/16" PUMP VRC28510 @ 1.5 PINTS/DAY CYCLE TIME 60 SEC.	1
SINGLE STAGE		
VRC28602	BLOCK, DIVIDER, 1 (or 2) STG, 2.5-4.0 USE WITH 3/16" PUMP VRC28510 @ 3.6 PINTS/DAY CYCLE TIME 25 SEC.	1
VRC28603	BLOCK DIVIDER 1 STG, 4.5-6.0 USE WITH 1/4" PUMP VRC28512 @ 4.8 PINTS/DAY CYCLE TIME 25 SEC.	1
VRC28604	BLOCK DIVIDER 1 STG, 6.5-8.0 USE WITH 1/4" PUMP VRC28512 @ 6.0 PINTS/DAY CYCLE TIME 25 SEC.	1
VRC28613	BLOCK DIVIDER 1 STG, 9.5-10.0 USE WITH 3/8" PUMP VRC28514 @ 7.5 PINTS/DAY CYCLE TIME 24 SEC.	1
TWO STAGE		
VRC28602	BLOCK, DIVIDER, 2 (OR 1) STG 3.0-4.5 × 2.5-4.0 USE WITH 3/16" PUMP VRC28510 @ 3.6 PINTS/DAY CYCLE TIME 25 SEC.	1
VRC28600	BLOCK, DIVIDER, 2 STG, 4.5-6.5 × 2.5-5.0 USE WITH 1/4" PUMP VRC28512 @ 4.76 PINTS/DAY CYCLE TIME 22 SEC.	1
VRC28605	BLOCK, DIVIDER, 2 STG. 6.5-8.0 × 3.5-6.5 USE WITH 1/4" PUMP VRC28512 @ 5.85 PINTS/DAY CYCLE TIME 22 SEC.	1
VRC28616	BLOCK, DIVIDER, 2 STG, 9.5-10.0 x 4.5-6.0 USE WITH PUMP 1/4" VRC28512 @ 6.0 PINTS/DAYS CYCLE TIME 30 SEC.	
VRC28617	BLOCK, DIVIDER, 2 STG, 9.5-10.0 X 6.5-8.0 USE WITH 3/8" PUMP VRC28514 @ 7.2 PINTS/DAYS CYCLE TIMES 22 SEC.	
THREE STAGE		
VRC28606	BLOCK, DIVIDER, 3 STG, 3.5-5.5 × 3.5-4.5/2.25-2.50HP WITH 1/4" PUMP VRC28512 @ 5.20 PINTS/DAY CYCLE TIME 37 SEC. *	1
VRC28608	BLOCK, DIVIDER, 3 STG 4.0-6.5 × 3.5-5.0/2.25-3.5 USE WITH 3/8" PUMP VRC28514 @ 6.12 PINTS/DAY CYCLE TIME 22 SEC.	1
VRC28609	BLOCK, DIVIDER, 3 STG 5.5-7.0 × 4.5-6.0/3.0-3.5 USE WITH 3/8" PUMP VRC28514 @ 6.8 PINTS/DAY CYCLE TIME 24 SEC.	1
VRC28601	BLOCK, DIVIDER, 3 STG 7.0-8.0 × 5.0-7.0/3.0-4.5 USE WITH 3/8" PUMP VRC28514 @ 7.50 PINTS/DAY CYCLE TIME 20 SEC.	1
VRC28618	BLOCK, DIVIDER, 3 STG, 9.5-10.0 X 3.5-5.0 / 2.25-4.5 USE WITH 3/8" PUMP VRC28514 @ 7.5 PINTS/DAYS CYCLE TIMES 24 SEC.	
VRC28619	BLOCK, DIVIDER, 3 STG, 9.5-10.0 X 5.5-7.0 / 2.25-4.5 USE WITH 3/8" PUMP VRC28514 @ 8.25 PINTS/DAYS CYCLE TIMES 24 SEC.	
FOUR STAGE		
VRC28612	BLOCK, DIVIDER, 4 STG, 6.5-7.0 / 4.0-4.5 X 3.5-4.0 / 2.25 USE WITH 3/8" PUMP VRC28514 @ 9.69 PINTS/DAYS CYCLE TIMES 29 SEC.	

* High-pressure system is used when discharge pressure is > 1200PSI and requires 5 balancing valves, part number VRC28615.

6.11 Cylinder Lubrication (Belt Drive) System Running Conditions

1. Using the sight glass, check the oil level in the lubricator reservoir. The lubricator reservoir is used to lubricate the worm gear and cam. IT DOES NOT FLOW THROUGH THE SYSTEM. Only add oil if the sight glass indicates low oil in the reservoir.
2. If the piping has been removed or if the lube system has been drained, fill and prime the system through the 1/8" NPT connection end located in the lube pump manifold (VRC28640). Priming the force-feed lubrication system requires the use of a priming pump (VRC29480).
3. If the unit has been overhauled, it is important to adjust the lubricator for maximum lubricant distribution.

The following steps will guide you through the process of adjusting the lubricator:

- Loosen the adjusting screw locknut.
- Turn the plunger stroke adjustment screw to the full upward position.
- Tighten the adjusting screw locknut.
- Proper feed rate may be set after the compressor is started.

4. The operator may choose to use a gear oil in the reservoir instead of the 30-weight oil provided by the manufacturer. Gear oils reduce noise and increase the longevity of the pump.

NOTE: Gear oil is optional. It is NOT a requirement.

5. When the compressor is running, make sure the oil level in the lubricator reservoir is at the designated sight glass.

NOTE: See your packager's specific data to determine the normal operating conditions, the cylinder working pressures, and the rated speed.

6.12 Lubrication System Troubleshooting

Pump does not discharge lubricant	
Possible Causes	**Possible Solutions**
Crankcase oil starving pump suction	Check crankcase oil pump and/or blockage in line to lubricating pump.
Empty Day Tank	Fill day tank.
Air entrapment within pump	Make certain that clean air free lubricant can be observed at the pump inlet. This should be done prior to the oil line from the day tank or crankcase is connected.
Defective pump	Replace pump.

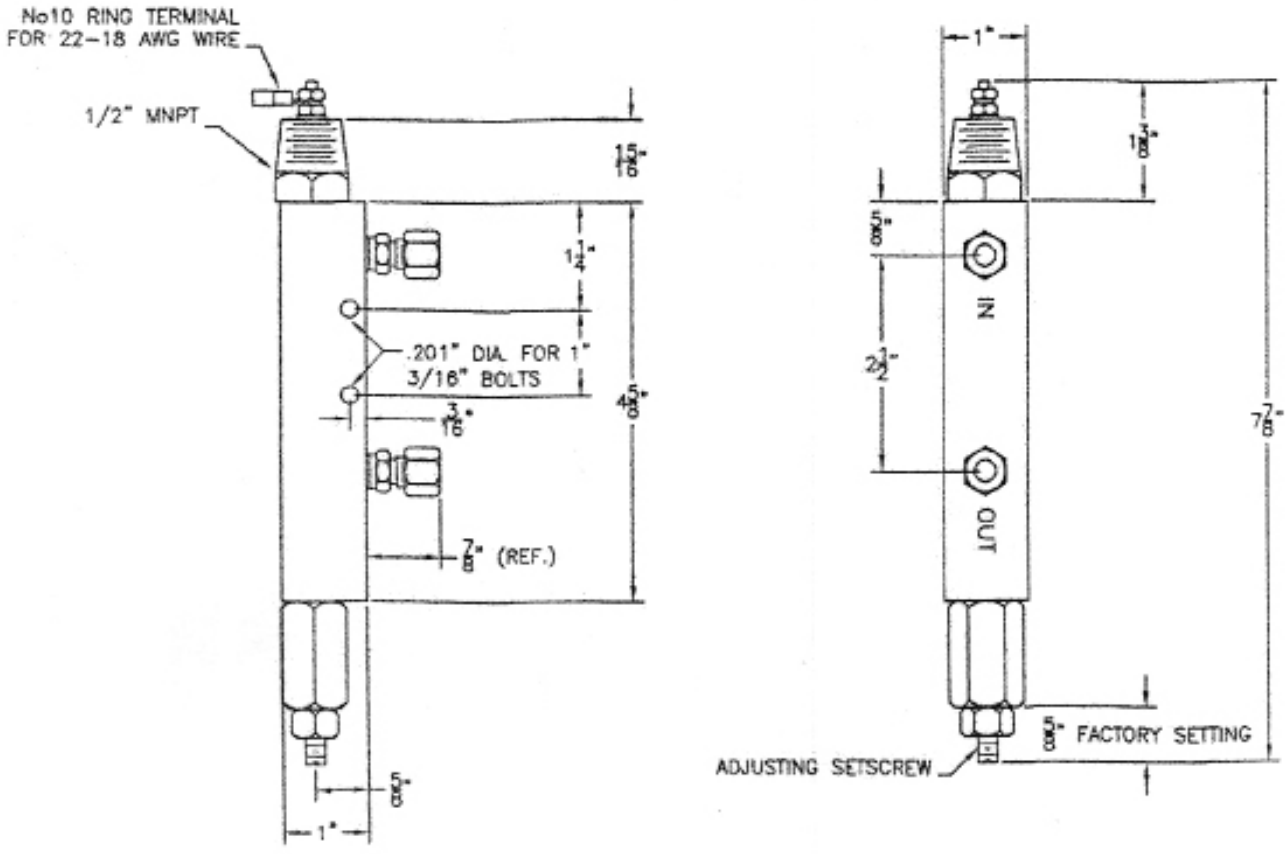
Divider block does not cycle or operates at erratic pressures	
Possible Causes	**Possible Solutions**
Contaminated or trapped air	Operate the hand priming pump until clean, air free lubricant appears at the inlet of the divider valve. Then retighten the tubing connection at the inlet and operate the hand priming pump to purge air from the divider valve. When air free lubricant is observed at all outlets retighten tube connections.
Stuck piston within divider block	Pressure gauge should not exceed 300-500 PSI.
	Replace divider block metering element.

Divider block repeatedly ruptures disc	
Possible Causes	**Possible Solutions**
Blocked or crushed line downstream	Replace line as necessary.
Defective injection point check valve	Replace check valve.
Rupture disc over tightened	Torque nut to 36 in/lbs. max. DO NOT OVER TIGHTEN. If a torque wrench is not available, hand tighten, then tighten 1/8th turn with a wrench. Use a backup wrench when installing return fitting.
Clogged lube filter	Clean or replace filter element.
Trapped air	Operate the hand priming pump until clean, air free lubricant appears at the inlet of the divider block. Then retighten the tubing connection at the inlet and operate the hand priming pump to purge air from the divider valve. When air free lubricant is observed at all outlets retighten tube connections.

6.13 Locating Blockage

1. Check to ensure all twin elements "T" have two outlets in base and all single elements "S" have one outlet and one pipe plug in base.
2. Loosen tube connection at inlet and install a hand priming pump. Operate hand priming pump to dispel contamination of air. If necessary loosen (DO NOT REMOVE) the two bleed screws on each side of the modular base farthest from the inlet.
3. If high-pressure continues, remove (one at a time) each alternate outlet plug, which is common to an outlet port in the base. If the pressure gauge drops and the divider block cycles freely after the plug is removed, the blockage is downstream of that individual outlet. If the pressure remains high when pumping oil with all alternate outlet plugs removed, the blockage is within the divider block.

6.14 No-flow Switch



IMPORTANT: The No-flow switch must be mounted terminal end up with a minimum angle of 20° off horizontal to prevent condensation around the switch contact.

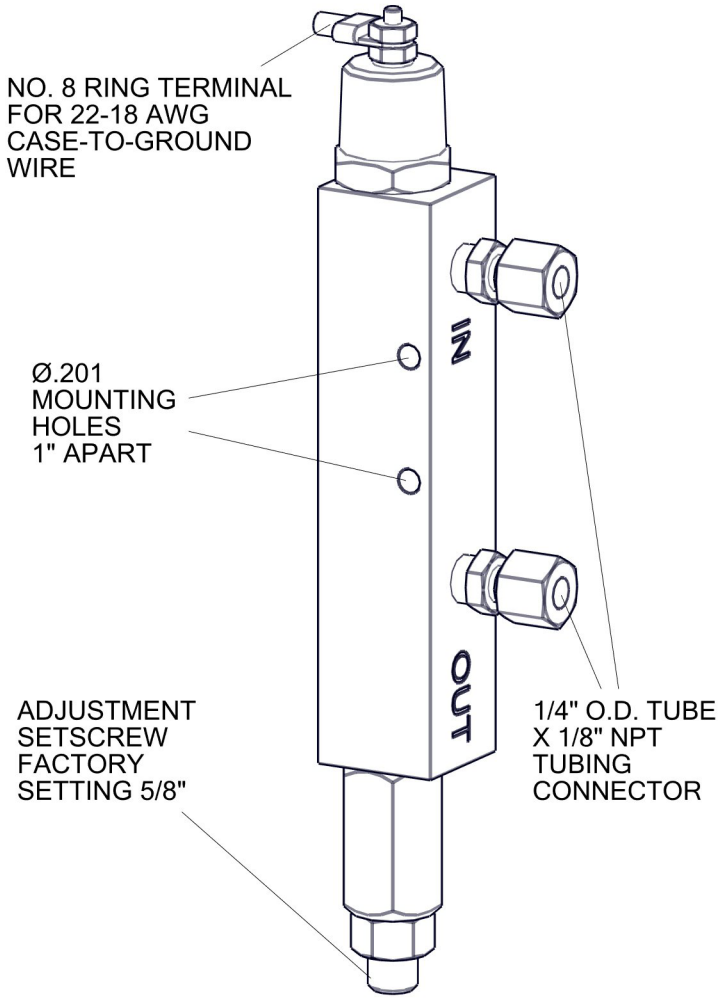
6.14.1 No-flow Switch Overview

The No-flow Switch mounts in the line between the lubricator and the cylinder. Oil flow is through the switch-forcing the plunger off its contact. Its rate of travel is controlled by fluid slippage past the precision- fit plunger, preventing premature shutdown. If the lubricator stops pumping, the plunger will drift to the contact and stop the engine. On start-up, the first stroke of the lubricator automatically opens the switch. In operation the plunger can pump out of its hole on high feed rates and does not obstruct flow. The time interval between lubrication failure and shutdown can be adjusted by increasing or decreasing the compression on the spring.

The switch is available with an overpressure rupture assembly which will instantaneously bleed off and stop the engine in the event the lube-line check-valve plugs. The standard rupture disc fails at 1750 PSI. The explosion-proof switch has been tested to 5,000 PSI and its recommended working pressure is 8,600 PSI.

6.14.2 No-flow Switch Installation

1. The no-flow switch must be mounted either vertically (terminal end upward) or at a minimum angle of 20° off horizontal with the terminal end at the high point. This prevents water from accumulating around the switch contact.



2. A 25 micron sintered bronze or similar in-line type filter should be installed ahead of the no-flow switch. These are available from Arrow or most manufactures of lubricators.

3. To assure constant oil viscosity, mount the switch in a warm place near the cylinder lube-line check valve or point of lubrication.

4. Connect line from the lubricator to the inlet port on the no-flow switch.

5. Hand pump the lubricator until oil flows from the outlet port; then connect the line from the outlet to the point of lubrication.

6. The no-flow switch is factory adjusted for a shutdown time of approximately 3 minutes using SAE 30 oil at 100°F (38°C). The switch is viscosity sensitive, therefore, shutdown time will vary with oil viscosity. Many compressor manufacturers indicate that 10-15 minutes operations after cessation of lubricant flow is acceptable so it should NOT be necessary to make seasonal adjustments.

7. If adjustments are necessary, ensure that the adjustments are made while the compressor and no-flow switch are at their normal operating conditions. The adjustment setscrew is located on the bottom of the switch housing.

Turn the setscrew IN to decrease shutdown time and OUT to increase shutdown time. Shutdown time can be determined by removing or disabling the lubricator pumping unit.

On the multiple pump installations pumping at the same rate, the setting can usually be transferred from one switch to another by making the distance from the end of the adjustment setscrew to the end of the adjustment set screw housing equal on all switches.

7 RECOMMENDED MAINTENANCE

7.1 Suggested Maintenance Intervals

Keeping any equipment running and operating correctly and efficiently requires regular maintenance, Arrow compressors are no different. The frequency of maintenance depends upon the environment in which the compressor is operating, the work load that is required as well as the cleanliness of the gas the compressor is compressing.

IMPORTANT: The primary item to be completed first on the preventative maintenance list is to be compliant to Arrow Engine's and the packager's compressor start-up checklist (see "Compressor Start-up Checklist").

All items listed to be done on this checklist must be followed before and after start-up.

This section serves only as a guide as to Arrow's recommended maintenance to keep your compressor running efficiently and at peak performance. Conditions may vary and so your maintenance time lines and intervals may be different or change due to environmental condition at your location.

Maintenance time intervals start from the date and time of initial start-up of the compressor. If your oil supplier's recommended oil service changes are more frequent than Arrow's recommendations, the supplier's maintenance intervals should be followed. Regular oil analysis is recommended. If problems develop, the oil should be changed immediately and the cause of the problem should be investigated and solved.

It is a good idea to keep a maintenance log book for the compressor or compressors if you have more than one at a location. Every maintenance item should be recorded with exact detail in order to have a good history as to what was done and for tracking maintenance issues and costs.

Check lubricator block cycle pin indicator. Refer to the information plate on the side of the lubricator reservoir or section 6.10.2, Divider Blocks. These logs should be reviewed by qualified personnel to determine performance and maintenance trends of the compressor.

7.2 Daily Maintenance Requirements

1. Check frame oil pressure. It should be 50 to 60 PSIG when at operating temperature. Compressor inlet oil temperature is 250°F (121°C) maximum.
2. Check frame oil level. Oil level should be seen in the sight glass. If you can not see oil in the sight glass determine the cause and correct the problem. If oil needs to be added, be sure you add the correct weighted oil and be careful not to overfill.
3. Check lubricator block cycle pin indicator. Refer to the information plate on the side of the lubricator reservoir or section 6.10.2, Divider Blocks, for correct cycle time.

NOTE: Very dirty or wet gas may require a more frequent cycle time than normal.

4. Check primary and secondary packing vents for blowing. If excessive blowing is occurring, determine the cause and replace the packing if necessary.
5. Check for any gas leaks. Correct immediately if any gas leaks are found.
6. Check and correct any oil leaks.
7. Check operating pressures and temperatures. If abnormalities exist, investigate and correct the problems. It is recommended that a daily operating temperature log be maintained and available for reference.
8. Check shutdown set points.
9. Low oil pressure shutdown is to be set at 25 PSI minimum.
10. The high cylinder discharge temperature shutdown is to be set within 25°F (-4°C) of the actual operating temperature. It is NOT to exceed 350°F (177° C).
11. High-low pressure shutdowns set as close as practical. Rod load capacity of the compressor should be taken into consideration.
12. Check lubricator reservoir oil level.
13. Check for any unusual noises or vibrations.

Monthly Maintenance Requirements

In addition to the daily maintenance requirements, check and confirm safety shutdown functions.

7.2.1 Six-month or 4,000 Hours Maintenance Requirements

In addition to the daily and monthly maintenance requirements:

1. Drain and replace lubricator reservoir oil.
2. Change oil filter.
3. Change oil. More frequent oil changes may be required due to environmental influences, the oil supplier recommends it or if oil analysis requires it. A less frequent oil change may be allowed because the oil is replaced at regular intervals due to force-feed lubricator usage.
4. Clean the oil strainer anytime the oil is changed.
5. Open the frame when oil is changed and visually inspect for any dirt or foreign material that may have entered into the frame. You do not have to disassemble the frame for this inspection, however, it may become necessary if serious damage has been done to the frame has been identified.
6. Re-tighten hold down stud-nuts to proper torque values and perform a soft foot check. If the hold down fasteners on the compressor frame or driver have become loose, it is recommended that the coupling alignment be checked.

7.2.2 Yearly or 8,000 Hours Maintenance Requirements

In addition to the daily and monthly maintenance requirements:

1. Check crankshaft main bearing for abnormal wear, connecting rod bearing clearance and end play clearance with a feeler and indicator. If outside the wear limits listed on Table 3.4 of this manual, Clearances, then replace the affected bearings.

2. Check crosshead guide clearance with feelers, if outside the wear limits replace effective parts.
3. Inspect valves for broken plates and loose center bolts. Replace any broken plates and tighten center bolts to proper torque value (see Table 3.11 in section 3.4, Fastener Tightening Torque).
4. Inspect cylinder bores for damage or wear.
5. Inspect piston ring end gap. Replace all rings that are outside the maximum wear limits (see Table 3.9, Piston to Bore Clearance and Conventional Piston Ring End Gap for Double-acting and Steeple Cylinders).
6. Rebuild cylinder packing case (see section 4.16.1).
7. Inspect for frame twisting or bending. This is done by shimming of the compressor feet.
8. Realign if necessary to hold coupling alignment within 0.005" (0.127 mm).
9. Check and re-calibrate all temperature and pressure gauges.
10. Check and record compressor rod run-out.
11. Grease VVCP stem threads at grease fitting, using a multi-purpose grease and standard hand pump grease gun.
12. Clean frame breather filter.
13. Check divider blocks.

7.2.3 Two-year or 16,000 Hours Maintenance Requirements

In addition to the daily, monthly, and yearly maintenance requirements:

Check auxiliary and chain drive for sprocket teeth undercutting and chain for excessive stretching.

This would be a good time to replace all chain drive parts.

7.2.4 Four-year or 32,000 Hours Maintenance Requirements

In addition to the daily, monthly, yearly, and two year maintenance requirements:

1. Check main and connecting rod bearing clearances by using the dial indicator.

NOTE: Disassembly is not necessary nor is it recommended to check for clearances. Disassembly should only be performed IF excessive clearance is discovered.

2. Check crosshead guide clearances with feeler gauges.
3. Check crosshead pin to crosshead pin bore and connecting rod bushing bore by removing crosshead pins.
4. Check for excessive wear in the accessory end drive chain tensioner.
5. Check for excessive ring groove wear in the pistons.

7.2.5 Six-year or 48,000 Hours Maintenance Requirements

In addition to the daily, monthly, yearly, two-year and four-year maintenance requirements:

1. Replace crankshaft main roller bearing and connecting rod bearing shells and bushings.
2. Replace lubricator divider blocks if needed.
3. Replace crosshead bushings if needed.

7.2.6 Common Problems and Possible Causes

Minor problems can be expected during the routine operation of an Arrow VRS-2 Compressor. These issues are most often traced to liquid, dirt, improper adjustment or to operating personnel that may be unfamiliar with the Arrow compressor. Difficulties of this type can usually be corrected by cleaning, proper adjustment, replacing a minor part or proper training of operating personnel.

Major problems can usually be traced to long periods of operation with unsuitable lubrication, careless operation, lack of routine maintenance or the use of the compressor for purposes for which it was not intended.

Recording of the inter stage pressures and temperatures on a multistage unit is valuable. Any vibration, when operating at a given load point, indicates trouble in one of the stages. Normally, if the inter stage pressure drops the trouble is in the lower pressure cylinder. If it rises, the problem is normally in the higher pressure cylinder.

The following section lists common problems that could occur with the Arrow VRS-2 Compressor. It is impossible to give a complete list of every possible maintenance issue, but this list will give you some of the most typical problems and their possible cause.

PROBLEM	POSSIBLE CAUSES
Low Oil Pressure	Oil pump failure
	Oil foaming from counterweights striking oil surfaces or oil level too high
	Cold oil
	Dirty oil filter
	Excessive leakage at bearings
	Improper low oil pressure switch setting
	Oil pump relief valve set too low
	Defective pressure gauge
	Plugged oil sump strainer
Noise in Cylinder	Loose piston
	Piston hitting cylinder head-end head or crank-end head
	Loose crosshead jam nut
	Broken or leaking valve(s)
	Worn or broken piston rings or rider bands
	Valve improperly seated or damaged seat gasket
	Liquids in cylinder

PROBLEM	POSSIBLE CAUSES
Excessive Packing leakage	Worn packing rings
	Improper lube oil and or insufficient lube rate
	Dirt in packing
	Packing rings assembled incorrectly
	Improper ring side or end gap clearance
	Plugged packing vent system
	Scored, tapered or out of round piston rod
	Excessive piston rod run-out
	Packing not seated or properly run in
Packing Over Heating	Lubrication failure
	Improper lube oil and/or insufficient lube rate
	Worn packing rings
	Dirt in packing
	Improper ring side or end gap clearance
	Scored, tapered or out of round piston rod
	Excessive piston rod run-out
Excessive Carbon on Valves	Excessive lube oil
	Improper lube oil
	Oil carry-over from inlet system or previous stage
	Broken or leaking valves causing high temperature
	Excessive temperature due to high-pressure ratio across cylinders
Relief Valve Popping	Faulty relief valve
	Leaking suction valves or rings on next higher stage
	Obstruction, blind or valve closed in discharge line
High Discharge Temperature	Excessive ratio across cylinder due to leaking inlet valves or rings on the next higher stage
	Bent or damaged intercooler piping
	Leaking discharge valves or piston rings
	High inlet temperature
	Improper lube oil and/or lube rate

PROBLEM	POSSIBLE CAUSES
Frame Knocks	Loose crosshead pin or retainer caps
	Loose or worn main, crank pin or crosshead bearings
	Low oil pressure
	Cold oil
	Incorrect oil
	Knock is actually from cylinder end
Accessory End of Crank-shaft Oil Leak	Clogged vent or vent piping
	Improper sealing of plug
Piston Rod Packing Case Leaks	Worn wiper rings
	Wiper rings incorrectly assembled
	Worn/scored rod
	Improper fit of rings to rod/side clearance

8 WARRANTY

VRS Gas Compressor
Continuous Duty Warranty

CONTINUOUS DUTY DEFINITION: The highest load and speed which can be applied, subject to Arrow Engine Company's ratings in effect at time of sale.

I. ARROW ENGINE COMPANY COMPRESSOR AND COMPRESSOR PARTS WARRANTY POLICY

The goods manufactured by Arrow Engine Company and delivered hereunder will be free of defects in material and workmanship for a period of 12 months from the date the goods are placed in service by the buyer or 18 months from date of shipment, whichever shall occur first. In addition, the manufacture warrants for a period of 36 months after delivery the following parts to be free of defects in material and workmanship under normal use and when properly maintained: crankshaft, crankcase casting (structural elements only) and connecting rods. Maintenance or wear items such as Piston Rings, Packing Rings, Wiper Rings, Valve Plates, Valve Springs, Gaskets, O-rings, etc. are not warrantable. Prototypes or nonstandard Manufacturers configurations are covered under a separate agreement. Damage resulting from improper storage, neglect, extreme environmental conditions, misapplication, service and maintenance inconsistent with the Arrow VRS Gas Compressor Operations and Maintenance Manual or overloading of a compressor is not covered under this warranty policy. For warranty coverage of units test run at a Distributor's facility and not to be field started within one month from the date of testing, the compressor should be re-preserved, according to Arrow Engine's compressor preservation guidelines. For the warranty period, manufacturer shall repair or replace defective material.

II. EXTENDED WARRANTY

Effective for all Arrow VRS Gas Compressors shipped from Arrow after July 1, 2010, Arrow provides an extended warranty for units that continuously use and maintain 100% Arrow original equipment replacement parts. The extended warranty will be applied as follows:

Arrow warrants for a period of 72 months after delivery, the following parts to be free from defects in material or workmanship under normal use when properly maintained according to the Arrow VRS Compressor Operations and Maintenance manual: (1) Crankshaft, (2) Crankcase Casting, (3) Connecting Rods, (4) Crossheads, (5) Crosshead Guide Castings.

In addition, Arrow warrants for a period of 24 months after delivery, the following parts to be free from defects in material or workmanship under normal use in lubricated cylinders when properly maintained according to the Arrow VRS Compressor Operations and Maintenance manual: (1) Cylinder Bodies, (2) Pistons, (3) Piston Rods.

Arrow warrants that all remaining components manufactured or delivered by Arrow will be free of defects in material and workmanship for a period of 12 months from the date the goods are placed in use by the purchaser or 18 months from date of shipment, whichever occurs first. Labor coverage remains at one year and remains under the terms and conditions of the standard Arrow Compressor Warranty. If at any time parts not manufactured or delivered by Arrow (non-OEM replacement parts) are placed into service on the compressor, the extended warranty will be null and void and the standard limited warranty will apply.

OEM parts and additional information regarding Arrow's limited warranty can be obtained from Arrow Engine Company.

III. WARRANTY – MANUFACTURED AND NON-MANUFACTURED AFTER-MARKET PARTS AND START-UP

Parts manufactured by Arrow Engine Company are warranted to be free of defects in material and workmanship for 12 months from the date of Shipment. Certain parts on Arrow Engine Company's VRS Compressor are furnished as aftermarket parts from other sources. The warranty on these items is passed through the Distributor, from the other manufacturers.

A. COMPRESSOR IN USE

A completed "Compressor In Use" form must be completed by the Distributor and in the Manufacturer's possession before a "Warranty Claim" can be processed. "The Compressor In Use" form must be completed by the Distributor and forwarded to the Manufacturer upon shipment of any package with Arrow Engine Company products.

B. COMPRESSOR START-UP

The Arrow VRS Compressor must be started-up in accordance with the latest version of the Arrow Engine Company VRS Compressor Start-up Report. The VRS Compressor Start-up Report must be completed and forwarded to the Manufacturer upon completion of start-up.

C. DEFERRED START-UPS

Warranty coverage on VRS Compressors not started within 12 months from the factory ship date, see the Manufacturer's "Deferred Start-up Policy."

IV. OWNER/DISTRIBUTOR'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY

Owner shall be responsible for:

A. The operation and maintenance of the Products within the guidelines established by Arrow Engine Company.

B. Making the Products available to Arrow Engine Company's authorized contractors or distributors for any warranty repair, during normal business hours.

C. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium overtime schedule.

D. All costs incurred as the result of removal or reinstallation of the Products as may be required to effect any warranted repair.

E. All administrative costs and expenses resulting from a warranted failure.

F. Any costs of transportation, towing, repair facilities, or associated costs.

G. Loss of revenue and loss of/or damage to real and/or personal property.

H. Payment of labor charges is limited to failure on items of the Manufacturer that occurred during packaging and within the first 90 days of start-up. The Manufacturer reserves the right to adjust the labor on warranty claims so that the labor paid will be within the Manufacturer's "Standard Repair Hours Policy" or within a reasonable amount of time to accomplish the task for which the claim is submitted. The initial investigation of a warranty item will be at the expense of the Distributor.

I. Arrow Engine Company will not be responsible for additional repair time as a result of normal job site location, remote location, non-standard gas, or special equipment, end cost of transporting personal, parts and equipment to and from the package site. Travel time and mileage

will be restricted to 150 miles one way from the packager's closest service location to land based site. For ocean or water based compressor sites, please contact Arrow Engine Company for travel policy.

V. INTERNATIONAL WARRANTY

The Manufacturer's coverage for VRS Compressors shipped outside the United States or Canada is limited to parts only F.O.B. Tulsa, Oklahoma.

VI. LIMITATION OR ARROW ENGINE COMPANY'S OBLIGATIONS

The obligation of Arrow Engine Company under this express limited warranty shall be waived and voided, and Arrow Engine Company shall not, thereafter, be responsible for:

A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, installation, application, or maintenance practice not in accordance with guidelines or specifications established by Arrow Engine Company; or

B. Any failure resulting from unauthorized modifications or repairs of the Products or;

C. Any failure resulting from overload, overspeed, overheat, accident, improper storage; or

D. Failure of owner to promptly provide notice of a claimed defect – all warranty claims must be authorized, documented, and submitted within 30 days of the failure date while under the warranty period; or

E. Failure of Products for which Arrow Engine Company did not receive properly completed start-up reports; or

F. Repairs of a covered failure performed with non-genuine Arrow Engine Company parts; or

G. Repairs of a covered failure performed by non-authorized contractors or distributors; or

H. Failure to make Products available to Arrow Engine Co. or its authorized representatives, or

I. Failure to supply documents such as drawing and specifications relating to the specific application of the Products.

VII. APPLICABILITY AND EXPIRATION

The warranties set out above are extended to all owners in the original chain of distribution. The warranties and obligations of Arrow Engine Company shall expire and be of no further effect upon the dates of expiration of the applicable warranty periods.

The foregoing sets forth Arrow Engine Company's only obligations and owners' exclusive remedy for breach of warranty, whether such claims are based on breach of contract, tort (including negligence and strict liability), or other theories, and the foregoing is expressly in lieu of other warranties whatsoever expressed, implied, and statutory, including without limitation, the IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

Notwithstanding the preceding, in no event shall Arrow Engine Company be liable for any direct, special, incidental or consequential damages (whether denominated in contract, tort, strict liability, negligence or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based on breach of contract, tort (including negligence and strict liability), or other theories must be commenced within one year after the cause of action accrues or it shall be barred.

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ENGINES

A-SERIES	A32	A42	A54 A54E	A62 A62 Turbo A62 Genset
C-SERIES	C-46	C-66	C-96	C-106
KP-SERIES	KP3 KP3TA	KP4 KP4TA	KP6 KP6TA	KP8 KP8TA
VRD-SERIES	VRD30	VRD40	VRD60	VRD100

COMPRESSION PRODUCTS

Compressor Frames VRC-2 VRS-2 VRS-4	CNG Compressor Frames and Packages VRC-CNG	Vapor Recovery Units VRU-1 VRU-2	Gas Lift Packages Electric HP Gas Engine (VR, A-Series, CAT)	Custom Compression Packages

GAS PRODUCTS

Coalescers

REPLACEMENT PARTS

Waukesha	145G/F817	140G/F554	F18	H24	WAK/1197

ARROW ENGINE™ ENGINES & COMPRESSION

ARROW ENGINE COMPANY
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www.arrowengine.com

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