VRC-CNG

PARTS OPERATION MAINTENANCE

ARROW ENGINE COMPANY

VRCCNG-POM-C-APR12

In 1955 Arrow Engine Company opened for business, beginning the tradition of providing premium service and exceptional products to the oil & gas industry, as well as the industrial engine market, throughout the world.

Arrow is a part of IES Infrastructure, which operates as one of four divisions under IES Holdinps, Inc. comprised of over 8,000 employees nationwide. IES Infrastructure provides electrical and mechanical apparatus services, custom steel fabrication, and custom power solutions includinp penerator enclosures and bus systems to customers both in the United States and abroad.

With a consistent focus on our customers' needs, striving to help them grow their business, and producing the most reliable equipment and parts in the industry, Arrow has forged a 55-year tradition of excellence.

ARROW ENGINE COMPANY
VRC-CNG GAS COMPRESSOR
OPERATION, MAINTENANCE & PARTS MANUAL

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PARTS

OPERATION & MAINTENANCE

PARTS

PREFACE

DEFINITIONS - RECOMMENDED SPARE PARTS

START-UP SPARE PARTS

Start-up spares are intended to satisfy parts required for initial start-up and consists primarily of gaskets, O-rings, and common wear parts. As valves are sometimes damaged from debris in the piping during start-up, Arrow recommends having a full set of replacement valves on hand. Arrow also has available valve repair kits in Section 4 of this book.

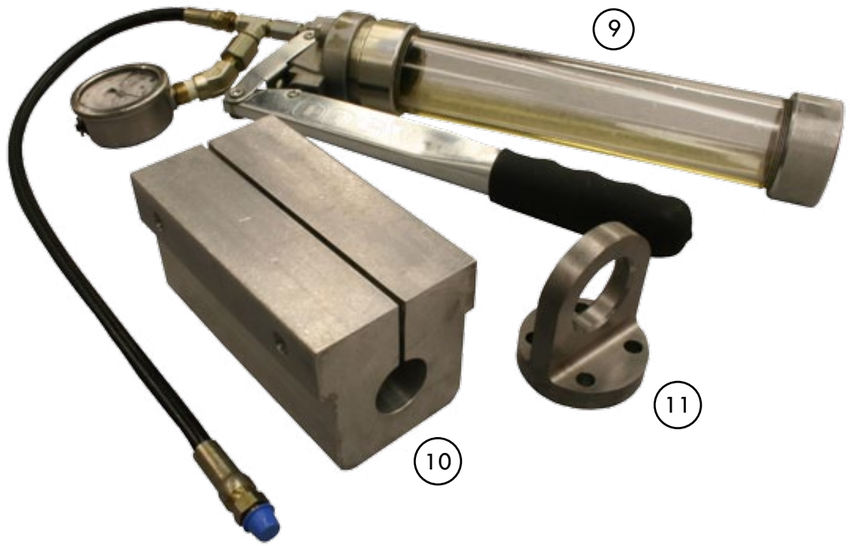
MINOR SPARE PARTS

Minor spare parts include the minor plus start-up spare parts. We have recommended some parts such as pumps, belts, divider block, etc., not because these parts are expected to wear out under normal conditions, but because they could be damaged due to neglect, abuse, or abnormal wear and tear from extreme or dirty operating conditions.

MAJOR SPARE PARTS

Major spare parts include the major parts plus the minor parts plus the start-up parts. This is a more complete list of parts "recommended" as though the unit is in a *remote area* with limited replacement parts access, or for operating in a critical service. We have recommended some major parts such as a crankshaft and connecting rods not because these parts are expected to fail, but they could be damaged due to neglect, abuse, or abnormal wear and tear from extreme or dirty operating conditions.

This list could also be used as a recommended *overhaul repair kit* to be used when a complete overhaul becomes necessary.



1 RECOMMENDED SPARE TOOLS

1.1 RECOMMENDED AND OPTIONAL SPECIAL TOOLS

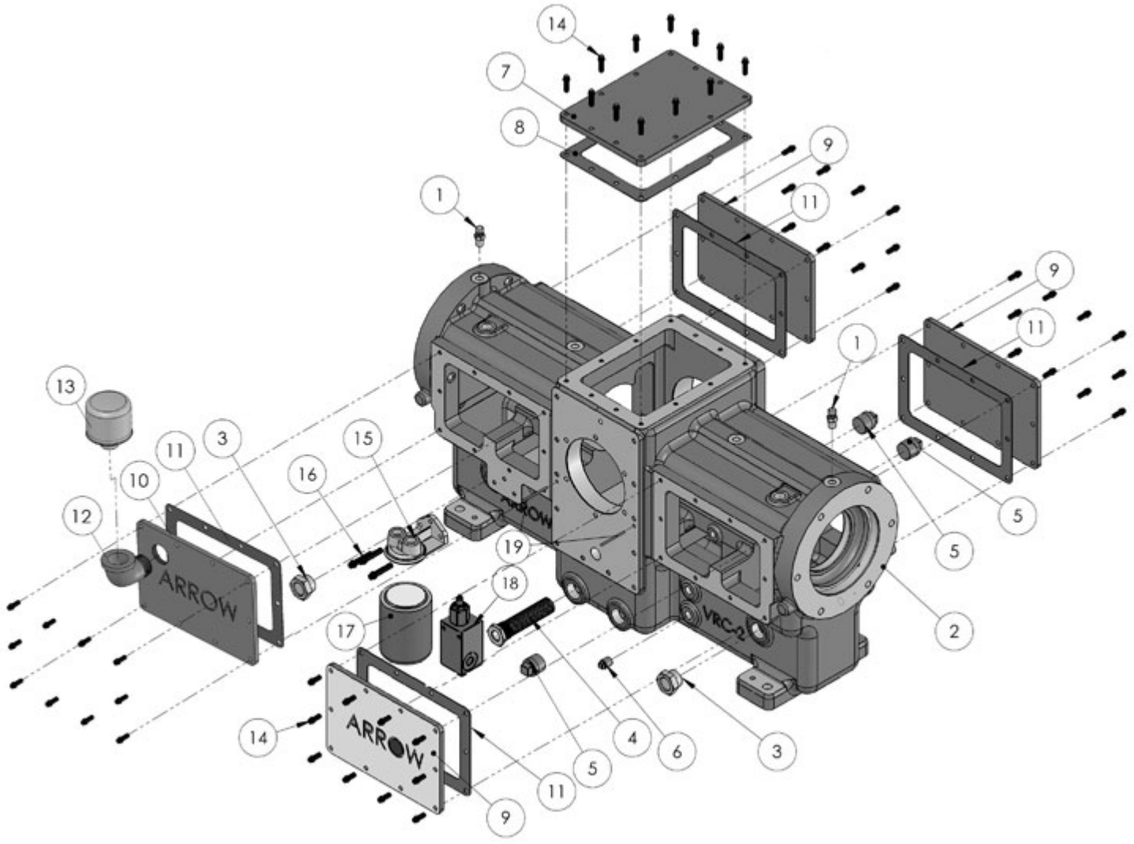
Special tools may be ordered as follows: 1) Tool Box (A complete set of Recommended Tools); 2) Individual Recommended Tools; 3) Individual Optional Tools; or 4) A combination of individual Recommended Tools and individual Optional Tools.

SPECIAL TOOLS AND TOOL BOX					
			QUANTITY		
NUMBER	PART NUMBER	DESCRIPTION OF PART	Std. Issue	Recommended Tool	Optional Tool
TOOL BOX (RECOMMENDED TOOLS)					
	VRC29400C	**TOOL BOX**			
1	VRC29490	Piston Nut Adaptor (for 2.25” Piston)		1	
2	VRC29492	PISTON ROD ENTERING SLEEVE		1	
3	VRC29482	OIL SEAL ENTERING SLEEVE		1	
4	VRCC9403	TOOL, EXPANDER, RING, 1.125” CNG		1	
5	VRC29463	TOOL, VALVE INSTALLATION, 2.25 - 4.0” CYLS.		1	
5	VRC29464	TOOL, VALVE INSTALLATION, 4.5 - 8.5” CYLS.		1	
6	VRC21140	ADAPTOR, BAR-OVER, CRANKSHAFT	1	1	
7	VRCC9490	PISTON NUT ADAPTOR (for 8.5” Piston)		1	
8	VRC29496	2” Jam Nut Wrench		1	
		24” Tool Box (Not shown)		1	
		Filter, Oil Frame (Not shown)	1	1	
OPTIONAL TOOLS*					
9	VRC29480	HAND PRIMING PUMP *			1
10	VRC29494	PISTON ROD CLAMP *			1
11	VRC29410	TOOL, CRANKSHAFT LIFTING EYE*			1
** Not included in Tool Box. These tools must be ordered separately.*					

2 - FRAME

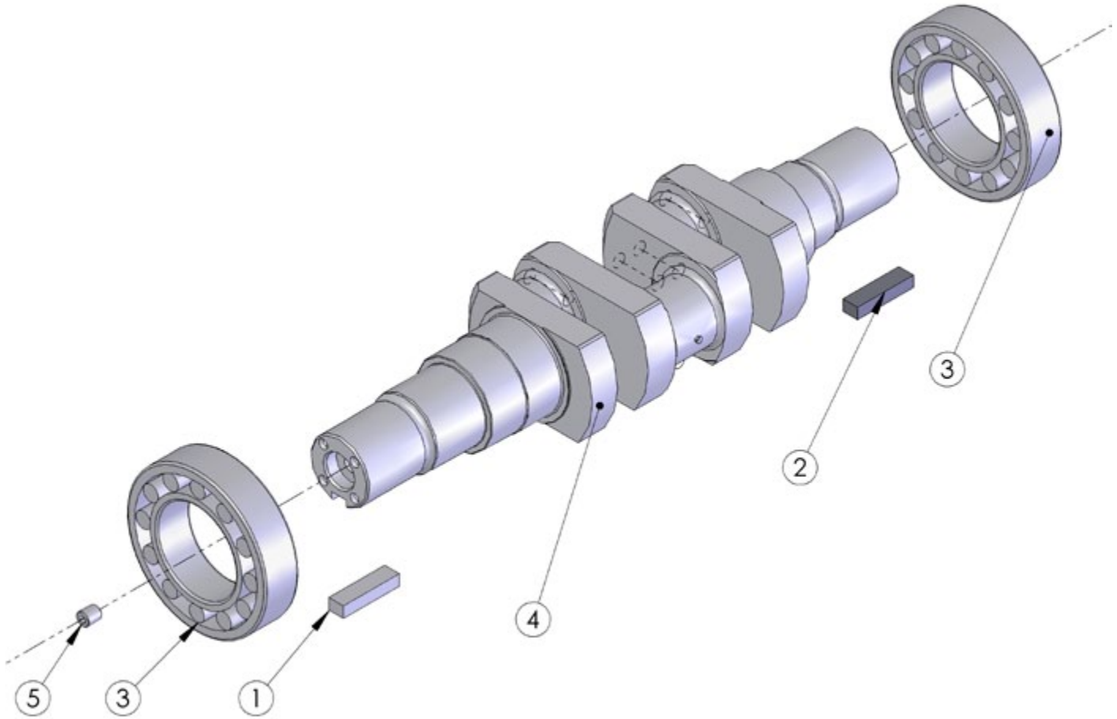
PARTS, KITS, ASSEMBLIES & ACCESSORIES

2.1 FRAME PARTS - FRAME, COVERS, GASKETS, OIL STRAINER, SIGHT GLASS AND PLUGS



FRAME PARTS						
NUMBER	PART NUMBER	DESCRIPTION	PART QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
1	VRC28888	CAP, VENT	2			
2	VRC21025	FRAME (2) TWO-THROW VRC-2 COMPRESSOR	1			
3	VRC21400	SIGHTGLASS, FRAME OIL LEVEL	2			2
4	VRC28340	STRAINER, FRAME OIL (1" NPT)	1			1
5	VRC21519	PLUG, PIPE, 1" NPT	3			
6	VRC21509	PLUG, PIPE, 3/8" NPT	1			
7	VRC21310	COVERPLATE, FRAME, TOP	1			
8	VRC21315	GASKET, COVERPLATE, FRAME, TOP	1	1	1	1
9	VRC21320	COVERPLATE, FRAME, SIDE	3			
10	VRC21321	COVERPLATE, FRAME, SIDE W/BREATHER HOLE	1			
11	VRC21325	GASKET, COVERPLATE, FRAME SIDE	4	4	4	4
12	VRC21419	ELBOW, 1 1/4" STREET 90	1			
13	VRC21410	BREATHER, FRAME VENT	1			1
14	VRC21327	SCREW, TOP COVER, SIDE PLATE, & PUMP SUP-PORT, 12 PT	52			
15	VRC28320	BRACKET, MOUNTING, FRAME OIL FILTER	1			
16	VRC28327	SCREW, FILTER BRACKET, 12 PT	3			
17	VRC28310	FILTER, OIL, FRAME	1	2	2	2
18	VRC28350	VALVE, RELIEF, OIL PRESSURE	1			1
19	VRC28006	PIN, DOWEL, HOUSING	2			

2.2 FRAME – CRANKSHAFT PARTS

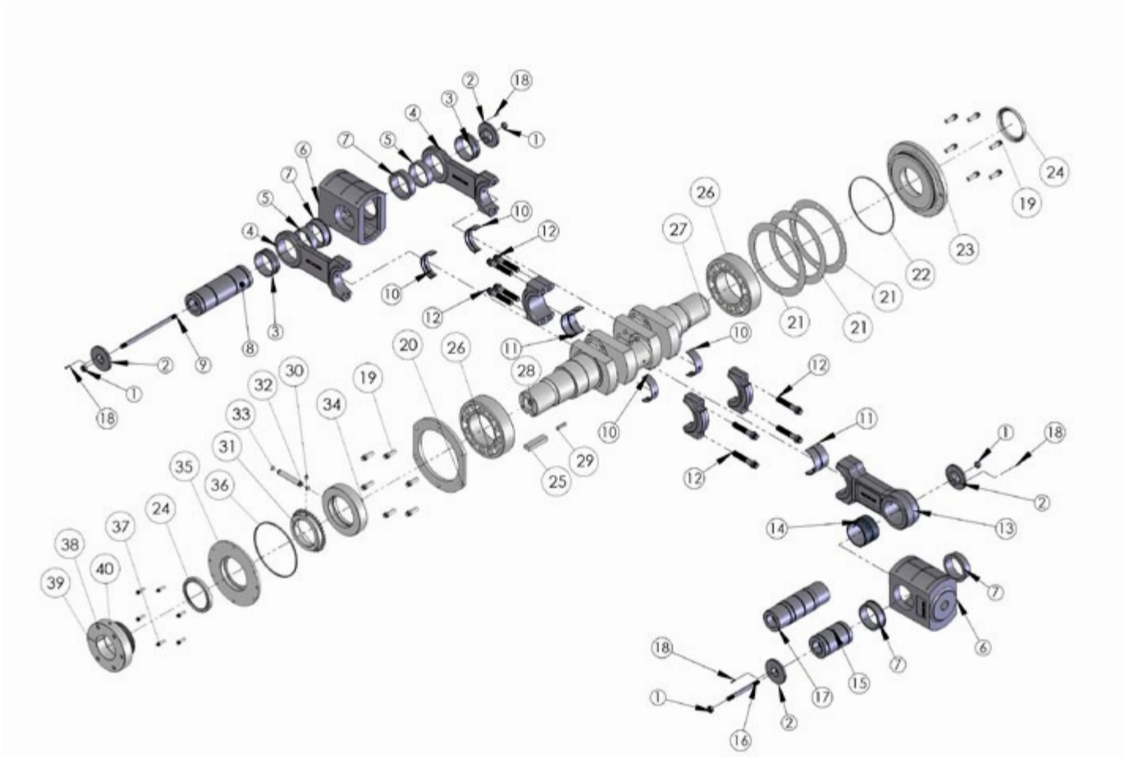


CRANKSHAFT ASSEMBLY							
ITEM NUMBER		PART NUMBER	DESCRIPTION	PART QTY	RECOMMENDED SPARE PARTS		
					Start-Up	Minor	Major
VRC21101A		VRC21101A	CRANKSHAFT, VRC-2, ASSEMBLY W/MAIN BRGS. (2) (VRC21101)	1			1
	1	VRC21106	KEY, CRANKSHAFT, ACCESSORY-END, VRC-2	1		1	1
	2	VRC21107	KEY, CRANKSHAFT, DRIVE-END, VRC-2	1		1	1
	3	VRC21101	BEARING, CRANKSHAFT MAIN	2			
	4	VRC21100	CRANKSHAFT, VRC-2 COMPRESSOR	1			
	5	VRC21109	PLUG, CRANKSHAFT 1/4" NPT	1			

2.2.1 CRANKSHAFT, CROSSHEAD AND CONNECTING ROD ASSEMBLIES

FRAME ASSEMBLIES		
PART NUMBER	DESCRIPTION OF PART	QTY.
VRC21101A	CRANKSHAFT, VRC-2, ASSEMBLY w/MAIN BEARINGS	1
VRC22005A	CROSSHEAD, VRC-2 ASSEMBLY w/BABBITT & BUSHINGS	2
VRC21025A	FRAME, TWO-THROW, VRC-2 COMPRESSOR ASSEMBLY	1
VRC21220A	ROD, CONNECTING, LIGHT ASSEMBLY (w/BUSHING & SCREWS)	2
VRC21210A	ROD, CONNECTING, HEAVY, ASSEMBLY (w/BUSHING & SCREWS)	1
Crankshaft Assembly includes (see above)**:** *Main Bearings* *Crankshaft Accessory-End Key* *Crankshaft Drive-End key,* *1/4" Plug*		

2.3 FRAME – CROSSHEAD AND CONNECTING ROD PARTS



• FRAME •
SINGLE AND DOUBLE CONNECTING ROD ASSEMBLY

ITEM NUMBER	PART NUMBER	DESCRIPTION	PART QTY	REC. SPARE PARTS		
				Start-Up	Minor	Major
1	VRC22119	NUT, CROSSHEAD PIN RETAINER STUD	4		2	4
2	VRC22200	CAP, RETAINER, CROSSHEAD PIN (Fits All Pins)	4			4
3	VRC21222	BUSHING, CONNECTING ROD LIGHT (Crosshead Pin) (Included W/Rod)	2			
4	VRC21220A	ROD, CONNECTING, LIGHT, ASSEMBLY (w/Bushings & Screws)	2			2
5	VRC22420	SPACER, PIN, CROSSHEAD, LONG	2			2
6	VRC22005A	CROSSHEAD, VRC-2 COMPRESSOR, ASSEMBLY (w/Bushings + Babbitt)	2			2
7	VRC22002	BUSHING, CROSSHEAD VRC-2 (Included with Crosshead)	4			
8	VRC22120	PIN, CROSSHEAD, LONG (FOR LIGHT RODS)	1			1
9	VRC22128	STUD, CROSSHEAD PIN RETAINER, LONG LT. RODS	1			1

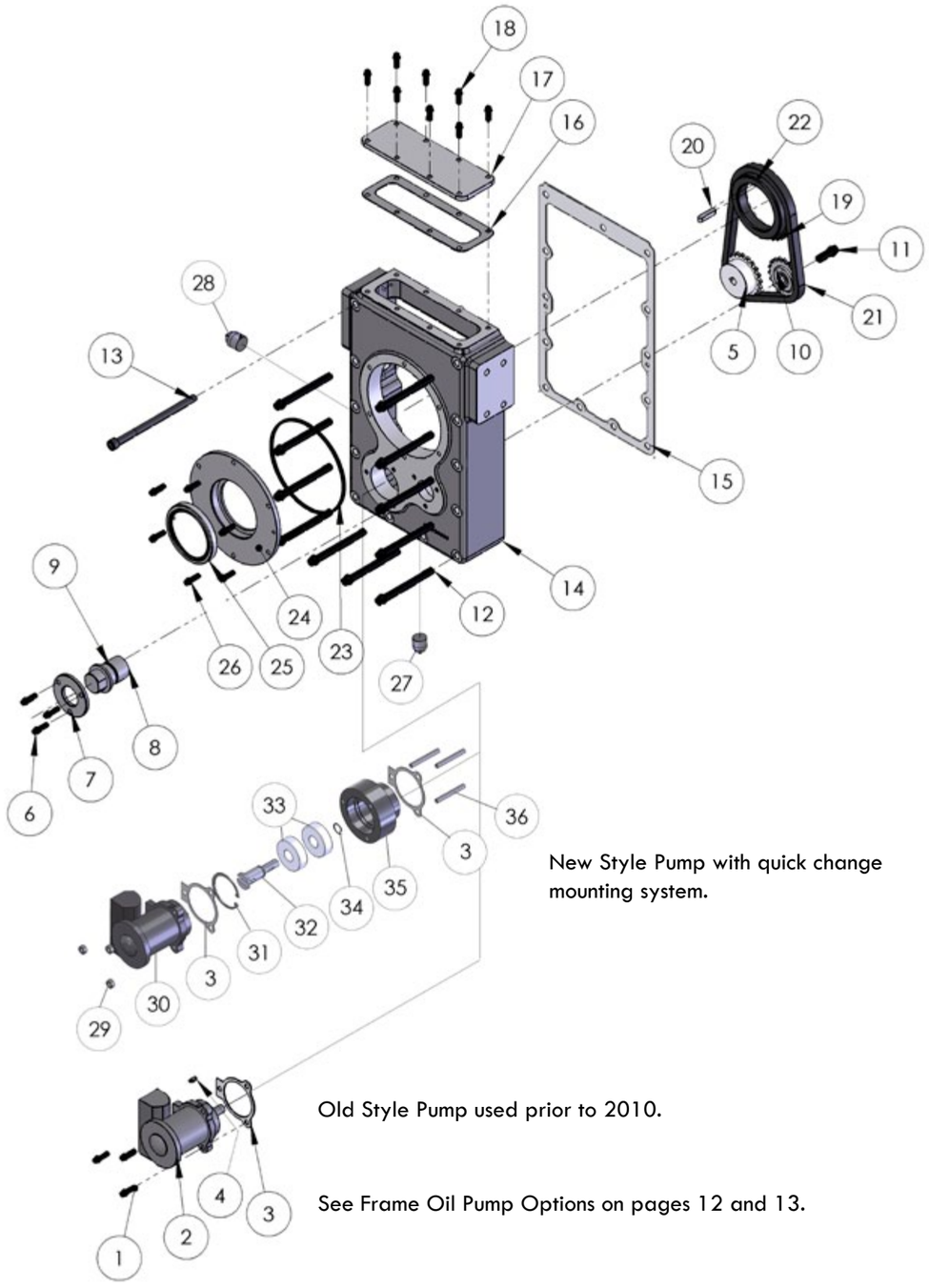
• FRAME •
SINGLE AND DOUBLE CONNECTING ROD ASSEMBLY (continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	PART QTY	REC. SPARE PARTS		
				Start-Up	Minor	Major
10	VRC21221	BEARING, CONNECTING ROD, LIGHT (Order Kit VRC21232K)**	2			1
11	VRC21211	BEARING, CONNECTING ROD, HEAVY, PAIR (Order Kit VRC21232K)**	2			1
12	VRC21217	SCREW, CONNECTING ROD CAP (Included w/Rods), 12 PT	8			
13	VRC21210A	ROD, CONNECTING, HEAVY, ASSEMBLY (w/Bushing & Screws)	1			1
14	VRC21212	BUSHING, CONNECTING ROD HEAVY (Crosshead Pin) (Included W/Rod)	1			
15	VRC22110	PIN, CROSSHEAD, SHORT (HEAVY ROD WITHOUT WEIGHTS)	1			1
16	VRC22118	STUD, CROSSHEAD PIN RETAINER, SHORT (HEAVY ROD)	1			1
17	VRC22130	PIN, CROSSHEAD, LONG BALANCE (HEAVY. ROD WITH WEIGHTS)*	1			1
18	VRC22206	PIN, ROLL, CROSSHEAD CAP	4			4
19	VRC21117	SCREW, RETAINER, MT. PLATE AND TENSIONER, 12 PT	12			
20	VRC21120	RETAINER, BEARING, ACCESSORY-END	1			
21	VRC21119	SHIM PACK, RETAINER, DRIVE-END	1			1
22	VRC21114	O-RING, RETAINER, DRIVE-END	1			1
23	VRC21110	RETAINER, BEARING, DRIVE-END	1			
24	VRC28024	SEAL, OIL, CRANKSHAFT	2			2
25	VRC21106	KEY, CRANKSHAFT, ACCESSORY END	1		1	1
26	VRC21101	BEARING, CRANKSHAFT, MAIN	2			2
27	VRC21100	CRANKSHAFT, VRC-2 COMPRESSOR	1			1
28	VRC21109	PLUG, CRANKSHAFT, 1/4" NPT (Not shown)	1			1
29	VRC28236	KEY, SPROCKET	1		1	1
30	VRC28239	SETSCREW, DRIVE SPROCKET	1			1
31	VRC28248	SPROCKET, CRANKSHAFT DRIVE	1			1
32	VRC28110	TUBE, OIL, SLINGER	1			
33	VRC28104	O-RING, SLINGER OIL TUBE	2		2	2
34	VRC28100	SLINGER, OIL, LUBE DRIVE	1			1
35	VRC28020	RETAINER, OIL SEAL, CRANKSHAFT	1			
36	VRC28022	O-RING, RETAINER, OIL SEAL	1		1	1
37	VRC28027	SCREW, SEAL RETAINER, 12 PT	6			
38	VRC28425	SHEAVE, BELT, DRIVE, LUBE PUMP	1			
39	VRC28427	SCREW, SHEAVE, DRIVE, LUBE PUMP, 12 PT (not shown)	1			
40	VRC28429	SETSCREW, SHEAVE, DRIVE, LUBE PUMP (not shown)	1			1
Not Shown	VRC22301	WEIGHT, CROSSHEAD PIN, 3.29 LBS, - PAIR IS 6.58 LBS*	2			
Not Shown	VRC22303	WEIGHT, CROSSHEAD PIN, 2.7 LBS, - PAIR IS 5.4 LBS*	2			
Not Shown	VRC22304	WEIGHT, CROSSHEAD PIN, 1.07 LBS, - PAIR IS 2.14 LBS*	2			

* *Not all parts apply to the CNG unit.*

** *VRC21232K BEARING KIT. Includes all bearings for connecting rod, heavy and light.*

2.4 FRAME LUBRICATION SYSTEM:
FRAME LUBRICATION SYSTEM – CHAIN DRIVE



New Style Pump with quick change mounting system.

Old Style Pump used prior to 2010.

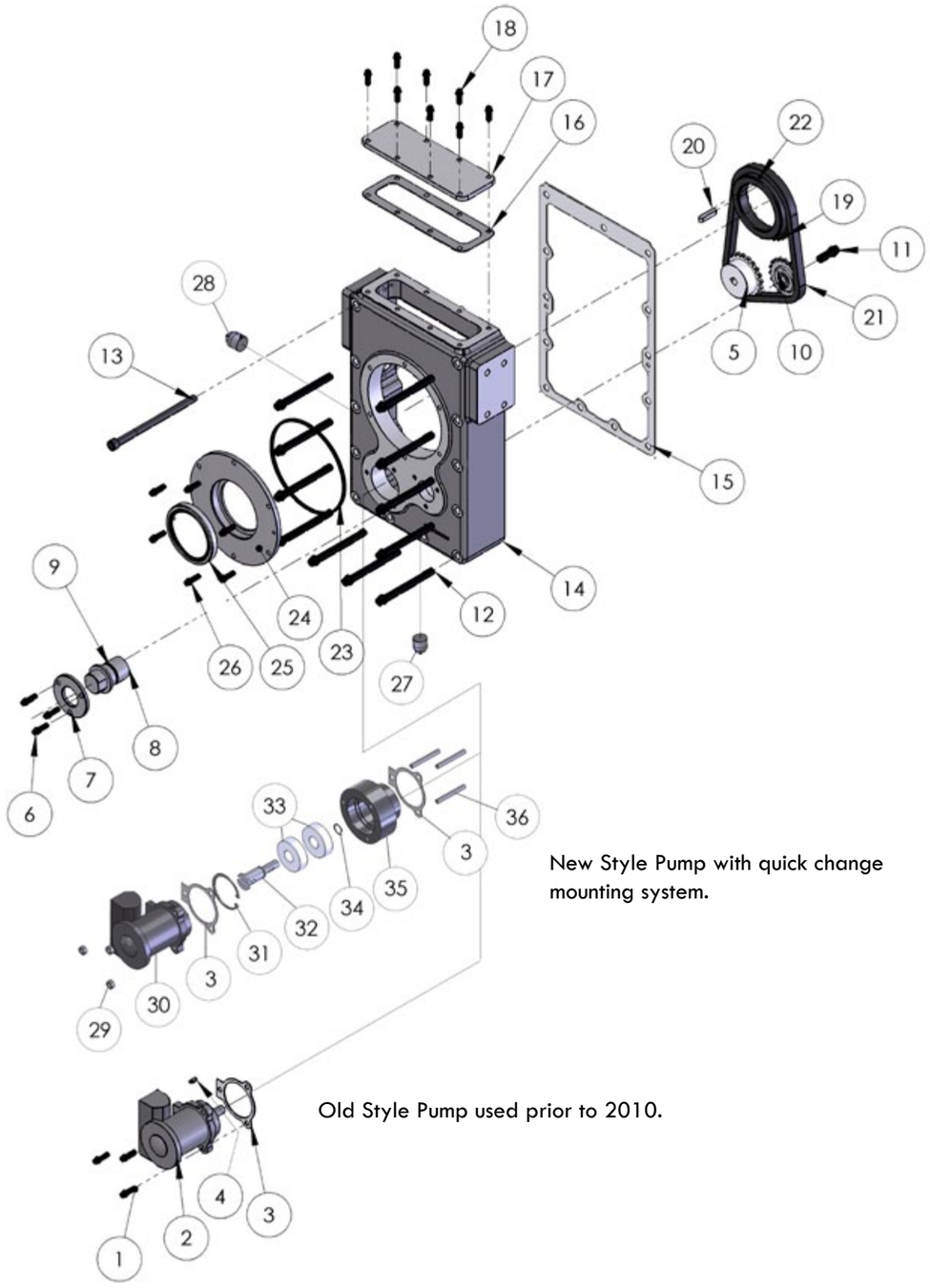
See Frame Oil Pump Options on pages 12 and 13.

• FRAME •
FRAME (CHAIN DRIVE) LUBRICATION SYSTEM

ITEM NUMBER	PART NUMBER	DESCRIPTION	PART QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
1	VRC28027	SCREW, PUMP, FRAME OIL, 12 PT	3			
2	VRC28300	PUMP, OIL, FRAME (Old Style)	1		1	
3	VRC28305	GASKET, PUMP, FRAME OIL	2		1	1
4	VRC28236	KEY, SPROCKET	1		1	1
5	VRC28232	SPROCKET, DRIVE, FRAME OIL PUMP	1			1
6	VRC28027	SCREW, CLAMP, IDLER CHAIN, 12 PT	3			3
7	VRC28253	CLAMP, IDLER, CHAIN	1			1
8	VRC28250	IDLER, CHAIN, FRAME OIL PUMP	1			
9	VRC28254	O-RING, IDLER, CHAIN	1			1
10	VRC28220	SPROCKET, IDLER, CHAIN	1			1
11	VRC28227	SCREW, IDLER, SPROCKET, 12 PT	1			1
12	VRC28007	SCREW, HOUSING, 12 PT	11			
13	VRC28067	SCREW, HOUSING AND IDLER (Socket Head)	1			
14	VRC28000	HOUSING, LUBE OIL DRIVE	1			
15	VRC28005	GASKET, HOUSING, LUBE OIL DRIVE	1	1	1	1
16	VRC28015	GASKET, COVERPLATE, HOUSING	1	1	1	1
17	VRC28010	COVERPLATE, HOUSING, LUBE OIL DRIVE	1			
18	VRC28017	SCREW, HOUSING COVERPLATE, 12 PT	8			
19	VRC28248	SPROCKET, CRANKSHAFT DRIVE	1			1
20	VRC28206	KEY, DRIVE SPROCKET	1			1
21	VRC28200	CHAIN, DRIVE, ENDLESS RIVETED	1			1
22	VRC28239	SETSCREW, DRIVE SPROCKET	1			
23	VRC28022	O-RING, RETAINER, OIL SEAL	1			1
24	VRC28020	RETAINER, OIL SEAL CRANKSHAFT	1			
25	VRC28024	SEAL, OIL, CRANKSHAFT	2			2
26	VRC28027	SCREW, SEAL RETAINER, 12 PT	6			
27	VRC21529	PLUG, PIPE, 1/2" NPT	1			
28	VRC21519	PLUG, PIPE, 1" NPT	1			
29	VRC28489	NUT, BELT GUARD & OIL PUMP	3			
30	VRC28301	PUMP, OIL, FRAME - WITH TANG SHAFT	1		1	
31	VRC28335	RING, RETAINING, LARGE, PUMP MOUNT	1			
32	VRC28332	SHAFT, PUMP MOUNT, FRAME OIL	1			
33	VRC28333	BEARING, SHAFT, PUMP MOUNT	2			
34	VRC28334	RING, RETAINING, SMALL, PUMP MOUNT	1			
35	VRC28331	MOUNT, PUMP, FRAME OIL	1			
36	VRC28337	STUD, PUMP MOUNT	3			

NOTE: Not all parts may be used on all CNG compressors.

NOTE: The VRC-CNG compressor is available in only one cylinder configuration (8.5/4.0/2.25/1.125) and has been designed so that the throws are inherently balanced. It is therefore unnecessary to use extra heavy jam nuts or crosshead assembly weights on the CNG unit.



New Style Pump with quick change mounting system.

Old Style Pump used prior to 2010.

2.4.1 FRAME OIL PUMP OPTIONS

The new style pump (VRC28301) with a short tang shaft is provided as a standard on compressors built from 2010 onward (with serial number greater than or equal to 1001). The old style pump (VRC28300) with the longer keyed shaft was provided on compressors built prior to 2010.

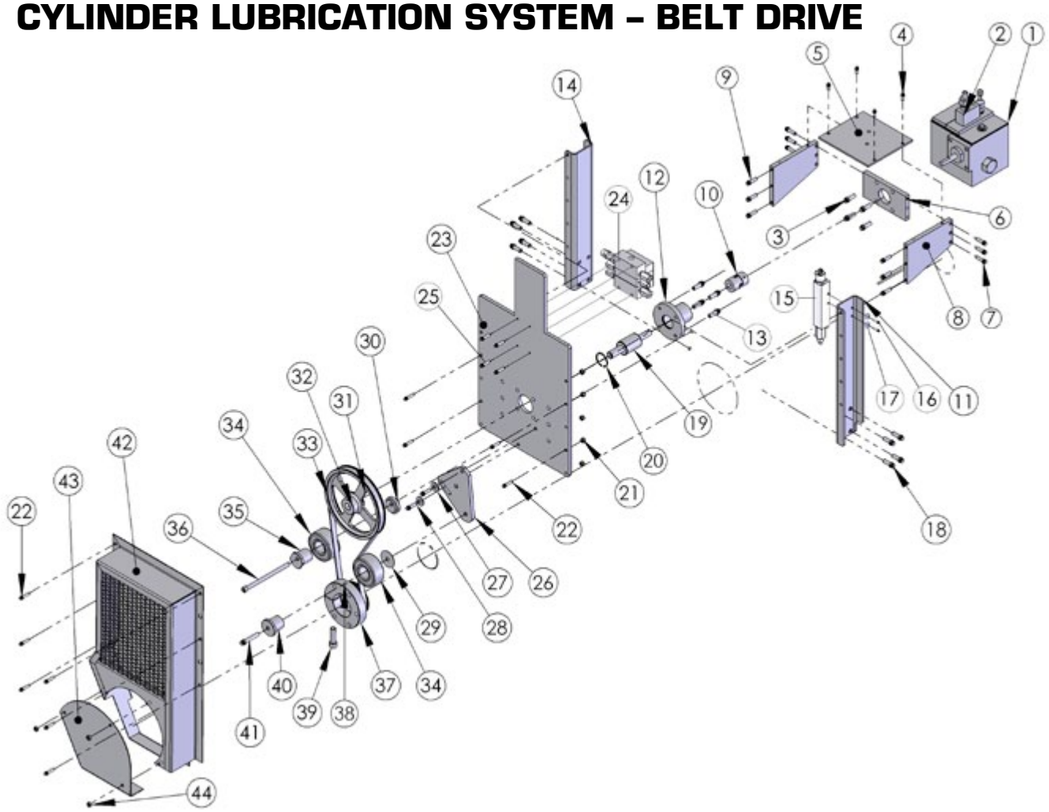
The new style pump requires the quick change mounting assembly. This allows the pump to be changed without having to open up the lube oil housing to remove the oil pump drive sprocket. This new mount system reduces the labor required to change the frame oil pump.

A retrofit kit is available with all the parts necessary to change from the old style pump to the new style pump and pump mounting assembly.

1 FRAME OIL PUMP RETROFIT KIT

ITEM NUMBER	PART NUMBER	DESCRIPTION	PART QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
	VRC28330K	KIT, MOUNT, PUMP, FRAME OIL - TO RETRO-FIT PUMP VRC28300 TO VRC28301	1			
3	VRC28305	GASKET, PUMP, FRAME OIL	2			
29	VRC28489	NUT, BELT GUARD & OIL PUMP	3			
30	VRC28301	PUMP, OIL, FRAME- WITH TANG SHAFT	1		1	
VRC28330A	VRC28330A	MOUNT, PUMP, FRAME OIL, ASSEMBLY (USED W/PUMP VRC28301)	1			
	31	VRC28335	RING, RETAINING, LARGE, BEARING, PUMP MOUNT	1			
	32	VRC28332	SHAFT, PUMP MOUNT, FRAME OIL	1			
	33	VRC28333	BEARING, SHAFT, PUMP MOUNT	2			
	34	VRC28334	RING, RETAINING, SMALL, SHAFT, PUMP MOUNT	1			
	35	VRC28331	MOUNT, PUMP, FRAME OIL	1			
36		VRC28337	STUD, PUMP MOUNT	3			
Sec 5.1, 2		VRC28810B	TUBING ASSEMBLY, STRAINER TO PUMP	1			
Sec 5.1, 4		VRC28811B	TUBING ASSEMBLY, RV TO FILTER INLET	1			
Sec 5.1, 5		VRC28812B	TUBING ASSEMBLY, RV TO SUMP	1			

2.5 FRAME LUBRICATION SYSTEM:
CYLINDER LUBRICATION SYSTEM – BELT DRIVE



• FRAME • CYLINDER LUBRICATION (BELT DRIVE) SYSTEM						
ITEM NUMBER	PART NUMBER	DESCRIPTION	PART QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
1	VRC28530A	RESERVOIR, PUMP, CYLINDER LUBE	1			
2	VRC28512	PUMP, OIL, CYLINDER LUBE, 1/4"	1	1		1
3	VRC21117	SCREW, LUBE OIL PUMP, 12 PT	4			
4	VRC28017	SCREW, TOP PLATE, 12 PT	4			
5	VRCC8570	PLATE, TOP PUMP SUPPORT, CNG	1			
6	VRC28572	PLATE, END PUMP SUPPORT	1			
7	VRC21327	SCREW, PLATE, SIDE PUMP SUPPORT, 12 PT	6			
8	VRC28571	PLATE, SIDE PUMP SUPPORT	2			
9	VRC21117	SCREW, PLATE SUPPORT, 12 PT	6			
10	VRC28573	COUPLING, SHAFT, LUBE OIL PUMP	1			1
11	VRC28551	SUPPORT, PLATE, MOUNTING, LEFT	1			
12	VRC28560	FLANGE, MOUNTING, CYLINDER LUBE PUMP	1			
13	VRC28427	SCREW, MOUNTING FLANGE, 12PT	4			

• FRAME • CYLINDER LUBRICATION (BELT DRIVE) SYSTEM						
ITEM NUMBER	PART NUMBER	DESCRIPTION	PART QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
14	VRC28552	SUPPORT, PLATE, MOUNTING, RIGHT	1			
15	VRC28720	SWITCH, NO-FLOW	1			
16	VRC28727	SCREW, NO-FLOW SWITCH	2			
17	VRC28728	LOCKNUT, NYLON, NO-FLOW SWITCH	2			
18	VRC21117	SCREW, PLATE SUPPORT, 12 PT	8			
19	VRC28581	SHAFT, INTEGRAL BEARING, LUBE OIL PUMP	1			
19A**	VRC28565A	FLANGE & INTEGRAL BEARING SHAFT ASSEMBLY - Includes: VRC28560 - FLANGE, MOUNTING, CYLINDER LUBE PUMP VRC28581 - SHAFT, INTEGRAL BEARING, LUBE OIL PUMP VRC28583 - RING, RETAINING, PUMP SHAFT"				
20	VRC28583	RING, RETAINING, PUMP SHAFT	1			
21	VRC28559	NUT, LOCK, MOUNTING PLATE	10			
22	VRC28557	SCREW, MOUNTING PLATE, AND BLT GRD, 12 PT	10			
23	VRCC8550	PLATE, MOUNTING, CYLINDER LUBE, CNG	1			
24	VRCC86XX	BLOCK, DIVIDER, CYLINDER LUBE OIL *	1		1	
25	VRC28607	SCREW, DIVIDER BLOCK, 12 PT	1			
26	VRC28472	PLATE, ADJUSTING BELT TENSIONER	1			
27	VRC28476	WASHER, ADJUSTING PLATE 3/8"	1			
28	VRC21117	SCREW, ADJUSTING BELT TENSIONER, 12 PT	2			
29	VRC28475	WASHER, BELT TENSIONER	1			
30	VRC28473	SPACER, IDLER, ECCENTRIC BELT	1			
31	VRC28465	SHEAVE, BELT, DRIVEN, LUBE PUMP	1			
32	VRC28239	SETSCREW, DRIVE SPROCKET	1			
33	VRC28400	BELT, DRIVE, CYLINDER LUBE PUMP	1	1	1	1
34	VRC28470	BEARING, IDLER AND TENSIONER, BELT	2		1	2
35	VRC28474	SLEEVE, IDLER, ECCENTRIC BELT	1			
36	VRC28067	SCREW, HOUSING AND IDLER (Socket Head)	1			
37	VRC28425	SHEAVE, BELT, DRIVE, LUBE PUMP	1			
38	VRC28429	SETSCREW, SHEAVE, DRIVE, LUBE PUMP	1			
39	VRC25017	SCREW, SHEAVE, DRIVE, LUBE PUMP, 12 PT	1			
40	VRC28471	SLEEVE, TENSIONER, BELT	1			
41	VRC28477	SCREW, IDLER SHEAVE, 12 PT	1			
42	VRC28480	GUARD, BELT, CYLINDER LUBE PUMP	1			
43	VRC28481	COVER, ACCESSORY DRIVE, BELT GUARD	1			
44	VRC28559	NUT, BELT GUARD	3			

* *Refer to Lubrication System Tubing & Fittings, Section 5.1*

** *Assembly not shown*

2.6 FRAME KITS

2.6.1 CONNECTING ROD BEARING KIT

BEARING KIT		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
VRC21232K	BEARING KIT, CONNECTING ROD, HEAVY AND LIGHT *	1
* *Kit contains all bearings for both heavy and light connecting rods.*		

2.6.2 FRAME GASKET KIT

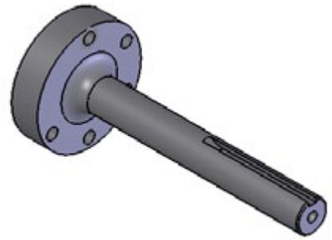
FRAME GASKET KIT		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
VRC21025K	GASKET KIT, FRAME, VRC-2 COMPRESSOR	1
Kit Contains: *1 - Gasket, Coverplate, Frame Top* *4 - Gasket, Coverplate, Frame Side*		

2.7 LUBRICATION SYSTEM ASSEMBLIES

LUBRICATION SYSTEM ASSEMBLIES		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
BELT DRIVE SYSTEM ASSEMBLIES		
VRC28502A	PUMP, OIL, CYLINDER LUBE, 1/4" w/RESERVOIR	1
VRC28565A	FLANGE & INTEGRAL BEARING SHAFT ASSEMBLY *	1
*** Assembly Includes:** *Flange, Mounting, Cylinder Lube Pump* *Shaft, Integral Bearing, Lube Oil Pump* *Ring, Retaining, Pump Shaft* *See Section 5.1 for additional lubrication system information.*		

2.8 FRAME ACCESSORIES

2.8.1 STUBSHAFT



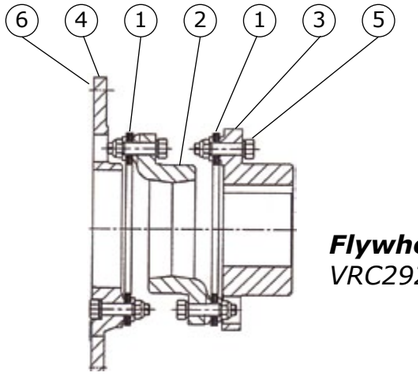
STUBSHAFT		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
VRC21150	STUBSHAFT, ACCESSORY-END, 1 7/16"D × 12"L 3/8" KEYWAY	1
VRC25077	SCREWS, STUB SHAFT, 12 PT (Not Shown)	5

This shaft is designed to belt drive a maximum of 10 horsepower, or direct drive a maximum of 15 horsepower.

2.8.2 BELL HOUSING

BELL HOUSING		
PART NUMBER	**DESCRIPTION**	**QTY**
VRC29260A	BELL HOUSING (Purchased as an assembly)	1
Assembly includes: *(1) Bell Housing, Top Piece* *(1) Bell Housing, Bottom Piece* *(1) Ring, Pilot, Bell Housing* *(2) Pin, Dowel, Bell Housing* *(4) Screw, Bell Housing* *(14) Screw, Bell Housing to Frame*		

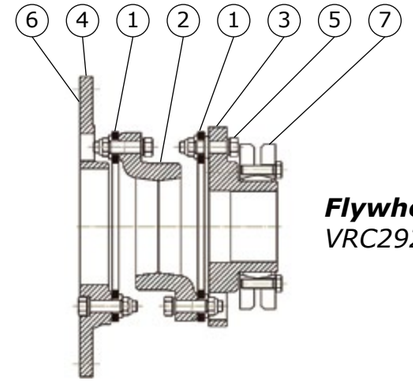
2.8.3 COUPLING PARTS – FLYWHEEL MOUNT



Flywheel Mount
VRC29230 or VRC29210

FLYWHEEL MOUNT			
ITEM NUMBER	**PART NUMBER**	**DESCRIPTION**	**QTY**
Arrow Standard Issue Rexnord VRC29230 COUPLING, FLEX-DISC, FLYWHEEL MT., REX CMR262			**1**
1	VRC29231	DISC PACK, TOMALLOY TPACK, REX	2
2	VRC29232	SPACER (SPIDER), CENTER SECTION, REX	1
3	VRC29233	HUB, COMPRESSOR SHAFT, 2.88"L STANDARD, REX	1
4	VRC29234	PLATE, FLYWHEEL ADAPTOR MT., 14SAE, REX	1
5	VRC29239	HARDWARE KIT: BOLTS, NUTS, AND WASHERS, REX (16 sets)	1
6	VRC29208	BOLT, FLYWHEEL ADAPTOR, COUPLING (Not Shown)	8
Optional TB Woods VRC29210 COUPLING, FLEX-DISC, FLYWHEEL MT., TB WOODS FSH26			**1**
1	VRC29211	DISC PACK, ALLOY STEEL, TB WOODS	2
2	VRC29212	SPACER (SPIDER), CENTER SECTION, TB WOODS	1
3	VRC29213	HUB, COMPRESSOR SHAFT, 2.38"L CUSTOM, TB WOODS	1
4	VRC29214	PLATE, FLYWHEEL ADAPTOR MT., 14SAE, TB WOODS	1
5	VRC29219	HARDWARE KIT: BOLTS, NUTS, AND WASHERS, TB WOODS (16 sets)	1
6	VRC29208	BOLT, FLYWHEEL ADAPTOR, COUPLING (Not Shown)	8

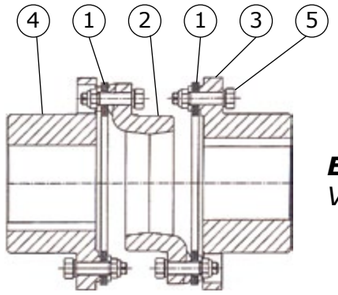
2.8.4 COUPLING PARTS – FLYWHEEL MOUNT W/CLAMP



Flywheel Mount w/Clamp
VRC29236

FLYWHEEL MOUNT w/CLAMP			
ITEM NUMBER	**PART NUMBER**	**DESCRIPTION**	**QTY**
Optional VRC29236 REXNORD COUPLING with CLAMP, FLEX-DISC, FLYWHEEL MT. W/CLAMP, REX CMR262			
1	VRC29231	DISC PACK, TOMALLOY TPACK, REX	2
2	VRC29232	SPACER (SPIDER), CENTER SECTION, REX	1
3	VRC29237	HUB, COMPRESSOR SHAFT, 2.38"L, REX (used with clamp VRC29238)	1
4	VRC29234	PLATE, FLYWHEEL ADAPTOR MT., 14SAE, REX	1
5	VRC29239	HARDWARE KIT: BOLTS, NUTS, AND WASHERS, REX (16 sets)	1
6	VRC29208	BOLT, FLYWHEEL ADAPTOR, COUPLING (Not Shown)	8
7	VRC29238	CLAMP, B-LOC, HALF SHRINK DISK TYPE HT	1

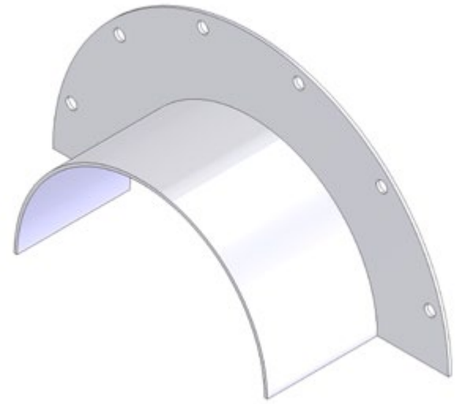
2.8.5 COUPLING PARTS – ELECTRIC MOTOR MOUNT



Electric Motor Mount
VRC29240

ELECTRIC MOTOR MOUNT			
ITEM NUMBER	**PART NUMBER**	**DESCRIPTION**	**QTY**
Optional VRC29240 REXNORD COUPLING for MOTOR DRIVE, FLEX-DISC, REX AMR262			**1**
1	VRC29231	DISC PACK, TOMALLOY TPACK, REX	2
2	VRC29232	SPACER (SPIDER), CENTER SECTION, REX	1
3	VRC29233	HUB, COMPRESSOR SHAFT, 2.88"L STANDARD, REX	1
4	VRC29245	HUB, MOTOR MT., BLANK BORE (ID to be machined by others)	1
5	VRC29239	HARDWARE KIT: BOLTS, NUTS, AND WASHERS, REX (16 sets)	1

2.8.6 COUPLING GUARD



COUPLING GUARD		
PART NUMBER	**DESCRIPTION**	**QTY**
VRC29250	GUARD, COUPLING, ENGINE MT. HALF-SHELL*	1*
VRC29317	SCREW, GUARD, HEX HEAD	6
* *Two are required to completely enclose the coupling.*		

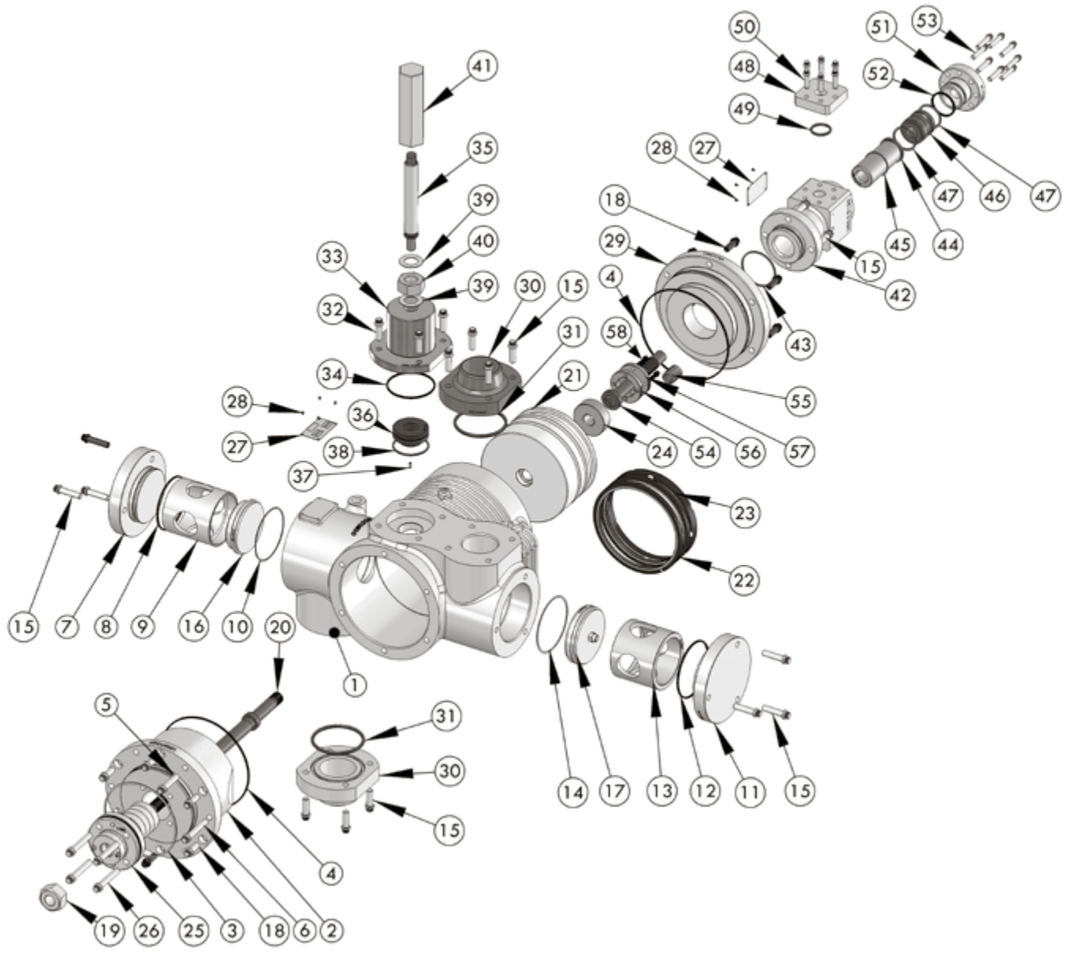
2.8.7 ADJUSTABLE MOUNTING CHOCK

ADJUSTABLE MOUNTING CHOCK		
PART NUMBER	**DESCRIPTION**	**QTY**
VRC29309	CHOCK, ADJUSTABLE, ENGINE MOUNTING	4

3 - CYLINDERS & PISTONS

PARTS, KITS & ASSEMBLIES

3.1 8.5” X 1.125” STEEPLE CYLINDER ASSEMBLY

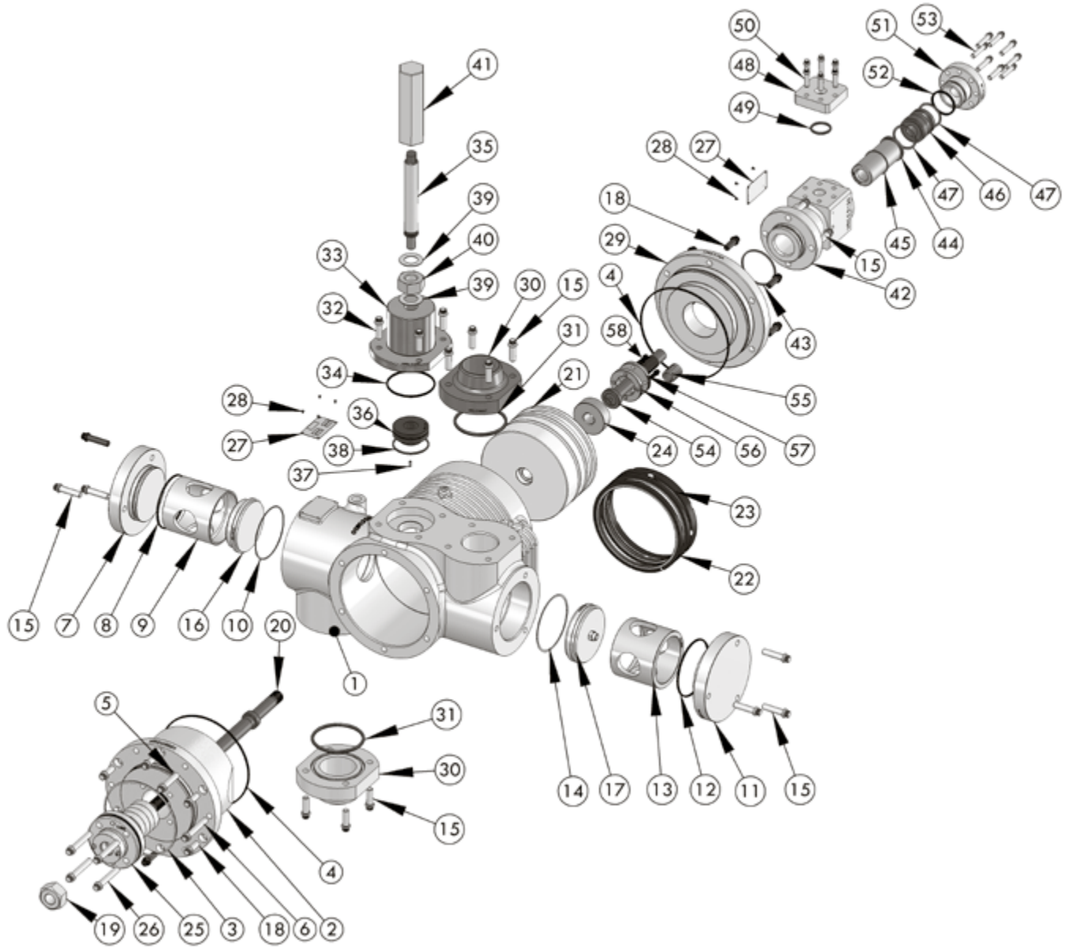


NUMBER	PART NUMBER	DESCRIPTION	QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
	VRCC5850A	CYLINDER, STEEPLE, 8.5" SACE CNG ASSEMBLY				
1	VRCC5850	CYLINDER, STEEPLE, 8.5” SACE CNG	1			
2	VRCC5851	HEAD, CRANK-END, 8.5” SACE CNG	1			
3	VRC25262	O-RING, HEAD, CRANK-END TO FRAME	1	1	1	1
4	VRCC5852	O-RING, CE & HE HEAD, 8.5” CNG	2	2	2	2
5	VRC25027	SCREW, CYLINDER TO FRAME, SHORT, 12PT	4			
6	VRC25037	SCREW, CYLINDER TO FRAME, LONG, 12PT	2			
7	VRCC5903	COVER, VALVE, DISCHARGE, 8.5” CNG	1			
8	VRCC5904	O-RING, COVER, DISCHARGE VALVE, 8.5” CNG	1	1	1	1
9	VRCC5858	RETAINER, VALVE, DISCHARGE, 8.5” CNG	1			1
10	VRCC5905	GASKET, DISCHARGE VALVE SEAT, 8.5” CNG	1	2	2	2
11	VRCC5853	COVER, VALVE, SUCTION, 8.5” CNG	1			
12	VRCC5854	O-RING, COVER, SUCTION VALVE, 8.5” CNG	1	1	1	1
13	VRCC5856	RETAINER, VALVE, SUCTION, 8.5” CNG	1			1
14	VRCC5655	GASKET, SUCTION VALVE SEAT, 6.5-8.5” CYLINDER	1	2	2	2
15	VRC25077	SCREW, 12PT	18			
16	VRCC6825	VALVE, DISCHARGE, 8.5” CNG	1	1	1	1
17	VRCC6815	VALVE, SUCTION, 8.5” CNG	1	1	1	1
18	VRC25067	SCREW, HEAD, CRANK-END, 12PT	12			
19	VRC24909	NUT, JAM, PISTON ROD	1			1
20	VRCC4112	ROD, PISTON, CNG 8.5” X 1.125”	1			1
21	VRCC4850	PISTON, CNG, 8.5” SACE	1			1
22	VRCC4851	RING, 8.5” CNG PISTON, WITH EXPANDER	2	2	2	2
23	VRCC4852	BAND, RIDER, 8.5” CNG PISTON	1	1	1	1
24	VRCC4989	NUT, PISTON, CNG 8.5” SACE	1			1
25	VRC23001A	CASE, PACKING ASSEMBLY*	1			1
26	VRC23107	SCREW, PACKING CASE, 12PT	4			
27	VRCC5100	NAMEPLATE, VRC-CNG CYLINDER	2			
28	VRC21606	PIN, NAMEPLATE	8			
29	VRCC5901	HEAD, HEAD-END, 8.5” SACE CNG	1			
30	VRCC5857	FLANGE, SUCTION & DISCHARGE, 3” WELD-NECK, 8.5” CNG	2			
	VRCC5859	FLANGE, SUCTION & DISCHARGE, 3” NPT, 8.5” CNG (Option)**	2			
31	VRCC5902	O-RING, FLANGE, SUCTION & DISCHARGE, 8.5” CNG	2	2	2	2
32	VRC25017	SCREW, 12PT	4			
33	VRCC7850	POCKET, VARIABLE VOLUME CLEARANCE., 8.5” CNG	1			
34	VRCC5233	O-RING, 2.25” CYLINDER, 4.0” HD. & VVCP	1	1	1	1

8.5 × 1.125 STEEPLE CYLINDER ASSEMBLY

* Packing Case Ring Kits are available. See Section 3.3.1

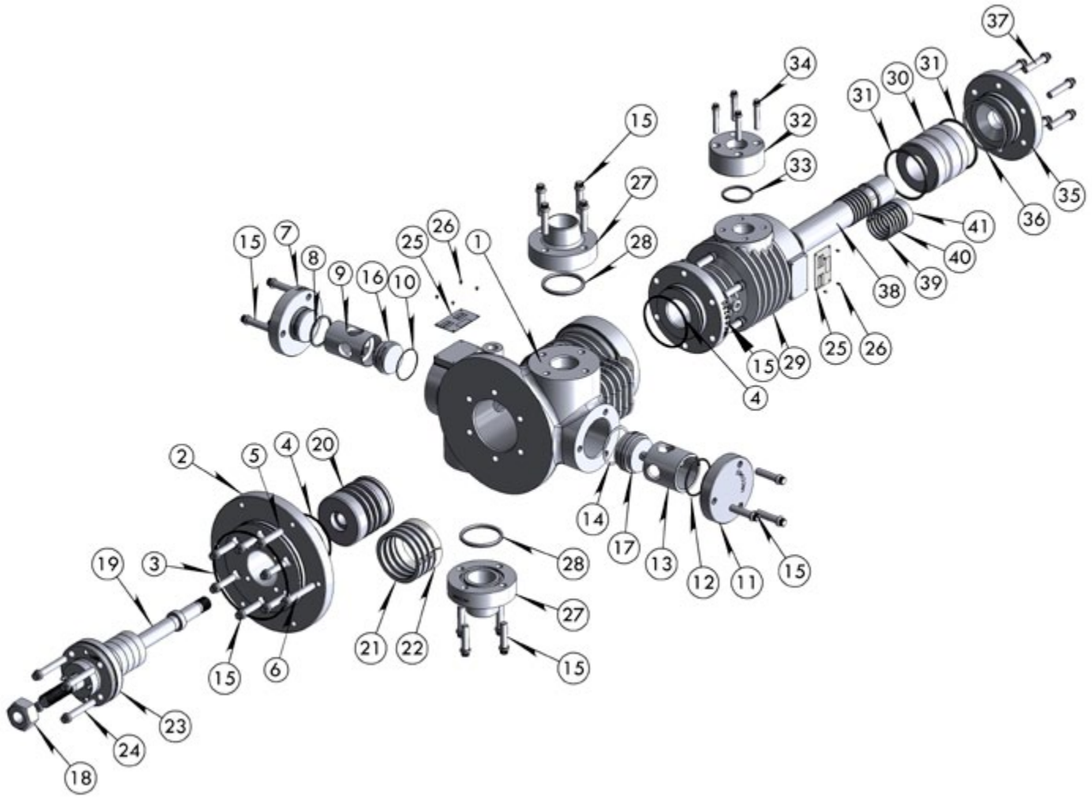
** For optional suction and discharge flange screws (Item 15), use VRCC5007



8.5 × 1.125 STEEPLE CYLINDER ASSEMBLY, *continued*

NUMBER	PART NUMBER	DESCRIPTION	QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
	VRCC7800A	PISTON & STEM ASSEMBLY, VVCP, CNG				
VRCC7800A 35	VRCC7800	STEM, VVCP ADJUSTING, CNG	1			
VRCC7800A 36	VRCC7857	PISTON, 8.5" VVCP, CNG	1			
VRCC7800A 37	VRCC7806	SPRING PIN, VVCP PISTON, CNG	1			
38	VRCC7858	O-RING, 8.5" VVCP PISTON, CNG	1	1	1	1
39	VRCC7805	GASKET, VVCP ADJUSTING STEM, CNG	2			2
40	VRCC7803	NUT, JAM, VVCP ADJUSTING STEM, CNG	1			1
41	VRCC7801	COVER, VVCP ADJUSTING STEM, CNG	1			
	VRCC5120A	CYLINDER, STEEPLE, 1.125" SAHE CNG ASSEMBLY				
42	VRCC5120	CYLINDER, STEEPLE, 1.125" SAHE CNG	1			
43	VRCC5123	O-RING, 1.125" CYLINDER, CNG	1	1	1	1
44	VRCC5121	LINER, CYLINDER, 1.125" SAHE CNG	1			1
45	VRCC5122	GASKET, LINER, CYLINDER, 1.125" SAHE CNG	1	1	1	1
46	VRCC6125	VALVE, CONCENTRIC, 1.125 " CNG	1	1	1	1
47	VRCC5125	GASKET, VALVE SEAT & TOP, 1.125" CNG	2	2	2	2
48	VRCC5126	FLANGE, SUCTION, 3/4" NPT, 1.125" CNG	1			
49	VRCC5127	O-RING, SUCTION FLANGE, 1.125" CNG	1	1	1	1
50	VRC28257	SCREW, 12PT	6			
51	VRCC5128	FLANGE/RTR., DISCHARGE, 3/4" NPT, 1.125" CNG	1			
52	VRCC5124	O-RING, DISCHARGE FLANGE, 1.125" CNG	1	1	1	1
53	VRCC5017	SCREW, DISCHARGE FLANGE, 1.125" CNG	8			
54	VRCC4120	PISTON, CNG, 1.125" SAHE	1			1
55	VRCC4121	RING, 1.125" CNG PISTON, BUTT CUT	6	6	6	6
56	VRCC4126	SPACER, CLIP, 1.125" CNG PISTON	1			1
57	VRCC4125	CLIP, 1.125" CNG PISTON	1			1
58	VRCC4127	SCREW, CLIP, 1.125" CNG PISTON	4			4

3.2 4.0” X 2.25” STEEPLE CYLINDER ASSEMBLY

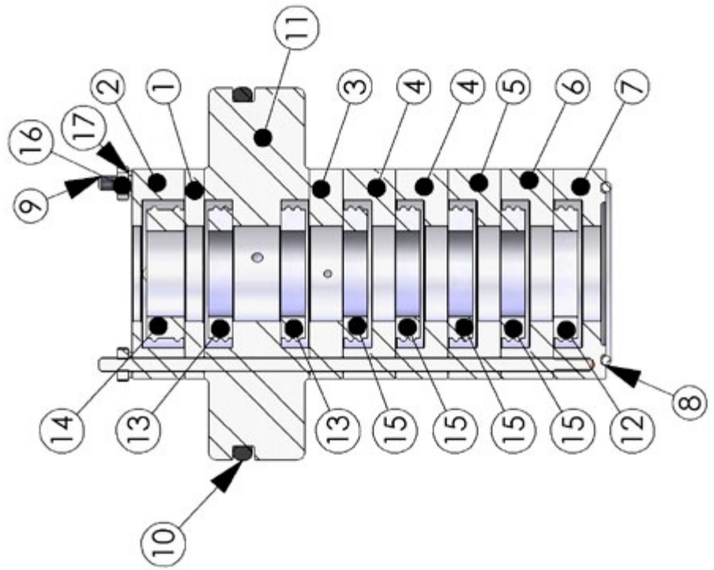


4.0 × 2.25 STEEPLE CYLINDER ASSEMBLY

NUMBER	PART NUMBER	DESCRIPTION	QTY	RECOMMENDED SPARE PARTS		
				Start-Up	Minor	Major
	VRCC5400	CYLINDER, STEEPLE, 4.0” SACE CNG ASSEMBLY				
1	VRCC5400	CYLINDER, STEEPLE, 4.0” SACE CNG	1			
2	VRCC5401	HEAD, CRANK-END, 4.0” SACE CNG	1			
3	VRC25262	O-RING, HEAD, CRANK-END TO FRAME	1	1	1	1
4	VRCC5233	O-RING, 2.25” CYLINDER, 4.0” HD. & VVCP	2	2	2	2
5	VRC25027	SCREW, CYLINDER TO FRAME, SHORT, 12 PT	4			
6	VRC25037	SCREW, CYLINDER TO FRAME, LONG, 12 PT	2			
7	VRCC5453	COVER, VALVE, DISCHARGE, 4.0” CNG	1			
8	VRCC5454	O-RING, COVER, DISCHARGE VALVE, 4.0” CNG	1	1	1	1
9	VRCC5408	RETAINER, VALVE, DISCHARGE, 4.0” CNG	1			1
10	VRCC5455	GASKET, DISCHARGE VALVE SEAT, 4.0” CNG	1	2	2	2
11	VRCC5403	COVER, VALVE, SUCTION, 4.0” CNG	1			
12	VRCC5404	O-RING, COVER, SUCTION VALVE, 4.0” CNG	1	1	1	1
13	VRCC5406	RETAINER, VALVE, SUCTION, 4.0” CNG	1			1
14	VRCC5405	GASKET, SUCTION VALVE SEAT, 4.0” CNG	1	2	2	2
15	VRC25077	SCREW, 12 PT	20			
16	VRCC6425	VALVE, DISCHARGE, 4.0” CNG	1	1	1	1
17	VRCC6415	VALVE, SUCTION, 4.0" CNG	1	1	1	1
18	VRC24909	NUT, JAM, PISTON ROD	1			1
19	VRCC4111	ROD, PISTON, CNG 4.0” X 2.25”	1			1
20	VRCC4400	PISTON, CNG, 4.0” SACE	1			1
21	VRCC4401	RING, 4.0” CNG PISTON, STEP CUT	3	3	3	3
22	VRCC4402	BAND, RIDER, 4.0” CNG PISTON	1	1	1	1
23	VRC23001A	CASE, PACKING ASSEMBLY *	1	1		1
24	VRC23107	SCREW, PACKING CASE	4			
25	VRCC5100	NAMEPLATE, VRC-CNG CYLINDER	2			
26	VRC21606	PIN, NAMEPLATE	8			
27	VRCC5407	FLANGE, SUCTION & DISCHARGE, 2” WELD-NECK, 4.0” CNG	2			
	VRCC5409	FLANGE, SUCTION & DISCHARGE, 2” NPT, 4.0” CNG (Option)	2			
28	VRCC5452	O-RING, FLANGE, SUCTION & DISCHARGE, 4.0” CNG	2	2	2	2
	VRCC5230A	CYLINDER, STEEPLE, 2.25” SAHE CNG ASSEMBLY				
29	VRCC5230	CYLINDER, STEEPLE, 2.25” SAHE CNG	1			
30	VRCC6235	VALVE, CONCENTRIC, 2.25” CNG	1	1	1	1
31	VRCC5235	GASKET, VALVE SEAT & TOP, 2.25” CNG	2	4	4	4
32	VRCC5236	FLANGE, SUCTION, 1 1/4” NPT, 2.25” CNG	1			
33	VRCC5237	O-RING, SUCTION FLANGE, 2.25” CNG	1	1	1	1
34	VRCC5017	SCREW, 12PT. *	4			
35	VRCC5238	FLANGE/RTR., DISCHARGE, 1 1/4” NPT, 2.25” CNG	1			
36	VRCC5234	O-RING, DISCHARGE FLANGE, 2.25” CNG	1	1	1	1
37	VRCC5007	SCREW, DISCHARGE FLANGE, 2.25” CNG	6			
38	VRCC4230	PISTON, CNG, 2.25” SAHE	1			1
39	VRCC4233	RING, 2.25” CNG PISTON, STEP CUT	2	2	2	2
40	VRCC4231	RING, 2.25” CNG PISTON, ANGLE CUT	3	3	3	3
41	VRCC4232	BAND, RIDER, 2.25” CNG PISTON	1	1	1	1

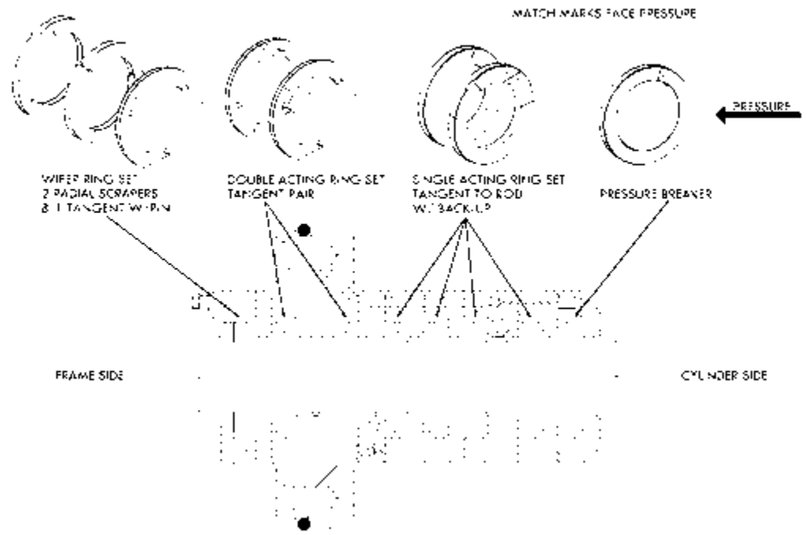
* For optional suction and discharge flange screws (item 15), use VRCC5007

3.3 PRESSURE PACKING, PISTON ROD



PISTON ROD PACKING CASE			
NUMBER	**PART NUMBER**	**DESCRIPTION**	**QTY**
	VRC23001A	CASE, PACKING ASSEMBLY	1
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	VRC23115	WASHER, SEAL, PACKING CASE STUD	3

3.3.1 PRESSURE PACKING KITS, PISTON ROD



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

PISTON ROD PRESSURE PACKING KITS FOR STEEPLE CYLINDERS		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
VRC23001A	CASE, PACKING ASSEMBLY , COMPLETE	1
VRC23501	RING KIT, PACKING RENEWAL W/PARTS INCLUDE: O-RING, NOSE GASKET, NUTS AND WASHERS	1 (Kit)
VRC23551	RING KIT, PACKING RENEWAL RINGS ONLY	1 (Kit)

3.4 CYLINDER O-RING & GASKET KITS

CYLINDER O-RING & GASKET KITS		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
VRCC5850K	**O-RING & GASKET KIT, 8.5" SACE CNG STEEPLE CYLINDER**	
VRC25262	O-RING, HEAD, CRANK-END TO FRAME	1
VRCC5852	O-RING, CE & HE HEAD, 8.5" CNG	2
VRCC5854	O-RING, COVER, SUCT. VALVE, 8.5" CNG	1
VRCC5855	GASKET, SUCT. VALVE SEAT, 8.5" CNG	1
VRCC5902	O-RING, FLANGE, SUCT. & DISCH., 8.5" CNG	2
VRCC5904	O-RING, COVER, DISCH. VALVE, 8.5" CNG	1
VRCC5905	GASKET, DISCH. VALVE SEAT, 8.5" CNG	1
VRCC5233	O-RING, 2.25" CYL., 4.0" HD. & VVCP	1
VRCC7858	O-RING, 8.5" VVCP PISTON, CNG	1
VRCC5400K	**O-RING & GASKET KIT, 4.0" SACE CNG STEEPLE CYLINDER**	
VRC25262	O-RING, HEAD, CRANK-END TO FRAME	1
VRCC5233	O-RING, 2.25" CYL., 4.0" HD. & VVCP	1
VRCC5404	O-RING, COVER, SUCT. VALVE, 4.0" CNG	1
VRCC5405	GASKET, SUCT. VALVE SEAT, 4.0" CNG	1
VRCC5452	O-RING, FLANGE, SUCT. & DISCH., 4.0" CNG	2
VRCC5454	O-RING, COVER, DISCH. VALVE, 4.0" CNG	1
VRCC5455	GASKET, DISCH. VALVE SEAT, 4.0" CNG	1
VRCC5230K	**O-RING & GASKET KIT, 2.25" SAHE CNG STEEPLE CYLINDER**	
VRCC5233	O-RING, 2.25" CYL., 4.0" HD. & VVCP	1
VRCC5234	O-RING, DISCH. FLANGE, 2.25" CNG	1
VRCC5235	GASKET, VALVE SEAT & TOP, 2.25" CNG	2
VRCC5237	O-RING, SUCT. FLANGE, 2.25" CNG	1
VRCC5120K	**O-RING & GASKET KIT, 1.125" SAHE CNG STEEPLE CYLINDER**	
VRCC5123	O-RING, 1.125" CYL., CNG	1
VRCC5122	GASKET, LINER, CYL., 1.125" SAHE CNG	1
VRCC5124	O-RING, DISCH. FLANGE, 1.125" CNG	1
VRCC5125	GASKET, VALVE SEAT & TOP, 1.125" CNG	2
VRCC5127	O-RING, SUCT. FLANGE, 1.125" CNG	1

3.5 STEEPLE CYLINDER AND PISTON/ROD ASSEMBLIES

STEEPLE CYLINDER & PISTON/ROD ASSEMBLIES		
PART NUMBER	**DESCRIPTION OF PART**	**QTY.**
8.5 ×1.125 STEEPLE CYLINDER AND PISTON / ROD		
VRCC5850A	CYLINDER, STEEPLE, 8.5" SACE CNG, ASSEMBLY	1
VRCC5120A	CYLINDER, STEEPLE, 1.125" SAHE CNG, ASSEMBLY	1
VRCC4850A	PISTON & ROD ASSEMBLY, 8.5"/1.125" CNG	1
4.0 × 2.25 STEEPLE CYLINDER AND PISTON / ROD		
VRCC5400A	CYLINDER, STEEPLE, 4" SACE CNG, ASSEMBLY	1
VRCC5230A	CYLINDER, STEEPLE, 2.25" SAHE CNG, ASSEMBLY	1
VRCC4540A	PISTON & ROD ASSEMBLY, 4.0"/2.25" CNG	1

All Piston/Rod Assemblies include:

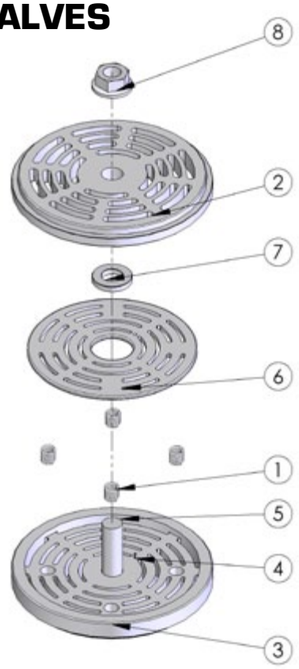
Pistons
Piston Rod
Piston Rings
Rider Bands
Piston Nut
*Piston Rod Jam Nut**

* The VRC-CNG compressor is available in only one cylinder configuration (8.5/4.0/2.25/1.125) and has been designed so that the throws are inherently balanced. It is therefore unnecessary to use extra heavy jam nuts or crosshead assembly weights on the CNG unit.

4 - VALVES

PARTS, KITS & ASSEMBLIES

4.1 SUCTION VALVES

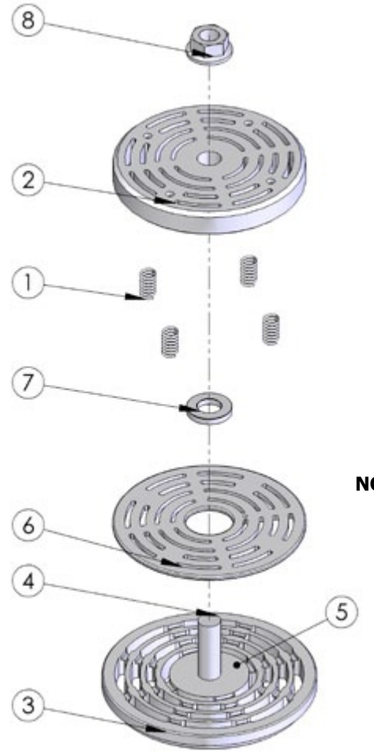


NOTE: Arrow Valve Repair Kits do not include valve seat gaskets. It is recommended that new valve seat gaskets be used every time a valve is installed. Refer to the specific cylinder size assembly parts list for "Gasket, Suction & Discharge Valve Seat" part numbers.

TYPICAL SUCTION VALVE PARTS & KITS

NUMBER	PART NUMBER	DESCRIPTION	QTY
1A	VRC26XX1	SPRING, CLOSING, VALVE, LIGHT	9-16
1B	VRC26XX3	SPRING, CLOSING, VALVE, MEDIUM LIGHT	9-16
1C	VRC26XX5	SPRING, CLOSING, VALVE, MEDIUM	9-16
1D	VRC26XX7	SPRING, CLOSING VALVE, HEAVY	9-16
2	VRC26XXX	SEAT, VALVE, SUCTION	1
3	VRC26XXX	GUARD, VALVE, SUCTION	1
4	VRC26XXX	PIN, LOCATING, VALVE	1
5	VRC26XXX	BOLT, CENTER, VALVE	1
6	VRC26XXX	PLATE, VALVE, SUCTION	1
7	VRC26XXX	RING, GUIDE, VALVE	1
8	VRC26XXX	NUT, LOCK, VALVE	1
NOTE: Part numbers are specific to each model valve depending on what size cylinder they are for.			
	VRCC6815K	KIT, VALVE, SUCTION, 8.5" CNG	
	VRCC6415K	KIT, VALVE, SUCTION, 4.0" CNG	
NOTE: Each kit contains one each - plate, spring set, nut, ring and pin.			

4.2 DISCHARGE VALVES

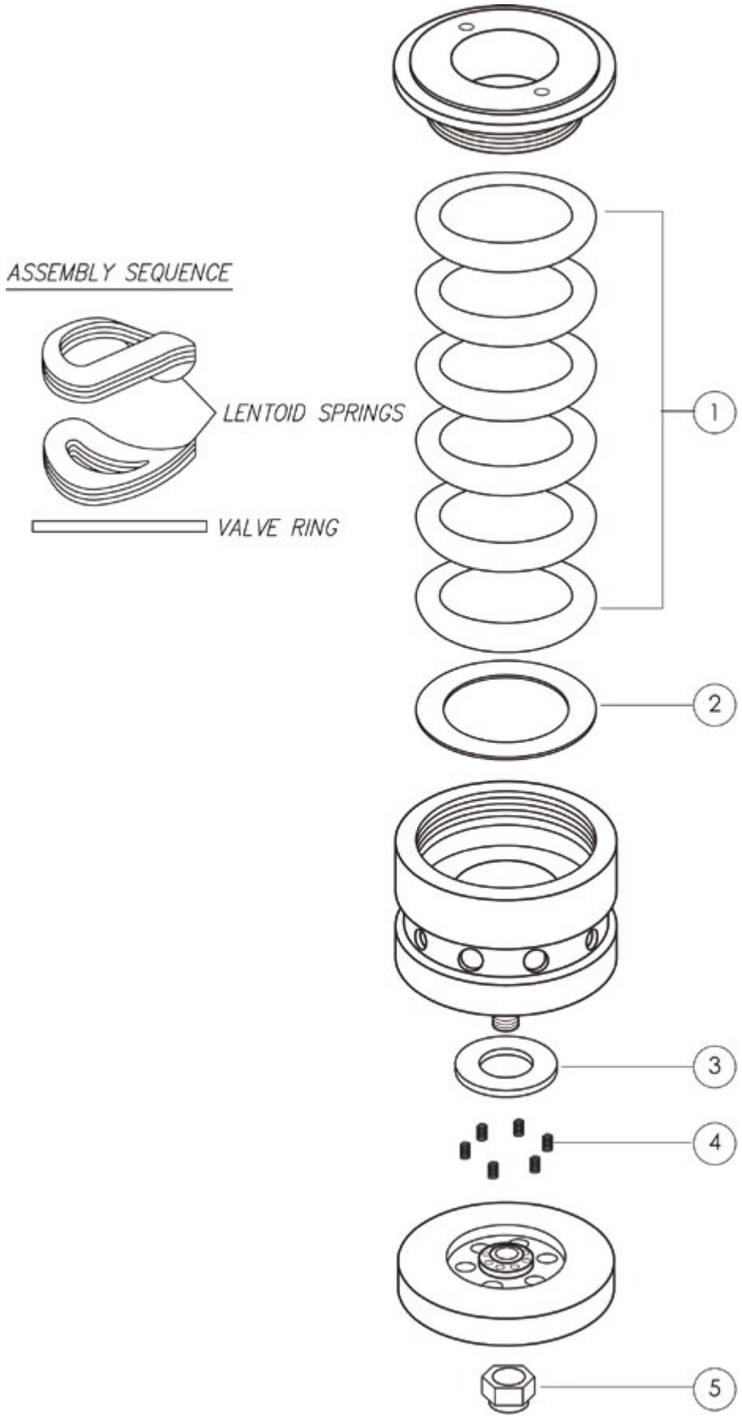


NOTE: Arrow Valve Repair Kits do not include valve seat gaskets. It is recommended that new valve seat gaskets be used every time a valve is installed. Refer to the specific cylinder size assembly parts list for "Gasket, Suction & Discharge Valve Seat" part numbers.

TYPICAL DISCHARGE VALVE PARTS & KITS

NUMBER	PART NUMBER	DESCRIPTION	QTY
1A	VRC26XX1	SPRING, CLOSING, VALVE, LIGHT	9-20
1B	VRC26XX3	SPRING, CLOSING, VALVE, MEDIUM LIGHT	9-20
1C	VRC26XX5	SPRING, CLOSING, VALVE, MEDIUM	9-20
1D	VRC26XX7	SPRING, CLOSING, VALVE, HEAVY	9-20
2	VRC26XXX	GUARD, VALVE, DISCHARGE	1
3	VRC26XXX	SEAT, VALVE, DISCHARGE	1
4	VRC26XXX	BOLT, CENTER, VALVE	1
5	VRC26XXX	PIN, LOCATING, VALVE (Part Not Shown)	1
6	VRC26XXX	PLATE, VALVE, DISCHARGE	1
7	VRC26XXX	RING, GUIDE, VALVE	1
8	VRC26XXX	NUT, LOCK, VALVE	1
NOTE: Part numbers are specific to each model valve depending on what size cylinder they are for.			
	VRCC6825K	KIT, VALVE, DISCHARGE, 8.5" CNG	
	VRCC6425K	KIT, VALVE, DISCHARGE, 4.0" CNG	
NOTE: Each kit contains one each - plate, spring set, nut, ring and pin.			

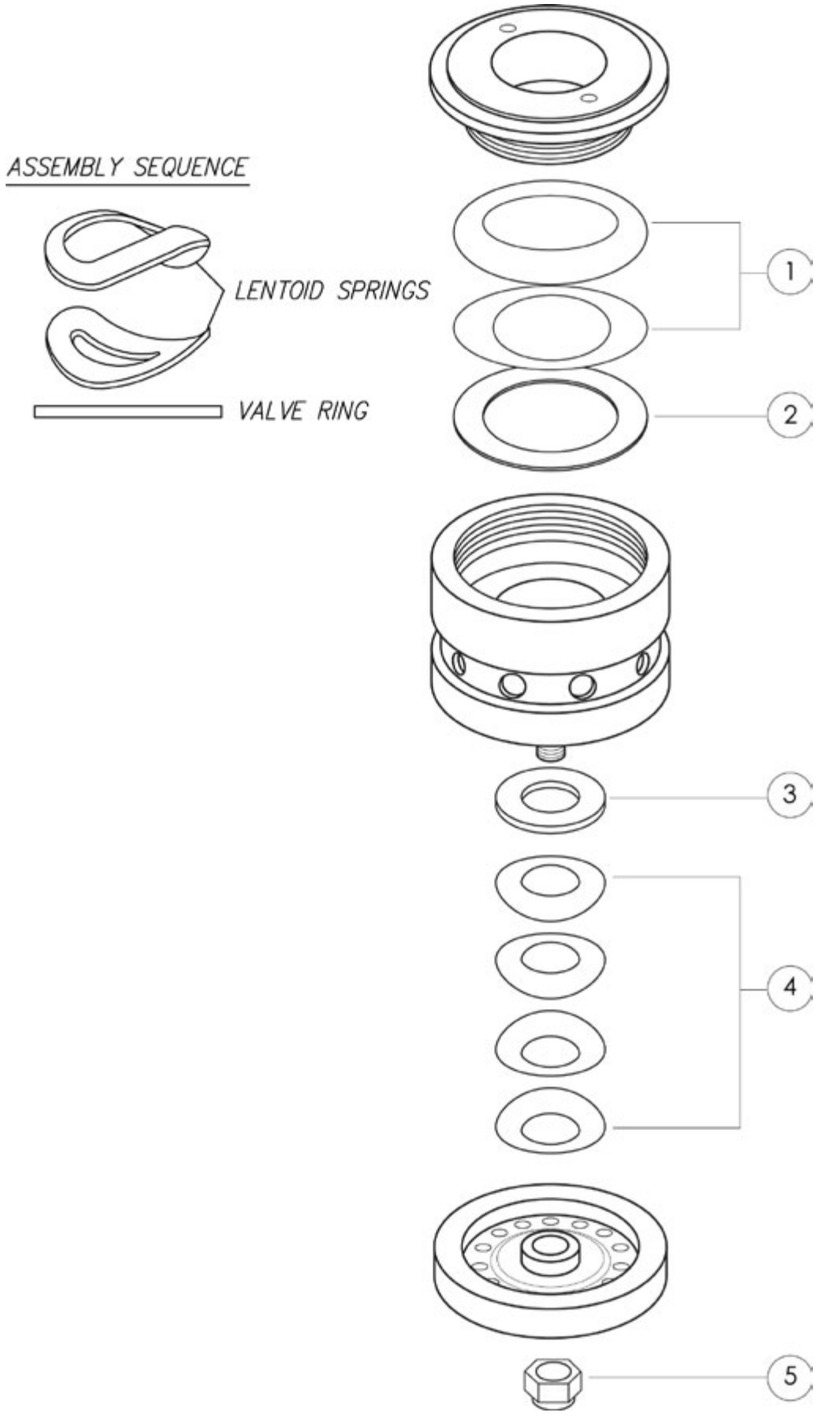
4.3 CONCENTRIC VALVE KIT FOR 2.25” CYLINDER



CONCENTRIC VALVE KIT - for 2.25” Cylinder			
PART NUMBER		**DESCRIPTION OF PART**	**QTY.**
VRCC6235A		**Valve, Concentric, 2.25” CNG Assembly**	
VRCC6235K		**Concentric Valve Repair Kit**	
VRCC6235K	1	Lentoid Springs, Suction	6
	2	Suction Plate/Ring	1
	3	Discharge Plate/Ring	1
	4	Closing Springs	6
	5	Lock Nut	1

NOTE: Arrow Valve Repair Kits do not include valve seat gaskets. It is recommended that new valve seat gaskets be used every time a valve is installed. Refer to the specific cylinder size assembly parts list for “Gasket, Suction & Discharge Valve Seat” part numbers.

4.4 CONCENTRIC VALVE KIT FOR 1.125” CYLINDER

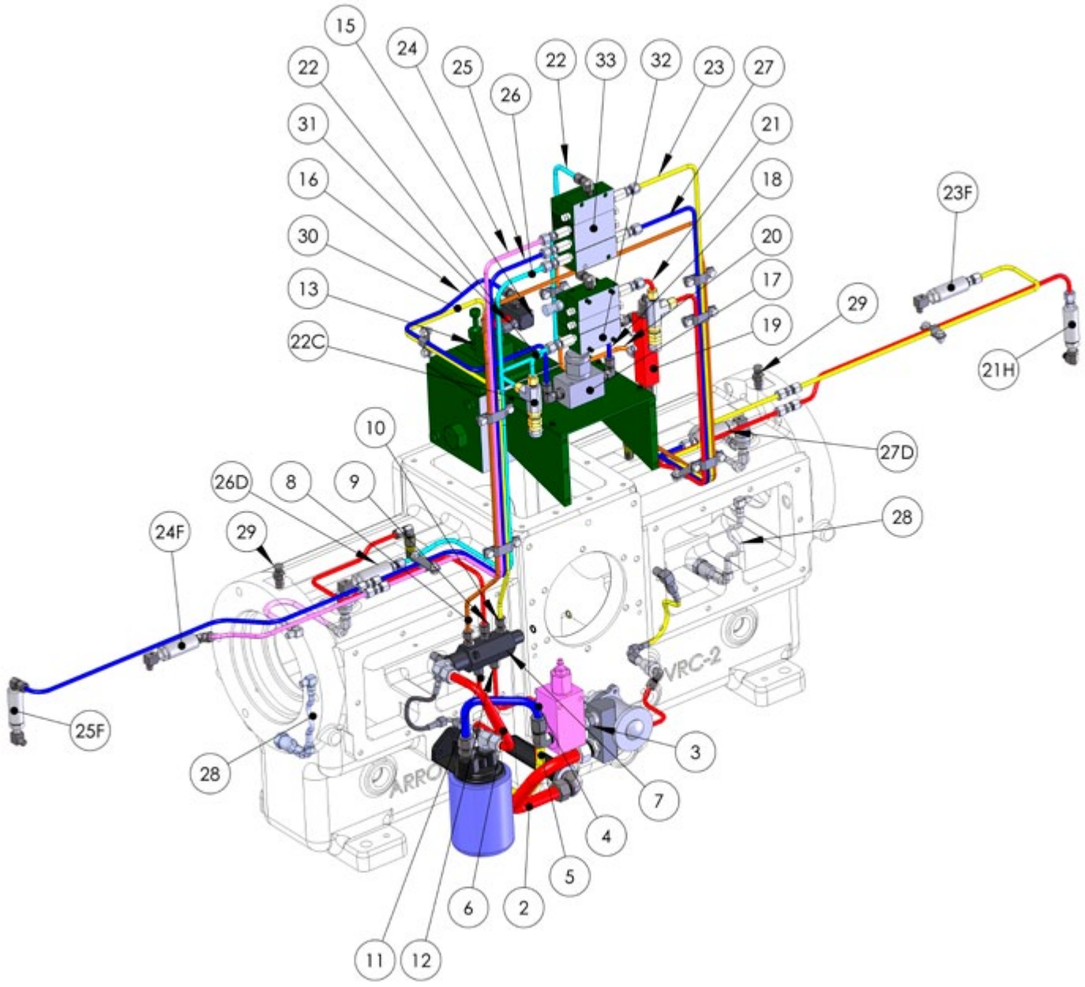


CONCENTRIC VALVE KIT - for 1.125” Cylinder			
PART NUMBER		**DESCRIPTION OF PART**	**QTY.**
VRCC6125A		**Valve, Concentric. 1.125” CNG Assembly**	
VRCC6125K		**Concentric Valve Repair Kit**	
VRCC6125	1	Lentoid Springs, Suction	2
	2	Suction Plate / Ring	1
	3	Discharge Plate / Ring	1
	4	Lentoid Springs, Discharge	4
	5	Lock Nut	1

NOTE: Arrow Valve Repair Kits do not include valve seat gaskets. It is recommended that new valve seat gaskets be used every time a valve is installed. Refer to the specific cylinder size assembly parts list for “Gasket, Suction & Discharge Valve Seat” part numbers.

5 - LUBRICATION SYSTEM

5.1 TUBING & DISTANCE PIECE VENTING



LUBRICATION SYSTEM TUBING & FITTINGS

	NUMBER	PART NUMBER	DESCRIPTION	QUANTITY	RECOMMENDED SPARE PARTS	
					Start-Up	Minor
	1	VRCC8800A	TUBING & FITTINGS KIT, COMPLETE, CNG (All Assemblies for One Unit)	1		
	1A	VRC28802	CLAMP, TUBING, 2 TUBE (W/Screws & Nuts)	5		
	1B	VRC28803	CLAMP, TUBING, 3 TUBE (W/Screws & Nuts)	2		
	1C	VRC28804	CLAMP, TUBING, 4 TUBE (W/Screws & Nuts)	5		
	1D	VRC28805	CLAMP, TUBING, 5 TUBE (W/Screws & Nuts)	2		
VRC28810B	2	VRC28810B	TUBING ASSEMBLY, STRAINER TO PUMP	1		
VRC28810B	2A	VRC28871	FITTING, 1/2" 14 NPT X 3/4" TUBE 90	1		
VRC28810B	2B	VRC28875-12	TUBING, 3/4" 304SS, 12" LONG (.035 Wall)	1		
VRC28810B	2C	VRC28872	FITTING, 1/2" 14 NPT X 3/4" TUBE STR.	1		
	3	VRC28801A	FITTING, PUMP TO RV, 1/2" 14 NPTF X 3/4"- 16 SAE O-RING	1		
VRC28811B	4	VRC28811B	TUBING ASSEMBLY, RV TO FILTER INLET	1		
VRC28811B	4A	VRC28815	FITTING, 3/4" 16 SAE O-RING X 1/2" TUBE 90	1		
VRC28811B	4B	VRC2850-11.8	TUBING, 1/2" 304SS, 11.8" LONG (.035 Wall)	1		
VRC28811B	4C	VRC28851	FITTING, 1/2" 14 NPT X 1/2" TUBE STR.	1		
VRC28812B	5	VRC28812B	TUBING ASSEMBLY, RV TO SUMP	1		
VRC28812B	5A	VRC28815	FITTING, 3/4" 16 SAE O-RING X 1/2" TUBE 90	1		
VRC28812B	5B	VRC28850-11.7	TUBING, 1/2" 304SS, 11.71" LONG (.035 Wall)	1		
VRC28812B	5C	VRC28852	FITTING, 3/8" 18 NPT X 1/2" TUBE STR.	1		
VRC28813A	6	VRC28813A	TUBING ASSEMBLY, FILTER OUTLET TO 6 PORT MANIFOLD	1		
VRC28813A	6A	VRC28853	FITTING, 1/2" 14 NPT X 1/2" TUBE 90	1		
VRC28813A	6B	VRC28850-13.6	TUBING, 1/2" 304SS, 13.57" LONG (.035 Wall)	1		
	7	VRC28120	MANIFOLD, 6 PORT, CUSTOM	1		
VRCC8830A	8	VRCC8830A	TUBING ASSEMBLY, #1 PORT TO THROW 1 CROSSHEAD, TOP	1		
VRCC8830A	8A	VRC28821	FITTING, 1/4" 18 NPT X 1/4" TUBE STR.	1		
VRCC8830A	8B	VRCC8825-63.1	TUBING, 1/4" 304SS, 63.125" LONG (.035 Wall)	1		
VRCC8830A	8C	VRC28822	FITTING, 1/8" 27 NPT X 1/4" TUBE 90	1		
VRCC8830A	8D	VRC28835	FITTING, ORIFICE, 1/8" F x 1/4"M With .094 ORIFICE	1		1
VRCC8831A	9	VRCC8831A	TUBING ASSEMBLY, #2 PORT TO THROW 2 CROSSHEAD TOP	1		
VRCC8831A	9A	VRC28821	FITTING, 1/4" 18 NPT x 1/4" TUBE STR.	1		
VRCC8831A	9B	VRCC8825-25.7	TUBING, 1/4" 304SS, 25.688" LONG (.035 Wall)	1		
VRCC8831A	9C	VRC28822	FITTING, 1/8" 27 NPT X 1/4" TUBE 90	1		
VRCC8831A	9D	VRC28835	FITTING, ORIFICE, 1/8" F x 1/4"M With .094 ORIFICE	1		1
VRC28832A	10	VRC28832A	TUBING ASSEMBLY, #3 PORT TO CYLINDER LUBE PUMP	1		
VRC28832A	10A	VRC28848	FITTING, REDUCER, 1/4" M X 1/8" F	1		
VRC28832A	10B	VRC28890	FITTING, CHECK VALVE, 1/8" M X 1/4" TUBE STR.	1		1
VRC28832A	10C	VRC28825-33.6	TUBING, 1/4" 304SS, 33.61" LONG (.035 Wall)	1		
VRC28832A	10D	VRC28823	FITTING, 1/8" 27 NPT x 1/4" TUBE STR.	1		

* Part NOT included in the "Tubing & Fittings Complete Kit" and should be ordered separately.

LUBRICATION SYSTEM TUBING & FITTINGS

NUMBER		PART NUMBER	DESCRIPTION	QUANTITY	RECOMMENDED SPARE PARTS	
					Start-Up	Minor
VRC28833A	11	VRC28833A	TUBING ASSEMBLY, #4 PORT TO THROW 2 CROSSHEAD BOTTOM	1		
	11A	VRC28821	FITTING, 1/4" 18 NPT X 1/4" TUBE STR.	1		
	11B	VRC28825-9.2	TUBING, 1/4" 304SS, 9.18" LONG (.035 Wall)	1		
	11C	VRC28823	FITTING, 1/8" 27 NPT X 1/4" TUBE STR.	1		
	11D	VRC28836	FITTING, 3/8" 18 NPT X 1/8" 27 NPT W/ .094 ORIFICE	1		
	11E	VRC28837	HOSE, FLEX ASSEMBLY, FRAME TO CROSSHEAD	1		
	11F	VRC28838	FITTING, 7/16" 20 NPT X 1/4" TUBE 90	1		
VRC28834A	12	VRC28834A	TUBING ASSEMBLY, #5 PORT TO THROW 1 CROSSHEAD BOTTOM	1		
	12A	VRC28821	FITTING, 1/4" 18 NPT X 1/4" TUBE STR.	1		
	12B	VRC28825-24.7	TUBING, 1/4" 304SS, 24.71" LONG (.035 Wall)	1		
	12C	VRC28823	FITTING, 1/8" 27 NPT X 1/4" TUBE STR.	1		
	12D	VRC28836	FITTING, 3/8" 18 NPT X 1/8" 27 NPT W/ .094 ORIFICE	1		
	12E	VRC28837	HOSE, FLEX ASSEMBLY, FRAME TO CROSSHEAD	1		
	12F	VRC28838	FITTING, 7/16" 20 NPT X 1/4" TUBE 90	1		
	13	VRC28512	PUMP, OIL, CYLINDER LUBE, 1/4"	1		
	14	VRC28847	FITTING, REDUCER, MANIFOLD 1/8" 27 NPT X 1/4" 18 NPTM 90 (NOT SHOWN)	1		
	15	VRC28640	MANIFOLD, LUBE PUMP, CUSTOM	1		
VRCC8840A	16	VRCC8840A	TUBING ASSEMBLY, LUBE PUMP MANIFOLD TO IN-LINE FILTER	1		
	16A	VRC28826	FITTING, 1/4" 18 NPT X 1/4" TUBE 90	1		
	16B	VRCC8825-21.3	TUBING, 1/4" 304SS, 21.25" LONG (.049 Wall)	1		
	16C	VRC28826	FITTING, 1/4" 18 NPT X 1/4" TUBE 90	1		
	17	VRCC8710	FILTER, LUBE OIL, IN-LINE, 10 MICRON, CNG	1		
	17A	VRC28711	ELEMENT, FILTER, 10 MICRON	1	1	2
VRCC8841A	18	VRCC8841A	TUBING ASSEMBLY, IN-LINE FILTER TO NO-FLOW SWITCH	1		
	18A	VRC28826	FITTING, 1/4" 18 NPT X 1/4" TUBE 90	1		
	18B	VRCC8825-8.0	TUBING, 1/4" 304SS, 8.0" LONG (.049 Wall)	1		
	18C	VRC28822	FITTING, 1/8" 27 NPT X 1/4" TUBE 90	1		
	19	VRC28720	SWITCH, NO-FLOW SAFETY *	1		
VRCC8842A	20	VRCC8842A	TUBING ASSEMBLY, NO-FLOW SWITCH TO PRIMARY DIVIDER BLOCK	1		
	20A	VRC28823	FITTING, 1/8" 27 NPT X 1/4" TUBE STR.	1		
	20B	VRCC8825-16.9	TUBING, 1/4" 304SS, 16.875" LONG (.049 Wall)	1		
	20C	VRC28826	FITTING, 1/4" NPT X 1/4" TUBE 90	1		

* Part NOT included in the "Tubing & Fittings Complete Kit" and should be ordered separately.

LUBRICATION SYSTEM TUBING & FITTINGS

NUMBER		PART NUMBER	DESCRIPTION	QUANTITY	RECOMMENDED SPARE PARTS	
					Start-Up	Minor
VRCC8860A	21	VRCC8860A	TUBING ASSEMBLY, PRIMARY DIVIDER BLOCK TO 4TH. STAGE CYLINDER	1		
	21A	VRCC8823	FITTING, 1/8" NPT X 1/4" TUBE STR. (HP)	1		
	21B	VRCC8825-2.8	TUBING, 1/4" 304SS, 2.75" LONG (.049 Wall)	1		
	21C	VRCC8615	VALVE, BALANCING, DIVIDER BLOCK *	1		
	21D	VRCC8825-26.9	TUBING, 1/4" 304SS, 16.938" LONG (.049 Wall)	1		
	21E	VRCC8827	FITTING, UNION 1/4" X 1/4" TUBE STR. (HP)	1		
	21F	VRCC8825-24.5	TUBING, 1/4" 304SS, 24.50" LONG (.049 Wall)	1		
	21G	VRCC8823	FITTING, 1/8" NPT X 1/4" TUBE STR. (HP)	1		
	21H	VRC28730	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1	1	1
	21I	VRCC8867	FITTING, 1/8" NPTF X 1/8" NPTM 90 (HP)	1		
VRCC8861A	22	VRCC8861A	TUBING ASSEMBLY, PRIMARY DIVIDER BLOCK TO SECONDARY DIVIDER BLOCK	1		
	22A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	22B	VRCC8825-3.3	TUBING, 1/4" 304SS, 3.313" LONG (.049 Wall)	1		
	22C	VRCC8615	VALVE, BALANCING, DIVIDER BLOCK *	1	1	1
	22D	VRCC8825-22.9	TUBING, 1/4" 304SS, 22.938" LONG (.049 Wall)	1		
	22E	VRC28826	FITTING, 1/4" NPT X 1/4" TUBE 90	1		
VRCC8862A	23	VRCC8862A	TUBING ASSEMBLY, SECONDARY DIVIDER BLOCK TO 1ST. STAGE CYLINDER	1		
	23A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	23B	VRCC8825-37.9	TUBING, 1/4" 304SS, 37.875" LONG (.049 Wall)	1		
	23C	VRC28827	FITTING, UNION 1/4" X 1/4" TUBE STR.	1		
	23D	VRCC8825-26.8	TUBING, 1/4" 304SS, 26.75" LONG (.049 Wall)	1		
	23E	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	23F	VRC28730	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1		1
	23G	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1		
VRCC8863A	24	VRCC8863A	TUBING ASSEMBLY, SECONDARY DIVIDER BLOCK TO 2ND. STAGE CYLINDER	1		
	24A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	24B	VRCC8825-40.9	TUBING, 1/4" 304SS, 40.875" LONG (.049 Wall)	1		
	24C	VRC28827	FITTING, UNION 1/4" X 1/4" TUBE STR.	1		
	24D	VRCC8825-7.5	TUBING, 1/4" 304SS, 7.50" LONG (.049 Wall)	1		
	24E	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1		
	24F	VRC28730	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1		1
	24G	VRC28867	FITTING, 1/8" NPTF X 1/8" NPTM 90	1		

* Part NOT included in the "Tubing & Fittings Complete Kit" and should be ordered separately.

LUBRICATION SYSTEM TUBING & FITTINGS

NUMBER		PART NUMBER	DESCRIPTION	QUANTITY	RECOMMENDED SPARE PARTS	
					Start-Up	Minor
VRCC8864A	25	VRCC8864A	TUBING ASSEMBLY, SECONDARY DIVIDER BLOCK TO 3RD. STAGE CYLINDER	1		
	25A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	25B	VRCC8825-39.8	TUBING, 1/4" 304SS, 39.75" LONG (.049 Wall)	1		
	25C	VRC28827	FITTING, UNION 1/4" X 1/4" TUBE STR.	1		
	25D	VRCC8825-22.1	TUBING, 1/4" 304SS, 22.125" LONG (.049 Wall)	1		
	25E	VRC28822	FITTING, 1/8" 27NPT X 1/4" TUBE 90	1		
	25F	VRC28730	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1		
	25G	VRC28867	FITTING, 1/8" NPTF x 1/8" NPTM 90	1		
VRCC8865A	26	VRCC8865A	TUBING ASSEMBLY, SECONDARY DIVIDER BLOCK TO PACKING, THROW 2	1		
	26A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	26B	VRCC8825-32.3	TUBING, 1/4" 304SS, 32.25" LONG (.049 Wall)	1		
	26C	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	26D	VRC28730	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1		1
	26E	VRC28867	FITTING, 1/8" NPTF X 1/8" NPTM 90	1		
	26F	VRC28876	FITTING, PACKING, CUSTOM 1/2" 14NPT X 7/16-20	1		
	26G	VRC28877	HOSE, FLEX ASSEMBLY, PACKING LUBE	1		1
	26H	VRC28878	FITTING, HOSE TO PACKING, 1/8"M X 1/8"F 90	1		
VRCC8866A	27	VRCC8866A	TUBING ASSEMBLY, SECONDARY DIVIDER BLOCK TO PACKING, THROW 1	1		
	27A	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	27B	VRCC8825-31.6	TUBING, 1/4" 304SS, 31.625" LONG (.049 Wall)	1		
	27C	VRC28823	FITTING, 1/8" NPT X 1/4" TUBE STR.	1		
	27D	VRC28730	VALVE, CHECK, LUBE OIL, 1/8" NPT *	1		1
	27E	VRC28867	FITTING, 1/8" NPTF X 1/8" NPTM 90	1		
	27F	VRC28876	FITTING, PACKING, CUSTOM 1/2" 14NPT X 7/16-20	1		
	27G	VRC28877	HOSE, FLEX ASSEMBLY, PACKING LUBE	1		1
	27H	VRC28878	FITTING, HOSE TO PACKING, 1/8"M X 1/8"F 90	1		
VRC28870A	28	VRC28870A	TUBING ASSEMBLY, PACKING VENT, THROW 1 & 2	2		
	28A	VRC28876	FITTING, PACKING, CUSTOM 1/2" 14NPT X 7/16-20	1		
	28B	VRC28887	HOSE, FLEX ASSEMBLY , PACKING VENT	1		2
	28C	VRC28878	FITTING, HOSE TO PACKING, 1/8"M X 1/8"F 90	1		
VR-C28880A	29	VRC28880A	TUBING ASSEMBLY, DISTANCE PIECE VENT, THROW 1 & 2	2		
	29A	VRC28839	FITTING, REDUCER BUSHING, 1/4" 18M X 1/8" 27F	1		
	29B	VRC28888	CAP, VENT	1		
	30	VRCC8610	INDICATOR, OVERPRESURE, LUBE OIL *	1		
	30A	VRC28630	DISC, RUPTURE, OVERPRESSURE (6400 PSI) (May be ordered separately) *	1	2	4
	31	VRC28630	PORT, PURGE, 1/8" NPT *	1		
	32	VRCC8600	BLOCK, DIVIDER, PRIMARY *	1		1
	33	VRCC8601	BLOCK, DIVIDER, SECONDARY *	1		1

* Part NOT included in the "Tubing & Fittings Complete Kit" and should be ordered separately.

5.2 BALANCING VALVES FOR DIVIDER BLOCKS

DIVIDER BLOCK VALVES		
PART NUMBER	DESCRIPTION	QTY
VRC28615	VALVE, BALANCING, DIVIDER BLOCK *	1

* *High pressure system is used when discharge pressure is > 1200psi & requires 5 balancing valves, part number VRC28615.*

5.3 LUBRICATION SYSTEM REPAIR KITS

5.3.1 CYLINDER LUBRICATION SYSTEM REPAIR KIT

LUBRICATION SYSTEM REPAIR KIT		
PART NUMBER	DESCRIPTION OF PART	QTY.
VRC28700K	CYLINDER LUBRICATION SYSTEM REPAIR KIT	1

Kit Contains:
4 - Disc. Rupture, Overpressure
1 - Element, Filter, 10 Micron
1 - VALVE, CHECK, LUBE OIL, 1/8" NPT
1 - Sightglass & Seals for Lube Pump Reservoir
(includes: Sightglass; (2) Gaskets & (4) Screws)

NOTE: Kit is for reservoir with tube sight glass

5.3.2 TUBING AND FITTINGS KIT

TUBING AND FITTING COMPLETE KIT		
PART NUMBER	DESCRIPTION OF PART	QTY.
VRC28800K	KIT, TUBING & FITTING COMPLETE	1

Kit Contains all parts listed in the Lubrication System Tubing & Fittings Section 5.1 with the exception of the parts show with an (*). These parts designated with (*) are not included in the kit and must be ordered separately.

5.4 DIVIDER BLOCKS

FLOW REQUIREMENTS:

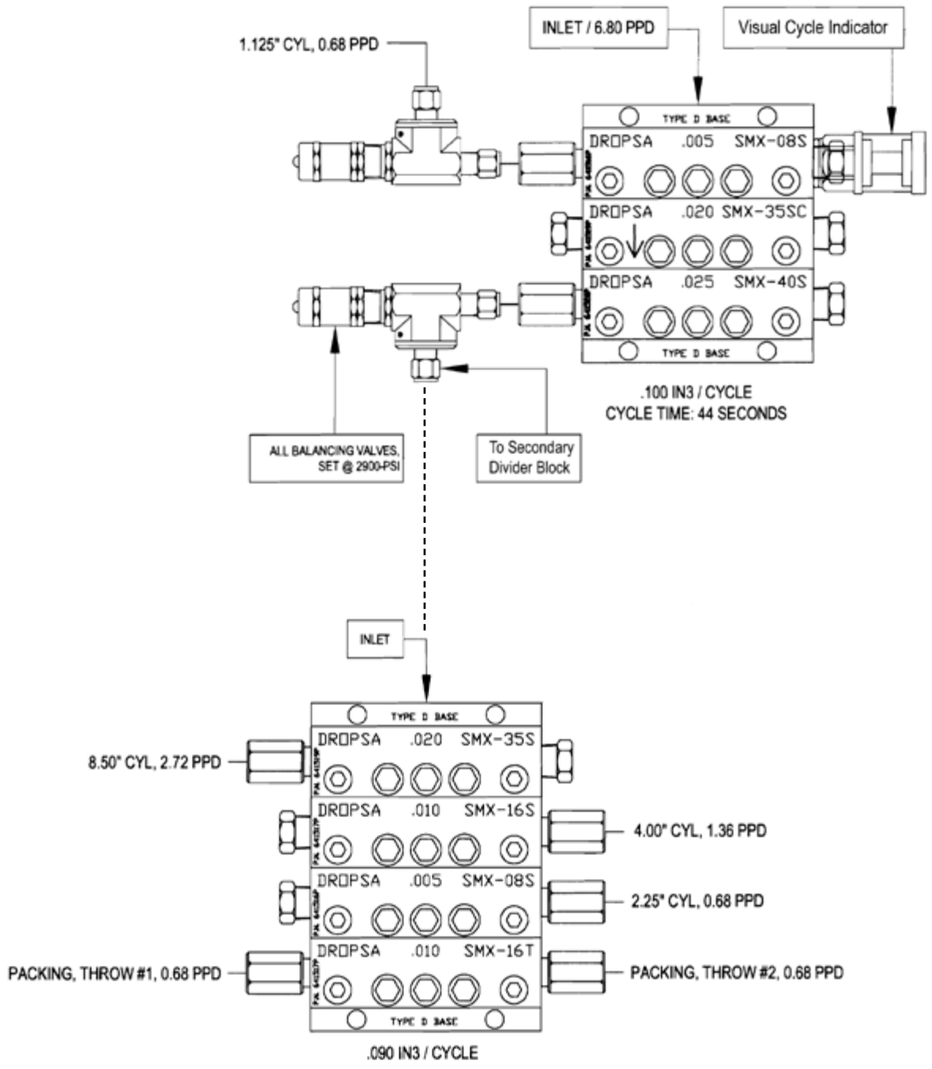
Stages 1, 2 & 3, Standard Lube Rate
- .3 x 8.50 = 2.55ppd (1ea)
- .3 x 4.00 = 1.20ppd (1ea)
- .3 x 2.25 = 0.675ppd (1ea)
- .6 x 1.125 = 0.675ppd (2ea)

Stage 4, 2X Lube Rate
- .6 x 1.125 = 0.675ppd (1ea)

PRESSURES:

1st Stage	33 + 121 = 154 ÷ 2 = 77 PSI
2nd Stage	117 + 377 = 494 ÷ 2 = 247 PSI
3rd Stage	370 + 1256 = 1626 ÷ 2 = 813 PSI
4th Stage	1243 + 4545 = 5788 ÷ 2 = 2894 PSI

Balancing Valve Set Pressure = 2900 PSI



OPERATION & MAINTENANCE

IMPORTANT:

Gas compressor units are complicated and dangerous pieces of equipment, do not attempt to repair, start-up, shut down or operate the unit without proper supervision or training.

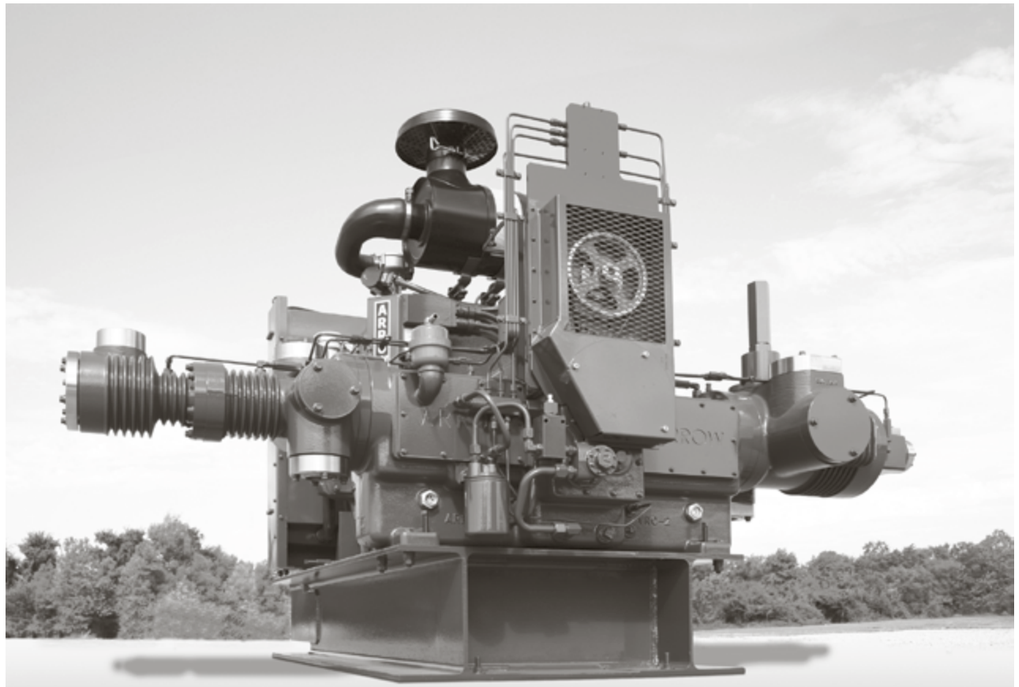
Before starting the compressor:

- Familiarize yourself with the unit.
- Read and study the start-up and shut-down information for both package and compressor carefully.
- A gas/air mixture under pressure can explode! You can be severely injured or killed. Make sure the compressor is sufficiently purged of any explosive mixture before handling or loading.
- After completing the previous step, begin proper starting procedure.

CAUTION:

DO NOT attempt to start-up the unit without referring to Section 8, Compressor Start-Up. It is also important to refer to the packager's operating instructions or manual.

6 INTRODUCTION



6.1 PURPOSE OF THIS MANUAL

The Arrow Engine Company "VRC-CNG" gas compressor is designed to meet the requirements of today's modern compressed natural gas fueling station. The VRC-CNG incorporates four unique steeple cylinders (sizes 8.5", 4.0", 2.25" and 1.125" diameter) to achieve four stages of compression and the high discharge pressures needed for CNG applications.

The compressor frame used for the VRC-CNG is the same reliable frame used for the VRC-2 compressor. The sections of this book pertaining to the frame are a duplicate of the VRC-2 Operation and Maintenance book with "Notes" added to describe the minor and very occasional differences between the VRC-2 and the VRC-CNG frames. The sections of this book pertaining to the cylinders are unique to the CNG compressor

This manual provides design specifications standards for the VRC-CNG 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 VRC-CNG Compressor.

7

GENERAL INFORMATION & DESIGN SPECIFICATIONS

7.1 ARROW ENGINE VRC-CNG COMPRESSOR OVERVIEW

The Arrow VRC-CNG is a two-throw separable reciprocating gas compressor. The horizontally opposed cylinders are accurately balanced for smooth running and long lasting durability at 1800 RPM. Unlike many other reciprocating compressors, the VRC-CNG 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 VRC-CNG a truly balanced, high-performance, durable compressor specifically designed for continuous operation at high speed. The 1800 RPM speed design, 125 horsepower rating and 14,000 pound combined rod load capability make the VRC-CNG a perfect fit for direct coupling with today's higher speed gas engines or an electric motor.

The Arrow VRC-CNG is a four stage natural gas compressor with an 8.5" first stage, 4.0" second stage, 2.25" third stage and an 1.125" fourth stage cylinder. Cylinders are air-cooled which reduces packaging and maintenance costs. As a standard feature, the first stage cylinder has a variable volume clearance pocket for flexibility and adjustment to allow accurate fits for a range of suction pressures.

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 VRC-CNG gas compressor unequaled in the industry.

7.2 COMPRESSOR FRAME SPECIFICATION

VRC-CNG Compressor Frame Specifications	
STROKE	3 in. (76.2 mm)
SPEED, RPM (MAXIMUM)	1,800 RPM
PISTON SPEED	900 ft/min (4.57 m/s)
NUMBER OF THROWS	2
HORSEPOWER	125 hp (93 kW)
PISTON ROD DIAMETER	1.125 in. (28.575 mm)
CRANKSHAFT DIAMETER	2.50 in. (63.50 mm)
HEIGHT - BOTTOM TO CRANKSHAFT	12.75 in. (323.85 mm)
MAXIMUM WIDTH	87 in. (2.21 m)
MAXIMUM LENGTH	22.5 in. (0.5715 m)
APPROXIMATE WEIGHT WITH CYLINDERS	1,700 lb (771 kg)
ROD LOAD - TENSION	7,000 lb (3175 kg)
ROD LOAD - COMPRESSION	7,000 lb (3175 kg)
ROD LOAD COMBINED	14,000 lb (6350 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 7.1 - VRC-CNG Compressor Specifications

COMPONENTS	INCHES (MM)
CRANKSHAFT MAIN BEARING DIAMETER	3.346 (84.988)
CRANK PIN DIAMETER	2.447 (62.154)
MAIN BEARING TYPE	Spherical Roller
CONNECTING ROD LENGTH CL-CL	7.375 (187.325)
CONNECTING ROD BEARING WIDTH (SINGLE)	1.604 (40.742)
CONNECTING ROD BUSHING WIDTH (SINGLE)	1.750 (44.45)
CONNECTING ROD BOLTS (SINGLE)	(FOUR) 1/2”
CONNECTING ROD BEARING WIDTH (DOUBLE)	0.802 (20.371)
CONNECTING ROD BUSHING WIDTH (DOUBLE)	0.875 (22.225)
CONNECTING ROD BOLTS (DOUBLE)	(TWO) 1/2”
CROSSHEAD SURFACE	5.25 X 3.5 (133.35 X 88.90)
FLOATING CROSSHEAD PIN DIAMETER	2.235 (56.769)
PISTON ROD DIAMETER	1.125 (28.575)

Table 7.2 - VRC-CNG Compressor Components

MATERIALS	
FRAME	Class 40 Gray Iron
CRANKSHAFT	Forging With Induction Hardened Journals
CONNECTING RODS	Forging
CONNECTING ROD BEARINGS	Tri-Metal
CROSSHEADS CROSSHEADS (Optional)	65-45-12 Ductile Iron 65-45-12 Ductile Iron with Babbitt
CROSSHEAD PINS	SAE 8620 Carbonized
CROSSHEAD PIN BUSHINGS	SAE 660 Bronze
PISTON RODS	SAE 4140 Induction Hardened
PACKING RINGS	Carbon Filled Teflon with Cast Iron Backup Rings
PISTON	Aluminum or Ductile Iron
PISTON RINGS	Carbon Filled Teflon, High Performance Graphite Filled Teflon and premium PEEK Materials
CYLINDERS	80-55-06 Ductile Iron + Steel Billet

Table 7.3 - VRC-CNG Compressor Materials

CLEARANCES (AS NEW)		
DESCRIPTION	CLEARANCE Inches	mm
Crankshaft Thrust (End Play)	0.004 to 0.009	0.1016 to 0.2286
Crankshaft Journal Bearing	0.0005 to 0.0035	0.0127 to 0.0889
Crankshaft Pin To Connecting Rod Bearing	0.0015 to 0.0040	0.381 to 0.1016
Connecting Rod Thrust (Side)	0.007 to 0.016	0.1778 to 0.4064
Connecting Rod Bushing To Crosshead Pin	0.0014 to 0.0031	0.03556 to 0.07874
Crosshead To Crosshead Pin	0.0015 to 0.0025	0.381 to 0.0635
Crosshead To Guide (Feeler Gauge)	0.007 to 0.011	0.1778 to 0.2794
Piston End Clearance - Crank End (Steeple Cylinder)	30% Of Total Clearance - 0.050 (approx.)	1.6002 (approx.)
Piston End Clearance - Head End (Steeple Cylinder)	70% Of Total Clearance - 0.080 (approx.)	2.3622 (approx.)
Maximum Acceptable Piston Rod Run Out - Vertical	0.002	0.0508
Maximum Acceptable Piston Rod Run Out - Horizontal	0.001	0.0245

Table 7.4 - VRC-CNG Compressor Clearances

ARROW VRC-CNG STEEPLE CYLINDER DATA

BORE SACE + SAHE IN	FLANGE SIZE - see note *	VALVE TYPE	LIFT AREA SUCT/DISCH SQ/IN	VALVE LIFT SUCT/DISCH IN.	ADDED CLEARANCE/ MAXIMUM %	MAWP PSI	RDP PSI
8.5” SACE	3” Weld Neck 3” NPT (optional)	105 CRE	5.82/3.98	.079/.055	11% with VVCP	250	225
4.0” SACE	2” Weld Neck 2” NPT (optional)	52 CRE	1.36/1.36	.071/.071	N/A	750	675
2.25” SAHE	1.25” NPTF	Concentric	.346/.343	.031/.039	N/A	2500	2250
1.125” SAHE	0.75” NPTF	Concentric	.152/.164	.039/.031	N/A	6000	5400

* Companion flanges are standard on CNG cylinders.

Table 7.5 - VRC-CNG Compressor Steeple Cylinder Data

7.3 PISTON RING & PACKING RING SIDE CLEARANCE & END GAP

The standard side clearance in inches (mm) for the VRC-CNG compressor piston rings, when new, are shown in the following tables.

NEW CONVENTIONAL PISTON RING SIDE CLEARANCE

NOMINAL WIDTH	ACTUAL GROOVE WIDTH inches (mm)	TEFLON ONE-PIECE inches (mm)
1/8 (3.175)	0.125 to 0.127 (3.175 to 3.226)	0.002 to 0.006 (0.051 to 0.152)
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 7.6 - VRC-CNG Compressor Piston Ring Side Clearance

NEW RIDER BAND SIDE CLEARANCE

NOMINAL WIDTH	ACTUAL GROOVE WIDTH inches (mm)	TEFLON ONE-PIECE inches (mm)
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 7.7 - VRC-CNG Compressor New Rider Band Side Clearance

PISTON TO BORE CLEARANCE & CONVENTIONAL PISTON RING END GAP

BORE DIAMETER (inches)	PISTON TO BORE CLEARANCE (inches)	PISTON RING END GAP - TFE New Minimum - Maximum (inches)
1.125	0.005 to 0.006	0.015 to 0.021
2.25 (angle cut)	0.040 to 0.045	0.024 to 0.034
2.25 (step cut)	0.040 to 0.045	0.036 to 0.046
4.0	0.061 to 0.066	0.094 to 0.116
8.5	0.089 to 0.099	0.190 to 0.232

Table 7.8 - Piston to Bore Clearance and Conventional Piston Ring End Gap

7.4 FASTENER TIGHTENING TORQUE

The following tables list the fastener tightening torque values required for proper assembly of the Arrow VRC-CNG 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 ftlb (122 Nm)
CROSSHEAD PIN THROUGH BOLT - LOCK NUT	3/8 - 16	Hex - Flexloc	25 ftlb (34 Nm)
FRAME TO CYLINDER - SCREW	1/2 - 13	12 Point - Grade 8	82 ftlb (111 Nm)
ECCENTRIC CHAIN IDLER CLAMP - SCREW	1/4 - 20	12 Point - Grade 8	109 inlb (16 Nm)
IDLER SPROCKET - SCREW	3/8 - 24	12 Point - Grade 8	30 ftlb (55 Nm)
ROD PACKING - SCREW	1/2 - 13	12 Point - Grade 8	45 ftlb (61 Nm)
PISTON NUT	7/8 - 14	Arrow Design	330 ftlb (447 Nm)
CROSSHEAD JAM NUT	2 - 14	Arrow Design	255 ftlb (346 Nm)
RUPTURE DISC - BLOW OUT FITTING CAP	1/4 - Nom. Tube	Hex - Tube Fitting	36 inlb (4 Nm)*
VALVE COVER/CYLINDER HEAD/VVCP - SCREW	1/2 - 13	12 Point - Grade 8	82 ftlb (111 Nm)
STEEPLE CYLINDER TO CYLINDER - SCREW	1/2 - 13	12 Point - Grade 8	82 ftlb (111 Nm)
DIVIDER BLOCK VALVE - SCREW	1/4 - 28	Socket Head	109 inlb (16 Nm)
PISTON CLIP SCREW	5/16 - 24	12 Point - Grade 8	25 ftlb (41 Nm)
1.125” CYLINDER DISCHARGE FLANGE SCREW	3/8 - 16	12 point - Grade 8	35 ftlb (4 Nm)
* Because the aluminum disk may be damaged if tightened to tight, Arrow recommends hand tighten and then 1/8 turn with a wrench for proper tightening.			

Table 7.9 - VRC-CNG Compressor Fastener Tightening Values

VALVE ASSEMBLY FASTENERS - TIGHTENING VALUES		
CYLINDER SIZE (inches)	**CENTER BOLT SIZE (inches)**	**TORQUE VALUE (ftlbs)**
1.125 & 4.0	5/16 - 24 UNF	13 - 15
2.25	3/8 - 24 UNF	18 - 21
8.5	1/2 - 20 UNF	32- 38

Table 7.10 - VRC-CNG Compressor Valve Assembly Fasteners - Tightening Values

7.5 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. Since 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 be come inaccurate over time.

7. The torque wrench should not be used to break fasteners loose. This could cause the torque wrench to loose calibration.

7.6 BOLTING

Bolts used with the VRC-CNG 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 7.9 "Fastener Tightening Values". This information provides assistance in the identification of bolts used in the Arrow VRC-CNG compressor.

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

7.7 SAFETY PLATES AND 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 VRC-CNG 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 VRC-CNG COMPRESSOR OPERATIONS AND MAINTENANCE MANUAL FOR PROPER VALVE INSTALLATION INSTRUCTIONS.

CAUTION

NOISE GENERATED BY THE VRC-CNG 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.

8

COMPRESSOR START UP

8.1 MAXIMUM ALLOWABLE WORKING PRESSURE

All Arrow VRC-CNG 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).

8.2 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.

8.3 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 accessory end. Oil level at start up should be in the middle of the sight glass. Be careful NOT TO OVER FILL 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 over filled.

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 (1/2) the height of the sight glass; however, it must never exceed two-thirds (2/3) height, while the compressor is running during normal operations.

3. When the sump is filled to the proper level, replace and tighten up the breather by hand. Tightening by hand will help when removing the breather at a later date.

* **NOTE:** API SPEC 11P has been replaced by ISO 13631.

8.4 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 “Divider Block Selection and Cycle Time” . An indicator pin on the divider block shows the rate at which the block is cycling.

The VRC-CNG compressor will always be equipped with the same (8.5”/4.0”/2.25”/1.125”) cylinder configuration, therefore it will always be equipped with the same primary and secondary divider blocks as identified in the lubrication system Section 5.4.

The VRC-CNG cylinder lubrication system is considered a “Min-Lube” system as it needs to feed only a minimal amount of oil to each cylinder. It is not necessary to start with a break-in rate of twice the normal rate. The normal feed rate is 6.8 pints per day or a cycle time of 44 seconds. When the pump has been properly adjusted, the visual cycle indicator will cycle once every 44 seconds. For more details of the CNG diver blocks, refer to Section 5.4.

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.

NOTE: Remember this simple rule when making adjustments, UP IS UP (screw up to increase rate) and DOWN IS DOWN (Screw down to decrease rate).

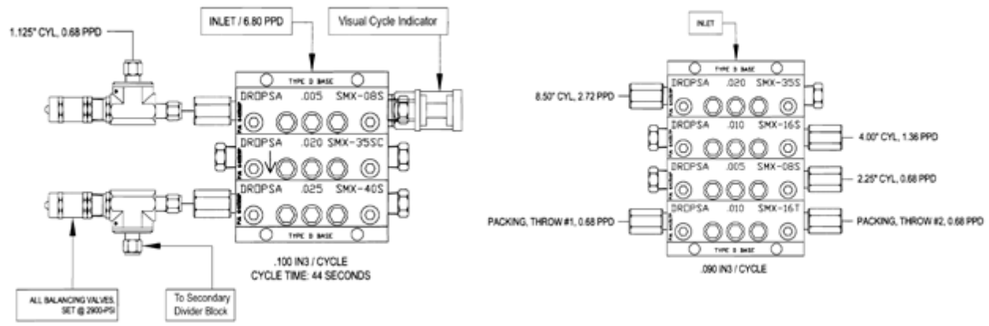
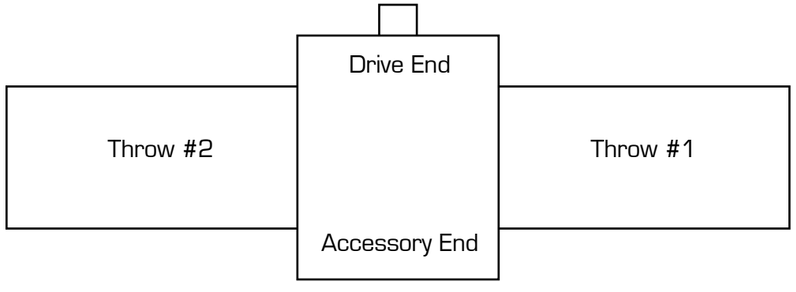


Figure 8.1 - VRC-CNG Standard Divider Block Configuration

8.5 VRC-CNG COMPRESSOR START UP CHECK LIST

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:				



8.5.1 PRE-START UP CHECK LIST

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

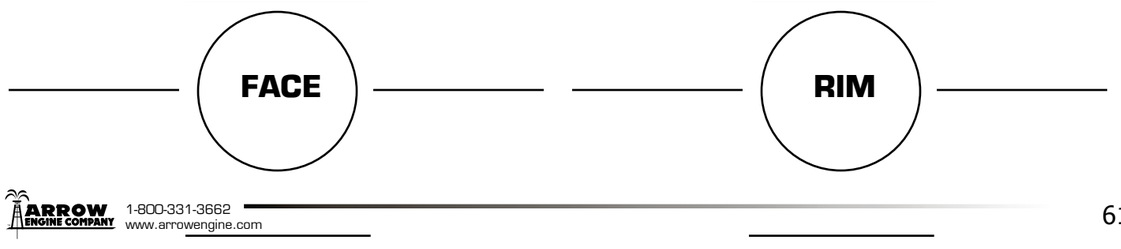
	YES	NO
4. Soft Foot Check: Have the compressor feet and crosshead guide supports been shimmed so that the machine is not twisted or bent?		
5. Have bottom crosshead clearances on all corners been checked? Max. 0.0015” (0.0381 mm) feeler inserted to 1/2” (12.7 mm) Max. depth.		

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?		
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 @ 6400 psi.		
30. Has the lubricator instruction plate or Divider Block Selection and Cycle Time (Section 8.4) 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 pip-ing 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 com-pressor 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 Pack-ager's Start Up and Operating Instructions for the unit with the unit operator?		

8.5.2 AFTER START UP CHECK LIST

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? Maximum for CNG first and second stages are 335F (168C), third stage is 350F (177C), and fourth stage is 400F (204C).		
5. Is the divider block cycle indicator pin moving, and have you set lubricator for proper flow rate? CNG cycle time is 44 seconds.		
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?		

9

COMPRESSOR MAINTENANCE

9.1 GENERAL INFORMATION

The main components of the frame assembly are: the frame, crosshead guides, crankshaft and bearings, connecting rods, chain drive system and the 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 VRC-CNG compressor.

Cleanliness is very 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.

9.2 FRAME ASSEMBLY

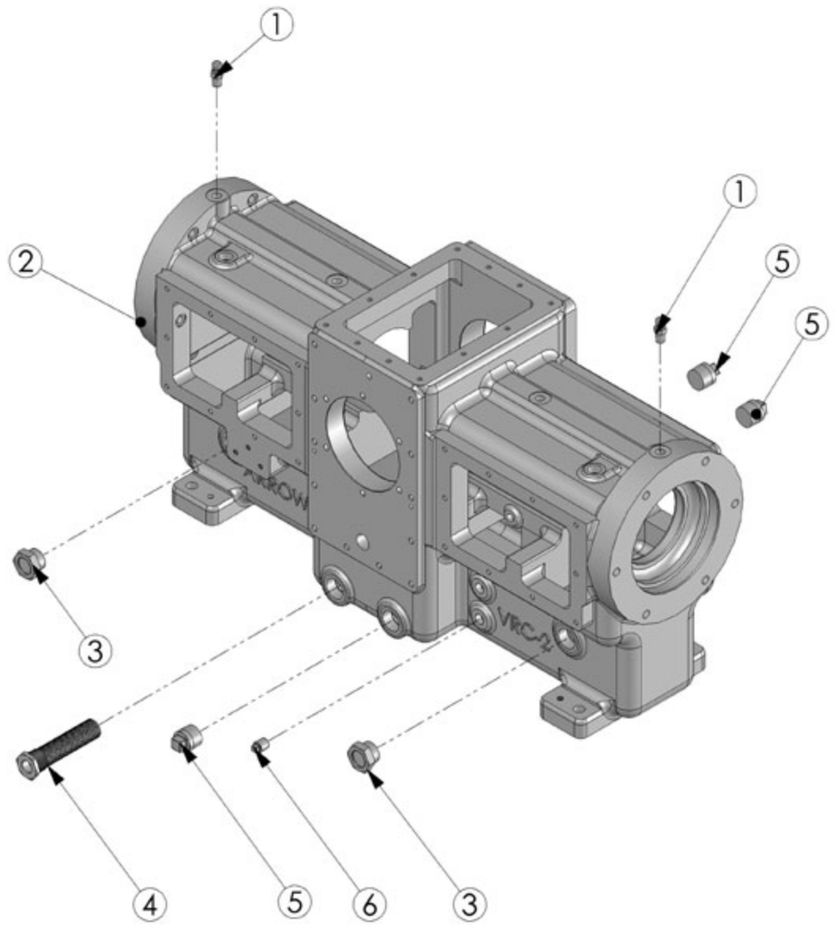


Figure 9.1 - VRC-CNG Compressor - Frame

FRAME, OIL STRAINER, SITE GLASS AND PLUG ASSEMBLY			
NUMBER	**PART NUMBER**	**DESCRIPTION**	**QTY**
1	VRC28888	CAP, VENT	2
2	VRC21025	FRAME TWO-THROW VRC-2 COMPRESSOR	1
3	VRC21400	SIGHT GLASS, FRAME OIL LEVEL	2
4	VRC28340	STRAINER, FRAME OIL (1" NPT)	1
5	VRC21519	PLUG, PIPE, 1" NPT	3
6	VRC21509	PLUG, PIPE, 3/8" NPT	1

9.2.1 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.

9.3 OIL STRAINER INSTALLATION

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

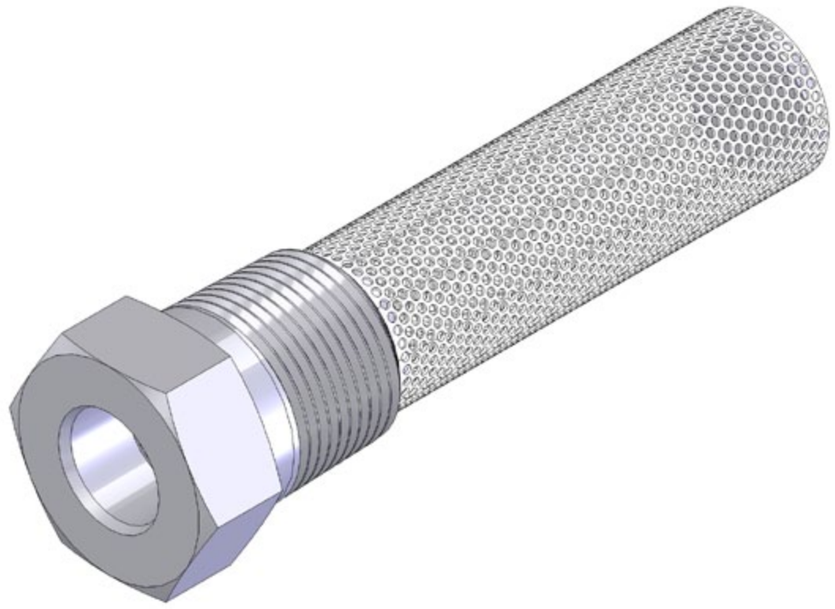


Figure 9.2 - Oil Strainer (VRC28340)

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.

Sight Glass (VRC21400)

9.4 SIGHT GLASS INSTALLATION

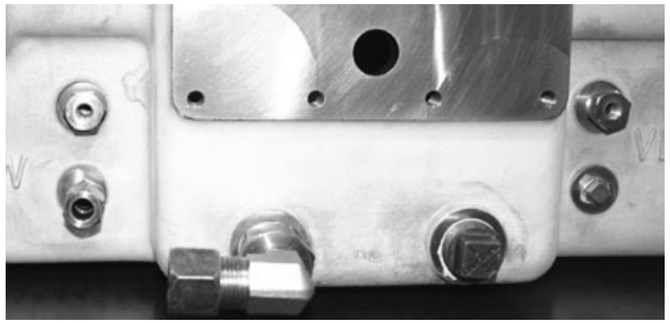
The sight glasses (VRC21400) are located on the accessory side at both ends of the frame. The sight glass allows the operator to see the oil level within the compressor. Oil level should be in the center of the sight glass.

Installation

1. Coat the threads of the sight glass with a Teflon sealant.

2. Insert the sight glass, one at each end of the frame, and tighten with wrench.

9.5 PLUG INSTALLATION



VRC-2 Frame Plugs (VRC21519 and VRC21509)

There are five plugs to be mounted on the frame. Three (3) 1” plugs (VRC21519) and two (2) 3/8” plugs (VRC21509). Two of the three 1” plugs (VRC21519) are both installed on the drive side of the frame. The remaining 1” plug (VRC21519) and the two 3/8” plugs (VRC21509) are installed on the accessory side.

Installation

1. Coat the threads of the plugs with a Teflon sealant.

2. Insert the plugs in the frame and tighten with wrench.

9.6 CRANKSHAFT PARTS

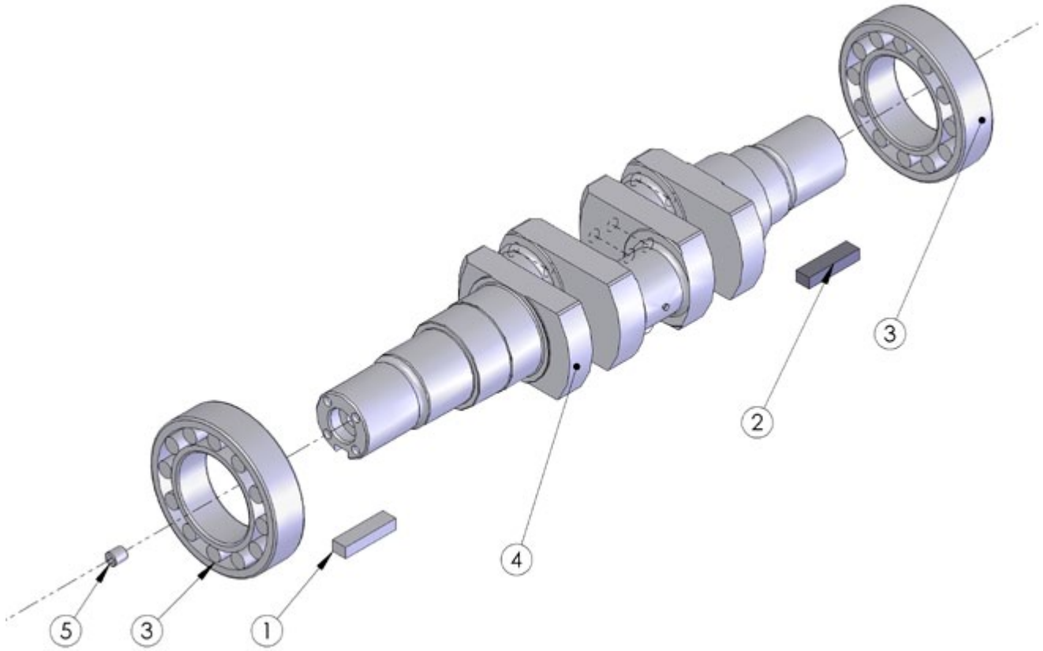


Figure 9.3 - Crankshaft Assembly Exploded View

FRAME - CRANKSHAFT			
NUMBER	**PART NUMBER**	**DESCRIPTION**	**QTY**
	VRC21101A	CRANKSHAFT, VRC-2, ASSEMBLY W/MAIN BRGS. (2) (VRC21101)	1
1	VRC21106	KEY, CRANKSHAFT, ACCESSORY-END	1
2	VRC21107	KEY, CRANKSHAFT, DRIVE-END	1
3	VRC21101	BEARING, CRANKSHAFT MAIN	2
4	VRC21100	CRANKSHAFT, VRC-2 COMPRESSOR	1
5	VRC21109	PLUG, CRANKSHAFT 1/4” NPT	1

9.6.1 CRANKSHAFT REMOVAL

Removing Crankshaft Procedures

1. Remove belt guard.
2. Loosen and remove serpentine belt.
3. Remove lube pump drive belt sheave.
4. Loosen idler chain and oil pump lines as well as relief valves.
5. Remove lines connected to the lubrication system.
6. Remove the 6 ports manifold.
7. Remove fitting for the oil slinger tube.
8. Remove oil slinger tube.
9. Remove left and right support bolts for lubrication system.
10. Remove housing making sure to release the chain from the crankshaft sprocket, then slowly pull the housing out.
11. Remove crankshaft drive sprocket.
12. Remove oil slinger.
13. Remove frame top cover.
14. Move the crosshead and connecting rod(s) to their full outer position.
15. Disconnect the connecting Rods both heavy and light (see Section 9.7.1 “Removing the Crosshead and Connecting Rod”).
16. Remove bearing retainer, drive side of the frame.
17. Remove bearing retainer on the accessory side of the frame.
18. Pull crankshaft with bearings from accessory end of frame.

9.6.2 CRANKSHAFT - CHAIN SPROCKET REMOVAL

Examine the sprocket carefully for signs of wear. If the chain sprocket has been in operation for five (5) years or more, it may be best to replace it.

1. Remove the two (2) set screws from the crankshaft drive sprocket (VRC28248).
2. Remove the sprocket from the crankshaft.

9.6.3 CHAIN SPROCKET INSTALLATION

1. Insert the woodruff key (VRC28236).
2. Slip the sprocket onto the crankshaft making sure the key way is properly aligned.
3. Tighten the two (2) set screws being careful not to break the screws when tightening.

9.6.4 SPHERICAL ROLLER BEARINGS REMOVAL AND INSTALLATION

The spherical roller bearings are heated prior to installation on the crankshaft. Arrow recommends purchasing a new crankshaft assembly with spherical roller bearings (VRC21101A) 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 (VRC21101A) installed and recommends the purchase of the crankshaft assemblies rather than trying to repair or replace the bearings yourself.

9.6.5 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.

9.6.6 CRANKSHAFT REASSEMBLY AND INSTALLATION

1. Move connecting rods to their full outer position. Insert the crankshaft horizontally into the frame.

2. 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.

3. Mount the accessory side bearing retainer on the accessory side of the frame using six (6) bearing retainer screws.

4. On the drive side of the frame, before securely mounting the drive side bearing retainer, check for crankshaft end-play (see procedures below in Section 9.6.6.1 “Crankshaft End-Play Check Procedures”).

9.6.6.1 CRANKSHAFT END-PLAY CHECK PROCEDURES

A. Mount drive side bearing retainer using six (6) bearing retainer screws.

B. Using the dial indicator, check end-play.

C. After checking the reading from the dial indicator, add or remove shims (VRC21119) as needed to achieve end-play of .004” to .009”.

D. Insert shims.

E. When correct end-play is achieved, mount the O-ring (VRC21114) and seal (VRC28024) to the drive-end bearing retainer and mount the bearing retainer assembly using the special Oil Seal Entering Sleeve tool (VRC29482) to the drive side of the frame with six (6) bearing retainer screws. **(See Section 10.3.8 “Crankshaft Oil Seal Installation”)**

F. Tighten drive-end bearing retainer and recheck end-play with dial indicator.

9.6.6 CRANKSHAFT REASSEMBLY AND INSTALLATION, CONTINUED...

5. Reinstall crankshaft seal retainers and top cover.

6. Reconnect the connecting rods and crossheads.
(See Section 9.7.4 “Single Connecting Rod and Crosshead Installation and Assembly”).

7. Reinstall the chain drive system.
(See Section 10.3.1 “Frame Lubrication System (Chain Drive) Installation”).

8. Install new cover gaskets. It is good to examine the top cover gasket to see if there is any wear or compromise to the gasket. If gaskets are not in good usable condition, the installation of new gaskets should be done.

    - **NOTE:** It is a good idea to apply anti-sieze to gaskets prior to installation. This will make the gaskets easier to remove if maintenance or replacing gaskets is necessary.

9. Reinstall remaining frame covers.

9.7 CROSSHEAD AND CONNECTING ROD

Figure 9.4 - Crosshead and Single Heavy Connecting Rod Assembly

Figure 9.5 - Crosshead and Double Light Connecting Rod Assembly

9.7 CROSSHEAD AND CONNECTING ROD, *continued...*

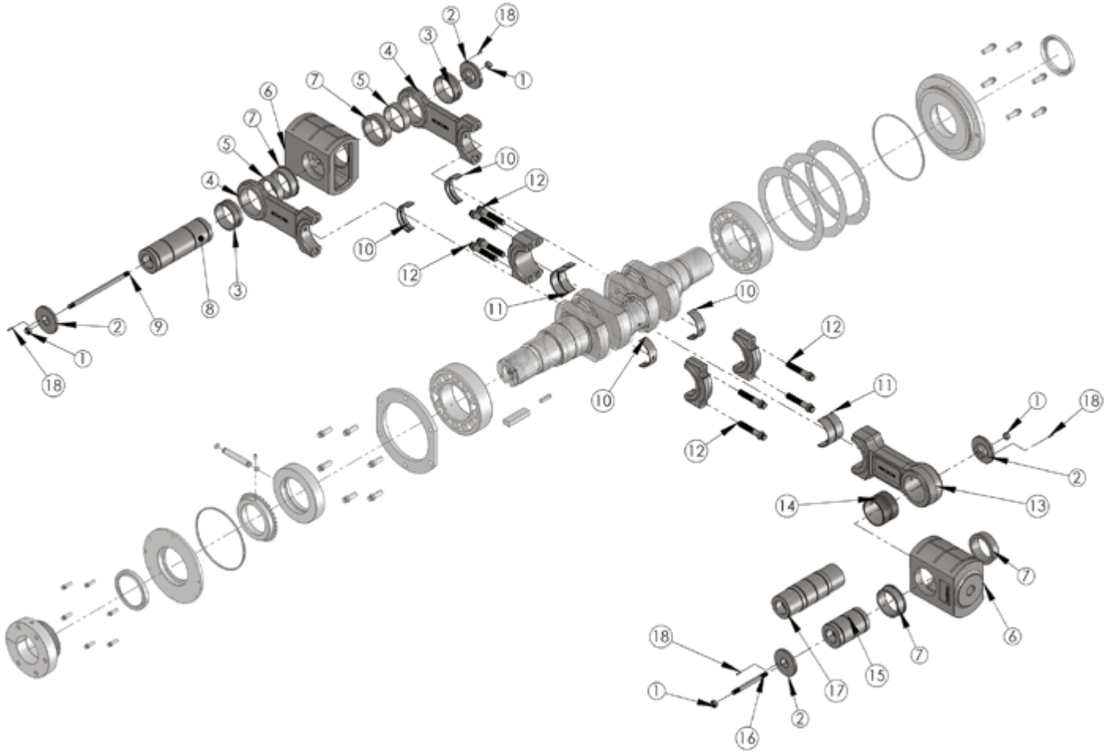


Figure 9.6 - Crosshead and Connecting Rod Exploded View

FRAME - SINGLE AND DOUBLE CONNECTING ROD ASSEMBLY			
NO.	**PART NUMBER**	**DESCRIPTION**	**QTY**
1	VRC22119	NUT, CROSSHEAD PIN RETAINER STUD	4
2	RC22200	CAP, RETAINER, CROSSHEAD PIN FITS ALL PINS	4
3	VRC21222	BUSHING, CONNECTING ROD, LIGHT (Crosshead Pin) (Included w/ Rod)	2
4	VRC21220A	ROD, CONNECTING, LIGHT, ASSEMBLY - (DOUBLE)	2
5	VRC22420	SPACER, PIN, CROSSHEAD, LONG	2
6	VRC22005A	CROSSHEAD, VRC-2 COMPRESSOR (ASSEMBLY)	2
7	VRC22002	BUSHING, CROSSHEAD VRC-2	4
8	VRC22120	PIN, CROSSHEAD, LONG (FOR LIGHT RODS)	1
9	VRC22128	STUD, CROSSHEAD PIN RETAINER, LONG LT. RODS	1
10	VRC21221	BEARING, CONNECTING ROD, LIGHT (PAIR)	2
11	VRC21211	BEARING, CONNECTING ROD HEAVY (PAIR)	2
12	VRC21217	SCREW, CONNECTING ROD CAP (INCLUDED WITH ROD)	8
13	VRC21210A	ROD, CONNECTING, HEAVY, ASSEMBLY - (SINGLE)	1
14	VRC21212	BUSHING, CONNECTING ROD, HEAVY (Crosshead Pin) (Included w/ Rod)	1
15	VRC22110	PIN, CROSSHEAD, SHORT (HEAVY ROD) (WITHOUT WEIGHTS)	1
16	VRC22118	STUD, CROSSHEAD PIN RETAINER, SHORT (HEAVY ROD)	1
18	VRC22206	PIN, ROLL, CROSSHEAD CAP 0.125” DIA X 0.5” LG	4

9.7.1 REMOVING THE CROSSHEAD AND CONNECTING ROD

1. Remove top cover from frame and the side covers from the crosshead guides.

2. Move the crosshead to its inner dead center position (back of throw) and back off the jam nut with an open end wrench. Arrow provides a 2" Jam Nut Wrench, part number VRC29496

3. Take off the outer-end head.

    - **CAUTION:** Before removing the cylinder head, back off all cap screws to 1/8 inches (3mm). Make sure that the head is loose and the cylinder has been properly vented and all pressure is relieved.

      Please be sure to read and follow the safety information.

4. Use the Piston Nut Adapter tool (VRC29490) to unscrew the piston rod from the crosshead. (The two dowels on the adapter fit in the holes in the piston nut.)

5. After the piston rod has been unscrewed from the crosshead, unscrew the jam nut off of the piston rod. Push the rod end forward to the edge of the packing to provide clearance and allow you to remove the crosshead.

6. Remove nuts from crosshead pin retainer studs and remove the retainer caps.

7. Remove any weight(s) (if applicable).

8. Move the crosshead to its outer dead center position, and remove the lock nut, retainer caps, retainer studs and then remove the crosshead pin from the crosshead.

9. Rotate the crankshaft until the connecting rod is separated from the crosshead.

    - **NOTE:** Make sure the connecting rod does not drop and damage the crosshead guide surface.

10. Roll crosshead out from the crosshead guide.

11. Visually inspect the surface of the crosshead guide and crosshead for any grooves, scuffing or markings on the surface. Since both are being lubricated under pressure during compressor operations, there should be no appreciable wear on either the crosshead guide or crosshead.

12. Remove the connecting rod cap screws.

13. Remove connecting rods.

    - **NOTE:** When removing the connecting rod(s), be sure to protect the crank pins from being nicked or scratched.

9.7.2 CRANK PIN BEARING AND CONNECTING ROD BUSHING

Check crosshead pin to crosshead bushing clearance (see Table 7.4 "Clearances"). Visually inspect surfaces for wear. If wear is detected, replace the pin and or bushings.

You will need a press to install new bushings. Any significant wear of the babbitt would expose the bronze underneath. This is an indication that the bushings needs to be replaced.

The bushing can be installed in the crosshead by cooling the bushing in a dry ice, alcohol solution or liquid nitrogen. The bushing needs to be left in the solution long enough to reach the same temperature as the solution, which is about -120°F (-84°C).

Check crosshead pin to bushing clearance to determine amount of wear on the connecting rod bushing. Any wear on the pin can be observed by visual inspection. Replace the pin if necessary. If a replacement bushing is needed, contact your Arrow Engine representative for a replacement part.

- **CAUTION:** When cooling the bushing in dry ice DO NOT TOUCH THE COLD SURFACE WITH BARE HANDS! USE PROPERLY INSULATED GLOVES TO PREVENT INJURY.

- **NOTE:** It is important that both bushing and crosshead is cleaned to prevent any dirt or debris from accumulating between the bushing and the crosshead.

9.7.3 SINGLE CONNECTING ROD AND CROSSHEAD PREPARATION

- **NOTE:** Make sure the crossheads are returned to their original throw location after installation is complete.

1. Clean crosshead guide making sure the area is free from dirt and metal shavings.

2. Clean connecting rods (VRC21210A) .

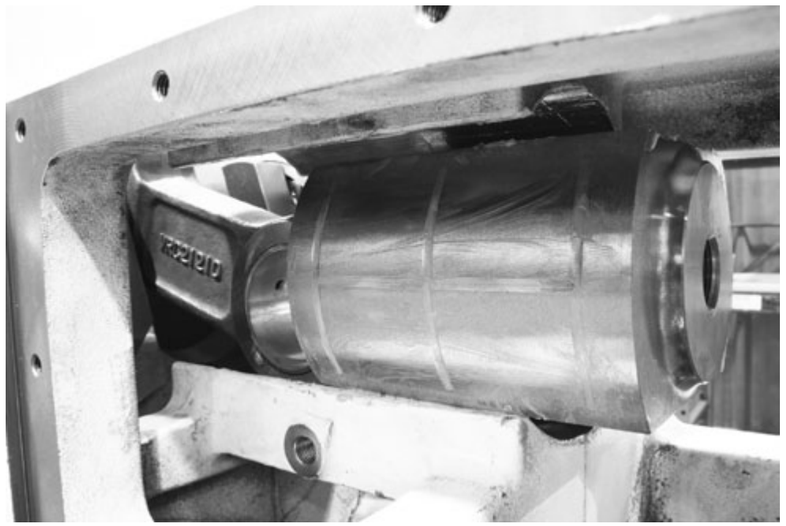
3. Clean the crossheads (VRC22005A). Inspect the bushing and the threads making sure both are clean and free from metal chips and shavings. Dirt or metal shavings can cause lock up and serious damage to the compressor.

4. Clean and inspect crosshead pin.

9.7.4 SINGLE CONNECTING ROD AND CROSSHEAD ASSEMBLY & INSTALLATION

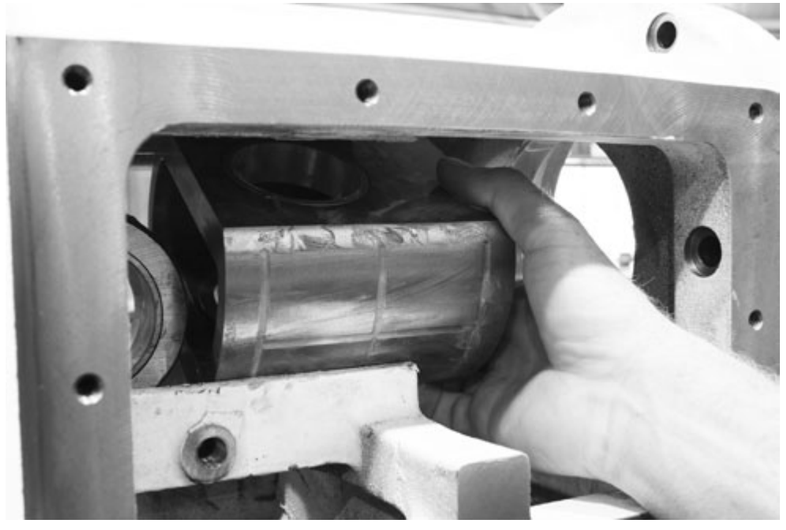
1. Apply a layer of white grease (Lubriplate or equivalent) on both the top and bottom of the crosshead surface. Lubricate the top and bottom of the crosshead guides.

2.Rotate the crankshaft so that the connecting rod is out of the way and toward the center of the frame.



Picture 1 Crosshead flat on side in guide

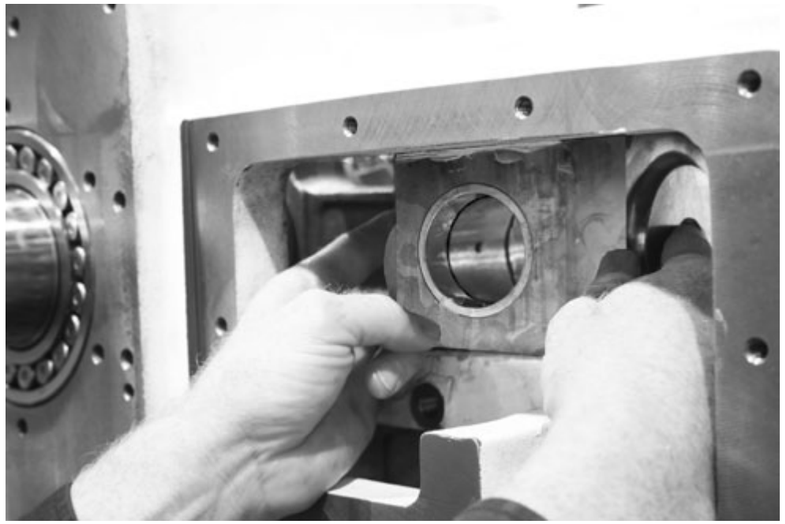
3. Using both hands, position the crosshead on its side with the flat side resting on the bottom of the guide (See picture 1 for illustration). Once inside the guide the crosshead can be rolled upright.



Picture 2 Crosshead “rolling into” final position

4. Lift the crosshead and carefully rotate the crosshead 90 degrees so that it rolls into its final position in the crosshead guides. This is a tight fit and may require some patience to ease the crosshead into the guides without using unnecessary force (See picture 2 for illustration).

- **IMPORTANT:** If the crosshead becomes tight or wedged, do not try to force it in the guides. Forcing the crosshead in the guides from a cocked or wedged position will damage the crosshead. Instead, ease the crosshead out and try installing it again.

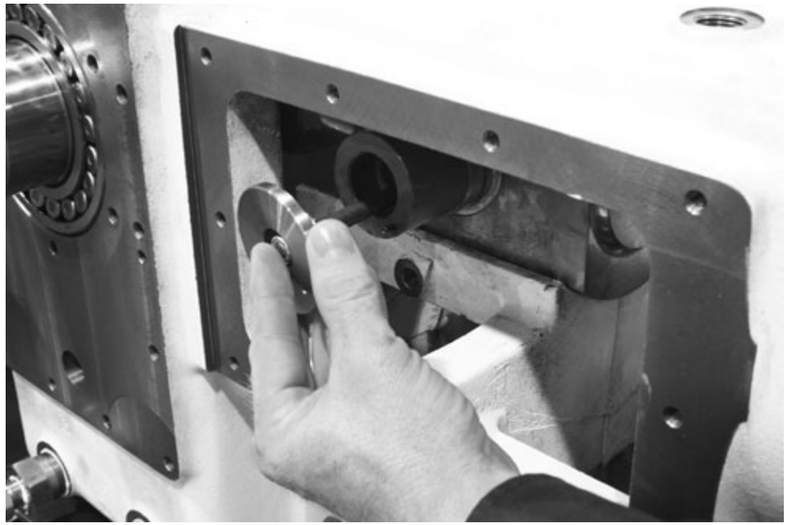


5. Slide the crosshead into position so that the hole in the crosshead is aligned with the hole of the connecting rod. Using your hands, lift the connecting rod so that the hole of the connecting rod lines up with the hole in the crosshead.

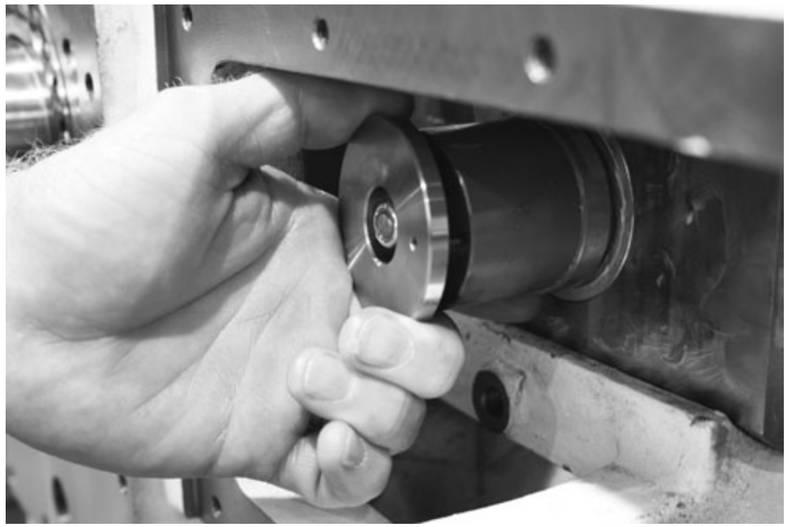
6. Insert roll pins (VRC22206) into the ends of the crosshead pin. This keeps the retainer caps from rotating. Using a brass hammer, gently striking the roll pin in the proper seating position.

7. Generously lubricate the crosshead pin (VRC22110 or VRC22130) and insert it carefully working the pin into the hole of the crosshead. Make sure the crosshead pin moves freely within the crosshead.

- **NOTE:** Either crosshead pin VRC22110 or VRC22130 will be used depending on whether weights are required or not.



7. Install the retainer caps, through bolt stud and locknuts. Torque the locknuts to 25 ftlbs.



Retainer Caps (VRC22200) aligned with the roll pin (VRC22206)

At this point, you must check crosshead clearance before proceeding any further. Check the Table 7.4 “Clearances” for crosshead guide to crosshead clearance values.

9.7.4.1 CHECKING CROSSHEAD CLEARANCE

Before continuing with connecting rod and crosshead installation you must first check crosshead clearance.

Crosshead guide to crosshead clearance is to be checked by inserting a standard 0.500” (12.7 mm) wide feeler stock from one side edge of the crosshead across to the opposite side. This is to be done at both ends. The crosshead guide to top clearance is to be 0.007” (0.1778 mm) to 0.011” (0.2794 mm).

The bottom clearance is to be checked with 0.0015” (0.0381 mm) feeler stock at the four (4) corners. If the feeler can be inserted more than 0.500” (12.7 mm), the assembly is not acceptable **(See Table 7.4 “Clearances”)** for crosshead clearance values.

After crosshead clearance check has been complete, you may continue with the assembling and installing of the connecting rod and crosshead procedure.

(Continue with Single Connecting Rod and Crosshead Installation)

8. Apply anti-seize lubricant to the gaskets before installing the side covers. Applying the anti-seize lubricant to the gaskets will make them easier to remove.

9. Check movement of the installed parts making sure the pin and cap assembly rotates freely in the crosshead hole.

10. Spin crankshaft to make sure all parts move freely with no obstructions.

11. Replace the crosshead guide side covers and tighten all screws.

9.8 DOUBLE CONNECTING ROD AND CROSSHEAD

9.8.1 DOUBLE CONNECTING ROD AND CROSSHEAD PREPARATION

1. Clean crosshead guides making sure the area is free from dirt and metal shavings.

2. Clean connecting rods (VRC21220A) and crosshead pin (VRC22120).

3. Clean the crossheads. Also inspect the bushing and threads making sure both are clean and free from metal chips and shavings. Dirt or metal shavings can cause lock up and serious damage to the compressor.

9.8.2 DOUBLE CONNECTING ROD AND CROSSHEAD ASSEMBLY AND INSTALLATION

1. Apply a layer of white grease (Lubricate or equivalent) on both the bottom and the top of the crosshead surfaces. Also lubricate the top and bottom crosshead guides.

2. Rotate crankshaft so that the connecting rod is out of the way and toward the center of the frame.

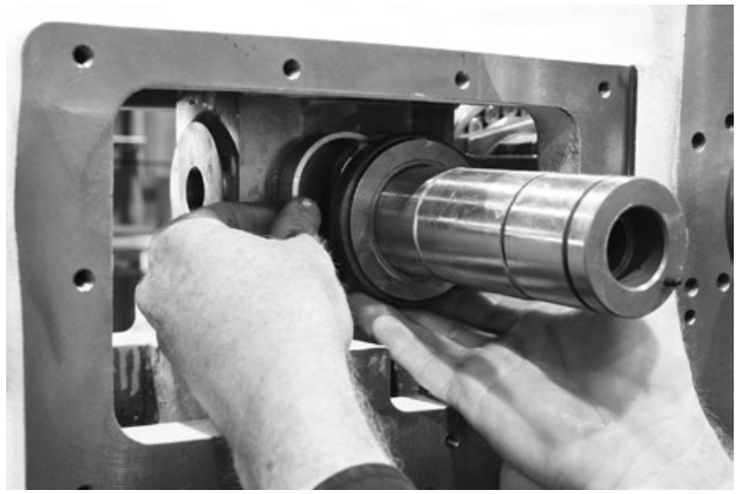
3. Using both hands position the crosshead on its side with the flat side resting on the bottom of the guide.

4. Lift the crosshead and carefully rotate the crosshead 90 degrees so that it rolls into its final position in the crosshead guides. This is a tight fit and may require some patience to ease the crosshead into the guides without using unnecessary force. (See pictures 1 and 2 in Section 9.7.4)

    - **IMPORTANT:** If the crosshead becomes tight or becomes wedged, do not try to force it in the guides. Forcing the crosshead in the guides from a cocked position will damage the crosshead. Instead, ease the crosshead out and try installing it again.

5. Rotate crankshaft until the two connecting rods are at the end of their throw.

6. Insert roll pins (VRC22206) into the ends of the crosshead pin. This keeps the retainer cap from rotating. Gently hammer the roll pins into position. Use a brass hammer to carefully strike each of the roll pins until the pins are properly seated.



7. Slide the crosshead into position so that the hole in the crosshead is aligned with the holes of each of the two connecting rods. Using your hands, lift each of the connecting rods so that the hole of the connecting rods line up with the hole in the crosshead. Do this for each connecting rod.

8. Generously lubricate the crosshead pin.

9. Insert the crosshead pin carefully working the pin first into the hole in the connecting rod, then into a spacer (VRC22420), then into the hole in the crosshead, then into another spacer. Finally, fit the crosshead pin through the hole in the second connecting rod. Make sure the crosshead pin moves freely within the crosshead.

    - **NOTE:** Spacers are not the same as the weights installed on the single rod side. Weights are used only on the single rod side when it is necessary to balance out a heavier piston on the opposite throw. These are aluminum spacers and are not intended to add weight, but only to fill what would otherwise be a gap between the connecting rod and crosshead.

10. Install crosshead pin stud.

11. Install crosshead pin caps (VRC22200) with crosshead pin stud (VRC22128) and nylon insert lock nuts (VRC22119). Align the hole in the caps with the roll pin at both ends of the crosshead pin.

12. Using two wrenches at both ends of the crosshead pin retainer stud, tighten the lock nuts to 25 ftlbs.

13. Check movement of the installed parts making sure the pin and cap assembly rotates freely in the crosshead hole.

14. Spin crankshaft to make sure all parts move freely with no obstructions.

9.9 CYLINDER REMOVAL AND DISASSEMBLY

- **CAUTION**: To prevent serious injury, be sure that the compressor's crankshaft cannot be turned by the driver or compressor cylinder gas pressure during maintenance.

  Lock the flywheel on engine-driven compressors. On electric motor-driven compressors, detach the driver from the compressor, the driver switch gear must be locked out during maintenance.

  Remember, when performing any type of maintenance to the compressor, make sure that the system is completely vented.

  Before removing a cylinder head, back off all screws. Make sure the head is lose and the cylinder is completely vented.

1. Remove suction and discharge piping.

    - **NOTE:** It is important that you make sure the unit is purged of gas. Loosen valve covers so that gas can escape.

2. After evacuating the gas and pressure from inside the cylinder, remove the cylinder head.

3. Loosen jam nut on piston rod.

4. Using the special tool, piston nut adaptor (VRC29490), screw the piston and piston rod assembly out of the crosshead.

5. Remove jam nut from piston rod.

6. Pull the piston rod assembly out of the cylinder.

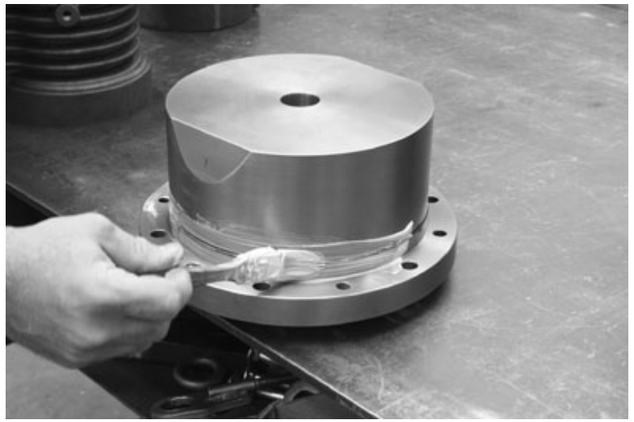
7. Remove tubing from packing case.

8. Remove frame screws from cylinder.

9. Separate cylinder from frame using proper lifting device.

    - **NOTE:** You will need some type of lifting devise to carefully remove and to balance the cylinder during removal from the frame

9.9.1 CYLINDER ASSEMBLY AND INSTALLATION - 8.5”/1.125”



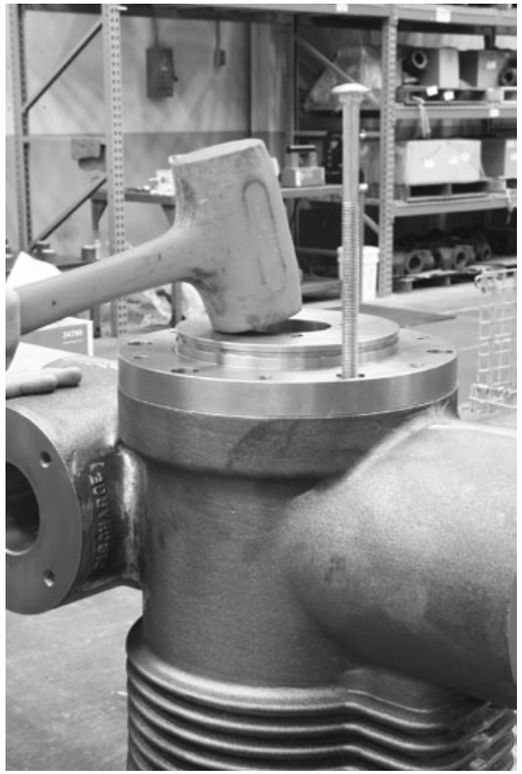
1. Clean crank-end head making sure the crank-end O-ring groove is free of any debris.

2. Liberally lubricate crank-end O-ring.

3. Insert crank-end O-ring in the O-ring groove in the crank-end head.

4. Coat the inside of the cylinder with a liberal amount of lubricant.

5. Insert the crank-end head into the cylinder.

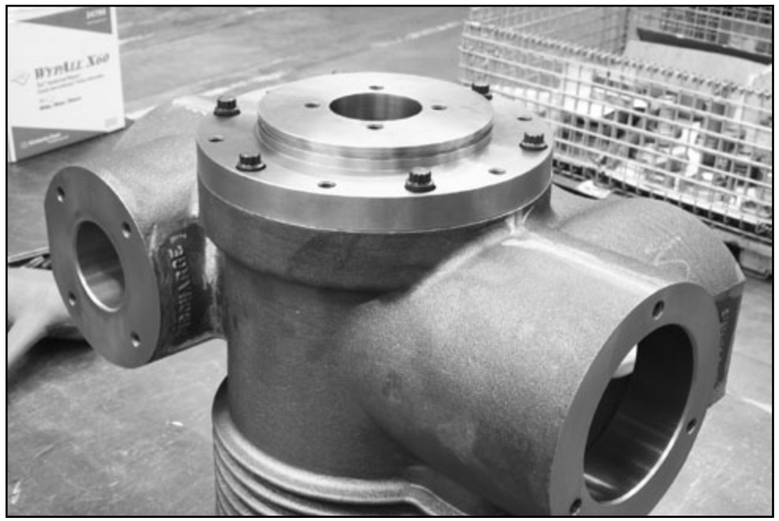


- **NOTE:** Take extreme care when inserting the crank-end head so that the flats of the crank-end head face the valve ports.

  To ease installation of the crank-end head to the cylinder, use alignment studs to help guide the crank-end head into the cylinder.

  You also may need to use a rubber mallet to help ease the crank-end head in to the cylinder. Gently tap the crank-end head until the head is inserted properly into the cylinder.

6. Once the crank-end head is inserted into the cylinder, remove alignment studs if used.



7. Insert 12 screws using a 1/2 inch 12 point socket and torque wrench and torque to 82 ftlbs.

   NOTE: Torque using a criss-cross pattern.

8. Lubricate crank-end head to frame O-ring and insert into O-ring groove.

9. Clean packing case hole in crank-end head making sure that it is free of debris.

10. Liberally lubricate the O-ring on the packing case.

11. Insert packing case making sure the “lube” hole is at the top and the “vent” hole is at the bottom.

12. Slide the packing case into the hole of the crank-end head. (The packing case WILL NOT go all the way in.)

13. Secure with 12 pt. screws.

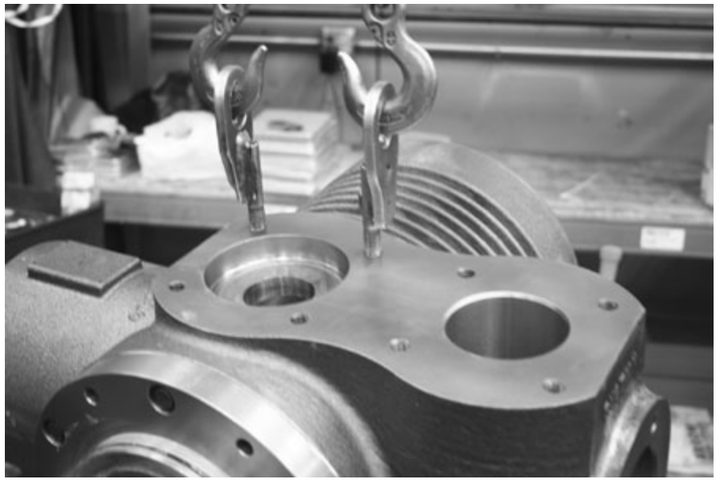
14. Torque to 45 ftlbs.

NOTE: Evenly torque screws in a criss-cross sequence.

15. Apply anti-size to threads of fitting and insert fitting into packing case in the “lube” hole.

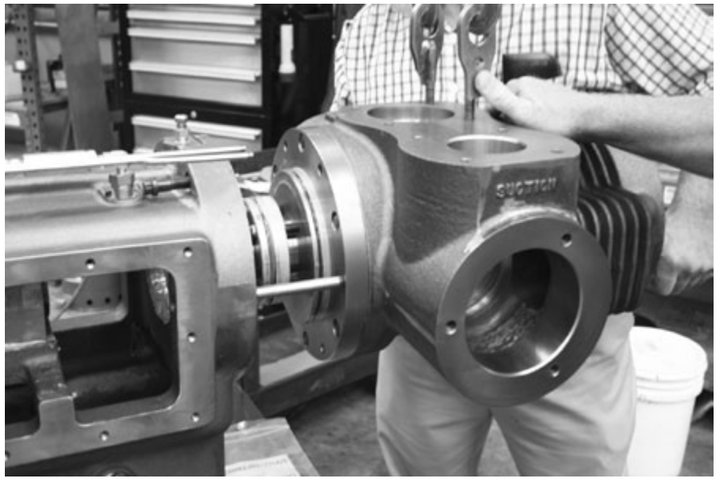
16. Tighten with 15 mm socket or wrench until opening of fitting (lube hole) faces to the right (see picture).

17. Use the same procedure for the fitting for the “vent” hole. The “vent” hole of the fitting will be facing DOWN. The cylinder is now ready to be attached to the frame.



9.9.2 MOUNTING CYLINDER TO FRAME

1. Using a proper lifting device, lift and carefully maneuver the cylinder into a position to be mounted on the frame.



2. Using four (4) screws (VRC25027), cylinder to frame short screws and two (2) screws (VRC25047) cylinder to frame long screws, attach the cylinder to the frame.

- **IMPORTANT:** Be careful and ease the cylinder into the frame making sure not to damage or compromise O-ring integrity.

3. Torque the cylinder to frame screws to 82 ftlbs.

- **NOTE:** The long cylinder to frame screws must be inserted and torqued from inside the frame

9.10 PISTON & ROD

9.10.1 PISTON AND PISTON ROD REMOVAL

- **CAUTION:** To prevent serious injury, be sure that the compressor's crankshaft cannot be turned by the driver or compressor cylinder gas pressure during maintenance. Lock the flywheel on engine-driven compressors. On electric motor-driven compressors, detach the driver from the compressor, the driver switch gear must be locked out during maintenance.

  Remember, when performing any type of maintenance to the compressor, make sure that the system is completely vented. Before removing a cylinder head, back off all cap screws. Make sure the head is lose and the cylinder is completely vented.

1. Remove the crosshead guide side covers and cylinder head/VVCP pocket. The cylinder head/VVCP is to be loosened and vented first. (See CAUTION instructions above.)

2. Move the crosshead(s) to its inner dead center position. Loosen but DO NOT REMOVE the standard hex piston rod jam nut (VRC24909). Loosen the piston rod jam nut with a 2" wrench.

3. Remove cylinder head/VVCP pocket.

4. Use the Piston Nut Adapter tool (VRCC9490) and a 1" socket wrench to screw the piston and rod assembly out of the crosshead. The two dowels on the Piston Nut Adapter fit the holes in the piston nut.

5. After the piston rod is screwed out of the crosshead, turn the jam nut off the piston rod.

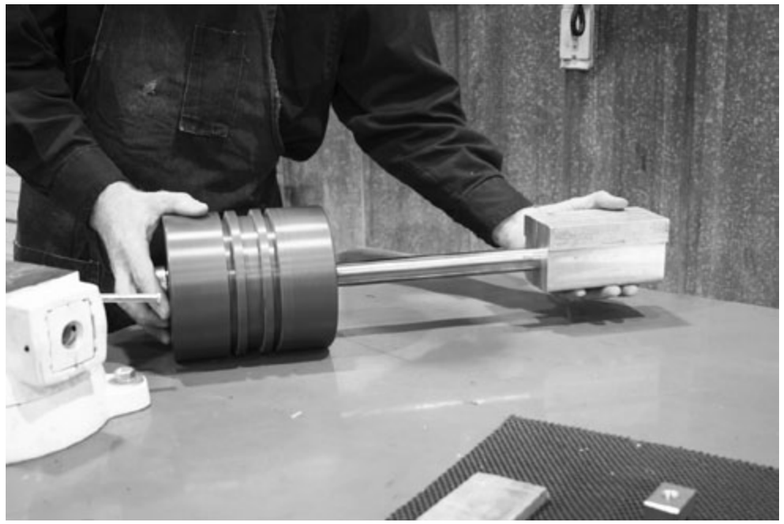
6. As the piston is removed from the cylinder, be careful handling the piston rings.

   - **NOTE:** The rings are fragile when removed from the piston. It is wise to carefully handle the rings protecting them from nicks, scrapes and bending.

7. Slide the piston rod assembly out of the head-end. The threaded crosshead end of the rod is 1/8" (3mm) smaller in diameter than the inside diameter of the packing. Slide the piston rod slowly and carefully, through the packing to avoid damaging the packing rings.

9.10.2 PISTON AND PISTON ROD DISASSEMBLY, CNG 8.5”/1.125”

The piston and rod clamp (VRC29494 - available from Arrow) device show below can be used to disassemble and assemble the piston and piston rod.



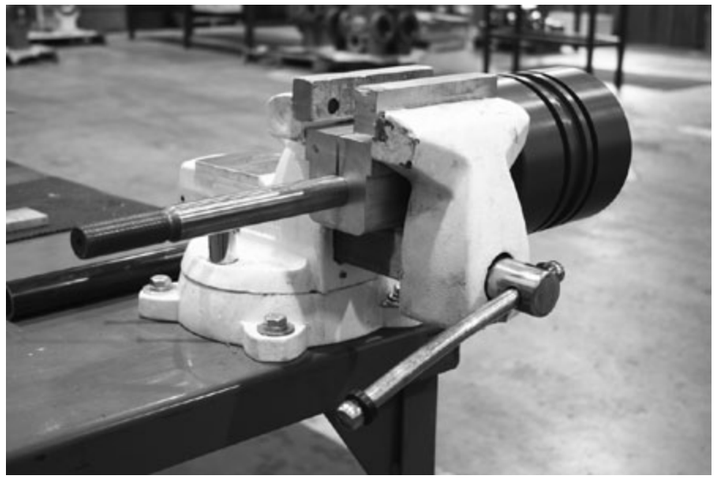
1. Clamp the piston rod in the piston rod clamp device (VRC29494). This device will properly hold the piston rod assembly in place and prevent any damage to the rod.

When using this tool follow these instructions:

i. Open the jaws of the rod clamp device by tightening the set screws.

ii. Slide the clamp onto the piston rod and close the jaws of the clamp as close as possible to the piston.

iii. Back off the set screws but DO NOT remove.



iv. Insert the clamp into a large vise so that the pressure is applied to the shoulder of the clamp (see picture).

v. Loosen the piston nut (VRC24919) using the piston nut adapter tool (VRC29490) and a 1” socket wrench.

vi. Remove the piston from the rod. The piston will slip off the end of the rod.

vii. Remove the clamp from the vise.

viii. Tighten the set screw in the clamp to open the jaws.

ix. Remove the clamp from the rod.

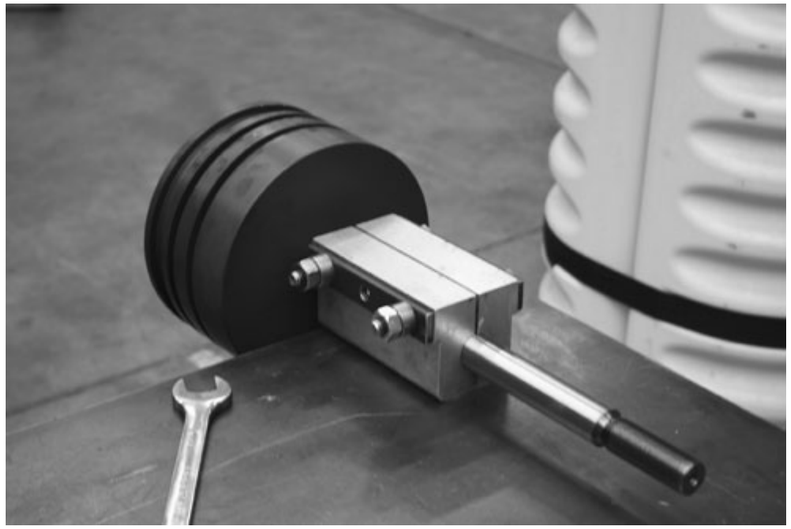
9.10.3 PISTON AND PISTON ROD ASSEMBLY - 8.5”/1.125”

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.

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



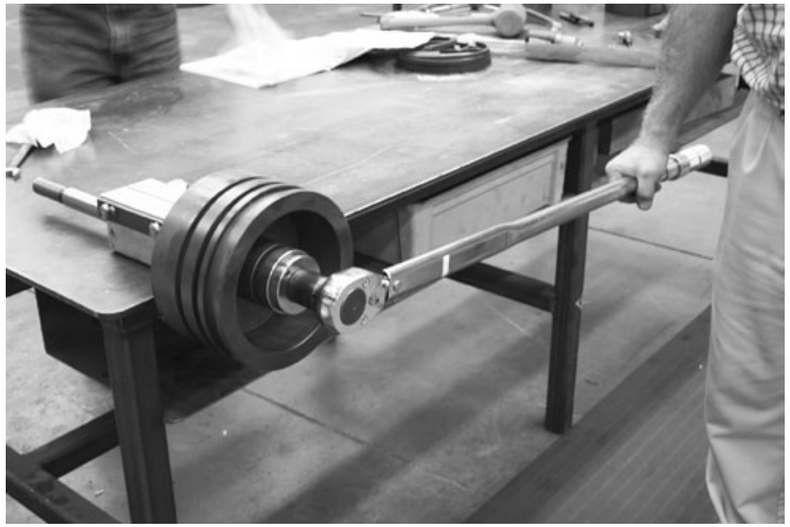
1. Place the 8.5” piston (VRCC4850) on its side and insert the 8.5” x 1.125” piston rod (VRCC4112) in the piston.

2. Carefully insert the piston rod until it bottoms out.

3. Thread the piston nut (VRCC4989) on to the piston rod so that the threaded holes are exposed.

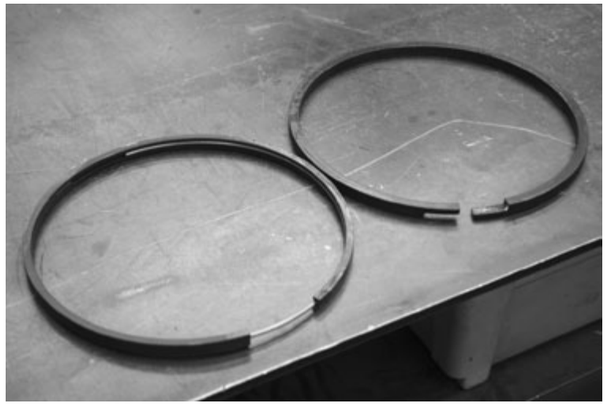
NOTE: DO NOT lubricate the piston nut threads.

4. Thread the piston nut by hand. Then using the piston nut adapter tool (VRCC9490), insert the pins of the adapter into the holes of the piston nut.



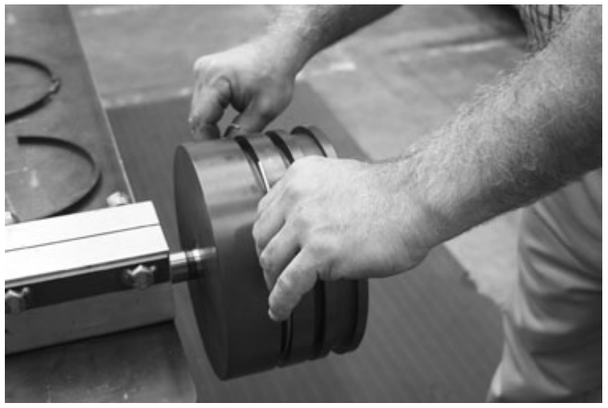
5. Insert the piston rod into the rod clamp (VRC29494) and place both into a vise and tighten firmly.

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



7. Remove piston rod and piston from vise.

8. Remove the piston rod clamp by tightening the set screws to open the jaws of the clamp.



9. Install piston rings and recessed wire expander. Expand the ring with your fingers and slide the ring over the piston to the narrow ring grooves.

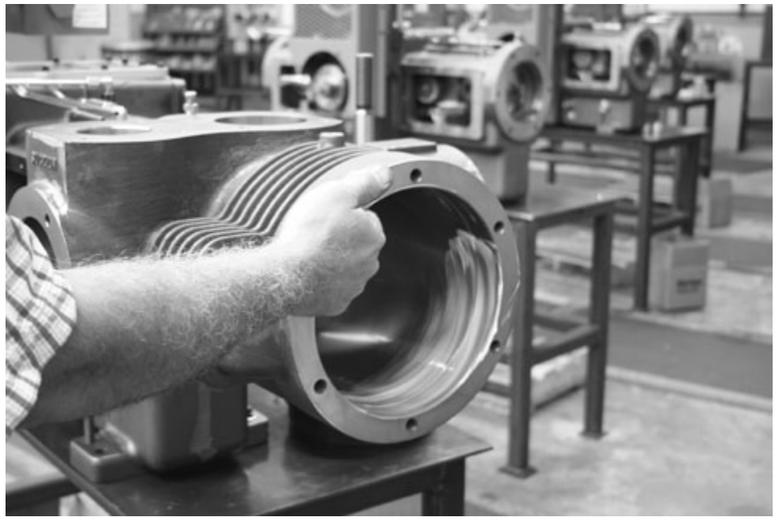
10. Next install the rider band by expanding the band with your fingers and sliding it over the piston inserting it in the wide band groove.

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

9.10.4 PISTON AND PISTON ROD INSTALLATION - 8.5”/1.125”

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.

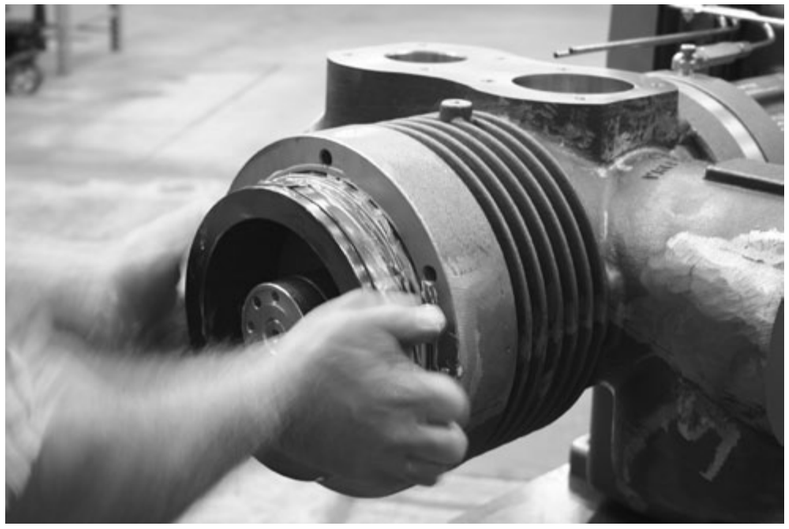
1. Liberally apply lubricant to the piston and piston rod assembly. The piston rings should be included in this lubrication process.



2. Liberally apply lubricant in the cylinder bore.

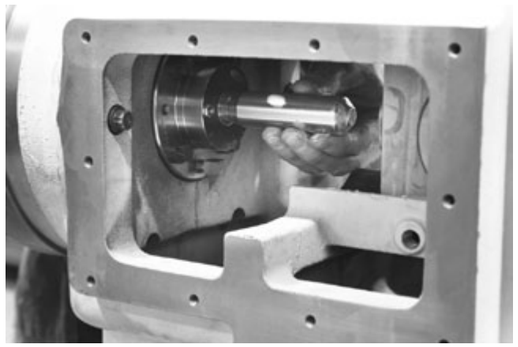
3. Install the piston rod assembly with piston rings into the cylinder. The threaded crosshead end of the rod is 1/8” (3 mm) smaller than the inside diameter of the packing. Its preferred to use an entering sleeve. This Piston Rod Entering sleeve tool (VRC29492) is provided by Arrow.

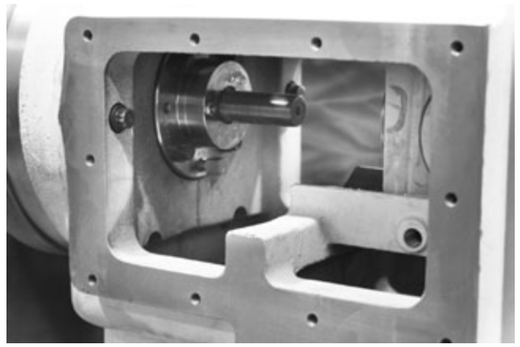
4. Stagger the piston ring gaps and then compress the piston rings with your fingers as you slide the piston rod assembly into the cylinder. Be careful not to pinch your fingers.



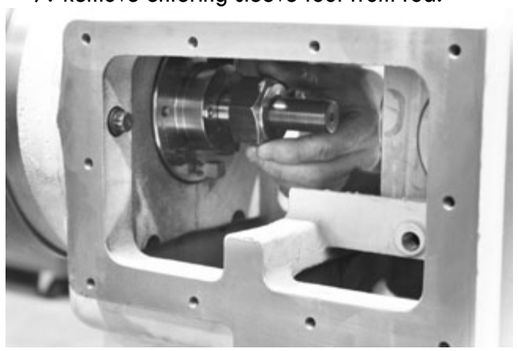
5. While your fingers are compressing the piston rings, carefully insert the piston and piston rod assembly into the cylinder bore (the cylinder is normally mounted to the frame prior to this step).

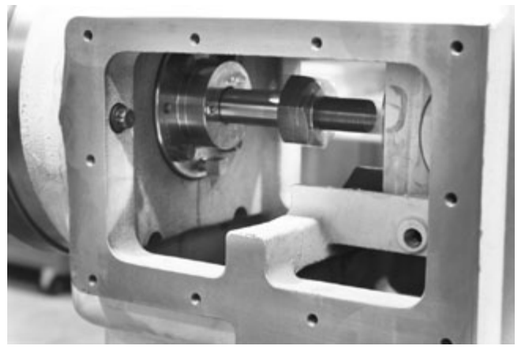
6. Make sure the crosshead is all the way back of its throw.





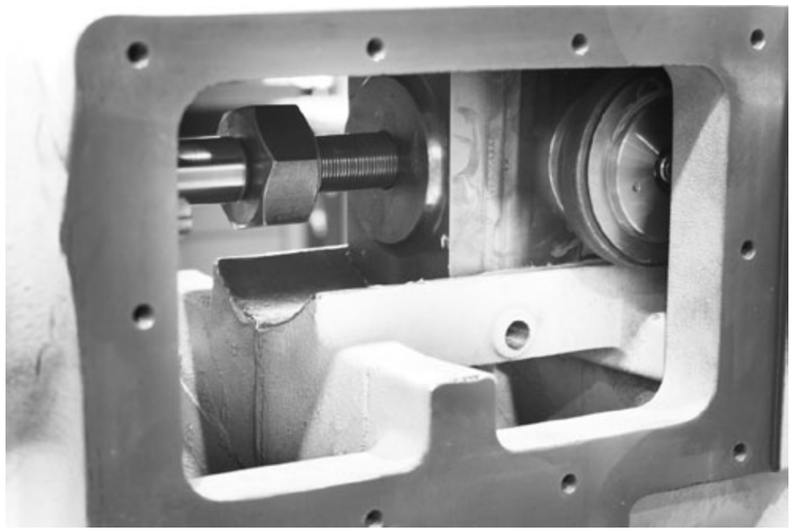
7. Remove entering sleeve tool from rod.





8. Install piston rod jam nut (VRCC4909). Make sure that the raised flat surface of the nut will be against the crosshead.

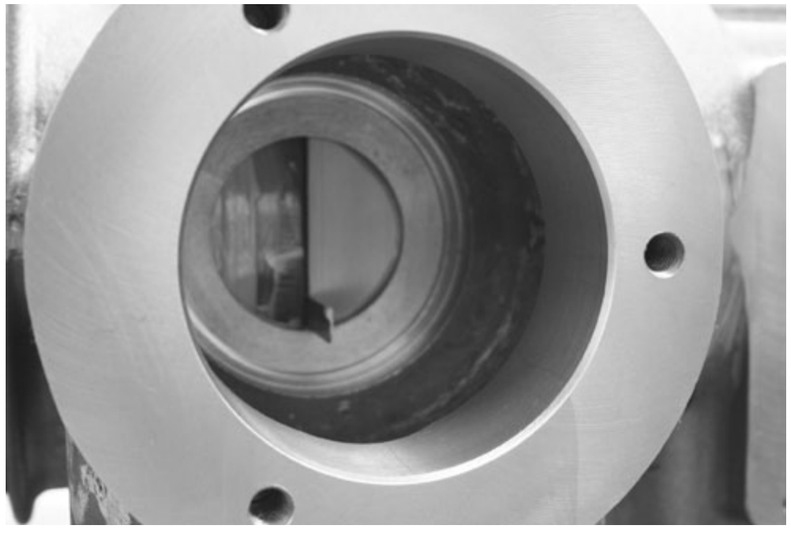
- **NOTE:** Screw piston rod jam nut to end of thread.



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

10. Using the piston nut adapter tool (VRCC9490) screw the piston and piston rod assembly into the crosshead while the crosshead is all the way to the back of its throw.

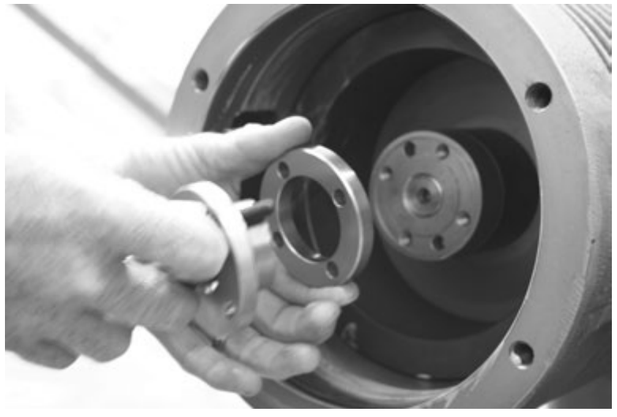
NOTE: Continue this process until the crank-end head end of the piston is approximately 0.046" from the crank end head.



Inset a 0.046" feeler gauge between the piston and the crank-end head to set the clearance correctly.

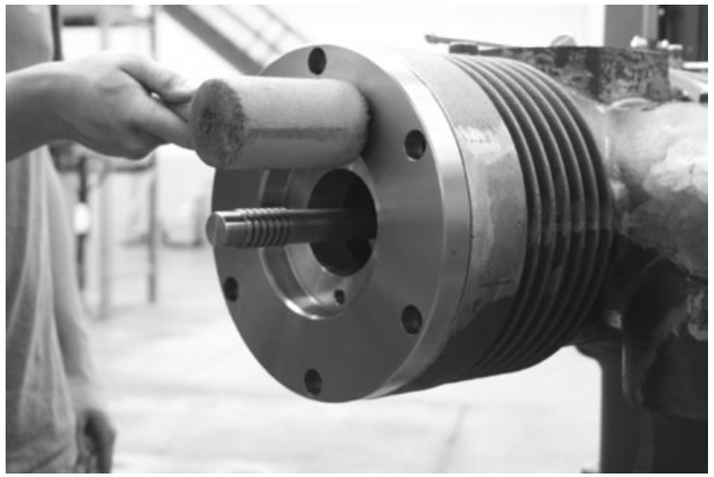
9.10.5 INSTALLING 1.125" PISTON

- Starting with the 1.125" piston (VRCC4120), slide the piston clip (VRCC4125) over the piston.



- Put one of the four clip screws (VRCC4127) through a bolt hole in the clip and through one of the bolt holes in the clip spacer (VRCC4126) and thread the screw into the piston nut.

- Thread in the remaining three clip screws and using a criss-cross pattern, torque the screws to 25 ft.lbs. (41Nm)
- **NOTE:** The 1.125" piston has a self-centering design, therefore it will not clamp tightly and should have a slight rattle in the piston clip/spacer mount fixture.



- Apply lubricant to the o-ring on the 8.5” head-end head (VRCC5901) and insert it into the 8.5” cylinder.

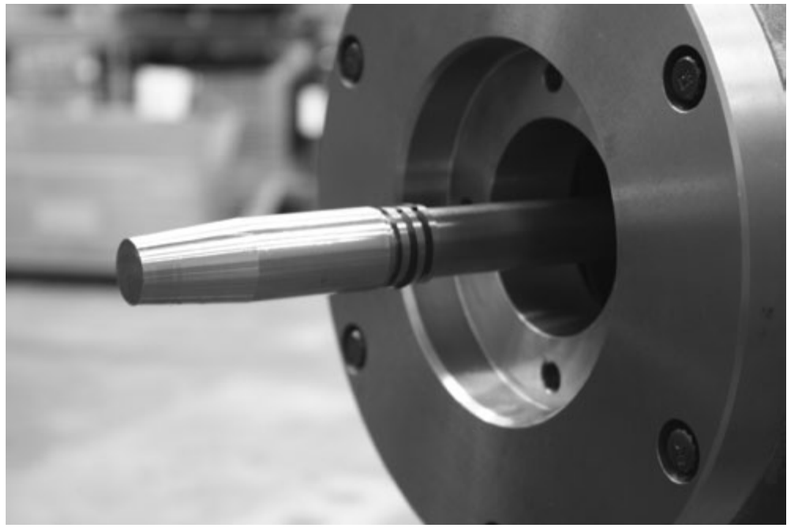
- It may be necessary to use a rubber mallet to carefully insert the head into the cylinder. Then thread in six screws (VRCC25067) and using a criss-cross pattern, torque them to 82 ft.lbs. (111Nm).

9.10.6 INSTALLING 1.125” PISTON RINGS

- Install the six piston rings (VRCC4121) on the 1.125” piston.
- **CAUTION:** These high temperature PEEK material rings are very brittle and can easily be broken if expanded too far. Arrow provides a special ring expander tool (VRCC9403) to insure proper installation of these fragile rings.

- Place the ring expander sleeve over the end of the 1.125” piston.

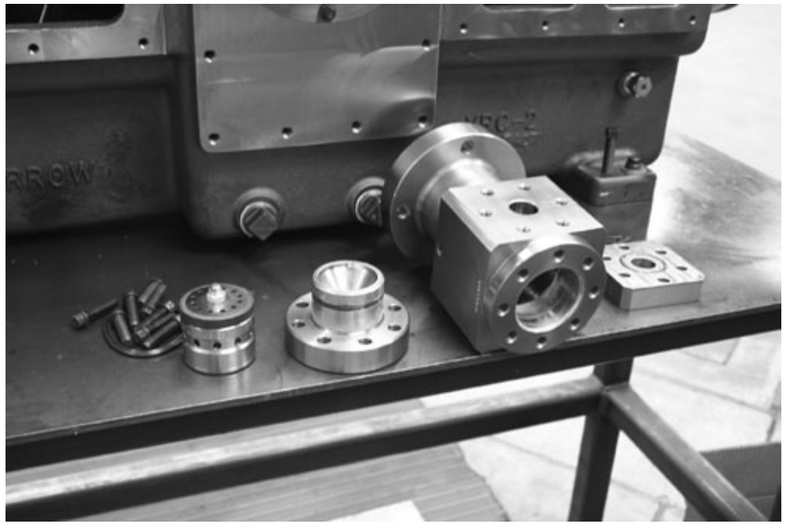
- Apply a little lubricant to the tool and slide the first ring on to the sleeve and to the end of the sleeve allowing the ring to slip off of the sleeve and into the furthermost ring gap.



- Pull the sleeve tool out slightly and slide the second ring into the next ring groove. Repeat this procedure until all six rings have been installed in the ring grooves.

- Stagger the ring gaps so that they do not line up and lubricate the piston and rings prior to installing the 1.125” cylinder.

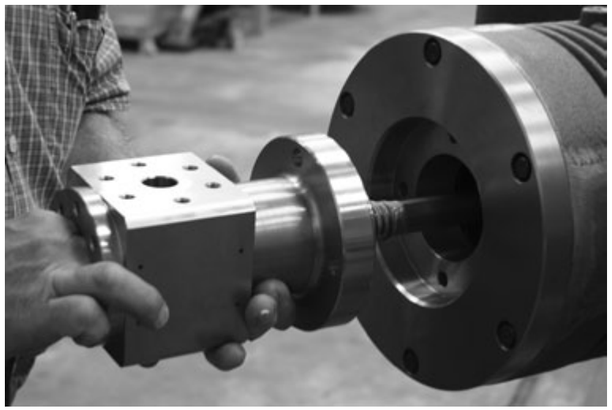
9.10.7 INSTALLING 1.125” CYLINDER



- Clean and prepare the 1.125” cylinder parts for installation.

- Install the cylinder liner gasket (VRCC5122) over the cylinder liner (VRCC5121) and insert the liner into the head-end of the 1.125” cylinder (VRCC5120)
- **NOTE:** The orientation of the liner oil holes is not critical as the liner will work in any position of rotation.

- Install the cylinder o-ring (VRCC5123) in the cylinder o-ring groove and apply lubricant.

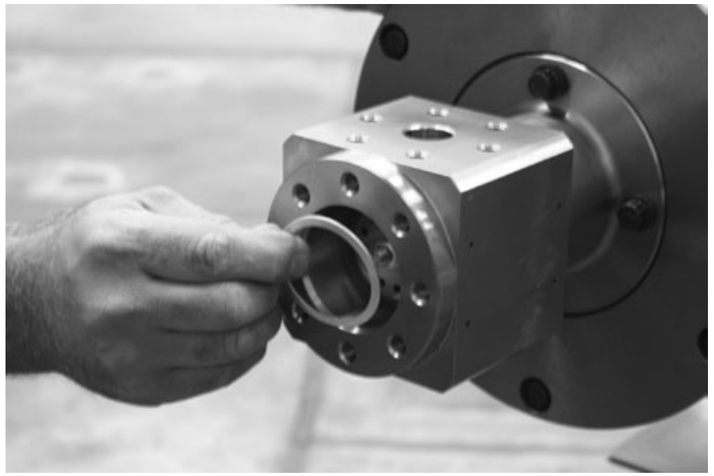


- Making sure that the suction port is at the top of the cylinder, carefully slide the 1.125” cylinder onto the 1.125” piston taking care not to damage the piston rings as they enter the cylinder bore.
- Continue pushing the cylinder over the piston until it goes into the counterbore in the 8.5” cylinder head.

- Thread the four screws (VRC25017) into the cylinder head and tighten with a criss-cross pattern to a torque of 82 ft.lbs. (111Nm)

9.10.8 INSTALLING 1.125” CYLINDER CONCENTRIC VALVE

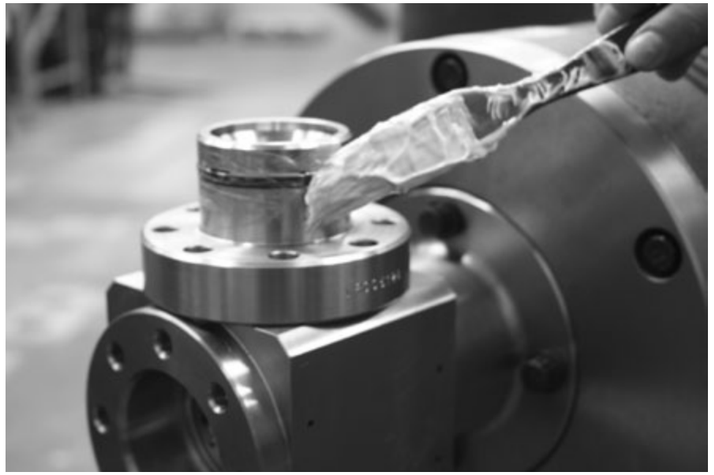
- Place a valve seat gasket (VRCC5125) under the concentric valve (VRCC6125) and slide the valve into the cylinder.
- The center bolt and locknut should be facing the head-end of the cylinder.

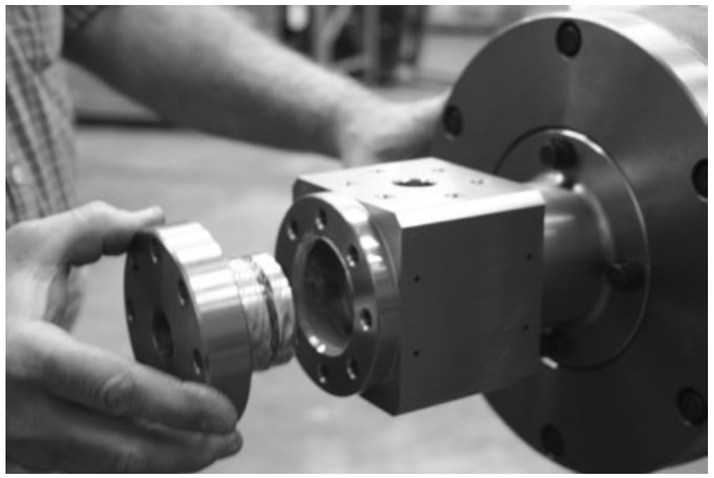


- Place another valve seat gasket on top of the concentric valve.

9.10.9 INSTALLING THE DISCHARGE FLANGE/VALVE RETAINER

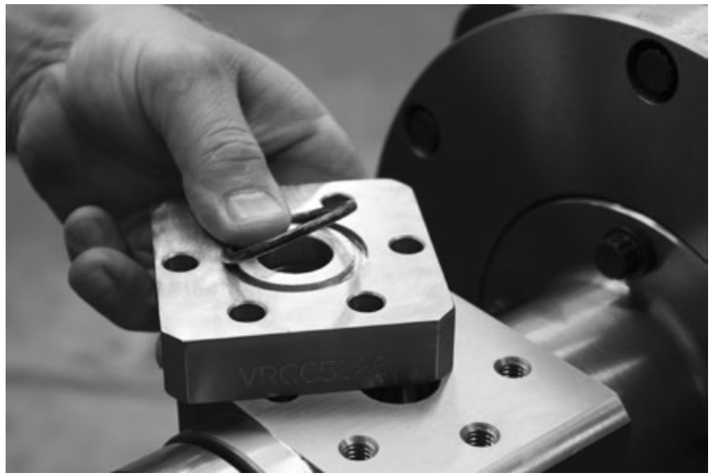
- Prepare the discharge flange/valve retainer (VRCC5128) for installation into the 1.125" cylinder by inserting the o-ring and back-up ring (VRCC5124) in the o-ring groove. The back-up ring is inserted first, and has a concave shape that should mate up to the o-ring. The o-ring should be on the inside or pressure side (closest to the valve) and the back-up ring on the outside.



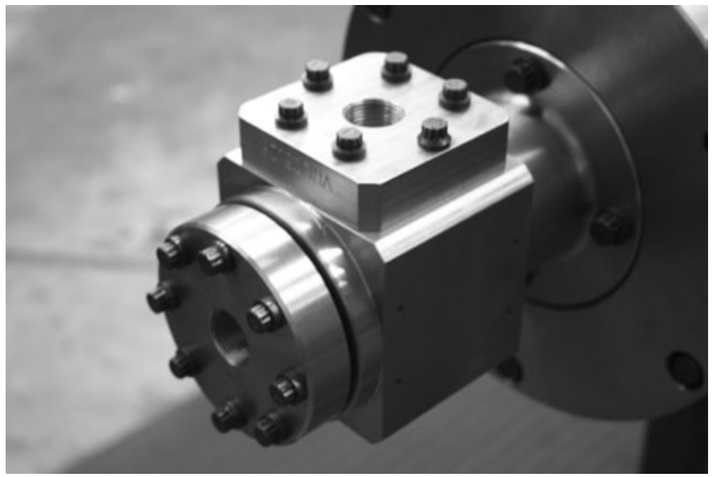


- Apply lubricant to the o-ring area and slide the discharge flange/retainer into the 1.125" cylinder
- Thread the eight screws (VRCC5017) into the discharge flange/retainer and tighten in a criss-cross pattern to a torque of 35 ft.lbs. (61Nm)

9.10.10 INSTALLING 1.125” CYLINDER SUCTION FLANGE



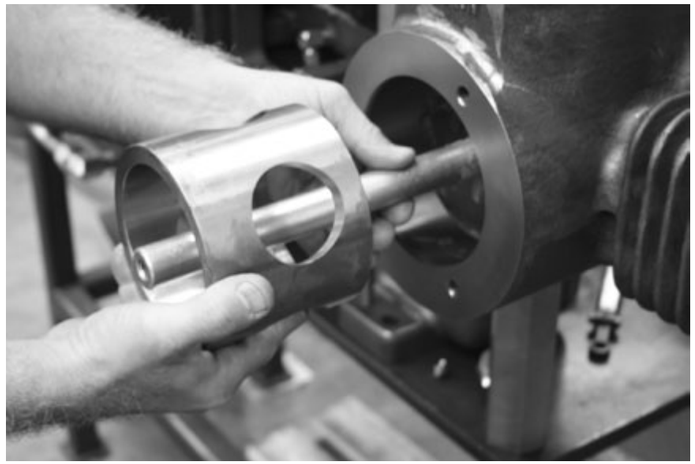
- Insert o-ring (VRCC5127) in suction flange (VRCC5126) o-ring groove.



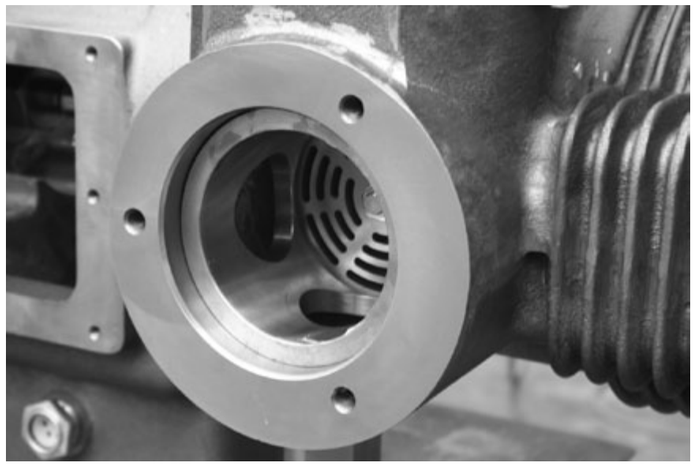
- Install suction flange with o-ring toward the cylinder and thread in six screws (VRCC5017) and tighten in a criss-cross pattern to a torque of 45 ft.lbs. (61Nm).

9.10.11 INSTALLING 8.5” CYLINDER VALVES

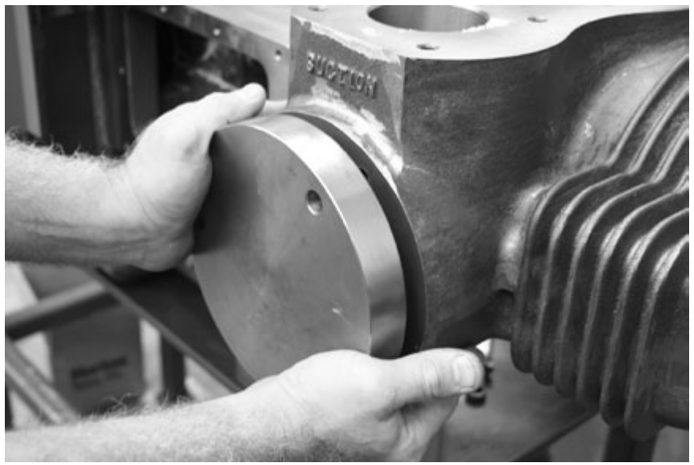
- Install the suction valve (VRCC6815) by first placing a valve seat gasket (VRCC5855) on the bottom of the valve.



- Using the valve installation tool (VRC29464) to hold the suction valve in the valve seat, slide the valve retainer (VRCC5856) into the valve port, with the tapered end of the retainer toward the valve and the flat end toward the valve cover.



9.10.12 INSTALLING 8.5” CYLINDER VALVE COVERS



- Insert the valve cover o-ring (VRCC5854) into the o-ring groove in the suction valve cover (VRCC5853) and apply lubricant.

- Slide the valve cover in the valve port and thread in the three screws (VRC25077) and tighten them to a torque of 82 ft.lbs. (111Nm)

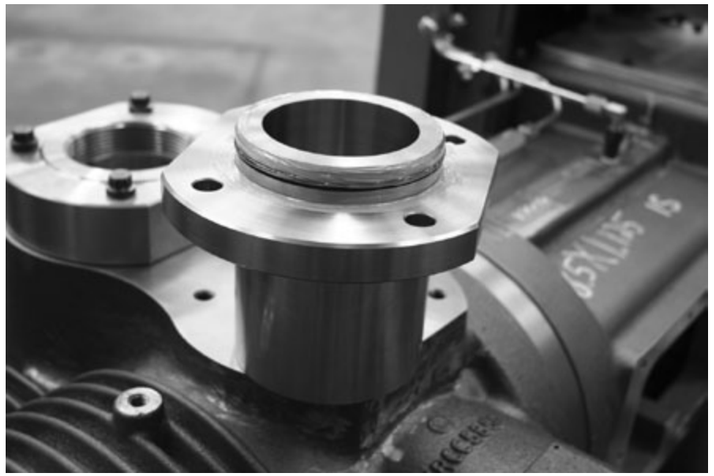
- Repeat the above procedure for the discharge valve (VRCC6825), valve seat gasket (VRCC5905), valve retainer (VRCC5858), valve cover o-ring (VRCC5904) and valve cover (VRCC5903).

9.10.13 INSTALLING THE 8.5” CYLINDER SUCTION AND DISCHARGE FLANGES

- **NOTE:** Companion flanges are provided by Arrow and are available in a standard 3” weld-neck design (VRCC5857) or in an optional 3” NPT design (VRCC5859, shown).

- Inset the flange o-ring (VRCC5902) in the flange o-ring groove. Install flange with the o-ring toward the cylinder and thread in the four screws (VRCC5007) and tighten to a torque of 82 ft.lbs. (111Nm).

9.10.14 INSTALLING 8.5” VARIABLE VOLUME CLEARANCE PACKET

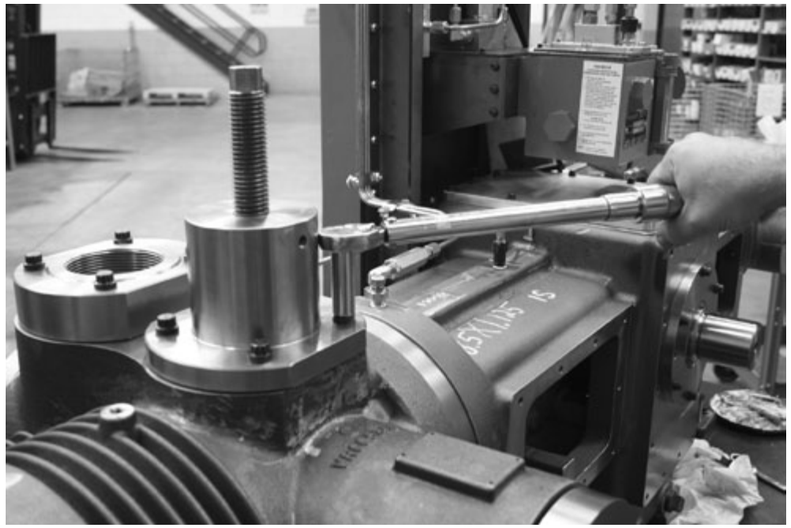


- Inset o-ring (VRCC5233) in the o-ring groove on the variable volume clearance packet (VRCC7850).

- Inset the piston o-ring (VRCC7858) in the piston o-ring groove on the piston of the VVCP piston and stem assembly (VRCC7800A) and apply lubricant to the o-ring.

- Apply anti-seize to the threads of the stem and thread the stem into the pocket so that the piston goes into the pocket.

- Continue turning the stem with a wrench until the piston is fully recessed in the pocket.



- Install the VVCP on the top of the 8.5” cylinder so that the grease zerk hole is opposite the suction flange.

- Thread in four screws (VRC25067) and torque them to 82 ft.lbs. (111Nm)

- Lubricate the threads of the grease zerk (VRC27109) and screw it into the grease zerk hole. Using a grease gun, fill this area with grease.

- Screw the VVCP piston and stem all the way in until it bottoms out (at base clearance). Slide a gasket (washer) (VRCC7805) over the stem, thread the jam nut (VRCC7803) all the way to the end of the stem and tighten.

- Slide another gasket over the stem and then thread on the VVCP stem cover (VRCC7801) and tighten.

9.10.15 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 (3) 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 VVCP piston o-ring that is seated in the o-ring groove in the piston.

9.10.16 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.

All Arrow Variable Volume Clearance Pockets have three (3) inches of total travel on a stem that has seven (7) threads per inch, therefore, it takes twenty one (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**
8.5”	11.0%	0.52%	21

Table 9.1 - VVCP Clearance

The VVCP piston o-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.

9.10.17 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 9.1 “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.

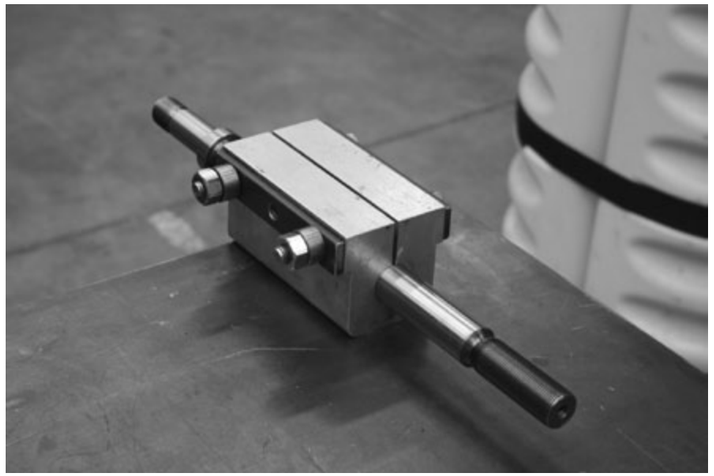
    - **NOTE:** On the VRC-CNG compressor, the VVCP is normally set at the base clearance, or no added clearance, position unless clearance is required. Depending on the horsepower capability of the driver and the available suction gas pressure, clearance may need to be added to keep from overloading the driver. The Arrow Engine compressor sizing program should be used to determine if added clearance is necessary, or you may contact Arrow Engineering for appropriate clearance packet settings.

      As a general rule, when the maximum of 125 horsepower is available for compression, suction pressure can be as high as 30psig without having to add clearance. When slightly above 30psig suction, clearance will need to be added. If suction pressure is much above 30psig, Arrow recommends using a suction pressure control valve to reduce suction pressure to 30psig.

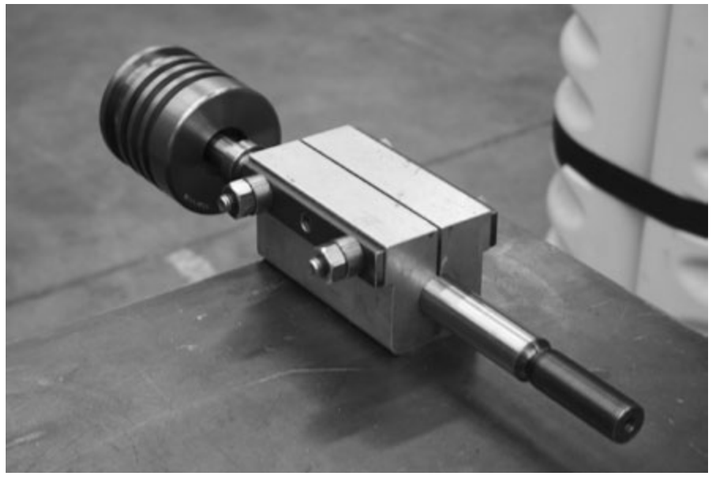
      Please consult the factory for further information.

9.11 PISTON & PISTON ROD ASSEMBLY

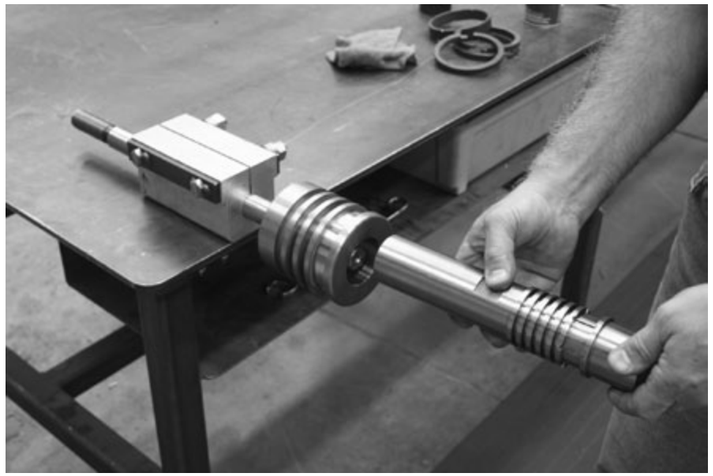
9.11.1 PISTON & PISTON ROD ASSEMBLY - 4.0”/2.25”



- NOTE: For piston and piston rod disassembly, follow the same procedure covered in Section 9.10.1
- Using the Arrow piston rod clamp tool (VRC29494), insert the 4.0” x 2.25” piston rod (VRCC4111) into the clamp.



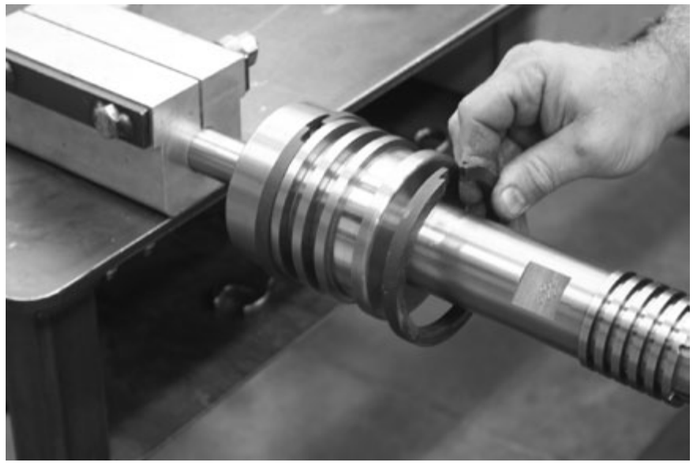
- Slide the 4.0” piston (VRCC4400) onto the rod so that the smaller countersunk end of the piston fits over the shoulder of the rod.



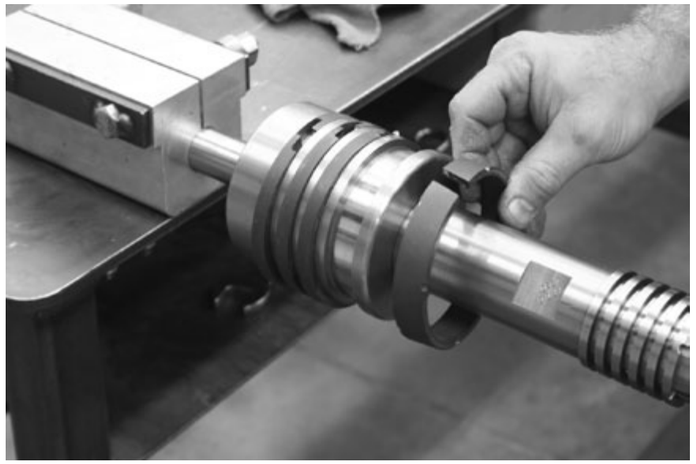
- Thread the 2.25” piston (VRCC4230) on to the rod so that it fits into the larger countersunk end of the 4.0” piston.

- Using the special piston nut adaptor tool (VRC29490) insert the two dowel pins into the holes in the end of the 2.25” piston, and, with a 1” socket and torque wrench, tighten the piston to the rod at a torque of 330 ft.lbs. (447Nm)

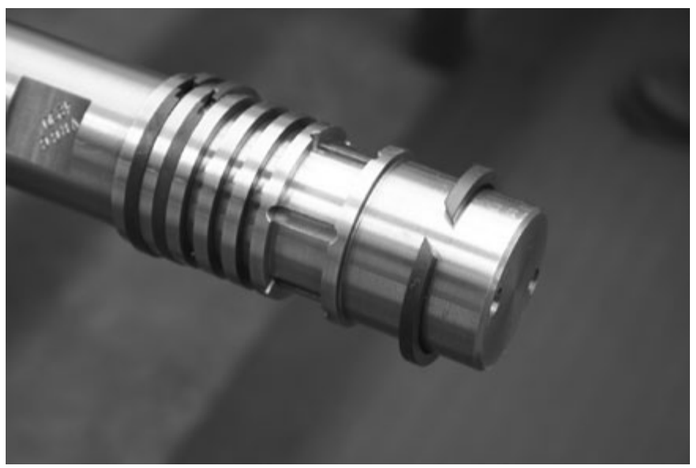
9.11.2 INSTALL 4.0”/2.25” PISTON RINGS



- Slide three of the 4.0” step-cut piston rings (VRCC4401) over the 4.0” piston and into the narrow ring grooves



- Then slide the rider band (VRCC4402) over the 4.0” piston and into the wide ring groove.



- Slide two of the 2.25” step-cut piston rings (VRCC4233) over the 2.25” piston and into the farthest narrow ring grooves, followed with three of the 2.25” angle-cut piston rings (VRCC4231) over the piston and into the remaining narrow ring grooves.

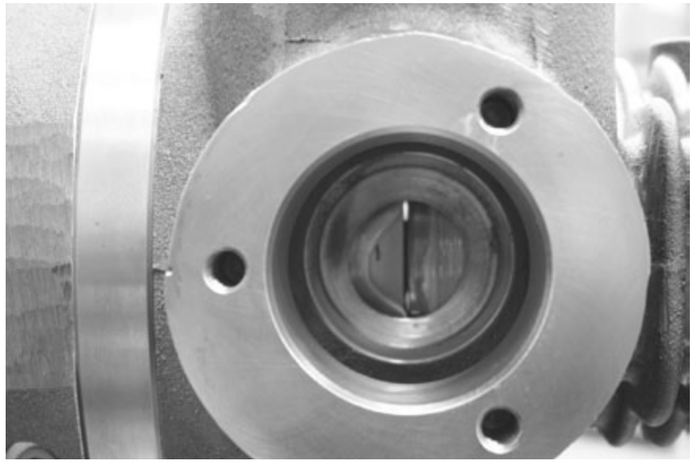
- Slide the 2.25” rider band (VRCC4232) over the 2.25” piston and into the wide ring groove.
- **NOTE:** Care must be taken when stretching rings over the pistons not to stretch them any more than necessary as damage may occur if they are stretched too much.

- Stagger the ring gaps so that they do not line up. Lubricate the pistons and rings prior to installing them in the cylinders.

9.11.3 PISTON & PISTON ROD INSTALLATION - 4.0”/2.25”

- Following the same procedure provided in Section 9.10.4, Piston & Piston Rod Installation, cover the piston rod threads with the special piston rod entering sleeve. Insert the rod through the packing case, remove the entering sleeve, thread on the jam nut and thread the rod into the crosshead using the piston nut adaptor tool.

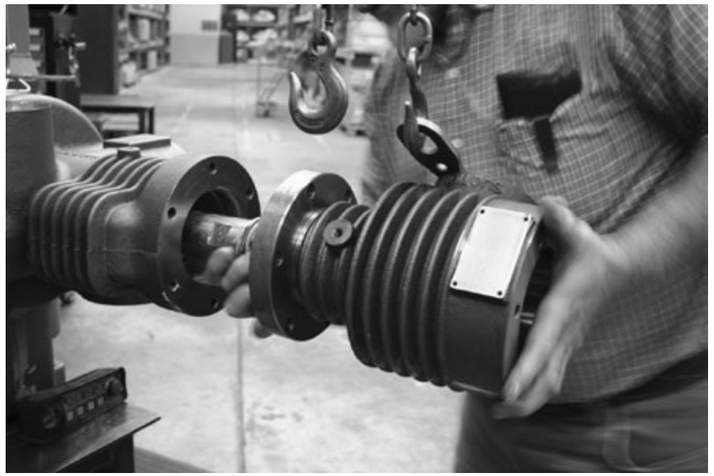
- Continue threading the rod into the crosshead (at the bottom dead center) until the 4.0” piston is about 0.050” from the crank-end head. Tighten the jam nut.



- Insert a 0.050” feeler gauge between the piston and the crank-end head to set the clearance corectly.

9.11.04 INSTALLING THE 2.25” CYLINDER

- Apply lubricant to the 2.25” piston and rings. Insert o-ring (VRCC5233) into the o-ring groove in the 2.25” cylinder (VRCC5230) and lubricate.



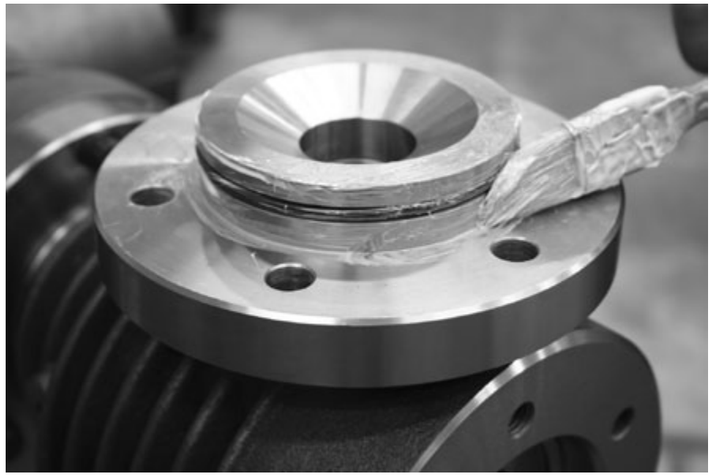
- Slide the 2.25” cylinder over the 2.25” piston while compressing the piston rings with your fingers. Take care not to pinch your fingers.

- Making sure that the suction port is at the top of the cylinder, thread in six screws (VRC25017) and tighten them in a criss-cross pattern to a torque of 82 ft.lbs. (111Nm)

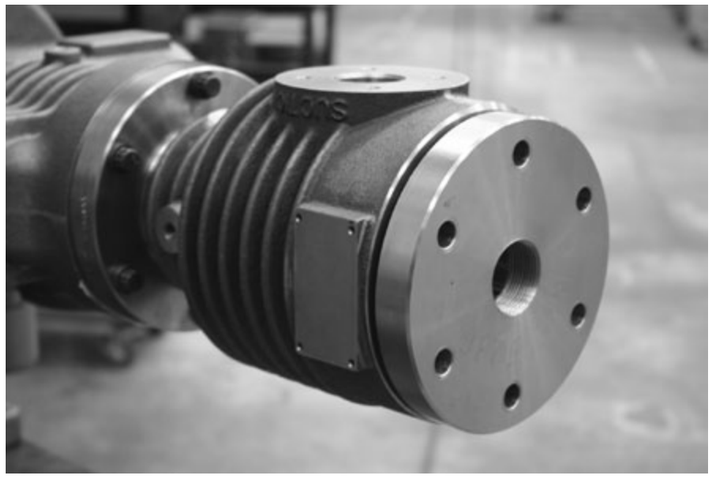
9.11.5 INSTALLING THE 2.25” CYLINDER CONCENTRIC VALVE

- Place a valve seat and top gasket (VRCC5235) under the concentric valve (VRCC6235) and slide the valve into the cylinder. Place another valve seat and top gasket on top of the valve.
- The center bolt and locknut should be facing the head-end of the cylinder.

- Prepare the discharge flange/valve retainer (VRCC5238) for installation in the 2.25” cylinder by inserting the o-ring and back-up ring (VRCC5234) in the o-ring groove. The back-up ring is inserted first - it has a concave shape that should mate up to the o-ring. The o-ring should be on the inside or pressure side (closest to the valve) and the back-up ring on the outside.



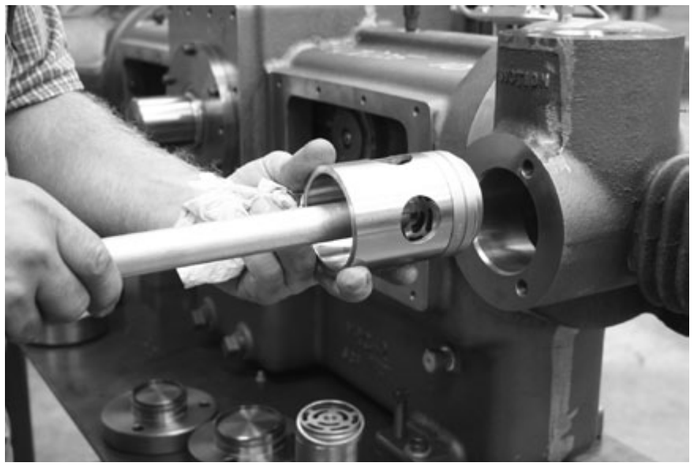
- Apply lubricant to the o-ring area and slide the discharge flange/retainer into the 2.25” cylinder.
- Thread the six screws (VRC25077) into the discharge flange/retainer and tighten in a criss-cross pattern to a torque of 82 ft.lbs (111Nm)



- Insert the o-ring (VRCC5237) into the suction flange (VRCC5236) o-ring groove. Install the suction flange with the o-ring toward the cylinder. Thread in four screws (VRC28477) and tighten to a torque of 45 ft.lbs. (61Nm)

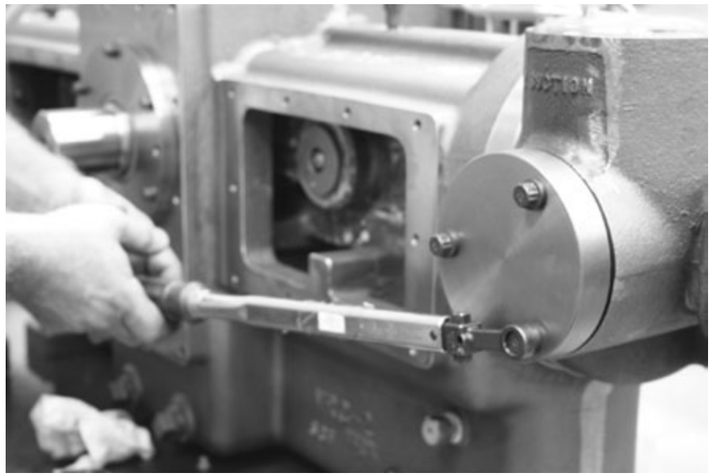
9.11.6 INSTALLING THE 4.0” CYLINDER VALVES

- Install the suction valve (VRCC6415) by first placing a valve seat gasket (VRCC5405) on the bottom of the valve.



- Using the valve installation tool (VRC29463) to hold the suction valve in the valve seat, slide the valve retainer (VRCC5406) into the valve port, with the tapered end of the retainer toward the valve and the flat end toward the valve cover.

- Insert the valve cover o-ring (VRCC5404) into the o-ring groove in the suction valve cover (VRCC5403). Apply lubricant and slide the valve cover into the valve port.



- Thread in three screws (VRC25077) and tighten them to a torque of 82 ft.lbs. (111Nm).

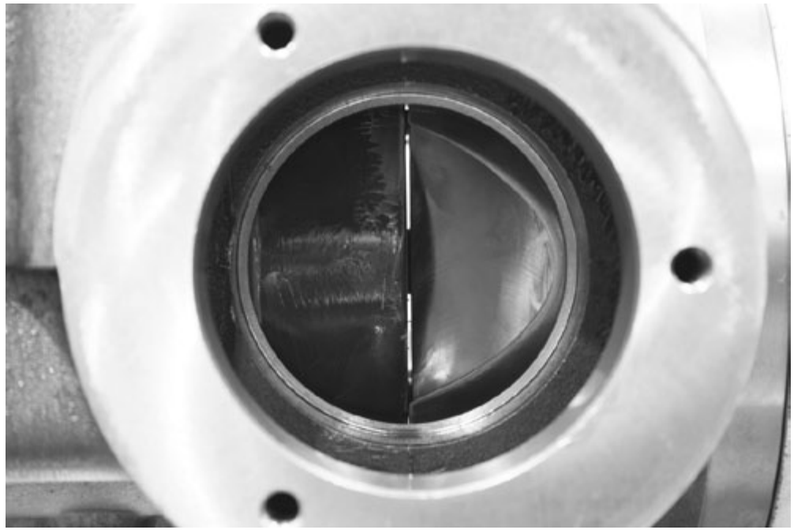
- Repeat the above procedure for the discharge valve (VRCC6425), valve seat gasket (VRCC5455), valve retainer (VRCC5408), valve cover o-ring (VRCC5454) and the valve cover (VRCC5453).

9.11.7 INSTALLING THE 4.0" CYLINDER SUCTION AND DISCHARGE FLANGES

- **NOTE**: Companion flanges are provided by Arrow and are available in a standard 2" weld-neck design (VRCC5407) or in an optional 2" NPT design (VRCC5409, shown).

- Insert the flange o-ring (VRCC5452) in the flange o-ring groove. Install the flange with the o-ring toward the cylinder and thread in four screws (VRCC5007). Tighten to a torque of 82 ft.lbs. (111Nm).

9.12.1 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 up 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.

9.12.2 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.

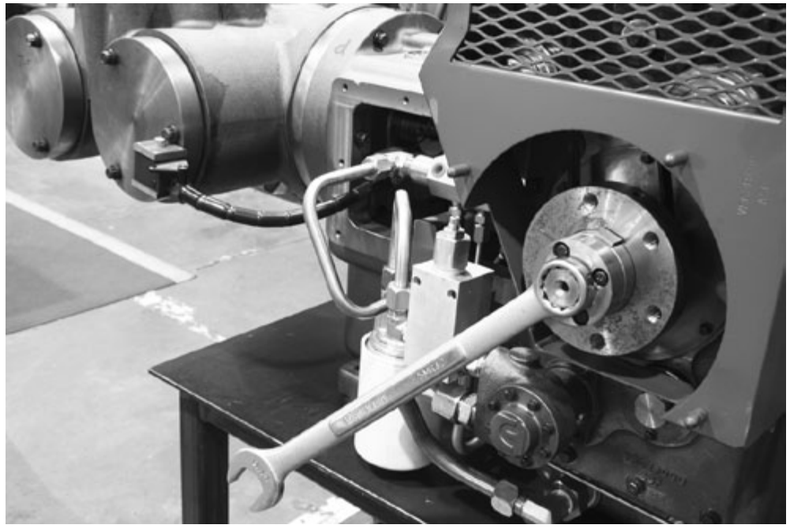
9.12.2.1
HORIZONTAL PISTON ROD RUN OUT READING

- Position the dial indicator PARALLEL to the flexible arm.

- 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.

1. 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.

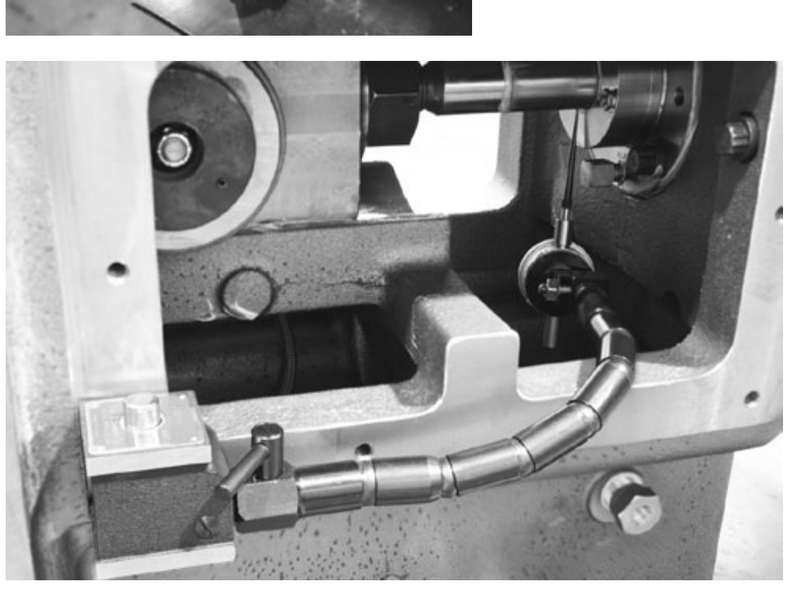


2. Using the crankshaft adapter tool and a 1 1/16” wrench, turn the crankshaft counter-clock wise one full turn (360°).

3. 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 9.2 “Maximum Acceptable Piston Rod Run Out Readings”).

9.12.2.3 VERTICAL PISTON ROD RUN OUT READING

- Position the dial indicator PERPENDICULAR to the flexible arm.



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

- With the magnetic base attached, position the dial indicator on the bottom side of the rod and zero out the dial indicator.
- 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°).
- 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 9.2 “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)

Table 9.2 - Maximum Acceptable Piston Rod Run Out Readings

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.

9.12.3 PISTON RINGS

The VRC-CNG Compressor cylinders use specially formulated piston ring materials designed for the relatively higher temperatures that are typical in CNG applications. The first and second stage rings are made of carbon filled Teflon. The third stage rings are a high performance carbon and graphite filled Teflon. The fourth stage rings are a premium PEEK based material.

9.12.4 DETERMINING RING WEAR

Arrow recommends replacing rings when the end gap has increased three (3) times the new dimension (see Table 7.8 “Piston To Bore Clearance and Conventional Piston Ring End Gap”) .

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.

9.12.5 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.

9.12.6 RIDER BANDS

The VRC-CNG compressor cylinders use a one-piece straight-cut carbon filled Teflon rider band.

9.12.7 DETERMINING RIDER BAND WEAR

Since 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 7.8 “Piston To Bore Clearance and Conventional Piston Ring End Gap.

9.12.8 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 “Piston and Piston Rod Installation”.

9.12.9 RIDER BAND INSTALLATION

The procedure for installing the rider ring is exactly like the procedure for installing the piston rings.

9.13 PRESSURE PACKING, PISTON ROD

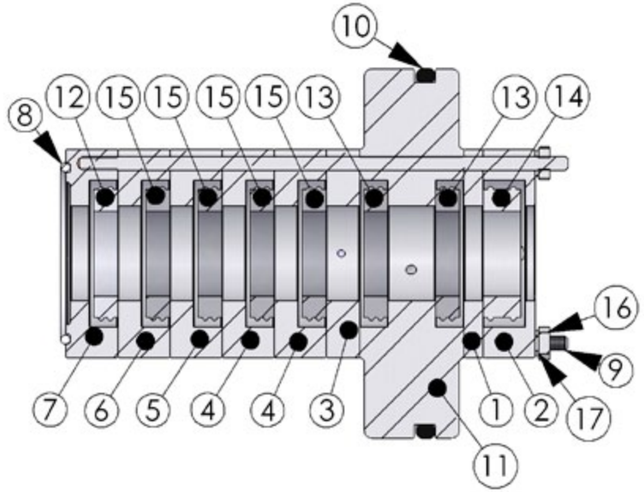
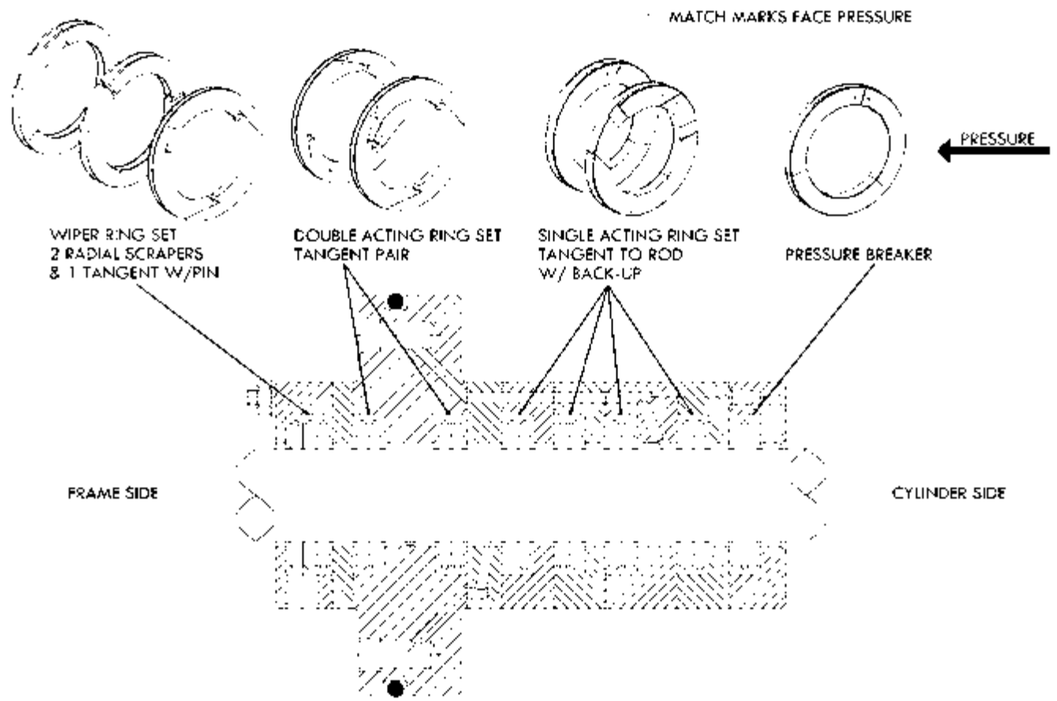


Figure 9.7 - Piston Rod Pressure Packing Exploded Views

PACKING CASE			
NUMBER	**PART NUMBER**	**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

9.13.1 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

Figure 9.8 - Typical Piston Rod Packing Ring configuration

Arrow part numbers for ordering renewal ring kits are:

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

VRC23551- Ring Kit, Packing Renewal (rings only)

9.13.2 PISTON ROD PRESSURE PACKING REMOVAL

1. Remove the piston and piston rod (see “Piston and Piston Rod Removal”).

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.

   Parts kits are available from Arrow for this. Contact your Arrow sales representative for more information regarding the parts kits. See Section 9.13.1 “Piston Rod Packing Ring Arrangement“ for part numbers.

7. 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.

8. Any wire edges on the rings due to wear should be filed off allowing all matching edges to be square.

9. If necessary, replace aluminum gasket prior to reassembling. Be careful not to scratch the sides of the gasket groove when removing the old gasket.

10. It is important to be sure that all parts are cleaned thoroughly before reassembly.

11. Refer to the packing case drawing, Section 9.13.1 for proper orientation of packing rings. Arrow Pressure Packing Replacement kits are available, see bottom of Section 9.13.1.

9.13.3
PISTON ROD PRESSURE PACKING REASSEMBLY AND INSTALLATION

1. Be sure to refer to the exploded view drawing of the pressure packing assembly (see Section 9.13 “Pressure Packing, Piston Rod and 9.13.1 “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 very 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 (See “Piston and Piston Rod Installation”).

11. After the crosshead jam nut has been tightened, tighten the rod packing screws evenly to the recommended torque of 40 ftlbs. 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 “Filling and Operating The Lubrication System” for instruction for priming the cylinder lube system.

      For fitting and tubing connections refer to Section 5.1 “Tubing and Distance Piece Venting”.

9.14 VALVES

9.14.1 VALVE PARTS

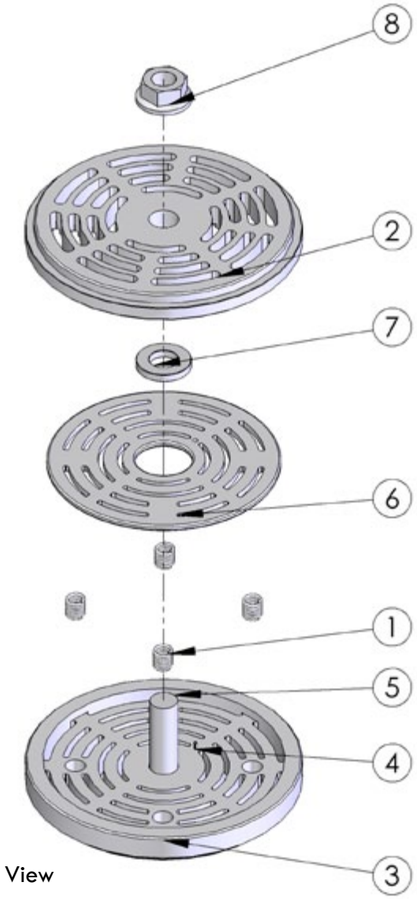


Figure 9.9 - Suction Valve Exploded View

SUCTION VALVE			
NUMBER	**PART NUMBER***	**DESCRIPTION**	**QTY**
1	VRC2XXXX	SPRING, CLOSING, VALVE	9-16
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 if you need replacement parts.

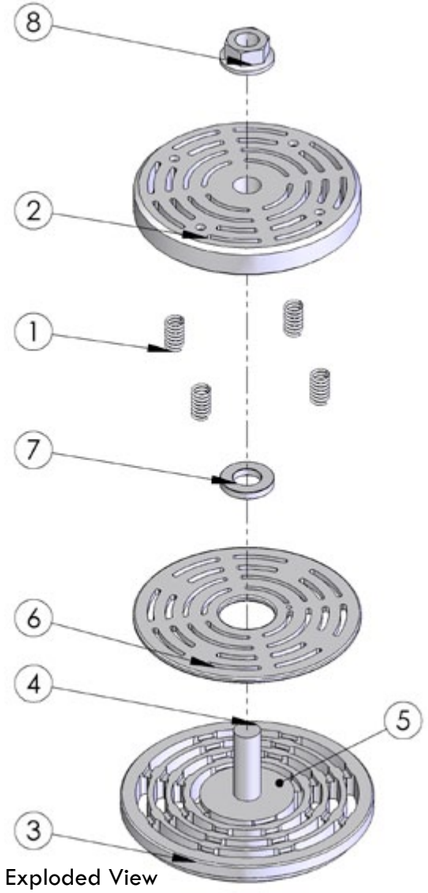


Figure 9.10 - Discharge Valve Exploded View

DISCHARGE VALVE			
NUMBER	**PART NUMBER***	**DESCRIPTION**	**QTY**
1	VRC2XXXX	SPRING, CLOSING, VALVE	9-20
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 if you need replacement parts.

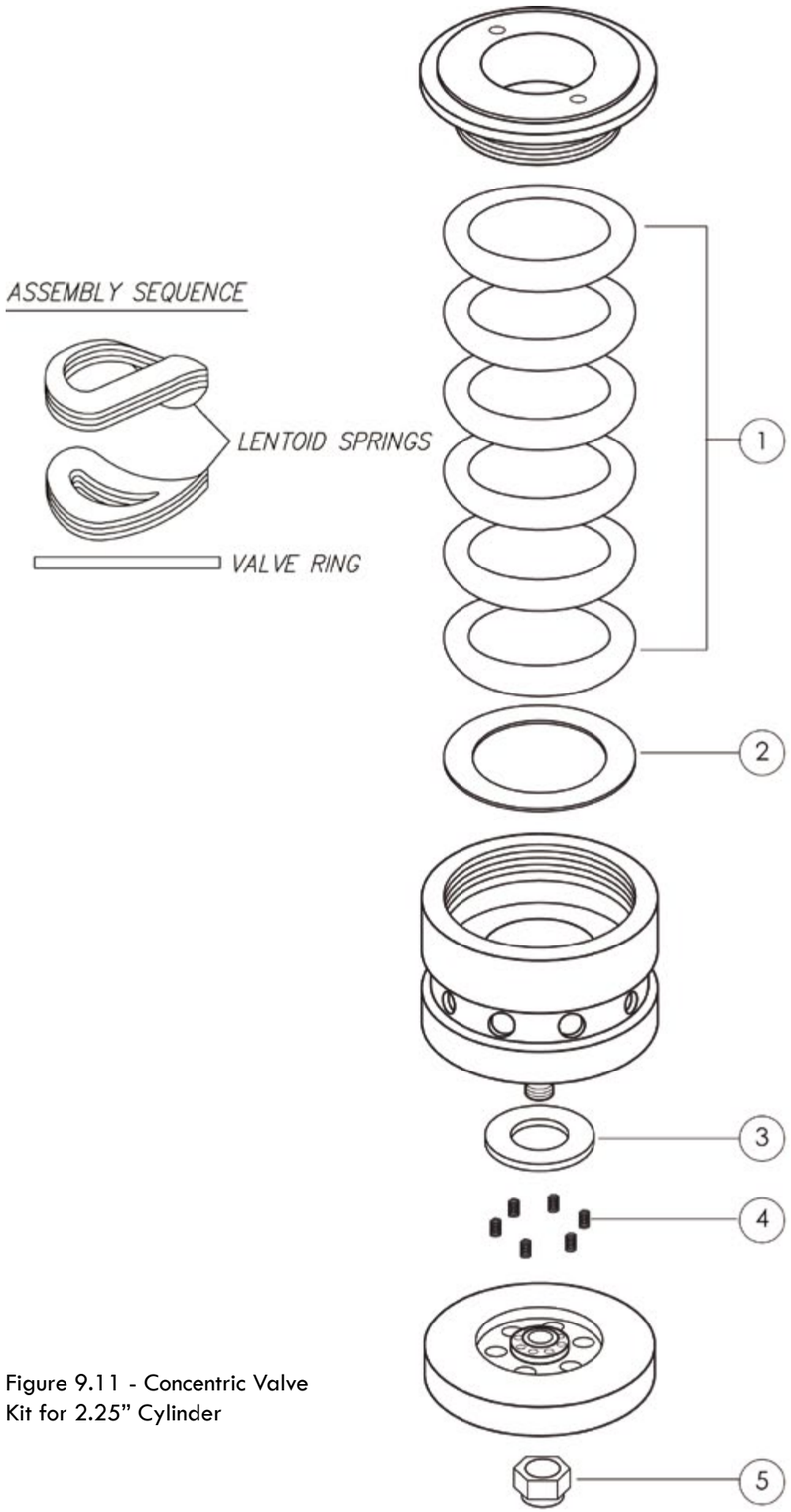


Figure 9.11 - Concentric Valve Kit for 2.25” Cylinder

CONCENTRIC VALVE KIT - for 2.25” Cylinder			
PART NUMBER		**DESCRIPTION OF PART**	**QTY.**
VRCC6235A		**Valve, Concentric, 2.25” CNG Assembly**	
VRCC6235K		**Concentric Valve Repair Kit**	
VRCC6235K	1	Lentoid Springs, Suction	6
	2	Suction Plate/Ring	1
	3	Discharge Plate/Ring	1
	4	Closing Springs	6
	5	Lock Nut	1

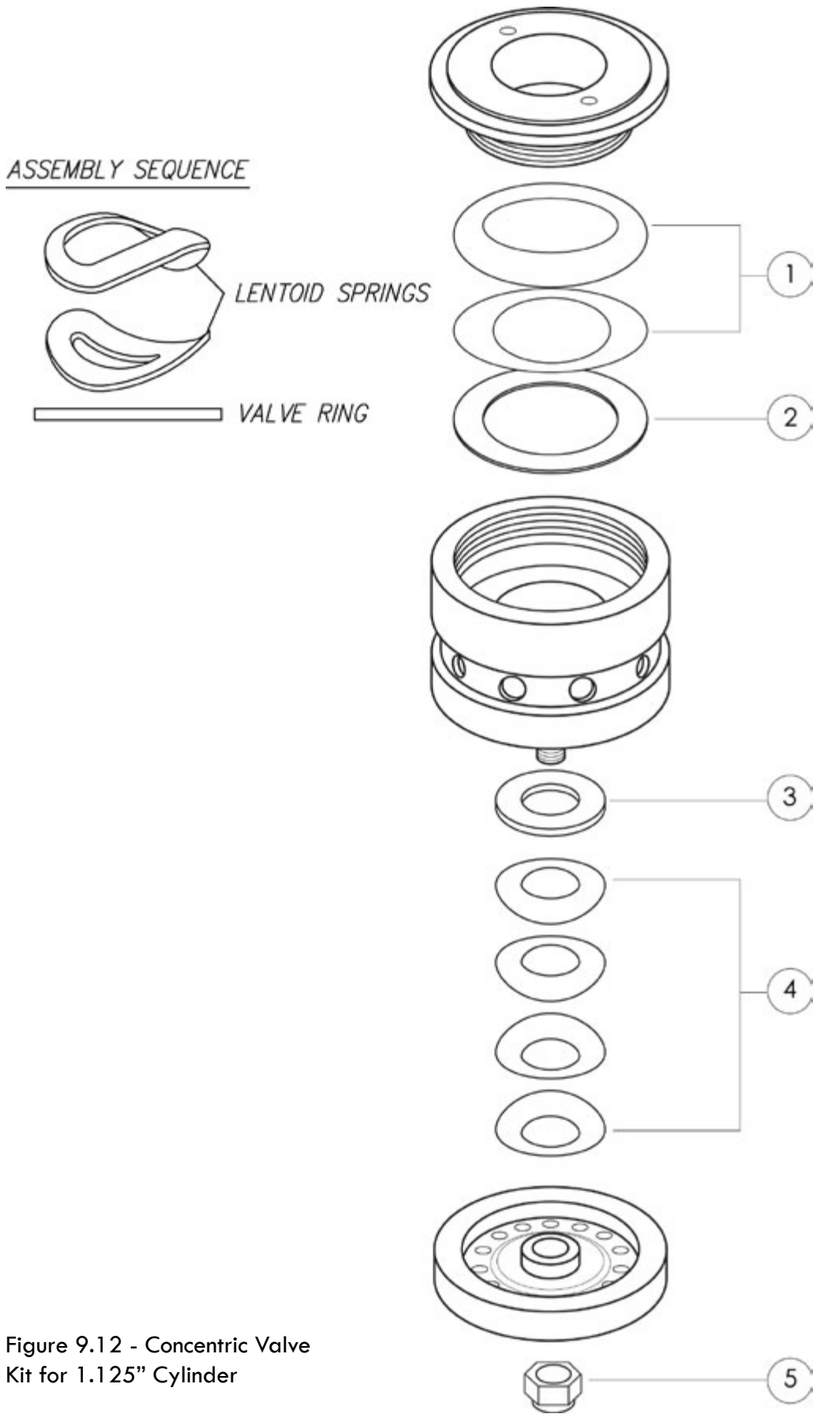


Figure 9.12 - Concentric Valve Kit for 1.125" Cylinder

CONCENTRIC VALVE KIT - for 1.125" Cylinder			
PART NUMBER		**DESCRIPTION OF PART**	**QTY.**
VRCC6125A		**Valve, Concentric, 1.125" CNG Assembly**	
VRCC6125		**Concentric Valve Repair Kit**	
VRCC6125	1	Lentoid Springs, Suction	2
	2	Suction Plate / Ring	1
	3	Discharge Plate / Ring	1
	4	Lentoid Springs, Discharge	4
	5	Lock Nut	1

9.14.2 REMOVING VALVES

- **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 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 NUMBER	**TOOL, VALVE INSTALLATION**
VRC29463	2.25” - 4.0” CYLINDERS 1/4” & 5/16” THREADS
VRC29464	4.5” - 8.0” CYLINDERS 3/8” & 1/2” THREADS

Table 9.3 - Valve Tool Size

4. The valve seat gasket will remain in the pocket. The gasket may fall into the gas passage. A small magnet on a flexible extension rod will help retrieve the gasket from the passage. The gasket should be replaced after several uses or each time the valves are replaced.

9.14.3 VALVE MAINTENANCE

Arrow Engine Company does not have a compressor valve repair facility. Arrow does stock and sell new Hoerbiger replacement valves and valve part repair kits.

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.

9.14.4 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 (See Table 9.3 “Valve Installation Tool Size”) 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 ftlbs. 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.

9.14.5 SCREW TIGHTENING FOR VALVE COVERS

Proper tightening technique is essential for sealing of the valve covers. It is important to draw up screws 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 criss-cross pattern.

3. Next tighten each screw to full torque, moving across from screw to screw, in a criss-cross pattern.

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

-10-
LUBRICATION SYSTEM ASSEMBLY & INSTALLATION

10.1 LUBRICATION SYSTEM OVERVIEW

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

Maximum allowable oil temperature into the VRC-CNG 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 lubricants' ability to adhere to a metal surface.

10.1.1 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.

10.1.2 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 traditional 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.

10.1.3 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 VRC-CNG 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 VRC-CNG compressor is equipped with a simplex, spin-on filter.

The compressor frame lubricating oil should be changed at regular maintenance cycles 6 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).

10.1.4 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 5.4. 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.

10.2 LUBRICATION SYSTEM ASSEMBLY & INSTALLATION

10.2.1 LUBRICATION SYSTEM ASSEMBLY & INSTALLATION: INTRO

Installation of the VRC-CNG Compressor lubrication system is a very 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**
   - i. The Chain Idler Assembly
     - Sprocket Alignment
   - ii. Chain Tensioner Adjustment
   - iii. 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**
   - i. Lube Pump/Integral Bearing Shaft/Cylinder Lube Pump Mounting Flange installation
   - ii. Belt Tensioner Assembly
   - iii. Belt Tensioner Bearing
     - Belt Tensioner Assembly Installation
   - iv. Idler Bearing Assembly Installation

10.2.2 FRAME LUBRICATING SYSTEM (CHAIN DRIVE)

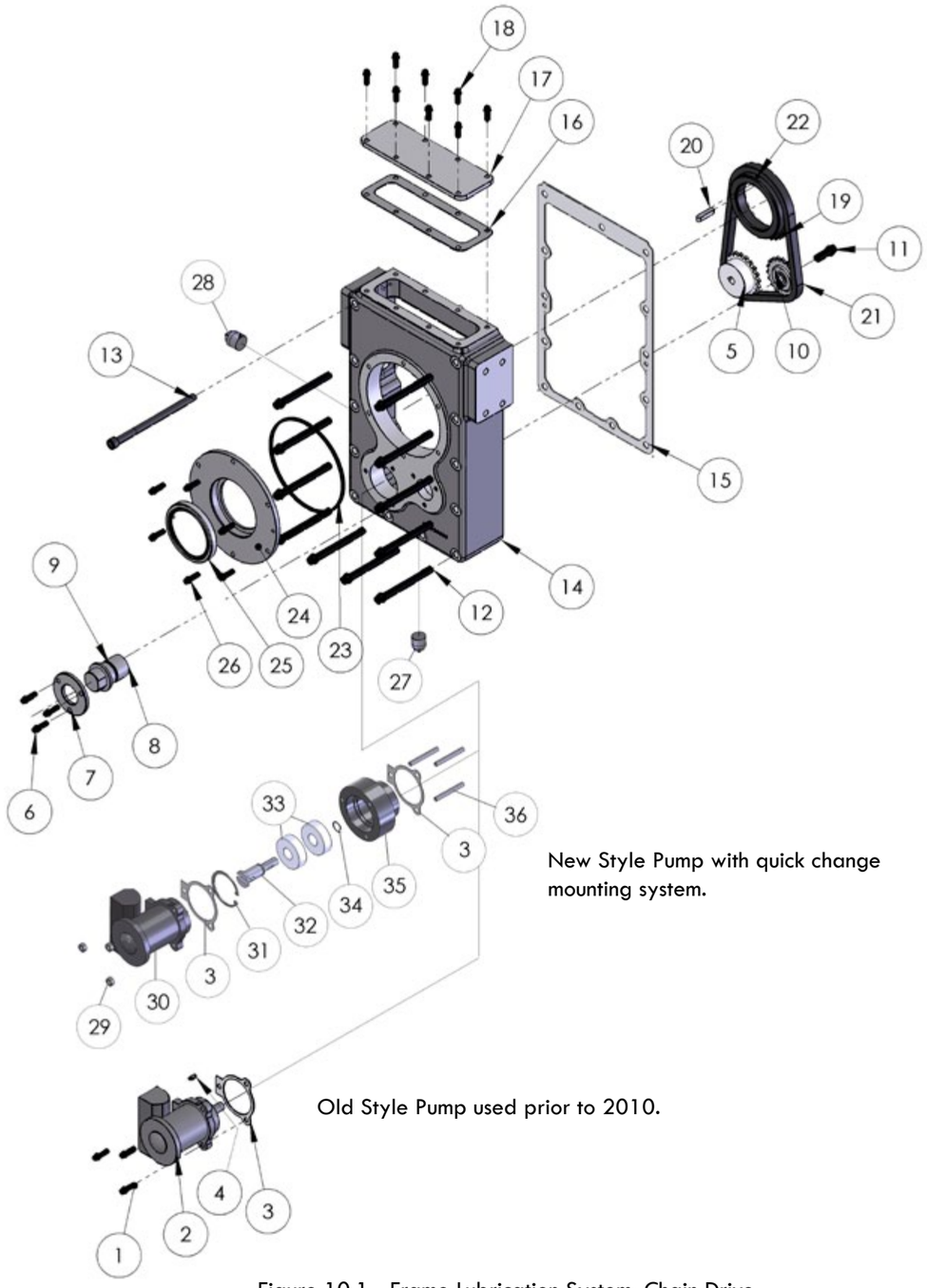
The frame lubrication system supplies oil to the internal frame running gear such as the crankshaft, connecting rods, crosshead pins and crossheads. The cylinder's lubrication originates from the cylinder lubrication system. Sight glass on the accessory side of the frame displays the oil level in the 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 (2/3) 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 (VRC28310) mounted on the accessory end of the frame.

Oil then flows from the filter to the six (6) port manifold (VRC28120) and then to the oil slinger system (VRC28100).

Oil then travels to the crankshaft, connecting rods, and crosshead pin. Oil also flows from the 6 port manifold to the crosshead guides.

10.3 FRAME LUBRICATION SYSTEM: CHAIN DRIVE



New Style Pump with quick change mounting system.

Old Style Pump used prior to 2010.

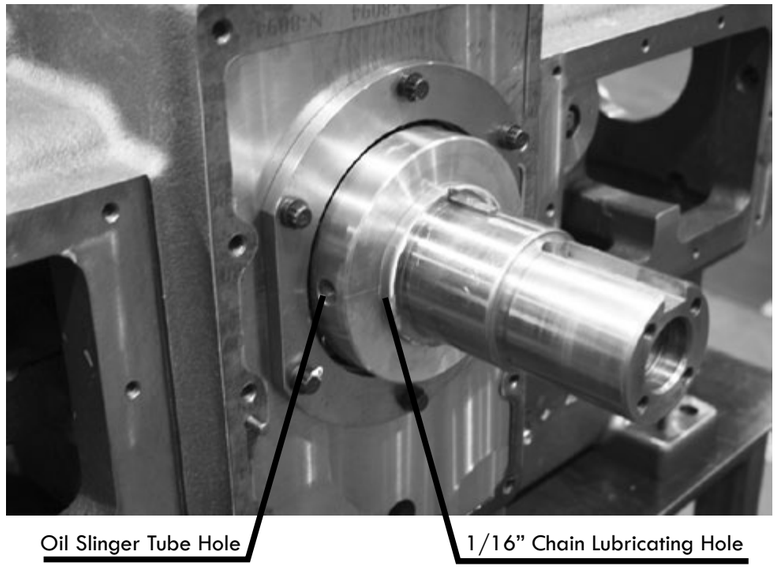
Figure 10.1 - Frame Lubrication System: Chain Drive

• FRAME • FRAME (CHAIN DRIVE) LUBRICATION SYSTEM			
ITEM NUMBER	**PART NUMBER**	**DESCRIPTION**	**PART QTY**
1	VRC28027	SCREW, PUMP, FRAME OIL, 12 PT	3
2	VRC28300	PUMP, OIL, FRAME (Old Style)	1
3	VRC28305	GASKET, PUMP, FRAME OIL	2
4	VRC28236	KEY, SPROCKET	1
5	VRC28232	SPROCKET, DRIVE, FRAME OIL PUMP	1
6	VRC28027	SCREW, CLAMP, IDLER CHAIN, 12 PT	3
7	VRC28253	CLAMP, IDLER, CHAIN	1
8	VRC28250	IDLER, CHAIN, FRAME OIL PUMP	1
9	VRC28254	O-RING, IDLER, CHAIN	1
10	VRC28220	SPROCKET, IDLER, CHAIN	1
11	VRC28227	SCREW, IDLER, SPROCKET, 12 PT	1
12	VRC28007	SCREW, HOUSING, 12 PT	11
13	VRC28067	SCREW, HOUSING AND IDLER (Socket Head)	1
14	VRC28000	HOUSING, LUBE OIL DRIVE	1
15	VRC28005	GASKET, HOUSING, LUBE OIL DRIVE	1
16	VRC28015	GASKET, COVERPLATE, HOUSING	1
17	VRC28010	COVERPLATE, HOUSING, LUBE OIL DRIVE	1
18	VRC28017	SCREW, HOUSING COVERPLATE, 12 PT	8
19	VRC28248	SPROCKET, CRANKSHAFT DRIVE	1
20	VRC28206	KEY, DRIVE SPROCKET	1
21	VRC28200	CHAIN, DRIVE, ENDLESS RIVETED	1
22	VRC28239	SETSCREW, DRIVE SPROCKET	1
23	VRC28022	O-RING, RETAINER, OIL SEAL	1
24	VRC28020	RETAINER, OIL SEAL CRANKSHAFT	1
25	VRC28024	SEAL, OIL, CRANKSHAFT	2
26	VRC28027	SCREW, SEAL RETAINER, 12 PT	6
27	VRC21529	PLUG, PIPE, 1/2" NPT	1
28	VRC21519	PLUG, PIPE, 1" NPT	1
29	VRC28489	NUT, BELT GUARD & OIL PUMP	3
30	VRC28301	PUMP, OIL, FRAME - WITH TANG SHAFT	1
31	VRC28335	RING, RETAINING, LARGE, PUMP MOUNT	1
32	VRC28332	SHAFT, PUMP MOUNT, FRAME OIL	1
33	VRC28333	BEARING, SHAFT, PUMP MOUNT	2
34	VRC28334	RING, RETAINING, SMALL, PUMP MOUNT	1
35	VRC28331	MOUNT, PUMP, FRAME OIL	1
36	VRC28337	STUD, PUMP MOUNT	3

NOTE: Not all parts may be used on all CNG compressors.

10.3.1 FRAME LUBRICATION SYSTEM (CHAIN DRIVE) PREPARATION AND INSTALLATION

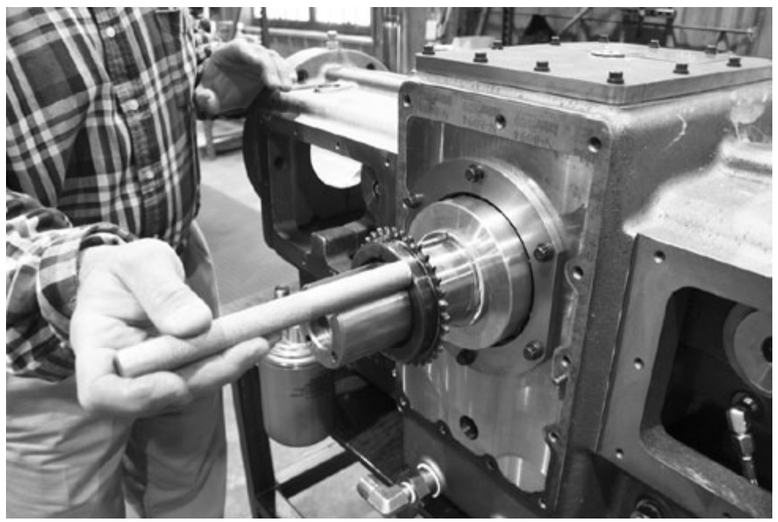
1. Lubricate the crankshaft and oil slinger (VRC28100).



2. Slide the oil slinger onto the crankshaft making sure the 1/16" chain lubricating hole points out and the oil slinger tube hole points to the left hand side (to throw number 2).

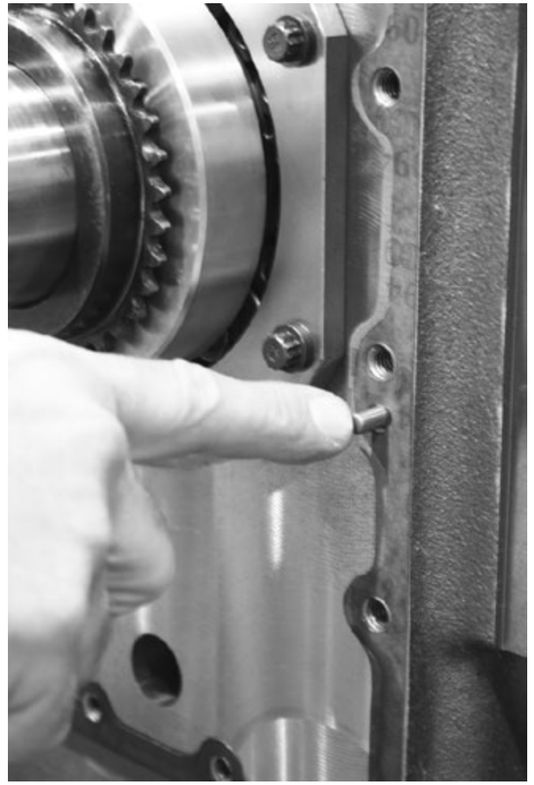
3. Check to make sure the slinger moves freely on the crankshaft.

4. Insert the drive sprocket key (VRC28206) into the crankshaft key way.



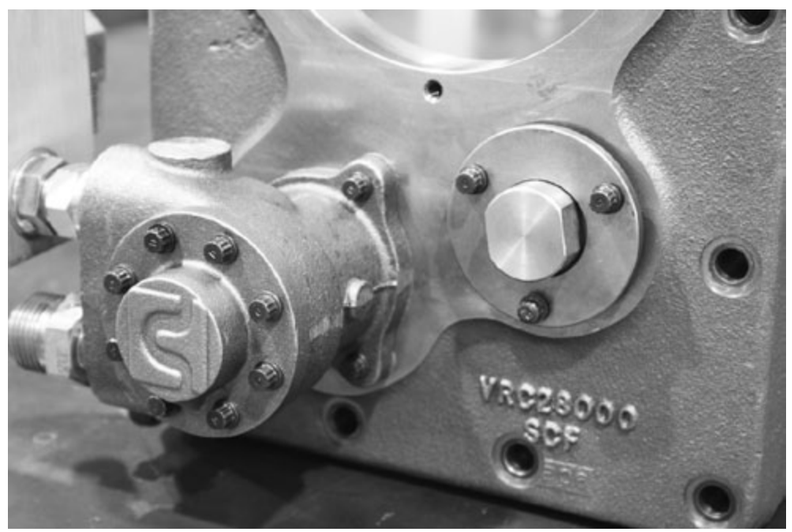
5. Install crankshaft drive sprocket (VRC28248). The teeth of the sprocket should be towards the oil slinger and the integral retainer toward the end of the shaft.

   NOTE: This is a tight fit. You may need to tap the drive sprocket with a rubber mallet or brass punch to insert the drive sprocket properly.



6. Tighten set screw with a 5/32" allen wrench.

7. Insert housing dowel pins (VRC28006) into frame with hammer until they are seated in holes.



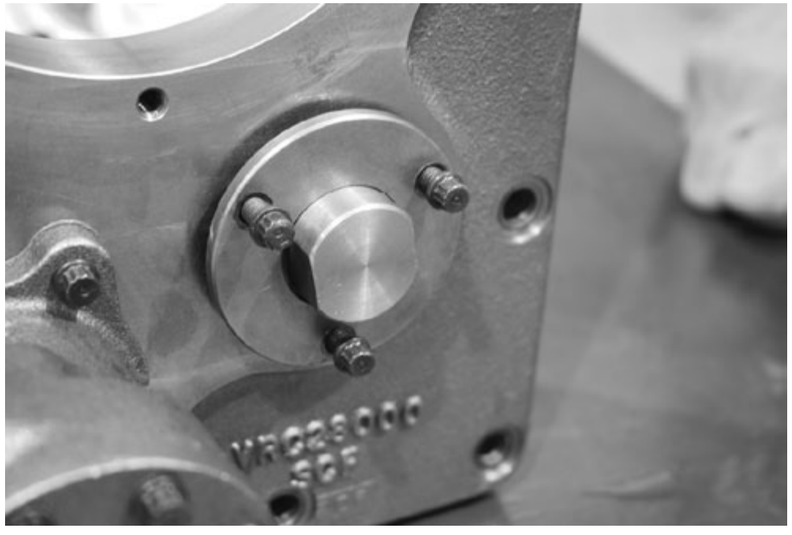
8. Mount frame oil pump (VRC28300A) to housing using the oil pump gasket (VRC28305) and oil pump screws (VRC28307).

10.3.2 CHAIN IDLER ASSEMBLY INSTALLATION (CHAIN DRIVE INSTALLATION)

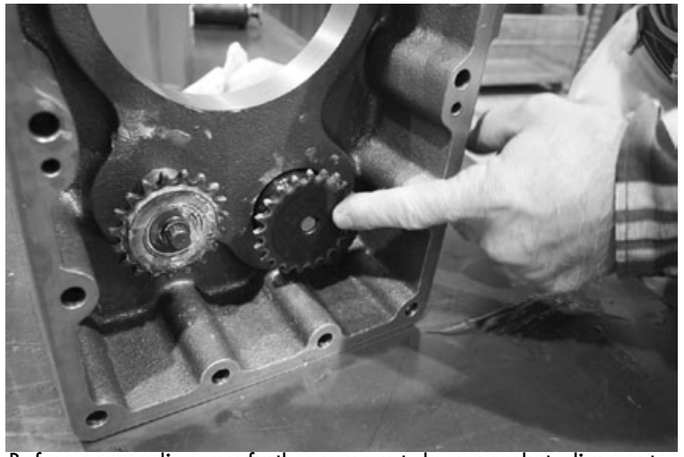
1. Lubricate the chain idler O-ring (VRC28254).

2. Seat the O-ring into the O-ring groove in the frame oil pump idler (VRC28250).

3. Insert idler into housing.



4. Install the chain idler clamp (VRC28253) over the chain idler and secure with three (3) idler chain clamp screws (VRC28257).

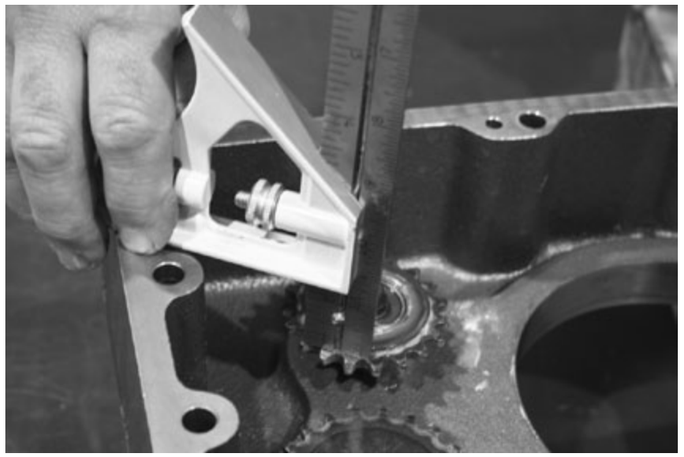


5. From the inside of the housing, install the key to the frame oil pump shaft (VRC28236). Then slide the oil pump drive sprocket (VRC28232) onto the shaft. DO NOT TIGHTEN. You must do a sprocket alignment first before you tighten.

   Inside of housing indicating where to install key to the frame oil pump shaft (VRC28236)

Before proceeding any further you must do a sprocket alignment.

10.3.3 SPROCKET ALIGNMENT PROCEDURES

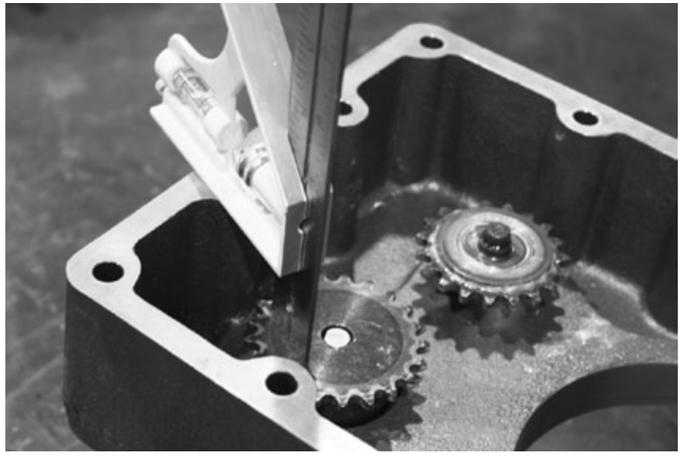


i. Using a combination square, measure the distance from the flat surface on the face of the housing to the flat surface of the teeth of the idler sprocket. Adjustment is made on the oil pump sprocket to match the dimensions that are measured from the housing face to the idler sprocket.

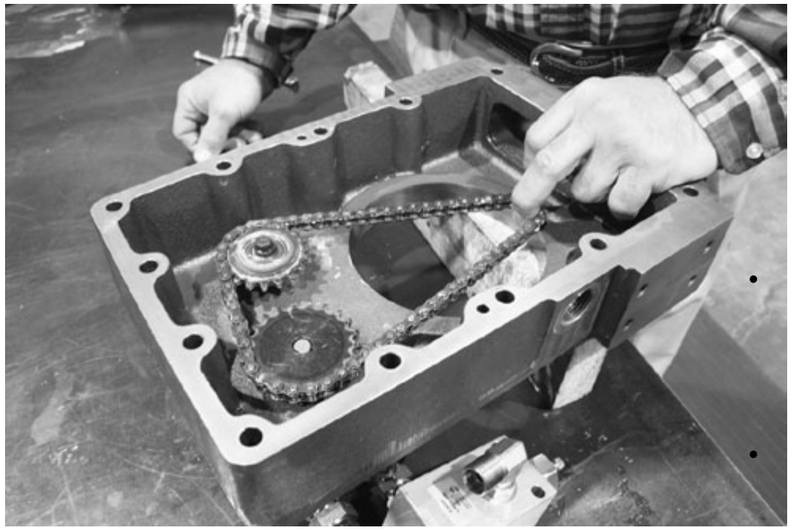
   Measuring the distance from the flat surface on the face of the housing to the flat surface of the teeth of the idler sprocket.

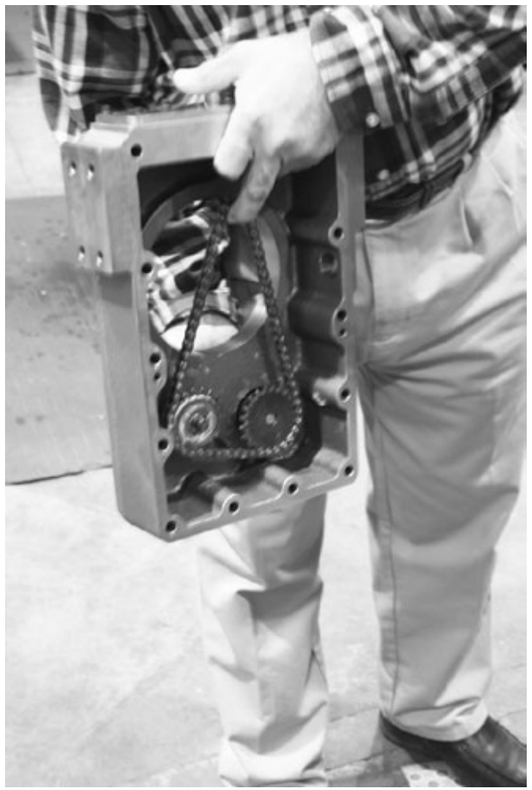
   Measuring the distance from the flat surface on the face of the housing to the flat surface of the teeth of the oil pump sprocket.

   To adjust the oil pump sprocket, simply move the sprocket up and down on the shaft.



ii. After all measurements and any adjustments have been made too the pump sprocket, tighten the sets screws on the sprocket. You may now continue with chain installation.





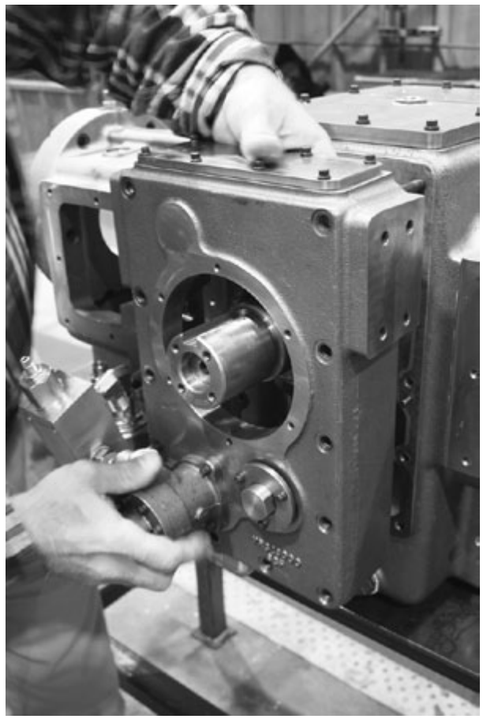
1. After sprocket alignment is complete, install the endless riveted drive chain (VRC28200) over the idler and oil pump sprockets.

- **NOTE:** Endless riveted drive chains do NOT have a master link and are NOT directional.

- **NOTE:** Hold the chain with your finger (as show in picture) towards the top of the housing. Keep the chain tight on the sprockets while mounting the housing onto the frame.

2. Lift drive chain and housing at the same time and prepare to mount the drive chain/housing assembly to the frame.

3. Install the lube oil housing gasket (VRC28005).



4. Mount the housing assembly to the frame. Make sure that the chain is on top of the crankshaft and push the housing all the way on the frame. Attach the housing to the frame using the housing screws (VRC28007).

The dowel pins will help align the housing to the frame.

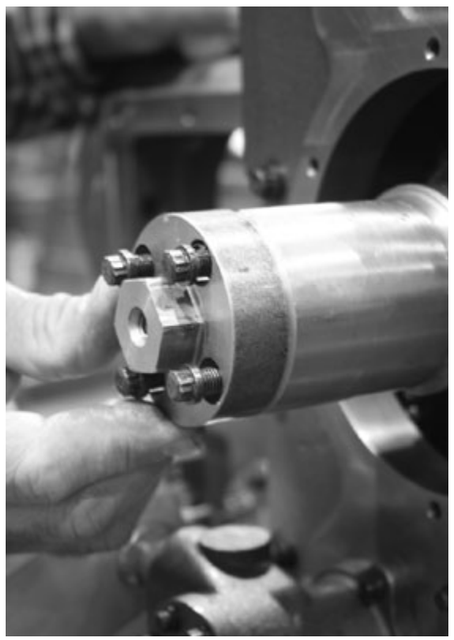
NOTE: You may use alignment studs for additional help with alignment when mounting the housing to the frame.

5. With the housing assembly securely in place, loosen the idler clamp screws and turn the idler so that the chain is in its most slack position.

1. Place the chain on the crankshaft drive sprocket.
2. Insert the remaining housing screws and tighten them.

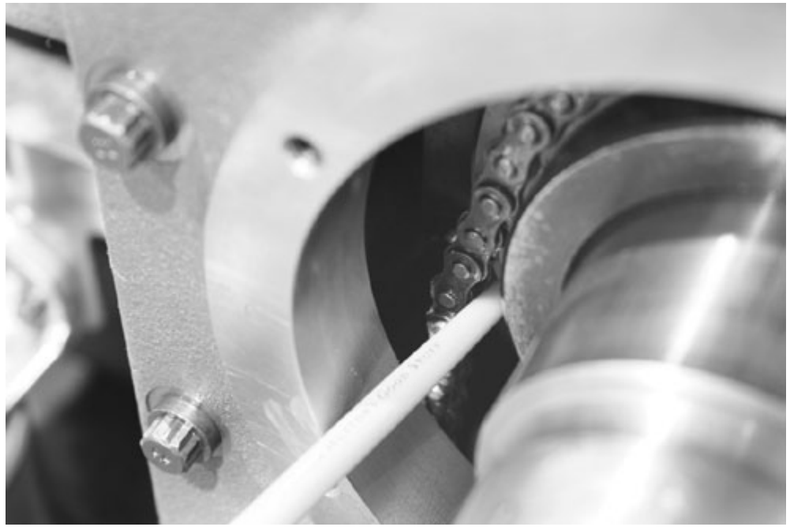
10.3.4 CHAIN TENSION ADJUSTMENT (Chain Drive Installation)

1. Turn the chain idler counter-clock wise until chain is snug (not tight). DO NOT OVER TIGHTEN.



2. Check the slack side of the chain with your fingers then install the crankshaft bar over adapter tool (VRC21140).

   Rotate the crankshaft until the chain is at it tightest position on the slack side. This usually occurs when the crankshaft key is in the up or down position.



3. Turn the idler clockwise (very slight turns) enough to loosen the chain so that there is a 1/4" of play or sag.

It is important that the chain is not too tight and has some sag or play!

4. After adjustment is complete, tighten screws on the chain idler clamp.
5. Turn crankshaft to make sure that the chain does not bind and everything is operating correctly.
6. After turning the crankshaft, check to make sure the chain has not loosened.

10.3.5 CHAIN DRIVE AND SPROCKET REPLACEMENT

The chain should be replaced if the elongation exceeds 0.084" or 2.1336 mm over a 10 pitch length or if abnormal wear is observed on the chain and or sprockets.

10.3.6 CHAIN IDLER SPROCKET REPLACEMENT - ECCENTRIC IDLER ADJUSTMENT

If there is appreciable wear on the chain or sprocket, Arrow recommends replacing the chain and all sprockets.

- All sprockets include: Sprocket, Idler, Chain (VRC28220)
- Sprocket, Crankshaft Drive (VRC28248)
- Sprocket, Drive, Frame Oil Pump (VRC28232)

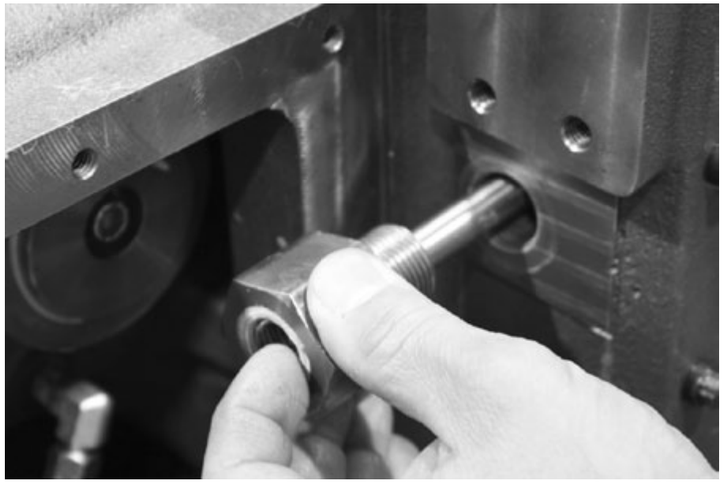
10.3.7
OIL SLINGER TUBE & FITTING INSTALLATION (Chain Drive Installation)

1. Lubricate and insert O-ring (VRC28104) on both ends of the oil slinger tube (VRC28110).

2. Insert the oil slinger tube into the oil slinger tube fitting (VRC28130).

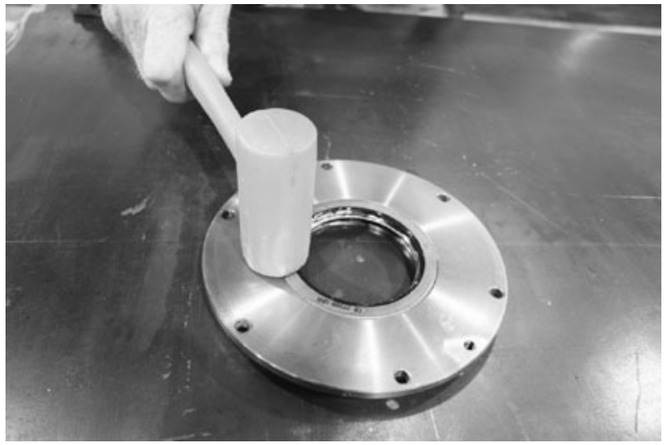
3. Install oil slinger fitting gasket (VRC28125) on the fitting and insert the fitting gasket and tube into the opening in the side of the housing.

4. Make sure the oil slinger tube engages into the hole in the side of the oil slinger. It may be necessary to rotate the slinger on the crankshaft until the hole in the slinger is aligned with the opening in the side of the housing.



5. Screw in the fitting making sure nothing is binding.

10.3.8
CRANKSHAFT OIL SEAL INSTALLATION (Chain Drive Installation)



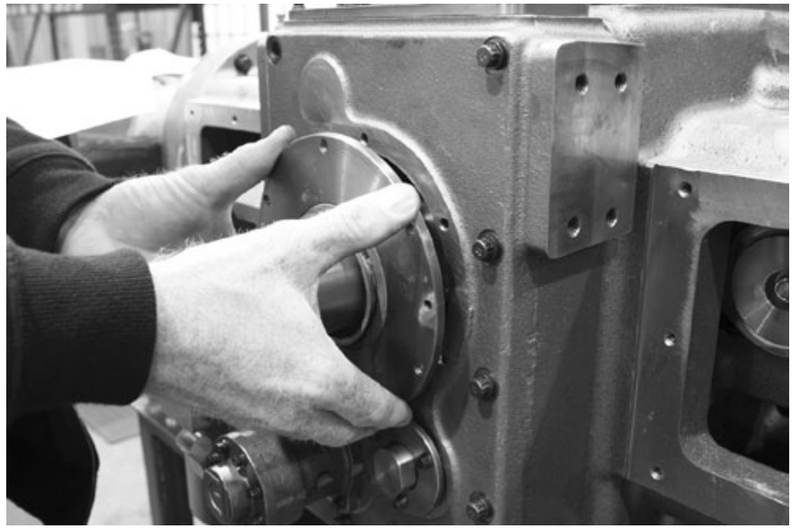
1. Install crankshaft oil seal (VRC28024) into the accessory-end bearing retainer (VRC21120) using a bench press or gently tap the seal into place using a rubber mallet.

Caution must be taken when using a mallet to keep from damaging the seal!

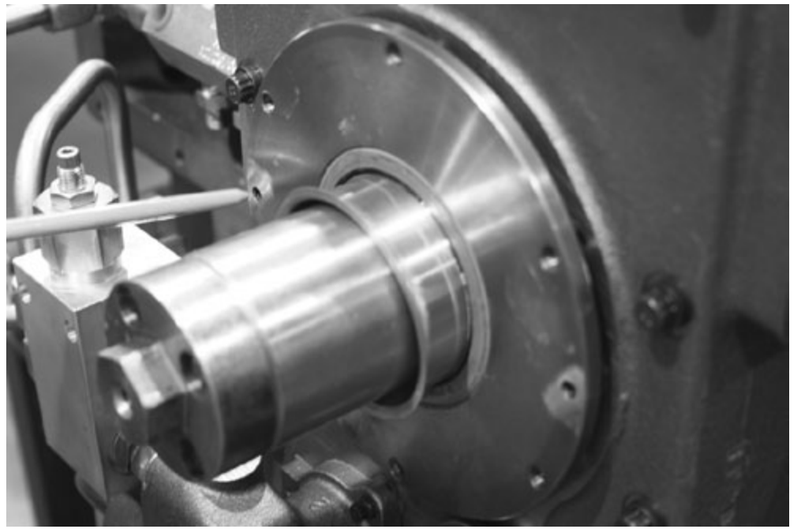
2. Apply lubricant to the oil seal retainer O-ring (VRC28022).

3. Install O-ring to the oil seal retainer.

4. Using the special tool, oil seal entering sleeve (VRC29482), insert the tool into the seal.



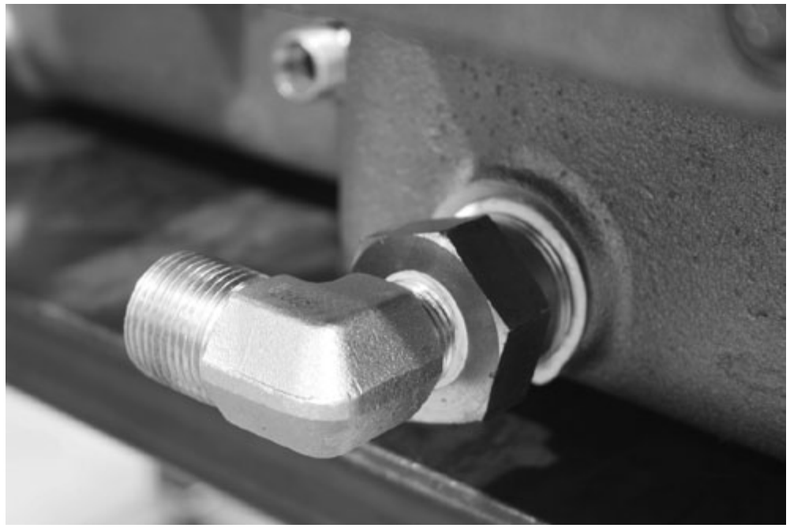
1. Carefully slide the retainer on to the shaft installing the retainer so that the retainer puller holes are positioned horizontally.



2. After installing the retainer, remove the oil seal entering sleeve tool.
3. Screw in the six (6) retainer screws (VRC21117) and tighten.
4. Install lube oil drive housing cover plate (VRC28010) and housing cover plate gasket (VRC28015) using cover plate housing screws (VRC28017).

10.3.9 FRAME OIL PUMP TUBING INSTALLATION

FRAME OIL STRAINER TO PUMP TUBING ASSEMBLY

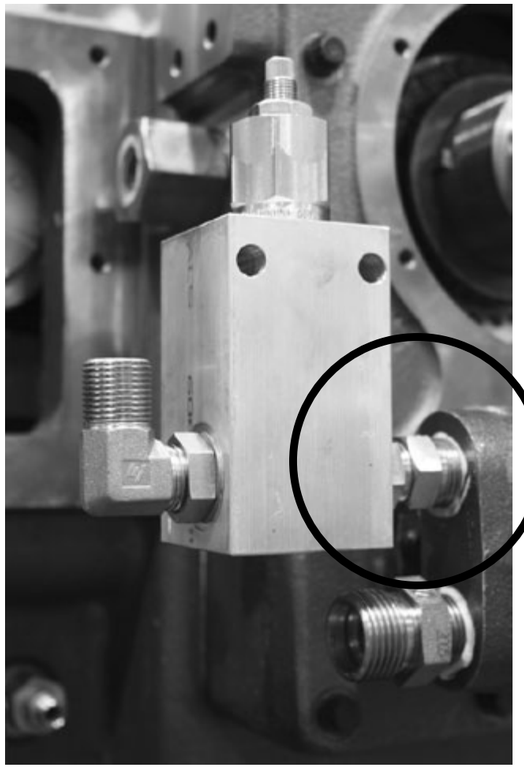


1. Install fitting (VRC28871) into the oil strainer (VRC28340) with the 90° outlet pointing toward throw number 2.
2. Install frame oil pump inlet fitting (VRC28872) in the bottom inlet hole of the pump.

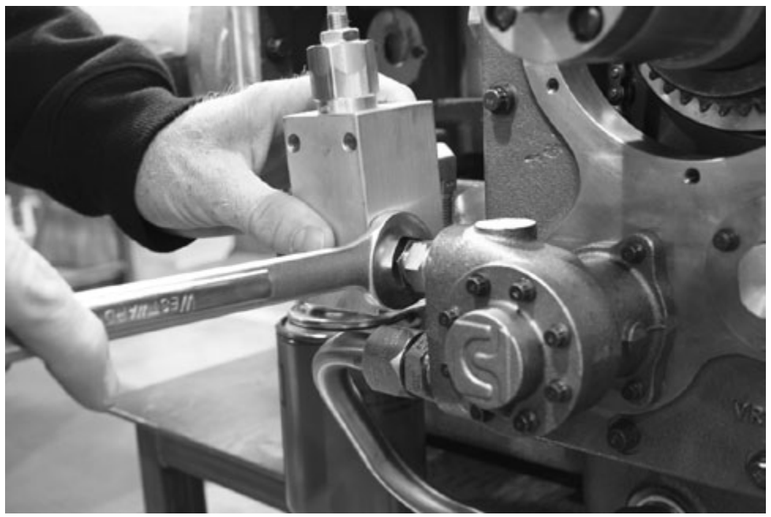
3. Install strainer to pump tubing (VRC28875-13.3) between the oil strainer and the inlet to the frame oil pump.

10.3.10 FRAME OIL PUMP TUBING INSTALLATION

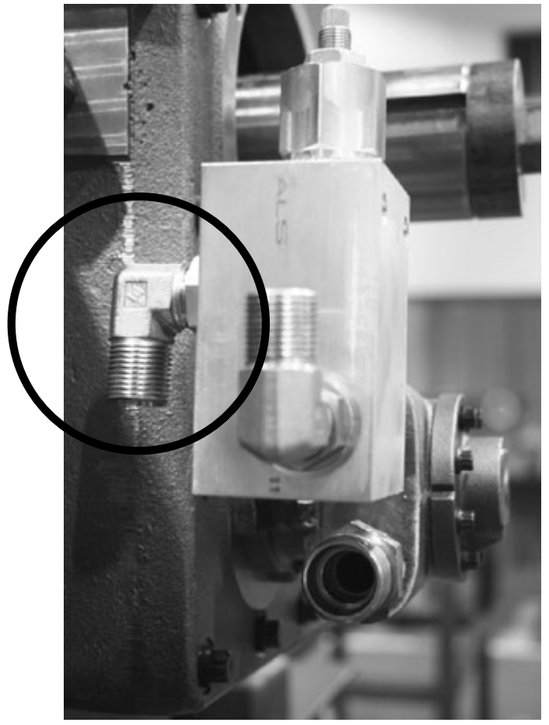
OIL PRESSURE RELIEF VALVE INSTALLATION



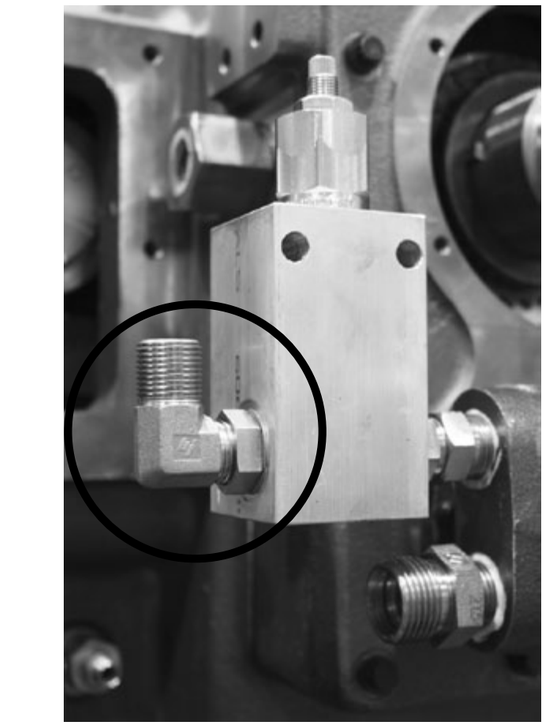
1. Install the pump to relief valve (RV) fitting (VRC28801) in the inlet of the top outlet hole of the pump. (For more information regarding the relief valve, see Section 10.6)



2. Screw the relief valve on to the pump to RV fitting and tighten the lock-nut so that the relief valve is in the upright position.



3. Install relief valve (RV) to sump tubing assembly (VRC28812A). Install fitting (VRC28815) in the outlet (Port #2) with 90° outlet pointing down.

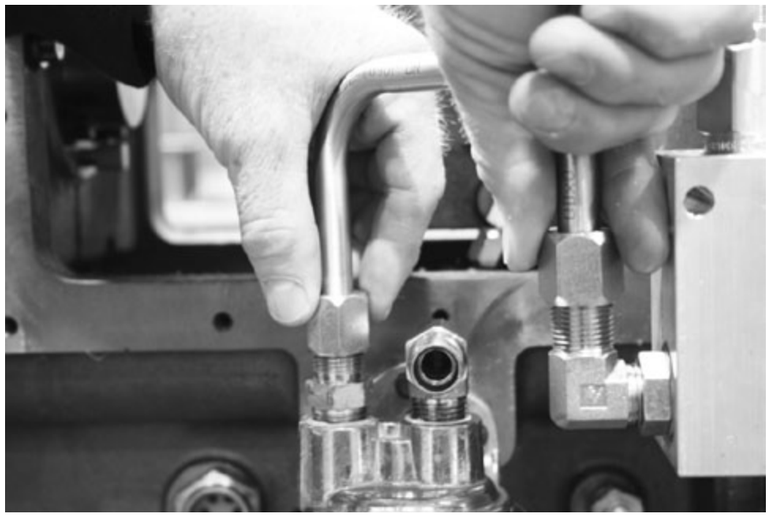


4. Install the relief valve to filter fitting (VRC28815) in the outlet of the relief valve with the 90° outlet pointing up.

10.3.11 FRAME OIL PUMP TUBING INSTALLATION
RELIEF VALVE TO SUMP TUBING ASSEMBLY

Install 1/2" tubing (VRC28850-10.7) by attaching it to the relief valve (RV) to sump fitting (VRC28815) on the relief valve and to the fitting at the bottom of the frame sump (VRC28852).

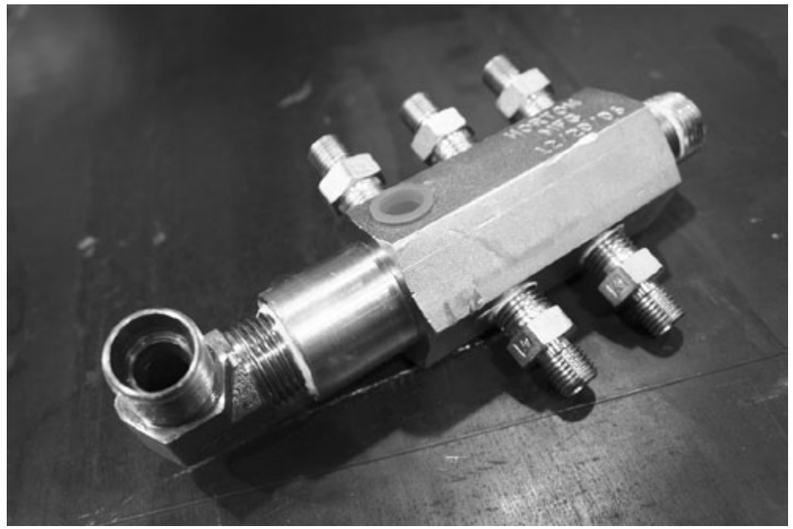
10.3.12 FRAME OIL PUMP TUBING INSTALLATION
RELIEF VALVE TO FILTER INLET TUBING ASSEMBLY



1. Install 1/2" tubing (VRC28850-12.5) to the fitting in the outlet of the relief valve (RV) and to the inlet fitting (VRC28851) of the filter bracket.

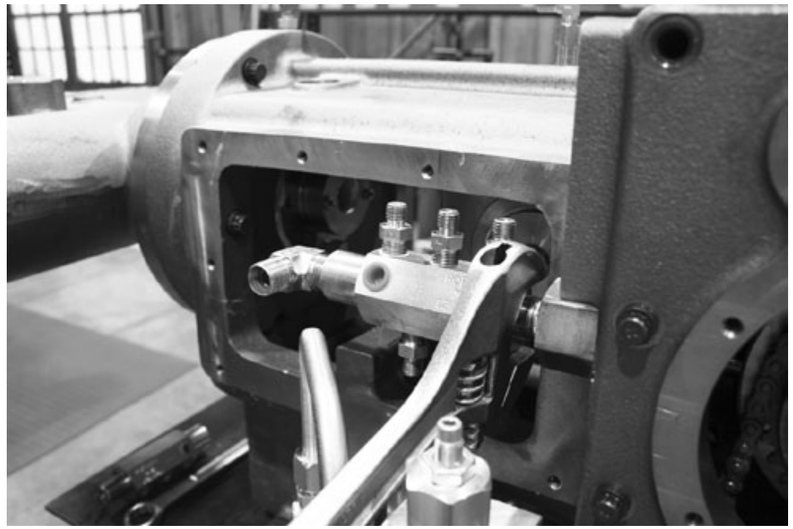
2. Tighten all fittings associated with the relief valve.

10.3.13 FRAME OIL PUMP TUBING INSTALLATION
FILTER OUTLET TO 6 PORT MANIFOLD TUBING ASSEMBLY

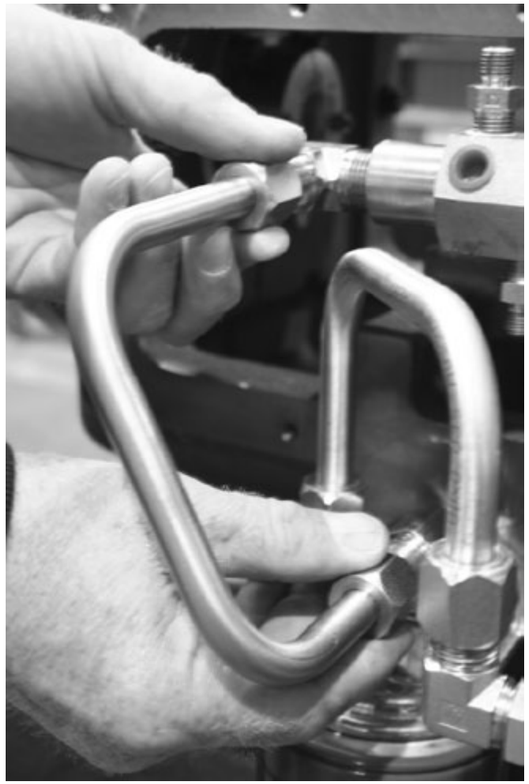


1. Install five (5) 1/4" fittings (VRC28821) into the three (3) ports at the top of the manifold and in the two (2) ports at the bottom of the manifold. Install the 1/2" 90° fitting (VRC28853) at the end of the manifold pointing out from the accessory end.

2. Apply thread sealer and install 6 port manifold (VRC28120) into the oil slinger fitting (VRC 28130).



3. Install fitting (VRC28853) in the outlet of the filter bracket with 90° outlet printing out from the accessory end.



1. Install 1/2” tubing (VRC28850-13.6) between the fitting of the filter bracket and the fitting of the 6 port manifold.

10.3.14 FRAME OIL STRAINER INSTALLATION

The oil strainer is located on the accessory side of the compressor frame below the oil level. The strainer should be taken out and cleaned using the appropriate solvents each time the oil is changed. (See Section 9.3 for installation information.)

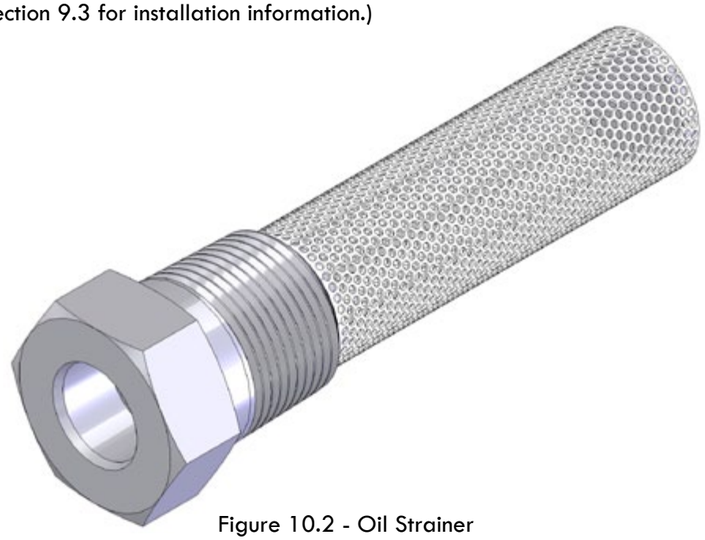


Figure 10.2 - Oil Strainer

10.3.14.1 FRAME OIL FILTER

Arrow Engine recommends replacing the frame oil filter element (VRC28310) at six month intervals, at each oil change, or more frequently depending on your location and the environment your compressor is operating. It is also a good idea to heed the recommendations from your oil sample analysis. The results from oil sample analysis can be a very good indicator for the need of an oil change.

10.3.14.2 FRAME OIL FILTER INSTALLATION

1. Clean filter base surface, and be certain the old gasket is removed.
2. Apply clean lube oil to the filter gasket.
3. When the gasket makes contact with the base, tighten hand tight.
4. Start the compressor and check for leaks. Retighten if necessary.
5. Replace only with an Arrow approved filter.

10.4 CYLINDER LUBRICATION (BELT DRIVE) SYSTEM

10.4.1 CYLINDER LUBRICATION SYSTEM (Belt Drive) - 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.

10.5 FRAME LUBRICATION SYSTEM: CYLINDER LUBRICATION SYSTEM – BELT DRIVE

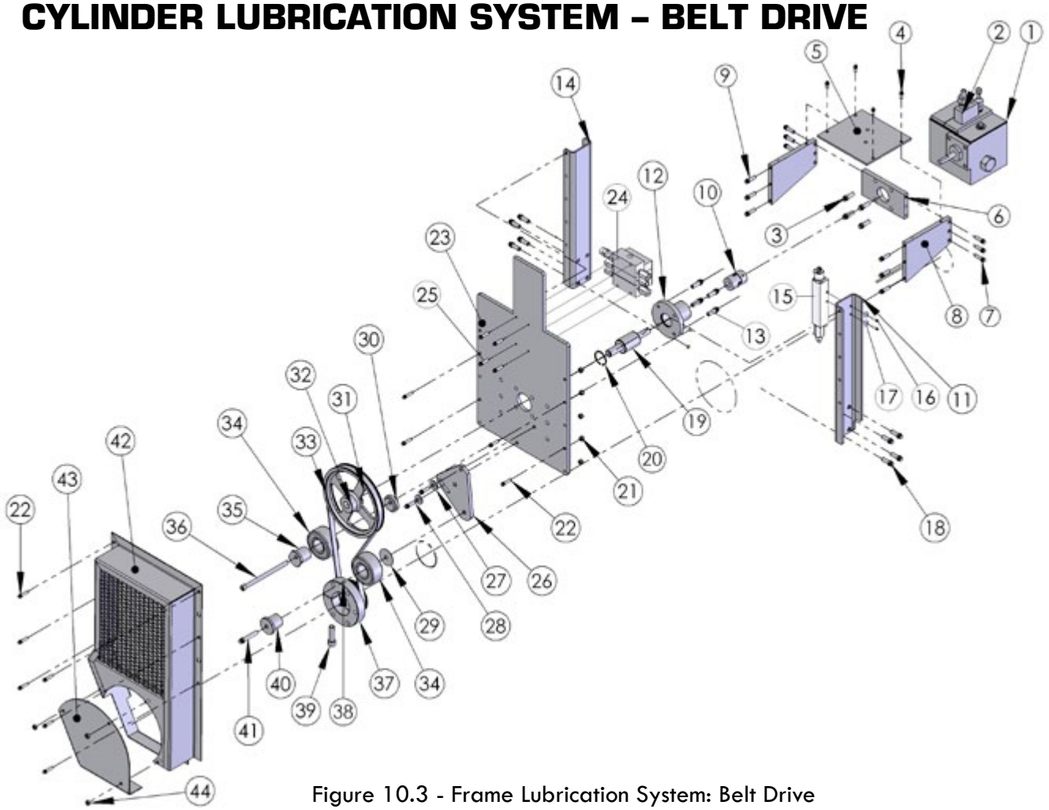


Figure 10.3 - Frame Lubrication System: Belt Drive

• FRAME • CYLINDER LUBRICATION (BELT DRIVE) SYSTEM			
ITEM NUMBER	**PART NUMBER**	**DESCRIPTION**	**PART QTY**
	VRC28502A	PUMP, OIL, CYLINDER LUBE, 1/4" w/RESERVOIR	
1	VRC28530	RESERVOIR, PUMP, CYLINDER LUBE	1
2	VRC28512	PUMP, OIL, CYLINDER LUBE, 1/4"	1
3	VRC21117	SCREW, LUBE OIL PUMP, 12 PT	4
4	VRC28017	SCREW, TOP PLATE, 12 PT	4
5	VRCC8570	PLATE, TOP PUMP SUPPORT, CNG	1
6	VRC28572	PLATE, END PUMP SUPPORT	1
7	VRC21327	SCREW, PLATE, SIDE PUMP SUPPORT, 12 PT	6
8	VRC28571	PLATE, SIDE PUMP SUPPORT	2
9	VRC21117	SCREW, PLATE SUPPORT, 12 PT	6
10	VRC28573	COUPLING, SHAFT, LUBE OIL PUMP	1
11	VRC28552	SUPPORT, PLATE, MOUNTING, LEFT	1
12	VRC28560	FLANGE, MOUNTING, CYLINDER LUBE PUMP**	1

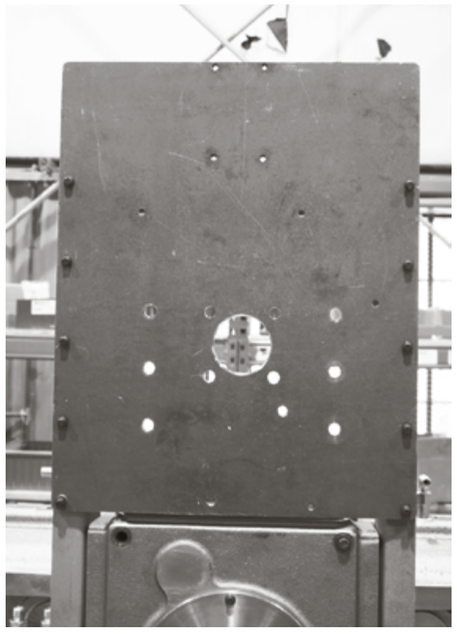
• FRAME • CYLINDER LUBRICATION (BELT DRIVE) SYSTEM			
ITEM NUMBER	**PART NUMBER**	**DESCRIPTION**	**PART QTY**
13	VRC28427	SCREW, MOUNTING FLANGE, 12PT	4
14	VRC28551	SUPPORT, PLATE, MOUNTING, RIGHT	1
15	VRC28720	SWITCH, NO-FLOW	1
16	VRC28727	SCREW, NO-FLOW SWITCH	2
17	VRC28728	LOCKNUT, NYLON, NO-FLOW SWITCH	2
18	VRC21117	SCREW, PLATE SUPPORT, 12 PT	8
19	VRC28581	SHAFT, INTEGRAL BEARING, LUBE OIL PUMP**	1
19A**	VRC28565A	FLANGE & INTEGRAL BEARING SHAFT ASSEMBLY - Incluldes: VRC28560 - FLANGE, MOUNTING, CYLINDER LUBE PUMP VRC28581 - SHAFT, INTEGRAL BEARING, LUBE OIL PUMP VRC28583 - RING, RETAINING, PUMP SHAFT"	
20	VRC28583	RING, RETAINING, PUMP SHAFT**	1
21	VRC28559	NUT, LOCK, MOUNTING PLATE	10
22	VRC28557	SCREW, MOUNTING PLATE, AND BLT GRD, 12 PT	10
23	VRCC8550	PLATE, MOUNTING, CYLINDER LUBE, CNG **	1
24	VRCC86XX	BLOCK, DIVIDER, CYLINDER LUBE OIL *	1
25	VRC28607	SCREW, DIVIDER BLOCK, 12 PT	1
26	VRC28472	PLATE, ADJUSTING BELT TENSIONER	1
27	VRC28476	WASHER, ADJUSTING PLATE 3/8"	1
28	VRC21117	SCREW, ADJUSTING BELT TENSIONER, 12 PT	2
29	VRC28475	WASHER, BELT TENSIONER	1
30	VRC28473	SPACER, IDLER, ECCENTRIC BELT	1
31	VRC28465	SHEAVE, BELT, DRIVEN, LUBE PUMP	1
32	VRC28239	SETSCREW, DRIVE SPROCKET	1
33	VRC28400	BELT, DRIVE, CYLINDER LUBE PUMP	1
34	VRC28470	BEARING, IDLER AND TENSIONER, BELT	2
35	VRC28474	SLEEVE, IDLER, ECCENTRIC BELT	1
36	VRC28067	SCREW, HOUSING AND IDLER (Socket Head)	1
37	VRC28425	SHEAVE, BELT, DRIVE, LUBE PUMP	1
38	VRC28429	SETSCREW, SHEAVE, DRIVE, LUBE PUMP	1
39	VRC25017	SCREW, SHEAVE, DRIVE, LUBE PUMP, 12 PT	1
40	VRC28471	SLEEVE, TENSIONER, BELT	1
41	VRC28477	SCREW, IDLER SHEAVE, 12 PT	1
42	VRC28480	GUARD, BELT, CYLINDER LUBE PUMP	1
43	VRC28481	COVER, ACCESSORY DRIVE, BELT GUARD	1
44	VRC28559	NUT, BELT GUARD	3
* *Refer to Lubrication System Tubing & Fittings, Section 5.1*			
** *Assembly not shown*			

NOTE: Not all parts may be used on all CNG compressors.

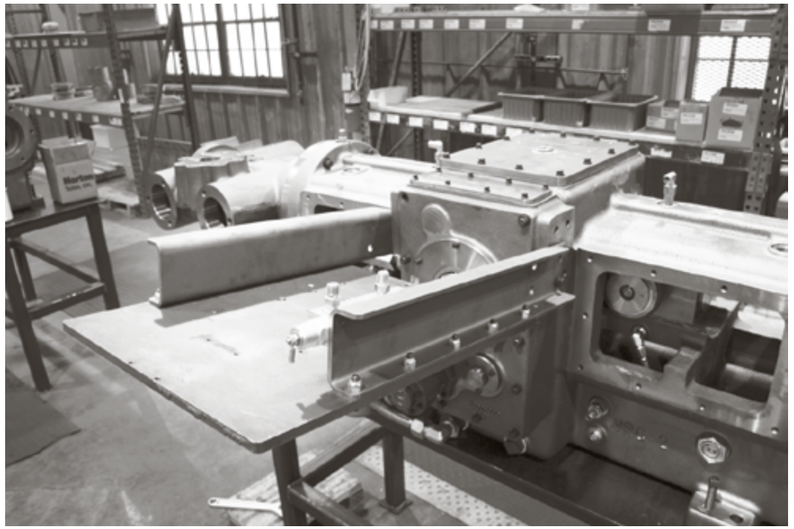
10.5.1 CYLINDER LUBRICATION (Belt Drive) SYSTEM PREPARATION AND INSTALLATION

Inspect all parts for nicks, marring or damage. Also, make sure all parts of the Frame Lubrication System are clean and free from any dirt or other foreign substance.

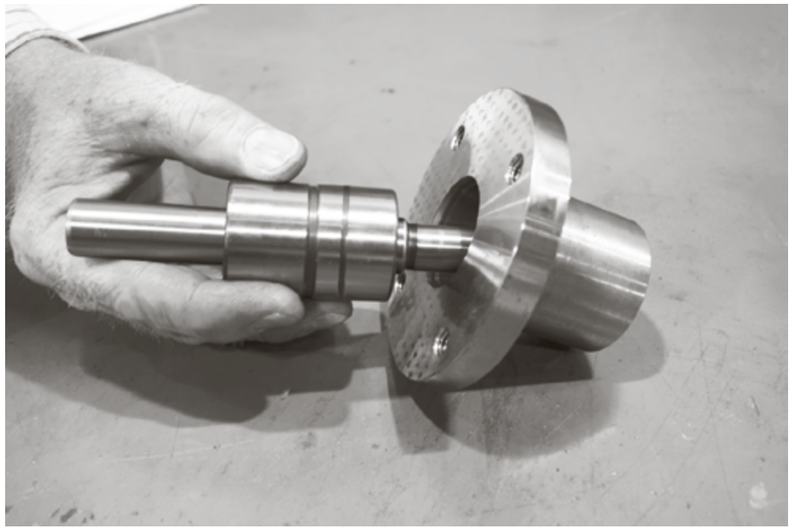
1. Install the Left Mounting Plate Support (VRC28552) and Right Mounting Plate Support (VRC28551) to the appropriate sides of the housing using the plate support screws (VRC28547).



2. Attach the mounting plate so that the tapped holes for the belt tensioner are on the right hand side (right hand side as you are looking at the accessary side of the compressor). Attach the mounting plate to the supports using the mounting plate screws (VRC28557) and mounting plate lock nuts (VRC28550).



3. Remove all but one (1) screw from each side of the mounting plate support and then angle the mounting plate and support assembly downward. Doing this will make the rest of the belt drive assembly easier to install.



4. Assemble the lube oil pump integral bearing shaft (VRC28581) into the cylinder lube pump mounting flange (VRC28560).

NOTE: The flange and integral bearing shaft assembly (VRC28565A) may be purchase from Arrow as an assembly.

10.5.2 LUBE OIL PUMP INTEGRAL BEARING SHAFT AND CYLINDER LUBE PUMP MOUNTING

Flange Installation (if not purchased as an assembly).

1. Insert small end of bearing shaft into the mounting flange.
2. Lube the bearing surface and inside the flange.
3. Press the bearing into the flange using the appropriate bench press.

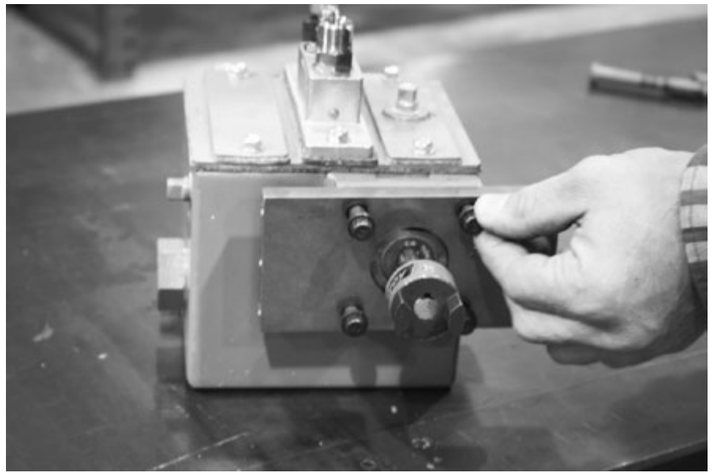
4. Insert pump shaft retaining ring (VRC28583) using snap ring pliers. Make sure the ring properly seats in the groove inside the flange.
5. Using four (4) screws (VRC21117), install the mounting flange on the mounting plate. Install these screws from the cylinder lube oil pump side of the mounting plate.

6. Install the lube oil pump shaft coupling (VRC28573) by first separating the coupling. Install the large diameter hole end on the integral bearing shaft. The small hole end installs on the shaft of the cylinder lube oil pump.

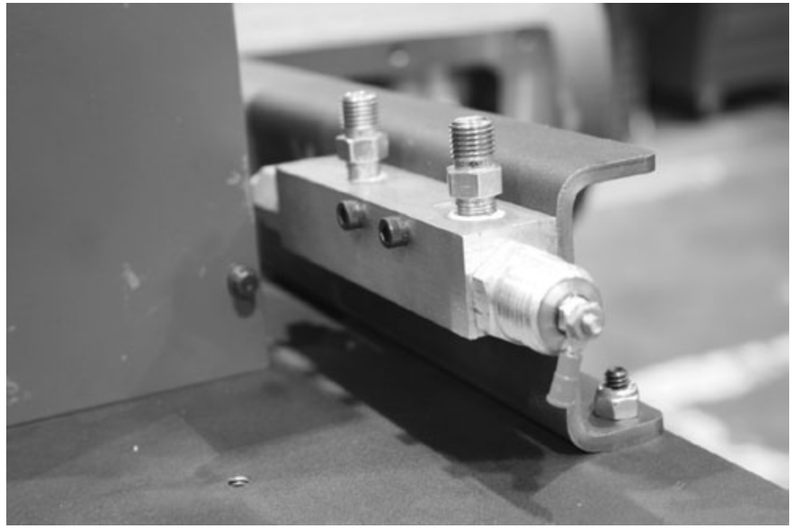
   NOTE: It may necessary to polish the inside diameter of the coupling holes to make it fit easier to the shaft.

   Do not tighten the set screws on the coupler until final assembly.

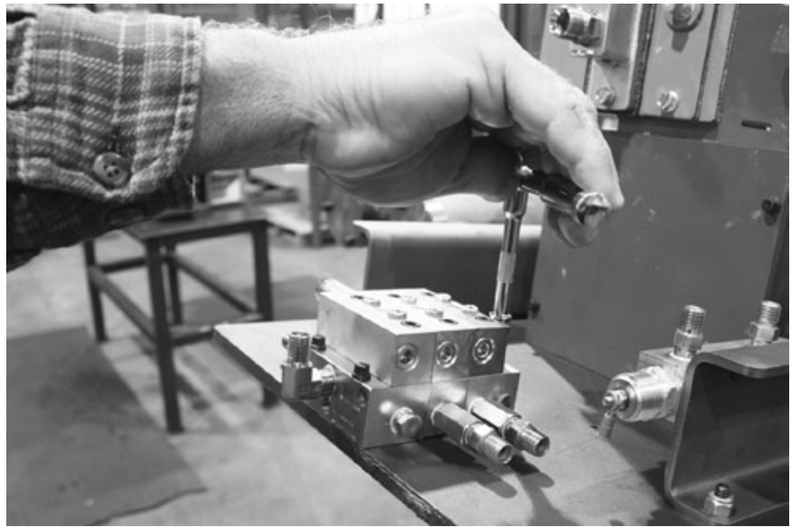
7. Attach the pump support side plates (VRC28572) to the mounting plate using six (6) screws (VC21117) three (3) screws for each side support plate. These screws should be hand tightened and left hand tight until all screws in the supports have been installed.



8. Install pump support end plate (VRC28572) to the cylinder lube oil pump (VRC28500) using four (4) screws and tighten.
9. Attach the cylinder lube oil pump and pump support end plate assembly to the side plates making sure the two coupling halves engage properly.
10. Fasten the end plate and side plate with six (6) screws (VRC21327) making sure the end plate and side plate are square and then tighten screws.
11. Push the two pieces of the coupler together and tighten set screws on coupler using 1/4” allen wrench.
12. Mount the top pump support plate (VRC28570) using four (4) screws (VRC28017) and then tighten.



13. Attach no-flow switch (VRC28720) (for more information about the no-flow switch, see Section 10.14) to the right side mounting plate support using two (2) screws (VRC28727) and tighten securely.



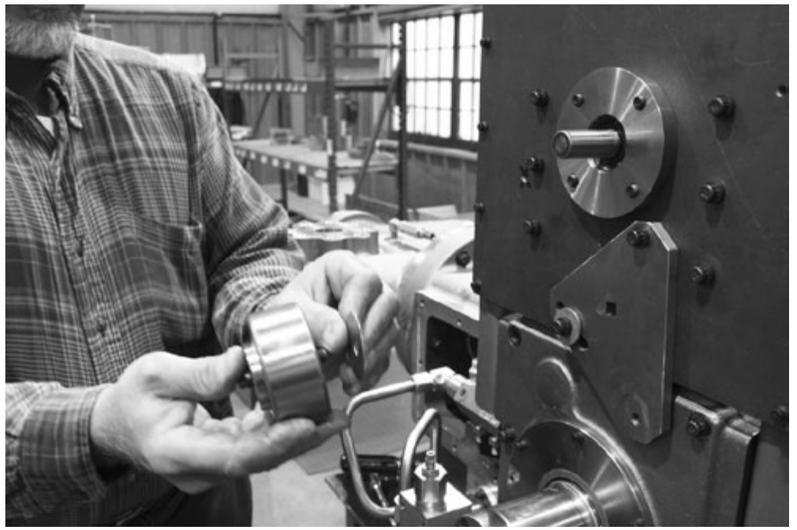
14. Mount cylinder lube oil divider block (see Secrion 8.4) to the back of the mounting plate using four (4) screws (VRC28607) and tighten.

15. Return the housing and mounting plate side supports to the original upright position. Snug (DO NOT TIGHTEN) the mounting plate screws (VRC28557) to allow position of the assembly for proper belt alignment.

16. Belt Tensioner Assembly

    i. Lubricate the eccentric belt idler sleeve (VRC28474) and inside of idler bearing (VRC28470).

    ii. Assemble the belt tension idler assembly by pressing the eccentric belt idler sleeve onto the tensioner bearing (VRC28470).



    iii. Install eccentric belt idler spacer (VRC28473) and insert eccentric idler bearing screw (VRC28471).

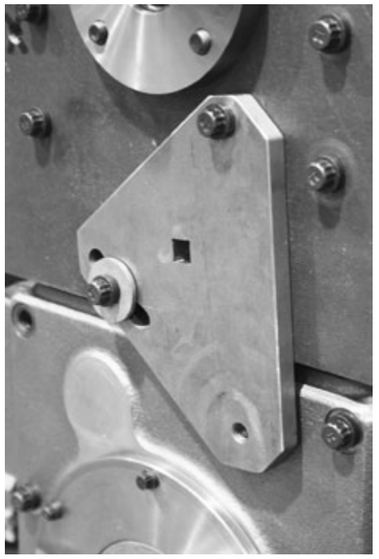
    iv. Lubricate the belt tensioner sleeve and bearing.

    v. Press belt tensioner sleeve into bearing. Using appropriate bench press.

    vi. Insert belt tensioner screw (VRC28467) into the belt tensioner sleeve (VRC29471) through the belt tensioner washer (VRC28475) and onto the belt tensioner adjusting plate.

10.5.3 INSTALLING BELT IDLER ASSEMBLY

1. Insert the idler bearing screw (VRC28477) into the eccentric idler sleeve (VRC28474) and through the eccentric idler spacer (VRC28473).



2. Mount the belt tensioner adjusting plate (VRC28472) using two (2) screws (VRC21117). There will be one (1) screw at the top of the adjusting plate and one (1) at the slotted adjusting hole using an adjusting plate washer (VRC28476).

3. Attach the belt tensioner bearing assembly to the adjusting plate.

4. Tighten screws to attach bearing securely. Leave the other screws snug. After the bearing is attached and the screws have been tightened, make sure the bearing turns freely.

10.5.4 INSTALLING LUBE PUMP DRIVEN BELT SHEAVE AND CYLINDER LUBE PUMP DRIVE BELT

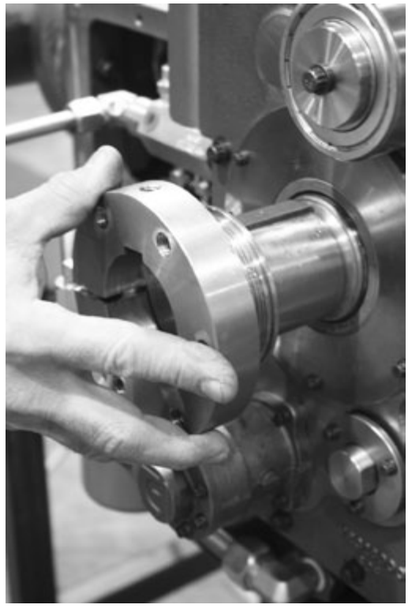
1. Install the lube pump driven belt sheave (VRC28465) to the integral bearing shaft.

   - **NOTE:** Make sure the flat of the pump shaft is in alignment with the set screw of the sheave.

2. Slide the sheave onto the shaft until the end of the shaft is flush with the hub of the sheave.

3. Tighten set screws using 5/32” allen wrench.

4. Install lube pump belt drive sheave (VRC28425) to the crankshaft by loosening the set screw in the drive sheave. Insert the accessory end crankshaft key (VRC21106) into the key way.



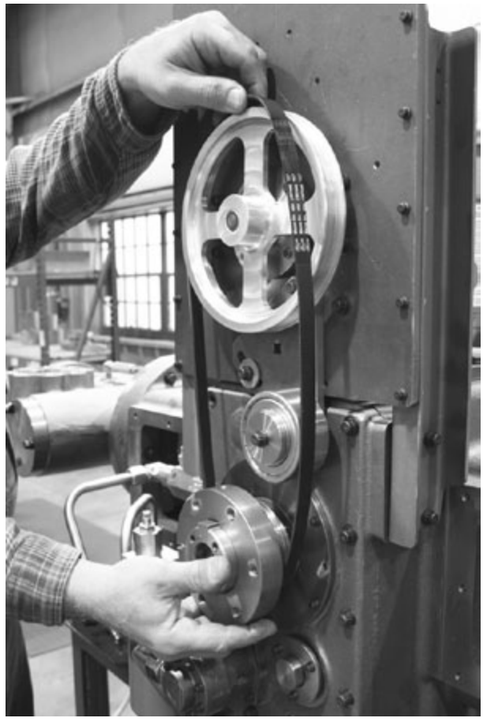
5. Slip the sheave onto the shaft with the belt grooved side towards the frame.

6. Align mounting plate with the face of the drive sheave by placing a level on either side of the mounting plate and observing the position of the bubble.

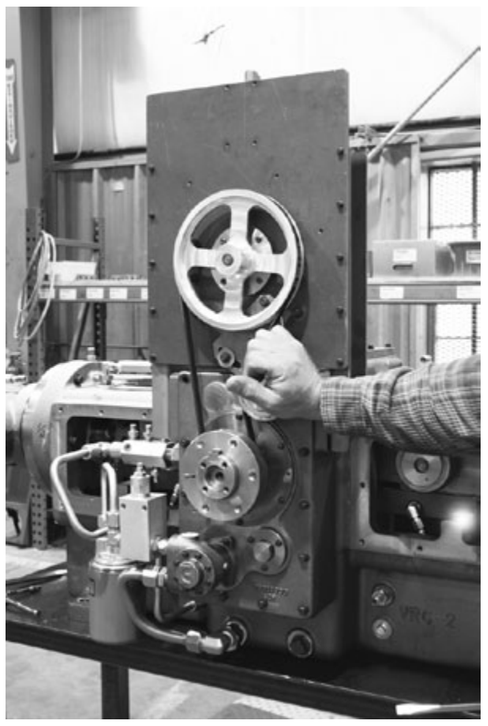
7. Next, put the level on the drive sheave.

    - **NOTE:** The bubble in the level should be the same on the drive sheave as observed on the mounting plate.

Adjustments will be made on the mounting plate. With the mounting plate support screws snug (not tight) the mounting plate assembly can be adjusted for proper positioning and then the support bracket screws can be tightened.

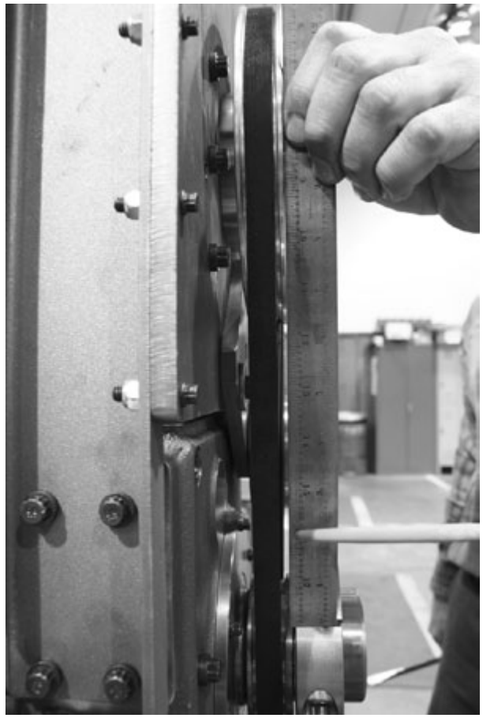


8. Install cylinder lube pump drive belt (VRC28400) over sheaves.



9. Tighten the belt tensioner by putting pressure on the belt tensioner bearing and tightening the adjusting screw. Tighten screw in the belt tensioner adjusting plate.

10. Check the alignment of sheaves by placing a straight edge on the face of the drive sheave and checking the gap between the straight edge and the belt. Make sure it is consistent throughout the length of the belt.



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

12. After alignment is complete, tighten the screw in the drive sheave using 3/8" allen wrench.

13. Tighten set screw over the accessory end crankshaft key in the drive sheave

10.5.5 CHECKING BELT TENSION

1. Hold 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 slack side of the belt.

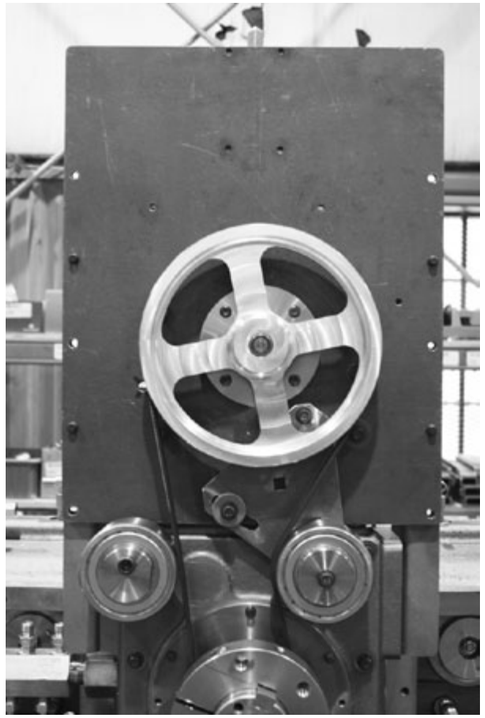
2. Belt tension should be such that when applying about 10 pounds of pressure to the slack side of the belt, there will be approximately 1/4" movement or slack.

10.5.6 INSTALLING THE IDLER BEARING ASSEMBLY TO HOUSING

1. Using the housing and idler screw (VRC28067) and tightening with a 5/16" allen wrench, fasten idler bearing assembly to the housing.

2. Position idler by using eccentric adjuster and apply only slight pressure to the belt. 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.



10.5.7 BELT GUARD INSTALLATION

1. To install the belt guard (VRC28480) starting with the top screw, remove every other screw in the mounting plate.

2. Mount the belt guard (VRC28480) onto the mounting plate, replace and tighten screws.

3. Mount the belt guard cover plate (VRC28481) at the bottom of the belt guard using lock nuts (VRC28489).

    - **NOTE:** The crankshaft bar over adapter must be removed PRI-OR to installing the belt guard cover plate.

10.6 FRAME OIL PRESSURE RELIEF VALVE

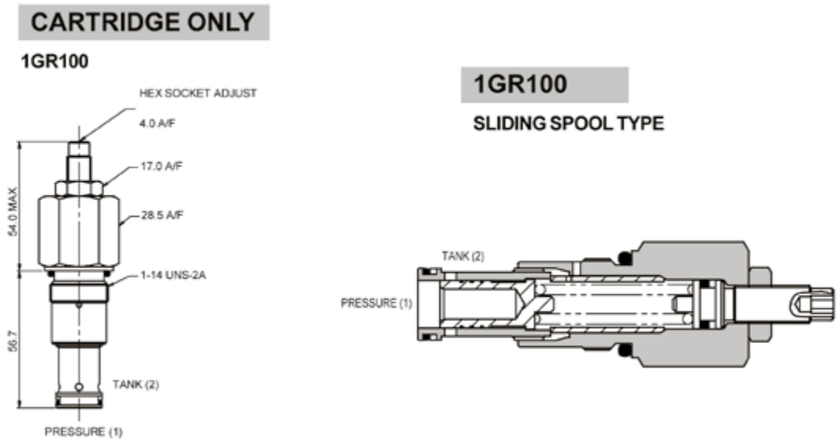


Figure 10.4 - Relief Valve Cartridge Only and Section View

10.6.1 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 ftlbs (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

Table 6.1 - Relief Valve Specification

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

10.6.2 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.

10.6.3 RELIEF VALVE OPERATION

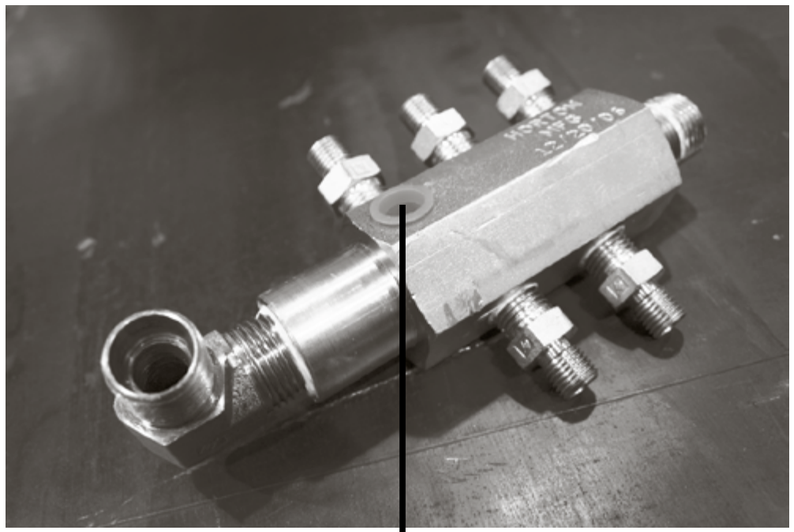
The relief valve is held closed by the spring until pressure on the piston overcomes the valve setting, allowing relief flow to the tank through a ring of radial holes.

10.6.4 ADJUSTING FRAME OIL PRESSURE

Loosen the lock nut on the oil pressure relief valve (VRC28350) and move the adjusting screw up to decrease pressure and down 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.

10.7 LUBE OIL PRESSURE

Normal pressure on the discharge side of the frame oil filter is set a the factory at 65 PSI at 1800 RPM. If oil pressure drops below 25 PSI, find the cause immediately and correct the problem.



10.8 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 6 port manifold (VRC28120).

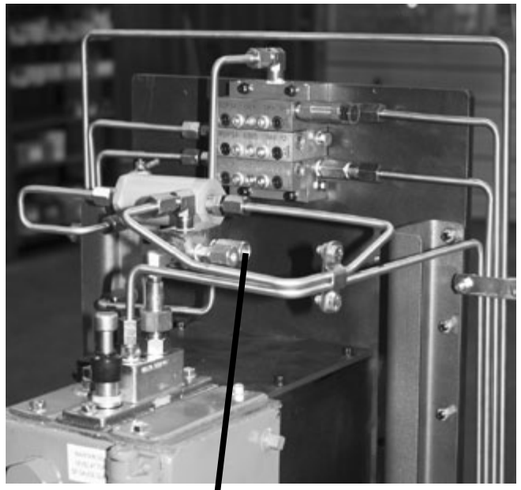
The compressor must have a working low oil pressure shutdown.

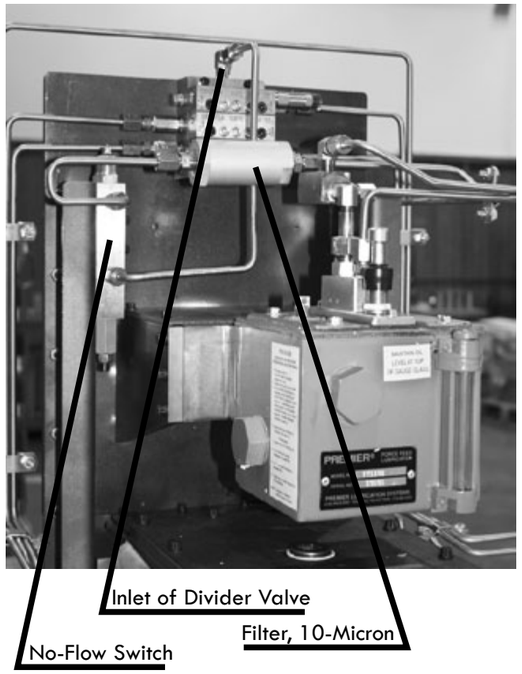
IMPORTANT: Never attempt to add oil to the frame through the breather hole while the compressor is running. This will cause oil foaming and unnecessary no flow shutdowns in the force feed lubrication system.

Since 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 (3) to five (5) minutes after disruption of lubrication flow.

10.9 FILLING AND OPERATING THE LUBRICATION SYSTEM





NOTE: View is of the VRC - see section 5.1 for the system used on CNG units.

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 3500 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.

10.10 DIVIDER BLOCK

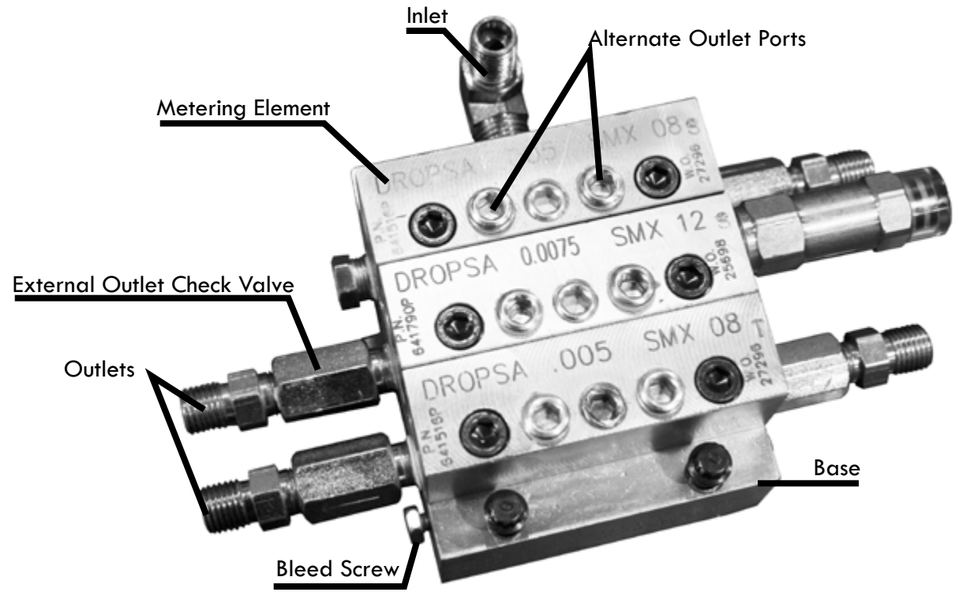


Figure 10.5 - Divider Block Parts

10.10.1 DIVIDER BLOCK OVERVIEW

The divider block is made up of three (3) 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.

10.10.2 DIVIDER BLOCK INSTALLATION

For divider block installation procedures see Section 5.4.

10.11 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) (see Section 1.1 "Special Tools").

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:

   i. Loosen the adjusting screw locknut.

   ii. Turn the plunger stroke adjustment screw to the full up position.

   iii. Tighten the adjusting screw locknut.

   iv. 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.

10.12 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 inlbs 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.

10.13 LOCATING BLOCKAGE

1. Check to ensure all twin elements “T” have two (2) outlets in base and all single elements “S” have one (1) outlet and one (1) 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 (2) 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.

10.14 NO-FLOW SWITCH

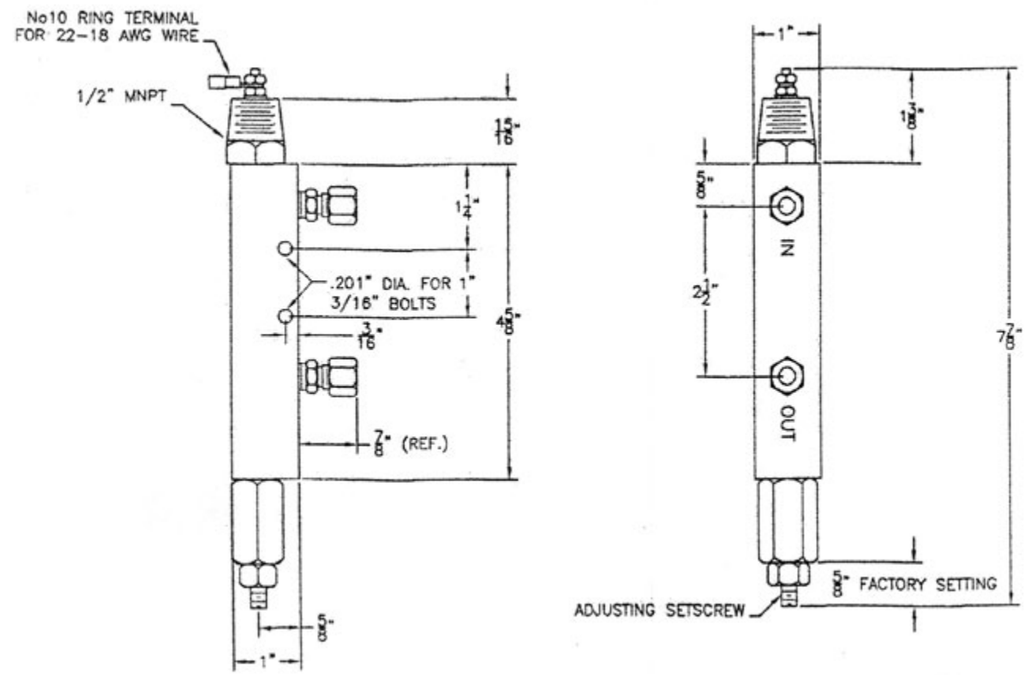


Figure 10.6 - No-Flow Switch

- **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.

10.14.1 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 very 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.

10.14.2 NO-FLOW SWITCH INSTALLATION

1. The no-flow switch must be mounted either vertically (terminal end up) 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.

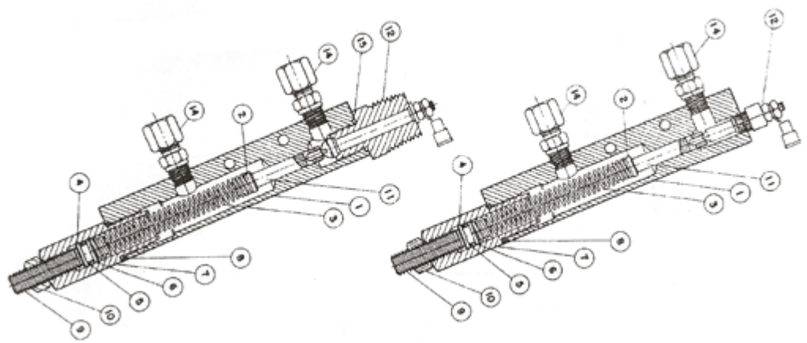


Figure 10.7 - No-Flow Switch Installation

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.

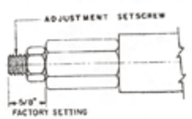


Figure 10.8 - No-Flow Switch Adjustment Set Screw

-11-

RECOMMENDED MAINTENANCE TIME LINES

11.1 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 check list (see "Compressor Start Up Check List" Section 8.5).

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

- **NOTE:** The hourly maintenance requirements in this section are based on the needs of units that run continuously 24 hours a day. Due to the intermittent and relatively brief running times associated with CNG application, maintenance times may vary. Running a unit intermittently is harder on some parts due to more frequent starts and stops. We recommend using these time lines as general guidelines. Preventive maintenance preformed more frequently will greatly improve the longevity of the unit.

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 the Section 8.4 for the correct cycle time. These logs should be reviewed by qualified personnel to determine performance and maintenance trends of the compressor.

11.2 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 over fill.

3. Check lubricator block cycle pin indicator. Refer to the information plate on the side of the lubricator reservoir or Section 8.4 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.

11.2.1 MONTHLY MAINTENANCE REQUIREMENTS

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

11.2.2 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.

11.2.3 8,000 HOUR MAINTENANCE REQUIREMENTS

In addition to the daily, monthly and 4,000 hour 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 the (see Table 7.4 “Clearance”) 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 7.10 in Section 7.4).

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 7.8 “Piston to Bore Clearance and Conventional Piston Ring End Gap”)

6. Rebuild cylinder packing case (see Section 9.13).

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.

11.2.4 16,000 HOURS MAINTENANCE REQUIREMENTS

In addition to the daily, monthly, 4,000 hour and 8,000 hour 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.

11.2.5 32,000 HOURS MAINTENANCE REQUIREMENTS

In addition to the daily, monthly, 4,000 hour, 8,000 hour and 16,000 hour 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 feller 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 accessary end drive chain tightener.

5. Check for excessive ring groove wear in the pistons.

11.2.6 48,000 HOURS MAINTENANCE REQUIREMENTS

In addition to the daily, monthly, 4,000 hour, 8,000 hour, 16,000 hour and 32,000 hour 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.

11.3 COMMON PROBLEMS AND POSSIBLE CAUSES

Minor problems can be expected during the routine operation of an Arrow VRC-CNG 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 VRC-CNG 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
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

PROBLEM	POSSIBLE CAUSES
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
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 Crankshaft 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

VRC 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 twelve (12) months from the date the goods are placed in service by the buyer or eighteen (18) months from date of shipment, whichever shall occur first. In addition, the manufacture warrants for a period of thirty six (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 VRC 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 VRC 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 seventy two (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 VRC 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 twenty our (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 VRC 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 twelve (12) months from the date the goods are placed in use by the purchaser or eighteen (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 twelve (12) months from the date of Shipment. Certain parts on Arrow Engine Company's VRC 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 VRC Compressor must be started-up in accordance with the latest version of the Arrow Engine Company VRC Compressor Start-Up Report. The VRC Compressor Start-Up Report must be completed and forwarded to the Manufacturer upon completion of start-up.

C. DEFERRED START-UPS

Warranty coverage on VRC Compressors not started within twelve (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 VRC Ccompressors 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 Company 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 (1) year after the cause of action accrues or it shall be barred

Compressor Parts
Standard Limited Warranty
Delivered and sold after January 1, 2008

Special Notes:

All prices, sales conditions, and discounts in catalog and/or on discount schedule are subject to change without notice. Any use of, or reference to, any original manufacturer's name, brand, or part number in Arrow catalog does not warrant nor imply that any Arrow parts or products are manufactured or guaranteed by anyone other than Arrow Engine Company. Warranty covering any defective or failing material covers only the material in question and specifically does not include wear parts and labor necessary to replace same.

Limited Warranty on Replacement Parts:

1. Arrow applies a Standard Parts Only Warranty of one (1) year to all purchased replacement parts. Labor expenses are eligible for reimbursement.
2. Removal and reinstallation expenses are not covered on service parts.
3. Because parts and major assemblies are not serial numbered, Arrow depends upon its Distributors to carefully screen all claims relating to such items and to be certain, before filing claims, that the material claimed defective was opened only within qualifying time limitations.
4. When manufacturers of trade accessories do not have an established dealer organization authorized to consider warranty claims, Arrow will accept the return of such accessories and will process claims with the manufacturers, provided replacement parts are purchased from Arrow. In filing such claims, it becomes necessary that all pertinent information be given, such as length of service, probable cause of failure, model and serial number of compressor from which accessory was removed, operating conditions, etc., so that we can give the accessory manufacturer complete information regarding the failure. Adjustments will be governed by the accessory manufacturer's reimbursement.
5. If a replacement part or assembly is found to be defective in manufacture of material prior to or at the time of installation, Arrow may, depending upon circumstances involved, elect to have the Distributor repair the part, rather than replace it in its entirety. In such cases, Arrow may elect to make an exception to its warranty policy which declines responsibility for payment of warranty labor on parts. The prime consideration will be whether repair of or replacing, the part is more economical. The Customer Service and Quality Departments should be consulted for a determination prior to the accomplishment of any major repairs.

Warranty Coverage:

ARROW'S LIABILITY FOR ANY DAMAGES DUE OWNER SHALL BE LIMITED TO THE PURCHASE PRICE OF THE GOODS. This paragraph states purchaser's sole and exclusive remedy against Arrow for warranty. Arrow shall not be liable for any loss, damage, or injury resulting from delay in delivery or installation of the goods or for any failure to perform which is due to circumstances beyond its control. Arrow's maximum liability for damages, including, without limitation, contract damages and damages for injuries to persons or property, with respect to the goods or any services in connection with the goods, IS LIMITED TO AN AMOUNT NOT TO EXCEED THE PURCHASE PRICE OF THE GOODS. In no event shall Arrow be liable to purchaser for any incidental, consequential or special damages. The statute of limitations applicable to all claims arising under this agreement or otherwise shall be one (1) year from the date the claim accrues.

Warranty Limitations:

Arrow will pay for parts and labor needed to repair compressor damage directly resulting from an above defined warranty failure which occurs within the warranty period stated. All warranty claims must be authorized, documented and submitted within 30 days of the failure date while under the warranty period. Costs will be limited to those required to restore the compressor to the functional condition existing immediately prior to the failure and will be calculated based on the prices paid for the Arrow parts installed during the original compressor build. Only straight time labor rates will be reimbursed based on a reasonable prevailing rate, not to exceed the published flat rate, for the geographic area in which the repairs are performed. Additional labor charges for overtime or holidays will not be allowed. Additionally, Arrow will pay the cost of maintenance items when these items are not reusable as a result of a warrantable failure.

Products Not Manufactured by Arrow:

With respect to products not manufactured by Arrow, Arrow makes no representations or warranties of whatsoever nature, directly or indirectly, expressed or implied including but not limited to any representations or warranties with respect to suitability, durability, fitness for a particular purpose or merchantability, except to the extent that Arrow can enforce warranties provided by the manufacturers of such parts.

Prices:

All quotations are subject to change without notice, and the price in effect at the time of the order will apply.

Seller's Right to Manufacture:

Seller, in its sole discretion, shall have the right to manufacture the products provided hereunder as far in advance of its estimated shipping schedule as it deems appropriate. Seller expressly reserves the right to change or modify the design and construction of any products in due course of Seller's manufacturing procedure, without incurring any obligaton or liability to furnish or install such changes, modifications or improvements on products previously or subsequently sold.

Limitation on Liability:

SELLER'S TOTAL RESPONSIBILITY FOR ANY CLAIMS, DAMAGES, LOSSES OR LIABILITIES ARISING OUT OF, OR RELATED TO, ITS PERFORMANCE OF THIS CONTRACT OR THE PRODUCTS COVERED HEREUNDER SHALL NOT EXCEED THE PURCHASE PRICE OF THE REPLACEMENT PART. In no event shall Seller be liable for any special, indirect, incidental or consequential damages of any character; but not limited to, loss of use of productive facilities of equipment, loss of profits, property damage, expenses incurred in reliance on Seller's performance hereunder, or lost production, whether suffered by Buyer or any third party. Seller disclaims all liablility for any and all costs, claims, demands, charges, expenses or other damages, either direct or indirect, incident to all property damages arising out of any cause of action based on strict liability including actions under Section 402A of the Restatement of Torts Second.

Modification, Rescission & Waiver:

This contract may not be modified or rescinded nor any of its provisions waived unless such modification, rescission or waiver is in writing and signed by an officer of Seller at its offices in Tulsa, Oklahoma.

Miscellaneous:

Seller reserves the right to furnish commercially equivalent or better substitutes for materials. Seller may during any periods of shortage due to causes beyond the control of Seller or its suppliers, prorate its supply of products among all of its Buyers in such manner as may be deemed equitable in the sole judgment of Seller. Seller shall not incur any liability to Buyer because of any proration hereunder. All orders must be accepted by an authorized employee of Seller. Failure of Seller in any one or more instances, upon the performance of any of the terms and conditions of this contract or the failure of Seller to excercise any of its rights hereunder shall not be construed as a waiver or relinquishment of any such term, condition or right hereunder and shall not affect Seller's right to insist upon strict performance and compliance with regard to any unexecuted portions of this contract or future performance of these terms and conditions.

Technical Advice:

Seller shall not be responsible for the results of any Technical Advice or Services rendered by any employee of Seller in connection with the design, installation, use or repair of the products sold hereunder.

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ARROW MANUFACTURED

REPLACEMENT PARTS

Caterpillar® Engines

G379 G3304
G398 G3306
G399

Waukesha® Engines

F2895 P9390
F3521 145G/F817
F5108 140G/F554
L5790 WAK/1197
L7042

Fairbanks Morse® Engines

ZC-118 ZC-503
ZC-208 ZC-739
ZC-346

Ajax® Engines

5 x 6½
EA-22, 6½ x 8 CMA
EA-30, 7¼ x 8 CMA
E-30, 7½ x 10 CMA
E-42, 8½ x 10 CMA
DP-60, 9½ x 10 CMA
DP-70/80/160, 11 x 14 CMA
DP-115/230, 13¼ x 16

Piston & Rod Assemblies
180
360
600
800

OEM

C-Series

*C-46 *C-96
*C-66 *C-101
*C-106 *C-255

VR-Series

VR-155 VR-310
VR-220 *VR-330
VR-232 *VR-330CF
*VR-260 VR-265
VR-283 *VR-380

A-Series

*A42 *A54 *A62

K6 Slow Speed Engine

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Lufkin Engines

L-333 L-1770
*L-795 L-2165

Witte Engines

98 E15 F32
B12 E20 F42

Arrow Chemical Pumps

*10 Series (beam operated)
*12 & 13 Series (pneumatic)
*430 Series (electric)
*500 & 510 Series (pneumatic)
*Solar Chempump

Gas Compressors

* *VRC-2 *VRC-CNG

Gas Products

*Volume Tanks
*Vertical & Horizontal Separators
*Suction Scrubbers
*Meter Runs
*Coalescers
*Skids

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