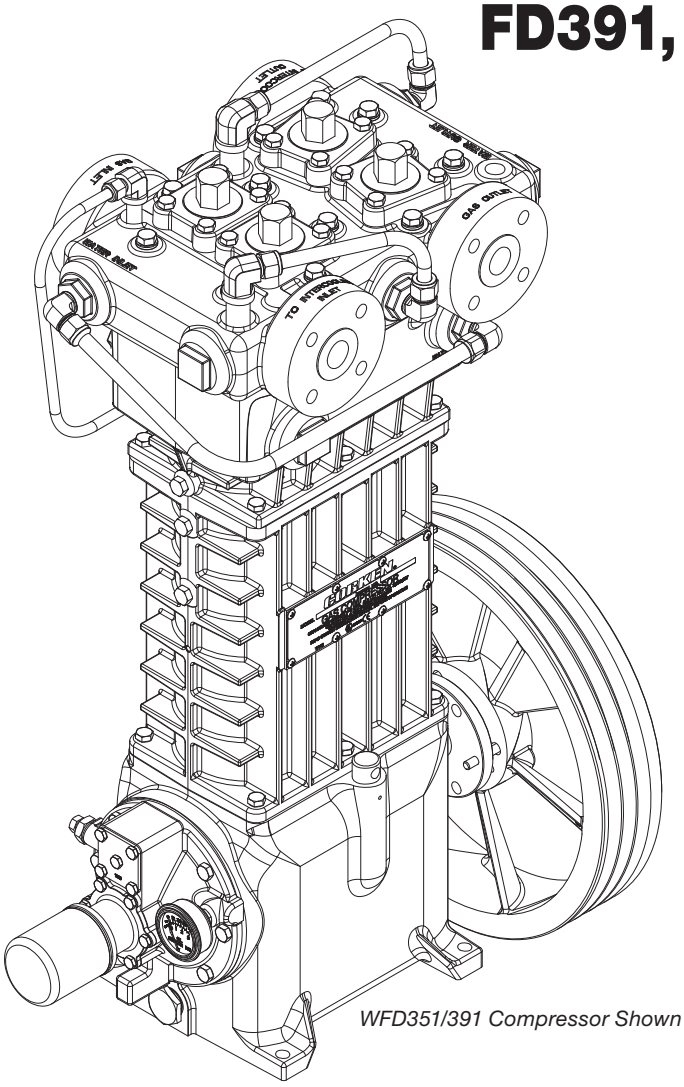
Installation, Operation & Maintenance Manual

D-Style Two-Stage Gas Compressors Models FD351, WFD351, D391, WD391, FD391, and WFD391



WFD351/391 Compressor Shown

Warning: (1) Periodic inspection and maintenance of Corken products is essential. (2) Inspection, maintenance and installation of Corken products must be made only by experienced, trained and qualified personnel. (3) Maintenance, use and installation of Corken products must comply with Corken instructions, applicable laws and safety standards (such as NFPA Pamphlet 58 for LP-Gas and ANSI K61.1-1972 for Anhydrous Ammonia). (4) Transfer of toxic, dangerous, flammable or explosive substances using Corken products is at user's risk and equipment should be operated only by qualified personnel according to applicable laws and safety standards.

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IDEX

Warning

Install, use and maintain this equipment according to Corken, Inc. instructions and all applicable federal, state, local laws and codes, and NFPA Pamphlet 58 for LP-Gas or ANSI K61.1-1989 for Anhydrous Ammonia. Periodic inspection and maintenance is essential.

Corken One Year Limited Warranty

Corken, Inc. warrants that its products will be free from defects in material and workmanship for a period of 12 months following date of purchase from Corken. Corken products which fail within the warranty period due to defects in material or workmanship will be repaired or replaced at Corken's option, when returned freight prepaid to: Corken, Inc., 9201 North I-35 Service Road, Oklahoma City, OK. 73131.

Parts subject to wear or abuse, such as mechanical seals, blades, piston rings, valves, and packing, and other parts showing signs of abuse are not covered by this limited warranty. Also, equipment, parts and accessories not manufactured by Corken but furnished with Corken products are not covered by this limited warranty and purchaser must look to the original manufacturer's warranty, if any. This limited warranty is void if the Corken product has been altered or repaired without the consent of Corken.

ALL IMPLIED WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY NEGATED TO THE EXTENT PERMITTED BY LAW AND SHALL IN NO EVENT EXTEND BEYOND THE EXPRESSED WARRANTY PERIOD.

Corken disclaims any liability for consequential damages due to breach of any written or implied warranty on Corken products. Transfer of toxic, dangerous, flammable or explosive substances using Corken products is at the user's risk. Such substances should be handled by **experienced, trained personnel in compliance with governmental and industrial safety standards.**

Contacting The Factory

For your convenience, the model number and serial number are given on the compressor nameplate. Space is provided below for you to keep a written record of this information.

Always include the model number and serial number when ordering parts.

Model No. _____

Serial No. _____

Date Purchased _____

Date Installed _____

Purchased From _____

Installed By _____

Table of Contents

Compressor Features

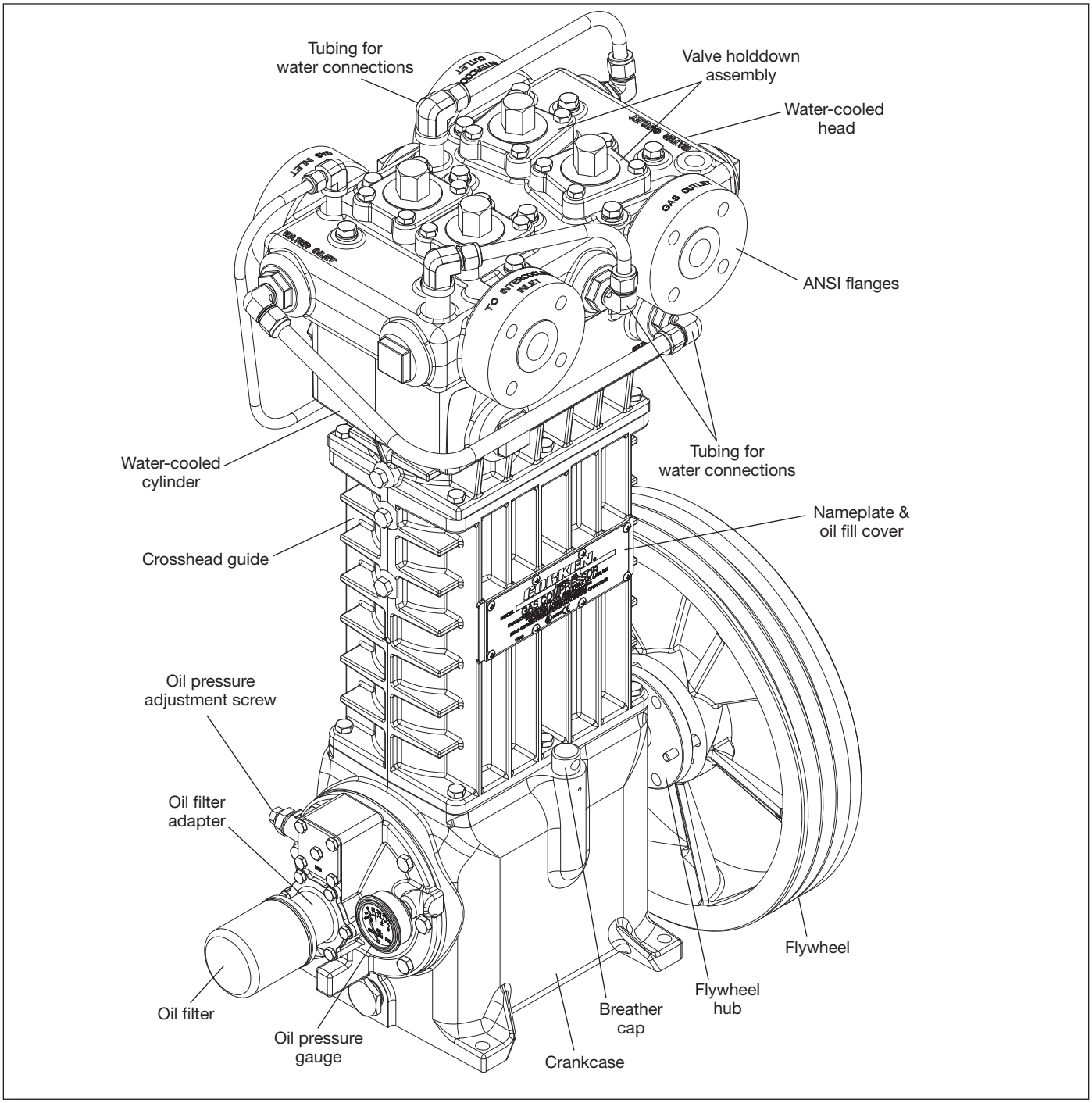


Figure 1.1

Why Corken Compressors are Special

Corken industrial gas compressors are unique among compressors their size. Unlike ordinary lubricated gas compressors, Corken compressors completely isolate the pressurized gas in the compression chamber from the crankcase. While piston rings seal the piston tightly enough for it to do compression work, they do not provide enough sealing to isolate the compression chamber from the crankcase. To further seal the compression chamber, a crosshead/piston rod design with seals around the piston rod is required.

By utilizing specialized piston-rod sealing systems, Corken compressors can compress pressurized, flammable and toxic gases. It is also used to compress harmless gases where oil-free compression or elevated suction pressures are required. With a large selection of design options available, Corken offers the most versatile line of small gas compressors in the world.

Chapter 1—Installing Your Corken Compressor

1.1 Location

Compressor must be installed in a well ventilated area.

WARNING

Corken compressors are designed and manufactured for outdoor duty. For applications where the compressor will be subjected to extreme conditions for extended periods such as corrosive environments, arctic conditions, etc., consult Corken. Check local safety regulations and building codes to assure installation will meet local safety standards.

Corken compressors handling toxic or flammable gases such as LPG/NH_3 should be located outdoors in a well ventilated area. A minimum of 18 inches (45 cm) clearance between the compressor and the nearest wall is recommended. This will make it accessible from all sides and provide unrestricted air flow for adequate cooling.

Noise Level: Many factors affect the noise level generated by a compressor installation. Several of these, including motor noise, piping vibration, foundation/skid design, and surrounding structures are outside Corken's control. The use of sufficient pipe supports, flexible hoses, and proper baseplate/skid support will all reduce noise. Thus, Corken can not guarantee a particular noise level from our compressors. However, noise levels from a properly installed Corken compressor typically do not exceed 85dBa at three feet.

1.2 Foundation

Proper foundations are essential for a smooth running compression system. Corken recommends the compressor be attached to a concrete slab at least 8 inches thick with a 2 inch skirt around the circumference of the baseplate. The baseplate should be securely anchored into the foundation by 1/2 inch diameter "J" bolts that are 12 inches long. The total mass of the foundation should be approximately twice the weight of the compressor system (compressor, baseplate, motor, etc.). See figure 1.2 for details.

After leveling and bolting down the baseplate, the volume beneath the channel iron baseplate can be grouted to prevent flexing of the top portion of the baseplate and the "J" bolt that extends beyond the foundation. The grout also improves the dampening capabilities of the foundation by creating a solid interface between the compressor and foundation.

On some of the longer baseplates, such as with the 107 mountings, a 3 inch hole can be cut in the baseplate for filling the middle section of the baseplate with grout.

For a more detailed explanation of a proper foundation design, please refer to Important "Instructions for Compressor Foundation Design" (item number ED410).

WARNING

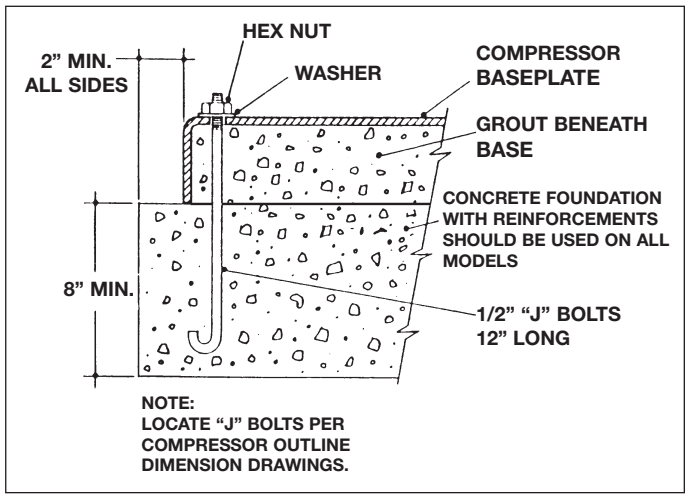


Figure 1.2: Recommended Foundation Details for Corken Compressors

1.3 Piping

Proper piping design and installation is as important as a proper foundation is to a smooth operating compressor. Improper piping installation will result in undesirable transmission of compressor vibration to the piping.

DO NOT SUPPORT PIPING WITH THE COMPRESSOR. Unsupported piping is the most frequent cause of vibration of the pipe. The best method to minimize transmission of vibration from the compressor to the piping is to use flexible connectors (see figure 1.3 for details).

WARNING

Pipe must be adequately sized to prevent excessive pressure drop between the suction source and the compressor as well as between the compressor and the final discharge point. In most cases, piping should be at least the same diameter as the suction nozzle on the compressor.

If a restrictive device such as a valve, pressure regulator, or back-check valve is to be installed in the compressor's suction line, care must be taken. The suction line volume

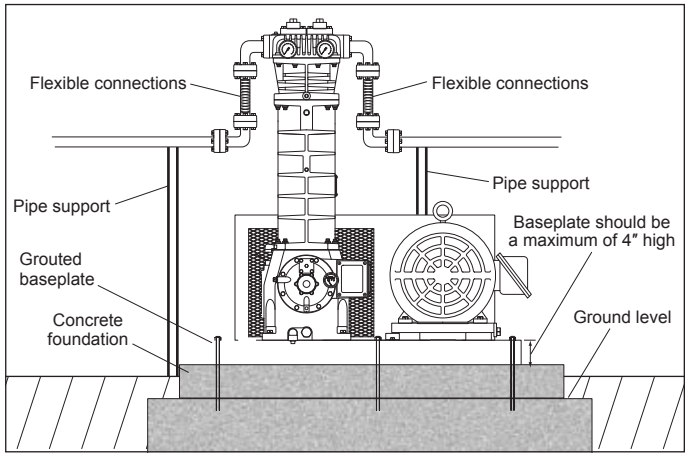


Figure 1.3: 103 mounting shown above. On 107 mountings, the flexible connectors should be located near the four way valve.

between the restrictive device and the compressor suction nozzle must be at least ten times the swept cylinder volume.

On liquefied gas applications such as LPG/NH_3, it is of extreme importance to prevent the entry of liquid into the compressor. Installing a liquid trap on the inlet side will prevent liquid from entering the compressor (see section 1.4).

It is of equal importance to protect the discharge side of the compressor from liquid entry. This may be done by installing a check valve on the discharge side of the compressor and using a piping design that does not allow liquid to gravity drain into the compressor.

For vapor recovery applications, be certain to install a check valve on vapor lines discharging to the liquid space of the tank.

All piping must be in accordance with the laws and codes governing the service. In the United States, the following codes apply:

For LP Gas—The National Fire Protection Association Pamphlet No. 58, Standard for the Storage and Handling of Liquefied Petroleum Gases.

For Ammonia—The American National Standards Institute, Inc., K61.1-1989, Storage and Handling of Anhydrous Ammonia.

Copies of these are available from NFPA, 60 Baterymarch Street, Boston, Mass, 02110 and ANSI, 1430 Broadway, New York, N.Y., 10018. Install, use and maintain this equipment according to Corken instructions and all applicable federal, state, and local laws and previously mentioned codes. Other laws may apply in different industries and applications.

1.4 Liquid Trap

Compressors are designed to pressurize gas—not to pump liquids. The entry of even a small amount of liquid into the compressor will result in serious damage.

On liquefied gas applications, a liquid trap must be used to prevent the entry of liquid into the compressor.

WARNING

If the liquid trap includes a level switch, the liquid level switch MUST be removed from the trap before grounding any welding devices to the trap or associated piping! **Failure to do so will damage the switch contacts.**

If your compressor is equipped with a liquid trap not manufactured by Corken, make sure it is adequately sized; otherwise it may not be able to remove the liquid entrained in the suction stream.

Corken offers three types of liquid traps for removal of entrained liquids. The simplest is a mechanical float trap (see Figure 1.4A). As the liquid enters the trap, the gas velocity is greatly reduced, allowing the entrained liquid to drop out. If the liquid level should rise too high, the float will plug the compressor suction. The compressor creates a vacuum in the inlet piping and continues to operate until it is manually shut down by the operator. Before restarting the compressor, drain the trap and open the vacuum-breaker valve to allow the float to drop back to the bottom of its holder. This type of trap is only appropriate for use where the compressor is kept under fairly close observation by the operator.

For continuous-duty operation applications such as those found in the chemical industry, an automatic trap should be used (see Figure 1.4B). The automatic trap replaces the mechanical float with an electrical float switch. If the liquid level should rise too high, the level switch will open and disconnect the power to the motor starter, stopping the compressor. This design ensures the machine will be protected even when it is not under close observation.

The most sophisticated trap provides the most thorough liquid separation (see Figure 1.4C). This trap is larger and is American Society of Mechanical Engineers (ASME) code stamped. It contains two level switches, one for alarm and one for shutdown. In some cases, the alarm switch can activate a dump valve (not included with trap) or sound an alarm. A drain valve is included to manually drain the trap.

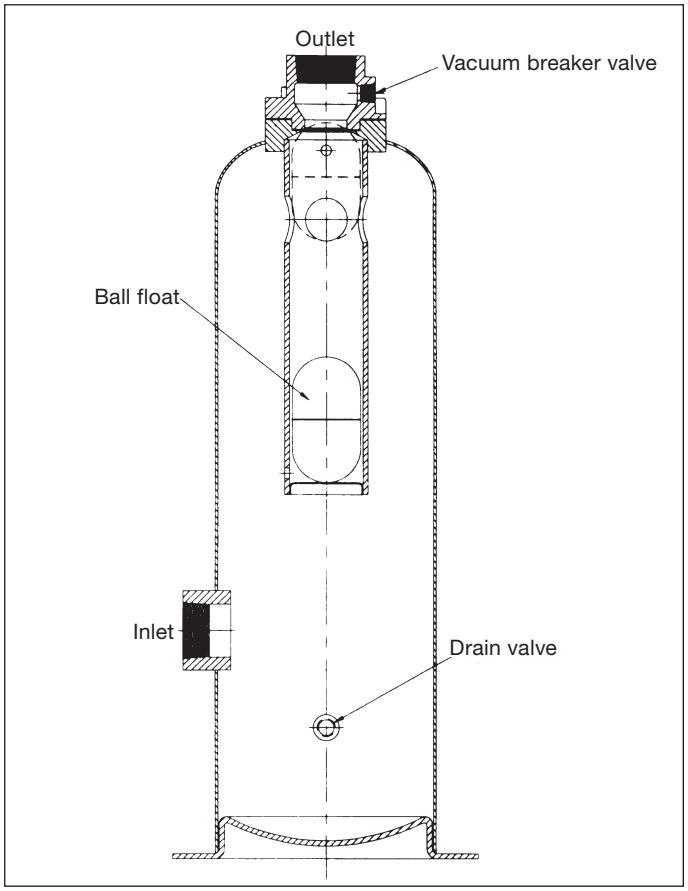


Figure 1.4A: Mechanical Trap Details

This trap also contains a mist pad (a mesh of interwoven wire to disentrain fine-liquid mists). The ASME code trap is standard on the 109B mounting configuration. A smaller ASME code trap with one level switch is used on a 109°F mounting.

1.5 Driver Installation/Flywheels

Corken vertical compressors may be driven by either electric motors or combustion engines (gasoline, diesel, natural gas, etc.).

WARNING Never operate a reciprocating compressor without a flywheel.

Drivers should be selected so the compressor operates between 400 and 825 RPM. The unit must not be operated without the flywheel or severe torsional imbalances will result that could cause vibration and a high horsepower requirement. The flywheel should never be replaced by another pulley unless it has a higher wk2 value than the flywheel.

Humid climates can cause problems with explosion proof motors. The normal breathing of the motor and alternating between being warm when running and cool when stopped can cause moist air to be drawn into the motor. This moist air will condense, and may eventually add enough water inside the motor to cause it to fail. To prevent this, make a practice of running the motor at least once a week on a bright, dry day for an hour or so without the V-belts. During this period of time, the motor will heat up and vaporize the condensed moisture. No motor manufacturer will guarantee their explosion proof or totally enclosed (TEFC) motor against damage from moisture.

For installation with engine drivers, thoroughly review instructions from the engine manufacturer to assure the unit is properly installed.

1.6 Crankcase Lubrication

To ensure proper lubrication of the crankcase parts before startup, the crankcase should be filled through the nameplate inspection opening (see figure 1.6C).

Non-detergent oil is recommended for Corken vertical compressors. Detergent oils tend to keep wear particles and debris suspended in the oil, whereas non-detergent oils let them settle in the bottom of the crankcase. When non-detergent oils are not available, detergent oils may usually be successfully substituted, although compressors handling ammonia, amine, or imine gases are notable exceptions. These gases react with the detergent and cause the crankcase oil to become corrosive and contaminated. Figures 1.6A and 1.6B show recommended oil viscosities and crankcase capacities. Ensure oil is compatible with the product being compressed.

Synthetic lubricants are generally not necessary. Please consult your lubricant supplier if you are considering the use of synthetic oil.

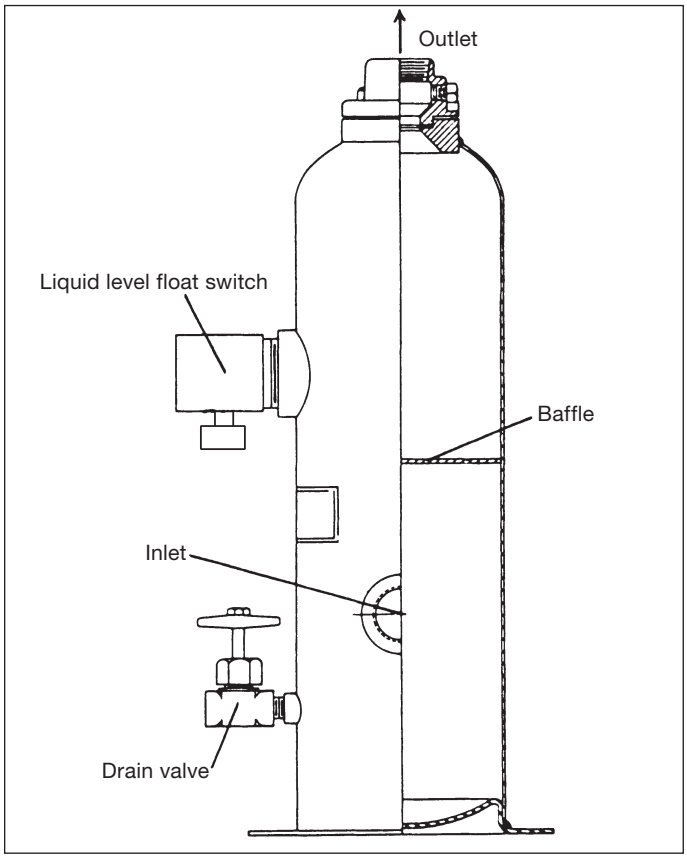


Figure 1.4B: Automatic Liquid Trap Details

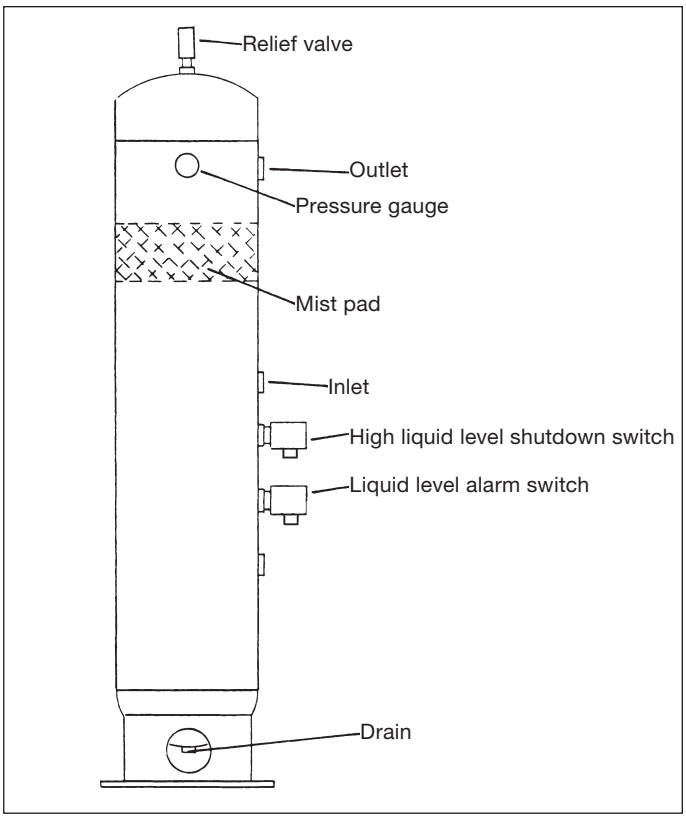


Figure 1.4C: ASME Automatic Liquid Trap

Acceptable Crankcase Oil Products for Corken Compressors				
Constant Weight - Non-Detergent - R&O Inhibited				
Oil product	**ISO**	**VI**	**SAE**	**Ambient Temp.**
Exxon®				
TERESSTIC	100	95	30	65° - 100° F
	68	95	20+	45° - 70° F
	46	95	20	35° - 50° F
Mobil®				
RARUS 427 Reciprocating Compressor Oil	100	95	30	65° - 100° F
DTE Oil Heavy Medium	64	95	20+	45° - 100° F
Dectol R&O Oil	44	95	20	35° - 50° F
Conoco®				
Dectol R&O Oil	100	98	30	65° - 100° F
	68	97	20+	45° - 70° F
	46	99	20	35° - 50° F
Texaco®				
Regal R&O Oil	100	92	30	65° - 100° F
	68	97	20+	45° - 70° F
	46	102	20	35° - 50° F
Sun®				
SunVis 900 Oil	100	100	30	65° - 100° F
	68	100	20+	45° - 70° F
	46	100	20	35° - 50° F

Figure 1.6A: Oil selection chart

Compressor Model	Approximate Quarts	Capacity Liters
FD/WFD351	3.0	2.8

Figure 1.6B: Oil capacity chart

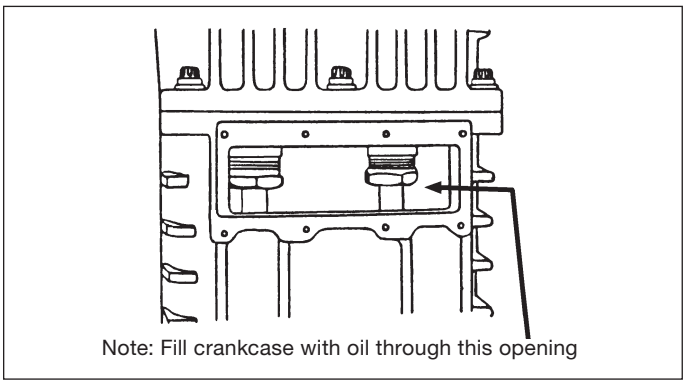


Figure 1.6C

WARNING **New or rebuilt units should be filled with oil through the opening behind the compressor nameplate. This provides excellent lubrication for the crossheads on initial startup (see Figure 1.6C).**

1.7 Purging, Padding, Venting and Draining of Distance Pieces on Two Stage D-Style Compressors.

The key to leakage control and oil-free operation of Corken compressors is the distance piece. The distance piece is integral with the crosshead guide and forms the upper portion of it. The distance piece is equipped with tapped holes to allow purging, padding, venting, and draining (see Figure 1.7). Proper connections to and from these tapped holes are essential for optimum compressor performance.

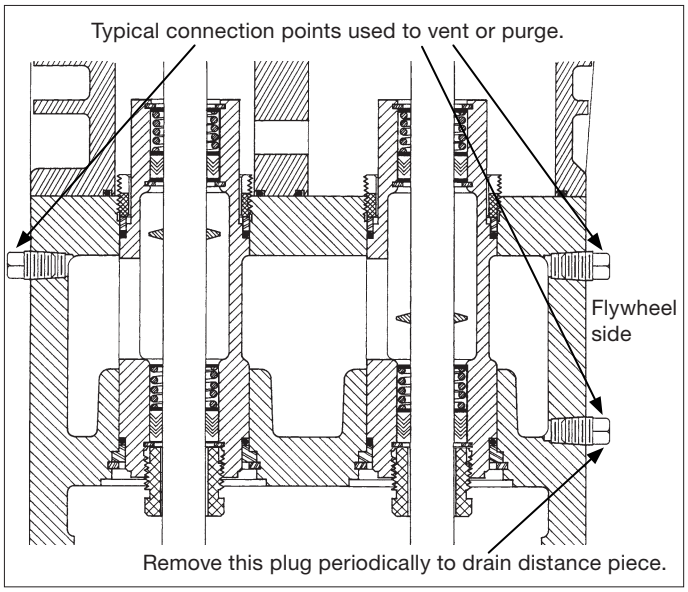


Figure 1.7

Compressors with the A-Style packing arrangement are shipped with all distance piece connections plugged. These compressors are used with inlet pressures above atmospheric pressure. Compressors with the B-Style packing arrangement have a distance piece connection tubed to the discharge of the compressor's first stage. These compressors are most often used for vacuum inlet conditions.

Corrosive gases should be prevented from entering the crankcase, since even small amounts of gas leakage into the crankcase can seriously contaminate the crankcase oil. To prevent this contamination, the distance piece may be purged, padded, or vented using a clean, non-corrosive gas like dry air or nitrogen.

Purging:

Purging of the distance piece controls leakage of process gas to the atmosphere. Process gas leakage into the distance piece is quickly diluted by the purge gas and swept away. The purge gas should be vented to a safe release area, flare, compressor's inlet, or treatment facility, depending on the gas and local regulations.

Purging can be performed on units with either A-Style packing or B-Style packing arrangements. If the purge pressure is to be at a pressure lower than the compressor's suction pressure, use A-Style packing. If the purge pressure is to be at a pressure higher than the compressor's suction pressure, use B-Style packing (remove the tube to the compressor's head if purging with B-Style packing). A small amount of purge gas may get into the process gas.

When purging, it is critical to maintain the proper pressure loading across each set of packing. The higher pressure should be on the open side of the “V”, which is also the side with the spring.

Moisture, oil, or condensate can be removed from the distance piece with the purge gas by using the lower distance piece connection (drain location) as the purge gas outlet connection.

Corken offers purge kits which include the necessary regulator, valves, fittings, etc. Consult the factory for further information.

Padding (Buffering):

If purging is not practical, the distance piece can be pressurized with a static pressure. This is called padding or buffering. This is best done using B-Style packing (remove the tube to the compressor’s head when padding with B-Style packing). Padding is done at a pressure above the compressor’s suction pressure using a clean non-corrosive gas like dry air or nitrogen. The higher pressure in the distance piece tends to reduce the process gas leakage to the atmosphere. A small amount of purge gas will likely get into the process gas. A pressure regulator can be used to maintain proper distance piece pressure.

When padding, it is critical to maintain the proper pressure loading across each set of packing. The higher pressure should be on the open side of the “V”, which is also the side with the spring.

Venting:

The distance piece can also simply be vented to an appropriate release area, flare, or treatment facility. This is sometimes useful for indoor installations.

Draining:

Since some oil will pass the bottom packing set, regular draining of the distance piece is essential to maintain oil-free operation (See Figure 1.7).

Corken recommends draining the distance piece once a week for units in continuous-duty operation. Installing a drain cock to the distance piece drain will help simplify draining of the distance piece.

Highly Corrosive Gases:

The compressor should be blocked from the system via valves on the suction and discharge piping, then purged with dry inert gas before being shut down. Experience has proven this significantly lowers corrosion damage to the machine.

1.8 Relief Valves

An appropriate relief valve must be installed on the discharge side of the compressor. Relief valves should be made of a material compatible with the gas being compressed. Local codes and regulations should be checked for specific relief valve requirements. Also, relief valves may be required at other points in the compressor’s system piping.

1.9 Shutdown/Alarm Devices

For many applications, shutdown/alarm switches will provide worthwhile protection that may prevent serious damage to your compressor system. All electronic devices should be selected to meet local code requirements. Shutdown/alarm devices typically used on Corken compressors are as follows:

1. **Low Oil Pressure Switch:** Shuts down the unit if crankcase oil pressure falls below 12 psi due to oil pump failure or low oil level in crankcase. The switch or the compressor controller must have a 30 second delay on startup which allows the compressor to build oil pressure in the crankcase.

2. **High Discharge Temperature Switch:** This switch is strongly recommended for all applications. Both the High Discharge Temperature switch (HDT) and compressor have an operating pressure range. It is preferable that the switch set point be midpoint in its range and 30°F (-1°C) above the normal discharge temperature, but below the maximum design temperature for the compressor of 350°F (176°C).

3. **Low Suction Pressure Switch:** Shuts down the unit if inlet pressure is not within the preset limit (set point). In some cases, it is important not to pull a vacuum because of the potential of pulling oil from the crankcase into the gas stream.

4. **High Discharge Pressure Switch:** Shuts down the unit if the outlet pressure reaches a preset limit (set point). Both the switch and the compressor have an operating range. The set point of the pressure switch should be as follows:

   Greater than the normal operating pressure for the compressor.

   Less than 90% of the relief valve set point pressure.

   Less than the maximum operating pressure of the compressor.

   Midpoint of the pressure switch range.

5. **Vibration Switch:** Shuts down the unit if vibration becomes excessive. Recommended for units mounted to a portable skid.

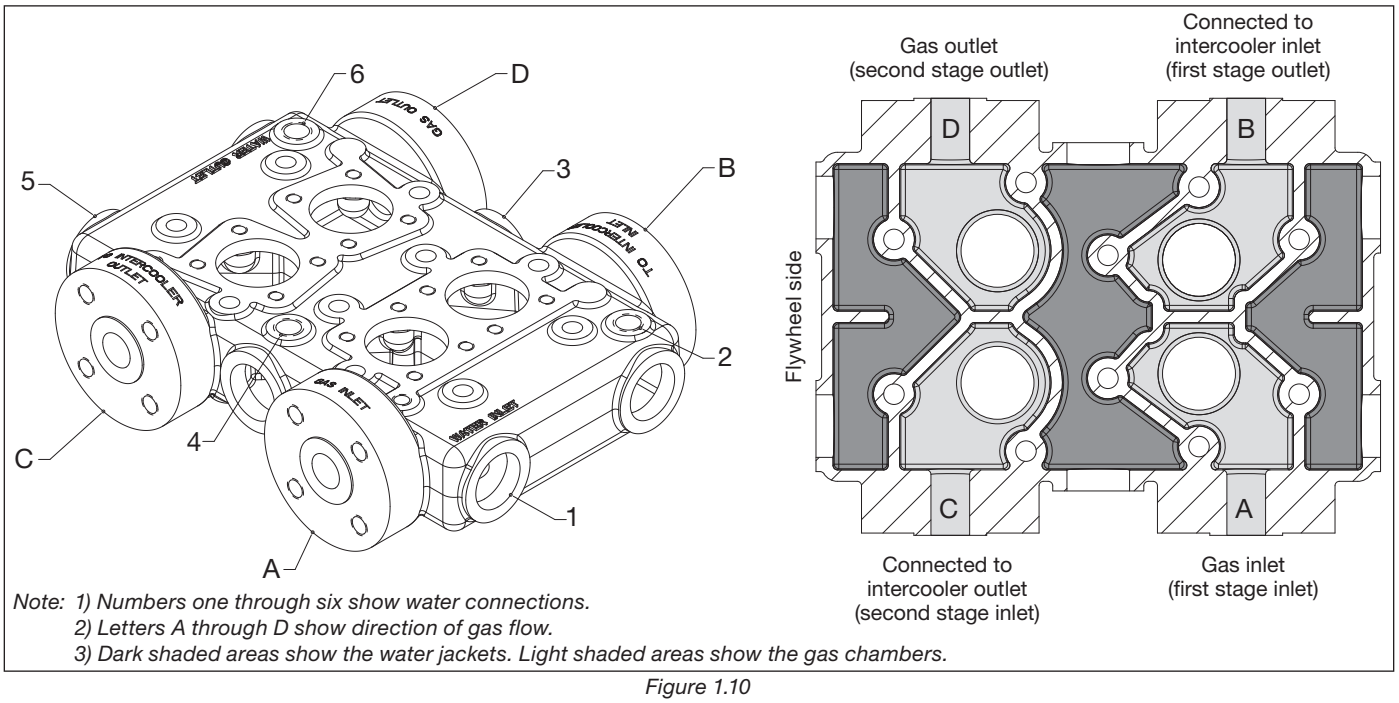
1.10 Compressor Cooling

On air-cooled models, it is important to maintain good air flow around your compressor. Keep this in mind as you select a location for the compressor to operate.

A minimum of 18 inches (45 cm) clearance between the compressor and the nearest wall is recommended.

Water-cooled models have a water-cooled head and cylinder. There are two water connections on the cylinder and six water connections on the head. All tubing for the water connections is provided by the factory except for the inlet connection at the cylinder and the outlet connection at the head. The owner of the compressor is responsible for the inlet and outlet water connections.

The cylinder has one water jacket while the head has three water jackets. See Figure 1.10 for details.



Note: 1) Numbers one through six show water connections.
2) Letters A through D show direction of gas flow.
3) Dark shaded areas show the water jackets. Light shaded areas show the gas chambers.

Figure 1.10

Chapter 2—Starting Up Your Corken Compressor

NOTE: Read this entire chapter, then proceed with the startup checklist.

2.1 Inspection After Extended Storage

If your compressor has been out of service for a long period of time, you should verify that the cylinder bore and valve areas are free of rust and other debris. For valve and/or cylinder head removal instructions, refer to chapter 4 of this IOM manual.

Drain the oil from the crankcase and remove the nameplate and crankcase inspection plate. Inspect the running gear for signs of rust and clean or replace parts as necessary. Replace the crankcase inspection plate and fill crankcase with the appropriate lubricant through the nameplate inspection opening. Squirt oil on the crossheads and rotate the crankshaft by hand to ensure that all bearing surfaces are coated with oil.

Rotate unit manually to ensure running gear functions properly. Replace nameplate and proceed with startup.

2.2 Flywheel and V-belt Alignment

Before working on the drive assembly, be sure that the electric power is disconnected. When installing new belts, always make sure the driver and compressor are close enough together to avoid forcing the belt onto the flywheel.

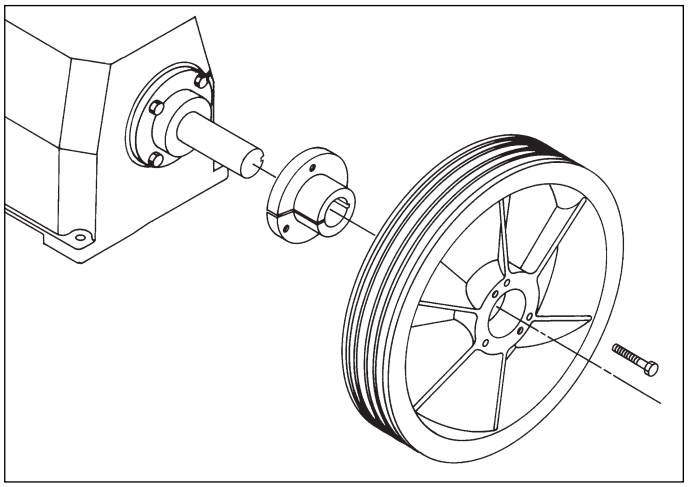


Figure 2.2A: Flywheel Installation

Improper belt tension and sheave alignment can cause vibration, excessive belt wear and premature bearing failures. Before operating your compressor, check alignment of the V-grooves of the compressor flywheel and driver sheave. Visual inspection often will indicate if the belts are properly aligned, but use of a square is the best method.

The flywheel is mounted on the shaft via a split, tapered bushing and three bolts (see figure 2.2A). These bolts should be tightened in an even and progressive manner to the specified torque values listed in the table below. There must be a gap between the bushing flange and the flywheel when installation is complete. Always check the flywheel runout before startup and readjust if it exceeds the value listed in Appendix B.

Hub Size	Diameter in. (cm)	Bolt Torque Ft-lb (kg-meter)	Set Screw Torque Ft-lb (kg-meter)
SF	4.625 (11.7)	12-18 (1.7–2.5)	22 (3.1)
E	6.0 (15.2)	30-36 (4.1–4.9)	22 (3.1)
J	7.25 (18.4)	75-81 (10.3–11.1)	109 (15.1)

Tighten the belts so that they are taut, but not extremely tight. Consult your V-belt supplier for specific tension recommendations. Belts that are too tight may cause premature bearing failure. Refer to figure 2.2B.

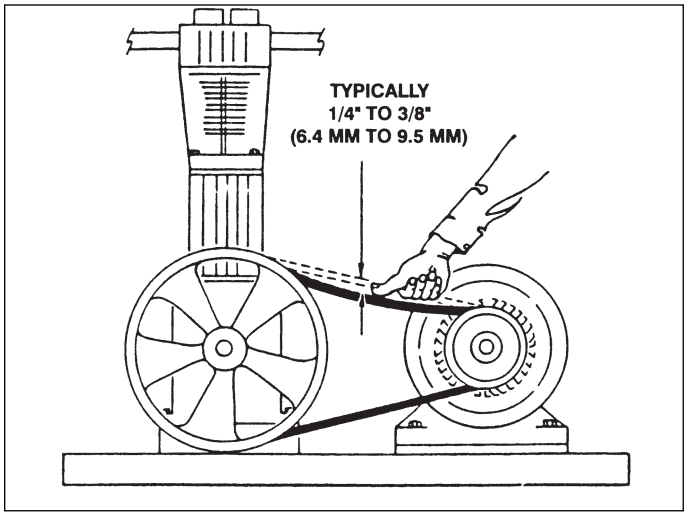


Figure 2.2B: Belt Tension

2.3 Crankcase Oil Pressure Adjustment

Your Corken compressor is equipped with an automatically reversible gear type oil pump. It is essential to ensure the pumping system is primed and the oil pressure is properly adjusted in order to assure smooth operation.

Before starting your compressor, check and fill the crankcase with the proper amount of lubricating oil.

When the compressor is first started, observe the crankcase oil pressure gauge. If the gauge fails to indicate pressure within 30 seconds, stop the machine. Loosen the oil filter and remove the pressure gauge. Restart the compressor and run it until oil comes out of the pressure gauge opening or around the filter. Tighten the filter reinstall the gauge.

The oil pressure should be about 20 psi (1.4 bars) minimum for normal service. If the compressor discharge pressure is above 200 psi (14.8 bars) the oil pressure must be maintained at a minimum of 25 psi (1.7 bars). A spring-loaded relief valve mounted on the bearing housing opposite the flywheel regulates the oil pressure. As shown in figure 2.3, turn the adjusting screw clockwise to increase the oil pressure and counterclockwise to lower it. Be sure to loosen the adjusting screw locknut before trying to turn the screw and tighten it after making any adjustment.

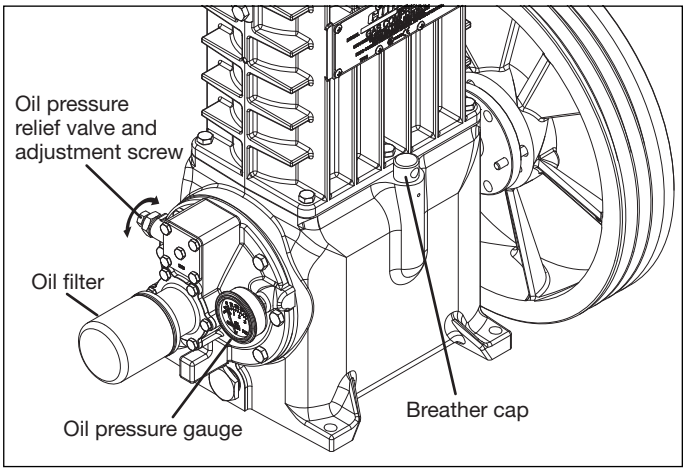


Figure 2.3: Oil Pressure Adjustment

2.4 Startup Check List

Please verify each item on this list below before starting your compressor! Failure to do so may result in a costly (or dangerous) mistake.

Before Starting the Compressor

1. Become familiar with the function of all piping associated with the compressor. Know each line's use!
2. Make certain actual operating conditions will match the anticipated conditions.
3. Ensure that the line pressures are within cylinder pressure ratings.
4. Clean out all piping.
5. Ensure all distance piece openings are tubed or plugged as desired.
6. Check all mounting shims, cylinder and piping supports to ensure that no undue twisting forces exist on the compressor.

7. Make certain strainer elements are in place and clean.

8. Make certain cylinder bore and valve areas are clean.

9. Check V-belt tension and alignment or drive alignment on direct drive units.

10. Rotate unit by hand and make certain there is no wobble or play.

11. Check crankcase oil level.

12. Drain all liquid traps, separators, etc.

13. Verify proper electrical supply to motor and panel.

14. Check all gauges and confirm a zero level reading.

15. Test piping system for leaks.

16. Purge unit of air before pressurizing with gas.

17. Carefully check for any loose connections or bolts.

18. Remove all stray objects (rags, tools, etc.) from vicinity of the unit.

19. Confirm all valves are open or closed as required.

20. Double-check all of the above.

After Starting Compressor

1. Verify and note proper oil pressure. Shut down and correct any problems immediately.

2. Observe noise and vibration levels. Correct immediately if excessive.

3. Verify proper compressor speed.

4. Examine entire system for gas or oil leaks.

5. Note rotation direction.

6. Check start-up voltage drop, running amperage and voltage at motor junction box (not at the starter).

7. Verify proper lubrication rate (lubed units only).

8. Test each shutdown device and record set points.

9. Test or confirm set point on all relief valves.

10. Check and record all temperatures, pressures and volumes after 30 minutes and 1 hour.

11. After 1 hour running time, tighten all head bolts, valve holddown bolts, and baseplate bolts. See Appendix B for torque values.

Chapter 3—Routine Maintenance Chart

Item to Check	Daily	Weekly	Monthly	Six Months	Yearly
Crankcase oil pressure	●				
Compressor discharge pressure	●				
Overall visual check	●				
Crankcase oil level			●[2]	●[2]	
Drain liquid from accumulation points		●[3]			
Drain distance pieces		●			
Clean cooling surfaces on compressor and intercooler (if any)		●			
Lubricator supply tank level (if any)		●			
Check belts for correct tension			●		
Inspect valve assemblies				●	
Lubricate motor bearings in accordance with manufacturers' recommendations				●	
Inspect motor starter contact points					●
Inspect piston rings[1]				●[1]	

[1]Piston ring life varies greatly, depending on application, gas, and operating pressures. Consult factory for additional recommendations for your specific application.

[2]Change oil every 2,200 hours of operation or every 6 months, whichever occurs first. If the oil is unusually dirty, change it as often as needed to maintain a clean oil condition. Change filter (part number 4225) with every oil change.

[3]Liquid traps should be drained prior to startup.

WARNING

Note: The recommended maintenance procedures listed above are general guidelines only. Your specific maintenance requirements may vary depending on the operating conditions and duty cycle.

Chapter 4—Routine Service and Repair Procedures

CAUTION: Always relieve pressure in the unit before attempting any repairs. After repair, the unit should be pressure tested and checked for leaks at all joints and gasket surfaces.

If routine maintenance is performed as listed in chapter 3, repair service on your Corken gas compressor is generally limited to replacing valves or piston rings. When it comes time to order replacement parts, be sure to consult the part details appendix in the back of this Installation, Operation & Maintenance (IOM) manual for a complete list of part numbers and descriptions.

4.1 Valves

Test the compressor valves by closing the inlet piping valves while the unit is running; however, do not allow the machine to operate in this way very long. If the inlet pressure gauge does not drop to zero almost immediately, one or more of the valves is probably damaged or dirty. However, it is possible for the pressure gauge itself to be faulty.

In most cases, if a valve or gasket is leaking, it will create more heat. On a single stage compressor, you may be able to compare the operating temperatures of the two suction or discharge valves and cover plates to each other. If a valve or gasket is leaking, it will have a higher operating temperature. NOTE: This method will not be suitable for two stage compressors if each stage does not have more than one valve.

Each suction and/or discharge valve assembly is easily removed as a unit for inspection. If any part of the valve assembly is broken, the valve assembly should be replaced. See valve assembly parts details in the Appendix E for a complete list of part numbers and descriptions.

If a valve is leaking due to dirt or any other foreign material that keeps the valve plate and seat from sealing, the valve may be cleaned and reused. New valve gaskets and O-rings should be used to assure a good seal.

The valve holddown assemblies and valve assemblies on the following pages show the various specifications used on models 351 and 391 compressors. Since more than one suction valve arrangement is available for each model of compressor, it is necessary to know your complete model number so you can identify the valve type specification number (see example listed below).

Model number FD351AM 4P FDAFSNN
Valve type = spec 4P

Valve Inspection and/or Replacement

Before removing and inspecting the valves, begin by depressurizing and purging (if necessary) the unit.

Disassembly

1. Unscrew the valve cap (or unloader if applicable) assembly and remove the O-ring.

2. Remove the valve cover plate, O-ring and holddown screw by removing each of the four bolts. The holddown screw is easily removed with the special wrench supplied with your compressor.

3. After the cover plate and O-ring have been removed, the valve cage, valve assembly and valve gasket can be lifted out.

4. Inspect valves for breakage, corrosion, debris and scratches on the valve plate. In many cases, valves may simply be cleaned and reinstalled.

5. To clean your valve assemblies, disassemble by removing the valve seat and/or bumper, valve spring and valve plate and soak in some rubbing alcohol for a few minutes. Remove the parts from the rubbing alcohol and dry each with a lint-free cloth. Reassemble the valve assemblies in the same order using the part details in Appendix E. After you have reassembled the valve assemblies, check for leaks by pouring a small amount of rubbing alcohol through the valve seat opening. If the valves are sealing properly, no alcohol will be allowed to seep through to the valve bumper.

6. If the valves show any damage, they should be repaired or replaced. Replacement is usually preferable although repair parts are available. If valve plates are replaced, seats should also be lapped until they are perfectly smooth. If more than .005 of an inch must be removed to achieve a smooth surface, the valve should be discarded. If plates are replaced without relapping the seat, rapid wear and leakage may occur.

Assembly

1. Insert metal valve gasket into the suction and/or discharge opening of the head. The metal valve gasket should always be replaced when the valve is reinstalled.

2. Insert cleaned or new valve assembly. Make sure the suction and discharge valves are in the proper suction and discharge opening in the head.

3. Insert the valve cage.

4. Replace the O-ring and valve cover plate. Torque the bolts to the value listed in Appendix B. CAUTION: Be sure the holddown screw has been removed.

5. To ensure the valve gasket is properly seated, insert the holddown screw and tighten to the value listed in Appendix B. NOTE: Gaskets and O-rings are not normally reusable.

6. Replace the O-ring and valve cap (or unloader assembly if applicable) and tighten to the value listed in Appendix B.

7. Check bolts and valve holddown screws after first week of operation. Re-torque if necessary. See Appendix B for torque values.

4.2 Heads

A compressor cylinder and head very seldom requires replacement if the compressor is properly maintained. The primary cause of damage to a cylinder or head is corrosion and the entry of solid debris or liquid into the compression chamber. Improper storage can also result in corrosion damage to the cylinder and head (for proper storage instructions see chapter 5).

Many compressor repair operations require removal of the cylinder and head. While the compressor is disassembled, special care should be taken to avoid damage or corrosion. If the compressor is to be left open for more than a few hours, bare metal surfaces should be coated with rust preventative.

When reassembling the compressor, make sure the bolts are retightened per the torque values listed in Appendix B.

4.3 Piston Rings and Piston Ring Expanders Replacement

Piston ring life will vary considerably from application to application. Ring life will improve dramatically at lower speeds and temperatures.

1. To replace the piston rings, depressurize the compressor and purge if necessary.

2. Remove the cylinder and head to gain access to the compressor cylinder.

3. Loosen the piston head bolts and remove the piston head as shown in figure 4.3 by pinching two loose bolts together.

4. Remove lock pin with needle nose pliers. Remove the locknut and lift the piston platform off the end of the piston rod.

5. Piston rings and expanders may then be easily removed and replaced. Corken recommends replacing expanders whenever rings are replaced. To determine if rings should be replaced, measure the radial thickness and compare it to the chart in Appendix B.

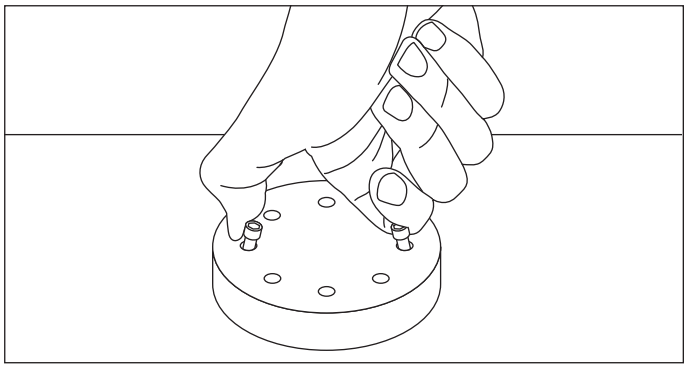


Figure 4.3: Piston head removal

4.4 Piston Replacement

WARNING To replace the pistons, **depressurize the compressor and purge if necessary**. Remove the compressor head (see section 4.2).

1. **To replace the first stage piston of the model 351 or the first and second stage pistons of the model 391,** remove the piston head by loosening and removing the socket head bolts holding the piston head to the piston platform (see Figure 4.3).

2. Next, remove the lock pin with needle nose pliers. The locknut may now be removed and the piston platform lifted off the end of the piston rod. Check the thrust washer and shims for damage and replace if necessary (see piston assembly details in Appendix E).

3. Reinstall the piston platform with the same thickness of shims as before, BUT DO NOT REINSTALL THE LOCK PIN. Reinstall the piston with new piston rings and expanders.

4. Now measure dimension “X”, shown in figure 4.4A. If

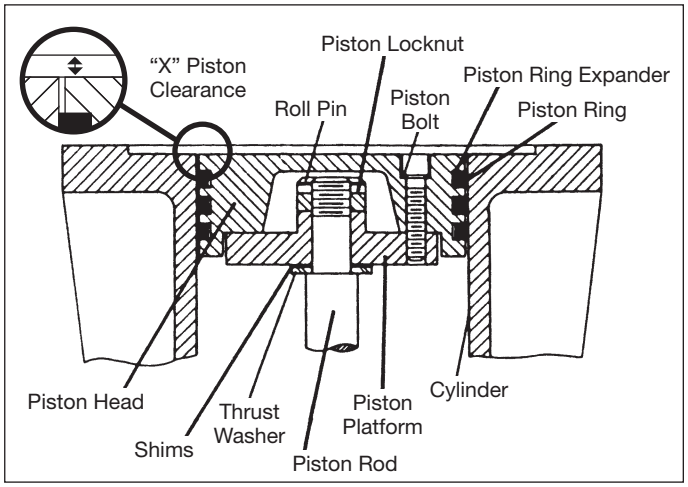


Figure 4.4A: 1st Stage Piston for Model 351 and the 1st and 2nd Stage Pistons for Model 391.

this measurement does not fall within the tolerances shown in Appendix B, remove the piston platform, adjust the shims as necessary and re-measure the "X" dimension. When the piston is properly shimmed, torque the locknut to the value listed in Appendix B.

5. Now install a new lock pin to secure the locknut.

6. Install the piston head and tighten the socket head bolts in an alternating sequence using the torque specification in Appendix B.

7. Reinstall the head and follow standard start-up procedure.

8. **To replace the second stage piston of the model 351**, remove the piston by using the spanner tool (part number 5207-X). Turn the piston counterclockwise and remove from the piston rod. NOTE: A LOCK PIN AND LOCKNUT ARE NOT USED ON THE SECOND STAGE PISTON (SEE PISTON ASSEMBLY DETAILS IN APPENDIX E).

9. Reinstall the piston with the same thickness of shims as before.

10. Next, measure dimension "X" in figure 4.4B. If necessary, add or remove shims until the piston clearance meets the tolerances listed in Appendix B.

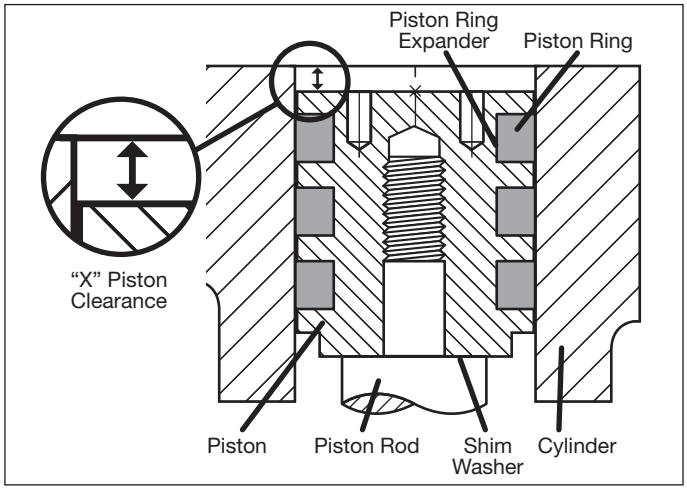


Figure 4.4B: 2nd Stage Piston for Model 351 Only.

11. After the piston is properly shimmed, apply a small amount of Loctite No. 272 to the threads of the piston rod and reinstall the piston with new piston rings and expanders. Use the spanner tool and torque the piston to the value listed in Appendix B.

4.5 Piston Rod Packing Adjustment

Piston rod packing should be replaced whenever leakage approaches an unacceptable level. "Acceptable leakage" should be determined by the customer according to safety and environmental regulations for their area . The upper packing is not adjustable. If the lower packing cannot be adjusted to an "acceptable leakage" rate, all packing sets (upper and lower) should be replaced. Typically, it is a good idea to replace piston rod packing and piston rings at the same time. Instructions for packing replacement are included with each set of packing.

To adjust the lower packing, remove the compressor nameplate (see Figure 4.5A), tighten the packing adjusting nut(s) 1/4 turn with the wrench supplied, then run the compressor a few minutes to reseat the packing. If the leakage is still unacceptable (see Figure 4.5B), tighten the adjusting nut as necessary, 1/4 turn at a time; do not over tighten! If the adjusting nut is tightened until the packing spring is solid, the packing should be replaced. If packing will not seal, carefully inspect piston rods for possible scoring and replace if necessary. Reattach the compressor nameplate after adjustments or repairs are made.

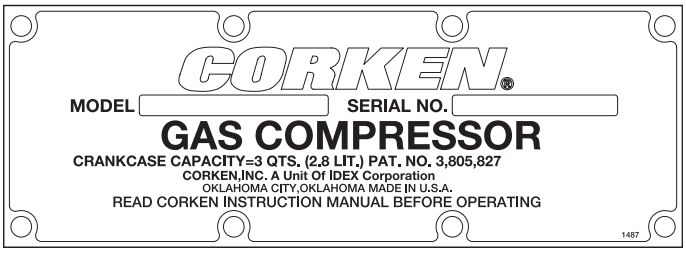


Figure 4.5A: Typical Nameplate
Also serves as the packing adjustment screw cover.

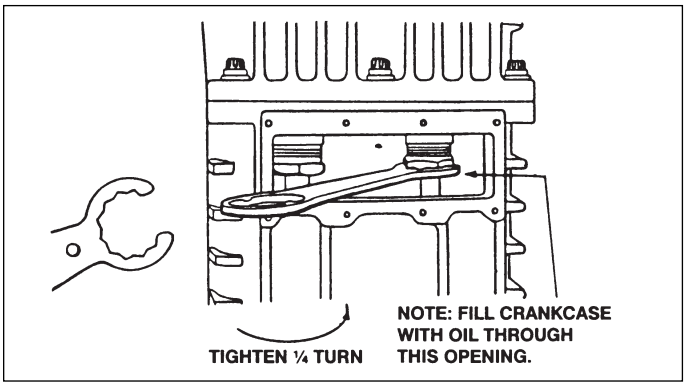


Figure 4.5B: Packing Adjusting Nuts

4.6 Cylinder Replacement

Cylinders very seldom require replacement if the compressor is properly maintained. The primary cause of damage to cylinders is corrosion and the entry of solid debris or liquid into the compression chamber. Improper storage can also result in corrosion damage to the cylinder (for proper storage instructions see chapter 5).

If the cylinder is damaged or corroded, use a hone to smooth the cylinder bore and then polish it to the value shown in Appendix B. If more than .005 of an inch must be removed to smooth the bore, replace the cylinder. Cylinder liners and oversized rings are not available.

WARNING

OVERBORING THE CYLINDER WILL RESULT IN GREATLY REDUCED RING LIFE.

Many compressor repair operations require removal of the cylinder. While the compressor is disassembled, special care should be taken to avoid damage or corrosion to the cylinder. If the compressor is to be left open for more than a few hours, bare metal surfaces should be coated with rust preventative.

When reassembling the compressor, make sure the bolts are retightened using the torque values listed in Appendix B.

4.6.1 Cylinder Installation and Alignment

Piston must not touch cylinder! To check this clearance, assembly personnel will need to check clearance with feeler gauges.

1. Place the cylinder on the crosshead guide and start the six 3/8"-16 bolts. Do not tighten them all the way. At this step, the cylinder must remain loose.

2. On the 1st stage of the model 351 and the 1st and 2nd stage of the model 391, attach the piston head to the piston platform using the sockethead screws. Tighten the sockethead screws using the torque specification listed in Appendix B.

3. Before assembling the 2nd stage piston of the model 351, apply a small amount Loctite No. 272 to the piston rod threads and tighten by hand. Using the Corken spanner wrench (part #5207-X), tighten the piston using the torque specification listed in Appendix B.

4. To properly align the cylinder, rotate the crankshaft all the way through the stroke. MAKE CERTAIN BOTH PISTONS ARE CENTERED ALL THE WAY THROUGH THE STROKE by adjusting the position of the cylinder as necessary. The cylinder wall must not touch the piston.

5. After the cylinder is properly aligned to the pistons, tighten the six 3/8”-16 bolts using the torque specification listed in Appendix B. Start in the center and work outward.

6. Rotate the crank one more time and make sure the pistons do not bind against the cylinder wall.

7. If there is interference, repeat steps 1-6 until clearance is obtained. When the proper clearance has been obtained, re-torque the six 3/8”-16 bolts using the torque specifications listed in Appendix B.

4.6.2 Packing Replacement

Caution: Before installing the new piston rod packing, bleed all pressure from the compressor and piping and purge if necessary. After the new piston rod packing has been installed, the unit should be pressure tested and checked for leaks at all joints and gasket surfaces. When the compressor is being used with toxic, dangerous, flammable or explosive gases, this pressure and leak testing should be done with air or a dry, inert gas such as nitrogen.

For simplicity, heads, pistons, and inspection plates are not shown. For specific construction details and actual part numbers, consult Appendix E in the back of this Installation, Operation & Maintenance (IOM) manual. Use instructions below that apply to the MODEL and SERIAL NUMBER of your compressor.

BE CAREFUL TO ARRANGE PACKING SETS IN THE PROPER ORDER.

Cleanliness:

Sealing a reciprocating piston rod is a very difficult task. Keep all parts, tools and your hands clean during installation. Your new packing needs every chance it can get, so keep it clean.

Workmanship:

Your Corken compressor is a precision piece of equipment with very close tolerances. Treat it as such. Never beat on it to get parts in or out.

Packing Configuration

The packing for these compressors includes V-ring packing in a packing cartridge.

Refer to Appendix E for packing assembly details. Note the arrangement of the particular packing sets for the model of machine that you have.

Disassembly of Packing

1. Depressurize and open the compressor.

2. Remove the head, pistons and cylinder.

3. Remove the cartridge holddown screw and spacer.

4. Remove the packing cartridge by rotating the flywheel or by lifting the packing cartridge upward.

5. On the lower V-ring packing set, remove adjusting screw, old packing, washers, packing spring, retainer ring and oil deflector ring from the bottom of the packing cartridge.

6. On the upper V-ring packing set, remove upper retainer ring, washers, packing spring, old packing, and lower retainer ring from the top of the packing cartridge.

Assembly of Packing

Replace packing as required and always use new O-rings during assembly.

Lower V-ring packing set

1. Clean and lightly coat packing area inside packing cartridge with oil.

2. From the bottom, install a retainer ring, packing washer, packing spring and another packing washer.

3. Insert one male packing ring, five packing rings and one female packing ring one at a time.

   WARNING **Note the packing direction shown in Appendix E.** Push in each one completely before adding the next ring.

4. Install adjusting screw so that locking device is engaged into first thread in packing cartridge.

Upper V-ring packing set

1. Clean and lightly coat packing area inside packing cartridge with oil.

2. From the top, insert the oil deflector ring and until it rests on top of the retainer ring in the lower packing set.

3. Install the retainer ring and insert a packing washer.

4. Insert one female packing ring, five packing rings, and one male packing ring one at a time.

   WARNING **Note the packing direction shown in Appendix E.** Push in each one completely before adding the next ring.

5. Insert one washer, one packing spring, another packing washer.

6. Push down on washer and install retainer ring.

7. Install packing installation cone part number 4005 over the threaded end of the piston rod.

8. Carefully install packing cartridge on the piston rod.

9. Install and tighten cartridge holddown screw with special wrench mounted on the side of the compressor (part number 2901).

10. Remove packing installation cone.

11. Replace the cylinder, pistons and head. For proper assembly of the cylinder, pistons and head, see assembly details in Sections 4.2, 4.4, 4.6 and torque specifications and sequence listed in Appendix B.

12. Rotate unit by hand to ensure proper assembly.

13. Refer to Section 4.5 for piston rod packing adjustment.

4.7 Bearing Replacement for Crankcase and Connecting Rod

1. To replace the crankcase roller bearings, wrist pin bushing and connecting rod bearings, begin by removing the head, cylinder, pistons, crosshead guide and crosshead assemblies.

2. Drain the crankcase and remove the inspection plates.

3. Before disassembly, choose and mark one connecting rod and the corresponding connecting rod cap.

   WARNING DO NOT MIX CONNECTING RODS AND CAPS.

   Loosen and remove the connecting rod bolts in order to remove the crosshead and connecting rod assembly.

4.7.1 Wrist Pin Bushing Replacement

1. To replace the wrist pin bushing, remove the retainer rings that position the wrist pin in the crosshead.

2. Press out the wrist pin so the crosshead and connecting rod may be separated. Inspect the wrist pin for wear and damage and replace if necessary.

3. Press out the old wrist pin bushing and press a new bushing into the connecting rod.

   WARNING DO NOT MACHINE THE O.D. OR I.D. OF THE BUSHING BEFORE PRESSING INTO CONNECTING ROD.

4. Make sure the lubrication hole in the bushing matches the oil passage in the connecting rod. If the holes do not align, drill out the bushing through the connecting rod lubricant passage with a long drill bit. Bore the wrist pin bushing I.D. as indicated in Appendix E, crosshead and connecting rod assembly details. Over boring the bushing can lead to premature failure of the wrist pin bushing.

5. Inspect the oil passage for debris and clean thoroughly before proceeding.

6. Press the wrist pin back into the crosshead and wrist pin bushing and reinstall retainer rings. NOTE: The fit between the wrist pin and bushing is tighter than lubricated air compressors and combustion engines.

4.7.2 Replacing Connecting Rod Bearings

Connecting rod bearings are easily replaced by removing the semicircular bearings. Make sure the indentations in the connecting rod bearing and connecting rod line up when installing the new bearings.

WARNING MAKE SURE THE ARROW AND/OR ALIGNMENT NOTCH ON CONNECTING ROD AND CAP ARE ALIGNED.

Before reinstalling the crosshead/connecting rod assembly, make sure the crankshaft throw and bearing surface are clean and lubricated. Tighten the connecting rod bolts to the torque values listed in Appendix B.

4.7.3 Replacing Crankcase Roller Bearings

To inspect the roller bearings, remove the flywheel from the crankshaft and then remove the bearing carrier and crankshaft from the crankcase. If corrosion or pitting is present, the roller bearings should be replaced. When replacing roller bearings, always replace the entire bearing and not just the cup or the cone.

1. To replace the bearings, press the cups out of the crankcase and bearing carrier and press the cones off the crankshaft.

2. Press the new bearings into position and reassemble the crankshaft and bearing carrier to the crankcase. When reinstalling the bearing carrier, make sure the oil pump shaft slot is aligned with the pin in the crankshaft. Make sure to install the bearing carrier gasket so the oil passage hole is not blocked (see figure 4.7).

3. In order to check the crankshaft endplay, the oil pump must first be removed (see section 4.8).

4. Press the end of crankshaft towards the crankcase; if a clicking noise or motion is detected, the crankshaft has too much endplay. For the proper amount of endplay, see Appendix B.

5. To reduce endplay, remove the bearing cover and remove a thin shim. Recheck the endplay after replacing the bearing cover.

6. When there is no detectable endplay, the shaft must still be able to rotate freely. If the crankshaft sticks or becomes abnormally warm, then the crankshaft bearings are too tight. If the crankshaft is too tight, add more shims, but make sure not to over shim. (Appendix B lists the proper crankshaft endplay). When the crankshaft can be rotated freely by hand with proper endplay, the rest of the compressor may be reassembled. If the crankshaft roller bearings are too tight or too loose, premature bearing failure will result.

7. Reinstall the oil pump and flywheel and check the run out as shown in Appendix B.

4.8 Oil Pump Inspection

If the compressor operates for a prolonged period with dirty or contaminated crankcase oil, damage to the oil pump and bearings may result.

1. To check the oil pump, unbolt the pump cover and remove the oil pump, spring guide, spring and oil pump shaft adapter as shown in figure 4.8.

2. Inspect the gears in the oil pump for corrosion or pitting and replace if necessary.

3. Check the oil pump shaft bushing in the bearing carrier. If the bushing is corroded, pitted or worn, the oil pump shaft bushing should be replaced. Inspect and replace other parts as necessary.

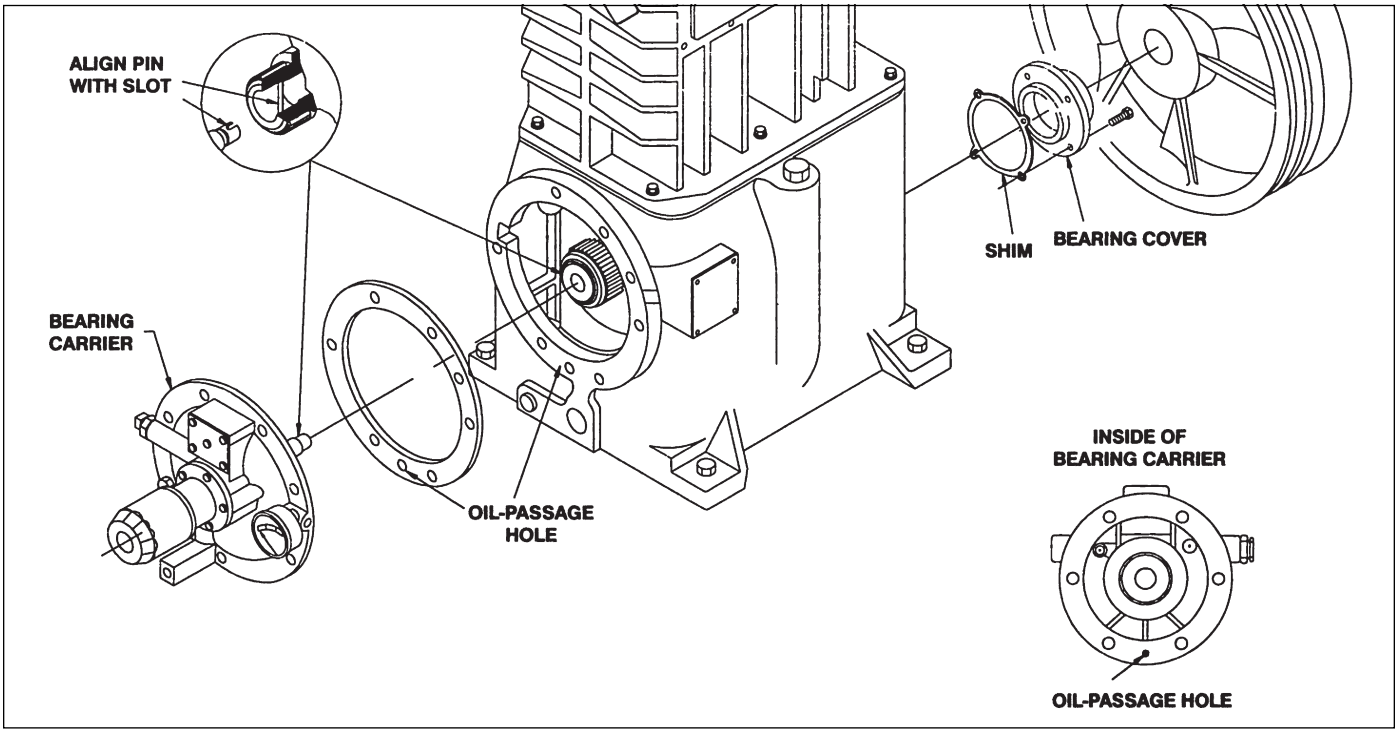


Figure 4.7: Crankcase Bearing Replacement

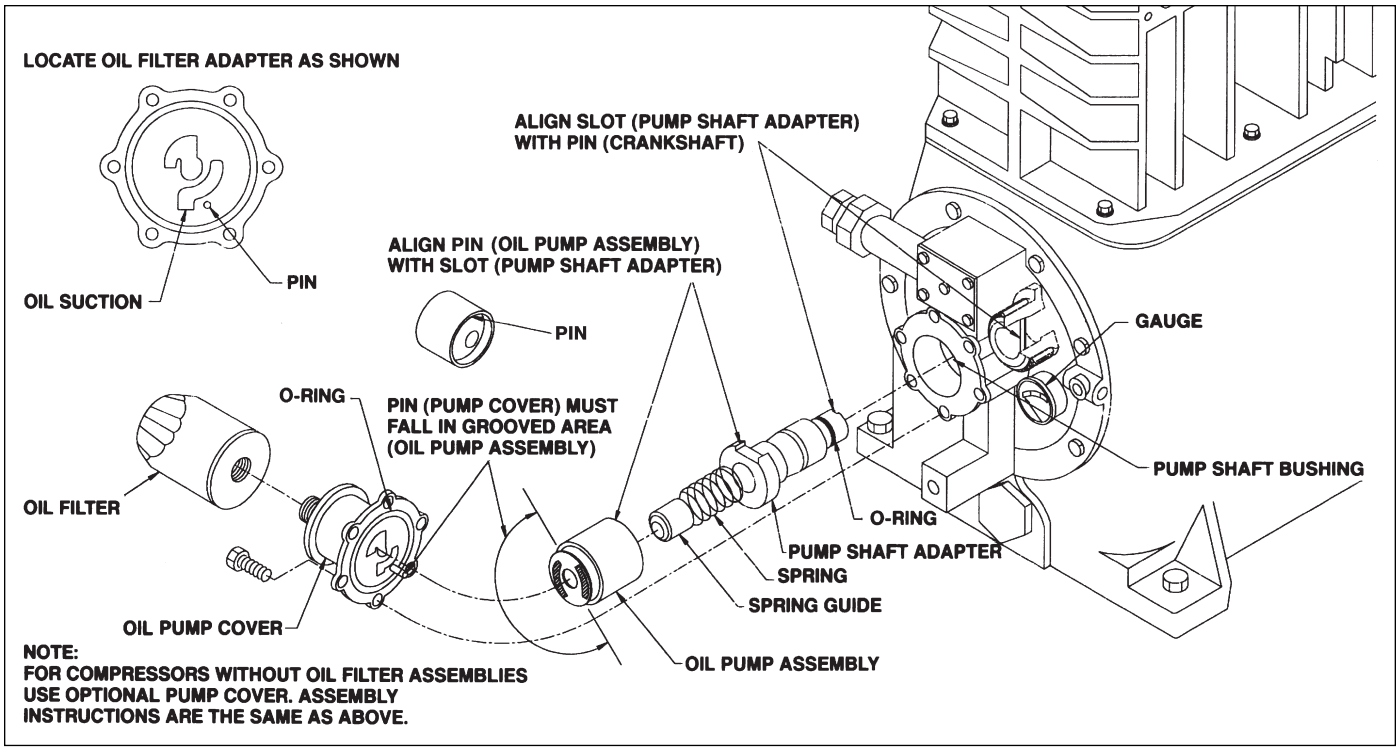


Figure 4.8: Oil Pump Inspection

4. Before reassembling the oil pump mechanism, replace the O-rings in the oil pump cover and on the oil pump shaft adapter (see figure 4.8).

5. Rotate the drive pin in the crankshaft to a vertical position for easiest reassembly.

6. Insert the shaft adapter so it engages the drive pin.

7. Next, insert the spring, spring guide and oil pump assembly. The pin on the oil pump must align with the slot in the pump shaft adapter.

8. Install the pump cover so the pin on the case is in the opening on the oil pump assembly as shown in figure 4.8. When you are sure the pin is properly aligned, install the cover bolts finger tight. If alignment is correct, the pump cover will mount flush to the bearing carrier. If it does not, re-check the pin alignment.

9. Tighten the bolts in an alternating sequence. See section 2.3 for directions on oil pressure adjustment.

10. Finally, rotate the crankshaft by hand to ensure smooth operation. Then rotate it in opposite directions, listening for a click, which indicates proper alignment of the oil pump's pins and slots.

Chapter 5—Extended Storage Procedures

Following a few simple procedures will greatly minimize the risk of the unit becoming corroded and damaged. Corken recommends the following precautions to protect the compressor during storage:

1. Drain the crankcase oil and refill with rust inhibiting oil.

2. Operate for a few minutes while fogging oil into the compressor suction.

3. Relieve V-belt tension.

4. Plug all openings to prevent entry of insects and moisture. (The cylinders may also be protected by the use of a vapor phase inhibitor, silica gel, or dry nitrogen gas. If the silica gel is used, hang a tag on the unit indicating that it must be removed before start-up.)

5. Store in a dry area and off the ground if possible.

6. Rotate the flywheel every two weeks if possible.

Appendix A—Model Number Identification Code—FD/WFD351

MODEL NUMBER

BASE X X X X X X X X X X

BASE MODEL NUMBER	FD351	WFD351
Inlet*	1" ANSI (600#)	1" ANSI (600#)
Outlet*	1" ANSI (600#)	1" ANSI (600#)
Intercooler connection*	1" ANSI (600#)	1" ANSI (600#)
Ship weight (lbs.)	340	350

*All ANSI flanges are 300 lb.

SPECIFICATION FIELDS

Packing Arrangement	Inlet pressure above atmospheric	Standard	A
	Atmospheric inlet or vacuum service	No charge option	B
Crankcase Style	Extended crankshaft	Charge option	E
	Pressure lubricated crankcase	Standard	M
	Std. crankcase with crankcase heater	Charge option	MH
	Std. crankcase with cylinder lubricator	Charge option	L
Valves	Standard valves with PEEK valve plates	Standard	4P
	Reverse unloaders and PEEK valve plates	Charge option	6P
Piston Ring and Packing Material	PTFE piston ring and packing material	Standard	F
	Same as F w/the addition of K-Ring spacers	Charge option	FK
	Alloy 50 piston rings and packing material	Charge option	G
	Same as G w/the addition of K-Ring spacers	Charge option	GK
	PEEK piston ring and Alloy 50 packing material	Charge option	H
	Same as H w/the addition of K-Ring spacers	Charge option	HK
Gasket Material	Aluminum gasket material	No charge option	B
	Copper gasket material	No charge option	C
	Iron-lead gasket material	Standard	D
O-ring Material	Buna-N	Standard	A
	Neoprene®	No charge option	B
	Viton®	Charge option	D
	PTFE	Charge option	E
	High pressure Viton®	Charge option	J
Intercooler	Intercooler not provided	Standard	F
Flywheel	14″ flywheel for extended crankshaft	No charge option	E
	Heavy duty flywheel	Charge option	H
	No flywheel supplied	No charge option	N
	Standard flywheel	Standard	S
Protective Coating	Coated cylinder only	Charge option	C
	No coating	Standard	N
	Coating on all necessary wetted parts	Charge option	W
Piston Rod	Nitrotec® piston rod coating	Standard	N

NA = Not Available NC = No Charge

Neoprene® and Viton® are registered trademarks of DuPont
Nitrotec® is a registered trademark of TTI Group Ltd.

Appendix A—Model Number Identification Code—D/WD391

MODEL NUMBER

BASE X X X X X X X X X X

BASE MODEL NUMBER	D391	WD391
Inlet	1" NPT	1" NPT
Outlet	¾" NPT	¾" NPT
Intercooler connection	1" NPT	1" NPT
Ship weight (lbs.)	340	350

SPECIFICATION FIELDS

Packing Arrangement	Inlet pressure above atmospheric	Standard	Standard	A
	Atmospheric inlet or vacuum service	Optional	Optional	B
Crankcase Style	Extended crankshaft	Optional	Optional	E
	Pressure lubricated crankcase	Standard	Standard	M
	Std. crankcase with crankcase heater	Optional	Optional	MH
	Std. crankcase with cylinder lubricator	Optional	Optional	L**
Valves	Liquid relief suction valves	Optional	Optional	3
	Standard suction and discharge valves	Standard	Standard	4
	Loadless start through suction valve unloaders and hydraulic unloader	Optional	Optional	7(a)
	Constant speed unloading through suction valve unloaders and pilot valve	Optional	Optional	8(b)
	Combination control: Loadless starting and constant speed unloading	Optional	Optional	78(a)(b)
	Suction valve unloaders	Optional	Optional	9
	Spec 3 valves with MC1002 corrosion resistant coating	Optional	Optional	3C*
	Spec 4 valves with MC1002 corrosion resistant coating	Optional	Optional	4C*
	Spec 9 valves with MC1002 corrosion resistant coating	Optional	Optional	9C*
Piston Ring and Packing Material	PTFE piston ring and packing material	Standard	Standard	F
	Same as F w/the addition of K-Ring spacers	Optional	Optional	FK
	Alloy 50 piston rings and packing material	Optional	Optional	G
	Same as G w/the addition of K-Ring spacers	Optional	Optional	GK
	PEEK piston ring and Alloy 50 packing material	Optional	Optional	H
	Same as H w/the addition of K-Ring spacers	Optional	Optional	HK
Gasket Material	Aluminum gasket material	Standard	Standard	B
	Copper gasket material	Optional	Optional	C
	Iron-lead gasket material	Optional	Optional	D
O-ring Material	Buna-N	Standard	Standard	A
	Neoprene®	Optional	Optional	B
	Viton®	Optional	Optional	D
	PTFE	Optional	Optional	E
Intercooler Connections	Air-cooled steel (rated for 325 psi)	Standard	NA	A
	Water-cooled brass (rated for 150 psi)	Optional	Standard	C
	Water-cooled stainless steel (rated for 150 psi)	Optional	Optional	D
	Heavy duty air cooled copper (rated for 250 psi)	Optional	Optional	E
	NPT flanges only, no intercooler	Optional	Optional	F
	Cooling loop - copper	Optional	NA	G
	Cooling loop - stainless steel	Optional	NA	H
Flywheel	14″ flywheel for extended crankshaft	Optional	Optional	E
	Heavy duty flywheel	Optional	Optional	H
	No flywheel supplied	Optional	Optional	N
	Standard flywheel	Standard	Standard	S
Protective Coating	Coated cylinder only	Optional	Optional	C
	No coating	Standard	Standard	N
	Coating on all necessary wetted parts	Optional	Optional	W*
Piston Rod Coating	Chrome oxide piston rod coating	Optional	Optional	C
	Nitrotec® piston rod coating	Standard	Standard	N

*Must select protective coating option “W” when selecting valve option “3C”, “4C”, or “9C’
** Not compatible with intercooler specification A
(a) 1 = up to 200 psi or 2 = above 200 psi
(b) 1 = 30 to 70 psi or 2 = 71 to 150 psi or 3 = 151 to 500 psi
NA = Not Available NC = No Charge
Neoprene® and Viton® are registered trademarks of DuPont

Nitrotec® is a registered trademark of TTI Group Ltd.

Appendix A—Model Number Identification Code—FD/WFD391

MODEL NUMBER

BASE X X X X X X X X X X

BASE MODEL NUMBER	FD391	WFD391
Inlet	1" ANSI (300#)	1" ANSI (300#)
Outlet	1" ANSI (300#)	1" ANSI (300#)
Intercooler connection	1" ANSI (300#)	1" ANSI (300#)
Ship weight (lbs.)	340	350

SPECIFICATION FIELDS

Packing Arrangement	Inlet pressure above atmospheric	Standard	Standard	A
	Atmospheric inlet or vacuum service	Optional	Optional	B
Crankcase Style	Extended crankshaft	Optional	Optional	E
	Pressure lubricated crankcase	Standard	Standard	M
	Std. crankcase with crankcase heater	Optional	Optional	MH
	Std. crankcase with cylinder lubricator	Optional	Optional	L
Valves	Liquid relief suction valves	Optional	Optional	3
	Standard suction and discharge valves	Standard	Standard	4
	Loadless start through suction valve unloaders and hydraulic unloader	Optional	Optional	7(a)
	Constant speed unloading through suction valve unloaders and pilot valve	Optional	Optional	8(b)
	Combination control: Loadless starting and constant speed unloading	Optional	Optional	78(a)(b)
	Suction valve unloaders	Optional	Optional	9
	Spec 3 valves with MC1002 corrosion resistant coating	Optional	Optional	3C*
	Spec 4 valves with MC1002 corrosion resistant coating	Optional	Optional	4C*
	Spec 9 valves with MC1002 corrosion resistant coating	Optional	Optional	9C*
Piston Ring and Packing Material	PTFE piston ring and packing material	Standard	Standard	F
	Same as F w/the addition of K-Ring spacers	Optional	Optional	FK
	Alloy 50 piston rings and packing material	Optional	Optional	G
	Same as G w/the addition of K-Ring spacers	Optional	Optional	GK
	PEEK piston ring and Alloy 50 packing material	Optional	Optional	H
	Same as H w/the addition of K-Ring spacers	Optional	Optional	HK
Gasket Material	Aluminum gasket material	Standard	Standard	B
	Copper gasket material	Optional	Optional	C
	Iron-lead gasket material	Optional	Optional	D
O-ring Material	Buna-N	Standard	Standard	A
	Neoprene®	Optional	Optional	B
	Viton®	Optional	Optional	D
	PTFE	Optional	Optional	E
Intercooler	No intercooler provided	Standard	Standard	F
Flywheel	14″ flywheel for extended crankshaft	Optional	Optional	E
	Heavy duty flywheel	Optional	Optional	H
	No flywheel supplied	Optional	Optional	N
	Standard flywheel	Standard	Standard	S
Protective Coating	Coated cylinder only	Optional	Optional	C
	No coating	Standard	Standard	N
	Coating on all necessary wetted parts	Optional	Optional	W*
Piston Rod Coating	Chrome oxide piston rod coating	Optional	Optional	C
	Nitrotec® piston rod coating	Standard	Standard	N

*Must select protective coating option “W” when selecting valve option “3C”, “4C”, or “9C’
(a) 1 = up to 200 psi or 2 = above 200 psi
(b) 1 = 30 to 70 psi or 2 = 71 to 150 psi or 3 = 151 to 500 psi
NA = Not Available NC = No Charge
Neoprene® and Viton® are registered trademarks of DuPont
Nitrotec® is registered trademark of TTI Group Ltd.

Appendix B—Material Specifications for All D-Style Models 351 and 391

Part	Model No.	Standard Material	Optional Material
Head, cylinder	351	Ductile iron ASTM A536	MC1002 coated
	391	Ductile iron ASTM A536	MC1002 coated
Crosshead guide, crankcase, flywheel, bearing carrier	351, 391	Gray iron ASTM A48, Class 30	
Valve seat & bumper	351	17-4 PH stainless steel	
	391	Ductile iron ASTM A536	
Valve plate	351	PEEK	
	391	17-7 PH stainless steel	
Valve spring	351	17-7 PH stainless steel	
	391	Inconel	
Valve gaskets	351	Iron-lead	Copper, aluminum
	391	Soft aluminum	Copper, iron-lead
Unloader body & spring cap	351		
Unloader cap	391		
Unloader spring	351, 391		
Unloader piston	351, 391		
Unloader actuator	351, 391		
Piston & piston platform	351, 391	1st stage: Gray iron ASTM A48, class 30	
	351	2nd stage: 17-7 PH stainless steel	
	391	2nd stage: Gray iron ASTM A48, Class 30	
Piston rod	351, 391	C1050 steel Nitrotec coated	Chrome oxide (391 only)
Crosshead	351, 391	Gray iron ASTM 48, Class 30	
Piston rings	351	1st stage: PTFE, glass & molly filled	Alloy 50
		2nd stage: PTFE, glass & molly filled	PEEK
	391	1st & 2nd stage: PTFE, glass & molly filled	Alloy 50, PEEK
Ring expanders	351, 391	302 stainless steel	
Head gasket (O-ring)	351, 391	Buna-N	PTFE, Viton®[1], Neoprene®[1]
Packing cartridge, connecting rod	351, 391	Ductile iron ASTM A536	
Packing rings	351, 391	PTFE, glass and moly filled	Alloy 50
Crankshaft	351, 391	Ductile iron ASTM A536	
Con. rod bearing	351, 391	Bimetal D-2 Babbit	
Wrist pin	351, 391	C1018 steel	
Wrist pin busing	351, 391	Bronze SAE 660	
Main bearing	351, 391	Tapered roller	
Inspection plate	351, 391	Aluminum	
O-rings	351, 391	Buna-N	PTFE, Viton®[1], Neoprene®[1]
Retainer rings	351, 391	Steel	
Misc. gaskets	351, 391	Rubber compositions	

[1] Viton® and Neoprene® are registered trademarks of the DuPont company.

Appendix B—Mechanical Specifications for All D-Style Models 351 and 391

Mechanical Specifications

Specification	All Models 351	All Models 391
Bore of cylinder, inches (mm)		
first stage	2.75 (69.9)	4.5 (114.3)
second stage	1.75 (44.5)	2.5 (63.5)
Stroke, inches (mm)	3.0 (76.2)	3.0 (76.2)
Piston displacement, cfm (m^3/hr)		
minimum @ 400 RPM	4.1 (7.0)	11.0 (18.8)
maximum @ 825 RPM	8.5 (14.5)	22.8 (38.7)
Maximum working pressure, psig (bar g)	1,200 (82.8)	625 (43.1)
Maximum brake horsepower, kW	15 (11)	15 (11)
Maximum rod load, lb (kg)	4,000 (1,814)	4,000 (1,814)
Maximum outlet temperature °F (°C)	350 (177)	350 (177)
Approximate bare unit weight, lb (kg)	340 (154)	350 (158.8)

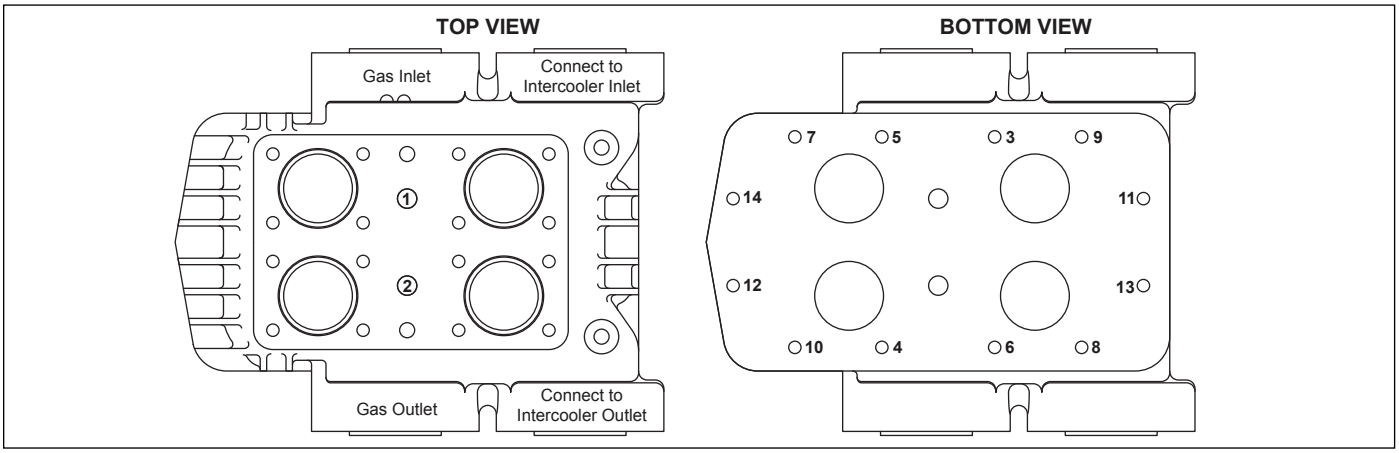
Bolt Torque Values

Connecting rod bolt	30 ft•lb
Bearing carrier	25 ft•lb
Bearing cover	35 ft•lb
Crankcase inspection plate	10 ft•lb
Crosshead guide	30 ft•lb
Cylinder to head[1,2]	30 ft•lb
Valve cover plate bolt	35 ft•lb
Valve holddown screw[2]	40 ft•lb
Piston locknut	45 ft•lb
Socket head piston screw	100 in•lb
Valve / unloader cap (w/ O-rings)	25 ft•lb
2nd stage piston (351 only)	15 ft•lb

[1]Preliminary tightening: Snug all head bolts in the sequence shown below. Final torque: Torque all head bolts in the sequence shown to the listed value.

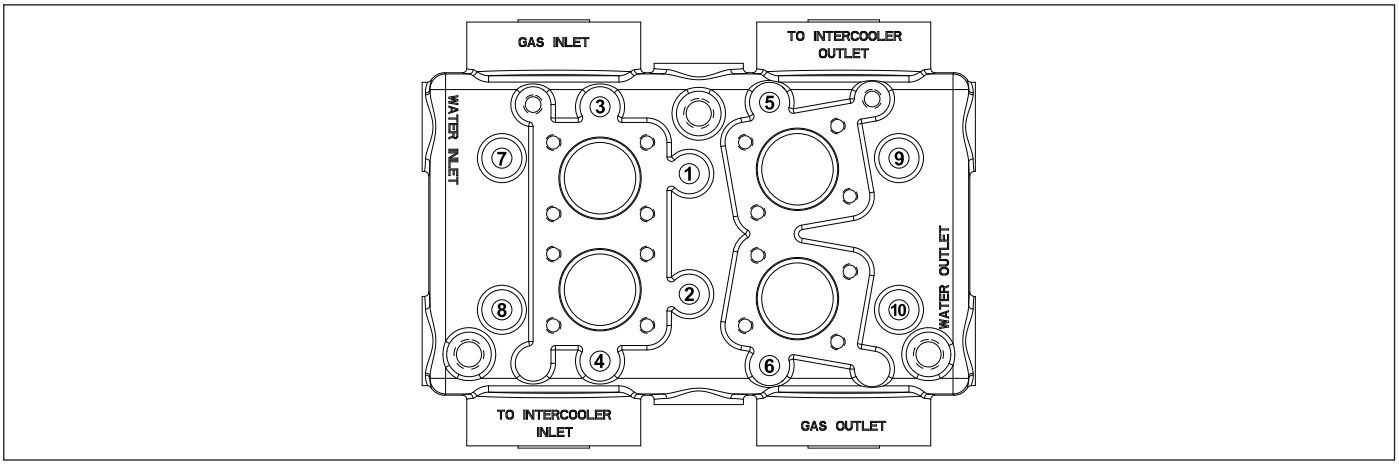
[2]Re-torque to the value listed above after 2 to 5 hours of running time.

Head Bolt Torque Sequence for All Air-cooled Models FD351, D391, and FD391



Note: Torque bolts in the sequence shown above. Two bolts are inserted through the top of the head while the remaining bolts are inserted through the bottom.

Head Bolt Torque Sequence for All Water-cooled Models WFD351, WD391, and WFD391



Note: Torque head bolts in the sequence shown above. All bolts are inserted through the top of the head.

Appendix B—Mechanical Specifications for All D-Style Models 351 and 391

Clearances and Dimensions

Description	351		391	
	1st Stage	2nd Stage	1st Stage	2nd Stage
Clearance: Conrod bearing to crankshaft journal	0.0005 to 0.0025		0.0005 to 0.0025	
Clearance: Wrist pin to wrist pin bushing* (max)	0.0009		0.0009	
Cylinder bore diameter (max)	2.754	1.753	4.506	2.504
Cylinder finish (RMS)	16–32		16–32	
Piston ring radial thickness (min)	0.090	0.082	0.093	0.082
Clearance: Oil pump adapter shaft to bushing* (max)	0.0050		0.0050	
Crankshaft end play (cold)	0.000 0.002		0.000 0.002	
Flywheel runout at O.D. (max)	0.020		0.020	
Clearance: Crosshead to crosshead guide bore (max)	0.011		0.011	
Crosshead guide bore finish (max)	32 RMS (Limited number of small pits and scratches are acceptable)		32 RMS (Limited number of small pits and scratches are acceptable)	

**Dimensions for honing are included with new bushings (install bushings before honing).*

Piston Clearance 'X' (Cold)[a] Specifications

"X" Inches (Millimeter)	
Minimum	**Maximum**
0.025 (0.64)	0.049 (1.24)

[a] The distance from the bottom of the head to the top of the piston.

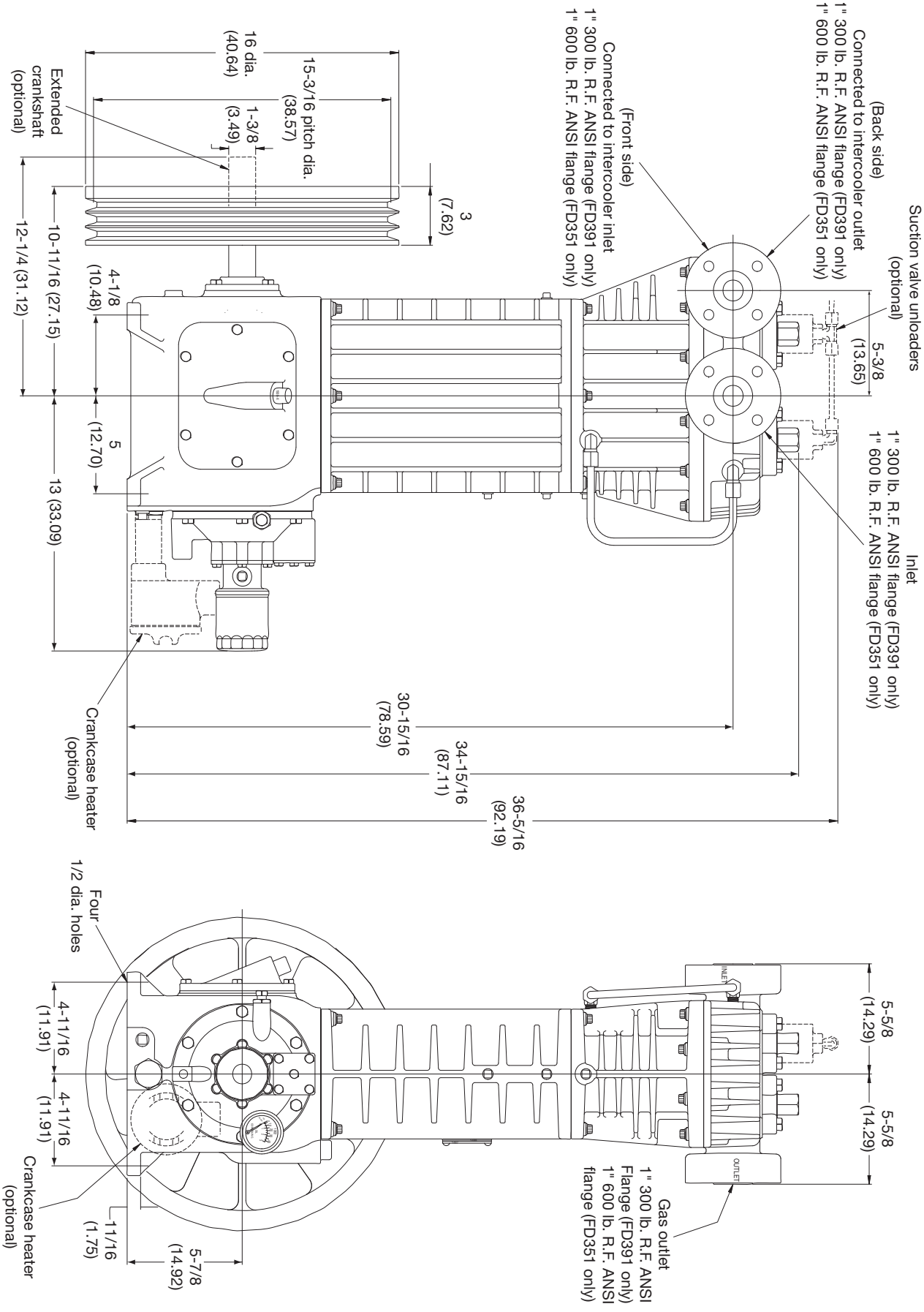
WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Distance Piece Connections and Piston Rod Packing Orientation

Model	Packing Arrangement	Conditions	Service	Distance Piece Opening, 1/4" NPT		V-Rings Point	
				Upper	Lower	Upper	Lower
All models 351 and 391	Specification A	Inlet pressure: above 15 psia	1) General gas transfer	Plugged to allow the distance piece pressure to reach its own level.	Pipe to drain or vent with a shut-off valve. Distance piece must be drained weekly to prevent an accumulation of oil or condensate.	Spring 	Spring 
			2) Highly toxic gases	Pressurized via an external gas source to a pressure below suction pressure and above atmospheric pressure. Or, vented to atmospheric pressure (at a suitable location) or to a low pressure flare.			
All models 351 and 391	Specification B	Inlet pressure: below atmosphere (vacuum)	1) General gas transfer	Tube to second stage inlet.		Spring 	Spring 
			2) Highly toxic gases	Pressurized via an external gas source to a pressure above suction pressure and above atmospheric pressure.			

Appendix C—Outline Dimensions

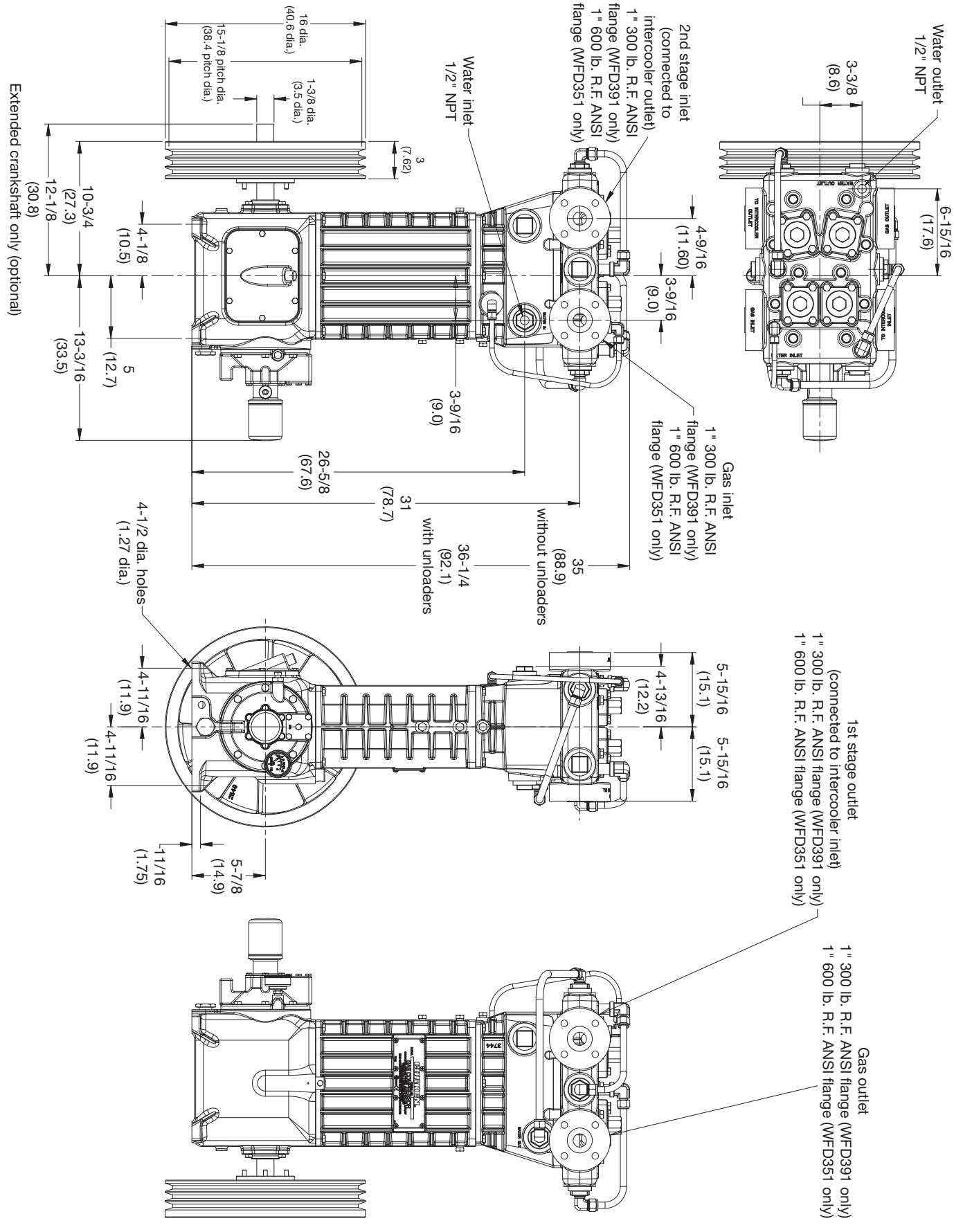
Model FD351 and FD391 Bare Compressor with Flywheel



Inches (Centimeters)

Appendix C—Outline Dimensions

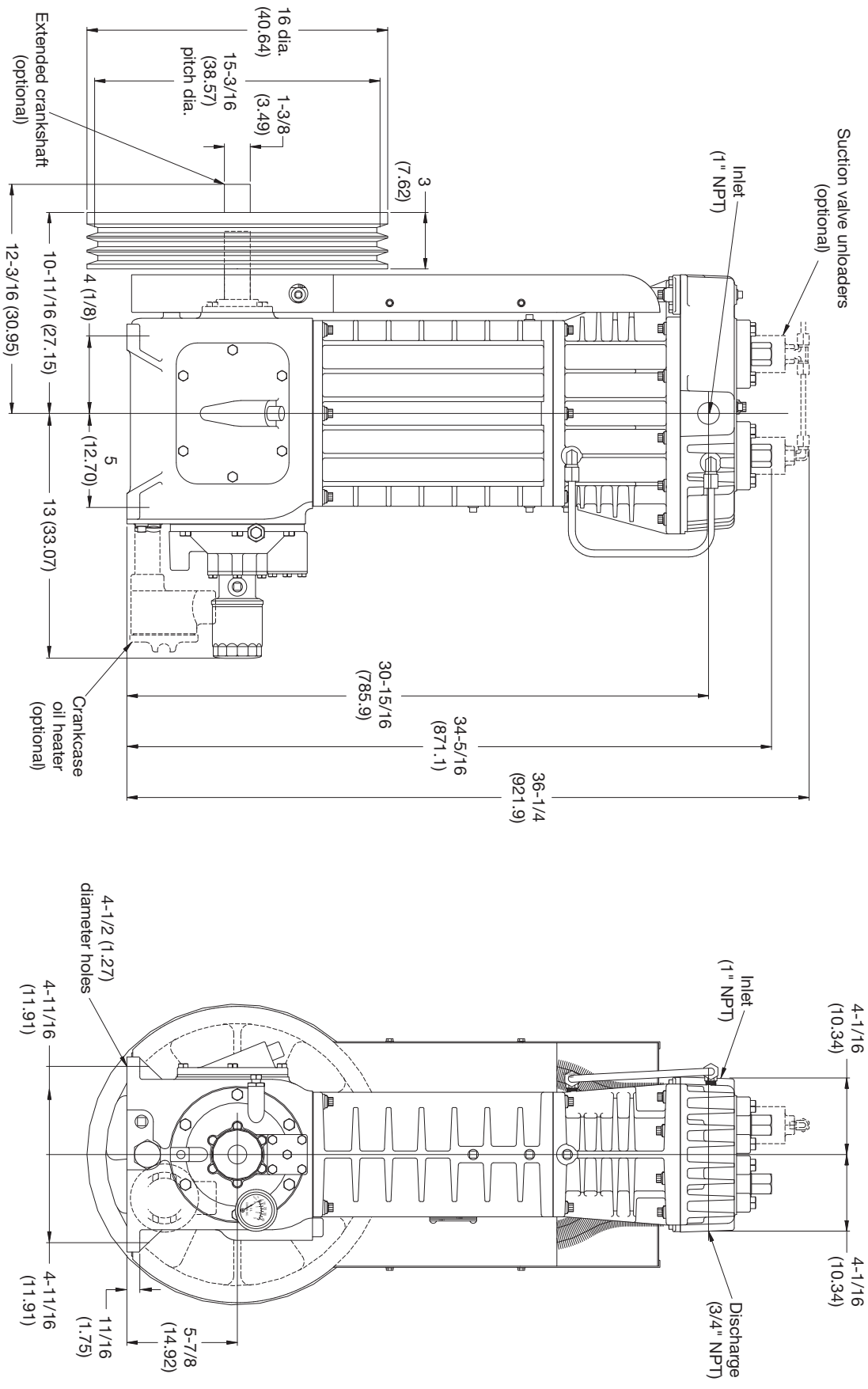
Model WFD351 and WFD391 Bare Compressor with Flywheel



Inches (Centimeters)

Appendix C—Outline Dimensions

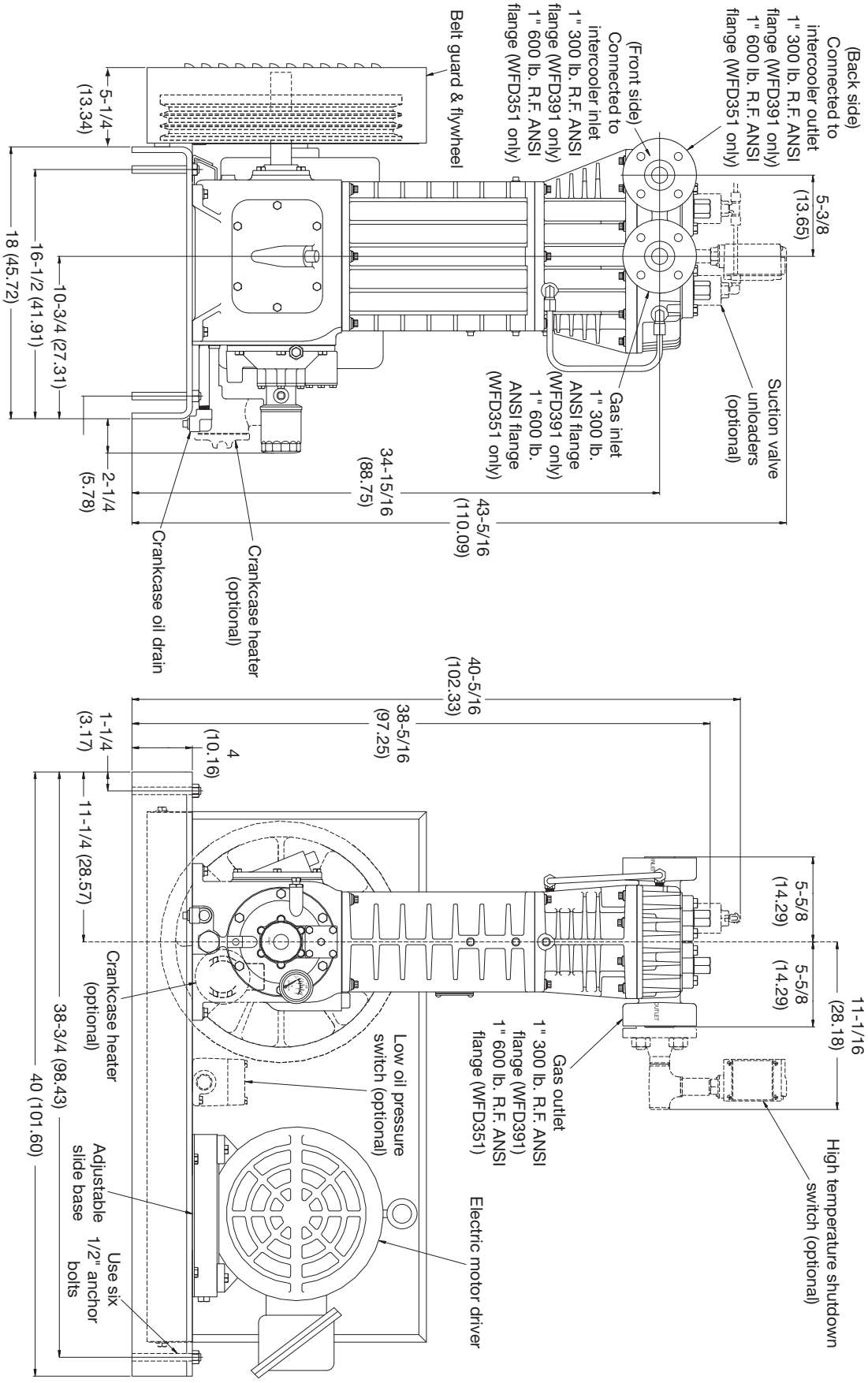
Model D391 Bare Compressor with Flywheel



Inches (Centimeters)

Appendix C—Outline Dimensions

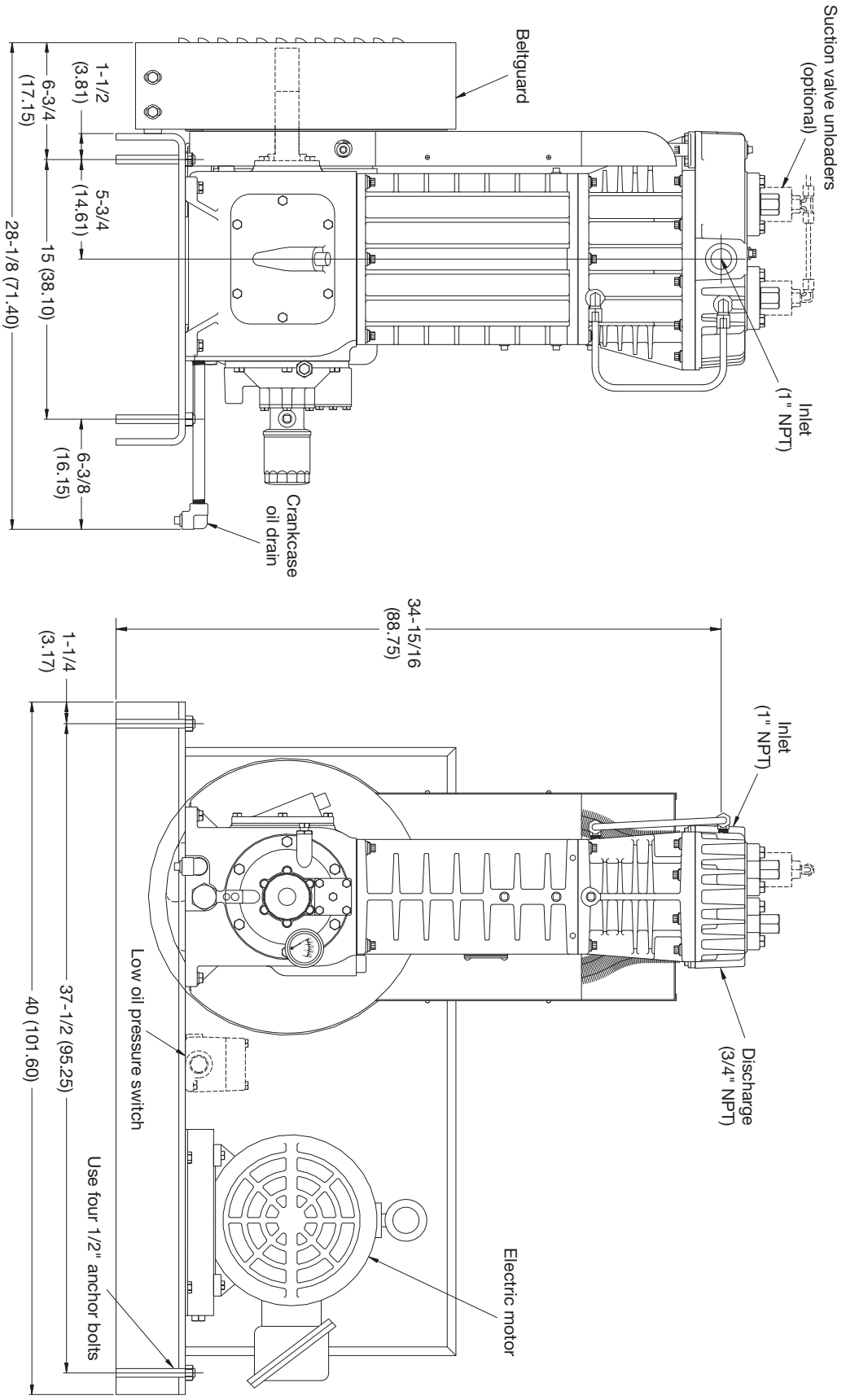
Model FD351 and FD391 with 103 Mounting



Inches (Centimeters)

Appendix C—Outline Dimensions

Model D391 with 103 Mounting



Inches (Centimeters)

Appendix D—Troubleshooting

In most cases, problems with your Corken gas compressor can be solved quite simply. This chart lists some of the more frequent problems that occur with reciprocating compressors along with a list of possible causes. If you are having a problem which is not listed, or if you cannot find the source of the problem, consult the factory.

Problem	Possible Cause
Low capacity	1, 2, 3, 4, 8, 15, 17
Overheating	1, 2, 3, 5, 6, 11, 16
Knocks, rattles and noise	1, 7, 9, 10, 11, 15
Oil in cylinder	8, 12, 15
Abnormal piston-ring wear	1, 3, 5, 6, 11, 15, 16
Product leaking through crankcase breather	8, 15
Product leakage	4, 8, 15, 17
Oil leakage around compressor base	17, 18, 19, 20
No oil pressure	19, 20
Excessive vibration	1, 7, 9, 10, 11, 13, 14, 28
Motor overheating or starter tripping out	21, 22, 23, 24, 25, 26, 27, 28

Ref.	Possible Causes	What To Do
1.	Valves broken, stuck or leaking	Inspect and clean or repair
2.	Piston ring worn	Inspect and replace as necessary
3.	Inlet strainer clogged	Clean or replace screen as necessary
4.	Leaks in piping	Inspect and repair
5.	Inlet or ambient temperature too high	Consult factory
6.	Compression ratio too high	Check application and consult factory
7.	Loose flywheel or belt	Tighten
8.	Worn piston-rod packing	Replace
9.	Worn wrist-pin or wrist-pin bushing	Replace
10.	Worn connecting-rod bearing	Replace
11.	Unbalanced load	Inspect valve or consult factory
12.	Oil in distance piece	Tighten packing nut — drain weekly
13.	Inadequate compressor base	Strengthen, replace or grout
14.	Improper foundation or mounting	Tighten mounting or rebuild foundation
15.	Loose valve, piston or packing	Tighten or replace as necessary
16.	Dirty cooling fins	Clean weekly
17.	4-way control valve not lubricated	Inspect and lubricate
18.	Leaking gas blowing oil from crankcase	Tighten packing
19.	Bad oil seal	Replace
20.	No oil in crankcase	Add oil
21.	Oil-pump malfunction	See oil pressure adjustment
22.	Low voltage	Check line voltage with motor nameplate. Consult power company
23.	Motor wired wrong	Check wiring diagram
24.	Wire size too small for length of run	Replace with correct size
25.	Wrong power characteristics	Voltage, phase and frequency must coincide with motor nameplate. Consult with power company.
26.	Wrong size of heaters in starter	Check and replace according to manufacturer's instructions
27.	Compressor overloading	Reduce speed
28.	Motor shorted out	See driver installation
29.	Bad motor bearing	Lubricate according to manufacturer's instructions

Two-Stage Compressor Troubleshooting

Two-stage compressors can have problems that never occur with single-stage machines. Interstage pressure is an important indicator of the condition of a two-stage compressor.

If interstage pressure is too high:

1. Second stage valves may be broken or leaking.
2. Second stage piston rings may be worn.

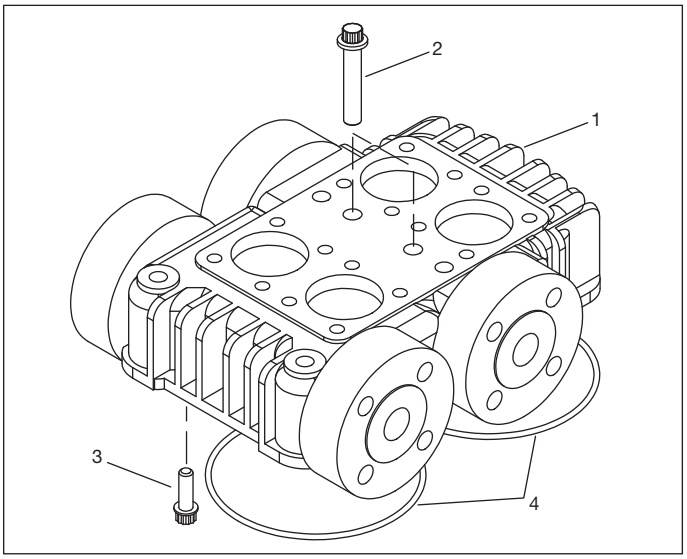
If interstage pressure is too low:

1. First stage valves may be broken or leaking.
2. First stage piston rings may be worn.

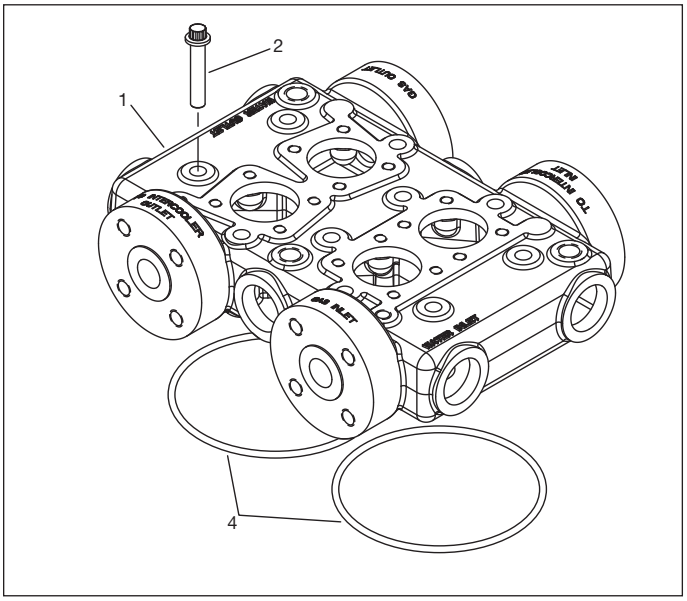
Another cause for high interstage pressure is a low compression ratio. Two-stage machines should not be used in applications where the compression ratio is below 5. To use two-stage compressors in this kind of situation results in rapid ring wear, machine imbalance and excessive horsepower. If you think you have a problem in this area, consult factory.

Appendix E—Head and Valve Assembly Details—All D-Style Models 351

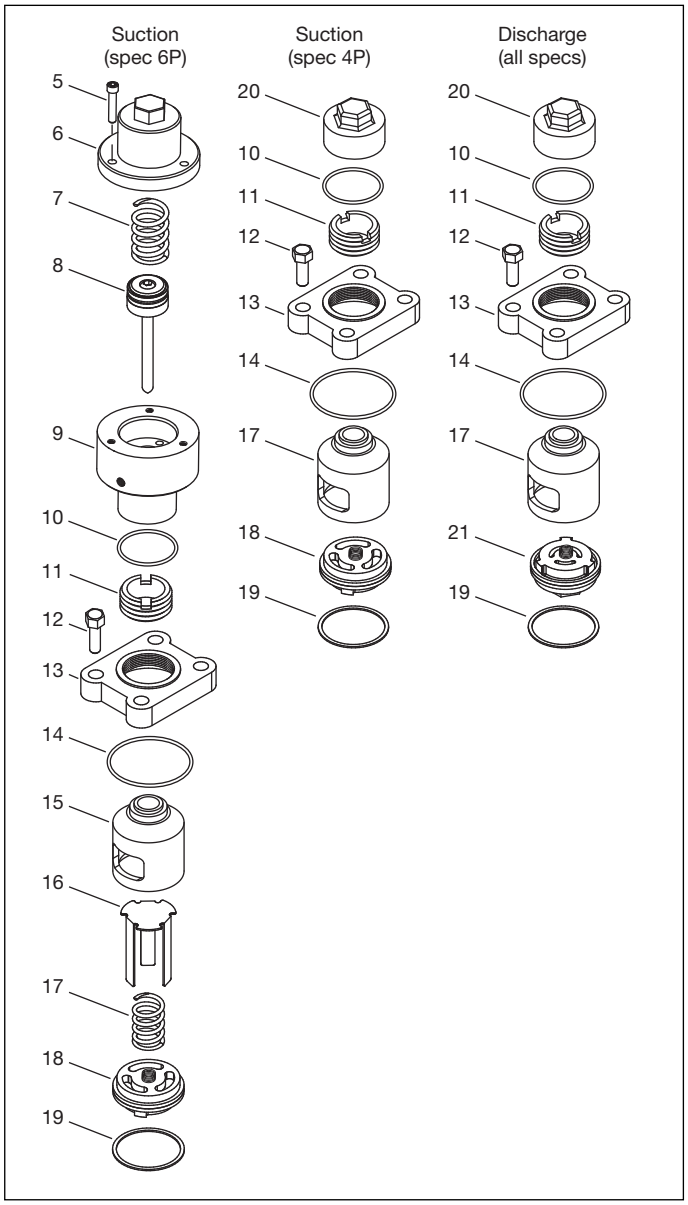
FD Head



WFD Head

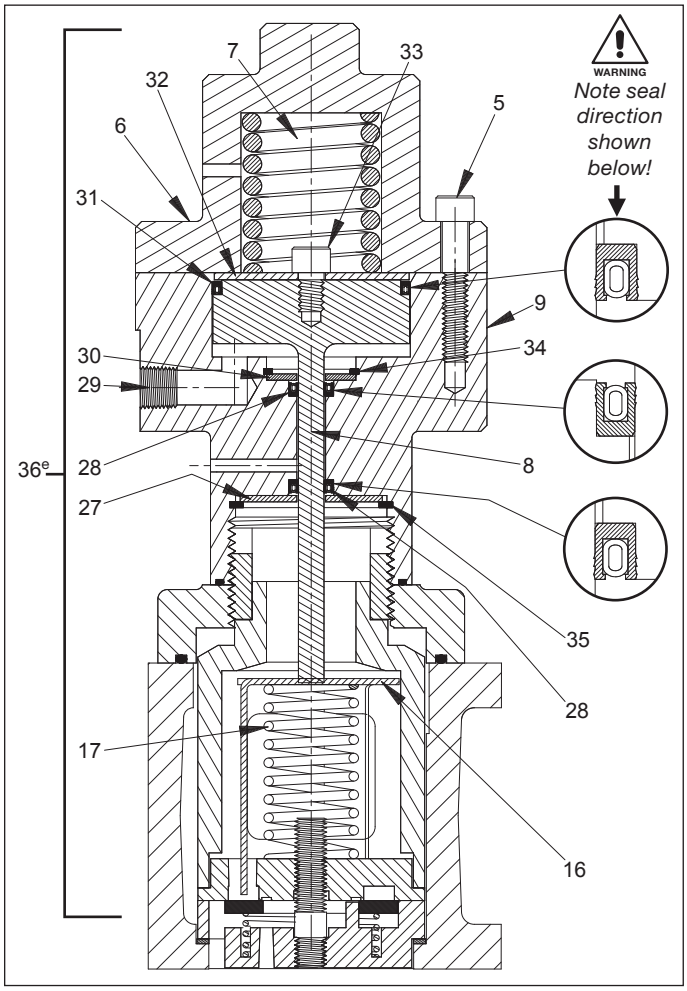


Valve Holddown Assemblies

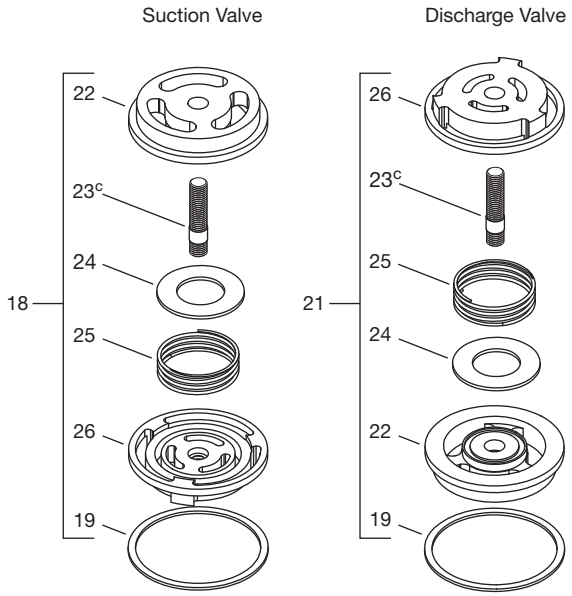


Appendix E—Head and Valve Assembly Details—All D-Style Models 351

Unloader Assembly (5320-X1[e])



Valve Assemblies



NOTE: A small amount of Loctite #263 should be applied around the complete circumference of the valve stud (part number 3920) before final assembly.

Head and Valve Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1	4366	Head—FD351	1
	4372-3	Head—WFD351	1
2	1647	Center head bolt—FD351 only	2
		Head bolt—WFD351 only	10
3	7005-043NC150A	Head bolt—FD351 only	12
4	2-253_[a]	O-ring—1st stage & 2nd stage (FD351 only)	2
	2-253_[a]	O-ring—2nd stage (WFD351 only)	1
	2-256_[a]	O-ring—1st stage (WFD351 only)	1
5.	7002-025TP125A[f]	Socket head 1/4"-20 x 1-1/4"	6
6.	5275[f]	Unloader body cap (spec 6P)	2
7.	5277[f]	Unloader spring (spec 6P)	2
8.	5273	Unloader piston (spec 6P)	2
9.	5345[f]	Unloader body (spec 6P)	2
10.	2-031_[a]	O-ring	4
11.	2715	Valve hold-down screw	4
12.	7001-043NC125A	Hex head 7/16-14 x 1-1/4"	16
13.	2205	Cover plate (3-1/4)	4
14.	2-143_[a]	O-ring	4
15.	5319	Valve cage	4
16.	5320[f]	Unloader actuator (spec 6P)	2
17.	5277[f]	Unloader spring (spec 6P)	2
18.	5311-3X_[d]	Suction valve assembly	2
19.	1418-2	Valve gasket (iron-lead standard)	4
	1418-1	Valve gasket (copper optional)	4
	1418	Valve gasket (aluminum optional)	4
20.	2714-1	Valve cap (spec 4P and discharge)	4
21.	5318-3X_[d]	Discharge valve assembly	2
22.	5311	Valve seat	4
23.	3920[c]	Valve stud	4
24.	5312	Valve plate	4
25.	5313	Valve spring	4
26.	5318-3	Valve bumper	4
27.	5281[f]	Unloader washer	1
28.	5278-X[f]	Piston seal assembly	2
29.	2590[f]	Pipe plug 1/8" NPT flush	1
30.	5280[f]	Unloader washer	1
31.	5279-X[f]	Piston seal assembly	1
32.	5272[f]	Unloader piston cap	1
33.	7002-025NC037A[f]	Bolt 1/4-20 soc. button hd	1
34.	5000-87SS[f]	Retainer ring	1
35.	5000-150SS[f]	Retainer ring	1
36.	5320-X1[e]	Unloader assembly	1

O-ring Code	
A	Buna-N
B	Neoprene®[b]
D	Viton®[b]
E	PTFE
K	Kalrez®[b]

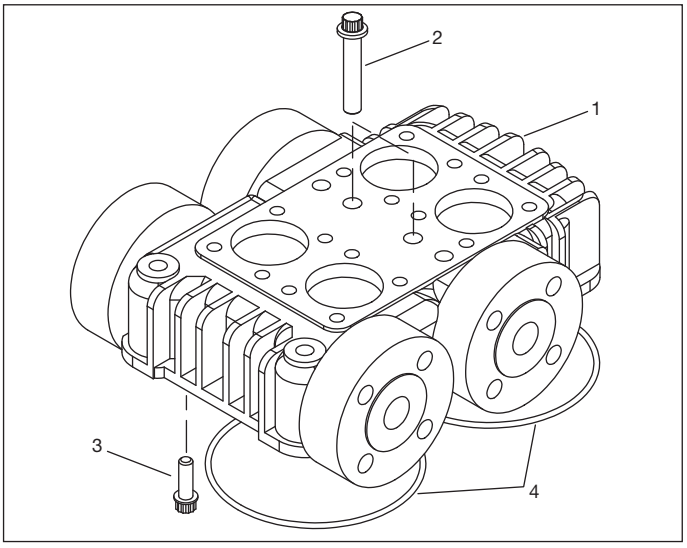
Gasket Material Code	
	Aluminum
1	Copper
2	Iron-lead

[a] _ denotes O-ring code. See O-ring chart for details.
[b] Registered trademark of the DuPont company.
[c] Apply Loctite #263 before final assembly.
[d] _ denotes gasket material.
[e] Only the numbered items are included in the assembly.
[f] Included with unloader assembly #5320-X1.

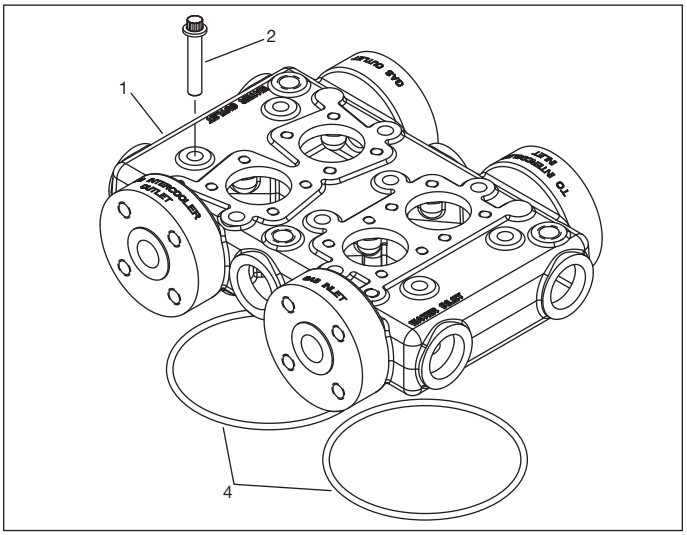
WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Appendix E—Head and Valve Assembly Details—All D-Style Models 391

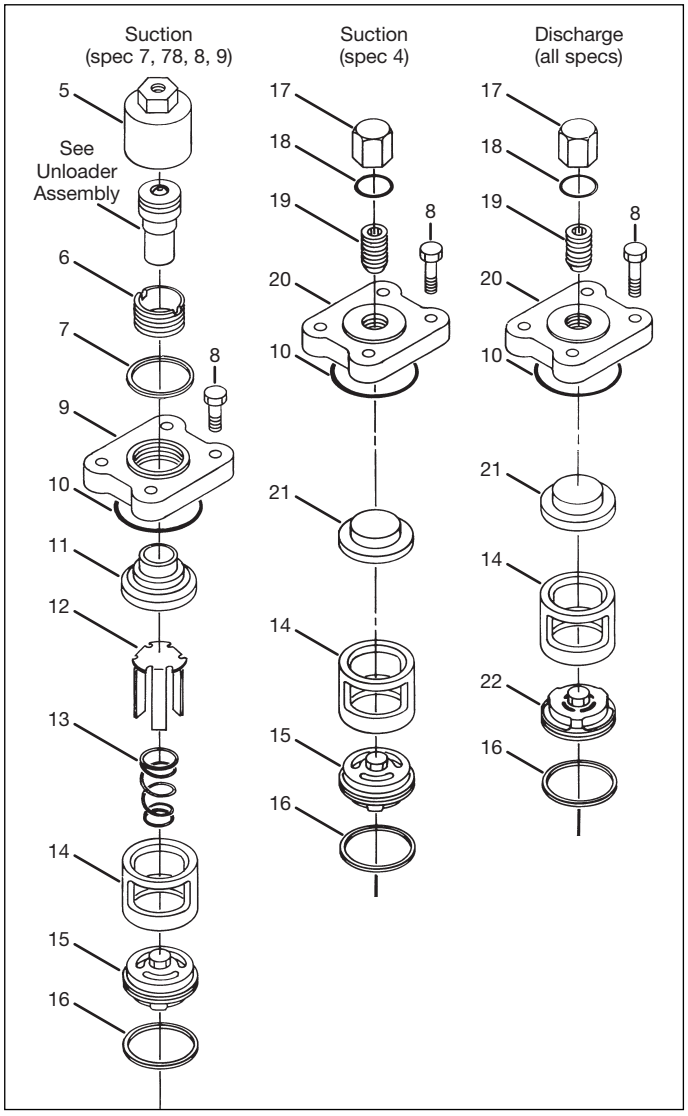
FD Head Shown Below



WFD Head Shown Below



Valve Holddown Assemblies



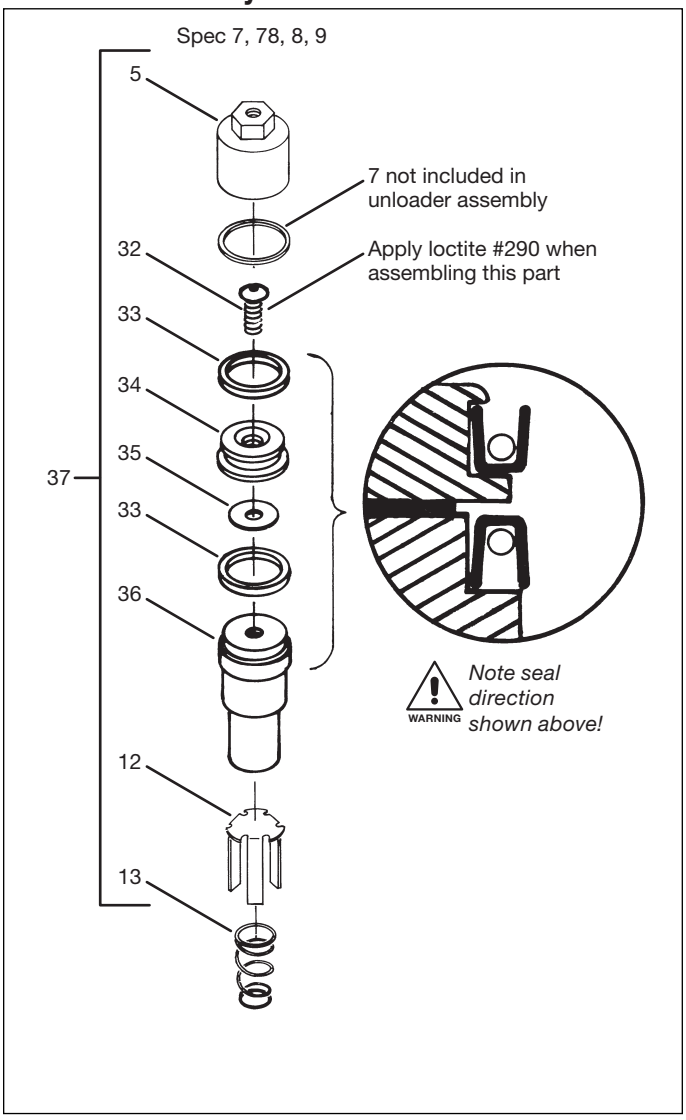
Head and Valve Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1	4159	Head—D391	1
	4366	Head—FD391	1
	3745	Head—WD391	1
	4372-3	Head—WFD391	1
2	1647	Center head bolt—D391, FD391 only	2
	1647	Head bolt—WD391, WFD391 only	10
3	7005-043NC150A	Head bolt—D391, FD391 only	12
4	2-253_[a]	O-ring—1st stage & 2nd stage (D391, FD391 only)	2
	2-253_[a]	O-ring—2nd stage (WD391, WFD391 only)	1
	2-256_[a]	O-ring—1st stage (WD391, WFD391 only)	1
5	2598-1	Unloader cap (spec 7, 78, 8, 9)	2
6	2715	Holddown screw (spec 7, 78, 8, 9)	2
7	2-031_[a]	O-ring (spec 7, 78, 8, 9)	2
8	7001-043NC125A	Bolt—7/16-14x1-1/4" hex head	16

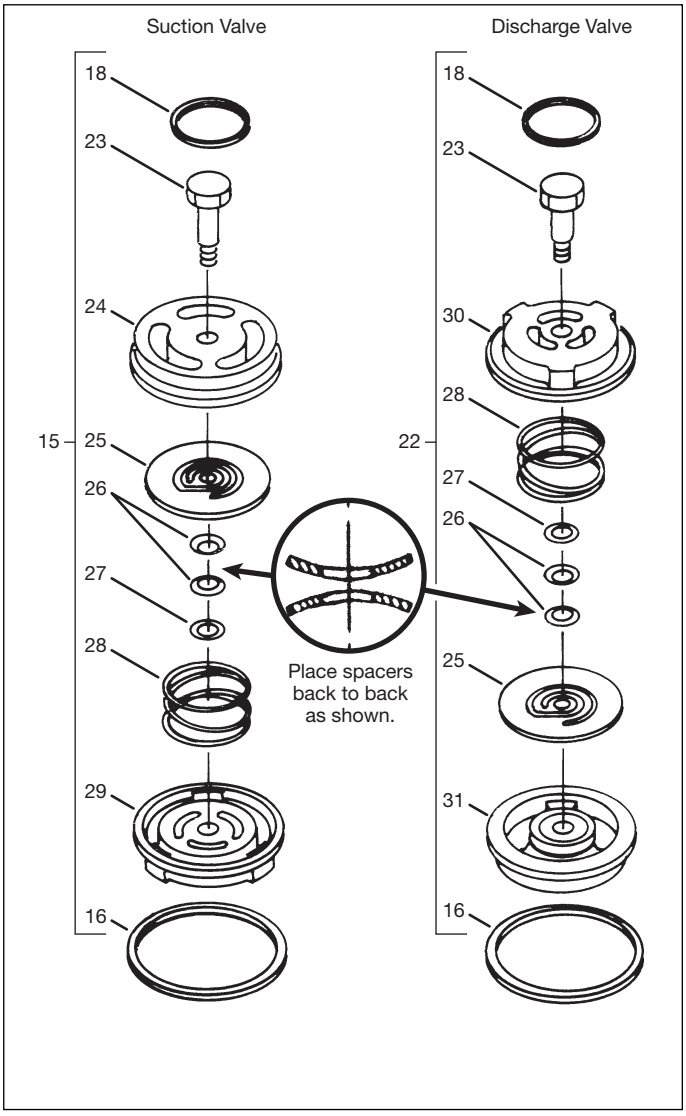
Ref No.	Part No.	Description	Qty.
9	2205	Valve cover plate (spec 7, 78, 8, 9)	2
10	2-143_[a]	O-ring	4
11	2207	Valve spacer (spec 7, 78, 8, 9)	2
12	2449	Unloader actuator (spec 7, 78, 8, 9)	2
13	2450	Unloader spring (spec 7, 78, 8, 9)	2
14	2448	Cage	4
15	2438-X	Suction valve assembly (aluminum standard)	2
	2438-X1	Same as 2438-X but with copper gaskets (optional)	2
	2438-X2	Same as 2438-X but with iron-lead gaskets (optional)	2
16	1418	Valve gasket (aluminum standard)	4
	1418-1	Valve gasket (copper optional)	4
	1418-2	Valve gasket (iron-lead optional)	4
17	1477	Valve screw nut (spec 4 and discharge)	4

Appendix E—Head and Valve Assembly Details—All D-Style Models 391

Unloader Assembly



Valve Assemblies



Ref No.	Part No.	Description	Qty.
18	1478	Gasket—steel (standard) (spec 4 and discharge)	4
	1478-1	Gasket—copper (optional) (spec 4 and discharge)	4
19	1476	Valve holddown screw (spec 4 and discharge)	4
20	1475	Valve cover plate (spec 4 and discharge)	4
21	1409	Valve spacer (spec 4 and discharge)	4
22	2439-X	Discharge valve assembly (aluminum standard)	2
	2439-X1	Same as 2439-X but with copper gaskets (optional)	2
	2439-X2	Same as 2439-X but with iron-lead gaskets (optional)	2
23	2446	Valve bolt	4
24	2438	Suction valve seat	2
25	2442	Valve plate	4
26	2445_[b]	Spacer (two per valve)	8

Ref No.	Part No.	Description	Qty.
27	3355	Washer	4
28	1407	Valve spring	4
29	2440	Suction valve bumper	2
30	2441	Discharge valve bumper	2
31	2439	Discharge valve seat	2
32	1910	Bolt (1/4-20 X 1/2 hex socket)	2
33	2619-X	Piston seal assembly	2
34	2857	Piston cap	2
35	2858	Gasket	2
36	2618	Unloader piston	2
37	2618-X	Unloader assembly	2

O-ring Code	
A	Buna-N
B	Neoprene®[c]
D	Viton®[c]
E	PTFE
K	Kalrez®[c]

[a] *_ denotes O-ring code. See O-ring chart for details.*

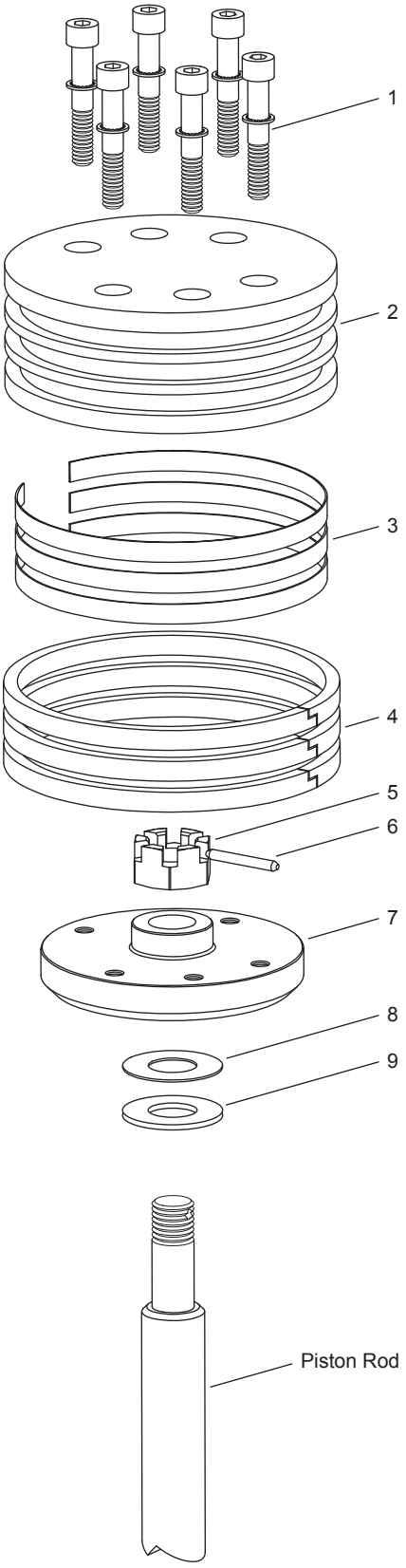
[b] *Included with valve assembly.*

[c] *Registered trademark of the DuPont company.*

WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

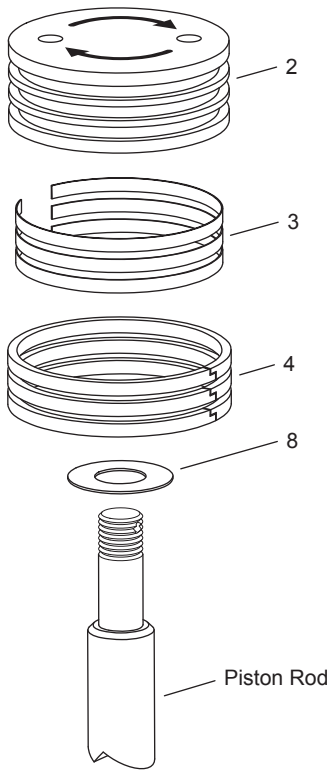
Appendix E—Piston Assembly Details—All D-Style Models 351

1st Stage



NOTE: Torque socket head screws and locknut to the value listed in Appendix B.

2nd Stage



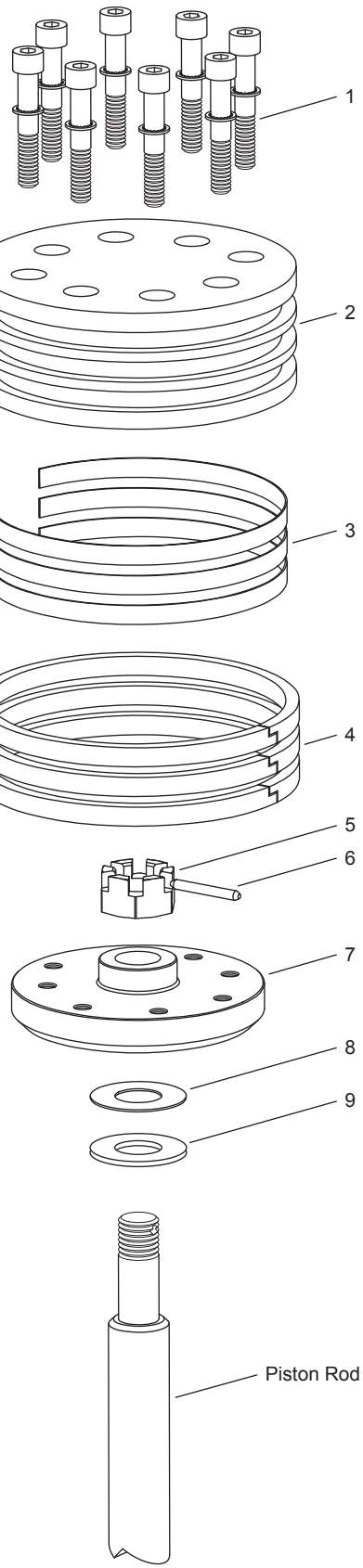
NOTE: Apply a small amount of Loctite #272 to the circumference of the 2nd stage piston rod threads and torque the piston with the spanner tool (part number 5207-X) to the value listed in Appendix B.

Piston Assembly Bill of Materials

Piston Assembly No.		**1st Stage**		**2nd Stage**	
		5305-X		**5307-X**	
Piston Diameter		**2-3/4" (6.98 cm)**		**1-3/4" (4.45 cm)**	
Ref. No.	**Part Name**	**Part No.**	**Qty.**	**Part No.**	**Qty.**
1.	Screw, sockethead	7002-008 NC125A	6	Does not apply	
	Lock washer	7207-008A	6		
2.	Piston head	5305	1	5307	1
3.	Ring expander	1774	3	2015	3
4.	Piston ring	5315—PTFE (standard)	3	1770—PTFE (standard)	3
		5315-2—Alloy 50 (optional)	3	1770-3—PEEK (optional)	3
5.	Locknut	1482	1	Does not apply	
6.	Lock pin	1483	1	Does not apply	
7.	Piston platform	5306	1	Does not apply	
8.	Shim washer, thick	1528	As req.	1378	As req.
	Shim washer, thin	1528-1			
9.	Thrust washer	1527	1	Does not apply	

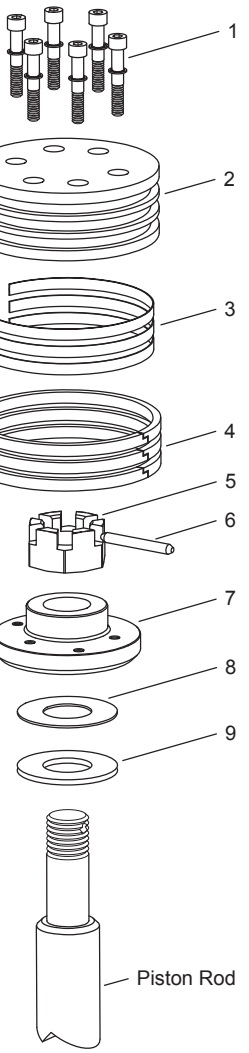
Appendix E—Piston Assembly Details—All D-Style Models 391

1st Stage



NOTE: Torque socket head screws and locknut to the value listed in Appendix B.

2nd Stage



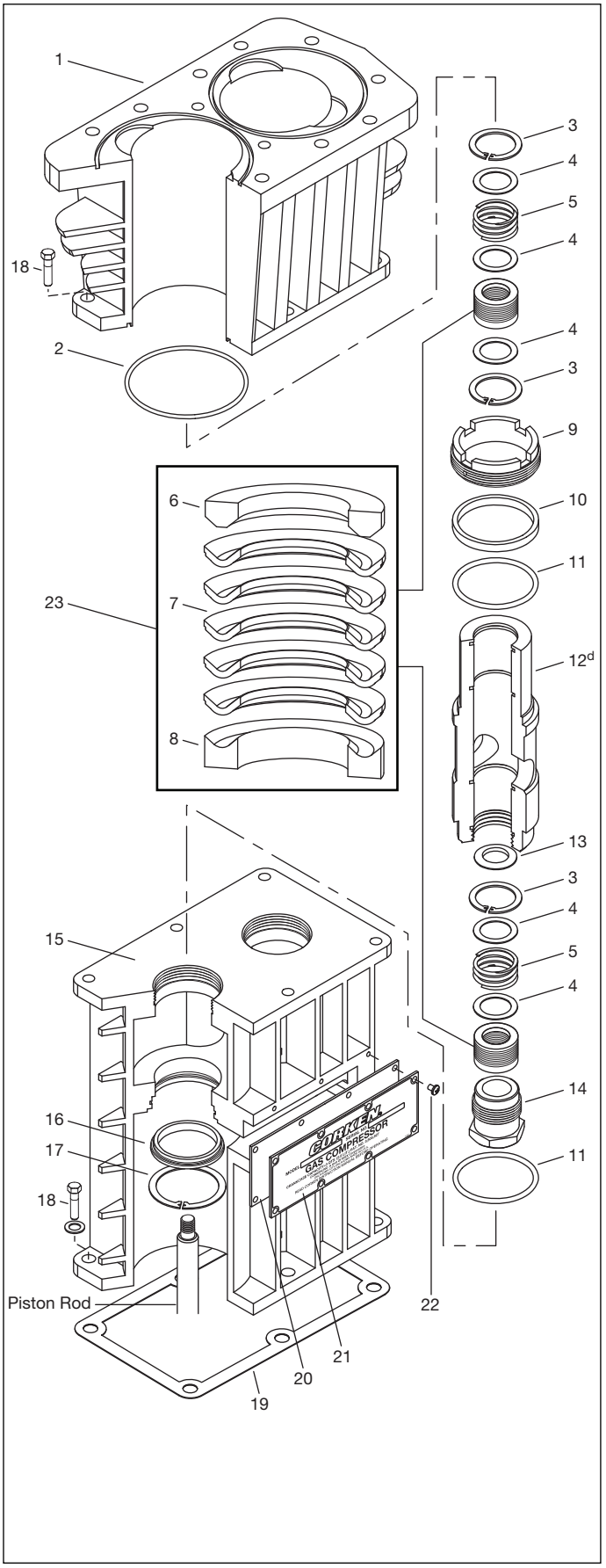
NOTE: Torque socket head screws and locknut to the value listed in Appendix B.

Piston Assembly Bill of Materials

Piston Assembly No.		1st Stage		2nd Stage	
		1987-X		1981-X	
Piston Diameter		4-1/2" (11.43 cm)		2-1/2" (6.35 cm)	
Ref. No.	Part Name	Part No.	Qty.	Part No.	Qty.
1.	Screw, sockethead	7002-025 OC125A	8	7002-008 NC125A	6
	Lock washer	7207-025A	8	7207-008A	6
2.	Piston head	1987	1	1981	1
3.	Ring expander	1740	3	1774	3
4.	Piston ring	1739—PTFE (std.)	3	1771—PTFE (std.)	3
		1739-2—Alloy 50 (opt.)	3	1771-2—Alloy 50 (opt.)	3
		1739-3—PEEK (opt.)	3	1771-3—PEEK (opt.)	3
5.	Locknut	1482	1	1482	1
6.	Lock pin	1483	1	1483	1
7.	Piston platform	1986	1	1982	1
8.	Shim washer, thick	1528	As req.	1528	As req.
	Shim washer, thin	1528-1		1528-1	
9.	Thrust washer	1527	1	1527	1

Appendix E—Packing Assembly Details—All D-Style Models 351 and 391

Packing Spec. A



Packing Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	5334	Cylinder—FD351	1
	5259	Cylinder—WFD351	1
	4160	Cylinder—D391, FD391	1
	3744	Cylinder—WD391, WFD391	1
2.	2-231_[a]	O-ring—2nd stage (all models)	1
	2-247_[a]	O-ring—1st stage (all models)	1
3.	5000-125	Retainer ring	6
4.	1714	Packing box washer	10
5.	1628	Packing spring	4
6.	1453-1	Male packing ring	4
7.	1454	Packing ring	20
8.	1452-1	Female packing ring	4
9.	2801	Cartridge holddown screw	2
10.	2778	Spacer	2
11.	2-227_[a]	O-ring	4
12.	2776[d]	Packing cartridge	2
13.	1677-1	Oil deflector ring	2
14.	1387-X	Adjustment screw assembly (includes part number 1192)	2
	1192	Locking device TFE 1/8" dia. x 1/4" long	2
15.	2773-X	Crosshead guide assembly	1
16.	2777[c]	Cartridge plate	2
17.	5000-262[c]	Retainer ring	2
18.	7005-043NC125A	Ferry head bolt	12
	7206-043A	Lock washer	6
19.	1489	Crankcase gasket	1
20.	1488	Inspection plate gasket	1
21.	1487	Inspection plate	1
22.	7003-025NC037E	1/4-20x3/8"	8
23.	1452-1X3	Packing set (PTFE standard) includes 1452-1, 1453-1, 1454 (5), 1628, 1714	4
	1452-2X3	Packing set (Alloy 50 optional) includes 1452-1, 1453-1, 1454 (5), 1628, 1714	4

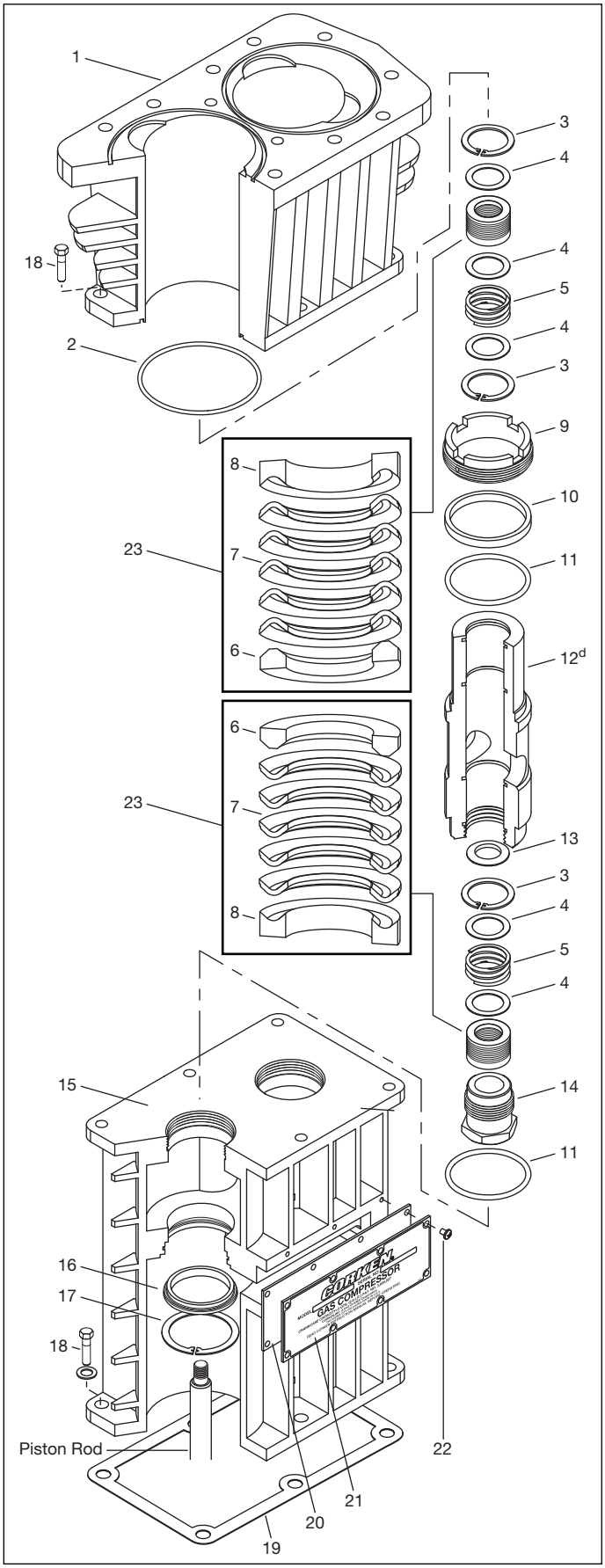
O-ring Code	
A	Buna-N
B	Neoprene®[b]
D	Viton®[b]
E	PTFE
K	Kalrez®[b]

[a] _ denotes O-ring code. See O-ring chart for details.
[b] Registered trademark of the DuPont company.
[c] Included with crosshead guide assembly 2773-X.
[d] Before installing the packing cartridge and packing on the piston rod, use packing cone (part number 4005) on the 1st stage of model 351 and both stages of model 391. Use packing cone (part number 5268) on the 2nd stage of model 351 only. See crosshead and connecting rod assembly details for more information.

WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Appendix E—Packing Assembly Details—All D-Style Models 351 and 391

Packing Spec. B



Packing Assembly Bill of Materials

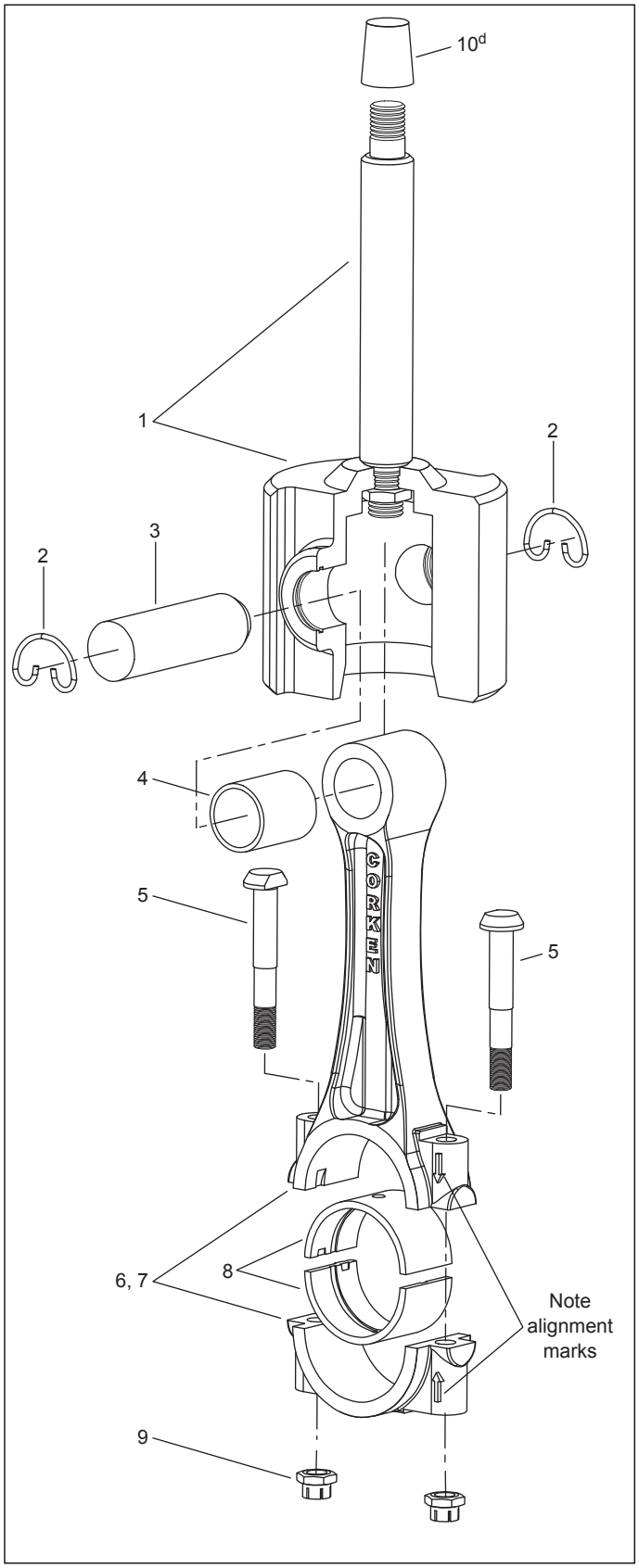
Ref No.	Part No.	Description	Qty.
1.	5334	Cylinder—FD351	1
	5259	Cylinder—WFD351	1
	4160	Cylinder—D391, FD391	1
	3744	Cylinder—WD391, WFD391	1
2.	2-231_[a]	O-ring—2nd stage (all models)	1
	2-247_[a]	O-ring—1st stage (all models)	1
3.	5000-125	Retainer ring	6
4.	1714	Packing box washer	10
5.	1628	Packing spring	4
6.	1453-1	Male packing ring	4
7.	1454	Packing ring	20
8.	1452-1	Female packing ring	4
9.	2801	Cartridge holddown screw	2
10.	2778	Spacer	2
11.	2-227_[a]	O-ring	4
12.	2776[d]	Packing cartridge	2
13.	1677-1	Oil deflector ring	2
14.	1387-X	Adjustment screw assembly (includes part number 1192)	2
	1192	Locking device TFE 1/8" dia. x 1/4" long	2
15.	2773-X	Crosshead guide assembly	1
16.	2777[c]	Cartridge plate	2
17.	5000-262[c]	Retainer ring	2
18.	7005-043NC125A	Ferry head bolt	12
	7206-043A	Lock washer	6
19.	1489	Crankcase gasket	1
20.	1488	Inspection plate gasket	1
21.	1487	Inspection plate	1
22.	7003-025NC037E	1/4-20x3/8"	8
23.	1452-1X3	Packing set (PTFE standard) includes 1452-1, 1453-1, 1454 (5), 1628, 1714	4
	1452-2X3	Packing set (Alloy 50 optional) includes 1452-1, 1453-1, 1454 (5), 1628, 1714	4

O-ring Code	
A	Buna-N
B	Neoprene®[b]
D	Viton®[b]
E	PTFE
K	Kalrez®[b]

[a] _ denotes O-ring code. See O-ring chart for details.
[b] Registered trademark of the DuPont company.
[c] Included with crosshead guide assembly 2773-X.
[d] Before installing the packing cartridge and packing on the piston rod, use packing cone (part number 4005) on the 1st stage of model 351 and both stages of model 391. Use packing cone (part number 5268) on the 2nd stage of model 351 only. See crosshead and connecting rod assembly details for more information.

WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Appendix E—Crosshead and Connecting Rod Assembly Details—All D-Style Models 351 and 391



Connecting Rod Assembly Bill of Materials

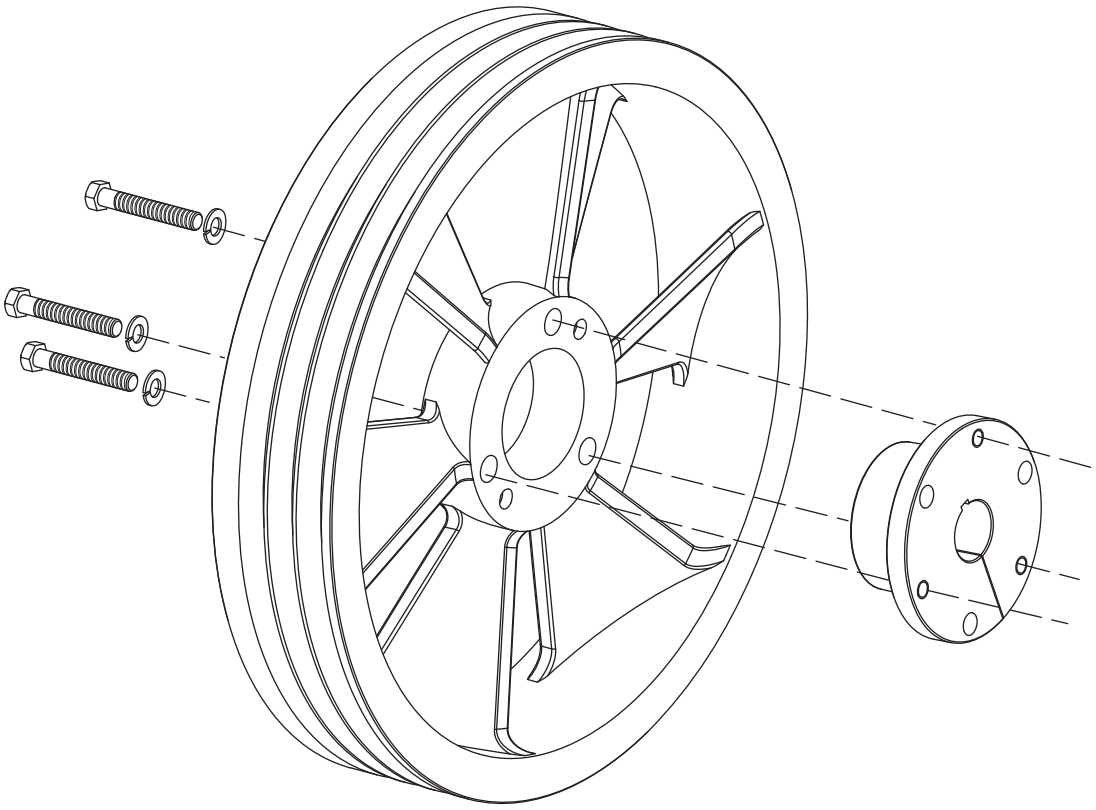
Ref No.	Part No.	Description	Qty.
1.	1384-X1	Crosshead assembly—1st stage (351 only)	1
		Crosshead assembly—1st and 2nd stage (391 only)	2
	1384-X4	Crosshead assembly—1st and 2nd stage (391 only) - chrome oxide (opt.)	2
	1384-X5	Crosshead assembly—2nd stage (351 only)	1
2.	1498	Retainer ring	4
3.	1496	Wrist pin	2
4.	1495-X[a,b]	Wrist pin bushing	2
5.	1492[b]	Bolt	4
6.	1490-X	Connecting rod assembly	2
7.	1490[b]	Connecting rod	2
8.	1491[b]	Connecting rod bearing	2
9.	1493[b,c]	Nut	4
10.	4005[d]	Packing cone—1st stage (351 only)	1
		Packing cone—1st and 2nd stage (391 only)	1
	5268[d]	Packing cone—2nd stage (351 only)	1

[a]Must be rebored after replacing (0.8754/0.8751 dia.)
[b]Included with connecting rod assembly
[c]Torque connecting rod nut to value shown in Appendix B.
[d]Only used when installing the packing cartridge and packing on the piston rod.

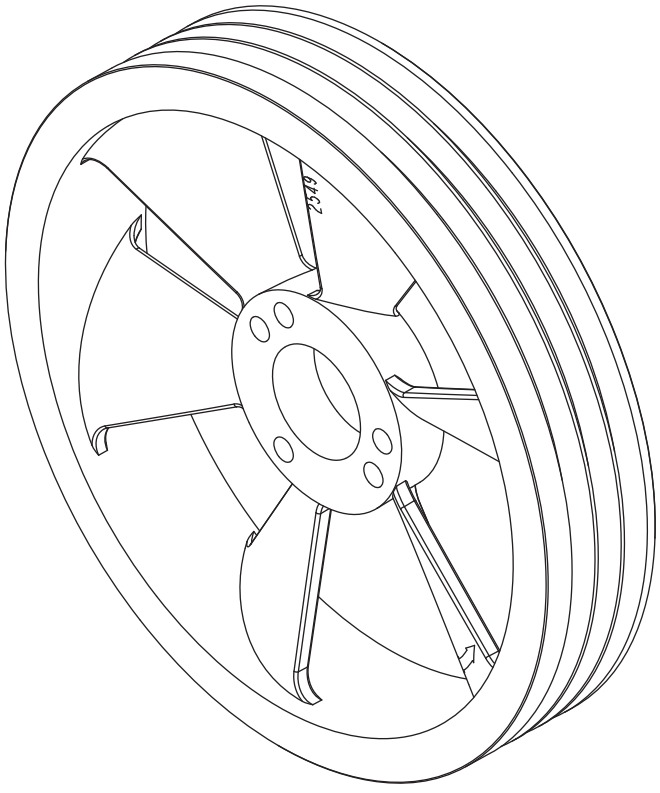
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Appendix E—Flywheel Assembly Details—All D-Style Models 351 and 391



Back Side



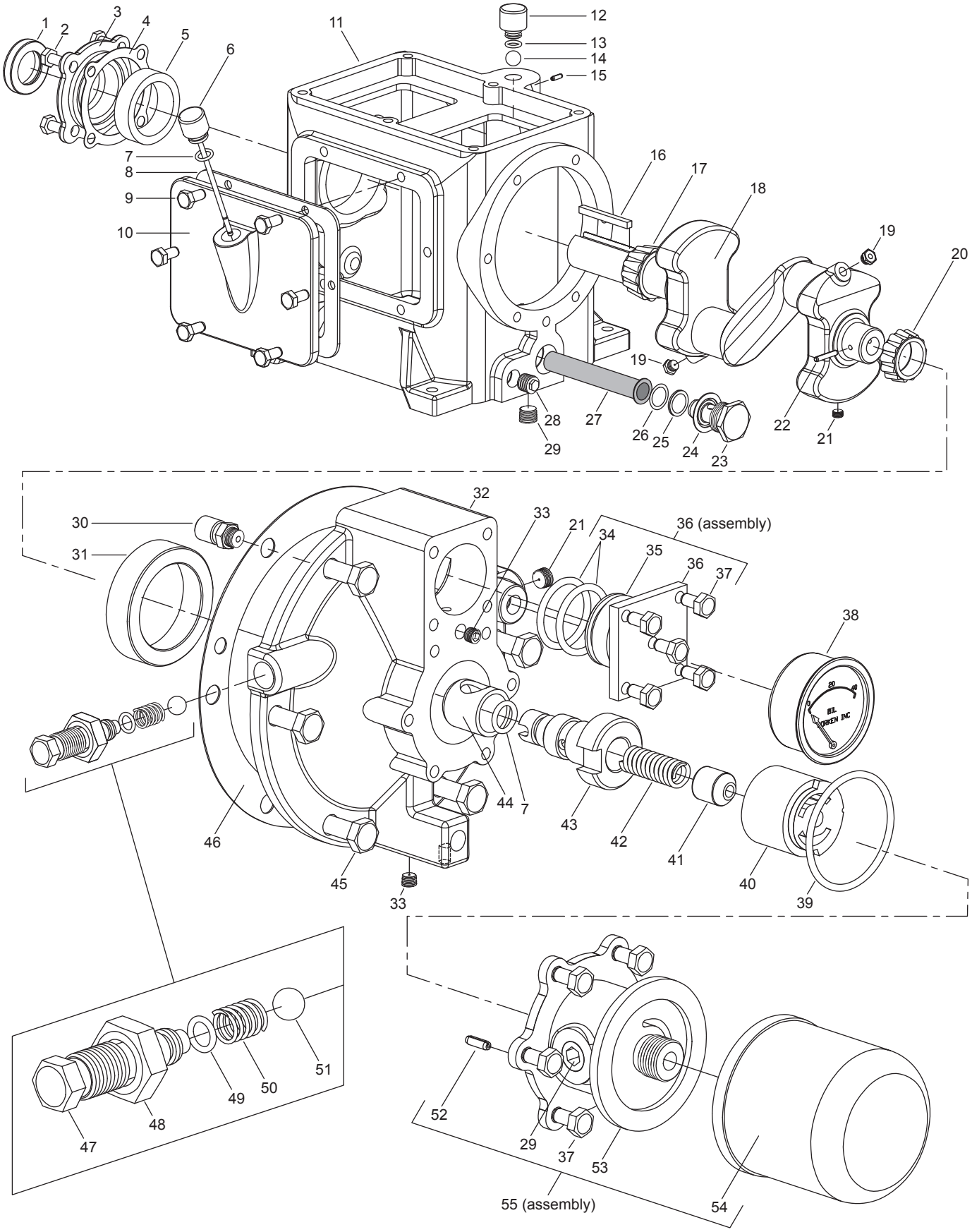
Front Side

Flywheel Assembly Bill of Materials

Assembly Number	Assembly Name
2549-X	Flywheel assembly (flywheel, hub, three bolts and lockwashers)
2549	Flywheel: 16" O.D., 3 groove
H SF-1.375	Hub with three bolts and lockwashers

NOTE: For details on flywheel runout, refer to the Clearances and Dimensions in Appendix B.

Appendix E—Crankcase Assembly Details—All D-Style Models 351 and 391



Appendix E—Crankcase Assembly Details—All D-Style Models 351 and 391

Crankcase Assembly Bill of Materials

Ref No.	Part No.	Description
1.	4438	Oil seal
2.	7001-037NC075A	Hex head bolt 3/8-16 x 3/4
3.	2847-1	Bearing cover
	2847-1X	Bearing cover assembly (includes 2847-1, 4438)
4.	1504	Bearing adjustment shim (0.005")
	1504-1	Bearing adjustment shim (0.007")
	1504-2	Bearing adjustment shim (0.020")
5.	1502	Bearing cup
6.	1508-X	Oil bayonet
	1508-X1	Oil bayonet assembly (includes part numbers 1508-X, 2-112A)
7.	2-112A[b]	O-ring (oil bayonet & pump shaft)
8.	1511	Crankcase inspection plate gasket
9.	7001-031NC075A	Hex head bolt 5/16-18 x 3/4
10.	2853	Crankcase inspection plate
11.	2803[a]	Crankcase
12.	1279	Breather cap
	1279-X	Breather cap assembly (includes part numbers 1279, 2-111A)
13.	2-111A[b]	O-ring (breather cap)
14.	2796	Breather ball
15.	1483	Lock pin
16.	1663	Flywheel key
17.	1501	Bearing cone
18.	1499-X	Crankshaft assembly—standard (includes part numbers 1284 (2), 1286, 1499, 1501, 1503, 2590)
	1499-SX	Extended crankshaft assembly—optional (includes part numbers 1284 (2),1286, 1499-S, 1501, 1503, 2590)
19.	1284	Crankcase orifice (2)
20.	1503	Bearing cone
21.	1459	Crankshaft plug
	2590	Pipe plug
22.	1286	Pump shaft drive pin
23.	1280	Filter screw
24.	1281	Filter screen screw gasket
25.	2-116A[b]	O-ring (filter screen)
26.	1276	Filter screen washer
27.	1275	Oil filter screen
28.	1661	Plug 3/8" NPT
29	3289	Pipe plug
30.	2961-X	Air release valve assembly (includes part numbers 2961, 2962, 2963)
31.	1500	Bearing cup

Ref No.	Part No.	Description
32.	2804	Bearing carrier
	2804-X	Bearing carrier assembly (includes part numbers 1290, 1291, 1292, 1293, 1500, 1513, 1515-X, 1629 (2), 2590, 2804, 2849-X, 2850, 2851, 2852, 2961-X, 2-011A, 2-112A, 2-228A, 4222-X, 7001-025NC050A (10))
33.	1629	1/16" NPT pipe plug, flush seal
34.	2-218A[b]	O-ring for closure body (2) (Spec. 4, 8, 9 only)
35.	1516	Closure body
36.	1515	Closure cap
	1515-X	Closure cap assembly (includes part numbers 2-218A (2), 1516, 1515, 7001-025NC050A) (Spec. 4, 8, 9 only)
37.	7001-025NC050A	Hex head bolt 1/4-20 x 1/2
38.	1302	Oil pressure gauge
39.	2-228A[b]	O-ring (pump cover)
40.	2849-X	Oil pump assembly
41.	2851	Spring guide
42.	2852	Oil pump spring
43.	2850	Pump shaft adapter
44.	2805-X	Pump shaft bushing
45.	7001-037NC100A	Hex head bolt 3/8-16 x 1
46.	1513	Bearing carrier gasket
47.	1290	Relief valve adjusting screw
48.	1291	Adjusting screw locknut
49.	2-011A[b]	O-ring (relief valve adjusting screw)
50.	1292	Relief valve spring
51.	1293	Relief valve ball
52.	2798	Pump cover pin (included with part number 2848-X)
	2848-X	Pump cover (includes pin)
53.	4222	Oil filter adapter
54.	4225	Oil filter
55.	4222-X	Oil filter assembly—external

O-ring Code	
A	Buna-N

[a] *Crankcase capacity: 3 quarts (2.8 liters)*
[b] *See O-ring chart above for details.*

WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

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