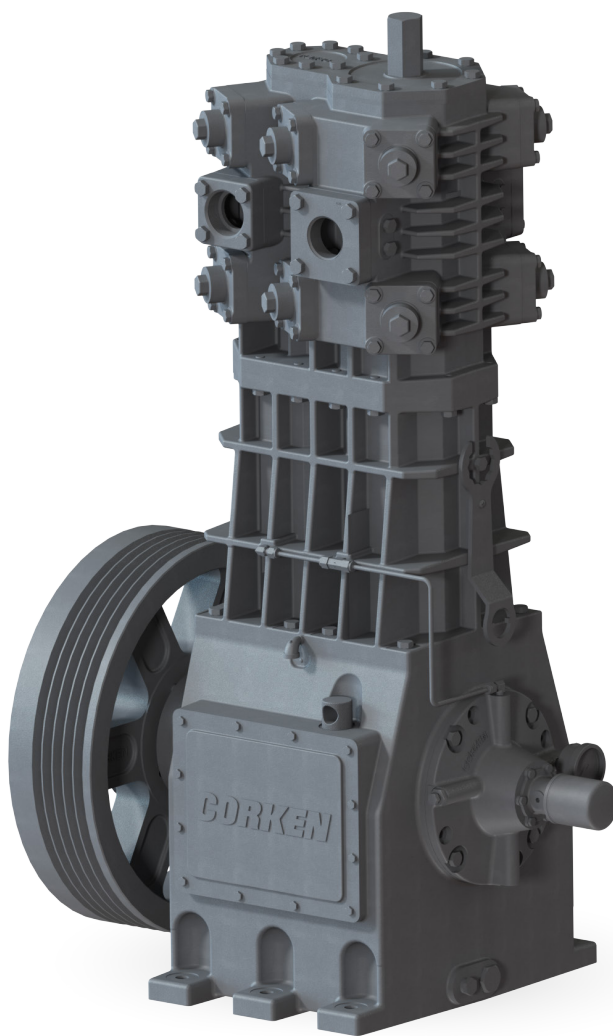


Installation, Operation & Maintenance Manual

D991 Double-Acting Gas Compressor



Model D991 Compressor

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. (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.

CORKEN®
Trusted Since 1924

Warning

Install, use and maintain this equipment according to Corken's instructions and all applicable federal, state, local laws and codes. Periodic inspection and maintenance is essential.

Corken One Year Warranty

CORKEN, INC. warrants that its products will be free from defects in material and workmanship for a period of one year from date of installation, provided that the warranty shall not extend beyond twenty-four (24) months from the date of shipment from CORKEN. If a warranty dispute occurs, the DISTRIBUTOR may be required to provide CORKEN with proof of date of sale. The minimum requirement would be a copy of the DISTRIBUTOR'S invoice to the customer.

CORKEN products which fail within the warrant 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, Oklahoma 73131.

Parts subject to wear or abuse, such as mechanical seals, blades, piston rings, valves and packing, and other parts showing signs of abuse, neglect or failure to be properly maintained 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 the 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 warrantee 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. Experienced, trained personnel in compliance with governmental and industrial safety standards should handle such substances.

Important notes relating to the European Union (EU) Machinery Directive

Compressors delivered without electric motors are not considered as machines in the EU Machinery Directive. To ensure EU compliance, the compressor should be ordered with the optional 3022-1X Declaration of Conformity. The fabricator of the machinery must assure and declare full compliance with this Directive before the machine in which the compressor will be incorporated, or of which it is a part, is put into service.

Contacting the Factory

Before contacting the factory, note the model and serial numbers. The serial number directs Corken personnel to a file containing all information on material specifications and test data applying to the product. When ordering parts, the Corken service manual or Installation, Operations, and Maintenance (IOM) manual should be consulted for the proper part numbers. ALWAYS INCLUDE THE MODEL NUMBER AND SERIAL NUMBER WHEN ORDERING PARTS.

The model and serial numbers are shown on the nameplate of the unit. Record this information for future reference.

Model No. _____

Serial No. _____

Date Purchased _____

Date Installed _____

Purchased From _____

Installed By _____

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Chapter 2—Installation

1.1 Location

NOTE: Compressor must be installed in a well ventilated area.

Corken's compressors are designed for outdoor duty. Consult the factory before installing a compressor in extreme conditions such as corrosive environments and arctic conditions for extended periods of time. Always review the local safety regulations and building codes and ensure the installation meets all local safety and building standards.

Since Corken's compressors typically handle toxic and flammable gases, they should be located outdoors in a well ventilated area. To ensure the compressor is accessible from all sides and has unrestricted air flow for adequate cooling, a minimum of 18 inches (45 cm) clearance between the compressor and the nearest wall is recommended.

Noise:

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 cannot 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 (0.91 meters).

1.2 Foundation

A proper foundation is essential for a smooth running compression system. The compressor should be mounted to a structural steel skid that is attached to a concrete slab. The slab must be at least eight inches thick with a two inch skirt around the circumference of the structural steel skid. The structural steel skid should be securely anchored into the foundation by 3/4 inch diameter by eight inch long "J" bolts. The total mass of the foundation should be approximately twice the weight of the compressor system (compressor, structural steel skid, motor, etc.). See figure 1.2 for details.

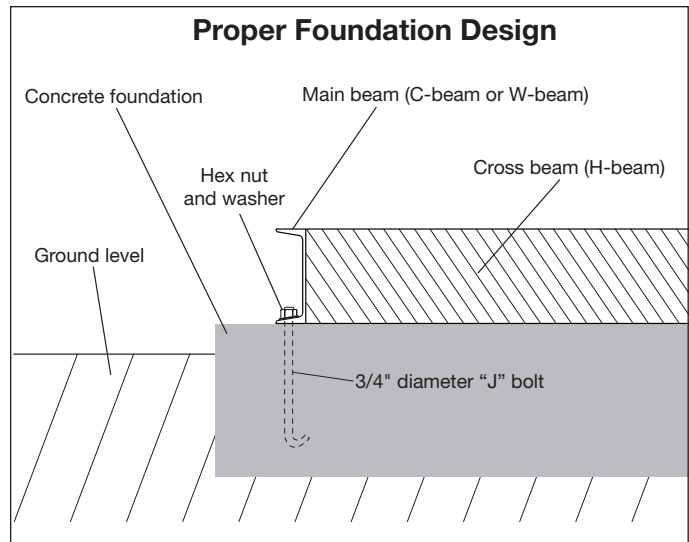


Figure 1.2: Recommended foundation details for Corken compressors

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

1.3 Piping

A proper piping design is as important as a proper foundation when it comes to a smooth operating compressor. A poorly designed piping system results in an undesirable transmission of compressor vibration to the piping. For best results follow the recommendations below.

DO NOT SUPPORT PIPING WITH THE COMPRESSOR. Unsupported piping is the most frequent cause of vibration. To minimize the transmission of vibration from the compressor to the piping, install flexible connectors vertically as shown below (see figure 1.3 for details).

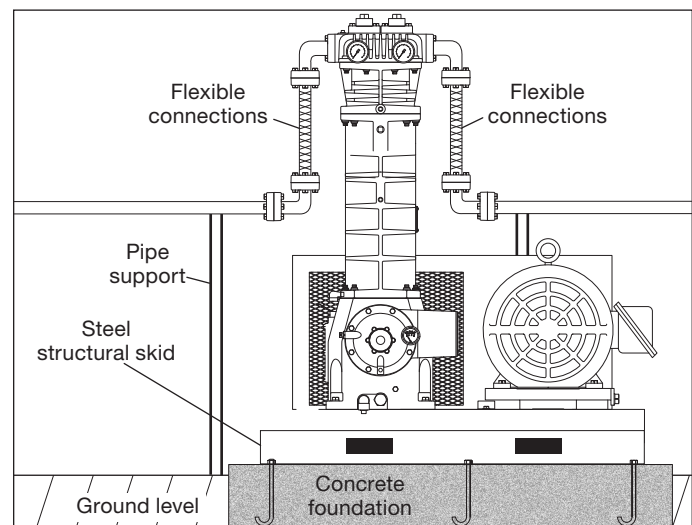


Figure 2.3: Flexible connectors should be used to minimize transmission of vibration to the piping.

To prevent excessive pressure drop between the suction source and the compressor and the final discharge point and the compressor, the piping must be adequately sized. 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 between the restrictive device and the compressor suction nozzle must be at least ten times the swept cylinder volume.

On liquefied gas applications, a liquid trap must be installed on the inlet side of the compressor. This prevents 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. Always install a check valve on the discharge side of the compressor and use 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., K61.1-1999, 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's 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 pressurize gas and are not designed to pump liquids. The entry of even a small amount of liquid into the compressor results in serious damage.

On liquefied gas applications, a liquid trap must be used to prevent liquid from entering the compressor.

Corken's liquid trap is ASME code stamped and provides the most thorough liquid separation (see figure 1.4). It contains two level switches, one for alarm and one for shutdown. In some cases the alarm switch is used to activate a dump valve (not included with trap) or sound an alarm so the trap can be manually drained by the operator. It also contains a mist pad; a mesh of interwoven wire designed to remove fine liquid mists. The ASME code trap comes standard on Corken's 107B and 109B mountings.

NOTE: Before grounding any welding devices to the trap or

associated piping, the LIQUID LEVEL SWITCH MUST BE REMOVED from the trap. **Failure to do so will damage the contacts of the switch.**

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

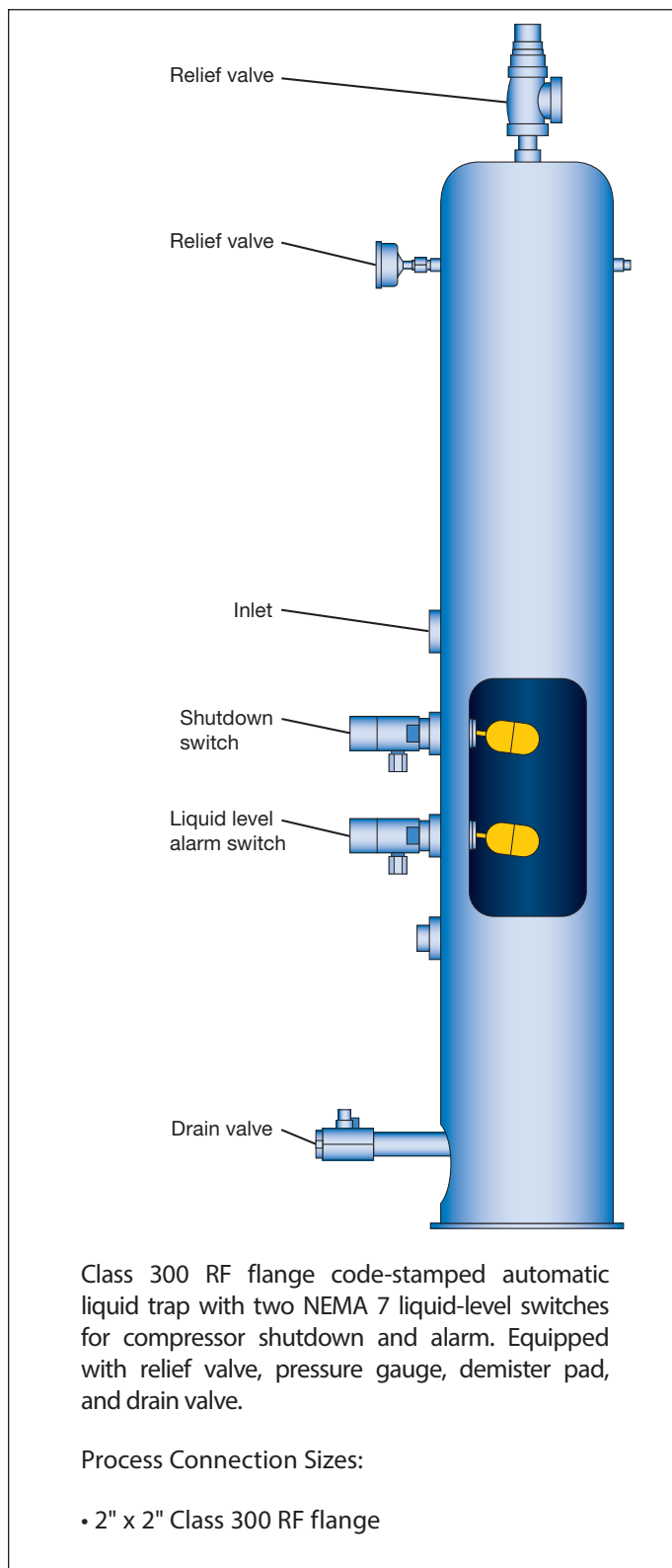


Figure 1.4: ASME automatic liquid trap

1.5 Driver Installation and Flywheels

Corken's vertical compressors can be driven by electric motors or combustion engines (gasoline, diesel, natural gas, etc.). A proper driver selection should turn the compressor between 400 and 825 RPM.

NOTE: Never operate a reciprocating compressor without a flywheel. Severe torsional imbalances will result causing vibration and an unusually high horsepower requirement. The flywheel should never be replaced by another pulley unless it is equal to or higher than the the wk2 value of the flywheel.

Humid climates can cause problems with explosion proof motors. The normal breathing of the motor and alternating temperatures—warm when running and cool when stopped—can drawn moist air into the motor. As the moist air condenses, it can build up and cause motor failure. 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 attached. During this period of time, the motor will heat up and vaporize the condensed moisture. NOTE: No motor manufacturer guarantees an explosion proof or totally enclosed (TEFC) motor against damage from moisture.

When installing an engine driver, carefully review the instructions from the manufacturer and ensure the engine is properly installed.

1.6 Crankcase Lubrication

The crankcase was drained before shipment. Before starting the machine, fill the crankcase to the full mark on the oil bayonet and not above. To ensure proper lubrication of the crankcase parts, the crankcase should be filled through the crankcase inspection plate (see figure 1.6A for the proper oil filling location).

INSERT TABLE FROM IJ100 HERE (TWO COLUMN SPREAD)

Figure 1.6A: Oil selection chart.

Compressor Model	Approximate Quarts	Capacity Liters
991	9.0	8.5

Figure 1.6B: Oil capacity chart.

General Notes on Crankcase Oil

Corken gas compressors handle a wide variety of gases in a multitude of operating conditions. They are used in all areas of the world from hot dusty deserts, to humid coastal areas, to cold arctic climates. Some compressors may be lightly loaded and run only occasionally, while others may be heavily loaded and operate 24/7. Thus, no single crankcase oil or maintenance schedule is right for every compressor. Availability of brands and grades of oil can vary from one location to another. These factors can make it challenging for a Corken compressor user to select a suitable crankcase oil. This guide is intended to aid

in that regard.

It is safe to say that purchasing a quality crankcase oil, and changing it regularly, is significantly less costly than the repair bill and downtime associated with a lubrication failure in any gas compressor. Considering the relatively small volume of oil used in Corken compressors, and the critical nature of the services where these compressors are used, selecting the appropriate high quality oil is the most economical choice. It will help ensure the dependability and longevity of the compressor.

Corken recommends using industrial oils (rather than engine oil or “motor oil”). Industrial oils have additives selected and blended for specific purposes. Many are designed specifically for the challenges inherent in compressor crankcases. Industrial oils are available as a conventional (mineral based) oil, a synthetic oil, or a blend of the two.

All new Corken compressors are tested at the factory using a conventional mineral oil. This oil is drained prior to shipment. An oil suitable for the anticipated environmental and operating conditions must be selected and added to the compressor prior to the initial startup.

Oils to Avoid

Selecting a crankcase oil based on low price or easy availability is seldom the most economic decision. Following are oils to avoid.

- **Do not use** any oil with a viscosity index below 95.
- **Do not use** any oil with a pour point less than 20°F (11°C) lower than the anticipated minimum ambient temperature (unless a crankcase oil heater is used).
- **Do not use** engine/motor oil.

See below for additional detail on each of these parameters.

Critical Oil Characteristics

Viscosity

Viscosity is the most important physical property of lubricating oil. Simply put, the viscosity of an oil is a measure of its resistance to flow. In gas compressors, oils with higher viscosity (like ISO 100) are thicker and are used for higher ambient temperatures. Oils with lower viscosity (like ISO 68) are thinner and are used at lower ambient temperatures. If the oil's viscosity is too high, the oil may not circulate through the compressor adequately. If the viscosity is too low, the lubricating film will be unable to protect the components from wear.

Viscosity Index

Viscosity Index (VI) is a measure of how much the oil's viscosity changes as its temperature changes. A low viscosity index is an indication that the viscosity changes more as the temperature changes. Oils with low viscosity index tend to become thin as the oil temperature increases. This can cause lubrication failure as well as unstable oil pressure. A high viscosity index reflects a more stable viscosity, and is generally preferred for Corken compressors. The minimum Viscosity Index for oils used in Corken compressors is 95 (VI is a unit-less number). This is particularly important when operating at high or low temperature extremes, or at a variety of ambient temperatures (seasonal changes). Oils with a high viscosity index can be used at wider ambient temperature range compared to oils with a lower viscosity index.

It should be noted that a conventional oil (not synthetic) with a high viscosity index may not necessarily be suitable for continuous service at high temperature. Such an oil will oxidize faster than a synthetic oil. Synthetics have naturally high viscosity index, and are therefore recommended for "heavy service" as described below—including high temperature and continuous duty applications. In many climates, the use of the correct synthetic oil will eliminate the need to change oil viscosity grades as the seasons change.

Pour Point

The pour point of an oil is the lowest temperature at which the oil flows. At temperatures below the pour point, the oil is essentially solid and can't freely flow to the compressor's bearings and other wear surfaces, or even to the compressor's oil pump.

The oil's pour point is particularly critical when starting a compressor at low temperature conditions. An oil should have a pour point at least 20°F (11°C) below the lowest expected ambient temperature. For example, if the minimum ambient temperature is expected to be 0°F (-18°C), the pour point must be no higher than -20°F (-29°C).

Do not assume the pour point of an oil is low enough. Consult the oil's technical data sheet – generally available on the oil manufacturer's website. Many conventional oils have a pour point around 0 to 15°F (-18 to -9°C) which is too high to use at low ambient temperatures. Synthetic oils generally have a lower pour point than conventional oils.

Crankcase Oil Recommendations (Except Ammonia Service)

Normal Service					
Ambient Temperature ¹	Oil Product	Oil Type ²	Viscosity ISO ³	Viscosity Index ³	Pour Point ³
40 to 100°F (4 to 38°C)	Mobil DTE 10 Excel 100	C	100	127	-27°F (-33°C)
	Mobil Rarus 427	C	100	100	16°F (-9°C)
	Phillips 66 Gas Compressor Oil	C	100	102	-20°F (-29°C)
	Chevron Regal R&O	C	100	97	5°F (-15°C)
	Sunoco Sunvis 900	C	100	95	-15°F (-26°C)
10 to 65°F (-12 to 18°C)	Mobil DTE 10 Excel 68	C	68	156	-38°F (-39°C)
	Mobil DTE Heavy Medium	C	68	95	5°F (-15°C)
	Phillips 66 Premium Gas Compressor Oil	B	68	133	-27°F (-33°C)
	Chevron Regal R&O	C	68	99	-11°F (-24°C)
	Sunoco Sunvis 900	C	68	104	-21°F (-29°C)
Heavy Service					
10 to 100°F (-12 to 38°C)	Mobil SHC 627 ⁴	S	100	162	-49°F (-45°C)
	Royal Purple Synfilm NGL 100	S	100	130	-44°F (-42°C)
	Dyna-Plex 21C Synzol CO ISO 100	S	100	132	-49°F (-45°C)
-20 to 90°F (-29 to 32°C)	Mobil SHC 626 ⁴	S	68	165	-59°F (-51°C)
	Royal Purple Synfilm NGL 68	S	68	132	-76°F (-60°C)

¹ Consult Corken for oil recommendations in very hot climates—ambient temperatures consistently above 100°F (38°C).

² Oil type: C=Conventional, S=Synthetic, B=Conventional/Synthetic blend

³ Information available from oil manufacturers at the time of publication.

⁴ Mobil SHC oils are synthetic oils which require that the crankcase be flushed of residual mineral oil.

⁵ Mobil Gargoyles Arctic SHC oils are synthetic oils which require that the crankcase be flushed of residual mineral oil

If crankcase with lubricated guide option installed. The top of the flywheel rotation must rotate towards the lubrication lines on the crosshead guide. **Do not operate the compressor in the opposite direction of rotation.** Max 885 RPM Displacement: 128.7 (218.7)

Crankcase Oil Recommendations

The primary factors for selecting a suitable crankcase oil from the chart are ambient temperature range and the anticipated service – normal service or heavy service. The ambient temperature determines the required oil viscosity. Consider the full range of high and low ambient temperatures at the compressor’s location when selecting an oil. It may be necessary to use an ISO 100 in summer and an ISO 68 in winter. Synthetic oils generally have a wider ambient temperature range due to their higher viscosity index.

For the purpose of selecting a suitable crankcase oil for a Corken compressor, normal and heavy service are defined below.

Normal Service

“Normal service” can be defined as anything that is not considered “heavy service” as described below.

Common examples of “normal service” applications:

- LPG liquid transfer (intermittent duty)
- Most tank evacuation applications

Conventional mineral based oils have been used successfully for many years in these services.

Heavy Service

“Heavy Service” is defined as an application where the compressor is subject to any one (or more) of the following:

- Continuous duty service (several hours each day or more)
- Compressor consistently loaded at or near its maximum horsepower rating
- Compressor speed is at or near its maximum speed rating
- Services with a “wet” gas such as natural gas with high content of heavy hydrocarbons such as butane, pentane, etc.
- Services dealing with low vapor pressure hydrocarbons (such as butane unloading in winter) where condensation of the gas can result in dilution of the crankcase oil
- Compressors operating at high or low temperature extremes

Synthetic oils are recommended for “heavy” services.

Oil Change Intervals

Oil change intervals can vary significantly depending on local environmental conditions, the gas being compressed, and the oil being used. Unless there are factors that shorten the life of the oil, the following recommendations apply:

Conventional oil: 2200 hours or 6 months—whichever comes first

Synthetic oil: 6000–8000 hours* or one year—whichever comes first

* Oil change intervals in this range should be confirmed via oil analysis.

Environmental or operational issues such as dirty/dusty or humid conditions will require more frequent oil changes. Contamination/dilution of the oil by liquids in the gas stream can also shorten the life of the oil. Visually check the oil level and the oil condition at least monthly (compare to unused oil).

Indications that dictate more frequent oil changes:

- Unusually dirty or discolored oil (or unusual smell)
- Oil dilution by condensation or other liquids in the gas stream (see below)
- Change in viscosity for any reason (various oil additives can break down over time)
- Changing ambient temperature may cause the need for a different viscosity

The oil should be changed as often as necessary to maintain clean, undiluted oil of the proper viscosity. Each time the oil is changed, the oil filter (Corken part number 4225) should also be changed.

Oil Analysis

The best way to determine the needed oil change interval for any particular compressor is to have an oil analysis conducted. Numerous labs can analyze a used oil sample and advise its condition. After 2–3 such tests, a determination can be made for a recommended oil change interval for a particular compressor in its specific environmental situation and operating conditions. Regular oil analysis can help improve the compressor durability and decrease oil usage by maximizing the oil change intervals. Based on the oil analysis, the oil can be changed when it is needed, and not changed when it is not yet necessary.

Oil Dilution

Crankcase oil can be diluted by various products in the gas stream. As an example, when compressing butane in winter, the vapor pressure is very low and there can be a lot of entrained liquid butane with the gas stream. This liquid can collect in the compressor and dilute the crankcase oil. This thins the oil and reduces its ability to properly lubricate the compressor.

Hydrocarbon mixtures containing heavy hydrocarbons such as butane, pentane, hexane, etc. often operate at pressure above the vapor pressure of these heavier constituents. Thus, they often produce a “wet” gas which can dilute the crankcase oil.

Long Term Storage

When a compressor is removed from long term storage, the oil should be changed before putting the compressor back into service. Specifically, if it has been unused over a season (such as over a winter), the oil should be changed.

Crankcase Oil Heater Option

Corken offers a crankcase oil heater as an option on all models except the small model 91. This heater is available in 110V and 220V versions and is rated for Class 1, Division 1 and 2, Group B, C, D service. The heater includes a thermostat set at 70°F (21.1°C). The heater alleviates concerns about cold weather startup. When using the heater, an ISO 100 viscosity oil will do well regardless of low ambient temperature.

Cylinder Lubricating Oil

All Corken gas compressors are designed to operate without cylinder lubrication. However, many Corken Customers, particularly in the oil and gas industry, use lubricated compressor cylinders to extend the service life of the compressor’s valves, piston rings, and packing. Compressor cylinders operate at higher temperatures than the crankcase, so oils used in this service often have a higher viscosity than the crankcase oil. A viscosity of ISO 150 (or higher) is common for cylinder lube oil. Several companies make oil specifically designed for this service and many of these oils have properties that inhibit dilution or washing away of the oil by condensates in the process gas. These oils typically also have properties that prevent corrosion and carbon buildup in the cylinders and valves. Contact Corken if assistance is needed in selecting a suitable cylinder lubricating oil. Oil manufacturers are often a

good source for this information as well.

Engine oils (motor oils) should never be used as a cylinder lubricant. The additives in engine oil are poorly suited for that purpose.

Engine Oils (Motor Oils)

As noted above, engine oils (or motor oils) are not recommended for use in Corken compressor crankcases or cylinders. Engine oils are formulated for use in internal combustion engines and contain additives that specifically counter the contaminants created by the combustion of fuel (soot, CO₂, water, etc.). As such, they are not necessarily the best oils to use in a gas compressor.

Detergents and dispersants in engine oils can react with the compressor’s process gas, or form emulsions inside the compressor’s crankcase that are detrimental to lubrication. Ultimately, this negatively affects the oil’s properties and damages the compressor’s critical internal components.

If a suitable industrial oil is not readily available, engine oils can temporarily be used in Corken compressors in normal service, but only until a suitable industrial oil can be sourced (see above for definition of “normal service”). Engine oils should not be used for compressors in “heavy service”.

Engine oil is labeled with an API “donut” indicating the API Service Grade. It is critical that the engine oil have an API Service Grade of SJ or better. Engine oils with an API Service Grade of SA and SB are obsolete, but still readily available. These very low quality oils should never be used in Corken compressors. Industrial oils do not receive an API Service Grade like engine oil does.

1.7 Venting, and Draining of Distance Pieces

Venting:

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

Draining:

Since some oil passes the lower packing set, the distance piece must be drained on a regular basis to maintain oil-free compression. Corken recommends draining the distance piece once a week in continuous-duty operation. Installing a drain cock to the distance piece helps simplify the process.

1.8 Relief Valves

A relief valve must be installed on the discharge side of the compressor before the first block valve. With Corken's 107 mountings, a relief valve should be fitted in the piping between the compressor discharge and the four-way valve. NOTE: Relief valves may be required at other points in the piping system.

The material specification for the relief valve must be compatible with the gas being compressed. Review local codes and regulations for specific requirements related to relief valves.

1.9 Shutdown and Alarm Devices

For many applications shutdown and alarm switches provide worthwhile protection and may prevent serious damage to the compression system. All electronic devices must meet local code requirements. The shutdown and alarm devices typically used with Corken's compressors are as follows:

Low Oil Pressure Switch: Shuts down the compressor if the crankcase oil pressure falls below 15 psi due to oil pump failure or low oil level in crankcase.

High Temperature Switch: Shuts down the compressor if the normal discharge temperature is exceeded. This is strongly recommended for all applications. Typically, the set point is about 30°F (-17°C) above the normal discharge temperature but not exceed the 250°F (121°C) when using Buna-N or Neoprene® trim or 300°F when using PTFE or Viton® (Neoprene and Viton are registered trademarks of the DuPont company).

Low Suction, High Discharge Pressure Switch: Shuts down the compressor if inlet or outlet pressures are not within preset limits.

Vibration Switch: Shuts down the compressor if vibration becomes excessive. Recommended for compressors mounted on portable skids.

Chapter 2—Start Up

NOTE: Read all of this chapter, before proceeding with the startup checklist.

2.1 Inspection After Extended Storage

If the compressor has been out of service for an extended period of time, make certain the cylinder bore and valve areas are free of rust or debris of any kind. For instructions on removing the valves and/or cylinder head, refer to chapter five.

Drain the oil from the crankcase and remove the dipstick in the crankcase. Inspect the running gear for signs of rust and clean or replace parts as necessary. Replace the access cover

and fill the crankcase with the appropriate amount of lubricant through the dipstick hole in the crankcase.

Rotate the compressor manually and ensure running gear functions properly. Replace the nameplate and proceed with the startup.

2.2 Flywheel and V-belt Alignment

Before working on the drive assembly, make sure the electric power is disconnected. When mounting new belts, always make sure the driver and compressor are close enough together to avoid forcing/prying the belts over the flywheel grooves.

Improper belt tension and/or sheave alignment can cause vibration, excessive belt wear, and premature bearing failure. Before operating the compressor, confirm V-belt grooves of the flywheel and driver sheave are properly aligned. Visual inspection often will indicate if the belts are properly aligned, but use of a square is the best method (See video titled "How to Align the Sheave to the Flywheel" on Corken's YouTube Channel).

The flywheel is mounted on the shaft via a split, tapered hub, and three bolts (see figure 2.2A). These bolts should be tightened in an even and progressive manner to the specified torque values listed 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.

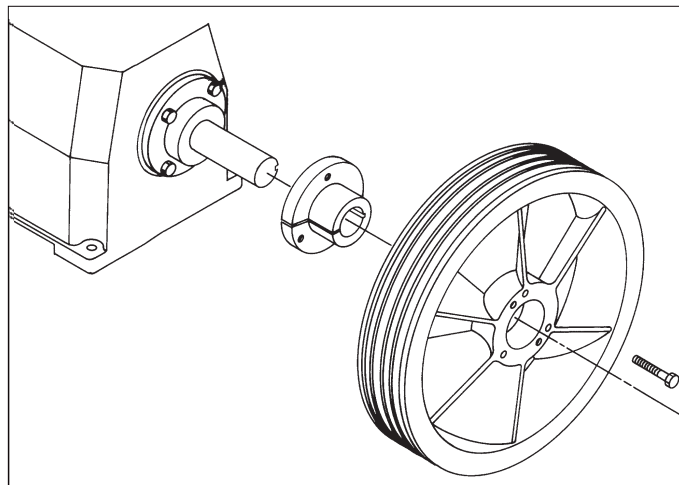


Figure 2.2A: Flywheel installation

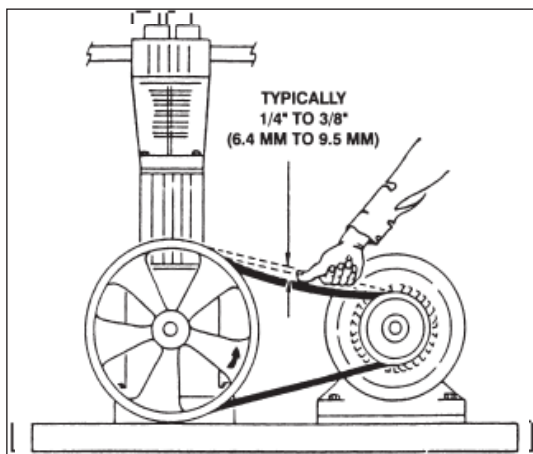


Figure 2.2B: Proper belt tension

Hub Size	Diameter in. (cm)	Bolt Torque Ft-lb (kg-meter)	Set Screw Torque Ft-lb (kg-meter)
J	7.25 (18.4)	75-81 (10.3-11.1)	22 (28.8)



Scan QR Code and refer to the maintenance video titled "How to Align the Sheave to the Flywheel and Set Proper V-Belt Tension".

Tighten the belts until taut which means they should not be extremely tight. Consult your V-belt supplier for specific tension recommendations. Over tightened belts can cause premature bearing failure. Refer to figure 2.2B for general guidelines.

2.3 Crankcase Oil Pressure Adjustment

Corken's compressors are equipped with an automatically reversible gear type oil pump. Before starting the compressor, check and fill the crankcase with the proper amount of lubricating oil.

Make sure the pumping system is primed and the oil pressure is properly adjusted. When the compressor is first started, observe the pressure gauge on the crankcase. 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 opening for the pressure gauge or around the filter. Retighten the filter and reinstall the pressure gauge.

The oil pressure should be about 20 psi (1.4 bars) minimum for normal service. A spring-loaded relief valve mounted in the bearing housing opposite the oil pressure gauge 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 retighten it after making any adjustment.

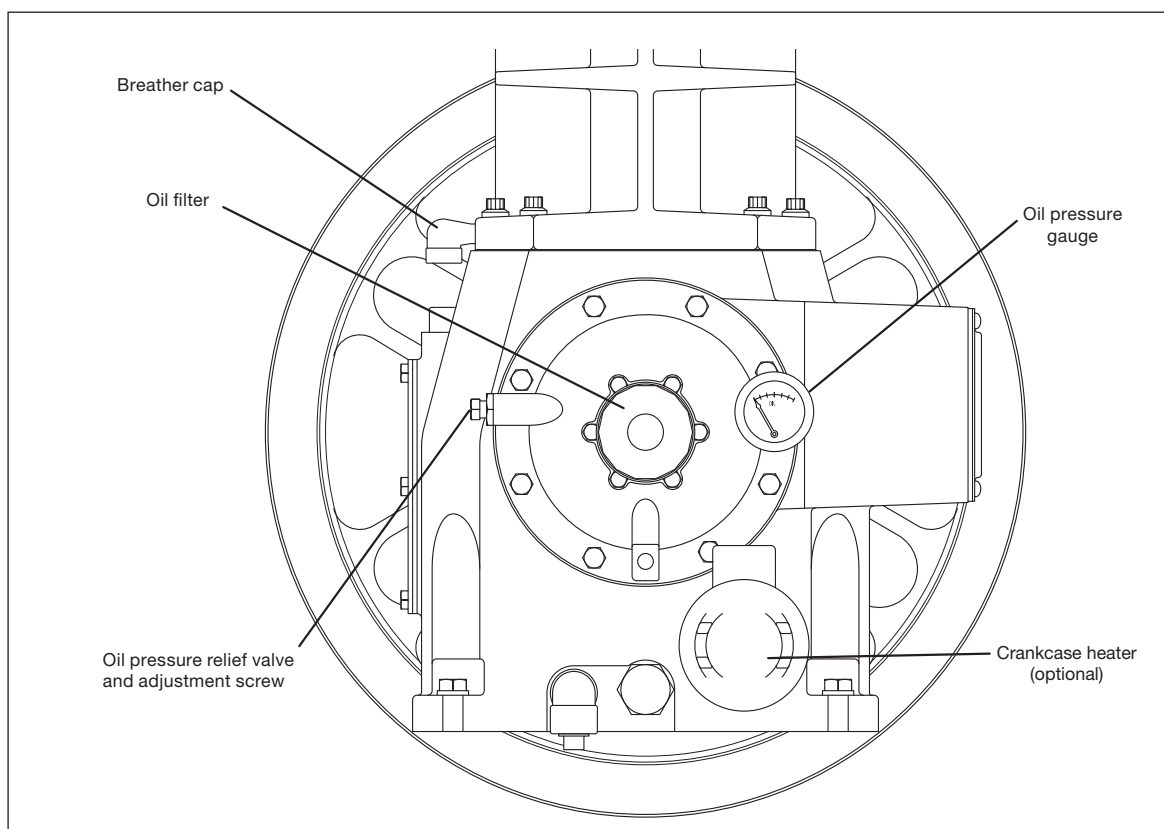


Figure 2.3: Oil pressure adjustment

2.4 Startup Check List

NOTE: Before starting the compressor, verify each item on the list below!

Failure to do so may result in a costly (or dangerous) mistake.

1. Become familiar with the function of all piping associated with the compressor. You must know each line's purpose!
2. Make certain actual operating conditions match the anticipated conditions.
3. Ensure line pressures are within cylinder pressure ratings.
4. Clean out all piping.
5. Ensure all distance piece openings are tubed or plugged as needed.
6. Check all mounting shims, cylinder, and piping supports and ensure 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 the V-belt tension and alignment or drive alignment on direct drive units.
10. Rotate flywheel by hand and make certain there is no wobble or play.
11. Confirm the oil level in the crankcase is correct.
12. Drain all liquid traps, separators, etc.
13. Verify proper electrical supply to the 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 items listed above.

After Starting Compressor

1. Verify and note oil pressure. Shut down and correct any problems immediately if the pressure is not within specification.
2. Observe the noise and vibration levels and correct immediately if excessive.
3. Confirm the RPMs are within 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 thirty minutes and one hour.
11. After one hour running time, tighten all head bolts, valve holddown bolts, and baseplate bolts.
12. If crankcase with lubricated guide option is installed, the top of the flywheel rotation must rotate towards the lubrication lines on the crosshead guide. As seen in Figure 2.4A **Do not operate the compressor in the opposite direction of rotation.**

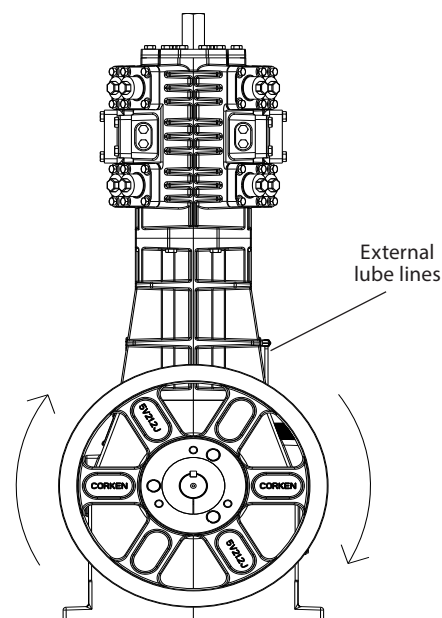


Figure 2.4A: Correct Flywheel Rotation

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			● ¹	● ¹	
Drain liquid from accumulation points		● ²			
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				● ³	

¹ 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 replacement filter 4225 with every oil change.

² Liquid traps should be drained prior to startup.

³ Piston ring life varies greatly, depending on application, gas, and operating pressures. Consult factory for additional recommendations for your specific application.

Chapter 4—Service Procedures

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

If routine maintenance is performed as listed in chapter four, repair service on Corken's 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 in Appendix D 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 still 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. NOTE: A faulty pressure gauge is also possible so make sure it is in good operational order before assuming the valves are faulty.

In most cases if a valve or gasket is leaking, it will create more heat. On a single-stage compressor, compare the operating temperatures of either 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 is not suitable for two-stage compressors that do not have at least two suction valves or two discharge valves per cylinder.

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

If a valve is leaking due to dirt or any other foreign material between the valve plate and seat, the valve can be cleaned and reused. However, new valve gaskets and O-rings should be used to ensure a proper seal.

Valve Inspection and/or Replacement

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

Disassembly

1. Unscrew the valve cap 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 using the special wrench supplied with the 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. If the valves show any damage, they should be repaired or replaced. Replacement is usually preferred since it always ensures a proper seal; however, repair parts are available. If valve plates are replaced, the existing valve seats must 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. Replacing valve plates without relapping the seat may cause rapid wear and leakage.

Reassembly

1. Insert the metal valve gasket into the suction and/or discharge opening of the cylinder. The metal valve gasket should always be replaced when a new or repaired valve is installed.
2. Insert the repaired or new valve assembly. Make sure each suction and discharge valve is placed in the proper opening in the cylinder.
3. Insert the valve cage.
4. Replace the O-ring and valve cover plate. Torque the bolts to the value listed in Appendix B.

NOTE: Make sure the holddown screw has been removed before tightening the bolts in the cover plate.

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. With a new O-ring, screw on the valve cap and tighten to the value listed in Appendix B.
7. Check bolts and valve holddown screws after first week of operation and re-torque if necessary. See Appendix B for torque values.

4.2 Heads/Cylinder Cap

A compressor cylinder cap and cylinder head very seldom require replacement if the compressor is properly maintained. The primary cause of damage to a cylinder cap or head is

corrosion, entry of solid debris, or liquid into the compression chamber. Improper storage methods can cause corrosive damage to the cylinder cap and cylinder head. For proper storage instructions, see chapter five.

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

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

4.3 Piston Rings and Piston Ring Expanders

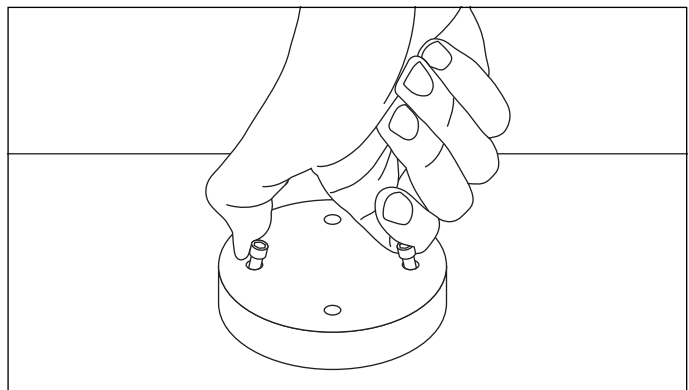


Figure 4.3: Piston cap removal

Piston ring life will vary considerably from application to application. Ring life is much longer at lower speeds and temperatures.

1. To replace the piston rings, depressurize the compressor and purge if necessary.
2. To gain access to the piston, remove the cylinder cap or cylinder head.
3. Loosen the piston cap bolts and remove the piston cap as shown in figure 4.3 by pinching two loose bolts together.
4. Remove the lock nut and lift the piston off the end of the piston rod.
5. After the piston is removed, the piston rings and expanders can be easily removed and replaced. Corken recommends replacing expanders whenever rings are replaced. To determine if the piston rings need to be replaced, measure the radial thickness and compare it to the chart in Appendix B.

4.4 Piston Replacement

1. To replace the pistons, depressurize the compressor and purge if necessary.
2. Remove the cylinder cap and cylinder head (see section 5.2).
3. Remove the piston cap by loosening and removing the socket head bolts holding the piston cap to the piston (see figure 5.3).
4. Next, remove the lock nut and lift the piston off the end of the piston rod.
5. Check the thrust washer and shims for damage and replace if necessary.
6. Before installing the new piston, measure the thickness of the existing shims.
7. Reinstall the piston with new piston rings and expanders using the same thickness of shims as before and tighten the lock nut to the torque value listed in Appendix B.
8. For this step please refer to the section labeled Piston Clearance (Cold) listed in Appendix D—Piston Assembly Details. Next, remove a lower valve and measure dimension Y at the bottom of the piston as shown in Appendix D. If the measurement does not fall between the minimum and maximum tolerances, adjust the shims as necessary and confirm dimension Y is within tolerance.
9. When the piston is properly shimmed to the tolerances listed in the table labeled Piston Clearance (Cold), tighten the lock nut as shown in Appendix B.
10. Reinstall the piston cap with the same thickness of shims as before and torque to the value listed in Appendix B.
11. Reinstall the cylinder head.
12. Now remove an upper valve and measure dimension X at the top of the piston shown in Appendix D—Piston Assembly Details. If this measurement does not fall within the tolerances in Appendix D, remove the cylinder head and piston cap and adjust the shims as necessary. Repeat the steps and measure dimension X is within tolerance.
13. When the piston cap is properly shimmed, tighten the socket head bolts in an alternating sequence and torque the socket head bolts to the values listed in Appendix B.
14. Reinstall valves in the proper suction and discharge openings. NOTE: For best results insert new valve gaskets before reinstalling the valves.
15. Follow standard startup procedures.

4.5 Cylinder and Packing Replacement

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

If the cylinder is damaged or corroded, use a honing device 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. **OVERBORING THE CYLINDER RESULTS IN GREATLY REDUCED RING LIFE.**

Many compressor services 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.

Packing Replacement

For specific construction details and actual part numbers, consult Appendix D. Be careful to arrange packing sets in the proper order.

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

Cleanliness:

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

Workmanship:

Corken's compressors are a precision piece of equipment with very close tolerances so treat them with care and never hammer parts in or out of the compressor.

Disassemble D-Style Packing

1. Depressurize and open the compressor.
2. Remove the cylinder cap, cylinder heads, pistons, and cylinder.
3. Remove the packing barrels by prying upwardly under each one and lifting entire packing barrel and cartridge assembly up from piston rod.
4. Remove the four socket head screws that hold the packing box cartridge to the barrel.
5. Remove segmented packing and cups from barrel.
6. Remove the four socket head screws from the cartridge cap to remove the U-cup packing.

Segmented packing:

NOTE: The instructions below are for packing specification G. Depending on the packing specification used in the compressor, the order of assembly for the segmented packing arrangement (radial or tangent) will vary. Refer to Appendix D to view the segmented packing arrangements. If you do not know the packing arrangement used in the compressor, refer to the model number identification table listed in Appendix A.

- a. Clean the segmented packing cups and the area inside the packing barrel.
 - b. Insert the segmented packing cups, segmented packing pairs, and backup rings one at a time in the order shown in Appendix D.
 - c. Reattach the packing adapter to the packing barrel using the four socket head screws.
 - d. Install TWO O-rings on the packing barrel as shown in the D-Style Crosshead Guide Assembly Details in Appendix D.
7. Install the packing installation cone (part number 9937) over the threaded end of the piston rod as shown in Connecting Rod and Crosshead Assembly Details - Appendix D.
 8. NOTE: Before installing the packing box cartridge over the packing cone and piston rod, ATTACH THE TWO O-RINGS SHOW IN THE D-STYLE CROSSHEAD GUIDE ASSEMBLY DETAILS-APPENDIX D. Next, insert the oil deflector ring through the side opening of the packing box cartridge. The oil deflector ring should rest on top of the lower packing set. Make sure the oil deflector ring is centered over the piston rod opening before sliding packing cartridge over the installation cone and piston rod.
 9. Install cages.

10. Install and tighten holddown screws with Corken's special compressor wrench.
11. Install packing barrels. NOTE: The valve scallops on the barrels must align properly with the valves in the cylinder.
12. Remove the packing installation cone.
13. Replace cylinder, pistons, cylinder heads, and cylinder cap. See details in Sections 4.2 through 4.4 for proper assembly of pistons.
14. Rotate the flywheel by hand to ensure proper assembly.

4.6 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 cylinder caps, cylinder heads, cylinder, pistons, crosshead guide, and crosshead assemblies.
2. Drain the crankcase and remove the access cover.
3. Before disassembly, choose and mark one connecting rod and the corresponding connecting rod cap. DO NOT MIX CONNECTING RODS AND CAPS. Loosen and remove the connecting rod bolts in order to remove the crosshead and connecting rod assembly.

4.6.1 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 can 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. 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. Bore the wrist pin bushing I.D. as indicated (see Appendix D for 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.

4.6.2 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. **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.

4.6.3 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 4.6).

3. In order to check the crankshaft endplay, the oil pump must be removed (see section 5.8).
4. Press the end of crankshaft towards the crankcase; if a clicking noise or motion is detected, the crankshaft has too much 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 then the crankshaft bearings are too tight. When the crankshaft is too tight, add more shims but do not 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.

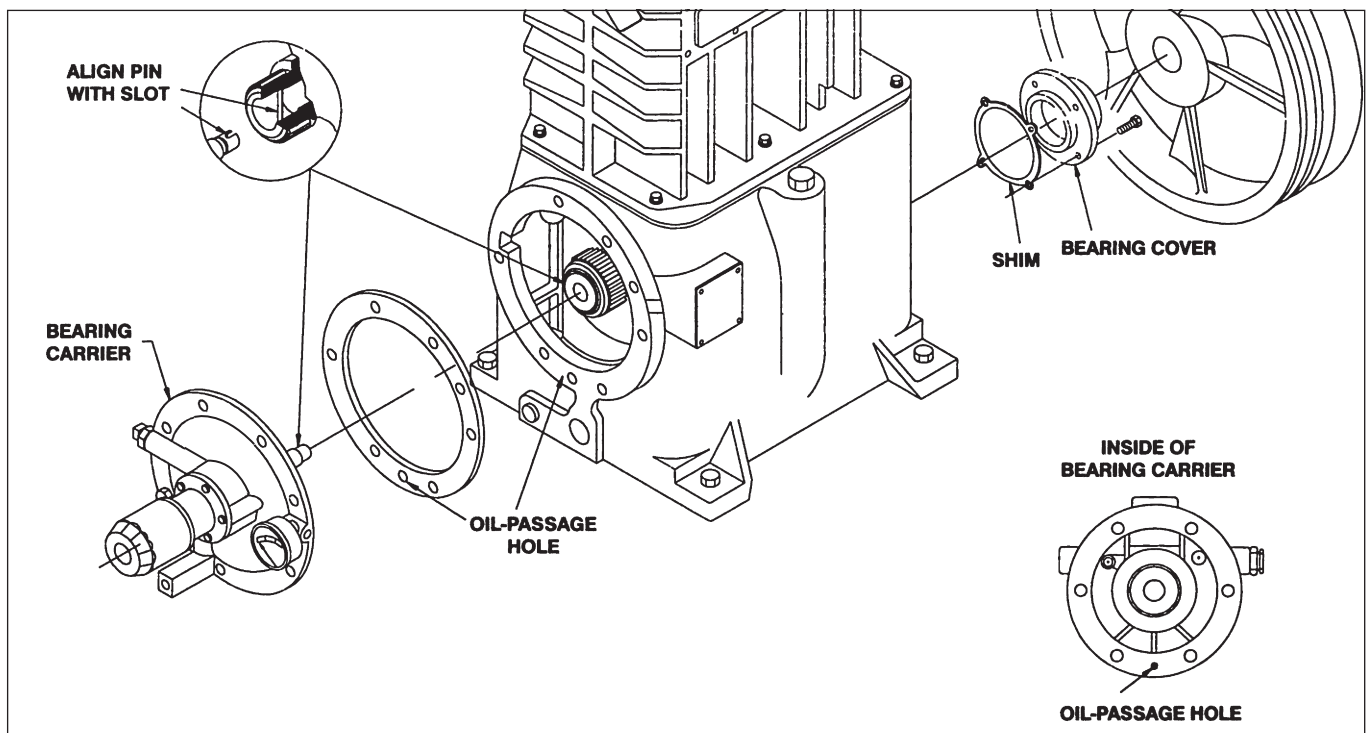


Figure 4.6: Bearing carrier replacement

4.7 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 5.8.
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.
4. Before reassembling the oil pump mechanism, replace the O-rings in the oil pump cover and on the oil pump adapter shaft (see figure 4.7).
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 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 4.7. 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.

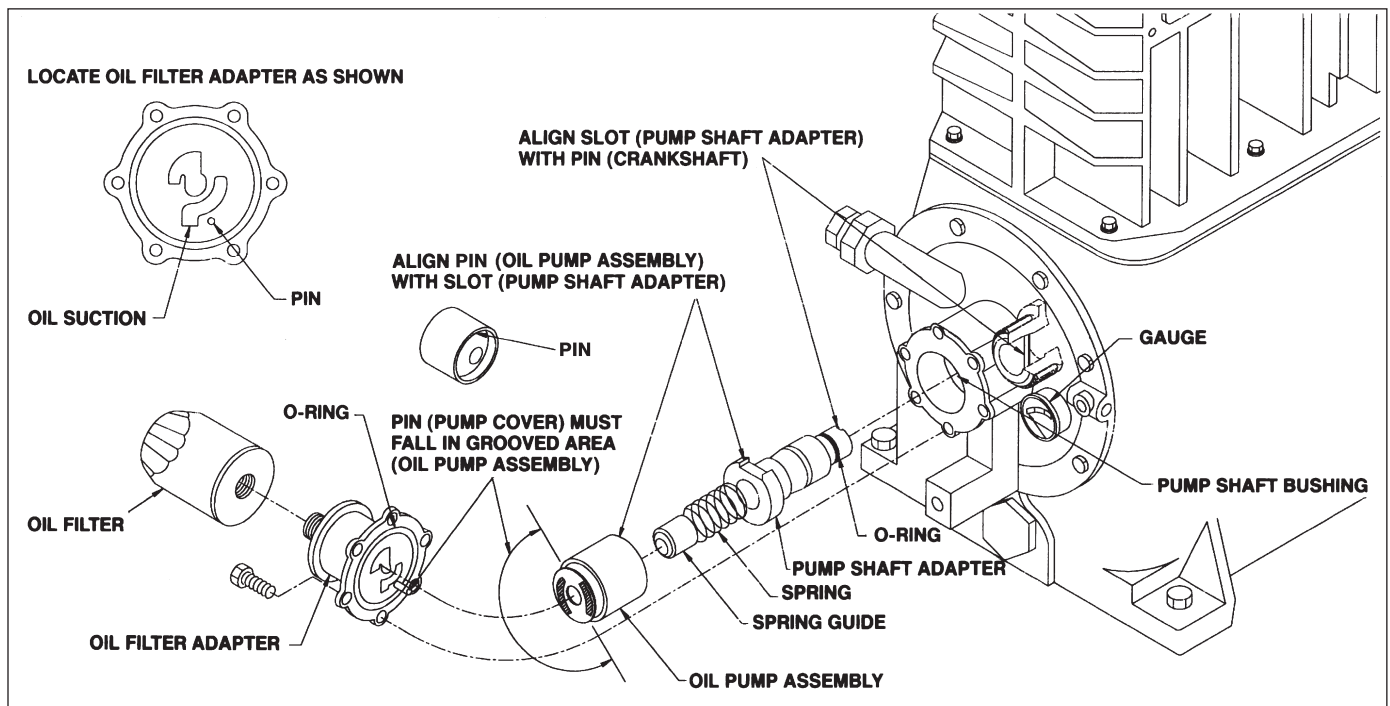


Figure 4.7: Oil pump inspection

Appendix A—Model Number Identification Code and Available Options

Double Acting, Two Stage Model with Weld Flange Connections (D-Style 991)

Double Packed	BASE MODEL NUMBER		AIR COOLED		MODEL NUMBER												
			D991		BASE X X X X X X X X X X X X X X												
	Inlet		3" weld														
	Outlet		2" weld														
	Intercooler connection (First Stage Outlet / Second Stage Inlet)		3" weld / 2" weld														
	Ship weight (lb)		1425														
SPECIFICATION FIELDS																	
Packing	Packing arranged for U-cup lip seal		Standard		U												
Crankcase	Pressure lubricated crankcase		Standard		M												
	Std. crankcase with crankcase heater		Consult Factory		MH												
	Crankcase with lubricated guide (c)		Available		MT												
	Crankcase with lubricated guide and crankcase heater (c)		Consult Factory		MTH												
Valves	Standard suction & discharge valves w/stainless steel plates		Standard		4S												
	Standard suction & discharge valves w/PEEK plates		Consult Factory		4P												
	Suction valve unloaders w/stainless steel plates		Available		9S												
	Suction valve unloader w/PEEK plates		Consult Factory		9P												
Piston Ring & Packing	Alloy piston rings with U-cup lip seal packing		Standard		U												
Gasket	Steel		Standard		D												
O-rings	Buna-N		Consult Factory		A												
	Neoprene® (a)		Consult Factory		B												
	Viton® (a)		Standard		D												
	PTFE and Kalrez® (a)		Consult Factory		E												
Intercooler Connections	Weld flanges only (less intercooler)		Standard		F												
Flywheel	Less flywheel		Available		N												
	Standard flywheel		Standard		S												
Protective Coating	Cylinder only		Consult Factory		C												
	Less coating		Standard		N												
	All necessary wetted parts		Consult Factory		W												
Piston Rod Coating	Nitrotec® (b)		Standard		N												
Inlet & Outlet Connections	2" NPT connection in lieu of 3" & 2" weld flanges		Available		1												

(a) Registered trademarks of DuPont

(b) Nitrotec® is a registered trademark of TTI Group Ltd

(c) If lubricated guide option installed, reference page 12 for flywheel rotation requirement

Appendix B—Specifications

Operating Specifications

Specification	D991
Bore of cylinder, inches (mm) First stage Second stage	6.375 (161.9) 3.50 (88.9)
Stroke, inches (mm)	4.0 (101.6)
Piston displacement, cfm (m ³ /hr) Minimum @ 400 RPM Maximum @ 885 RPM	58.0 (98.5) 128.7 (218.7)
Maximum working pressure, psig (bar g) First stage Second stage	350 (24.1) 800 (41.3)
Maximum brake horsepower, kW	100 (73.5)
Maximum rod load, lb (kg)	8,500 (3855)
Maximum outlet temperature °F (°C)	350 (177)

Clearances and Dimensions

Specification	Inches
Piston clearance (see Appendix D)	
Clearance: connecting rod bearing to crankshaft journal	0.0019 0.0035
Clearance: wrist pin to wrist pin bushing (maximum) ³	0.0009 0.0015
Cylinder bore diameter (maximum) First stage 991 Second stage 991	6.939 3.510
Cylinder finish	16–32 RMS
Piston ring radial thickness (minimum) First stage 991 Second stage 991	0.155 0.082
Clearance: oil pump adapter shaft to bushing (maximum) ³	0.0050
Crankshaft end play (cold)	0.002 0.003
Flywheel runout at O.D. (maximum)	0.020
Clearance: crosshead to crosshead guide bore (maximum)	0.008
Crosshead guide bore finish (limited number of small pits and scratches are acceptable)	32 RMS

Bolt Torque Values

Specification	ft•lb (N•m)
Connecting rod bolt	40 (54.23)
Bearing carrier	40 (54.23)
Bearing cover	40 (54.23)
Crankcase inspection plate	9 (12.2)
Crosshead guide	65 (88.13)
Cylinder to head ^{1, 2}	65 (88.13)
Valve cover plate bolt	37 (50.17)
Valve holddown screw ²	40 (54.23)
Piston lock nut	150 (203.37)
Piston screw	8 (10.85)
Valve cap	25 (52.88)

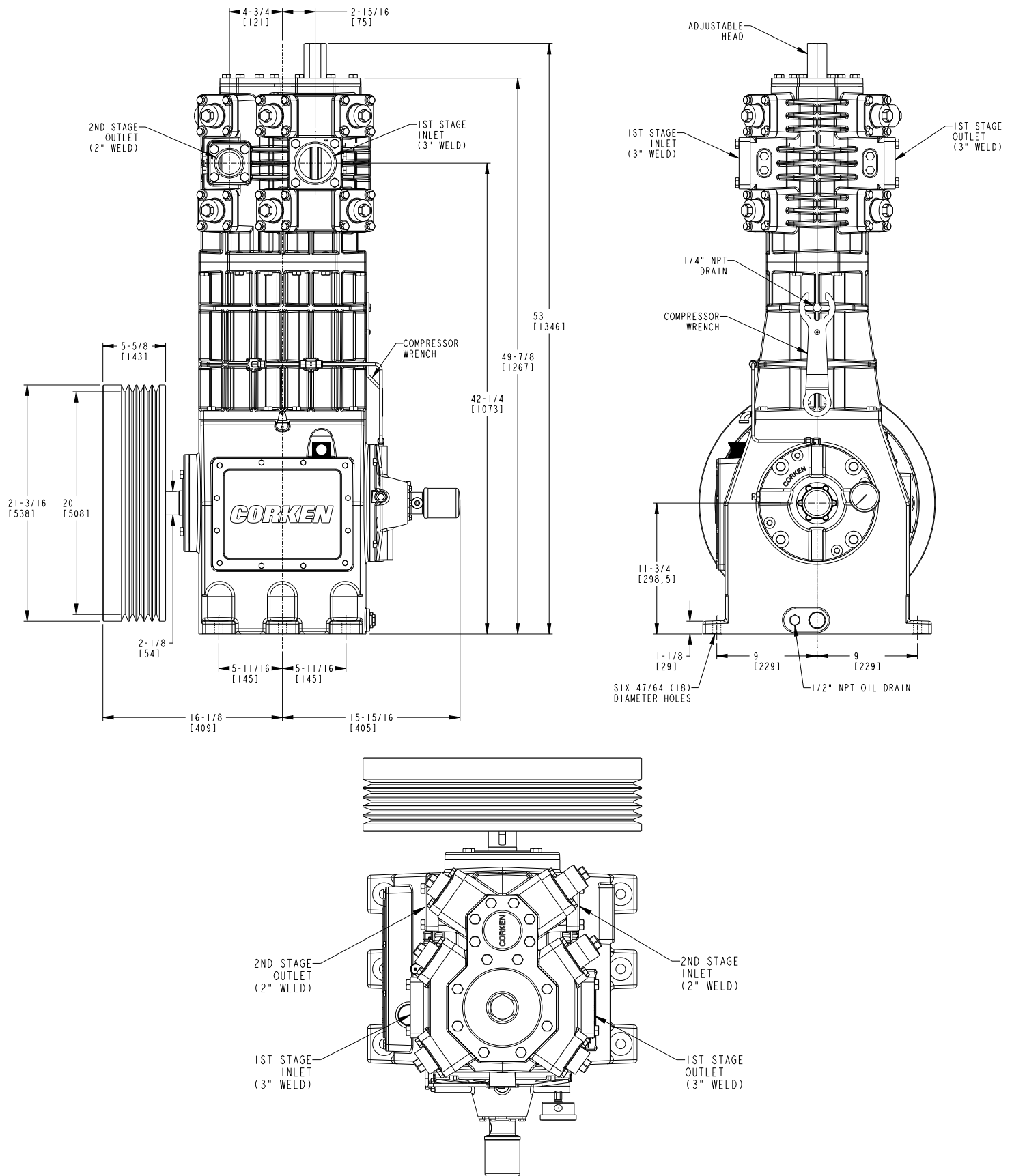
¹ Preliminary tightening—snug all head bolts in the sequence shown. Final torquing—torque all head bolts in the sequence shown to the listed value.

² Retorque to the listed value after 2–5 hours running time.

³ Dimensions for honing are included with new bushings (which must be installed, then honed).

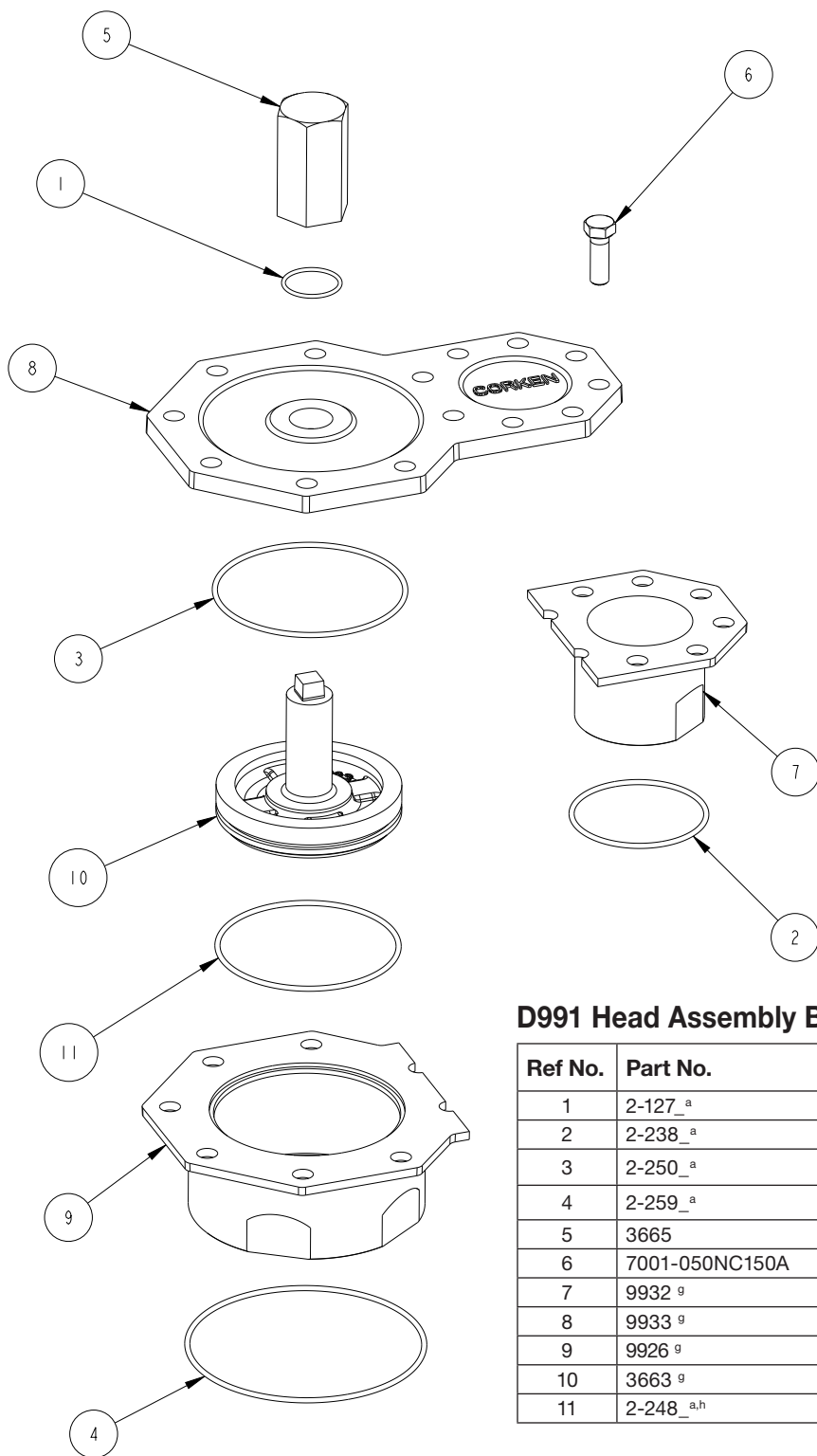
Appendix C—Outline Dimensions

Model D991 (Two Stage) Bare Compressor with Flywheel



All dimensions are in inches (millimeters).

Appendix D—Head Assembly Details for Model D991



D991 Head Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1	2-127_ ^a	O-ring	1
2	2-238_ ^a	O-ring	1
3	2-250_ ^a	O-ring	1
4	2-259_ ^a	O-ring	1
5	3665	Adjusting screw nut	1
6	7001-050NC150A	1/2-13 x 11 /2 Hex head bolt	14
7	9932 ^g	Cylinder head - 3.5"	1
8	9933 ^g	Adjusting cap	1
9	9926 ^g	Cylinder head - 6.375"	1
10	3663 ^g	Adjusting cup	1
11	2-248_ ^{a,h}	O-ring	1

Material Code	
A	Buna-N
B	Neoprene ^{®f}
D	Viton ^{®f}
E	PTFE

^a Denotes O-ring material code.

^b Included with valve assembly.

^c Included with unloader assembly.

^d Included with valve repair kit.

^e Install spacers back to back.

^f Registered trademark of the DuPont company.

^g Add "C" to end of the part number if the item requires MC1002 coating.

^h If material code calls for E (PTFE), use K (Kalrez).

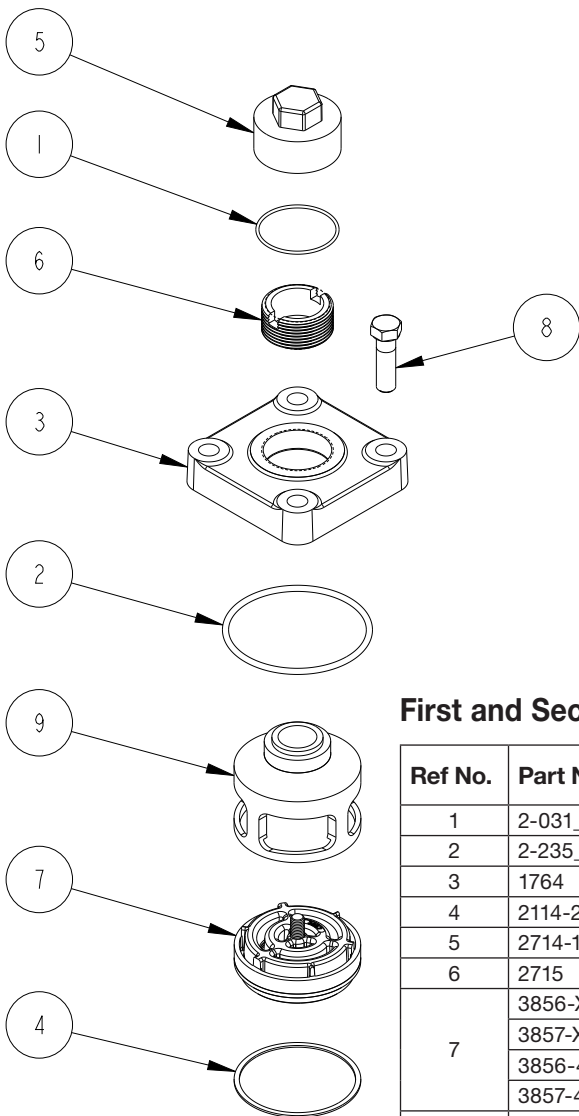


WARNING

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

Appendix D (Continued)—Valve Holddown Assembly Details for Model 991

First and Second Stage Holddown Assy.



First and Second Stage Holddown Assy. Bill of Materials

Ref No.	Part No.	Description	Qty. Per Compressor
1	2-031_a	O-ring	12
2	2-235_a	O-ring	12
3	1764	Cover plate	12
4	2114-2	Valve gasket	12
5	2714-1	Valve cap	12/6
6	2715	Hold down screw	12
7	3856-X2	Suction valve assembly (1st stage)	4
	3857-X2	Discharge valve assembly (1st stage)	4
	3856-4X2	Suction valve assembly (2nd stage)	2
	3857-4X2	Discharge valve assembly (2nd stage)	2
8	7001-043NC150A	7/16-14 x 1 1/2 Hex head bolt	48
9	9934_g	Valve cage	12

Material Code	
A	Buna-N
B	Neoprene ^{®f}
D	Viton ^{®f}
E	PTFE

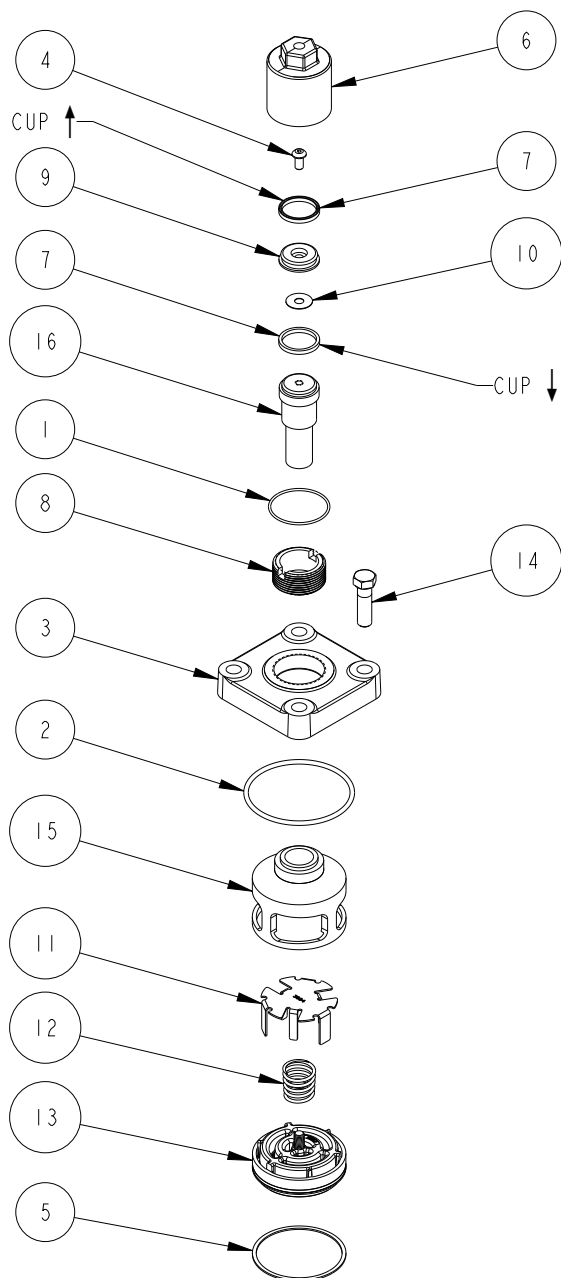
- a Denotes O-ring material code.
- b Included with valve assembly.
- c Included with unloader assembly.
- d Included with valve repair kit.
- e Install spacers back to back.
- f Registered trademark of the DuPont company.
- g Add "C" to end of the part number if the item requires MC1002 coating.
- h If material code calls for E (PTFE), use K (Kalrez).



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

Appendix D (Continued)—Holddown Assy. Unloader Details for Model 991

First and Second Stage 991 Holddown Assy. Unloaders Bill of Materials



Ref No.	Part No.	Description	Qty. Pe Compressor
1	2-031 ^a	O-ring	6
2	2-235 ^a	O-ring	6
3	1764	Cover plate	6
4	1910	Bolt	6
5	2114-2	Valve gasket	1
6	2598-1 ^g	Unloader cap	6
7	2619-X	Seal assembly - unloader piston	12
8	2715 ^g	Hold down screw	1
9	2857	Piston cap	6
10	2858	Gasket	6
11	3694	Unloader actuator (1st stage)	4
	3956	Unloader actuator (2nd stage)	2
12	3695	Spring	6
13	3856-X2	Suction valve assembly (1st stage)	4
	3856-4X2	Suction valve assembly (2nd stage)	2
14	7001-043NC150A	7/16-14 x 1 1/2 Hex head bolt	24
15	9934 ^g	Valve cage	1
16	9938	Unloader piston (1st stage)	4
	9939	Unloader piston (2nd stage)	2
17	????	Unloader assembly (1st Stage)	4
18	????	Unloader assembly (2nd Stage)	4

Material Code

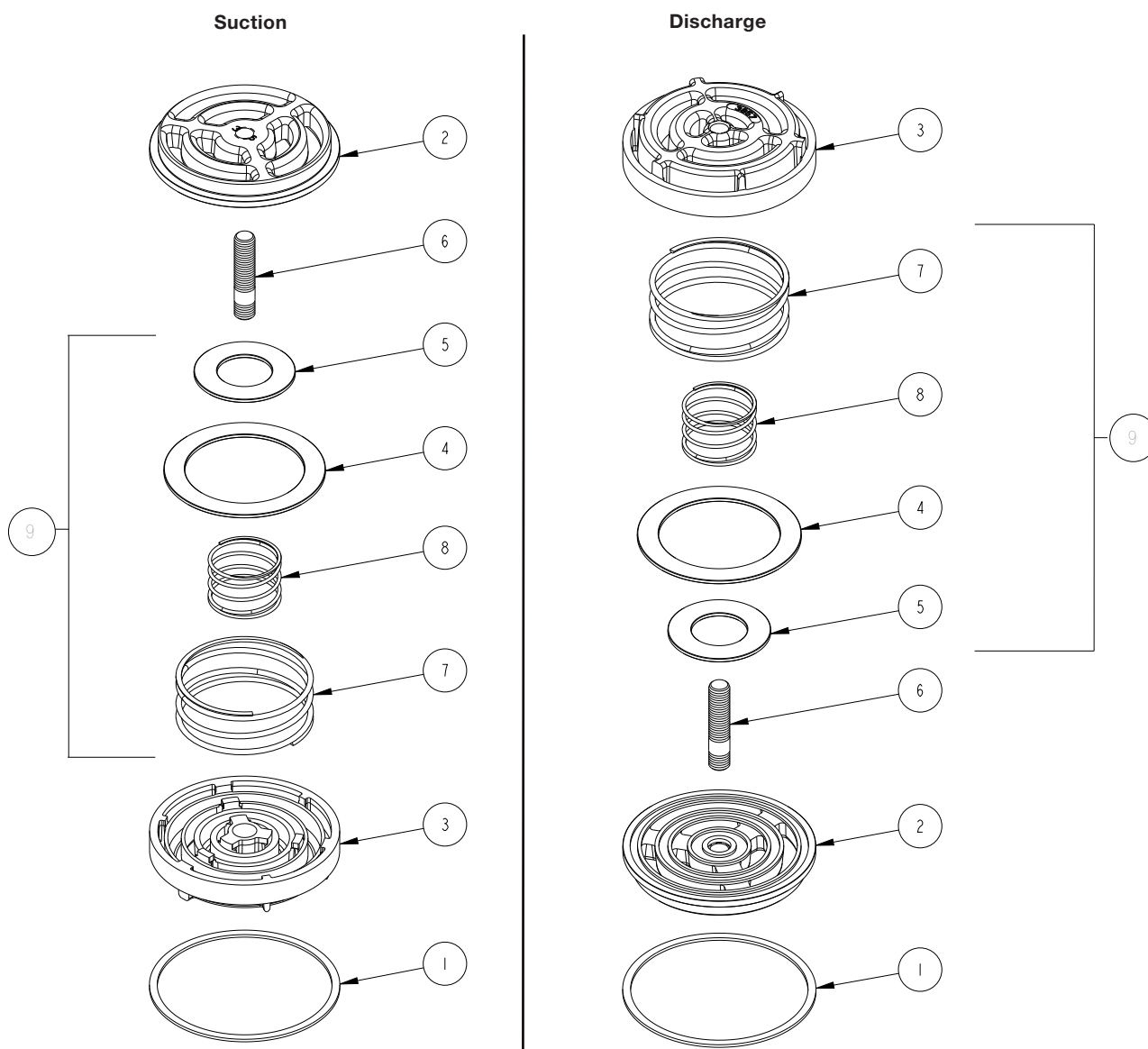
A	Buna-N
B	Neoprene ^{®f}
D	Viton ^{®f}
E	PTFE

- a* Denotes O-ring material code.
b Included with valve assembly.
c Included with unloader assembly.
d Included with valve repair kit.
e Install spacers back to back.
f Registered trademark of the DuPont company.
g Add "C" to end of the part number if the item requires MC1002 coating.
h If material code calls for E (PTFE), use K (Kalrez).



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

Appendix D (Continued)—Valve Assembly Details for Model 991



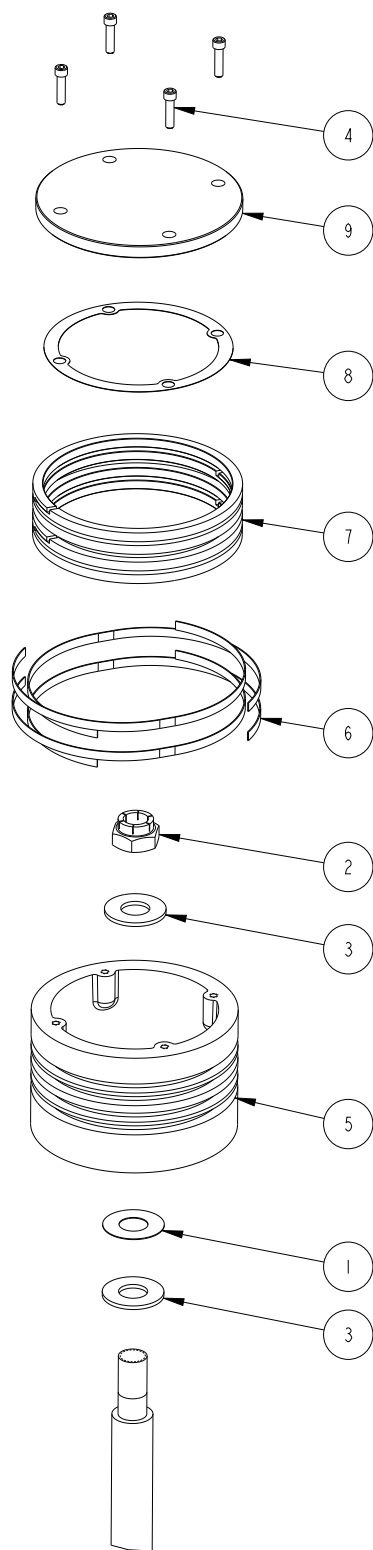
D991 Valve Assy. Bill of Materials

Ref No.	Part No.	Description	Qty. Per Valve Assy.
1	2114	Valve gasket	1
2	3856	Valve seat	1
	3856-4	Valve seat (2nd stage)	1
3	3857	Valve bumper	1
4	3871	Outer plate, s.s.	1
5	3872	Inner valve plate, s.s.	1
6	3920	Valve stud	1
7	3928	Outer spring	1
8	3929	Inner spring	1
9	3146-X1	Valve repair kit	1



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

Appendix D (Continued)—6.375" Piston Assembly Details for Model



6.375" Piston Assembly (9921-X) Bill of Materials

Ref. No.	Part No.	Description	Qty. Per Piston
1.	3603	Shim washer - Thick	As req.
	3603-1	Shim washer - Thin	
2.	3604	Locknut	1
3.	3730	Piston thrust washer	2
4.	7002-025TP100A	Socket head screw (torque to 8ft*lbs)	4
5.	9921 ^a	Piston - 6.375"	1
6.	9922	Expander ring - 6.375"	4
7.	9923	Piston ring - Alloy	4
8.	9924	Piston cap shim - Thick	As req.
	9924-1	Piston cap shim - Thin	
9.	9925 ^a	Piston cap - 6-3/8" - Thick	1

Piston Clearance (Cold)

Model	(X) Top Min. ^b	(X) Top Max. ^b	(Y) Bottom Min. ^c	(Y) Bottom Max. ^c
D991	0.084" (2.13 mm)	0.104" (2.64 mm)	0.010" (0.25 mm)	0.020" (0.50 mm)

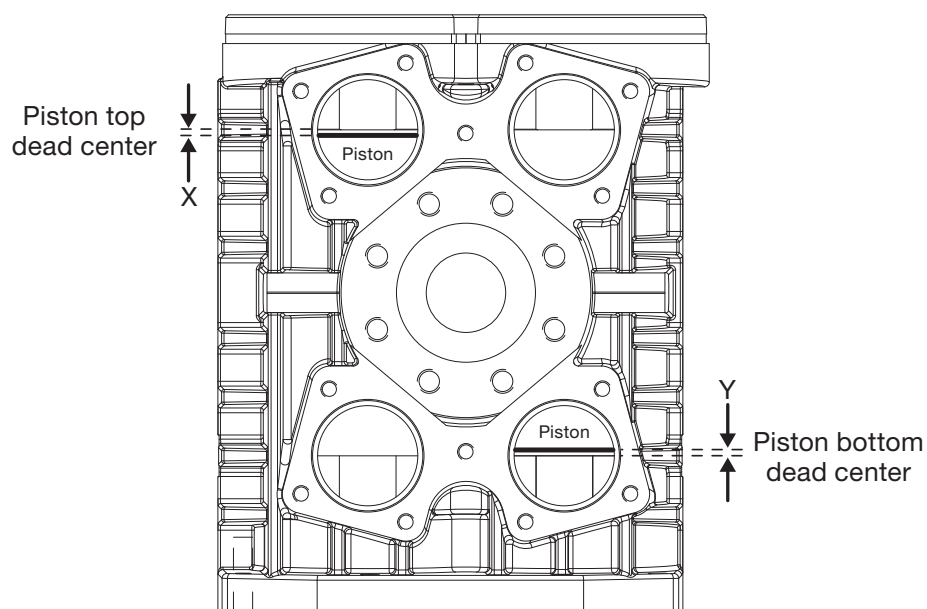
^a MC1002 coated piston and cap available. Add "C" to end of a standard part number (e.g. 3562C)

^b The distance from the bottom of the head to the top of the piston.

^c The distance from the bottom of the piston to the top of the packing barrel.

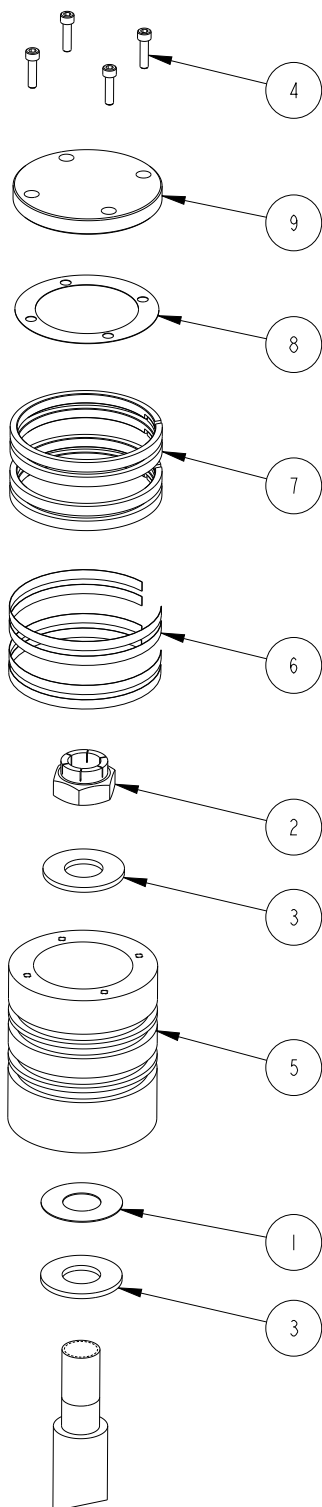


CAUTION: Always relieve pressure in the unit before attempting any repairs.



Appendix D (Continued)—3.50" Piston Assembly Details for Model 991

3.50" Piston Assembly (9927-X) Bill of Materials



Ref. No.	Part No.	Description	Qty. Per Piston
1.	9930	Shim washer - Thick	As req.
	9930-1	Shim washer - Thin	
2.	3604	Locknut	1
3.	3730	Piston thrust washer	2
4.	7002-010NC075A	Socket head screw (torque to 8ft*lbs)	4
5.	9927 ^a	Piston - 3.50"	1
6.	9928	Expander ring - 3.50"	4
7.	9929	Piston ring, Alloy	4
8.	9924	Piston cap shim - Thin	As req.
	9924-1	Piston cap shim - Thick	
9.	9931 ^a	Piston cap - 6-3/8"	1

Piston Clearance (Cold)

Model	(X) Top Min. ^b	(X) Top Max. ^b	(Y) Bottom Min. ^c	(Y) Bottom Max. ^c
D991	0.084" (2.13 mm)	0.104" (2.64 mm)	0.010" (0.25 mm)	0.020" (0.50 mm)

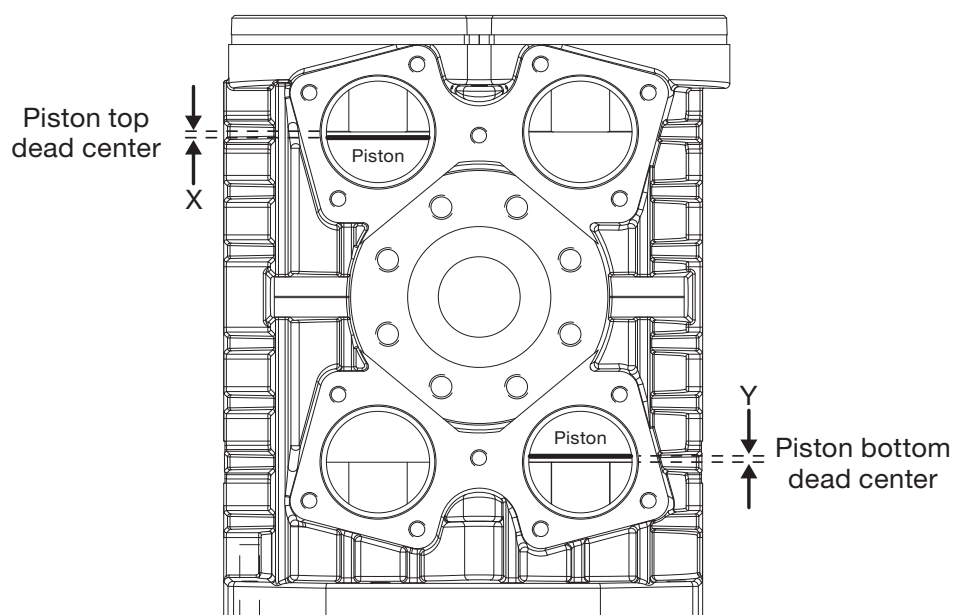
^a MC1002 coated piston and cap available. Add "C" to end of a standard part number (e.g. 3562C)

^b The distance from the bottom of the head to the top of the piston.

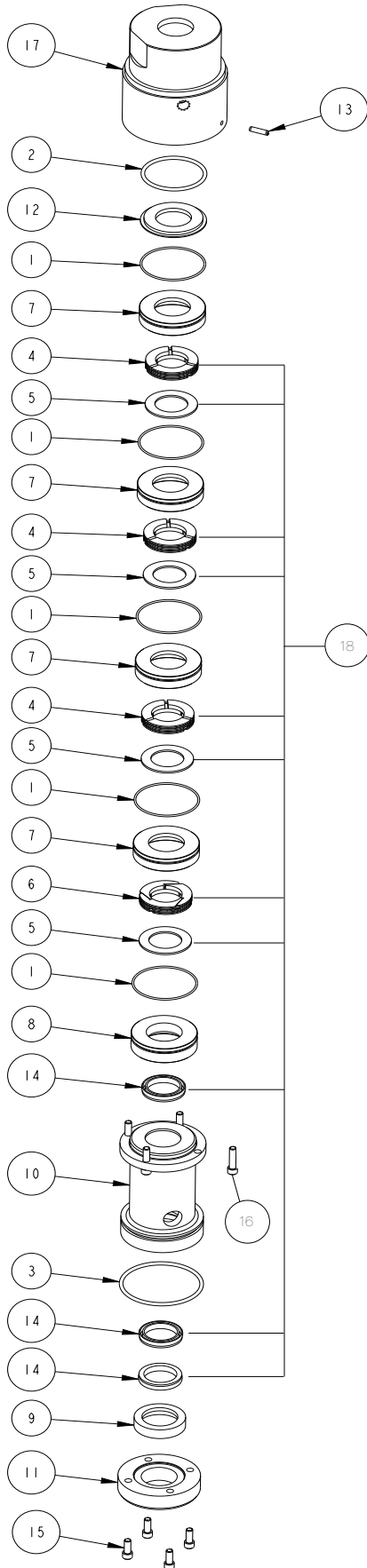
^c The distance from the bottom of the piston to the top of the packing barrel.



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



Appendix D—Packing Assembly Details for Model D991



Packing Assembly (9919-X1_ & 9918-X1_) Bill of Materials

Ref. No.	Part No.	Description	Qty. Per Compressor
1.	2-036_ ^{a,e}	O-ring	10
2.	2-228_ ^{a,e}	O-ring	2
3.	2-231_ ^{a,e}	O-ring	2
4.	3810	Segmented packing - rad tan	6
5.	3811	Packing backup ring	8
6.	3814	Segmented packing - tan tan	2
7.	3817	Packing cup	8
8.	3817-1	Packing cup, lip seal, barrel	2
9.	3817-2	Packing cup, lip seal, cartridge	2
10.	3855-1 ^f	Packing box cartridge	2
11.	3855-2 ^f	Packing cartridge cap, lip seal	2
12.	4272	Purge packing spacer	2
13.	4702	Roll pin- 3/16 X 3/4" (Second stage only)	2
14.	5070	Lip seal	6
15.	7002-025NC062A	Socket head bolt	8
16.	7002-025TP100A	Socket head screw	8
17.	9919 ^f	Packing barrel (3-1/2" cylinder) (Second stage)	1
	9918 ^f	Packing barrel (6-3/8" cylinder) (First stage)	1
18.	3814-X4	Segmented packing set	1

a Denotes O-ring material code.

b Deflector ring is loose within the packing cartridge until fitted on the piston rod. Must be put in from the bottom of the cartridge.

c Starting with serial number NN51397.

d Registered trademark of the DuPont company.

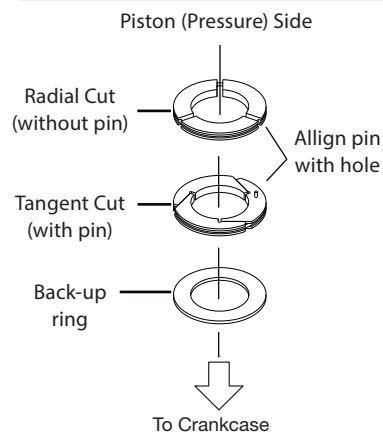
e If the material code call for E, use K for this part number.

f Add "C" to end of the part number if the item requires MC1002 coating

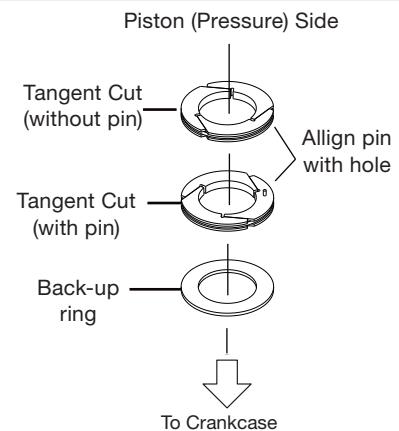


CAUTION: Always relieve pressure in the unit before attempting any repairs.

3810 Orientation



3814 Orientation



Appendix D Appendix D (Continued)—Crosshead Guide Parts Details

Crosshead Guide Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2-231 ^a	O-ring	2
2.	2-238 ^{a,c}	O-ring	3
3.	2-259 ^{a,c}	O-ring	1
4.	1064	Street elbow, 1/4"	1
5.	1399-1	Tube fitting 90 °elbow	2
6.	1435-1	Tube tee-1/4T X 1/8P steel	1
7.	2590	Pipe plug 1/8" npt flush plug	2/4
8.	2644	Compressor wrench	1
9.	3442	Pipe plug - 1/4 npt	9
10.	3793-2S	Flange - 2" npt ductile iron	2
11.	3794-2S	Flange - npt 2"	2
12.	7001-050NC175A	1/2-13 x 1 3/4 Hex head bolt	40
13.	7001-025NC050A	1/4-20 X 1/2" Hex head bolt	1
14.	9916	Crankcase gasket	1
15.	9917	Crosshead guide	1
16.	9918-X1	Packing box assembly, lip seal, 6-3/8"	1
17.	9919-X1	Packing box assembly, lip seal, 3-1/2"	1
18.	9920 ^d	Cylinder	1
19.		Tube,ss,14 x .035, 3.800 in long	1
20.	2-242 ^a	O-ring	2

Material Code

A	Buna-N
B	Neoprene ^{®b}
D	Viton ^{®b}
E	PTFE
K	Kalrez ^{®b}

^a Denotes material code.

^b Registered trademark of the DuPont company.

^c When PTFE is specified as the trim option for the compressor, this O-ring must be Kalrez.

^d Add "C" to end of the part number if the item requires MC1002 coating

NOTE:

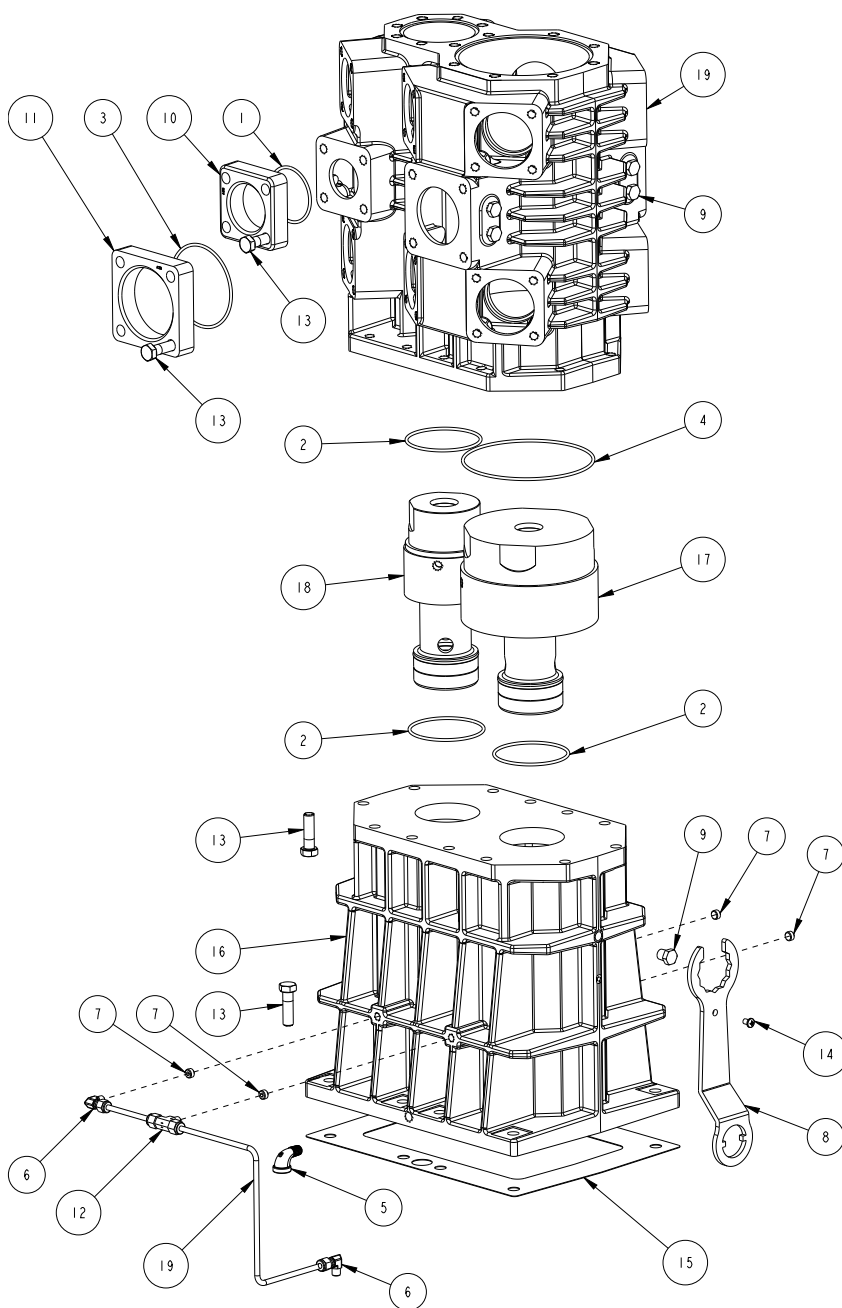
Packing barrel installation:

1. Use packing installation cone #9937 on the piston rod.
2. Insert small barrel first, use finger holes to align slinger ring on to the rod. Slip the packing barrel into place.
3. Align pin with slot in large packing barrel.
4. Slip large packing barrel in place.

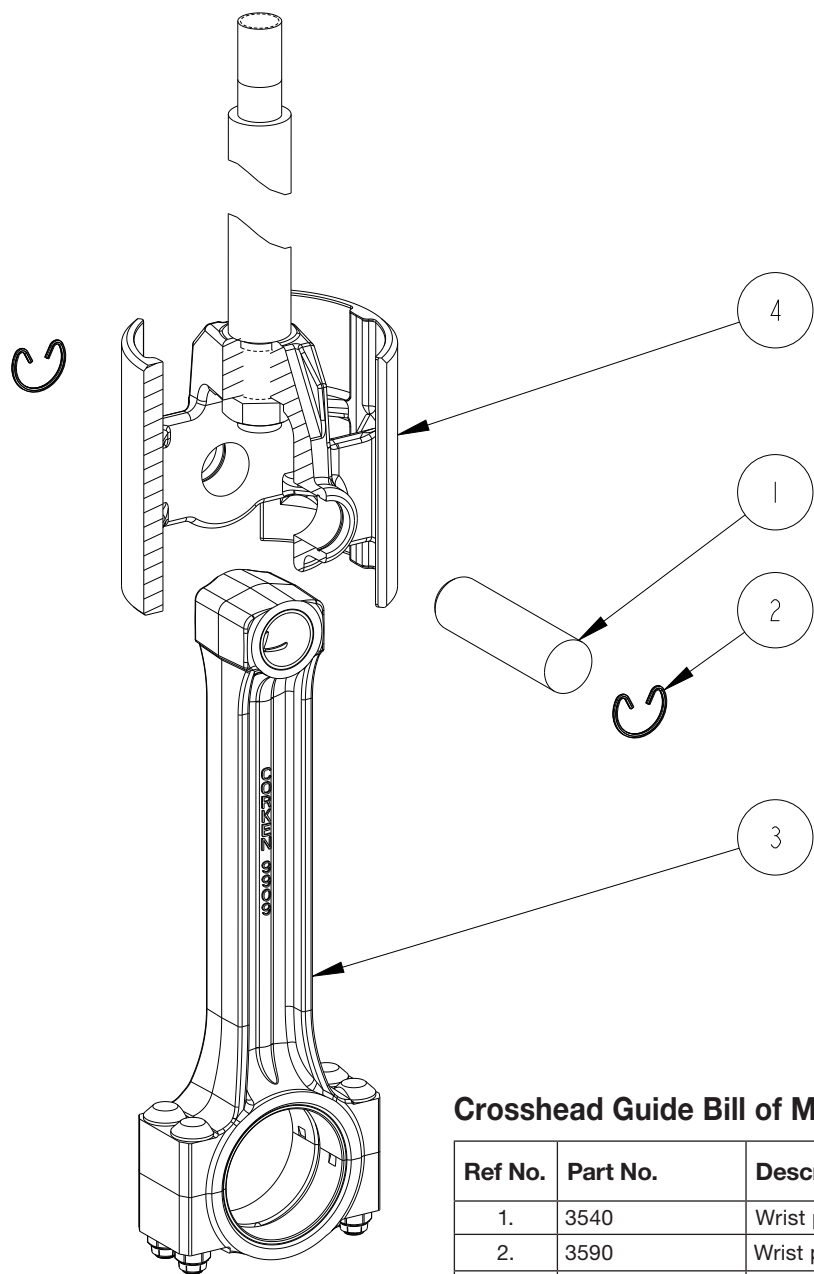
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.



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



Appendix D (Continued)—Crosshead Assembly Parts Details for Model D991



Crosshead Guide Bill of Materials

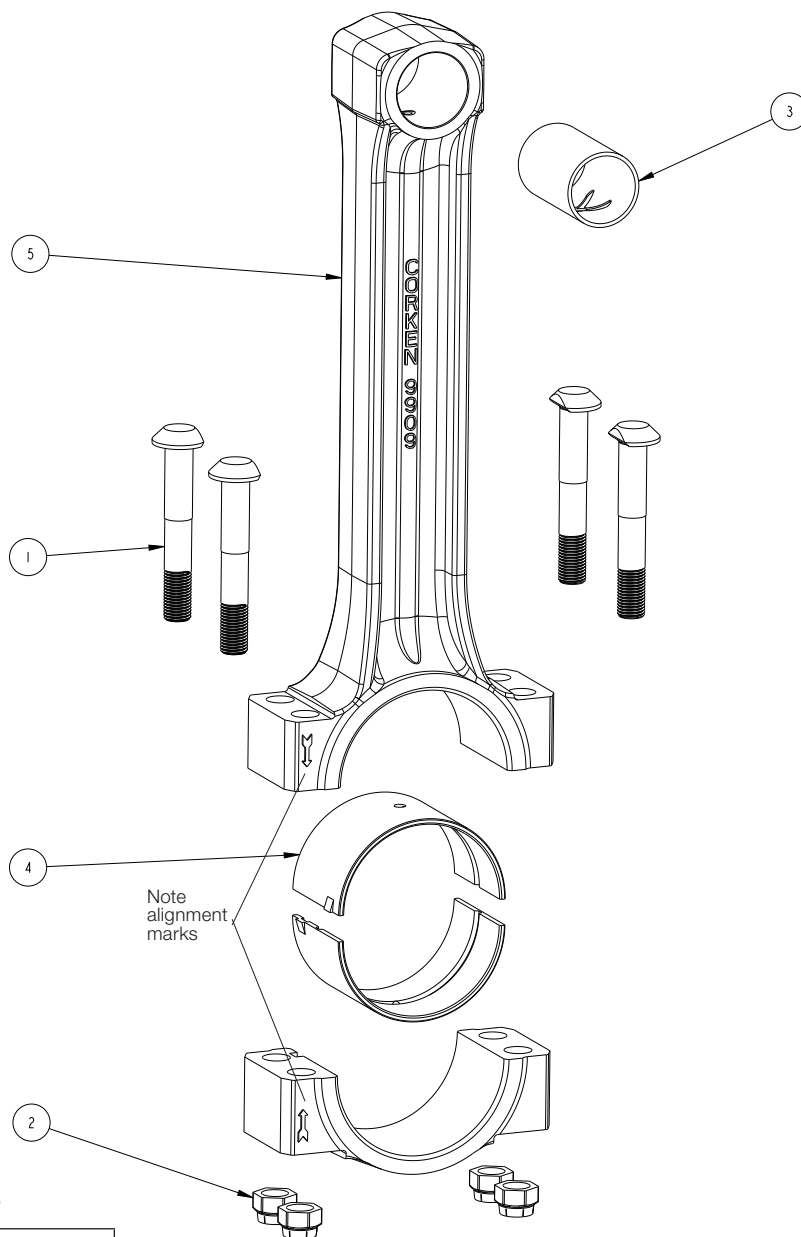
Ref No.	Part No.	Description	Qty. Per Compressor
1.	3540	Wrist pin	2
2.	3590	Wrist pin retainer ring	4
3.	9909-X	Connecting rod assembly	2
4.	9910-X	Crosshead assembly	2

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



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

Appendix D Appendix D (Continued)—Connecting Rod Assembly (9909-X) Parts Details



Connecting Rod (9909-X) Bill of Materials

Ref No.	Part No.	Description	Qty. Per Conn. Rod
1.	1726 ^{a,b}	Connecting rod bolt	4
2.	1727 ^{a,c}	Connecting rod nut	4
3.	3541-X ^a	Wrist pin bushing	1
4.	3542	Connecting rod bearing - pair	2
5.	9909-X	Connecting rod assembly	1

^a Included with connecting rod assembly

^b Torque connecting rod nut to 40 ft. lbs.

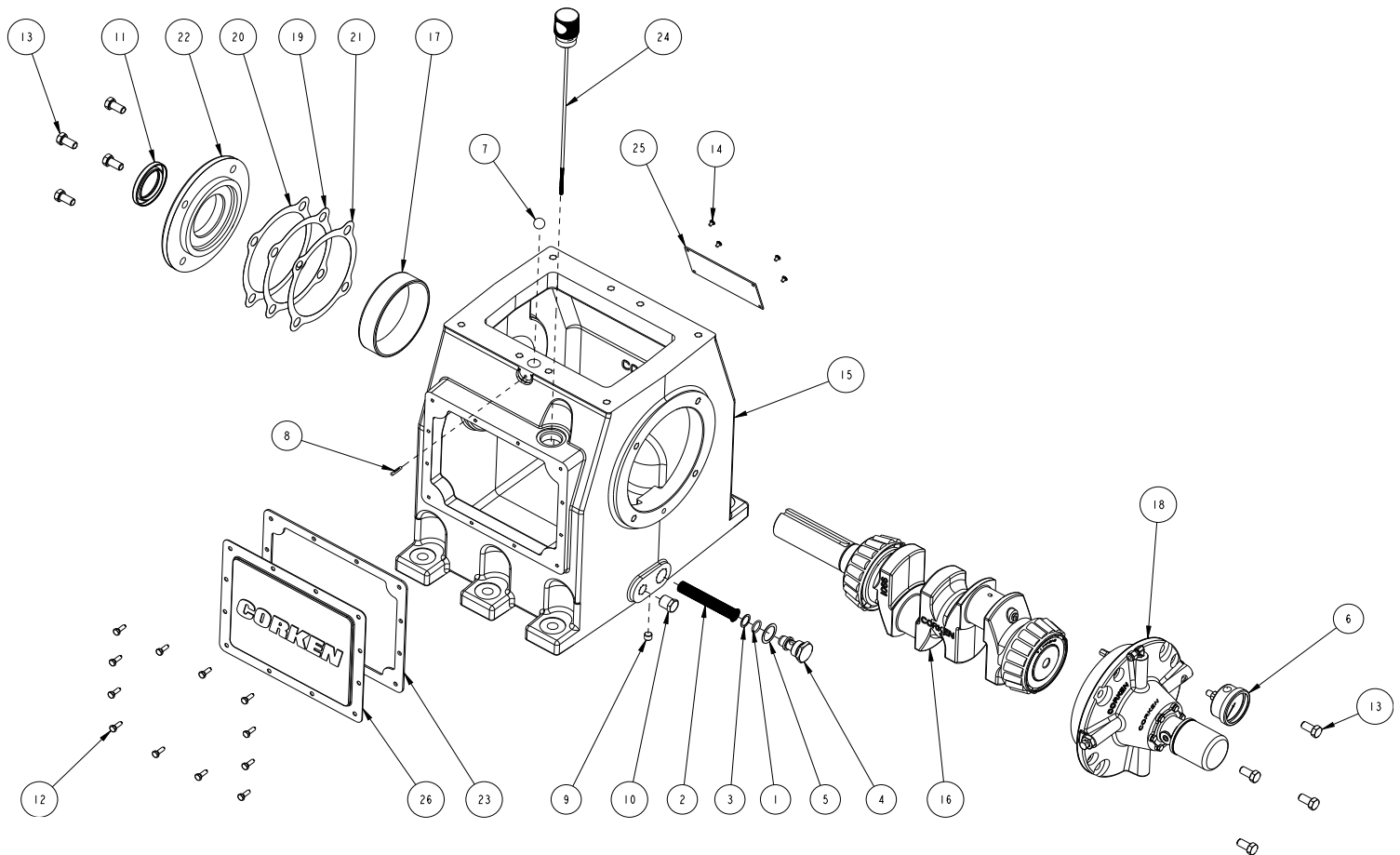
^c After the wrist pin bushing has been pressed into the connecting rod, it must be honed to 1.1258/1.1254. A hydraulic press and honing machine are recommended for this step.

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



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

Appendix D (Continued)—Crankcase Assembly Parts Details for Model D991



Crankcase Assembly Guide Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2-116A	O-ring (Buna-N)	1
2.	1275	Oil pump filter screen	1
3.	1276	Filter screen washer	1
4.	1280	Filter screw	1
5.	1281	Screen screw gasket	1
6.	1302	Oil pressure gauge	1
7.	2126	Breather ball	1
8.	2197	Groovepin	1
9.	3289	Pipe plug (1/4" NPT, flush seal)	1
10.	3443	Pipe plug (1/2" NPT, steel)	1
11.	3526	Oil seal	1
12.	7001-025NC075A	1/4-20 x 3/4 Hex head bolt	12
13.	7001-050NC100A	1/2-13x1 Hex head bolt	8

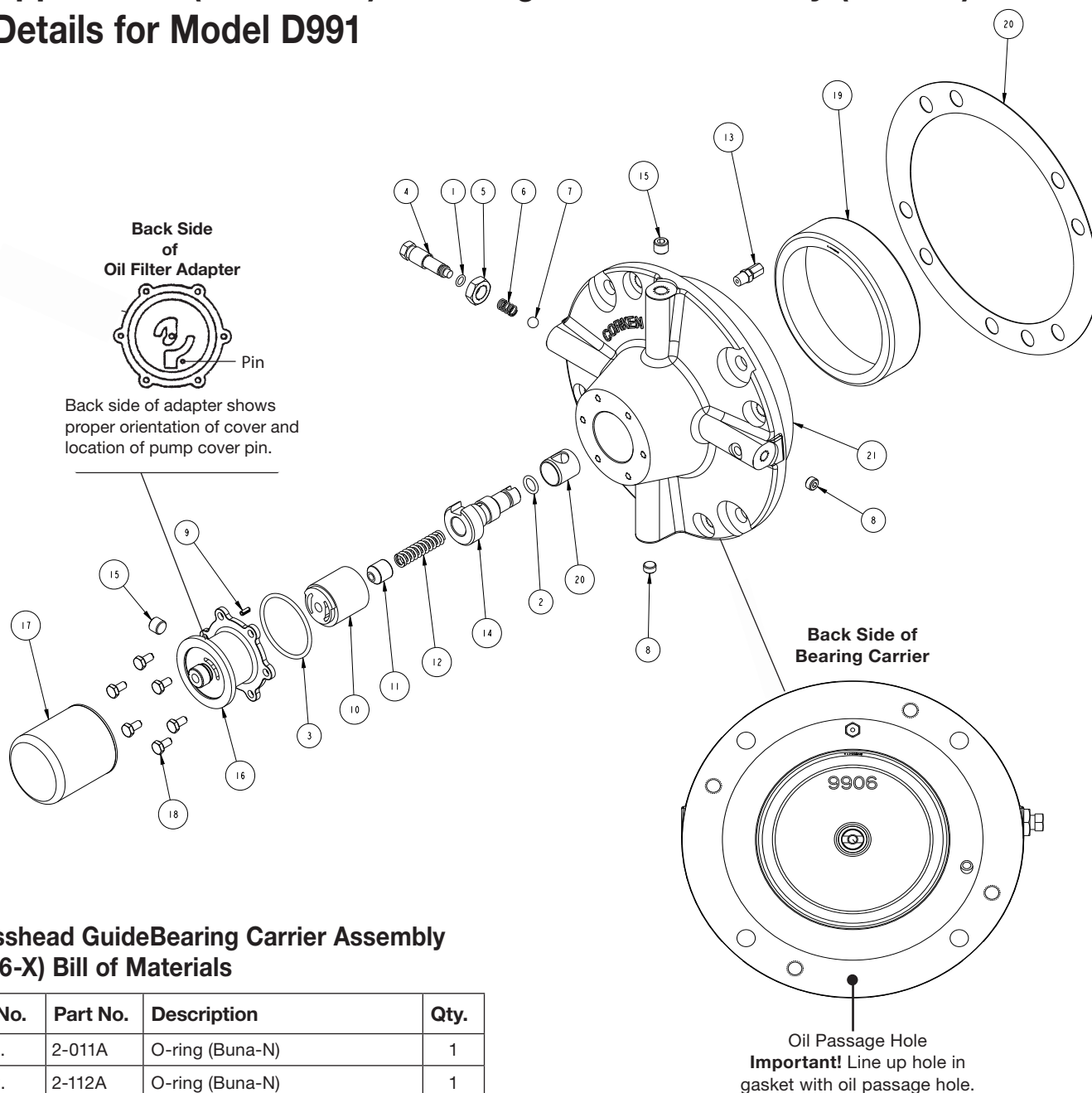


CAUTION: Always relieve pressure in the unit before attempting any repairs.

Ref No.	Part No.	Description	Qty.
14.	7012-010NC25B	Screw (10 - 24 x 1/4") Phillips head	4
15.	9900	Crankcase	1
16.	9901-X	Crankshaft assembly	1
17.	9904	Bearing cup	1
18.	9906-X	Bearing carrier assembly	1
19.	9907	Bearing adjustment shim	As req.
20.	9907-1	Bearing adjustment shim	As req.
21.	9907-2	Bearing adjustment shim	As req.
22.	9908-X	Bearing cover assembly	1
23.	9912	Crankcase inspection cover gasket	1
24.	9915-X1	Oil bayonet assembly w/o-ring	1
25.	9935	Inspection plate	1
26.	9913	Crankcase inspection plate	1
27.	3526	Oil Seal	1
28.	3503	Flywheel Key	1

^a Caution: To avoid damage during assembly, refer to installation Instruction Manual IE400.

Appendix D (Continued)—Bearing Carrier Assembly (9906-X) Parts Details for Model D991



Crosshead GuideBearing Carrier Assembly (9906-X) Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2-011A	O-ring (Buna-N)	1
2.	2-112A	O-ring (Buna-N)	1
3.	2-228A	O-ring (Buna-N)	1
4.	1290	Relief valve adjusting screw	1
5.	1291	Hex nut	1
6.	1292	Relief valve spring	1
7.	1293	Relief valve ball	1
8.	1399-1	Tube fitting 90 °elbow	1
9.	2590	Pipe plug 1/8 inch npt flush plg	2
10.	2849-1X ^a	Oil pump	1
11.	2851	Oil pump screen guide	1
12.	2852	Oil pump spring	1
13.	2961-X	Air release valve assembly	1

Ref No.	Part No.	Description	Qty.
14.	3219	Shaft adapter	1
15.	4222-X ^a	Oil filter assy	1
16.	7001-025NC050A	1/4-20 x 1/2 Hex head bolt	6
17.	9904	Bearing cup	1
18.	9905	Bearing carrier gasket	1
19.	9906	Bearing carrier	1

^a Caution: To avoid damage during assembly, refer to installation Instruction Manual IE400.



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

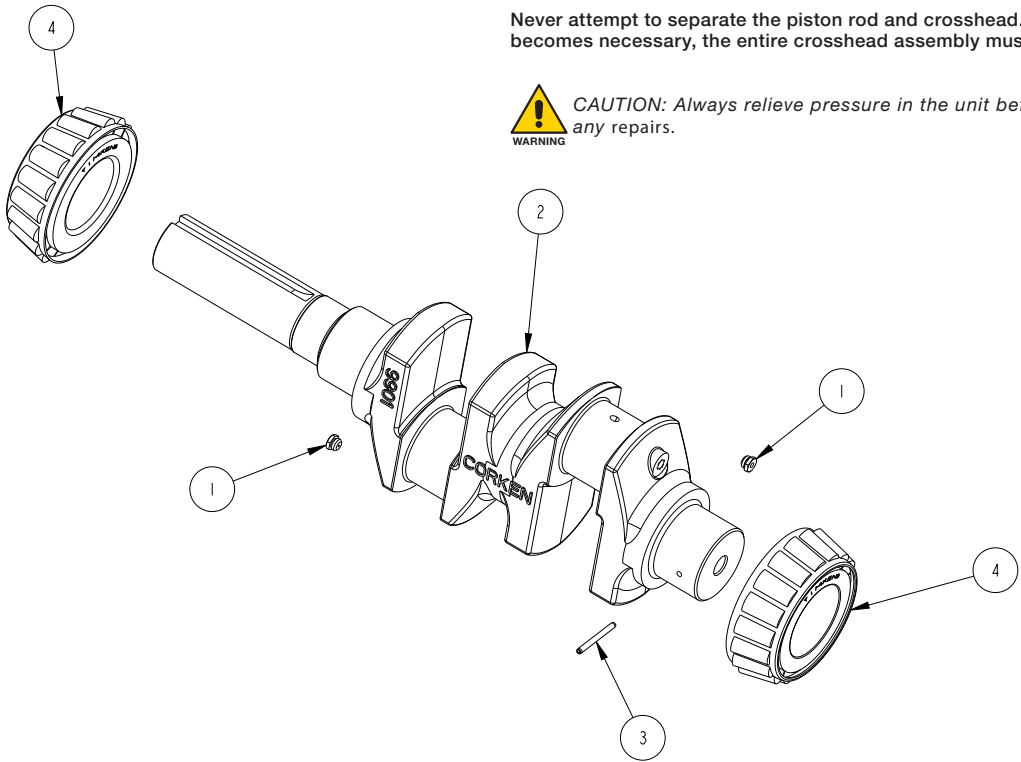
Appendix D Appendix D (Continued)—Crankshaft Assembly Parts Details

Crankshaft Assembly 9901-X—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	1284	Crankshaft orifice	2
2.	9901	Crankshaft	1
3.	9902	Roll pin - 3/16" X 2"	1
4.	9903	Bearing cone	2

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

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

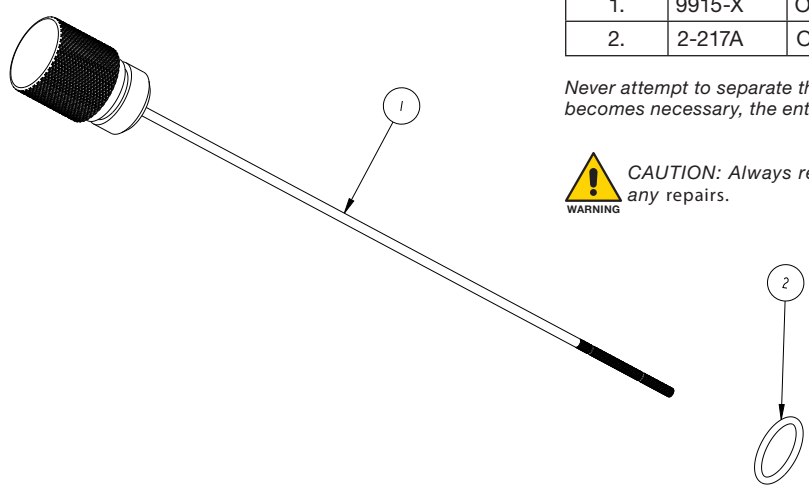


Oil Bayonet Assembly 9915-X1—Bill of Materials

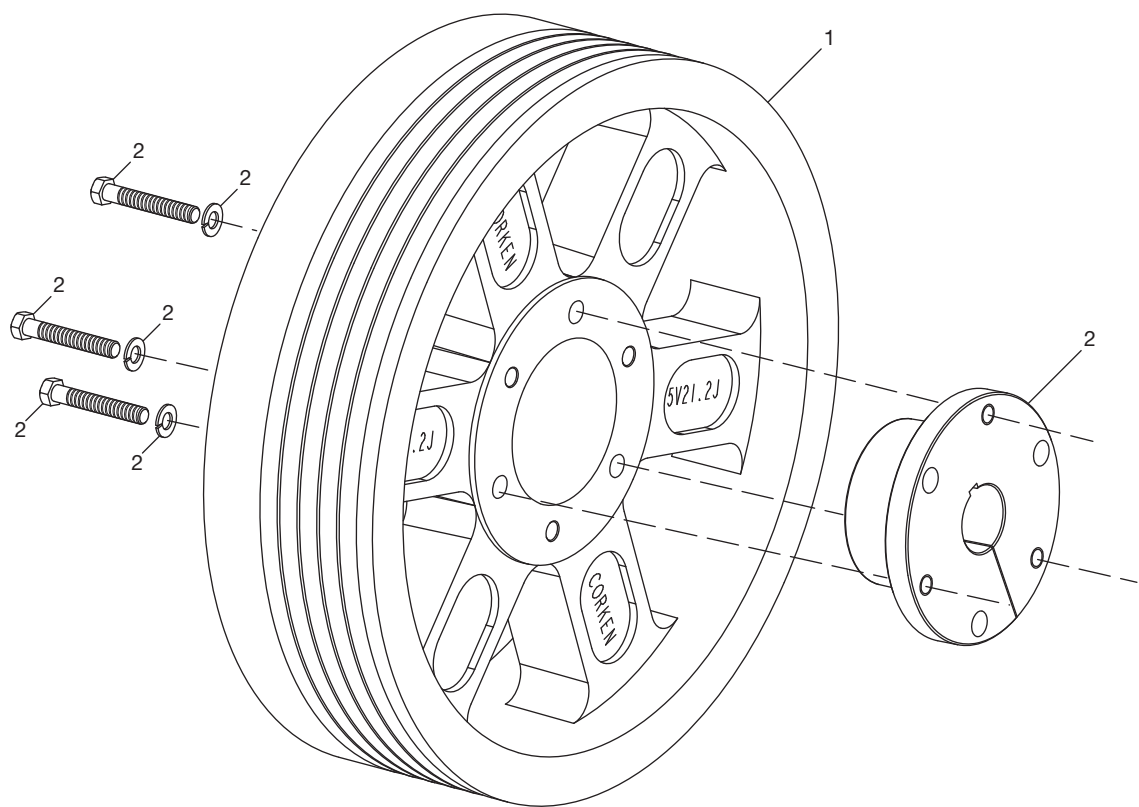
Ref No.	Part No.	Description	Qty.
1.	9915-X	Oil bayonet assembly	1
2.	2-217A	O-ring (Buna-N)	1

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

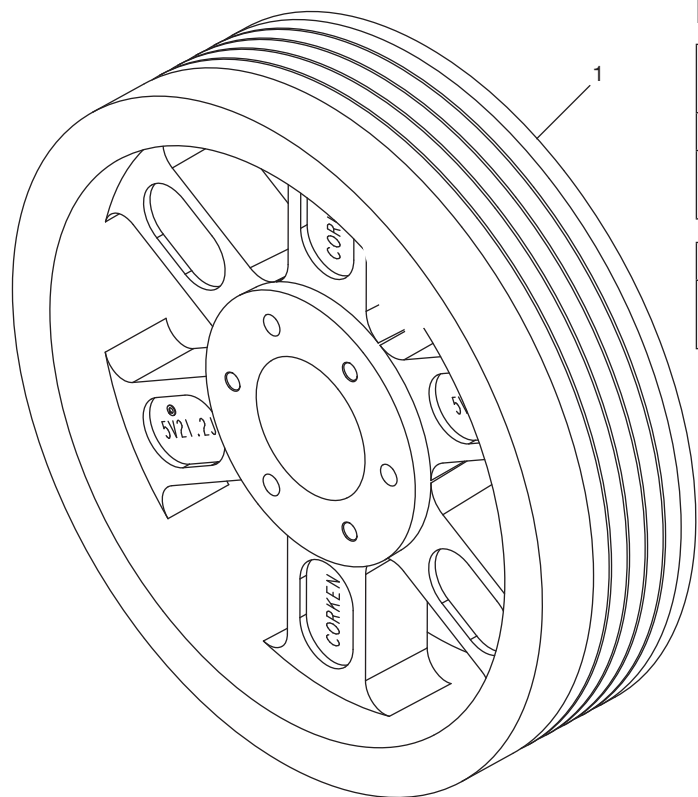
 **CAUTION:** Always relieve pressure in the unit before attempting any repairs.



Appendix D (Continued)— Flywheel Assembly Parts Details for All



Back Side



Front Side

Flywheel—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3852	Flywheel (21.2" O.D., 5 groove)	1
2.	H J-2.125	Hub with three bolts and lockwashers	1

Assembly Number	Assembly Name
3852-X	Flywheel assembly (flywheel, hub, and three bolts)

Appendix E—Troubleshooting

In most cases, problems with a Corken 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 there is a problem not listed below, or if the source of the problem cannot be identified, consult

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

Ref. No.	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.	Inadequate compressor base	Strengthen, replace or grout
13.	Improper foundation or mounting	Tighten mounting or rebuild foundation
14.	Loose valve, piston or packing	Tighten or replace as necessary
15.	Dirty cooling fins	Clean weekly
16.	Leaking gas blowing oil from crankcase	Tighten packing
17.	Bad oil seal	Replace
18.	No oil in crankcase	Add oil
19.	Oil-pump malfunction	See oil-pressure adjustment
20.	Low voltage	Check line voltage with motor nameplate. Consult power company
21.	Motor wired wrong	Check wiring diagram
22.	Wire size too small for length or run	Replace with correct size
23.	Wrong power characteristics	Voltage, phase and frequency must coincide with motor nameplate. Consult with power company.
24.	Wrong size of heaters in starter	Check and replace according to manufacturer's instructions
25.	Compressor overloading	Reduce speed
26.	Motor shorted out	See driver installation
27.	Bad motor bearing	Lubricate according to manufacturer's instructions

Appendix F—Extended Storage Procedures

Performing a few simple procedures greatly minimizes the risk of the compressor becoming corroded and damaged. The following precautions will protect it from corrosion during storage:

1. Drain the oil from the crankcase and refill it with a rust inhibiting oil.
2. Operate for a few minutes while fogging oil into the compressor suction.
3. Relieve the tension on the V-belt.
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. NOTE: If a silica gel is used, place a tag on the compressor stating "Silica Gel Must Be Removed Prior To Start-up."
5. Store in a dry area and off the ground. A temperature controlled room is recommended but not mandatory.
6. For best results rotate the flywheel every two weeks.



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