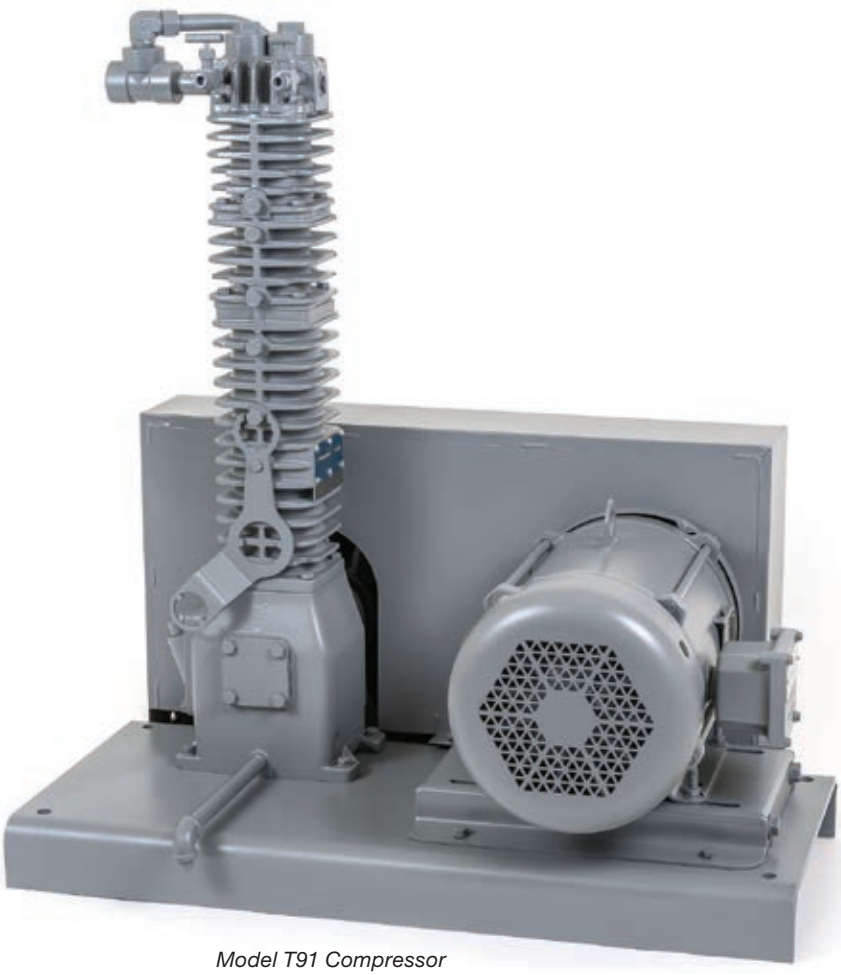
Installation, Operation & Maintenance Manual

D- and T-Style Model 91 Compressors



Model T91 Compressor with 103 Mounting

Bare D91 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.

Solutions beyond products...

CORKEN®

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, 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, 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 _____

Table of Contents

Chapter 1—Introduction

Connections:
Available in threaded NPT or Class 300 RF flanges.

High-efficiency valves:
Valves are quiet and highly durable. Special suction valves tolerating small amounts of condensate are available.

O-ring seals:
Easy to install O-ring seals head and cylinder.

Ductile iron construction:
Cylinder and head are made of ductile iron for maximum thermal shock endurance.

Self-lubricating PTFE piston rings:
State-of-the-art piston ring designs to provide the most cost-effective operation of compressors for non-lube service. The step-cut design provides higher efficiencies during the entire life of the piston ring.

Upper distance piece
Barrier 1
(purge, pad, or vent)

Piston rod seals:
Seals constructed of PTFE incorporating special fillers to maximize leakage control. Spring loaded seal design self adjusts to compensate for normal wear.

Lower distance piece
Barrier 2
(purge, pad, or vent)

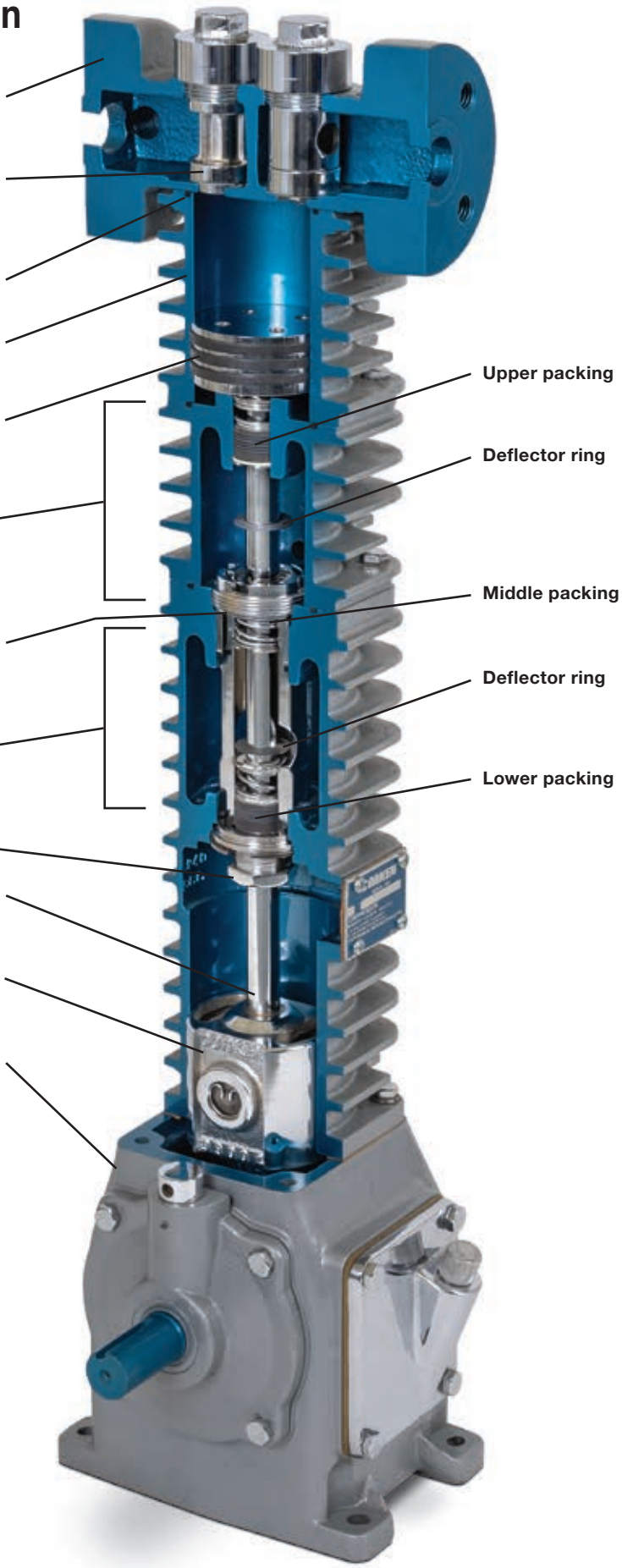
Adjustable packing screw

Nitrotec®[1] coated piston rods:
Impregnated nitride coating provides superior corrosion and wear resistance.

Cast-iron crosshead:
Durable cast-iron crossheads provide superior resistance to corrosion and galling.

Pressure-lubricated crankcase with filter:
Self-reversing oil pump ensures proper lubrication regardless of directional rotation to main and connecting rod bearings. Standard 10-micron filter ensures long-lasting bearing life (not available on Model 91).

[1] Registered trademark of TTI Group Ltd.



Construction Details—Model FT91 Compressor

1.1 Construction Features

The Corken liquid transfer-vapor recovery compressor is a vertical single-stage, single-acting reciprocating compressor designed to handle flammable gases like LPG and toxic gases such as ammonia. Corken compressors can handle these potentially dangerous gases because the LPG/NH_3 is confined in the compression chamber and isolated from the crankcase and the atmosphere. A typical liquid transfer-vapor recovery compressor package is shown in figure 1.1A.

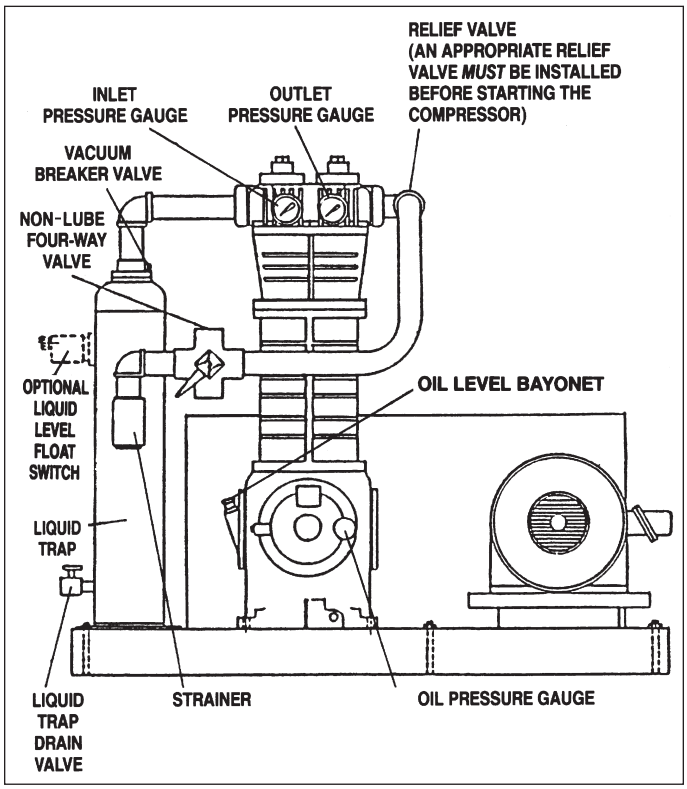


Figure 1.1A: 107-style compressor mounting.

Corken compressors use iron pistons locked to the piston rod. The standard piston ring material is a glass-filled PTFE polymer specially formulated for non-lubricated services. Piston ring expanders are placed behind the rings to ensure that the piston rings seal tightly against the cylinder wall.

Piston rod packing is used to seal the gas in the compression chamber and prevent crankcase oil from entering the compression chamber. The packing consists of several PTFE V-rings sandwiched between a male and female packing ring and held in place by a spring (see figure 1.1B).

The typical Corken compressor valve consists of a seat, bumper, one or more spring(s) and one or more valve(s) and plates as shown in figure 1.1C. Special heat-treated alloys are utilized to prolong life of the valve in punishing non-lubricated services. The valve opens whenever the pressure on the seat side exceeds the pressure on the spring side.

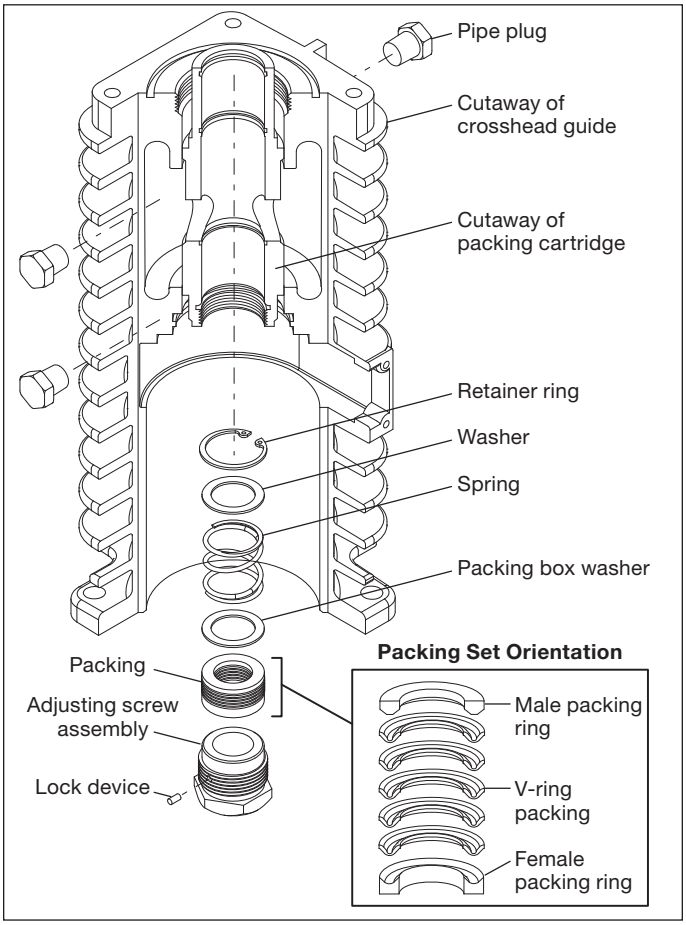


Figure 1.1B: Compressor sealing system

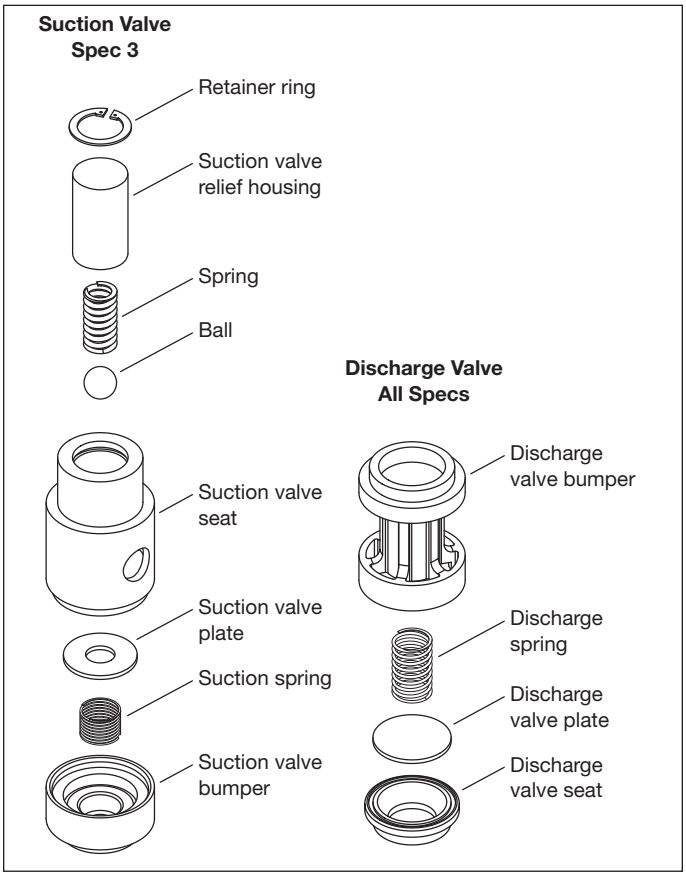


Figure 1.1C: Compressor sealing system

NOTE: To confirm the specifications for any compressor, locate the model number on the nameplate and refer to the model identification tables listed in Appendix A. The model identification tables show the specifications for each section of the compressor.

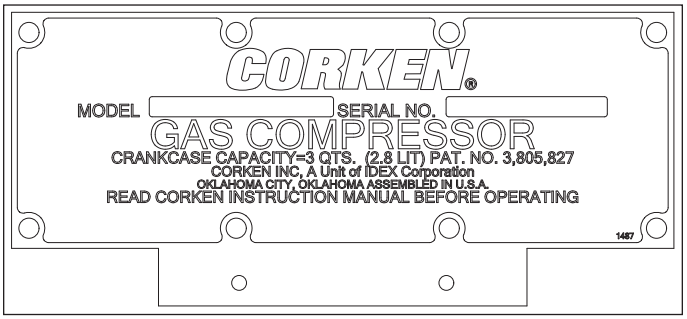


Figure 1.1D: Typical nameplate: The opening behind the nameplate is used to fill the compressor crankcase with oil and adjust the lower set of packing.

1.2 Running Gear

The D- and T-Style model 91 gas compressors are mounted on oil lubricated crankcases remaining at atmospheric pressure. Crankshafts are supported by heavy-duty roller bearings and the connecting rods ride the crankshaft on journal bearings. The model 91 compressor has a dipper mounted to bottom of the connecting rod that splash lubricates the journal bearings and wrist pins. Sturdy iron crossheads transmit reciprocating motion to the piston.

Chapter 2—Installation

2.1 Location

NOTE: Always install the compressor in a well ventilated area.

Corken compressors are designed and manufactured for outdoor duty. When the compressor is subjected to extreme conditions (i.e. corrosive environments and arctic conditions) for extended periods of time, consult Corken. Check local safety regulations and building codes and ensure the installation meets all regulations and codes.

Compressors handling toxic or flammable gases should be located outdoors. A minimum of 18 inches (457.2 mm) clearance between the compressor and the nearest wall is recommended for easy access from all sides and unrestricted air flow for adequate cooling.

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 85 dBa at three feet (0.91 meters).

2.2 Foundation

A proper foundation is essential for a smooth running compression system. The concrete slab should be at least 8 inches thick with a 2 inch skirt around the circumference of the baseplate. The total mass of the foundation should be approximately twice the weight of the compressor system (compressor, baseplate, motor, etc.). For a model 91, the baseplate should be secured to the foundation using 1/2" diameter x 12" long "J" bolts.

NOTE: Always use all anchor holes.

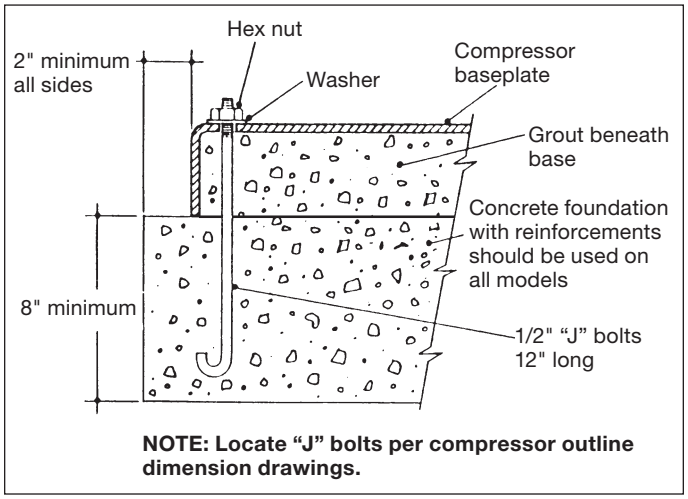


Figure 2.2A: Recommended foundation details for a model 91 compressor.

After leveling and bolting down baseplate and/or skid, the volume beneath the channel iron baseplate must be grouted to prevent flexing between the top of the baseplate and the "J" bolt that extends beyond the foundation. Creating a solid interface between the compressor and foundation improves the dampening capabilities of the foundation.

For more information, see Compressor Foundation Design Guide (item number ED410). See Appendix F.

2.3 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 2.3A).

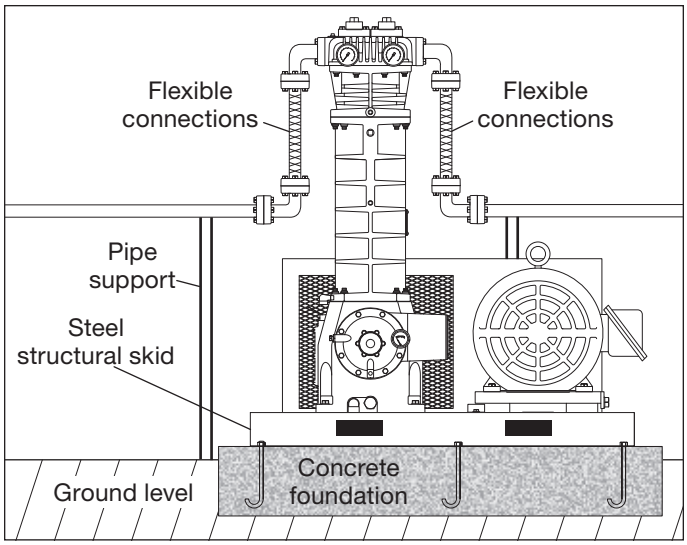


Figure 2.3A: Flexible connectors should be used to minimize transmission of vibration to the piping.

Piping must be adequately sized to prevent excessive pressure drops between the suction source and the compressor and the final discharge point and the compressor. In most cases, the piping should be at the same diameter as the suction nozzle on the compressor. Typically, liquid transfer systems are designed to limit pressure drops to 20 psi (1.4 bar).

Care must be taken when a restrictive device (i.e. a valve, pressure regulator, or back-check valve) is installed in the compressor's suction line. The volume of the suction line between the restrictive device and the compressor suction nozzle must be at least ten times the swept cylinder volume. See Appendix B for specifications on cylinder and stroke.

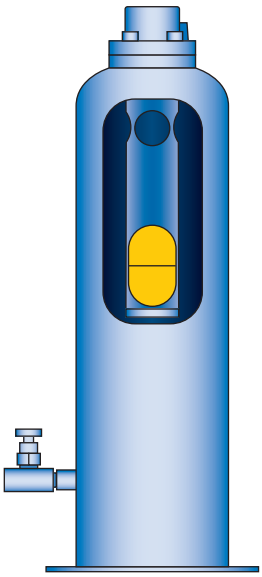
2.4 Liquid Traps

Compressors are designed to pressurize gas and not pump liquids. Even a small amount of liquid into a compressor results in serious damage.

To prevent the entry of liquid into the compressor, a liquid trap is always used on liquefied gas applications. Corken offers three liquid trap options for removing liquids in the gas stream (see figure 2.4A).

Standard Liquid Trap: The trap is the simplest design and comes with a mechanical float. As the liquid enters the trap, the gas velocity is greatly reduced, which allows the liquid to drop out. If the liquid level rises above the inlet, the ball float will plug the compressor suction. The compressor creates a vacuum in the inlet piping and continues to operate until the operator manually shuts it down. Before restarting the compressor, the trap must be drained and the

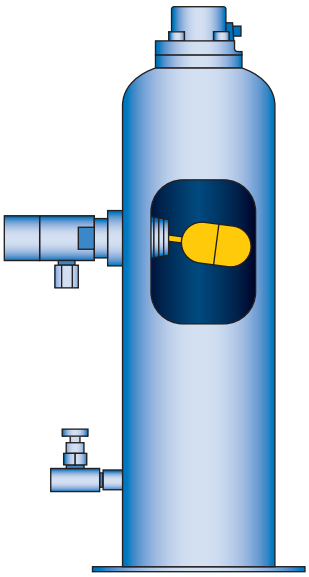
Standard Liquid Trap



Standard liquid trap with mechanical float assembly and drain valve.

Connections:
1-1/4" In x 1-1/4" NPT Out

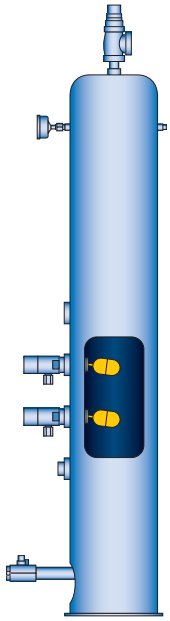
Automatic Liquid Trap



Automatic liquid trap, with one NEMA 7 liquid-level switch for compressor shutdown and drain valve.

Connections:
1-1/4" In x 1-1/4" NPT Out

ASME Automatic Liquid Trap



Code-stamped automatic liquid trap with two NEMA 7 liquid-level switches for compressor shutdown and alarm. Equipped with relief valve, pressure gauge, demister pad, and drain valve.

Connections:
1-1/2" In x 1-1/2" NPT Out

Figure 2.4A: Liquid traps.

vacuum-breaker valve opened so the float can drop back. This type of trap is used when the compressor is under fairly close or constant observation. This trap is used with the 109 and 107 compressor mountings.

Automatic Liquid Trap: When a compressor is not under constant observation, an automatic trap is highly recommended. With this design the mechanical float is replaced with electrical float switches. If the liquid level rises too high, the level switch opens and disconnects the power to the motor starter and stops the compressor. This design is standard on Corken's 109A and 107A compressor mountings.

ASME Automatic Liquid Trap: This is Corken's most sophisticated design and provides the best liquid separation. It's the largest design of the three traps, ASME code stamped, and contains two level switches. One sounds an alarm so the operator can manually drain the liquid from the trap and one is used for shutdown. In some cases the alarm switch is used to activate a dump valve (not included with trap). This trap also features a mist pad made of interwoven wire for catching fine liquid mists. The ASME code trap is standard on the 109B and 107B compressor mountings.

A typical wiring diagram for the liquid level switch is shown in figure 2.4B.

Typical Float Switch Wiring Diagram

1 = Common, black
2 = Normally closed, blue
3 = Normally open, red

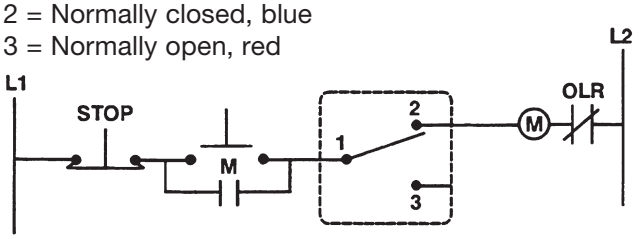


Figure 2.4B: Typical float switch wiring diagram.

NOTE: The 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 Corken's compressor is equipped with a liquid trap from a different manufacturer, make sure it is adequately sized to remove all liquid in the suction stream.

2.5 Driver and Flywheel

Corken vertical compressors may be driven by either electric motors or combustion engines (gasoline, diesel, natural gas, etc.). Corken compressors are usually V-belt driven but they are also suitable for direct drive applications as well. Direct drive applications require an extended crankshaft to allow the attachment of a rigid metal coupling.

Select a driver that allows the compressor to operate between 400 and 800 RPM. Do not operate the compressor without the flywheel or severe torsional imbalances will result causing vibration and a high horsepower requirement. The flywheel should never be replaced by another pulley unless it has a higher WK^2 value than the flywheel.

A humid climate can cause problems, particularly in explosion proof motors. The normal breathing of the motor — alternating between being warm when running and being cool when stopped — can draw moist air into the motor. The moist air will condense adding water to the inside the motor and may cause it to fail. To prevent this from happening, run 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 within the motor. No motor manufacturer guarantees an explosion proof or totally enclosed (TEFC) motor against damage from moisture.

Before installing an engine driver, thoroughly review installation instructions provided by the engine manufacturer.

2.6 Crankcase Lubrication

The crankcase is always drained prior to shipping. Before starting the machine, fill the crankcase to the full mark - not above - of the oil bayonet. To ensure proper lubrication of the crossheads, crosshead guide, and all critical parts, fill the crankcase through inspection/ nameplate (see figure 2.6A and 2.6B for the proper oil filling location).

Compressor Model	Approximate Quarts	Capacity Liters
91	0.9	0.8

Figure 2.6A: Oil capacity chart.

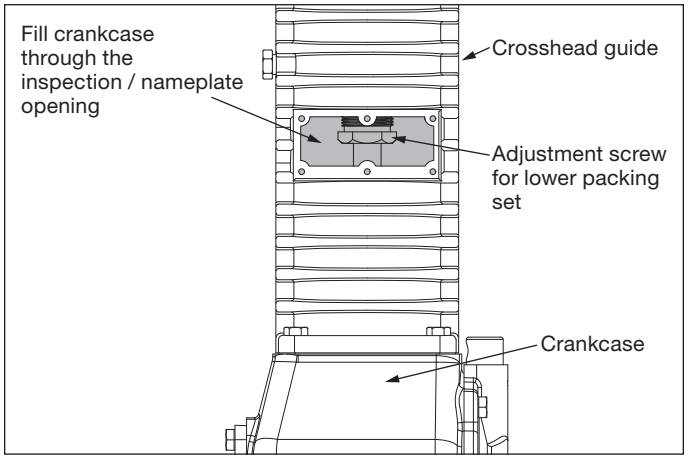


Figure 2.6B.

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.

2.6.1 Oils to Avoid

Selecting a crankcase oil based on low price or easy availability is seldom the best 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.

2.6.2 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. It 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.

2.6.3 Crankcase Oil Recommendations

The primary factors for selecting a suitable crankcase oil from the chart below 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)
- Ammonia 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 a butane, pentane, etc.
- Services dealing with low vapor pressure hydrocarbons (such as butane unloading in winter) where condensation in 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.

Ammonia Service

Compressing ammonia presents particular challenges from a lubrication standpoint. Never use a detergent oil in a compressor in ammonia service. Ammonia will react with the detergent and cause lubrication failure. Fortunately, some oils are specifically blended for use in ammonia compressors — though some of these are best suited only for cooler climates.

Consult these charts or the oil manufacturer's product data sheet for information regarding the oil's viscosity, viscosity index, pour point, etc. This information is generally available on line or from the oil supplier. Do not use an oil if it's critical properties can not be confirmed, of if there is any other reason to doubt its suitability. Contact Corken if additional assistance is needed when selecting a crankcase oil.

Food Grade Service

Oils used in "Food Grade" service fall under much more restrictive rules than a typical industrial lubricating oil. The various requirements for food grade oils are outlined by NSF, FDA Title 21, Orthodox Union (Kosher, Pareve), IFANCA (Halal), and others. The most prevalent requirement seems to be NSF H1 which dictates the requirements of lubricants that may have incidental food contact.

All lubricating oils consist of a base oil plus multiple additives that improve various properties of the base oil. For food safety reasons, many additives used in industrial lubricants are not permissible for use in food grade service. Thus, food grade oils generally have lesser lubricating properties or require more frequent oil changes.

Like industrial oils, the basis for a food grade oil can be either a conventional mineral oil or a synthetic oil. Since synthetic-based oils have significantly better lubricating properties and service life than mineral-based oils, Corken recommends using a synthetic food grade oil in applications requiring food grade oil. The inherent properties of the synthetic-based oil help overcome additives that may be less than ideal. Some synthetic food-grade oils perform better than non-food grade industrial mineral oils.

Due to the high viscosity index and low pour point of synthetic oils, most Corken compressor operators can use an ISO 100 grade oil year-round. Those in cooler climates may need an ISO 68 oil with a lower viscosity.

All Corken compressors are tested at the factory using a standard industrial (non-food grade) mineral oil. The mineral oil is drained, but some residual oil will always remain inside the crankcase. If the end user intends to use any synthetic oil (or a synthetic food grade oil in particular), the crankcase should be flushed with the new oil.

2.6.4 Basic Steps for Flushing Oil

- Confirm that the crankcase is drained to the lowest extent possible.
- Remove and drain the oil filter or replace with a new one (part number 4225). NOTE: The Corken model 91 compressor does not use an oil filter.

- Add the proper amount of new synthetic food grade oil to the compressor.
- Run the compressor five minutes to circulate the new synthetic oil.
- Drain the synthetic oil and discard since it will not be reused.
- Refill the crankcase with the proper amount of new synthetic food grade oil.
- Confirm proper oil level.

2.6.5 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: 2,200 hours or 6 months—whichever comes first

Synthetic oil: 6,000–8,000 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.

2.6.6 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)

2.6.7 Crankcase Oil Recommendations (Ammonia Service Only)

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 Rarus 427	C	100	100	16°F (-9°C)
10 to 65°F (-12 to 18°C)	Phillips 66 Ammonia Compressor Oil	C	68	102	-27°F (-33°C)
	Chevron Capella P68	C	68	96	-44°F (-42°C)
	Mobil Rarus 426	C	68	105	16°F (-9°C)
Heavy Service					
10 to 100°F (-12 to 38°C)	Mobil Gargoyle Arctic SHC 228 [5]	S	100	147	-43°F (-45°C)
	Royal Purple Uni-Temp 100	S	100	124	-53°F (-47°C)
-20 to 90°F (-29 to 32°C)	Mobil Gargoyle Arctic SHC 226E [5]	S	68	136	-58°F (-50°C)
	Royal Purple Uni-Temp 68	S	68	118	-51°F (-46°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 Gargoyle Arctic SHC oils are synthetic oils which require that the crankcase be flushed of residual mineral oil.

2.6.8 Crankcase Oil Recommendations (Synthetic Food Grade Oils)

Ambient Temperature °F (°C) [1]	Oil Product	Viscosity ISO Grade [2]	Viscosity Index [2]	Pour Point °F (°C) [2]	Registrations/Compliance/Certifications [2]
10 to 100 (-12 to 38)	Mobil SHC Cibus 100	100	143	-49 (-45)	NSF H1, Kosher, Halal, FDA 21 CFR 178.3570, ISO 22000, ISO 21469
	Royal Purple Poly-Guard FDA 100	100	136	-38 (-39)	NSF H1, FDA 21 CFR 178.3620
	Ultrachem Omnilube 5131	100	145	-38 (-39)	NSF H1, FDA 21 CFR 178.3570, Halal, Kosher
	Summit (Kluber) R Series R300	100	149	-60 (-51)	NSF H1, Kosher, Halal, ISO 21469
	Petro-Canada Purity FG Synthetic 100	100	147	-71 (-57)	NSF H1, FDA 21 CFR 178.3570, Kosher, Pareve, Halal
-20 to 80 (-29 to 27)	Mobil SHC Cibus 68	68	140	-52 (-47)	NSF H1, Kosher, Halal, FDA 21 CFR 178.3570, ISO 22000, ISO 21469
	Royal Purple Poly-Guard FDA 68	68	140	-38 (-39)	NSF H1, FDA 21 CFR 178.3620
	Citgo Clarion CompressorGuard 68	68	135	-65 (-54)	NSF H1, FDA 21 CFR 178.3570

NOTES:
[1] Consult Corken for Oil Recommendations in very hot climates—ambient temperatures consistently above 100°F (38°C)
[2] Information stated by oil manufacturers at the time of publication. See oil manufacturer's product data sheets for additional details.

2.6.9 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.

2.6.10 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.

2.6.11 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.

2.6.12 Engine Oils (Motor Oils)

At 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, CO_2, 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 effects 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.

2.7 Relief Valves

An relief valve must be installed at the compressor discharge. On Corken's 107-style mountings, a relief valve should be fitted in the piping between the compressor discharge and the four-way valve (see figure 1.1A). The material specification for the relief valve should be compatible with the gas being compressed. Review the local codes and regulations for specific relief valve requirements. Additional relief valves may be required at other points in the compressor's piping system.

2.8 Shutdown/Alarm Devices

Shutdown and alarm sensors (switches or transmitters) protect the compressor system from potential damage and are recommended for any application. All electronic devices must meet local codes.

The following shutdown and alarm devices are typically used with Corken compressors:

1. **High Discharge Temperature Sensor:** This sensor is strongly recommended for all applications. Both the sensor and compressor have an operating range. The preferred sensor set point is 30°F (17°C) above the normal compressor discharge temperature, but below the maximum design temperature of the O-ring material used on the compressor.

NOTE: To confirm the O-ring used the compressor, refer to the Appendix A.

Maximum O-ring temperature for the following material specifications:

• Buna-N and Neoprene®[1] 250°F (121°C)

• Viton®[1] and PTFE 350°F (177°C)

[1] *Registered trademark of the DuPont Company.*

2. **Low Suction Pressure Sensor:** Shuts down the unit if inlet pressure is below a preset limit (set point). The set point should follow these guidelines:

    • For safety shut off, it must be greater than the compressor minimum suction pressure (atmospheric) to prevent pulling oil from the crankcase into the gas stream.

    • For process shut off, the set point should be 25% of product vapor pressure. It can be lower or higher based on economic decision on how much product can be recovered. This decision must be made by the customer.

3. **High Discharge Pressure Sensor:** Shuts down the unit if outlet pressure is above a preset limit (set point). The set point should follow these guidelines:

    • Less than the compressor's maximum working pressure.

    • Less than 80–90% of the relief valve pressure set point (consult relief valve manufacturer)

    • Greater than the compressor's discharge pressure based on normal operating conditions.

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

Chapter 3—Start Up

NOTE: Before starting up the compressor, review and understand the principles of liquefied gas transfer and vapor recovery using a compressor listed in Chapter 1. Read the entire chapter before proceeding to the startup checklist.

3.1 Inspection After Extended Storage

If the compressor has been out of service for a long period of time, make sure the cylinder bore and valve areas are free of rust and other debris (see chapter 5 of this IOM manual for valve and/or cylinder head removal instructions).

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 oil. 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.

3.2 Flywheel and V-belt Alignment

Before working on the drive assembly, disconnect the electric power. Before removing old belts or mounting new ones, always make sure the motor driver and compressor are close enough together to slide the belts off by hand. Never pry or force the belts on or off.

Improper belt tension and sheave alignment can cause vibration, excessive belt wear, and premature bearing failure. Before operating the compressor, check V-groove alignment between the flywheel and driver sheave. Visual inspection often will indicate if the belts are properly aligned, but use of a square is the best method. For more details, see How To Align the Sheave to the Flywheel on Corken's YouTube channel.

The flywheel is mounted on the shaft via a split, tapered bushing and three bolts (refer to figure 3.2A). These bolts should be tightened in an even and progressive manner until the torque specification listed below is reached. 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)

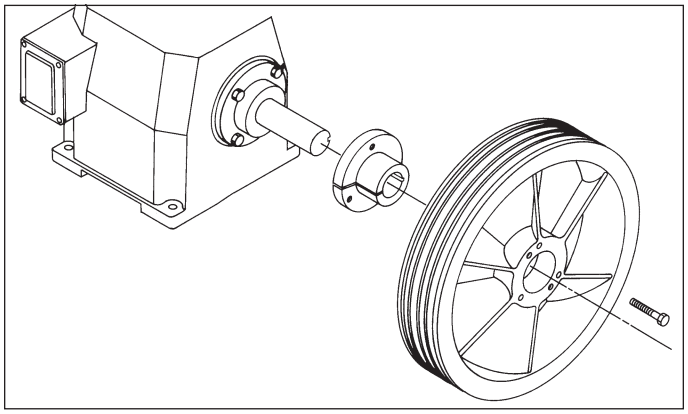


Figure 3.2A: Flywheel installation.

Tighten the belts until 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 3.2B.

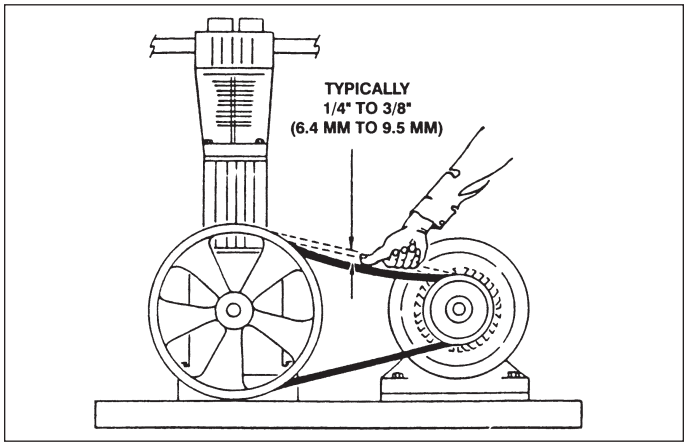


Figure 3.2B: Belt tension.

3.3 Startup Check List

Please verify all of the items on this list before starting the 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. Verify that actual operating conditions will match the anticipated conditions.
3. Ensure that line pressures are within cylinder pressure ratings.
4. Clean out all piping.

5. Check all mounting shims, cylinder and piping supports to ensure that no undue twisting forces exist on the compressor.
6. Verify that strainer elements are in place and clean.
7. Verify that cylinder bore and valve areas are clean.
8. Check V-belt tension and alignment. Check drive alignment on direct drive units.
9. Rotate unit by hand. Check flywheel for wobble or play.
10. Check crankcase oil level.
11. Drain all liquid traps, separators, etc.
12. Verify proper electrical supply to motor and panel.
13. Make sure all gauges are at zero level reading.
14. Test piping system for leaks.
15. Purge unit of air before pressurizing with gas.
16. Carefully check for any loose connections or bolts.
17. Remove all stray objects (rags, tools, etc.) from vicinity of unit.
18. Verify that all valves are open or closed as required.
19. Double-check all of the above.

After Starting Compressor

1. Observe noise and vibration levels. Correct immediately if excessive.
2. Verify proper compressor speed.
3. Examine entire system for gas, oil, or water levels.
4. Note rotation direction.
5. Check start-up voltage drop, running amperage, and voltage at motor junction box (not at the starter).
6. Test each shutdown device and record set points.
7. Test all relief valves.
8. Check and record all temperatures, pressures, and volumes after 30 minutes and 1 hour.
9. After 1 hour running time, tighten all head bolts, valve holddown bolts, and baseplate bolts. See Appendix B for torque values.

Chapter 4—Routine Maintenance Chart

Item to Check	Daily	Weekly	Monthly	Six Months	Yearly
Compressor discharge pressure	●				
Overall visual check	●				
Crankcase oil level			●[1]	●[1]	
Drain liquid from accumulation points	●[2]				
Drain distance pieces	●[4]				
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] *Conventional oil: change oil every 2,200 hours of operation or every 6 months, whichever occurs first. Synthetic oil: change oil every 6,000–8,000 hours or one year, whichever comes 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.*
[4] *Drain distance piece. See figure 4.1.*

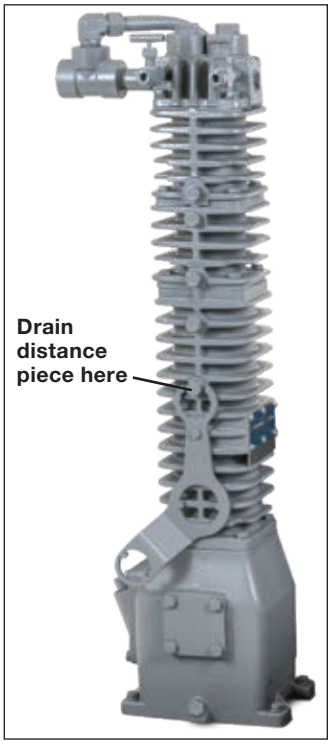


Figure 4.1

Chapter 5—Routine Service and Repair Procedures

⚠ CAUTION: Always relieve pressure in the unit before attempting any repairs. After repairs have been completed, the unit should be pressure tested and checked for leaks at all joints and sealing surfaces.

If routine maintenance is performed as listed in chapter 4, repairs are 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.

5.1 Valves

Test the compressor valves by closing the inlet piping shutoff valves while the unit is running; however, do not allow the machine to operate this way very long. If the compressors valves are still in good working order, the inlet pressure gauge should drop to zero almost immediately. Assuming the pressure gauge itself is not faulty, if it does not drop to zero, one or more of the valves are likely damaged or dirty.

For inspection purposes, each suction and/or discharge valve assembly can be removed as one unit. If any part of the valve assembly is broken, the complete valve assembly should be replaced. See parts details in the appendices for a complete list of part numbers and descriptions.

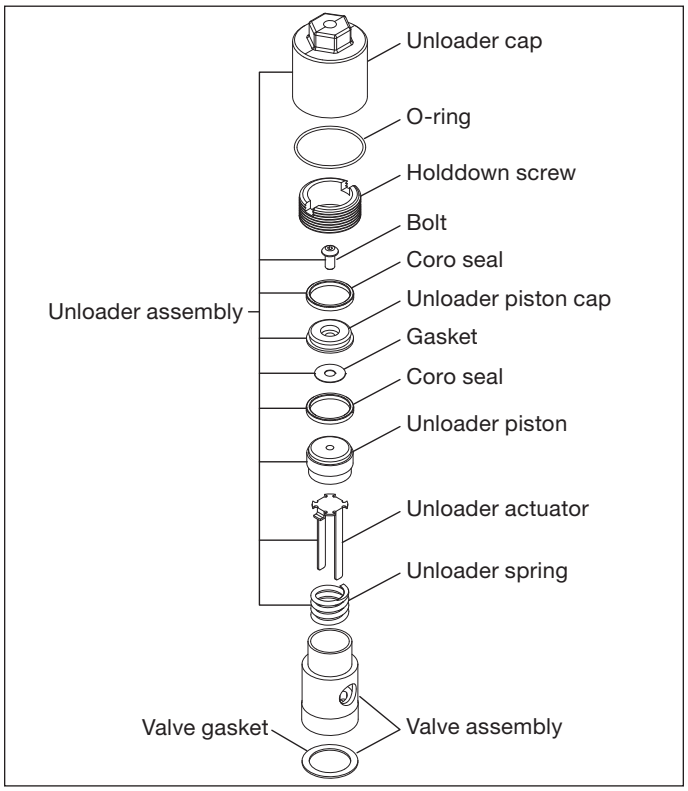
If a valve is leaking due to dirt or any other foreign material that keeps the valve plate and seat from sealing, the valve may be cleaned and reused. New gaskets and/or O-rings should be used to assure a good seal.

For a complete list of the valve specifications, refer to the parts details for head and valve assemblies in Appendix E. Since more than one suction valve arrangement is available for each model of compressor, it is necessary to know the complete model number. In most cases for liquid transfer and/or vapor recovery compressors, the valve type will be spec 3 or 3P (see below).

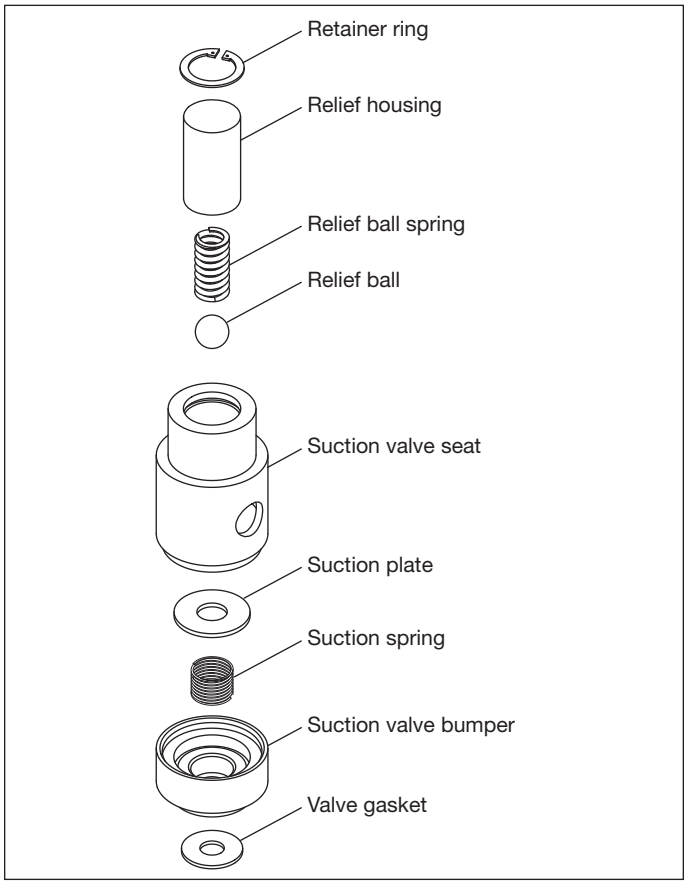
Model number D91AJ [3] FBANSNN
Valve type = spec 3

Model number T91GJ [3P] FBANSNN
Valve type = spec 3P

Valve Holddown Assemblies: Depending on the model of compressor, the valve holddown assembly has all or a combination of the following (Spec 9 shown below):



Valve Assemblies: Depending on the valve specification, the valve assembly has all or a combination of the following (Spec 3 shown below):



For a complete list of part numbers, parts details for head and valve assemblies in the Appendix E.

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 O-ring.

2. Remove the holddown screw with the special wrench supplied with the compressor at time of purchase.

3. After the holddown screw has been removed, the valve assembly and gasket can be lifted out.

4. Carefully inspect for dirt or damaged parts.

5. Inspect the valves for breakage, corrosion, debris, and scratches on the valve disc. In many cases, the valves may be cleaned and reinstalled. If the valves show any damage, they should be repaired or replaced. Replacement is usually preferred, although individual parts are available. If valve discs are replaced, seats should also be lapped until they are perfectly smooth. A maximum of .005 inch can be removed during the lapping process. If more than .005 inch is removed to achieve a smooth surface, the valve should be discarded. If discs 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.

   NOTE: Never use old gaskets. Always replace the metal valve gasket before re-installing the valve assembly.

2. Insert the cleaned or new valve assembly. Make sure the suction and discharge valves are in the proper opening in the head. NOTE: The spec 3 suction valves for a model 91 are pre-set so no adjustments to the liquid relief pressure are necessary.

3. Replace the holddown screw and tighten to the torque value listed in Appendix B. This ensures the valve gasket is properly seated.

4. Install the valve cap with a new O-ring and tighten to the torque value listed in Appendix B. Never re-use old O-rings for re-assembly.

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

5.2 Heads

If the compressor is properly maintained, head replacement is rarely required. The primary cause of damage to a head is corrosion or the entry of solid debris or liquid into the compression chamber. An improperly stored compressor can cause corrosion on the inside and damage the head. For proper storage procedures, see chapter 6.

Many compressor repair services require removal of the head. While the compressor is disassembled, avoid leaving the compressor open more than a few hours. All bare metal surfaces - including the head - should be coated with a rust preventative.

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

5.3 Piston Rings and Piston Ring Expanders

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 head to gain access to the compressor cylinder.

3. Loosen the piston head bolts. Remove the piston as shown in figure 5.3A by pinching two loose bolts together.

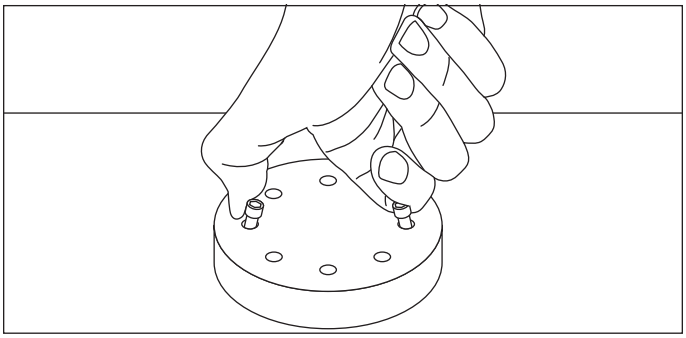


Figure 5.3A: Piston removal

4. Piston rings and expanders may then be easily removed and replaced. Corken recommends replacing expanders when the piston rings are replaced.

NOTE: To determine if rings should be replaced, measure the radial thickness and compare it to the chart in Appendix C.

5.4 Pistons

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

2. Remove the compressor cylinder and head (see section 5.2).

3. Remove the piston head by loosening and removing the socket head bolts holding the piston head to the piston platform (see figure 5.3A).

4. Next, remove the lock pin with a pair of needle nose pliers. The locknut may then be removed and the piston platform lifted 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. The shims are placed between the thrust washer and piston platform (see figures 5.4A and 5.4B).

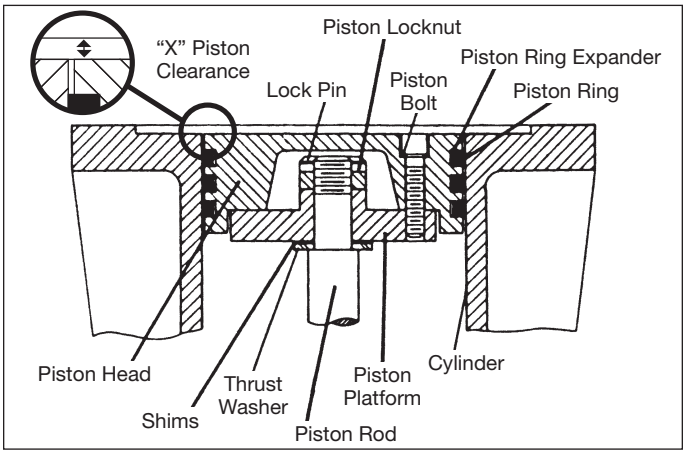


Figure 5.4A: Piston cross section model sizes 91 through 491

7. Reinstall the piston platform with the same thickness of shims as before, **BUT DO NOT REINSTALL THE LOCK PIN.**

8. Install the cylinder and install the piston heads with new piston rings and expanders.

9. Now measure dimension "X" shown in the illustration. If this measurement does not fall within the tolerances shown in Appendix B, remove the piston, adjust the shims as necessary and remeasure the "X" dimension.

10. When the piston is properly shimmed, tighten the lock nut to the torque value shown in Appendix B.

11. Now install a new lock pin and lock the piston nut in place.

12. Install the piston head and tighten the socket head bolts in an alternating sequence.

13. Reinstall the head (see section 5.2) and follow standard startup procedure. (Note: Some compressors may have self-locking nuts without roll pins.)

5.5 Piston Rod Packing Adjustment

Piston rod packing should be adjusted or replaced whenever leakage becomes noticeable. Start with one quarter turn, run the compressor and check for leakage after each quarter turn. NOTE: DO NOT overtighten. Repeat this process until leakage is minimized. If the adjusting nut bottoms out and leakage is still noticeable, all packing must be replaced. Typically, it is a good idea to replace piston rod packing and piston rings at the same time. For instructions on replacing the piston rod packing, see section 5.6.

NOTE: Packing that cannot be adjusted should be replaced.

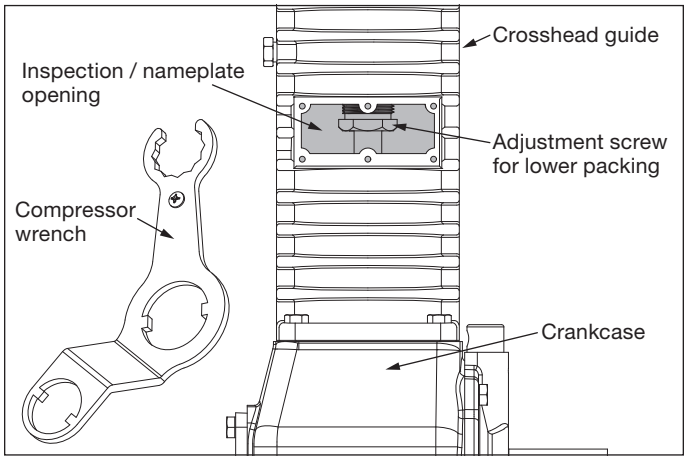


Figure 5.5A: Packing adjusting nuts.

5.6 Cylinder and Packing

If the compressor is properly maintained, the cylinder is rarely replaced. The primary causes for a damaged cylinder are corrosion and the entry of solid debris or liquid into the compression chamber. An improperly stored compressor can also cause corrosion in the cylinder. See Chapter 6 for proper storage procedures.

If the cylinder wall 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 in. must be removed to smooth the bore, replace the cylinder. Cylinder liners or oversized rings are not available.

NOTE: Overboring the cylinder reduces the ring life.

Many repair services require removal of the cylinder. While the compressor is disassembled, avoid leaving the compressor open more than a few hours. All bare metal

surfaces - including the head - should be coated with a rust preventative.

When reassembling the compressor, make sure the bolts are torqued to the valves shown in Appendix B.

Packing Replacement Instructions

CAUTION: Bleed all pressure from the compressor and piping, and purge (if necessary) BEFORE installing new piston rod packing. After all repairs have been completed, the unit should be pressure tested and checked for leaks at all joints, gaskets, and O-ring connections. When the compressor is used with toxic, dangerous, flammable or explosive gases, use air or a dry inert gas such as nitrogen to pressurize the compressor during the leak test.

For simplicity, heads, pistons, and inspection plates are not shown. For specific construction details and actual part numbers, consult the appendix in the back of this IOM manual. Use the instructions below that apply to the MODEL on the nameplate of the compressor and make sure packing sets are arranged in the proper order as shown in the parts details.

Cleanliness:

Prior to installation, inspect all parts for cleanliness and visible defects. There should not be any scratches, dings, porosity issues, or foreign materials on bearing surfaces, sealing surfaces, and inner and outer surfaces of the packing cartridge.

Workmanship:

Corken's compressor is a precision piece of equipment with very close tolerances so treat it with care and never force parts in or out.

5.6.1 Model D91 (D-Style) Compressor

Before starting these instructions, refer the parts details for packing listed in Appendix E during disassembly and assembly.

Disassembly of Packing (D-Style)

NOTE: Refer to the parts details pages while performing the following procedures.

1. Depressurize and open the compressor.

2. Remove the head, piston, cylinder, and the inspection/ nameplate on the side of the crosshead guide.

3. Locate the cartridge holddown screw on top of the crosshead guide and packing barrel. Remove the cartridge holddown screw, spacer, and O-ring.

4. Reach through the opening behind the inspection/ nameplate on the side of the crosshead guide with a screw driver and lightly pry up on the adjusting screw on the bottom of the packing cartridge. The packing cartridge should pop up (see Figure 5.5A).

5. Slowly rotate the flywheel until the packing cartridge moves up and out of the crosshead guide.

6. Remove the packing cartridge, oil deflector ring (inside cartridge), and second O-ring from the bottom of the crosshead guide.

7. Starting with the top of the packing cartridge, remove the top retainer ring, washer, spring, second washer, old packing set, and third washer.

8. On the bottom of the packing cartridge, remove the adjusting screw, old packing set, washer, spring and second washer.

NOTE: The retainer ring does not need to be removed unless it is being replaced.

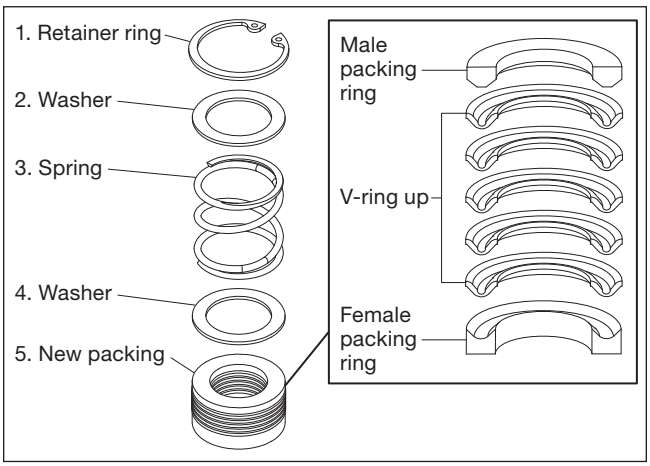
Assembly of Packing (D-Style)

Clean and lightly oil the inside and outside of the packing cartridge.

Lower packing set for Specs A and B:

NOTE: Make sure the new packing set is in the proper orientation. Refer to the parts details listed in Appendix E while following the instructions below. Install the male, V-ring, and female packing one at a time in the order shown. Push in each one completely before adding the next ring.

1. Start at the bottom of the packing cartridge and insert all parts in the following order:

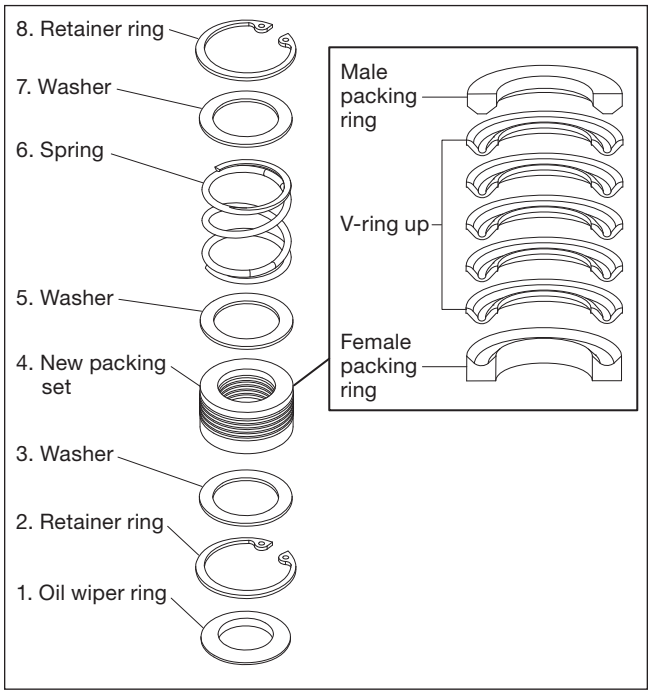


2. After installing the new packing set, install PTFE locking device (part number 1192) into adjusting screw and cut, leaving 1/8" exposed. Tighten adjusting screw until plastic locking device engages the first thread in the crosshead guide.

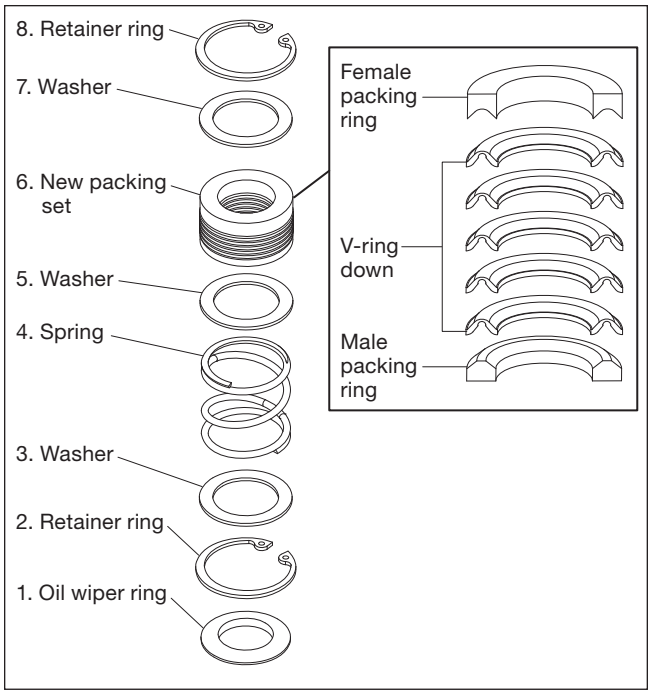
Upper packing set (Spec A or B):

NOTE: Make sure the new packing set is in the proper orientation. Refer to the parts details listed in Appendix E while following the instructions below. Install the male, V-ring, and female packing one at a time in the order shown. Push in each one completely before adding the next ring.

1. **Spec A only:** Before inserting the packing assembly, insert the oil wiper ring through the top of the packing cartridge and lay loose until it is time to slide the packing cartridge over the piston rod. Insert all remaining parts in the following order:



1. **Spec B only:** Before inserting the packing assembly, insert the oil wiper ring through the top of the packing cartridge and lay loose until it is time to slide the packing cartridge over the crosshead guide. Insert all remaining parts in the following order:



2. Oil piston rod and install the packing installation cone (part number 4005) over the threaded end of the piston rod.

3. Carefully slide the packing cartridge over the piston rod; otherwise, the lips of the packing rings may be damaged. NOTE: As the piston rod comes through the bottom set of packing, make sure the oil wiper ring is centered with the piston rod and pushes through to the upper set of packing.

4. After the packing cartridge is properly seated, remove packing installation cone.

5. Re-install the O-ring, spacer, and cartridge holddown screw.

6. Install the crosshead guide O-ring, cylinder, piston, O-ring, and head.

7. Rotate unit by hand to ensure proper assembly.

5.6.2 Model T91 (T-Style) Compressor

Before starting these instructions, refer the parts details for packing listed in Appendix E during disassembly and assembly.

Disassembly of Packing (T-Style)

NOTE: Refer to the parts details pages while performing the following procedures.

1. Depressurize and open the compressor.

2. Remove the head, piston, cylinder, distance piece, and the inspection/nameplate on the side of the crosshead guide.

3. Locate the cartridge holddown screw on top of the crosshead guide and packing barrel. Remove the cartridge holddown screw, spacer, and O-ring.

4. Reach through the opening behind the inspection/ nameplate on the side of the crosshead guide with a screw driver and lightly pry up on the adjusting screw on the bottom of the packing cartridge. The packing cartridge should pop up.

5. Slowly rotate the flywheel until the packing cartridge moves up and out of the crosshead guide.

6. Remove the packing cartridge, oil deflector ring (inside cartridge), and second O-ring from the bottom of the crosshead guide.

7. Starting with the top of the packing cartridge, remove the top retainer ring, washer, spring, second washer, old packing set, and third washer.

8. On the bottom of the packing cartridge, remove the adjusting screw, old packing set, washer, spring and second washer.

NOTE: The retainer ring does not need to be removed unless it is being replaced.

9. Locate the top of the distance piece and remove the first retainer ring followed by the washer, spring, second washer, old packing set, and third washer. The bottom (second) retainer ring can be left in the distance piece since it will be reused.

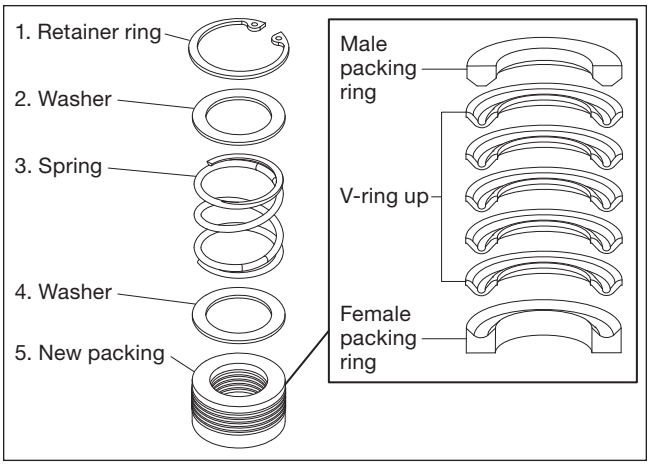
Assembly of Packing (T-Style)

Clean and lightly oil the inside and outside of the packing cartridge.

NOTE: Make sure the new packing set is in the proper orientation. Refer to the parts details listed in Appendix E. Install the male, V-ring, and female packing one at a time in the order shown. Push in each one completely before adding the next ring.

Lower packing set for Specs F, G and H:

1. Starting at the bottom of the packing cartridge, insert all parts in the following order:



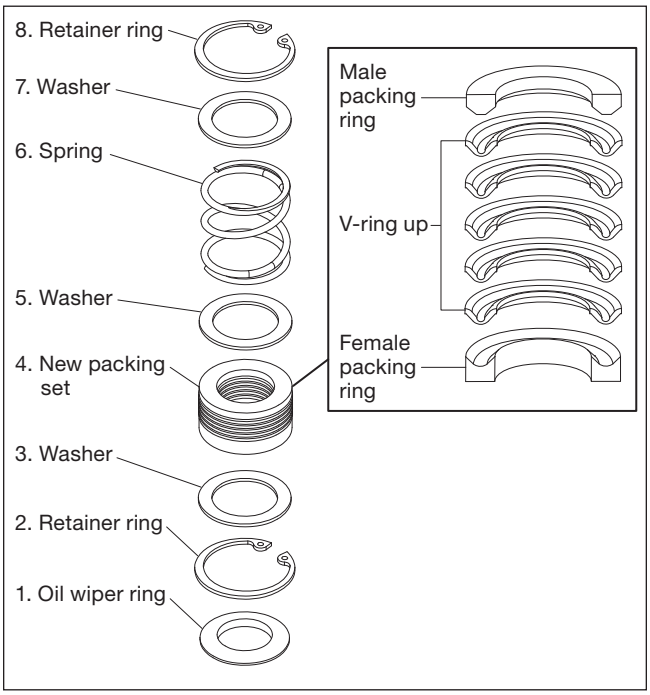
2. After installing the new packing set, install PTFE locking device (part number 1192) into adjusting screw and cut, leaving 1/8" exposed. Tighten adjusting screw until plastic locking device engages the first thread in the crosshead guide.

Middle packing set for Specs F, G, and H:

NOTE: Make sure the new packing set is in the proper orientation. Refer to the parts details listed in Appendix E while following the instructions below. Install the male, V-ring, and female packing one at a time in the order shown. Push in each one completely before adding the next ring.

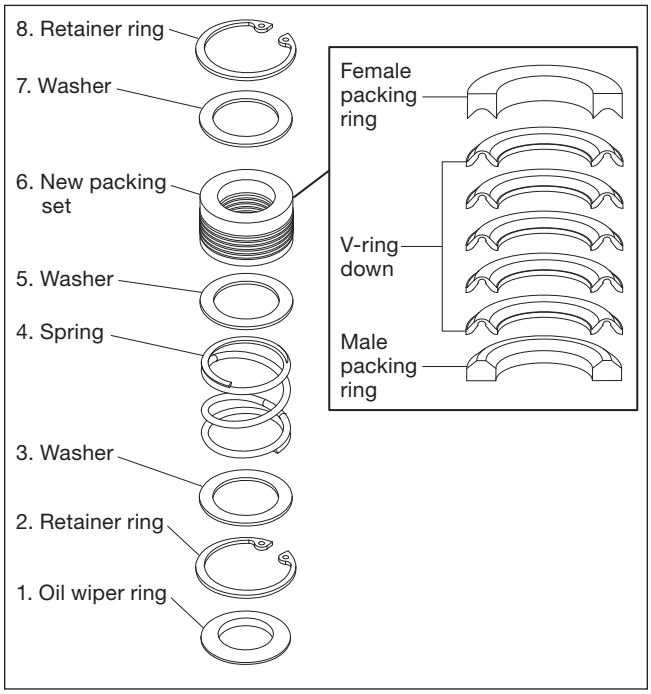
Spec F and G only:

1. Before inserting the packing assembly, insert the oil wiper ring through the top of the packing cartridge and lay loose until it is time to slide the packing cartridge over the piston. Insert all remaining parts in the following order:



Spec H only:

1. Before inserting the packing assembly, insert the oil wiper ring through the top of the packing cartridge and lay loose until it is time to slide the packing cartridge over the crosshead guide. Insert all remaining parts in the following order:



2. Oil piston rod and install the packing installation cone (part number 4005) over the threaded end of the piston rod.

3. Carefully slide the packing cartridge over the piston rod; otherwise, the lips of the packing rings may be damaged. NOTE: As the piston rod comes through the bottom set of packing, make sure the oil wiper ring is centered with the piston rod and pushes through to the upper set of packing.

4. After the packing cartridge is properly seated, remove packing installation cone.

5. Re-install the O-ring, spacer, and cartridge holddown screw.

6. Install the crosshead guide O-ring, cylinder, piston, O-ring, and head.

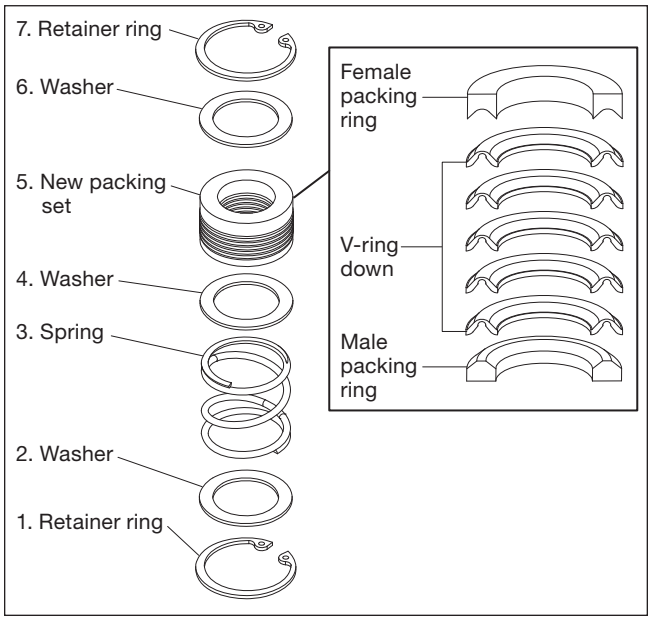
Upper packing set for Specs F, G, and H:

Clean and lightly oil the packing area inside the distance piece.

NOTE: Make sure the new packing set is in the proper orientation. Refer to the parts details listed in Appendix E while following the instructions below. Install the male, V-ring, and female packing one at a time in the order shown. Push in each one completely before adding the next ring.

Spec F only:

1. Starting at the top of the packing cartridge, insert all parts in the following order:

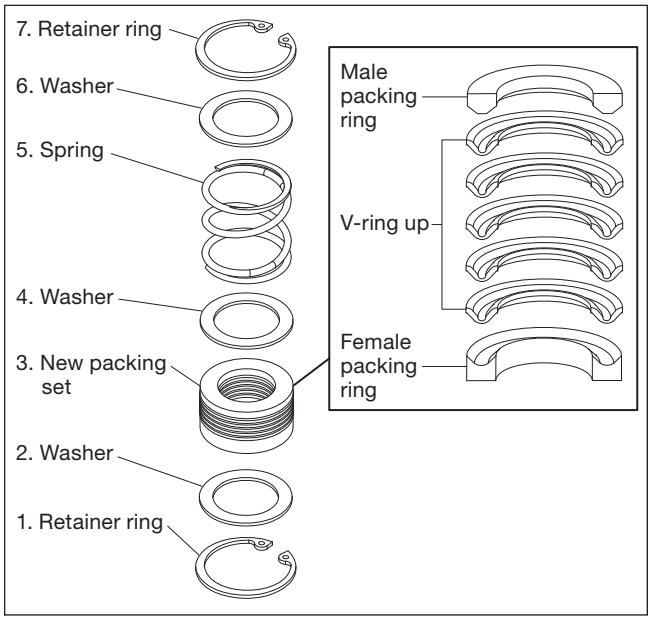


2. Install the crosshead guide O-ring, cylinder, piston, O-ring, and head.

3. Rotate unit by hand to ensure proper assembly.

Spec G and H only:

1. Starting at the top of the packing cartridge, insert all parts in the following order:



2. Install the crosshead guide O-ring, cylinder, piston, O-ring, and head.

3. Rotate unit by hand to ensure proper assembly.

5.7 Bearing Replacement for Crankcase and Connecting Rod

Before starting these instructions, refer the parts details listed in Appendix E during disassembly and assembly.

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

2. Drain the crankcase and remove the inspection plate.

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

5.7.1 Wrist Pin Bushing Replacement

1. To replace the wrist pin bushing, remove the retainer rings that secure the wrist pin inside 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, press out and insert a new one. Bore the wrist pin bushing I.D. as indicated in Appendix E. See parts details for connecting rod assembly. 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 through the crosshead and connecting rod and re-install each retainer ring. NOTE: The fit between the wrist pin and wrist pin bushing is tighter than a lubricated air compressor or combustion engine.

5.7.2 Replacing Connecting Rod Bearings

Connecting rod bearings are easily replaced but they must be properly aligned.

- Make sure the indentations in the connecting rod bearing and connecting rod line up when installing the new bearings.

- Make sure the alignment notch on the connecting rod and cap are aligned (see Appendix E for details).

Before re-installing the crosshead and connecting rod assembly, make sure the crankshaft throw and bearing surfaces are clean and lubricated. Tighten the connecting rod bolts to the torque values listed in Appendix B.

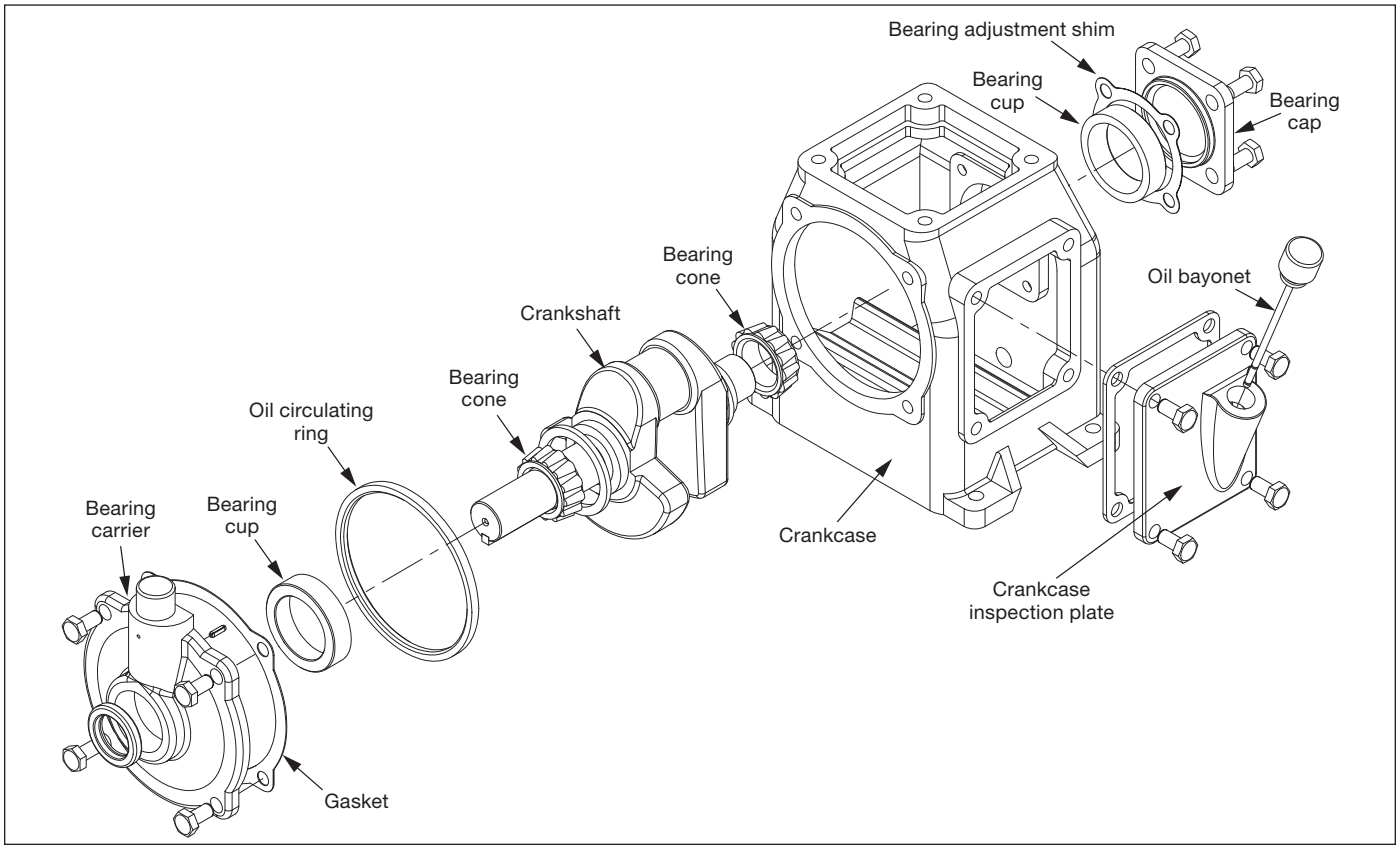


Figure 5.7.3: Bearing carrier replacement.

5.7.3 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, not just the cup or the cone.

1. Press out the cups out from the crankcase and bearing carrier and remove the cones from the crankshaft.

2. Press in new cups and slide on new cones onto the crankshaft.

3. Install the crankshaft inside the crankcase followed by the bearing carrier and bearing cap.

4. After the crankshaft is installed, check the crankshaft endplay by pressing the one end of crankshaft towards the crankcase. If a clicking noise or motion is detected, the crankshaft has too much endplay (see specifications proper endplay in Appendix B).

5. To reduce endplay, remove the bearing cover and one thin shim. After re-installing the bearing, recheck the endplay.

6. After there is no detectable endplay, make sure the shaft still rotates freely. If it sticks or becomes abnormally warm, the crankshaft bearings are too tight and a shim(s) should be added until it rotates freely. When the crankshaft can be rotated freely by hand with proper endplay, the rest of the compressor can be reassembled.

NOTE: Do not to under or over shim. If the crankshaft roller bearings are too tight or too loose, premature bearing failure will result.

7. Reinstall the flywheel on the crankshaft and confirm proper run out as shown in Appendix B.

Chapter 6—Extended Storage Procedures

Following a few simple procedures greatly minimize the risk of corrosion and damage. Corken recommends the following:

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

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

3. Relieve V-belt tension.

4. Plug all openings to prevent entry of insects and moisture.

5. The cylinders can 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 startup.

6. Store in a dry area, off the ground.

7. Rotate the flywheel every two weeks.

8. If possible, store compressor in a climate controlled area.

9. When a compressor is pulled out of long-term storage, remove the compressor's nameplate and pour new oil over the crossheads to ensure good crosshead lubrication at startup.

6.1 Gasket Sets

Model 91 Gasket Set (2526-XA)

Part No.	Description
2526-X1A	Gasket set (D/T91) Buna-N, aluminum
2526-X1A2	Gasket set (D/T91) Buna-N, iron-lead
2526-X1B	Gasket set (D/T91) Neoprene®[1], aluminum
2526-X1D	Gasket set (D/T91) Viton®[1], aluminum
2526-X1D2	Gasket set (D/T91) Viton®[1], iron-lead
2526-X1E	Gasket set (D/T91) PTFE, aluminum
2526-X1E2	Gasket set (D/T91) PTFE, iron-lead

[1] Registered trademark of the DuPont company.

Appendix A—Model Number Identification Code and Available Options

D91 Single-stage with NPT and FD91 ASME Class 300 RF Flanged Connections (D-Style)

	Base Model Number	D91 (NPT)	FD91 (ASME Class 300 RF Flange)
Double Packed	Inlet	3/4"	3/4"
	Outlet	3/4"	3/4"
	Weight lbs. (kg)	150 (68.0)	150 (68.0)

Model Number
Base X X X X X X X X X X X

Specification Fields

Packing Arrangement	Inlet pressure above atmospheric	Standard	A
	Atmospheric inlet or vacuum service	No charge option	B
Crankcase Style	Splash lubricated with extended crankshaft	Standard	J
Valves	Liquid relief suction valves	No charge option	3
	Standard suction and discharge valve	Standard	4
	Suction valve unloaders	Charge option	9
	Spec. 3 valves with PEEK valve plates	Charge option	3P
	Spec. 4 valves with PEEK valve plates	Charge option	4P
	Spec. 9 valves with PEEK valve plates	Charge option	9P
Piston Ring and Packing Material	PTFE piston ring and PTFE packing material	Standard	F
	Alloy 50 piston ring and Alloy 50 packing material	Charge option	G
	PEEK piston ring and Alloy 50 packing material	Charge option	H
Gasket Material	Steel	Standard	D
O-ring Material	Buna-N	Standard	A
	Neoprene ®[1]	No charge option	B
	Viton ®[1]	Charge option	D
	PTFE	Charge option	E
Intercooler	Less intercooler (not applicable)	Standard	N
Flywheel	Heavy duty flywheel	Charge option	H
	Less flywheel	No charge option	N
	Standard flywheel	Standard	S
Protective Coating	Cylinder only	Charge option	C
	Less coating	Standard	N
	All necessary wetted parts	Charge option	W
Piston Rod Coating	Nitrotec ®[2]	Standard	N

[1] Registered trademark of the DuPont company.
[2] Registered trademark of TTI Group Ltd.

Appendix A—Model Number Identification Code and Available Options

T91 Single-stage with NPT and FT91 ASME Class 300 RF Flanged Connections (T-Style)

	Base Model Number	T91 (NPT)	FT91 (ASME Class 300 RF Flange)
Triple Packed	Inlet	3/4"	3/4"
	Outlet	3/4"	3/4"
	Weight lbs. (kg)	150 (68.0)	150 (68.0)

Model Number
Base X X X X X X X X X X

Specification Fields

Packing Arrangement	Vacuum service	No charge option	F
	Standard packing arrangement for T-style	Standard	G
	Packing arranged to purge distance piece	No charge option	H
Crankcase Style	Splash lubricated with extended crankshaft	Standard	J
Valves	Liquid relief suction valves	No charge option	3
	Standard suction and discharge valve	Standard	4
	Suction valve unloaders	Charge option	9
	Spec. 3 valves with PEEK valve plates	Charge option	3P
	Spec. 4 valves with PEEK valve plates	Charge option	4P
	Spec. 9 valves with PEEK valve plates	Charge option	9P
Piston Ring and Packing Material	PTFE piston ring and PTFE packing material	Standard	F
	Alloy 50 piston ring and Alloy 50 packing material	Charge option	G
	PEEK piston ring and Alloy 50 packing material	Charge option	H
Gasket Material	Steel	Standard	D
O-ring Material	Buna-N	Standard	A
	Neoprene®[1]	No charge option	B
	Viton®[1]	Charge option	D
	PTFE	Charge option	E
Intercooler	Less intercooler	Standard	N
Flywheel	Heavy duty flywheel	Charge option	H
	Less flywheel	No charge option	N
	Standard flywheel	Standard	S
Protective Coating	Cylinder only	Charge option	C
	Less coating	Standard	N
	All necessary wetted parts	Charge option	W
Piston Rod Coating	Nitrotec®[2]	Standard	N

[1] Registered trademark of the DuPont company.
[2] Registered trademark of TTI Group Ltd.

Appendix B—Specifications for All Models 91

Equipment Type and Options

Single-acting, vertical, reciprocating piston type vapor compressor
Single packed rod
NPT or Class 300 RF connections

Applications

Bulk transfer	Tank evacuation
Vapor recovery	Gas scavenging

Features and Benefits

Self-lubricating piston rings:	Non-lubricated operation to minimize oil in gas
NPT or Class 300 RF connections:	Versatility for your application
Multiple mounting configurations:	Versatility for your application
High efficiency valves:	Quiet, reliable operation
Reversible oil pump:	Allows operation in either direction
Simplified top down design:	Routine maintenance is minimally invasive

Operating Specifications

Bore of cylinder inches (mm)	3.0 (76.2)
Stroke inches (mm)	2.5 (63.5)
Piston displacement cfm (m^3/hr)	
minimum @ 400 RPM	4.1 (7.0)
maximum @ 800 RPM	8.2 (13.9)
Maximum working pressure psig (bar g)[1]	335 (23.1)
Maximum brake horsepower (kW)	7.5 (5.6)
Maximum rod load lb (kg)	3,600 (1,632.9)
Maximum outlet temperature °F (°C)	350 (177)
Maximum flow—propane gpm (m^3/hr)	50 (11.4)

[1] *These numbers specify pressure-containing abilities of the compressor cylinder and head. For many applications, factors other than the pressure rating will limit the maximum allowable discharge pressure to lower values. These factors include horsepower, temperature and rod load.*

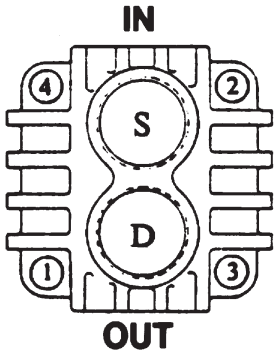
Appendix B—Specifications for All Models 91

Material Specifications

Part	Standard Material
Head, Cylinder	Ductile iron ASTM A536
Crosshead guide crankcase, flywheel, bearing carrier	Gray iron ASTM A48, Class 30
Flange	Ductile iron ASTM A536
Valve seat and bumper	17-4 PH stainless steel
Valve plate	410 stainless steel
Valve spring	17-7 PH stainless steel
Valve gaskets	Soft aluminum
Piston	Gray iron ASTM A48, Class 30
Piston rod	1045 steel Nitrotec®[1] coated
Crosshead	Gray iron ASTM A48, Class 30
Piston rings	PTFE, glass, and moly filled
Ring expanders	302 stainless steel
Packing cartridge, connecting rod	Ductile iron ASTM A536
Packing V-rings	PTFE, glass and moly filled
Crankshaft	Ductile iron ASTM A536
Connecting rod bearing	Bimetal D-2 babbit
Wrist pin	C1018 steel
Wrist pin busing	Bronze SAE J461
Main bearing	Tapered roller
Inspection plate	Aluminum
O-rings	Buna-N, Neoprene®[2], PTFE, Viton®[2] (optional)
Retainer rings	Steel
Misc. gaskets	Rubber compositions
Distance piece	Ductile iron ASTM A536

Bolt Torque Values (in ft•lb Except Piston Screws)

Connecting rod bolt	28
Bearing carrier	38
Bearing cover	38
Crankcase inspection plate	15
Crosshead guide	30
Cylinder to head[3,4]	20
Valve cover plate bolt	—
Valve holddown screw[4]	40
Piston locknut	45
Piston screw (in•lb)	50
Valve cap with gaskets	40
Valve cap with O-rings	25



[1] Registered trademark of TTI Group Ltd.
[2] Registered trademark of the DuPont company.
[3] Preliminary tightening – snug all head bolts in the sequence shown. Final torqueing – torque all head bolts in the sequence shown to the listed value.
[4] Retorque to the listed value after 1 hour running time.

Appendix B—Specifications for All Models 91

Clearances and Dimensions for Single-Acting Models

"X" piston clearance figure 5.4A and 5.4B[1]	0.020 0.044
Clearance from connecting rod bearing to crankshaft journal	0.001 0.0025
Clearance from wrist pin to wrist pin bushing[2]	0.0006 0.0011
Maximum cylinder bore diameter	3.009
Cylinder finish (RMS)	16–32
Minimum piston ring radial thickness	0.082
Maximum clearance from oil pump adapter shaft to bushing[2]	N/A
Crankshaft end play	0.000 0.002
Maximum flywheel runout at O.D.	0.020
Maximum clearance from crosshead to crosshead guide bore	0.011
Crosshead guide bore finish	32 RMS (limited number of small pits and scratches are acceptable)

Distance Piece Connections and Piston Rod Packing Orientation

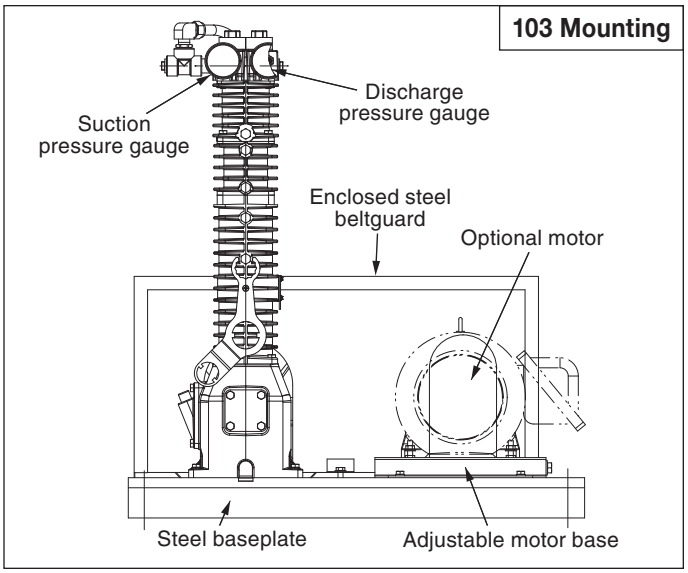
Model	Packing Arrangement	Conditions	Service	Distance Piece Opening, 1/4" NPT		V-Rings Point		
				Upper	Lower	Upper	Middle	Lower
All models D91	Specification A	Inlet pressure: above 15 psia	General gas transfer	Plugged to allow the distance piece pressure to reach its own level.	Pipe to drain with a shut-off valve. Distance piece must be drained weekly to prevent an accumulation of oil or condensate.	Spring 	NA	Spring 
	Specification B	Inlet pressure: below atmosphere (vacuum)	1) General gas application	Tube to discharge port.	Pipe to drain with a shut-off valve. Distance piece must be drained weekly to prevent an accumulation of oil or condensate.	 Spring	NA	Spring 
			2) Highly toxic gases	Pressurized via an external gas source to a pressure above suction pressure and above atmospheric pressure.				
All models T91	Specification F	Inlet pressure: below atmosphere (vacuum)	1) General gas application	Tube to discharge port.	Pipe to drain with a shut-off valve. Distance piece must be drained weekly to prevent an accumulation of oil or condensate.	 Spring	Spring 	Spring 
			2) Highly toxic gases	Pressurized via an external gas source to pressure close or below to discharge pressure.				
	Specification G	Inlet pressure: above 15 psig	General gas application	Plugged to allow the distance piece pressure to reach its own level.	Pipe to drain with a shut-off valve. Distance piece must be drained weekly to prevent an accumulation of oil or condensate.	Spring 	Spring 	Spring 
	Specification H	Inlet pressure: above 15 psig	Toxic gases	Maintain a gas flow of about 1 SCFH from an external gas source and send this gas to a suitable location for proper disposal. Pressure needs to be below discharge pressure and lower distance piece pressure.	Pressurized via an external gas source to a pressure atmospheric pressure.	Spring 	 Spring	Spring 

Appendix C—Compressor Selection

Compressor Mounting Selections

103 Mounting

- Steel baseplate
- V-belt drive
- Adjustable driver slide base
- Enclosed steel beltguard
- Suction and discharge pressure gauges



Standard 107 Items

- Steel baseplate
- V-belt drive
- Adjustable driver side base
- Enclosed steel guard
- Suction and discharge pressure gauges
- 40 Micron strainer
- Non-lube 4-way valve
- Interconnecting piping
- Liquid trap as specified below

107 Mounting

- Mechanical liquid trap with ball float

107A Mounting

- Automatic liquid trap with one NEMA 7 liquid level switch

107B Mounting

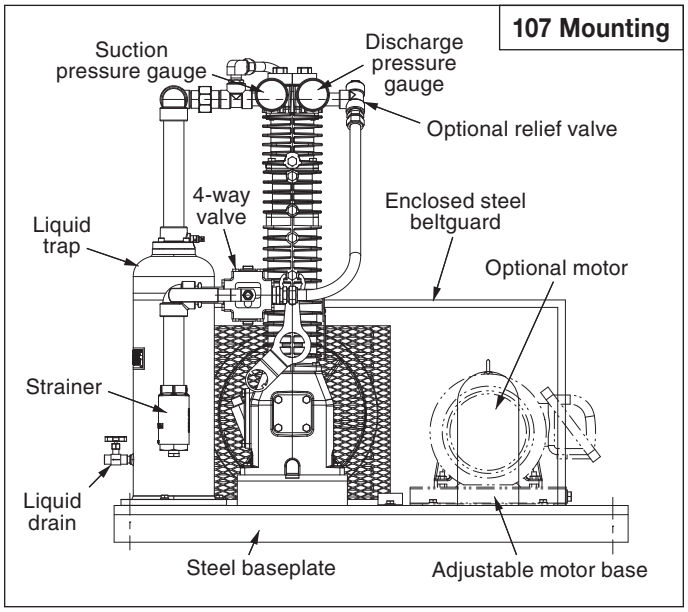
- Automatic liquid trap with two NEMA 7 liquid level switches

107F Mounting

- 107A or 107B with Class 300 RF flanged components and connections

107TR Mounting

- Must specify 14” flywheel and extended crankshaft



Standard 109 Items

- Steel baseplate
- V-belt drive
- Adjustable driver side base
- Enclosed steel guard
- Suction and discharge pressure gauges
- 40 Micron strainer
- Non-lube 4-way valve
- Interconnecting piping
- Liquid trap as specified below

109 Mounting

- Mechanical liquid trap with ball float

109A Mounting

- Automatic liquid trap with one NEMA 7 liquid level switch

109B Mounting

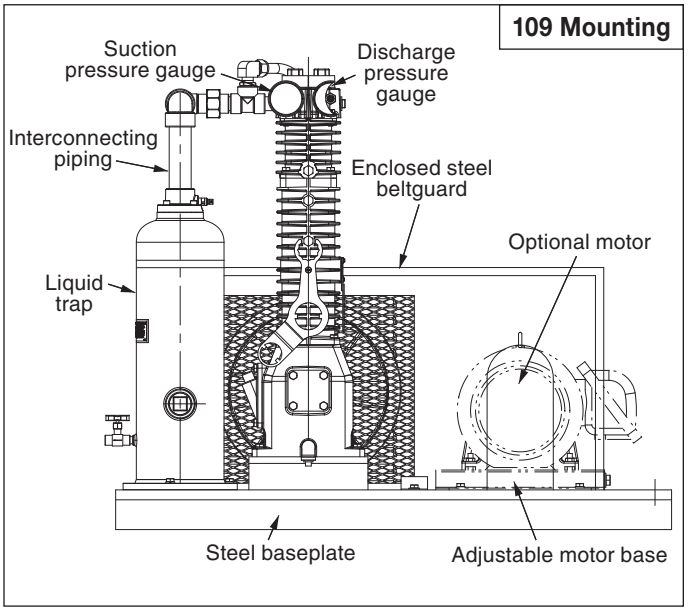
- Automatic liquid trap with two NEMA 7 liquid level switches

109F Mounting

- 109A or 109B with Class 300 RF flanged components and connections

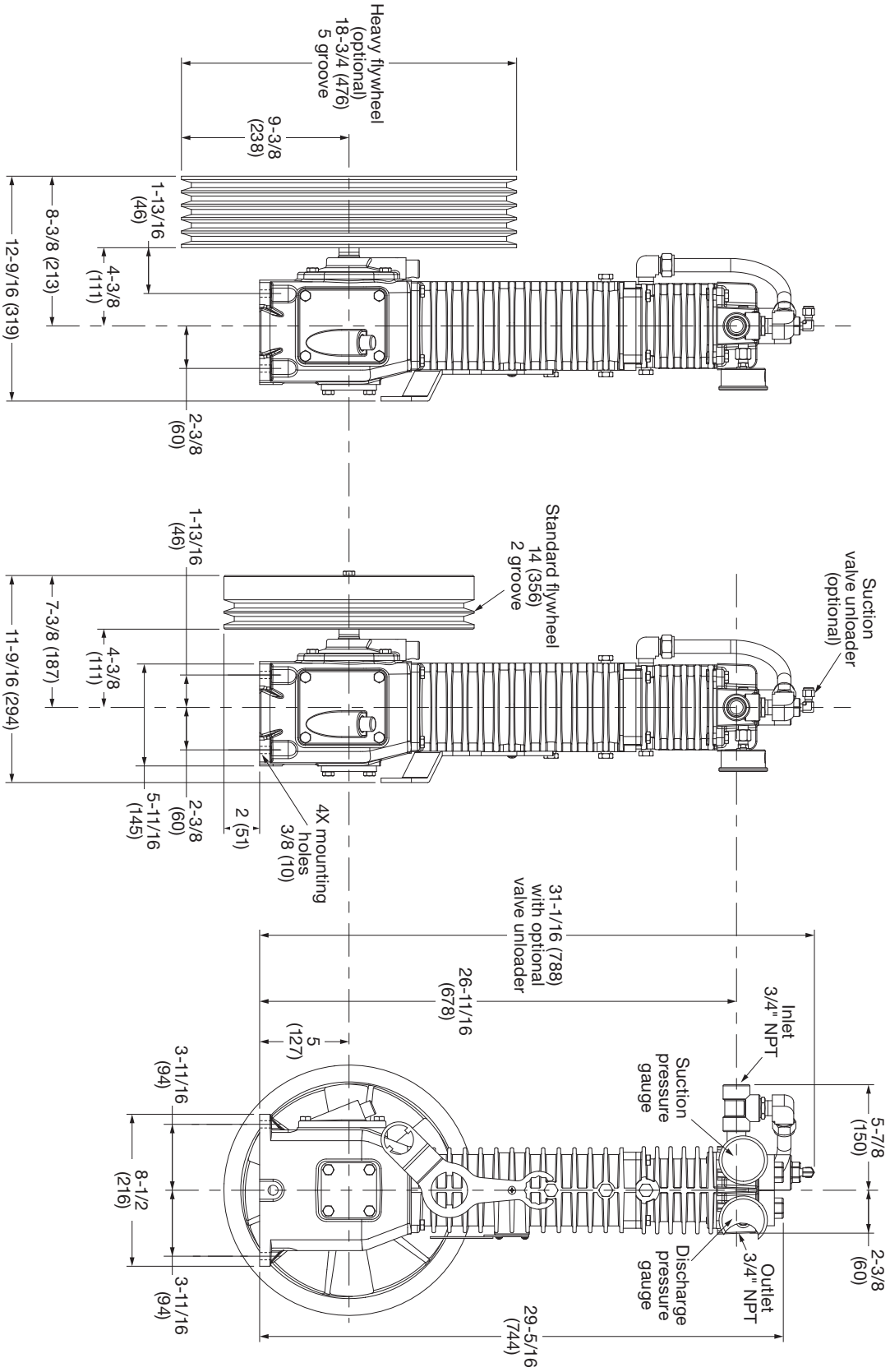
109TR Mounting

- Must specify 14” flywheel and extended crankshaft



Appendix D—Outline Dimensions

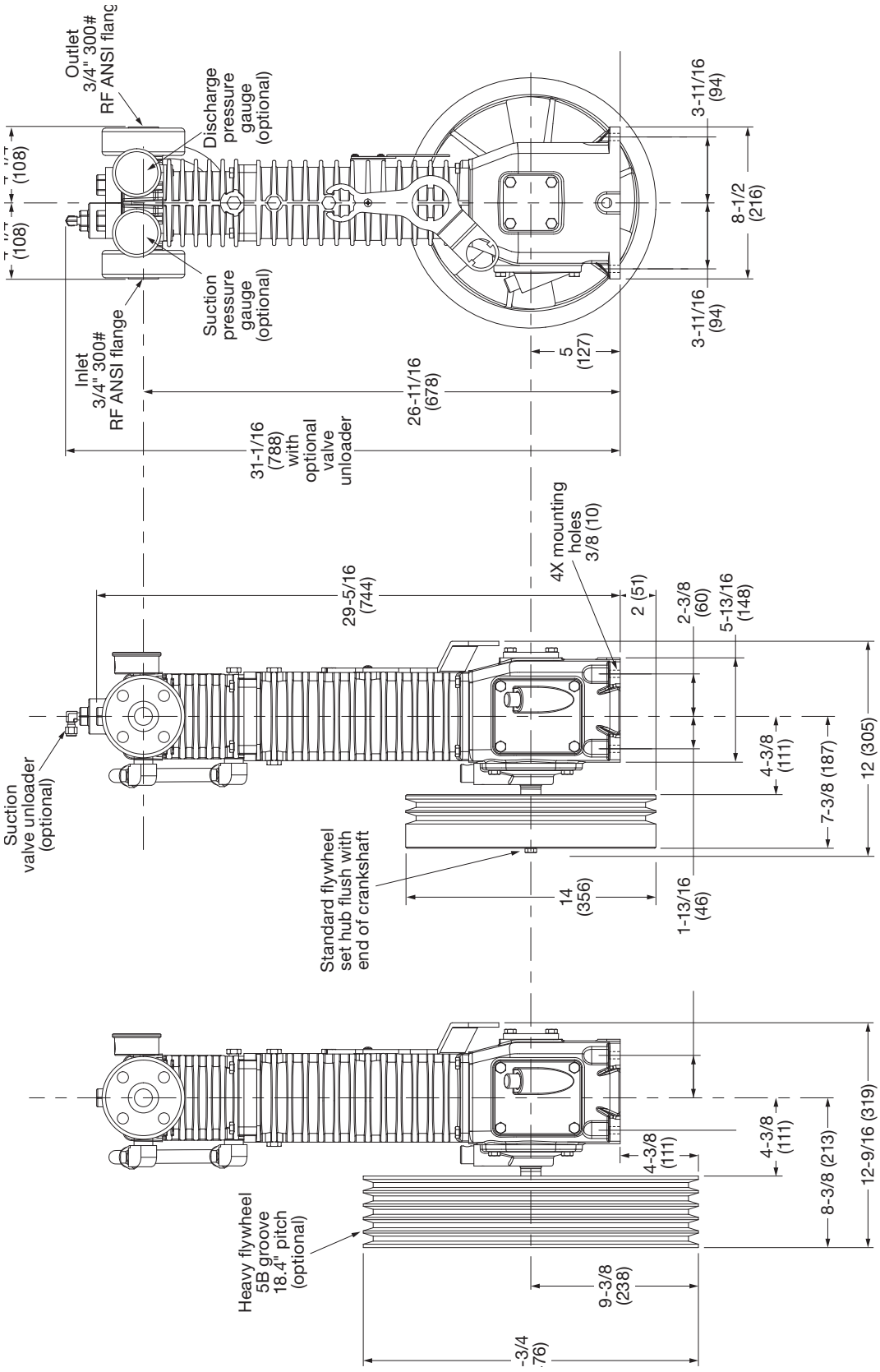
Model D91



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

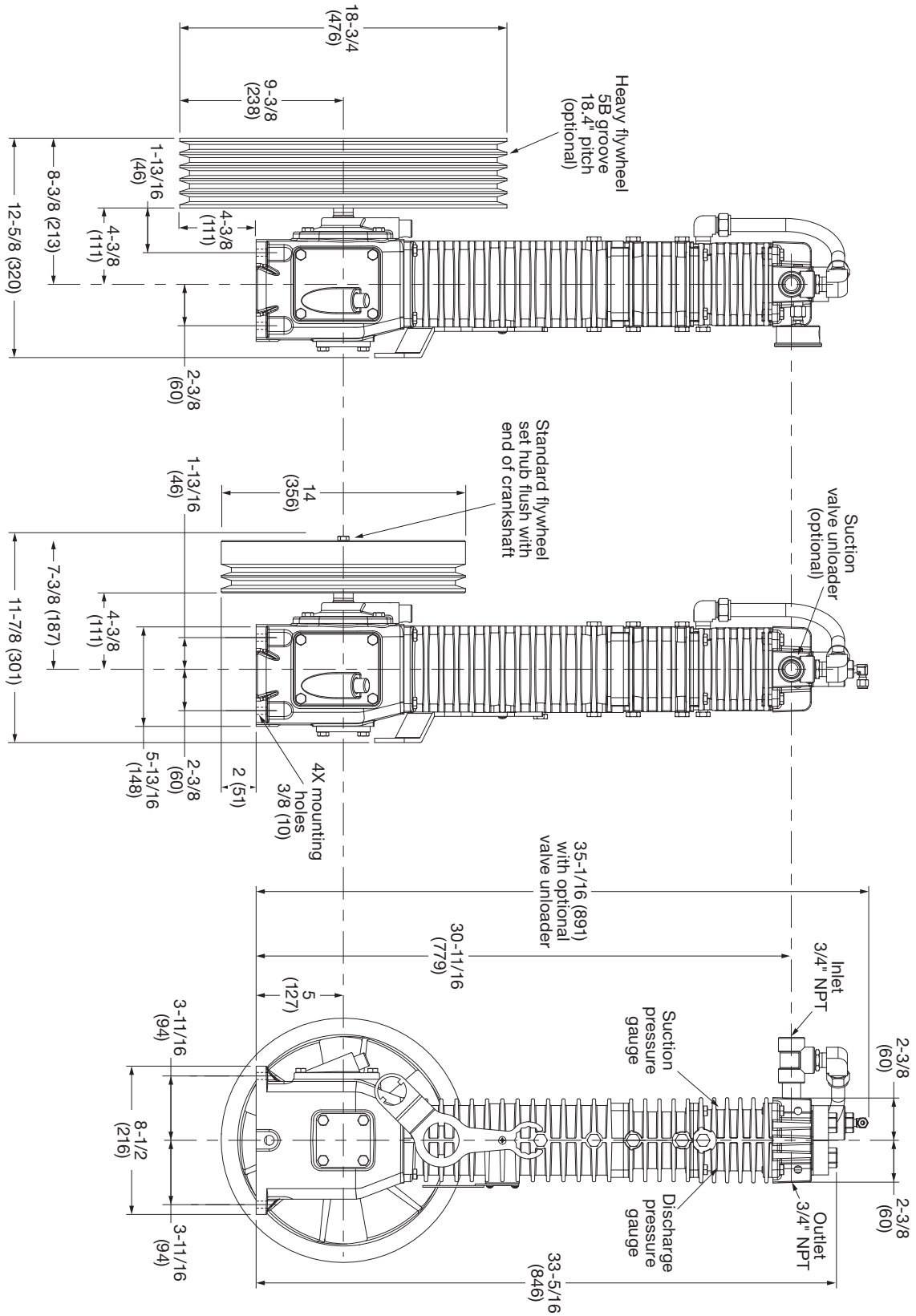
Model FD91



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

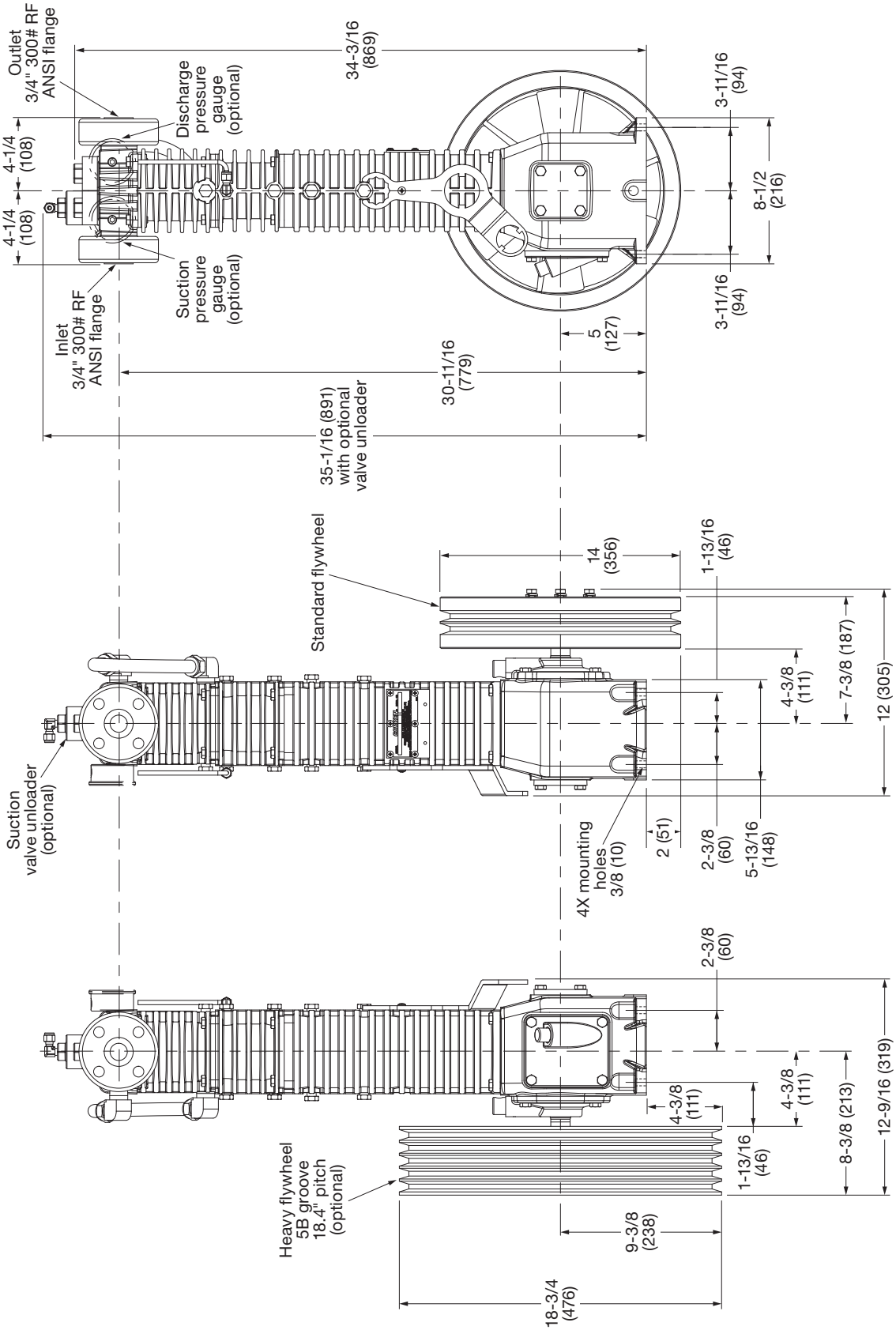
Model T91



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

Model FT91



All dimensions are in inches (millimeters).

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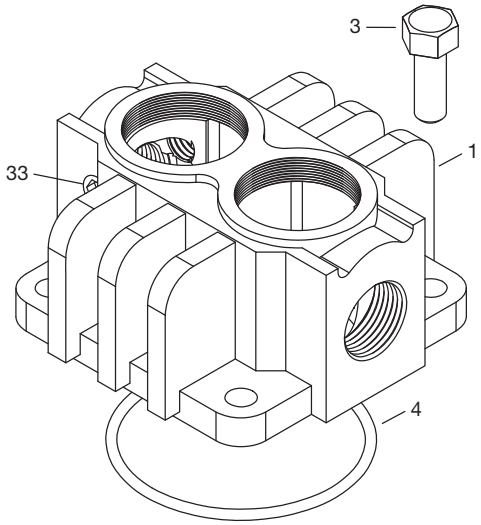
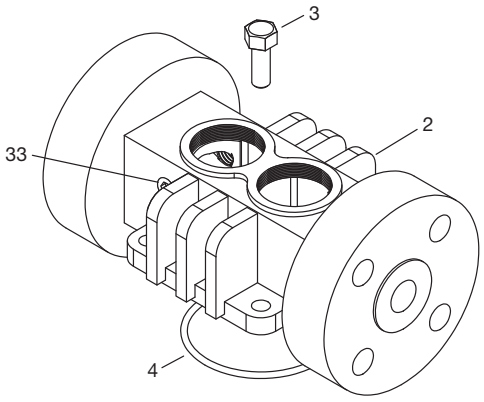
Appendix E—Parts Details for 91 and F91 Head and Valve Assembly

D91 and T91 Head Assembly



FD91 and FT91 Head Assembly

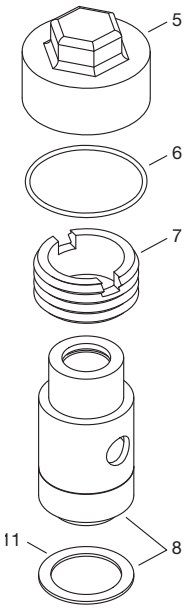


WARNING

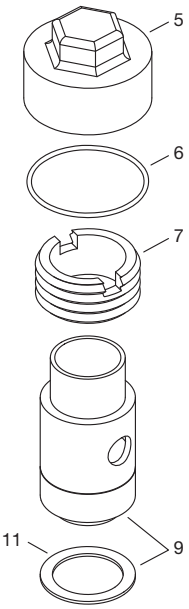
CAUTION: Always relieve pressure in the unit before attempting any repairs.

Valve Holddown Assemblies

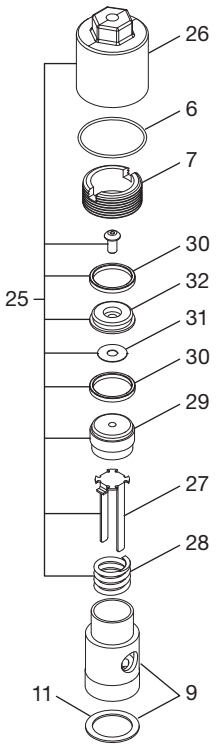
Suction Spec. 3



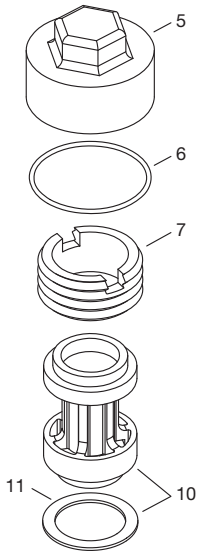
Suction Spec. 4



Suction Spec. 9

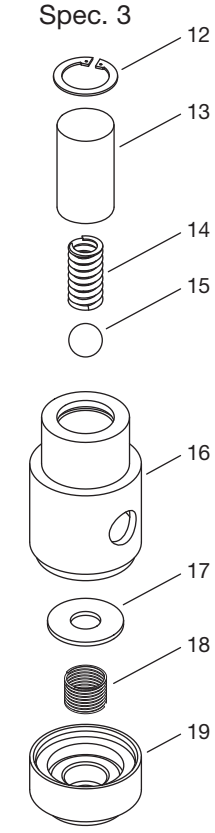


Discharge All Specs.

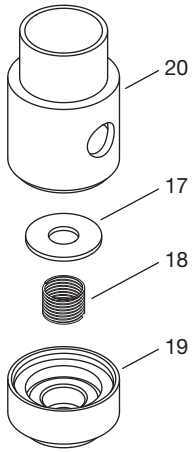


Valve Assemblies

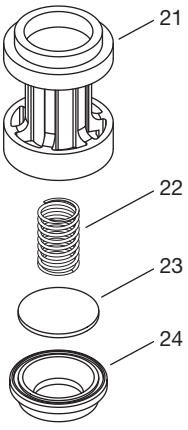
Suction Valve Spec. 3



Suction Valve Spec. 4 and 9



Discharge Valve All Specs.



Appendix E—Parts Details for 91 and F91 Head and Valve Assembly

Head and Valve Bill of Materials

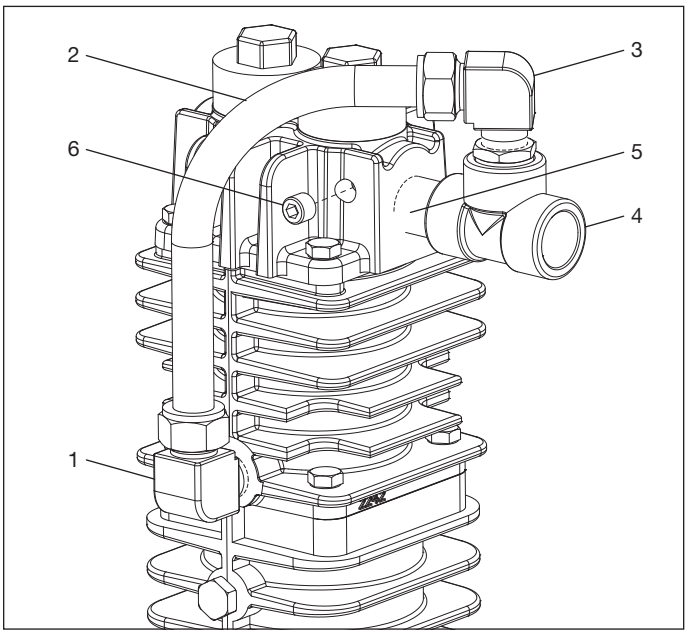
Ref No.	Part No.	Description	Qty.
1.	2374	Head (model 91)	1
	2374-X	Head assembly (model 91, spec. 3)	1
	2374-X1	Head assembly (model 91, spec. 4)	1
	2374-X2	Head assembly (model 91, Spec 9)	1
	2374C[d]	Head, coated (model 91)	1
2.	4302	Head (model F91, Class 300 RF flange)	1
	4302C[d]	Head, coated (model F91, Class 300 RF flange)	1
3.	7001-037NC100A	Bolt (hex head 3/8"-16 x 1-1/4")	4
4.	2-235_[a]	O-ring	1
5.	2714-1	Valve cap	2
	2714-1C[d]	Valve cap, coated	2
6.	2-031_[a]	O-ring	2
7.	2715	Holddown screw	2
	2715C[d]	Holddown screw, coated	2
8.	3483-1X2	Suction valve assembly (Spec 3 - Steel gasket with stainless steel valve plate)	1
9.	3483-X2	Suction valve assembly (Spec 4 and 9 - Steel gasket with steel valve plate)	1
	3483-2X2	Suction valve assembly (Spec 4 and 9 - Steel gasket with PEEK valve plate)	1
10.	3485-X2	Discharge valve assembly (All specs - Steel gasket with Stainless steel valve plate)	1
	3485-2X2	Discharge valve assembly (All specs - Steel gasket with PEEK valve plate)	1
11.	2717-2	Valve gasket (Steel)	2
12.	5000-77	Retainer ring (spec. 3)	1
13.	3977	Suction valve relief housing (spec. 3)	1
14.	1411	Spring (spec. 3)	1
15.	1410	Ball (spec. 3)	1
16.	3483-1	Suction valve seat (spec. 3)	1
17.	3972[b]	Suction valve plate (Stainless steel)	1
18.	4009	Suction spring	1
19.	3484	Suction valve bumper	1
20.	3483	Suction valve seat (spec. 4)	1
21.	3486	Discharge valve bumper	1
22.	4008	Discharge spring	1
23.	3973[b]	Discharge valve plate (Stainless steel)	1
24.	3485	Discharge valve seat	1
25.	3919-X	Unloader assembly	1
26.	2598-1	Unloader cap	1
	2598-1C[d]	Unloader cap, coated	1
27.	3975	Unloader actuator	1
28.	3976	Unloader spring	1
29.	3919	Unloader piston	1
30.	2619-X	Coro seal (unloader)	2
31.	2858	Gasket (unloader)	1
32.	2857	Unloader piston cap	1
33.	3289	Pipe plug-1/4" NPT flush	

[a] "_" denotes material code. See material code chart for details.
[b] For other material options, consult factory.
[c] Registered trademark of the DuPont Company.
[d] See pages 25 and 26 for model code for coating designation.

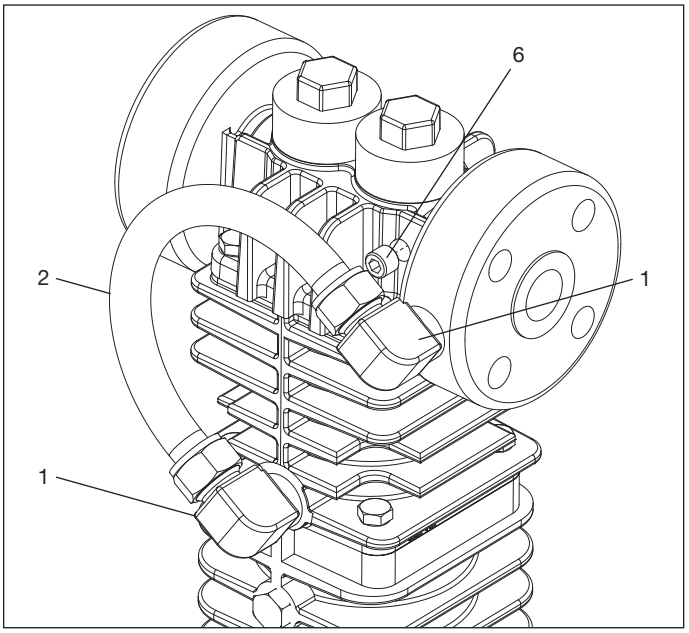
Material Code	
A	Buna-N
B	Neoprene®[c]
D	Viton®[c]
E	PTFE

Appendix E—Parts Details for 91 and F91 Equalization Tube Assembly

Model 91



Model F91



Tube Assembly—Bill of Materials

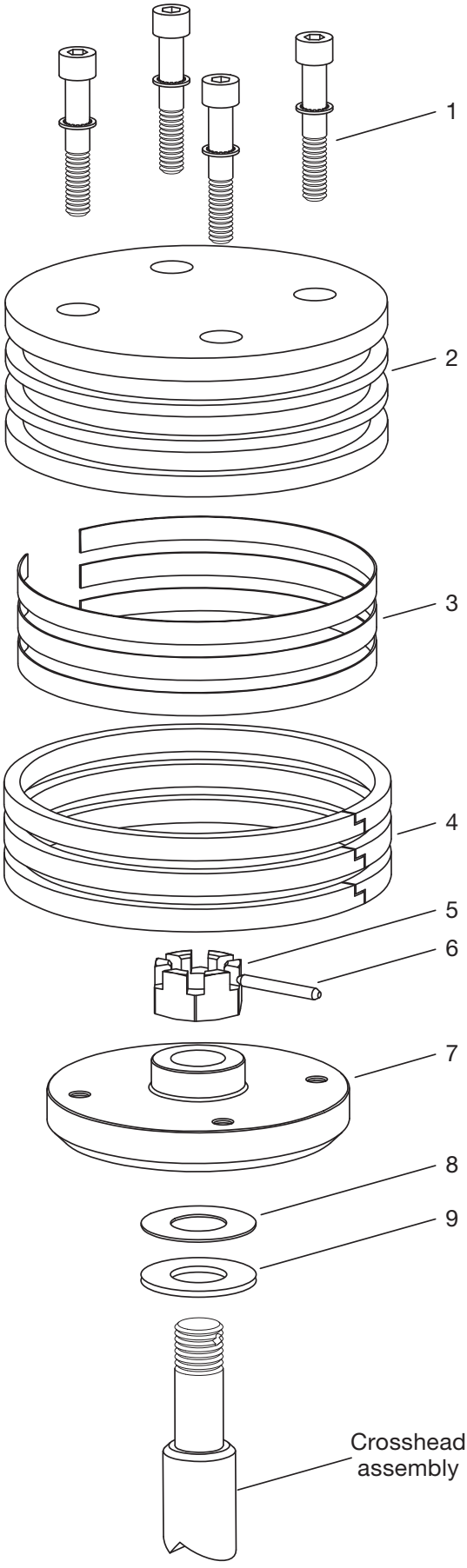
Standard Non Coated Compressor

Ref No.	Part No.	Description	Qty.
1.	2388-1	Tube elbow (3/4T x 1/2P)	1
2.	3434-1	Tube (3/4 x 0.035 304 stainless steel)	1
3.	2321-1	Tube elbow (3/4T x 3/4P)	1
4.	1051	Tee (3/4" NPT)	1
5.	1068	Nipple (3/4" x 2", schedule 80)	1
6.	3289	Pipe plug (1/4" NPT)	1

Coated Compressor

Ref No.	Part No.	Description	Qty.
1.	2388-2	Tube elbow (3/4T x 1/2P)	1
2.	3434-1	Tube (3/4 x 0.035 304 stainless steel)	1
3.	2321-2	Tube elbow (3/4T x 3/4P)	1
4.	4001-1	Tee (3/4" NPT, stainless steel)	1
5.	1074-1	Nipple (3/4" x 2-1/2", stainless steel)	1
6.	4974	Pipe plug (1/4" NPT stainless steel)	1

Appendix E—Parts Details for 91 and F91 Head and Valve Assembly



Piston—Bill of Materials
Piston Diameter 3" (7.62 cm)

Ref No.	Part No.	Description	Qty.
1.	7002-010TP100A	Screw (socket head)	4
	7207-010A	Lock washer	4
2.	1983 [a]	Head (iron)	1
	1983C [d]	Head, coated (iron)	1
3.	1775	Ring expander	3
4.	1772	Piston ring (PTFE)	3
	1772-2	Piston ring (Alloy)	3
	1772-3	Piston ring (PEEK)	3
5.	1482 [a, b]	Locknut (steel)	1
	1482C [d]	Locknut, coated (steel)	
6.	1483	Lock pin	1
7.	1984 [b]	Piston platform	1
	1984C [d]	Piston platform, coated	
8.	1528 [b]	Shim washer (thick)	As Req.
	1528-1 [b]	Shim washer (thin)	As Req.
9.	1527 [b]	Thrust washer	1

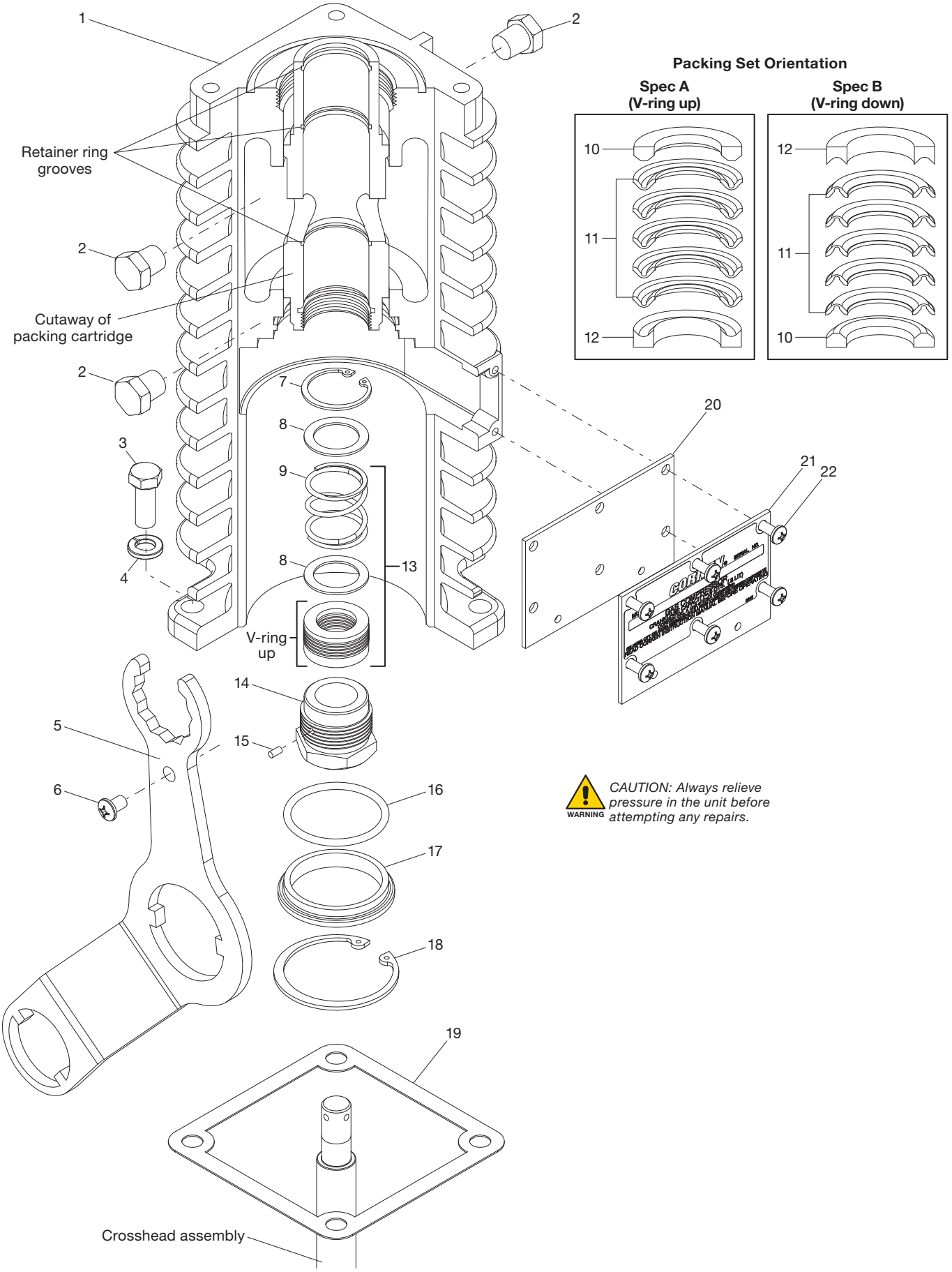
Piston Clearance (Cold) [b]

Model	Minimum (x)	Maximum (x)
D91	0.025" (0.64 mm)	0.049" (1.24 mm)
T91	0.030" (0.76 mm)	0.054" (1.35 mm)

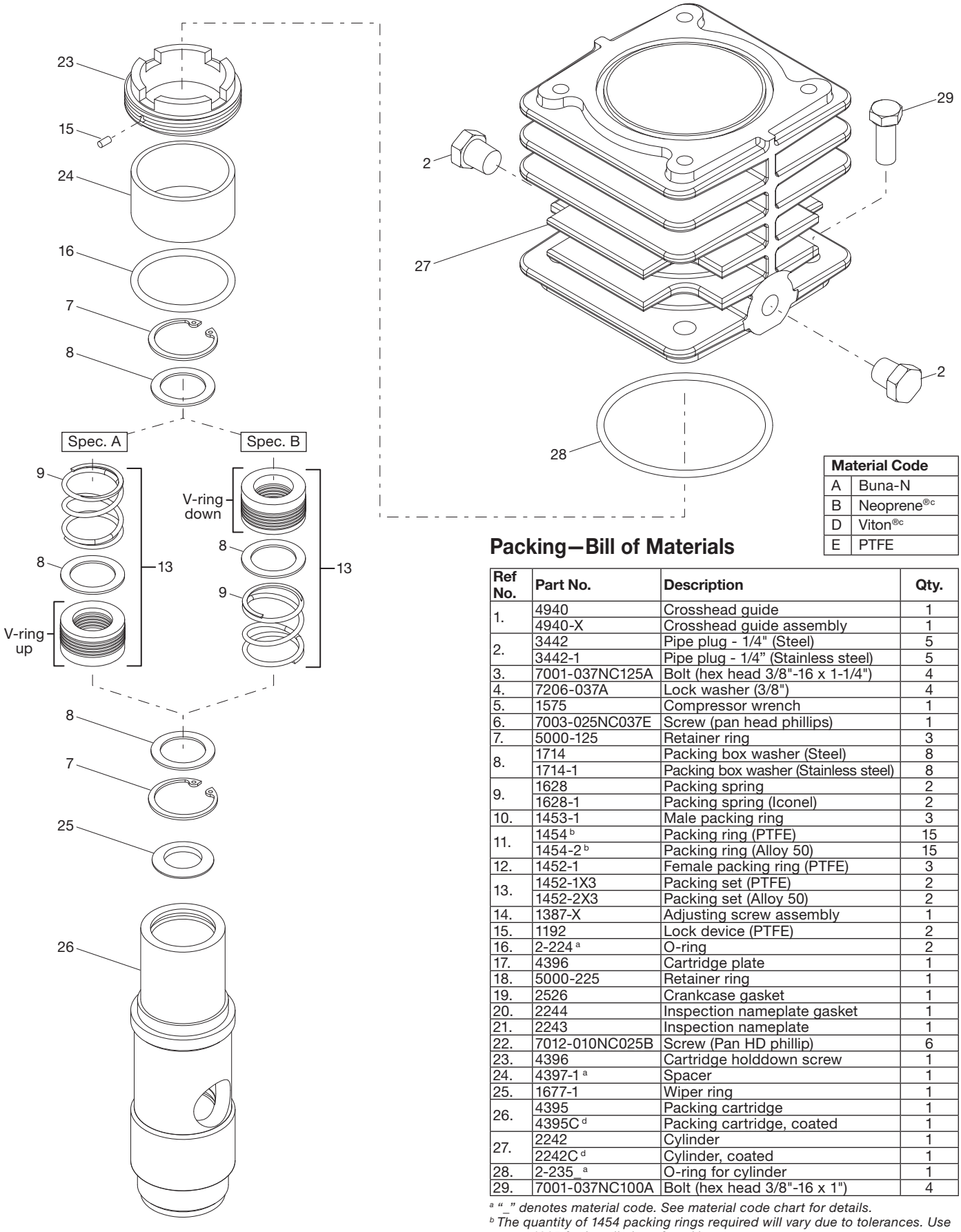
[a] Optional MC1002 coating available. Consult factory for details.
[b] Optional materials available. Consult factory for details.
[c] The distance from the bottom of the head to the top of the piston.
[d] See pages 25 and 26 for model code for coating designation.

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

Appendix E—Parts Details for 91 and F91 D-Style Packing Assembly



Appendix E—Parts Details for 91 and F91 D-Style Packing Assembly



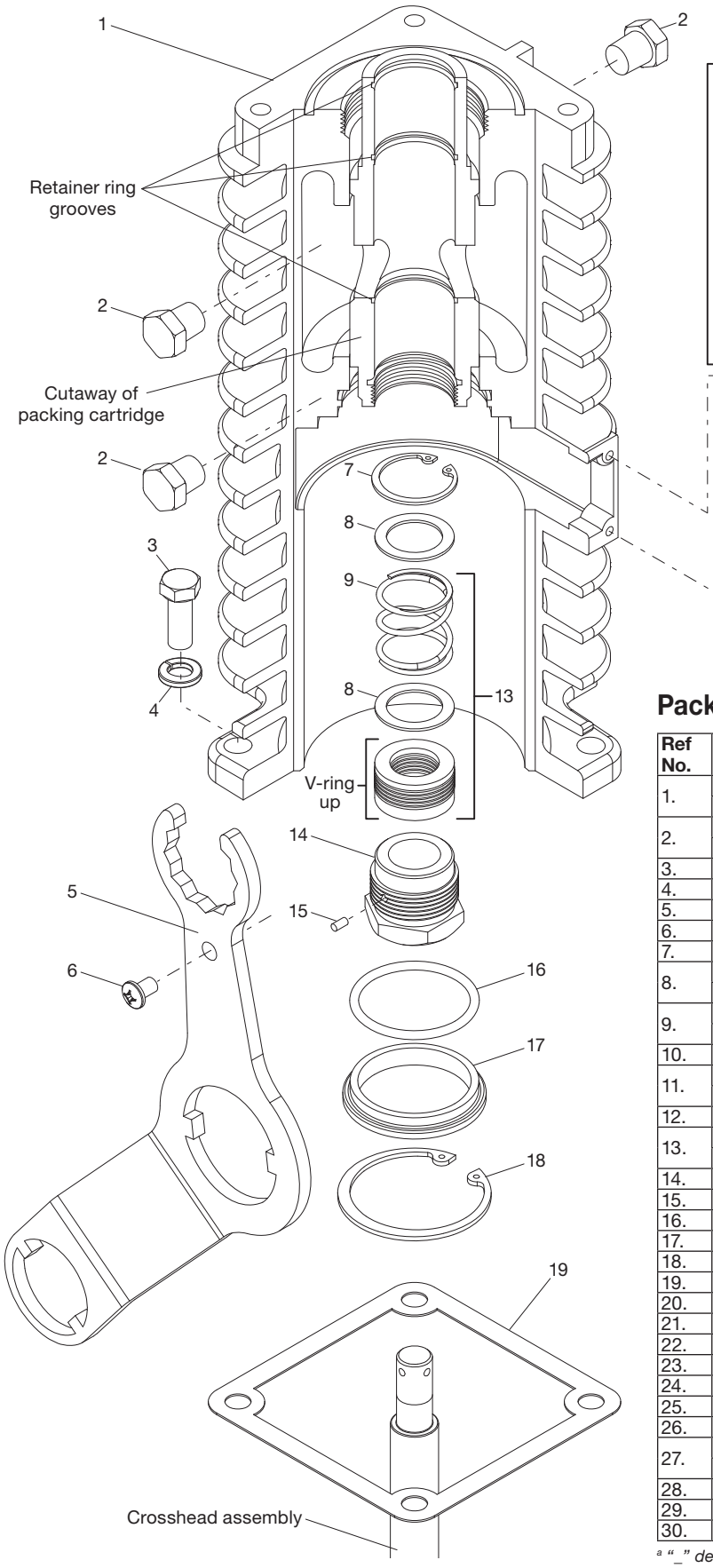
Material Code	
A	Buna-N
B	Neoprene®[c]
D	Viton®[c]
E	PTFE

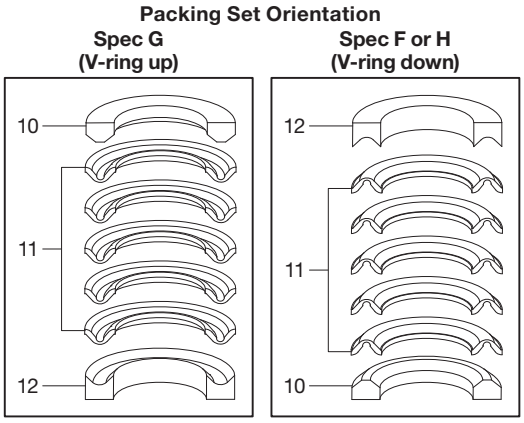
Packing—Bill of Materials

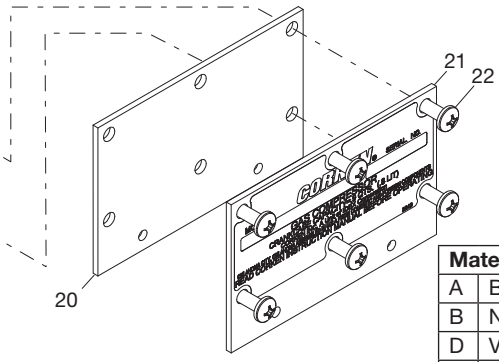
Ref No.	Part No.	Description	Qty.
1.	4940	Crosshead guide	1
	4940-X	Crosshead guide assembly	1
2.	3442	Pipe plug - 1/4" (Steel)	5
	3442-1	Pipe plug - 1/4" (Stainless steel)	5
3.	7001-037NC125A	Bolt (hex head 3/8"-16 x 1-1/4")	4
4.	7206-037A	Lock washer (3/8")	4
5.	1575	Compressor wrench	1
6.	7003-025NC037E	Screw (pan head phillips)	1
7.	5000-125	Retainer ring	3
8.	1714	Packing box washer (Steel)	8
	1714-1	Packing box washer (Stainless steel)	8
9.	1628	Packing spring	2
	1628-1	Packing spring (Iconel)	2
10.	1453-1	Male packing ring	3
11.	1454[b]	Packing ring (PTFE)	15
	1454-2[b]	Packing ring (Alloy 50)	15
12.	1452-1	Female packing ring (PTFE)	3
13.	1452-1X3	Packing set (PTFE)	2
	1452-2X3	Packing set (Alloy 50)	2
14.	1387-X	Adjusting screw assembly	1
15.	1192	Lock device (PTFE)	2
16.	2-224[a]	O-ring	2
17.	4396	Cartridge plate	1
18.	5000-225	Retainer ring	1
19.	2526	Crankcase gasket	1
20.	2244	Inspection nameplate gasket	1
21.	2243	Inspection nameplate	1
22.	7012-010NC025B	Screw (Pan HD phillip)	6
23.	4396	Cartridge holddown screw	1
24.	4397-1[a]	Spacer	1
25.	1677-1	Wiper ring	1
26.	4395	Packing cartridge	1
	4395C[d]	Packing cartridge, coated	1
27.	2242	Cylinder	1
	2242C[d]	Cylinder, coated	1
28.	2-235_[a]	O-ring for cylinder	1
29.	7001-037NC100A	Bolt (hex head 3/8"-16 x 1")	4

[a] *"_" denotes material code. See material code chart for details.*
[b] *The quantity of 1454 packing rings required will vary due to tolerances. Use cone 4005 for installation of packing.*
[c] *Registered trademark of the DuPont company.*
[d] *See pages 25 and 26 for model code for coating designation.*

Appendix E—Parts Details for 91 and F91 T-Style Packing Assembly







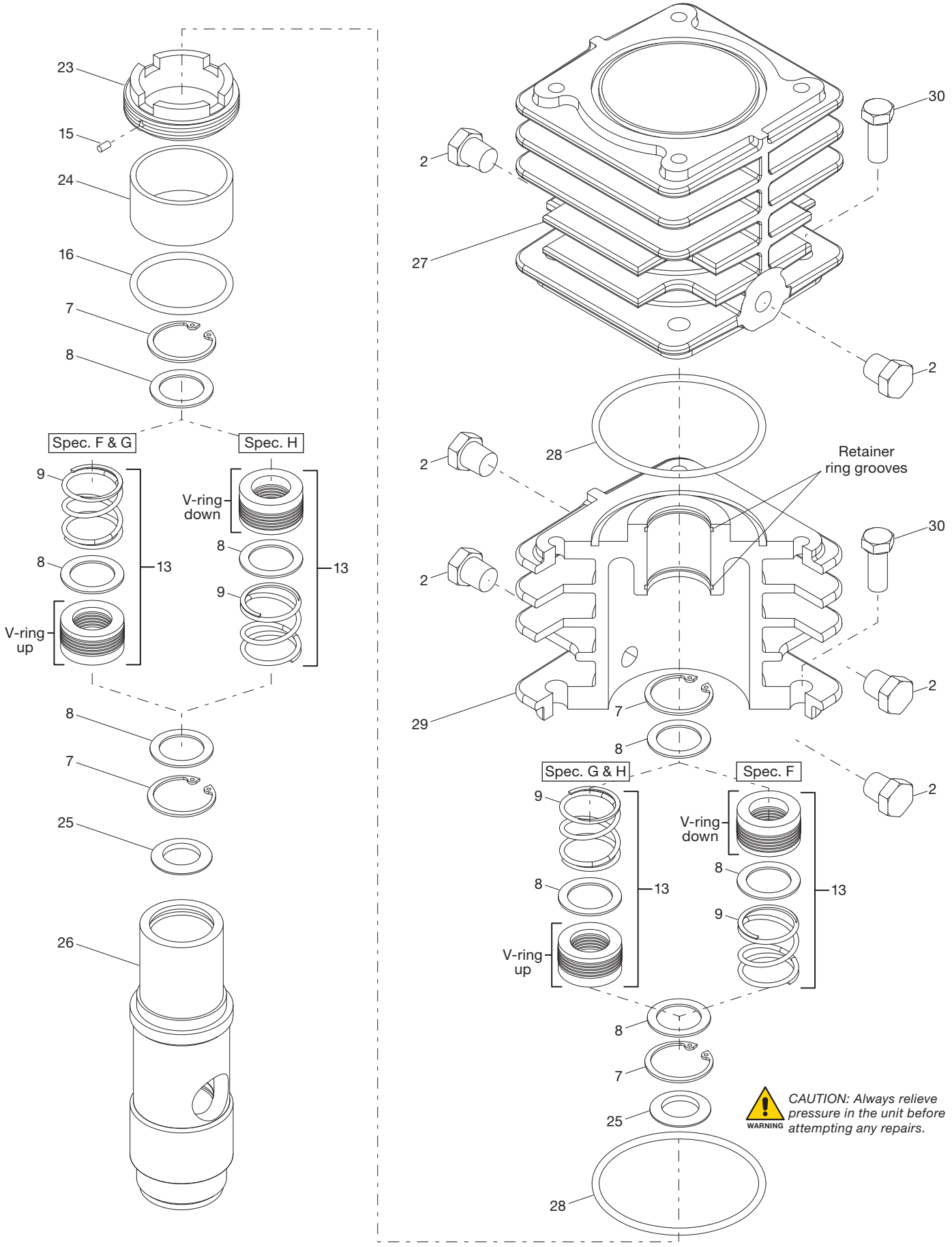
Material Code	
A	Buna-N
B	Neoprene®[c]
D	Viton®[c]
E	PTFE

Packing—Bill of Materials

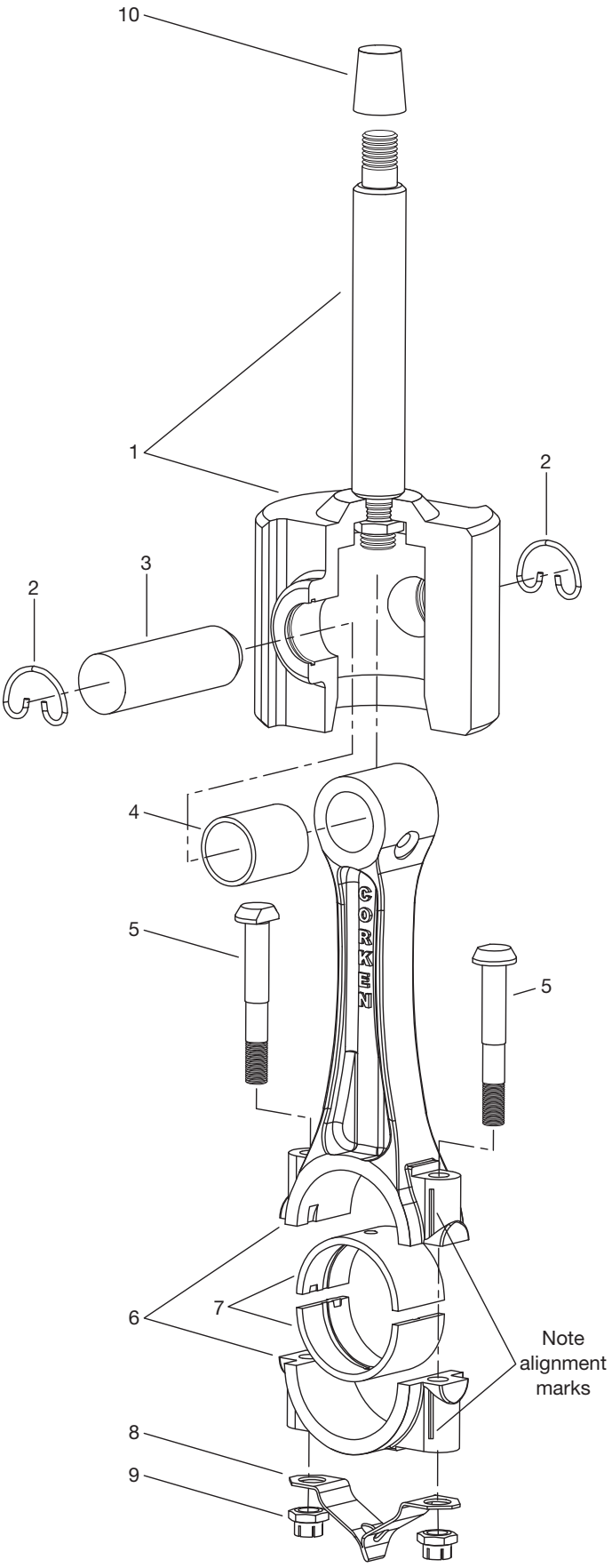
Ref No.	Part No.	Description	Qty.
1.	4940	Crosshead guide	1
	4940-X	Crosshead guide assembly	1
2.	3442	Pipe plug - 1/4" (Steel)	5
	3442-1	Pipe plug - 1/4" (Stainless steel)	5
3.	7001-037NC125A	Bolt (hex head 3/8"-16 x 1-1/4")	4
4.	7206-037A	Lock washer (3/8")	4
5.	1575	Compressor wrench	1
6.	7003-025NC037E	Screw (pan head phillips)	1
7.	5000-125	Retainer ring	5
8.	1714	Packing box washer (Steel)	8
	1714-1	Packing box washer (Stainless steel)	8
9.	1628	Packing spring	2
	1628-1	Packing spring (Iconel)	2
10.	1453-1	Male packing ring	3
11.	1454[b]	Packing ring (PTFE)	15
	1454-2[b]	Packing ring (Alloy 50)	15
12.	1452-1	Female packing ring	3
13.	1452-1X3	Packing set (PTFE)	2
	1452-2X3	Packing set (Alloy 50)	2
14.	1387-X	Adjusting screw assembly	1
15.	1192	Lock device (PTFE)	2
16.	2-224[a]	O-ring	2
17.	4396	Cartridge plate	1
18.	5000-225	Retainer ring	1
19.	2526	Crankcase gasket	1
20.	2244	Inspection nameplate gasket	1
21.	2243	Inspection nameplate	1
22.	7012-010NC025B	Screw (Pan HD phillip)	6
23.	4398	Cartridge holddown screw	1
24.	4397-1	Spacer	1
25.	1677-1	Wiper ring	1
26.	4395	Packing cartridge	1
27.	2242	Cylinder	1
	2242C[d]	Cylinder, coated	1
28.	2-235_[a]	O-ring for cylinder	2
29.	4941	Distance piece	1
30.	7001-037NC100A	Bolt (hex head 3/8"-16 x 1")	4

[a] "_" denotes material code. See material code chart for details.
[b] The quantity of 1454 packing rings required will vary due to tolerances. Use cone 4005 for installation of packing.
[c] Registered trademark of the DuPont company.
[d] Optional MC1002 coating available. Consult factory for details.

Appendix E—Parts Details for 91 and F91 T-Style Packing Assembly



Appendix E—Parts Details for 91 and F91 Connecting Rod Assembly



Connecting Rod—Bill of Materials

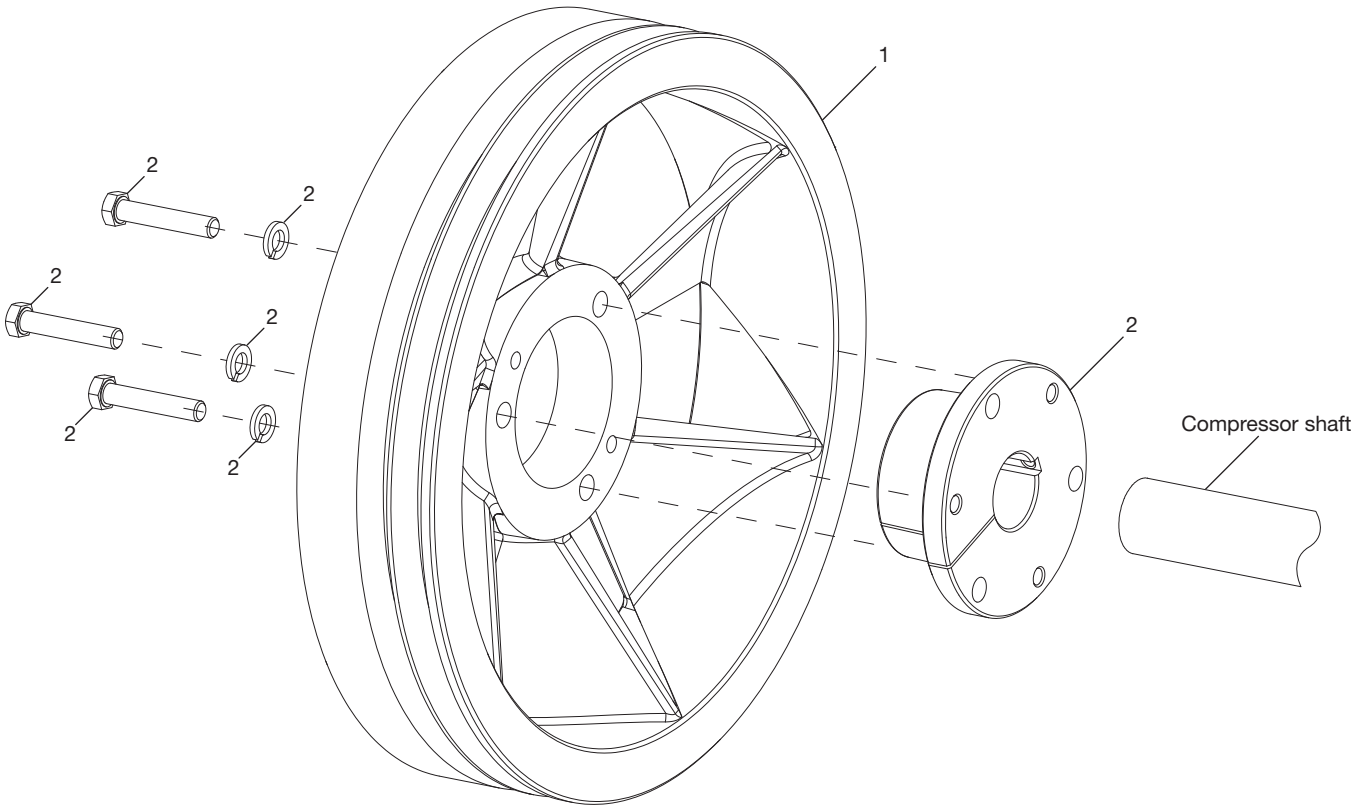
Ref No.	Part No.	Description	Qty. per Compressor
1.	1132-X3	Crosshead assembly (D-Style)	1
	1132-X7	Crosshead assembly (T-Style)	
2.	1498	Retainer ring	2
3.	2505	Wrist pin	1
4.	1846-X [a, b]	Wrist pin bushing	1
5.	1599 [b]	Bolt	2
6.	1889-1X	Connecting rod assembly	1
7.	1367 [b]	Connecting rod bearing (pair)	1
8.	2011 [b]	Dipper	1
9.	1600 [b, c]	Nut	2
10.	4005	Packing installation cone	1

[a] After the wrist pin bushing has been pressed into the connecting rod, it must be honed to .8759/.8756. A hydraulic press and honing machine are recommended for this step.
[b] Included with connecting rod assembly, not sold separately.
[c] Torque connecting rod nut to 28 ft. lbs.

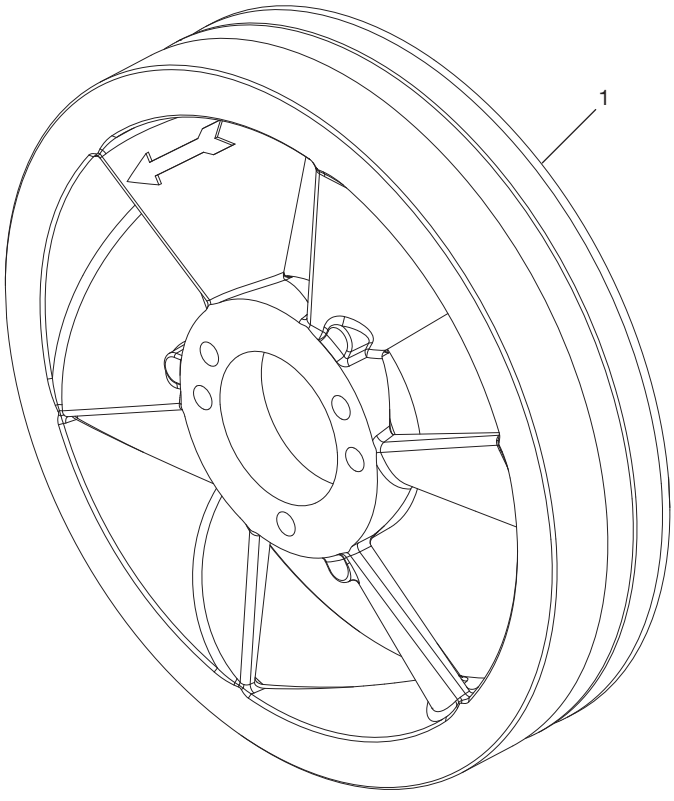
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

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

Appendix E—Parts Details for 91 and F91 Flywheel Assembly



Back Side



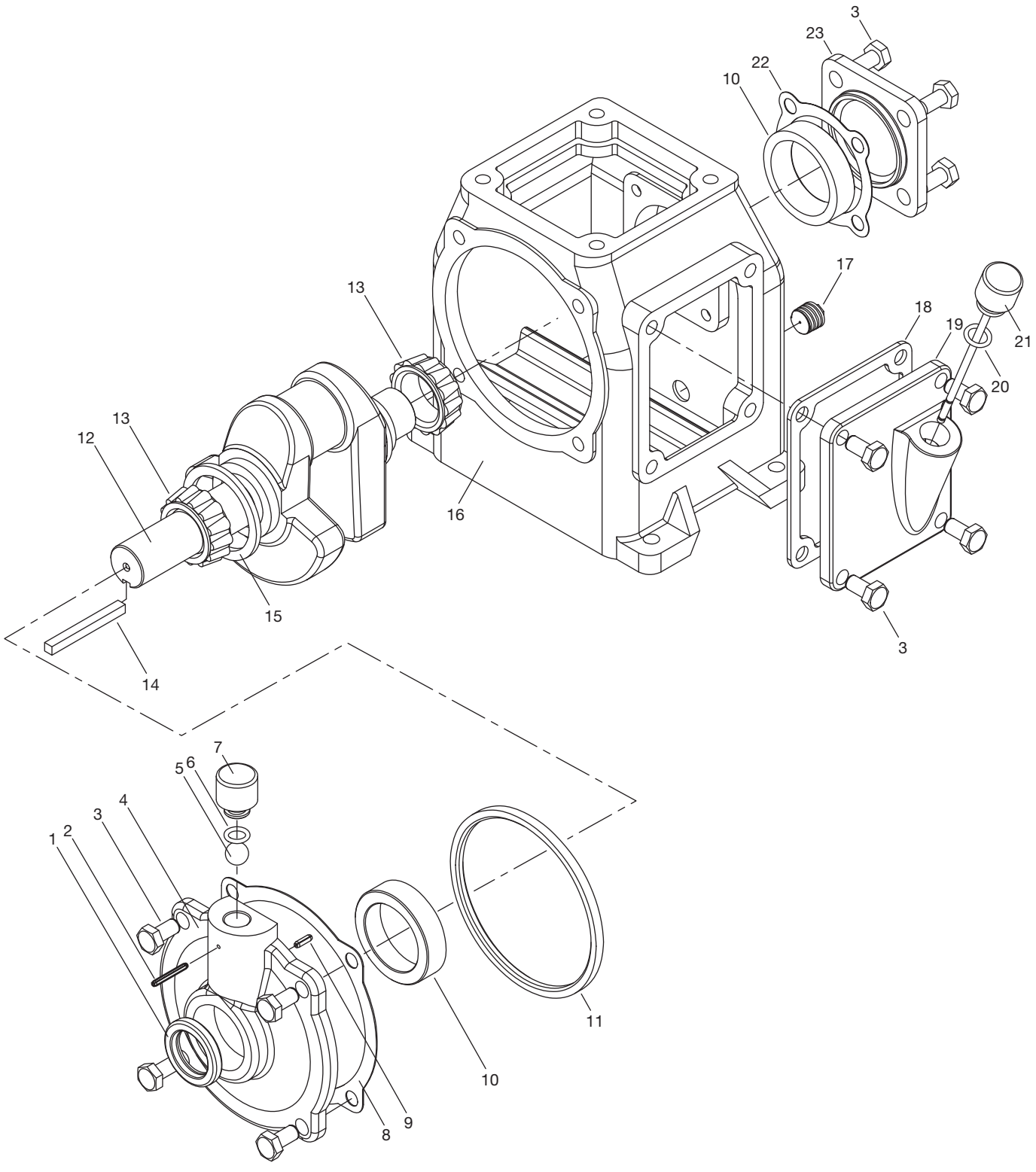
Front Side

Flywheel—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3271	Flywheel (14" O.D., 2 groove)	1
2.	H SF-1.125	Hub with three bolts and lockwashers	1

Assembly Number	Assembly Name
3271-X2	Flywheel assembly (flywheel, hub, and three bolts) standard

Appendix E—Parts Details for 91 and F91 Crankcase Assembly



Appendix E—Parts Details for 91 and F91 Crankcase Assembly

Packing—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3259	Oil seal	1
2.	1450	Groove pin (1/8" x 1")	1
3.	7001-037NC075A	Hex head (3/8"–16 x 3/4", grade 5)	12
4.	3260	Bearing carrier	1
5.	2796	Breather ball	1
6.	2-111A	O-ring (Buna-N)	1
7.	1279-X	Breather cap	1
8.	2725	Bearing carrier gasket	1
9.	1807	Roll pin (1/8" x 5/8")	1
10.	2718	Bearing cup	2
11.	2723	Oil circulating ring	1
12.	2476	Crankshaft	1
13.	2719	Bearing cone	2
14.	2289	Flywheel key	1
15.	2290	Oil ring retainer washer	1
16.	2554	Crankcase (capacity: 0.9 quarts, 0.8 liters)	1
17.	1661	Pipe plug (3/8" NPT square or hex head)	1
18.	2729	Inspection plate gasket	1
19.	2728	Crankcase inspection plate	1
20.	2-112A	O-ring (Buna-N)	1
21.	1368-X1	Oil bayonet assembly (with O-ring)	1
22.	2721	Bearing adjustment shim (0.005)	As needed
	2721-1	Bearing adjustment shim (0.007)	As needed
	2721-2	Bearing adjustment shim (0.020)	As needed
23.	2720	Bearing cap	1

Assembly Number	Assembly Name
2476-X	Crankshaft assembly with 2476, 2290 and 2719
2476-SX [a]	Extended crankshaft assembly with 2719 (2) and 2290
3260-X	Bearing carrier assembly with 3260, 2718, 3259, 1279-X, 2-111A, 1450, 2796 and 1807
3271-X2 [a]	Flywheel assembly 14" - 2 groove with H SF-1.125 and 3271

[a] *Optional equipment.*

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

Appendix F—Compressor Foundation Design Considerations

Before you begin, you should know there are three primary factors that cause vibration and noise within a compressor mounting. Both factors are inherent in the compressor design and must be considered when selecting a proper mounting location and foundation for your compressor.

1. **Reciprocating Design:** The reciprocating design of Corken compressors produces inherent vibration that must be taken into account when designing an adequate compressor foundation. Most all issues arising from excessive compressor vibration (e.g., broken anchor bolts) relate to an inadequate baseplate design, inadequate concrete foundation and inadequate structural steel base and/or inadequate piping supports.

2. **Vertical Compressors:** Vertical reciprocating compressors, in which one piston goes up while the other goes down, produce unbalanced forces that inherently result in vibration and tend to rock the machines back and forth about a horizontal axis through the center of gravity. This is particularly a factor on Corken's larger vertical machines (Models 591, 691, 791, and 891). These compressors have more mass in the moving parts and are taller which raises the center of gravity, and therefore vibrate more than smaller machines. It is imperative to properly secure any vertical compressor and the baseplate or structural steel base/skid to which it is mounted. Even though the 791 and 891 are double-acting compressors, their size necessitates the same type of mounting as the other large compressors.

3. **Horizontal Compressors:** Corken's horizontal compressors (Models HG600) have horizontally-opposed piston movement and are generally double acting so that they inherently run more smoothly than comparable vertical compressors. However, there are still forces in horizontal compressors that tend to rock them back and forth about a vertical axis through the center of gravity. For this reason, and because of their relatively large size, Corken horizontal compressors should be mounted in the same manner as the larger vertical machines as described in these instructions.

Listed below are other factors that amplify the magnitude of any vibration present and must be considered when selecting a proper mounting location and foundation for your compressor.

1. Size of compressor (larger compressors generally vibrate more)
2. Speed of compressor
3. Use of undersized flywheel
4. Height of the compressor (D- and T-style designs are taller compressors)
5. Engine drives
6. Baseplate or structural steel skid deflection
7. Improper anchor bolt selection or unsecured anchor bolts

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 can not guarantee a particular noise level from our compressors. However, noise levels from a properly installed Corken compressor typically do not exceed 85 dBa at three feet.

Noise testing is not available from the Corken factory. It would not be a reliable indicator of noise generated in the field once all the variables are established.

Vibration

Compressor users sometimes experience excessive vibration from their compressors. All reciprocating compressors like Corken's will create some vibration. It is an unavoidable consequence of the reciprocating motion of the internal parts of the compressor. The compressor itself is essentially a solid piece of iron and does not "flex". Thus, if the top of the compressor is moving, it is because the bottom is moving. Basically, the baseplate or skid deflects slightly and "allows" the compressor to vibrate.

The most common causes of vibration are loose or inadequate anchor bolts, or insufficient support under the baseplate.

All bolts should be tight including the bolts that fasten the compressor to the baseplate, and the baseplate to

the foundation. The compressor's baseplate should be secured along the full length on each side and not at the ends only.

Small Corken vertical compressors (models 91, 151, 191, 291, 351, 391 and 491) do fine with the baseplate mounted directly to a solid reinforced concrete foundation. However, as already noted, special attention should be given to the larger vertical compressors (models 591, 691, 791, and 891). The larger vertical compressors require a very firm foundation due to their vertical height. The HG600 series is a horizontal balanced-opposed compressor, but we recommend using the foundation guidelines for larger compressors.

Proper Foundation Design

The foundation design is the end-user's responsibility. Local soil conditions can affect the foundation design. Generally speaking, the larger the foundation, the less likely you are to have vibration or shaking problems. As a rule of thumb, when preparing the foundation, the mounting slab should be 8 to 10 inches thick with the overall length and width 4 inches longer and wider on each side of the baseplate.

Grouting the Baseplate

Grouting the baseplate helps reduce vibration on the larger compressors (models 591, 691, 791, 891 and HG600).

Sometimes, the baseplate or skid itself flexes and allows the compressor to vibrate. On the large compressors (model 591 and up), Corken welds gussets/webs to the underside of the baseplate to help prevent vibration.

Proper Anchor Bolt Selection

Permanent anchor bolts such as J- and I-bolts should be of sufficient size, strength and quantity and embedded in the concrete. Expansion bolts should not be used. All-thread is too soft for a proper anchor bolt and should never be used. All anchor bolts must be tightened on a routine basis. All anchor bolt holes in the baseplate should be used.

Proper Flywheel Selection Installation

Corken's standard flywheel is sufficient for most applications. However, certain conditions require an optional oversize flywheel. An undersized flywheel will cause vibration. In some instances, an improperly installed flywheel or V-belt drive will result in vibration. In addition, an uneven load caused by a damaged compressor valve can cause vibration. Problems inside the compressor that cause vibration generally also cause knocking, high temperatures, and reduced capacity.

Isolation Devices

Some Corken customers have used vibration isolating rubber pads or springs with mixed results. Sometimes they work and other times they do not. Vibration isolating springs generally do not work and can actually magnify the problem. Corken's recommendation is to bolt the compressor down as solidly as possible to a properly installed concrete foundation as mentioned above.

Proper Piping Supports

The compressor must not support any significant piping weight; therefore, the piping must be fully supported. The use of flexible connections to the compressor is highly recommended. Rigid, unsupported piping combined with a poor foundation will result in severe vibration problems. In order to reduce pipe vibration induced by the compressor, flex hoses should be installed in the piping on either side of the compressor. These should be oriented vertically — **not horizontally** — as shown in Illustration 13. Pipe vibration can also be caused by the pulsating flow of gas inside the pipes.

The pulsating flow is normal and to be expected from a piston type compressor. If this is a problem, it can generally be corrected with pipe supports or pulsation dampeners. In Corken's size range, generally, a small vessel in the piping is all that is required to act as a pulsation dampener.

As mentioned previously, a properly engineered foundation should be installed before placing the new compressor into service. The illustrations on the following pages show some basic guidelines for designing a proper foundation and installing a baseplate or skid. The mounting variations shown are guidelines only.

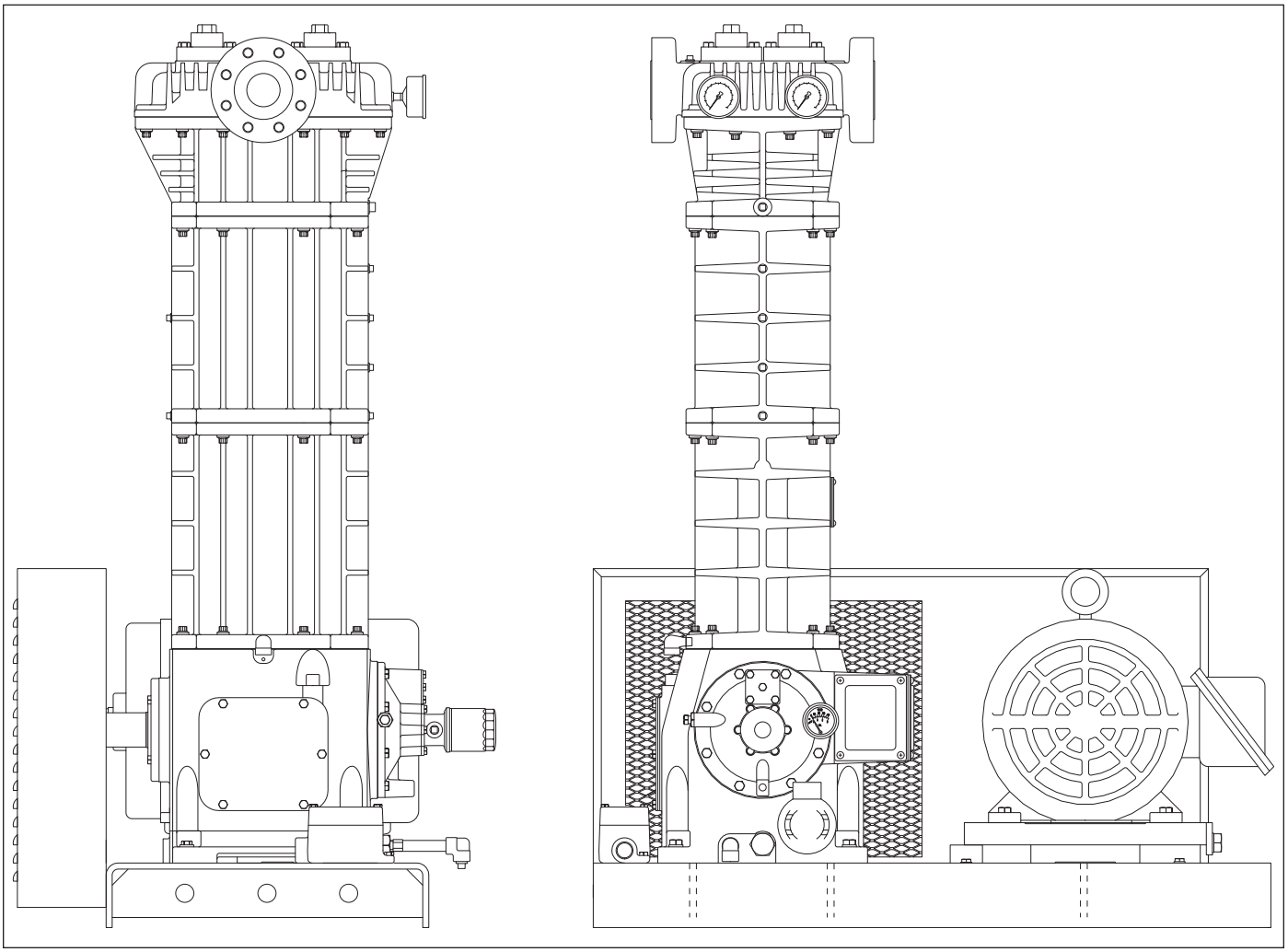
NOTE: A special baseplate is required on some of the illustrations. Any proposed isolation mounting arrangement ***must*** be properly engineered. Failure to do so will most likely increase the severity of the problem.

If you have any questions concerning the compressor foundation for your installation, please do not hesitate to contact Corken.

Specifications for Baseplate and Skid Mountings

Formed Steel Baseplate Specifications

1. Baseplate thickness should be at least 3/8 inches (1 cm).
2. Maximum height of baseplate is 4 inches (10 cm).
3. Maximum width should not exceed 26 inches (66 cm).
4. Welded internal stiffening gussets/webs must be used on models 591 thru 891 or if the width of the baseplate exceeds 18 inches (46 cm).
   a. Two gussets/webs under the compressor.
   b. One gusset/web under an electric motor and two under an engine.
   c. Gussets/webs should be welded to the top and each side of the baseplate.
   d. More gussets/webs is always better than not having enough.
5. Baseplate must be mounted to a concrete foundation or welded to a structural steel skid and should never be mounted on the ground/soil.
6. Mounting bolt holes should be located on the top of each side of the baseplate.
   a. The spacing between each bolt hole should not exceed 26 inches (66 cm).



Formed steel baseplate configuration

Structural Steel Skid Specifications

1. You may use top plates as needed; however, the compressor must be placed directly over the main beams. See illustrations 10, 11, and 12 on the following pages.

2. Forklift slots are acceptable.

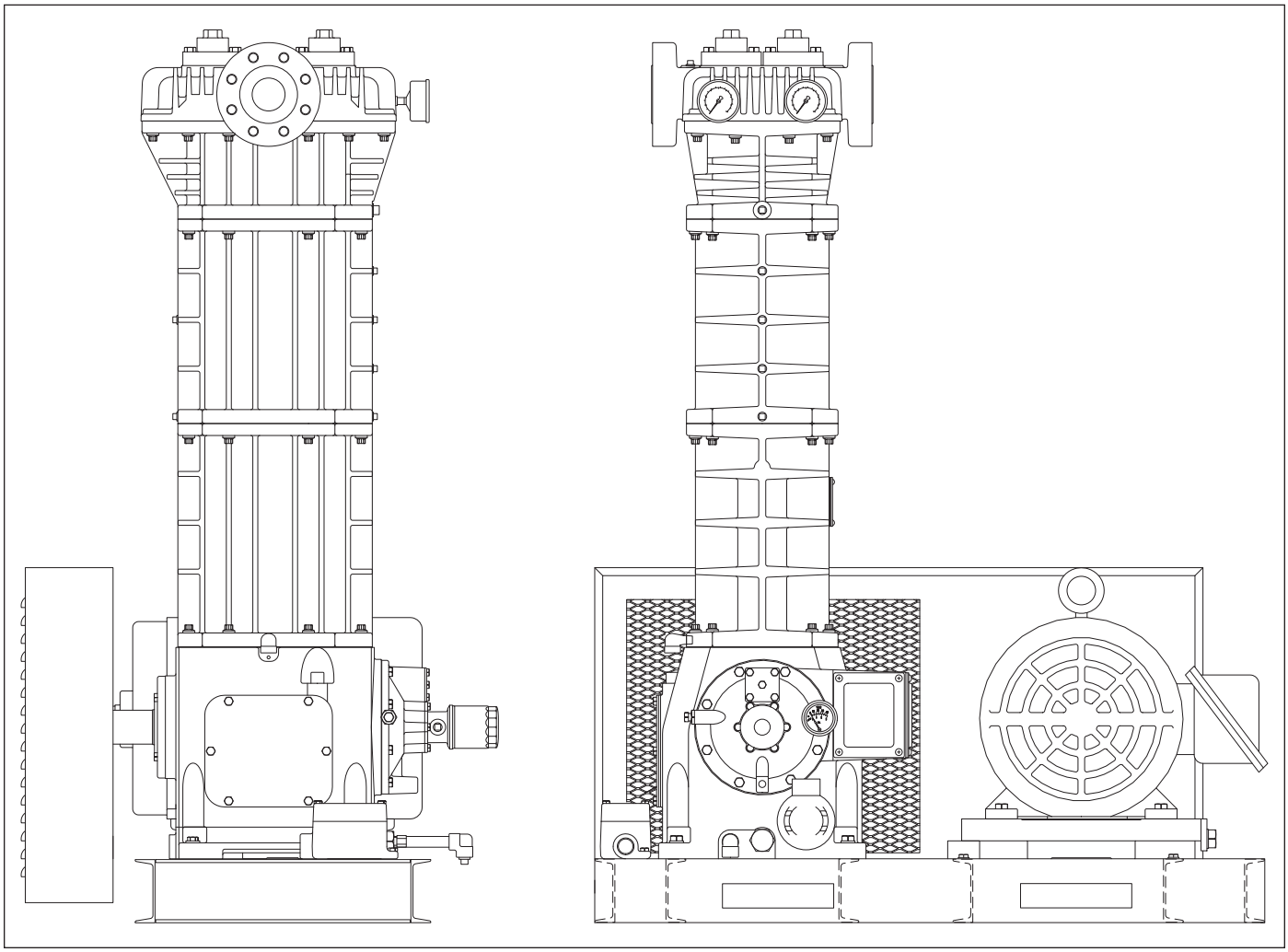
3. Acceptable types of construction are C-section beams, I-beams or wide-flange I-beams.

    a. When placing the skid on the soil, I-beams or wide-flange I-beam construction should be used.

        i. Filling the skid with concrete is recommended when placing the I-beam or wide-flange construction on the soil.

4. Mounting bolt holes should be located at the bottom flange of the beam and run along each side.

    a. The spacing between each bolt hole should not exceed 26 inches (66 cm).



Structural steel baseplate configuration

Illustration 1

Foundation—Ground Level

Your concrete foundation should be 8 to 10 inches deep and larger than the compressor baseplate. Length and width should be 4 inches longer and wider. Proper depth is necessary for adequate bolting and stability. The foundation should also be slightly above ground or grade level as shown.

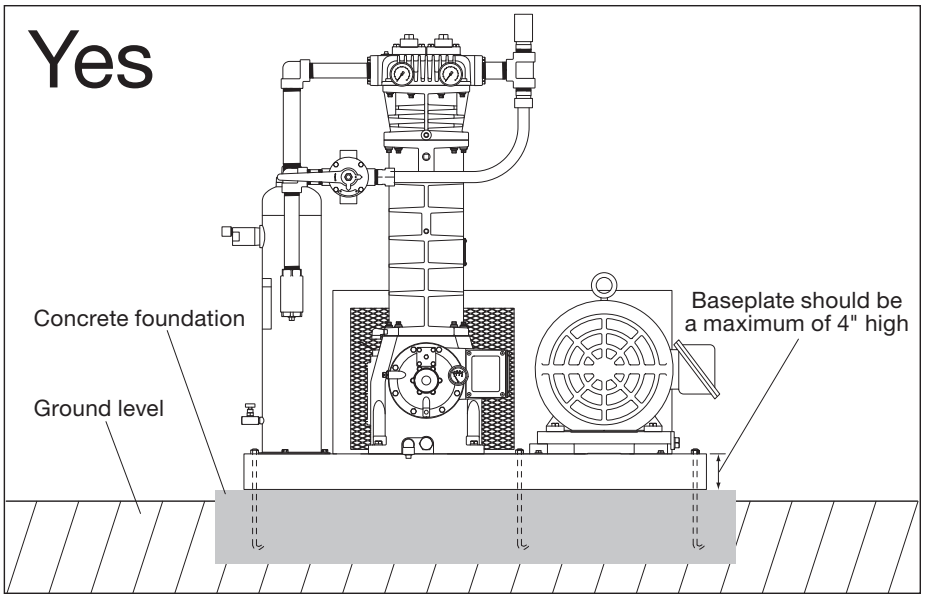


Illustration 2

Foundation—Floor Level

If the existing floor is not thick enough to support the compressor mounting, cut out the existing floor and mount a separate foundation directly on the ground. The top of the foundation should be slightly above floor level and 8 to 10 inches deep as shown.

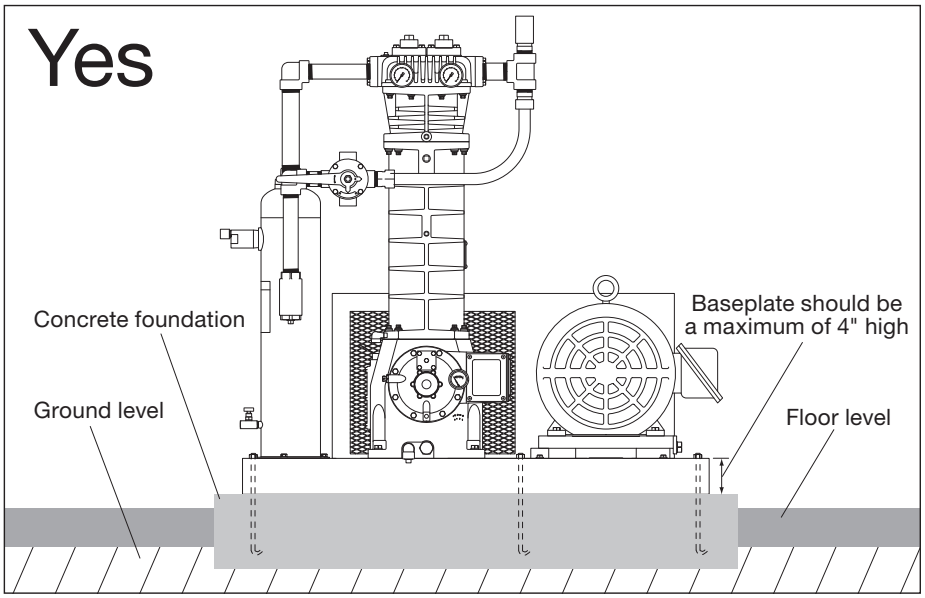


Illustration 3

Foundation—Floor Level

Anchors or lags with a shallow foundation will pull loose. Be sure the existing floor is solid. Note: Special consideration should be given to compressors mounted on suspended floors.

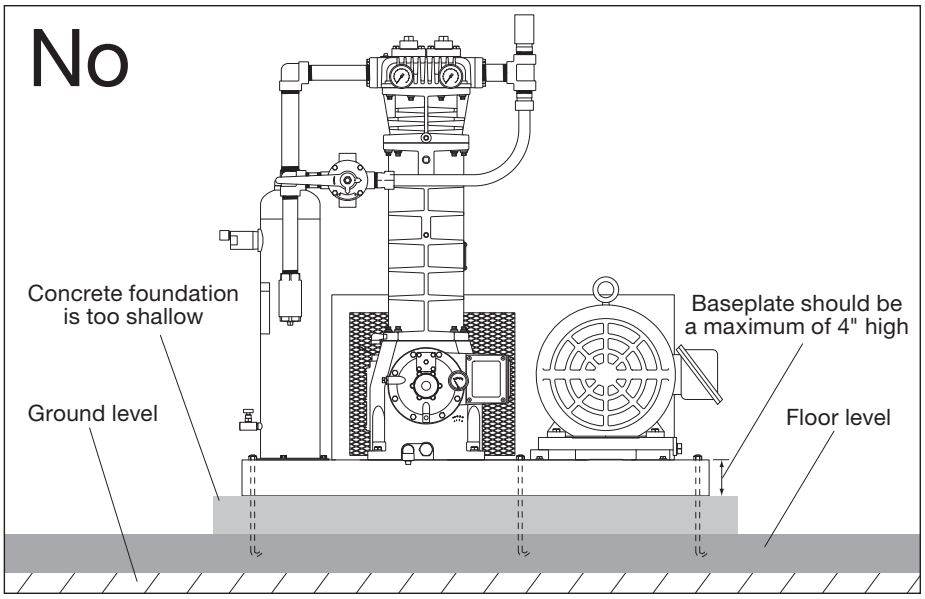


Illustration 4

Proper Anchoring

Permanent anchor bolts embedded in the concrete foundation is a very good installation method. Grouting the baseplate to the concrete foundation is highly recommended.

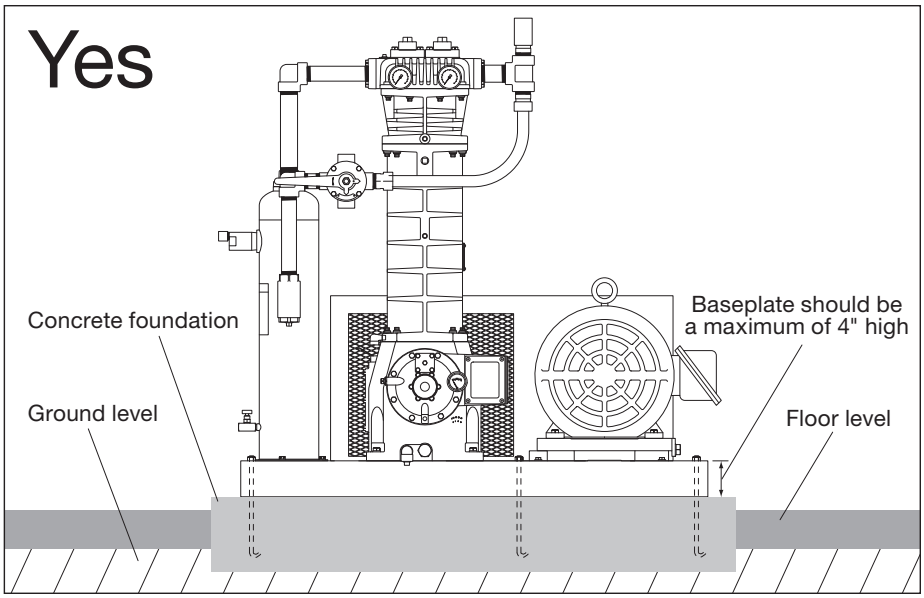


Illustration 5

Mounting Baseplate—Concrete

The concrete foundation must support the entire length of the baseplate on each side. Some shims may be required for unlevel foundations. The baseplate should be a maximum of 4 inches high while the foundation should be 8 to 10 inches deep. **Grouting the baseplate to the concrete foundation is highly recommended for the small compressors** (91, 151, 191, 291, 351, 391, and 491) and is **required** for the large compressors (591, 691, 791, 891, and HG600).

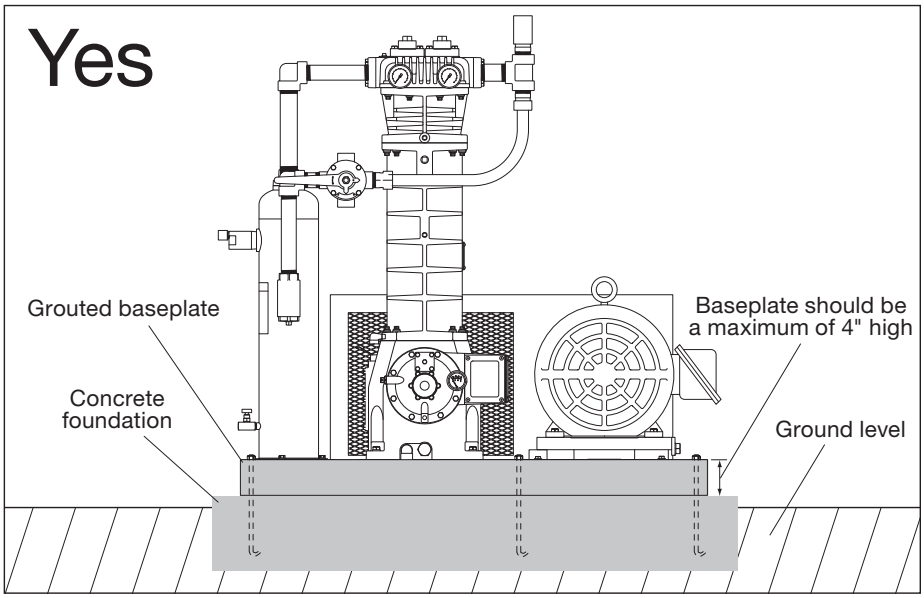


Illustration 6

Mounting Baseplate—Concrete and Shims

Do not suspend baseplate with spacers or shims that allow support at the anchor bolts only. **The baseplate should not be suspended in the air.**

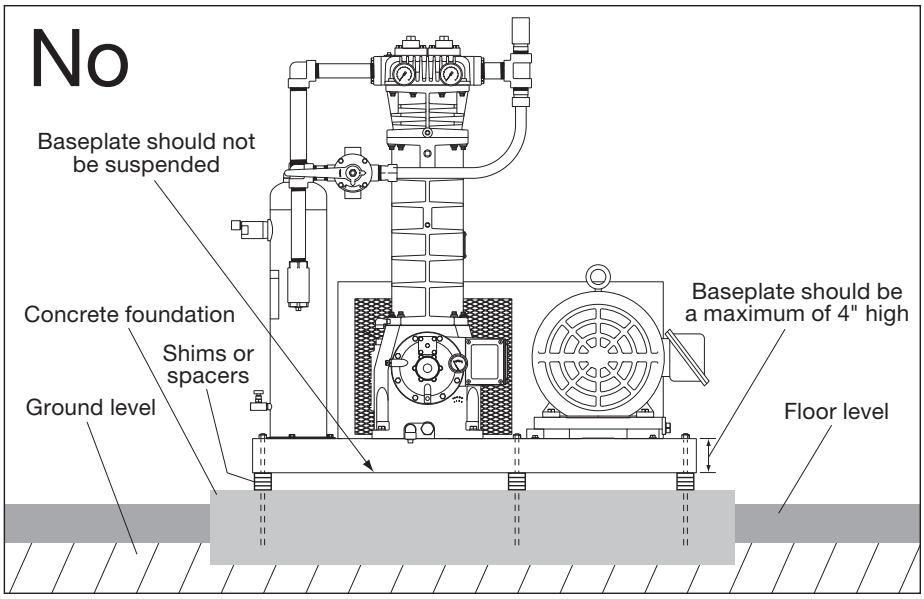


Illustration 7

Mounting Baseplate—Concrete and Rubber Mounts

Rubber mounts or pads have mixed results and generally are not recommended. At times they can magnify the vibration. **The baseplate should not be suspended in the air.**

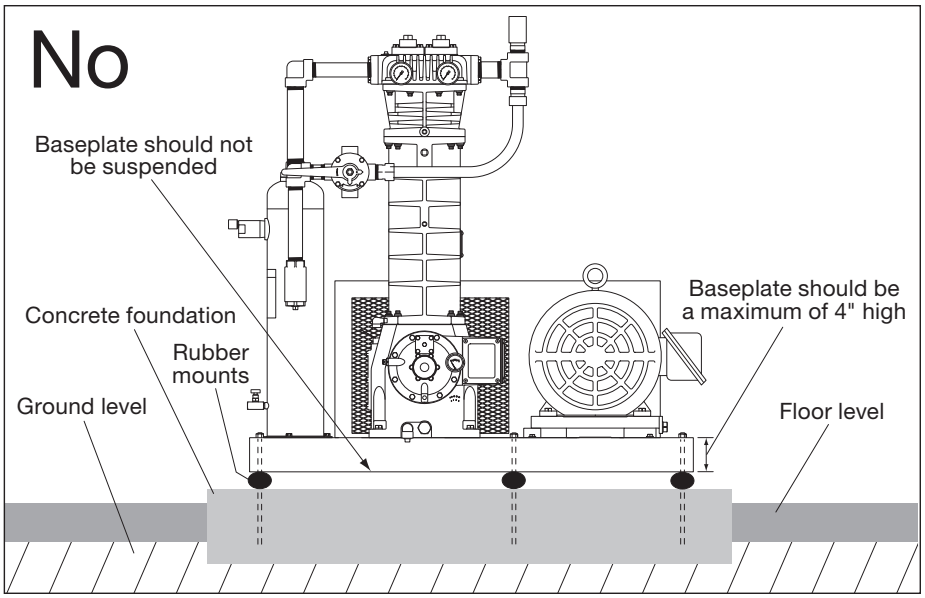


Illustration 8

Mounting Baseplate—Concrete and Welded Anchor Bolt Tabs

Do not weld anchor bolt tabs to the side of the baseplate. If the tabs should extend beyond the bottom edge of the baseplate, the baseplate will not be able to rest firmly against the foundation and vibration will occur. Each side of the baseplate must be **fully** supported by the foundation.

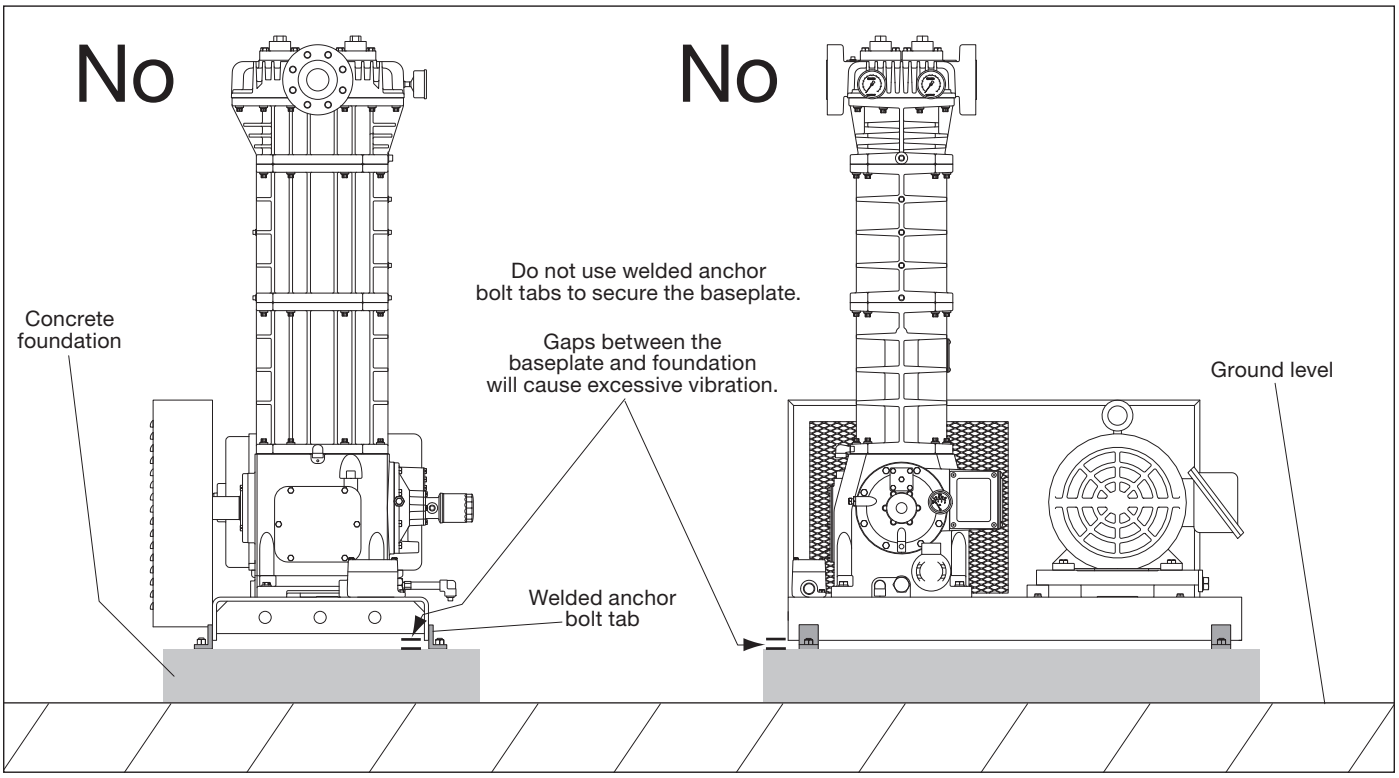


Illustration 9

Mounting Baseplate—Suspended

Note: A special rigid baseplate is required for this type of mounting. Installing mounts at the compressor's center of gravity is effective on smaller compressors (models 91, 151, 191, 291, 351, 391, and 491).

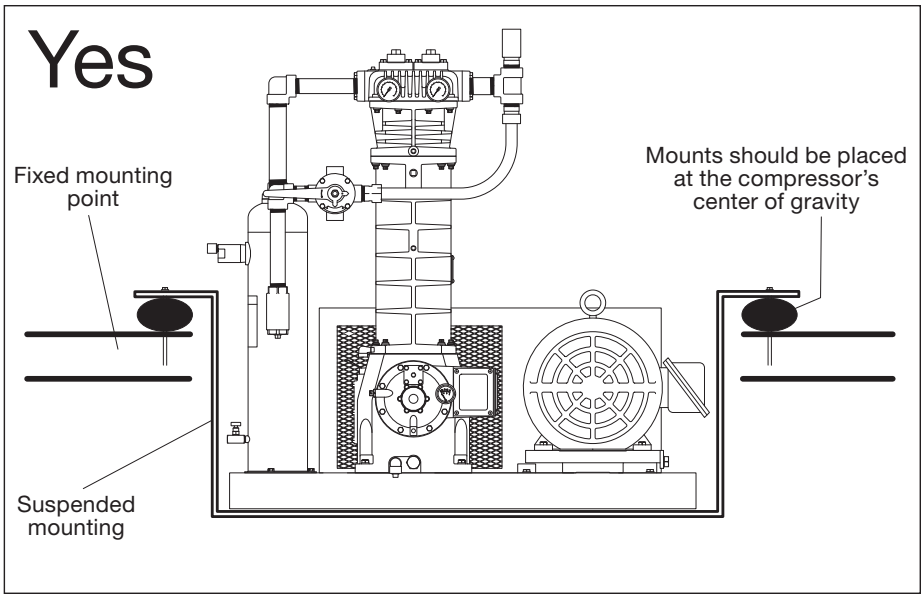


Illustration 10

Mounting Baseplate—Concrete and Steel Mounting Base

Do not mount the compressor baseplate across beams without center support as shown. **The baseplate should not be suspended in the air.** For a proper installation, the baseplate should be fully supported on each long side of the baseplate.

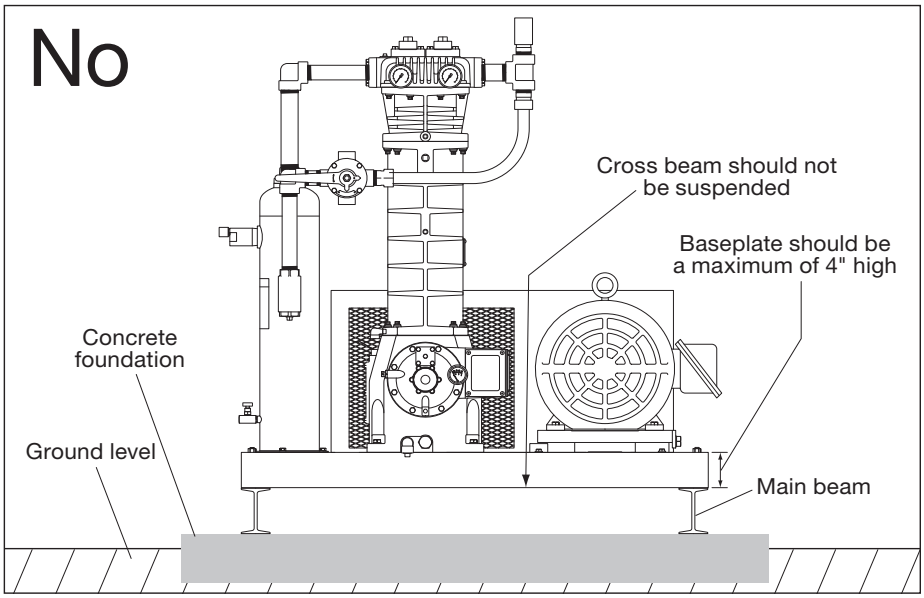


Illustration 11

Mounting Baseplate—Concrete and Steel Mounting Base

When mounting to a skid or structural steel base, do not mount the compressor baseplate to suspended beams or angle iron as shown. All main beams and cross beams should mount **flush** to the concrete foundation.

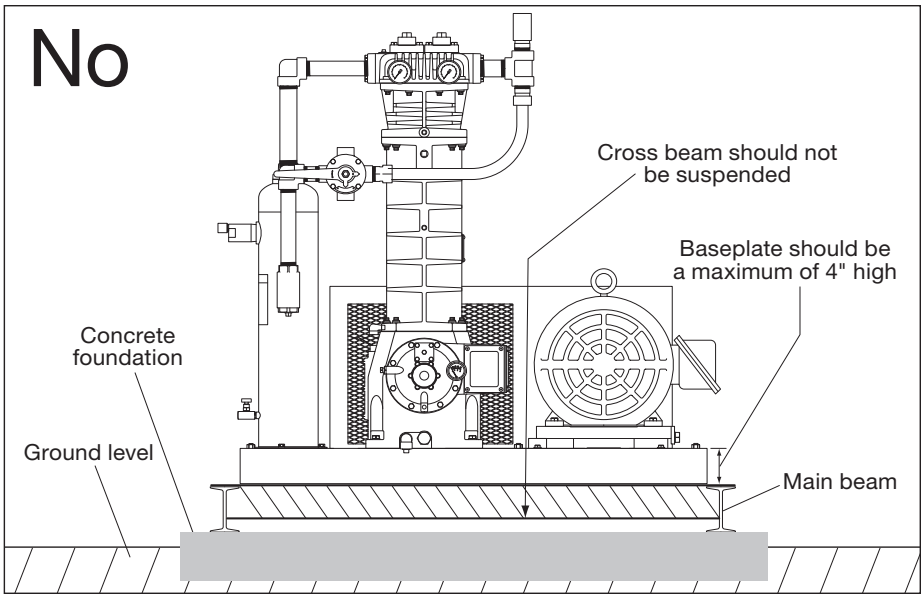


Illustration 12

Mounting Baseplate—Concrete and Steel Mounting Base

Mount the compressor baseplate on the main beams or channels of the steel mounting base. This will give support to the long sides of the baseplate. NOTE: Crossbeams should be the same height as the main beams. The baseplate should be welded to the steel mounting base directly over the vertical web of the main support beam.

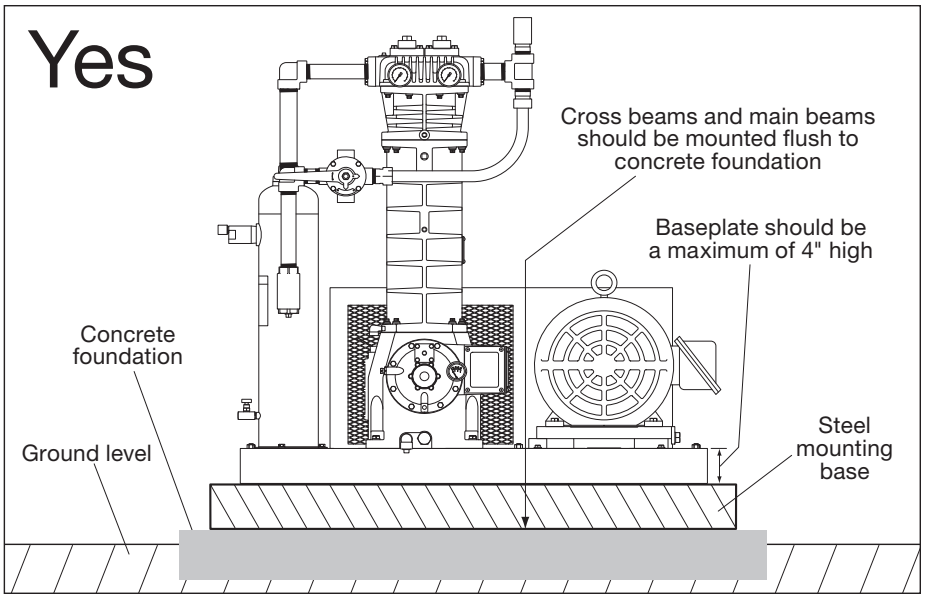


Illustration 13

Flexible Connections and Piping Supports

The compressor must not support any significant piping weight. The piping must be properly supported. The use of flexible connections at the compressor is highly recommended. Flexible connections must be mounted vertically—not horizontally—as shown. Rigid, unsupported piping combined with an inadequate foundation will result in severe vibration problems.

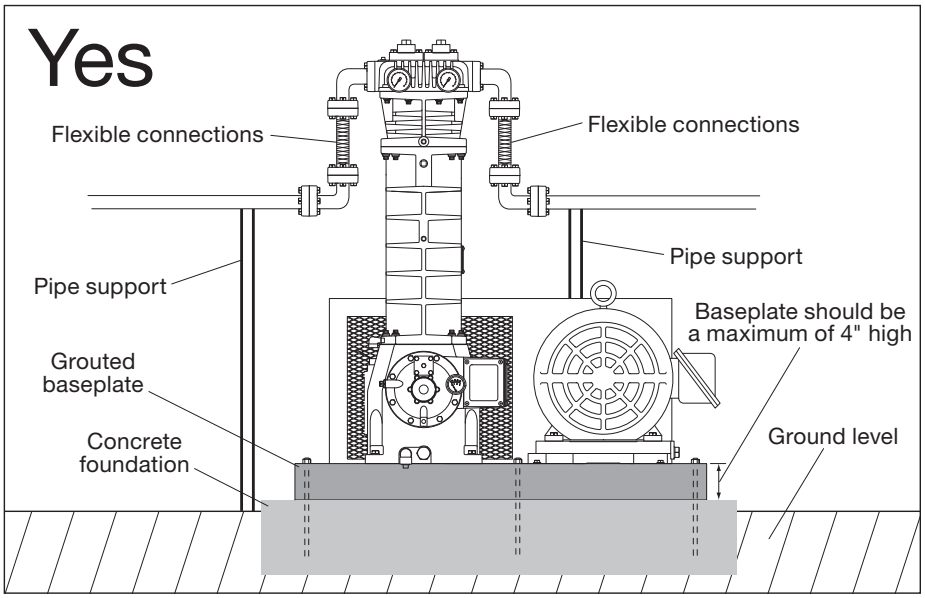
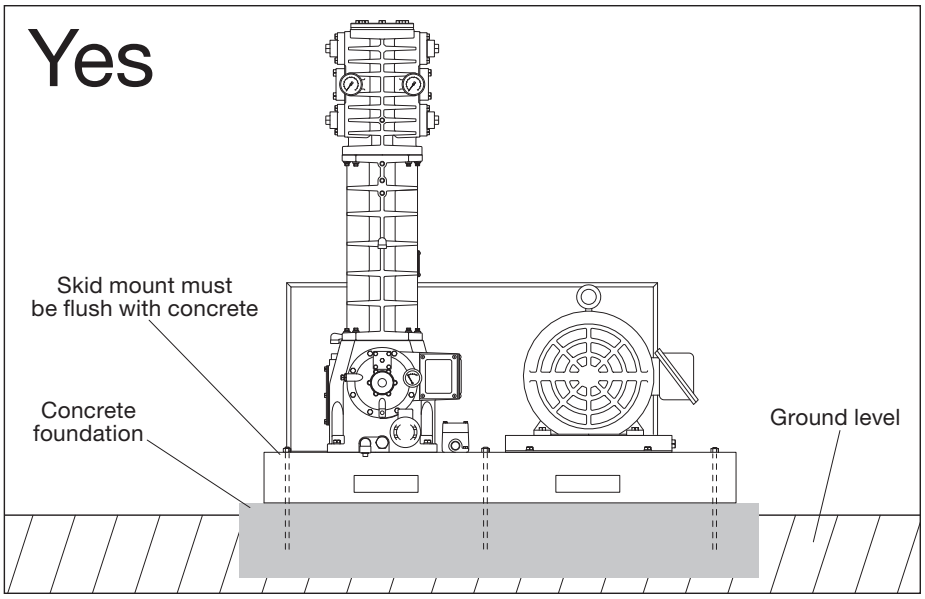


Illustration 14

Mounting Steel Base/Skid to a Concrete Foundation

A steel mounting base/skid should be mounted flush to the concrete base as shown.



Appendix G—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
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

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