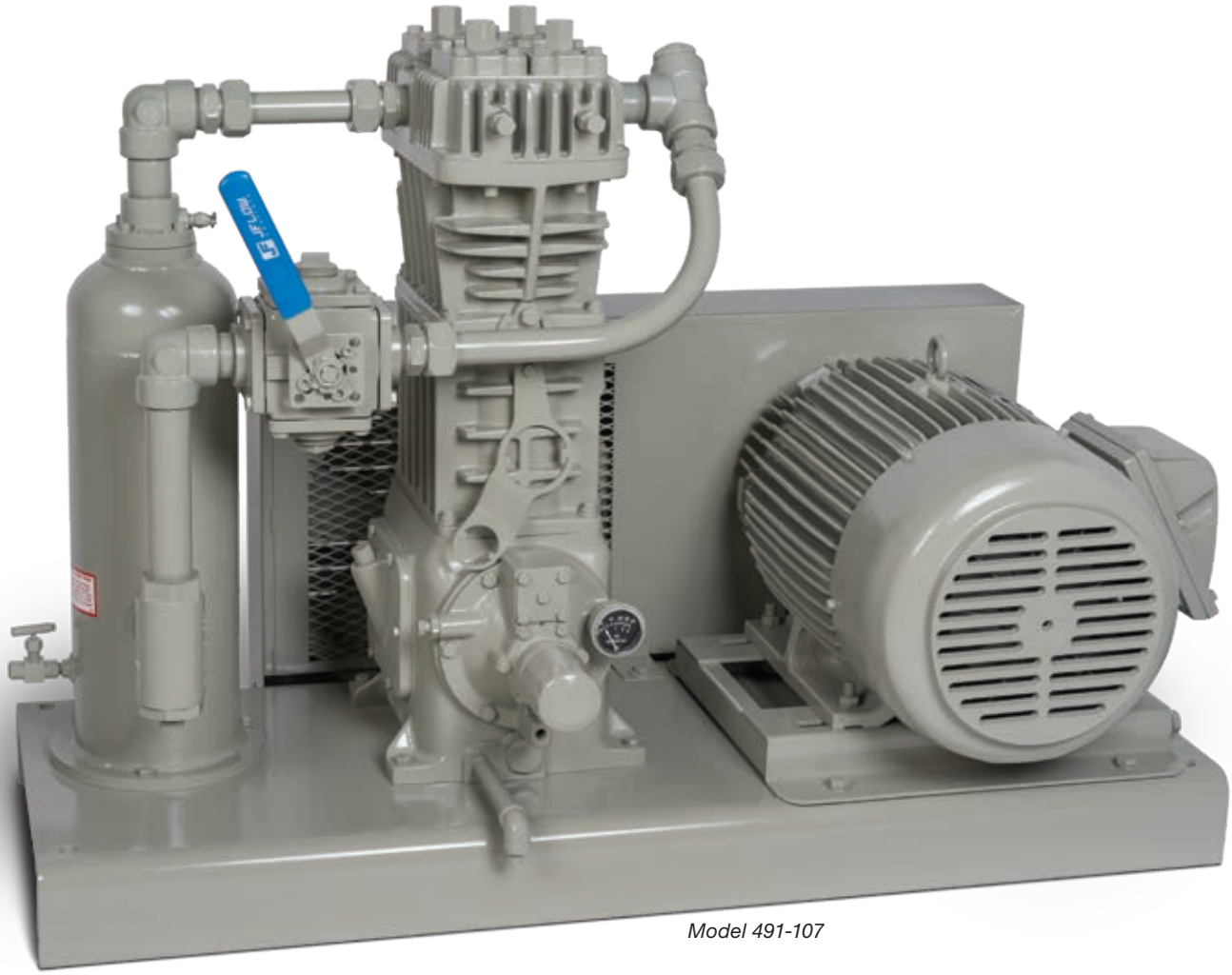
Installation, Operation & Maintenance Manual

Plain Style Compressors for Liquid Transfer-Vapor Recovery



Model 491-107

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.

Positively locked piston:
Simple piston design allows end clearance to be precisely set to provide maximum efficiency and long life.

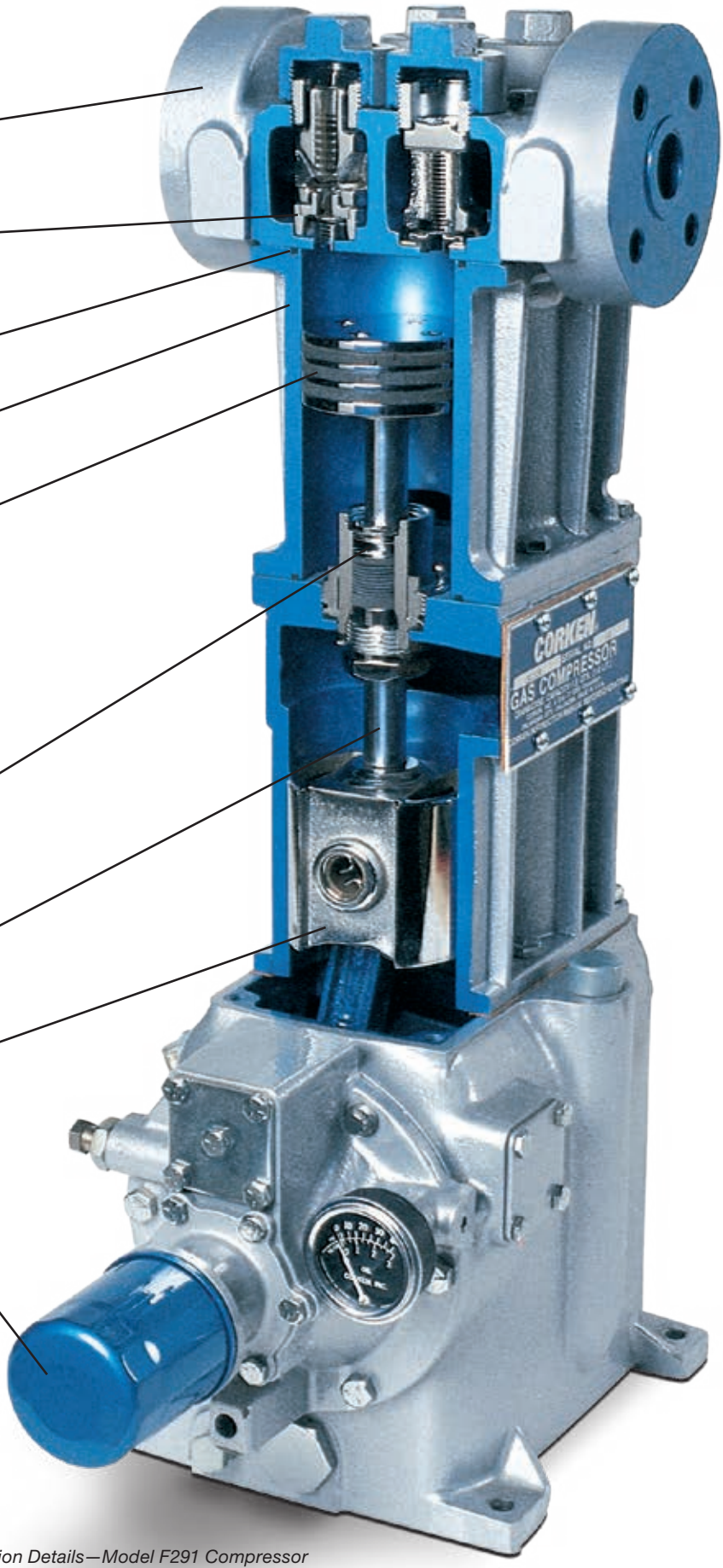
Piston rod seals:
Seals constructed of PTFE incorporating special fillers to maximize leakage control. Spring loaded seal design self adjusts to compensate for normal wear.

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 F291 Compressor

1.1 Liquid Transfer By Vapor Differential Pressure

Corken LPG/NH_3 compressors are designed to transfer liquefied gases such as butane/propane mixtures (liquefied petroleum gas or LPG) and Anhydrous Ammonia (NH_3) from one tank to another. Liquefied gases such as LPG and NH_3 are stored in closed containers where both the liquid and vapor phases are present.

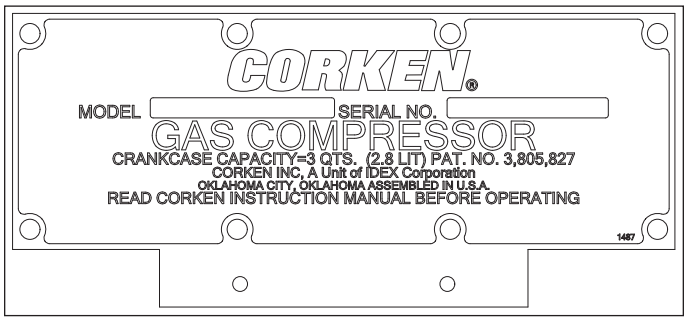


Figure 1.1A: Typical nameplate
(also serves as the packing adjusting screw cover)

There is a piping connection between the vapor sections of the storage tank and the tank being unloaded, and there is a similar connection between the liquid sections of the two tanks. If the connections are opened, the liquid will seek its own level and then flow will stop; however, by creating a pressure in the tank being unloaded which is high enough to overcome pipe friction and any static elevation difference between the tanks, all the liquid will be forced into the storage tank (see figure 1.1B). The gas compressor accomplishes this by withdrawing vapors from the storage tank, compressing them and then discharging into the tank being unloaded. This procedure slightly decreases the storage tank pressure and increases the pressure in the other tank, thereby causing the liquid to flow.

The process of compressing the gas also increases the temperature, which aids in increasing the pressure in the tank being unloaded.

1.2 Residual Vapor Recovery

The principle of residual vapor recovery is just the opposite of liquid transfer. After the liquid has been transferred, the four-way control valve (or alternate valve manifolding) is reversed so that the vapors are drawn from the tank just unloaded and discharged into the receiving tank. **Always discharge the recovered vapors into the liquid section of the receiving tank.** This will allow the hot, compressed vapors to condense, preventing an undesirable increase in tank pressure (see figure 1.2A).

Residual vapor recovery is an essential part of the value of a compressor. There is an economical limit to the amount of vapors that should be recovered, however.

When the cost of operation equals the price of the product being recovered, the operation should be stopped. For most cases in LP-Gas and Anhydrous Ammonia services, this point is reached in the summer when the compressor inlet pressure is 40 to 50 psig

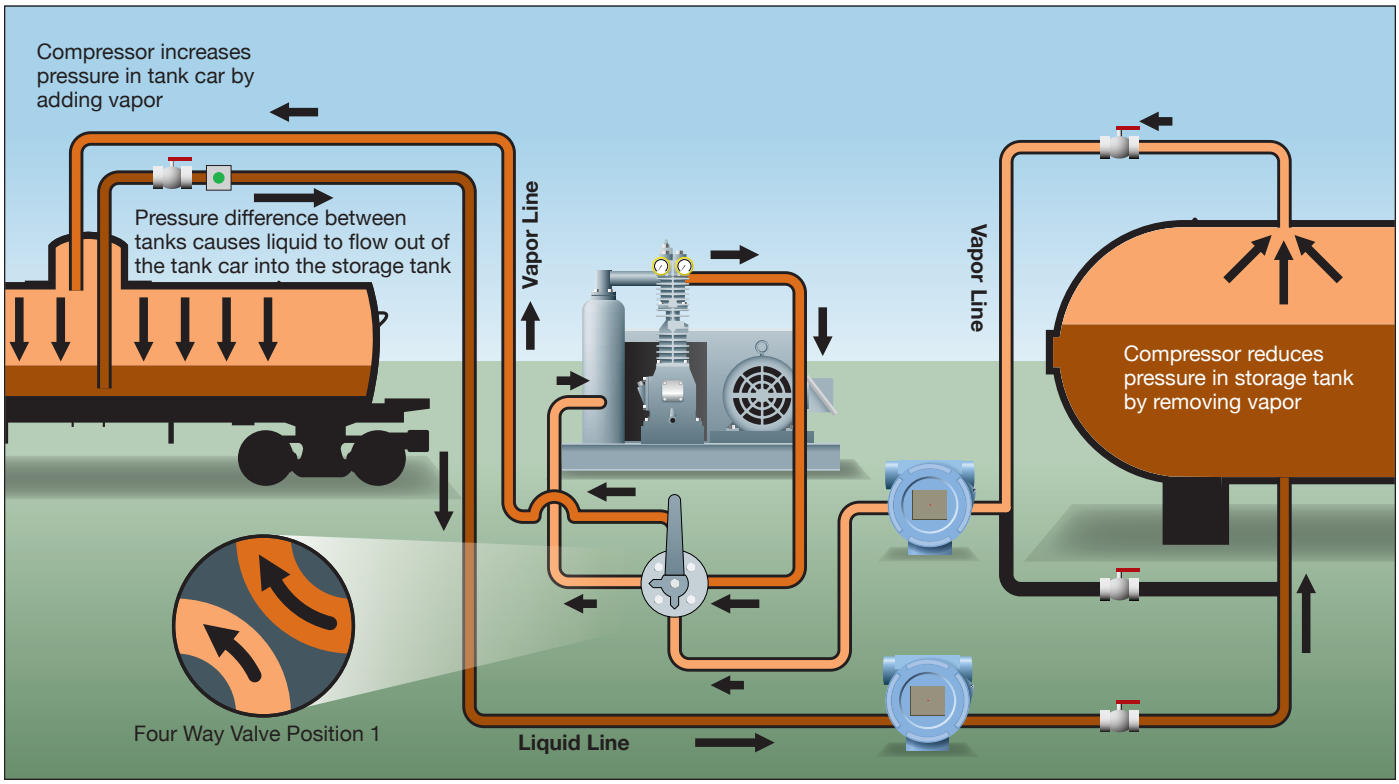


Figure 1.1B: Liquid transfer by vapor differential pressure.

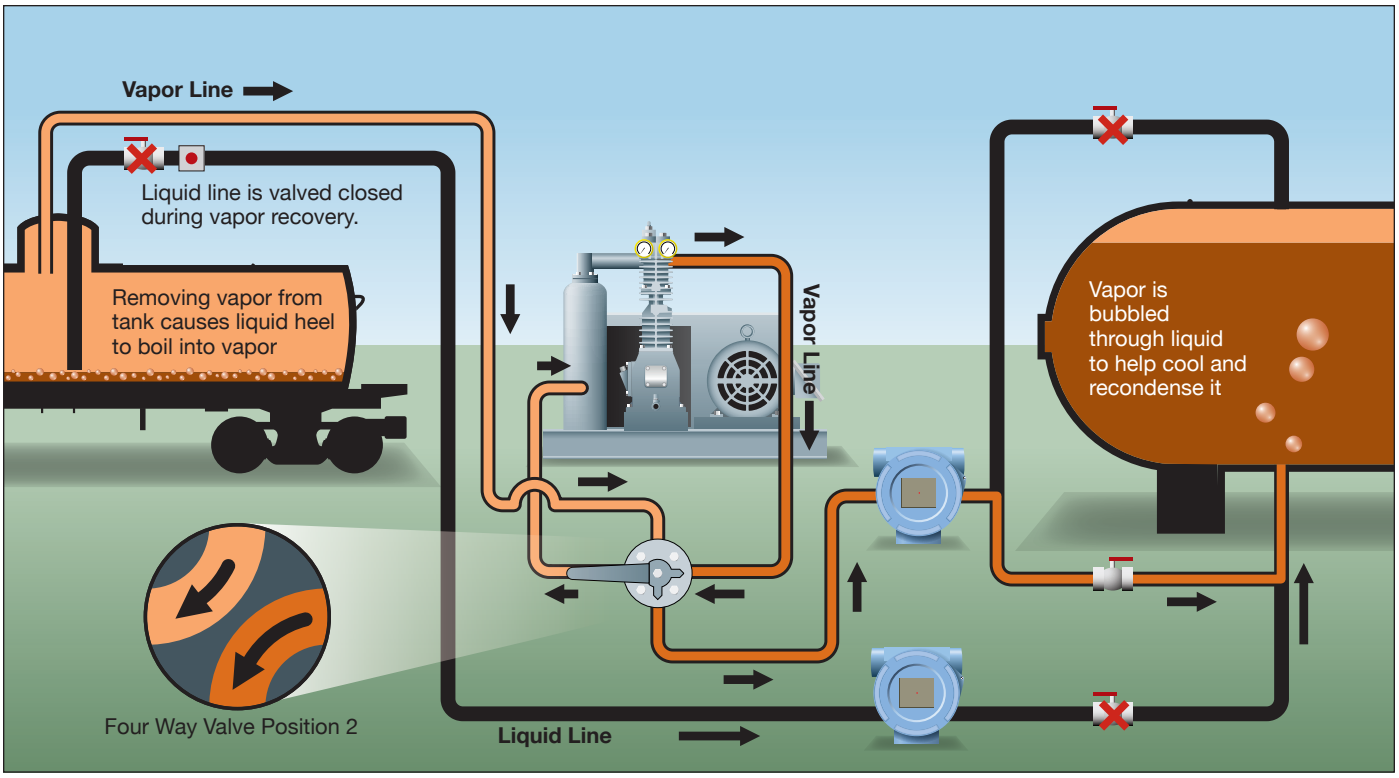


Figure 1.2A: Residual vapor recovery.

(3.8 to 4.5 bars). A good rule of thumb is not to operate beyond the point at which the inlet pressure is one-fourth the discharge pressure. Some liquids are so expensive that further recovery may be profitable, but care should be taken that the ratio of absolute discharge pressure to absolute inlet pressure never exceeds 7 to 1. Further excavation of very high value products would require a Corken two-stage gas compressor.

Invariably, there is some liquid remaining in the tank after the liquid transfer operation. This liquid "heel" must be vaporized before it can be recovered, so do not expect the pressure to drop immediately. Actually, more vapor will be recovered during the first few minutes while this liquid is being vaporized than during the same period of time later in the operation. Remember that more than half of the economically recoverable product is usually recovered during the first hour of operation on properly sized equipment.

1.3 Compressor 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 1.3A.

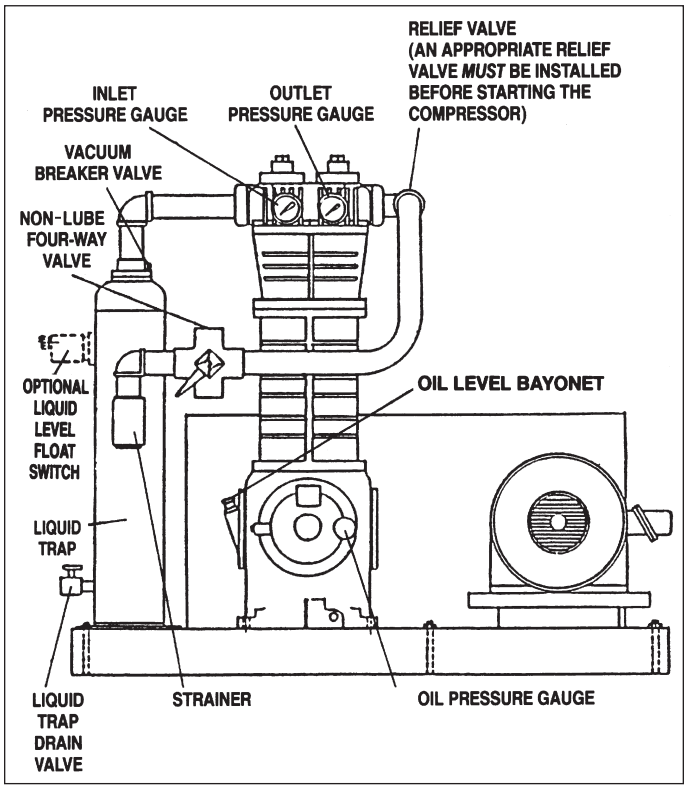


Figure 1.3A: 107-style compressor mounting.

Corken 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. With the exception of the small size model 91 compressor, all compressor crankcases are lubricated by an automotive type oil pressure system. An automatically reversible gear

type oil pump circulates oil through passages in the crankshaft and connection rod to lubricate the journal bearings and wrist pins (see figure 1.3B). Sturdy iron crossheads transmit reciprocating motion to the piston.

Corken's **automatically** reversible oil pump design allows the machine to function smoothly in either direction of rotation.

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.

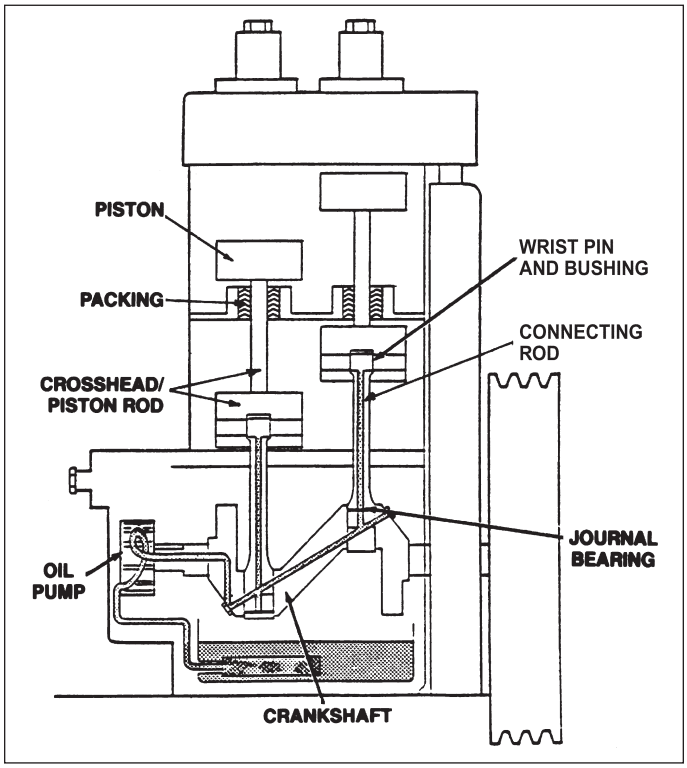


Figure 1.3B: Pressure lubrication system (not available on Model 91).

Piston rod packing is used to seal the gas in the compression chamber and prevent crankcase oil from entering the compressor cylinder. 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 1.3C).

The typical Corken compressor valve consists of a seat, bumper, one or more spring/s and one or more valve/s discs or plates as shown in figure 1.3D. 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.

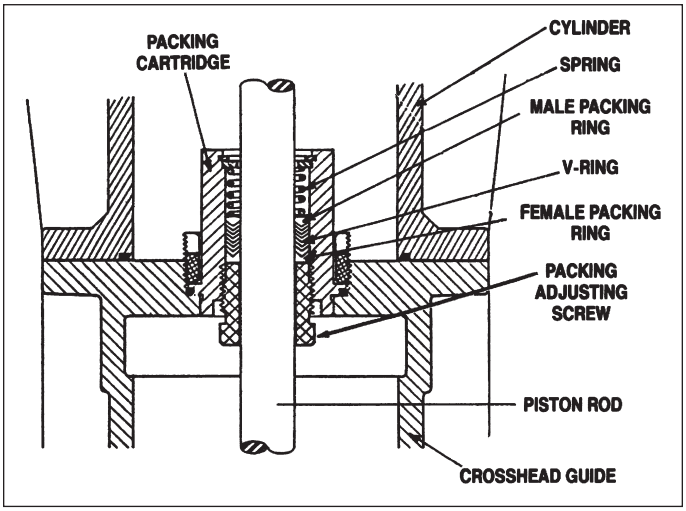


Figure 1.3C: Compressor sealing system

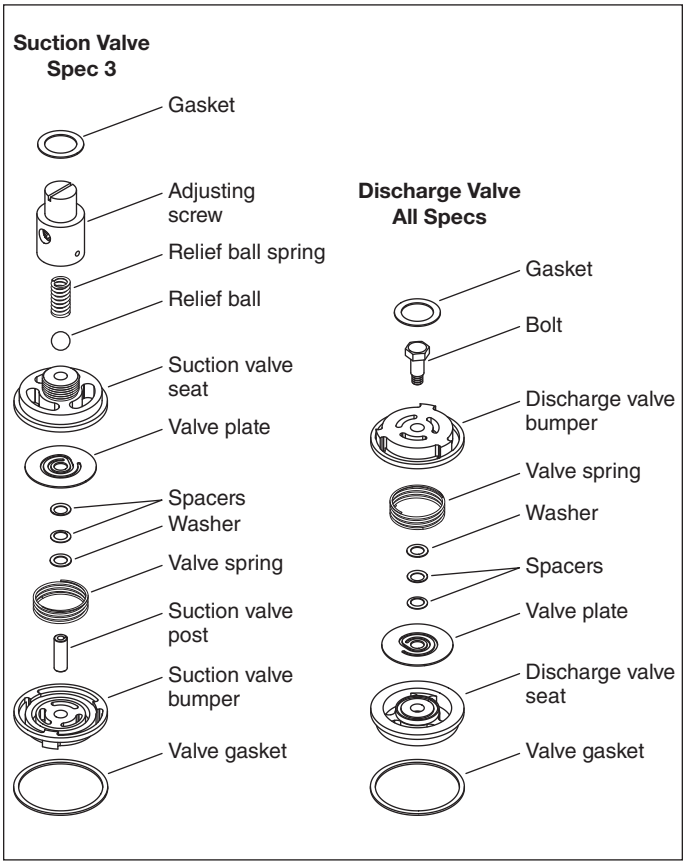


Figure 1.3D: Compressor sealing system

Chapter 2—Installing Your Corken Compressor

2.1 Location

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

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

Corken compressors handling toxic or flammable gases such as LPG/NH_3 should be located outdoors. A minimum of 18 inches (457.2 mm) clearance between the compressor and the nearest wall is advised to make it accessible from all sides and to provide unrestricted air flow for adequate cooling.

NOISE. Corken vertical compressors sizes model 91 through 891 should not exceed an 85 DBA noise level at a distance of one meter (3.3 ft.) when properly installed.

2.2 Foundation

Proper foundations are 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 Models 91, 291, 491, and 691, the baseplate should be secured to the foundation using 1/2" diameter x 12" long “J” bolts. Use 3/4" x 12" anchor bolts for 891.

NOTE: Be sure to use all anchor holes.

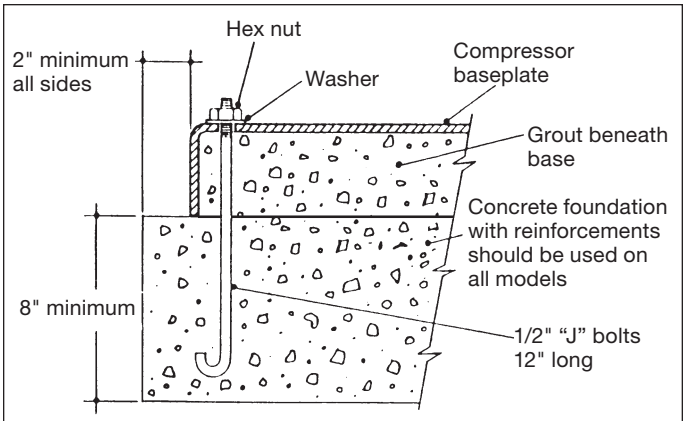


Figure 2.2A: Recommended foundation details for Corken compressors 91–691.

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

See ED410: Compressor Foundation Design for more information.

2.3 Piping

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

DO NOT SUPPORT PIPING WITH THE COMPRESSOR. Unsupported piping is the most frequent cause of vibration of the pipe. The best method to minimize transmission of vibration from the compressor to the piping is to use flexible connectors (see figure 2.3A).

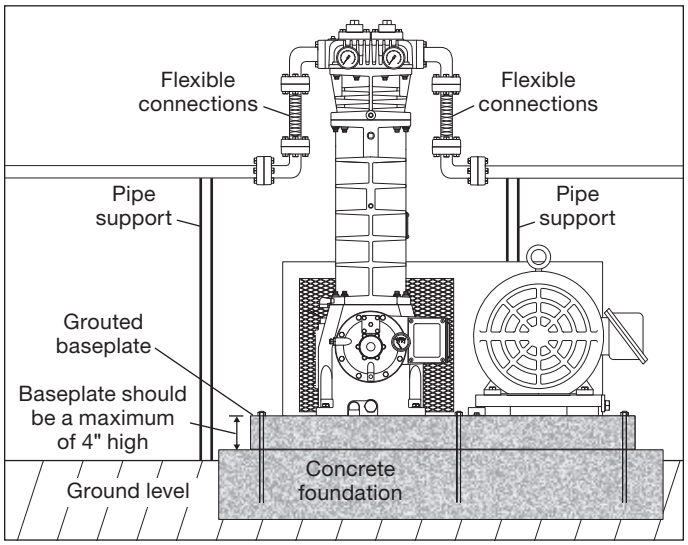
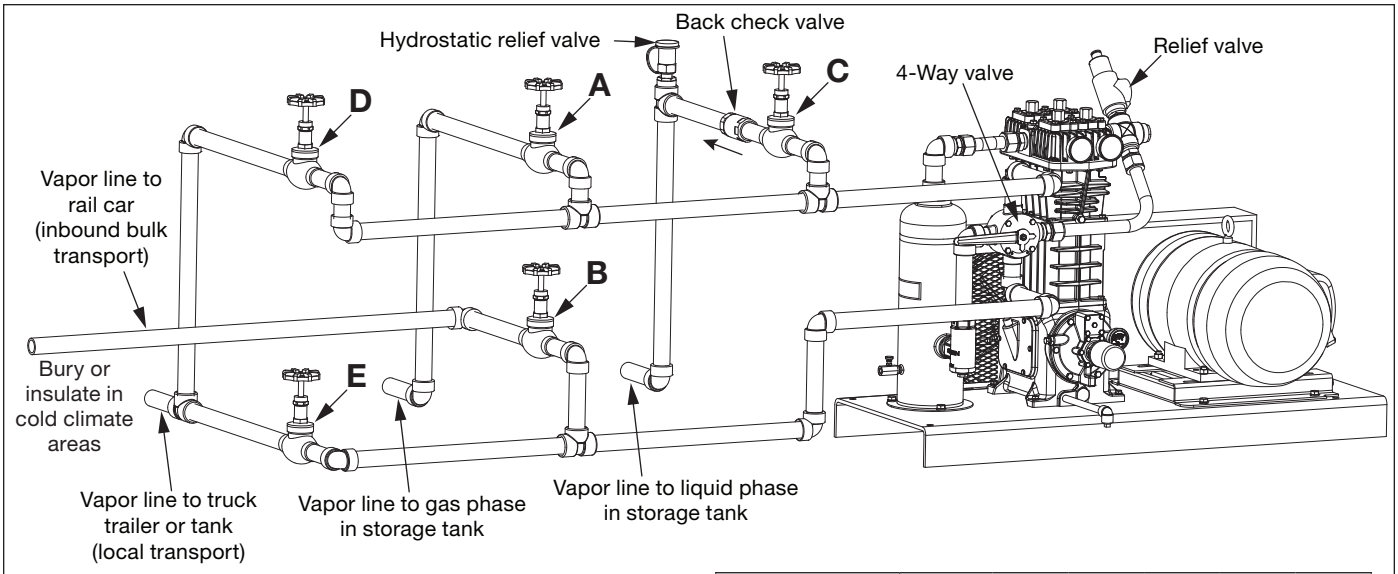


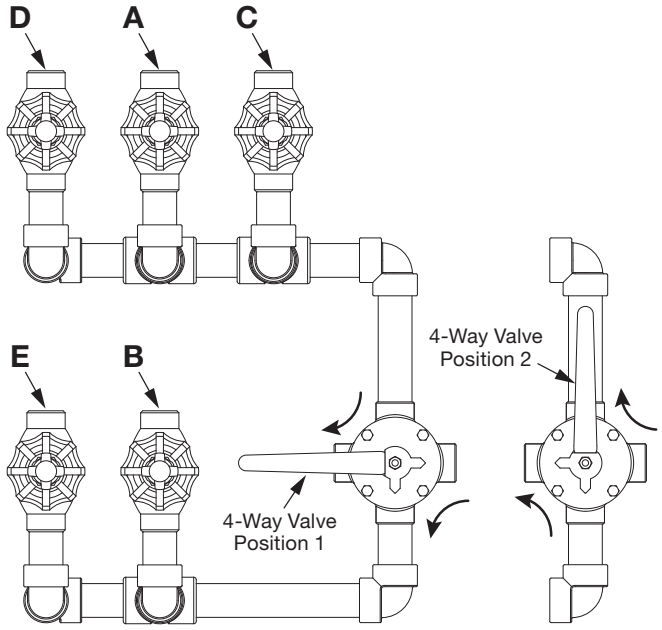
Figure 2.3A: On –107 mountings, the flexible connectors should be located near the four way valve.

Pipe must be adequately sized to prevent excessive pressure drop between the suction source and the compressor as well as between the compressor and the final discharge point. In most cases, piping should be at least the same diameter as the suction nozzle on the compressor. Typically, LPG/NH_3 liquid transfer systems should be designed to limit pressure drops to 20 psi (1.4 bar). Appendix C shows recommended pipe sizes for each compressor for typical LPG/NH_3 installations.

Care must be taken if a restrictive device such as a valve, pressure regulator, or back-check valve is to be installed in the compressor’s suction line. The suction line volume between the restrictive device and the compressor suction nozzle must be at least ten times the swept cylinder volume. See Appendix B for details on cylinder and stroke.



4-way Valve Operation



Service to Perform	Valve Position					
	4-way	A	B	C	D	E
1. Unload tank car into storage tank	Position One	Open	Open	Close	Close	Close
2. Recover vapors from tank car into storage tank	Position Two	Close	Open	Open	Close	Close
3. Unload transport or truck into storage tank	Position One	Open	Close	Close	Close	Open
4. Recover vapors from transport or truck into storage tank	Position Two	Close	Close	Open	Close	Open
5. Load truck or field tank from storage tank	Position Two	Open	Close	Close	Close	Open
6. Load truck or field tank from tank car	Position One	Close	Open	Close	Open	Close
7. Equalize between tank car and storage tank without using vapor pump	—	Open	Open	Close	Open	Open
8. Equalize between truck or field tank and storage tank without using vapor pump	—	Open	Close	Close	Open	Close

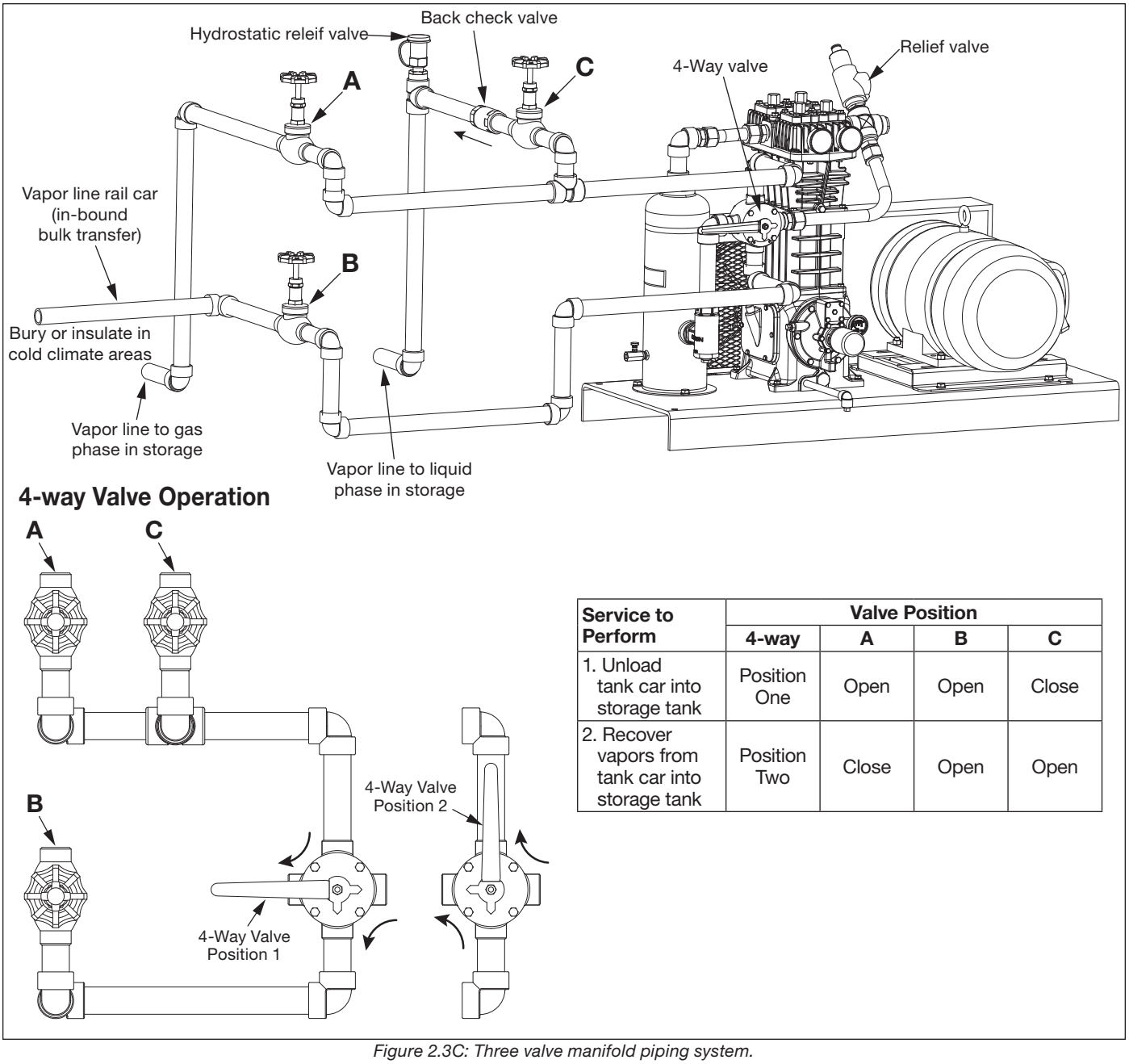
Figure 2.3B: Five valve manifold piping system.

107 style compressors are usually connected using a five-valve (figure 2.3B) or three-valve manifold (figure 2.3C). The five-valve manifold allows the storage tank to be both loaded and unloaded. The three-valve manifold only allows the storage tank to be loaded. Adequate sizing of the liquid and vapor lines is essential to limit the pressure drop in the system to a reasonable level (20 psi or less).

The line size helps determine the plant capacity almost as much as the size of the compressor, and liquid line sizes are a bigger factor than vapor lines. If the pressure gauges on the head indicate more than a 15 to 20 psi (1.0 to 1.4 bars) differential between the inlet and outlet pressures, the line sizes may be too small or there is too much piping restriction. The less restriction in the piping, the better the flow. Appendix C shows recommended pipe sizes for typical LPG/NH_3 compressor installation.

A tank car unloading riser should have two liquid hoses connected to the car liquid valves. If only one liquid hose is used, the transfer rate will be slower and there is a good possibility that the car's excess flow valve may close.

Since the heat of compression plays an important part in rapid liquid transfer, the vapor line from the compressor to the tank car or other unloading container should be buried or insulated to prevent the loss of heat and the compressor should be located as near as possible to the tank being emptied. In extremely cold climates, if the line from the storage tank to the compressor is over 15 feet (4.6 meters) long, it should be insulated to lessen the possibility of vapors condensing as they flow to the compressor. The vapor recovery discharge line **should not** be insulated. Placing the compressor as close as possible to the tank



Service to Perform	Valve Position			
	4-way	A	B	C
1. Unload tank car into storage tank	Position One	Open	Open	Close
2. Recover vapors from tank car into storage tank	Position Two	Close	Open	Open

Figure 2.3C: Three valve manifold piping system.

being unloaded will minimize heat loss from the discharge line for the best liquid transfer rate.

Unloading stationary tanks with a compressor is quite practical. Delivery trucks and other large containers can be filled rapidly if the vapor system of the tank to be filled will permit fast vapor withdrawal, and if the liquid piping system is large enough. Many older trucks (and some new ones) are not originally equipped with vapor excess flow valves large enough to do a good job and these should be replaced by a suitable size valve. The liquid discharge should be connected to the tank truck pump inlet line rather than the often oversized filler valve connection in the tank head.

It is of extreme importance to prevent the entry of liquid into the compressor. The inlet of the compressor should be protected from liquid entry by a liquid trap (see section 2.4). It is of equal importance to protect the discharge of the compressor from liquid. This may be done by installing a check valve on the discharge and designing the piping so liquid cannot gravity-drain back into the compressor. Make sure to install a check valve on vapor lines discharging to the liquid space of the tank.

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

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

For Ammonia — The American National Standards Institute, Inc., K61.1-1999, Storage and Handling of Anhydrous Ammonia.

Install, use and maintain this equipment according to Corken instructions and all applicable federal, state, and local laws and previously mentioned codes.

2.4 Liquid Traps

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

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

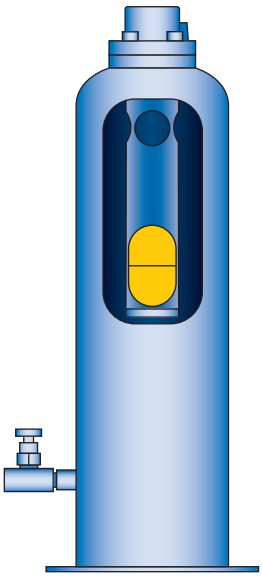
Corken offers three types of liquid traps for removal of liquids in the gas stream (see figure 2.4A). The simplest is a mechanical float trap. As the liquid enters the trap the gas velocity is greatly reduced, which allows the liquid to drop out. If the liquid level rises above the inlet, the float will plug the compressor suction. The compressor creates a vacuum in the inlet piping and continues to operate until the operator manually shuts it down. The trap must be drained and the vacuum-breaker valve opened before restarting the compressor, to allow the float to drop back. This type of trap is only appropriate for use where the operator keeps the compressor under fairly close observation. This trap is provided with the 109 and 107 compressor mountings (see Appendix D for details on standard Corken compressor mountings).

When the compressor will not be under more-or-less constant observation an automatic trap is recommended. The automatic trap replaces the float with electrical float switches. If the liquid level should rise too high, the level switch will open and disconnect the power to the motor starter, stopping the compressor. This design ensures the machine will be protected even when it is not under close observation and is standard in the 109A and 107A mounting configurations.

Corken's most sophisticated trap provides the most thorough liquid separation. This trap is larger and is ASME code stamped. It contains two level switches, one for alarm and one for shutdown. In some cases the alarm switch is used to activate a dump valve (not included with trap) or sound an alarm for the trap to be manually drained by the operator. This trap also contains a mist pad. A mist pad is a mesh of interwoven wire to catch fine liquid mists. The ASME code trap is standard in the 109B and 107B mounting configurations.

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

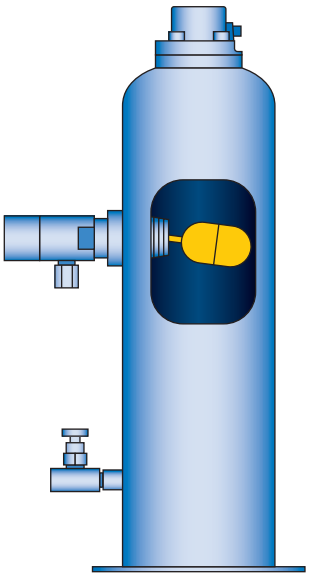
Standard Liquid Trap



Standard liquid trap with mechanical float assembly and drain valve.

Sizes:
- 1-1/4" x 1-1/4" NPT
- 1-1/4" x 1-1/2" NPT

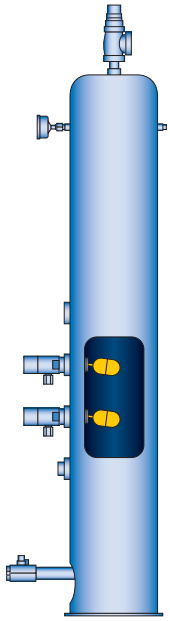
Automatic Liquid Trap



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

Sizes:
- 1-1/4" x 1-1/4" NPT
- 1-1/4" x 1-1/2" NPT

ASME Automatic Liquid Trap



Class 300 RF flange 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.

Sizes:
- 1-1/2" x 1-1/2" NPT
- 2" x 2" Class 300 RF flange

Figure 2.4A: Liquid traps.

Typical Float Switch Wiring Diagram

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

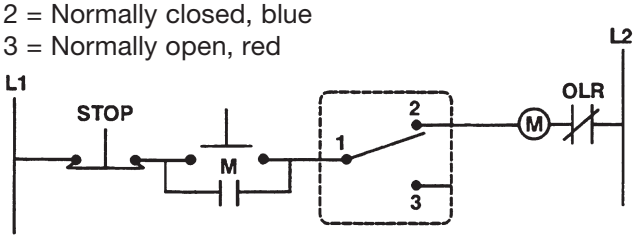


Figure 2.4B: Typical float switch wiring diagram.

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 your compressor is equipped with a liquid trap of other than Corken manufacture, make sure it is of adequate size to thoroughly remove any liquid present in the suction stream.

2.5 Driver Installation / Flywheels

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.

Note: Flexible couplings are not suitable for reciprocating compressors. Never operate a reciprocating compressor without a flywheel.

Drivers should be selected so the compressor operates between 350 to 825 RPM. The unit must not be operated without the flywheel or severe torsional imbalances will result that could cause vibration and 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, and alternating between being warm when running and being cool when stopped, can cause moist air to be drawn into the motor. This moist air will condense, and may eventually add enough water inside the motor to cause it to fail. To prevent this, make a practice of running the motor at least once a week on a bright, dry day for an hour or so without the V-belts. In this period of time the motor will heat up and vaporize the condensed moisture, driving it from the motor. No motor manufacturer will guarantee their explosion proof or totally enclosed (TEFC) motor against damage from moisture.

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

2.6. Crankcase Lubrication

Non-detergent oil is recommended for Corken vertical compressors. Detergent oils tend to keep wear particles and debris suspended in the oil, whereas non-detergent oils let them settle in the bottom of the crankcase. When non-detergent oils are not available, detergent oils may usually be successfully substituted, although compressors handling ammonia, amine, or imine gases are notable exceptions. These gases react with the detergent and cause the crankcase oil to become corrosive and contaminated. Figures 2.6A and 2.6B show recommended oil viscosities and crankcase capacities.

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

Figure 2.6A: Oil selection chart.

Compressor Model	Approximate Quarts	Capacity Liters
91	0.9	0.8
291	1.5	1.4
491	3.0	2.8
691/891	7.0	6.6

Figure 2.6B: Oil capacity chart.

Synthetic lubricants are generally not necessary. Please consult your lubricate supplier if you are considering the use of synthetic oil. To add oil, remove the name plate and pour through the opening.

General Notes on Crankcase Oil

Corken gas compressors are used for 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. No single crankcase oil or maintenance schedule is right for every compressor installation. Availability of brands and grades

of oil varies from one location to another. These factors can make it challenging for a Corken compressor user to select a suitable crankcase oil.

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. Given the relatively small volume of oil used in the crankcase of a Corken compressor, and the critical nature of the services where these compressors are typically used, selecting the appropriate high-quality oil is the most economical choice. It will help ensure the dependability and longevity of the compressor.

Oils to Avoid

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

- **Do not use** engine/motor oil with an API Service SA through SH.
- **Do not use** any oil with a viscosity index below 95.
- **Do not use** any oil with a pour point less than 15°F (8°C) lower than the anticipated minimum ambient temperature (unless a crankcase oil heater is used).

See below for additional detail on each of these parameters.

Industrial Oils

Corken recommends using industrial oils (rather than engine oil or "motor oil"). Industrial oils have additives specifically selected and blended for specific purposes. Many are designed specifically for the conditions inherent in compressor crankcases. Such industrial oils are required for Corken compressors operating in continuous duty or heavily loaded applications.

Industrial oils do not receive an API service designation like an engine oil does.

Critical Oil Characteristics

Viscosity

The viscosity of a crankcase oil is a measure of its resistance to flow. Viscosity is the most important physical property of lubricating oil. Oils with higher viscosity (ISO 100 and ISO 150) are thicker and are used for higher ambient temperatures. Oils with lower viscosity (ISO 68, ISO 46, and ISO 32) are thinner and are used at lower ambient temperatures. However, oils with a high viscosity index (see below) can be used at wider ambient temperature range compared to oils with a lower viscosity index.

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. A high viscosity reflects a more stable viscosity, and is generally preferred for Corken compressors.

Oil with a low viscosity index tends to thin out as the oil temperature increases. This can cause lubrication failure as well as unstable oil pressure. **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).

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 very thick and can't freely flow to the compressor's bearings and other wear surfaces, or even to the compressor's oil pump.

In low ambient temperature operation, the oil's pour point is critical. An oil should have a pour point at least 15°F (8°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 -15°F (-26°C).

Do not assume the pour point of an oil is low enough. Consult the oil's technical data sheet. Many oils have a pour point around 0 to 10°F (-18 to -12°C) which is too high for low ambient temperatures. Synthetic oils often have a lower pour point than conventional oils.

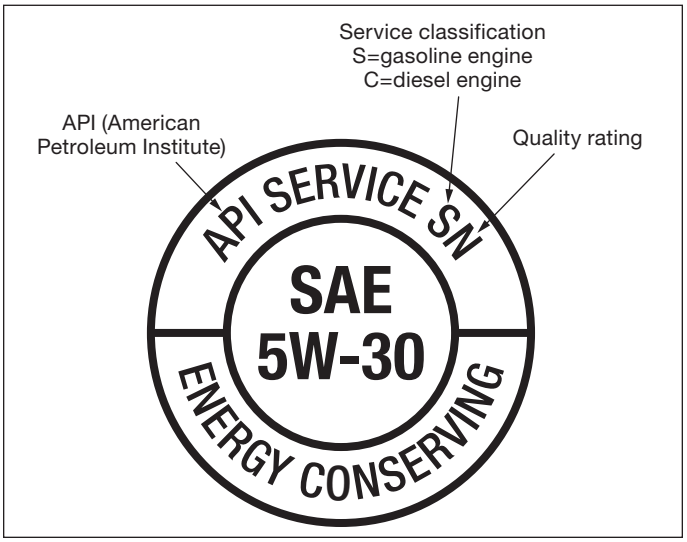
Engine Oils (Motor Oils)

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.). A gas compressor crankcase is a different environment than an engine crankcase. Thus, engine oils are not necessarily the best oils to use in a gas compressor. They are by far the most readily available oils.

If a suitable industrial oil is not available, engine oils can be used in Corken compressors used in intermittent service. Heavily loaded compressors or those in continuous duty service should always use high quality industrial oil. If engine oil is used, it is critical that the engine oil have an adequate API Service Grade.

API Service

The American Petroleum Institute (API) grades motor oils (oils designed for use in engines in cars and trucks) with a two letter classification. Oils with API grades “SA” through “SH” are obsolete and should never be used in modern engines or gas compressors. Unfortunately, motor oils with an “SA” and “SB” ratings are still readily available at parts stores, service stations, and other retail outlets at low prices. These are low quality oils and should NEVER be used in Corken compressors. **If motor oil is used in a Corken compressor, it should have an API Service of SJ or better.** Multigrade motor oils such as 10W-40 tend to have a higher viscosity index.



Example of API “Donut” symbol used on motor oil.

Oil suppliers post product data sheets on line that contain various physical properties of the oil , and the API Service classification. **If there is any doubt, do not use the oil.**

Oil Change Intervals

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

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

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

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

Factors that shorten the life of the oil:

- Dirty or dusty environmental conditions that cause the oil to become dirty or discolored
- Oil dilution caused 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. Each time the oil is changed, the oil filter (Corken part number 4225) should also be changed.

Ammonia Services

Never use a detergent oil in a compressor in ammonia service. Ammonia will react with the detergent and cause lubrication failure.

Oils that can be used in ammonia compressors:

- Royal Purple: Uni-Temp
- Phillips 66: Ammonia Compressor Oil
- Chevron: Capella P68

Crankcase Oil Heater Option

Corken offers a crankcase oil heater as an option on all models except the small model 91. This heater is available in 110V and 220V versions and is rated for Class 1, Division 1 and 2, Group B, C, D service. The heater includes a thermostat set at 70°F (21.1°C).

If a crankcase heater is desired, it is best to order the heater with the compressor (crankcase specification “MH”). The mounting hole for the heater is not drilled unless the heater is ordered with the compressor. It is also possible to order the compressor with the hole drilled (1" NPT), but without the heater (crankcase specification “MR”). With this option, a customer can supply their own heater.

2.7 Relief Valves

An appropriate relief valve must be installed at the compressor discharge. On Corken 107-style mounted units a relief valve should be fitted in the piping between the compressor discharge and the four-way valve (see figure 1.3A). Relief valves should be made of a material compatible with the gas being compressed. Local codes and regulations should be checked for specific relief valve requirements. Also, relief valves may be required at other points in the compressor’s system piping.

2.8 Truck Mounted Compressors

Corken compressors may be mounted on trucks to perform liquid transfer operations as described in section 1.1. The compressor should be mounted so the inspection plate is accessible for packing adjustment. The compressor must be protected against liquid as explained in section 2.4 and a relief valve must be installed in the discharge piping before the first downstream shutoff valve.

Three types of mountings are typically used. The inside mounting (figure 2.8A) drives the compressor directly off the PTO shaft. The PTO must be selected to drive the compressor between 400 and 800 RPM. An extended compressor crankshaft is required so the U-joint yoke may connect to the compressor without removing the flywheel. Do not operate the compressor without a flywheel. Use a U-joint with a splined joint and make sure the connections are parallel and in line. The U-joint angle should be less than 15 degrees (see figure 2.8B). Always use an even number of U-joints.

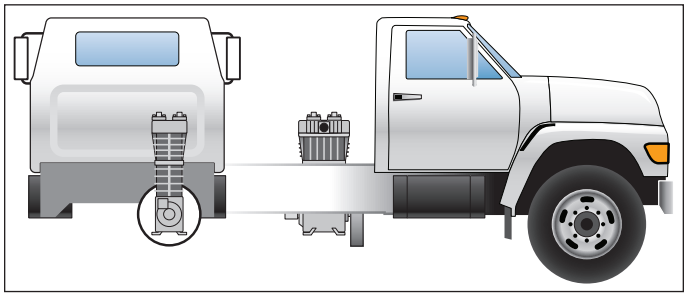


Figure 2.8A: Inside transport mounting.

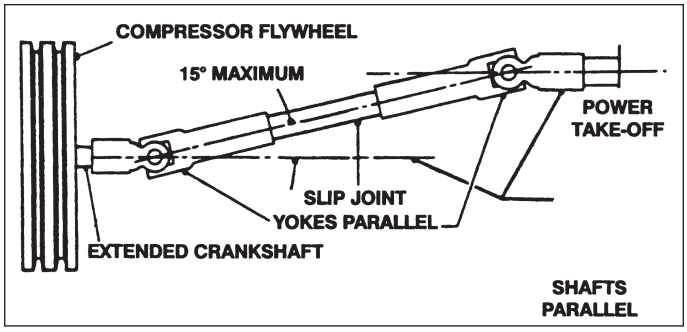


Figure 2.8B: U-joint drive for compressor.

Depending on the truck design, the compressor may be outside or top mounted as shown in figures 2.8C and 2.8D to be V-belt driven. Power is transmitted through a U-joint drive shaft, jackshaft with two pillow block bearings, V-belt sheave and V-belts. An idle pulley may be used under the truck frame.

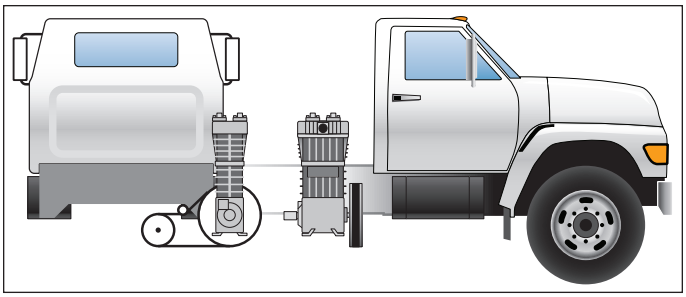


Figure 2.8C: Outside transport mounting

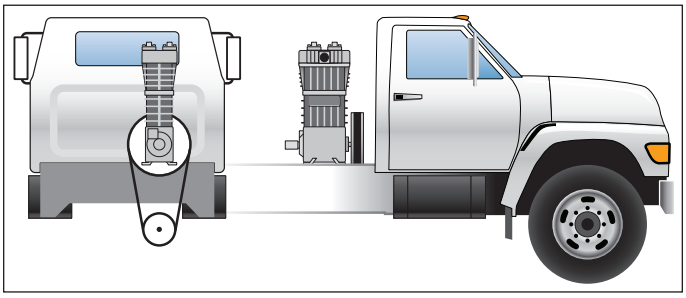


Figure 2.8D: Top transport mounting.

2.9 Shutdown/Alarm Devices

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

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

2. **High Discharge Temperature Switch:** This switch is strongly recommended for all applications. Both the High Discharge Temperature switch (HDT) and compressor have an operating pressure range. It is preferable that the switch set point be midpoint in its range and 30°F (-1°C) above the normal discharge temperature, but below the maximum design temperature for the compressor of 350°F (176.7°C).

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

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

Greater than the normal operating pressure for the compressor.

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

Less than the maximum operating pressure of the compressor.

Midpoint of the pressure switch range.

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

Chapter 3—Starting Up Your Corken Compressor

NOTE: Before initial startup of the compressor be sure the principal of using a compressor for liquid transfer by vapor differential pressure is understood (see section 1.1). Read this entire chapter, then proceed with the startup checklist.

3.1 Inspection After Extended Storage

If your compressor has been out of service for a long period of time, you should verify 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 lubricant. 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, be sure that the electric power is disconnected. When mounting new belts, always make sure the driver and compressor are close enough together to avoid forcing.

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

The flywheel is mounted on the shaft via a split, tapered bushing and three bolts (refer to figure 3.2A). These bolts should be tightened in an even and progressive manner until torqued as specified below. There must be a gap between the bushing flange and the flywheel when installation is complete. Always check the flywheel runout before startup and readjust if it exceeds the value listed in Appendix B.

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

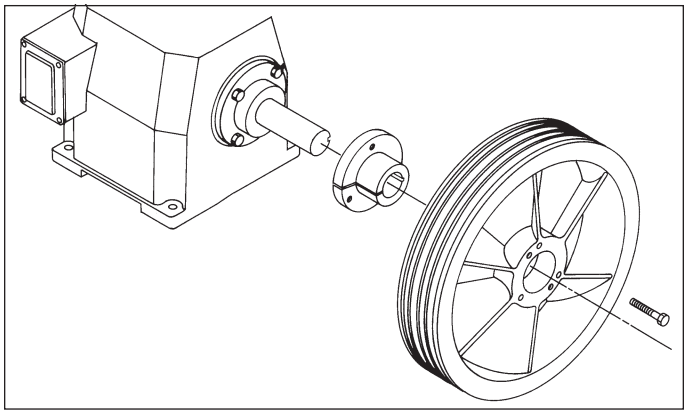


Figure 3.2A: Flywheel installation.

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.

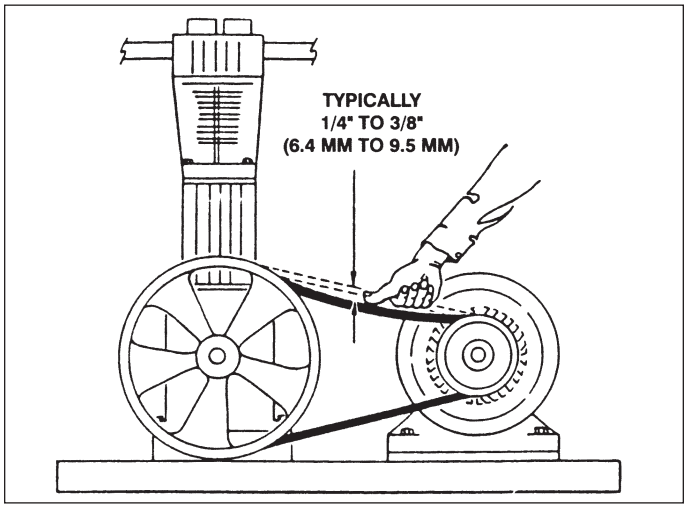


Figure 3.2B: Belt tension.

3.3 Crankcase Oil Pressure Adjustment

Corken compressor models 291 through 891 are equipped with an automatically reversible gear type oil pump (if your compressor is the splash lubricated Model

91, proceed to section 3.4). It is essential to ensure the pumping system is primed and the oil pressure is properly adjusted in order to assure smooth operation.

Before starting your compressor, check and fill the crankcase with the proper quantity of lubricating oil. (Refer to section 2.6)

When the compressor is first started, observe the crankcase oil pressure gauge. If the gauge fails to indicate pressure within 30 seconds, stop the machine and loosen the oil filter. Restart the compressor and run until oil comes out and tighten the filter.

The oil pressure should be about 20 psi (1.4 bars) minimum for normal service. If the discharge pressure is above 200 psi (13.8 bars) the oil pressure must be maintained at a minimum of 25 psi (1.7 bars). A spring-loaded relief valve mounted on the bearing housing opposite the flywheel regulates the oil pressure. As shown in figure 3.3A, turn the adjusting screw clockwise to increase the oil pressure and counterclockwise to lower it. Be sure to loosen the adjusting screw locknut before trying to turn the screw and tighten it after making any adjustment.

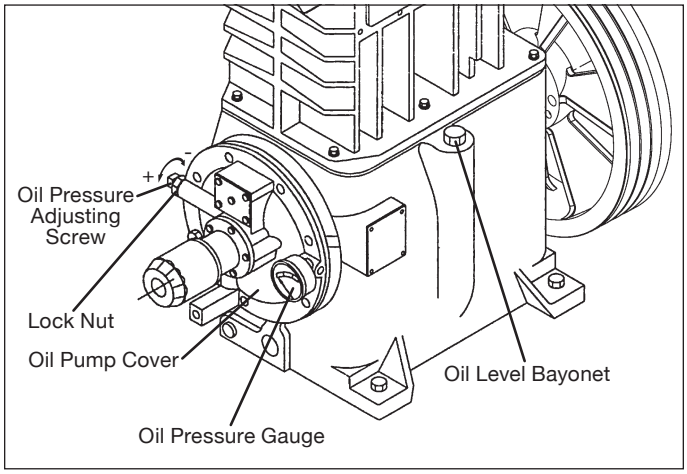


Figure 3.3A: Oil pressure adjustment.

3.4 Startup Check List

Please verify all of the items on this list before starting your compressor! Failure to do so may result in a costly (or dangerous) mistake.

Before Starting the Compressor

1. Become familiar with the function of all piping associated with the compressor. Know each line's use!
2. 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. Check that 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. Verify and note proper oil pressure. Shut down and correct any problem immediately.
2. Observe noise and vibration levels. Correct immediately if excessive.
3. Verify proper compressor speed.
4. Examine entire system for gas, oil or water levels.
5. Note rotation direction.
6. Check start-up voltage drop, running amperage and voltage at motor junction box (not at the starter).
7. Test each shutdown device and record set points.
8. Test all relief valves.
9. Check and record all temperatures, pressures and volumes after 30 minutes and 1 hour.
10. 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
Crankcase oil pressure	●				
Compressor discharge pressure	●				
Overall visual check	●				
Crankcase oil level			●[1]	●[1]	
Drain liquid from accumulation points	●[2]				
Drain distance pieces	●				
Clean cooling surfaces on compressor and intercooler (if any)		●			
Lubricator supply tank level (if any)		●			
Check belts for correct tension			●		
Inspect valve assemblies				●	
Lubricate motor bearings in accordance with manufacturers' recommendations				●	
Inspect motor starter contact points					●
Inspect piston rings[1]				●[3]	

[1] Change oil every 2,200 hours of operation or every 6 months, whichever occurs first. If the oil is unusually dirty, change it as often as needed to maintain a clean oil condition. Change replacement filter 4225 with every oil change.
[2] Liquid traps should be drained prior to startup.
[3] Piston ring life varies greatly, depending on application, gas, and operating pressures. Consult factory for additional recommendations for your specific application.

Chapter 5—Routine Service and Repair Procedures

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

If routine maintenance is performed as listed in chapter 4, repair service on your Corken gas compressor is generally limited to replacing valves or piston rings. When it comes time to order replacement parts, be sure to consult the part details appendix in the back of this Installation, Operation & Maintenance (IOM) manual for a complete list of part numbers and descriptions.

5.1 Valves

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

Inspect valves for breakage, corrosion, debris, and scratches on the valve disc. In many cases, valves may simply be cleaned and reinstalled. If the valves show any damage, they should be repaired or replaced. Replacement is usually preferable, 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 must be 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.

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

The valve holddown assemblies and valve assemblies on the following pages show the various specifications used on models 91, 291, 491, 691 and 891 compressors. Since more than one suction valve arrangement is available for each model of compressor, it is necessary to know your complete model number so you can identify the valve

type specification number (see examples listed below). In most cases for liquid transfer and/or vapor recovery compressors, the valve type will be spec 3 or 3P.

Model number 491AM [3] FBANSNN
Valve type = spec 3

Model number 691AM [3P] FBANSNN
Valve type = spec 3P

Valve Holddown Assemblies: Depending on your model of compressor, the valve holddown assembly has all or a combination of the following:

1. Valve cap / cover
2. Valve cap O-ring
3. Holddown screw
4. Valve cover plate
5. Valve cover plate bolts
6. Valve cover plate O-ring
7. Valve spacer (model 491 only)
8. Valve cage
9. Valve assembly
10. Valve gasket

Valve Assemblies: Depending on your valve specification, the valve assembly has all or a combination of the following:

1. Gasket
2. Adjusting screw
3. Relief ball spring
4. Relief ball
5. Valve seat
6. Valve plate
7. Spacers
8. Washer
9. Valve spring
10. Suction valve post
11. Valve bumper
12. Valve gasket

See valve holddown and valve assembly part details in the appendix for a complete list of part numbers and descriptions.

Valve Inspection and/or Replacement for Models 91 and 291 Compressors

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

Disassembly

1. Unscrew the valve cap and remove O-ring.
2. With the special wrench supplied with your compressor at time of purchase, remove the holddown screw.
3. After the holddown screw has been removed, the valve assembly and valve gasket can be lifted out.
4. Carefully inspect for dirt or broken/damaged parts.
5. Inspect valves for breakage, corrosion, debris and scratches on the valve disc or plate. In many cases, valves may simply be cleaned and reinstalled. If the valves show any damage, they should be repaired or replaced. Replacement is usually preferable although repair parts are available. If valve plates are replaced, seats should also be lapped until they are perfectly smooth. If more than .005 in. must be removed to achieve a smooth surface, the valve should be discarded. If plates are replaced without relapping the seat, rapid wear and leakage may occur.

Assembly

1. Insert metal valve gasket into the suction and/or discharge opening of the head. The metal valve gasket should always be replaced when the valve is reinstalled.
2. Insert cleaned or new valve assembly. Make sure the suction and discharge valves are in the proper suction and discharge opening in the head. NOTE: The spec 3 suction valves for a model 91 and 291 compressor are pre-set so no adjustments to liquid relief pressure are necessary.
3. Replace the holddown screw and tighten to the value listed in Appendix B to ensure the valve gasket is properly seated. NOTE: Gaskets and O-rings are not normally reusable.
4. Replace the O-ring and valve cap and tighten to the value listed in Appendix B. O-rings sealing the valve caps should be replaced.
5. Check bolts and valve holddown screws after first week of operation. Re-torque if necessary. See Appendix B for torque values.

Valve Inspection and/or Replacement for Models 491, 691 and 891 Compressors

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

Disassembly

1. Unscrew the valve cap/nut and remove the O-ring from the coverplate.

2. Remove the valve cover plate, O-ring and holddown screw by removing each of the four bolts. NOTE: Since the holddown screw has been secured with an impact wrench at the factory, you will probably need to wait to remove the holddown screw until after the cover plate has been removed. At this point in time, the holddown screw can be easily removed from the cover plate. The holddown screw on model 691 and 891 is most easily removed with the special wrench supplied with your compressor at time of purchasing.

3. After the cover plate and O-ring have been removed, the valve spacer (model 491 only), valve cage, valve assembly and valve gasket can be lifted out.

4. Inspect valves for breakage, corrosion, debris, and scratches on the valve plate. In many cases, valves may simply be cleaned and reinstalled. If the valves show any damage, they should be repaired or replaced. Replacement is usually preferable although repair parts are available. If valve plates are replaced, seats should also be lapped until they are perfectly smooth. If more than .005 in. must be removed to achieve a smooth surface, the valve should be discarded. If plates are replaced without relapping the seat, rapid wear and leakage may occur.

Assembly

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

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

3. Insert the valve cage and valve spacer (NOTE: spacer applies to model 491 compressor only).

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

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

6. Replace the O-ring (or gasket) and valve cap/nut and tighten to the value listed in Appendix B. O-rings sealing the valve cap should be replaced if they show signs of wear or damage. Valve caps sealed by flat metals gaskets should be reinstalled with new gaskets.

7. NOTE: The Model 491 Spec 3 suction valve has an adjusting screw to set the liquid relief pressure. To set the liquid relief pressure, the screw bottom must be tightened to 1.8" from the top of the valve body.

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

5.2 Heads

A compressor head very seldom requires replacement if the compressor is properly maintained. The primary cause of damage to a head is corrosion and the entry of solid debris or liquid into the compression chamber. Improper storage can also result in corrosion damage to the head (for proper storage instructions see chapter 6).

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

When reassembling the compressor, make sure the bolts are retightened as 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.

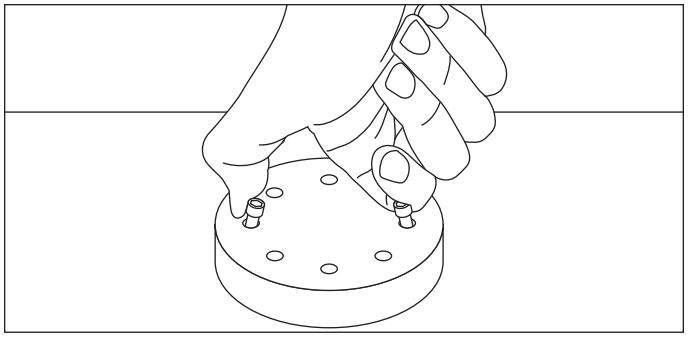


Figure 5.3A: Piston removal

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

5.4 Pistons

Models 91, 291, 491, and 691

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. For Models 91, 291, and 491, the shims are placed between the thrust washer and piston platform. For model 691, the shims are placed between the platform and piston head (see figures 5.4A and 5.4B).

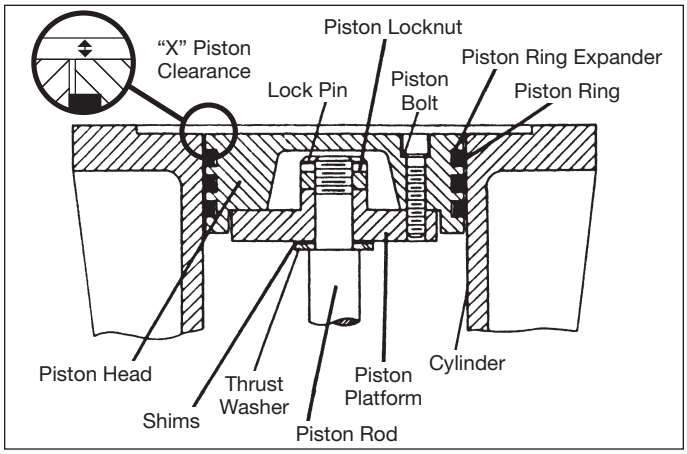


Figure 5.4A: Piston cross section model sizes 91 through 491

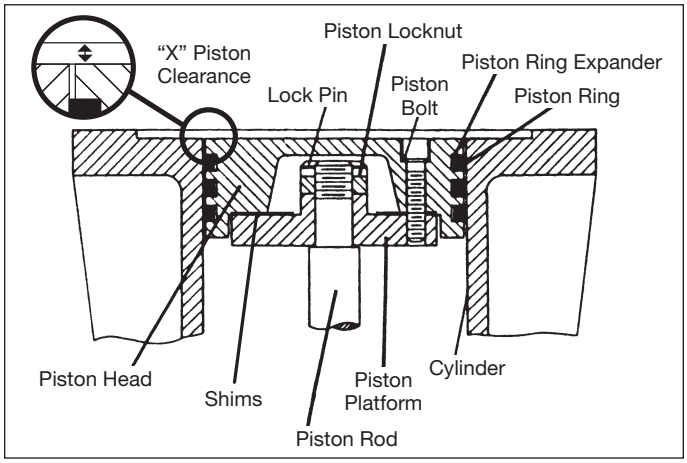


Figure 5.4B: Piston cross section model 691

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

Model 891

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

2. Remove the cylinder cap, head and cylinder.

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

4. Next, remove the lock nut and lift the piston off the end of the piston rod.

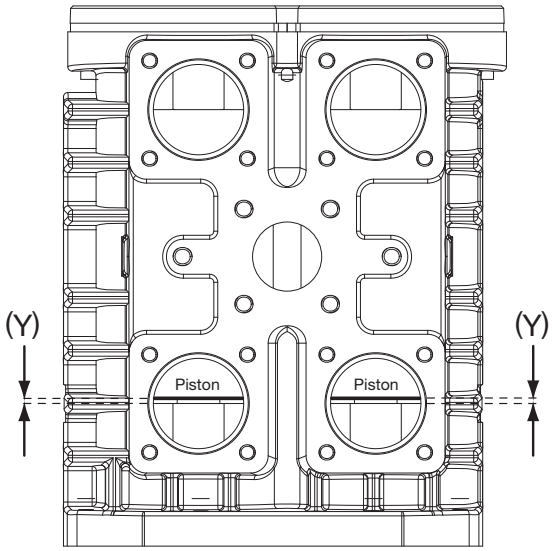
5. Check the thrust washer and shims for damage and replace if necessary.

6. Before installing the new piston, measure the thickness of the existing shims.

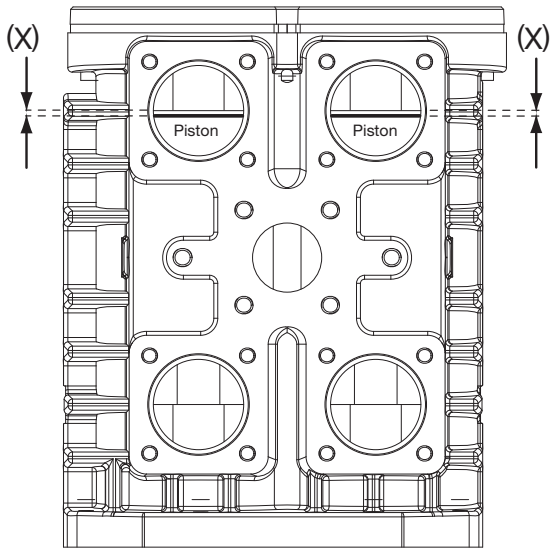
7. Replace the cylinder.

8. Install the piston with the same thickness of shims as before, and with new piston rings and expanders.

9. Now remove a lower valve and measure dimension "Y" at the bottom of the piston shown in Appendix E—Piston Assembly Details. If this measurement does not fall within the tolerances listed in the piston assembly details (Appendix E), remove the piston, adjust the shims as necessary and measure the "Y" dimension.



Piston bottom dead center



Piston top dead center

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

11. Replace the piston cap with the same thickness of shims as before.

12. Reinstall the piston cap and cylinder head.

13. Now remove an upper valve and measure dimension "X" at the top of the piston shown in Appendix E—Piston Assembly Details. If this measurement does not fall within the tolerances in Appendix E, remove the cylinder head and piston cap and adjust the shims as necessary. Repeat the steps and measure the "X" dimension again.

14. When the piston cap is properly shimmed, tighten the socket head bolts in an alternating sequence. Torque socket head bolt to the values listed in Appendix B.

15. Replace the previously removed valves. Best results will be obtained if new valve gaskets are used.

16. Follow standard startup procedures.

5.5 Piston Rod Packing Adjustment

Piston rod packing should be adjusted or replaced whenever leakage becomes noticeable. 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.

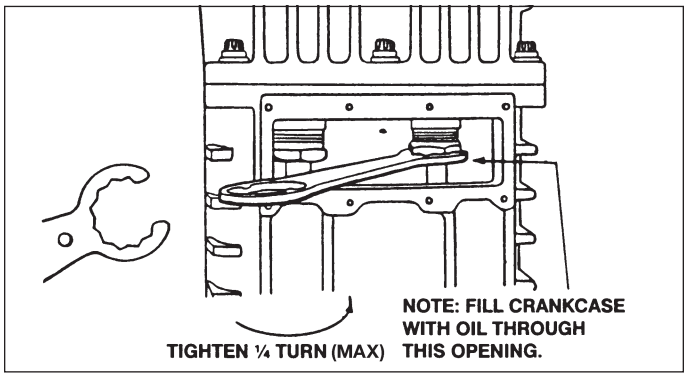


Figure 5.5A: Packing adjusting nuts.

5.6 Cylinder and Packing Replacement

Cylinders very seldom require replacement if the compressor is properly maintained. The primary cause of damage to cylinders is corrosion and the entry of solid debris or liquid into the compression chamber. Improper storage can also result in corrosion damage to cylinder (for proper storage instructions see chapter 6).

If the cylinder does become 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 and oversized rings are not available. OVERBORING THE CYLINDER WILL RESULT IN GREATLY REDUCED RING LIFE.

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

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

Packing Replacement Instructions

Caution: Bleed all pressure from the compressor and piping, and purge (if necessary), before starting to install new piston rod packing. After repair, the unit should be pressure tested and checked for leaks at all joints and gasket surfaces. When the compressor is being used with toxic, dangerous, flammable or explosive gases, this pressure and leak testing should be done with air or a dry, inert gas such as nitrogen.

For simplicity, heads, pistons, and inspection plates are not shown. For specific construction details and actual part numbers, consult the appendix in the back of this IOM manual. Use instructions below that apply to the MODEL and SERIAL NUMBER of your compressor. Be careful to arrange packing sets in the proper order.

Cleanliness:

Prior to installation, inspect all parts for cleanliness and visible defects. There should be absolutely no scratches, dings, porosity, or foreign materials on bearing surfaces, sealing surfaces, and packing cartridge inner and outer diameters.

Workmanship:

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

Model 91 Compressor

(Refer to Appendix E for packing assembly details)

Disassembly of Packing

1. Depressurize and open the compressor.
2. Remove head, piston, cylinder, inspection plate and crosshead guide.
3. Loosen adjusting screw and remove retainer ring, washers, packing spring and old packing from crosshead guide.

Assembly of Packing

1. Clean, then lightly oil, packing area inside the crosshead guide.
2. Slightly thread in the adjusting screw into the crosshead guide.
3. Install packing rings including male and female packing rings one at a time as shown in Appendix E. Push in each one completely before adding the next ring. The quantity of packing rings required will vary due to tolerances; a good rule of thumb is to put in as many as are removed.
4. Insert thin packing box washer, packing spring and thicker washer into the top of the crosshead guide.
5. Install 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.
6. Oil piston rod and install the packing installation cone (part number 4005) over the threaded end of the piston rod.
7. Carefully slip the crosshead guide over the piston rod; otherwise, you may damage the lips of the packing rings.
8. Remove packing installation cone.
9. Install the crosshead guide O-ring, cylinder, piston and head.

Model 291 Compressor (serial number SS55685 and later)

Model 491 Compressor (serial number XC30633 and later)

(Refer to Appendix E for packing assembly details)

Disassembly of Packing

1. Depressurize and open the compressor.
2. Remove head, pistons and cylinder.
3. Remove cartridge holddown screw with special wrench supplied with the compressor and packing box cartridge.
4. Loosen adjusting screw and remove retainer ring, washers, packing spring and old packing from packing box cartridge.

Assembly of Packing

1. Clean, and then lightly oil, packing area inside packing box cartridge.
2. Slightly thread in adjusting screw.
3. Install packing rings including male and female packing rings, one at a time, as shown in Appendix E. Push in each one completely before adding the next ring. The quantity of packing rings required will vary due to tolerances; a good rule of thumb is to put in as many as are removed.
4. Insert thin packing box washer, packing spring and thicker washer.
5. Push down on washer and insert retainer ring.
6. Tighten adjusting screw until plastic locking device (part number 1192) engages the first thread in the packing box cartridge.
7. Lubricate piston rod and replace cartridge O-ring.

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

9. Carefully slip the packing cartridge over the piston rod; otherwise, you may damage the lips of the packing rings.

10. Remove packing installation cone.

11. Install and tighten cartridge holddown screw with special compressor wrench.

12. Install cylinder O-ring, cylinder, pistons, and head.

Model 691 Compressor

(Refer to Appendix E for packing assembly details)

Disassembly of Packing

1. Depressurize and open the compressor.

2. Remove head, pistons and cylinder.

3. Remove cartridge holddown screw with special wrench supplied with the compressor and packing box cartridge.

4. Loosen adjusting screw and remove retainer ring, washers, packing spring and old packing from packing box cartridge.

Assembly of Packing

1. Clean then lightly oil packing area inside packing box cartridge.

2. Thread in adjusting screw until locking device (part number 1192) is engaged into first thread of the packing cartridge.

3. Install packing rings, including male and female packing rings, one at a time, as shown in Appendix E. Push in each one completely before adding the next ring.

4. Insert a packing washer, packing spring, and another packing washer.

5. Push down on washer and insert retainer ring.

6. Oil piston rod and replace cartridge O-ring.

7. Install packing installation cone (part number 3905) over the threaded end of the piston rod.

8. Carefully slip the packing cartridge over the piston rod; otherwise, you may damage the lips of the packing rings.

9. Install and tighten cartridge holddown screw with special compressor wrench.

10. Replace cylinder O-ring, cylinder, pistons and head.

Model 891 Compressor

(Refer to Appendix E for packing assembly details)

Disassembly of Packing (D-Style)

1. Depressurize and open the compressor.

2. Remove the cylinder cap, heads, pistons and cylinder.

3. Remove the packing barrels by prying upwardly under each one and lifting entire packing barrel/cartridge assembly up from piston rod.

4. Remove the four socket head screws that hold the packing box cartridge to the barrel.

5. Remove segmented packing and cups from barrel.

6. Remove lower retainer ring, washers, packing spring and old V-ring packing from packing box cartridge.

Assembly of Packing (D-Style)

1. Replace packing as required. The segmented packing and cups are located in the packing barrel while the V-ring packing is located in the packing box cartridge. **NOTE: Always use new O-rings when replacing the packing.**

2. V-ring packing set:

   NOTE: The instructions below are for packing specification "J". Depending on the packing specification used in your compressor, the order of assembly for the packing rings, V-ring packing, washers and packing spring will vary. Refer to Appendix E to view the V-ring packing arrangements and follow the order of assembly and V-ring direction. If you do not know the packing arrangement used in your compressor, refer to the model number identification codes listed in Appendix A.

   a. Clean and lightly oil the packing area inside the packing box cartridge.

   b. Insert the oil deflector ring through the bottom opening of the packing box cartridge.

   c. Insert the first retainer ring followed by a washer.

   d. Insert the packing spring followed by another washer.

   e. Insert a male packing ring followed by four V-rings and one female packing ring. NOTE: Insert packing rings and V-rings one at a time. Refer to Appendix E for the proper direction of the male and female packing rings and V-rings.

   f. Lastly, insert the final washer. Push in on the washer and install the second retainer ring.

3. Segmented packing:

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

   a. Clean the segmented packing cups and the area inside the packing barrel.

   b. Insert the segmented packing cups, segmented packing pairs and backup rings one at a time in the order shown in Appendix E.

   c. Reattach the packing box cartridge to the packing barrel using the four socket head screws.

4. Install three O-rings on the packing barrel and packing box cartridge as shown in the D-Style Crosshead Guide Details in Appendix E.

5. Install packing installation cone (part number 3905) over the threaded end of the piston rod.

6. Carefully install barrel/cartridge assemblies over the piston rods, noting the alignment of the barrels as they sit on the crosshead guide. The valve scallops on the barrels must align properly with the valves in the cylinder.

7. Remove packing installation cone.

8. Replace pistons, cylinders, heads and cylinder cap. See details in Section 5.3 for proper assembly of pistons.

9. Rotate unit by hand to ensure proper assembly.

5.7 Bearing Replacement for Crankcase and Connecting Rod

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

2. Drain the crankcase and remove the inspection plate(s).

3. Before disassembly, choose and mark one connecting rod and the corresponding connecting rod cap. DO NOT MIX CONNECTING RODS AND CAPS. Loosen and remove the connecting rod bolts in order to remove the crosshead and connecting rod assembly.

5.7.1 Wrist Pin Bushing Replacement

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

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

3. Press out the old wrist pin bushing and press a new bushing into the connecting rod. 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 on the respective connecting rod assembly details. These pages are located in Appendix E. Over boring the bushing can lead to premature failure of the wrist pin bushing.

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

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

5.7.2 Replacing Connecting Rod Bearings

Connecting rod bearings are easily replaced by removing the semicircular bearings. Make sure the indentations in the connecting rod bearing and connecting rod line up when installing the new bearings. MAKE SURE THE ARROW AND/OR ALIGNMENT NOTCH ON CONNECTING ROD AND CAP ARE ALIGNED.

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

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

2. Press the new bearings into position and reassemble the crankshaft and bearing carrier to the crankcase. When reinstalling the bearing carrier, make sure the oil

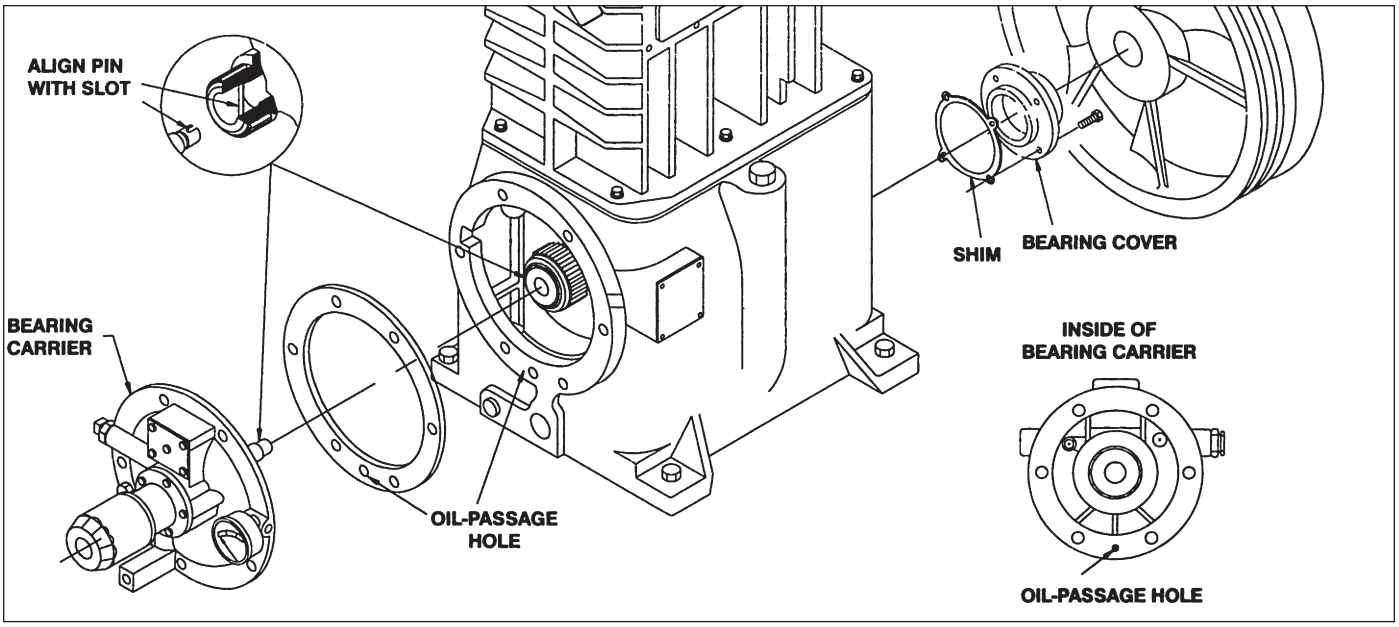


Figure 5.7.3: Bearing carrier replacement.

pump shaft slot is aligned with the pin in the crankshaft. Make sure to install the bearing carrier gasket so the oil passage hole is not blocked (see figure 5.7.3).

3. In order to check the crankshaft endplay, the oil pump must first be removed (see section 5.8).

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

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

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

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

5.8 Oil Pump Inspection

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

1. To check the oil pump, unbolt the pump cover and remove the oil pump, spring guide, spring, and oil pump shaft adapter as shown in figure 5.8.

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

3. Inspect the oil pump shaft bushing in the bearing carrier. If the bushing is corroded, pitted or worn, the oil pump shaft bushing should be replaced.

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

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

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

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

8. Install the pump cover so the pin on the case is in the opening on the oil pump assembly as shown in figure 5.8. When you are sure the pin is properly aligned, install the cover bolts finger tight.

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

10. Finally, tighten the bolts in an alternating sequence. See section 3.3 for directions on oil pressure adjustment.

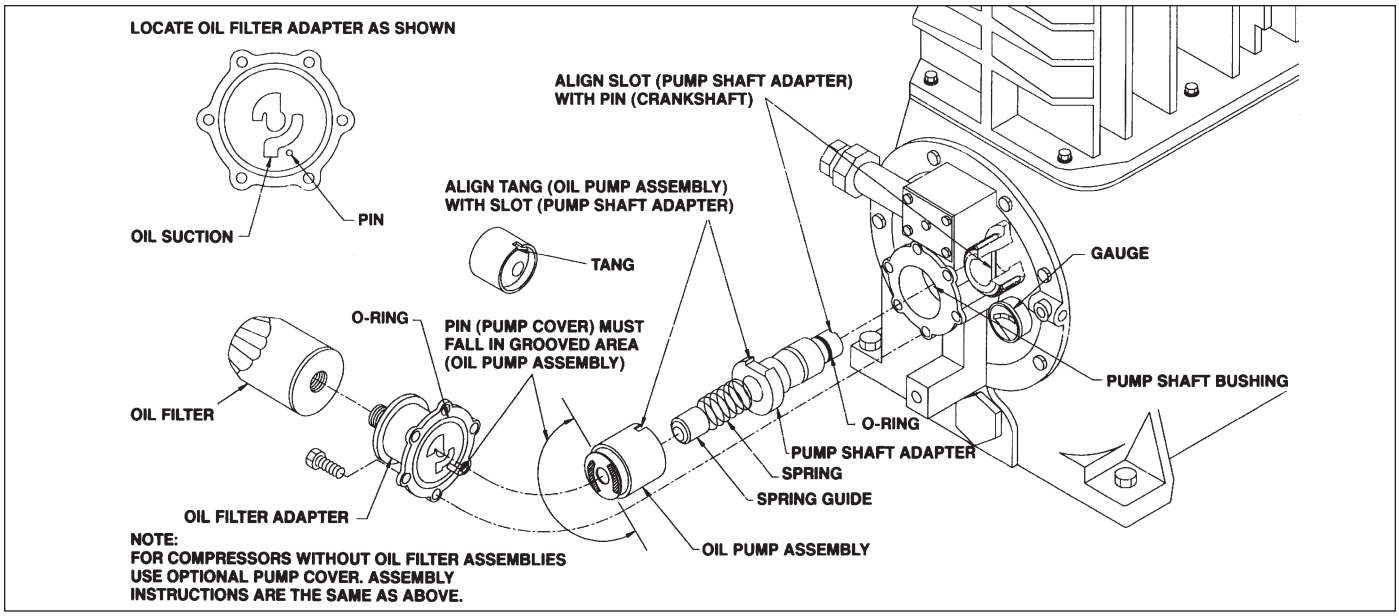


Figure 5.8

Chapter 6—Extended Storage Procedures

Following a few simple procedures will greatly minimize the risk of corrosion and damage. Corken recommends the following precautions to protect the compressor during storage:

1. Drain the crankcase oil and refill with rust inhibiting oil.
2. When a compressor is returned from long-term storage, the compressor's nameplate should be removed and the new oil poured over the crossheads to ensure good crosshead lubrication at startup.
3. Operate for a few minutes while fogging oil into the compressor suction.
4. Relieve V-belt tension.
5. Plug all openings to prevent entry of insects and moisture. (The cylinders may also be protected by the use of a vapor phase inhibitor, silica gel, or dry nitrogen gas. If the silica gel is used, hang a tag on the unit indicating that it must be removed before start-up.)
6. Store in a dry area, off the ground if possible.
7. Rotate the flywheel every two weeks if possible.
8. If possible, store compressor in a climate controlled area.

6.1 Repair Kits

Compressor Repair Kits[a]

Part Number	3549-X1	3550-X1	3551-X1	3552-X1	3552-X4	5578-X3A
Model Number	90J3, 91J3	290K3, 291M3	490K3, 491M3	690K3, 690P3	690M3, 691M3	891M3
Suction valve assembly	3483-1X	3483-1X (2)	2532-1X	3948-X (2)	3948-2X (2)	3856-2X (4)
Discharge valve assembly	3485-X	3485-X (2)	2439-X (2)	3857-X (2)	3857-2X (2)	3857-2X (4)
Connecting rod bearing (pair)	1367	1367 (2)	1491 (2)	1719 (2)	3542 (2)	3542 (2)
Packing set	1452-1X1	1452-1X1 (2)	1452-1X1 (2)	1725-2X (2)	1725-2X (2)	1725-2X, 3810-X1
Piston rings	1772 (3)	1772 (6)	1773 (6)	1739 (6)	1739 (6)	1739 (8)
Ring expanders	1775 (3)	1775 (6)	1776 (6)	1740 (6)	1740 (6)	1740 (8)
Gasket set[b]	2526-XA	1281-XA	1481-X6A	1744-X1A	1744-X1A	3970-X1A
O-ring[b]	—	—	—	—	2-261A (2)	—
O-ring[b]	—	—	2-242A (2)	—	—	—
O-ring[b]	—	—	2-253A (2)	—	—	—
Oil seal	3259	1278	1507 (490 only)	—	3526	3526
Oil seal	—	—	4438 (491 only)	—	—	—
Adapter plate gasket	—	—	1486 (2)	—	—	—
Oil deflector ring	—	—	—	—	—	1732 (2)

[a] *Quantities greater than one are shown in parenthesis.*
[b] *All repair kits are furnished with Buna-N O-rings which are suitable for LPG and NH_3 applications.*

6.2 Gasket Sets

Model 91 Gasket Set (2526-XA)

Part No.	Description	Qty
2-235A	O-ring (Buna-N)	2
2526	Crankcase gasket	1
2717	Valve gasket (aluminum)	2
2729	Crankcase inspection plate gasket	1
2-031A	O-ring (Buna-N)	2
2244	Inspection plate gasket	1
2716	Valve cap gasket (aluminum)	2
2725	Bearing carrier gasket	1

Model 291 Gasket Set (1281-XA)

Part No.	Description	Qty
1281	Filter screen screw gasket	1
1651	Inspection plate gasket	1
2-113A	O-ring (Buna-N)	2
2-228A	O-ring (Buna-N)	1
2702	Crankcase gasket	1
2716	Valve cap gasket (aluminum)	4
2732	Center headbolt gasket (steel)	2
1190	Adapter plate gasket	2
1285	Bearing carrier gasket	1
2-031A	O-ring (Buna-N)	4
2-135A	O-ring (Buna-N)	2
2-235A	O-ring (Buna-N)	4
2713	Crankcase inspection plate gasket	1
2717	Valve gasket (aluminum)	4
1276	Filter screen	1
2-011A	O-ring	1
2-111A	O-ring	1
2-112A	O-ring	2
2-116A	O-ring	1

Model 491 Gasket Set (1481-X6A)

Part No.	Description	Qty
1418	Valve gasket (aluminum)	4
1480	Center headbolt gasket (steel)	2
1488	Inspection plate gasket	1
1511	Crankcase inspection plate gasket	1
2-139A	O-ring (Buna-N)	2
2-228A	O-ring (Buna-N)	1
1281	Filter screen screw gasket	1
1478	Valve cap gasket (steel)	4
1481	Head gasket	1
1489	Crankcase gasket	1
1513	Bearing carrier gasket	1
2-143A	O-ring (Buna-N)	4
2-243A	O-ring (Buna-N)	2
1276	Filter screen	1
2-011A	O-ring	1
2-111A	O-ring	1
2-112A	O-ring	2
2-116A	O-ring	1

Model 691 Gasket Set (1744-X3A)

Part No.	Description	Qty
1760	Inspection plate gasket	1
2-031A	O-ring (Buna-N)	4
2-231A	O-ring (Buna-N)	2
2-235A	O-ring (Buna-N)	4
2-261A	O-ring (Buna-N)	2
2123	Crankcase inspection plate gasket	2
2131	Bearing carrier gasket	1
2716	Valve cap gasket (aluminum)	4
4127	Lubricator gasket	1
1281	Filter screen screw gasket	1
1761	Crankcase gasket	1
2-228A	O-ring (Buna-N)	1
2-233A	O-ring (Buna-N)	2
2-247A	O-ring (Buna-N)	2
2114	Valve gasket (aluminum)	4
2129	Oil inlet gasket	1
2177	Flange gasket	2
3874	Access cover gasket	2
1276	Filter screen	1
2-011A	O-ring	1
2-112A	O-ring	2
2-116A	O-ring	1
2-218A	O-ring	2

Model 891 Gasket Set (3970-X1A)

Part No.	Description	Qty
1281	Filter screen screw gasket	1
1761	Crankcase gasket	1
2-036A	O-ring (Buna-N)	8
2-231A	O-ring (Buna-N)	4
2-238A	O-ring (Buna-N)	2
2114	Valve gasket (aluminum)	8
2131	Bearing carrier gasket	1
4127	Lubricator gasket	1
1760	Inspection plate gasket	1
2-031A	O-ring (Buna-N)	8
2-228A	O-ring (Buna-N)	1
2-235A	O-ring (Buna-N)	8
2-246A	O-ring (Buna-N)	4
2123	Crankcase inspection plate gasket	1
3874	Access cover gasket	2
3906	Gasket spiral wound	2
1276	Filter screen	1
2-011A	O-ring	1
2-112A	O-ring	2
2-116A	O-ring	1
2-118A	O-ring	2

Appendix A—Model Number Identification Code and Available Options

Reciprocating Vertical Compressors (Plain Style) LPG and Anhydrous Ammonia Models

Plain Style (Single Packed)	**Base Model #**	**91**	**291**	**491**	**691**	
	Inlet	3/4" NPT	3/4" NPT	1-1/4" NPT	2" NPT	
	Outlet	3/4" NPT	3/4" NPT	1-1/4" NPT	1-1/2" NPT	
	Weight lbs. (kg)	145 (65.8)	190 (86.1)	300 (136.1)	670 (303.9)	

Plain Style (Single Packed)	**Base Model #**	**F91**	**F291**	**F491**	**F691**	
	Inlet	3/4" Class 300 RF	3/4" Class 300 RF	1-1/4" Class 300 RF	2" Class 300 RF	
	Outlet	3/4" Class 300 RF	3/4" Class 300 RF	1-1/4" Class 300 RF	2" Class 300 RF	
	Weight lbs. (kg)	145 (65.8)	190 (86.1)	300 (136.1)	670 (303.9)	

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

Specification Fields

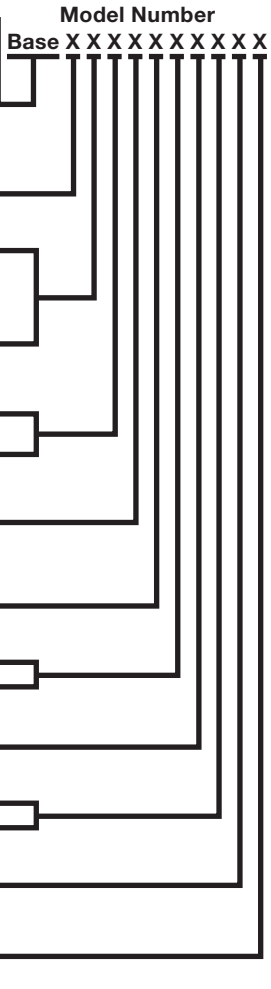
Packing Arrangement	Inlet pressure above atmospheric	Standard				A
Crankcase Style	Splash lubricated	Standard	NA	NA	NA	J
	Extended crankshaft	Optional	Optional	Optional	NA	E
	Pressure lubricated crankcase	NA	Standard	Standard	Standard	M
	Standard crankcase with heater	NA	Optional	Optional	Optional	MH
	Standard crankcase drilled for heater	NA	NA	NA	Optional	MR
Valves	Liquid relief suction valves	Standard			NA	3
		NA			Standard	3P
	Standard suction and discharge valve	Optional			NA	4
		NA			Optional	4P
Piston Ring and Packing Material	PTFE piston ring with PTFE packing material	Standard	Standard	Standard	NA	F
	PTFE piston ring with Alloy 50 packing material	NA	NA	NA	Standard	
Gasket Material	Aluminum gasket material	Standard				B
O-ring Material	Buna-N	Standard				A
	Neoprene®[1]	Optional				B
Intercooler	Not applicable—single stage	Standard				N
Flywheel	14" flywheel used in conjunction with extended crankshaft	NA	Optional	Optional	NA	E
	Heavy duty flywheel	Optional				H
	No flywheel supplied	No charge option				N
	Standard flywheel	Standard				S
Protective Coating	No coating	Standard				N
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

Reciprocating Vertical Compressors (D-Style) Double-acting, Single-stage Models

D-Style (Double Packed)	**Base Model #**	**D891**	**FD891**
	Inlet	2" weld	2" Class 300 RF
	Outlet	2" weld	2" Class 300 RF
	Weight lbs. (kg)	900 (408.2)	915 (415.0)



Specification Fields

Packing Arrangement	Packing arranged for padding of distance piece	Standard	J
Crankcase Style	Pressure lubricated crankcase	Standard	M
	Standard crankcase with heater	Optional	MH
	Standard crankcase drilled for heater	Optional	MR
Valves	Standard suction and discharge valves	Standard	4P
	Suction valve unloaders	Optional	9P
Piston Ring and Packing Material	PTFE piston ring with Alloy 50 packing material	Standard	F
Gasket Material	Aluminum gasket material	Standard	B
O-ring Material	Buna-N	Standard	A
	Neoprene®[1]	Optional	B
Intercooler Connections	No intercooler—not applicable on single stage compressors	Standard	N
Flywheel	No flywheel supplied	Optional	N
	Standard flywheel	Standard	S
Protective Coating	No coating	Standard	N
Piston Rod Coating	Nitrotec®[2] piston rod coating	Standard	N

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

Appendix B—Specifications for Vertical Single-Acting Models 91–691

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

Model	**91**	**291**	**491**	**691**
Bore of cylinder inches (mm)	3.0 (76.2)	3.0 (76.2)	4.0 (101.6)	4.5 (114.3)
Stroke inches (mm)	2.5 (63.5)	2.5 (63.5)	3.0 (76.2)	4.0 (101.6)
Piston displacement cfm (m^3/hr)				
minimum @ 400 RPM	4.1 (7.0)	8.2 (13.9)	17.5 (29.7)	29.5 (50.0)
maximum @ 825 RPM	8.4 (14.3)	16.9 (28.7)	36.0 (61.2)	60.7 (103.2)
Maximum working pressure psig (bar g)[1]	335 (23.1)			
Maximum brake horsepower (kW)	7.5 (5.6)	15 (11.2)	15 (11.2)	45 (33.6)
Maximum rod load lb (kg)	3,600 (1,632.9)	3,600 (1,632.9)	4,000 (1,814.4)	7,000 (3,175.1)
Maximum outlet temperature °F (°C)	350 (177)			
Maximum flow—propane gpm (m^3/hr)	50 (11.4)	101 (22.9)	215 (48.8)	361 (82.0)

[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 Vertical Single-Acting Models 91–691

Material Specifications

Part	Model	Standard Material
Head, Cylinder	All	Ductile iron ASTM A536
Crosshead guide crankcase, flywheel, bearing carrier	All	Gray iron ASTM A48, Class 30
Flange	691	Ductile iron ASTM A536
Valve seat and bumper	91, 291	17-4 PH stainless steel
	491	Ductile iron ASTM A536
	691	17-4 PH stainless steel
Valve plate	91, 291	410 stainless steel
	491	17-7 PH stainless steel
	691	PEEK
Valve spring	91, 291, 691	17-7 PH stainless steel
	491	Inconel
Valve gaskets	None	Soft aluminum
Piston	All	Gray iron ASTM A48, Class 30
Piston rod	None	1045 steel Nitrotec®[1] coated
Crosshead	All	Gray iron ASTM A48, Class 30
Piston rings	91, 291, 491	PTFE, glass and moly filled
	691	Alloy 50
Ring expanders	All	302 stainless steel
Packing cartridge, connecting rod	All	Ductile iron ASTM A536
Packing V-rings	91, 291, 491	PTFE, glass and moly filled
	691	Alloy 50
Crankshaft	All	Ductile iron ASTM A536
Connecting rod bearing	All	Bimetal D-2 babbit
Wrist pin	All	C1018 steel
Wrist pin busing	All	Bronze SAE J461
Main bearing	All	Tapered roller
Inspection plate	All	Aluminum
O-rings	All	Buna-N, Neoprene®[2] (optional)
Retainer rings	All	Steel
Misc. gaskets	All	Rubber compositions

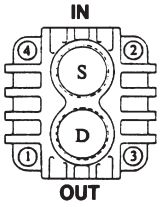
[1] Registered trademark of TTI Group Ltd.
[2] Registered trademark of the DuPont company.

Appendix B—Specifications for Vertical Single-Acting Models 91–891

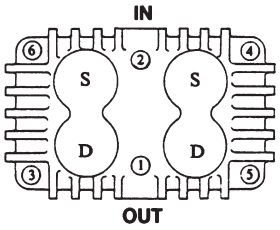
Bolt Torque Values (in ft•lb)

Model	91	291	491	691	891
Connecting rod bolt	28	28	30	40	40
Bearing carrier	38	30	26	40	40
Bearing cover	38	30	35	40	40
Crankcase inspection plate	15	13	8	9	9
Crosshead guide	30	25	33	40	65
Cylinder to head[1,2]	20	20	33	30	65
Valve cover plate bolt	—	—	35	37	37
Valve holddown screw[2]	40	40	40	40	40
Piston locknut	45	45	45	60	150
Piston screw	50	50	100	100	8
Valve cap with gaskets	40	40	40	40	—
Valve cap with O-rings	25	25	25	25	25

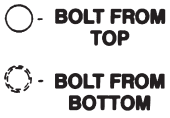
[1] Preliminary tightening – snug all head bolts in the sequence shown. Final torqueing – torque all head bolts in the sequence shown to the listed value.
[2] Retorque to the listed value after 1 hour running time.

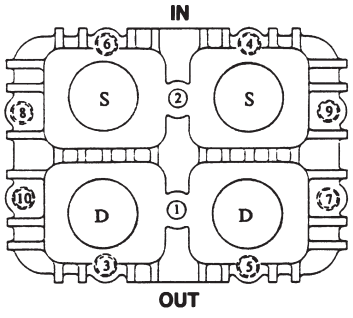


MODEL 91

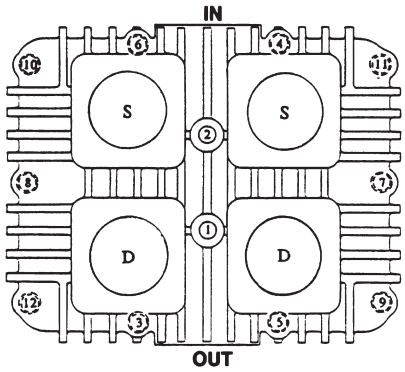


MODELS 290 AND 291

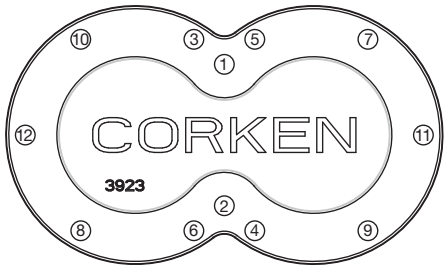




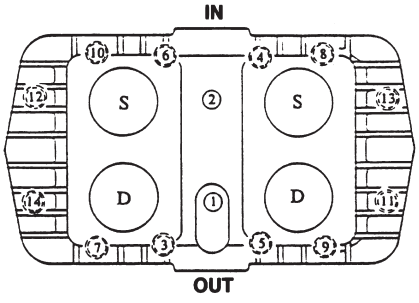
MODEL 490



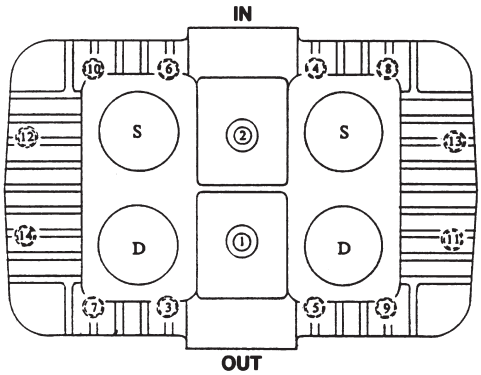
MODEL 690



MODEL 891



MODEL 491



MODEL 691

Appendix B—Specifications for Vertical Single and Double-Acting Models 91–891

Clearances and Dimensions for Single-Acting Models

Model	**91**	**291**	**490**	**491**	**691 (M crankcase)**
"X" piston clearance figure 5.4A and 5.4B[1]	0.020 0.044	0.020 0.044	0.000 0.024	0.020 0.044	0.025 0.040
Clearance from connecting rod bearing to crankshaft journal	0.001 0.0025	0.001 0.0025	0.001 0.0025		0.0019 0.0035
Clearance from wrist pin to wrist pin bushing[2]	0.0006 0.0011	0.0006 0.0011	0.0006 0.0011		0.0009 0.0015
Maximum cylinder bore diameter	3.009	3.009	4.011		4.515
Cylinder finish (RMS)	16–32	16–32	16–32		16–32
Minimum piston ring radial thickness	0.082	0.082	0.082		0.082
Maximum clearance from oil pump adapter shaft to bushing[2]	N/A	0.0050	0.0050		0.0050
Crankshaft end play	0.000 0.002	0.000 0.002	0.000 0.002		0.002 0.003
Maximum flywheel runout at O.D.	0.020	0.020	0.020		0.020
Maximum clearance from crosshead to crosshead guide bore	0.011	0.011	0.012		0.013
Crosshead guide bore finish	32 RMS (limited number of small pits and scratches are acceptable)				

Clearances and Dimensions for Double-Acting Models

Model	**891**
"X" piston clearance figure 5.4A and 5.4B[1]	0.010/0.020 (bottom) 0.084/0.104 (top)
Clearance from connecting rod bearing to crankshaft journal	0.0019 0.0035
Clearance from wrist pin to wrist pin bushing[2]	0.0009 0.0015
Maximum cylinder bore diameter	4.515
Cylinder finish (RMS)	16–32
Minimum piston ring radial thickness	0.082
Maximum clearance from oil pump adapter shaft to bushing[2]	0.0050
Crankshaft end play	0.002 0.003
Maximum flywheel runout at O.D.	0.020
Maximum clearance from crosshead to crosshead guide bore	0.008
Crosshead guide bore finish	32 RMS (limited number of small pits and scratches are acceptable)

[1] Clearances should be set with machine cold.
[2] Dimensions for honing are included with new bushings (which must be installed, then honed).

Appendix B—Specifications for Vertical Double-Acting Model D891/FD891

Equipment Type and Options

Double-acting, vertical, reciprocating piston type vapor compressor
Double packed rod
Slip-on weld connections or Class 300 RF flanges

Applications

Bulk transfer	LTVR and scavenger applications
Truck, tank, railcar, barge unloading	Emergency evacuation

Features and Benefits

Self-lubricating piston rings:	Non-lubricated operation to minimize oil in gas
Multiple materials and configurations:	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

Model	**D891/FD891**
Bore of cylinder inches (mm)	4.5 (114)
Stroke inches (mm)	4.0 (101.6)
Piston displacement cfm (m^3/hr)	
minimum @ 400 RPM	56.6 (96.2)
maximum @ 825 RPM	116.8 (198.4)
Maximum working pressure psig (bar g)	450 (31.0)
Maximum brake horsepower (kW)	45 (34)
Maximum rod load lb (kg)	7,000 (3,175.2)
Maximum outlet temperature °F (°C)	350 (177)
Maximum flow—propane gpm (m^3/hr)	694 (157.6)

[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 Vertical Double-Acting Model D891/FD891

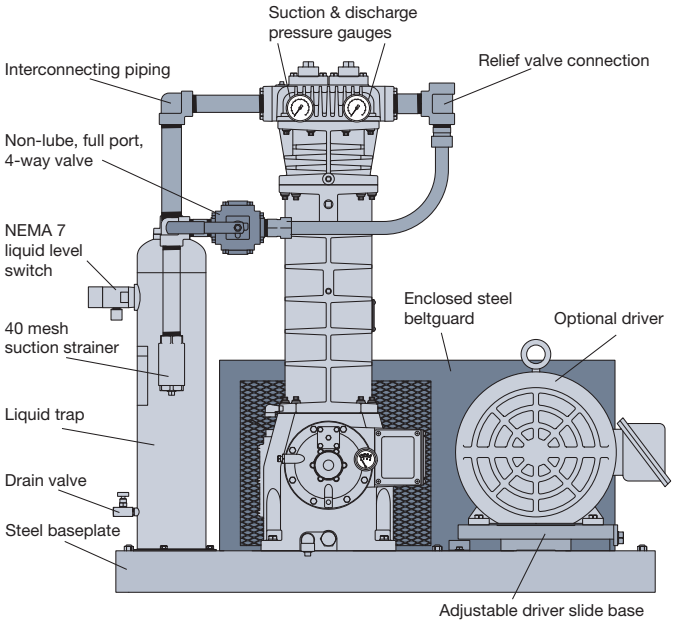
Material Specifications

Part	Standard Material
Head, cylinder, and cylinder cap	Ductile iron ASTM A536
Crosshead guide	Gray iron ASTM A48, Class 30
Crankcase, flywheel	Gray iron ASTM A48, Class 30
Bearing carrier	Gray iron ASTM A48, Class 30
Flange	ASTM A36 carbon steel (D891 only)
Valve seat, bumper	17-7 PH stainless steel
Valve plate	PEEK
Valve spring	17-7 PH stainless steel
Valve gaskets	Soft aluminum
Piston	Ductile iron ASTM A536
Piston rod	1045 steel, Nitrotec
Crosshead	Ductile iron ASTM A536
Piston rings	PTFE, glass and moly filled
Piston ring expanders	302 stainless steel
Packing cartridge and barrel	Ductile iron ASTM A536
Connecting rod	Ductile iron ASTM A536
Segmented packing	Carbon filled PTFE
V-ring packing	Alloy 50
Crankshaft	Ductile iron ASTM A536
Connecting rod bearing	Bimetal D-2 SAE 12
Wrist pin	C1018 steel or equivalent
Wrist pin bushing	Bronze SAE J461
Main bearing	Tapered roller
Inspection plate	Aluminum
O-rings	Buna-N or Neoprene®[1] (optional)
Retainer rings	Steel
Miscellaneous gaskets	Rubber compositions

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

Appendix C—Compressor Selection

Compressor Mounting Selections



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

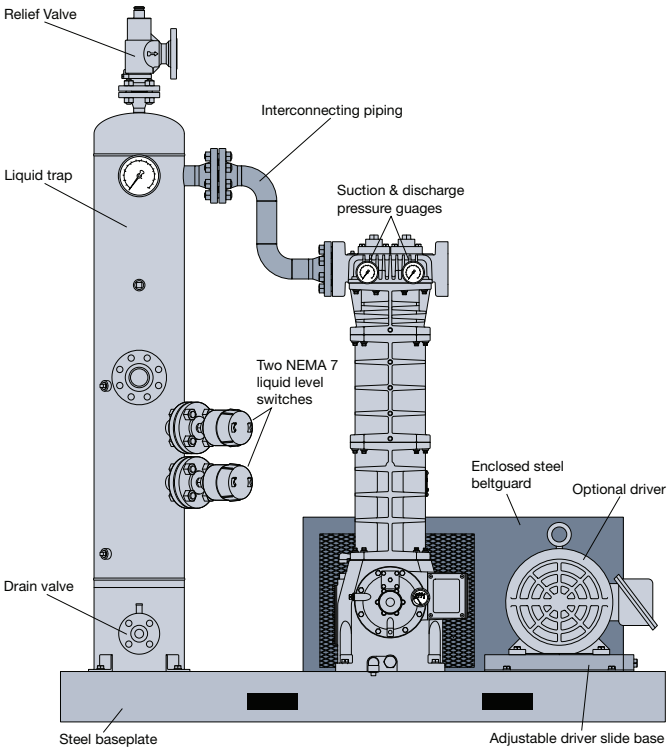
- Automatic liquid trap with two NEMA 7 liquid level switches

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 C—Compressor Selection

Butane Compressor Selection Table

Service	Capacity gpm[1]	Displacement cfm	Compressor		Driver Sheave Size Pitch Diameter (inches)[2]		Driver Horsepower				Piping Size[3]	
							Liquid Transfer With Residual Vapor Recovery		Liquid Transfer Without Residual Vapor Recovery			
			Model	RPM	1,750 RPM	1,450 RPM	100°F	80°F	100°F	80°F	Vapor	Liquid
Small bulk plants	13	4	91	400	A 3.0	B 3.6	3	3	3	3	3/4	1-1/4
	17	5	91	505	B 3.8	B 4.6	3	3	3	3	3/4	1-1/4
	20	6	91	590	B 4.6	B 5.6	3	3	3	3	1	1-1/4
	24	7	91	695	B 5.4	B 6.6	5	5	5	5	1	1-1/2
	23	7	291	345	A 3.0	A 3.6	2	2	2	2	1	1-1/2
Unloading single tank car or transport	27	8	91	800	B 6.2	B 7.4	5	5	5	5	1	1-1/2
	26	8	291	390	A 3.4	B 4.0	2	2	2	2	1	1-1/2
	30	9	291	435	A 3.8	B 4.6	3	3	3	3	1	1-1/2
	33	10	291	490	B 4.4	B 5.2	3	3	3	3	1	2
	36	11	291	535	B 4.8	B 5.8	3	3	3	3	1	2
	39	12	291	580	B 5.2	B 6.2	5	3	5	3	1	2
	42	13	291	625	B 5.6	B 6.6	5	5	5	5	1-1/4	2
	47	14	291	695	B 6.2	B 7.4	5	5	5	5	1-1/4	2
	50	15	291	735	B 6.6	B 8.0	5	5	5	5	1-1/4	2-1/2
	50	15	491	345	A 3.0	A 3.6	5	5	5	5	1-1/4	2-1/2
	53	16	291	780	B 7.0	B 8.6	7-1/2	5	7-1/2	5	1-1/4	2-1/2
	53	16	491	370	A 3.2	A 3.8	5	5	5	5	1-1/4	2-1/2
Unloading two or more tank cars at one time or large transport with excess flow valves of adequate capacity	56	17	491	390	A 3.4	B 4.0	5	5	5	5	1-1/4	3
	60	18	491	415	A 3.6	B 4.4	5	5	5	5	1-1/4	3
	63	19	491	435	A 3.8	B 4.6	5	5	5	5	1-1/4	3
	65	20	491	445	B 4.0	B 4.8	5	5	5	5	1-1/4	3
	68	21	491	470	B 4.2	B 5.0	5	5	5	5	1-1/4	3
	71	22	491	490	B 4.4	B 5.2	7-1/2	5	7-1/2	5	1-1/4	3
	75	23	491	515	B 4.6	B 5.6	7-1/2	5	7-1/2	5	1-1/4	3
	77	24	491	535	B 4.8	B 5.8	7-1/2	7-1/2	7-1/2	7-1/2	1-1/4	3
	81	25	491	560	B 5.0	B 6.0	7-1/2	7-1/2	7-1/2	7-1/2	1-1/4	3
	84	26	491	580	B 5.2	B 6.2	7-1/2	7-1/2	7-1/2	7-1/2	1-1/4	3
	87	27	491	605	B 5.4	B 6.4	7-1/2	7-1/2	7-1/2	7-1/2	1-1/4	3
	91	28	491	625	B 5.6	B 6.6	7-1/2	7-1/2	7-1/2	7-1/2	1-1/2	3
	94	29	491	650	B 5.8	B 7.0	10	7-1/2	10	7-1/2	1-1/2	3
	97	30	491	670	B 6.0		10	7-1/2	10	7-1/2	1-1/2	3
	94	30	691	400	B 4.4	B 5.2	7-1/2	7-1/2	7-1/2	7-1/2	1-1/2	3
	100	31	491	695	B 6.2	B 7.4	10	7-1/2	10	7-1/2	1-1/2	3
	98	31	691	420	B 4.6	B 5.6	10	7-1/2	10	7-1/2	1-1/2	3
	107	32	491	740	B 6.6	B 8.0	10	10	10	10	1-1/2	3
Unloading large tank cars, multiple vessels, barges or terminals	103	32	691	440	B 4.8	B 5.8	10	7-1/2	10	7-1/2	1-1/2	3
	110	33	491	760	B 6.8	B 8.0	10	10	10	10	1-1/2	3
	113	34	491	780	B 7.0	B 8.6	10	10	10	10	1-1/2	3
	107	34	691	455	B 5.0	B 6.0	10	10	10	10	1-1/2	3
	111	35	691	475	B 5.2	B 6.2	10	10	10	10	1-1/2	3
	119	36	491	825	B 7.4	B 8.6	15	10	15	10	1-1/2	3
	116	36	691	495	B 5.4	A 6.4	10	10	10	10	1-1/2	3
	120	38	691	510	B 5.6	B 6.8	10	10	10	10	1-1/2	4
	124	39	691	530	B 5.8	B 7.0	10	10	10	10	1-1/2	4
	129	41	691	550	B 6.0	A 7.0	10	10	10	10	1-1/2	4
	133	42	691	565	B 6.2	B 7.4	10	10	10	10	2	4
	137	43	691	585	B 6.4	A 7.4	10	10	10	10	2	4
	142	45	691	605	B 6.6	B 8.0	15	10	15	10	2	4
	145	46	691	620	B 6.8		15	10	15	10	2	4
	150	47	691	640	B 7.0	A 8.2	15	10	15	10	2	4
	158	48	691	675	B 7.4	B 8.6	15	15	15	15	2	4
	171	54	691	730	B 8.0	B 9.4	15	15	15	15	2	4
	184	58	691	785	B 8.6		15	15	15	15	2	4
	193	60	691	820	TB 9.0	A 10.6	15	15	15	15	2	4
	260	82.1	D/FD891	580	5V 7.1	5V 8.5	20	20	20	20	3	6
	359	113.3	D/FD891	800	5V 9.75	5V 11.8	25	25	25	25	3	6

[1] The capacities shown are based on 70°F, but will vary depending upon piping, fittings used, product being transferred and temperature. The factory can supply a detailed computer analysis if required.
[2] Driver sheaves: 91 - 2 belts; 291, 491 - 3 belts; 691 - 4 belts.
[3] The piping sizes shown are considered minimum. If the length exceeds 100 ft., use the next larger size.

Consult factory for compressors with higher flows.

Appendix C—Compressor Selection

Propane Compressor Selection Table

Service	Capacity gpm[1]	Displacement cfm	Compressor		Driver Sheave Size Pitch Diameter (inches)[2]		Driver Horsepower				Piping Size[3]	
							Liquid Transfer With Residual Vapor Recovery		Liquid Transfer Without Residual Vapor Recovery			
			Model	RPM	1,750 RPM	1,450 RPM	100°F	80°F	100°F	80°F	Vapor	Liquid
Small bulk plants	23	4	91	400	A 3.0	B 3.6	5	3	3	3	3/4	1-1/4
	29	5	91	505	B 3.8	B 4.6	5	5	5	5	3/4	1-1/4
	34	6	91	590	B 4.6	B 5.6	5	5	5	5	1	1-1/4
	40	7	91	695	B 5.4	B 6.6	5	5	5	5	1	1-1/2
	39	7	291	345	A 3.0	A 3.6	3	3	3	3	1	1-1/2
Unloading single tank car or transport	45	8	91	800	B 6.2	B 7.4	7-1/2	7-1/2	7-1/2	7-1/2	1	1-1/2
	44	8	291	390	A 3.4	B 4.0	5	3	3	3	1	1-1/2
	50	9	291	435	A 3.8	B 4.6	5	5	3	3	1	1-1/2
	56	10	291	490	B 4.4	B 5.2	5	5	5	5	1	2
	61	11	291	535	B 4.8	B 5.8	5	5	5	5	1	2
	66	12	291	580	B 5.2	B 6.2	7-1/2	5	5	5	1	2
	71	13	291	625	B 5.6	B 6.6	7-1/2	5	7-1/2	5	1-1/4	2
	79	14	291	695	B 6.2	B 7.4	7-1/2	7-1/2	7-1/2	7-1/2	1-1/4	2
	84	15	291	735	B 6.6	B 8.0	10	7-1/2	10	7-1/2	1-1/4	2-1/2
	84	15	491	345	A 3.0	A 3.6	7-1/2	7-1/2	5	5	1-1/4	2-1/2
	89	16	291	780	B 7.0	B 8.6	10	10	10	10	1-1/4	2-1/2
	89	16	491	370	A 3.2	A 3.8	7-1/2	7-1/2	7-1/2	5	1-1/4	2-1/2
Unloading two or more tank cars at one time or large transport with excess flow valves of adequate capacity	95	17	491	390	A 3.4	B 4.0	7-1/2	7-1/2	7-1/2	7-1/2	1-1/4	3
	101	18	491	415	A 3.6	B 4.4	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	106	19	491	435	A 3.8	B 4.6	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	108	20	491	445	B 4.0	B 4.8	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	114	21	491	470	B 4.2	B 5.0	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	119	22	491	490	B 4.4	B 5.2	10	10	7-1/2	7-1/2	1-1/4	3
	125	23	491	515	B 4.6	B 5.6	10	10	10	7-1/2	1-1/4	3
	130	24	491	535	B 4.8	B 5.8	15	10	10	10	1-1/4	3
	136	25	491	560	B 5.0	B 6.0	15	10	10	10	1-1/4	3
	141	26	491	580	B 5.2	B 6.2	15	10	10	10	1-1/4	3
	147	27	491	605	B 5.4	B 6.4	15	10	15	10	1-1/4	3
	152	28	491	625	B 5.6	B 6.6	15	15	15	15	1-1/2	3
	158	29	491	650	B 5.8	B 7.0	15	15	15	15	1-1/2	3
	163	30	491	670	B 6.0		15	15	15	15	1-1/2	3
	163	30	691	400	B 4.4	B 5.2	15	15	10	10	1-1/2	3
	168	31	491	695	B 6.2	B 7.4	15	15	15	15	1-1/2	3
	171	31	691	420	B 4.6	B 5.6	15	15	10	10	1-1/2	3
	179	32	491	740	B 6.6	B 8.0	15	15	15	15	1-1/2	3
	178	32	691	440	B 4.8	B 5.8	15	15	10	10	1-1/2	3
	186	34	691	455	B 5.0	B 6.0	15	15	15	10	1-1/2	3
	193	35	691	475	B 5.2	B 6.2	15	15	15	10	1-1/2	3
	200	36	691	495	B 5.4	B 6.4	15	15	15	15	1-1/2	3
Unloading large tank cars, multiple vessels, barges or terminals	208	38	691	510	B 5.6	B 6.8	20	15	15	15	1-1/2	4
	215	39	691	530	B 5.8	B 7.0	20	15	15	15	1-1/2	4
	223	41	691	550	B 6.0	A 7.0	20	15	15	15	1-1/2	4
	230	42	691	565	B 6.2	B 7.4	20	15	15	15	2	4
	237	43	691	585	B 6.4	A 7.4	20	15	15	15	2	4
	245	45	691	605	B 6.6	B 8.0	20	15	15	15	2	4
	252	46	691	620	B 6.8		20	20	15	15	2	4
	260	47	691	640	B 7.0	A 8.2	20	20	20	15	2	4
	275	48	691	675	B 7.4	B 8.6	25	20	20	20	2	4
	297	54	691	730	B 8.0	B 9.4	25	20	20	20	2	4
	319	58	691	785	B 8.6		25	20	25	20	2	4
	334	60	691	820	TB 9.0	A 10.6	30	25	25	20	2	4
	452	82	D/FD891	580	5V 7.1	5V 8.5	30	30	30	30	3	6
	623	113	D/FD891	800	5V 9.75	5V 11.8		40	40	30	3	6

[1] The capacities shown are based on 70°F, but will vary depending upon piping, fittings used, product being transferred and temperature. The factory can supply a detailed computer analysis if required.
[2] Driver sheaves: 91 - 2 belts; 291, 491 - 3 belts; 691 - 4 belts.
[3] The piping sizes shown are considered minimum. If the length exceeds 100 ft., use the next larger size.

Consult factory for compressors with higher flows.

Appendix C—Compressor Selection

Ammonia Compressor Selection Table

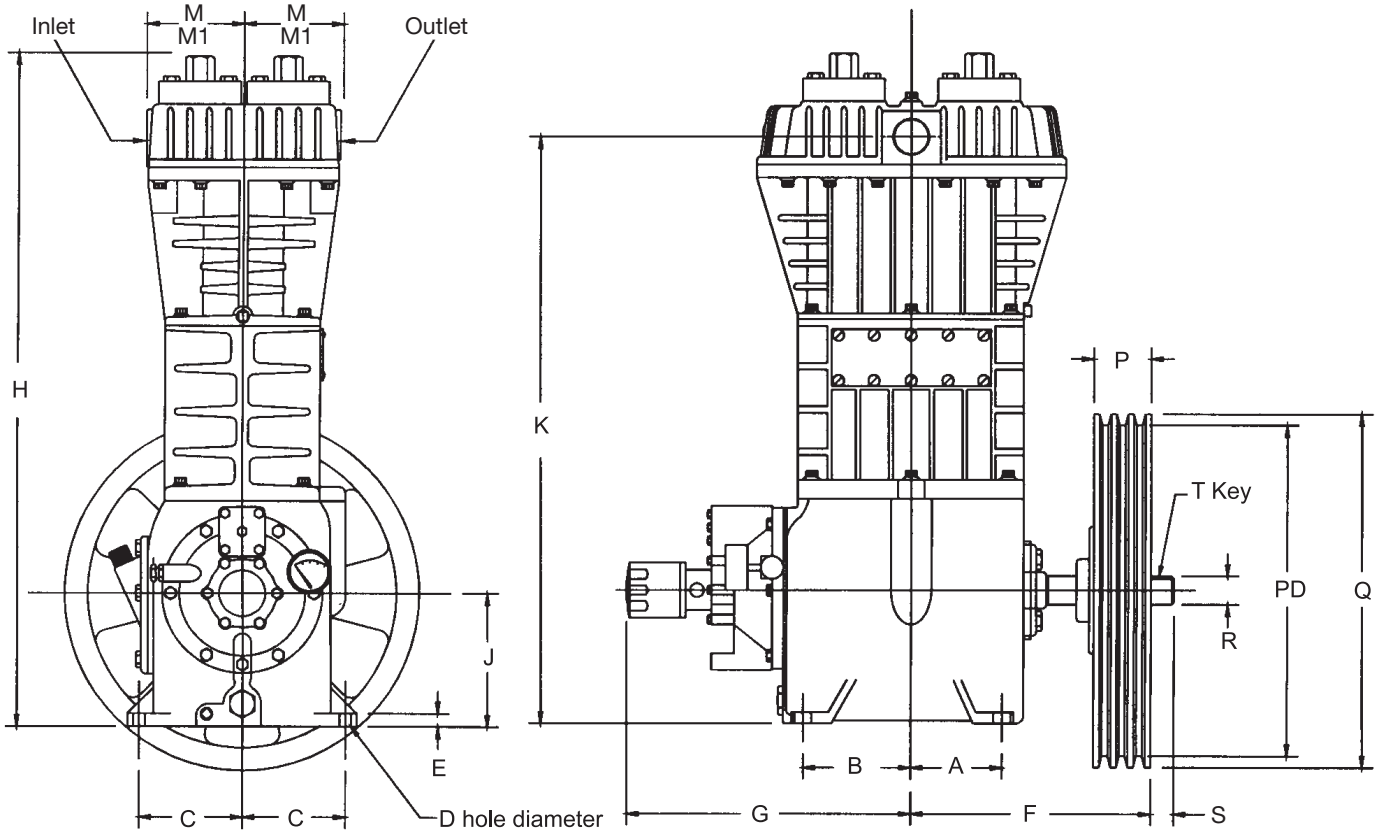
Service	Capacity gpm[1]	Displacement cfm	Compressor		Driver Sheave Size Pitch Diameter (inches)[2]		Driver Horsepower				Piping Size[3]	
							Liquid Transfer With Residual Vapor Recovery		Liquid Transfer Without Residual Vapor Recovery			
			Model	RPM	1,750 RPM	1,450 RPM	100°F	80°F	100°F	80°F	Vapor	Liquid
Small bulk plants	23	4	91	400	A 3.0	B 3.6	5	3	3	3	3/4	1-1/4
	29	5	91	505	B 3.8	B 4.6	5	5	5	3	3/4	1-1/4
	34	6	91	590	B 4.6	B 5.6	5	5	5	5	1	1-1/4
	40	7	91	695	B 5.4	B 6.6	5	5	5	5	1	1-1/2
	43	7	291	345	A 3.0	A 3.6	5	3	3	3	1	1-1/2
Unloading single tank car or transport	46	8	91	800	B 6.2	B 7.4	7-1/2	5	5	5	1	1-1/2
	45	8	291	390	A 3.4	B 4.0	5	3	3	3	1	1-1/2
	50	9	291	435	A 3.8	B 4.6	5	5	3	3	1	1-1/2
	56	10	291	490	B 4.4	B 5.2	5	5	5	3	1	2
	62	11	291	535	B 4.8	B 5.8	7-1/2	5	5	5	1	2
	67	12	291	580	B 5.2	B 6.2	7-1/2	5	5	5	1	2
	72	13	291	625	B 5.6	B 6.6	7-1/2	5	5	5	1-1/4	2
	80	14	291	695	B 6.2	B 7.4	7-1/2	7-1/2	7-1/2	5	1-1/4	2
	85	15	291	735	B 6.6	B 8.0	10	7-1/2	7-1/2	7-1/2	1-1/4	2-1/2
	85	15	491	345	A 3.0	A 3.6	7-1/2	7-1/2	5	5	1-1/4	2-1/2
	90	16	291	780	B 7.0	B 8.6	10	7-1/2	7-1/2	7-1/2	1-1/4	2-1/2
	90	16	491	370	A 3.2	A 3.8	10	7-1/2	5	5	1-1/4	2-1/2
Unloading two or more tank cars at one time or large transport with excess flow valves of adequate capacity	96	17	491	390	A 3.4	B 4.0	10	7-1/2	5	5	1-1/4	3
	102	18	491	415	A 3.6	B 4.4	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	107	19	491	435	A 3.8	B 4.6	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	110	20	491	445	B 4.0	B 4.8	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	115	21	491	470	B 4.2	B 5.0	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	120	22	491	490	B 4.4	B 5.2	15	10	7-1/2	7-1/2	1-1/4	3
	126	23	491	515	B 4.6	B 5.6	15	10	7-1/2	7-1/2	1-1/4	3
	131	24	491	535	B 4.8	B 5.8	15	10	10	7-1/2	1-1/4	3
	138	25	491	560	B 5.0	B 6.0	15	10	10	7-1/2	1-1/4	3
	142	26	491	580	B 5.2	B 6.2	15	10	10	7-1/2	1-1/4	3
	148	27	491	605	B 5.4	B 6.4	15	10	10	10	1-1/4	3
	153	28	491	625	B 5.6	B 6.6	15	10	10	10	1-1/2	3
	160	29	491	650	B 5.8	B 7.0	15	15	10	10	1-1/2	3
	165	30	491	670	B 6.0		15	15	15	10	1-1/2	3
	165	30	691	400	B 4.4	B 5.2	15	15	10	10	1-1/2	3
	170	31	491	695	B 6.2	B 7.4	15	15	15	10	1-1/2	3
	173	31	691	420	B 4.6	B 5.6	15	15	10	10	1-1/2	3
	181	32	491	740	B 6.6	B 8.0	15	15	15	15	1-1/2	3
	180	32	691	440	B 4.8	B 5.8	15	15	10	10	1-1/2	3
	188	34	691	455	B 5.0	B 6.0	20	15	10	10	1-1/2	3
	195	35	691	475	B 5.2	B 6.2	20	15	10	10	1-1/2	3
	203	36	691	495	B 5.4	B 6.4	20	15	15	10	1-1/2	3
Unloading large tank cars, multiple vessels, barges or terminals	211	38	691	510	B 5.6	B 6.8	20	15	15	10	1-1/2	4
	218	39	691	530	B 5.8	B 7.0	20	15	15	15	1-1/2	4
	226	41	691	550	B 6.0	A 7.0	20	15	15	15	1-1/2	4
	233	42	691	565	B 6.2	B 7.4	20	15	15	15	2	4
	240	43	691	585	B 6.4	A 7.4	20	20	15	15	2	4
	248	45	691	605	B 6.6	B 8.0	20	20	15	15	2	4
	255	45	691	620	B 6.8		25	20	15	15	2	4
	263	47	691	640	B 7.0	A 8.2	25	20	15	15	2	4
	278	48	691	675	B 7.4	B 8.6	25	20	15	15	2	4
	301	54	691	730	B 8.0	B 9.4	25	20	20	15	2	4
	323	58	691	785	B 8.6		30	25	20	20	2	4
	338	60	691	820	TB 9.0	A 10.6	30	25	20	20	2	4
	459	82	D/FD891	580	5V 7.1	5V 8.5	40	30	30	30	3	6
	633	113	D/FD891	800	5V 9.75	5V 11.8		40	40	30	3	6

[1] The capacities shown are based on 70°F, but will vary depending upon piping, fittings used, product being transferred and temperature. The factory can supply a detailed computer analysis if required.
[2] Driver sheaves: 91 - 2 belts; 291, 491 - 3 belts; 691 - 4 belts.
[3] The piping sizes shown are considered minimum. If the length exceeds 100 ft., use the next larger size.

Consult factory for compressors with higher flows.

Appendix D—Outline Dimensions

Models 91–691 and F91–F691 Bare with Flywheel



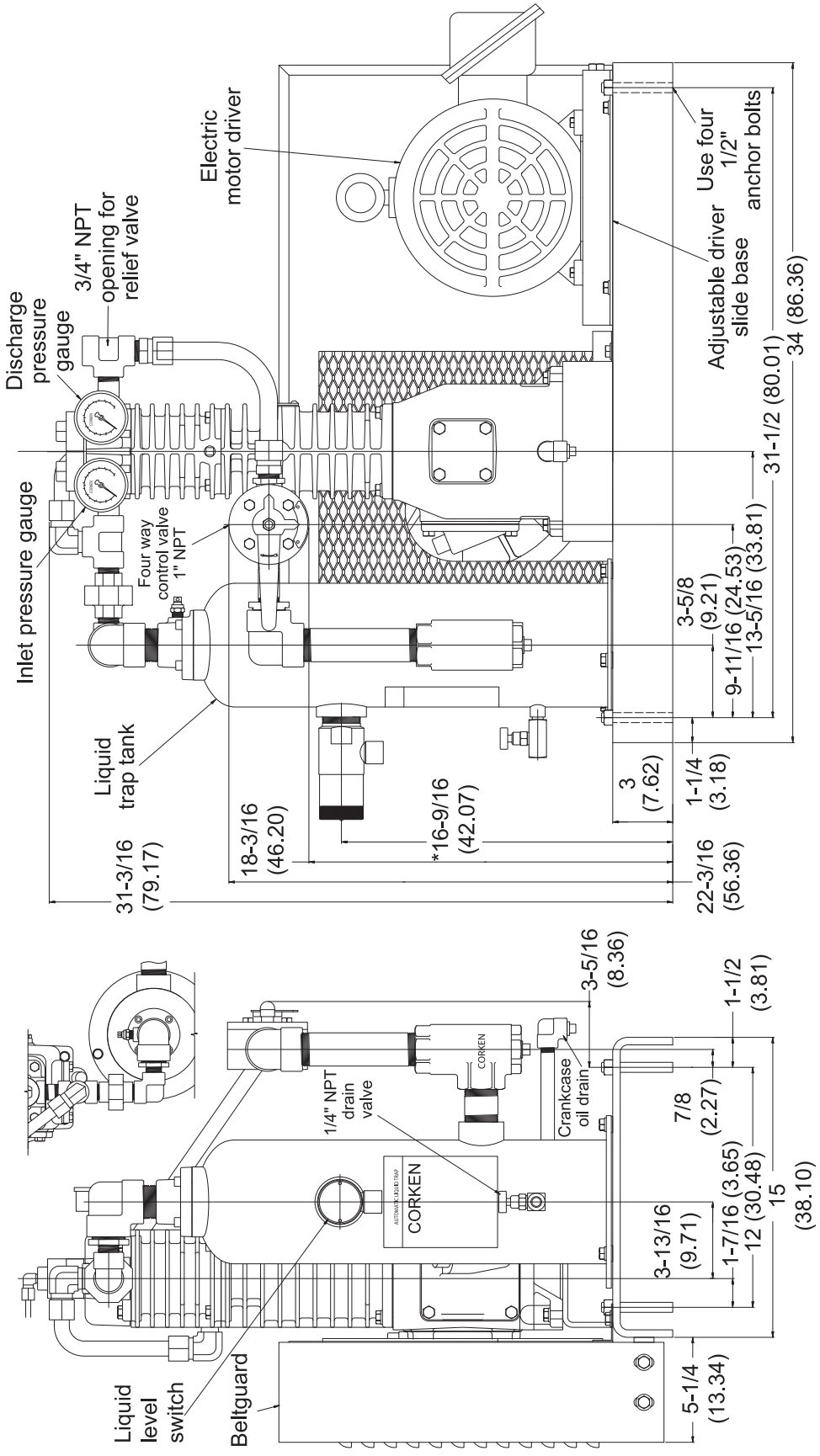
Model	A	B	C	D	E	F	G	H	J	K
91, F91	1-13/16 (46.0)	2-3/8 (60.3)	3-11/16 (93.7)	13/32 (10.3)	5/8 (15.9)	6-1/4 (158.8)	3-7/8 (98.4)	25-5/16 (642.9)	5 (127.0)	22-11/16 (576.3)
291, F291	3-3/8 (85.7)	4-1/8 (104.8)	3-11/16 (93.7)	7/16 (11.1)	25/32 (19.8)	9-13/16 (249.2)	12-1/16 (306.4)	25-11/16 (652.5)	5-3/8 (136.5)	23-3/8 (593.7)
491, F491	4-1/8 (104.8)	5 (127.0)	4-11/16 (119.1)	1/2 (12.7)	11/16 (17.5)	10-11/16 (271.5)	13-3/16 (335.0)	29-5/8 (752.5)	5-7/8 (149.2)	26-3/16 (665.2)
691, F691	4-3/4 (120.7)	5-1/2 (139.7)	5-3/8 (136.5)	9/16 (14.3)	1 (25.4)	14-1/2 (368.3)	14-3/8 (365.1)	39-1/8 (993.8)	8-1/4 (209.6)	35-1/16 (890.6)

Model	M*	M1**	P	Q	R	S***	T	A-belt	Groove	B-belt	Groove
91, F91	2-3/8 (60.3)	4-1/4 (108.0)	3 (76.2)	14 (355.6)	1-1/8 (28.6)	1-1/4 (31.8)	1/4 (6.4)	13.2 (335.3)	2	13.6 (345.4)	2
291, F291	2-5/8 (66.7)	4-1/4 (108.0)	3 (76.2)	16 (406.4)	1-1/4 (31.8)	1-1/4 (31.8)	1/4 (6.4)	15.2 (386.1)	3	15.6 (396.2)	3
				141 (3,581.4)				13.21 (335.5)	2	13.61 (345.7)	2
491, F491	3-7/8 (98.4)	5-5/8 (142.9)	3 (76.2)	16 (406.4)	1-3/8 (34.9)	1-1/4 (31.8)	5/16 (7.9)	15.2 (386.1)	3	15.6 (396.2)	3
				141 (3,581.4)				13.21 (335.5)	2	13.61 (345.7)	2
691, F691	6-5/16 (160.3)	6-15/16 (176.2)	3-13/16 (96.8)	19-1/2 (495.3)	2-1/8 (54.0)	—	1/2 (12.7)	—	—	19-1/8 (485.8)	4

All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

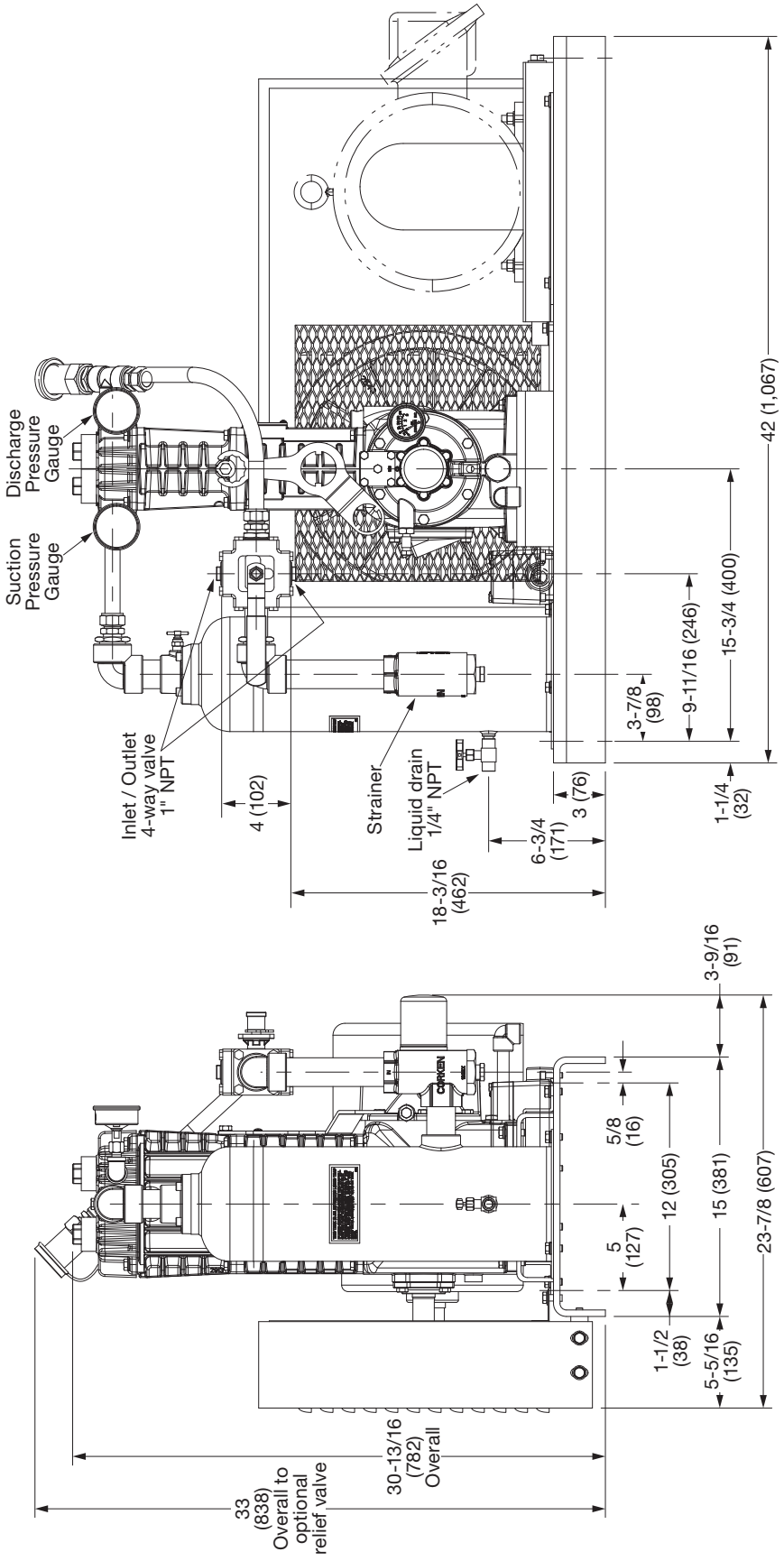
Models 91 with -107 or -107A Mounting (Model -107A Shown Below)



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

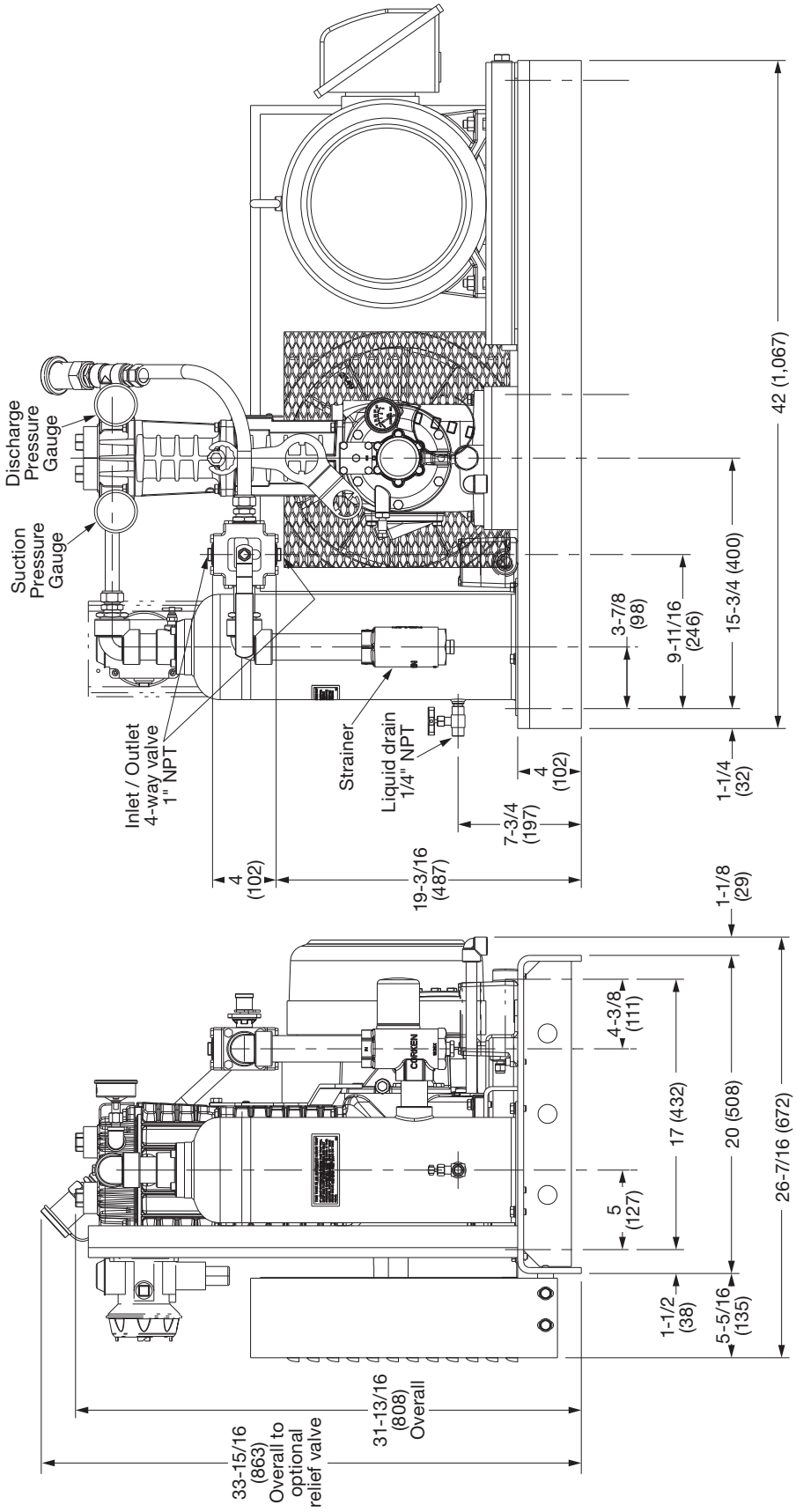
Model 291 with 107 Mounting (Motor Frames Up to 215T)



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

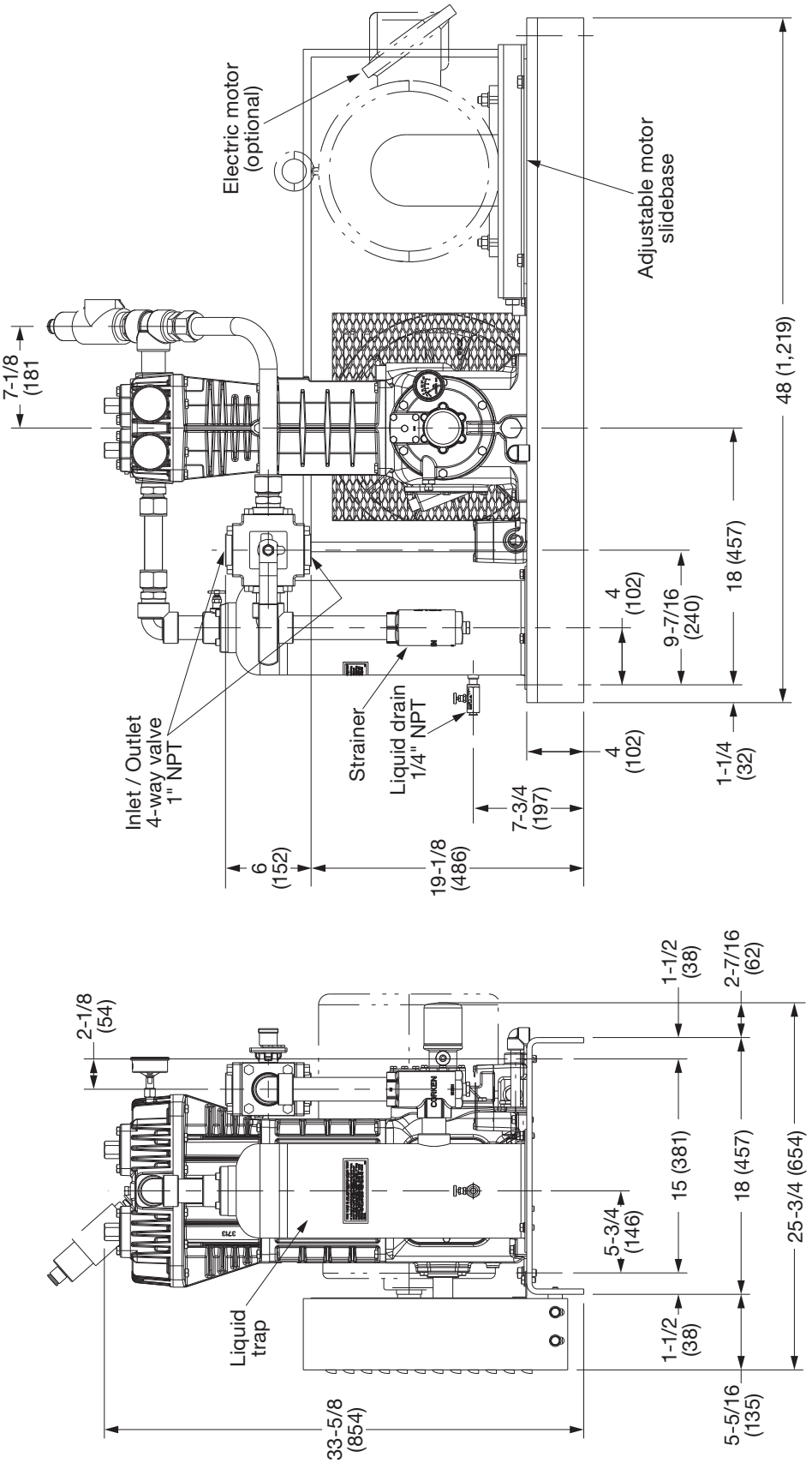
Model 291 with 107 Mounting (Motor Frames 254T and Up)



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

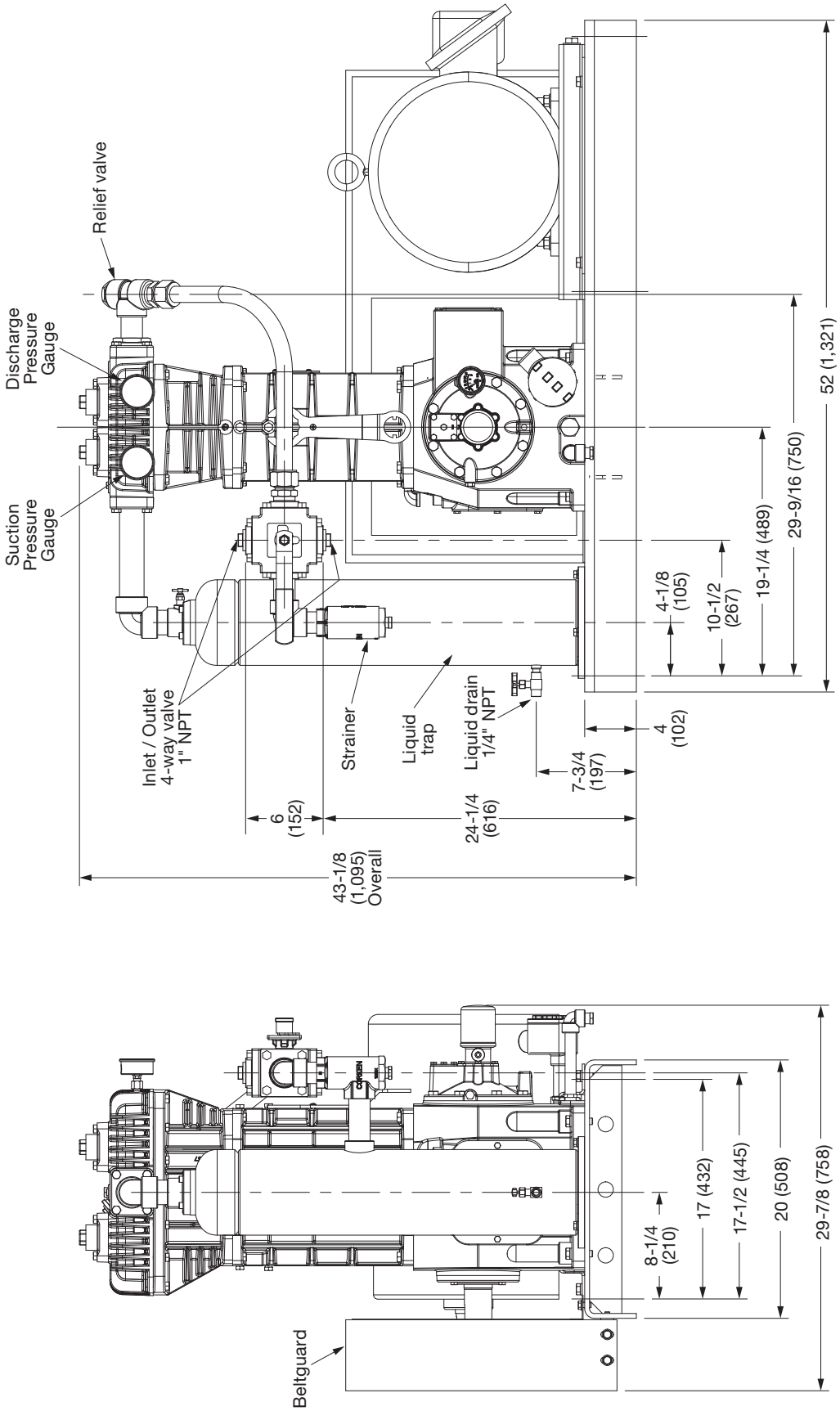
Model 491 with 107 Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

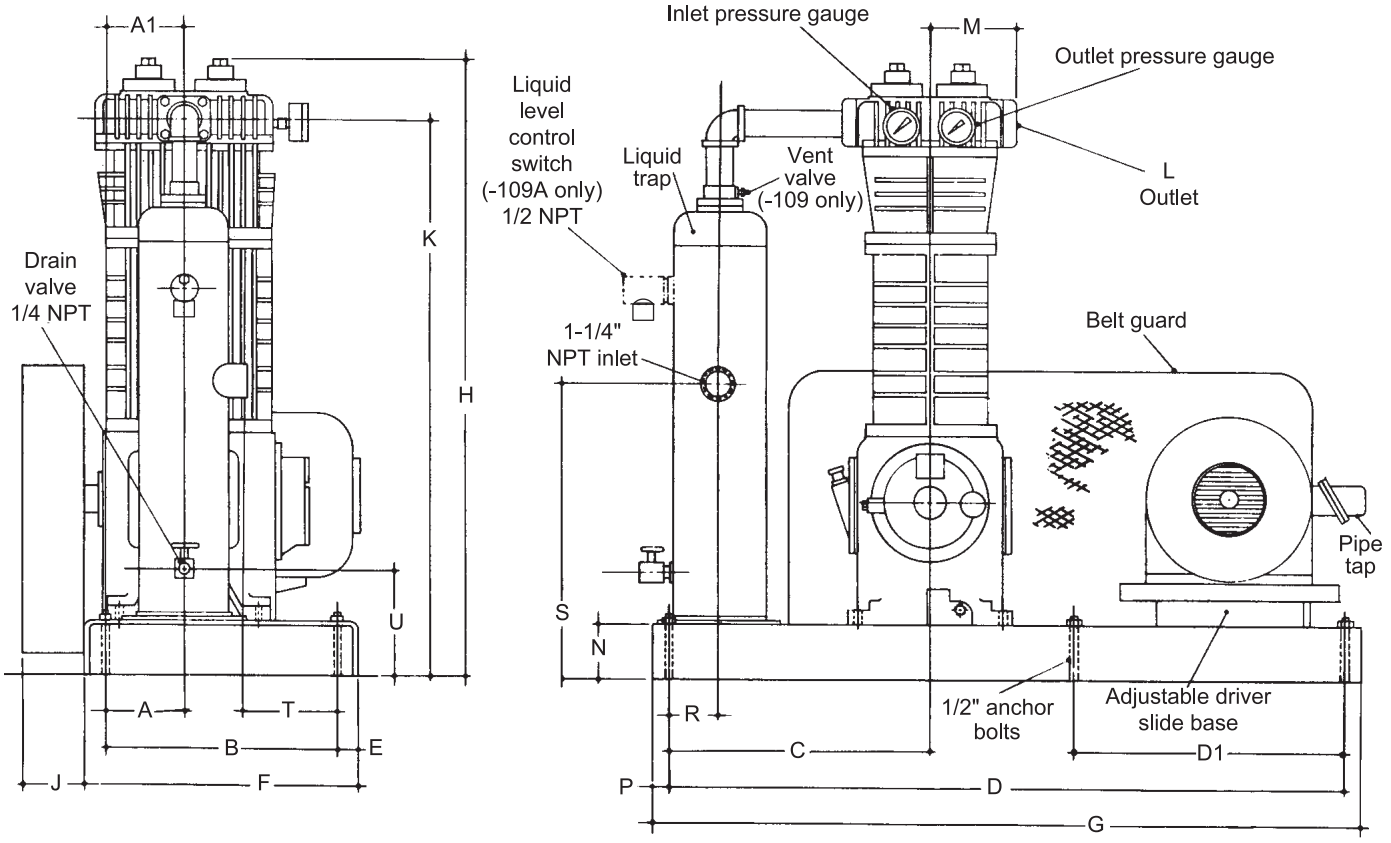
Model 691 with 107 Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

Models 91–691 with -109 or -109A Mounting (Model -109A Shown Below)



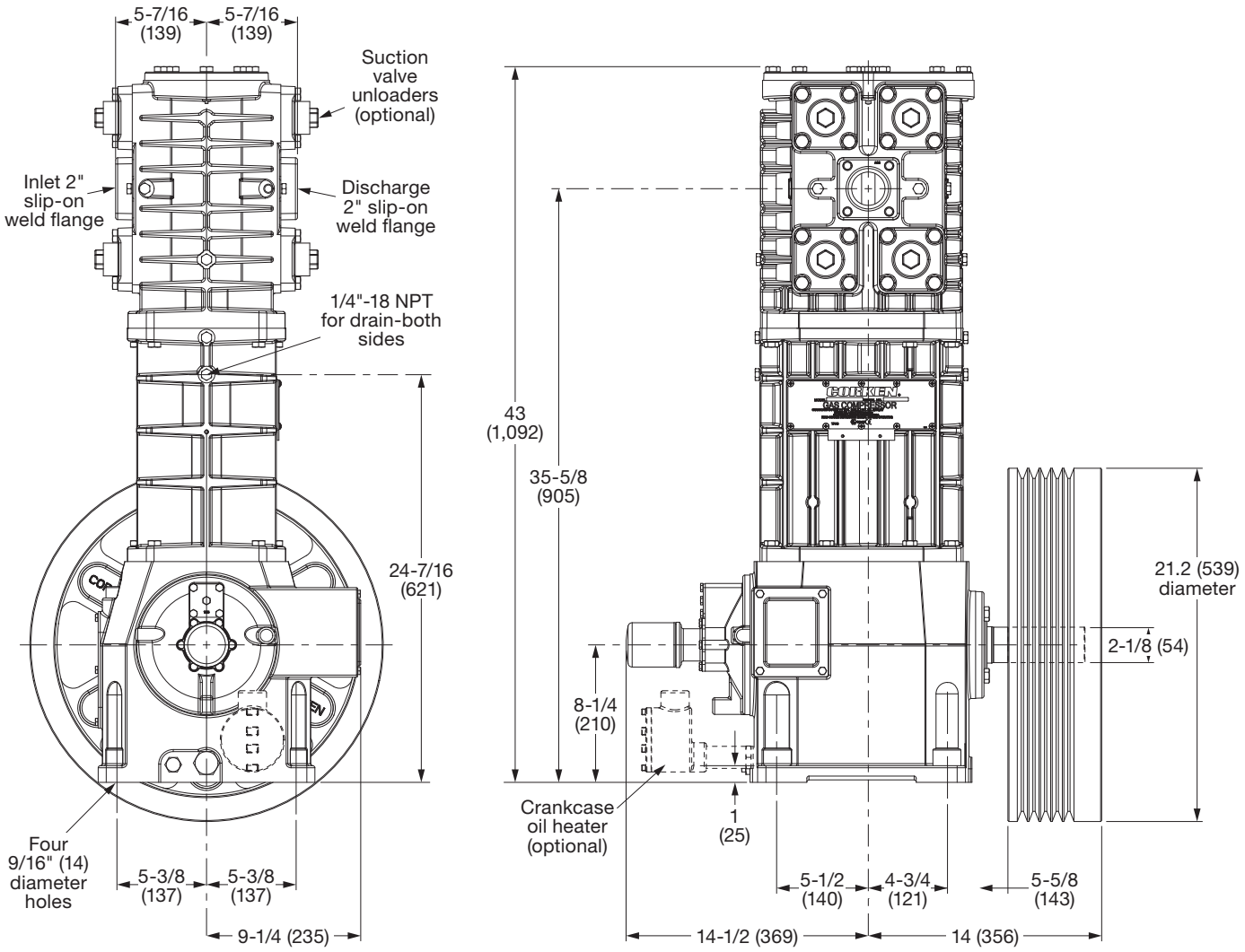
Model	A	A1	B	C	D	D1	E	F	G	H
91-109, -109A	1-3/16 (30.2)	5-1/4 (133.4)	12 (304.8)	13-5/16 (338.1)	31-1/2 (800.1)	—	1-1/2 (38.1)	15 (381.0)	34 (863.6)	31-3/16 (792.2)
291-109, -109A	5 (127.0)	—	12 (304.8)	15-3/4 (400.1)	39-1/2 (1,003.3)	—	1-1/2 (38.1)	15 (381.0)	42 (1,066.8)	30-7/8 (784.2)
491-109, -109A	5-3/4 (146.1)	—	15 (381.0)	18 (457.2)	45-1/2 (1,155.7)	—	1-1/2 (38.1)	18 (457.2)	48 (1,219.2)	33-5/8 (854.1)
691-109, -109A	8-1/4 (209.6)	—	17 (431.8)	19-1/4 (489.0)	49-1/2 (1,257.3)	19-3/4 (501.7)	1-1/2 (38.1)	20 (508.0)	52 (1,320.8)	43-1/8 (1,095.4)

Model	J	K	L	M	N	P	R	S	T	U
91-109, -109A	5-1/4 (133.4)	28-3/16 (716.0)	3/4" NPT	2-5/16 (58.7)	3 (76.2)	1-1/4 (31.8)	3-5/8 (92.1)	9-1/2 (241.3)	2-3/4 (69.9)	6-3/4 (171.5)
291-109, -109A	5-1/4 (133.4)	28-1/2 (723.9)	3/4" NPT	2-11/16 (68.3)	3 (76.2)	1-1/4 (31.8)	3-7/8 (98.4)	9-1/2 (241.3)	4-1/2 (114.3)	6-3/4 (171.5)
491-109, -109A	5-1/4 (133.4)	30-1/8 (766.8)	1-1/4" NPT	4 (101.6)	4 (101.6)	1-1/4 (31.8)	4-1/16 (103.2)	10-7/8 (276.2)	5.25 (133.4)	8-1/8 (206.4)
691-109, -109A	5-5/8 (142.9)	39-1/8 (993.8)	1-1/2" NPT	6-3/8 (161.9)	4 (101.6)	1-1/4 (31.8)	4-9/16 (115.9)	21-7/16 (544.5)	4-3/4 (120.7)	7-3/4 (196.9)

All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

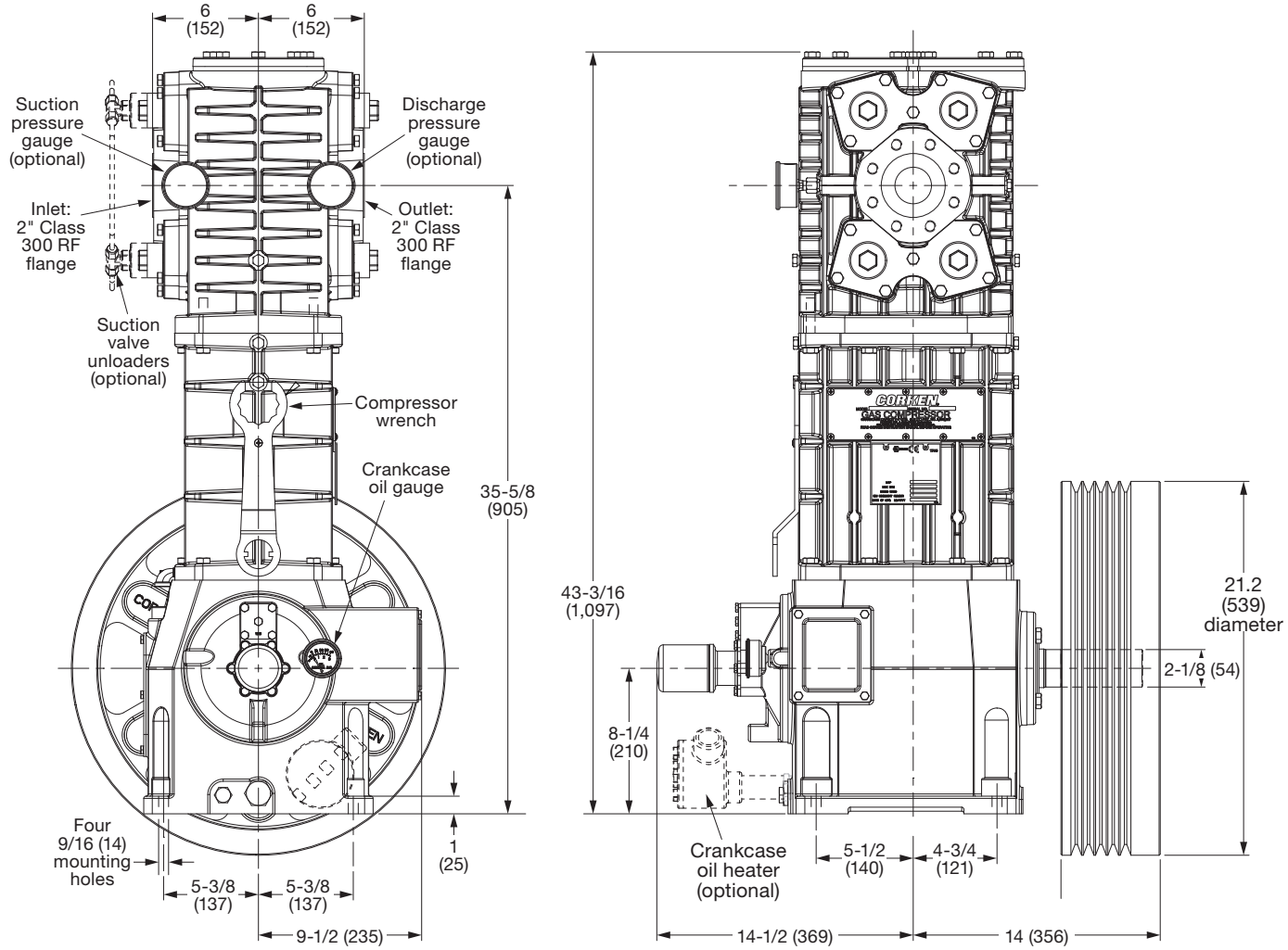
Model D891 Bare with Flywheel



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

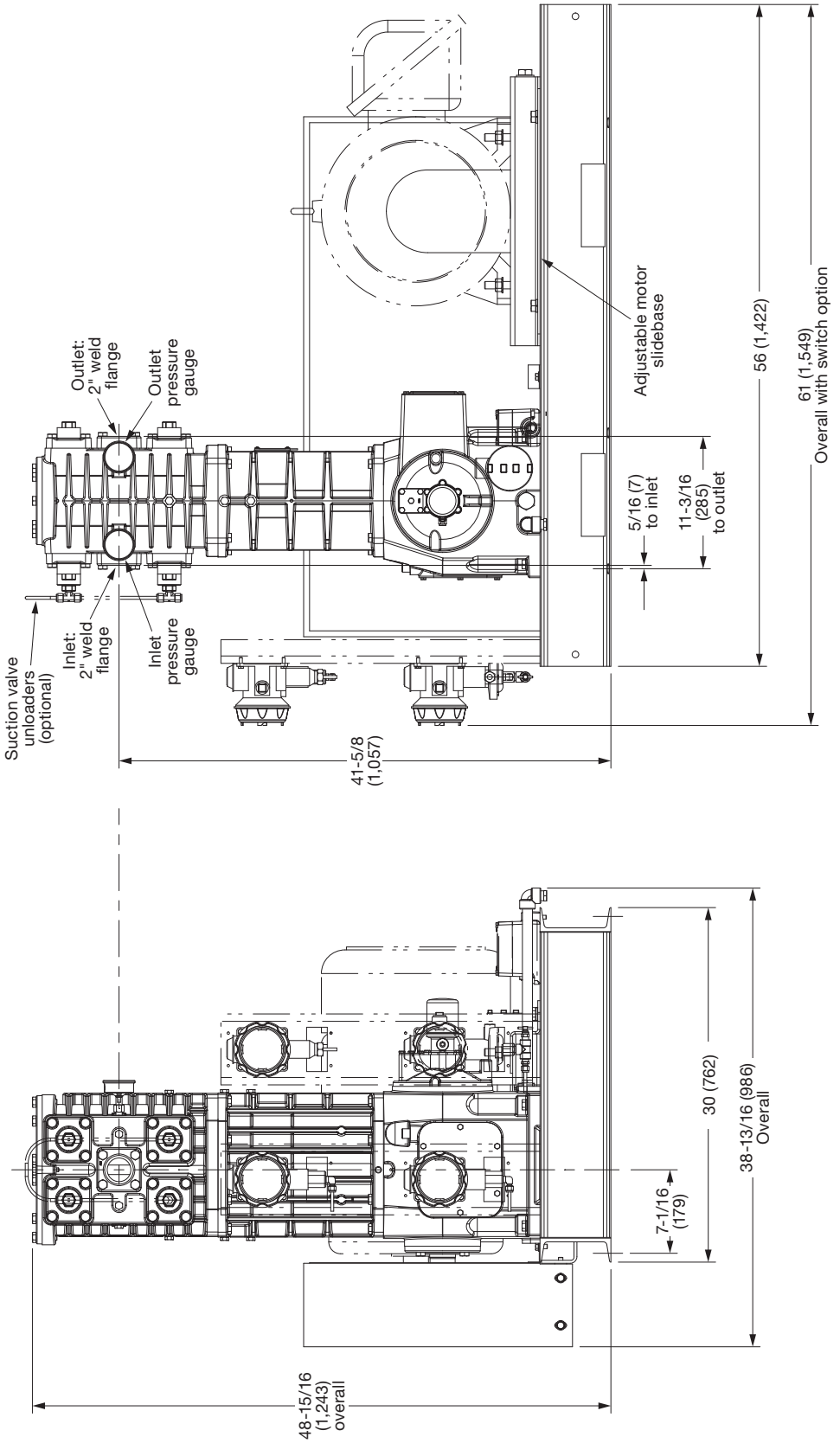
Model FD891 Bare with Flywheel



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

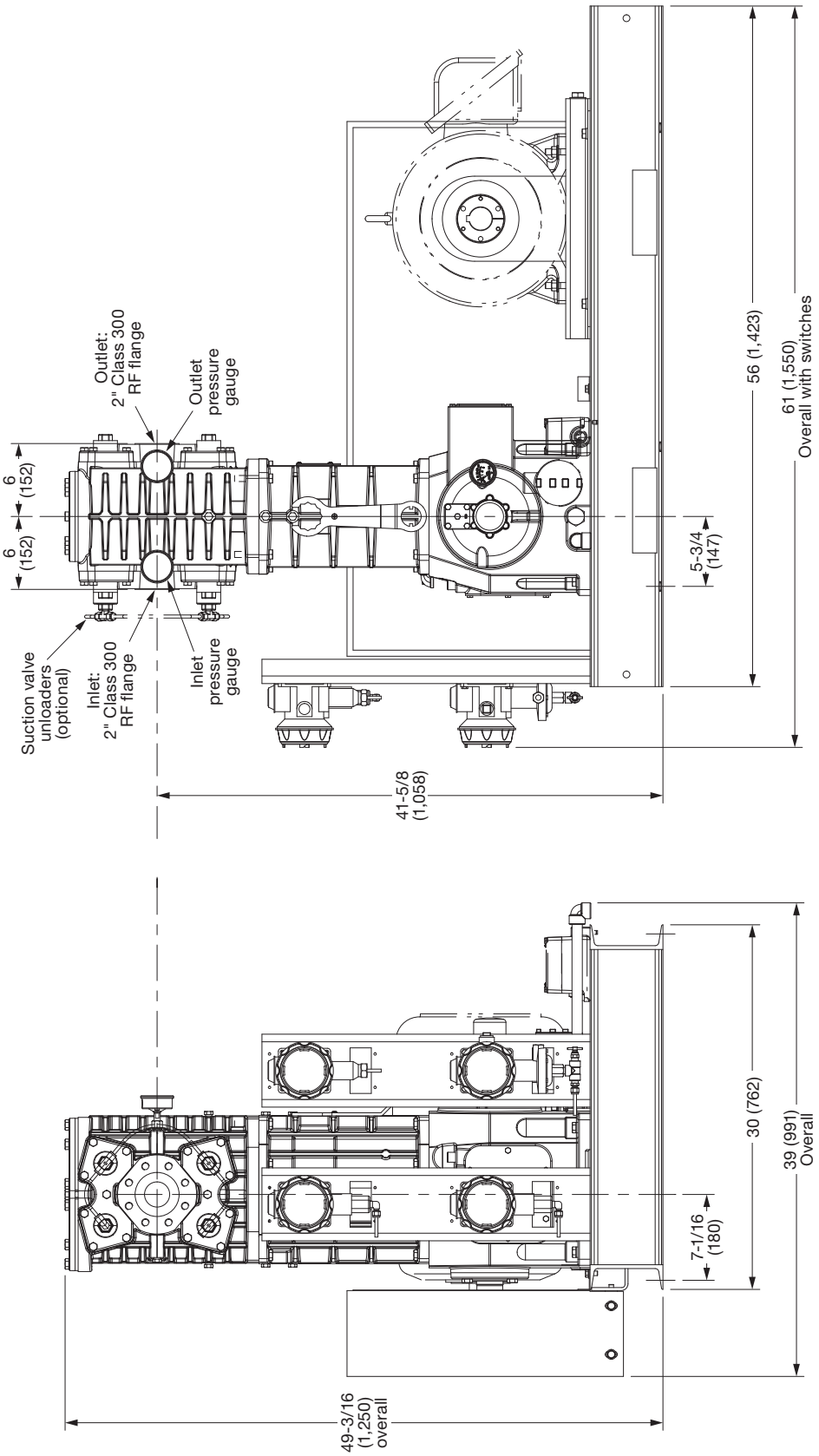
Model D891 with 103 Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

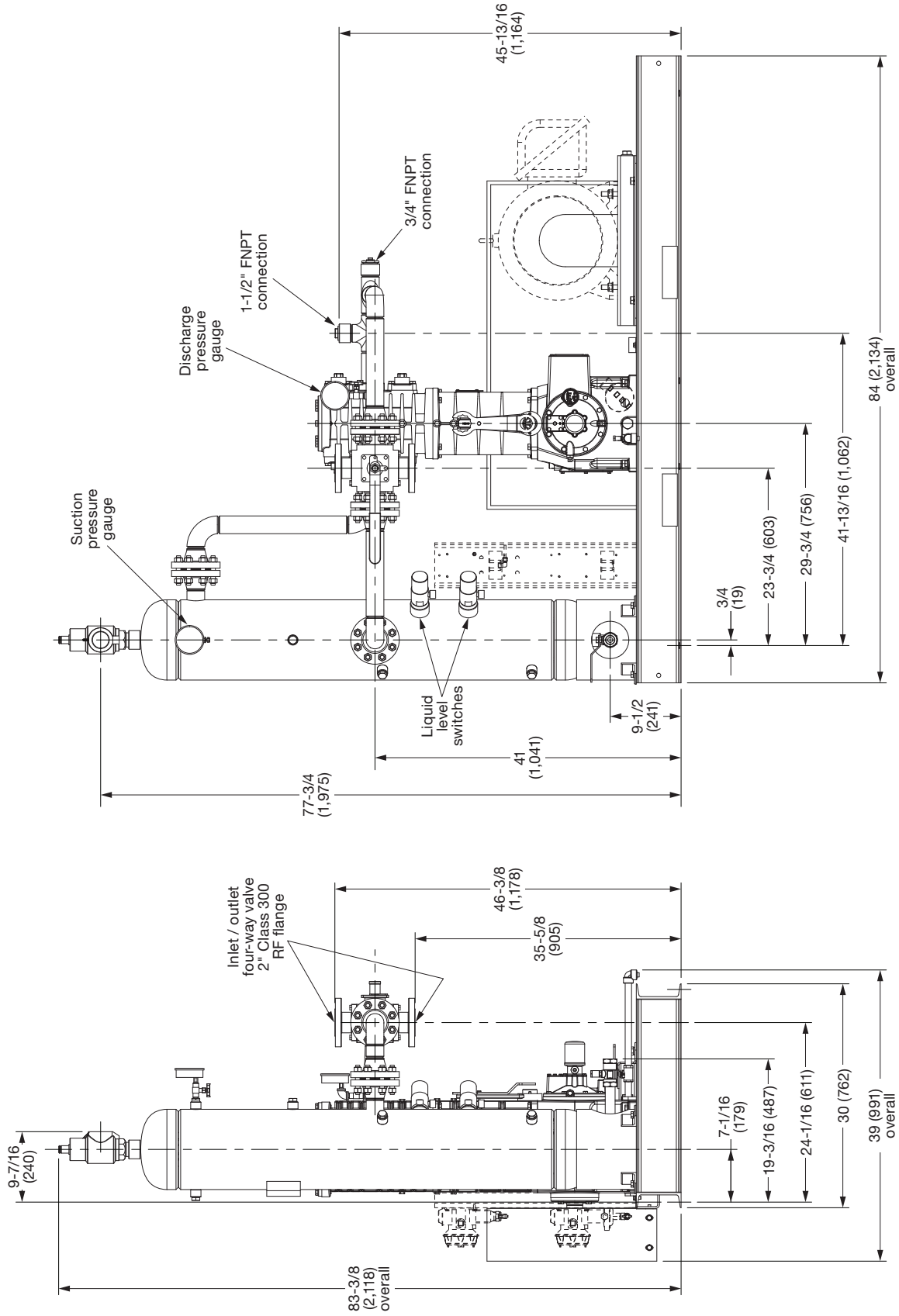
Model FD891 with 103 Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

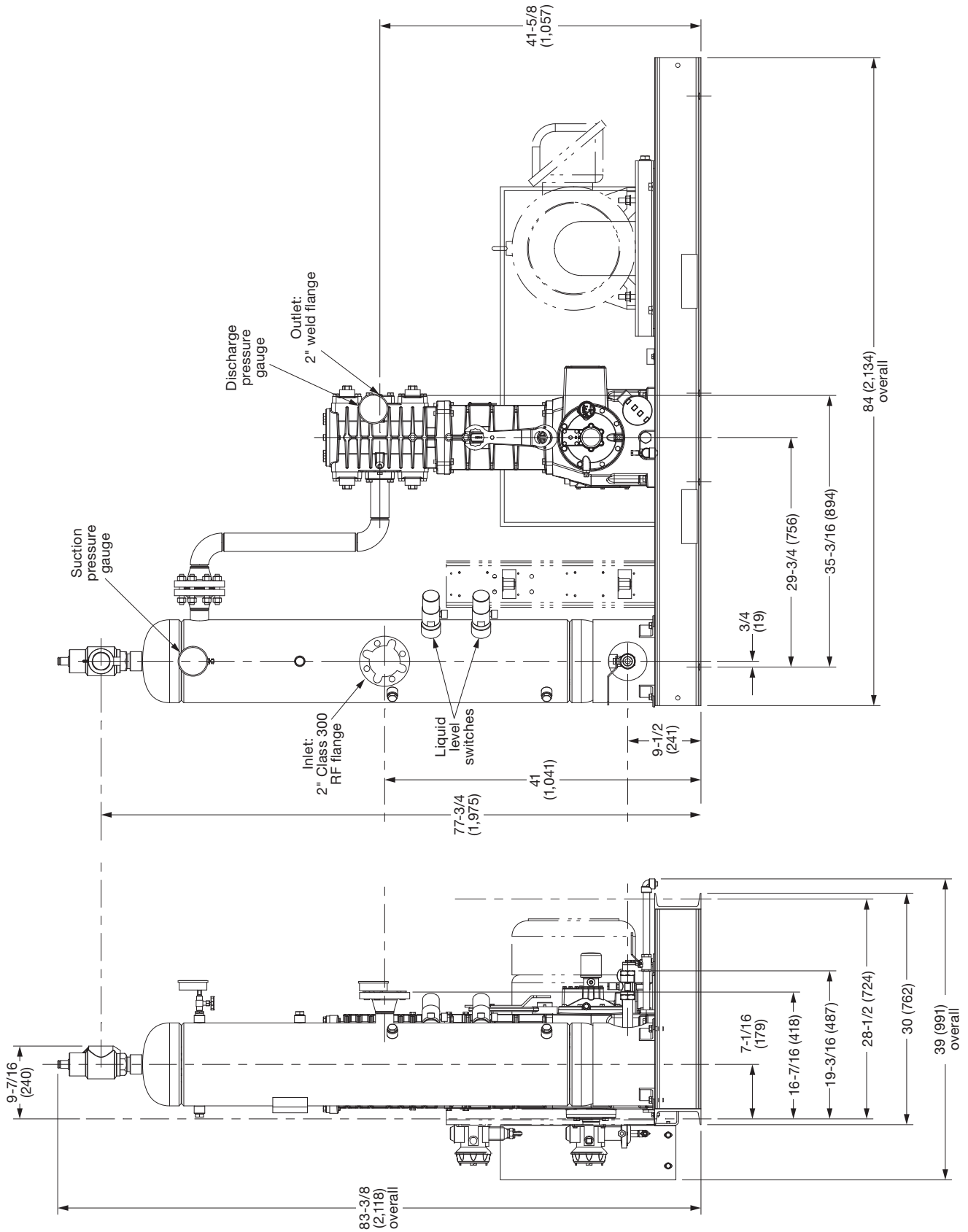
Model FD891 with 107 Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

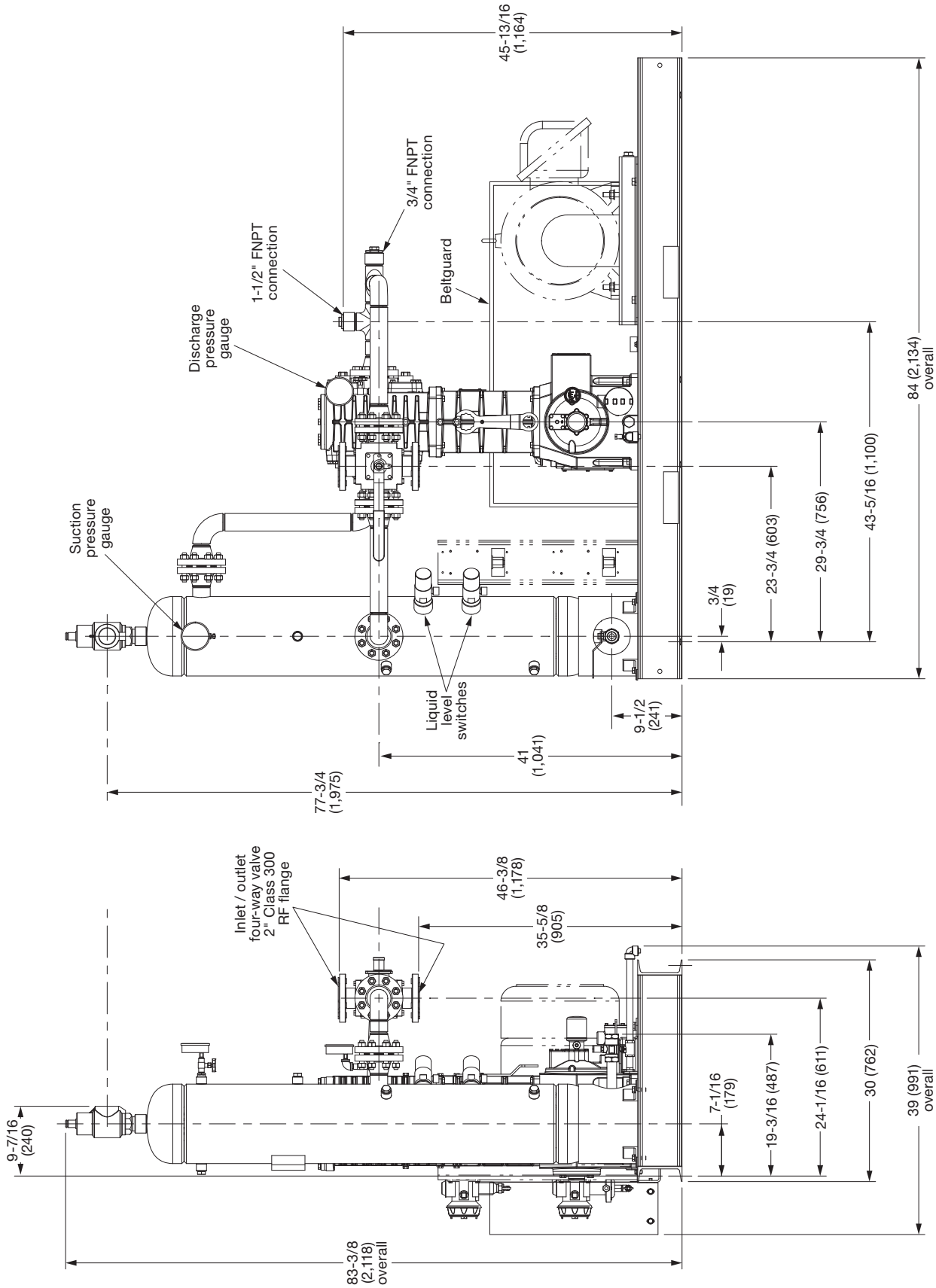
Model D891 with 107B Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

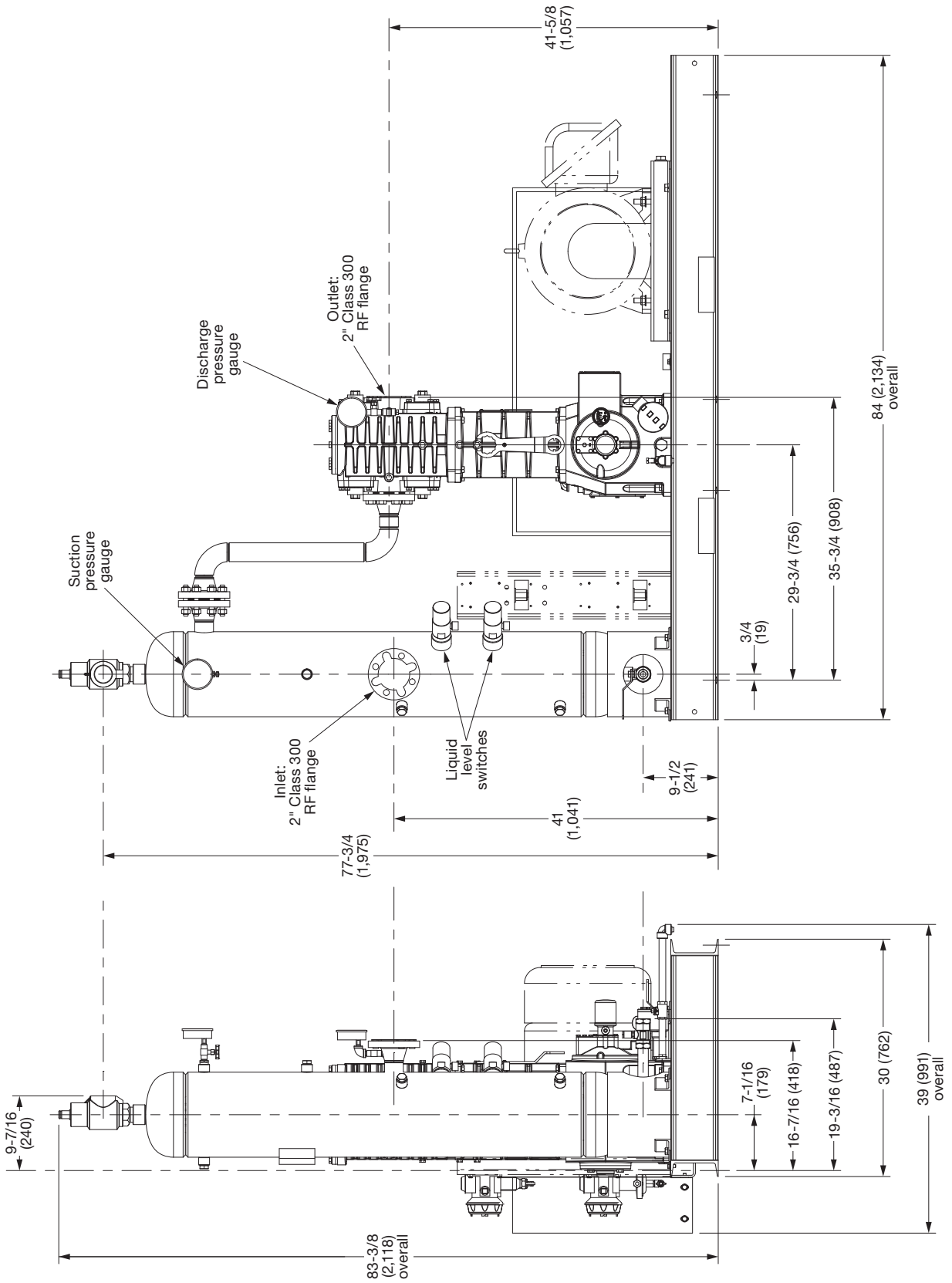
Model FD891 with 107B Mounting



All dimensions are in inches (millimeters).

Appendix D—Outline Dimensions

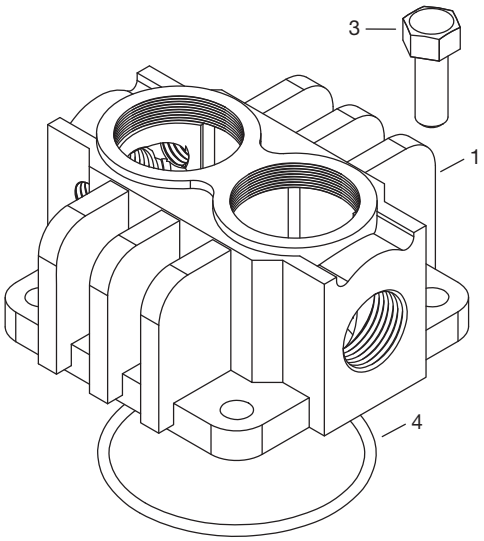
Model D891 with 109B Mounting



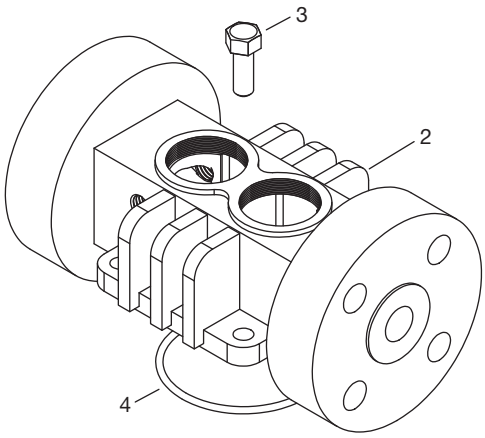
All dimensions are in inches (millimeters).

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

91 Head Assembly



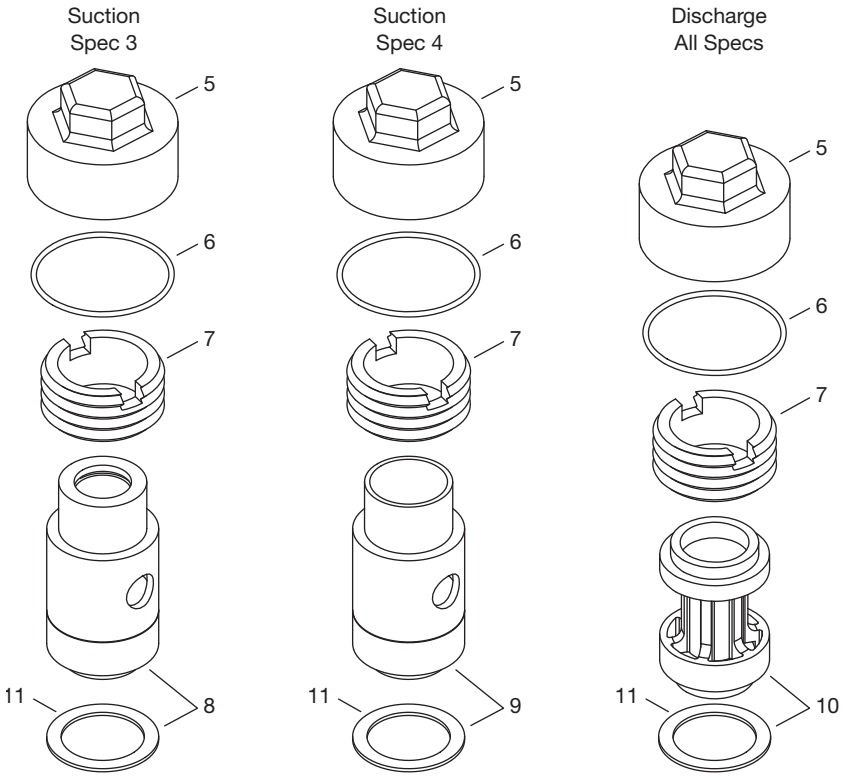
F91 Head Assembly



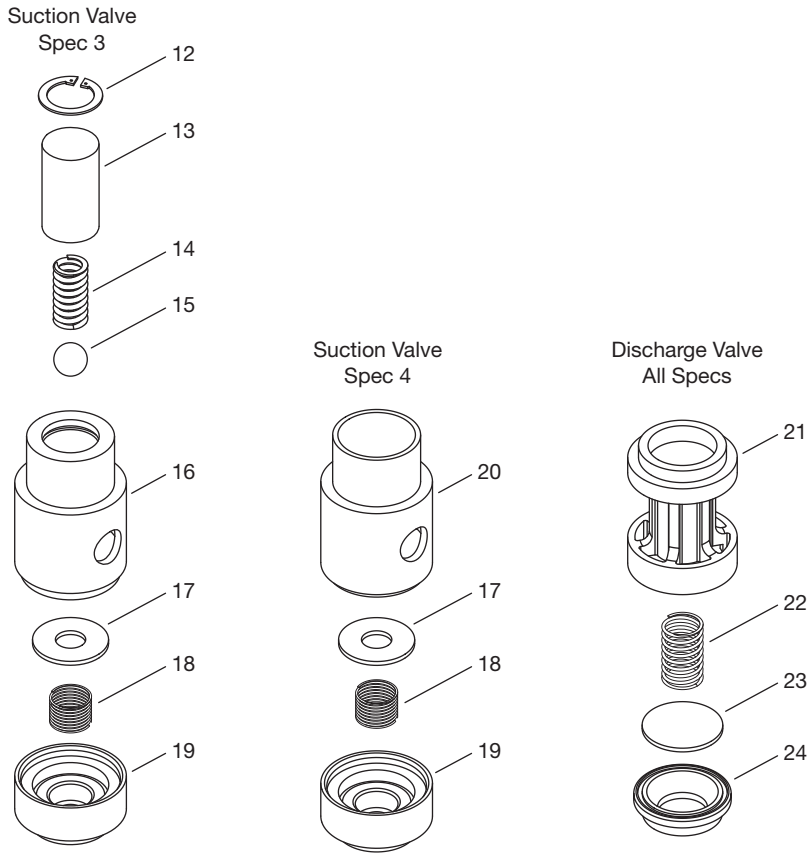
CAUTION: Always relieve pressure in the unit before attempting any repairs.

WARNING

Valve Holddown Assemblies



Valve Assemblies



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

Head and Valve Bill of Materials

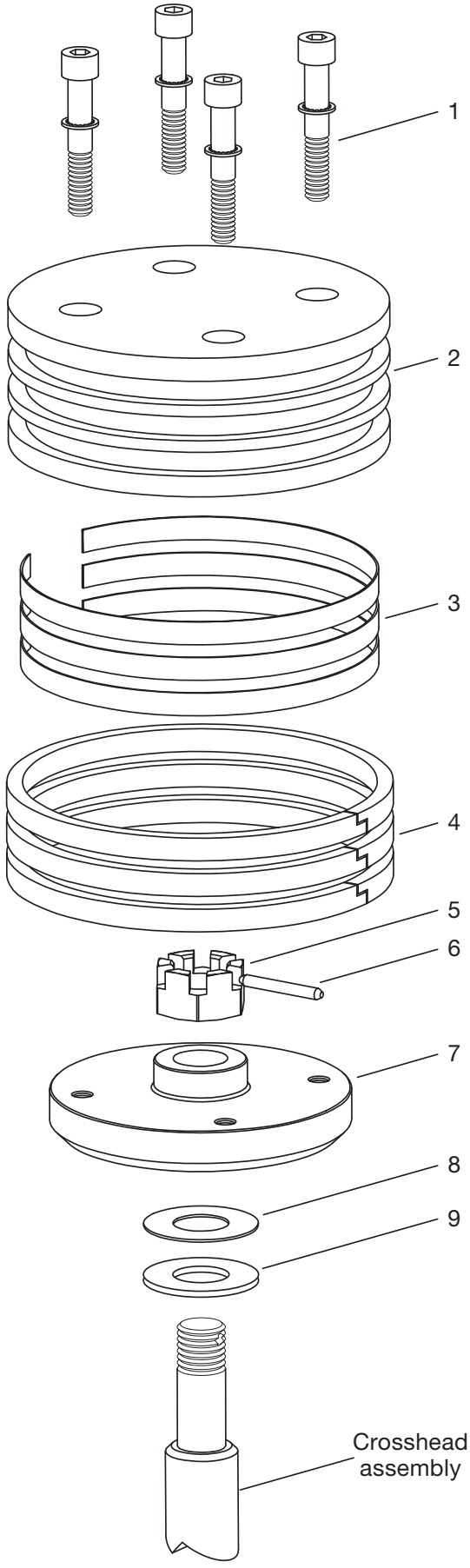
Ref No.	Part No.	Description	Qty.
1.	2374	Head (model 91)	1
	2374-X	Head assembly (model 91, spec 3)	1
	2374-X1	Head assembly (model 91, spec 4)	1
2.	4302	Head (model F91, Class 300 RF flange)	1
3.	7001-037NC100A	Bolt (hex head 3/8"-16 x 1-1/4")	4
4.	2-235_[a]	O-ring	1
5.	2714-1	Valve cap	2
6.	2-031_[a]	O-ring	2
7.	2715	Holddown screw	2
8.	3483-1X	Suction valve assembly (aluminum, spec 3)	1
9.	3483-X	Suction valve assembly (aluminum, spec 4)	1
10.	3485-X	Discharge valve assembly (aluminum, all specs)	1
11.	2717	Valve gasket (aluminum)	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	Suction valve plate	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	Discharge valve plate	1
24.	3485	Discharge valve seat	1

[a] *_ denotes material code. See material code chart for details.*

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

Material Code	
A	Buna-N
B	Neoprene®[b]

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	Head (iron)	1
3.	1775	Ring expander	3
4.	1772	Piston ring	3
5.	1482	Locknut	1
6.	1483	Lock pin	1
7.	1984	Piston platform	1
8.	1528	Shim washer (thick)	As Req.
	1528-1	Shim washer (thin)	As Req.
9.	1527	Thrust washer	1

Piston Clearance (Cold)[a]

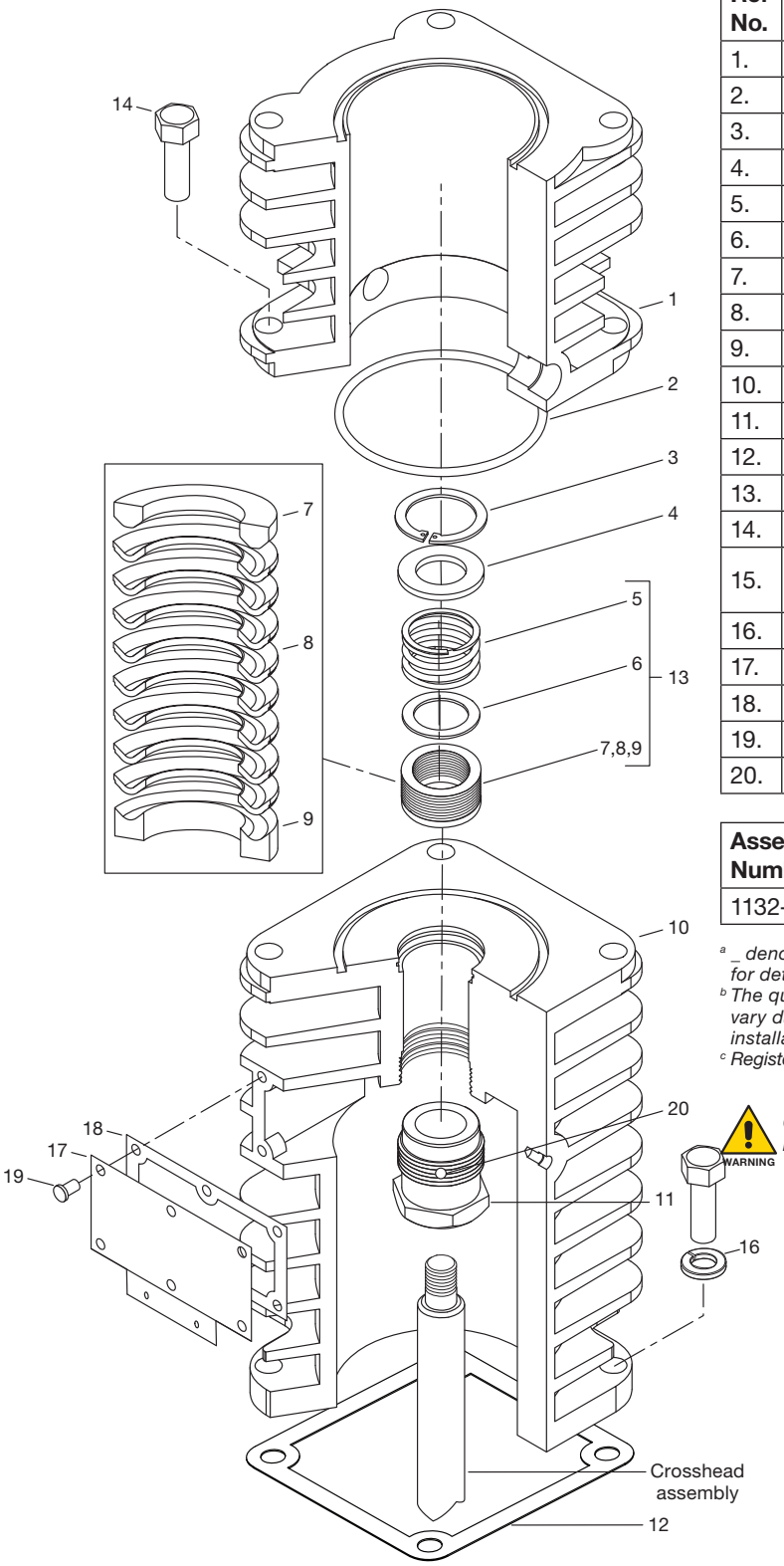
Model	Minimum (x)	Maximum (x)
91	0.020" (0.51 mm)	0.044" (1.12 mm)

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

WARNING

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

Appendix E—Parts Details for 91 and F91 Packing Assembly



Packing—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2242	Cylinder	1
2.	2-235_ [a]	O-ring for cylinder	1
3.	5000-137	Retainer ring	1
4.	1012	Washer	1
5.	1628	Packing spring	1
6.	1714	Packing box washer	1
7.	1453-1	Male packing ring	1
8.	1454 [b]	Packing ring	8
9.	1452-1	Female packing ring	1
10.	2240	Crosshead guide	1
11.	1387-X	Adjusting screw assembly	1
12.	2526	Crankcase gasket	1
13.	1452-1X1	Packing set	1
14.	7001-037NC100A	Bolt (hex head 3/8"-16 x 1")	4
15.	7001-037NC125A	Bolt (hex head 3/8"-16 x 1-1/4")	4
16.	7206-037A	Lock washer (3/8")	4
17.	2243	Inspection plate	1
18.	2244	Inspection plate gasket	1
19.	7012-010NC025B	Screw (Pan HD phillip)	6
20.	1192	Lock device (not shown)	1

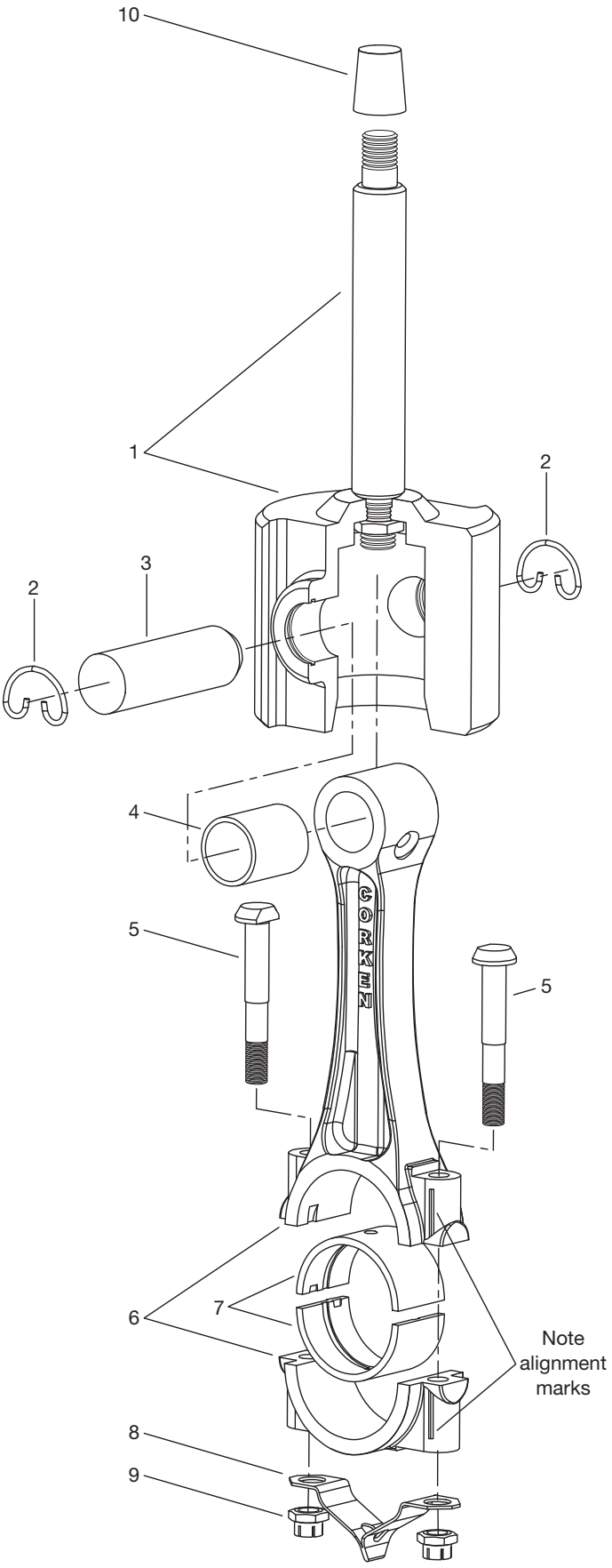
Assembly Number	Assembly Name
1132-X2	Crosshead—piston rod assembly

[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.*

Material Code	
A	Buna-N
B	Neoprene®[c]

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

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



Connecting Rod—Bill of Materials

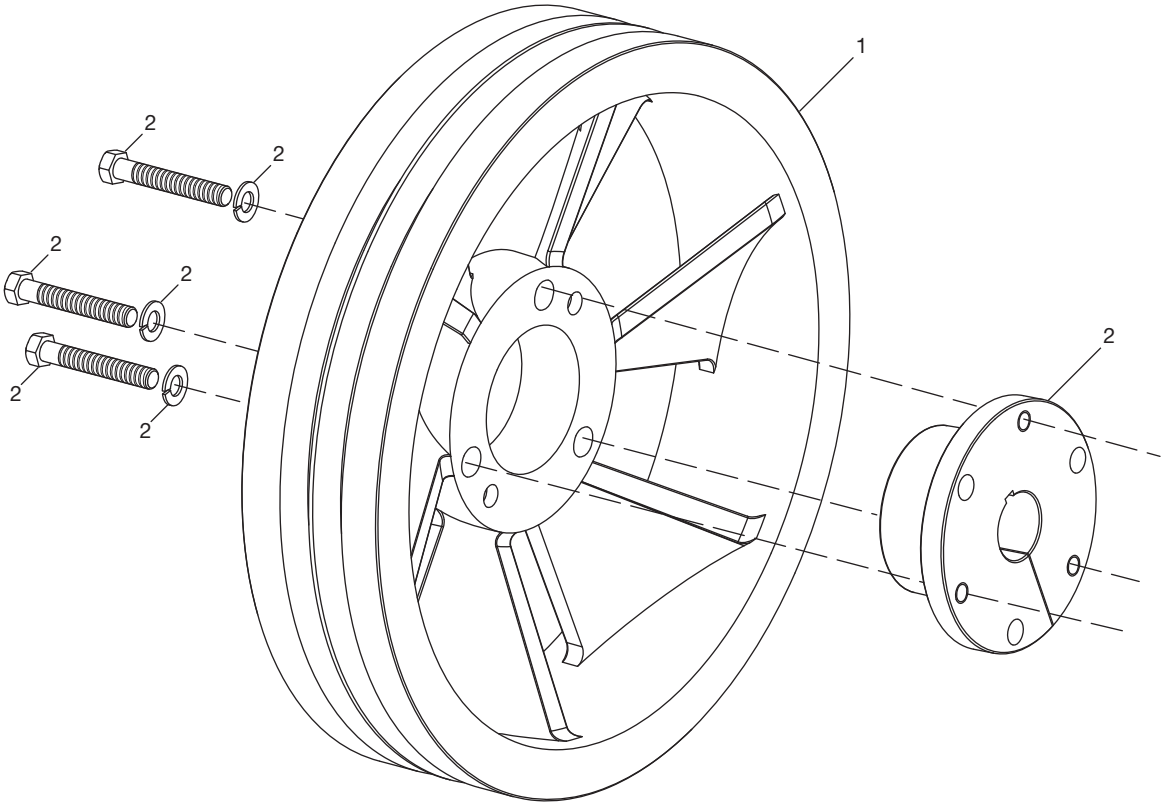
Ref No.	Part No.	Description	Qty. per Compressor
1.	1132-X2	Crosshead assembly	1
2.	1498	Retainer ring	2
3.	2505	Wrist pin	1
4.	1846-X[a, b]	Wrist pin bushing	1
5.	1599[b]	Bolt	2
6.	1889-1X	Connecting rod assembly	1
7.	1367[b]	Connecting rod bearing (pair)	1
8.	2011[b]	Dipper	1
9.	1600[b, c]	Nut	2
10.	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.

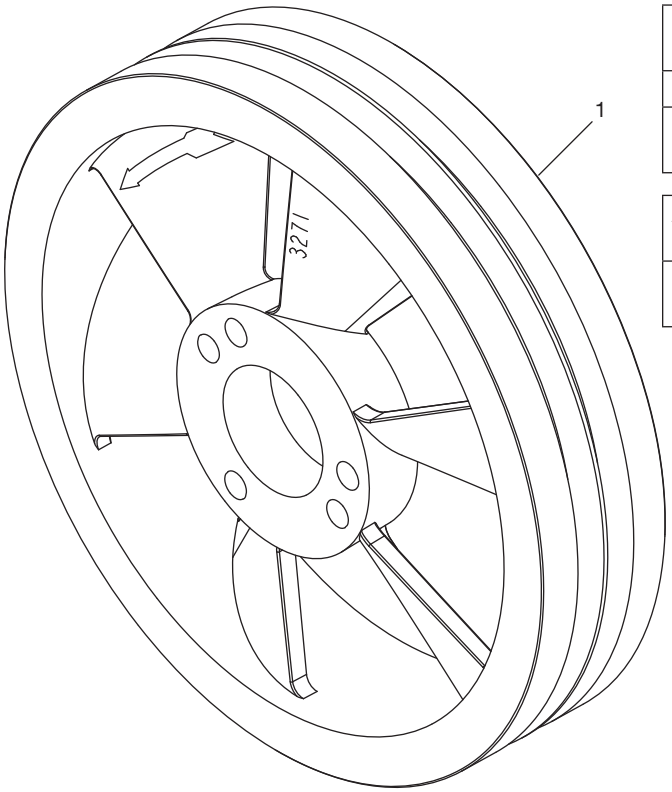
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

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

Appendix E—Parts Details for 91 and F91 Flywheel Assembly



Back Side



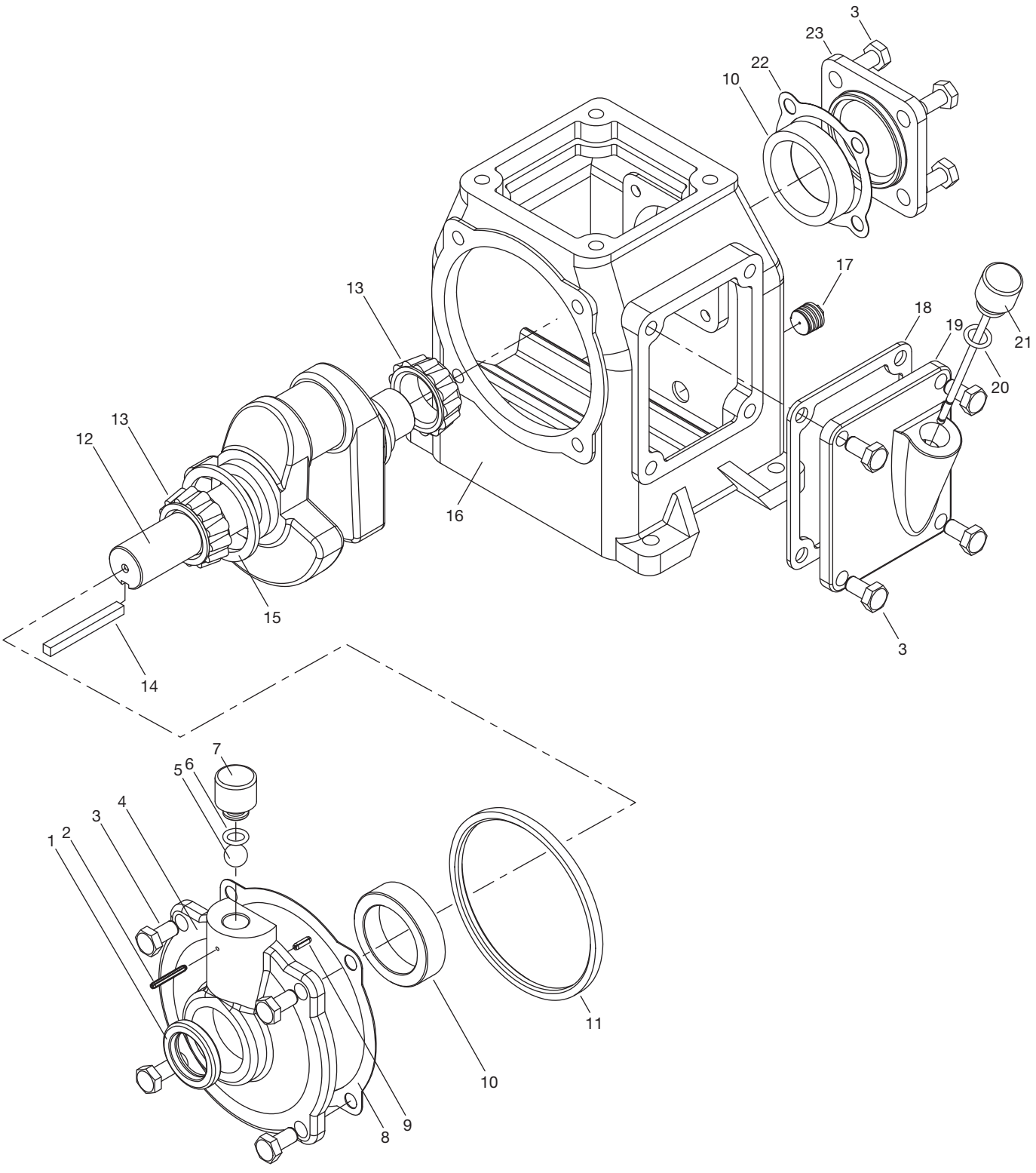
Front Side

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

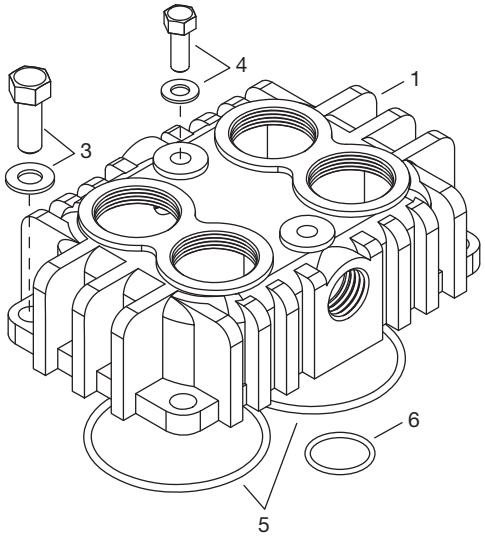
Assembly Number	Assembly Name
2476-X	Crankshaft assembly with 2476, 2290 and 2719
2476-SX [a]	Extended crankshaft assembly with 2719 (2) and 2290
3260-X	Bearing carrier assembly with 3260, 2718, 3259, 1279-X, 2-111A, 1450, 2796 and 1807
3271-X2 [a]	Flywheel assembly 14" - 2 groove with H SF-1.125 and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

[a] *Optional equipment.*

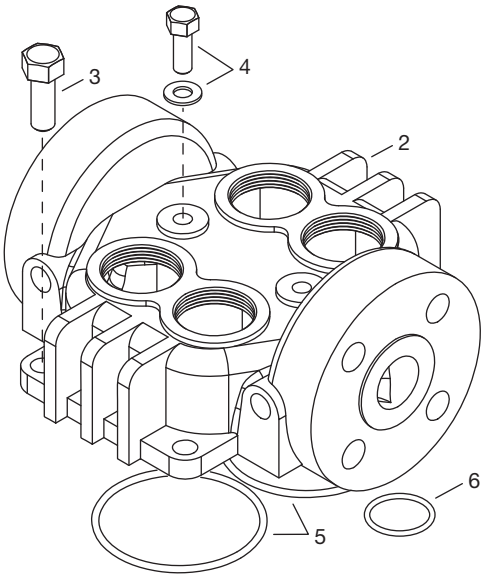
CAUTION: Always relieve pressure in the unit before attempting any repairs.

Appendix E—Parts Details for 291 and F291 Head and Valve Assembly

291 Head Assembly



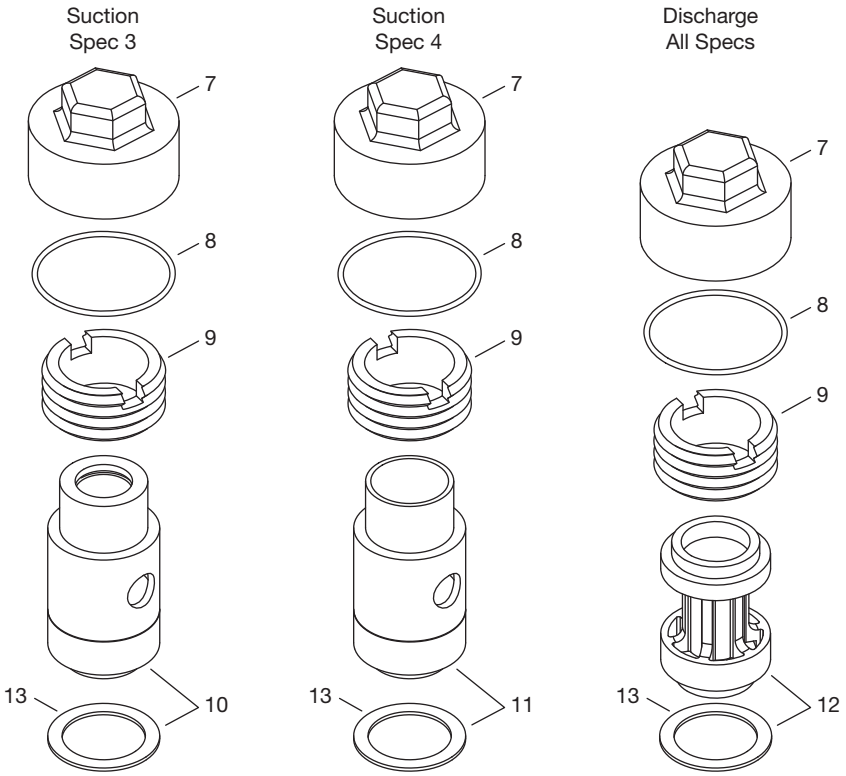
F291 Head Assembly



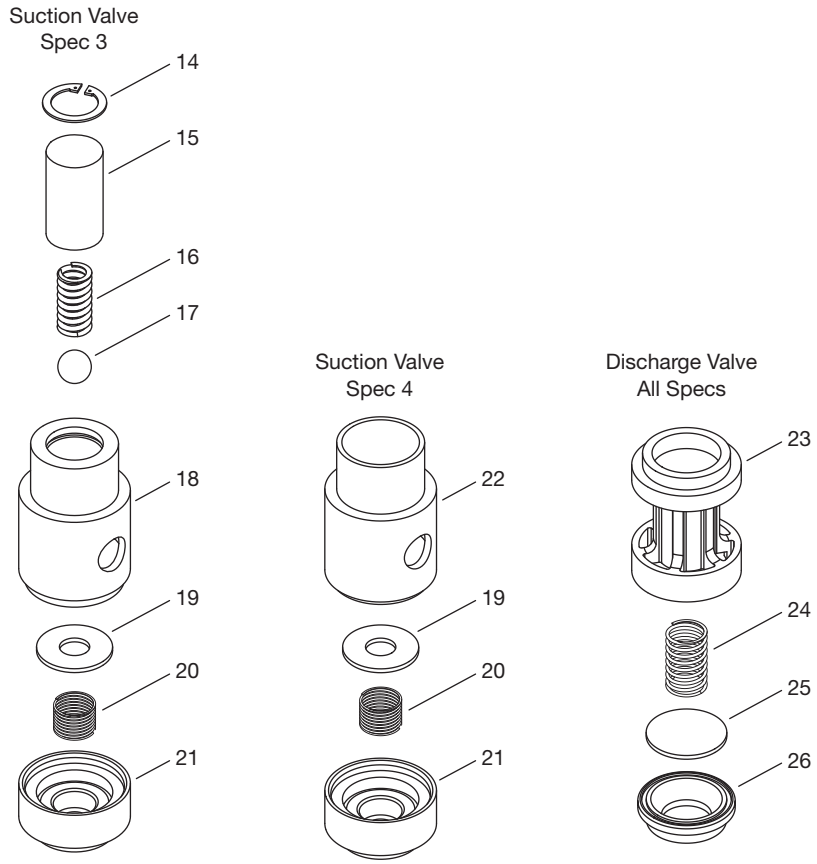
WARNING

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

Valve Holddown Assemblies



Valve Assemblies Details



Appendix E—Parts Details for 291 and F291 Head and Valve Assembly

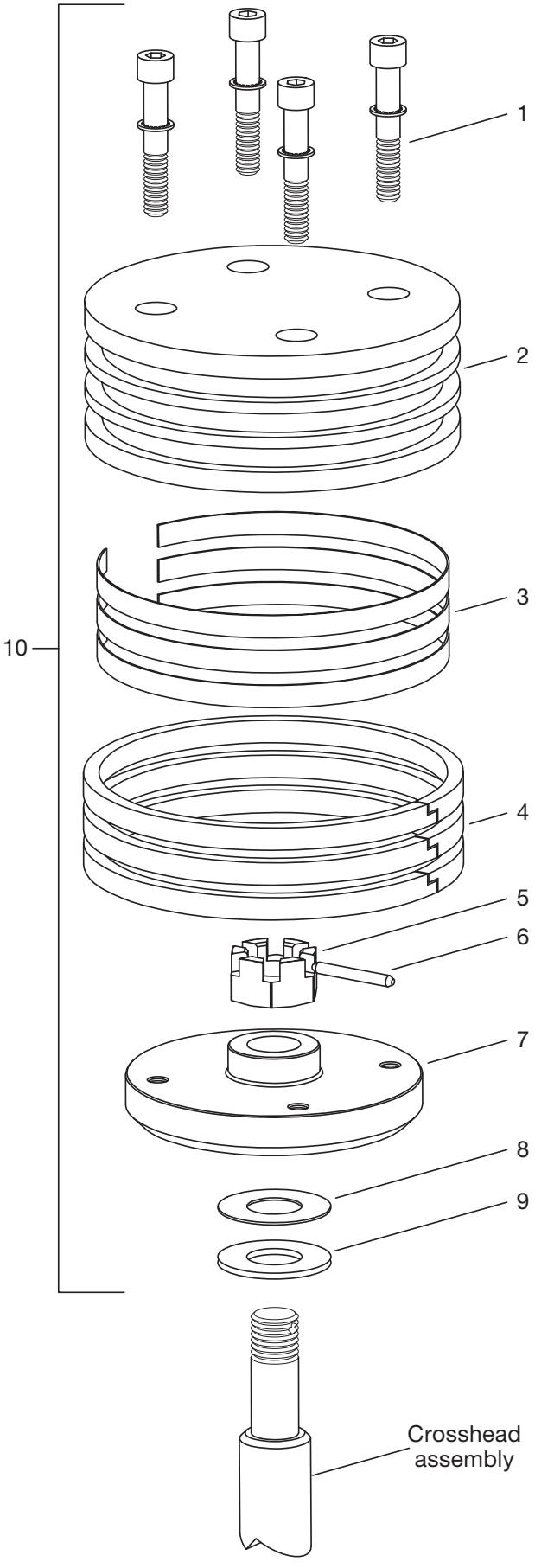
Head and Valve Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2912	Head (model 291)	1
	2912-X1	Head assembly (model 291, spec 3)	1
	2912-X2	Head assembly (model 291, spec 4)	1
2.	4300	Head (model F291, Class 300 RF flange)	1
3.	7001-037NC100A	Bolt (hex head, 3/8-16 x 1-1/4")	4
	7206-037A	Lock washer	4
4.	2731	Center headbolt	2
	2732	Gasket (center headbolt)	2
5.	2-235_[a]	O-ring	2
6.	2-113_[a]	O-ring	1
7.	2714-1	Valve cap	4
8.	2-031_[a]	O-ring	4
9.	2715	Holddown screw	4
10.	3483-1X	Suction valve assembly (aluminum, spec 3)	2
11.	3483-X	Suction valve assembly (aluminum, spec 4)	2
12.	3485-X	Discharge valve assembly (aluminum, all specs)	2
13.	2717	Valve gasket (aluminum)	4
14.	5000-77	Retainer ring (spec 3)	2
15.	3977	Suction valve relief housing	2
16.	1411	Spring (spec 3)	2
17.	1410	Ball (spec 3)	2
18.	3483-1	Suction valve seat (spec 3)	2
19.	3972	Suction valve plate	2
20.	4009	Suction spring	2
21.	3484	Suction valve bumper	2
22.	3483	Suction valve seat (spec 4)	2
23.	3486	Discharge valve bumper	2
24.	4008	Discharge spring	2
25.	3973	Discharge valve plate	2
26.	3485	Discharge valve seat	2

[a] *_ denotes material code. See material code chart for details.*
[b] *Registered trademark of the DuPont company.*

Material Code	
A	Buna-N
B	Neoprene®[b]

Appendix E—Parts Details for 291 and F291 Piston Assembly



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

Ref No.	Part No.	Description	Qty.
1.	7002-010TP100A	Screw (socket head)	8
	7207-010A	Lock washer	8
2.	1983	Head (iron)	2
3.	1775	Ring expander	6
4.	1772	Piston ring	6
5.	1482	Locknut	2
6.	1483	Lock pin	2
7.	1984	Piston platform	2
8.	1528	Shim washer (thick)	As req.
	1528-1	Shim washer (thin)	
9.	1527	Thrust washer	2

Ref No.	Assembly Number	Assembly Name	Qty.
10.	1983-X	Piston assembly	2

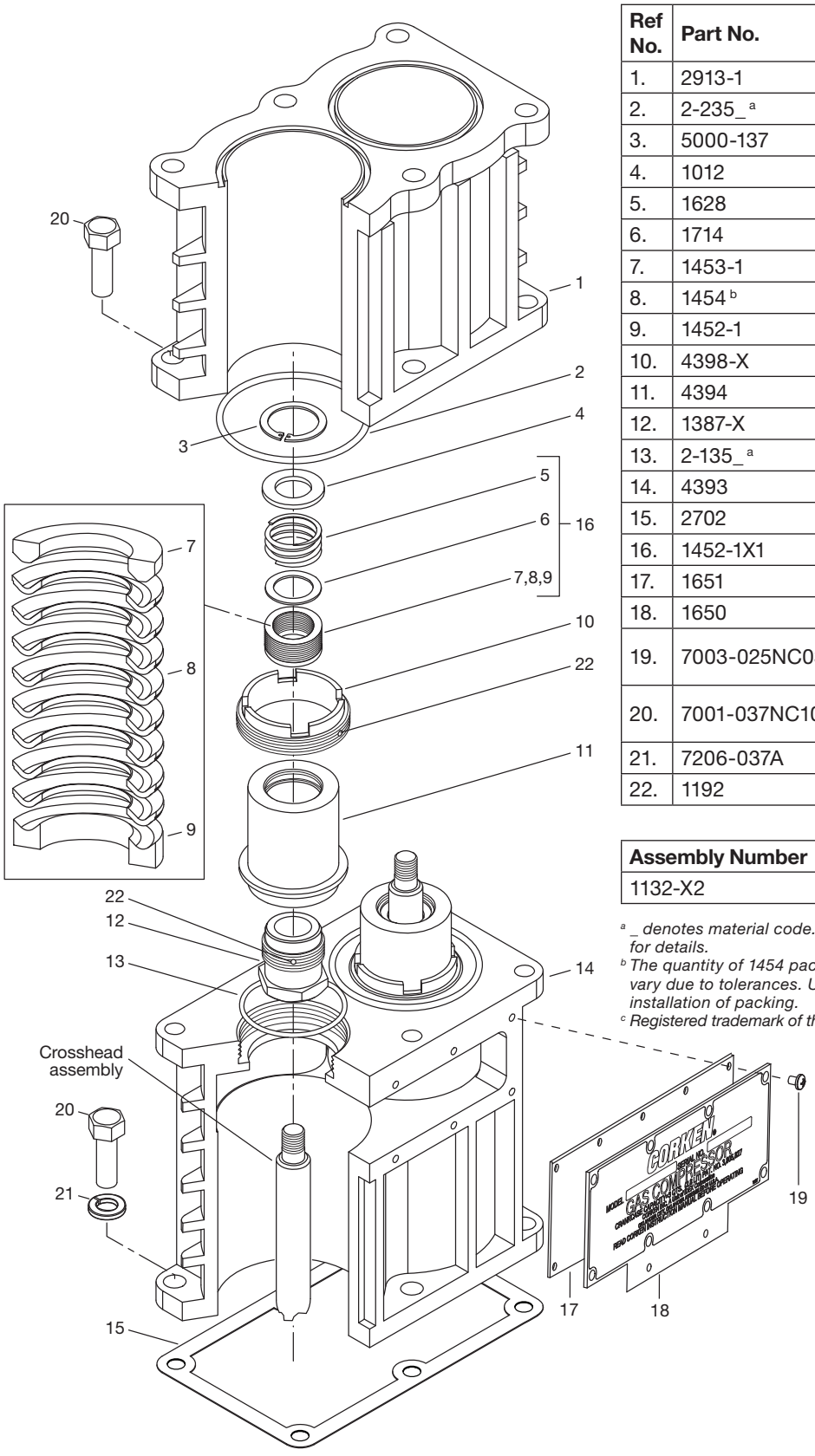
Piston Clearance (Cold)[a]

Model	Minimum	Maximum
291	0.020" (0.51 mm)	0.044" (1.12 mm)

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

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

Appendix E—Parts Details for 291 and F291 Packing Assembly



Packing—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2913-1	Cylinder	1
2.	2-235_ [a]	O-ring (cylinder)	2
3.	5000-137	Retainer ring	2
4.	1012	Washer	2
5.	1628	Packing spring	2
6.	1714	Packing box washer	2
7.	1453-1	Male packing ring	2
8.	1454 [b]	Packing	16
9.	1452-1	Female packing ring	2
10.	4398-X	Cartridge holddown screw	2
11.	4394	Packing box cartridge	2
12.	1387-X	Adjusting screw	2
13.	2-135_ [a]	O-ring (packing cartridge)	2
14.	4393	Crosshead guide	1
15.	2702	Crankcase gasket	1
16.	1452-1X1	Packing set	2
17.	1651	Inspection plate gasket	1
18.	1650	Inspection plate	1
19.	7003-025NC037E	Screw (1/4"-20 x 3/8" pan hd phillip)	10
20.	7001-037NC100A	Bolt (hex head 3/8"-16 x 1-1/4")	12
21.	7206-037A	Lock washer	12
22.	1192	Locking device (not shown)	1

Assembly Number	Assembly Name
1132-X2	Crosshead—piston rod assembly

[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.*

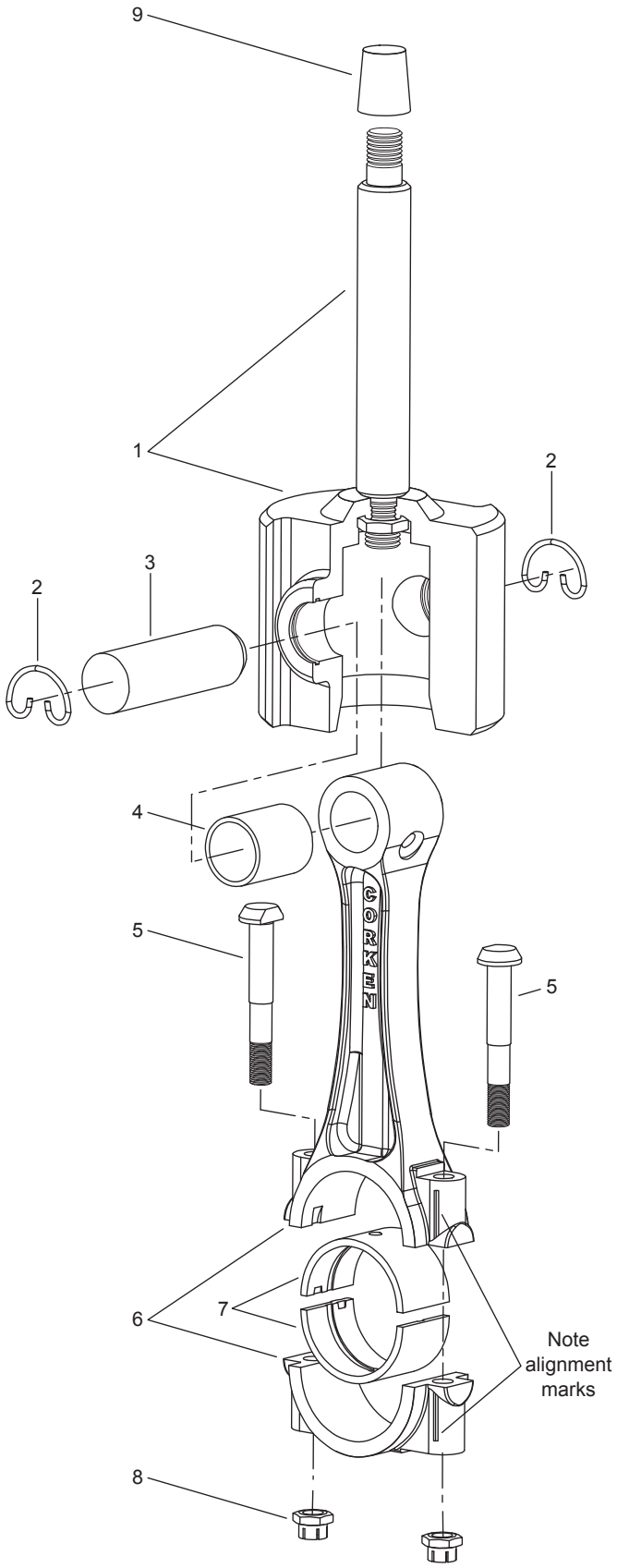
[c] *Registered trademark of the DuPont company.*

Material Code	
A	Buna-N
B	Neoprene®[c]

WARNING

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

Appendix E—Parts Details for 291 and F291 Connecting Rod Assembly



Connecting Rod—Bill of Materials

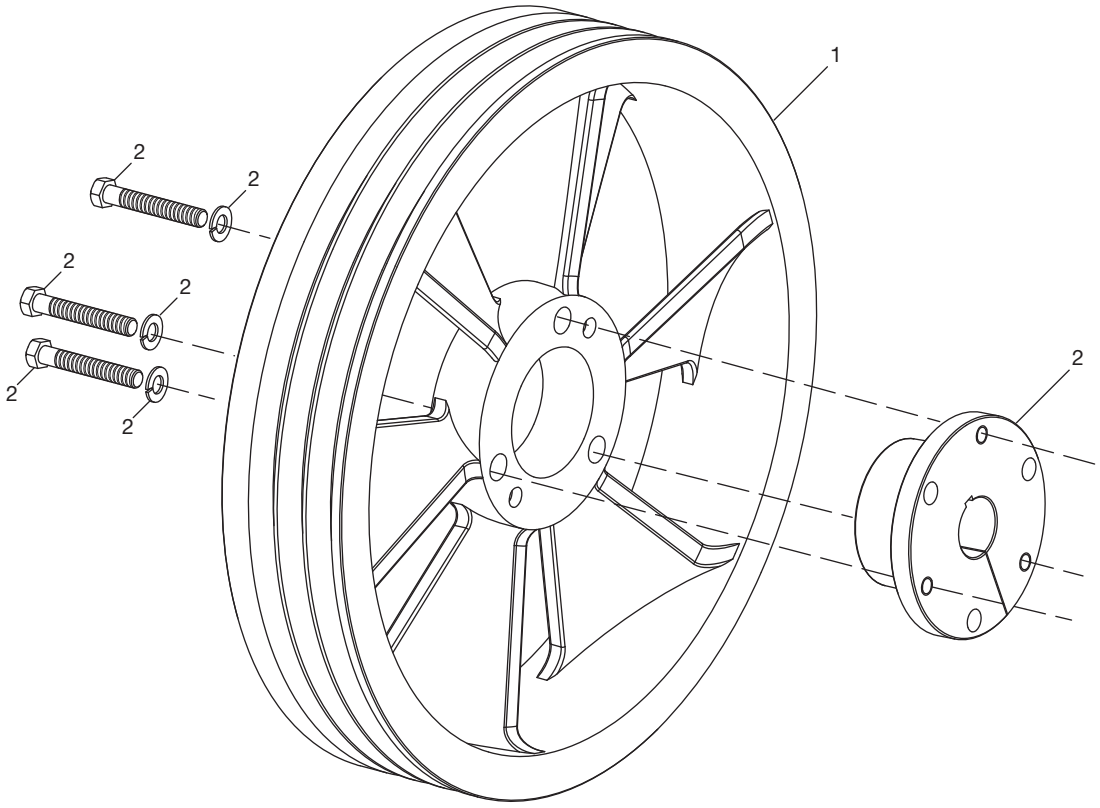
Ref No.	Part No.	Description	Qty. per Compressor
1.	1132-X2	Crosshead assembly	2
2.	1498	Retainer ring	4
3.	2505	Wrist pin	2
4.	1846-X [a, b]	Wrist pin bushing	2
5.	1599 [b]	Bolt	4
6.	1889-X	Connecting rod assembly	2
7.	1367 [b]	Connecting rod bearing (pair)	2
8.	1600 [b, c]	Nut	4
9.	4005	Packing installation 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.
[c] Torque connecting rod nut to 28 ft. lbs.

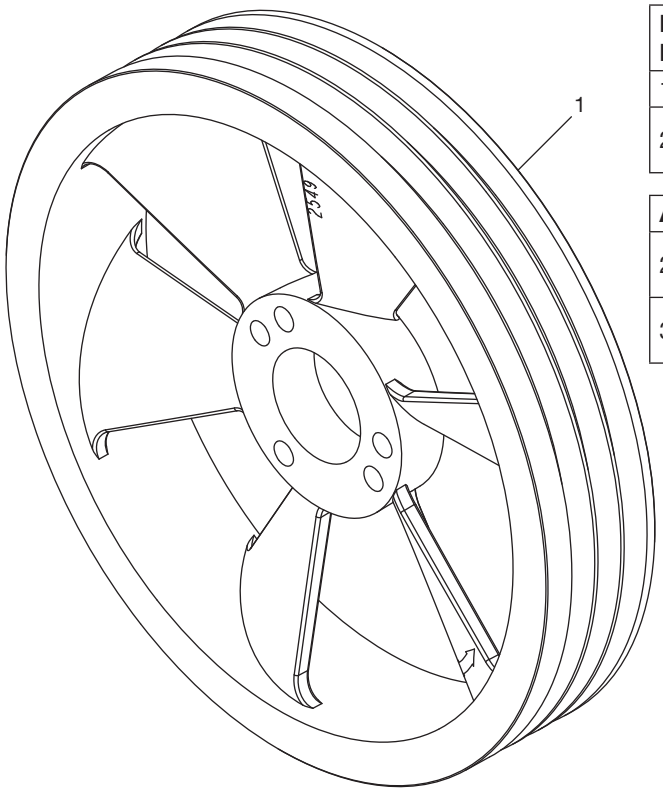
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

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

Appendix E—Parts Details for 291 and F291 Flywheel Assembly



Back Side



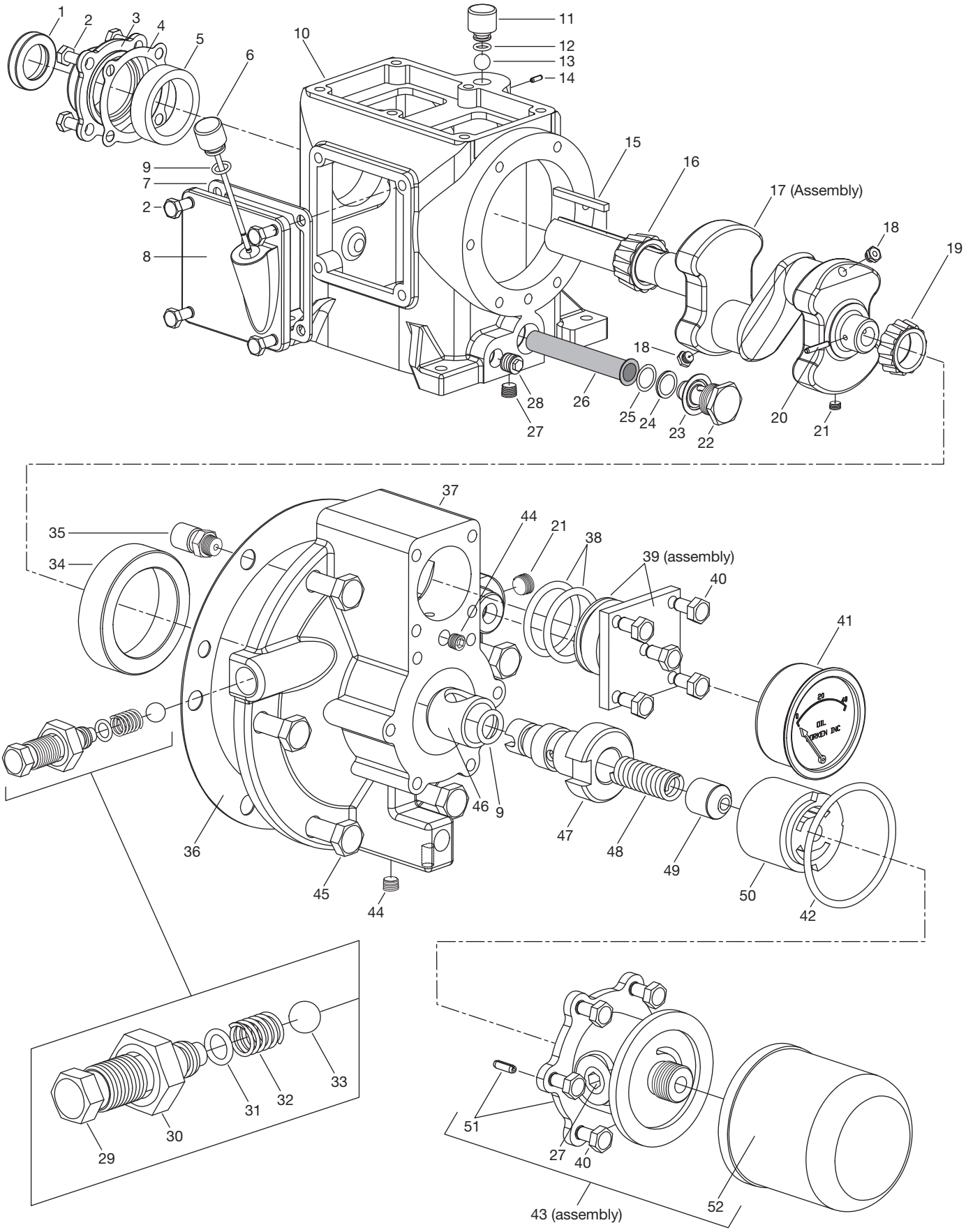
Front Side

Flywheel—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2549	Flywheel (16" O.D., 3 groove)	1
2.	H SF-1.250	Hub with three bolts and lockwashers	1

Assembly Number	Assembly Name
2549-X1	Flywheel assembly (flywheel, hub, and three bolts)—standard
3271-X1	Flywheel assembly for extended crankshaft—optional

Appendix E—Parts Details for 291 and F291 Crankcase Assembly



Appendix E—Parts Details for 291 and F291 Crankcase Assembly

Packing Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	1278	Oil seal	1
2.	7001-037NC075A	Bolt (hex head, 3/8"-16 x 3/4")	8
3.	2957	Bearing cover	1
4.	1273	Bearing adjustment shim (0.005")	As needed
	1273-1	Bearing adjustment shim (0.007")	As needed
	1273-2	Bearing adjustment shim (0.020")	As needed
5.	1500	Bearing cup	1
6.	1368-X	Oil bayonet	1
7.	2713	Crankcase inspection plate gasket	1
8.	2958	Crankcase inspection plate	1
9.	2-112A	O-ring (Buna-N)	2
10.	2955	Crankcase	1
11.	1279	Breather cap	1
12.	2-111A	O-ring (Buna-N)	1
13.	2796	Breather ball	1
14.	1450	Lock pin (1/8" x 1")	1
15.	1671	Flywheel key	1
16.	1501	Bearing cone	1
17.	1341-X1	Crankshaft assembly with 1284 (2), 1286, 1341, 1501, 2590, 2719	1
18.	1284	Crankshaft orifice	2
19.	2719	Bearing cone	1
20.	1286	Pump shaft drive pin	1
21.	2590	Pipe plug (1/8" NPT, flush seal)	2
22.	1280	Filter screen screw	1
23.	1281	Filter screen screw gasket	1
24.	2-116A	O-ring (Buna-N, filter screen)	1
25.	1276	Filter screen washer	1
26.	1275	Oil filter screen	1
27.	3289	Pipe plug (1/4" NPT, flush seal)	2
28.	1661	Pipe plug (3/8" NPT)	1
29.	1290	Relief valve adjusting screw	1
30.	1291	Adjusting screw locknut	1
31.	2-011A	O-ring (Buna-N, relieve valve adjustment screw)	1
32.	1292	Relief valve spring	1
33.	1293	Relief valve ball	1
34.	2718	Bearing cup	1
35.	2961-X	Air release valve assembly with 2961, 2962, 2963	1
36.	1285	Bearing carrier gasket	1
37.	2956	Bearing carrier	1
38.	2-218A	O-ring (Buna-N, closure body, 2 required)	2
39.	1515-X	Closure cap assembly including 2-218A (2)	1
40.	7001-025NC050A	Bolt (hex head, 1/4"-20 x 1/2")	10
41.	1302	Oil pressure gauge	1
42.	2-228A	O-ring (Buna-N, pump cover)	1
43.	4222-X	Oil filter assembly	1
44.	1629	Pipe plug (1/16" NPT, flush seal)	2
45.	7001-037NC100A	Bolt (hex head, 3/8"-16 x 1")	6
46.	2805	Pump shaft bushing	1
47.	2850	Pump shaft adapter	1
48.	2852	Oil pump spring	1
49.	2851	Spring guide	1
50.	2849-X	Oil pump assembly (individual pump parts not available)	1
51.	2798	Pump cover pin with 4222	1
52.	4225	Filter	1

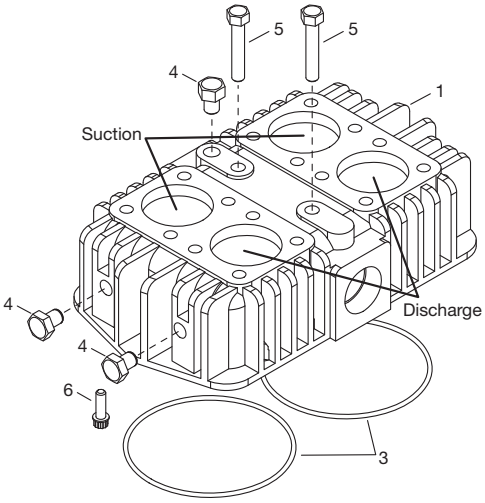
Assembly Number	Assembly Name
1279-X	Breather cap assembly with 1279, 2-111A
1342-X1[a]	Extended crankshaft assembly with 1284 (2), 1286, 1342, 1501, 2590, 2719
1368-X1	Oil bayonet assembly with 1368-X, 2-112A
2956-X	Bearing carrier assembly with 1285, 1290, 1291, 1292, 1293, 1515-X, 2718, 2805, 2806 (2), 2848-X, 2849-X, 2850, 2851, 2852, 2956, 2961-X, 2-011A, 2-112A, 2-228A.
2957-X	Bearing cover assembly with 2957 and 1278

[a] *Optional equipment.*

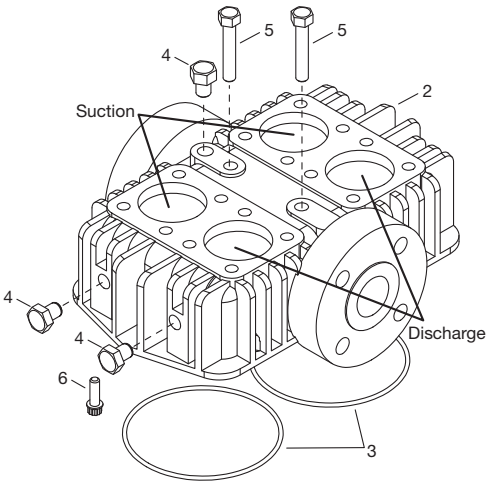
WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Appendix E—Parts Details for 491 and F491 Head and Valve Assembly

491 Head Assembly



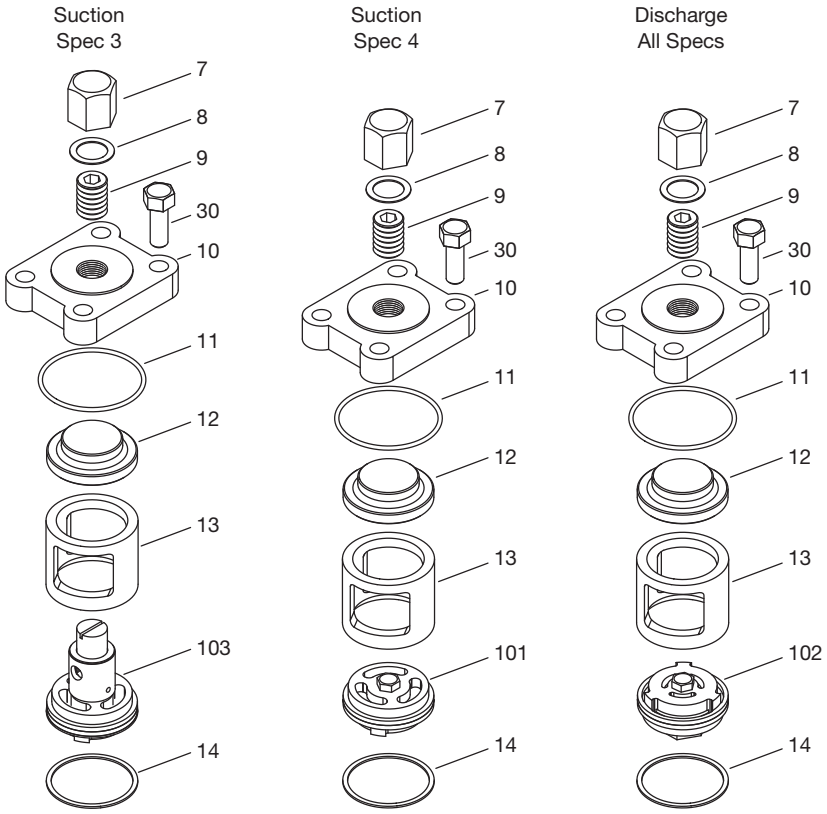
F491 Head Assembly



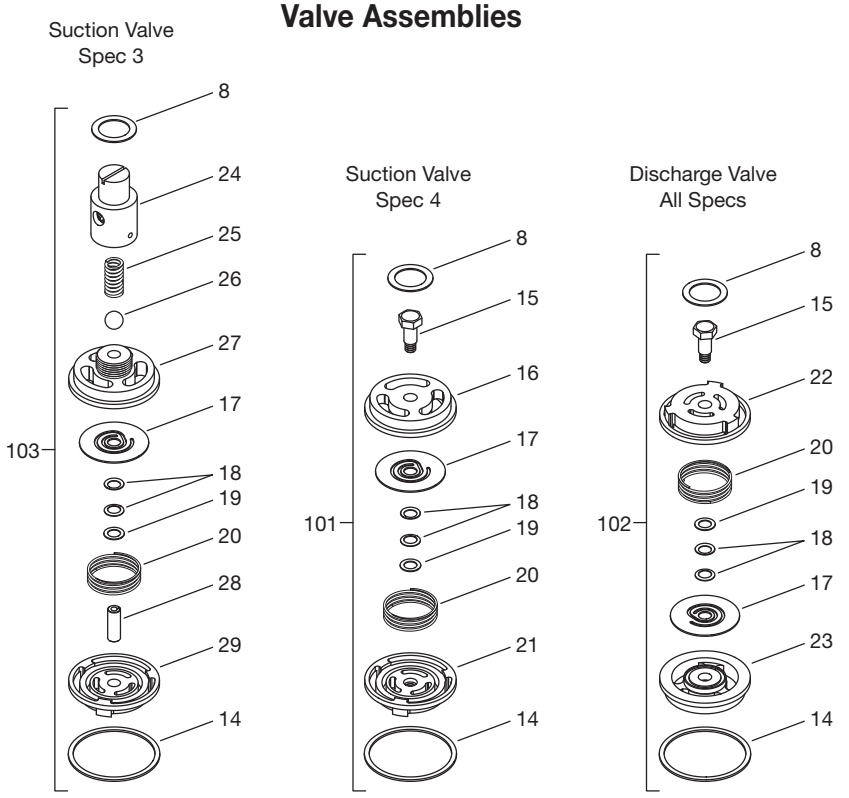
WARNING

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

Valve Holddown Assemblies



Valve Assemblies



Appendix E—Parts Details for 491 and F491 Head and Valve Assembly

Head and Valve Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3712[a]	Head (model 491, ductile iron)	1
2.	4297	Head (model F491, Class 300 RF flange)	1
3.	2-253_[a, b, c]	O-ring (model 491)	2
4.	3442	Pipe plug (1/4" NPT)	3
5.	1479[b]	Center head bolt	2
6.	7005-043NC125A[b]	Bolt (ferry head, 7/16"-14 x 1-1/4", 490 and 491 prior to serial #FZ44188)	12
	7005-043NC150A[b]	Bolt (ferry head, 7/16"-14 x 1-1/2", 491 serial # FZ44188 and later)	12
7.	1477	Valve screw nut	4
8.	1478	Gasket (steel)	4
9.	1476	Valve holddown screw	4
10.	1475	Valve cover plate	4
11.	2-143_[c]	O-ring for cover plate	4
12.	1409[d]	Valve spacer	4
13.	2448	Cage	4
14.	1418	Valve gasket (aluminum)	4
15.	2446	Bolt	2 or 4
16.	2438	Suction valve seat	2
17.	2442	Valve plate	4
18.	2445[d]	Spacer (two per valve)	8
19.	3355	Washer	4
20.	1407	Valve spring	4
21.	2440	Suction valve bumper (spec 4)	2
22.	2441	Discharge valve bumper	2
23.	2439	Discharge valve seat	2
24.	2533-1	Adjusting screw	2
25.	1411	Relief ball spring	2
26.	1410	Relief ball	2
27.	2532-1	Suction valve seat	2
28.	2534-1	Suction valve post	2
29.	2447	Suction valve bumper (spec 3)	2
30.	7001-043NC125A	Bolt (hex head, 7/16"-14 x 1-1/4")	16

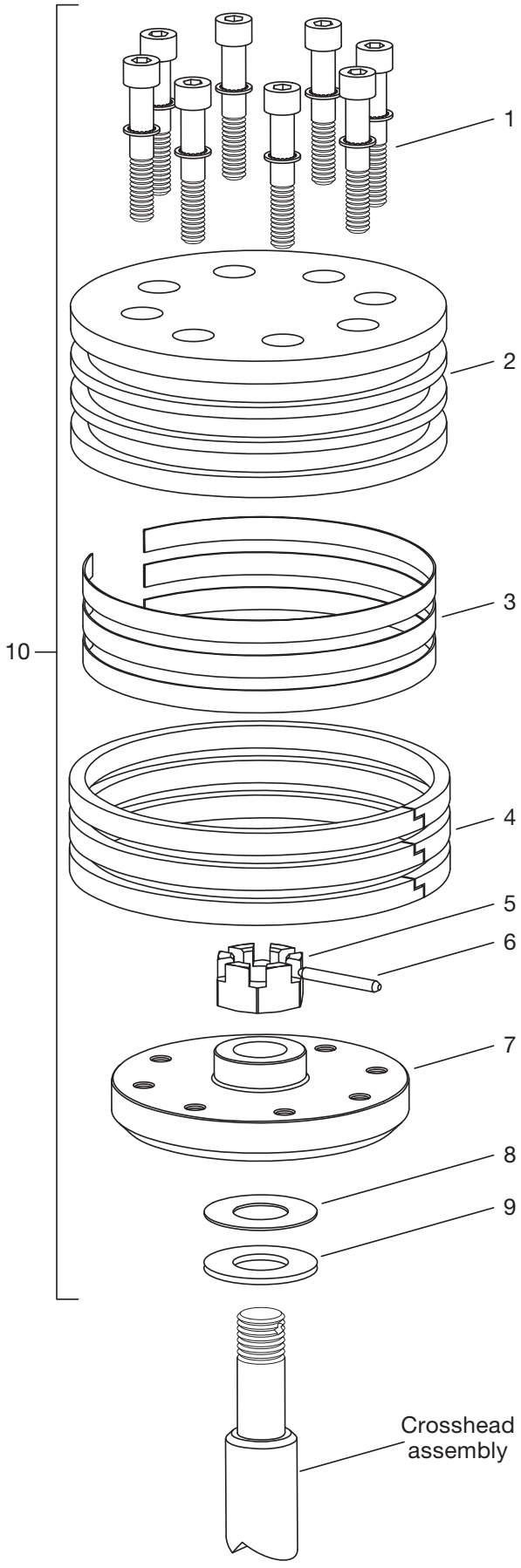
Ref No.	Valve Assembly No.	Assembly Name
101.	2438-X	Suction valve assembly—spec 4
102.	2439-X	Discharge valve assembly—all specs
103.	2532-1X	Suction valve assembly—spec 3

Head Assembly No.	Model	Valve Specification
3712-X1[a]	491	3
3712-X2[a]	491	4
4297-X1	F491 (Class 300 RF)	3
4297-X2	F491 (Class 300 RF)	4

[a] S/N FZ44188 and later.
[b] Not included in head assembly.
[c] _ denotes material code. See material code chart for details.
[d] Place spacers back to back as shown.
[e] Registered trademark of the DuPont company.

Material Code	
A	Buna-N
B	Neoprene®[e]

Appendix E—Parts Details for 491 and F491 Piston Assembly



Piston—Bill of Materials
Piston Diameter 4" (10.16 cm)

Ref No.	Part No.	Description	Qty.
1.	7002-025TP125A	Screw (socket head)	16
	7207-025A	Lock washer	16
2.	1985	Head (iron)	2
3.	1776	Ring expander	6
4.	1773	Piston ring	6
5.	1482	Locknut	2
6.	1483	Lock pin	2
7.	1986	Piston platform	2
8.	1528	Shim washer (thick)	As Req.
	1528-1	Shim washer (thin)	
9.	1527	Thrust washer	2

Ref No.	Assembly Number	Assembly Name	Qty.
10.	1985-X	Piston assembly	2

Piston Clearance (Cold)[a]

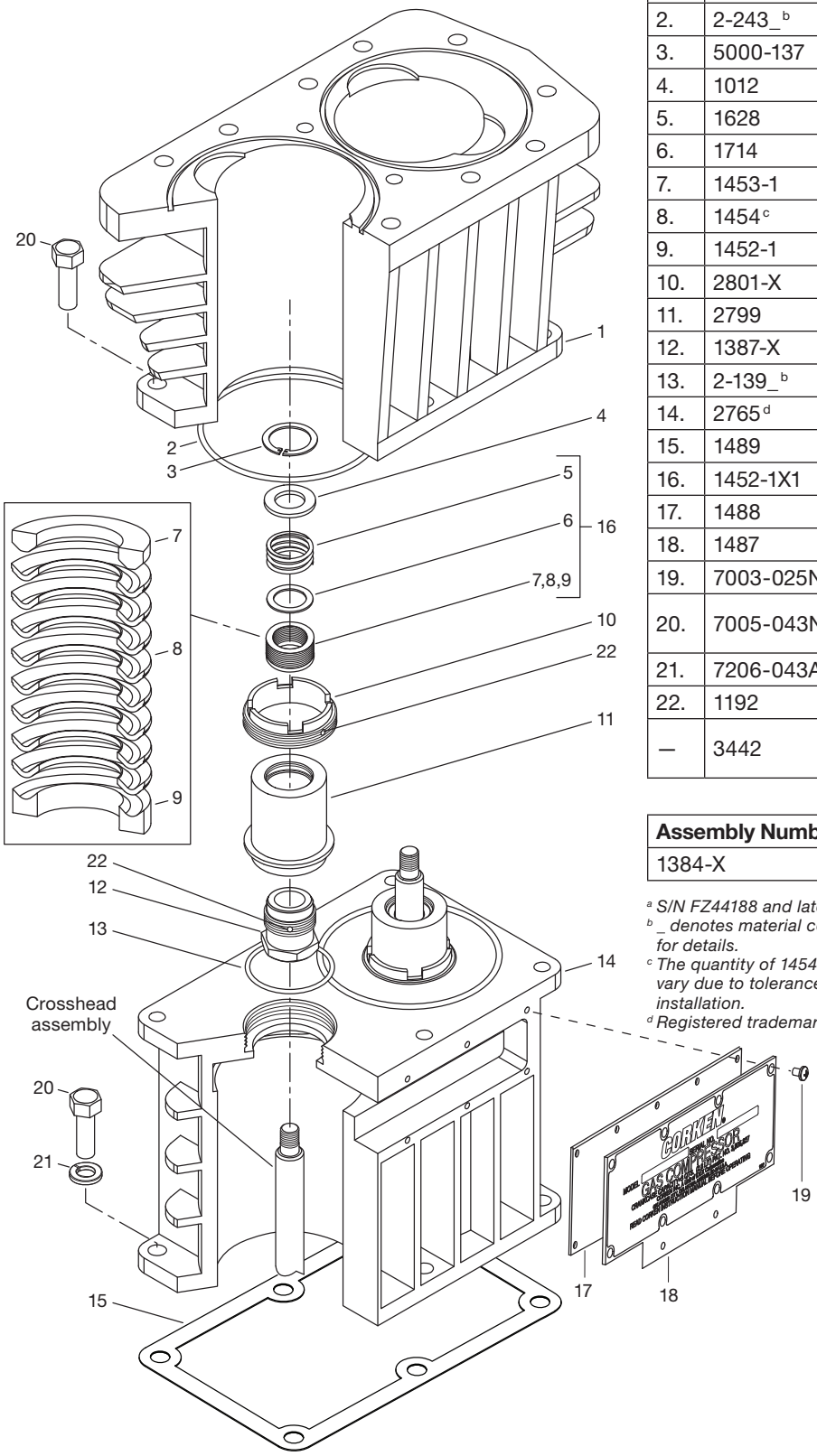
Model	Minimum	Maximum
491[b]	0.020" (0.51 mm)	0.044" (1.12 mm)

[a] The distance from the bottom of the head to the top of the piston.
[b] For 491 compressor with head O-rings.

WARNING

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

Appendix E—Parts Details for 491 and F491 Packing Assembly



Packing—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3713[a]	Cylinder (491 with O-ring)	1
2.	2-243_[b]	O-ring (cylinder)	2
3.	5000-137	Retainer ring	2
4.	1012	Washer	2
5.	1628	Packing spring	2
6.	1714	Packing box washer	2
7.	1453-1	Male packing ring	2
8.	1454[c]	Packing ring	16
9.	1452-1	Female packing ring	2
10.	2801-X	Cartridge holddown screw	2
11.	2799	Packing box cartridge	2
12.	1387-X	Adjusting screw	2
13.	2-139_[b]	O-ring (packing cartridge)	2
14.	2765[d]	Crosshead guide	1
15.	1489	Crankcase gasket	1
16.	1452-1X1	Packing set	2
17.	1488	Inspection plate gasket	1
18.	1487	Inspection plate	1
19.	7003-025NC037E	Screw (1/4"-20 x 3/8")	10
20.	7005-043NC125A	Bolt (ferry head, 7/16"-14 x 1-1/4")	12
21.	7206-043A	Lock washer (7/16")	6
22.	1192	Locking device (not shown)	1
—	3442	Pipe plug (1/4" NPT, not shown)	1

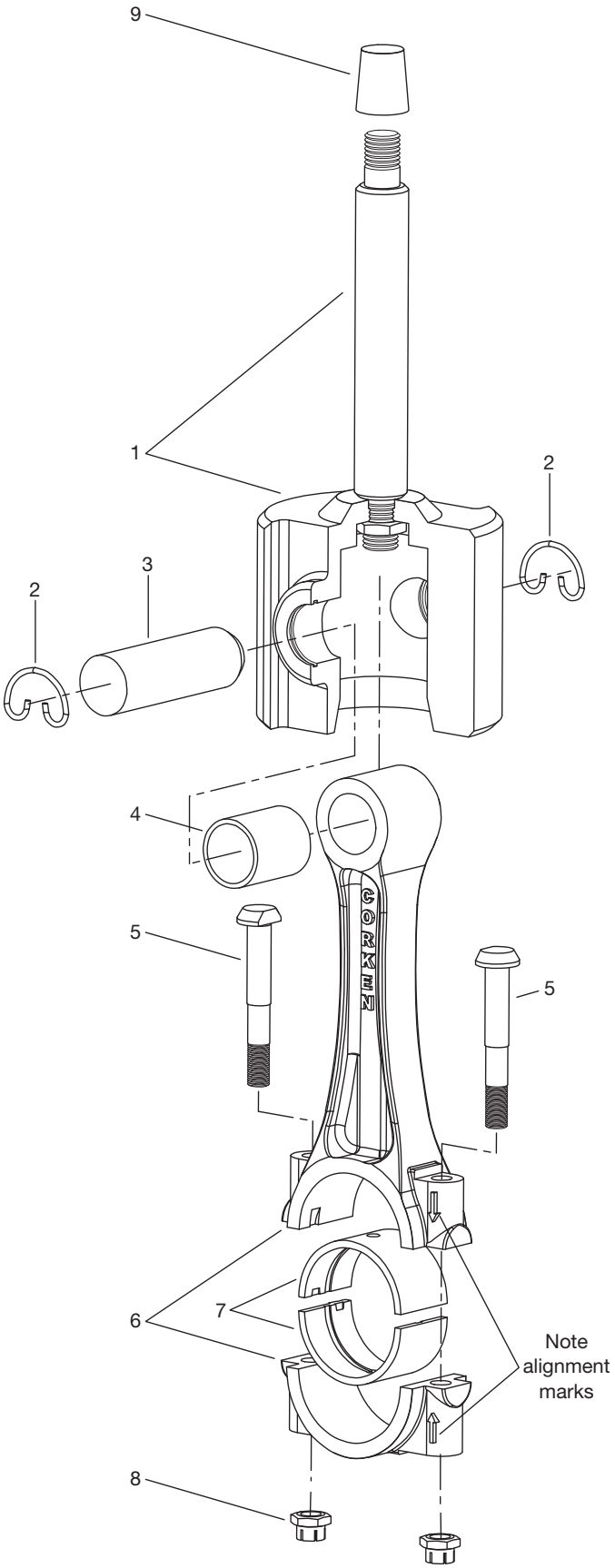
Assembly Number	Assembly Name
1384-X	Crosshead assembly

[a] *S/N FZ44188 and later.*
[b] *_ denotes material code. See material code chart for details.*
[c] *The quantity of 1454 packing rings required will vary due to tolerances. Use Cone 4005 for packing installation.*
[d] *Registered trademark of the DuPont company.*

Material Code	
A	Buna-N
B	Neoprene®[d]

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

Appendix E—Parts Details for 491 and F491 Connecting Rod Assembly



Connecting Rod—Bill of Materials

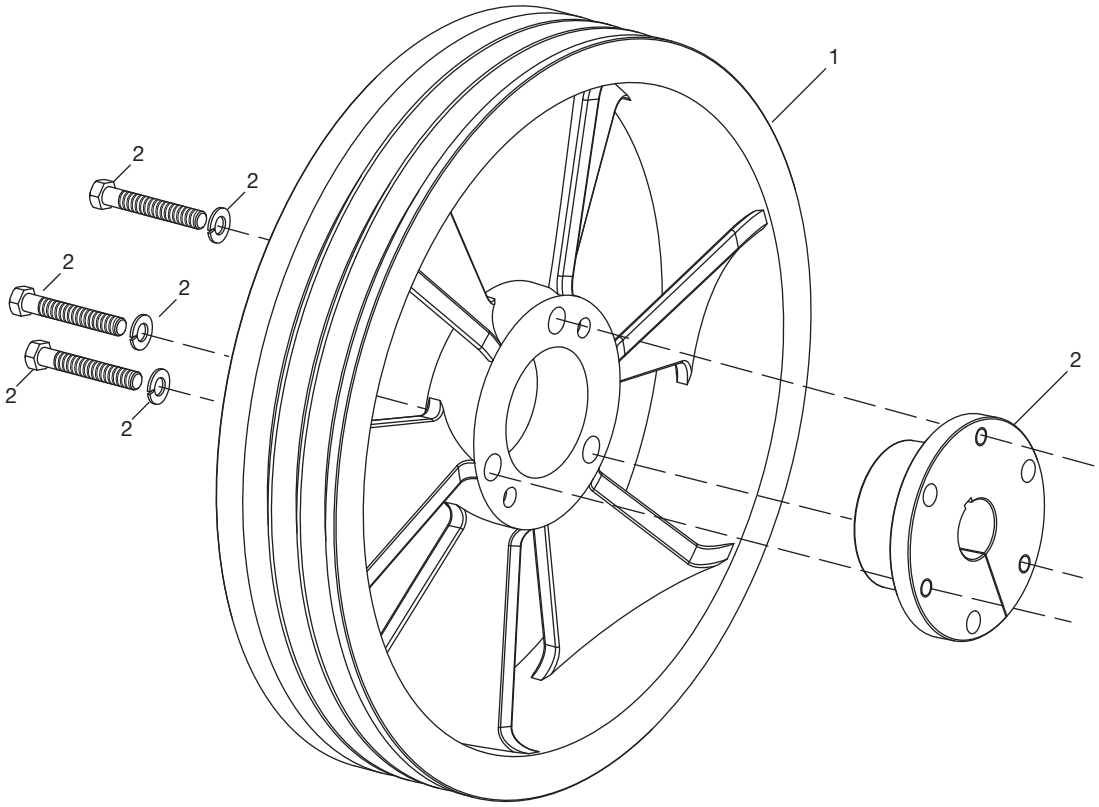
Ref No.	Part No.	Description	Qty. per Compressor
1.	1384-X	Crosshead assembly	2
2.	1498	Retainer ring	4
3.	1496	Wrist pin	2
4.	1495-X[a, b]	Wrist pin bushing	2
5.	1492[b]	Bolt	4
6.	1490-X	Connecting rod assembly	2
7.	1491[b]	Connecting rod bearing (pair)	2
8.	1493[b, c]	Nut	4
9.	4005	Packing installation 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.
[c] Torque connecting rod nut to 30 ft. lbs.

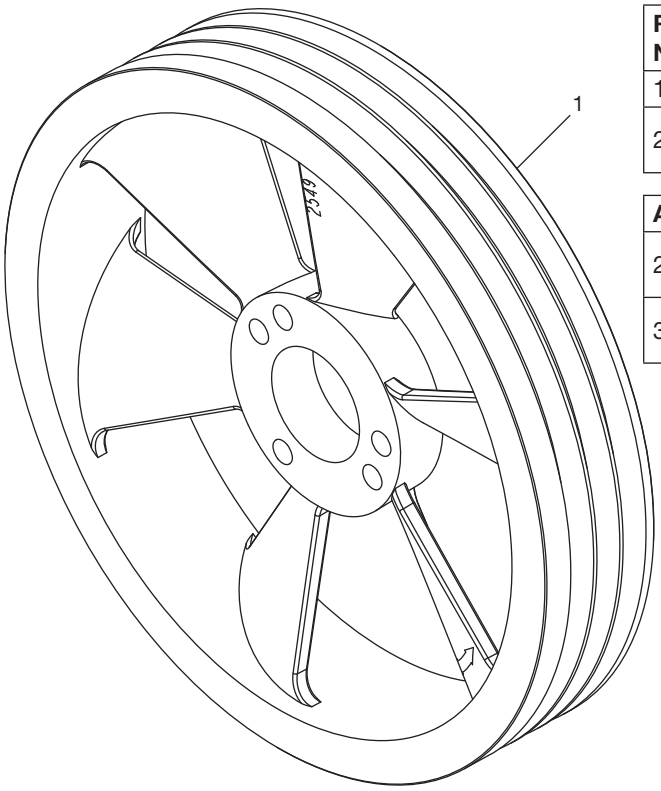
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

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

Appendix E—Parts Details for 491 and F491 Flywheel Assembly



Back Side



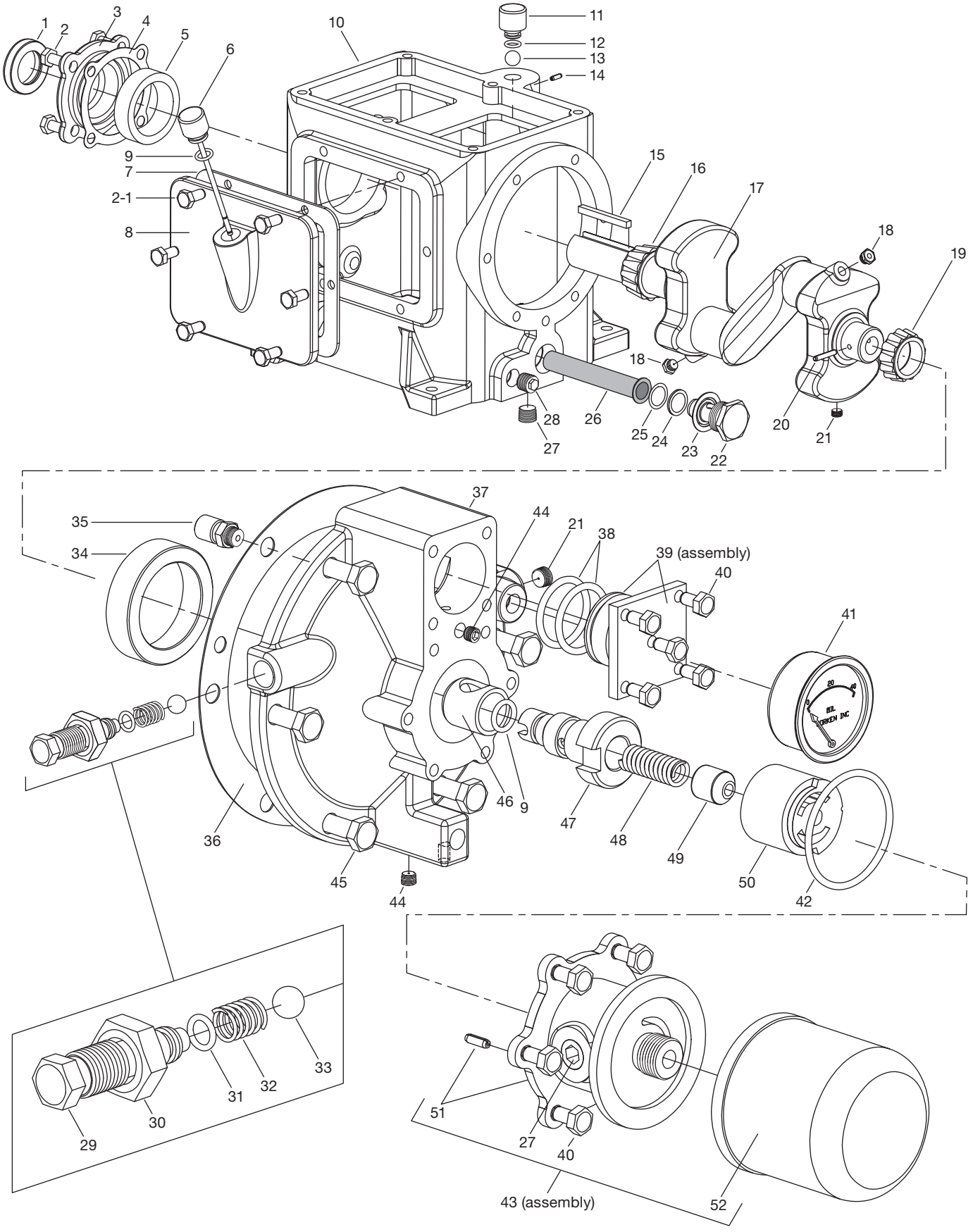
Front Side

Flywheel—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	2549	Flywheel (16" O.D., 3 groove)	1
2.	H SF-1.375	Hub with three bolts and lockwashers	1

Assembly Number	Assembly Name
2549-X	Flywheel assembly (flywheel, hub, and three bolts)—standard
3271-X1	Flywheel assembly for extended crankshaft—optional

Appendix E—Parts Details for 491 and F491 Crankcase Assembly



Appendix E—Parts Details for 491 and F491 Crankcase Assembly

Packing Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	4438	Oil seal	1
2.	7001-037NC075A	Bolt (hex head, 3/8"-16 x 3/4")	4
2-1.	7001-031NC075A	Bolt (hex head, 5/16"-18 x 3/4")	6
3.	2847-1	Bearing cover	1
4.	1504	Bearing adjustment shim (0.005")	As needed
	1504-1	Bearing adjustment shim (0.007")	As needed
	1504-2	Bearing adjustment shim (0.020")	As needed
5.	1502	Bearing cup	1
6.	1508-X	Oil bayonet	1
7.	1511	Crankcase inspection plate gasket	1
8.	2853	Crankcase inspection plate	1
9.	2-112A	O-ring (Buna-N, oil bayonet and pump shaft)	2
10.	2803	Crankcase	1
11.	1279	Breather cap	1
12.	2-111A	O-ring (Buna-N, breather cap)	1
13.	2796	Breather ball	1
14.	1450	Lock pin	1
15.	1663	Flywheel key	1
16.	1503	Bearing cone	1
17.	1499-X	Crankshaft assembly with 1284 (2), 1286, 1499, 1501, 1503, 2590	1
18.	1284	Crankcase orifice (2)	2
19.	1501	Bearing cone	1
20.	1286	Pump shaft drive pin	1
21.	2590	Pipe plug	2
22.	1280	Filter screw	1
23.	1281	Filter screen screw gasket	1
24.	2-116A	O-ring (Buna-N, filter screen)	1
25.	1276	Filter screen washer	1
26.	1275	Oil filter screen	1
27.	3289	Pipe plug	2
28.	1661	Plug (3/8" NPT)	1
29.	1290	Relief valve adjusting screw	1
30.	1291	Adjusting screw locknut	1
31.	2-011A	O-ring (Buna-N, relief valve adjusting screw)	1
32.	1292	Relief valve spring	1
33.	1293	Relief valve ball	1

Ref No.	Part No.	Description	Qty.
34.	1500	Bearing cup	1
35.	2961-X	Air release valve assembly with 2961, 2962, 2963	1
36.	1513	Bearing carrier gasket	1
37.	2804	Bearing carrier	1
38.	2-218A	O-ring (Buna-N, closure body, 2)	2
39	1515-X	Closure cap assembly	1
40.	7001-025NC050A	Bolt (hex head, 1/4"-20 x 1/2")	11
41.	1302	Oil pressure gauge	1
42.	2-228A	O-ring (Buna-N, pump cover)	1
43.	4222-X	Oil filter assembly (external)	1
44.	1629	Pipe plug (1/16" NPT, flush seal)	2
45.	7001-037NC100A	Bolt (hex head, 3/8"-16 x 1")	6
46.	2805-X	Pump shaft bushing	1
47.	2850	Pump shaft adapter	1
48.	2852	Oil pump spring	1
49.	2851	Spring guide	1
50.	2849-X	Oil pump assembly (individual pump parts not available)	1
51.	2798	Pump cover pin with 4222	1
52.	4225	Oil filter	1

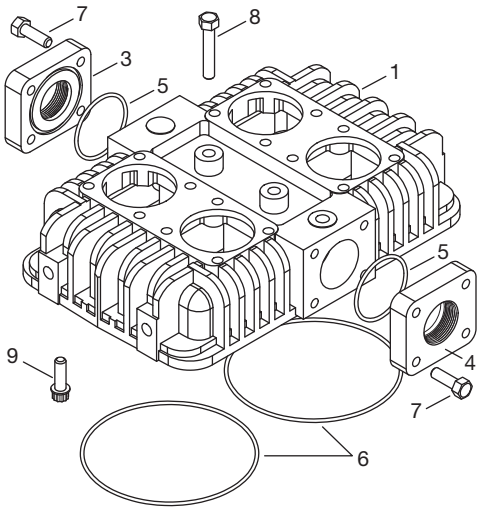
Assembly Number	Assembly Name
1279-X	Breather cap assembly with 1279, 2-111A
1499-SX[a]	Extended crankshaft assembly with 1284 (2), 1286, 1499-S, 1501, 1503, 2590
1508-X1	Oil bayonet assembly with 1508-X, 2-112A
2804-X	Bearing carrier assembly with 1290, 1291, 1292, 1293, 1500, 1513, 1515-X, 1629 (2), 2590, 2804, 2849-X, 2850, 2851, 2852, 2961-X, 2-011A, 2-112A, 2-228A, 4222-X
2847-1X	Bearing cover assembly with 2847-1, 4438

[a] *Optional equipment.*

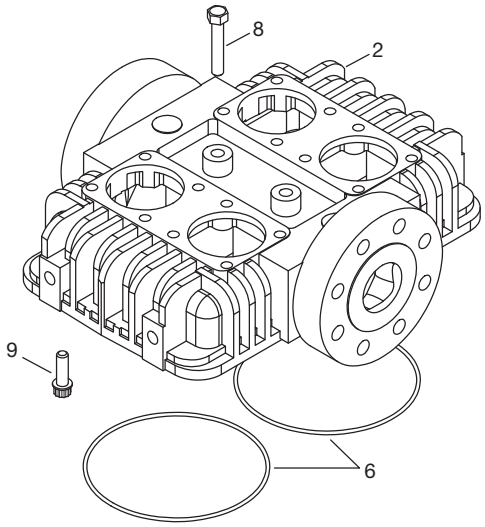
WARNING *CAUTION: Always relieve pressure in the unit before attempting any repairs.*

Appendix E—Parts Details for 691 and F691 Head and Valve Assembly

691 Head Assembly



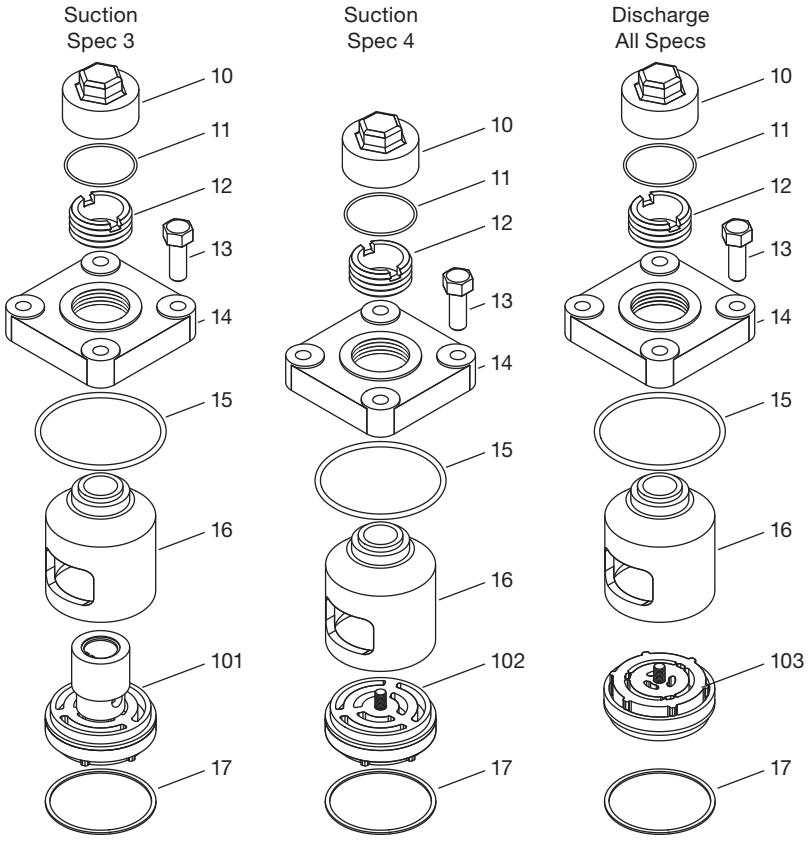
F691 Head Assembly



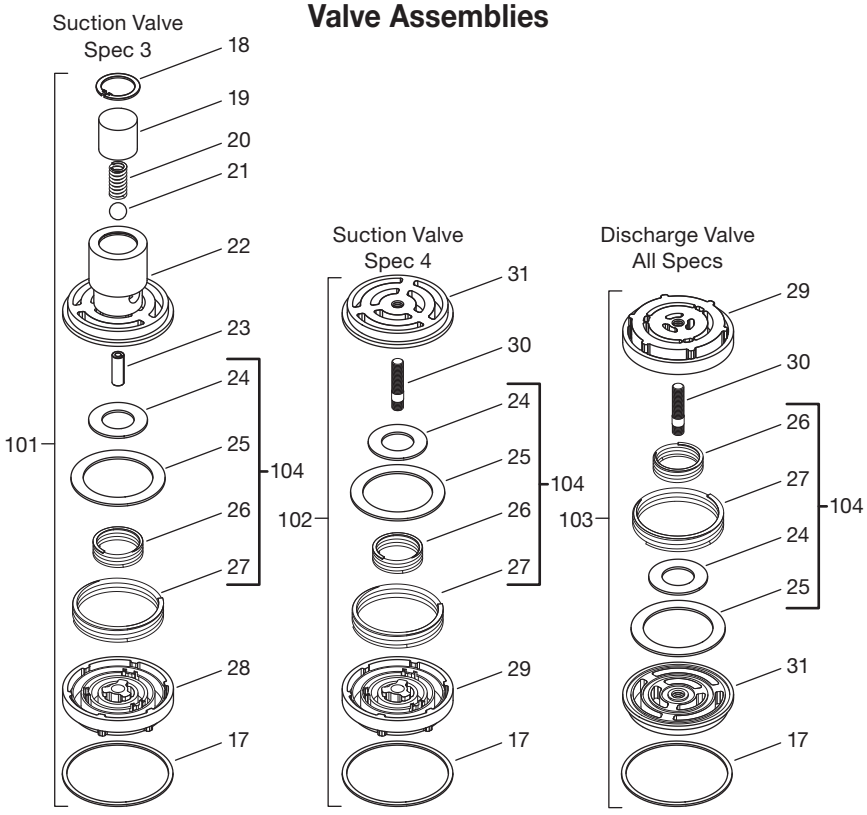
CAUTION: Always relieve pressure in the unit before attempting any repairs.

WARNING

Valve Holddown Assemblies



Valve Assemblies



Appendix E—Parts Details for 691 and F691 Head and Valve Assembly

Head and Valve Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3458 [a]	Head (model 691)	1
2.	4299	Head (model F691, Class 300 RF flange)	1
3.	2144-2	Flange (2" NPT, suction)	1
4.	2144-1.5	Flange (1-1/2" NPT, discharge)	1
5.	2-231_ [b]	O-ring	2
6.	2-261_ [b]	O-ring (model 691 head)	2
7.	7001-043NC150A	Bolt (hex head, 7/16"-14 x 1-1/2")	8
8.	2136	Center head bolt	2
9.	7005-050NC150A	Bolt (ferry head, 1/2"-13 x 1-1/2")	12
10.	2714	Valve cap	4
	2714-1	Valve cap (grooved for O-ring)	4
11.	2-031_ [b]	O-ring (valve cap)	4
12.	2715	Holddown screw	4
13.	7001-043NC137A	Bolt (hex head, 7/16"-14 x 1-3/8")	16
14.	1764	Valve cover plate	4
15.	2-235_ [b]	O-ring (cover plate)	4
16.	2797	Valve cage	4
17.	2114	Valve gasket (aluminum)	4
18.	5000-77	Retainer ring	2
19.	3977	Suction valve relief housing (spec 3)	2
20.	1411	Spring	2
21.	1410	Relief ball	2
22.	3948	Valve seat (spec 3)	2
23.	2534-1	Suction valve post (spec 3)	2
24.	4230	Inner valve plate	2
25.	4229	Outer valve plate	2
26.	3929	Inner valve spring	2
27.	3928	Outer valve spring	2
28.	3949-1	Valve bumper (spec 3)	2
29.	3857-1	Valve bumper (spec 3)	4
		Valve bumper (spec 4)	6
30.	3920	Valve stud	4
31.	3856	Valve seat	2

Ref No.	Valve Assembly No.	Assembly Name
101.	3948-2X	Suction valve assembly—spec 3
102.	3856-2X	Suction valve assembly—spec 4
103.	3857-2X	Discharge valve assembly—all specs
104.	3146-X2	Valve repair kit—all specs (suction and discharge)

Head Assembly No.	Model	Valve Specification
3458-X	691	3

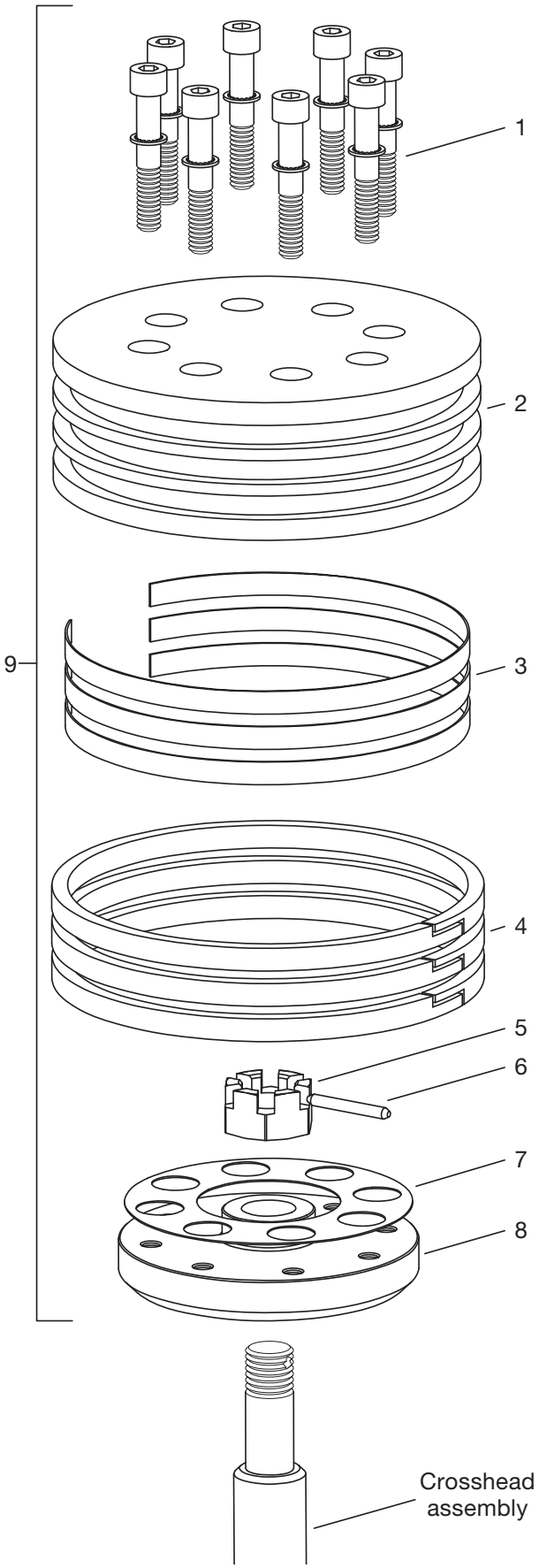
[a] S/N NQ51455 and later. Earlier models use gasket #2177.

[b] _ denotes material code. See material code chart for details.

[c] Registered trademark of the DuPont company.

Material Code	
A	Buna-N
B	Neoprene®[c]

Appendix E—Parts Details for 691 and F691 Piston Assembly



Piston—Bill of Materials
Piston Diameter 4.5" (11.43 cm)

Ref No.	Part No.	Description	Qty.
1.	7002-025TP125A	Screw (socket head)	16
	7207-025A	Lock washer	16
2.	1987	Head, iron	2
3.	1740	Ring expander	6
4.	1739	Piston ring	6
5.	1482	Locknut	2
6.	1483	Lock pin	2
7.	1735	Shim washer (thick)	As Req.
	1735-1	Shim washer (thin)	
8.	1986	Piston platform	2

Ref No.	Assembly Number	Assembly Name	Qty.
9.	1987-X1	Piston assembly	2

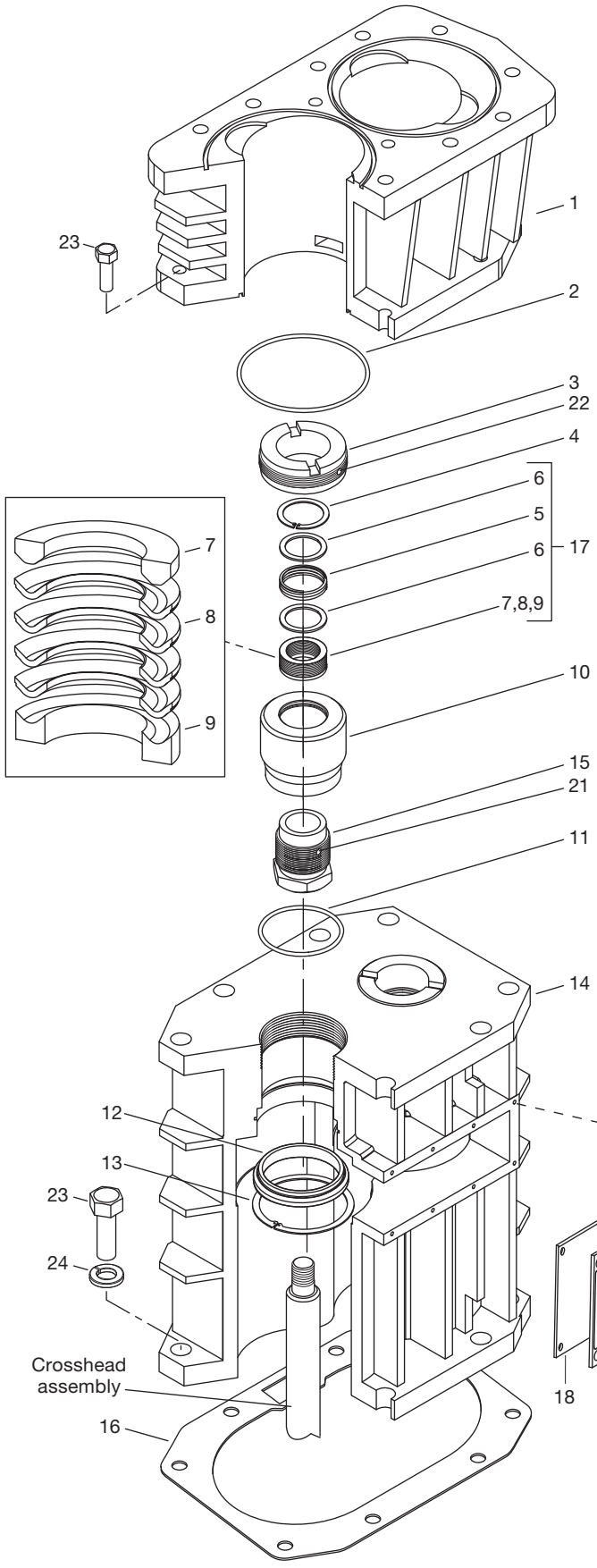
Piston Clearance (Cold)[a]

Model	Minimum	Maximum
691	0.025" (0.64 mm)	0.040" (1.02 mm)

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

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

Appendix E—Parts Details for 691 and F691 Packing Assembly



Packing—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3457	Cylinder (model 691)	1
2.	2-247_ [a]	O-ring (cylinder)	2
3.	1749-X	Cartridge holddown screw	2
4.	5000-175	Retainer ring	2
5.	1731	Packing spring	2
6.	1728	Packing washer	2
7.	1724	Male packing ring	2
8.	1725-2	Packing ring	8
9.	1723	Female packing ring	2
10.	2407	Packing box cartridge	2
11.	2-233_ [a]	O-ring (packing cartridge)	2
12.	1748	Cartridge plate	2
13.	5000-350	Retainer ring	2
14.	2405	Crosshead guide	1
15.	1722-X	Adjusting screw	2
16.	1761	Crankcase gasket	1
17.	1725-2X	Packing set	2
18.	1760	Inspection plate gasket	1
19.	1721	Inspection plate	1
20.	7003-025NC037E	Screw (1/4"-20 x 3/8")	10
21.	1192	Locking device (for adjusting screw, not shown)	2
22.	2893	Locking device cartridge holddown screw (not shown)	2
23.	7005-050NC175A	Bolt	16
24.	7206-050A	Lock washer	16

Assembly Number	Assembly Name
2405-X	Crosshead guide assembly with 1748 (2), 2405, 5000-350 (2)
3544-X4	Crosshead assembly “M” style

[a] _ *denotes material code. See material code chart for details.*

[c] *The quantity of 1454 packing rings required will vary due to tolerances. Use Cone 4005 for packing installation.*

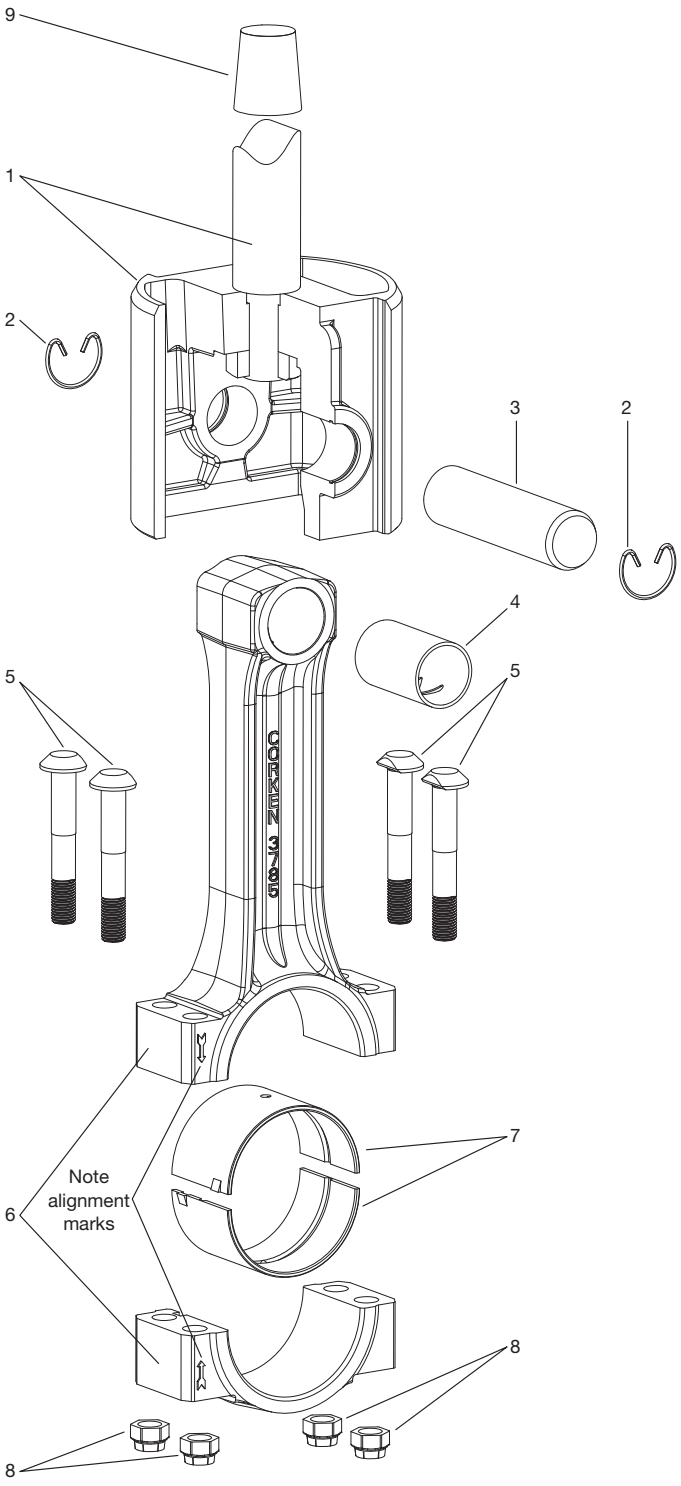
[d] *S/N XC30633 and later.*

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

Material Code	
A	Buna-N
B	Neoprene®[d]

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

Appendix E—Parts Details for 691 and F691 Connecting Rod Assembly



Connecting Rod—Bill of Materials

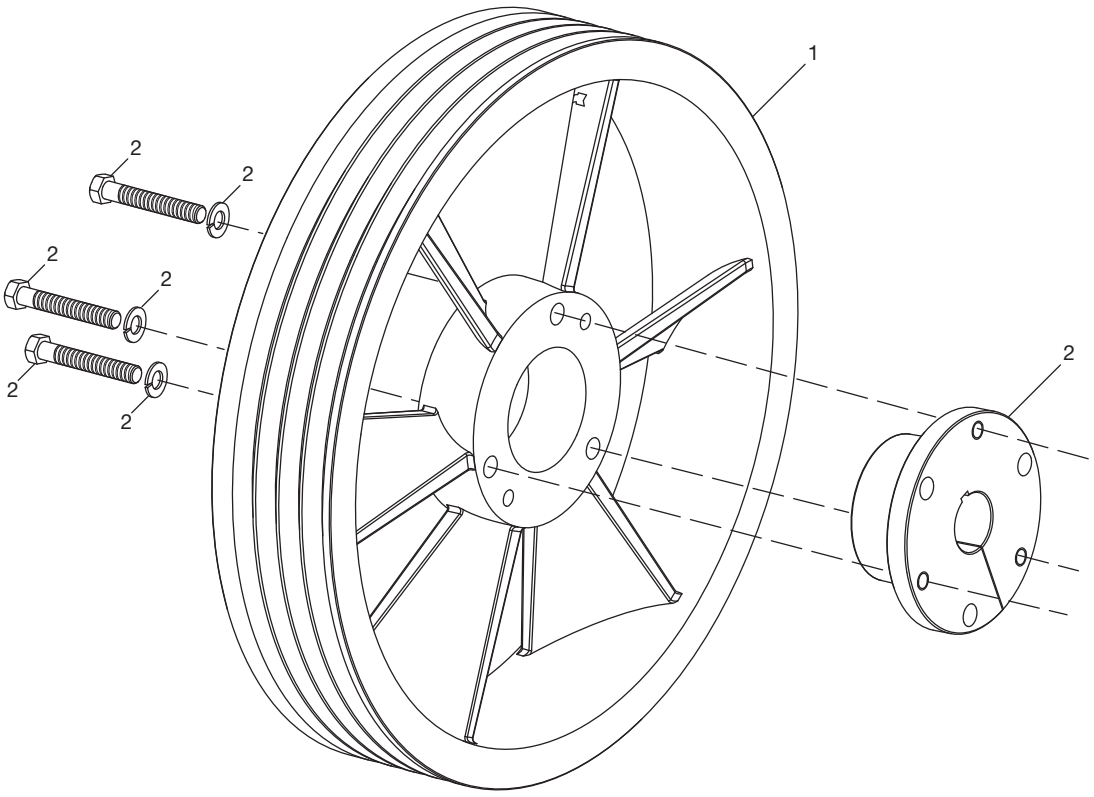
Ref No.	Part No. Spec M Only	Description	Qty. per Compressor
1.	3544-X4	Crosshead assembly	2
2.	3590	Retainer ring	4
3.	3540	Wrist pin	2
4.	3541-X [a, c]	Wrist pin bushing	2
5.	1726 [a]	Bolt	8
6.	3785-X1	Connecting rod assembly	2
7.	3542 [a]	Connecting rod bearing (pair)	2
8.	1727 [a, b]	Nut	8
9.	4692	Packing installation cone	1

[a] *Included with connecting rod assembly*
[b] *Torque connecting rod nut to 40 ft. lbs.*
[c] *After the wrist pin bushing has been pressed into the connecting rod, it must be honed to 1.1263/1.1259 (Spec M ONLY). A hydraulic press and honing machine are recommended for this step.*

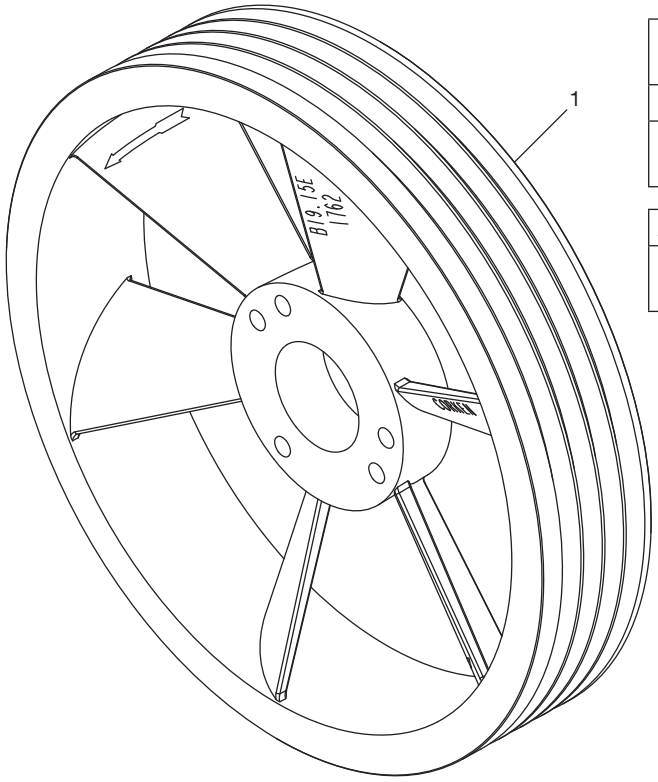
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

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

Appendix E—Parts Details for 691 and F691 Flywheel Assembly



Back Side



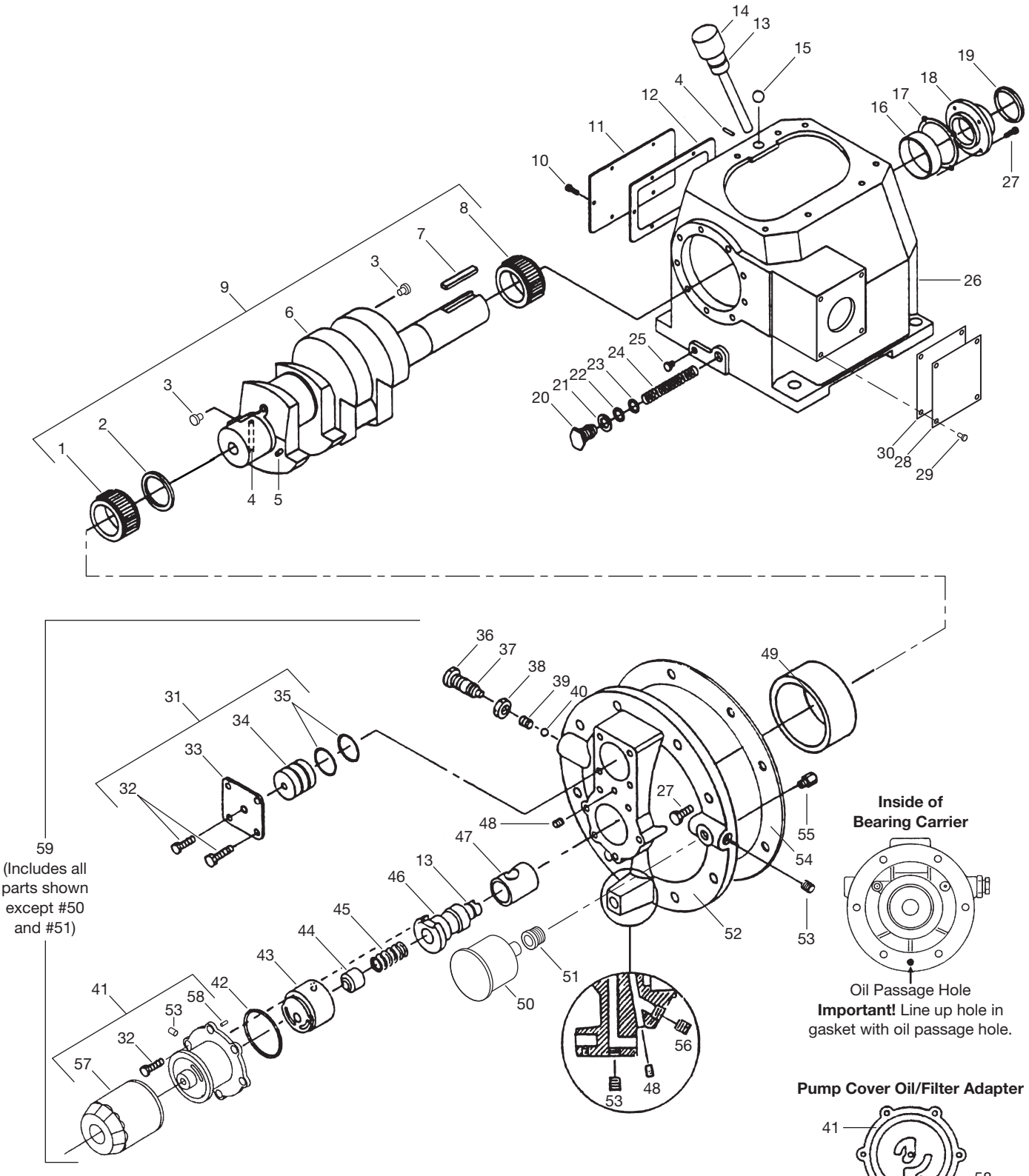
Front Side

Flywheel—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	1762	Flywheel (19.5" O.D., 4 groove)	1
2.	H E-2.125	Hub with three bolts and lockwashers	1

Assembly Number	Assembly Name
1762-X	Flywheel assembly (flywheel, hub, and three bolts)—standard

Appendix E—Parts Details for 691 and F691 Crankcase Assembly



Appendix E—Parts Details for 691 and F691 Crankcase Assembly

Packing—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	1737	Bearing cone	1
2.	3638-1	Spacer	1
3.	1284	Crankshaft orifice	2
4.	2197	Drive pin	1
5.	2933	Link pin	1
6.	3786	Crankshaft	1
7.	3503	Flywheel key	1
8.	3580	Bearing cone	1
9.	3786-X1	Crankshaft assembly	1
10.	7001-031NC075A	Bolt (hex head, 5/16"–18 x 3/4")	6
11.	2122	Inspection cover	1
12.	2123	Gasket (inspection cover)	1
13.	2-112A	O-ring, Buna-N	2
14.	3225-X1	Oil bayonet assembly (with O-ring)	1
15.	2126	Breather ball	1
16.	3579	Bearing cup	1
17.	3589	Bearing adjustment shim (.005")	As needed
	3589-1	Bearing adjustment shim (.007")	As needed
	3589-2	Bearing adjustment shim (.020")	As needed
18.	3539	Bearing cover	1
19.	3526	Oil seal	1
20.	1280	Filter screw	1
21.	1281	Gasket (filter)	1
22.	2-116A	O-ring (Buna-N)	1
23.	1276	Washer	1
24.	1275	Oil filter screen	1
25.	3443	Pipe plug (1/2" NPT, steel)	1
26.	3221	Crankcase	1
27.	7001-037NC100A	Bolt (hex head, 3/8"–16 x 1", grade 5)	12
28.	3875	Access cover	1
29.	7003-025NC037E	Screw (1/4"–20 x 3/8")	4
30.	3874	Gasket, access cover	1
31.	1515-X	Closure cap assembly	1
32.	7001-025NC050A	Bolt (hex head, 1/4"–20 x 1/2")	11
33.	1515	Closure cap	1
34.	1516	Closure body	1
35.	2-218A	O-ring (Buna-N)	2
36.	1290	Relief valve adjusting screw	1
37.	2-011A	O-ring (Buna-N)	1
38.	1291	Adjusting screw locknut	1
39.	1292	Relief valve spring	1

Ref No.	Part No.	Description	Qty.
40.	1293	Relief valve ball	1
41.	4222-X[a]	Oil filter adapter assembly (with pin)	1
42.	2-228A	O-ring (Buna-N)	1
43.	2849-1X[a]	Oil pump assembly	1
44.	2851	Spring guide	1
45.	2852	Oil pump spring	1
46.	3219	Pump shaft adapter	1
47.	2805-X[b]	Pump shaft bushing	1
48.	1629	Pipe plug (1/16" NPT, flush seal)	1
49.	1736	Bearing cup	1
50.	1302	Oil pressure gauge	1
51.	1044	Bushing (1/8" x 1/4" NPT)	1
52.	3220-2	Bearing carrier	1
53.	3289	Pipe plug (1/4" NPT, flush seal)	4
54.	2131	Bearing carrier gasket	1
55.	2961-X	Air release valve assembly	1
56.	2590	Pipe plug (1/8" NPT, flush seal)	1
57.	4225	Filter	1
58.	2798	Pump cover pin (included with 4222-X)	1
59.	3220-2X	Bearing carrier assembly M3 style	1

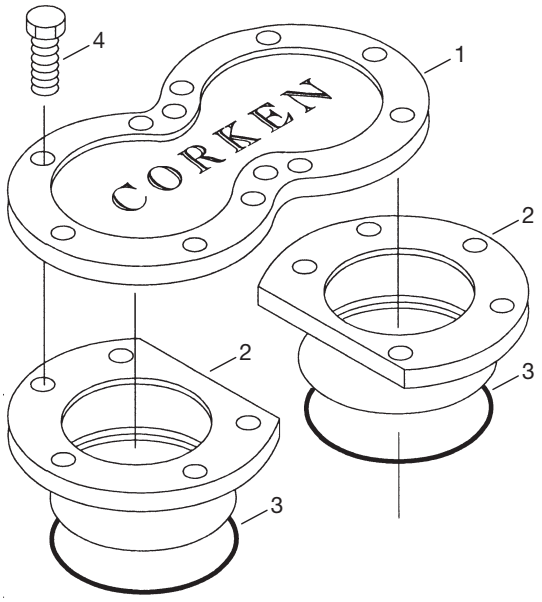
Assembly Number	Assembly Name
3221-X1	Crankcase assembly (M3, 4, 8, 9) without lubrication (not shown)

[a] *Caution: To avoid damage during assembly, refer to installation Instruction Manual IE400.*
[b] *Must be rebored and honed after replacing (0.876"/0.875" diameter).*

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

Appendix E—Parts Details for D891 and FD891 Head and Valve Assembly

891 Head

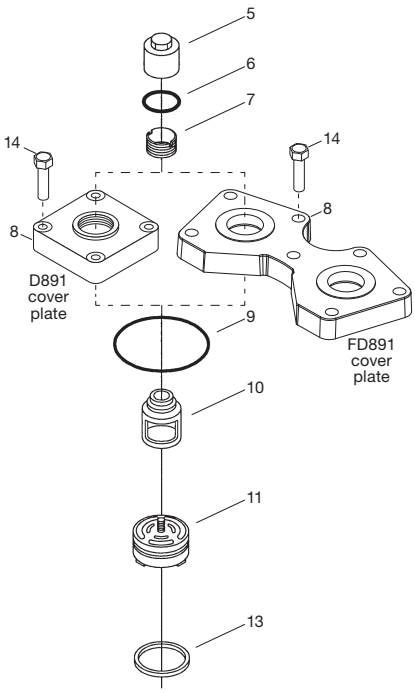


CAUTION: Always relieve pressure in the unit before attempting any repairs.

WARNING

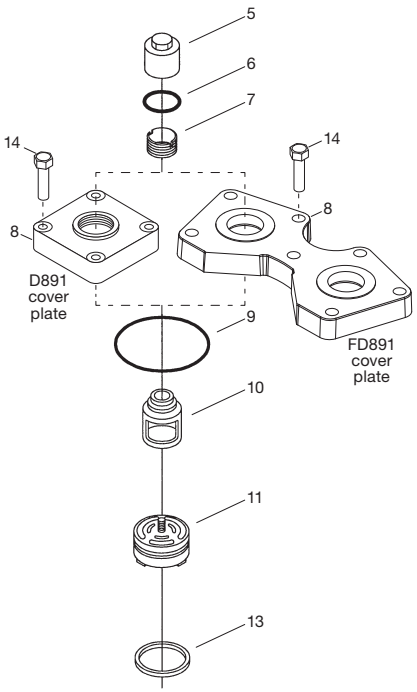
Valve Holddown Assembly (4-1/2")

Suction



Valve Holddown Assembly (4-1/2")

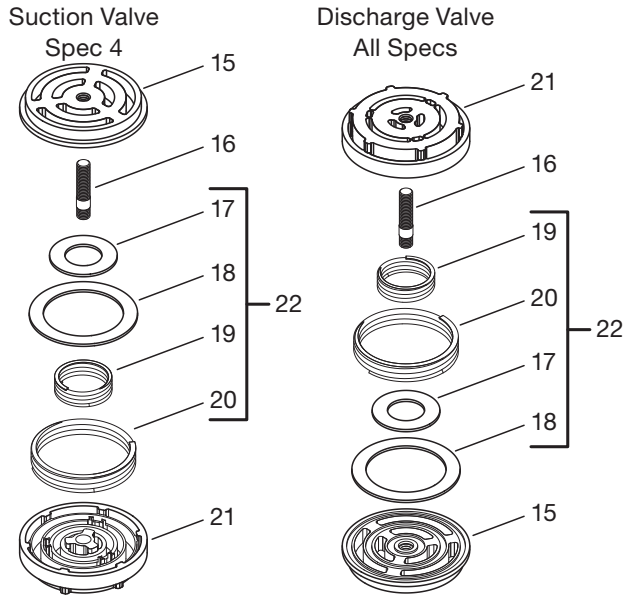
Discharge



Head and Valve Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3923	Cylinder cap	1
2.	3924	Cylinder head (4-1/2")	2
3.	2-246__ [a]	O-ring	2
4.	7001-050 NC175A	Bolt (hex head, 1/2"–13 x 1-3/4", grade 5, torque to 65 ft•lbs)	12
5.	2714-1	Valve cap	8
6.	2-031__ [a]	O-ring	8
7.	2715	Holddown screw	8
8.	1764	Valve cover plate (model D891)	8
	4854	Valve cover plate (model FD891)	4
9.	2-235__ [a]	O-ring	8
10.	3570-1	Valve cage	8
11.	3856-2X	Valve assembly (4-1/2", suction)	4
12.	3857-2X	Valve assembly (4-1/2", discharge)	4
13.	2114 [b]	Valve gasket	8
14.	7001-043 NC150A	Bolt (hex head, 7/16"–14 x 1-1/2", torque to 37 ft•lbs)—model FD891	28
		Bolt (hex head, 7/16"–14 x 1-1/2", torque to 37 ft•lbs)—model D891	32
15.	3856	Valve seat (4-1/2")	8
16.	3920	Stud	8
17.	4230 [c]	Valve plate (inner)	8
18.	4229 [c]	Valve plate (outer)	8
19.	3929 [c]	Inner spring	2
20.	3928 [c]	Outer spring	2
21.	3857-1	Valve bumper (4-1/2")	8
22.	3146-X2	Valve repair kit	1

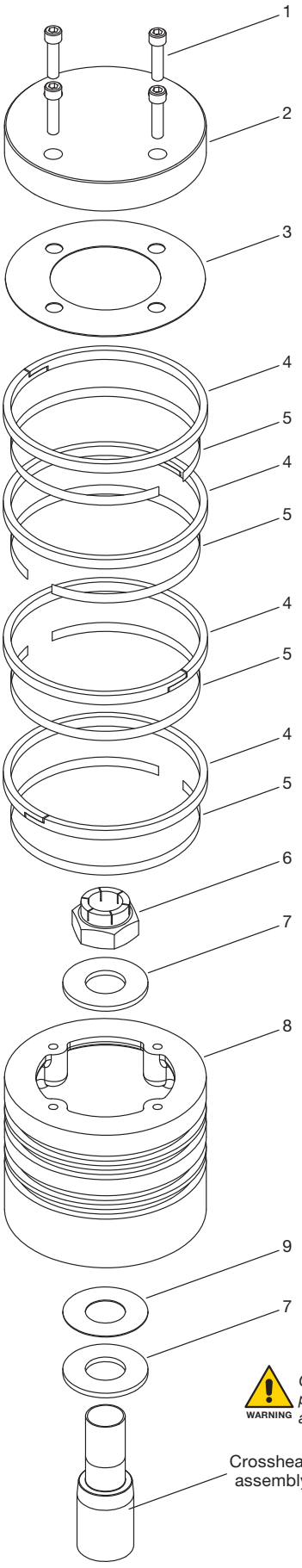
Valve Assemblies (4-1/2")



[a] *_ denotes material code. See material code chart for details.*
[b] *Included with valve assembly.*
[c] *Included with valve repair kit.*
[d] *Registered trademark of the DuPont company.*

Material Code	
A	Buna-N
B	Neoprene®[d]

Appendix E—Parts Details for D891 and FD891 Piston



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

Piston—Bill of Materials
Piston Diameter 4.5" (11.43 cm)

Ref No.	Part No.	Description	Qty.
1.	7002-025TP100A	Screw (orlo, gr. 8, torque to 8 ft•lbs)	4
2.	3927	Piston cap	1
3.	2902	Shim washer (thick)	As req.
	2902-1	Shim washer (thin)	
4.	1739	Piston rings	4
5.	1740	Expander ring	4
6.	3604	Lock nut (torque to 150 ft•lbs)	1
7.	3730	Thrust washer	2
8.	3925	Piston (4-1/2" diameter)	1
9.	3603	Shim washer (thick)	As req.
	3603-1	Shim washer (thin)	
10.	3812	Loctite tube (620, not shown)	1

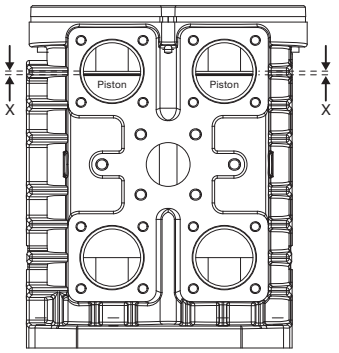
Ref No.	Assembly Number	Assembly Name
11.	3925-X1	Piston assembly

Piston Clearance (Cold)[a]

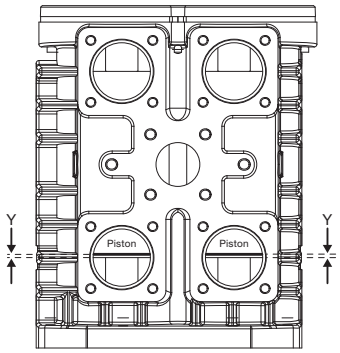
Model	Top (X) Minimum[a]	Top (X) Maximum[a]	Bottom (Y) Minimum[b]	Bottom (Y) Maximum[b]
D891	0.084" (2.13 mm)	0.104" (2.64 mm)	0.010" (0.25 mm)	0.020" (0.51 mm)

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

Model D891 Piston Clearance

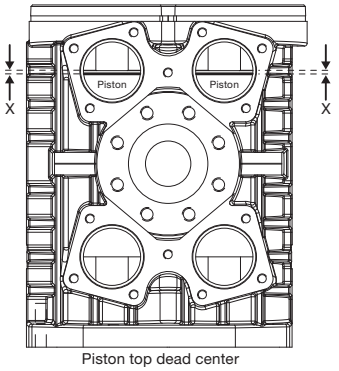


Piston top dead center

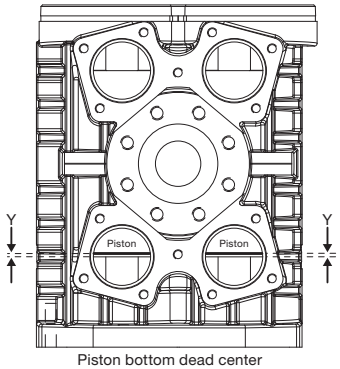


Piston bottom dead center

Model FD891 Piston Clearance



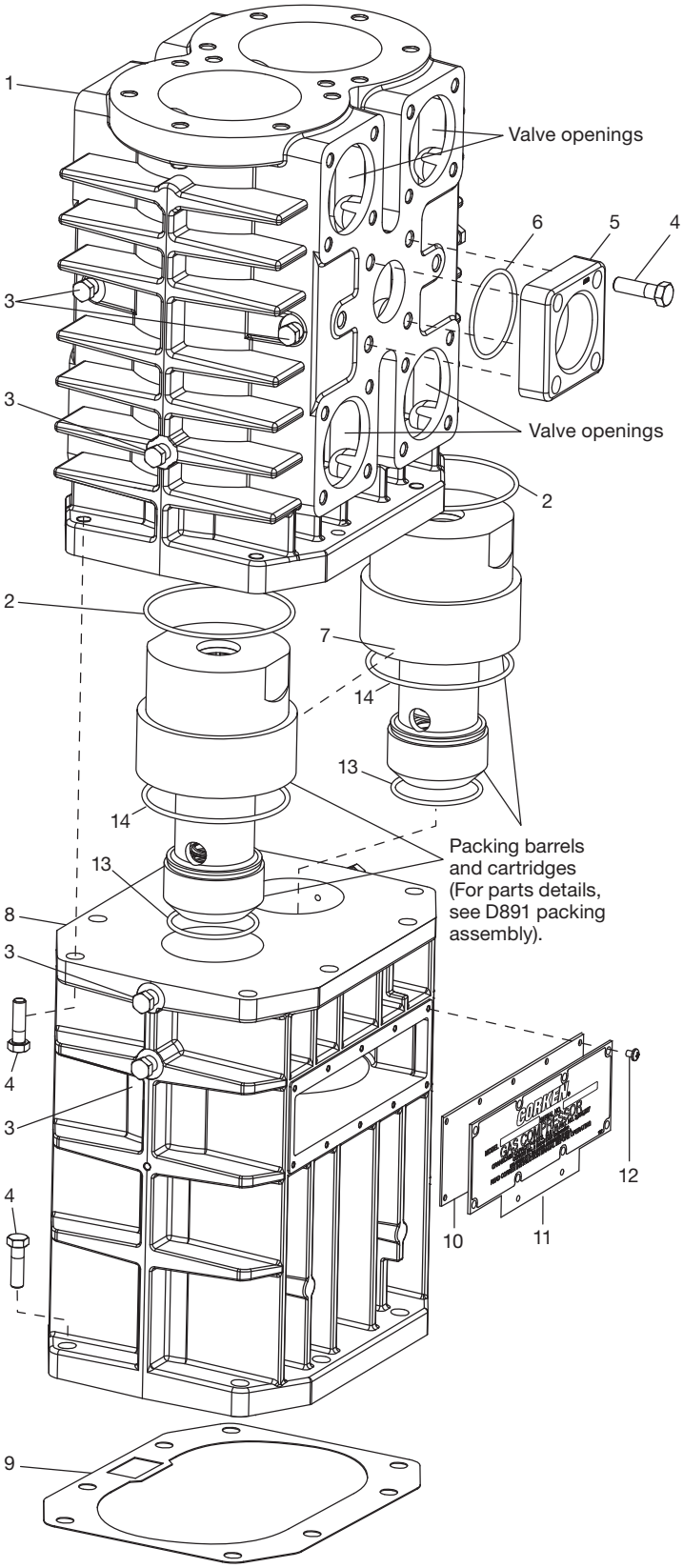
Piston top dead center



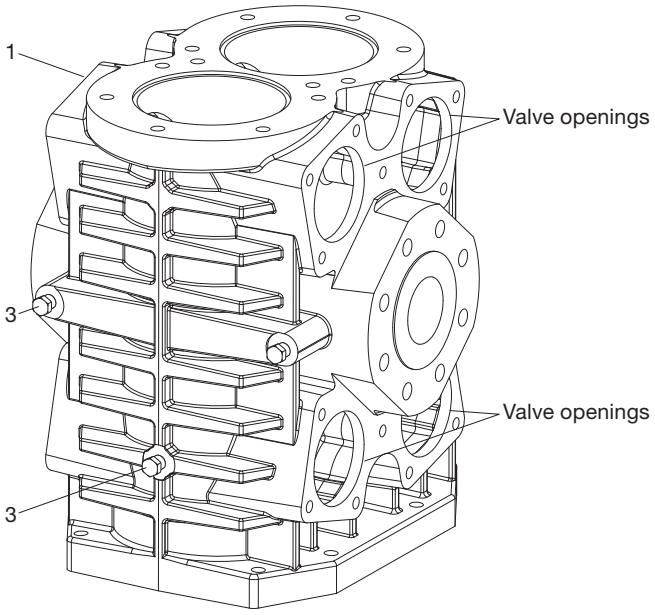
Piston bottom dead center

Appendix E—Parts Details for D891 and FD891 Crosshead Guide

D891 Cylinder



FD891 Cylinder



Crosshead Guide—Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	3922	Cylinder (model D891)	1
	4851	Cylinder (model FD891, Class 300 RF flange)	1
2.	2-246_[a]	O-ring for cylinder	2
3.	3442	Pipe plug (1/4" NPT)	3
4.	7001-050NC175A	Bolt (hex head, 1/2"—13 x 1-3/4", grade 5, model D891)	18
		Bolt (hex head, 1/2"–13 x 1-3/4", grade 5, model FD891)	14
5.	3793-2S	Flange (inlet / outlet, model D891 only)	2
6.	2-231_[a]	O-ring (flange, model D891 only)	2
7.	3253	Roll pin	1
8.	2405-1	Crosshead guide	1
9.	1761	Gasket (crankcase)	1
10.	1760	Gasket (inspection cover)	1
11.	1721	Inspection cover	1
12.	7012-010NC025B	Bolt (phillip head, 10"–24 x 1/4")	10
13.	2-231_[a]	O-ring	2
14.	2-238_[a]	O-ring	2

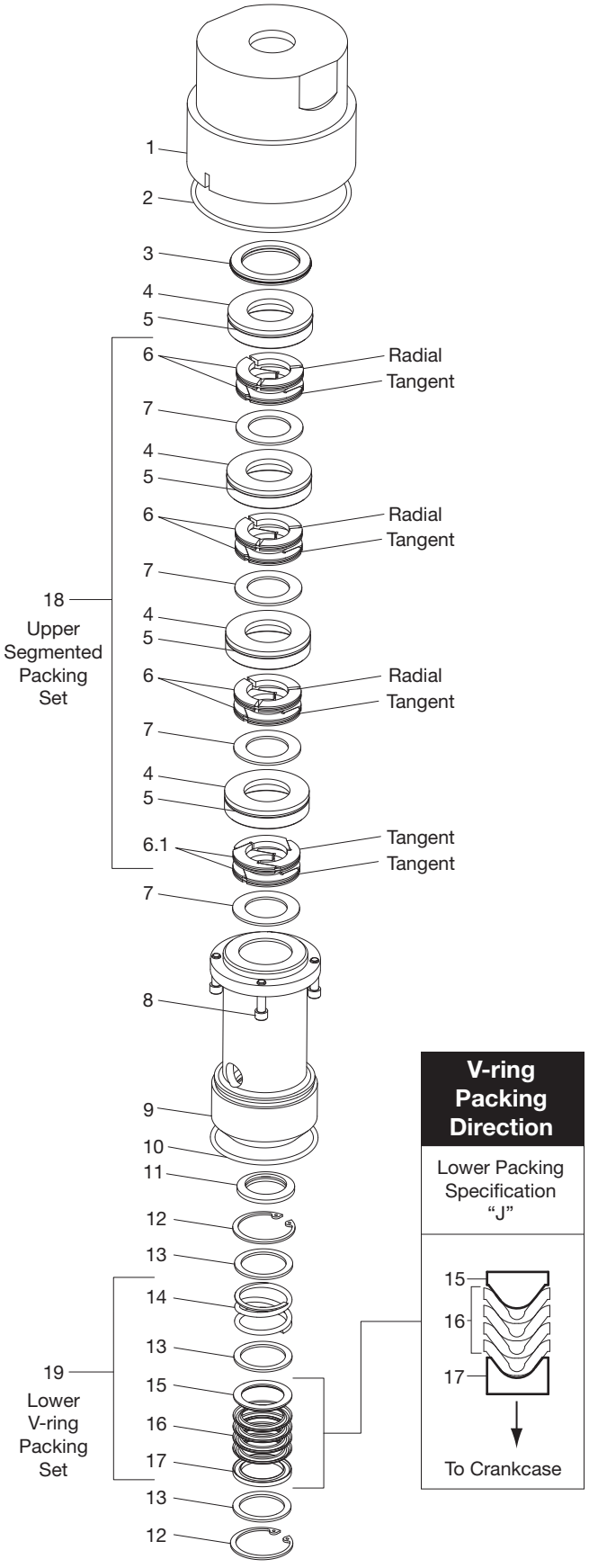
[a] *_ denotes material code. See material code chart for details.*
[b] *Registered trademark of the DuPont company.*

Material Code	
A	Buna-N
B	Neoprene®[b]

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

Appendix E—Parts Details for D891 and FD891 Packing

Specification "J"



Packing—Bill of Materials

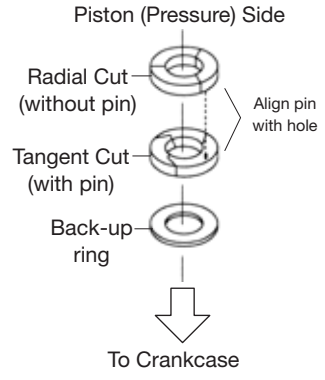
Ref No.	Part No.	Description	Qty.
1.	3926	Packing barrel (4-1/2")	2
2.	2-238_ [a, c]	O-ring	2
3.	3906	Crush gasket	2
4.	3817	Packing cup (Not included in 3810-X1 packing set)	8
5.	2-036_ [a, d]	O-ring (cup)	8
6.	3810	Segmented packing (radial—tangent) pair	6
6.1.	3814	Segmented packing (tangent—tangent) pair	2
7.	3811	Back-up ring	8
8.	7002-025TP100A	Screw (socket head, 1/4"–20 x 1")	8
9.	3885	Cartridge	2
10.	2-231_ [a]	O-ring	4
11.	1732 [b]	Oil deflector ring	2
12.	5000-175	Retainer ring	4
13.	1728	Washer	6
14.	1731	Spring	2
15.	1724	Packing ring (male)	2
16.	1725-2	V-ring packing	8
17.	1723	Packing ring (female)	2
18.	3810-X1 [e]	Packing set (segmented)	2
19.	1725-2X	Packing set (V-ring)	2

Identification of Packing Specification

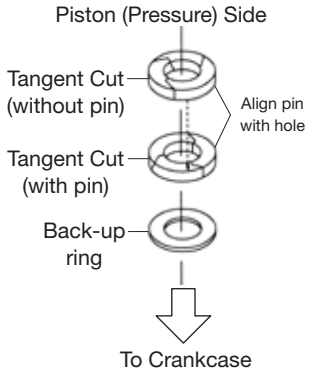
Example: Model Number FD891 [J] M4PFBANSNN

Packing Spec

Segmented Packing for Specification "J"



Segmented packing for Specification "J"



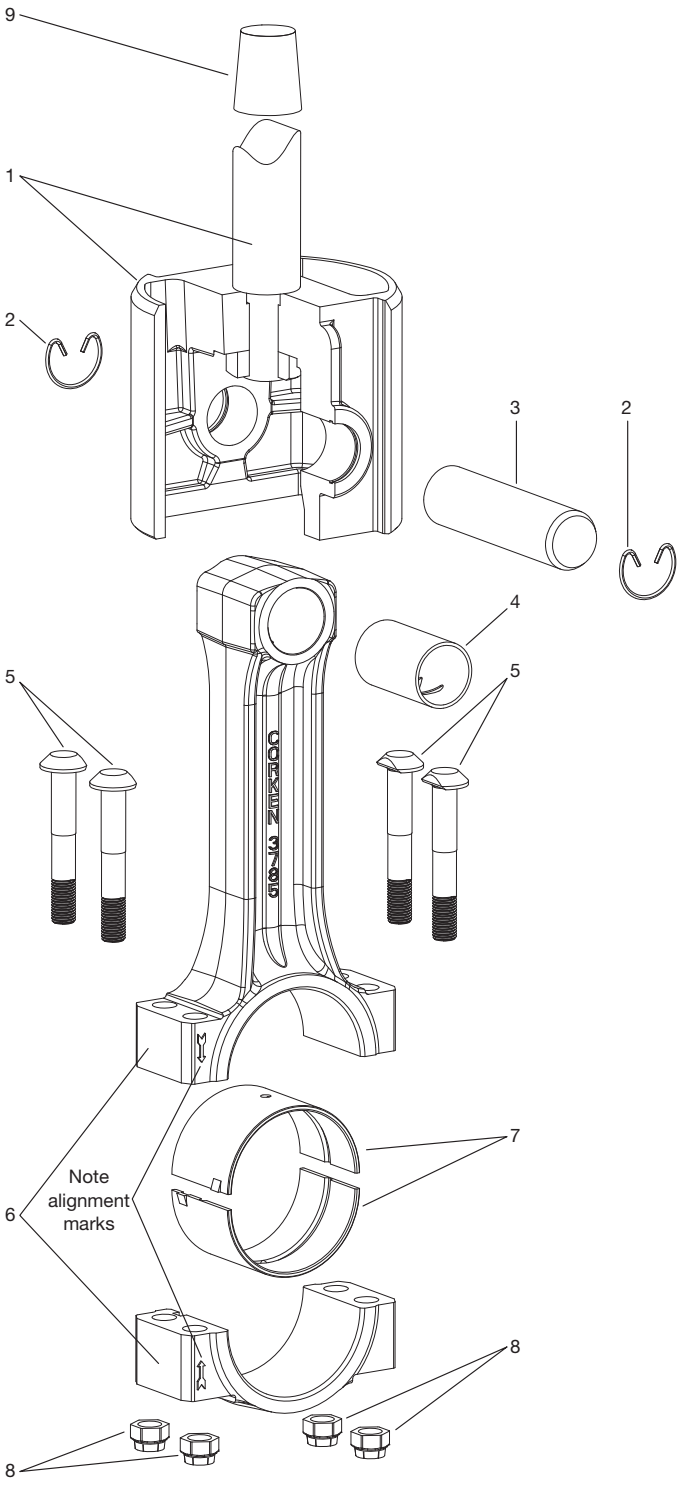
IMPORTANT: Identify and line up the rings before installing. Be sure they face the way shown here and that the pin and hole are aligned when assembled.

[a] *_ denotes material code. See material code chart for details.*
[b] *Deflector ring is loose within the packing cartridge until fitted on the piston rod. Must be put in from the bottom of the cartridge.*
[c] *Insert O-ring into the groove in the bottom of the barrel.*
[d] *Starting with S.N. NN51397.*
[e] *Packing cup O-ring not included in packing set.*
[f] *Registered trademark of the DuPont company.*

Material Code	
A	Buna-N
B	Neoprene®[f]

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

Appendix E—Parts Details for D891 and FD891 Connecting Rod Assembly



Connecting Rod—Bill of Materials

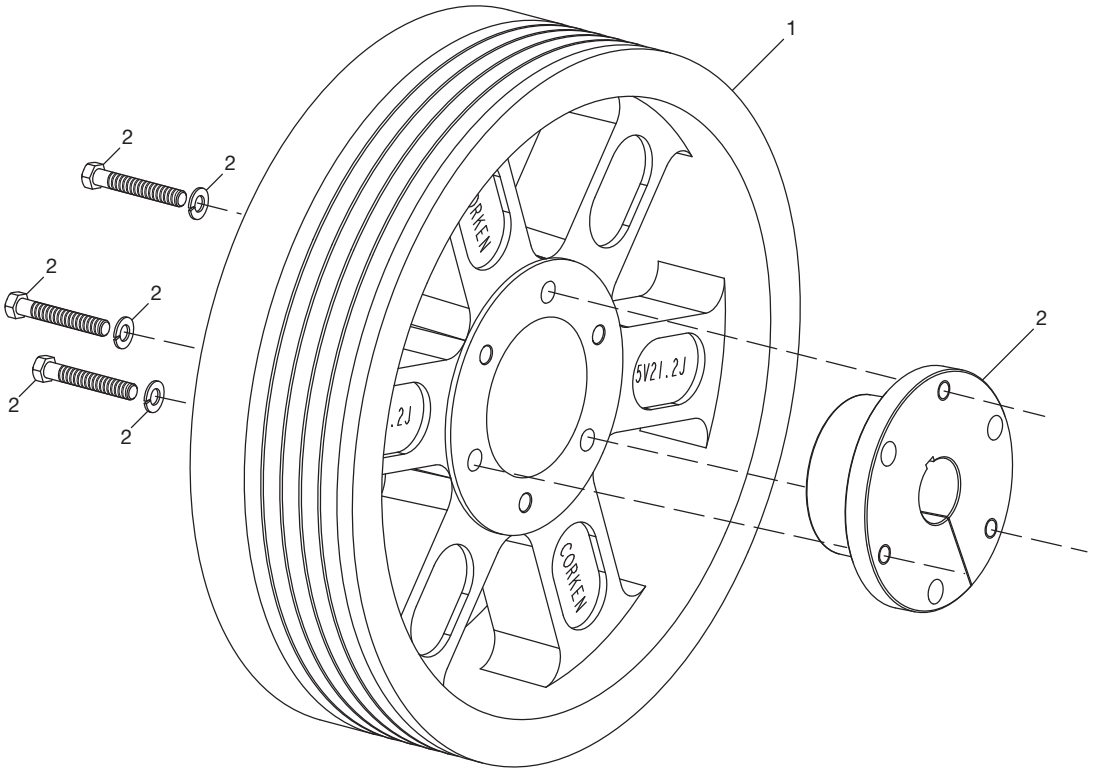
Ref No.	Part No.	Description	Qty. per Compressor
1.	3544-X3	Crosshead assembly	2
2.	3590	Retainer ring	4
3.	3540	Wrist pin	2
4.	3541-X [a, c]	Wrist pin bushing	2
5.	1726 [a]	Bolt	8
6.	3785-X1 [a]	Connecting rod assembly	2
7.	3542 [a]	Connecting rod bearing (pair)	2
8.	1727 [a, b]	Nut	8
9.	3905	Packing installation cone	1

[a] Included with connecting rod assembly
[b] Torque connecting rod nut to 40 ft. lbs.
[c] After the wrist pin bushing has been pressed into the connecting rod, it must be honed to 1.1263/1.1259. A hydraulic press and honing machine are recommended for this step.

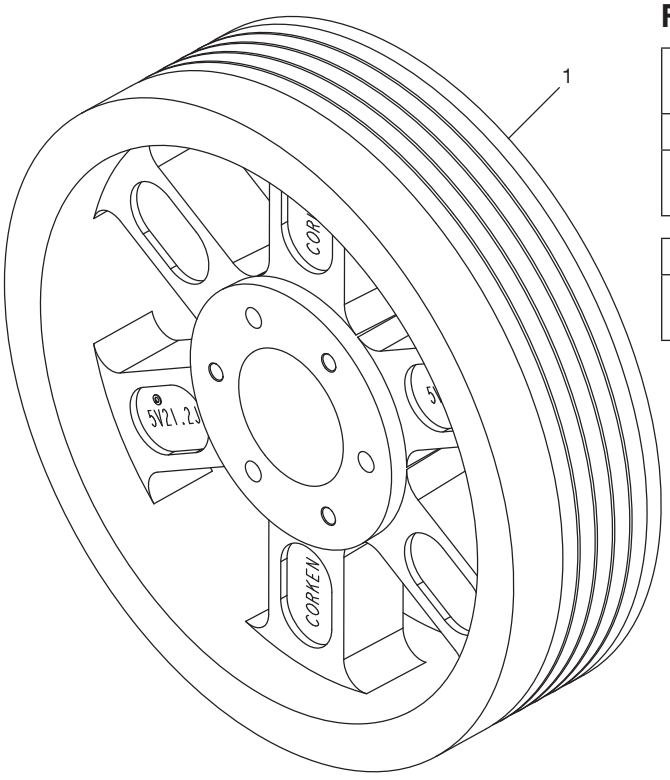
Never attempt to separate the piston rod and crosshead. When repair becomes necessary, the entire crosshead assembly must be replaced.

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

Appendix E—Parts Details for D891 and FD891 Flywheel Assembly



Back Side



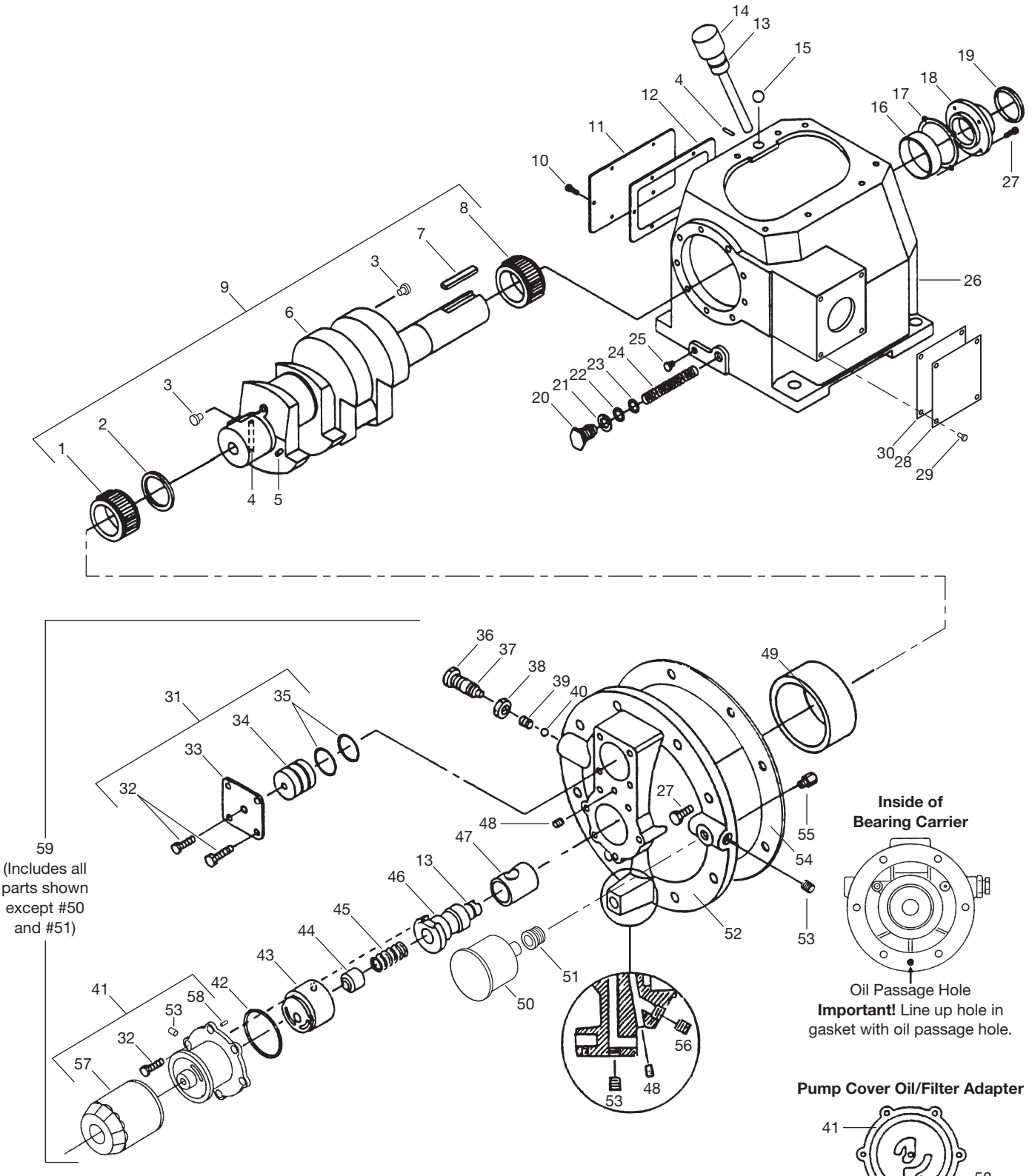
Front Side

Flywheel—Bill of Materials

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

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

Appendix E—Parts Details for D891 and FD891 Crankcase Assembly



Appendix E—Parts Details for D891 and FD891 Crankcase Assembly

Packing Assembly Bill of Materials

Ref No.	Part No.	Description	Qty.
1.	1737	Bearing cone	1
2.	3638-1	Spacer	1
3.	1284	Crankshaft orifice	2
4.	2197	Drive pin	1
5.	2933	Link pin	1
6.	3786	Crankshaft	1
7.	3503	Flywheel key	1
8.	3580	Bearing cone	1
9.	3786-X1	Crankshaft assembly	1
10.	7001-031NC075A	Bolt (hex head, 5/16"–18 x 3/4")	6
11.	2122	Inspection cover	1
12.	2123	Gasket (inspection cover)	1
13.	2-112A	O-ring (Buna-N)	2
14.	3225-X1	Oil bayonet assembly (with O-ring)	1
15.	2126	Breather ball	1
16.	3579	Bearing cup	1
17.	3589	Bearing adjustment shim (.005")	As needed
	3589-1	Bearing adjustment shim (.007")	As needed
	3589-2	Bearing adjustment shim (.020")	As needed
18.	3539	Bearing cover	1
19.	3526	Oil seal	1
20.	1280	Filter screw	1
21.	1281	Gasket (filter)	1
22.	2-116A	O-ring (Buna-N)	1
23.	1276	Washer	1
24.	1275	Oil filter screen	1
25.	3443	Pipe plug (1/2" NPT, steel)	1
26.	3221	Crankcase	1
27.	7001-037NC100A	Bolt (hex head, 3/8"–16 x 1", grade 5)	12
28.	3875	Access cover	1
29.	7003-025NC037E	Screw (1/4"–20 x 3/8")	4
30.	3874	Gasket (access cover)	1
31.	1515-X	Closure cap assembly	1
32.	7001-025NC050A	Bolt (hex head, 1/4"–20 x 1/2")	11
33.	1515	Closure cap	1
34.	1516	Closure body	1
35.	2-218A	O-ring (Buna-N)	2
36.	1290	Relief valve adjusting screw	1
37.	2-011A	O-ring (Buna-N)	1
38.	1291	Adjusting screw locknut	1
39.	1292	Relief valve spring	1
40.	1293	Relief valve ball	1
41.	4222-X[a]	Oil filter adapter assembly (with pin)	1
42.	2-228A	O-ring (Buna-N)	1
43.	2849-1X[a]	Oil pump assembly	1
44.	2851	Spring guide	1
45.	2852	Oil pump spring	1
46.	3219	Pump shaft adapter	1
47.	2805[b]	Pump shaft bushing	1
48.	1629	Pipe plug (1/16" NPT, flush seal)	1
49.	1736	Bearing cup	1
50.	1302	Oil pressure gauge	1
51.	1044	Bushing (1/8" x 1/4" NPT)	1
52.	3220-2	Bearing carrier	1
53.	3289	Pipe plug (1/4" NPT, flush seal)	4
54.	2131	Bearing carrier gasket	1
55.	2961-X	Air release valve assembly	1
56.	2590	Pipe plug (1/8" NPT, flush seal)	1
57.	4225	Filter	1
58.	2798	Pump cover pin (included with 4222-X)	1
59.	3220-2X	Bearing carrier assembly M3 style	1

Assembly Number	Assembly Name
3221-X1	Crankcase assembly (M3, 4, 8, 9) without lubrication (not shown)

[a] *Caution: To avoid damage during assembly, refer to installation Instruction Manual IE400.*
[b] *Must be rebored and honed after replacing (0.876"/0.875" diameter).*

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

Appendix F—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

Solutions beyond products...

CORKEN®

CORKEN, INC. • A Unit of IDEX Corporation

9201 North I-35 Service Road, Oklahoma City, OK. 73131

Phone (405) 946-5576 • Fax (405) 948-7343

Website: www.corken.com

E-mail: cocsalesdept@idexcorp.com

@CorkenInc LinkedIn YouTube

Printed in the U.S.A.
March 2020